Section 3 – Introduction to Fire Engineering

Clause G3.1 Introduction

The Building Authority recognizes that fire safety may be approached in a number of ways the best of which is not necessarily prescriptive, namely an alternative approach. This is particularly pertinent to buildings of special hazards which, because of their size, use, complexity or location, may necessitate special consideration and specific standards. The alternative approach may be a performance-based approach whereby the relevant Performance Requirement(s) need to be identified and demonstrated through a fire safety assessment.

Where an alternative approach is adopted to develop an Alternative Solution, the relationship between the Deemed-to-Comply provisions and the Performance Requirements must be considered. An FSAR should be submitted to illustrate the formulation of an Alternative Solution.

Commentary
The International Standards Organisation (ISO) defines fire safety engineering as:

"*The application of engineering principles, rules and expert judgement based on a scientific appreciation of the fire phenomena, of the effects of fire, and the reaction and behaviour of people, in order to:*

- *save life, protect property and preserve the environment and heritage;*
- *quantify the hazards and risk of fire and its effects;*
- *evaluate analytically the optimum protective and preventative measures necessary to limit, within prescribed levels, the consequences of fire*."

Clause G3.2 Relevant Considerations

The approach to develop and complete the FSAR will vary for each building, due to variation in the number and type of non-compliances with the Deemed-to-Comply provisions in this Code. The aspects that require a detailed assessment are:

(a) Number and inter-relationship (if any) of the non-compliances with the Deemed-to-Comply provisions in this Code.

(b) Alternative Solutions to be addressed.

(c) Relevant Performance Requirements.

(d) Building site and access.

(e) Building form and construction.

(f) Use Classification and interaction of occupants.

(g) Occupant capacity and means of escape.

(h) Fire hazards and ignition sources.

(i) Credible fire scenarios and sensitivity assessment.

(j) Fire safety provisions to be provided.

(k) Management measures.

(l) Fire service intervention.

Clause G3.3 Application

A performance-based approach using fire engineering can be adopted to formulate an Alternative Solution when there is genuine difficulty in complying with the Deemed-to-Comply provisions in this Code, especially for buildings of special hazards (due to their size, use, complexity or location).

Fire engineering aims to attain an overall level of safety that is equivalent to that which would result if fire safety was achieved through full compliance with the Deemed-to-Comply provisions in this Code and it can offer higher flexibility in design of buildings.

Commentary

Fire engineering allows detailed assessment of the fire safety provisions (taking into account the active, passive and management provisions) which will be most appropriate for the occupants, building and site characteristics and fire service intervention. The performance-based approach must take into account the potential for future changes or variations that may occur, with any significant variation in building form, fire load or occupancy characteristics that should be addressed by a new assessment as required by the Bounding Conditions (see Section 8).

However, despite advances in the science, fire safety is not a well-defined problem as certain areas of knowledge are still not yet well-developed and some variables depend on the assumed future state of a building. In fact, fire engineering is not as mature as other traditional engineering disciplines, with the absence of any simple approach that can be readily accepted and understood by the practitioners and related parties. Thus, there are constraints in the application of fire engineering.

Clause G3.4 Safety Margins and Safety Factors

There are various safety margins or safety factors that can be utilised for fire engineering. A safety margin can be used for a time-based assessment whereas a safety factor can be used for other comparative assessments or test verification methods. As an example, life safety fire engineering assessments are typically performed utilising a deterministic time based analysis and therefore the use of safety margins is more appropriate than safety factors.

Safety margins are adjustments made to compensate for uncertainty in the methods, calculations, assumptions and engineering judgement employed in the development of engineering designs. Safety margins do not necessarily need to be a number, for instance, in calculating the physical evacuation time for a group of people that has a mix of ambulant occupants and mobility impaired occupants, an inherent safety margin will have been included if the calculation assumes the majority of occupants are mobility impaired with a slower travel speed.

On the other hand, safety factors are adjustments made to numerical quantities of some uncertain parameters in order to provide an appropriate degree of reliability.

Safety Factors and Safety Margins for Use in Design

Safety factors or safety margins for fire engineering will vary, depending on the type of assessment and analysis being undertaken. Safety factors for normal scenarios as part of a fire engineering design will typically range from 1.5 to 2.0. Where the degree of reliability has been verified with the carrying out of an analysis with single system failure, the safety factor used can be suitably reduced or even be omitted.

Safety margins will be dependent on the worst credible fire or potentially a "worst credible fire" with single system failures to ensure the overall design is robust.

Commentary

Safety factors are commonly used, but need to be applied carefully, due to the number of inputs that a design is dependent on. Providing an overall safety factor of 1.5 may not be practical as the inputs will differ markedly in the make-up of the analysis – i.e. calculation of means of escape time is based on detection time, which can be calculated fairly accurately relative to other inputs. Pre-movement time will have a wide range of values compared to other inputs. Travelling time and queuing time can be calculated reasonably accurate.

Safety margins or safety factors should be determined according to the nature of the problems and the degree of knowledge available to solve such problems. They should be developed as part of the acceptance criteria for the fire engineering, to be confirmed on a case-by-case basis. The authorized person who is responsible for the fire engineering approach must be able to justify and explain the safety margins or safety factors utilised for their specific case.

Engineering Judgement

A performance-based approach to design may require more engineering judgement than other form of analysis, as part of the design and approval process. The level of judgement for fire engineering is higher than many other engineering disciplines because a fire engineering approach requires a fire safety strategy to be developed from first principles, which is the basis of performance-based design that requires consensus between the designers and the Building Authority on all assumptions, inputs, limitations and acceptance criteria, on a case-by-case basis.

Fire engineering is a newer field of engineering and greater judgement is needed. The assumptions of a fire engineering design should be more conservative and should normally have higher safety factors.

Commentary

To provide a structured approach to fire engineering analysis, the use of the fire safety sub-systems is recommended to be utilised for all Alternative Solutions (see Section 5).