MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

Please find attached Amendment 6, effective 5 November 2020, to Verificaton Method C/VM2 for Clauses C1–C6 Protection from Fire of the New Zealand Building Code. The previous amendment to C/VM2, Amendment 5, was in November 2017.

Section	**Previous version**	**November 2020 amendment**
Title pages	Remove title page and document history/status	Replace with new title page and document history/status
Contents	Remove page 5/6	Replace with new page 5/6
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Definitions	Remove page 9/10	Replace with new page 9/10
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MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

C/VM2

Verification Method: Framework for Fire Safety Design

For New Zealand Building Code Clauses C1-C6 Protection from Fire

C
BUILDING CODE

Using this Verification Method

The Ministry of Business, Innovation and Employment may amend parts of this Verification Method at any time. People using this Verification Method should check on a regular basis whether new versions have been published. The current version can be downloaded from www.building.govt.nz

Users should make themselves familiar with the preface to the New Zealand Building Code Handbook, which describes the status of Verification Methods and explains other ways of achieving compliance.

Defined words (italicised in the text) are explained in the Building Code Clause A2 and in the Definitions section of this Verification Method. Classified uses of buildings are explained in the Building Code Clause A1. Importance levels of building are buildings (italicised in the text) are explained in the Building Code Clause A3.

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Acceptable Solutions and Verification Methods are available from www.building.govt.nz

New Zealand Government

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 Verification Method.

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 5 November 2020. It can be used to show compliance with the Building Code Clauses C1-C6 Protection from Fire. It does not apply to building consent applications submitted before 5 November 2020.

The previous version, Amendment 5, of this Verification Method can be used to show compliance with the Building Code Clauses C1-C6 Protection from Fire until 3 November 2021. It can be used for building consent applications submitted before 4 November 2021.

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.	
Amendment 1 (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
Amendment 2 (Errata 2)	Effective from 15 February 2013 until 18 June 2014	p. 9 Definitions pp. 25–26 2.2.1 p. 33 Table 2.4 p. 40 3.2.4 p. 41 3.2.7	p. 58 4.8 p. 59 4.9 p. 61 4.10 p. 64 Index
Amendment 3	Effective from 19 December 2013 until 28 February 2015	p. 5 Contents p. 7 References p. 10 Definitions p. 15 Figure 1.1 c pp. 25–26 2.2.1 pp. 28–32 Tables 2.1, 2.2, 2.3 p. 35 Table 3.1	pp. 39–42 3.2.4, 3.4, Table 3.3 pp 49–64 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, Tables 4.1 and 4.2 pp. 66–68 A1.1, A1.4, A1.5, Table A1 p. 69 Index
Amendment 4	Effective from 1 July 2014 until 23 November 2017	p. 5–6 Contents pp. 7-8 References p. 10–10A Definitions p. 11–13 1.2, 1.3, Figure 1.1 pp. 14–23 Figure 1.1 p. 24 1.5, Table 1.1 pp. 25–28, 30–31, 33–33A 2.2.1, 2.4, 2.4.4, 2.5, Tables 2.1, 2.2 and 2.4 pp. 34–44 3.1, 3.2.4, 3.2.5, 3.2.6, 3.3, 3.4, 3.4.1, 3.6.1, 3.6.3, 3.6.5, Tables 3.1, 3.2, 3.3	p. 45 Part 4 Contents pp. 46–47 4.1, 4.2 pp. 50–52, 4.5 pp. 53–56, 4.6, Table 4.2 p. 59 4.7 pp. 61–62 4.8 p. 63 4.9 p. 65 4.10 pp. 69–70 A1.6, A1.7, Tables A.1 and A.2 p. 71 Appendix B, Table B1 p. 72 Index
Amendment 5	Effective from 24 November 2017 until 3 November 2021	pp. 11-12 1.2 Scope	
Amendment 6	Effective from 5 November 2020	pp. 5–6 Contents pp. 7–8A References pp. 9–10 Definitions p. 11 Part 1 Contents pp. 25–26, Part 2 Contents, 2.2.1	p. 34 Part 3 Contents pp. 50–56 4.5, 4.6, Table 4.1 pp. 72-91 New Appendix C p. 92 Index

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References

Amend 6 Nov 2020

For the purposes of New Zealand Building Code compliance, the New Zealand and other Standards, and other documents referred to in this Verification Method (primary reference documents) shall be the editions, along with their specific amendments, listed below. Where the primary reference documents refer to other Standards or other documents (secondary reference documents), which in turn may also refer to other Standards or other documents, and so on (lower order reference documents), then the applicable version of these secondary and lower order reference documents shall be the version in effect at the date that the primary reference document was published.

Standards New Zealand			
NZS 4510: 2008	Fire hydrant systems for buildings *Amend: 1*	4.8	
NZS 4512: 2010	Fire detection and alarm systems in buildings	3.4	
NZS 4515: 2009	Fire sprinkler systems for life safety in sleeping occupancies (up to 2000 m^2)	Definitions	
Amend 3 Dec 2013 NZS 4541: 2013	Automatic fire sprinkler systems	Definitions, 4.5	Amend 6 Nov 2020
AS/NZS 3837: 1998	Method of test for heat and smoke release rates for materials and products using an oxygen consumption calorimeter *Amend: 1* (Amend 3 Dec 2013)	Table 4.1	Amends 3 and 6
Standards Australia			
AS 1366:-	Rigid cellular plastics sheets for thermal insulation		Amend 4 Jul 2014
Part 1: 1992	Rigid cellular polyurethane (RC/PUR) *Amend: 1*	4.7, A1.7	
Part 2: 1992	Rigid cellular polyisocyanurate (RC/PIR)	4.7, A1.7	
Part 3: 1992	Rigid cellular polystyrene – moulded (RC/PS-M) *Amend: 1*	4.7, A1.7	
Part 4: 1989	Rigid cellular polystyrene – extruded (RC/PS-E)	4.7, A1.7	
AS 1530:-	Methods for fire tests on building materials, components and structures		
Part 1: 1994	Combustibility test for materials	4.7	
Part 2: 1993	Test for flammability of materials	4.7	
Part 4: 2005	Fire resistance tests for elements of construction	2.4	
AS 4254:-	Ductwork for air-handling systems in buildings	4.7, A1.4	
Part 1: 2012	Flexible duct		
Part 2: 2012	Rigid duct (Amend 3 Dec 2013)		
AS 5113: 2016	Classification of external walls of buildings based on reaction-to-fire performance *Amend: 1* (Amend 6 Nov 2020)	4.6	
British Standards Institution			
BS 7273:-	Code of practice for the operation of fire protection measures		
Part 4: 2007	Actuation of release mechanisms for doors	4.10	Amends 3 and 4

BS 8414:-	Fire performance of external cladding systems	
Part 1: 2015	Test method for non-loadbearing external cladding systems applied to the masonry face of a building *Amend: 1 (2017)*	4.6
Part 2: 2015	Test method for non-loadbearing external cladding systems fixed to and supported by a structural steel frame *Amend: 1 (2017)*	4.6
BS EN 13501:-	Fire classification of construction products and building elements	
Part 1: 2018	Classification using test data from reaction to fire tests	Definitions

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International Standards Organisation

ISO 1182: 2010	Reaction to fire tests for products – Non-combustibility test	4.7
ISO 5660:-	Reaction-to-fire tests	
Part 1: 2002	Heat release, smoke production and mass loss rate	4.7, A1.1, A1.2, A1.3, A1.7, Table 4.1
Part 2: 2002	Smoke production rate (dynamic measurement)	A1.1
ISO 9239:-	Reaction to fire tests for floorings	
Part 1: 2010	Determination of the burning behaviour using a radiant heat source	4.7, B1.0 Table B1,
ISO 9705: 1993	Fire tests – Full-scale room test for surface products	4.7, A1.1, A1.2, A1.7
ISO 13571: 2007	Life-threatening components of fire Guidelines for the estimation of time available for escape using fire data.	2.2.1
ISO 13784:-	Reaction-to-fire tests for sandwich panel building systems	
Part 1: 2002	Test method for small rooms	A1.1, A1.7

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European Committee for Standardisation

Eurocode DD ENV 1991:-	Eurocode 1: basis of design and actions on structures,	
Part 2.2: 1996	Actions on structures exposed to fire	2.4 Comment, 2.4.4

National Fire Protection Association of America

NFPA 285: 2019	Standard fire test method for evaluation of fire propagation characteristics of exterior wall assemblies containing combustible components	4.6

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Australian Building Codes Board

International Fire Engineering Guidelines (IFEG): 2005	1.3 Comment

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BRE Global

BR 135: 2013	Fire performance of external thermal insulation for walls of multistorey buildings – Third Edition	4.6

Society of Fire Protection Engineers

The Handbook of Fire Protection Engineering, 4th Edition,	National Fire Protection Association, Quincy, M.A, USA, 2008.	
	Gwynne, S.M.V, and Rosenbaum, E.R, "Employing the Hydraulic Model in Assessing Emergency Movement", Section 3 Chapter 13.	3.2 Comment 3.2.6 Comment
SFPE Engineering Guide to Predicting 1st and 2nd Degree Skin Burns	from Thermal Radiation, 2000	3.6.1

General publications

Fire Engineering Design Guide (Centre for Advanced	Engineering, 2008)	2.4.4 Comment

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Definitions

The full list of definitions for italicised words may be found in the New Zealand Building Code Handbook.

Available safe egress time (ASET) Time available for escape for an individual occupant. This is the calculated time interval between the time of ignition of a fire and the time at which conditions become such that the occupant is estimated to be incapacitated (ie, unable to take effective action to escape to a *place of safety*).

Burnout Means exposure to fire for a time that includes fire growth, full development, and decay in the absence of intervention or automatic suppression, beyond which the fire is no longer a threat to building elements intended to perform loadbearing or fire separation functions, or both.

Amend 6 Nov 2020

Cavity barriers A *construction* provided to close openings within a *concealed space* against the passage of *fire*, or to restrict the spread of *fire* within such spaces.

Computational fluid dynamics (CFD) Calculation method that solves equations to represent the movement of fluids in an environment.

Design fire Quantitative description of assumed *fire* characteristics within the *design scenario*.

Design scenario Specific scenario on which a deterministic *fire safety engineering* analysis is conducted.

Detection time Time interval between ignition of a *fire* and its detection by an automatic or manual system.

Evacuation time Time interval between the time of warning of a *fire* being transmitted to the occupants and the time at which the occupants of a specified part of a *building* or all of the *building* are able to enter a *place of safety*.

Fire decay Stage of *fire* development after a *fire* has reached its maximum intensity and during which the *heat release rate* and the temperature of the *fire* are decreasing.

Fire growth Stage of *fire* development during which the *heat release rate* and the temperature of the *fire* are increasing.

Fire load Quantity of heat which can be released by the complete combustion of all the *combustible* materials in a volume, including the facings of all bounding surfaces (Joules).

Fire load energy density (FLED) *Fire load* per unit area (MJ/M^2).

Fire safety engineering Application of engineering methods based on scientific principles to the development or assessment of designs in the built environment through the analysis of specific *design scenarios* or through the quantification of risk for a group of *design scenarios*.

Flashover Stage of *fire* transition to a state of total surface involvement in a *fire* of *combustible* materials within an enclosure.

Fractional effective dose (FED) The fraction of the dose (of carbon monoxide (CO) or thermal effects) that would render a person of average susceptibility incapable of escape.

Comment:
The definition for FED has been modified from the ISO definition to be made specific for this Verification Method. The ISO definition is "Ratio of the exposure dose for an insult to that exposure dose of the insult expected to produce a specified effect on an exposed subject of average susceptibility."

Fully developed fire State of total involvement of *combustible* materials in a *fire*.

Heat of combustion Thermal energy produced by combustion of unit mass of a given substance (kJ/g).

Heat release Thermal energy produced by combustion (Joules).

Heat release rate (HRR) Rate of thermal energy production generated by combustion (kW or MW).

Importance level As specified in Clause A3 of the *Building Code*.

Incapacitated State of physical inability to accomplish a specific task. Errata 2 Feb 2013

Insulation In the context of *fire* protection, the time in minutes for which a prototype specimen of a *fire separation*, when subjected to the *standard test* for *fire* resistance, has limited the transmission of heat through the specimen.

