MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

File No. DOIA 1617-0615

13 DEC 2016

Ms Nicola Wolley
fyi-request-4949-ee6bd9cb@requests.fyi.org.nz
fyi-request-4948-bc50f33e@requests.fyi.org.nz

Dear Ms Wolley

Thank you for your emails of 15 November 2016 requesting the following under the Official Information Act 1982 (the OIA):

> ***Request 1***
> *Please provide a copy of Project 6: Re-introducing Alternative Solutions, which is currently in draft form.*
>
> ***Request 2***
> *Please provide a copy of the approved budget for the MBIE Fire Programme and the total cost incurred to date.*

Information in response to each of part of your requests is provided in this response.

Please provide a copy of Project 6: Re-introducing Alternative Solutions, which is currently in draft form.

Please find attached a copy of the draft "Guide to Alternative Solutions for Protection from Fire" document, released to you without redaction.

Please provide a copy of the approved budget for the MBIE Fire Programme and the total cost incurred to date.

Please find the information requested in the table below.

Financial year	Budget	Actuals
2015/16	489,210	487,508
2016/17	352,206	165,706 (to end of October 2016)

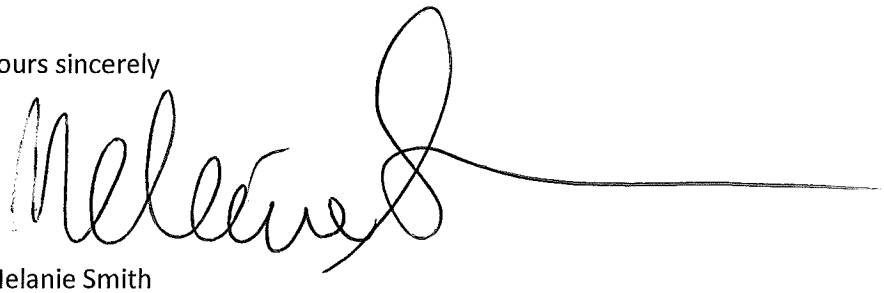
Building, Resources and Markets
15 Stout Street, PO Box 1473, Wellington 6140 New Zealand
E info@mbie.govt.nz T +64 4 472 0030
W www.mbie.govt.nz F +64 4 499 0969 or +64 4 473 7010

You have the right to seek an investigation and review of my decision by the Ombudsman, in accordance with section 28(3) of the OIA. The relevant details are:

The Ombudsman
Office of the Ombudsman
P O Box 10 162
WELLINGTON 6143

0800 802 602
www.ombudsman.parliament.nz

Yours sincerely

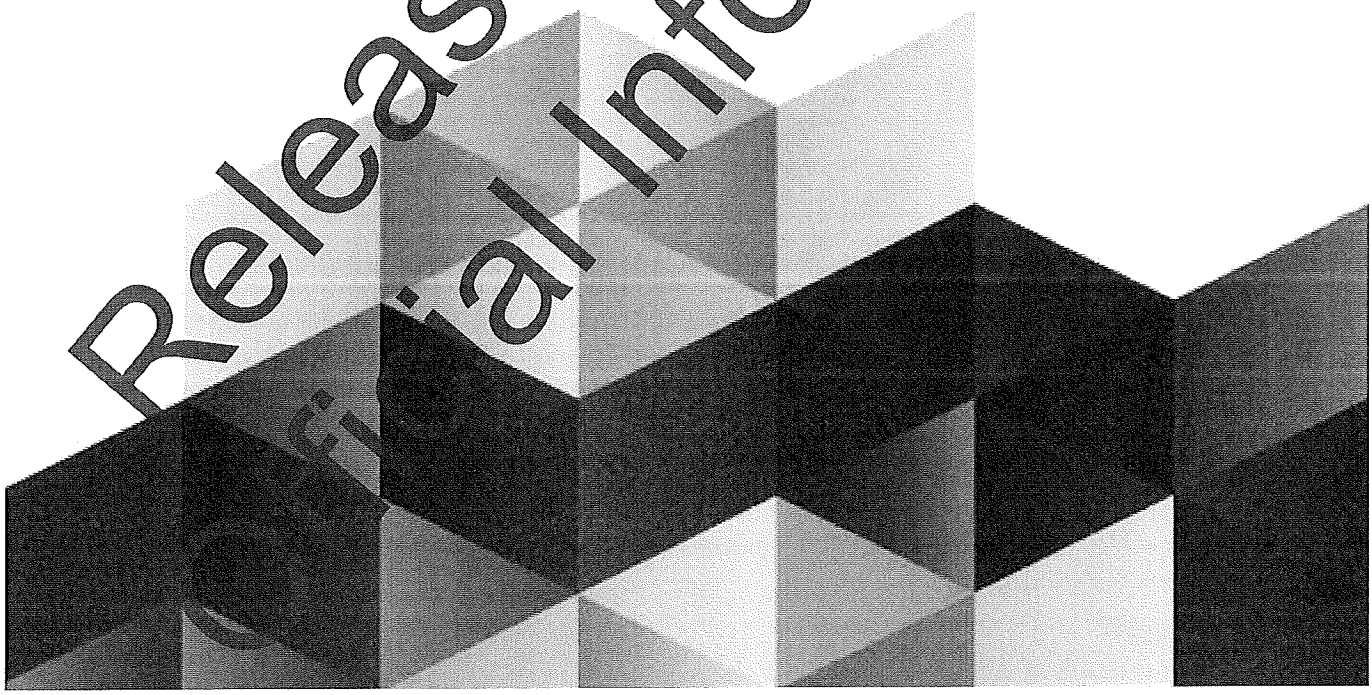


Melanie Smith
Manager, Engineering Design and Science
Building System Performance
Building, Resources and Markets

BUILDING
PERFORMANCE

Guide to alternative solutions for protection from fire

DRAFT at 6 December 2016



Contents

Use of this guide

The Ministry of Business, Innovation and Employment (MBIE) has produced this guide in accordance with section 175 of the Building Act 2004 (the Building Act), which relates to guidance published by MBIE's Chief Executive. While MBIE has taken every care in preparing this document it should not be relied upon as establishing all the requirements of the Building Act. Readers should always refer to the Building Act and associated regulations as the source documents and be aware that for specific situations or problems it may be necessary to seek independent advice.

Note that all references to the Building Act in this guide are to the Building Act 2004 and all references to the Building Code are to the Building Code (Schedule 1, Building Regulations 1992) in force at the time of writing.

What this guide covers

This is a guide to alternative solutions for complying with the performance requirements of Building Code clauses C1-C6 Protection from Fire (the fire clauses).

It will be of interest to fire engineers and designers developing alternative solutions, as well as to building consent authorities (BCAs) and others considering them.

The guide discusses:

- alternative solutions and where they fit in the building regulatory system
- what the fire clauses require
- types of alternative solution suitable for fire design
- the recommended levels of expertise and analysis for each type
- factors of safety, and
- the Fire Engineering Brief.

Appendices cover common fire engineering terms and more details of the fire clauses.

Alternative Solutions for Building Code compliance

An alternative solution is a building design, or part of one, that:

- demonstrates compliance with the Building Code, but
- differs partially or completely from the relevant Acceptable Solutions or Verification Methods.

For Code clauses C1-C6 Protection from Fire (the fire clauses) there are seven Acceptable Solutions, C/AS1-C/AS7, and two Verification Methods, C/VM1 and C/VM2.

