BUILDING PERFORMANCE

Consultation on fire safety proposals

Changes to the Building Code

Amendments to Verification Method

Guidance for Alternative Solutions

May 2017

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

New Zealand Government

CONTENTS

Disclaimer

The opinions and proposals in this consultation document are those of the Ministry of Business, Innovation and Employment (MBIE) and do not necessarily reflect government policy. MBIE does not accept any responsibility or liability whatsoever whether in contract, tort (including negligence), equity or otherwise for any action taken as a result of reading, or for reliance on, any or all of the information contained in this document, or for any error, inadequacy, flaw in, or omission from this document.

Published May 2017 by
Ministry of Business, Innovation and Employment
PO Box 1473
Wellington 6140
New Zealand

ISBN: 978-0-473-39892-7

This publication is also available on the MBIE website at www.mbie.govt.nz/about/our-work/have-your-say

Fire safety proposals at a glance

Proposal	How	Why	Of interest to:
1 – Increase flexibility in use of internal surface finishes (details p 10)	Replace Building Code clause C3.4 Related changes to C/AS2-7 and C/VM2, including a revised fire design method	Current Code clause is restrictive on use of some products This rebalances fire testing requirements proportional to risk	Architects, designers, engineers, building consent authorities (BCAs)
2 – Clarify Building Code requirements for structural performance in fire (details p 13)	Revise Building Code clause C6 Related changes to definitions, C/AS1-C/AS6 and B1/VM1	Current Code clause is not easy to interpret and it is not clear if it should be the responsibility of a fire or structural engineer to meet the clause requirements	Fire engineers, structural engineers, architects, BCAs
3 – Update the Verification Method and include more safeguards for tall buildings (details p 16)	Update C/VM2	Addresses specific fire safety design for tall buildings (over 60 m), provides more alternative design methods	Fire engineers, BCAs
4 – Support alternative solutions for fire designs (details p 20)	Issue guidance (under section 175 of the Building Act)	Supports performance based code for fire design and reinforces alternative solution route to compliance	Fire designers, fire engineers, BCAs

Note: Building Code clauses C1-C6 cover protection from fire. Clause C3.4 concerns the fire performance of internal surface finishes for walls, ceilings and floors. Clause C6 concerns structural stability in fire. Verification Method C/VM2 is a way to comply with the Code's fire clauses.

Why we are consulting

Proposals aim to improve the efficiency of fire safety design

The fire safety proposals in this document are part of MBIE's drive to:

- make the Building Code requirements easier to interpret and apply
- promote innovation, and
- work more collaboratively with stakeholders.

MBIE has developed each proposal with significant industry input through working groups and other feedback channels.

The proposals are mostly adjustments and rebalancing designed to simplify and support the way fire design is currently occurring or to facilitate a shift towards how it should be occurring. Changes to the fire safety requirements are relatively minimal apart from specialised areas such as tall buildings, where MBIE considers it necessary to include more safeguards for building occupants and firefighters. Other proposed changes are designed to increase efficiency, reduce cost and improve workability.

MBIE is now seeking public feedback on these proposals and encourages you to have your say through the submissions process.

MBIE's Fire Programme charts the direction for ongoing improvements

In 2012 the Fire Safety clauses of the Building Code (Schedule 1 to the Building Regulations 1992) were replaced with six new clauses: C1 to C6 Protection from Fire. In addition, a new set of seven Acceptable Solutions and a new Verification Method were introduced. These changes were significant and aimed to provide designers, fire engineers and building consent authorities (BCAs) with better design criteria so that fire design could be applied more consistently.

In 2014 MBIE carried out a review to gauge the effectiveness of these changes, determine whether any adjustments were needed, and decide how to better support an industry facing some challenges adapting to the revised framework. This review involved extensive stakeholder feedback and also drew on guidance from international fire experts.

The review identified a number of areas where regulation, compliance and guidance could be improved or developed. As a result MBIE established the Fire Programme to address the concerns raised in the review and to improve the efficiency and effectiveness of the fire regulatory system. The aim: to shift the fire-safety regulatory framework towards a more performance-based regime, as originally intended.

The Fire Programme was an extensive stakeholder engagement programme designed to understand and address the issues within the fire regulatory system. Working groups have involved participants across the sector including fire engineers, architects, BCAs, the Fire Service and designers. Many of these groups have provided useful input into elements of fire regulations and have recommended to MBIE a range of changes.

The first phase of these changes is described in this document and includes:

- changes to Building Code clause C3.4 for internal surface finishes
- changes to Code clause C6 for structural performance in fire
- amendments to Verification method C/VM2, and
- guidance for alternative solutions.

The detailed proposals for each change have been developed in close collaboration with industry participants.

The overall goal: a high performing sector that can rely on an effective regulatory system

The Government, through MBIE, can drive improvement in the building and housing sector through direct influence over four key areas: people, processes, products and performance. The overall goal is to create a high performing sector that can rely on an effective regulatory system.

The fire safety proposals in this document contribute to the Government's broader strategy for the building and construction sector by:

- **People**
  - improving productivity through improved clarity, usability and buy-in from stakeholders
  - making responsiblities clearer for structural and fire engineers (by revising Code clause C6)
- **Processes**
  - providing appropriate safeguards for firefighters and those who occupy or access buildings (for example, by including new provisions for tall buildings in the Verification Method)
  - rebalancing the requirements so fire safety performance is proportional to the level of risk (through changes to Code clause C3.4)
- **Products**
  - enabling innovation and ensuring products are fit for purpose (through changes to Code clause C3.4)
- **Performance**
  - removing prescriptive elements from the Building Code with a shift to a more performance-based model (by revising clause C3.4)
  - amending load requirements so it is more appropriate for the construction type (through changes to Code clause C6 and supporting compliance documents).

These changes intend to support a building and construction sector that is focussed on quality, productive and efficient, and customer centred and accountable.

How to have your say

Provide your feedback by 14 July 2017

MBIE invites written comments on the proposals in this document by 5:00pm, Friday 14 July 2017.

You are welcome to make submissions on some or all of these proposals. Key questions are provided throughout the document to guide your responses (in each proposal and again in the Appendices detailing the proposed changes or draft guidance). Your submissions may incorporate relevant material provided to other reviews or consultation.

A submission may range from a brief online response or a short letter on one portion of one of the proposals, to a substantial response covering multiple proposals. You can download a submission form at www.mbie.govt.nz/info-services/building-construction/consultations/fire-review.

You can complete your submission on the MBIE website. If you are able, MBIE appreciates submissions via this online consultation page www.mbie.govt.nz/info-services/building-construction/consultations/fire-review.

Or, if you do not want to use the submission form:

- Email a submission to firereview@mbie.govt.nz with 'Consultation on fire safety proposals' in the subject line, or
- Post/courier your submission to –
  Ministry of Business, Innovation and Employment
  15 Stout Street
  PO Box 1473
  Wellington 6140
  Attention: Consultation on fire safety proposals
- Please include your contact details.

Please provide relevant facts, figures, data, examples and documents where possible to support your views. Electronic submissions must be either online, or use a Microsoft Word or searchable PDF format.

Your submission may be made public

MBIE intends to post a report on submissions at www.mbie.govt.nz except for material that may be defamatory. MBIE will not publish the content of your submission on the internet if you state that you object to its publication when you provide it. However, your submission will remain subject to the Official Information Act 1982 and therefore may be released in part or full.

The Privacy Act 1993 also applies to your submission. This means any personal information you supply to MBIE in the course of making your submission will be used by MBIE only in conjunction with matters covered by this document.

When making your submission please state if you have any objections to the release of any information it contains. If so, please identify which parts of your submission you request to be withheld and the grounds under the Official Information Act that you believe apply. For example, reasons could include that you have provided commercially sensitive material or you have privacy concerns.

Out of scope

A single Acceptable Solution that combines the six Acceptable Solutions C/AS2 to C/AS7 is being developed. This is currently being tested with interested stakeholders before being released for public consultation.

Other current fire related projects include the Fire Safety Design Guide for Supported Housing. This is being prepared in consultation with the disability sector, New Zealand Fire Service, councils, and service, housing and funding providers (the Ministry of Health). It will provide the sector with guidance on the provision of supported living in a residential setting with the appropriate fire safety measures.

What happens next

MBIE will analyse all submissions. If this consultation results in substantive changes to any of the proposals in this document then MBIE will seek your further feedback.

The provisional timeline for the next steps is as follows:

Proposals 1 and 2 – Changes to the Building Code

MBIE will report to the Government with recommendations for its consideration and suggestions on how to proceed. Your submission will potentially inform the drafting of changes to the Building Code.

Cabinet agreement to regulatory changes is likely to be sought in early 2018.

Amendments to the Building Code may be introduced by early 2018 and could take effect from June 2018.

Proposal 3 – Changes to the Verification Method

Your submission will potentially inform the drafting of changes to C/VM2. This document details the options that were considered and the rationale for the proposal presented here. If there are no substantive changes MBIE may implement this proposal by October 2017. There will be a five-month transition period during which time both versions of the Verification Method can be used to assess building consent applications.

Note that Proposals 1 and 2 contain some consequential changes to the Acceptable Solutions C/AS1-C/AS7 and Verification Method CVM2. However, these changes will not be implemented until the Building Code changes in Proposals 1 and 2 have occurred.

Proposal 4 – Issue of guidance

Your submission will potentially inform the drafting of guidance that MBIE issues under section 175 of the Building Act 2004 (the Building Act). MBIE will publish this guidance once your feedback has been analysed and incorporated, which is likely to be October 2017

Proposal 1: Make the Building Code less prescriptive for internal surface finishes

Proposal	How	Why	Of interest to:
Increase flexibility in use of internal surface finishes	Revise Building Code clause C3.4 Related changes to C/AS2-7 and C/VM2, including a revised fire design method	Current Code clause is restrictive on use of some products This rebalances fire testing requirements proportional to risk	Architects, designers, engineers, building consent authorities (BCAs)

Key points

Building Code clause C3 relates to fire affecting areas beyond the fire source. Clause C3.4 is a performance clause within this that prescribes the fire performance of materials that can be used on walls, ceilings and floors.

MBIE proposes replacing clause C3.4 a), b) and c) and making related changes to C/AS2-7 and C/VM2 to:

- remove the prescriptive requirements for Group Numbers and critical heat flux currently at Code level
- rebalance the requirements for internal surface finishes so fire safety performance is proportional to the level of risk in the spaces where these are exposed
- allow an alternative means of assessment through the Verification Method C/VM2.

This proposal includes replacing Code clause C3.4 with qualitative performance requirements for the internal surface finishes of walls, ceilings and floors and for suspended fabric.

Increasing the flexibility in use of internal surface finishes has a potential positive benefit to those working with heritage buildings as there is a direct impact on the suite of new and existing products, inclusive of native timbers, able to be specified particularly by conservation Architects.

Related changes to the Acceptable Solutions C/AS2-7 and Verification Method C/VM2 include:

- defining a new term, 'internal surface finishes', to reduce the current ambiguity of application
- replacing the term 'crowd' and introducing a new term 'place of assembly' to refine the level of risk for public spaces
- differentiating pipes and ducts requirements from internal surface finishes (these building services descriptions are currently in the Code clause 3.4), and
- re-writing the design scenario (IS) for internal surface finishes in C/VM2 with a new fire engineering method for assessment of the contribution of internal surface finishes.

Go to Appendix A for full details of this proposal.

Why make the proposed changes?

In 2012 Building Code clause C3.4 was revised to provide quantified measures of internal surface finishes when exposed to fire. The clause is prescriptive and provides no alternative to a benchmarked fire test. The clause is not only highly conservative but is also complicated by exemptions and modifications within the Acceptable Solutions and Verification Method for surface finishes for different types of use.

The rigidity of this Code clause caused concerns for multiple stakeholders. In particular, suppliers of surface finishes such as timber linings considered this rigidity to be prohibitive.

A working group was formed to review the issues with internal surface finishes. This working group comprised architects, fire engineers, timber industry members, product suppliers and product specifiers. The group studied the feedback from industry on the issues with Clause C3.4 and produced a range of problem statements. The key problem was the restrictive Code clause that precluded performance-based solutions.

The working group considered a number of issues, questions and potential solutions, including the following:

- The Building Code definitions do not capture all technical terms referenced in the fire safety clauses.
- Performance Clause C3.4 precludes the ability to undertake performance-based design.
- Whether surface finishes are dealt with by other Standards.
- Are the criteria for surface finishes appropriate?
- Can equivalency to other Standards and jurisdictions be easily achieved or demonstrated?
- The exemptions within the Acceptable Solutions regarding internal spread of flame are not clear and exhaustive.
- New definitions are needed for ‘crowd’ and ‘internal surface finish’.
- Should the Acceptable Solution look different?
- Could a risk-assessment approach be adopted for determining the appropriateness of a surface finish?
- What standard products are precluded and how can they be incorporated effectively?

The resulting proposal in this document rewords the Code clause and moves its prescriptive requirements to the Acceptable Solutions. A new definition for ‘internal surface finish’ is also proposed, together with a new fire engineering method within the Verification Method.

Tell us your views

1.1 Do you agree with the proposal to move the prescriptive requirements out of Code clause C3.4? If not, why not?

1.2 Do you agree with the proposed wording for this clause? If not, why not and what would you suggest?

1.3 Do you agree with the proposed definition of ‘internal surface finshes’? If not, why not?

1.4 Do you agree with the revised list of exemptions to the ‘internal surface finishes’? If not, what would you suggest?

1.5 Do you agree with the definition of ‘place of assembly’? If not, what changes would you suggest?

1.6 Do you agree with the proposed changes to internal surface finish requirements as set out in Table 4.1? If not, why not?

1.7 Are there any other changes you suggest to the internal surface finish requirements set out in Table 4.1? If so, please give your reasons.

1.8 Do you agree with the proposed changes to Design scenario (IS): Rapid fire spread involving internal surface finishes? If not, why not?

1.9 Is there anything else you suggest adding to or changing in Design scenario (IS)? Please give your reasons.

1.10 Do you agree with moving the requirements for pipes and ducts to Acceptable Solutions C/AS2-7 and Verification Method C/VM2? If not, why not?

1.11 Do you have any suggested changes to the proposal to move pipes and ducts to C/AS2-7 and C/VM2?

1.12 Do you agree with the proposal to add specified performances for typical finishes to the Verification Method? If not, why not?

1.13 Do you agree with introducing alternative fire tests for testing critical radiant flux for flooring? If not, why not?

