

## Section 2 - Framework for Fire Engineering

### Clause G2.1 Performance Requirements and Level of Safety

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The Performance Requirements in Part A may apply differently to different buildings and different Use Classifications, e.g. the Performance Requirements related to means of escape are interpreted and applied differently for a shopping centre, a high-rise domestic building and a hospital. Although there is no explicit level of safety stated for the Performance Requirements in Part A, when adopting a performance-based approach, the Building Authority will normally accept a level of performance not inferior to that of the Deemed-to-Comply provisions. The Deemed-to-Comply provisions in Parts B to E provide a benchmark on the acceptable level of fire safety of buildings.

#### **Commentary**

It is not possible to design or obtain a goal of absolute safety for all building occupants, with respect to fire safety. There is always a finite risk of injury, death or property damage as a result of a fire. Due to the difficulty in predicting the outcomes of fire and its impact on life safety and property safety, all fire safety solutions, whether performance-based or those complying fully with the Deemed-to-Comply provisions will have a certain risk to life and property associated. Deemed-to-Comply provisions in this Code provide a benchmark with respect to the acceptable level of risk, with regard to the risk of fatality, injury and loss of adjacent structures through fire. It is not intended that this benchmark should be “absolute safety” or “zero risk” because these concepts are not achievable and the benchmark risk needs to take into account what the community expects and the cost to the community, which may only be determined by a cost benefit analysis.

In order to complete a performance-based assessment (Alternative Solution), acceptance criteria must be developed in order to analyse the outcome of the design. The relationship between the acceptance criteria and the relevant Performance Requirements may vary in different scenarios and must be considered on a case-by-case basis, which is part of the fire engineering approach process.

### Clause G2.2 Complying with the Framework for Fire Engineering

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This Part provides guidance on the application of fire engineering for the formulation of an Alternative Solution for fire safety provisions in buildings to comply with the fire safety objectives, Functional Statements and Performance Requirements in Part A.

For example, an Alternative Solution for the provisions of means of escape may be formulated as follows:

#### Step 1 Fire Safety Objectives

The fire safety provisions in a building should achieve the fire safety objectives and they should be provided for:

1. Protection of life of building occupants.
2. Minimization of fire spread between fire compartments.
3. Prevention of building collapse as a result of fire.
4. Facilitation of firefighting and rescue by fire services personnel.

## Step 2 Functional Statement

The Functional Statement clarifies the fire safety objectives. The Functional Statement for means of escape is provided in the Building (Planning) Regulation 41(1), stating *“Every building shall be provided with such means of escape in case of emergency as may be required by the intended use of the building.”*

## Step 3 Performance Requirements

The Performance Requirements provide the criteria by which a solution for fire safety can be formulated. The Performance Requirements consists of two parts:

- (a) The Performance Requirement itself; and
- (b) The guidance to the Performance Requirements which provides the factors to be considered for demonstrating compliance.

Performance Requirements B1 to B7 should be complied with.

## Step 4 Relevant Performance Requirements

Performance Requirements under various Functional Statements may need to be satisfied for an Alternative Solution. For example, an assessment of means of escape requires assessment of all Performance Requirements B1 to B7 but Performance Requirement C1 may also have to be evaluated as this relates to the protection of the means of escape from fire.

All relevant Performance Requirements should be assessed against the Deemed-to-Comply provisions for an Alternative Solution.

## Step 5 Guidance

The guidance lists a “checklist” that should be considered in conjunction with each of the Performance Requirement. For example, the assessment of means of escape for a high-rise domestic building (Use Classification 1), as part of an Alternative Solution, should be based on the assessment of Performance Requirements B1 to B7.

Taking Performance Requirement B1 as an example, which states that:

*“A building, fire compartment or storey should be provided with adequate means of escape for all occupants to evacuate safely without being overwhelmed by the effects of fire.”*

This indicates that the design must satisfy that the subject building has adequate number of required staircases and exits of adequate width, both of which have adequate protection allowing all occupants to evacuate in case of fire. The number and design of required staircases or exits and the protection required to achieve a safe evacuation can be further determined by an evaluation of the guidance in G2.3. For example, each Performance Requirement can be addressed in detail through the use of the guidance, which assists the design of appropriate fire safety provisions that satisfy the relevant Performance Requirement and hence, meet the Functional Statement and finally achieve compliance.

This process can be carried out for all relevant Performance Requirements, as part of an Alternative Solution and the process of evaluation should be supported through calculations and detailed assessment.