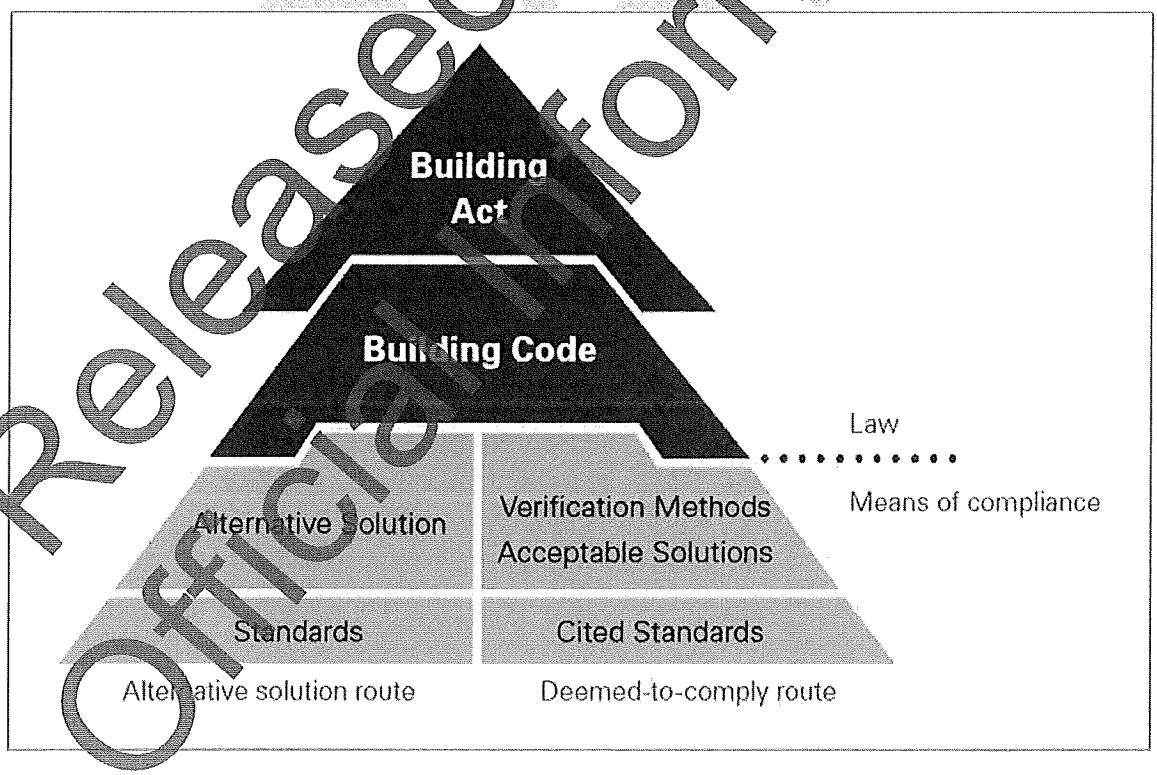
Many building projects – especially renovations or upgrades to existing buildings, and more complex projects – will need to follow alternative solutions for fire design. Fire engineers and designers may also decide to depart from the Acceptable Solutions and Verification Methods to provide innovative designs they consider will create the best outcome for a particular project.

At a glance:

Acceptable Solutions and Verification Methods are produced by MBIE. If followed, they provide evidence to BCA of compliance with the Building Code.

Alternative solutions demonstrate compliance directly with the Building Code performance. A BCA must be satisfied of this compliance on reasonable grounds before granting a building consent. Alternative solutions usually require specific design and input from suitably qualified people, such as architects or engineers.

Figure 1: The building regulatory framework



Understanding the Fire Clauses

The first step in developing an alternative solution for fire design is to consider carefully which Building Code clause or clauses apply to the particular project.

It is important to assess the applicable Code clauses holistically right from the start of the project to make sure it addresses all the relevant performance requirements.

The key objectives are life safety, property protection and firefighting

Code clause C1 contains the three main objectives of the fire clauses:

- life safety
- protection of other property, and
- firefighting operations.

While these are objectives and not performance requirements in their own right, they will be the main focus of any alternative solution.