Integrity In the context of *fire* protection, the time in minutes for which a prototype specimen of a *fire separation*, when subjected to the *standard test* for *fire* resistance, has prevented the passage of flame or hot gases.

Comment:
The precise meaning of *integrity* depends on the type of *building elements* being treated and how it is defined in the *standard test* being used.

Limited combustible A material that does not comply with the requirements for a *non-combustible* material and is classified as A2 in accordance with to BS EN 13501-1.

Non-combustible Material either—

a) composed entirely of glass, concrete, steel, brick/block, ceramic tile, or aluminium; or

b) classified as non-combustible when tested to AS 1530.1; or

c) classified as A1 in accordance with BS EN 13501-1.

Amend 6 Nov 2020

Optical density of smoke Measure of the attenuation of a light beam passing through smoke expressed as the logarithm to the base 10 of the opacity of smoke.

Opacity of smoke Ratio of incident light intensity to transmitted light intensity through smoke under specified conditions.

Place of safety means either—

a) a *safe place*; or

b) a place that is inside a *building* and meets the following requirements:

i) the place is constructed with *fire separations* that have *fire* resistance sufficient to withstand *burnout* at the point of the *fire source*; and

ii) the place is in a *building* that is protected by an automatic fire sprinkler system that complies with NZS 4541 or NZS 4515 as appropriate to the *building's* use; and

iii) the place is designed to accommodate the intended number of persons at a design occupant density – depending on the usage this shall not be less than 1.0 m^2 per person; and

Amends 3 and 4

iv) the place is provided with sufficient means of escape to enable the intended number of persons to escape to a *safe place* that is outside a *building*.

Pre-travel activity time Time period after an alarm or *fire* cue is transmitted and before occupants first travel towards an exit.

Required safe egress time (RSET) Time required for escape. This is the calculated time period required for an individual occupant to travel from their location at the time of ignition to a *place of safety*.

Response Time Index (RTI) The measure of the reaction time to a *fire* phenomenon of the sensing element of a *fire safety system*.

Safe place A place, outside of and in the vicinity of a single *building* unit, from which people may safely disperse after escaping the effects of a *fire*. It may be a place such as a street, *open space*, public space or an *adjacent building* unit.

Comment:
The Fire Safety and Evacuation of Buildings Regulations 2006 use the term *'place of safety'* and allow the *place of safety* to be within the *building* provided that it is protected with a sprinkler system.

Separating element Barrier that exhibits fire *integrity*, *structural adequacy*, thermal *insulation*, or a combination of these for a period of time under specified conditions (in a fire resistance test).

Smoke production rate Amount of smoke produced per unit time in a *fire* or *fire* test.

Smoke separation Any *building element* able to prevent the passage of smoke between two spaces. *Smoke separations* shall:

a) Be a smoke barrier complying with BS EN 12101 Part 1, or

b) Consist of rigid *building elements* capable of resisting without collapse:

i) a pressure of 0.1 kPa applied from either side, and

ii) self weight plus the intended vertically applied live loads, and

c) Form an imperforate barrier to the spread of smoke, and

Amend 4 Jul 2014

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

1.2.1 This Verification Method is for *fire* designs for all *buildings* except those *buildings* that:

a) Do not have simultaneous evacuation schemes that evacuate immediately to the outside, or

b) Require a managed evacuation, or

c) Contain *fire hazards* that are not defined by Part 2 of this Verification Method "The rules and parameters for the Design Scenarios".

Comment:

Errata 1 Amend 4

1. This Verification Method is an analysis tool for *buildings* with simultaneous evacuation schemes that evacuate immediately to the outside, and with typical *fire growth* rates.
2. Additional *fire* safety precautions to those determined by this Verification Method may be necessary to facilitate approval of the intended evacuation procedures to meet the Fire Safety and Evacuation of Buildings Regulations 2006.
3. Examples of *buildings* outside of the scope include hospitals, care homes, stadia, principal transport terminals, large shopping malls (greater than 10,000 m^2 and contain mezzanine floors), tall *buildings* (greater than 60 metres or 20 storeys in height) or tunnels.
4. *Fire* safety design for *buildings* that are outside of the scope can be performed using the Fire Engineering Brief (FEB) process and the appropriate parts of this Verification Method, which can be considered by the *building consent authority* as an *alternative solution*.

Amend 5 Nov 2017

1.2.2 This Verification Method does not provide *fire* design where there is use, storage or processing of *hazardous substances*.

Comment:
Compliance with NZBC F3 and the Hazardous Substances and New Organisms (HSNO) Act 1996 should be considered where applicable in addition to the requirements of this Verification Method.

Amend 5
Nov 2017

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.

The concept *fire* design shall be trialled using *building* specific *fire* design requirements ascertained via the Fire Engineering Brief (FEB) process as described in internationally recognised *fire* engineering process documents.

Comment:
There are a number of internationally recognised process documents including the International Fire Engineering Guidelines and others published by British Standards and the Society for Fire Protection Engineers.

Amend 4
July 2014

Follow the process schematically illustrated 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 (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 Figure 1.1, the numbered references are to paragraph numbers in this Verification Method.

Figure 1.1 is guidance information illustrating how the use of this Verification Method – in particular the *design scenarios* – fits into the general iterative *fire* design process. The flowchart assumes design starts at concept design stage. The sequence of assessing each of the *design scenarios* may vary from that idealised in Figure 1.1. The design process outlined in the flowchart will vary when using this Verification Method for assessing Code compliance of existing *buildings*. The overall process described in Figure 1.1 is not itself a normative part of C/VM2.

The communication process relating to FEB development will vary for each project and may include both written and verbal communication to collect stakeholder considerations and test options when preparing trial designs. Similarly, the form of FEB documentation will vary depending on the complexity and scale of the project and the design issues. The key features of both the FEB communication and documentation are that it is unambiguous, complete (i.e. provided with appropriate context) and recorded in some form for later reference.

Amends
3 and 4

Part 2: Rules and parameters for the design scenarios

CONTENTS

Amend 6 Nov 2020

2.1 Applying the design scenarios

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 C1-C6: Protection from Fire.

This section sets out the *fire* modelling rules, *design fire* characteristics and other parameters to be used in calculations required by the *design scenarios*. Occupancy criteria and calculations for the movement of people are provided in Part 3.

2.2 Fire modelling rules

The *fire* modelling rules in Paragraphs 2.2.1 and 2.2.2 shall be applied to the *design scenarios* as appropriate.

2.2.1 Fire modelling rules for life safety design

The model to be used, and the spaces or volumes to be modelled, shall be established at FEB.

The trial design shall identify the type of separations (eg *fire separation*, smoke separation or unrated *construction*) and closures (eg *fire* or *smoke control doors* etc) proposed, and which of these are relevant for inclusion in the analysis. These modelling rules detail the assumptions to be made regarding the different types of separation or closure. These modelling rules are not intended to imply that it is necessary to include all separations and closures in the analysis. Only those separations and closures forming the volumes required to demonstrate the safe evacuation of occupants need be considered in an *ASET* analysis.

Amend 4 Jul 2014

Fire modelling rules for life safety design shall be as follows:

a) Warning systems in accordance with Paragraph 3.4 shall be installed.

b) *Fire* and *smoke control doors* with self-closers complying with a recognised national or international Standard are assumed closed unless being used by occupants. During egress, when *occupant load* is low, doors are assumed to be open for three seconds per occupant. However, when the *occupant load* is high and queuing is expected, the door is considered to be open for the duration of queuing.

c) *Smoke control doors* serving bedrooms in sleeping areas where care is provided (these do not have self closers) shall be considered to be closed from the time that evacuation from the bedroom is completed in accordance with Paragraph 3.2 and Table 3.3.

Amend 4 Jul 2014

d) External doors and other closures such as roller shutters shall be modelled as closed unless explicitly designed to open in the event of *fire.*

Amend 3 Dec 2013

Amend 3 Dec 2013

e) All doors not described in Paragraph 2.2.1 b), c) and d) shall be considered to be open during the analysis unless:

i) there is a high likelihood that the door will be closed for security or other functional reasons throughout the time period of analysis; and

Amend 4 Jul 2014

ii) the substantiated functional reason is established at FEB.

Amend 6 Nov 2020

Amend 3 Dec 2013

f) Doors being used for egress, when in the open position, are assumed to be half-width for smoke flow calculations.

Amend 3 Dec 2013

g) Leakage area through non *fire*-rated walls shall be calculated according to Paragraph 2.2.1 i). The leakage may be modelled either as a tall narrow slot from floor to ceiling with the width determined by the calculated area, or as two vents, one at floor level and one at ceiling level, to fit within the computational grid (in the case of *CFD* modelling). Where the leakage is from a room to the outside, it may also be modelled as a single vent at floor level. Where there is a permanent opening between two spaces, the leakage between those spaces may be ignored if the area of the permanent opening is at least five times the leakage area.

Errata 2 Feb 2013

Errata 2 Feb 2013

Amend 3 Dec 2013

h) Where *CFD* modelling is used, leakage areas shall be calculated according to Paragraph 2.2.1 i) and modelled as described in Paragraph 2.2.1 g). In cases where the required leakage vent area is smaller than a single grid cell, the leakage may be increased to fit within the computational grid. However, the combined area of the modelled leakage vents shall not exceed 5 times that of the calculated leakage area.

Amend 4 Jul 2014

Amend 3 Dec 2013

i) Leakage areas assumed for modelling shall be as follows:

Amend 4 Jul 2014

i) *smoke control doors* that comply with a recognised national or international Standard (including doors that have both *fire* and smoke control capability complying with a recognised national or international Standard) and *smoke separations* are assumed to have zero leakage area, except for a 10 mm gap under doors

Amend 4 Jul 2014

ii) *fire* doors that are not *smoke control doors* are assumed to have a 10 mm gap over the height of the door

iii) *construction* having a *fire resistance rating* (excluding doors) is considered to have no leakage, and

iv) non *fire*-rated internal and *external walls* are assumed to have leakage areas that are proportional to the surface area of the walls. Leakage area is equal to the wall area multiplied by 0.001 m^2/m^2 (ie, 0.1%) for lined internal and *external walls* and 0.005 m^2/m^2 for unlined *external walls*.

j) The volume of storage racking, furniture and other contents need not be subtracted from the gross volume.

Amends 3 and 4

Errata 1 Amend 3

k) *Smoke separations* including glazing that comply with recognised national or international Standards for use as a smoke barrier are assumed to remain in place up to the rated temperature or the time at which *flashover* occurs, whichever is sooner.

Amend 3 Dec 2013

l) *Smoke separations* that are not tested (eg, non *fire* rated but imperforate *construction*) are assumed to remain in place until the average upper layer temperature reaches 200°C.

Amend 4 Jul 2014

Errata 1 Amend 3

m) Exterior windows that are not *fire resisting glazing* are assumed to break (ie, glass falls out to become completely open) at the sooner of either average upper layer temperature reaching 500°C or when the *fire* becomes limited by ventilation. Windows that are *fire resisting glazing* may be assumed to remain in place up to the rated time.

Amend 3 Dec 2013

n) The *fire* shall be located away from walls and corners to maximise entrainment of air into the fire plume. The base of the *fire* shall be located at a height of no more than 0.5 m above floor level.

Amend 3 Dec 2013

o) *Fractional Effective Dose (FED)* for CO and thermal effects shall be calculated using the procedures described in ISO 13571. FED_{CO} shall include contributions from CO, CO_2 and O_2 gases. $FED_{thermal}$ shall include radiative and convective effects.

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Part 3: Movement of people

CONTENTS

3.1 Occupant numbers

The occupancy of any space in a *building* shall be calculated using the occupant densities provided in Table 3.1.

If, in a particular situation, the *occupant load* derived from Table 3.1 is clearly more than that which will occur, the basis of any proposal for a lesser *occupant load* must be substantiated to the *building consent authority*. However, note that designing a building for a reduced *occupant load* can severely restrict future occupancy options and may involve significant expense in meeting the *means of escape from fire* provisions for increased numbers.