1.14 Are there any changes you would suggest to the proposal to introduce new alternatives for testing critical radiant flux for flooring? Please give your reasons.

Proposal 2: Clarify Building Code requirements for structural performance in fire

Proposal	How	Why	Of interest to:
Clarify Building Code requirements for structural performance in fire	Revise Building Code clause C6 Related changes to definitions, C/AS1-C/AS6 and B1/VM1	Current Code clause is not easy to interpret and it is not clear if it should be the responsibility of a fire or structural engineer to meet the clause requirements	Fire engineers, structural engineers, architects, BCAs

Key points

The proposed changes address known terminology issues with Code clause C6.

The proposed changes to Code clause C6 include to:

- add a performance criteria for the protection of occupants during fire
- replace or redefine incorrect and unclear terms
- allow at Code level structural behaviour as a result of fire that is not currently accommodated but is sometimes acceptable (e.g. progressive inward movement of exterior walls and roofs in single storey buildings and in the top level of multi-storey buildings)
- simplify the performance criteria for the protection of other property
- correct inconsistencies in usage of the terms ‘during fire’ and ‘after fire’, and
- accept at Code level that building elements with lesser fire resistance can support building elements with higher fire resistance, provided that failure of the former does not have adverse consequences.

Related changes include clarification that design loads given in Verification Method B1/VM1 do not apply to houses, townhouses, small multi-unit dwellings and outbuildings that comply with C/AS1 and B1/AS1.

Go to Appendix B for full details of this proposal.

Why make the proposed changes?

MBIE and stakeholders recognised that the current Building Code clause C6 contains some inconsistent wording and does not accommodate certain structural fire engineered designs. Issues with the current clause include:

- Interpreting the undefined term 'structural systems' has caused some difficulties (for example, whether secondary structural elements such as façade panels on a building are included or not).
- There is some inconsistency in the use of the terms 'during fire' and 'after fire'.
- Stakeholders identified that the current wording does not accommodate controlled inwards collapse of non-fire-rated roofs.

A working group was formed to investigate the requirements for structural stability during and after fire in order to clarify the current requirements. The working group comprised fire engineers, structural engineers, researchers, a territorial authority representative and a member of the fire service. The group considered feedback from industry on current issues and produced a range of problem statements which addressed, among other things: a lack of clarity of performance objectives; roles and responsibilities not being clearly defined; and inconsistencies between Building Code clauses B1 and C6.

It was felt that the intent of the code for structural stability in fire had, at least in part, been lost. Individuals from the working group were asked to assist MBIE in developing specific proposals to address the issues identified.

A paper has therefore been produced to outline the proposed changes to Code clause C6, definitions and Acceptable Solutions C/AS1-C/AS6 (Appendix B of this document). Other proposals include clarification on the lateral load requirements in B1/VM1.

Tell us your views

2.1 Do you agree with the proposed changes to Building Code clause C6? Why, or why not?

2.2 Do you think the term 'structural performance' is sufficiently well understood by structural engineers and fire engineers or should this be defined in Building Code clause A2?

2.3 Do you agree with the proposed definition updates for 'fire resistance rating (FRR)' and 'primary element' in Building Code clause A2? Why or why not?

2.4 Do you have any feedback on the proposed definitions listed in question 2.3? If so, please provide.

2.5 In your view, are the proposed loadings in B1/VM1 adequate? Why or why not? If not, what would you propose?

2.6 Do you agree with the proposed changes to C/AS2-C/AS6 regarding performance of structures affected by fire? Why, or why not?

2.7 In C/AS2-C/AS6 the requirements for the performance of structures affected by fire are not exclusive to Part 4 'Control of internal fire and smoke spread'. Is section 4.3 as proposed above more appropriately located in a new Part 8 rather than in Part 4? If so, why? Alternatively, a simple clause could be added to Part 5 referring to the proposed requirements in section 4.3. If not, why not?

Proposal 2: Clarify Building Code requirements for structural performance in fire

2.8 Do you agree with the proposed addition to C/AS1 to clarify that the lateral load requirements in B1/VM1 do not apply? Why, or why not?

2.9 Do you agree that the loads in Paragraph 2.2.4 in B1/VM1 do not need to be highlighted in C/AS7 (buildings used for vehicle storage and parking) or C/VM2, or should these loading requirements be added to these documents? If so, why?

2.10 Do you agree with the proposed amendments to the definitions of ‘primary element’ and ‘structural adequacy’ in these Acceptable Solutions? If not, why not?

Proposal 3: Update the Verification Method and include more safeguards for tall buildings

Proposal	How	Why	Of interest to:
Update the Verification Method and include more safeguards for tall buildings	Update C/VM2	Addresses specific fire safety design for tall buildings (over 60 m), provides more alternative testing methods	Fire engineers, BCAs

Key points

The main changes proposed to this Verification Method relate to tall buildings (over 60 metres in height) as these present extra challenges for life safety, means of escape and firefighting. These changes concern:

- **structure**: modifications to the design fire load energy density (FLED) to introduce height factors for calculating the fire rating
- **escape**: changes to provide additional checks for large occupancies, vertical escape routes and travel speed for those with slower mobility
- **firefighting**: additional requirements for access, water supply and ventilation
- **reliability of systems**: changes to provide additional redundancy for fire safety systems
- **external cladding**: reduced combustibility at height.

More general updates to C/VM2 include:

- clarifying the scope of the Verification Method
- revising Design scenario (BE) Blocked exit to clarify the application of the method and provide an alternative
- changes to some of the fire design scenarios to clarify when they apply, and
- additions to provide radiant heat flux for storage buildings and requirements for special hazard.

Go to Appendix C for full details of this proposal.

Why make the proposed changes?

In 2012 a new Verification Method (C/VM2) was created to standardise fire engineering methods. The new method proved successful as a means of introducing rigour and certainty into fire engineering design.

However, in 2016 some technical issues emerged and it was discovered that C/VM2 did not fully address fire safety requirements for certain types of buildings, particularly buildings over 60 m (tall buildings). *Practice Advisory 18: Fire safety design for tall buildings* was produced highlighting the specific design considerations to achieve the fire safety performance requirements of the Building Code.[1]

Tall buildings present unique challenges for safe means of egress, access for firefighters and safety of the wider community. Their fire safety requirements need to be considered to address safety in a way that is specific to New Zealand needs, behaviours and societal risk. In particular, their fire design needs to align with the New Zealand Fire Service (NZFS) standard operating procedures for firefighting at height and the limits of NZFS specialist equipment.

To consider these and other potential updates to C/VM2 MBIE formed a working group consisting of the Verification Method's original authors as well as Society of Fire Protection Engineers (SFPE) representative fire engineers and NZFS representation. This group studied practices overseas and investigated key issues with C/VM2, including:

- concerns related to tall buildings
- the scope of C/VM2
- the current 'blocked exit' design scenario
- radiant heat criteria for storage buildings, and
- requirements for non-simultaneous evacuations.

With regard to tall buildings, the working group concluded that the application of C/VM2 had highlighted gaps in the Verification Method. All the parties involved in designing and consenting these buildings (specific councils, the fire engineers undertaking their design, MBIE and NZFS) also agreed that the fire safety measures required to satisfy the Verification Method when applied to tall buildings were not sufficient.

The options explored for ensuring this Verification Method performs satisfactorily and provides a means of complying with the Building Code, particularly for tall buildings were to:

- update the Verification Method for requirements for tall buildings
- amend the scope of the Verification Method with a building height limit, or
- withdraw the Verification Method from circulation in its entirety.

MBIE decided to retain and amend the Verification Method to limit the disruption to the sector for those currently using this design method; i.e. to refine its application and include a regular cycle of updates.

When C/VM2 is amended there will be a lead-in time before the new version applies and then a five-month transition period (during which time the current version of C/VM2 can also be used). The

[1] *Practice Advisory 18: Fire safety design for tall buildings* can be found on the MBIE website: www.building.govt.nz/building-code-compliance/b-stability/b1-structure/practice-advisory-18/

amendments to C/VM2 will not apply to building work for which a building consent has already been issued or to building consent applications submitted before the new version takes effect.

Expected timeframes are as follows:

- The amended version of C/VM2 is effective from October 2017 and can be used from then on to show compliance with the Building Code Clauses C1-C6 Protection from Fire.
- For building consent applications submitted between October 2017 and March 2018 either the current or amended version of C/VM2 can be used to show compliance.
- For building consent applications submitted after March 2018 only the amended version of C/VM2 may be used.

Tell us your views

3.1 Do you agree with the revisions to clarify the compliance with the Building Code of this Verification Method? If not, why not?

3.2 Do you agree with the clarification of scope of the Verification Method for managed buildings? If not, why not?

3.3 Do you agree with the proposed FLED changes for tall buildings in Table 2.3? If not, why not?

3.4 Do you agree with the removal of 'dependable deformation' in the table? If not, why not?

3.5 Do you agree with the cap of 120 minutes FRR on structural fire rating? If not, why not?

3.6 Do you agree with addressing the whole building escape within the stairwells? If not, why not?

3.7 Do you agree to the proposed requirements for phased evacuation? If not, why not?

3.8 Do you agree with the change to travel speed from 1.2 m/s to 0.6 m/s for less mobile occupants? If not, why not?

3.9 Do you agree with the changes to Design scenario (BE): Fire blocks exit? If not, why not?

3.10 Do you agree with the proposal to allow design fire sizes using FLED without limiting storage height in Design scenario (HS)? If not, why not?

3.11 Do you agree with the new requirements to control combustibility for external cladding systems in tall buildings? If not, why not?

3.12 Do you agree with the other changes proposed to this scenario? If not, why not?

3.13 Do you agree to the proposed changes to lower roofs for protection of other property? If not, why not?

3.14 Do you agree with the changes relating to external cladding for vertical fire spread? If not, why not?

3.15 Do you agree to the proposed changes to the C/VM2 scenario description for Design scenario (FO):Firefighting operations for tall buildings? If not, why not?

3.16 Do you agree with the changes to Design scenario (CF): Challenging fire for single escape routes? If not, why not?

3.17 Do you agree with the changes to Design scenario (CF): Challenging fire for escape for large occupancies? If not, why not?

3.18 Do you agree with the changes to Design scenario (CF): Challenging fire for areas of special fire risk? If not, why not?

3.19 Do you agree with the proposed changes to Design scenario (RC): Robustness check to provide more reliable fire safety systems for tall buildings? If not, why not?

3.20 Do you agree with the criteria for cladding systems as outlined in the new Appendix C? If not, why not?

Proposal 4: Support alternative solutions for fire design

Proposal	How	Why	Of interest to:
Support alternative solutions for fire designs	Issue guidance (under section 175 of the Building Act)	Supports performance based code for fire design and reinforces alternative solution route to compliance	Fire designers, fire engineers, BCAs

Key points

MBIE will issue guidance for alternative solutions for fire design (under section 175 of the Building Act) to provide a framework for developing and approving such designs while still maintaining safety and quality.

The proposed guidance covers:

- types of alternative solution suitable for fire design
- the recommended levels of expertise and analysis for each type
- factors of safety, and
- a high-level outline of the Fire Engineering Brief and associated design team coordination process.

The guidance provides the message that alternative solutions are a means of complying with the NZBC C clauses. It is intended to support BCAs and designers with the process of developing an alternative solution and the documentation expected for various types of alternative solutions.

Go to Appendix D for the draft guidance.

Tell us your views

4.1 Do you agree with the framework for alternative solutions proposed in the draft guidance for alternative solutions for protection from fire? If not, why not?

4.2 Does the guidance adequately cover the main topics for alternative solutions? If not, what else would you include?

4.3 Does the guidance provide sufficient information to enable you to formulate an alternative solution? If not, what other information would you include?

4.4 Do you agree with the proposed levels of expertise to undertake alternative solutions? If not, why not?

Appendix A: Proposal 1 detailed changes

Proposal for changes to Building Code clause C3.4 regarding internal surface finishes

What MBIE is consulting on and why

MBIE is proposing changes to Building Code clause C3.4 regarding fire safety of internal surface finishes, and consequential changes to the Acceptable Solutions C/AS2-7 and Verification Method C/VM2.

These changes intend to:

- remove the prescriptive requirements for Group Numbers and Critical Heat Flux at Code level
- rebalance the requirements for internal surface finishes such that the impact of fire spread is proportional to the vulnerability of the occupants and level of risk in the spaces where the surface finishes are exposed
- allow a means of assessment through the Verification Method C/VM2.

Note:

Building Code clause C3 relates to fire affecting areas beyond the fire source; Performance Requirement C3.4 currently prescribes the fire performance of materials that can be used on internal walls, ceilings and floors.

Proposals at a glance

Revise Code clause C3.4	Remove current version of Clause C3.4 a), b) and c) and replace with qualitative performance requirements for internal surface finishes, flooring, and suspended fabric
Make related changes to the relevant Acceptable Solutions C/AS2-7 and Verification Method C/VM2	Changes include: o Define a new term, 'internal surface finishes', to reduce the current ambiguity of application o Update the requirements for maximum permitted Group Numbers for walls and ceilings with new term 'place of assembly' to refine the level of risk for public spaces o Provide a new table for requirements for pipes and ducts separate to internal surface finishes o Rewrite the design scenario (IS) for internal surface finishes in C/VM2 for a fire engineering method for assessment of the contribution of internal surface finishes

Context for change

In 2012 the NZBC clauses C1-6 (Protection from Fire) were revised following a major review which noted, among other things, that performance requirements for the fire spread behaviour of materials used on internal walls, ceilings and floors were poorly defined and provided too much flexibility.

As a result, the Building Code was amended to set clear, quantifiable performance measures for the reaction to fire of building materials. These changes included a new Code clause Performance Requirement C3.4 that prescribed maximum Group Numbers (using the test method in ISO 9705) for wall and ceiling materials depending on the building use, the defined occupancy risk group and whether the building is protected with a fire sprinkler system. Clause C3.4 also prescribed minimum critical radiant flux for flooring when tested to Standard ISO 9239.1.

Group Numbers

Group Numbers provide a way of categorising building materials by their relative performance when subject to a fire. A Group Number can be achieved by testing to either Standard ISO 9705 or ISO 5660.

Group Numbers are assigned based on the time taken to release 1MW of heat (flashover) within the test room. Materials in Group Number 1 are the least flammable and those in Group Number 4 are the most flammable. However, Group Number 3 materials are the maximum allowed under the current Code clause C3.4.