Performance requirements follow the fire's development

Code clauses C2 to C6 step through the requirements for:

- preventing fire occurring (clause C2)
- limiting fire spread (clause C3)
- assisting the evacuation of occupants (clause C4)
- safeguarding firefighters (clause C5), and
- maintaining the stability of the structure (C6).

The order of these clauses follows the natural timeline of the fire's development, starting with an ignition source and going through to full building/firecell involvement (refer

There may be more than one Code clause and more than one performance objective – and the relevance of some of these may not be immediately obvious.

Example: Vertical Fire Spread

A building has an issue with vertical fire spread. This can affect life safety as well as property protection. In this case, Code clauses C3.2, C3.3, C3.5 and C4.3 all need to be addressed. This is to deal with fire spread via openings and cladding to neighbouring property and to make sure occupants on upper levels

Figure 2).

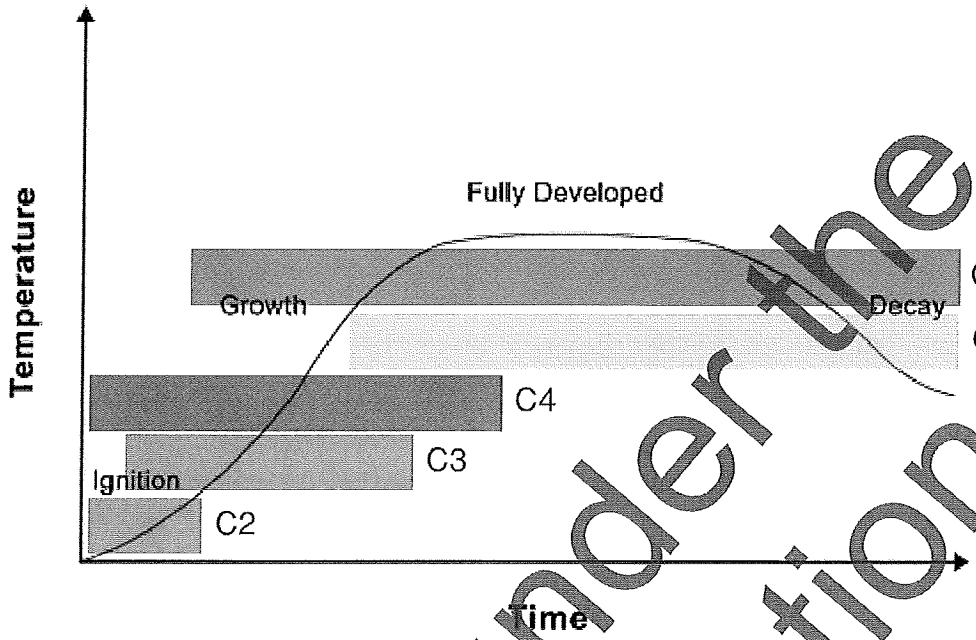
Appendix B explains these clauses and their sub-clauses in more detail and lists the performance objectives they each relate to.

There may be more than one Code clause and more than one performance objective – and the relevance of some of these may not be immediately obvious.

Example: Vertical Fire Spread

A building has an issue with vertical fire spread. This can affect life safety as well as property protection. In this case, Code clauses C3.2, C3.3, C3.5 and C4.3 all need to be addressed. This is to deal with fire spread via openings and cladding to neighbouring property and to make sure occupants on upper levels

Figure 2: Development of fire and the relationship with the Code clauses



Key Considerations

There are several key consideration for developing an alternative solution for the fire clauses:

- Understand the building and its associated fire safety design - and then describe the issue to be addressed. This should outline the building and its features i.e. height, occupancy, use etc
- Scope the project and outline the issue that requires being resolved using an Alternative Solution.
- Holistically identify which Fire Code clauses are affected by the alternative solution and to which the designer needs to demonstrate compliance with.
- Determine what type of Alternative Solution is required from simple to advanced. The path of compliance should be established whether it is initially Acceptable Solution, Verification Method or specific design.
- Determine the appropriate level of expertise/experience required to undertake the design, review, and approval of the Alternative Solution.
- Prepare the Fire Engineering Brief (optional) to agree high level requirements.
- Collate evidence to show the identified performance criteria of all relevant clauses will be met.
- Provide a strongly argued case to the BCA. The clearer the supporting documentation, the easier the evaluation of it will be.