If the maximum *occupant load* is greater than that calculated from Table 3.1, the higher number shall be used as the basis for the *fire* safety design and will need to be justified to the *building consent authority*.

Amend 4 Jul 2014

4.4 Design scenario (SF): Smouldering fire

Scenario in brief	A fire is smouldering in close proximity to a sleeping area.
Code objective	*C1(a) Safeguard people from an unacceptable risk of injury or illness caused by fire.*
What you must satisfy	For *buildings* with a sleeping use, ensure that there are automatic means of smoke detection and alarm complying with a recognised national or international Standard for occupants who may be sleeping.
Required outcome	Provide an automatic smoke detection and alarm system throughout the *building* that has been designed and installed to a recognised national or international Standard.

Scenario description

This scenario addresses the concern regarding a slow, smouldering *fire* that causes a threat to sleeping occupants. Assume that active and passive *fire safety systems* in the *building* perform as intended by the design.

Method

Amend 3 Dec 2013

Provide an automatic detection and alarm system throughout the *building* including smoke detection in sleeping areas, designed and installed to a recognised national or international Standard. No further analysis is expected.

4.5 Design scenario (HS): Horizontal fire spread

Scenario in brief	A fully developed *fire* in a *building* exposes the *external walls* of a neighbouring *building* or *firecell*.
Code objectives	***C1(b)*** *Protect other property from damage caused by fire.*
What you must satisfy	The performance criteria in C3.6 and C3.7. This will require calculation. C4.2 is to be considered in relation to horizontal *fire* spread across a *notional boundary* to sleeping occupancies and *exitways* in *buildings* under the same *ownership*. ***C3.6*** *Buildings must be designed and constructed so that in the event of fire in the building the received radiation at the relevant boundary of the property does not exceed 30 kW/m² and at a distance of 1 m beyond the relevant boundary of the property does not exceed 16 kW/m².* ***C3.7*** *External walls of buildings that are located closer than 1 m to the relevant boundary of the property on which the building stands must either:* *a) be constructed from materials which are not combustible building materials, or* *b) for buildings in Importance levels 3 and 4 be constructed from materials that, when subjected to a radiant flux of 30 kW/m², do not ignite for 30 minutes, or* *c) for buildings in Importance levels 1 and 2, be constructed from materials that, when subjected to a radiant flux of 30 kW/m², do not ignite for 15 minutes.* ***C4.2*** *Buildings must be provided with means of escape to ensure that there is a low probability of occupants of those buildings being unreasonably delayed or impeded from moving to a place of safety and that those occupants will not suffer injury or illness as a result.*
Required outcome	Demonstrate that the criteria in C3.6 and C3.7 are not exceeded by calculating the radiation from *unprotected areas* in the *external wall* to the closest point on an adjacent *boundary* and at 1.0 m beyond an adjacent *boundary*, and specifying exterior cladding materials with adequate resistance to ignition Control horizontal *fire* spread across a *notional boundary* to sleeping occupancies and *exitways* in *buildings* under the same *ownership.*

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Scenario description

A fully developed *fire* in a *building* exposes the *external walls* of a neighbouring *building* (*other property*) or *firecell* (sleeping occupancy, *exitway* or *other property*).

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This scenario addresses a *fire* in a *building* that leads to high levels of radiation heat exposure across a *relevant boundary*, potentially:

1) Igniting the *external walls* of a neighbouring *building*, or
2) Leading to *fire* spread to *other property*, sleeping occupancies and *exitways*.

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The performance requirements of C3.6 are also to be applied to limit the radiation at the *notional boundary* to sleeping occupancies and *exitways* in *buildings* under the same ownership.

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An exception to 2) above is if a sprinklered unit-titled *building* is subdivided, the protection between any title and areas in common need not be *fire* rated for the protection of *other property* unless required for separation of *escape routes*, to separate sleeping occupancies, or by the FO scenario.

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Unprotected area shall include both unrated *external wall construction* as well as any unrated window/door assemblies and other openings. Areas of the *external wall* that are not designated as *unprotected area* shall have a *fire resistance rating* meeting the *integrity* criteria sufficient to resist the full *burnout design fire* described in Paragraph 2.4 and with *insulation* sufficient to meet NZBC C3.7.

Furthermore, the structural system supporting those parts of the *external wall* that are not permitted to be unprotected must also provide *structural adequacy* sufficient to keep the *external wall* in place for the full duration of the *fire*.

Unprotected area is not permitted within 1.0 m of a *relevant boundary*, except for a combination of small *unprotected area* and/or *fire resisting glazing* as described in Acceptable Solution C/AS2 Paragraph 5.4 or in Appendix C for this Verification Method.

There are no restrictions on the amount of *unprotected area* and the performances specified in NZBC C3.6 are deemed to be achieved if:

a) the *external wall* is more than 1.0 m of the *relevant boundary;* and

b) the *firecell* does not contain a storage occupancy with a capability to store to more than 3.0 m; and

c) the *building* is provided with a sprinkler system complying with either:

i) NZS 4541 with a Class A or Class B2 water supply, or

ii) NZS 4541, as amended by Appendix B of C/AS2, with a Class A or Class B2 water supply.

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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 as:

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a) for unsprinklered *firecells:*

i) 83 kW/m² for *FLED* ≤ 400 MJ/m²,

ii) 103 kW/m² for *FLED* > 400 to ≤ 800 MJ/m², and

iii) 144 kW/m² for *FLED* > 800 MJ/m²; and

b) for sprinklered *firecells*:

i) 58 kW/m² for *FLED* ≤ 400 MJ/m²,

ii) 72 kW/m² for *FLED* > 400 to ≤ 800 MJ/m², and

iii) 101 kW/m² for *FLED* > 800 MJ/m².

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

Method A Calculation

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Calculate radiation from *unprotected areas* in the *external wall* to the closest point on an adjacent boundary and at 1.0 m beyond an adjacent boundary. The calculations must take into account:

a) The distance to the boundary, and

b) The size/shape of the *unprotected area* in the *external walls*, assuming the emitted radiant heat flux specified above for the applicable *FLED* range.

In a *firecell* not containing a storage occupancy or a storage occupancy with a capability to store to more than 3.0 m, and which is protected with an automatic sprinkler system, the calculation for maximum permitted *unprotected area* may use:

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a) the emitted radiation flux for sprinklered *firecells* for the appropriate *FLED*

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b) the height of the enclosing rectangle as the vertical distance between the floor and the ceiling level beneath which the sprinklers are 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 metres.

The *unprotected area* calculated using the emitted radiation flux for sprinklered *firecells* is not permitted to be doubled.

The fire engineer only needs to consider one *fire separated* space at a time as a potential source of thermal radiation.

For unsprinklered *buildings*, the width of the enclosing rectangle need be no greater than 20 m for *FLED* up to and including 800 MJ/m², or no greater than 30 m for *FLED* greater than 800 MJ/m². The actual width of the enclosing rectangle shall be used if it is less than 20 m.

Method B Tabulated values

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Use the tabulated values of the maximum percentage of permitted *unprotected area* directly from Acceptable Solution C/AS2 as appropriate for the *firecell*, or the tables as provided in Appendix C of this Verification Method.

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The tables in Appendix C have been produced in accordance with this Verification Method. These tables can be used directly for unsprinklered *firecells* as long as *external walls* are parallel to, or angled at no more than, 10° to the *relevant boundary* and are no closer than 1.0 m to the *relevant boundary*.

For *external walls* at greater angles to the *relevant boundary*, appropriate calculations shall be undertaken to demonstrate that the performance criteria are achieved and minimum dimensions shall be specified for return and/or wing walls as necessary or use tables as provided in Appendix C.

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In all *firecells* protected with an automatic sprinkler system, the maximum permitted *unprotected area* obtained from tabulated values in Appendix C for an unsprinklered space can be doubled.

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Horizontal fire spread from roofs

In addition for unsprinklered *buildings* where the average *fire load* exceeds 1200 MJ/m² and the *building* is located within 1.0 m of a *relevant boundary,* horizontal *fire* spread via a non-rated roof shall be resisted. This requirement can be satisfied by undertaking one of the following:

a) *Fire* rating (for *fire* exposure from below) that part of the roof within 1.0 m of a *relevant boundary*. The *FRR* shall be based on the *burnout fire* determined in Paragraph 2.4. The determined *FRR* needs to meet with *structural adequacy* and *integrity* criteria as a minimum, or

b) Extending the wall, being a *fire separation* along or adjacent to the *relevant boundary*, no less than 450 mm above the roof to form a *parapet*, or

c) Undertaking specific calculation to demonstrate that the resultant incident radiation 1.0 m beyond the *relevant boundary* due to *fire* breaking through a non-rated roof does not exceed 16 kW/m².

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Canopies

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The potential for any space to expose *other property* shall be evaluated. However, the area beneath a canopy roof does not need to be assessed as a source of external *fire* spread if all the following conditions apply:

a) The nearest distance between any part of the canopy and the *relevant boundary* is not less than 1.0 m, and

b) The average *FLED* applying to the area beneath the canopy is not greater than 800 MJ/ m², and

c) The canopy has at least 50% of the perimeter area open to the outside.

External wall cladding materials

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To demonstrate that NZBC C3.7 is achieved, where *external walls* are located less than 1.0 m from a *relevant boundary*, cladding materials shall be:

a) *Non-combustible* or *limited combustible* materials; or

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b) Tested in accordance with the relevant *standard test* in Table 4.1 and achieve a Type A classification.

For *buildings* containing *sleeping care* or *sleeping detention* uses, where *external walls* are located more than 1.0 m from a *relevant boundary*, cladding materials shall be:

a) *Non-combustible* or *limited combustible* materials; or

b) Tested in accordance with the relevant *standard test* in Table 4.1 and achieve a Type A or Type B classification.

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Table 4.1	Classification of cladding materials	
Cladding material type[1,2,3,4]	Peak heat release rate (kW/m^2)	Total heat released (MJ/m^2)
Type A	≤ 100	≤ 25
Type B	≤ 150	≤ 50

Notes:

1. Cladding materials shall be classified as Type A or Type B based on the peak heat release rate and total heat released when tested in accordance with:

a) ISO 5660 Reaction-to-fire tests – Heat release, smoke production and mass loss rate – Part 1: Heat release rate (cone calorimeter method), or

b) AS/NZS 3837 Method of test for heat and smoke release rates for materials and properties using an oxygen consumption calorimeter.

2. In addition to meeting the general requirements of ISO 5660 Part 1 or AS/NZS 3837, testing shall be in accordance with the following specific requirements:

a) an applied external heat flux of 50 kW/m^2, and

a) a test duration of 15 minutes, and

b) the total heat release measured from start of the test, and

c) sample orientation horizontal, and

d) ignition initiated by the external spark igniter.

3. Timber claddings which have a *fire retardant* treatment incorporated in or applied to them shall be subjected to the regime of accelerated weathering described in ASTM D 2898 Method B with the water flow rate from Method A before testing in accordance with the requirements in Note 1.

4. Cladding materials incorporating a metal facing with a melting point of less than 750°C covering a *combustible* core or insulant shall be tested as described in Note 2 without the metal facing present.

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4.6 Design scenario (VS): External vertical fire spread

Scenario in brief	A *fire source* exposes the *external wall* and leads to significant vertical *fire* spread.
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.*
What you must satisfy	The performance criteria of C3.5 (ie, if *buildings* are taller than 10 m or have upper floors that are *other property* or contain people sleeping, *fire* shall be prevented from spreading more than 3.5 m vertically) so that: • tenable conditions are maintained on *escape routes* until the occupants have evacuated, and • vertical *fire* spread does not compromise the safety of firefighters working in or around the *building*. ***C3.5*** *Buildings must be designed and constructed so that fire does not spread more than 3.5 m vertically from the fire source over the external cladding of multi-level buildings.*
Required outcome	Demonstrate that the *building's* external claddings do not contribute to excessive vertical *fire* spread using one of the methods described.