## Step 6 Demonstrate Compliance

Compliance with the Performance Requirements can be achieved by:

- (a) Complying with the Deemed-to-Comply provisions in this Code, or*
- (b) Formulating an Alternative Solution which complies with the Performance Requirements, or*
- (c) A combination of (a) and (b).*

Compliance has to be demonstrated by proving that all relevant Performance Requirements are satisfied. The Alternative Solution involves a process of setting the relevant acceptance criteria and then providing an assessment that demonstrates the acceptance criteria are met. The fire safety sub-systems in Section 5 provide the evaluation methodology for detailed assessment.

### **Commentary**

It is expected that most of the Alternative Solutions will be based on demonstrating a building is safe and complies with the Performance Requirements, the Functional Statements and the fire safety objectives through fire safety provisions.

The interpretation and application of Performance Requirements will vary for different buildings or Use Classifications.

Because of the uncertainties that can arise from the qualitative Performance Requirements and interpretations in the methods and data available to determine whether the acceptance criteria have been met, it is recommended that sensitivity assessment and design redundancies (with careful evaluation on relevant safety factor) are addressed as part of the fire engineering assessment to be evaluated by utilising the fire safety sub-systems (see Section 5).

## Clause G2.3 Evaluation Criteria on Guidance to Performance Requirements

The following criteria should be evaluated when considering the Guidance to Performance Requirements:

### Guidance to Performance Requirements for Means of Escape

	<i>Guidance Statement</i>	<i>Evaluation of Factors</i>
<b>B-a</b>	<b>Use Classification of the building</b>	The Use Classification of a building will have impact on the number of exits required, due to the number of occupants in the building. The Use Classification also determines whether the occupants of the building are potentially asleep, awake, familiar with the building or require assistance to evacuate.
<b>B-b</b>	<b>Occupant capacity, nature, location and awareness</b>	The total number of required staircases or exits is dependent on the number of occupants and the travel distances expected. Care should be taken for high occupancy buildings and where occupants maybe unfamiliar with the building.
<b>B-c</b>	<b>Fire hazard, its potential growth and duration</b>	The fire hazard within the Use Classification may impact adversely on evacuating occupants and will need to be considered with regard to the speed of fire growth, intensity and smoke spread.
<b>B-d</b>	<b>Building height</b>	Occupant evacuation may be more difficult for taller buildings and hence extra provisions such as refuge floors are provided.
<b>B-e</b>	<b>Building area and fire compartment area</b>	Required staircases and exits are dependent on the overall building size and the fire compartments that separate the building. Openings between fire compartments, especially floor voids can increase the risk of fire and smoke spread impacting on evacuation.
<b>B-f</b>	<b>Security measures impairing escape</b>	Doors to a required staircase may be electronically secured and security devices which can be released in case of fire or other methods to ensure exit and access must be considered.
<b>B-g</b>	<b>Fire safety provisions installed within the building</b>	The fire safety provisions within the building may assist the timely evacuation of occupants by providing earlier detection or allowing faster movement to a safe environment.
<b>B-h</b>	<b>Type, number, size, location and layout of exit routes</b>	Exit routes must be adequately sized and readily located for all occupants to evacuate safely and used efficiently. Exit signs assist occupants finding their ways to the required staircases.
<b>B-i</b>	<b>Suitable resting areas to avoid fatigue</b>	For tall buildings, refuge floors are required to allow occupants descending to have a short rest at intermediate floors before they continue using the required staircases.

<b>B-j</b>	<b>Suitable construction to prevent slipping and falling</b>	Staircases should be constructed to reduce the risk of occupants slipping and falling through the provision of handrails, tread and riser dimensions and lighting.
<b>B-k</b>	<b>Temperature, visibility, toxicity of smoke</b>	The exposure of occupants may be received from a fire will need to be assessed if the proposed layout of the floor has exits and protection of exits that differ from the Deemed-to-Comply provisions.
<b>B-l</b>	<b>Protection from adjoining and adjacent buildings</b>	Required staircases within a building will need to be protected from a fire in an adjoining or adjacent building.
<b>B-m</b>	<b>Fire service intervention</b>	Appropriate access to the building and firefighting equipment to allow firefighters to suppress a fire is required.

