Dear Customer

Please find enclosed Errata 1, effective 30 April 2012, to the Verification Method C/VM2, Framework for Fire Safety Design.

<table>
<thead>
<tr>
<th>Section</th>
<th>Old C/VM2</th>
<th>April 2012 Errata to C/VM2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status page</td>
<td>Remove page 3/4</td>
<td>Replace with new page 3/4</td>
</tr>
<tr>
<td>C/VM2</td>
<td>Remove pages 11-14, 19/20, 31/32, 39/40, 59/60</td>
<td>Replace with new pages 11-14, 19/20, 31/32, 39/40, 59/60</td>
</tr>
</tbody>
</table>
**Status of C/VM2**

This Verification Method C/VM2, Framework for Fire Safety Design, provides a means of compliance with the New Zealand Building Code Clauses C1-C6 Protection from Fire. It is issued under section 22 of the Building Act 2004 as a compliance document.

This Verification Method is one way that can be used to show compliance with the New Zealand Building Code Clauses C1-C6 Protection from Fire. Other ways of complying with the Building Code are described, in general terms, in the preface of the New Zealand Building Code Handbook.

### When can you use C/VM2


This Verification Method is effective from 30 April 2012. It can be used to show compliance with the Building Code Clauses C1-C6 Protection from Fire. It does not apply to building consents issued before 30 April 2012.

The Compliance Document for Fire Safety Amendment 9 may be used to show compliance with the Building Code Clauses C1-C4 Fire Safety for building consent applications made before 10 April 2013.

From 10 April 2013, the Compliance Document for Fire Safety Amendment 9 ceases to have effect.

### Document History

<table>
<thead>
<tr>
<th>Date</th>
<th>Alterations</th>
</tr>
</thead>
<tbody>
<tr>
<td>New document</td>
<td>Effective from 10 April 2012 C/VM2 is a new publication that can be used to show compliance with the Building Code Clauses C1-C6 Protection from Fire.</td>
</tr>
<tr>
<td>Errata 1</td>
<td>Effective from 30 April 2012 p. 11, 1.2 p. 13, Figure 1.1 a) p. 19, Figure 1.1 g)</td>
</tr>
</tbody>
</table>
1 Introduction and scope

1.1 Purpose

This is a Verification Method for the specific design of buildings to demonstrate compliance with NZBC C1 to C6 Protection from Fire. It is suitable for use by professional fire engineers who are proficient in the use of fire engineering modelling methods.

1.2 Scope

This Verification Method can be applied to fire designs for all buildings.

Comment:
This Verification Method will usually be used for fire designs that, for whatever reason, cannot be shown to comply with NZBC C: Protection from Fire using the relevant Acceptable Solutions C/AS1 to C/AS7. However, a designer may opt to use this Verification Method even if the building could be designed using the Acceptable Solutions.

There are some minor exceptions to 'all buildings', for example tunnels.

1.3 How to use this Verification Method

This Verification Method sets out 10 design scenarios that must each be considered and designed for, where appropriate, in order to achieve compliance with NZBC C: Protection from Fire.

Trial the fire design based on the requirements ascertained via the Fire Engineering Brief (FEB) as described in the International Fire Engineering Guidelines and other fire engineering process documents.

Follow the process shown in Figure 1.1 as appropriate, analysing or testing the fire design against the design scenarios as applicable and modelling the design scenario: CF Challenging Fire (see Paragraph 4.9) a number of times with the design fire positioned in the most challenging locations.
Comment:
ASET/RSET and other computational modelling is only required for a few of the design scenarios. Many can be satisfied by inspection or by providing certain features (e.g., fire separations or smoke detection systems).

In many cases the location that is the most challenging (that which will provide the shortest ASET/RSET) will be easily determined.

In all parts of Figure 1, the numbered references are to paragraph numbers in this Verification Method.
Figure 1.1 a: The design process for C/VM2

- Concept
- Fire Engineering Brief Process
- FEB Report
- Prepare trial design
- VM2 Evaluation
- Occupant characteristics
  - Initial determination of active and passive fire safety systems that are preferred
  - Design will not use an Acceptable Solution
- Inputs determined from data in Verification Method Scenario CF (challenging fire) locations
  - Design fire(s) to use in modelling
  - Fire load energy density
  - Occupant related data
  - Active system inputs (alarms and sprinklers)
- Revising trial design from 4.5, 4.6, 4.8, 4.9 and 4.10
  - Complies with all relevant design scenarios
  - Document the process and the design
  - Approval

Verifications Method C/VM2

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Figure 1.1 b): Design scenario BE – Blocked exit

From design process 4.1

More than 50 people in space or 150 people in unsprinklered multi-storey building or 250 in sprinklered multi-storey building?