Scenario description

This *design scenario* applies to:

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a) All multi-level *buildings* with a *building height* of more than 10 m, and

b) Any other multi-level *buildings* with upper floors

i) where people sleep, or

ii) are defined as *other property*, or

iii) that have external *exitways* with an *external wall*, and

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

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Comment:
1. This scenario is not concerned with horizontal *building*-to-*building fire* spread across a *relevant boundary*, as this is addressed in the *design scenario*: HS (see Paragraph 4.5).
2. Multi-level *buildings* include:
   a) *Buildings* with more than one full floor
   b) *Buildings* that have more than one *intermediate floor* and the *escape height* of the uppermost *intermediate floor* is greater than 10 m, e.g. a multi-storey office with an atrium.

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There are three considerations in this scenario:

Part A: External vertical *fire* spread over the cladding materials and within the *external wall* cladding system, and

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Part B: *Fire* plumes spreading *fire* vertically up the *external wall* via openings and *unprotected areas*, and

Part C: *Fire* plumes spreading *fire* from a lower *firecell* through an unprotected lower roof to an adjacent higher *external wall* via *unprotected areas*.

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Comment:
Part A addresses concerns regarding the contribution of the *external wall* cladding system to vertical *fire* spread. Parts B and C look at the use of aprons, spandrels, *fire* rated lower roofs, *fire* rated external walls, or sprinklers to prevent external *fire* spread between openings at different levels in the *building*. In the case of Part C, vertical *fire* spread via an unprotected lower roof to an adjacent *building* also needs to be considered.

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Part A: External vertical fire spread over facade materials

This part applies to all multi-level *buildings* with a *building height* of more than 10 m.

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The *design fire* for this scenario shall be a *fire source* that is either:

a) In close contact with the façade (eg, in a rubbish container/skip) that could ignite and spread *fire* vertically to higher levels in the *building*, or

b) Adjacent to an *external wall*, such as a *fire* plume emerging from a window opening or from an *unprotected area* of the wall burning.

The *design fire* exposure is:

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a) Radiant flux of 50 kW/m² impinging on the façade for 15 minutes for *buildings* in *importance levels* 2 and 3, or

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b) Radiant flux of 90 kW/m² impinging on the façade for 15 minutes for *buildings* in *importance level* 4.

The intention is to prevent façade cladding materials from contributing to significant flame spread propagation beyond the area initially exposed. Some damage to the area initially exposed is expected.

This can be achieved by limiting the extent of the vertical flame spread distance of the *external wall* cladding system above the *fire* source.

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Method

For all *buildings* where this scenario applies, the entire *external wall* cladding system shall be:

a) Comprised of *non-combustible* or *limited combustible* materials; or

b) Classified in accordance with AS 5113 and achieve a EW classification; or

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c) Tested in accordance with BS 8414-1 and satisfy the acceptance criteria in BR 135; or

d) Tested in accordance with BS 8414-2 and satisfy the acceptance criteria in BR 135; or

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e) Tested in accordance with NFPA 285 and pass, and have all substantive components in the *external wall* cladding system:

i) comprised of *non-combustible* or *limited combustible* materials; or

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ii) achieve a Type A classification from Table 4.1.

The spread of fire through cavities in an external wall shall be avoided by providing cavity barriers at each floor level. Cavity barriers shall comply with the requirements in Paragraphs 4.15.3 to 4.15.5 of Acceptable Solution C/AS2.

The requirements given in Acceptable Solution C/AS2 Paragraphs 5.8.3 to 5.8.5 are an acceptable means of demonstrating compliance with Part A above for *buildings* with an *importance level* not higher than 3.

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Part B: External vertical fire spread via openings and unprotected areas

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This part applies to multi-level *buildings* with a *building* height greater than 10 m where people sleep, have external *exitways* or *exitways* with an *external wall,* or that are defined as *other property.*

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The *design fire* exposure is a *fire* plume projecting from openings or *unprotected areas* in the *external wall*, with characteristics determined from the *design fire* as described in Part 2 of this Verification Method for the applicable occupancy.

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The intention is to prevent *fire* spread in unsprinklered *buildings* from projecting *fire* plumes to *unprotected areas* on upper floors where they are within 1.5 m vertically of a projecting plume *fire source*.

This can be achieved by either:

a) Limiting external vertical *fire* spread with the introduction of *fire* rated construction on certain areas of the *external wall* to prevent a *fire* plume extending from a lower opening or *unprotected area*, and then re-entering the *building* via an opening or *unprotected area* at a higher level, or

b) Installing an automatic sprinkler system in accordance with an approved standard.

Method

For Part B, either:

a) Follow the requirements of Acceptable Solution C/AS2 and provide *construction* features such as aprons and/or spandrels, or

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b) Install an automatic sprinkler system in accordance with an approved standard, or

c) Calculate the effect of the radiation from *fire* plumes projected from openings. *Fire* plume characteristics and geometry shall be derived from the design fires as described in Part 2 of this Verification Method for the applicable geometry.

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Part C: Lower Roof Exposure

This part applies if there is a lower roof exposure to external *exitways* or a higher *external wall* within the same or an *adjacent building*, where spaces behind the higher *external wall* are sleeping occupancies or *other property*.

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The design *fire* exposure is a *fire* plume spreading through a lower non *fire* rated roof to an adjacent higher *external wall* and spreading vertically via openings and *unprotected areas* in the same or *adjacent building*.

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The intention is to prevent *fire* from spreading from unsprinklered *buildings* due to a *fire* that has initiated below a non-*fire* rated lower roof that could spread to *unprotected areas* or openings that are located in a higher *external wall*.

The lower roof exposure risk is to be addressed where compartments behind the higher *external wall* contain sleeping or *other property*, for the same *building* or an *adjacent building* on the same site. The exposure risk needs also to be assessed for *buildings* on *other property* that have an *external wall* that is higher than the lower roof exposure.

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This can be achieved by:

a) *Fire* rating the underside of the lower roof where it represents an exposure risk to the higher *external wall* in order to prevent a *fire* plume extending through the lower roof, or

b) *Fire* rating parts of the higher *external wall* to prevent the *fire* plume that has passed through the unrated lower roof spreading into the higher levels , or

c) Installing sprinklers in the compartment below the unprotected lower roof.

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Method

For Part C follow the requirements of Part 5: Control of external fire spread of Acceptable Solution C/AS2 and use:

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a) Construction features that will provide a *fire* rating to the underside of any part of the lower roof that is within 5.0 metres of the higher *external wall*. The *fire resistance rating* to be applied over the rated area of the lower roof shall be based on the *burnout fire* determined in Paragraph 2.4 for the space below the roof or,

b) Construction features that will enable a fire rating to be provided to all parts of the *external wall* that are within 9.0 metres vertically, of any area of unprotected lower roof that is within 5 metres horizontally of the higher *external wall*. The *fire resistance rating* to be provided over the required area of the *external wall* shall be based on the *burnout fire* determined in Paragraph 2.4 for the space below the roof,

c) The installation of sprinklers to an approved standard throughout the space below the roof.

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Appendix B (normative): Critical Radiant Flux values for some flooring materials

B1.0 For the purposes of compliance with Clause C3.4(b) of the Building Code the following critical radiant flux values may be assigned as shown in Table B1 for the given flooring material without further evidence of testing to ISO 9239-1:2010.

Table B1 Specified performances for some flooring materials

Flooring material	Critical Radiant Flux (CRF)
Concrete[2], brick, ceramic or porcelain tile	4.5 kW/M^2
Wood Products, Plywood or Solid Timber [1,2] ≥ 12 mm thick; and ≥ 400 kg/m^3	2.2 kW/M^2

Note

1. Some timber species and thicknesses and with/without applied coatings when tested may achieve a higher CRF. When a greater CRF is required to meet Clause C3.4 (b) than given in this table, supporting test data to ISO 9239-1:2010 for the product is required.
2. May include waterborne or solvent borne applied surface coatings not more than 0.4 mm thick and not more than 100 g/m^2.

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Appendix C (normative): Methodology for design scenario HS: Horizontal fire spread (Tabular Data)

C1.1 Horizontal fire spread from external walls

C1.1.1 This Appendix contains tabular data that can be used to satisfy Method B of *design scenario* HS: Horizontal fire spread. The requirements in this Appendix depend on the intersection angle of the *external wall* and the *relevant boundary*.

Intersection Angle

C1.1.2 The intersection angle is the angle produced between two horizontal lines, one being the line projected along the exterior face of a space bounded by *separating elements*, and the other being the *relevant boundary* (see Figure C1). Where *external walls* are parallel to one another, or to a *relevant boundary*, the intersection angle is zero degrees.

C1.1.3 The following methods shall be applied depending on the intersection angle.

a) For angles ≤ 10°, apply Methods 1 or 2.

b) For angles > 10° to < 80° or for *buildings* of irregular shape, apply Method 3.

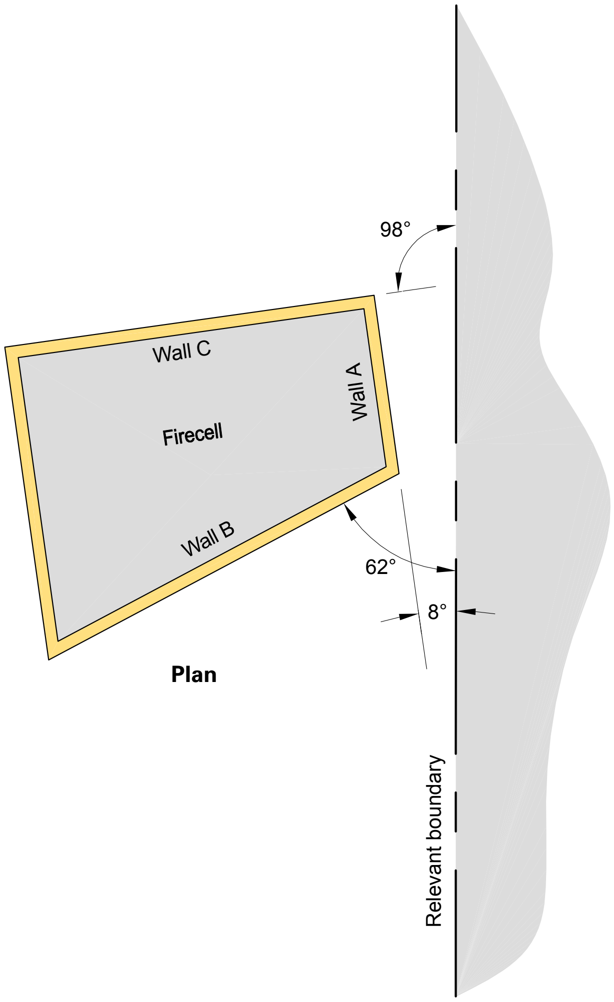
c) For angles ≥ 80° to < 135°, apply Method 4.

For angles of 135° or greater there are no requirements and an *unprotected area* of 100% is permitted for the *external wall.*

Notional boundary firecells on the same property

Amend 6 Nov 2020 **C1.1.4** For *buildings* on the same property, the words *relevant boundary* shall be interpreted as *notional boundary* for the application of this Appendix.

Figure C1 **Measuring intersection angle in external walls adjacent to a relevant boundary**
Paragraph C1.1.2



This example illustrates the situation where each of the methods 1, 2, 3 and 4 are used to restrict the size and/or location of *unprotected areas* in *external walls* close to the *relevant boundary* with *other property*.

Wall A: Intersection angle of 10° or less (shown as 8° in above example). If any part of the wall is within 1.0 m of the *relevant boundary* use Method 1. If the wall is 1.0 m or more from the *relevant boundary* use Method 2.

Wall B: Intersection angle between 10° and 80° (shown as 62° in above example). Use Method 3 applying the case for *buildings* which are irregular or non-parallel to the *relevant boundary*.

Wall C: Intersection angle from 80° to 135° (shown as 98° in above example). Use Method 4 for return walls and wing walls.

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C2.1 Method 1 – Small openings and fire resisting glazing

C2.1.1 The provisions for *external wall construction* are satisfied if:

a) Small *unprotected areas* with a maximum area of 0.1 m^2 (Type A areas) and areas of *fire resisting glazing* (Type B areas) are located to comply with Figure C2, and

b) The remainder of the *wall* is *fire* rated equally for exposure to *fire* on both sides.

C2.1.2 The *fire resisting glazing* shall be rated for *integrity* and the *FRR* of both the glazing and *external wall* shall be derived from the full *burnout design fire* as described in Paragraph 2.4 of this Verification Method.

