



Product review report

Performance of Stramit Uniguard wall systems against NCC 2019

Client: Promat Australia Pty Ltd

Product: NCC Class 7b and 8 Type C construction external walls within 3 metres of the boundary

Job number: FAS190166 Report No: 22765300-RPT01 Revision: R6.0

Issue date: 3 October 2019 Expiry date: 31 October 2024

Amendment schedule

Previous versions of reports					
Version	Date	Description		Prepared by	Reviewed by
0	28/05/2008	Update of WFRA 40981B V3.0 to BCA 2008		Vincent Chow	Nabeel Kurban
1	30/05/2008	Correction to revision history		Vincent Chow	Nabeel Kurban
2	13/08/2010	Update of report to BCA 2010		Peter Gardner	Keith Nicholls
3	29/04/2013	Update of report to BCA 2013		Peter Gardner	Keith Nicholls/ Simon Krishnan (QLD RPEQ No. 13510)
4	12/08/2014	Update of report to BCA 2014		Peter Gardner	Keith Nicholls/ Simon Krishnan (QLD RPEQ No. 13510)
5	18/03/2016	Update of report to BCA 2016		Peter Gardner	Keith Nicholls/ Simon Krishnan (QLD RPEQ No. 13510)
Version	Date	Information relating to report			
R6.0	Issue: 03/10/2019	Reason for issue	Updated to NCC 2019 and reformatted report.		
			Prepared by	Reviewed by	Approved by
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Exova Warringtonfire rebranded to Warringtonfire on 1 December 2018. Apart from the change to our brand name, no other changes have occurred. The introduction of our new brand name does not affect the validity of existing documents previously issued by us.

Executive summary

Warringtonfire Australia Pty Ltd had been appointed by Promat Australia Pty Ltd to formulate an opinion on the expected performance of Stramit Uniguard – Fire Resisting Wall System as an external wall system for NCC Class 7b and 8 buildings of Type C Construction within 3m of the boundary, as defined in the National Construction Code (NCC).

This report updates the previous version 5 of this report in consideration of NCC 2019. Promat Australia Pty Ltd has confirmed that the product has not changed since the original assessment was procured.

The wall system comprises a 15mm thick Promina 60 calcium silicate board overlaid externally with horizontal steel battens clad with a 0.42 – 0.48mm BMT (bare metal thickness) Stramit® Corrugated, Stramit® Monoclad® or Stramit Longspan® steel cladding fixed to horizontal battens.

The wall system varies from the NCC Deemed-to-Satisfy Provisions for external walls within 3m of the boundary in that it has been evaluated against the requirements of the NCC Verification Method CV1 instead of being subjected to a standard fire resistance test.

The proposed fire safety design solution, specific to the use of the subject proprietary Stramit Uniguard – Fire Resisting Wall System in circumstances described in this report, has been considered against the relevant NCC Performance Requirements CP1 and CP2 to the extent that they apply to fire spread to the building via the external walls

Based on the discussion in this report, technical specification derived in Appendix A, Test Report 40981 and Appendix B of AS 1530.4:2014, it is the opinion of Warringtonfire Australia Pty Ltd that the proposed fire safety design solution satisfies the relevant NCC 2019 Performance Requirements CP1 and CP2.

It should be noted that this report must be submitted to the relevant regulatory authorities having jurisdiction and relevant stakeholders at the preliminary design stage to obtain acceptance of the proposed fire safety design solution.

Approval for the use of any material, form of construction or design in a building is subject to the relevant building regulations in each jurisdiction. No liability is accepted if this report is not accepted by stakeholders or the relevant regulatory authorities.

The analysis are documented in section 2 to section 7 of this report. The assessment found that the proposed variations are likely to achieve compliance with NCC 2019 for an external wall system when constructed in Class 7b and 8 buildings of Type C construction. The system is required to have a fire resistance level (FRL) of at least 90/90/90 if located within 1.5 metres from a property boundary/fire source feature and FRL of 60/60/60 if located between 1.5 to less than 3 metres from the property boundary /fire source feature.

Table 1 and

Cladding Profile	BMT (mm)	Mass in Zinalume finish kg/m ²	Minimum Fixings per width of cladding sheet (1200mm)
Stramit Monoclad®	0.42	4.28	4
Stramit Monoclad®	0.48	4.86	4
Stramit Corrugated	0.42	4.28	4
Stramit Corrugated	0.48	4.86	4
Stramit Corrugated	0.60	6.02	4
Stramit Longspan®	0.42	4.66	4
Stramit Longspan®	0.48	5.29	4

Table 2 below summarises the assessment outcomes

Table 1 Alternative cladding profiles

Cladding Profile	BMT (mm)	Mass in Zinalume finish kg/m ²	Minimum Fixings per width of cladding sheet (1200mm)
Stramit Monoclad®	0.42	4.28	4
Stramit Monoclad®	0.48	4.86	4
Stramit Corrugated	0.42	4.28	4
Stramit Corrugated	0.48	4.86	4
Stramit Corrugated	0.60	6.02	4
Stramit Longspan®	0.42	4.66	4
Stramit Longspan®	0.48	5.29	4

Table 2 Alternative Purlin framing profiles

Section	Minimum Section Depth (mm)	Steel Thickness (mm)
Stramit C Section Purlins	100	1.2
Stramit Z Section Purlins	100	1.2
Stramit Top-hats	64	0.75

The variations and outcome listed in this opinion report are subject to the limitations and requirements described in section 2 of this report. The results of this report are valid until 31 October 2024.

It should be noted that whilst the expiry date of this report is 5 years from issuance ie in 2024, the impending change in the NCC 2022 will likely invalidate the test data from the referenced tests. The referenced tests were conducted in accordance with older versions of AS1530.4 which will no longer be accepted. New tests will likely be required to validate or reconfirm the relevance and validity of the baseline data prior to the cut-off date in 2022, in order to revalidate this report.

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1. Introduction

This report presents a fire engineering analysis of a proposed fire safety design solution specific to the use of Stramit Uniguard – Fire Resisting Wall System as an external wall system within 3m of a boundary for Class 7b and 8 buildings of Type C Construction, as defined in the National Construction Code Volume One - Building Code of Australia (NCC) 2019¹.

The external wall system tested comprised a 15mm thick Promina 60 calcium silicate board overlaid externally with a 0.42mm BMT Stramit Monoclad® steel cladding on the external face.

The NCC Deemed-to-Satisfy Provision C1.1 prescribes that for this classification and type of construction, ie class 7b and 8 of type C construction, load bearing external wall elements are to have the respective fire resistance levels when tested from the outside only:

- Located less than 1.5 metres from a fire source feature – 90/90/90 FRL.
- Located 1.5 metres to less than 3 metres from a fire source feature – 60/60/60 FRL.

A fire safety design solution is proposed to use the subject Stramit Uniguard – Fire Resisting Wall System as an external wall element, evaluated against BCA Verification Method CV1 to demonstrate compliance with NCC Performance Requirements CP1 and CP2.