Yes

More than 50 people on a floor or in a room?

Yes

Single escape route?

Yes

Provide additional escape route

Yes

More than 150 people in unsprinklered multi-storey building or 250 people in sprinklered multi-storey building?

Yes

Single escape route?

No

More than 150 people in unsprinklered multi-storey building or 250 people in sprinklered multi-storey building?

No

More than 150 people in unsprinklered multi-storey building or 250 people in sprinklered multi-storey building?

No

Back to design process Figure 1.1 a)
Figure 1.1 g): Design scenario VS – Vertical spread of fire

From design process 4.6

Importance level 1?

No

Building has upper level with sleeping occupancies or other property?

Yes

Assess external vertical fire spread via façade materials using:
1. C/AS2 to C/AS6 as appropriate, or
2. Non-combustible materials, or
3. Flame spread models, or
4. Fire tests of external cladding system

Complies with acceptance criteria?

No

Back to design process to revise trial design

Yes

Back to design process to revise trial design

Assess fire plumes spreading fire vertically through higher openings using:
1. C/AS2 to C/AS6 as appropriate, or
2. Fire rating of the unprotected areas, or
3. Providing sprinkler system in building, or
4. Providing aprons or spandrels

Complies with acceptance criteria?

No

Back to design process to revise trial design

Yes

Back to design process Figure 1.1 a)
Figure 1.1 h: Design scenario IS – Surface finishes

From design process 4.7

Walls, ceilings, duct surfaces, acoustic treatment and pipe insulation tested to ISO 9705 and meet material Group Numbers as per NZBC C3.4(a) (values are different for sprinklered buildings)

Flooring to be tested to ISO 9239-1 and comply with minimum critical radiant flux as per NZBC C3.4(b) (values are different for sprinklered buildings)

Suspended flexible fabrics?

Foamed plastics?

Yes

Suspending flexible fabrics used as underlay to exterior cladding or roofing shall comply with NZBC C3.4(c)

Suspended flexible fabrics and membrane structures shall comply with NZBC C3.4(c)

Back to design process Figure 1.1 a)

No

Where foamed plastics form part of a wall, ceiling or roof system, they shall comply with NZBC C3.4(a)

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2.4 Full burnout design fires

Comment:
Design fire characteristics include parameters for FLED, fire growth rate and heat of combustion. This means a post-flashover 'full burnout design fire' can be defined.

The 'full burnout design fire' for structural design and for assessing fire resistance of separating elements shall be based on complete burnout of the firecell with no intervention. However, the maximum fire resistance rating for a sprinklered firecell need not exceed 240/240/240 determined using AS 1530.4.

There are three choices for modelling the full burnout design fire:

a) Use a time-equivalent formula to calculate the equivalent fire severity and specify building elements with a fire resistance rating not less than the calculated fire severity. In this case, an equivalent fire severity of 20 minutes shall be used, if the calculated value is less.

b) Use a parametric time versus gas temperature formula to calculate the thermal boundary conditions (time/temperature) for input to a structural response model, or

c) Construct an HRR versus time structural design fire as described in Paragraph 2.3.3. Then, taking into account the ventilation conditions, use a fire model or energy conservation equations to determine suitable thermal boundary conditions (time/temperature/flux) for input to a structural response model.

Comment:
A common approach to use with this Verification Method is the 'equivalent fire severity' method described in Eurocode 1 Actions on structures, Part 2-2. This allows the equivalent time of exposure to the standard test for fire resistance to be estimated based on the compartment properties, FLED and available ventilation given complete burnout of the firecell with no intervention.
2.4.1 Modifications to the design FLED

For assessing the fire resistance of structural and non-structural elements, the design FLED from Table 2.2 used for the design fire shall be modified by multiplying the FLED by the applicable \( F_m \) factor from Table 2.3.

For assessing fire duration for life safety calculations the design FLED from Table 2.2 shall be modified by multiplying the FLED by the applicable \( F_m \) factor from Table 2.3.