### Guidance to Performance Requirements for Fire Resisting Construction

	<b><i>Guidance Statement</i></b>	<b><i>Evaluation of Factors</i></b>
<b>C-a</b>	<b>Use Classification of the building</b>	The Use Classification of a building will have impact on the fire load, fire intensity, duration of burning and the hazard to the occupants. The Use Classification will also have impact on firefighting operations.
<b>C-b</b>	<b>Occupant capacity, nature, location and awareness</b>	The total number of occupants, their location within the building and their ability to evacuate, will need to be considered with regard to the FRR and compartmentation to be provided.
<b>C-c</b>	<b>Fire hazard, its potential growth and duration</b>	The fire hazard within the Use Classification will have impact on the FRR and compartmentation required. The impact on evacuating occupants will need to be considered with regard to the speed of fire growth, intensity and smoke spread.
<b>C-d</b>	<b>Building height</b>	Building height will be a factor for consideration for the determination of FRR, compartmentation and firefighting access.
<b>C-e</b>	<b>Building area and fire compartment area</b>	Overall building size and compartmentation need to be considered to reduce the impact of a potential fire. Fire compartmentation may also be utilised to separate more hazardous areas to facilitate evacuation of occupants. Openings between fire compartments, especially floor voids can increase the risk of fire and smoke spread.
<b>C-f</b>	<b>Building location in relation to property boundaries</b>	The potential for fire to spread between buildings must be considered and openings should be provided with appropriate fire barriers.
<b>C-g</b>	<b>Location of roof having regard to other buildings</b>	The potential for fire to spread to other buildings via a roof must be considered.

<b>C-h</b>	<b>Required duration of tenable conditions to be maintained in fire compartments other than that of fire origin</b>	Fire compartment and fire barrier may be required to prevent untenable conditions occurring before occupant evacuation in parts of a building remote from the area of fire origin. This will be of particular importance where floor voids are present.
<b>C-i</b>	<b>Active fire safety provisions installed within the building</b>	The active fire safety provisions within a building may assist in providing protection to evacuating occupants and assist firefighting operations.
<b>C-j</b>	<b>The timing of the works</b>	Where a building or fire compartment is undergoing alterations or additions, the works being undertaken may result in hazardous conditions and the extent that these works impact on occupants and firefighting operations should be considered.
<b>C-k</b>	<b>Fire service intervention</b>	FRR and compartmentation will assist firefighters in carrying out their firefighting operations.

**Guidance to Performance Requirements for Means of Access**

<i>Guidance Statement</i>		<i>Evaluation of Factors</i>
<b>D-a</b>	<b>Use Classification of the building</b>	The Use Classification of a building will have impact on the fire load, fire intensity, duration of burning and the hazard to the occupants and firefighters. The Use Classification will also impact on the numbers of persons and assistance that may be required from firefighters for complete evacuation.
<b>D-b</b>	<b>Occupant capacity, nature, location and awareness</b>	The total number of occupants, their location within the building and their ability to evacuate, will need to be considered with regard to the FRR and compartmentation to be provided to assist firefighting operation and safe evacuation.
<b>D-c</b>	<b>Fire hazard, its potential growth and duration</b>	The fire hazard within the Use Classification will have impact on the FRR and compartmentation required for firefighting access and operations. The impact of the fire hazards on evacuating occupants will need to be considered with regard to the firefighting access.
<b>D-d</b>	<b>Building height</b>	Building height will be a factor for consideration for the determination of FRR and compartmentation to assist firefighting access and their operations.
<b>D-e</b>	<b>Building area and fire compartment area</b>	Overall building size and compartmentation need to be considered with regard to firefighting access.
<b>D-f</b>	<b>Active fire safety provisions installed within the building</b>	The active fire safety provisions within a building may assist in providing protection to evacuating occupants and assist firefighting access and operations.

<b>D-g</b>	<b>Building location in relation to property boundaries</b>	EVA needs to be considered with regard to the location of the building and neighbouring buildings. The potential for fire to spread between buildings must be considered and openings should be provided with appropriate fire barriers.
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**Guidance to Performance Requirements for Fire Safety Management**

	<b><i>Guidance Statement</i></b>	<b><i>Evaluation of Factors</i></b>
<b>F-a</b>	<b>Use Classification of the building</b>	The Use Classification of a building will have impact on the fire safety maintenance required and the motivation to complete the maintenance correctly. The Use Classification also determines the need for fire safety management and training to assist safe evacuation of occupants.
<b>F-b</b>	<b>Active fire safety provisions installed within the building</b>	The active fire safety provisions within a building will determine the type of maintenance to be provided and the fire safety management strategy to be implemented.
<b>F-c</b>	<b>Fire hazard, its potential growth and duration</b>	The fire hazard within the Use Classification will have impact on the need for fire safety management plans to be in place and well practiced to assist evacuation of occupants. The fire hazards within a building may also have impact on the type and frequency of fire safety maintenance.