Whilst NCC Verification Method CV1 defines the acceptance criterion for the exposure of external walls to a radiant heat flux, it is necessary to derive further acceptance criteria to manage the potential of ignition of the contents of the building and ignition of the wall itself². The derivation of these acceptance criteria, additional to NCC Verification Method CV1, is provided in Appendix 1 - Interpretation and Application of Verification Method CV1 for Class 7b and 8 buildings of Type C Construction.

The wall system has been tested by subjecting it to a radiant heat flux of 80 kW/m². Results of the test are reported in WFRA 40981A³ and analysis of the results against the acceptance criteria presented in this report. The requirements of NCC Deemed-to-Satisfy Provision C1.8 have not been included in this report.

This opinion report documents the findings in determining the likely performance of an external wall system through the application of a fire safety design solution to achieve the compliance requirements of NCC 2019. The application is for Class 7b and 8 buildings of Type C construction having a fire resistance level (FRL) of at least 90/90/90 if located within 1.5 metres from a property boundary/fire source feature. The required FRL of the wall systems shall be at least 60/60/60 if the wall system is located between 1.5 to less than 3 metres from the property boundary/fire source feature, if tested in accordance with AS 1530.4:2014. This opinion report was conducted at the request of Promat Australia Pty Ltd. The sponsor details are included in Table 3.

Table 3 Sponsor details

Client	Address
Promat Australia Pty Ltd	1 Scotland Road Mile End South Adelaide, SA 5031 Australia

¹ National Construction Code Volume One - Building Code of Australia 2019, Australian Building Codes Board, Australia.

² Babrauskas, V. "Ignition of Wood: A Review of the State of the Art", Journal of Fire Protection Engineering, Vol 12, No. 3, 2002

³ 3m×3m Radiant panel test on an External Wall comprising Monoclad zinc alumel steel sheeting and 15mm thick Promina 60 board

2. Framework for the assessment

An assessment is an opinion about the likely performance of a component or element of structure if it were subject to a standard fire test.

No specific framework, methodology, standard or guidance documents exists in Australia for doing these assessments. Therefore, we have followed the Guide to Undertaking Assessments In Lieu of Fire Tests prepared by the Passive Fire Protection Federation (PFPF) in the UK⁴.

This guide provides a framework to undertake assessments in the absence of specific fire test results. 'Some areas where assessments may be offered are:

- Where a modification is made to a construction which has already been tested
- Interpolation or extrapolation of results of a series of fire resistance tests, or utilisation of a series of fire test results to evaluate a range of variables in a construction design or a product
- Where, for various reasons – eg size or configuration – it is not possible to subject a construction or a product to a fire test.'

Assessments will vary from relatively simple judgements on small changes to a product or construction through to detailed and often complex engineering assessments of large or sophisticated constructions.

3. Description of tested wall system for the proposed fire safety design solution

The tested wall system comprises a 15mm thick Promina 60 board overlaid with a Monoclad steel cladding (refer to Figure 1) on the exposed (external) face (refer to Figure 3 and Figure 4). The panel boards are nominally 1220mm × 2440mm × 15mm and are butt-jointed without treatment. The Monoclad steel cladding panels are 0.42mm BMT (code MC42ZA) and 762mm ± 4mm wide. They are screw-fixed through the Promina 60 board into horizontal steel purlins (C15012, Figure 2) and are installed with 1 flute overlap on the exposed face.



Figure 1 0.42mm BMT Monoclad steel cladding

⁵ M.Hurley(ed.), SFPE Handbook of Fire Protection Engineering, DOI 10.1007/978-1-4939-2565-0_1©Society of Fire Protection Engineers 2016



Figure 2 C15012 steel purlins



Figure 3 Exposed side of wall system



Figure 4 Unexposed side of wall system

4. Proposed fire safety design solution for compliance with NCC 2019.

This section describes the extent of variation from deemed-to-satisfy provisions and the application of a fire safety design solution for compliance with the NCC 2019 deemed-to-satisfy provision.

NCC 2019 Specification C1.1 Table 5 prescribes that a load bearing external wall building element within 1.5m of a fire source feature is to achieve an FRL of 90/90/90 for buildings of Type C construction. In addition, BCA Clause 5.1 (b) stipulates, "an external wall that is required by Table 6 to have an FRL need only be tested from the outside to satisfy the requirement."

Compliance with NCC Deemed-to-Satisfy Provision C1.8 relating to the resistance of the wall from static pressure, impact and surface indentation has not been included in the scope of this analysis.

4.1 Proposed fire safety design solution

Instead of evaluating the prescribed fire resistance level, the proposed fire safety design solution includes analysing the resistance to fire spread and structural adequacy, when exposed to an incident radiation heat flux of 80kW/m^2 on the external face, commensurate to the relevant NCC 2019 Performance Requirements.

This report is written on the basis of test evidence and understanding of the Performance Requirements of NCC 2019. This has been further set out in the next sections.

4.2 Acceptable NCC2019 assessment methods

4.2.1 Evidence of suitability

Section A5.2 (1)(d) sets out one of the routes for demonstrating compliance. Excerpt from NCC 2019 is shown in Figure 5.

A5.2 Evidence of suitability—Volumes One and Two

Application 1:
A5.2 is only applicable to the BCA.

(1) Subject to A5.4, A5.5 and A5.6, evidence to support that the use of a material, product, form of construction or design meets a Performance Requirement or a Deemed-to-Satisfy Provision may be in the form of any one, or any combination of the following:

- (a) A current CodeMark Australia or CodeMark Certificate of Conformity.
- (b) A current Certificate of Accreditation.
- (c) A current certificate, other than a certificate described in (a) and (b), issued by a certification body stating that the properties and performance of a material, product, form of construction or design fulfil specific requirements of the BCA.
- (d) A report issued by an Accredited Testing Laboratory that—
 - (i) demonstrates that a material, product or form of construction fulfils specific requirements of the BCA; and
 - (ii) sets out the tests the material, product or form of construction has been subjected to and the results of those tests and any other relevant information that has been relied upon to demonstrate it fulfils specific requirements of the BCA.
- (e) A certificate or report from a professional engineer or other appropriately qualified person that—
 - (i) certifies that a material, product, form of construction or design fulfils specific requirements of the BCA; and
 - (ii) sets out the basis on which it is given and the extent to which relevant standards, specifications, rules, codes of practice or other publications have been relied upon to demonstrate it fulfils specific requirements of the BCA.

Figure 5 Excerpt from Part A5 of NCC 2019

4.2.2 Performance requirements

In order to demonstrate compliance with the NCC 2019, Clause A2.0 requires compliance with the NCC 2019 Performance Requirements.

NCC 2019 Clause A2.1 states that compliance with the Performance Requirements can only be achieved by (Extract from NCC 2019 Clause A2.1):

Performance Requirements are satisfied by one of the following, as shown in Figure 1:

- (1) A Performance Solution.
- (2) A Deemed-to-Satisfy Solution.
- (3) A combination of (1) and (2).