<table>
<thead>
<tr>
<th>Table 2.3</th>
<th>( F_m ) factors to be applied to FLED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sprinklered firecell</td>
</tr>
<tr>
<td>Fire resistance of primary structural elements in any structural system which is unable to develop dependable deformation capacity under post-flashover fire conditions (^1)</td>
<td>1.00</td>
</tr>
<tr>
<td>Fire resistance of primary structural elements whose failure would consequently lead to disproportionate extent of collapse (^2)</td>
<td>1.00</td>
</tr>
<tr>
<td>All other structural and non-structural elements or for life safety calculations of fire duration.</td>
<td>0.50</td>
</tr>
</tbody>
</table>

Notes

1. This factor accounts for non-uniformity of fire load and/or ventilation and hence local structural fire severity. The structural system comprises the individual members and the connections between these members. The dependable deformation capacity shall have been established by rational analysis supported by evidence from experimental testing. One example is composite floor systems comprising concrete slab on steel deck supported on steel beams.

2. Guidance on an extent of collapse which would be regarded as disproportionate is given in the commentary document for this Verification Method. One example is isolated columns near the base of a tall, multi-storey structure where the column would suffer sudden and complete loss of load-carrying capacity if subjected to the deformations expected in a severe fire.

2.4.2 Openings for full burnout fires

For the purposes of calculating \( A_v \) (the total area (m\(^2\)) of vertical windows and doors) in full burnout design fire calculations it shall be assumed that doors in external walls are closed. Wall areas clad in sheet metal shall not be included in the area \( A_v \).

Comment:
Also refer to the fire modelling rules for full burnout fires in Paragraph 2.2.2 for effective openings.

2.4.3 Structural fire severity for interconnected floors

Where a space contains interconnected floors, separate calculations shall be made to determine the structural fire severity, first by considering the total floor area of the space and then by considering the interconnected floor at each level. The greatest magnitude of structural fire severity shall be applied to all levels, unless the structural system supporting floors is designed to dependably prevent collapse during the fire.
### Table 3.3 Pre-travel activity times

<table>
<thead>
<tr>
<th>Description of building use</th>
<th>Pre-travel activity time(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Buildings where the occupants are considered awake, alert and familiar with the building</strong> (eg, offices, warehouses not open to the public)</td>
<td></td>
</tr>
<tr>
<td>Enclosure of origin</td>
<td>30</td>
</tr>
<tr>
<td>Remote from the enclosure of origin</td>
<td>60</td>
</tr>
<tr>
<td><strong>Buildings where the occupants are considered awake, alert and unfamiliar with the building</strong> (eg, retail shops, exhibition spaces, restaurants)</td>
<td></td>
</tr>
<tr>
<td>Enclosure of origin (standard alarm signal)</td>
<td>60</td>
</tr>
<tr>
<td>Remote from the enclosure of origin (standard alarm signal)</td>
<td>120</td>
</tr>
<tr>
<td>Enclosure of origin (voice alarm signal)</td>
<td>30</td>
</tr>
<tr>
<td>Remote from the enclosure of origin (voice alarm signal)</td>
<td>60</td>
</tr>
<tr>
<td><strong>Buildings where the occupants are considered sleeping and familiar with the building</strong> (eg, apartments)</td>
<td></td>
</tr>
<tr>
<td>Enclosure of origin (standard alarm signal)</td>
<td>60</td>
</tr>
<tr>
<td>Remote from the enclosure of origin (standard alarm signal)</td>
<td>300</td>
</tr>
<tr>
<td><strong>Buildings where the occupants are considered sleeping and unfamiliar with the building</strong> (eg, hotels and motels)</td>
<td></td>
</tr>
<tr>
<td>Enclosure of origin</td>
<td>60</td>
</tr>
<tr>
<td>Remote from the enclosure of origin (standard alarm signal)</td>
<td>600</td>
</tr>
<tr>
<td>Remote from the enclosure of origin (voice alarm signal)</td>
<td>300</td>
</tr>
<tr>
<td><strong>Buildings where the occupants are considered awake and under the care of trained staff</strong> (eg, day care, dental office, clinic)</td>
<td></td>
</tr>
<tr>
<td>Enclosure of origin (independent of alarm signal)</td>
<td>60</td>
</tr>
<tr>
<td>Remote from the enclosure of origin (independent of alarm signal)</td>
<td>120</td>
</tr>
<tr>
<td><strong>Buildings where the occupants are considered sleeping and under the care of trained staff</strong> (eg, hospitals and rest homes)</td>
<td></td>
</tr>
<tr>
<td>Enclosure of origin (assume staff will respond to room of origin first)</td>
<td>60 s for staff to respond to alarm then 120 s (per patient per 2 staff)¹</td>
</tr>
<tr>
<td>Remote from the enclosure of origin (independent of alarm signal)</td>
<td>1800</td>
</tr>
<tr>
<td>Remote from the enclosure of origin (independent of alarm signal) where occupants are unable to be moved due to the procedure or other factor</td>
<td>1800 or as per specific requirements, whichever is the greater</td>
</tr>
<tr>
<td><strong>Spaces within buildings which have only focused activities</strong> (eg, cinemas, theatres and stadiums)</td>
<td></td>
</tr>
<tr>
<td>Space of origin (occupants assumed to start evacuation travel immediately after detection and notification time or when fire in their space reaches 500 kW, whichever occurs first)</td>
<td>0</td>
</tr>
</tbody>
</table>