Types of alternative solution and recommended expertise and analysis

While alternative solutions for fire design vary greatly, they can be broadly categorised as one of three types:

- **Single minor departure** from the Acceptable Solutions C/AS1-7, or
- **Major or multiple departures** from C/AS1-7, or
- **Departure from Verification Method C/VM2 or specific fire engineering design.**

The features of each are set out below together with the recommended level of expertise and analysis. This is summarised in

Table 1.

Note:

Fire engineering relates to the interaction between fire dynamics and human behaviour. An alternative solution proposal requires at least a basic understanding of fire and smoke development and the behaviour and interaction of occupants. Protection of other property requires further understanding of structural behaviour and of large fire development and radiant heat.

Table 1: Types of alternative solutions and recommended levels of analysis and expertise

Type of alternative solution	Analysis	Suggested Designer	Suggested Reviewer
Single minor departure from C/AS1-7	Qualitative	Suitably experienced fire designer	Regulatory review (internal or external to BCA) for applicability of qualitative assessment
Multiple or major departures from C/AS1-C/AS7	Quantitative	Suitably qualified fire engineer	Regulatory review (internal or external to BCA) and/or Peer review,
Departure from C/VM2 or specific fire engineering design	Quantitative	Suitably qualified and experienced chartered fire engineer	Suitably experienced peer review and/or external regulator reviewer

Single minor departure from the Acceptable Solutions

A minor departure from Acceptable Solutions C/AS1-C/AS7 may require a simple qualitative, or perhaps quantitative analysis. This will typically require a basic level of understanding of fire design and a good understanding of the Acceptable Solutions.

The most common justification for a minor departure to Acceptable Solutions C/AS1-7 is some kind of compensatory or mitigating feature or features (refer example below).

By understanding the holistic nature of fire design and the construct of the relevant Acceptable Solution a fire engineer/designer should be able to propose various features that achieve the required criteria for a safe building.

These design features also need to be correctly balanced in relation to the required Building Code objective or performance requirement (i.e. the design deficiency and the compensation for this must relate to the same objective).

Justification for the proposed mitigating feature for the departure from Acceptable Solutions may be provided, in some instances, with a qualitative argument. This should be provided by a suitably experienced designer with a good understanding of the Acceptable Solutions.

EXAMPLE: EXTENDED TRAVEL DISTANCE

A building design complies with the relevant Acceptable Solution apart from a minor extension to the travel distance.

In this case, compliance with Code clauses C4.3 and C4.5 (which relate to the toxicity of smoke and reliability of systems) needs to be addressed. Providing a smoke detection system where one is otherwise not required may be considered a suitable way to do this.

Major or multiple departures from the Acceptable Solutions

For more complex alternative solutions involving a significant departure or a number of departures from C/AS1-C/AS7, quantitative fire engineering analysis will almost certainly be required.

This requires a higher level of understanding of fire safety design, the Acceptable Solutions and Verification Method, and the inter-relationship between various aspects of these.

This type of alternative solution is similar to the one described above (a single minor departure). However, it is scaled up in terms of complexity as the engineer/designer is now managing major or multiple departures from the Acceptable Solutions and will have to carry out multiple analyses to deal with each of these. He or she will also need to consider the effect of each proposed departure on the others.

One means of compliance would be to utilise the appropriate design scenarios from Verification Method C/VM2 as a quantitative assessment.