Size and spacing of Type A and Type B areas

C2.1.3 Type A areas shall be no greater than 0.1 m^2. Type B areas shall be no greater than permitted by Table C1 according to the distance from the *relevant boundary*.

C2.1.4 There is no limitation on the spacing between adjacent Type A and Type B areas which occur in different spaces bounded by *separating elements*. Within a space bounded by *separating elements* the following requirements shall apply:

a) Type A areas shall be no closer, both vertically and horizontally, than 1.5 m to another Type A or to a Type B area.

b) Type B areas shall be no closer to one another, vertically or horizontally, than the dimensions X or Y shown on Figure C2.

Comment:
To determine dimensions X and Y, measure the width and height of both the adjacent Type B areas. The minimum value for X is the greater of the two widths, and for Y the greater of the two heights

c) Where Type B areas are staggered, rather than being aligned vertically or horizontally, the shortest distance, in any direction, between adjacent areas shall be no less than the greater of the X and Y measurements.

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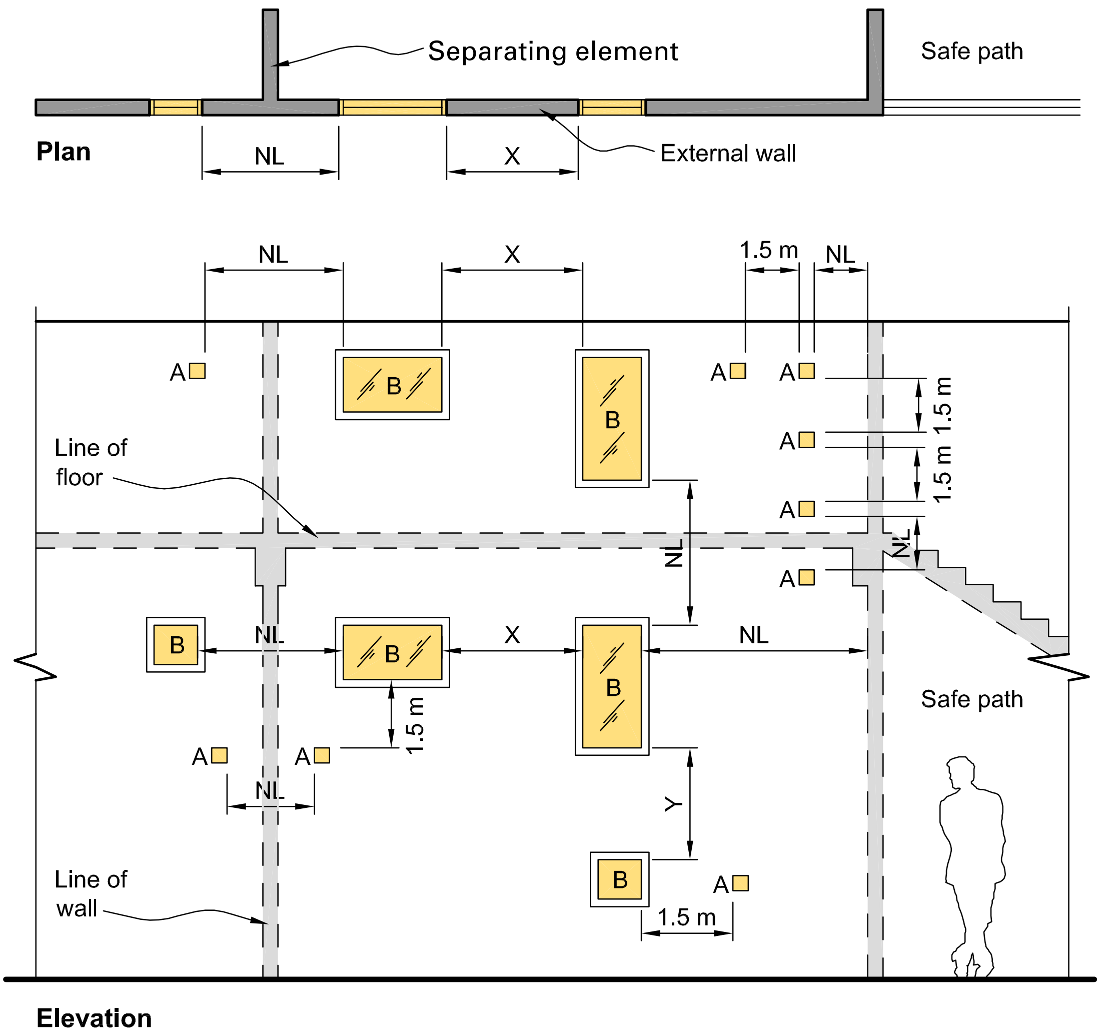
Figure C2 **Method 1 – Permitted small unprotected areas and fire resisting glazing**
Paragraph C2.1.4



Dimensions shown are minimum distances between Type A unprotected areas and of Type B fire resisting glazing

Legend

A☐ Type A *unprotected areas* of 0.1 m^2 maximum

B Type B areas of *fire resisting glazing* complying with Table C1

NL No limitation on spacing

X Spacing to be no less than the greater of the widths of the two Type B areas being considered

Y Spacing to be no less than the greater of the heights of the two Type B areas being considered

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Table C1	Maximum permitted areas of fire resisting glazing (m^2) Paragraph C2.1.3				
Minimum distance to relevant boundary (m)	FLED				
	≤ 400 MJ/m^2	> 400 to ≤ 800 MJ/m^2		> 800 MJ/m^2	
	Unsprinklered[1]	Unsprinklered	Sprinklered	Unsprinklered	Sprinklered
0.0	1.0	1.0	5.0	1.0	1.0
0.1	1.0	1.0	6.5	1.0	1.0
0.2	1.0	1.0	7.5	1.0	1.0
0.3	1.0	1.0	9.0	1.0	1.0
0.4	1.0	1.0	10.0	1.0	1.5
0.5	1.5	1.0	11.0	1.0	2.5
0.6	2.0	1.0	13.0	1.0	3.5
0.7	3.0	1.5	14.0	1.0	5.0
0.8	3.5	2.0	15.0[3]	1.0	6.5
0.9	5.0	3.0		1.5	7.5
1.0	6.0	3.5		1.5	8.5
1.1	7.5	4.5		2.0	9.5
1.2	8.5	5.5		2.5	10.0
1.3	10.0	7.0		3.0	11.0
1.4	12.0	8.0		3.5	12.0
1.5	13.0	8.5		4.0	13.0
1.6	14.0	9.5		5.0	14.0
1.7	15.0[2]	10.0		5.5	15.0[3]
1.8		10.0		6.0	
1.9		11.0		6.5	
2.0		12.0		7.0	
2.1		13.0		7.5	
2.2		14.0		8.0	
2.3		15.0[3]		8.5	
2.4				9.0	
2.5				9.5	
2.6				10.0	
2.7				11.0	
2.8				11.0	
2.9				12.0	
3.0				12.0	
3.1				13.0	
3.2				14.0	
3.4				15.0[3]	

Notes:

1. For *sprinklered firecells* with a *FLED* ≤ 400 MJ/m^2, the area of *fire resisting glazing* is unlimited and may be any distance from the *relevant boundary.*
2. For *firecells* with a *FLED* ≤ 400 MJ/m^2, there is no limit on the permitted area of *fire resisting glazing* at distances greater than 1.7 m from the *relevant boundary.*
3. For *firecells* with a *FLED* > 400 MJ/m^2, the maximum permitted area of *fire resisting glazing* is 15 m^2.

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C2.2 Method 2 – enclosing rectangles – parallel boundary

Application

C2.2.1 This method shall be applied to *external walls* of *buildings* that are parallel to or angled at no more than 10° to the *relevant boundary*.

C2.2.2 This method is used to calculate the maximum percentage of *unprotected area* in the *external wall* of each space bounded by *separating elements*. This is based on the dimensions of *unprotected areas*, *FLED,* and the distance from the *external wall* to the *relevant boundary.*

Enclosing rectangle dimensions

C2.2.3 The dimensions of the *unprotected areas* in the *external wall* of each space shall be determined by drawing a rectangle enclosing all *unprotected areas* and the protected areas between them (see Figure C3) and measuring the height and width of the enclosing rectangle.

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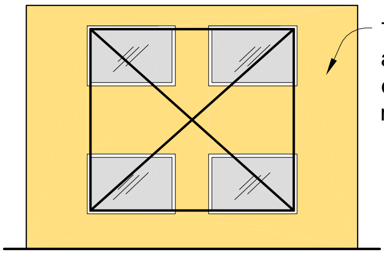
Figure C3 **Method 2 – Enclosing rectangles (unprotected areas)**
Paragraph C2.2.4

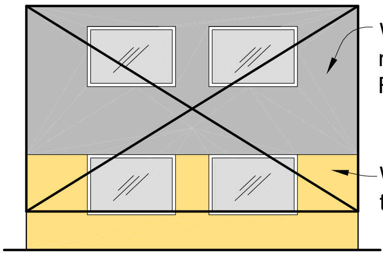
Rectangle construction

Diagram A, B and C demonstrate how, for a given *external wall* of a single *firecell*, dimensions of the enclosing rectangle (indicated by the rectangle diagonals) vary according to the extent and location of *fire rated construction*. The essential requirement is for the rectangle to enclose all *unprotected areas*. This means that such things as an isolated window or door or other non-*fire rated* part of the wall can significantly alter the rectangle dimensions and may include part of the *fire rated* wall.



The whole of the wall area (except the openings) has the required FRR

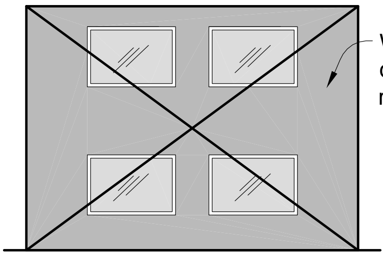
Diagram A



Wall area which does not have the required FRR

Wall area which has the required FRR

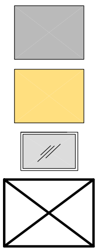
Diagram B



Whole of wall area does not have the required FRR

Diagram C

Legend



External wall with less than the required *FRR* (includes zero *FRR*)

External wall with required *FRR*

Openings or windows

Rectangle containing diagonals is the 'enclosing rectangle' for calculations

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Maximum percentage of unprotected area allowed

C2.2.4 The maximum *unprotected area* for the *external walls* shall be specified in:

a) Table C2a for an enclosing rectangle height of 1.0 m

b) Table C2b for an enclosing rectangle height of 2.0 m

c) Table C2c for an enclosing rectangle height of 3.0 m

d) Table C2d for an enclosing rectangle height of 4.0 m

e) Table C2e for an enclosing rectangle height of 6.0 m

f) Table C2f for an enclosing rectangle height of 8.0 m

For enclosing rectangle heights greater than 8.0 m, radiation from *unprotected areas* in the *external wall* shall be determined using Method A Calculations in accordance with Paragraph 4.5 of the Verification Method.

Tables C2a to C2f are split into three parts according to the *FLED* range. The design *FLED* is provided in Table 2.2. The maximum enclosing rectangle width shall be 20 m for *FLED* ≤ 800 MJ/m^2 and 30 m for *FLED* > 800 MJ/m^2.

C2.2.5 If Tables C2a to C2f do not contain the exact measurements for the enclosure being considered, use the next highest value for rectangle height or rectangle width or next lowest value for distance to the *relevant boundary*.

C2.2.6 Where the enclosure is sprinklered, increases are permitted in accordance with Paragraph 4.5 of this Verification Method.

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Required distance from the relevant boundary

C2.2.7 Tables C2a to C2f can also be used to determine the required distance from the *relevant boundary* where the percentage of *unprotected area* has previously been determined. Select the permitted percentage of *unprotected areas* (under the column "Width of enclosing rectangle (metres)") and read the minimum permitted distance to the *relevant boundary* from the left hand column of the table.