**NOTE:**

1. This allows 120 s to move each patient from their room to the next adjacent firecell. This includes time for staff to prepare the patient and transport them to the adjacent firecell, and then to return to evacuate another patient. The commentary document for this Verification Method gives details of staff to patient ratios.
3.2.4 Travel time

Travel time within a space is governed by:

a) The time taken to travel to the doorway ($t_{\text{trav}}$), or

b) The flow time (ie, the time taken for all the occupants to flow through a restriction, typically a doorway, when queueing is necessary).

The greater of these two times is the evacuation time from the space.

For horizontal travel, the travel time shall be calculated based on the estimated walking speed. Horizontal travel speed shall be calculated using equation 3.2 with a maximum travel speed of 1.2 m/s.

$$S = K - akD$$  \hspace{1cm} \text{Equation 3.2}

where:

- $S$ = horizontal travel speed (m/s)
- $D$ = occupant density of the space (persons/m$^2$)
- $k = 1.4$ for horizontal travel, and
- $a = 0.266$.

Travel time ($t_{\text{trav}}$) is calculated by using equation 3.3:

$$t_{\text{trav}} = L_{\text{trav}} / S$$  \hspace{1cm} \text{Equation 3.3}

where:

- $t_{\text{trav}} =$ travel time (s), and
- $L_{\text{trav}} =$ travel distance (m).

The maximum horizontal travel distance ($L_{\text{trav}}$) shall be determined by either:

a) The measured length around furniture if this is known, or

b) Adding together the length and width measurements of the room.

For vertical travel, equation 3.2 applies but the values used for $k$ are a function of the stair riser and tread size as given in Table 3.4.

<table>
<thead>
<tr>
<th>Exit route elements</th>
<th>k</th>
<th>Speed m/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corridor, aisle, ramp, doorway</td>
<td>1.40</td>
<td>1.19</td>
</tr>
<tr>
<td>Stair riser (mm)</td>
<td>Stair tread (mm)</td>
<td></td>
</tr>
<tr>
<td>191</td>
<td>254</td>
<td>1.00</td>
</tr>
<tr>
<td>178</td>
<td>279</td>
<td>1.08</td>
</tr>
<tr>
<td>165</td>
<td>305</td>
<td>1.16</td>
</tr>
<tr>
<td>165</td>
<td>330</td>
<td>1.23</td>
</tr>
</tbody>
</table>
4.9 Design scenario (CF): Challenging fire

**Scenario in brief**
A fire starts in a normally occupied space and presents a challenge to the building’s fire safety systems, threatening the safety of its 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 of C4.3 and C4.4. This will require analysis.

- **C4.3** The evacuation time must allow occupants of a building to move to a place of safety in the event of a fire so that occupants are not exposed to any of the following:
  - (a) a fractional effective dose of carbon monoxide greater than 0.3;
  - (b) a fractional effective dose of thermal effects greater than 0.3;
  - (c) conditions where, due to smoke obscuration, visibility is less than 10 m except in rooms of less than 100 m² where the visibility may fall to 5 m.

- **C4.4** Clause C4.3 (b) and (c) do not apply where it is not possible to expose more than 1000 people in a firecell protected with an automatic fire sprinkler system.

**Required outcome**
Demonstrate ASET>RSET for design fires in various locations within the building.

**Scenario description**
The challenging fires are intended to represent credible worst case scenarios in normally occupied spaces that will challenge the fire protection features of the building.

This scenario requires the use of design fires in various locations within the building. ASET need not be determined for occupants of the enclosure of fire origin for the following fire locations:

- a) Any room with a floor area less than 2.0 m², or
- b) Sanitary facilities adjoining an exitway, or
- c) Any room or space of fire origin other than sleeping areas where care or detention is provided, which has all of the following:
  - i) a total floor area, including intermediate floors, of less than 500 m², and
  - ii) more than one direction of travel or a single direction of travel that is less than 25 m, and
  - iii) an occupant load of less than 150 people for the room or less than 100 people for any intermediate floor.