Example: Multiple Departures

An alternative solution for an office building has a number of departures from the Acceptable Solutions relating to means of escape i.e. longer travel distances and a reduced exit width.

In this case, an appropriate method of analysis could be a fire engineering ASET v RSET analysis using the relevant design scenarios – UT, CF and RC – from Verification Method C/VM2. This analysis shows that there is sufficient escape time to meet the relevant performance requirements.

Departure from Verification Method C/VM2 or Specific Fire Engineering Design

Departures from C/VM2 are likely to be from either:

- feature of design (e.g. door swing, or prescribed FRR requirement), or
- method of analysis (e.g. a change in input parameter, adjustment of the acceptance criteria, or modification of an analysis method).

A fire design which has departure from the Verification Method C/VM2 would need to be undertaken by a suitably qualified fire engineer with experience in the use of C/VM2. Any departure to the C/VM2 design scenarios needs to be carefully considered for any unintended consequences to other design scenarios.

This type of alternative solution should be reviewed by a peer reviewer or BCA regulatory reviewer with a good understanding of the methodology.

Engineers or designers proposing any type of alternative solution should also:

- include the appropriate factor of safety (refer to page 12), and
- consider a Fire Engineering Brief (refer to page 13).

Specific fire engineering design requires a high level of understanding of the Building Code and the inter-relationship between Code clauses. BCAs should be satisfied that the engineers and reviewers involved have the relevant qualifications and experience for doing this.

This type of design can be from first principles or using Acceptable Solutions or Verification Method as basis for compliance with the method tested during the Fire Engineering Brief. It should use a range of international fire engineering guidelines, research and methodology.

Note:

Specific fire engineering design may be necessary for unique and specialised buildings, such as tunnels, and for complex projects.

Factor of safety in fire design

Fire engineering design typically involves comparing the outcome of an analysis to threshold acceptance values. Some of these acceptance criteria are quantified within the Building Code (e.g. tenability criterion related to visibility, FED(CO), and FED thermal, and radiant flux levels to relevant boundaries).

The appropriate use of a safety margin, or 'factor of safety' (FOS), in fire engineering design can be applied to design inputs as they enter an analysis, or alternatively to design or analysis outputs. Factors of safety are needed to address issues such as:

- uncertainty in the documented input values because limitations in the data collection
- known non-conservatisms in the method of analysis because of a simplified approach
- uncertainty in the method of analysis or its outputs, such as modelling or calculation uncertainty.

The use of factors of safety also gives a general level of comfort for particularly critical design outcomes to cover the possible variation in inputs the methodology may be sensitive to.

Factor of safety and Verification Method C/VM2

If the alternative solution is a departure from C/VM2, the key point an engineer must address is the FoS inherent in the C/VM2 methodology against the quantified acceptance criteria explicitly stated in the Code.

A design which follows C/VM2 completely is assessed against the acceptance criteria stated in the Code with a FOS of unity (FOS = 1). This implies that all the necessary factors of safety and margins are built into the method itself (inherent in conservative input parameters, prescribed form of analysis, and method for measuring outputs).

Therefore, it is critically important that if an engineer modifies an aspect of C/VM2 as part of an alternative solution they in turn modify the FoS against which the acceptance criteria stated in the Code are compared.

The engineer needs to discuss and agree an appropriate increase in the FoS (i.e. above unity) with the peer reviewer and regulatory stakeholders for this alternative solution.

Proposing and agreeing a factor of safety

As the appropriate FoS for an alternative solution is typically not specified, it should be agreed with the regulatory stakeholders and reviewers during the Fire Engineering Brief Process.

One way to test if the FoS is appropriate is to carry out sensitivity analyses. Doing this is an essential part of performance based design as it tests what happens if any component of the system fails to operate, or if changes occur in particularly sensitive input values.

Fire Engineering Brief (FEB)

All forms of alternative solution benefit from some discussion early in the design process with key stakeholders, particularly review and regulatory stakeholders, and documenting the agreed principles. This is known as the Fire Engineering Brief (FEB) process.