Figure 1: NCC compliance option structure

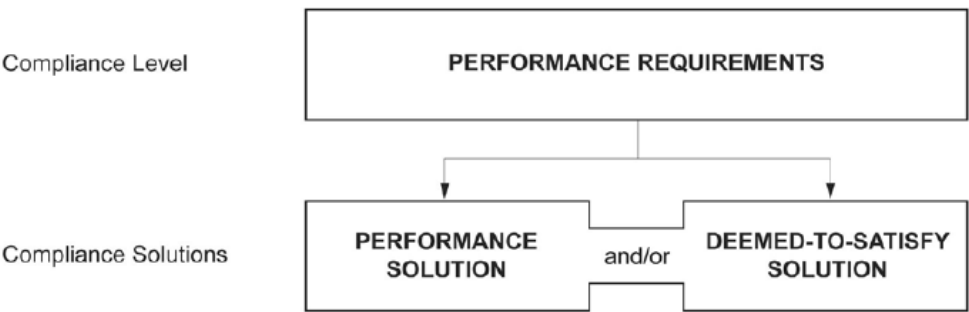


Figure 6 Performance requirements extracted from NCC2019

As permitted by A2.1(3), a combination of A2.1(1) and (2) will be used to demonstrate compliance.

NCC 2019 Clause A2.2(2) identifies assessment methods that are to be used for determining that a performance solution complies with the NCC 2019 Performance Requirements. Extract from NCC 2019 below.

A *Performance Solution* must be shown to comply with the relevant *Performance Requirements* through one or a combination of the following *Assessment Methods*:

- (a) Evidence of suitability in accordance with *Part A5* that shows the use of a material, product, *plumbing* and *drainage product*, form of construction or design meets the relevant *Performance Requirements*.
- (b) A *Verification Method* including the following:
 - (i) The *Verification Methods* provided in the NCC.
 - (ii) Other *Verification Methods*, accepted by the *appropriate authority* that show compliance with the relevant *Performance Requirements*.
- (c) *Expert Judgement*.
- (d) Comparison with the *Deemed-to-Satisfy Provisions*.

Figure 7 Definition of Performance Solution extracted from the NCC

Relevant NCC 2019 performance requirements

The ability of external walls to resist fire spread and maintain structural adequacy when exposed to external fires will be assessed against the relevant NCC 2019 Performance Requirements. These have been identified as NCC 2019 Performance Requirements CP1 and CP2 having regard for the requirements of A2.2.

These NCC 2019 Performance Requirements require consideration to the spread of fire between buildings.

As the building is of Type C Construction, guidance in the NCC Deemed-to-Satisfy Provisions is provided in NCC Specification C1.1 Clause 5.1 (b) that stipulates that an external wall that is required by Table 6 to have an FRL need only be tested from the outside to satisfy the requirement. This provides indication to the NCC intended hazard for fire spread for Type C Construction circumstances. Support of this direction of fire hazard is reinforced by NCC Deemed-to-Satisfy Provision C3.2 which prescribes that if wall wetting sprinklers are used to protect openings in the external wall, they are located externally. Based on the above, this analysis will only consider resistance to an external fire.

NCC 2019 Performance Requirement CP2 – Spread of Fire

CP2 in NCC 2019 outlines the Deemed to Satisfy provisions for spread of fire. Since the NCC Deemed-to-Satisfy Provisions also require a level of structural stability when exposed to external fire conditions, NCC Performance Requirement CP1 - structural stability during a fire will also be considered.

The primary NCC 2019 Performance Requirements in CP2 for spread of fire and CP1 for structural stability during a fire (as extracted from NCC 2019) are as stated below:

CP1 Structural stability during a fire

A building must have elements which will, to the degree necessary, maintain structural stability during a fire appropriate to—

- (a) the function or use of the building; and
- (b) the *fire load*; and
- (c) the potential *fire intensity*; and
- (d) the *fire hazard*; and
- (e) the height of the building; and
- (f) its proximity to *other property*; and
- (g) any active *fire safety systems* installed in the building; and
- (h) the size of any *fire compartment*; and
- (i) *fire brigade* intervention; and
- (j) other elements they support; and
- (k) the *evacuation time*.

Figure 8 Deemed to Satisfy provisions for structural stability during fire

CP2 Spread of fire

- (a) A building must have elements which will, to the degree necessary, avoid the spread of fire—
- (i) to *exits*; and
 - (ii) to *sole-occupancy units* and *public corridors*; and

Application:

CP2(a)(ii) only applies to a Class 2 or 3 building or Class 4 part of a building.

- (iii) between buildings; and
 - (iv) in a building.
- (b) Avoidance of the spread of fire referred to in (a) must be appropriate to—
- (i) the function or use of the building; and
 - (ii) the *fire load*; and
 - (iii) the potential *fire intensity*; and
 - (iv) the *fire hazard*; and
 - (v) the number of *storeys* in the building; and
 - (vi) its proximity to *other property*; and
 - (vii) any active *fire safety systems* installed in the building; and
 - (viii) the size of any *fire compartment*; and
 - (ix) *fire brigade* intervention; and
 - (x) other elements they support; and
 - (xi) the *evacuation time*.

Figure 9 Deemed to satisfy provisions for spread of fire

4.3 Regulatory assessment

As identified previously, the relevant NCC 2019 Deemed-to-Satisfy Provisions prescribe that the fire resistance level of an external wall in a building of Type C Construction need only be considered from the external side. The issue of fire spread between buildings is identified in NCC Performance Requirement CP2 (a)(iii).

It therefore follows that the suitability of an external wall in a building of Type C Construction, which is designed to resist fire spread and maintain structural adequacy when exposed to fire, need only be considered from the external side to demonstrate equivalency to the NCC Deemed-to-Satisfy Provisions. This is appropriate provided all factors in NCC Performance Requirement CP2 (b) being consistent with a building which complies with the NCC Deemed-to-Satisfy Provisions.

The method of regulatory assessment by the Authorities Having Jurisdiction is therefore a determination of the proposed fire safety design solution against NCC 2019 Performance Requirement CP2(a)(iii) and compliance with the Deemed-to-Satisfy Provisions for other parts of Performance Requirement CP2, as permitted in Clause A2.1(3).

The proposed fire safety design solution for NCC 2019 Performance Requirement CP2 (a)(iii) can then be determined using the NCC Verification Method CV1 (b), which identifies a heat flux of 80 kW/m² that the building must withstand without ignition when located on the boundary.

NCC 2019 Verification Method CV1(a) is concerned with the ability of the wall to withstand fire exposure from the internal side, which is not relevant to this analysis since compliance with the NCC Deemed-to-Satisfy Provisions applies to NCC Verification Method CV1(a), as discussed above.

5. Acceptance criteria

The following sub-sections describe the derivation of criteria that were adopted for this analysis.

5.1 NCC 2019 verification method CV1

Figure 10 below shows the details of CV1 extracted from NCC 2019:

CV1 Fire spread between buildings on adjoining allotments

Compliance with CP2(a)(iii) to avoid the spread of fire between buildings on adjoining allotments is verified when it is calculated that—

- (a) a building will not cause heat flux in excess of those set out in Column 2 of Table CV1 at the location on an adjoining property set out in Column 1 of Table CV1; and
- (b) when located at the distances from the allotment boundary set out in Column 1 of Table CV1, a building is capable of withstanding the heat flux set out in Column 2 of Table CV1 without ignition.

