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Department of
Building and Housing
Te Tari Kaupapa Whare

Dear Customer

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

Section	Old C/VM2	April 2012 Errata to C/VM2
Status page	Remove page 3/4	Replace with new page 3/4
C/VM2	Remove pages 11-14, 19/20, 31/32, 39/40, 59/60	Replace with new pages 11-14, 19/20, 31/32, 39/40, 59/60

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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

The Building Code Clauses C1-C6 Protection from Fire take effect on 10 April 2012. The Building Code Clauses C1-C6 Protection from Fire replaces the Building Code Clauses C1-C4 Fire Safety on 9 April 2013.

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

	Date	Alterations	
New document	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.	
Errata 1	Effective from 30 April 2012	p. 11, 1.2 p. 13, Figure 1.1 a) p. 19, Figure 1.1 g)	p. 32, Table 2.3 p. 39, Table 3.3 p. 59, 4.9

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1 Introduction and scope

CONTENTS

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.

Errata 1 Apr 2012

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.

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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 (eg, *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.

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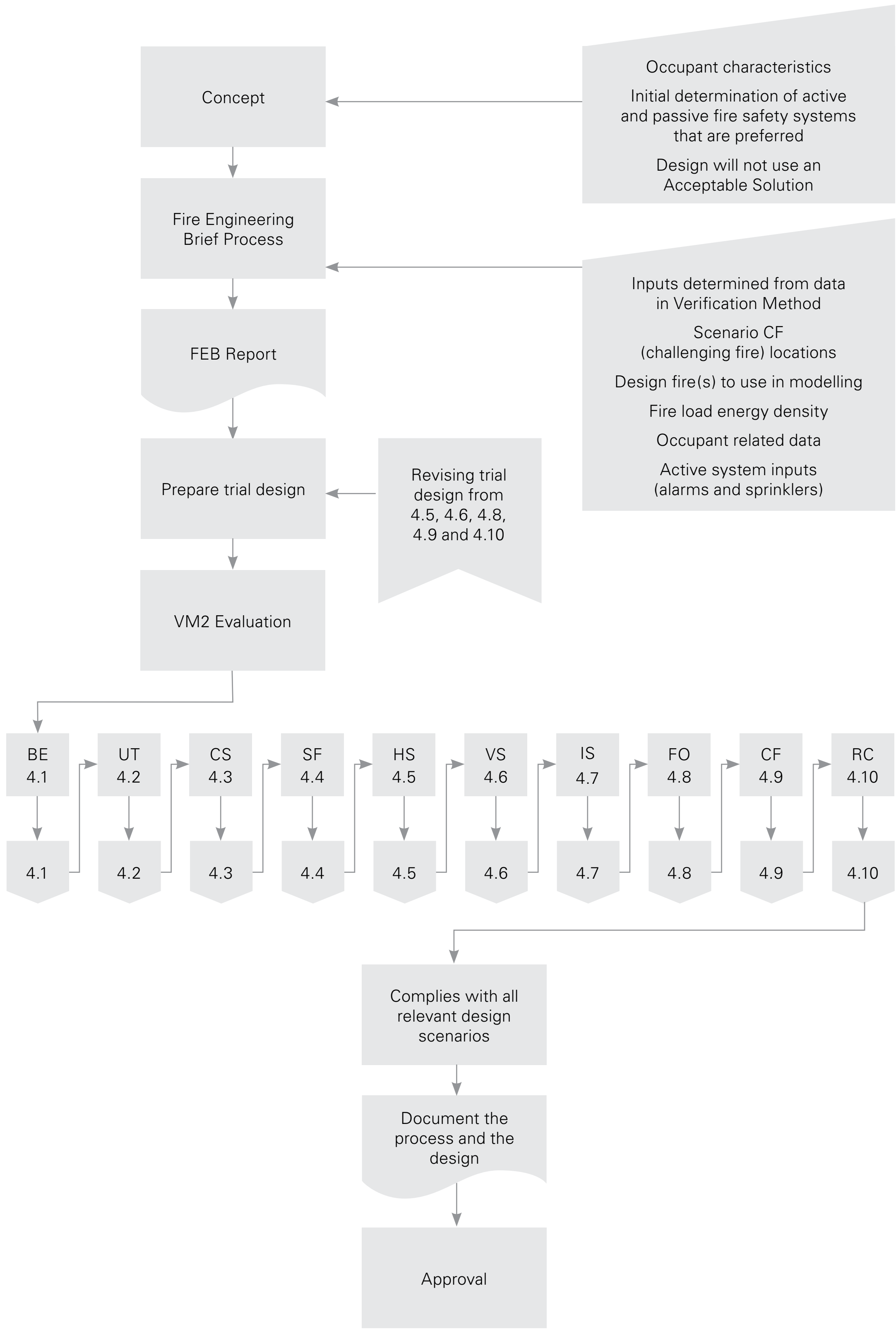
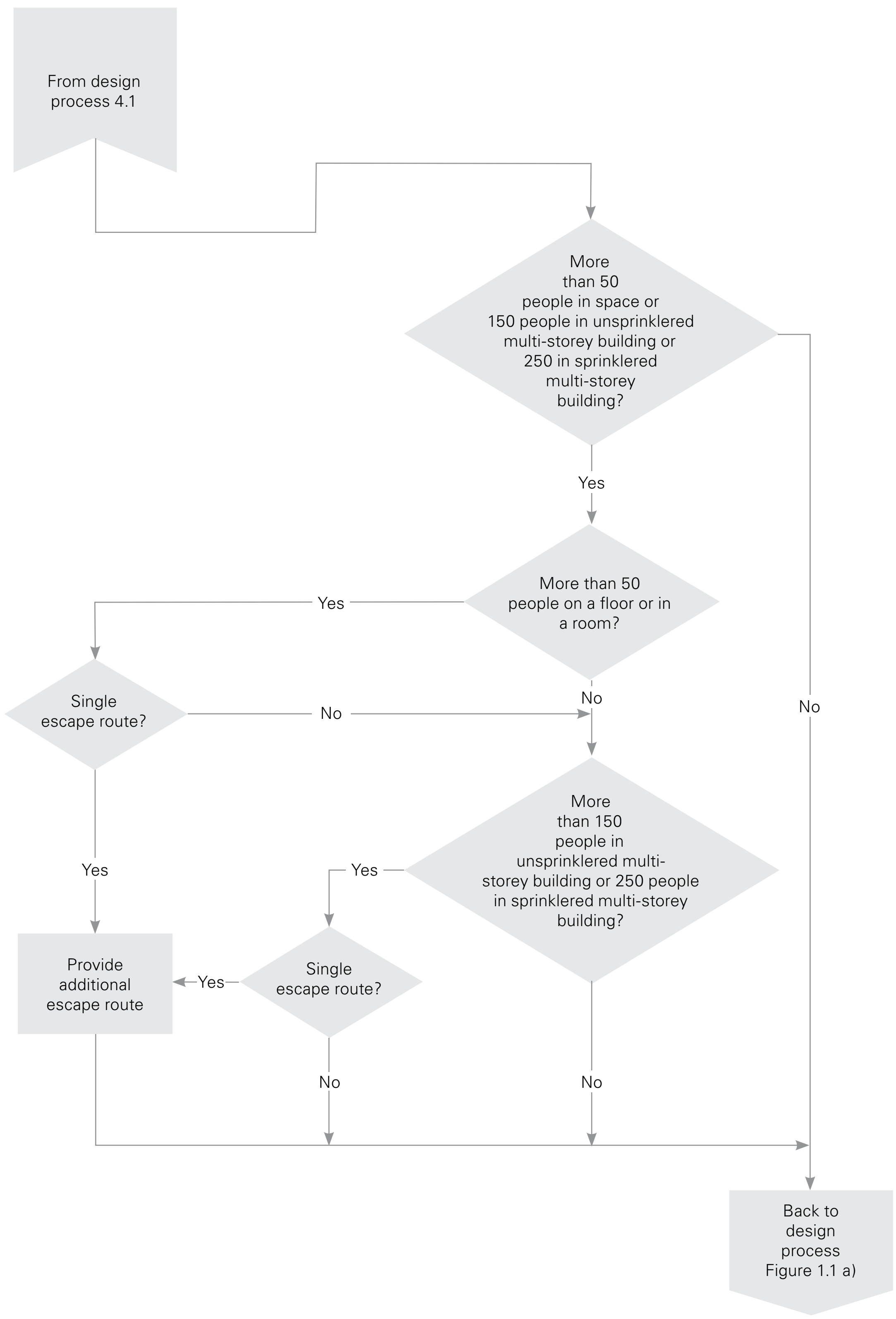
Figure 1.1 a): The design process for C/VM2