After the 2012 changes took effect a number of stakeholders raised concerns about including these prescriptive requirements at Building Code level. Feedback raised concerns that prescriptive performance requirements effectively meant alternative test methods or performance-based fire engineering design could no longer be used to demonstrate Code compliance.

Another unintended consequence of the performance requirement C3.4 changes was that timber lining and surface finishes could not be used within any 'crowd' use as timber does not meet Group Number 1 or 2 required for this building use. This was further compounded by the lack of definition for 'crowd', which was generally interpreted as a space for public use. In 2015 MBIE highlighted this particular issue with the regulatory settings by issuing two separate determinations[2] that recommended modifying clause C3.4 to permit timber linings in small buildings with additional design features.

In December 2016, MBIE changed the Acceptable Solutions C/AS2-C/AS7 so other test methods (specifically Australian and European Standards) could be used to achieve Group Numbers. Despite these changes, the code remained prescriptive and the use of timber linings limited.

MBIE formed a working group of building sector representatives (architects, specifiers, timber industry, BRANZ) with the objective to review the performance requirement C3.4, test the applicability of the Group Number testing protocol (ISO 9705) and provide guidance on any relevant changes to the NZBC. This discussion document summarises the findings of the working group and presents discussion points intended to test the relevance of these findings.

[2] Determinations 2015-010 and 2015-022, available at www.building.govt.nz (search 'previous determinations')

Specific issues with clause C3.4

MBIE has observed the following issues with the current performance requirement C3.4:

- **Test methods** – The clause cites test methods (IS0 9705:1993 and ISO 9239.1:2010) when other test methods may be suitable.
- **Crowd definition** – The use of the term 'crowd' in relation to building uses is problematic as it is not defined, is too broad, and its interpreted meaning has resulted in very restrictive enforcement. By its broad definition, the term 'crowd' captures a variance in building use and vulnerability of occupants applying the same limitations to a hairdresser salon as to an arena. As a result the Building Code requirements are often overly restrictive for some smaller buildings and tenancies.
- **Timber** – Untreated timber achieves a Group 3 classification when tested to ISO 9705. All 'crowd' use occupancies currently require a Group 2 or better classification for walls and ceilings. Therefore, all timber requires an applied treatment before it can be used in any crowd use occupancy, irrespective of the volume of timber used.
- **Exemptions** – The Acceptable Solutions contain exemptions for education buildings, trampers' huts and marae buildings that do not align with the Building Code requirements.
- **Household units** – The current performance requirement contradicts itself with regards to household units, as these are listed in the limit on application but included in C3.4 a).
- **Building services** – Performance requirements for pipes and ducts are specified but these are not naturally considered internal surface linings. These need to be controlled due to their conduit ability to transfer spread of fire and smoke.
- **Existing buildings** – There are problems when assessing alterations to existing buildings under section 112 of the Building Act for compliance 'as nearly as is reasonably practicable' (ANARP) due to the rigidity of having a fire test standard at Code level.

The proposals presented for discussion change the current regulatory framework for specifying internal surface finishes.

Reassessing risk

Internal surface finishes need to be appropriate for the vulnerability of the risk group and the probability of fire occurring in the space where they are exposed. By defining specifics with the performance requirement for surface finishes, the current Code clause 3.4 does not allow performance-based design. Reviewing this clause to remove the specifics and define 'crowd' in terms of the risk profile reintroduces the ability to undertake performance based design. As a consequence, internal surface linings can be assessed with due regard to the risk profile of the building.

Proposed Building Code clause C3.4 to remove prescriptive requirements

Proposed wording for Building Code clause C3.4

Performance requirement

The spread of fire and development of smoke from *internal surface finishes* on walls, ceilings, floors and suspended flexible fabrics must result in a low probability of injury or illness to persons escaping a fire when considering:

(a) geometry and characteristics of the escape routes; and
(b) number and type of the occupants; and
(c) function and use of the occupied space; and
(d) the fire hazard; and
(e) the active fire safety systems installed in the building.

Limit on application

Clause C3.4 does not apply to *detached dwellings*, *outbuildings* or *ancillary buildings*.

Explanation:

- The proposed performance requirement is now written to have a qualitative performance relative to the occupancy, use and type of protection provided in an occupied space. The proposal does not include prescriptive requirements. These are to be retained in the Acceptable Solutions and the Verification Method (C/VM2).
- The proposed clause now requires the same performance criteria for walls and ceilings, flooring and flexible fabrics.
- The risk based approach allows for future development in research of reaction of materials to fire for developing innovation in alternative solutions.
- Household units in multi-unit dwellings are no longer in the limit on application (this is a conflict in the current clause, as they are included in the table in the current clause).

Note: The proposed clause aligns with international precedence. The clause is similar to the National Construction Code of Australia clause CP4:

> To maintain tenable conditions during occupant evacuation, a material and an assembly must, to the degree necessary, resist the spread of fire and limit the generation of smoke and heat, and any toxic gases likely to be produced, appropriate to –
>
> (a) the evacuation time; and
> (b) the number, mobility and other characteristics of occupants; and
> (c) the function or use of the building; and
> (d) any active fire safety systems installed in the building.
>
> **Application:**
> CP4 applies to linings, materials and assemblies in a Class 2 to 9 building.

The clause also uses some of the language in the current Code clause 3.4(c):

(*c) suspended flexible fabrics and membrane structures used in the construction of buildings must have properties resulting in a low probability of injury or illness to persons not in close proximity to a fire source.*

The term 'low probability' is used extensively throughout the Code and is considered appropriate to apply to internal surface finishes clause C3.4.

What do you think?

1.1. Do you agree with the proposal to move the prescriptive requirements out of Code clause C3.4? If not, why not?

1.2. Do you agree with the proposed wording for this clause? If not, why not and what would you suggest?

New definitions in the Acceptable Solutions and Verification Method, for 'internal surface finishes' and 'place of assembly'

Proposed definition to: C/AS2-7 Paragraph 4.17.6 and C/VM2 4.7 Design scenario IS: Rapid fire spread involving internal surface finishes

Internal surface finishes are exposed internal faces of walls, ceilings and floors in occupied spaces that have the potential for the spread of flame and smoke development that will hinder evacuation from fire.

Internal surface finishes do not include:

a) fixtures or fittings including joinery, cabinetry, free standing screens and wall features
b) electrical switches, outlets, cover plates and similar small items
c) building services including pipes, pipe insulation, ducts, acoustic treatment, cables, cable trays and luminaires
d) trim such as architraves, skirting, handrails, stair nosings, tactile indicators, and other narrow items
e) doorsets, window frames and components, including reveals
f) structural timber building elements constructed using solid wood, glulam, laminated veneer lumber, cross-laminated timber, of no more than 25% of the total wall area
g) permanently installed openable wall partitions with a total surface area of no more than 25% of the divided room floor area
h) uniformly distributed roof lights with a total area of no more than 15% of the ceiling area (in plan), in a space with a minimum floor to ceiling height of not less than 6.0 m.

Explanation:

- This definition will help clarify the objective where limited combustibility of surface finishes are required, and building elements to which the requirements of Code clause C3.4 apply.
- The current list of exemptions is revised to include more commonly used architectural terms given internal surface finishes are predominantly specified by architects and designers.
- The definition should resolve some industry uncertainty regarding to what constitutes an internal surface finish. Sector feedback advised that application of clause C3.4 varied, with particular reference to differentiating between wall-mounted furniture and a surface finish. Providing a more clear definition enables the specifier to answer the question "Do I need to treat this as a surface finish?"
- The guidance provided by the definition allows clarification between surfaces and services.

What do you think?

1.3. Do you agree with the proposed definition of 'internal surface finishes'? If not, why not?

1.4. Do you agree with the revised list of exemptions to the 'internal surface finishes'? If not, what would you suggest?

Proposed definition of 'place of assembly' in C/AS2-7 and C/VM2
Place of assembly Occupied spaces where people gather for a common activity, interest or purpose where escape routes are likely to be unfamiliar to the occupants.
Explanation: • This definition replaces the term 'crowd' used in the current clause C3.4 a). • The definition allows refinement of the CA risk group profile to reflect the risk of exposure to fire and the vulnerability of this risk group. The term crowd and its application in the NZBC Part C Acceptable Solutions and Verification Method C/VM2 currently classifies a small hairdressing salon in the same risk profile as a large sporting area. • By defining a new term, 'place of assembly', it is intended to describe those spaces which can contain people densely grouped together who may not be familiar with their surroundings, and which can lead to extended evacuation times. • Defining this term also allows more appropriate distinctions within the Acceptable Solutions for the applicability of surface finishes within buildings accessed by the public. For example, this could mean Group Number 3 materials can be used in low risk areas (refer to the following proposal for a revised Table 4.1).

What do you think?

1.5. Do you agree with the definition of 'place of assembly'? If not, what changes would you suggest?

Revised requirements for internal surface finishes

Revision of C/AS2-6 Paragraph 4.17.1 and Table 4.1 and C/VM2 4.7 Design scenario (IS): Rapid fire spread involving internal surface finishes

Internal surface finish requirements shall be as specified in Table 4.1.

Table 4.1	**Internal surface finishes – wall and ceiling linings**				
Fire protection	**Maximum permitted Group Number**				
	Exitways and Importance Level 4 buildings: walls and ceilings	Sleeping spaces where care or detention is provided: walls and ceilings	Other sleeping spaces and places of assembly > 100 people: ceiling surfaces	Other sleeping spaces and places of assembly > 100 people: wall surfaces	All other occupied spaces: walls and ceilings
Unsprinklered	1-S	1-S	2-S	2-S	3
Sprinklered	2	2	2	3	3

NOTE:
The requirements of this table do not apply to detached dwellings, outbuildings or ancillary buildings.

Explanation:

- The changes propose that '*places of assembly*' for less than 100 people have less stringent requirements for internal surface finishes as these are lower risk spaces. These spaces have faster evacuation times as they require a minimum of two escape routes, which will provide inherently larger escape widths.
- Internal surface finishes of household units within detached dwellings do not need to be controlled and this amendment will make it clear they are excluded from these requirements. The Group Numbers will only apply to household units in multi-unit dwellings where these have common means of escape.
- The use of foamed plastics in detached dwellings and outbuildings will continue to be restricted to limit fire growth within Acceptable Solution C/AS1.
- Trampers' huts will continue to have restrictions on the use of timber depending on occupant numbers and number of escape routes in the Acceptable Solutions.
- Marae buildings with traditional Māori construction will continue to be exempt from requiring Group Numbers. However, they will have restrictions on travel distance and escape width within the Acceptable Solutions. The use of the Verification Method is not permitted for these buildings.

- The requirements for flooring and suspended flexible fabrics remain, with the same prescription for compliance within the Acceptable Solutions C/AS2-6.

What do you think?

1.6. Do you agree with the proposed changes to internal surface finish requirements as set out in Table 4.1? If not, why not?

1.7. Are there any other changes you suggest to the internal surface finish requirements set out in Table 4.1? If so, please give your reasons.

Rewrite of Design scenario (IS) in the Verification Method for internal surface finishes

Revision of C/VM2 4.7 Design scenario (IS): Rapid fire spread involving internal surface finishes

Scenario in brief	Internal surface finishes are exposed to a growing fire that potentially endangers occupants.
Code objective	C1(a) *Safeguard people from an unacceptable risk of injury or illness caused by fire*.
What you must satisfy	The performance criteria in NZBC C3.4 for *internal surface finishes* and suspended flexible fabrics. Requirements for wall and ceiling elements that include foamed plastics or combustible insulating materials shall be as in accordance with Appendix A. Testing requirements for materials or coatings usually applied to a substrate shall be as in accordance with Appendix A.
Required outcome	Demonstrate that internal surface finishes comply with these performance requirements.

Scenario description

The performance criteria required for *internal surface finishes* will depend on their location within a building, the use of the building and its occupancy. These criteria shall be applied to all internal surface finishes apart from the exceptions listed in Acceptable Solutions C/AS2 to C/AS6 paragraph 4.17.6.

Group Numbers shall be determined following the procedures in Appendix A.

Method

For the *internal surface finishes* of walls and ceilings, use either Method 1 or Method 2 for each firecell.

Flooring shall either be:

- non-combustible or,
- when tested to ISO 9239:1 (radiant panel test), shall have a critical radiant flux of not less than that required by Table 4.2 in Acceptable Solutions C/AS2 to C/AS6. A critical radiant flux may be assigned to some flooring materials without any further evaluation using Appendix B.

Suspended flexible fabrics shall, when tested to AS 1530:2 (flammability test), within all occupied spaces including *exitways*:

- have a flammability index of no greater than 12, and
- when used as underlay to roofing or exterior cladding that is exposed to view, have a

flammability index of no greater than 5.

Pipes and ducts

For pipes and ducts refer to Table 4.3 of the Acceptable Solutions C/AS2 – C/AS6.

Method 1 Tabulated values

Use the tabulated values for Group Numbers directly from Table 4.1 in Acceptable Solutions C/AS2 to C/AS6 as appropriate for each occupied space within the firecell.

Method 2 Calculation

For any spaces where Group Numbers from Acceptable Solutions C/AS2-6 are not used, re-run the ASET vs RSET analysis for Design scenarios CF and RC using the design fire characteristics in Table 4.3.

In all circumstances, the internal surface finish shall not exceed Group Number 3.

Method 2 cannot be used for exitways, household units, Marae buildings or sleeping spaces where care or detention is provided, spaces capable of storage to a stack height of more than 3.0 m, or car parks with stacking systems.

Table 4.3	**Design fire characteristics for *internal surface finishes* for occupied spaces with a storage height of less than 3.0 m**		
Fire growth rate (kW)	**Species**	**Radiative fraction**	**Peak *HRR/* *HRR*/m^2**
0.188 t^2	Ysoot= 0.07 kg/kg YCO= 0.04 kg/kg ΔHC= 20 MJ/kg YCO_2= 1.5 kg/kg YH_2O= 0.82 kg/kg	0.35	20 MW 500 – 1000 kW/m^2 250 kW/m^2

KEY:
t = time in seconds
H = height to which storage is capable of in metres
Y = *yield* kg/kg
ΔHC = heat of combustion

NOTES:

1. As an alternative to CO2 + H2O *yields* use generic fuel as CH2O0.5 and calculate *yields*.
2. In a CFD model the *fire* is intended to be modelled as a plan area where the size is determined from the peak *HRR*/m^2. A range is provided for *HRR*/m^2 to accommodate different *HRR* and mesh sizes.
3. Use in a zone model.