Table CV1

Column 1	Column 2
Location	Heat flux (kW/m ²)
On boundary	80
1 m from boundary	40
3 m from boundary	20
6 m from boundary	10

Figure 10 Details of CV1 extracted from NCC 2019

NCC 2019 Verification Method CV1 therefore indicates that if the external wall of a single storey building of Type C construction can withstand 80 kW/m² without ignition, when tested only from the outside, then it would meet Performance Requirement CP2(a)(iii) of the NCC for buildings of Type C Construction.

In addition, if structural members maintain their structural adequacy when the external wall is exposed to a radiation heat flux of 80kW/m² from the outside it is considered that NCC 2019 Performance Requirement CP1 has been satisfied for Class 7b and 8 buildings of Type C Construction.

5.2 Technical specification

A technical specification described in Appendix A derived the following analysis criteria based on exposure to a radiation heat flux. The technical specification also derived a standard exposure with the incident radiation progressively increasing from 0 to 80kW/m² during the first 30 minutes after which it is maintained at approximately 80kW/m² up to a period of 240 minutes:

1. Ignition of the non-fire exposed face of the element (i.e. continuous flaming for more than 15s) shall not occur during the 240 minute test.
2. The measured radiant heat flux emitted from the non-fire side and from any feature more than 0.01m² of exposed area shall not exceed 10kW/m² during the 240 minute test. This can be measured directly using a radiometer, or the non-fire side temperature can be measured in accordance with AS 1530.4:1997 and a limiting temperature of 435°C applied to the mean temperature of the non-fire side or feature.
3. The element shall remain imperforate (no straight through gaps form) during the 240 minute test.
4. The mean temperature of structural steel members on the inside of the wall system should not exceed 400°C during the 240 minute test.
5. The temperature at any point on the non-fire side shall not exceed 380°C during the first 60 minutes of the test when measured by thermocouples complying with AS 1530.4-1997.

5.3 AS 1530.4:2014 – Alternative and additional test procedures for elements of construction

The test protocol developed above and subsequent testing of the prototype against this specification, as reported in test report WFRA40981a was undertaken before the release of AS 1530.4:2014.

AS 1530.4:2014 includes additional protocols in Appendix B which address alternative test procedures, for elements of construction considering specific radiant heat exposure conditions as well as temperature heating regimes.

Differences in AS 1530.4:2014 have been reviewed in Appendix C and are considered not to affect the conclusions drawn in this report.

6. Test results

Test WFRA 40981 was undertaken on a representative section of wall subjected to an incident radiation heat flux progressively increasing to 80kW/m² during the first 30 minutes of the test and then being maintained at 80kW/m² for the remainder of the 240 minute test. The following tables summarise the results of Test WFRA 40981, against the analysis criteria summarised in Section 4.5.

Table 4 Summary of Test Results

Acceptance criteria/ Failure criteria	Required time (mins)	Time criteria exceeded (mins)	Criteria satisfied (Yes / No)
Ignition of the non-fire exposed face of the element (i.e. continuous flaming for more than 15s)	240	No failure at 240	Yes
Mean temperature on the non-fire exposed face exceeds 435°C	240	No failure at 240	Yes
Wall remains imperforate	240	No failure at 240	Yes
Mean temperature of steel structural members exceeds 400°C	240	No failure at 240	Yes
Maximum temperature at any point on the non-fire exposed face exceeds 380°C	60	70	Yes

7. Acceptable variations to tested systems

7.1 Battens between Stramit® cladding and Promina® 60 board.

Proposed variation to the system is to incorporate 12.5mm deep galvanised batten over Promina® board and under the steel cladding. The connection of the battens will be via the fixings for the steel cladding

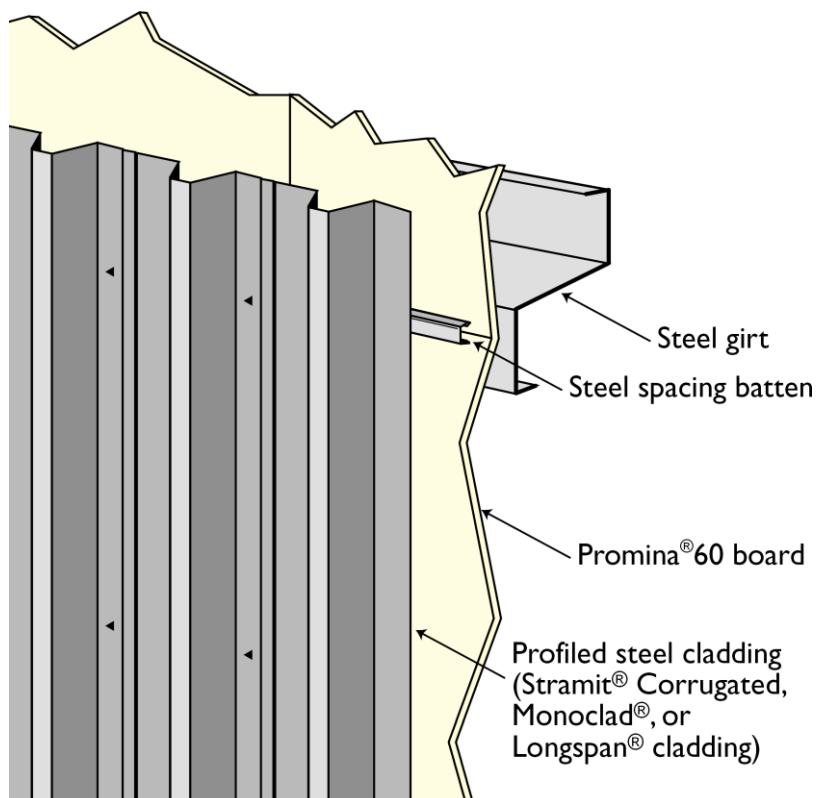


Figure 11 Section of proposed system

By incorporating a gap between the sheeting and the Promina board, heat transfer by conduction and radiation will be reduced and some heat will be lost from of the cavity via convection.

The loss of heat and the less effective conduction and radiation through joints will result in lower overall temperatures on the non-fire side and reduced variation between the temperatures at the joints and the temperatures in the field of the sheet on the unexposed side.

Based on the discussion above and in absence of any detrimental effects, it is considered that incorporating battens between the Stramit cladding and the Promina 60 board will not impair the fire performance of the of the tested prototype reported in Wfra 40981a.

7.2 Variations to the steel cladding profile

It is proposed that various profiles of steel cladding be used instead of the tested 0.42mm BMT Stramit Monoclad® (4.28kg/m²). The permitted variations are listed in Table 5 below.