Note:

The FEB is highly recommended for alternative solutions. Getting acceptance in principle for various aspects of the alternative solution early in design removes potential risk from the consenting process, avoids rework or aborted analysis, and reduces pressure on the project. This is especially true during final approval, when time delays and design changes can be costly.

The extent and form of the FEB varies depending on the particular project, its complexity and the type of alternative solution. It can range from an email trail through to full documentation and meetings between all parties.

If an engineer decides not to go ahead with an FEB they should acknowledge to their design team and project sponsors that their proposed design approach presents a possible consent risk. It should also be generally accepted that the BCA, peer reviewer, and other involved regulatory stakeholders are entitled to suggest or require changes and rework to methodology, analysis inputs, and factors of safety during their review at consent.

Table 2: Snapshot of the FEB

The FEB	
High level FEB information includes:	• Building use, occupancy and any future limitations • Evacuation strategy (i.e. Simultaneous or phased) • Fire safety systems and features extent and location • Fire separations and protection of other property • Structural fire resistance and extent of protection • Fire service access – water supply and firefighting facilities
Importantly, the FEB should cover:	• Relevant Code clauses affected by the alternative solution • Departure from the Acceptable Solutions or Verification Method • Proposed approach and methodology • Proposed inputs and set up of analysis • Acceptance criteria • Proposed factor of safety
Key stakeholders:	• Fire engineer • BCA • Architect/lead consultant • New Zealand Fire Service
Optional stakeholders who should also be considered:	• Client • Main contractor • Insurer • Other key design disciplines affected by the fire design

Resources

MBIE's website at www.building.govt.nz (search for 'alternative solutions')

MBIE FAQs website link.

MBIE guidance on FEBs

MBIE guidance on tall buildings

Performance based Fire Engineering Design

International Fire Engineering Guidelines 2005 at:
www.abcb.gov.au/Resources/Publications/Education-Training/International-Fire-Engineering-Guidelines

BS 7974-0:2002 Part 0 Application of fire safety engineering principles to the design of buildings:

shop.bsigroup.com/ProductDetail/?pid=000000000030028692

SFPE Engineering Guide to Performance-Based Fire Protection:

catalog.nfpa.org/SFPE-Engineering-Guide-to-Performance-Based-Fire-Protection-2nd-Edition-P14600.aspx

Contact

Freephone: 0800 24 22 43

Email: info@mbie.govt.nz

Post: Ministry of Business, Innovation and Employment

15 Stout Street, PO Box 1473, Wellington 6140, New Zealand

Appendix A: Fire engineering terms

Firecell

The Building Code uses the concept of firecells to divide a building into one or more compartments. It defines a firecell is defined as "any space including a group of contiguous spaces on the same or different levels within a building, which is enclosed by any combination of fire separations, external walls, roofs, and floors". A firecell may include a number of different building activities.

Fractional effective dose (FED) for carbon monoxide

A cumulative measure of the toxicity of smoke that would create conditions which make it very difficult to safely escape a building. As a fire grows in size the quantity of smoke and toxic gases being produced increases with time. This increases the density and toxicity of smoke in the building to a level that creates difficulty for occupants to breathe and to see or find escape routes and exits.

Fractional effective dose for thermal effects

A cumulative measure of the amount of heat people are exposed to an escape route and which creates difficult conditions for building occupants to escape safely. Fires produce hot gases which, when they migrate into an escape route, raise the temperature of the air in that escape route. This increased heat level creates a difficult environment for occupants to escape safely using the escape route, due to skin effects and breathing difficulty.

Radiant flux

A measure of heat produced from a fire at a specified distance. If fire reaches a significant size the radiant heat produced can ignite surrounding buildings and cause fire spread. To prevent the spread of fire to other property the radiant flux needs to be maintained below specified values.