Additional check of large unprotected openings

C2.2.8 The enclosing rectangle method assumes that *unprotected areas* are uniformly distributed openings over the total *external wall* of the *firecell*. In most cases, radiant heat flux is more intense from a single large opening than from several small openings with the same total area. As an additional safety check, identify the largest single *unprotected area* and use the height and width of this opening as an enclosing rectangle on its own with 100% *unprotected area*. The minimum permitted distance from the largest single *unprotected area* to the *relevant boundary* shall be no greater than the distance between the *external wall* and the *relevant boundary* used in Paragraphs C2.2.4 to C2.2.7.

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Table C2a	Height of enclosing rectangle 1.0 metres Paragraph C2.2.4																								
Minimum distance to *relevant boundary* (metres)	Maximum percentage of unprotected area in the external wall allowed																								
	FLED ≤ 400 MJ/m²								FLED > 400 to ≤ 800 MJ/m²								FLED > 800 MJ/m²								
	Width of the enclosing rectangle (metres)								Width of the enclosing rectangle (metres)								Width of the enclosing rectangle (metres)								
	2	**3**	**4**	**6**	**8**	**10**	**15**	**20**	**2**	**3**	**4**	**6**	**8**	**10**	**15**	**20**	**2**	**3**	**4**	**6**	**8**	**10**	**15**	**20**	**30**
1.0	100	89	85	82	81	81	80	80	81	71	68	66	66	65	65	64	58	51	49	47	47	47	46	46	46
1.1		98	92	89	87	85	84	84	91	79	75	72	70	69	68	67	65	56	53	51	50	49	48	48	48
1.2		100	100	96	92	90	88	87	100	87	81	78	74	72	71	70	73	62	58	56	53	52	51	50	50
1.3				100	96	94	92	91		95	88	82	78	76	74	73	81	68	63	59	56	54	53	53	52
1.4					100	98	96	95		100	96	87	81	79	77	77	90	74	68	62	58	57	55	55	55
1.5						100	100	99			100	91	85	83	80	80	100	81	74	65	61	59	57	57	57
1.6								100				96	89	86	84	83		88	80	69	64	62	60	59	59
1.7												100	93	90	87	86		96	86	72	67	64	62	61	61
1.8													97	93	90	89		100	91	75	70	67	64	64	63
1.9													100	97	93	92			96	79	72	69	67	66	66
2.0														100	97	95			100	83	76	72	69	68	68
2.1															100	99				87	79	75	72	71	70
2.2																100				90	82	78	74	73	72
2.3																				94	85	81	76	75	74
2.4																				99	88	83	79	78	77
2.5																				100	92	86	81	80	79
2.6																					95	89	84	82	81
2.7																					99	92	86	85	83
2.8																					100	95	89	87	86
2.9																						99	91	89	88
3.0																						100	94	92	90
3.1																							97	94	93
3.3																							100	99	97
3.5																								100	100

Note: For enclosing rectangle widths greater than given in the table, an enclosing rectangle width of 20 m for FLED ≤ 800 MJ/m² and 30 m for FLED > 800 MJ/m² may be used

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Table C2b Height of enclosing rectangle 2.0 metres
Paragraph C2.2.4

Minimum distance to *relevant boundary* (metres)	Maximum percentage of unprotected area in the external wall allowed																								
	FLED ≤ 400 MJ/m²								FLED > 400 to ≤ 800 MJ/m²								FLED > 800 MJ/m²								
	Width of the enclosing rectangle (metres)								Width of the enclosing rectangle (metres)								Width of the enclosing rectangle (metres)								
	2	3	4	6	8	10	15	20	2	3	4	6	8	10	15	20	2	3	4	6	8	10	15	20	30
1.0	65	57	53	47	45	44	43	43	53	46	43	38	36	36	35	35	38	33	31	27	26	25	25	25	25
1.1	71	61	57	50	47	46	45	45	57	49	46	40	38	37	36	36	41	35	33	29	27	27	26	26	26
1.2	78	66	60	52	49	48	47	47	63	53	48	42	40	39	38	38	45	38	35	30	28	28	27	27	27
1.3	85	71	64	55	51	50	49	49	69	57	51	44	41	40	39	39	49	41	37	32	30	29	28	28	28
1.4	93	76	67	57	54	52	51	50	75	61	54	46	43	42	41	41	53	44	39	33	31	30	29	29	29
1.5	100	82	71	60	56	54	53	52	81	66	57	48	45	44	42	42	58	47	41	35	32	31	30	30	30
1.6		88	75	63	58	56	55	54	89	71	60	51	47	45	44	44	63	50	43	36	34	32	31	31	31
1.7		94	79	66	61	59	57	56	96	76	64	53	49	47	46	45	69	54	46	38	35	34	33	32	32
1.8		100	83	69	63	61	58	58	100	81	67	55	51	49	47	47	75	58	48	40	36	35	34	33	33
1.9			88	72	66	63	60	60		86	71	58	53	51	49	48	81	61	51	41	38	36	35	34	34
2.0			92	75	68	65	62	62		90	74	60	55	53	50	50	87	65	53	43	39	38	36	36	35
2.1			97	78	71	68	64	64		95	78	63	57	54	52	51	94	68	56	45	41	39	37	37	36
2.2			100	82	74	70	66	65		100	82	66	59	56	54	53	100	72	59	47	42	40	38	38	37
2.3				85	76	72	69	67			86	69	62	58	55	54		76	61	49	44	42	40	39	38
2.4				89	79	75	71	69			90	71	64	60	57	56		80	64	51	46	43	41	40	40
2.5				92	82	77	73	71			94	74	66	62	59	57		84	67	53	47	45	42	41	41
2.6				96	85	80	75	73			99	77	69	64	60	59		88	71	55	49	46	43	42	42
2.7				100	88	82	77	75			100	80	71	66	62	61		92	74	57	51	48	44	43	43
2.8					91	85	79	77				84	73	69	64	62		96	77	60	53	49	46	45	44
2.9					94	88	81	79				87	76	71	66	64		100	80	62	54	51	47	46	45
3.0					98	90	84	81				90	79	73	67	66			84	64	56	52	48	47	46
4.0					100	100	100	100				100	100	97	86	83			100	91	77	69	62	59	57
5.0														100	100	100				100	100	90	77	72	69
6.0																						100	94	86	81
7.0																							100	100	94
7.5																									100

Note: For enclosing rectangle widths greater than given in the table, an enclosing rectangle width of 20 m for FLED ≤ 800 MJ/m² and 30 m for FLED > 800 MJ/m² may be used

Amend 6
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Table C2c **Height of enclosing rectangle 3.0 metres**
Paragraph C2.2.4

Minimum distance to *relevant boundary* (metres)	Maximum percentage of unprotected area in the external wall allowed																								
	FLED ≤ 400 MJ/m²								FLED > 400 to ≤ 800 MJ/m²								FLED > 800 MJ/m²								
	Width of the enclosing rectangle (metres)								Width of the enclosing rectangle (metres)								Width of the enclosing rectangle (metres)								
	2	3	4	6	8	10	15	20	2	3	4	6	8	10	15	20	2	3	4	6	8	10	15	20	30
1.0	57	47	40	35	34	33	32	32	46	38	33	29	27	27	26	26	33	27	23	20	19	19	19	19	19
1.1	61	49	43	37	35	34	34	33	49	40	34	30	28	28	27	27	35	29	24	21	20	20	19	19	19
1.2	66	52	45	39	36	35	35	34	53	42	36	31	29	29	28	28	38	30	26	22	21	20	20	20	20
1.3	71	55	47	40	38	37	36	35	57	45	38	32	30	30	29	29	41	32	27	23	22	21	21	20	20
1.4	76	59	49	42	39	38	37	37	61	47	40	34	32	31	30	29	44	34	28	24	23	22	21	21	21
1.5	82	62	52	44	41	39	38	38	66	50	42	35	33	32	31	30	47	36	30	25	23	23	22	22	22
1.6	88	65	55	46	42	41	39	39	71	53	44	37	34	33	32	31	50	38	31	26	24	23	23	22	22
1.7	94	69	57	47	44	42	40	40	76	56	46	38	35	34	33	32	54	40	33	27	25	24	23	23	23
1.8	100	73	60	49	45	43	42	41	81	59	48	40	36	35	34	33	58	42	35	28	26	25	24	24	24
1.9		77	63	51	47	45	43	42	86	62	51	41	38	36	35	34	61	44	36	30	27	26	25	24	24
2.0		81	66	53	49	46	44	44	90	65	53	43	39	37	36	35	65	46	38	31	28	27	25	25	25
2.1		85	69	56	50	48	45	45	95	68	56	45	41	39	37	36	68	49	40	32	29	28	26	26	26
2.2		89	72	58	52	49	47	46	100	72	58	47	42	40	38	37	72	51	42	33	30	28	27	27	26
2.3		93	76	60	54	51	48	47		75	61	48	43	41	39	38	76	54	44	35	31	29	28	27	27
2.4		98	79	62	56	52	49	49		79	64	50	45	42	40	39	80	56	46	36	32	30	28	28	28
2.5		100	82	65	58	54	51	50		83	66	52	46	44	41	40	84	59	48	37	33	31	29	29	28
2.6			86	67	59	56	52	51		86	69	54	48	45	42	41	88	62	50	39	34	32	30	29	29
2.7			90	70	61	57	54	52		90	72	56	50	46	43	42	92	65	52	40	35	33	31	30	30
2.8			94	72	63	59	55	54		94	75	58	51	48	44	43	96	68	54	42	37	34	32	31	30
2.9			97	75	66	61	56	55		99	79	60	53	49	45	44	100	71	56	43	38	35	32	32	31
3.0			100	78	68	63	58	56		100	82	63	55	51	47	45		74	58	45	39	36	33	32	32
4.0				100	91	82	73	70			100	87	74	66	59	56		100	85	62	53	48	42	40	39
5.0					100	100	90	85				100	96	85	73	68			100	84	69	61	52	49	47
6.0							100	100					100	100	89	82				100	88	77	63	58	55
7.0															100	96					100	94	76	69	63
8.0																100						100	90	80	72
9.0																							100	92	82
10.0																								100	91
10.8																									100

Note: For enclosing rectangle widths greater than given in the table, an enclosing rectangle width of 20 m for FLED ≤ 800 MJ/m² and 30 m for FLED > 800 MJ/m² may be used

Amend 6
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Table C2d **Height of enclosing rectangle 4.0 m**
Paragraph C2.2.4