Table 5 Proposed alternative cladding profiles

Cladding Profile	BMT (mm)	Mass in Zincalume finish kg/m ²	Minimum Fixings per width of cladding sheet (1200mm)
Stramit Monoclad®	0.48	4.86	4
Stramit Corrugated	0.42	4.28	4
Stramit Corrugated	0.48	4.86	4
Stramit Corrugated	0.60	6.02	4
Stramit Longspan®	0.42	4.66	4
Stramit Longspan®	0.48	5.29	4

It is proposed that the cladding shall be fixed to battens with fixings that pass through battens at a maximum spacing of 300mm centres (4 per 1200mm width).

The proposed cladding profiles have similar or greater mass (kg/m²) to the tested construction. The proposed mass range can be seen above to vary between 4 and 6.8 kg/m². The proposed steel sheeting are made from mild steel and therefore considered to have a similar response to heating as the tested mild steel sheeting.

7.3 Variation to perimeter details of the wall

The proposed system incorporates details that exclude embers from entering the system at the perimeter.

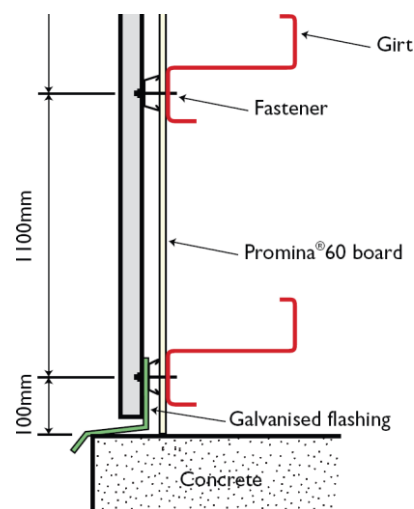


Figure 12 Base Detail: Option 1

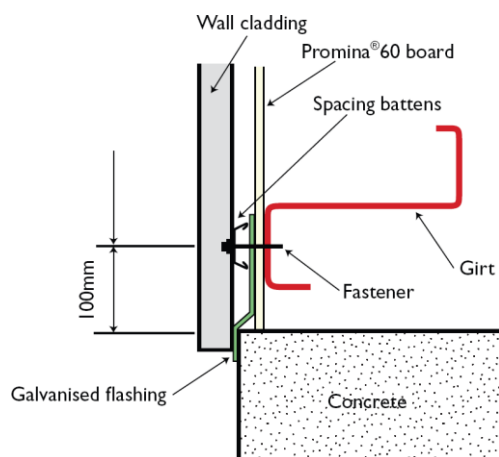


Figure 13 Base Detail: Option 2

The proposed base wall details in Figure 12 and Figure 13 make use of galvanised metal flashings that will remain in place when exposed to radiation and will exclude embers from freely entering under the Promina® 60 board at the base of the wall and would not impair the performance of the tested prototype reported in WFRA 40981a.

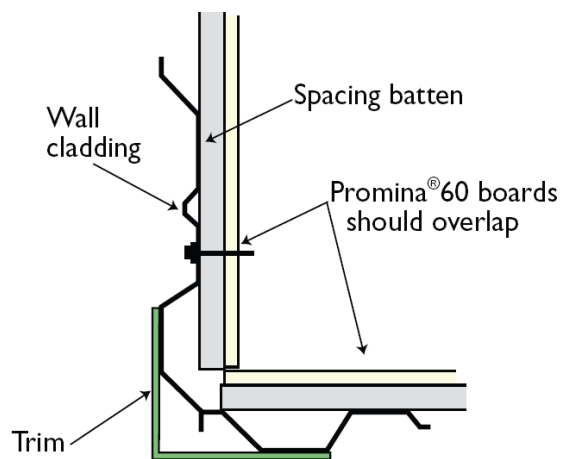


Figure 14 Corner Detail

The proposed corner detail Figure 14 incorporates metal trim profiles that will act to prevent embers from the freely entering the building at the corners. This proposed construction would not impair the performance of tested prototype reported in WFRA 40981a.

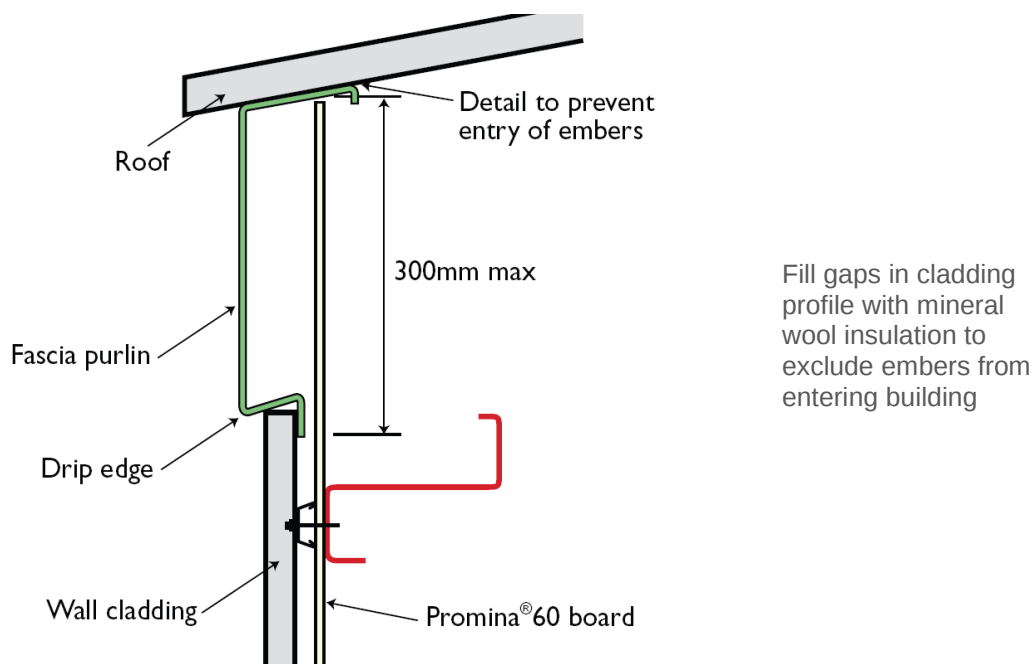


Figure 15 Head Detail

The proposed head detail Figure 15 incorporates mineral wool inserted into gaps created in the cladding profile to prevent embers from freely entering the building at the top of the wall. This proposed construction would not impair the performance of the tested prototype reported in WFRA 40981a.

7.4 Variation to the structural steel framed profile

It is proposed that various structural profiles may be used instead of the 1.5mm BMT Stramit Z girts tested in WFRA 40981a.

The purlins act to laterally support the wall system during wind events and laterally stabilise them during the fire and span horizontally between support columns. The purlins do not support any vertical load from above and therefore only support vertical loads consisting of their self-weight.

Based on the above discussion, it is considered that provided that the purlins do not significantly buckle and continue to laterally support the cladding without resulting in collapse, the fire resistance of the wall system will not be significantly impaired. The structural capacity of these elements is discussed below.

It is proposed that the above requirement can be met by various structural sections as listed in Table 6.