Errata 1
Apr 2012

ARCHIVED

Figure 1.1 b): Design scenario BE – Blocked exit



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Errata 1
Apr 2012

Figure 1.1 g): Design scenario VS – Vertical spread of fire

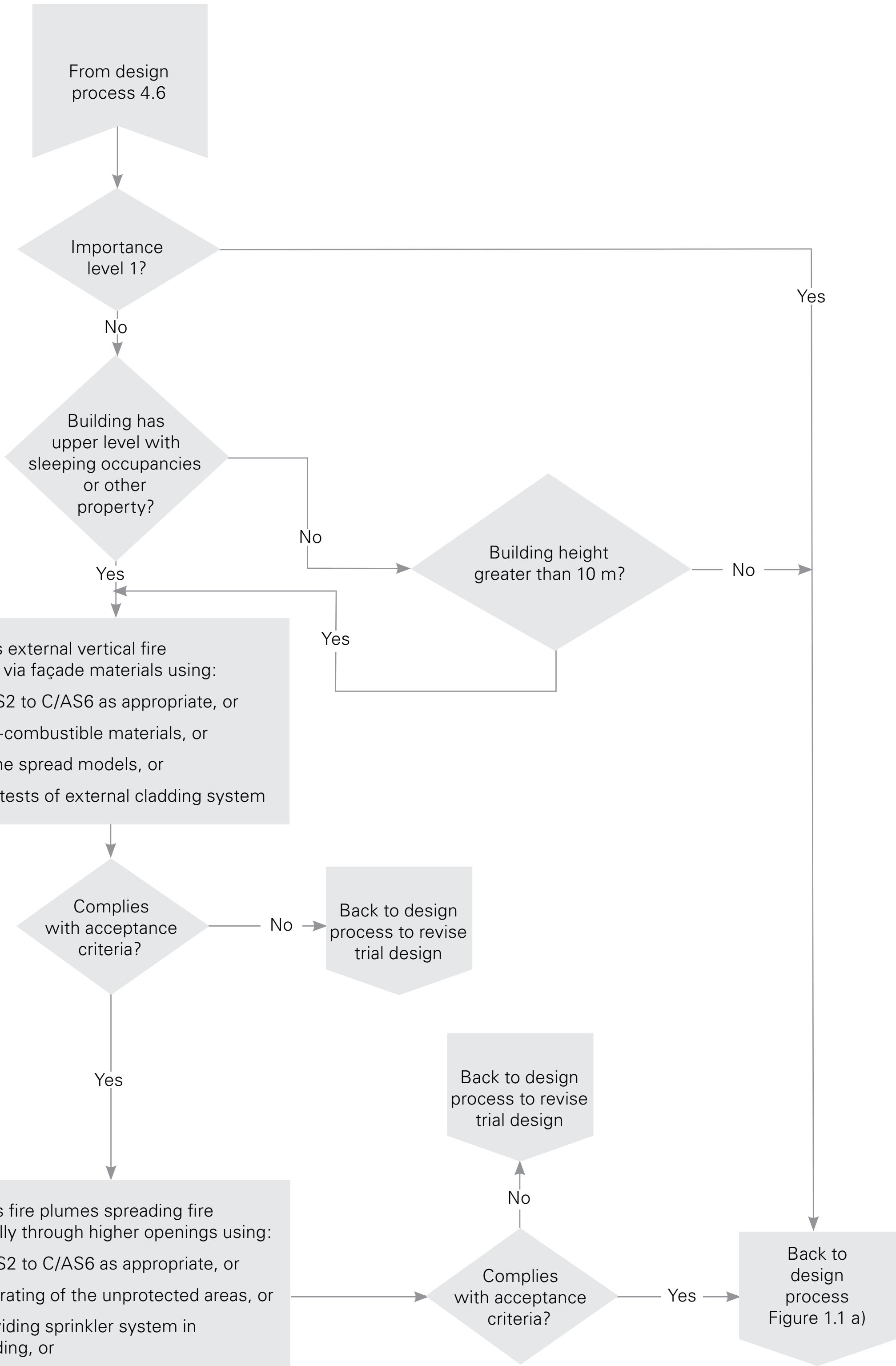

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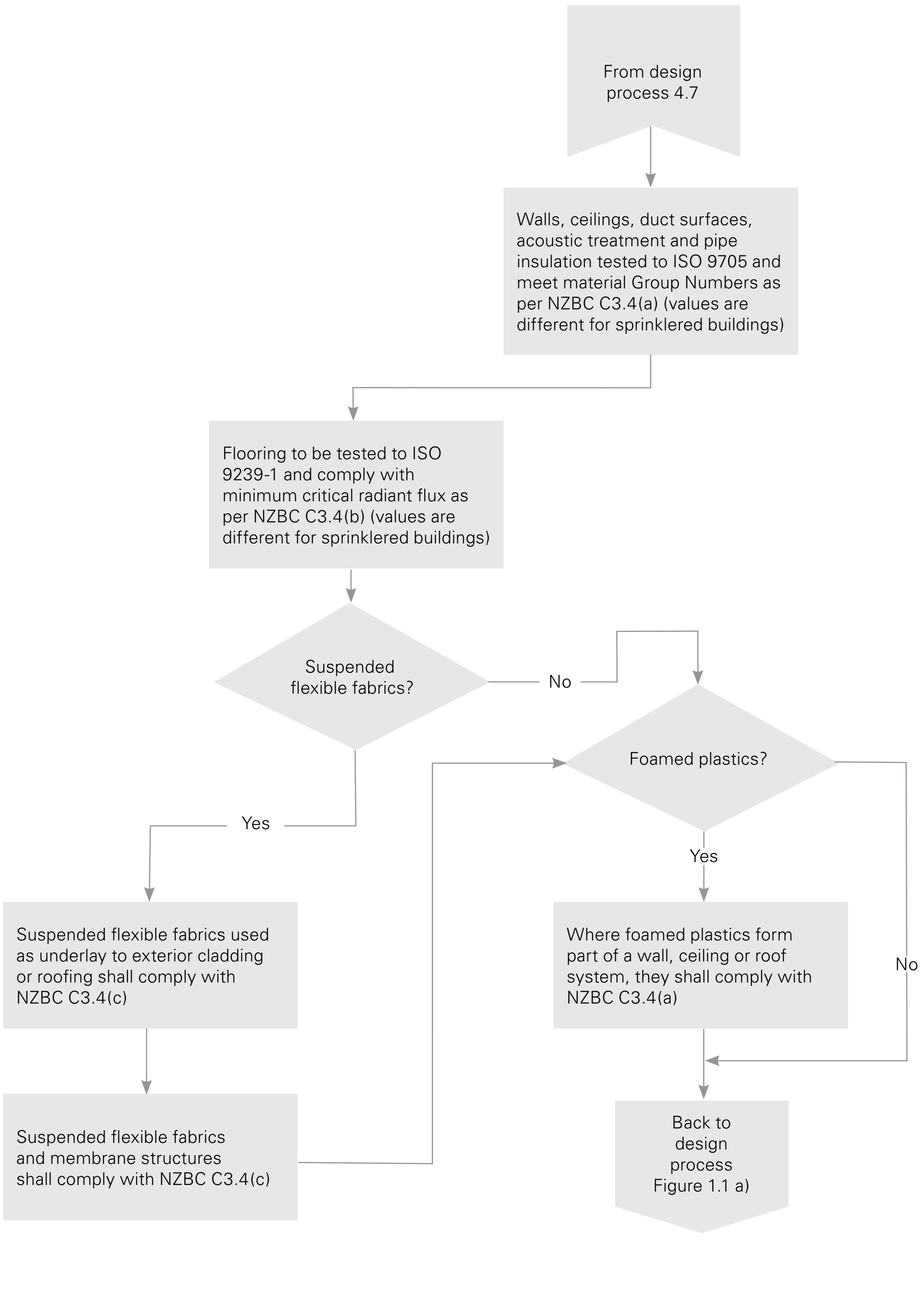
Figure 1.1 h): Design scenario IS – Surface finishes