Explanation:

- This proposal replaces the current design scenario (IS): Rapid fire spread involving internal surface linings. Method 1 remains prescriptive as a ways to meet the requirements for design scenario IS. This proposal provides an alternative fire design method, Method 2, which allows Group 3 materials to be used, where appropriate, by means of assessing the fire safety of the occupied space.
- Note that the criteria in Method 2 references the revised Table 4.1 (for internal surface finishes) and revised list of exemptions contained in earlier proposals.
- Method 2 would be applicable to high volume spaces where the use of combustible surface finishes can be justified by fire engineering analysis, as it takes a longer time for such a space to fill with smoke and reach untenable conditions.
- Method 2 would also allow the number of escape routes to be adjusted to compensate for combustible surface finishes.
- Method 2 is only applicable in areas that are not critical to the escape route or are high risk areas (e.g. exitways and sleeping spaces provided for care and detention). The method will not permit Group Numbers higher than 3, which is a premise of both the Acceptable Solution and Verification Method.

At present, there is not enough research to provide an accurate assessment of fire spread on internal surface finishes. In the meantime, as a conservative assumption, a faster fire growth must be predicted where combustible surface finishes are proposed. The faster fire growth (i.e. ultra-fast fire) simulates the influence of wall linings contributing to fire growth.

What do you think?

1.8. Do you agree with the proposed changes to Design scenario (IS): Rapid fire spread involving internal surface finishes? If not, why not?

1.9. Is there anything else you suggest adding to or changing in Design scenario (IS)? Please give your reasons.

Requirements for pipes and ducts to be defined separately in the Acceptable Solutions C/AS2-7 and Verification Method C/VM2

New C/AS2-7 paragraph 4.18.3 and Table 4.3, and addition to C/VM2 4.8 Design scenario (CF): Challenging Fire

The surfaces of building services shall be as per Table 4.3.

Table 4.3	Surfaces of building services	
Maximum Permitted *Group Numbers*		
Building services	***Spaces* not protected with an automatic *fire* sprinkler system**	***Spaces* protected with an automatic *fire* sprinkler system**
Internal surfaces of ducts for *HVAC systems* and *kitchen exhaust ducts*[1]	1-S	2
External surfaces of ducts, acoustic and pipe insulation of services within exitways[1]	1-S	2
Acoustic and pipe insulation of services within sleeping uses	2-S	2
External surfaces of ducts for *HVAC systems*[1]	3	3

Note:

1. Surfaces of rigid and flexible ductwork for *HVAC* systems shall be assigned a *Group Number* of 1-S when the ductwork complies with the fire hazard properties, as set out in AS 4254.

Explanation:

- The requirements for pipes and ducts move from the current Code clause 3.4(a) to the Acceptable Solutions. They are rehomed under paragraph 4.18 Building Services Plant to differentiate services from building structure.
- The requirements for services can then be linked to the performance requirements of clause C4.3 regarding movement to a place of safety.
- The terminology changes from buildings to spaces, to ensure concealed spaces without sprinklers are included and higher requirements are clarified.

What do you think?

1.10 Do you agree with moving the requirements for pipes and ducts to Acceptable Solutions C/AS2-7 and Verification Method C/VM2? If not, why not?

1.11 Do you have any suggested changes to the proposal to move pipes and ducts to C/AS2-7 and C/VM2?

Specified performance for some typical finishes added to Appendix C of the Acceptable Solutions

New paragraph C4.1.3 and Table C2 for C/AS2-6 Appendix C

For the purposes of compliance with the *internal surface finish* requirements, the following specified combinations of substrate and coating in Table C2 can be taken as having the performance indicated without the need for further evaluation using C/VM2 Appendix A paragraphs A1.2 or A1.3.

Table C2	**Specified performances for some substrate and coating combinations**	
Coating (coating in good condition and well adhered to substrate)	**Substrate**	**Group Number (with or without coating)**
Waterborne or solvent borne paint coatings ≤ 0.4 mm thick Polymeric films ≤ 0.2 mm thick	Concrete and masonry ≥ 15 mm thick Sheet metal ≥ 0.4 mm thick, Fibre-cement board ≥ 6.0 mm thick Non-combustible materials such as porcelain, ceramic, glass, solid stone	1-S
Waterborne or solvent borne paint coatings ≤ 0.4 mm thick	Gypsum plasterboard with or without paper facing ≥ 9.5 mm thick ≥ 400 kg/m^3 core density < 5% wt organic contribution to board	2-S
Waterborne or solvent borne paint coatings, varnish or stain ≤ 0.4 mm thick ≤ 100 g/m^2	Solid wood or wood product ≥ 9.0 mm thick ≥ 600 kg/m^3 for particle boards, or ≥ 400 kg/m^3 for all other wood and wood products	3
Note: The requirements of this table do not apply to metal faced panels with polymeric substrate.		

Explanation:

- The proposed table C2 is a reproduction of the existing 'deemed to comply' table (Table A1) from C/VM2 for typical surface finishes with the addition of non-combustible materials.
- Including this table in the Acceptable Solutions makes it clear these systems are also applicable for Acceptable Solution designs.

What do you think?

1.12 Do you agree with the proposal to add specified performances for typical finishes to the Verification Method? If not, why not?

New alternatives for testing critical radiant flux for flooring

Proposed new Paragraph C8.1 and Table C1 for C/AS2-7 Appendix C

C8.1 Flooring

……………………..……

For flooring systems an alternative fire test can be provided as described in Table C1.

Table C1	Approved European classification using EN 13501.1 to achieve critical radiant flux
Critical radiant flux when tested to ISO 9239.1	Critical radiant flux when tested to EN ISO 9239.1
Non-combustible	$A1_{FL}$ (non-combustible)
4.5 kW/m²	$A2_{FL}$ (≥ 8.0 kW/m²), B_{FL} (≥ 8.0 kW/m²), C_{FL} (≥ 4.5 kW/m²)
2.2 kW/m²	D_{FL} (≥ 3.0 kW/m²)
1.2 kW/m²	$A1_{FL}$ (non-combustible), $A2_{FL}$ (≥ 8.0 kW/m²), B_{FL} (≥ 8.0 kW/m²), C_{FL} (≥ 4.5 kW/m²) or D_{FL} (≥ 3.0 kW/m²)

Explanation:

- This table introduces alternative compliance for flooring materials tested to European Standards together with the current ISO test to allow the use of products imported from Europe.

What do you think?

1.13 Do you agree with introducing alternative fire tests for testing critical radiant flux for flooring? If not, why not?

1.14 Are there any changes you would suggest to the proposal to introduce new alternatives for testing critical radiant flux for flooring? Please give your reasons.

Appendix B: Proposal 2 detailed changes

Proposal for changes to Building Code clause C6 and associated documents in relation to the performance of structures affected by fire

What MBIE is consulting on and why

MBIE is proposing changes to Building Code (NZBC) clause C6 in relation to the performance of structures affected by fire. This proposal seeks to address known issues with clause C6, and to accommodate certain acceptable designs and behaviours in relation to fire.

The proposed changes will:

- add a performance criteria for the protection of occupants during fire
- replace or redefine incorrect and unclear terms
- allow at Code level structural behaviour as a result of fire that is not currently accommodated but is sometimes acceptable (for example, progressive inward movement of exterior walls and roofs in single storey buildings and in the top level of multi-storey buildings)
- simplify the performance criteria for the protection of other property
- correct inconsistencies in usage of the terms ‘during fire’ and ‘after fire’, and
- accept at Code level that building elements with lesser fire resistance can support building elements with higher fire resistance, provided that failure of the former as a result of fire does not detrimentally affect the latter

This proposal includes some consequential changes to Building Code clause A2 Interpretation, Verification Method B1/VM1, and Acceptable Solutions C/AS1-C/AS6. Amendments to Verification Method B1/VM1 will clarify how the fire combination actions are to be applied, and confirms that they need not be applied to houses, townhouses, small multi-unit dwellings and outbuildings that comply with C/AS1 and B1/AS1.

Proposals at a glance

Revise Building Code clause C6	Reword this clause to address known issues, and to accommodate certain acceptable behaviour that can result from fire.
New and amended definitions in Code clause A2: Interpretation	Replace '*stability*' – currently a component of a *fire resistance rating (FRR)*, which is incorrect – with *structural adequacy* as is currently in the definition in C/AS1-7. Add a new definition (taken from C/AS1-6 and slightly amended) for *primary elements* to cover its usage in the revised Code clause C6.
Make related changes to Verification Method B1/VM1 and Acceptable Solutions C/AS1-C/AS6	Changes include: ○ Clarify the application of the 0.5 kPa lateral load requirement in B1/VM1, and that it applies to C/AS2-6 designs. ○ Make it explicit in C/AS1 that the 0.5 kPa lateral load does not apply to C/AS1 and B1/AS1 buildings. ○ Slightly amend the definition of *primary elements* in C/AS1-C/AS6 to align with the new definition in Code clause A2. ○ Correct the comment in the definition of *structural adequacy* in C/AS1 (and C/VM1). ○ Update the wording used in paragraph 4.3 in C/AS2-6 to align with the revised wording in Code clause C6.

Context for change

In 2012 the NZBC C-clauses (Protection from fire) were reviewed and amended. Changes to clause C6 (until then, known as clause C4) included the following:

- The performance objectives were moved into clause C1.
- The concept of low probability was introduced into the functional requirements.
- The rigid hierarchy of fire resistance was removed, and
- Fire resistance of structural elements was replaced with requirements for the stability of structural systems in order to protect *other property* and firefighters.

However, MBIE and stakeholders recognised that the revised clause (the current C6) contained some inconsistent wording and did not accommodate certain acceptable structural behaviours of buildings as a result of fire.

In 2008, B1/VM1 (Amendment 8, paragraph 2.2.4) replaced clause 4.2.4 in AS/NZS 1170.0 and required the uniformly distributed horizontal face load of 0.5 kPa to be applied in any direction on remnant buildings after fire.

In New Zealand, AS/NZS 1170.0 is currently amended by B1/VM1 as follows:

2.2.4 AS/NZS 1170 Part 0, Clause 4.2.4
Replace the Clause with the following:

"The combination of actions for checking strength and stability for the ultimate limit state for *fire* shall be as follows:
(a) During the *fire*:
(i) [G, thermal actions arising from *fire*, ψ_lQ]
together with:
(ii) a lateral force of 2.5% of (G + ψ_cQ) applied as per Clause 6.2.2.

(b) After the *fire* until the building is either repaired or demolished:
(i) [G, thermal actions arising from *fire*, ψ_lQ]
together with the more critical of either:
(ii) a lateral force of 2.5% of (G + ψ_cQ) applied as per Clause 6.2.2.
or
(iii) a uniformly distributed horizontal face load of 0.5 kPa in any direction.

Account shall be taken of the effects of the *fire* on material properties and the geometry of the structure."

As there is no reference to external walls in the amendment the actions apply to all parts of the structure. Also, the amendment requires that the load be applied in any direction.

The value of 0.5 kPa was derived from NZS 1900 Chapter 5 (published in 1963) which required free-standing cantilever walls to resist a face load of two thirds of the wind load or half of the earthquake load, which was approximately 0.5 kPa in many cases.

The lateral load of 0.5 kPa for remnant structures after fire is greater than loads used in international standards. It is generally considered that the load of 0.5 kPa after fire is conservative because the building area will be made inaccessible after any severe fire, removing the immediate threat to life safety.

AS/NZS 1170.0.0

This joint Australian and New Zealand standard for structural design actions (general principles) provides designers with general procedures and criteria for the structural design of buildings. It outlines a design methodology that is applied in accordance with established engineering principles. The un-amended text of AS/NZS 1170.0 clause 4.2.4, as used in Australian practice, is:

"4.2.4 Combinations of actions for fire
The combination of factored actions used when confirming the ultimate limit state for fire shall be as follows:
[G, thermal actions arising from the fire, $\psi_l Q$]
NOTE: Where it is appropriate to consider the stability of remaining walls that may collapse outwards after a fire event, other ultimate limit states criteria are given in Section 6."

Specific issues with Building Code clause C6

MBIE has observed specific issues with the current Building Code clause C6 and definitions in clause A2 that include:

- The current wording does not allow for progressive inward movement of external walls and non-fire-rated roofs after occupant evacuation in single level buildings or at the top level of multi-storey buildings, which is accepted practice. (Refer to the “reassessing risk” note box below.)
- It does not include a performance criterion for the protection of occupants during fire, relying upon other C-clauses for coverage.
- It relies upon the term ‘structural systems’ which is not defined.
- It has a detailed performance criterion for the protection of ‘other property’ which could be simplified.
- There is some inconsistency in the use of the terms ‘during fire’ and ‘after fire’ – the functional requirement is ‘during fire’ but the performance criteria are ‘during fire and after fire’.
- The current wording does not allow for building elements with lesser fire resistance to support building elements with higher fire resistance. However, in instances where the failure of the former as a result of fire does not detrimentally affect the latter, this should be acceptable.

Reassessing risk

Paragraph 4.5 in C/AS2 to C/AS6 states that “an FRR of zero may apply to some walls and most roofs” and applies to single storey as well as multi-storey buildings. Exceptions apply when fire spread through a roof can result in vertical fire spread to other parts of the building or to other buildings.

In most cases the non-fire-rated roof will collapse early in the fire, leading to the possibility of collapse of the exterior walls. Wall panels falling/leaning inwards during a fire are not a safety issue because no-one will be inside the building during extreme post-flashover conditions. If the exterior wall panels move inwards, fire spread can be prevented by making sure the panels are well tied to each other to prevent any major gaps between these panels during the fire.

Revise Building Code clause C6 and add definitions to clause A2

Proposed wording for Building Code clause C6
Clause C6 – Structural performance **Functional requirement** C6.1 *Buildings* must retain structural performance when affected by *fire* to ensure a low probability of: a) injury or illness to occupants, b) injury or illness to fire service personnel during rescue and firefighting operations, and c) direct or consequential damage to *other property*. **Performance** C6.2 *Primary elements* and their connections must be designed and constructed so that structural performance, required to protect occupants during fire, is maintained. C6.3 *Primary elements* and *external walls*, including their connections, must be designed and constructed so that structural performance, required to protect firefighters during rescue and firefighting operations, is maintained. C6.4 *Primary elements* and *external walls*, including their connections, must be designed and constructed so that collapse onto other property as a result of fire is prevented. C6.5 Failure of *building elements* having lesser fire resistance must no detrimentally affect *building elements* required to have a higher fire resistance.
Explanation: • This clause replaces the term 'structural stability' with 'structural performance'. The new wording allows for progressive inward movement after occupant evacuation of external walls and non-fire-rated roofs in single level buildings or the top level of multi-storey buildings, which is accepted practice. Like 'structural stability', it is considered that 'structural performance' is well understood and need not be defined. • Adds a performance criterion for the protection of occupants during fire (sub-clause C6.2). • Replaces 'structural systems' (which was not defined) with buildings, primary elements and external walls (which are defined) as applicable. The wider term 'buildings' is proposed for the functional requirements but cannot be included in the structural performance criteria because like 'building elements' includes building services. The defined terms primary elements and external walls have been adopted in C6.2-C6.4. (External walls captures concrete panels that are not necessarily primary elements.) • Simplifies the performance criterion for the protection of 'other property', in C6.4. • The terms 'during fire' and 'after fire' have been removed. • The new wording in C6.5 allows for building elements with lesser fire resistance to support building *elements* with higher fire resistance as this is acceptable in certain situations.