Minimum distance to *relevant boundary* (metres)	Maximum percentage of unprotected area in the external wall allowed																								
	FLED ≤ 400 MJ/m²								FLED > 400 to ≤ 800 MJ/m²								FLED > 800 MJ/m²								
	Width of the enclosing rectangle (metres)								Width of the enclosing rectangle (metres)								Width of the enclosing rectangle (metres)								
	2	**3**	**4**	**6**	**8**	**10**	**15**	**20**	**2**	**3**	**4**	**6**	**8**	**10**	**15**	**20**	**2**	**3**	**4**	**6**	**8**	**10**	**15**	**20**	**30**
1.0	53	40	35	30	29	28	28	27	43	33	28	24	23	23	22	22	31	23	20	17	17	16	16	16	16
1.1	57	43	36	31	30	29	28	28	46	34	29	25	24	23	23	23	33	24	21	18	17	17	16	16	16
1.2	60	45	38	33	31	30	29	29	48	36	31	26	25	24	23	23	35	26	22	19	18	17	17	17	17
1.3	64	47	40	34	32	31	30	30	51	38	32	27	25	25	24	24	37	27	23	19	18	18	17	17	17
1.4	67	49	42	35	33	32	31	30	54	40	33	28	26	25	25	24	39	28	24	20	19	18	18	17	17
1.5	71	52	43	36	34	32	31	31	57	42	35	29	27	26	25	25	41	30	25	21	19	19	18	18	18
1.6	75	55	45	38	35	33	32	32	60	44	37	30	28	27	26	26	43	31	26	22	20	19	19	18	18
1.7	79	57	47	39	36	34	33	33	64	46	38	31	29	28	27	26	46	33	27	22	21	20	19	19	19
1.8	83	60	49	40	37	35	34	34	67	48	40	33	30	29	27	27	48	35	29	23	21	20	20	19	19
1.9	88	63	52	42	38	36	35	34	71	51	42	34	31	29	28	28	51	36	30	24	22	21	20	20	20
2.0	92	66	54	43	39	37	36	35	74	53	43	35	32	30	29	28	53	38	31	25	23	22	21	20	20
2.1	97	69	56	45	41	39	37	36	78	56	45	36	33	31	30	29	56	40	32	26	23	22	21	21	21
2.2	100	72	59	47	42	40	38	37	82	58	47	38	34	32	30	30	59	42	34	27	24	23	22	21	21
2.3		76	61	48	43	41	38	38	86	61	49	39	35	33	31	30	61	44	35	28	25	24	22	22	22
2.4		79	64	50	45	42	39	39	90	64	51	40	36	34	32	31	64	46	37	29	26	24	23	22	22
2.5		82	66	52	46	43	40	40	94	66	53	42	37	35	33	32	67	48	38	30	27	25	23	23	23
2.6		86	69	54	47	44	41	40	99	69	56	43	38	36	33	33	71	50	40	31	27	26	24	23	23
2.7		90	72	56	49	46	42	41	100	72	58	45	39	37	34	33	74	52	41	32	28	26	24	24	24
2.8		94	75	57	50	47	43	42		75	60	46	41	38	35	34	77	54	43	33	29	27	25	24	24
2.9		97	78	59	52	48	44	43		79	62	48	42	39	36	35	80	56	45	34	30	28	26	25	25
3.0		100	81	61	53	49	45	44		82	65	50	43	40	37	36	84	58	46	35	31	28	26	25	25
4.0			100	84	71	64	57	54		100	92	68	57	52	46	44	100	85	66	49	41	37	33	31	30
5.0				100	92	81	70	65			100	90	74	66	56	53		100	90	65	53	47	40	38	36
6.0					100	100	84	77				100	94	82	68	62			100	84	67	59	48	45	42
7.0							100	90					100	100	81	73				100	84	72	58	52	48
8.0								100							95	84					100	87	68	60	55
9.0															100	97						100	79	69	62
10.0																100							92	79	69
11.0																							100	90	77
12.0																								100	85
13.0																									94
13.7																									100

Note: For enclosing rectangle widths greater than given in the table, an enclosing rectangle width of 20 m for FLED ≤ 800 MJ/m² and 30 m for FLED > 800 MJ/m² may be used

Amend 6
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Table C2e **Height of enclosing rectangle 6.0 metres**
Paragraph C2.2.4

Minimum distance to *relevant boundary* (metres)	Maximum percentage of unprotected area in the external wall allowed																								
	FLED ≤ 400 MJ/m²								FLED > 400 to ≤ 800 MJ/m²								FLED > 800 MJ/m²								
	Width of the enclosing rectangle (metres)								Width of the enclosing rectangle (metres)								Width of the enclosing rectangle (metres)								
	2	3	4	6	8	10	15	20	2	3	4	6	8	10	15	20	2	3	4	6	8	10	15	20	30
1.0	47	35	30	26	25	24	23	23	38	29	24	21	20	19	19	19	27	20	17	15	14	14	14	13	13
1.1	50	37	31	27	25	25	24	24	40	30	25	22	20	20	19	19	29	21	18	16	15	14	14	14	14
1.2	52	39	33	28	26	25	24	24	42	31	26	22	21	20	20	19	30	22	19	16	15	14	14	14	14
1.3	55	40	34	28	26	26	25	24	44	32	27	23	21	21	20	20	32	23	19	16	15	15	14	14	14
1.4	57	42	35	29	27	26	25	25	46	34	28	24	22	21	20	20	33	24	20	17	16	15	15	14	14
1.5	60	44	36	30	28	27	26	25	48	35	29	24	22	21	21	20	35	25	21	17	16	15	15	15	15
1.6	63	46	38	31	28	27	26	26	51	37	30	25	23	22	21	21	36	26	22	18	16	16	15	15	15
1.7	66	47	39	32	29	28	27	26	53	38	31	26	23	22	21	21	38	27	22	18	17	16	15	15	15
1.8	69	49	40	33	30	28	27	27	55	40	33	26	24	23	22	22	40	28	23	19	17	16	16	15	15
1.9	72	51	42	34	31	29	28	27	58	41	34	27	25	23	22	22	41	30	24	19	18	17	16	16	16
2.0	75	53	43	35	31	30	28	28	60	43	35	28	25	24	23	22	43	31	25	20	18	17	16	16	16
2.1	78	56	45	36	32	30	29	28	63	45	36	29	26	24	23	23	45	32	26	21	19	17	17	16	16
2.2	82	58	47	37	33	31	29	29	66	47	38	30	27	25	24	23	47	33	27	21	19	18	17	17	16
2.3	85	60	48	38	34	32	30	29	69	48	39	31	27	26	24	24	49	35	28	22	19	18	17	17	17
2.4	89	62	50	39	35	32	30	30	71	50	40	32	28	26	24	24	51	36	29	23	20	19	17	17	17
2.5	92	65	52	40	36	33	31	30	74	52	42	32	29	27	25	24	53	37	30	23	20	19	18	17	17
2.7	100	70	56	43	37	35	32	31	80	56	45	34	30	28	26	25	57	40	32	25	22	20	19	18	18
3.0		78	61	47	40	37	34	33	90	63	50	38	33	30	27	27	64	45	35	27	23	21	20	19	19
4.0		100	84	62	52	47	41	39	100	87	68	50	42	38	33	32	91	62	49	36	30	27	24	23	22
5.0			100	81	66	58	49	46		100	90	65	53	47	40	37	100	84	65	46	38	33	28	27	25
6.0				100	82	71	59	54			100	83	66	58	47	44		100	84	59	48	41	34	31	29
7.0					100	87	70	63				100	82	70	56	51			100	74	58	50	40	36	33
8.0						100	81	72					99	84	66	58				90	71	60	47	42	38
9.0							95	82					100	99	76	66				100	85	71	54	48	42
10.0							100	94						100	88	75					100	83	63	54	47
11.0								100							100	85						97	72	61	52
12.0																96						100	82	68	58
13.0																100							92	77	63
14.0																							100	85	59
16.0																								100	83
18.4																									100

Note: For enclosing rectangle widths greater than given in the table, an enclosing rectangle width of 20 m for FLED ≤ 800 MJ/m² and 30 m for FLED > 800 MJ/m² may be used

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Table C2f **Height of enclosing rectangle 8.0 metres**
Paragraph C2.2.4

Minimum distance to *relevant boundary* (metres)	Maximum percentage of unprotected area in the external wall allowed																								
	FLED > 400 to ≤ 800 MJ/m²								FLED > 800 MJ/m²								FLED > 800 MJ/m²								
	Width of the enclosing rectangle (metres)								Width of the enclosing rectangle (metres)								Width of the enclosing rectangle (m)								
	2	3	4	6	8	10	15	20	2	3	4	6	8	10	15	20	2	3	4	6	8	10	15	20	30
1.0	45	34	29	25	23	23	22	22	36	27	23	20	19	18	18	17	26	19	17	14	13	13	13	13	12
1.1	47	35	30	25	24	23	22	22	38	28	24	20	19	18	18	18	27	20	17	15	14	13	13	13	13
1.2	49	36	31	26	24	23	22	22	40	29	25	21	19	19	18	18	28	21	18	15	14	13	13	13	13
1.3	51	38	32	26	24	24	23	22	41	30	25	21	20	19	18	18	30	22	18	15	14	14	13	13	13
1.4	54	39	33	27	25	24	23	23	43	32	26	22	20	19	19	19	31	23	19	16	14	14	13	13	13
1.5	56	41	34	28	25	24	23	23	45	33	27	22	20	20	19	19	32	23	19	16	15	14	13	13	13
2.0	68	49	39	31	28	26	25	24	55	39	32	25	23	21	20	20	39	28	23	18	16	15	14	14	14
2.5	82	58	46	36	31	29	27	26	66	46	37	29	25	23	22	21	47	33	27	20	18	17	15	15	15
3.0	98	68	53	40	35	32	29	28	79	55	43	33	28	26	23	23	56	39	31	23	20	18	17	16	16
4.0	100	91	71	52	43	39	34	32	100	74	57	42	35	31	27	26	77	53	41	30	25	22	20	19	18
5.0		100	92	66	54	47	40	37		96	74	53	43	38	32	30	100	69	53	38	31	27	23	22	21
6.0			100	82	66	57	47	43		100	94	66	53	46	38	35		88	67	48	38	33	27	25	23
7.0				100	81	69	55	49			100	82	65	55	44	40		100	84	58	46	40	32	28	26
8.0					97	82	64	56				99	78	66	51	45			100	71	56	47	37	33	29
9.0					100	96	74	64				100	92	77	59	52				85	66	55	42	37	33
10.0						100	84	72					100	90	68	58				100	78	65	49	42	36
11.0							96	81						100	77	66					90	75	55	47	40
12.0							100	91							88	73					100	86	63	53	44
14.0								100							100	91						100	79	65	53
17.0																100							100	87	68
20.0																								100	86
22.2																									100

Note: For enclosing rectangle widths greater than given in the table, an enclosing rectangle width of 20 m for FLED ≤ 800 MJ/m² and 30 m for FLED > 800 MJ/m² may be used

C2.3 Method 3 – enclosing rectangles – irregular buildings and non-parallel boundaries

C2.3.1 This method applies where the *building* is of irregular shape or the intersection angle between the *external wall* and *relevant boundary* is between 10° and 80° (see Figure C4). The method is a variation of Method 2 and evaluates the enclosing rectangle on an assumed reference plane.

Comment:
Greatest advantage is obtained by locating the reference plane to achieve the maximum separation distance over the part of the wall having the largest *unprotected area*. In general, the most convenient location of the reference plane will be parallel to the *relevant boundary*.

C2.3.2 The reference plane shall be vertical, touch at least one point on the *external wall*, and not cross the *relevant boundary* within the length of the enclosure. The plane shall not pass through the enclosure, but may pass through projections such as balconies or copings.

C2.3.3 The enclosing rectangle is determined by projecting the *unprotected areas* onto the reference plane at right angles to the plane, and the distance to the *relevant boundary* used in the calculations shall be the shortest distance between that *relevant boundary* and the closest projected *unprotected area* on the reference plane. *Unprotected areas* which are more than 80° to the reference plane are not included.

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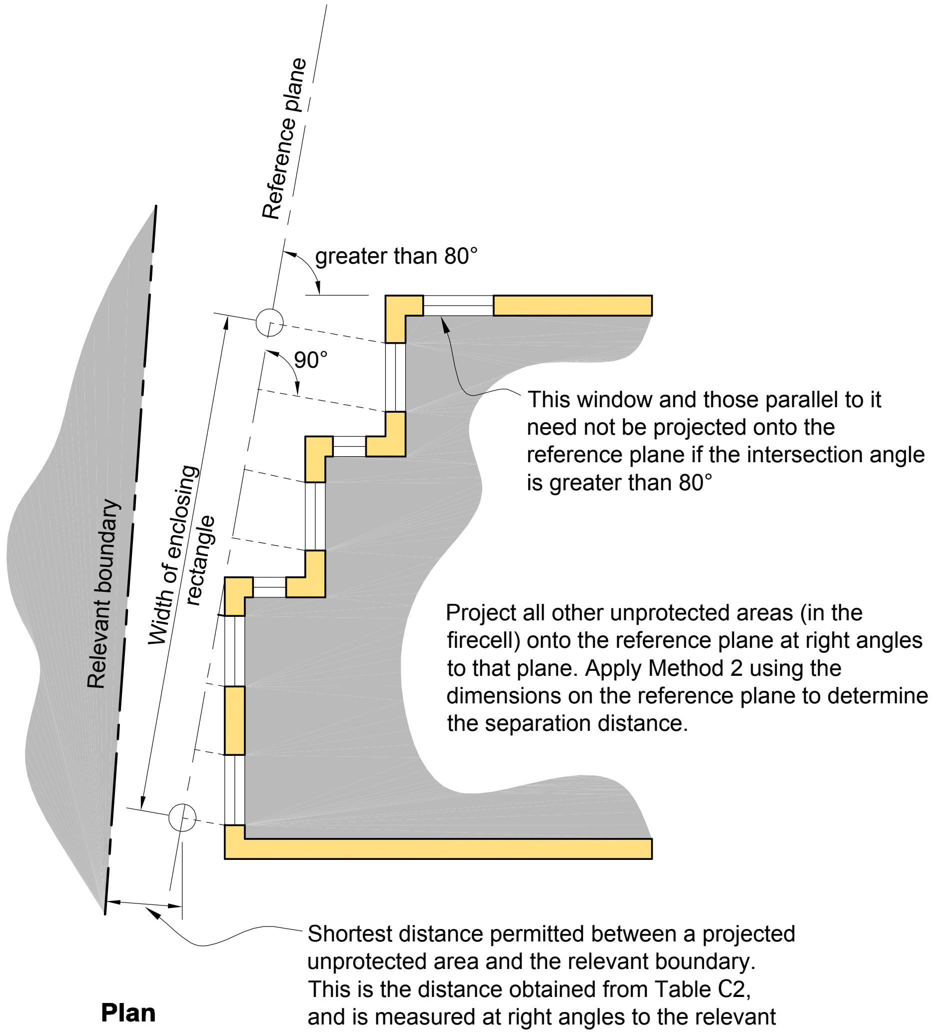
Once the enclosing rectangle is determined, comply with Paragraphs C2.2.4 to C.2.2.8 as required.