For c), the fire engineer does not have to demonstrate that tenability is maintained for occupants within the enclosure of origin; however, they must demonstrate that the challenging fire in this space does not threaten occupants in the rest of the building. The design fires shall be characterised with a power law HRR, peak HRR and FLED as specified in Part 2. Design values for yields are specified for CO, CO₂ and soot/smoke. Hydrogen cyanide production need not be considered.

The design fires are intended to represent ‘free-burning’ fires. However, they shall be modified during an analysis (depending on the methodology used) to account for building ventilation and the effects of automatic fire suppression systems (if any) on the fire. The design scenario: RC (see Paragraph 4.10) will require the overall robustness of the design to be examined separately.

The fire engineer shall:

- a) For each location of the challenging fire, use a single fire source to evaluate the building’s protection measures
- b) Consider the impact on occupants who may be using escape routes external to the building as well as internal routes, and
- c) Assume that active and passive fire safety systems in the building will perform as intended by the design.

**Method**
This scenario requires the ASET/RSET analysis of the impact on all building occupants of design fires located in various locations within the building, except for those rooms or spaces excluded in the scenario description above.

The fire engineer is expected to calculate the fire environment in the escape routes over the period of time the occupants require to escape. Assess the fire environment based on the fractional effective dose and visibility at the location of the occupants.

The fire engineer will typically select a fire calculation model appropriate to the complexity and size of the building/Space that allows the fractional effective dose and visibility to be determined.
### 4.10 Design scenario (RC): Robustness check

**Scenario in brief**
The fire design will be checked to ensure that the failure of a critical part of the fire safety system will not result in the design not meeting the objectives of the Building Code.

<table>
<thead>
<tr>
<th>Code objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1(a) Safeguard people from an unacceptable risk of injury or illness caused by fire.</td>
</tr>
<tr>
<td>C1(b) Protect other property from damage caused by fire.</td>
</tr>
<tr>
<td>C1(c) Facilitate firefighting and rescue operations.</td>
</tr>
</tbody>
</table>

**What you must satisfy**
This scenario contributes to testing the performance criteria of C3.9, C4.5, C5.8 and C6.2d). Where tenability criteria are evaluated, these criteria only need to be assessed based on FED (CO).

<table>
<thead>
<tr>
<th>Code objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>C3.9 Buildings must be designed and constructed with regard to the likelihood and consequence of failure of any fire safety system intended to control fire spread.</td>
</tr>
<tr>
<td>C4.5 Means of escape to a place of safety in buildings must be designed and constructed with regard to the likelihood and consequence of failure of any fire safety systems.</td>
</tr>
<tr>
<td>C5.8 Means to provide access for and safety of firefighters in buildings must be designed and constructed with regard to the likelihood and consequence of failure of any fire safety systems.</td>
</tr>
<tr>
<td>C6.2 Structural systems in buildings that are necessary for structural stability in fire must be designed and constructed so that they remain stable during fire and after fire when required to protect other property taking into account:</td>
</tr>
<tr>
<td>(a) …</td>
</tr>
<tr>
<td>(b) …</td>
</tr>
<tr>
<td>(c) …</td>
</tr>
<tr>
<td>(d) the likelihood and consequence of failure of any fire safety systems that affect the fire severity and its impact on structural stability.</td>
</tr>
</tbody>
</table>

**Required outcome**
Demonstrate that if a single fire safety system fails, where that failure is statistically probable, the building as designed will allow people to escape and fire spread to other property will be limited.

### Scenario description
This scenario applies where failure of a key fire safety system could potentially expose to untenable conditions:

- **a)** More than 150 people, or  
- **b)** More than 50 people in a sleeping occupancy firecell where the occupants are neither detained or undergoing some treatment or care, or  
- **c)** People detained or undergoing treatment or care.

For this scenario, key fire safety systems include:

- **a)** Smoke management systems (other than permanent natural/passive ventilation features that do not rely on the activation of any mechanical or electronic component)

  - **b)** Fire and/or smoke control doors or similar fire closures, and  

  - **c)** Any other feature or system required as part of the fire safety design that relies on a mechanical or electronic component to be activated during the fire, except that:

    - **i)** fire sprinkler systems and automatic fire alarms installed to a recognised national or international Standard, can be considered to be sufficiently reliable that they are exempt from this robustness scenario, and  

    - **ii)** in sprinklered buildings, fire and smoke control doors fitted with automatic hold-open devices that are designed and installed to BS 7273.4 or another recognised national or international Standard and are activated by the operation of the fire alarm system can be considered to be sufficiently reliable that they are exempt from this robustness scenario.