What do you think?

2.1 Do you agree with the proposed changes to Building Code clause C6? Why, or why not?

2.2 Do you think the term 'structural performance' is sufficiently well understood by structural engineers and fire engineers or should this be defined in Building Code clause A2?

2.3 Do you think the changes to C6 will allow fire engineers to demonstrate structural fire compliance with the code? If not why not?

Delete definition of stability in Building Code clause A2: Interpretation and the definition for structural adequacy
structural adequacy in the context of the standard test for *fire* resistance, is the time in minutes for which a prototype specimen has continued to carry its applied load within defined deflection limits.
Explanation: • 'Stability' is incorrectly defined in Code clause A2 as a component of a fire resistance rating (FRR). The structural component of an FRR is 'structural adequacy', not 'stability'. Hence, it is proposed to delete the current definition of 'stability' and add the definition of 'structural adequacy', as is currently used in the Acceptable Solutions C/AS1-C/AS7.

Proposed revision of existing definition for *fire resistance rating (FRR)* in Building Code clause A2: Interpretation
fire resistance rating (FRR) the term used to describe the minimum *fire* resistance required of *primary* and *secondary elements* as determined in the standard test for *fire* resistance, or in accordance with a specific calculation method verified by experimental data from standard *fire* resistance tests. It comprises three numbers giving the time in minutes for which each of the criteria *structural adequacy*, *integrity* and *insulation* are satisfied, and is presented always in that order.
Explanation: • Clarifies what this term means at Building Code level and matches the definition currently used in C/VM1 and C/AS1-C/AS7.

New definition for *primary element* in Building Code clause A2: Interpretation
primary element a *building element* providing the basic loadbearing capacity to the structure, or which if affected by *fire* may initiate structural collapse.
Explanation: • The term *primary element* is proposed to be introduced into Code clause C6, hence the need for this new definition in clause A2. • Copies and slightly amends the definition currently used in C/AS1-C/AS6, replacing 'and' with 'or' to capture cross-bracing members in braced structures. (Note that this amendment is also proposed for the Acceptable Solutions.)

What do you think?

2.4 Do you agree with the proposed definition updates for 'fire resistance rating (FRR)' and 'primary element' in Building Code clause A2? Why or why not?

2.5 Do you have any feedback on the proposed definitions listed in question 2.3? If so, please provide.

Revise requirements in Verification Method B1/VM1 for lateral loads

Proposed wording for B1/VM1 paragraph 2.2.4

2.2.4 AS/NZS 1170 Part 0, Clause 4.2.4

Replace the Clause with the following:

"The combination of actions for checking strength and stability for ultimate limit state affected by *fire* shall be as follows:

Primary elements shall be designed for:

(i) G, thermal actions arising from *fire*, $\Psi_l Q$, together with

(ii) A lateral force of 2.5% of (G + Ψ_cQ) applied as per Clause 6.2.2.

External walls not designed to be pulled inwards by a non-fire-rated roof shall be designed for:

(iii) A uniformly distributed horizontal face load of 0.5 kPa applied in any direction."

Explanation:

Changes to B1/VM1 in 2008 (paragraph 2.2.4) modified lateral loads on structures during and after fire. After these changes took effect stakeholders raised concerns which included:

- confusion about the terms during and after fire,
- an apparent lack of published justification for the remnant structure being subject to the 0.5 kPa load,
- and should the load be applied to external walls that are designed to collapse inwards.

There was also some confusion in the industry about whether smaller buildings and residential buildings also needed to be subject to the load.

- The revised paragraph 2.2.4 does not specify the most critical point in time at which the loads should be applied (during or after fire). For any particular building this will be dependant on the material properties, building geometry, and the expected *fire* severity.
- The reference to *primary elements* has been added to ensure that all *primary elements* including steel cross bracing members are designed for actions occurring as a consequence of *fire*.
- The proposed changes mean the 0.5 kPa load is not required for walls that are designed to be pulled inwards by a non fire-rated roof structure.
- The changes require that *primary elements*, including steel bracing elements, are designed to resist a lateral load of 2.5% of the building weight, which may be much less than a face load of 0.5 kPa on one face of the building. MBIE is seeking feedback in this consultation from structural engineers and structural fire engineers as to the adequacy of this proposed revision. The problem in single storey buildings is very different to tall buildings because repair or demolition of tall buildings may take much longer, and the possible consequences of a whole building collapse are much greater.

Note that no change is proposed for the concrete structures standard NZS 3101.1:2006 as amended by B1/VM1 paragraph 3.1. The standard includes requirements to prevent the outwards collapse of external walls in fire. In 2010 these requirements were modified in B1/VM1 so that external concrete walls are 'restrained from inwards or outward movement of the wall relative to the building structure'. This allows the primary structure to deform, taking the wall panels along with them. Hence no change is proposed for NZS 3101.1:2006 as amended by B1/VM1.

Outwards collapse after a fire is potentially far more dangerous than inwards collapse. It is unlikely that people will inside a severely fire damaged building without a proper assessment of the remaining structure. In order to maintain the protective function for *other property*, good design should ensure that the wall panels be well connected to each other so that gaps do not occur between panels allowing fire spread.

What do you think?

2.6 In your view, are the proposed loadings in B1/VM1 adequate? Why or why not? If not, what would you propose?

Amend Acceptable Solutions C/AS1-C/AS7 regarding structural performance and key definitions

Revised wording for paragraphs 4.3.2 and 4.3.5 in C/AS2-C/AS6

4.3 Performance of structures affected by fire

Stability of building elements having an FRR

4.3.2 *Primary elements* shall resist collapse under:

a) The design dead and live loads required by NZBC B1, and

b) Any additional loads caused by the *fire*.

Comment:

NZBC B1.3.3 (c) and (i) requires that structural stability takes account of temperature and fire.

Providing horizontal stability

4.3.5 *External walls* shall have their horizontal stability provided in one or more of the following ways:

a) Be cantilevered from a structural base having an *FRR* of no less than that of the *building element* concerned

b) Be supported within the *firecell* by other *building elements* having an *FRR* no less than that required for the element being supported. The *structural adequacy* and diaphragm action of supporting *building elements*, located entirely within a single *firecell*, must be assessed when exposed to *fire* from all relevant sides simultaneously

c) Be supported by *primary elements* outside the *firecell*

d) Be attached to a non fire-rated roof structure which is designed to collapse inwards during a *fire*.

Explanation:

The effect of the proposed changes are to prevent exterior wall panels from falling outwards will now be covered; i.e. to:

- support the walls with a fire-rated roof structure – paragraph 4.3.5 (b)
- support the walls with fire-rated cantilever columns – paragraph 4.3.5 (b)
- design the walls to cantilever from a fixed-base foundation – paragraph 4.3.5 (a)
- design the walls to be pulled inwards by a non-fire-rated roof structure – paragraph 4.3.5 (d).

Currently, C/AS2-C/AS6 all have the following identical paragraphs in Part 4 Control of internal fire and smoke spread:

4.3 Structural stability during fire

Stability of building elements having a FRR

4.3.2 During a *fire*, *primary elements* shall resist collapse under:

a) The design dead and live loads required by NZBC B1, and

b) Any additional loads caused by the fire.

Comment: NZBC B1.3.3 (c) and (i) requires that structural *stability* take account of vertical and horizontal loads, temperature and *fire* effects.

Providing horizontal stability

4.3.5 *Building elements* required to have an *FRR* shall have their horizontal *stability* provided in one or more of the following ways:

a) Be cantilevered from a structural base having an *FRR* of no less than that of the *building element* concerned

b) Be supported within the *firecell* by other *building elements* having an *FRR* no less than that required for the element being supported. The *structural adequacy* and diaphragm action of supporting *building elements*, located entirely within a single *firecell*, must be assessed when exposed to fire from all relevant sides simultaneously

c) Be supported by *primary elements* outside the *firecell*.

As it stands, paragraph 4.3.2 only requires *primary elements* to maintain structural stability during a *fire*, not after a *fire*. Note that the "design dead and live loads required by NZBC B1" do not include the lateral load of 0.5 kPa specified in paragraph 2.2.4 (b) (iii) of B1/VM1 because that paragraph is only for conditions after *fire*, not during the *fire*. It could be interpreted therefore that the load of 0.5 kPa is not required for designs in accordance with C/AS2-C/AS6. The proposed changes will eliminate this incorrect interpretation.

New paragraph 1.4 in C/AS1 (but no change to C/AS7 or C/VM2)

1.4 Performance of structures affected by fire

The structural design loads given in paragraph 2.2.4 of B1/VM1 do not apply to buildings that comply with this Acceptable Solution and B1/AS1.

Explanation:

- C/AS1 does not contain specific structural performance requirements equivalent to section 4.3 'Structural stability during fire' in C/AS2-C/AS6. Industry feedback has confirmed that the lateral load requirements in B1/VM1 should not apply to C/AS1 buildings (houses, townhouses, small multi-unit dwellings and outbuildings) constructed to B1/AS1. The new paragraph makes this explicit in C/AS1.
- Note there are no proposals for a similar paragraph in C/AS7 (buildings used for vehicle storage and parking) or C/VM2. It is considered that current requirements in these two documents for structural performance in fire are adequate and/or being addressed elsewhere.

What do you think?

2.7 Do you agree with the proposed changes to C/AS2-C/AS6 regarding performance of structures affected by fire? Why, or why not?

2.8 In C/AS2-C/AS6 the requirements for the performance of structures affected by fire are not exclusive to Part 4 'Control of internal fire and smoke spread'. Is section 4.3 as proposed above more appropriately located in a new Part 8 rather than in Part 4? If so, why? Alternatively, a simple clause could be added to Part 5 referring to the proposed requirements in section 4.3. If not, why not?

2.9 Do you agree with the proposed addition to C/AS1 to clarify that the lateral load requirements in B1/VM1 do not apply? Why, or why not?

2.10 Do you agree that the loads in paragraph 2.2.4 in B1/VM1 do not need to be highlighted in C/AS7 (buildings used for vehicle storage and parking) or C/VM2, or should these loading requirements be added to these documents? If so, why?

Proposed amended definition for *primary element* in Acceptable Solution C/AS1-C/AS6 (and C/VM1) Definitions

primary element a *building element* providing the basic loadbearing capacity to the structure, or which if affected by *fire* may initiate instability or premature structural collapse.

Comment:

Suspended floors in multi-storey *buildings* are *primary elements*.

Explanation:

- Changes ‘and’ to ‘or’ to capture cross-bracing members in braced structures.
- Note that this definition is not currently required in C/AS7.

Proposed amended definition for *structural adequacy* in Acceptable Solution C/AS1-C/AS7 (and C/VM1) Definitions

structural adequacy in the context of the standard test for *fire* resistance, is the time in minutes for which a prototype specimen has continued to carry its applied load within defined deflection limits.

Explanation:

- Deletes the incorrect comment below this definition.

What do you think?

2.11 Do you agree with the proposed amendments to the definitions of ‘primary element’ and ‘structural adequacy’ in these Acceptable Solutions? If not, why not?

Appendix C: Proposal 3 detailed changes

Proposed changes to C/VM2 Verification Method: Framework for Fire Safety Design

Proposals at a glance

This proposal outlines changes to Verification Method C/VM2 in relation to tall buildings as well as a range of general amendments and clarifications.

Through the MBIE Fire Programme it has become clear that the Verification Method C/VM2 is regarded as a successful new element in the fire regulatory system; one that has helped standardise fire engineering designs. However MBIE is aware that this Verification Method needs further development, particularly in relation to tall buildings (as outlined in the Practice Advisory 18: Fire safety for tall buildings issued mid 2016). Other areas, such as Design scenario (BE) Fire blocks exit, also require further clarification and explanation.

Tall buildings present additional risks to occupants and firefighters when escaping and firefighting at height. Additional measures are required for these buildings to safeguard means of escape, firefighting and protection of other property. A tall building is deemed to be any building above 60 m in height. The Verification Method is currently not height limited and needs to be updated for this type of building.

Tall building (height >60m) amendments include:

- modifications to Part 2 for the design FLED to introduce height factors for the rating (page 53)
- extending Design scenario (FO) for firefighting requirements for buildings with escape height > 60 m above ground or >10 m below ground (page 62)
- changes to Design scenario (RC) to provide additional redundancy for sprinkler systems (page 67)
- changes to Design scenarios (HS) and (VS) for reduced combustibility for cladding of tall buildings (page 58 and 60).

General changes to C/VM2 include:

- revising Part 1 Introduction and scope to clarify the purpose and scope of this Verification Method (page 51)
- moving the robustness check for single escape routes to Design scenario (CF) and adding in clarification of assessment of large firecells and special fire hazard (page 65)
- clarification of visibility assessment in stairwells in Design scenario (CF) (page 65)
- rewriting Design scenario (BE) Fire blocks exit to clarify application of the method and provide an alternative approach (page 56)
- updating Design scenario (VS) for protection of lower roofs (page 60)
- revising Design scenario (CF) for application of NZBC C4.4 for large occupancies and stairwells (page 65)

- revising Design scenario (HS) for radiant heat flux for storage buildings and requirements for special hazard (page 58)
- providing a new Appendix C for test methods for cladding systems (page 68).

Note that the proposal to change NZBC C3.4 contains related changes to this Verification Method; in particular, to Design scenario (IS).

Also note the proposal to change NZBC C6 contains related changes (to the scope of this Verification Method).

Revision to Part 1 Introduction and scope

Replace 1.1 Purpose:

1.1 Purpose

This is a Verification Method for the specific design of *buildings* to demonstrate compliance with NZBC C1-C6 Protection from fire. Where detail is not provided in this Verification Method, compliance shall be as per the Acceptable Solutions C/AS2-7 or by an alternative solution.