Errata 1
Apr 2012

ARCHIVED

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 2.3 F_m factors to be applied to FLED

	Sprinklered *firecell*	Unsprinklered *firecell*
Fire resistance of primary structural elements in any structural system which is unable to develop dependable deformation capacity under post-*flashover fire* conditions [1]	1.00	1.25
Fire resistance of primary structural elements whose failure would consequently lead to disproportionate extent of collapse [2]	1.00	1.25
All other structural and non-structural elements or for life safety calculations of *fire* duration.	0.50	1.00

Errata 1 Apr 2012

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 (m²) 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*.

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Table 3.3	**Pre-travel activity times**
Description of *building* use	*Pre-travel activity time(s)*
Buildings where the occupants are considered awake, alert and **familiar** with the *building* (eg, offices, warehouses **not** open to the public)	
Enclosure of origin	30
Remote from the enclosure of origin	60
Buildings where the occupants are considered awake, alert and **unfamiliar** with the *building* (eg, retail shops, exhibition spaces, restaurants)	
Enclosure of origin (standard alarm signal)	60
Remote from the enclosure of origin (standard alarm signal)	120
Enclosure of origin (voice alarm signal)	30
Remote from the enclosure of origin (voice alarm signal)	60
Buildings where the occupants are considered sleeping and **familiar** with the *building* (eg, apartments)	
Enclosure of origin (standard alarm signal)	60
Remote from the enclosure of origin (standard alarm signal)	300
Buildings where the occupants are considered sleeping and **unfamiliar** with the *building* (eg, hotels and motels)	
Enclosure of origin	60
Remote from the enclosure of origin (standard alarm signal)	600
Remote from the enclosure of origin (voice alarm signal)	300
Buildings where the occupants are considered awake and under the care of trained staff (eg, day care, dental office, clinic)	
Enclosure of origin (independent of alarm signal)	60
Remote from the enclosure of origin (independent of alarm signal)	120
Buildings where the occupants are considered sleeping and under the care of trained staff (eg, hospitals and rest homes)	
Enclosure of origin (assume staff will respond to room of origin first)	60 s for staff to respond to alarm then 120 s (per patient per 2 staff)[1]
Remote from the enclosure of origin (independent of alarm signal)	1800
Remote from the enclosure of origin (independent of alarm signal) where occupants are unable to be moved due to the procedure or other factor	1800 or as per specific requirements, whichever is the greater
Spaces within *buildings* which have only focused activities (eg, cinemas, *theatres* and stadiums)	
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)	0

Errata 1
Apr 2012

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_{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.

$S = K - akD$ 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_{trav}) is calculated by using equation 3.3:

$t_{trav} = L_{trav} / S$ Equation 3.3

where:

t_{trav} = travel time (s), and

L_{trav} = travel distance (m).

The maximum horizontal travel distance (L_{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 3.4 Maximum flow rates for use in equation 3.2 for horizontal and vertical travel speeds

Exit route elements		k	Speed m/s
Corridor, aisle, ramp, doorway		1.40	1.19
Stair riser (mm)	Stair tread (mm)		
191	254	1.00	0.85
178	279	1.08	0.95
165	305	1.16	1.00
165	330	1.23	1.05

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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 m^2 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:

Errata 1 Apr 2012

a) Any room with a floor area less than 2.0 m^2, 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:

Errata 1 Apr 2012

   i) a total floor area, including *intermediate floors*, of less than 500 m^2, 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, CO_2 and soot/smoke. Hydrogen cyanide production need not be considered.

Errata 1 Apr 2012

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*.
Code objectives	***C1(a)*** *Safeguard people from an unacceptable risk of injury or illness caused by fire.* ***C1(b)*** *Protect other property from damage caused by fire.* ***C1(c)*** *Facilitate firefighting and rescue operations.*
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). ***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.* ***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.* ***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.* ***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:* *(a) …* *(b) …* *(c) …* *(d) the likelihood and consequence of failure of any fire safety systems that affect the fire severity and its impact on structural stability.*
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.