Table 6 Steel framing details

Section	Minimum Section Depth (mm)	Steel Thickness (mm)
Stramit C Section Purlins	100	1.2
Stramit Z Section Purlins	100	1.2
Stramit Top-hats	64	0.75

It is considered that, provided the temperature of the proposed structural sections above do not exceed 400 degrees then, by reference to BS 5950-8-2003 they will retain at least 50% of their structural capacity.

With reference to WFRA 40981a, the critical temperatures on the sheet are summarised in Table 7.

Table 7 Critical temperature on the steel frame

Location	Temperature At 120mins (°C)	Temperature At 240mins (°C)
Vertical butt joint	239	356
Inner face central purlin	315	304

The above temperature indicate that the tested purlin reached equilibrium before 120 minutes and the temperature dropped off as the section temperature became more uniform, increasing its ability to shed heat.

The proposed sections are thinner and smaller, the elements will have higher rate of heat transfer. Therefore, the proposed sections are likely to have a quick temperature rise but it will not likely exceed the limiting temperature of 400°C.

Based on the discussion above and in absence of any detrimental effects, it is considered that incorporating battens between the Stramit® cladding and the Promina® 60 board will not impair the fire performance of the of the tested prototype reported in WFRA 40981a.

8. Conclusion

The Deemed-to-Satisfy Provisions of NCC 2019 prescribe that a loadbearing external wall system for a Class 7b & 8 buildings (factories and warehouses) of Type C Construction have a fire resistance level (FRL) of at least 90/90/90, if located less than 1.5 metres from a fire source feature.

The proposed fire safety design solution for the external wall is a proprietary Stramit Uniguard – Fire Resisting Wall System which comprises a 15mm thick Promin® 60 board overlaid with 12.5mm deep horizontal battens and any of the cladding profiles nominated in Table 8 on the exposed (external) face and nominated framing from Table 9 on the unexposed face. The perimeter details (Figure 12 to Figure 15) of this report are required to prevent embers from entering the building.

Table 8 Alternative cladding profiles

Cladding Profile	BMT (mm)
Stramit Monoclad®	0.42
Stramit Monoclad®	0.48
Stramit Corrugated	0.42
Stramit Corrugated	0.48
Stramit Corrugated	0.60
Stramit Longspan®	0.42
Stramit Longspan®	0.48

Table 9 Alternative Purlin framing profiles

Section	Minimum Section Depth (mm)	Steel Thickness (mm)
Stramit C Section purlins	100	1.2
Stramit Z Section purlins	100	1.2
Stramit Top-hats	64	0.75

The proposed fire safety design solution specific to the use of the subject proprietary Stramit Uniguard – Fire Resisting Wall System in circumstances described in this report, has been considered against the relevant Performance Requirements CP1 and CP2 of NCC 2019 to the extent that they apply to fire spread to the building via the external walls.

Based on the discussion in this report, technical specification derived in Appendix A, Test Report WFRA 40981a and Appendix B of AS 1530.4:2014, it is the opinion of Warringtonfire Australia Pty Ltd that the proposed fire safety design solution satisfies the relevant NCC Performance Requirements CP1 and CP2.

It is the responsibility and authority of the relevant regulatory authority to approve or refuse any submission in relation to a specific site and building. No liability is accepted if this report is not accepted by stakeholders or the relevant regulatory authorities.

9. Validity

Warringtonfire Australia does not endorse the tested or assessed product in any way. The conclusions of this opinion report may be used to directly assess fire hazard, but it should be recognised that a single test method will not provide a full assessment of fire hazard under all conditions.

Due to the nature of fire testing and the consequent difficulty in quantifying the uncertainty of measurement, it is not possible to provide a stated degree of accuracy. The inherent variability in test procedures, materials and methods of construction, and installation may lead to variations in performance between elements of similar construction.

This opinion report is based on information and experience available at the time of preparation. The published procedures for the conduct of tests and the assessment of test results are subject to constant review and improvement. It is therefore recommended that this report be reviewed on or, before, the stated expiry date. Furthermore, with the changes in the NCC 2019, the referenced tests, that were conducted based on older versions than those nominated in the NCC 2019, will no longer be valid and will inevitably invalidate this report. It may be necessary for the sponsor to conduct further test/s in order to determine if the existing baseline test data are still relevant and applicable.

This document has been prepared to document the derivation of proposed acceptance criteria for external walls of Class 7b and 8 buildings of Type C Construction as defined in volume 1 of National Construction Code (NCC) 2019. Whilst due care has been taken during the preparation of this document, no liability will be accepted for any loss or damage resulting from the use of this document in anyway unless the use of the document for a particular application is additionally supported in writing by Warringtonfire Australia Pty Ltd and appropriate test data.

This opinion is provided to the Promat Australia Pty Ltd for its own purposes and we cannot express an opinion on whether it will be accepted by building certifiers or any other third parties for any purpose.

Appendix A Interpretation and application of NCC verification method CV1

A.1 Introduction

Based on the extensive use of NCC 2019 Verification Method CV1, the need has been identified for verification method to be interpreted and a more detailed specification provided to ensure consistent application of the method. In particular, it is necessary to develop appropriate pass / fail criteria to enable external wall systems to be evaluated in a manner consistent with the objectives of the NCC 2019

This document presents the specification for an appropriate pass/fail criterion for consideration to fire spread, commensurate to the relevant NCC 2019 Performance Requirements that was adopted for this analysis.

A.2 Overview of NCC Verification method CV1

CV1 states the following:

Compliance with CP2(a)(iii) to avoid the spread of fire between buildings on adjoining allotments is verified when it is calculated that-

- (a) a building will not cause heat flux in excess of those set out in column 2 of Table CV1 at the location on an adjoining property set out in column 1 of Table CV1; and
- (b) when located at the distances from the allotment boundary set out in column 1 of Table CV1, a building is capable of withstanding the heat flux set out in column 2 of Table CV1 without ignition.

Table CV1

Column 1	Column 2
Location	Heat flux (kW/m ²)
On boundary	80
1 m from boundary	40
3 m from boundary	20
6 m from boundary	10

Figure 16 Verification method CV1 extracted from NCC 2019

A.3 Evaluation of the ability of a building to withstand levels of heat flux without ignition

A.3.1 Limiting heat flux from the non-fire exposed face

Examining the limiting incident radiant heat flux values from NCC 2019 Table CV1, a value of 20kW/m² is specified at a distance of 3m from the boundary. NCC clause C3.2 permits unprotected openings at distances greater than 3m. Therefore, an appropriate acceptance criterion for the verification method, would be that the building element does not ignite and the emitted radiant heat flux from the non-fire-exposed face of the element is maintained below 20kW/m²

Ignition is assumed to mean flaming ignition as opposed to glowing /charring ignition to be consistent with criteria adopted by test methods such as AS 1530.4:2014.