This Verification Method is suitable for use by professional fire engineers who are proficient in the use of fire engineering analysis.

Comment:

Clause C6 requires buildings to remain stable during a fire for protection of life safety and property protection. While C/VM2 provides fire resistance ratings of structural elements for the purposes of preventing the spread of fire, the detail for achieving structural stability of fire rated elements is prescribed by NZBC B1 and supporting structural design Standard cited in B1/VM1. Details for compliance are specified in Verification Method B1/VM1 and various structural standards cited within it.

1.2 Scope

The Verification Method can be applied to fire designs for all buildings, however for buildings that do not have simultaneous evacuation, require staff to assist in evacuation or contain special hazards additional measures required to comply with Fire Safety & Evacuation of Building Regulations 2006 and Hazardous Substances and New Organisms Act 1996 shall be developed and documented in the FEB with the understanding of all stakeholders.

Comment:

The Verification Method is an analysis tool for buildings with simple evacuation and typical fire growth rates. The method does not have additional requirements for managed evacuations or special fire hazard. The evacuation scheme or HSNO requirements of complex buildings can inform the fire design of the building and need to be agreed early in the design phase. Such buildings can include hospitals, care homes, stadia, transportation, large shopping malls, high rise buildings or buildings storing dangerous goods or foamed plastics. For example additional fire separations in hospital to enable staff to manage evacuations.

Explanation:

- At present, the Verification Method does not provide compliance for Code clauses C2 and C6. The proposal provides a means of compliance with these clauses.
- Note that there is a separate proposal to amend Clause C6.

What do you think?

3.1 Do you agree with the revisions to clarify the compliance with the Building Code of this Verification Method? If not, why not?

3.2 Do you agree with the clarification of scope of the Verification Method for managed buildings? If not, why not?

Revision to Part 2: Rules and parameters for the design scenarios

Revise Paragraph 2.4.1 Modifications to the design FLED:

Table 2.3: F_m factors to be applied to FLED

Table 2.3	**F_m factors to be applied to FLED**	
Building height	**Sprinklered firecells**	**Unsprinklered firecells**
≤ 60m	0.5	1.0
> 60m and ≤ 100m	1.0 for columns 0.75 for floors, beams and fire separations	2.0
> 100 m	1.5 for columns 1.25 for floors, beams and fire separations	3.0

Note:
For fire doors within fire separations the F_m factor shall be 0.5 for sprinklered firecells and 1.0 for unsprinklered *firecells*. Maximum fire resistance rating shall be 120 minutes FRR for *FLED* of < 1200 MJ/m^2.

Explanation:

- The Verification Method C/VM2 currently does not address building height risk. The amendment addresses clauses NZBC C3.9, C4.5, C5.8 and C6.2 where the likelihood and consequence of failure of structure during fire in tall buildings need to be considered.
- Failure of fire safety systems such as sprinklers and passive protection in tall buildings could have significant impact on occupants, firefighters and wider society.
- The factors to be applied to the FLED allow for uncertainty in sprinkler activation, structural protection and non-uniform fire loads.
- This table 2.3 removes the term ‘dependable deformation’ as it is no longer applicable, as modern material has dependable deformation.
- The F_m factor is higher for columns because a single column can be affected by a severe local fire generated by high local FLED in the vicinity of that column to a greater extent than a floor system. Failure of beams or floor systems is less susceptible to global structure collapse due to load sharing capabilities.

What do you think?

3.3 Do you agree with the proposed FLED changes for tall buildings in Table 2.3? If not, why not?

3.4 Do you agree with the removal of dependable deformation in the table? If not, why not?

3.5 Do you agree with the cap of 120 minutes FRR on strucutural fire rating? If not, why not?

Revision to Part 3: Movement of people

Add to the end of Paragraph 3.2.4 Travel time:

For early childhood care or where occupants are under the care of trained staff, the travel speed shall not exceed 0.6 m/s.

Comment:

From PD 7974-6 the average speed of 1.2 m/s is a considered a suitable speed to assess the escape time for the most remote person. However, for vulnerable populations where the majority will have slower mobility a lower travel speed shall be used.

Move part of the comment to in Paragraph 3.2.5 Time if flow governs to text at the end of this paragraph and add a new comment:

The egress analysis should be undertaken for the entire building and over the entire length of the escape routes, ensuring that the merging of occupant flows does not restrict egress at some point closer to the final exit.

Comment:

Where there is excessive queueing a delayed or phased/sequential evacuation strategy should be considered or additional exit capacity provided.

Add to the end of Paragraph 3.3: Requirements for delayed evacuation strategies:

Where evacuation is delayed a means of communication shall be provided to all floor levels.

Comment:

Communication can be provided via a voice communication system incorporated into the fire alarm system such as AS 2220 together with NZS 4512 and NZS 4541 or equivalent standards.

Where evacuation is phased smoke ingress shall be limited to between floor levels for the period of *RSET*.

Comment:

One method of limiting the passage of smoke to other *firecells* is to shut down air handling systems where sprinklers are provided. Alternatively, smoke dampers can be provided where ventilation ductwork passes through a fire separation or a zone pressurisation system where sprinklers are not provided.

Explanation:

- In tall buildings doors into stairwells are open for longer, increasing the risk of smoke flow into stairwells. Phased evacuation allows the occupants of the fire floor to escape first and reduces queueing. This in turn reduces the time that stairwell doors are held open and reduces the disruption to the rest of the building.
- Communication systems provide a means of relaying information to floors which are being temporarily held as place of safety for fire wardens and the Fire Service.
- Where there is partial evacuation it is important that the areas which are not being evacuated are separate smoke zones and are kept free of smoke while occupants wait to evacuate. BS 9999 outlines requirements for progressive evacuation and for smoke dampers fitted to ventilation systems where sprinklers are not provided.
- Within any occupancy population there will be a range of occupant mobility and travel speeds. Travel speed is to be adjusted where most people are expected to have mobility issues and need help to escape. Travel speeds are to be agreed through the FEB consultation with Stakeholders.

What do you think?

3.6 Do you agree with addressing the whole building escape within the stairwells? If not, why not?

3.7 Do you agree to the proposed requirements for phased evacuation? If not, why not?

3.8 Do you agree with the change to travel speed from 1.2 m/s to 0.6 m/s for less mobile occupants? If not, why not?

Revision of Design scenario (BE): Fire blocks exit

Replace the scenario description and method with the following:

Scenario description

This scenario addresses the concern that an *escape route* may be blocked due to proximity of the *fire source*. In this event, the number of exits must be sufficient for occupants to escape before *ASET* is reached.

This scenario applies to *escape routes* serving the building or part of the building that*:*

a) serve more than 50 people, or

b) have a single direction of travel.

Method

This design scenario requires the following:

a) Any horizontal *escape route* (including a horizontal exitway) that serves more than 50 people requires a second escape route.

b) Any vertical safe path that is a single escape route shall have a maximum capacity of 150 people in an unsprinklered *building* or 250 people in a sprinklered *building*.

c) The maximum horizontal open path travel distance along the escape route to reach an exitway shall be:

  - no more than 40 m with sleeping use, or
  - no more than 50 m if occupants are unfamiliar with the *building*, or
  - no more than 75 m if occupants are familiar with the *building.*

d) For *buildings* where a vertical safe path provides a single means of escape from one or more floors but not others, the vertical safe path shall be designed such that the maximum capacity is not exceeded.

In order to be regarded as alternative *escape routes*, the routes shall be separated from each other and shall remain separated until reaching a *final exit*. Separation shall be achieved by diverging (from the point where two *escape routes* are required) at an angle of no less than 90° until separated by:

a) a distance between closest parts of the escape routes of at least 8.0 m when:

  i. up to 250 occupants are required to use the *escape routes*, or

  ii. more than 250 occupants are requiring escape through more than two *escape routes,* or

b) at least 20 m when more than 250 occupants are required to escape through only two *escape routes*, or

c) *smoke separations* and *smoke control doors*.

As an alternative to separation of *escape routes* an *ASET/RSET* calculation can be provided using Equations 3.7 and 3.8 showing that occupants can move past a burning object on an escape route. Maximum radiant heat must not exceed 2.5 kW/m^2 along the escape route during the period of RSET. The location of the fire source shall be established in the FEB.

Comment:

Maximum capacity is determined by assuming occupants are distributed evenly among all exits available to them when considering a total *building* evacuation.

Travel distances are based on maximum open path distances within Acceptable Solutions C/AS2-6.

If there is more than one stair or exit providing an alternative means of egress from the space this scenario does not apply. There is no requirement to limit travel distance within *exitways*.

Explanation:

- The scenario is rewritten to clarify when the scenario applies and to differentiate the requirements for vertical and horizontal escape routes.
- Travel distances are revised and a reference provided.
- The method clarifies the requirement where there is more than one single escape stair serving part of the building.
- The addition to the method provides designers the option of calculating the separation of exits using radiant heat calculations if the separation distances are not suitable.

What do you think?

3.9 Do you agree with the changes to the Design scenario (BE): Fire Blocks Exits? If not, why not?

Revision of Design scenario (HS) Horizontal fire spread – for radiant heat for storage buildings and external claddings on tall buildings

Replace 4.5 Design fire with the following:

Design fire

The *design fire* for this scenario comprises an assumed emitted radiation flux from *unprotected areas* in *external walls* of the *fire source building* (assuming no intervention). This shall be taken for all occupancies as shown in Table 4.0.

Table 4.0	Emitted radiant heat flux from unprotected areas (kW/m^2)	
FLED	**Unsprinklered**	**Sprinklered**
<400 MJ/m^2	83	58
400 – 800 MJ/m^2	103	72
>800 MJ/m^2	144	101

Emissivity of *fire* gases shall be taken as 1.0.

Replace the second paragraph of Method 1 Calculation with the following:

Method 1 Calculation

The calculation for maximum permitted *unprotected area* may use:

a) the emitted radiation flux for sprinklered *firecells*

b) the height of the enclosing rectangle as the vertical distance between the floor and highest level of sprinklers installed in the area adjacent to the *external wall* facing the *relevant boundary*, and

c) the width of the enclosing rectangle as the least of the square root of the design maximum area of sprinkler operation or the actual width of the enclosing rectangle or 20 m.

Explanation:

- The sprinkler design fire aligns with other international codes that permit a reduction in radiant heat for storage buildings with a conservative factor of 0.7.
- Currently Method 1 does not allow for buildings with storage above 3 m. This revision provides increased flexibility with design fire sizes for buildings with storage above this height.

Replace Table 4.1: Acceptable heat release rates for external wall cladding systems for control of horizontal fire spread:

Table 4.1	**Acceptable heat release rates for external wall cladding systems for control of horizontal fire spread**	
Building height	**Distance to relevant boundary (all buildings)**	
	< 1.0 m	**1.0 m or more**
≤ 7.0 m	A	-
< 7.0 m and ≤ 60 m	A	B
> 60 m and ≤ 100 m	H	A
> 100 m	H	H

Notes:

1. Type A, B and H are described in Appendix C: Test methods.

Explanation:

- This introducese a new classification 'H' for tall buildings. There are stricter requirements for external cladding on these buildings as they present greater risk of vertical fire spread and exceed the height to which the Fire Service can apply water externally.
- Note that the dispensation for sprinklers has been removed to align with the Acceptable Solutions. Recent events have shown that sprinklers do not prevent external cladding fires.
- The types of external cladding systems are defined within a new C/VM2 Appendix C: Test methods.

What do you think?

3.10 Do you agree with the proposal to allow design fire sizes using FLED without limiting storage height in Design scenario (HS)? If not, why not?

3.11 Do you agree with the new requirements to control combustibility for external cladding systems in tall buildings? If not, why not?

3.12 Do you agree with the other changes proposed to this scenario? If not, why not?

Revisions to Design scenario (VS): Vertical fire spread – scenario description for lower roof exposure and vertical fire spread

Replace the scenario description part c) with the following:

Scenario description

c) Where there is a lower roof exposure to a higher *external wall* within the same or an adjacent *building* on the same allotment of land, where *firecells* behind the higher *external wall* have sleeping occupancies, *exitways* or *other property*.

Comment:

NZBC C3.5 is concerned with vertical fire spread over the external cladding of the building, not between *buildings* on separate titles beyond a relevant boundary. However, for separate titles on the same allotment (e.g. unit titles) exposure of lower roofs shall be assessed.

Replace Table 4.2: Acceptable heat release rates for external wall cladding systems for control of vertical fire spread:

Table 4.2	Acceptable heat release rates for external wall cladding systems for control of vertical fire spread	
Building height	**Sleeping uses or other property on an upper floor**	**No sleeping uses nor other property on an upper floor**
≤ 10 m	-	-
> 10 m and ≤ 25 m	A (sleeping care or detention) B (other sleeping or other property)	-
> 25 m and ≤ 60 m	A	-
> 60 m and ≤ 100 m	H	A
> 100 m	H	H

Notes:
1. Type A, B and H are described in Appendix C: Test methods.
2. Check design scenario HS for possible greater requirements.

Explanation:

- The scenario change clarifies that fire spread from an existing roof on an adjoining property does not need to be addressed due to lack of control over the roof construction or the provision of sprinklers in the adjacent property. Therefore, this requirement does not apply to existing lower roofs on separate allotments of land.

- This change also clarifies that the requirement also does not apply to exitways on the upper level on a separate title, as a neighbouring building is not required to evacuate for fire within an adjacent property.
- External walls are already required to comply with NZBC C3.6 and C3.7 for spread of fire from the other property. A new roof is required to comply with C3.6 and compliance is achieved by following Design scenario (HS). An alteration or change of use to the unit title plan requires the whole plan to be updated for spread of fire.
- The changes to Table 4.2 extend requirements for vertical spread of fire for tall buildings.
- Note that the dispensation for sprinklers has been removed to align with the Acceptable Solutions. Recent events have shown that sprinklers do not prevent external cladding fires.

What do you think?

3.13 Do you agree to the proposed changes to lower roofs for protection of other property? If not, why not?

3.14 Do you agree with the changes relating to external cladding for vertical fire spread? If not, why not?

Revise Design scenario (FO): Firefighting operations for tall buildings

Add to the end of the scenario description:

Internal hydrants shall be located in enclosures that provide safe access for firefighters and are fire separated from all other parts of the *building* that are designed to resist fire spread until *burnout.*

The arrangement of firefighting features and access shall be determined in consultation with the Fire Service through the FEB process. Justification can be assisted with the Fire Brigade Intervention Model (FBIM).