Visibility

A measure of the smoke density in an escape route. Smoke produced from fires thickens the air, making it hard for occupants to find their way toward an exit. Visibility has a lower threshold than FED as it only concerns occupants' ability to find their way through smoke, not breathability.

Note:

FED is a cumulative measure of dosage over a specified time period, whereas visibility and radiant flux are measures of actual values at any point in time.

For example, for an office building an FED CO of 0.3 is the total amount of carbon monoxide absorbed by an occupant for the five minute period he or she is exposed to smoke while escaping to the stairwell. Visibility of 15 m in the same building describes the density of smoke in the escape route at five minutes after fire ignition.

Appendix B: Fire clauses and links to the performance objectives

Table 3: Description of Building Code clauses C1-C6 Protection from fire

Building Code clause	Description
C1 Objectives of clauses C2-C6	There are three key objectives: • life safety – to safeguard people from an unacceptable risk of injury or illness caused by fire • property protection – to protect other property from damage caused by fire, and • firefighting operations – to facilitate firefighting and rescue operations. **Note**: While these are objectives only and not performance requirements, they provide the main components of any alternative solution.
C2 Prevention of fire occurring	Control of ignition sources within fixed appliances such as solid fuel heating and lighting. Sets a maximum surface temperature to prevent fires from occurring. For special hazards these fire risks shall be contained to prevent the outbreak of fire.
C3 Fire affecting areas beyond the fire source	Prescribes requirements for: • internal and external spread of fire • internal surface linings and suspended fabric. Vertical spread of fire for external cladding is restricted. External fire spread across property boundary is prescribed to limit the amount of unprotected openings on external walls. Large firecells are required to lower the probability of causing harm to firefighters. Fire suppression systems used to prevent fire spread are required to be reliable systems.
C4 Movement to place of safety	Sets out performance criteria for safe means of escape by prescribing a minimum smoke toxicity and visibility. A lower tolerable limit is permitted with provision of sprinklers.
C5 Access and safety for firefighting operations	Provides for safe access for fire service vehicles to the building and safe access route into the building. The Fire Service requires adequate water supply and provisions to allow safe access to floor of fire origin. Information on the building and its safety systems shall be provided. Any systems for protection of firefighters shall be reliable.
C6 Structural stability	All elements required to support fire rated elements shall provide structural stability during and after the fire. This is for period of escape, protection of other property and firefighting operations. Compliance with clause C6 needs to be demonstrated through Clause B1 Structure.

Table 4 groups the fire clauses' performance requirements, which are in the sub-clauses of C2-C6, under the three key objectives in clause C1: life safety, property protection and firefighting operations.

Table 4: Building Code objectives for protection from fire and the relevant performance clauses

Objectives	Requirements	Clauses
Life safety	Prevention of ignition sources	C2
	Internal surface finishes shall have minimum reaction to fire.	C3.4
	Minimum toxicity and visibility shall be provided for the period of escape.	C4.3, C4.4
	Fire safety systems required for life safety shall be reliable.	C3.9, C4.5
	Structural systems supporting fire rated escape routes shall remain stable.	C6.2
Protection of other property	Vertical spread of fire cladding is limited to 3.5 m.	C3.5
	External spread of fire across the boundary is limited in radiant heat flux.	C3.6, C3.7
	Structural systems supporting fire rated elements for prevention of external fire spread shall remain stable.	C6.2
Firefighting operations	Large firecells shall minimise harm to firefighters.	C3.8
	Safe access shall be provided for fire service vehicles to building.	C5.3, C5.4
	Adequate provision of water must be made for firefighting operations.	C5.5
	Safe access must be provided for firefighters to the floor of fire origin.	C5.6
	Information must be provided for the Fire Service.	C5.7
	Fire safety systems for protection of fire fighters shall be reliable.	C5.8
	Any structural systems for access for firefighting operations shall remain stable.	C6.3