The limiting radiant incident heat flux is further supported by the Guide to the NCC which provides the following examples illustrating the amount of radiant heat necessary to ignite common materials used in buildings and their construction as follows:

Item	Limiting radiant incident heat flux
Timber	Ignition in the absence of a spark 35 kW/m ²
	Ignition in the presence of a spark 20 kW/m ²
Curtain materials	Ignition in the absence of a spark 20 kW/m ²
	Ignition in the presence of a spark 10 kW/m ²

Therefore, if it is required that the wall remains imperforate, a limiting value of 20kW/m² is appropriate. To provide a reasonable margin of safety, a value of 10kW/m² will be adopted on the inside (non-fire exposed) side of the wall to address the potential piloted ignition of curtaining materials and the like, should burning embers penetrate the facade.

The surface temperature at which a radiation level of 10kW/m² is emitted can be calculated from the standard radiation formula as follows:

$$q = \phi \epsilon \sigma (T_s + 273)^4 \quad (1)$$

where T_s • temperature of surface emitting radiation (°C)

• q • radiation level (kW/m²)

• ϕ • configuration factor

• ϵ • emissivity

• σ • Stefan-Boltzmann's constant (5.67×10⁻⁸ W/m².K⁴)

Rearranging, • •

$$T_s = \left(\frac{q}{\phi \epsilon \sigma} \right)^{0.25} - 273 \quad (2)$$

Figure 17 Standard Stefan-Boltzmann equation

For the situation of a large wall, the configuration factor may be considered to be close to 1. Assuming an emissivity of 0.7, the surface temperature required to generate a radiation of 10kW/m² is about 435°C, using equation (2).

Therefore, the primary criteria for the analysis should be:

- Ignition of the non-fire exposed face of the element (i.e. continuous flaming for more than 15s).
- The measured radiant heat flux emitted from the non-fire side and from any feature more than 0.01m² exposed area shall not exceed 10kW/m². This can be measured directly using a radiometer or the non-fire side temperature can be measured in accordance with AS 1530.4-2014 and a limiting temperature of 435°C applied to the mean temperature of the non-fire side or feature.
- The element shall remain imperforate.

For the majority of applications of NCC Class 7b and 8 buildings, it is unlikely that significant quantities of combustible materials would be stacked in contact with the inner face of the external wall of a building due to the provision of purlins and other elements. However, if the building contents are in contact with the internal face of an external wall there could be a localised increase in the temperature at the interface and the materials may be coincident with joints and small openings. It is therefore considered appropriate to introduce a supplementary criterion.

In his review on the ignition of wood, Babrauskas² noted that the ignition temperatures at heat fluxes sufficient to cause flaming are 300–365°C for piloted ignition and 380-400°C for spontaneous ignition.

Since the wall is required to be imperforate, a maximum surface temperature rise limit of 380°C measured at any position by thermocouples covered with pads as prescribed in AS 1530.4 is considered reasonable for the supplementary criterion.

A.3.2 Fire resistance performance of external walls in Class 7b and 8 Buildings of Type C Construction.

The NCC classification of a building and Type of Construction on adjacent allotments cannot be specified or predetermined and therefore it is not possible to characterise the duration of a fire on an adjacent allotment, and therefore, the period of potential external fire exposure.

It is noted that experimental data is available that shows for many applications, the duration for which a fire burns at a high intensity is often short (in the order of 10 to 20 minutes) but there have been fire incidents where fires have burned for longer durations at high intensities. These longer durations have been considered for the primary criteria assuming no fire brigade intervention.

For the primary criteria which are considered applicable to most applications and required to be consistent with the requirements of NCC Verification Method CV1 and NCC Deemed-to-Satisfy Provision C3.2, an exposure period of 240 minutes inclusive of a 30 minute heating period (refer Figure 18) is considered reasonable since it would be expected to address the majority of fire durations assuming no fire brigade intervention.

Radiant Heat Exposure

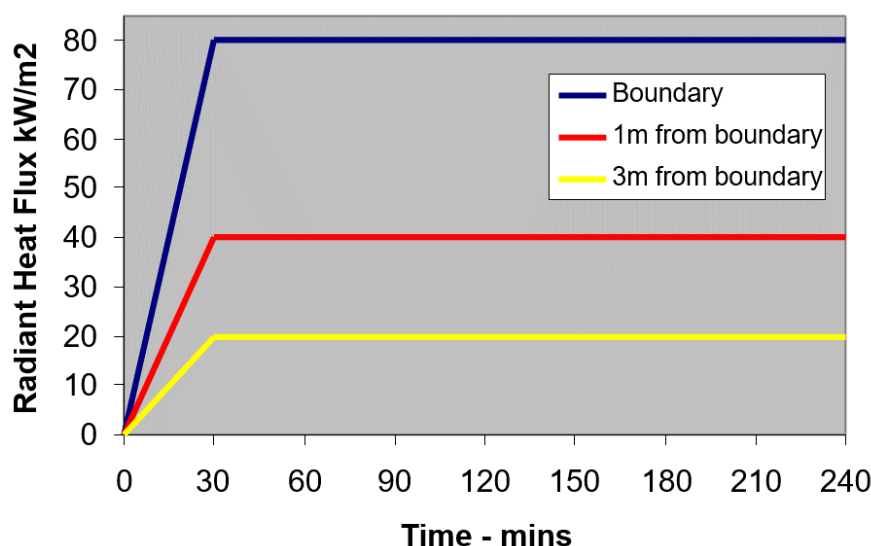


Figure 18 The radiant heat flux exposures for various distances from the boundary

However, for the purposes of determining the required period that should be applied to the additional criteria of a maximum limiting temperature rise at any point, fire brigade intervention is considered.

Fire Brigade Intervention

Appendix D shows a general application of the Fire Brigade Intervention Model for industrial buildings using conservative values for rural areas. It is recognized that in extreme cases some periods may be longer (eg. isolated country areas, but the frequency of high density industrial buildings in such areas would also be low). Using the target response times for fire brigades as a benchmark, the time of arrival was calculated to be approximately 18.5 minutes whilst the 90 percentile target for most brigades is under 8 minutes. If the initial fire brigade response has the ability to suppress the fire and/or protect exposures, the threat of fire spread would have been reduced after approximately 23.5 minutes. If additional resources have to be called to protect exposures or the like, it will be approximately 52.5 minutes before the exposures are protected.

The time of an alarm call to the fire brigade will be taken as the time the fire breaks out of the building. At this stage, strong visual, audible and olfactory cues would be provided over large distances. If the building of fire origin is fitted with an automatic fire detection or suppression system connected to a monitoring service or is occupied at the time of the fire a much earlier response would be expected.

Based on the above discussion, a reasonable period for application of the supplementary maximum temperature rise criteria would be 60 minutes.

Occupant Evacuation

Appendix C provides a conservative estimate of the time for evacuation of a NCC Class 7b or 8 building of Type C construction. Evacuation would be expected to be completed within 30 minutes of the breakout of the fire indicating that the 60 minute period for the supplementary requirement for the maximum temperature rise includes a reasonable margin of safety.

A.4 Criterion for structural adequacy of external walls

The NCC Deemed-to-Satisfy Provisions prescribe that load bearing external wall elements within 3 metres of a fire source feature for a Class 7b or 8 building of Type C construction have a fire resistance level having a structural adequacy component. Therefore, it is considered reasonable that an acceptance criterion be provided to reflect this provision.