Revise headings A and B:

Heading A. For buildings with an escape height > 10 m and ≤ 60 m, and < 10 m below ground:

Heading B. For buildings with an escape height ≤ 10 m and < 10 m below ground:

Add a new Category C for buildings with an escape height > 60 m above ground or ≥ 10 m below ground:

C. For buildings with an escape height > 60 m above ground or ≥ 10 m below ground:

Meet all the requirements of A.

To assist firefighting and search and rescue operations at height the following features are required to safeguard firefighters and limit fatigue.

Communication

Provide means for two-way communication between floor wardens on every level and to the main emergency evacuation panel.

Comment:

Two-way communication can be provided by Warden Interconnected Phones (WIPs) located within the protected stair or lobby. WIPs allow a two way communication to the emergency evacuation panel. Lifting the handset allows automatic calls to the emergency evacuation panel. Suggested standards for this are AS 2220 - Emergency warning and intercommunication systems in buildings or Type A outstations to BS 5839-Part 9:2003.

Fire control centre

Provide a dedicated facility for Fire Service use which shall:

a) be readily accessed from street level

b) be protected from the effects of fire including debris falling from an upper floor, and

c) contain all controls for *fire safety systems* installed in the *building*.

Comment:

The fire control centre should contain features such as fire alarm indication, smoke management controls, ventilation controls, emergency evacuation panels and sprinkler indication etc.

Firefighter vertical transportation

Provide means for firefighters to transport equipment to upper floors in tall *buildings* as quickly as possible. This means of transportation shall be capable of being used under the direct control of the Fire Service. It shall be fire separated from all other parts of the *building* that are designed to resist fire spread until *burnout*.

Comment:

Factors to consider for vertical transportation are co-location with stairs, minimum dimensions for lift car, protection against ingress of water and self-rescue. Vertical transportation allows firefighters to transport Breathing Apparatus (BA) equipment and additional hoses quickly to fire affected floors for set up. Firefighting lift installations could conform to BS EN 81-72, and to BS EN 81-1 or BS EN 81-2 as appropriate for the particular type of lift.

Ventilation

Provide means to limit the passage of smoke into the stairwell and vertical transportation used for firefighting access. A minimum visibility of 10 m shall be provided in the stairwell from the period of Fire Service arrival, with a 100 mm wide opening in the door from the firecell of fire origin into the stairwell.

Time for Fire Service arrival shall be 1200 seconds or as agreed with the Fire Service in the FEB.

The following systems are deemed to satisfy this requirement and do not need to be demonstrated by calculation:

a) stairwell and lift pressurisation systems at 2 m/s airflow through open stair and lift doors on the firecell of fire origin.

b) pressurised protected lobby to stair and lift at 1 m/s air flow through open lobby door on the firecell of fire origin.

c) ventilated protected lobbies to stairwell and lift that maintain an air exchange rate of 30 air changes per hour in each lobby on the firecell of fire origin, or

d) a zone pressurisation system that exhausts 6 air changes per hour from the firecell of fire origin and provide 20 Pa positive pressure to all other firecells.

Designed and installed to AS/NZS 1668.1 or an equivalent standard agreed in FEB.

Comment:
Useful references for design of ventilation systems for firefighting are:

- AS 1668.1 The use of ventilation and air conditioning in buildings - Part 1: Fire and smoke control in buildings
- EN 12101-6 Smoke and heat control systems — Part 6: Specification for pressure differential systems — Kits
- BS 9999 Code of practice for fire safety in the design, management and use of buildings
- NFPA 92A: Standard for Smoke-Control Systems Utilizing Barriers and Pressure Differences
- Fire Engineering Design Guide Chapter 10 Mechanical Smoke Movement.

A protected lobby shall have minimum of 5 m^2 floor area and be fire separated from all other parts of the *building* that are designed to resist fire spread until *burnout*.

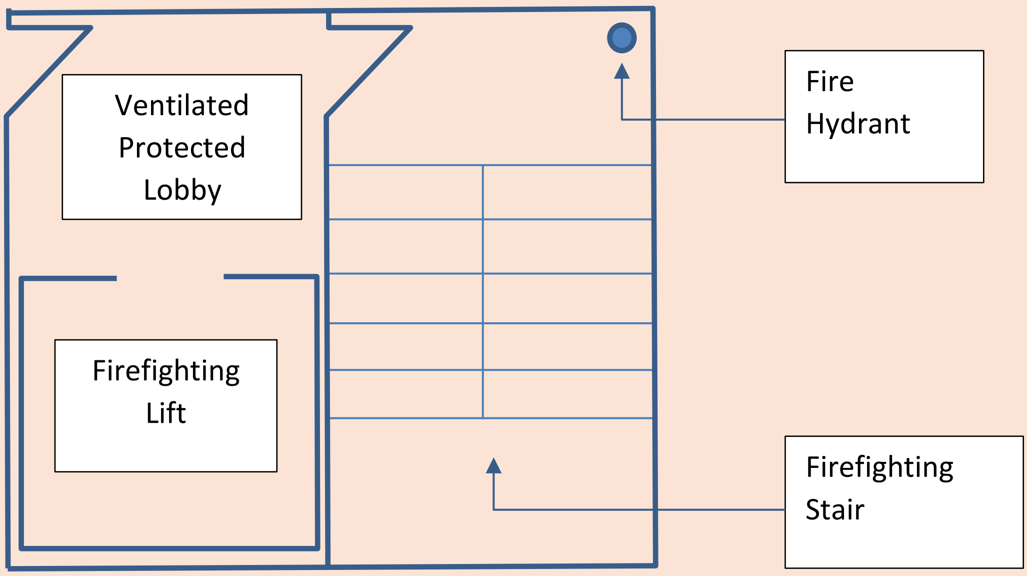
Comment:

Equivalent standards for smoke ventilation of exitways include but are not limited to BS-EN 12101, BS9999, NFPA 92A and the Fire Engineering Design Guide.

The Fire Service requires clear air within stairs and lifts to provide firefighting operations at height. This should allow for the door being held open for fire hoses. The stairwell and lift shaft can either be ventilated separately or ventilated via a common lobby.

Figure 4.1 provides one means of ventilating the stair and lift shaft for firefighting.

Figure 4.1: Suggested means of providing firefighting facilities by ventilating a protected lobby



Explanation:

- These amendments place greater emphasis on the discussions with the Fire Service early in the project, via the FEB, so that appropriate firefighting features are provided.
- The basic features that firefighters need to enter tall buildings safely are: communication and control, safe access for personnel and equipment, and adequate water supply.
- Tall buildings are complex for firefighting, so close liaison with the Fire Service is required to ensure enough of these features are provided and in the correct location.
- WIPs allow wardens and firefighters to communicate with the central control point and to advise on the control of smoke handling systems.
- The build-up of smoke and heat within firefighting access routes can seriously inhibit the ability of the Fire Service to carry out search and rescue and firefighting operations within a building. Access to upper/lower floors within the building shall be clear of smoke for firefighter access.
- Firefighting operations require firefighters to put on their gear and start in clear air. The Entry Control Officer (ECO) must be at the point/door (known as the Entry Control Point, or ECP) where firefighting crews enter the building/floor. The ECP cannot be relocated once crews

enter the building. A protected path environment maintains clear air for the ECO and for crews starting up before they enter the building/fire floor. To provide a clear air path the minimum visibility is set at 10 m.

- Protected lobbies need size limits: a minimum size to allow enough room for setting up and a maximum size to discourage their use for storage.

What do you think?

3.15 Do you agree to the proposed changes to the C/VM2 scenario description for Design scenario (FO): Firefighting operations, for tall buildings? If not, why not?

Revision to Design scenario (CF): Challenging fire – for stairwells, large occupancy and special fire hazards

Add to the end of the method:

Single escape routes

For buildings served by a single escape route the visibility within the vertical *escape route* shall not be less than 5.0 m for the period of the *RSET* in the following cases*:*

a) for sleeping occupancies where the vertical *escape route* serves more than 50 occupants who are neither detained nor undergoing some form of treatment or care, or
b) for any building with more than 150 people, or
c) for buildings where there are more than 20 people that are either detained, undergoing treatment or care, or are children in *early childhood centres*.

For a *building* where the vertical *escape routes* serve more than 250 people in a sleeping occupancy, visibility shall not be less than 5.0 m in at least two vertical *escape routes* for the period of the *RSET*.

Vertical Escape Routes

For a *building* where the vertical *escape routes* serve more than 1000 people, visibility shall not be less than 5.0 m in those vertical *escape routes* for the period of the *RSET*.

Where CFD analysis is undertaken, visibility in the stairwell shall be monitored one floor above the the floor of fire origin.

This check assumes that all *fire safety systems* are operating as designed.

Large occupancies

For the purposes of NZBC C4.4 *firecells* with design occupancy of over 1000 people shall be designed such that visibility is not less than 10 m for the duration of the evacuation.

Comment:

As an additional fire safety feature for this higher occupant load, NZBC C4.4 generally requires some form of smoke management that will prevent the occupants from leaving through smoke.

Various design standards can be used for smoke management including, but not limited to:

- BRE 368 Design methodologies for smoke and heat exhaust ventilation
- PD 7974-2:2002 Application of fire safety engineering principles to the design of buildings. Spread of smoke and toxic gases within and beyond the enclosure of origin
- NFPA 92: Standard for smoke control systems
- AS/NZS 1668: The use of ventilation and air-conditioning in buildings.

Special fire risk

Areas of special fire risk shall comply with Acceptable Solutions C/AS2-6 Paragraph 4.10.3 or alternatively by fire risk analysis established by the FEB process.

Risk analysis shall address probability and consequence of the source of fire and shall recommend measures to mitigate the risk with *FLEDs*, *fire safety systems* and means of escape and firefighting for the whole *building*.

Comment:

Such areas include but are not limited to incinerators, boilers, gas powered plant, car stacking systems, chemical manufacturing and processing, feed mills and flour mills. There are a number of internationally recognised documents that provide guidance on design of special hazard areas including British Standards and those produced by the National Fire Protection Association and the Society for Fire Protection Engineers.

Explanation:

- The requirement for single escape routes is an additional design check and not a robustness check, so it is moved from Design scenario (RC) to Design scenario (CF). It clarifies that this check is required and also extends it to unsprinklered buildings.
- The application of clause C4.4 is clarified; ie that this applies to design occupancy and also to stairs that serve more than 1000 people.
- The current Verification Method does not have a requirement to address areas of special fire hazard so this is now included with a suitable reference.

What do you think?

3.16 Do you agree with the changes to Design scenario (CF): Challenging fire for single escape routes? If not, why not?

3.17 Do you agree with the changes to Design scenario (CF): Challenging fire for escape for large occupancies? If not, why not?

3.18 Do you agree with the changes to Design scenario (CF): Challenging fire for special fire risk? If not, why not?

Revision of Design scenario (RC): Robustness check – for tall buildings

Add to the scenario description:

For *buildings* exceeding 60m in height the failure of key *fire safety systems* shall include the municipal water and power supply to the *building*. *Fire safety systems* shall be shown to continue to operate without the primary water and power supply for the duration of evacuation and firefighting operations, with the process to be agreed with relevant stakeholders in the FEB.

Comment:

As building height increases it becomes increasingly important that the fire safety systems function effectively. Events such as loss of power or water will have a detrimental effect on fire safety systems relied upon for evacuation and firefighting.

This requirement will generally require two water supplies (one of which is not dependent on the town's main water supply for the fire sprinkler system), emergency power supply for emergency lighting, signage, communication, smoke ventilation, firefighting water pumps and firefighting lifts.

For buildings exceeding 100m in height the loss of a sprinkler riser shall not isolate more than five floors.

Comment:

Should the main sprinkler riser become ineffective there should be means of delivering water to the sprinkler system in the remainder of the building from the main valveset.

Explanation:

- This proposal requires tall buildings to have back-up power and water supply to allow for the loss of the municipal utilities.
- For sprinkler systems, these are generally fed from a single riser providing a single point of failure. For very tall buildings loss of the riser needs to be considered such that water can be delivered at height by various other routes.

What do you think?

3.19 Do you agree with the proposed changes to Design scenario (RC): Robustness check, to provide more reliable fire safety systems for tall buildings? If not, why not?

New Appendix C: Test methods and classification for external cladding systems

Create new Appendix C (normative): Test methods and classification:

C1.1 Test methods for external wall cladding systems

Table C1 sets out the minimum performance requirements for classifying external wall cladding systems for the control of vertical and horizontal fire spread.

Table C1		
Classification Type	**Performance criteria**	
A **(Note 1)**	**Peak heat release rate (kW/m^2)** ≤ 100	**Total heat released (MJ/m^2)** ≤ 25
B **(Note 1 & 3)**	**Peak heat release rate (kW/m^2)** ≤ 150	**Total heat released (MJ/m^2)** ≤ 50
H	Note 2	
-	No requirement	

Notes:

1. Determined by testing to ISO 5660.1 or AS/NZS 3837 at an irradiance of 50 kW/m^2 for a duration of 15 minutes.
2. H requires at least one of the following to be satisfied:
    a. The *external wall* system achieves 'EW' classification to AS 5113 following full scale fire testing to ISO 13785-2 or BS 8414.
    b. The *external wall* system passes the NFPA 285 full scale fire test.
    c. Substantive components of the *external wall* system comprise only glass, concrete, steel, brick/block, ceramic tile, or aluminium; (i.e. sheet cladding materials, framing and any insulation or polymeric sheet within the wall) are classified non-combustible when tested to AS 1530.1 or ISO 1182, or achieve Euroclass A0 or A1 (EN 13501-1:2007+A1:2009).
3. An *external wall* system satisfying the 'H' criteria may also be used where 'A' or 'B' is required.
4. An *external wall* system satisfying classification type 'A' criteria may be used where type 'B' is required.
5. As an alternative to specifying a cladding meeting the 'B' performance level, engineers may calculate the contribution of a combustible cladding to the radiation received at and beyond the relevant boundary to demonstrate that the maximum permitted radiation flux criteria specified in the NZBC are not exceeded. The method shall be agreed in the FEB.
6. A cladding system is the outside or exterior weather-resistant surface of a building and includes cladding, underlays, cavity components, windows, doors and all penetrations, flashings, seals, joints and junctions. The testing requirement applies to all components within the cladding system.