Figure C4 Method 3 – Enclosing rectangles (irregular shaped buildings and non-parallel boundaries)
Paragraph C2.3.1



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C2.4 Method 4 – Return walls and wing walls

Application

C2.4.1 This method shall be applied to *external walls* of *buildings* where the intersection angle is 80° or greater and less than 135°. It may be used for all values of *FLED*.

C2.4.2 This method is used to determine the length of wing walls and return walls. Protection is achieved by providing either return walls or wing walls in accordance with Paragraphs C2.4.3 to C2.4.8 depending on the *construction* method proposed. Where the *firecell* is sprinklered, wing walls and return walls are not required.

Comment:
It is more economical to use a return wall in the *firecell* of *fire* origin than to use a wing wall as a shield between that *firecell* and the property being protected.

C2.4.3 For this method, there are two tables. Table C.3 is used for the separation from the *relevant boundary* with *other property*. Table C.4 is used for separation on the same property where one or both *firecells* being considered contains a sleeping use or is a *safe path*. When using Table C3, separation distances are measured between *unprotected areas* in the *firecells* being considered, and the *notional boundary* coinciding with the *external wall* of the other *firecell*.

Enclosing rectangle dimensions

C2.4.4 The dimensions of the *unprotected areas* in the *external wall* of each space shall be determined by drawing a rectangle enclosing all *unprotected areas* and the protected areas between them within a maximum distance of 20 m measured at right angles to the *relevant boundary*. The dimensions of the rectangle are:

a) A_o (the equivalent opening area) found by summing individual *unprotected areas* within the enclosing rectangle; and

b) h_{eq} (the equivalent opening height) based on the height of the enclosing rectangle; and

Amend 6 Nov 2020 c) W_{eq} (equivalent opening width) found by dividing A_o by h_{eq}.

Comments:
It is assumed that *unprotected areas* more than 20 m from the *relevant boundary* do not pose a radiation threat.

Return wall and wing wall lengths for intersection angles ≥ 80° to < 90°

C2.4.5 The length of return walls or wing walls shall be determined from equations C.1 and C.2.

$L_r = D_B - D_S$	Equation C.1
$L_w = \dfrac{L_B \times L_r}{D_B}$	Equation C.2

L_r is the return wall length (metres); and

L_W is the wing wall length (metres); and

D_B is the minimum permitted distance between *unprotected areas* in the *external wall* being considered and the *relevant boundary* (metres). D_B is determined from Tables C3 and C4 based on h_{eq} and W_{eq} from Paragraph C2.4.4; and

D_S is the shortest distance between the *external wall* of the space bounded by *separating elements* being considered and the *relevant boundary* (metres) (see Figure C5); and

L_B is the wing wall length if that wall is located on the *relevant boundary* (metres). L_B is determined from from Tables C3 and C4 based on h_{eq} and W_{eq} from Paragraph C2.4.4.

C2.4.6 L_r, D_B and D_S are measured at right angles to the *relevant boundary* (see Figure C5).

C2.4.7 On the *relevant boundary*, $D_S = 0$ and therefore for a return wall $L_r = D_B$ and for a wing wall $L_W = L_B$. If D_B is equal to or greater than D_S, the formula produces a zero or negative result and there is no requirement for a return wall or wing wall.

Comments:
1. Table C3 and Table C4 are based on the assumption that the equivalent opening area is located at the end of the wall nearest the *relevant boundary*. This is a conservative, but safe, simplification for determining the most severe thermal radiation likely to be emitted from a *fire* within the space bounded by *separating elements*.

Return wall and wing wall lengths for intersection angles ≥ 90° to < 135°

C2.4.8 For angles of 90° or greater, the return wall length and wing wall length can be reduced linearly to give shorter return walls or wing walls by applying Equations C.3 and C.4.

$$L_f = \left(\frac{135 - \theta}{45}\right) \times (D_B - D_S) \qquad \text{Equation C.3}$$

$$L_w = \left(\frac{135 - \theta}{45}\right) \times \frac{L_B \times L_r}{D_B} \qquad \text{Equation C.4}$$

L_r is the return wall length (metres); and

L_w is the wing wall length (metres); and

θ is the intersection angle (°); and

D_B is the minimum permitted distance between *unprotected areas* in the *external wall* being considered and the *relevant boundary* (metres). D_B is determined from Tables C3 and C4 based on h_{eq} and W_{eq} from Paragraph C2.4.4; and

D_S is the shortest distance between *external wall* of the space bounded by *separating elements* being considered and the *relevant boundary* (metres) (see Figure C5); and

L_B is the wing wall length if that wall is located on the *relevant boundary* (metres). L_B is determined from from Tables C3 and C4 based on h_{eq} and W_{eq} from Paragraph C2.4.4.

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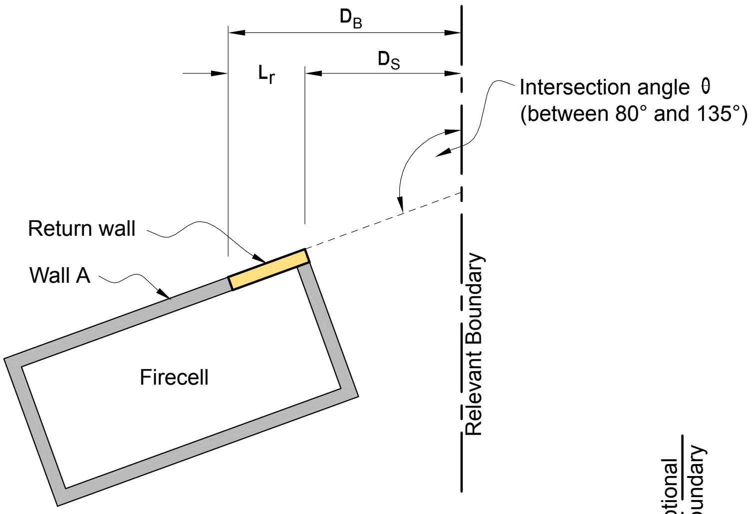
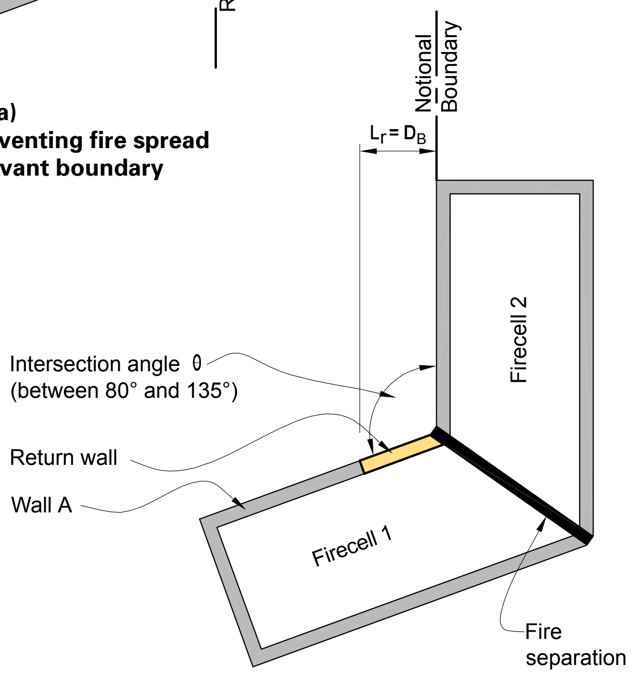
Figure C5 **Method 4 – Return walls on external walls having an intersection angle of between 80° and 135° with the relevant boundary or notional boundary**



Plan (a)
Return wall length for preventing fire spread from wall A to the relevant boundary



Plan (b)
Return wall for preventing fire spread from the external wall of firecell 1 to firecell 2 in the same or adjoining building

Key

D_S = The shortest distance between the *external wall* being considered and the *relevant boundary.*

D_B = Minimum permitted distance between *unprotected areas* in wall A and the *relevant boundary* as determined from Table C3 for plan (a), or the *notional boundary* as determined from Table C4 for plan (b).

L_r = The required return wall length measured at right angles to the *relevant boundary* or *notional boundary* as applicable.

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Table C3 Method 4 – Return walls and wing walls for unsprinklered firecells: protection of other property

Equivalent opening height h_{eq} (metres)	Return walls								Equivalent opening height h_{eq} (metres)	Wing walls							
	Minimum separation distance between unprotected areas and notional boundary D_B (metres)									Minimum length of wing wall if located on the relevant boundary L_B (metres)							
	Equivalent opening width W_{eq} (metres)									Equivalent opening width W_{eq} (metres)							
	1	2	3	4	6	8	10	20		1	2	3	4	6	8	10	20
1	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	1	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7
2	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	2	0.6	0.9	1.1	1.2	1.2	1.3	1.3	1.3
3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	3	0.7	1.1	1.4	1.6	1.7	1.8	1.9	1.9
4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	4	0.7	1.2	1.6	1.8	2.1	2.3	2.4	2.5
6	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	6	0.7	1.3	1.9	2.2	2.7	3.1	3.3	4.4
8	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.7	8	0.7	1.4	2	2.5	3.2	3.6	5.2	6.3
10	0.4	0.4	0.4	0.4	0.5	0.6	0.7	0.9	10	0.7	1.4	2.1	2.6	3.4	4.1	6.1	7.9

Table C4 Method 4 – Return walls and wing walls for unsprinklered firecells: protection of sleeping occupancies or safe paths on the same property

Equivalent opening height h_{eq} (metres)	Return walls								Equivalent opening height h_{eq} (metres)	Wing walls							
	Minimum separation distance between unprotected areas and notional boundary D_B (metres)									Minimum length of wing wall if located on the relevant boundary L_B (metres)							
	Equivalent opening width W_{eq} (metres)									Equivalent opening width W_{eq} (metres)							
	1	2	3	4	6	8	10	20		1	2	3	4	6	8	10	20
1	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	1	0.8	1.1	1.2	1.3	1.3	1.4	1.4	1.4
2	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	2	1	1.5	1.9	2.1	2.3	2.5	2.6	2.7
3	0.4	0.4	0.5	0.5	0.6	0.6	0.6	0.6	3	1.1	1.8	2.3	2.6	3.1	3.4	3.6	3.9
4	0.4	0.4	0.5	0.6	0.7	0.8	0.8	0.9	4	1.2	2	2.6	3.1	3.7	4.2	4.4	5.1
6	0.4	0.5	0.7	0.8	1	1.1	1.1	1.2	6	1.2	2.2	3	3.6	4.6	5.2	5.8	7.2
8	0.4	0.5	0.7	0.9	1.1	1.3	1.4	1.5	8	1.2	2.3	3.2	4	5.2	6.2	6.8	8.8
10	0.4	0.5	0.8	1	1.3	1.4	1.5	1.9	10	1.2	2.4	3.4	4.2	5.6	6.7	7.6	10.5

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References are to the relevent paragraphs, figures or tables in **C/VM2** unless otherwise stated. References to Appendices are prefixed by the Appendix letter.