Comment:

AS 5113 requires full scale fire testing to either ISO 13785-2 or BS 8414. These tests include a vertical section of wall assembly 6 m high x 3 m wide including an opening to a fire compartment containing a fuel source of wood cribs. External flaming from the opening exposes the façade wall above. The test configuration includes a re-entrant corner projecting at least 1.2 m from the face of the façade.

The performance criteria are given in AS 5113 and include temperatures above the opening and within the wall system, flaming of the specimen above the opening, flame spread beyond the confines of the specimen, and falling debris from the specimen. Specimens that pass all the test criteria are assigned a classification index of EW.

Explanation:

- This new appendix provides all testing requirements for cladding systems that are required in various design scenarios in one place.
- It also introduces a new classification type 'H' for an external wall cladding system used on tall buildings.

What do you think?

3.20 Do you agree with the criteria for cladding systems as outlined in the new Appendix C? If not, why not?

Appendix D: Proposal 4 draft guidance

Provide guidance for alternative solutions for protection from fire

What do you think?

MBIE welcomes your feedback on the following draft guidance.

In particular:

4.1 Do you agree with the framework for alternative solutions proposed in the draft guidance for alternative solutions for protection from fire? If not, why not?

4.2 Does the guidance adequately cover the main topics for alternative solutions? If not, what else would you include?

4.3 Does the guidance provide sufficient information to enable you to formulate an alternative solution? If not, what other information would you include?

4.4 Do you agree with the proposed levels of expertise to undertake alternative solutions? If not, why not?

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.

It is also for regulatory stakeholders (Territorial Authorities (TAs), Building Consent Authorities (BCAs), the New Zealand Fire Service (NZFS or the Fire Service) and regulatory reviewers) and others considering alternative solutions for these clauses.

This 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
- the safety margin, and
- the Fire Engineering Brief.

Use of this guide

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.

Alternative solutions for fire design

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.

Acceptable Solutions and Verification Methods are produced by MBIE. If followed, they must be accepted by a BCA as complying with the related Building Code provisions. For Code clause C: Protection from fire there are seven Acceptable Solutions, C/AS1-C/AS7, and two Verification Methods, C/VM1 and C/VM2.

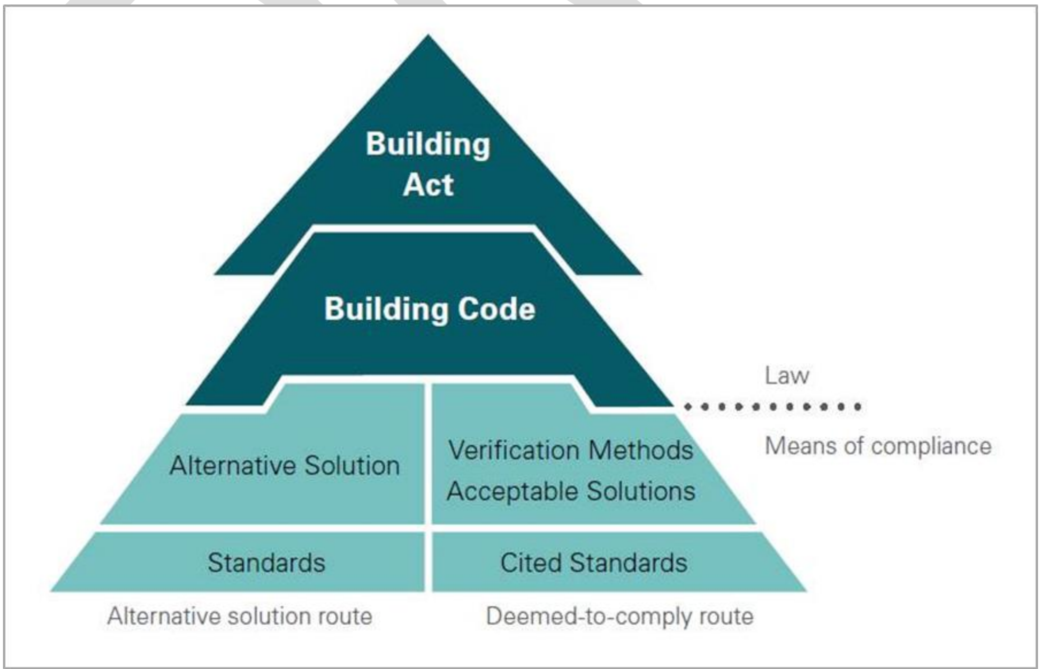
For many building projects – especially complex ones – the generic requirements of these compliance documents do not fit. These types of projects will need to follow an alternative solution for fire design. Fire engineers and designers may also decide to depart from the Acceptable Solutions and Verification Methods to provide innovative designs they consider will create the best outcome for a particular project.

Alternative Solutions usually require design input from suitably qualified people, such as architects or engineers.

Existing buildings

Alternative Solutions are applied to demonstrate compliance with the Building Code in full. For alterations to existing buildings the work need only comply as nearly as is reasonably practicable (ANARP) and therefore full Code compliance is not required. Alternative solutions, however, are a useful tool to assist with an ANARP decision for an existing building. An alternative solution can be used to establish the 'gap' between the existing building and full Code compliance.

Figure 1: The building regulatory framework



Key steps

Key steps for developing an alternative solution for fire design are as follows:

1. Scope the project outlining the building and its features (height, occupancy, use etc). Outline the issue that requires being resolved using an alternative solution.
2. Identify which fire clauses are affected by the alternative solution and which the designer needs to demonstrate compliance with.
3. Determine what type of alternative solution is required and the compliance path – whether it is a departure from the Acceptable Solutions or Verification Method, or specific fire engineering design.
4. Determine the appropriate level of expertise/experience required to undertake the design; review and approve the alternative solution.
5. Prepare the Fire Engineering Brief (optional) to agree high level requirements.
6. Collate evidence into the fire safety documentation for the BCA to show how the relevant performance criteria will be met. The clearer the supporting documentation, the easier the evaluation will be.

What the fire clauses require

An alternative solution needs to consider which Building Code clause or clauses are affected by the specific aspects of the alternative solution design.

Depending on the proposed design, the Engineer/Designer may need to consider more than one Code clause and more than one objective. The key is to ensure the assessment of applicable Code clauses is holistic, and so captures all relevant performance clauses which might be affected – some of which might not be immediately obvious.

Objectives – life safety, property protection and firefighting

Clause C1 sets out the three main objectives of the fire clauses which relate to life safety, property protection and firefighting operations. While these are only objectives and not performance requirements in their own right, they provide the main focus of any Alternative Solution.

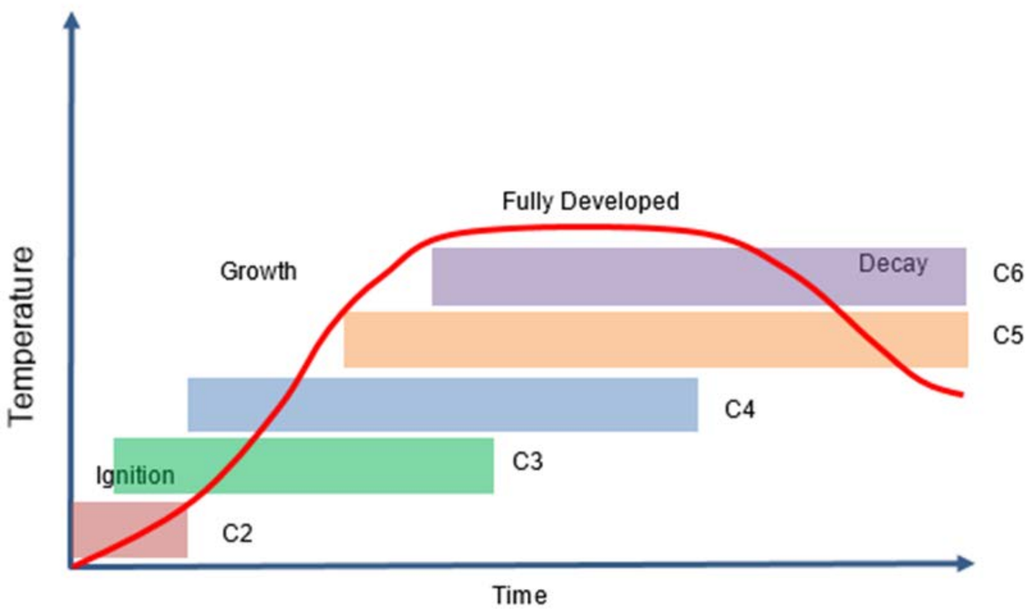
Performance requirements of the fire clauses

The rest of the fire clauses step through a number of requirements for:

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

The clauses can simplistically be observed to follow the natural timeline of the development of fire from an ignition source to full building/firecell involvement.

Figure 2: Timeline for fire development



Which fire clauses apply?

The Building Code Clauses C1-C6 provides the high level performance requirements for the protection from fire for fire safety in buildings. Clause C1 contains the three main objectives: life safety, protection of other property, and firefighting operations. An alternative solution can relate to one or more objectives and fire safety clauses. The following table provides assistance for linking the objectives to various fire safety clauses.

Table 1: Building Code objectives for protection from fire and the relevant performance clauses

Objectives	Requirements	Clauses
Life safety	Limiting the temperature of appliances to prevent fire ignition	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
	External fire spread limited from large firecells.	C3.8
	Structural systems supporting fire rated elements shall remain stable.	C6.2
Firefighting operations	Safe access to the building shall be provided for fire service vehicles.	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 firefighters shall be reliable.	C5.8
	Any structural systems for access for firefighting operations shall remain stable.	C6.3

Types of alternative solution and recommended levels of expertise and analysis

By their nature, alternative solutions can take a number of different forms. These can be simplistically classified depending on their level of complexity. Primarily, this complexity depends on the extent to which the proposed design deviates from the Acceptable Solutions or Verification Methods – and which of these documents the design is deviating from.

Alternative solutions for fire design can be broadly categorised as one of the following:

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

These are discussed below, along with the recommended levels of expertise and analysis.

Expertise needed for alternative solutions for fire design

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, large fire development and radiant heat.

Table 2: Types of alternative solution 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
Single major or multiple departures from C/AS1-C/AS7	Qualitative / 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 regulatory reviewer

Single minor departure from the Acceptable Solutions

A minor departure from Acceptable Solutions C/AS1-7 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 from 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 performance criteria of the building code.

Justification 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 for Protection from Fire.

Example: Extended travel distance

A building 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. The design solution could involve proposing a smoke detection system to provide early warning where one is not otherwise required to compensate for longer travel time. Alternatively, the building might have a very high ceiling which would allow for longer escape times.

Single major or multiple departures from the Acceptable Solutions

For more complex alternative solutions involving a significant departure or a number of departures from the Acceptable Solutions, 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 carries out analyses to consider the effect of each proposed departure on the others.

One approach to demonstrate Code compliance would be to use the appropriate design scenarios from Verification Method C/VM2 as a quantitative assessment.

Example: Multiple departures from the Acceptable Solutions

An office building complies with the Acceptable Solutions apart from 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 of UT, CF and RC from Verification Method C/VM2. This analysis shows that there is sufficient escape time to meet the relevant performance requirements.

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, 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 can escape in time. Design Scenario VS from the C/VM2 can be used to show compliance provided the objective of life safety or property protection is established.

Departure from Verification Method C/VM2 or specific fire engineering design

A fire design which departs from the Verification Method C/VM2 would need to be undertaken by a suitably qualified and experienced fire engineer with understanding of the construct of C/VM2. Any departure from the C/VM2 design scenarios needs to be carefully considered for any unintended consequences for other design scenarios.

This type of alternative solution will need to include an appropriate safety margin (refer to page 11).

Specific fire engineering design requires a high level of understanding of the Building Code and the inter-relationship between Code clauses.

This type of design can be from first principles or using the Acceptable Solutions or Verification Method as the basis for compliance. The proposal should use a range of international fire engineering guidelines, research and methodology such as:

- International Fire Engineering Guidelines 2005
- BS 7974 -0:2002 Part 0 Application of fire safety engineering principles to the design of buildings
- SFPE Engineering Guide to Performance-Based Fire Protection.

BCAs should be satisfied that the engineers and reviewers involved have the relevant qualifications and experience for the type of alternative solution proposed.

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

Safety margin in fire design

Fire engineering includes known uncertainties in the method of analysing fire spread and evacuation due to the limited data and modelling tools available. For this reason all fire engineering design has a safety margin. If the alternative solution is a departure from C/VM2, the key point an engineer must address is the safety margin.

Safety margins are needed in fire engineering to address issues such as:

- uncertainty in the input values because of 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 safety margins also gives a general level of comfort for especially critical design outcomes to cover the possible variation in inputs to the methodology.

The acceptance criteria are quantified within the Building Code: i.e. tenability criteria related to visibility, FED (CO) and FED Thermal, and radiant flux levels to relevant boundaries.

The appropriate use of a safety margin can either be applied to design inputs as they enter an analysis or to design or analysis outputs.

The current Verification Method C/VM2 is assessed against the acceptance criteria stated in the Code with a safety margin of unity. This is because 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 then the safety margin needs to be stated.

The engineer should discuss and agree the safety margin with the peer reviewer and regulatory stakeholders for the alternative solution during the Fire Engineering Brief process.

One way to test if the safety margin 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.

The Fire Engineering Brief

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

Note:

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 building 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 the safety margin during their building consent review.

Table 3: The FEB

The FEB and its components	
High level FEB information includes:	• Building use, occupancy and any future limitations • Evacuation strategy (i.e. simultaneous or phased) • Fire safety systems and features, their 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 • Type of alternative solution – minor, major or specific design • Proposed approach and methodology • Proposed inputs and analysis • Acceptance criteria • Proposed safety margin
Key stakeholders are:	• Fire engineer • BCA • Architect / lead consultant • New Zealand Fire Service
Optional stakeholders who should also be considered are:	• Client /client representative • Main contractor • Insurer • Other key design disciplines affected by the fire design

Resources

MBIE's Building Performance website at www.building.govt.nz

MBIE FAQs:

www.building.govt.nz/building-code-compliance/c-protection-from-fire/c-clauses-c1-c6/protection-from-fire-faqs/

MBIE guidance on alternative solutions:

www.building.govt.nz/building-code-compliance/how-the-building-code-works/different-ways-to-comply/alternative-solutions/

MBIE guidance on tall buildings:

www.building.govt.nz/building-code-compliance/b-stability/b1-structure/practice-advisory-18/fire-safety-design-for-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:

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

SFPE Engineering Guide to Performance-Based Fire Protection:

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

Contact MBIE

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