NCC Performance Requirement CP1 states that elements are to maintain structural stability, to the degree necessary, during a fire. Therefore, external walls should maintain the structural adequacy of internal members and members in the external walls when exposed to radiant heat from a building on the adjoining allotment.

The residual load-bearing capacity of members can be assessed based on critical temperatures for steel and concrete members. For tests performed on non-loadbearing specimens a critical temperature of 400°C can be adopted for steel elements in contact with the wall to minimise the risk of premature failure. Structural adequacy shall be maintained throughout the 240 minute test.

A.5 Summary of failure criteria

In summary, the primary criteria for assessment using NCC Verification Method CV1 should be:

- Ignition of the non-fire exposed face of the element (i.e. continuous flaming for more than 15s).
- The measured radiant heat flux emitted from the non-fire side and from any feature more than 0.01m² expose area shall not exceed 10kW/m². This can be measured directly using a radiometer or the non-fire side temperature can be measured in accordance with AS 1530.4:2014 and a limiting temperature of 435°C applied to the mean temperature of the non-fire side or feature.
- The element shall remain imperforate.

In addition,

- The temperature at any point shall not exceed 380°C during the first 60 minutes of the test when measured by thermocouples complying with AS 1530.4-2014.
- The mean temperature of structural steel members should not exceed 400°C during the 240 minute test.

Appendix B Evacuation calculations

Based on the requirements of NCC clauses D1.4 and D1.5 the maximum travel distance to an exit should not exceed 40m.

Assuming a travel speed of 1.2 m/s the time for evacuation once the occupants have received a fire cue and decided to evacuate would be 34s assuming no cueing etc, For added conservatism, this has been rounded up to one minute.

Based on NCC Table D1.13, the maximum occupant density for a factory or storage building is

0.2 person/m² (5 persons/m²). The maximum area of a building of Type C Construction is prescribed in NCC clause C2.2 to be 2000 m². Therefore, the maximum number of occupants would be 400 Flow speed through the door is assumed to be 50 persons/min⁵

Assuming all occupants choose to evacuate through one single leaf doorset, it would take approximately 400s (6 min 40 seconds) for the entire population to pass through a single door. For added conservatism, this has been rounded up to 7 minutes.

A fully developed fire in an adjacent building would tend to provide strong cues and multiple visual, audible and olfactory cues. The fire brigade would be expected to arrive on site within 18.5 minutes of the fire breaking out of the adjacent building.

A conservative allowance of 5 minutes after fire brigade arrival for commencement of fire brigade intervention has been included.

Therefore, a very conservative estimate of the evacuation time would be:

Table 10 Details of the evacuation time

Period	Time
Instruction to evacuate from Fire Brigade	18.5 minutes
Preparation and alert time	5 minutes
Travel time	1 minute
Queuing time	7 minutes
Total	~ 32 minutes

⁵ M.Hurley(ed.), SFPE Handbook of Fire Protection Engineering, DOI 10.1007/978-1-4939-2565-0_1©Society of Fire Protection Engineers 2016

Appendix C Commentary of AS1530.4:2014 and technical specification of NCC verification method CV1

Appendix B7 of AS1530.4:2014 provides an informative guide on performance solution test procedures, for elements of construction. In a similar vein to fire resistance testing, they are provided as verification methods for the assessment of construction elements considering specific heating regimes and exposure conditions.

It defines a method for carrying out a fire resistance test on elements exposed to different levels of radiant heat using a 3 m × 3 m furnace. The test may be used to obtain data to assess the performance of external walls using verification methods such as CV1 and CV2 of the NCC

NCC Table CV1 and CV2 are provided to determine exposure conditions to satisfy NCC Verification Method CV1 and CV2.

The performance criteria provided with the appendix B7 of AS 1530.4:2014 states that the performance of the specimen may be assessed against the criteria specified in Section 3. Additional criteria, such as ignition of the face exposed to radiant heat, may also be applicable.

The criteria for failure in AS1530.4:2014 are therefore also considered applicable to radiant heat exposure tests. Determination of structural adequacy, integrity and insulation are to be recorded, as well as a radiation component.

Therefore, the expression of results of a radiant heat exposure test to AS1530.4:2014 would state the following:

Fire performance of the walls when exposed to $rr \text{ kW/m}^2$ of radiant heat:

- (a) structural adequacy, xx minutes; and
- (b) integrity yy minutes; and
- (c) insulation zz minutes.

NOTE: An alternate heating regime to the standard heating regime specified in Section 2 (of AS 1530.4:2014) has been adopted. The results above should not be used as evidence of performance when subjected to the standard heating regime.

This would also be provided with the incident radiant heat flux/time measurements in lieu of the furnace temperature, as stated in Clause B7.4.6 (a) of AS1530.4:2014.

The failure criteria for each component can therefore be stated as follows:

Structural adequacy

Failure in relation to structural adequacy shall be deemed to have occurred upon collapse.

This has been considered similar to condition 4 in Section 5.2 (of this report) which limits the mean temperature of structural steel members on the inside of the wall system.

Integrity

Failure in relation to integrity shall be deemed to have occurred upon collapse, the development of cracks, fissures, or other openings through which flames or hot gases can pass, or upon other occurrences. It is deemed to have collapsed when -

- A 6 mm gap gauge can be passed through the specimen so that the gap gauge projects into the furnace and can be moved a distance of 150 mm along the gap;
- Sustained flaming on the surface of the unexposed face for 10 s or longer constitutes integrity failure.

This has been considered similar to conditions 1 and 3 in Section 5.2 with limits in the ignition of the non-fire exposed face of the element (sustained flaming on the surface of the unexposed face for at least 15s in lieu of 10s) and remaining fully imperforate during the test.

Insulation

Failure in relation to insulation shall be deemed to have occurred when measurement of insulation is made by thermocouples on the unexposed face and is deemed to have failed when—

1. the average temperature of the unexposed face of the test specimen, as measured by the thermocouples specified in Clause 2.2.3.1, exceeds the initial temperature by more than 140 K; or
2. the temperature at any location on the unexposed face of the test specimen exceeds the initial temperature by more than 180 K.

The temperature at any point on the non-fire side not exceeding 380°C was used in the assessment presented in this report based on the discussion in Appendix A.3.1 and the observed performance of combustible materials placed against the test specimen during the test described in test report 40981a.

Radiation

Failure in relation to radiation shall be deemed to have occurred when the calculated total heat flux at a distance of 365 mm exceeds 10 kW/m². This is to be determined in accordance with Appendix A of AS 1530.4:2014.

This has been considered as condition 2 in Section 4.2 which provides temperature limits corresponding to 10kW/m² at the un-exposed surface of the building element, rather than at a distance of 365mm from the unexposed surface which is considered to be more conservative.

Appendix D Supporting FBIM analysis

Activity	Resources	Unit Rate	No. of Units	Activity Time	Elapsed Time
Fire alarm received by fire brigade					0.0
notification (assumed by phone call 10 minutes after initiation)		0 s	1	0.0 s	0.0 s
Dispatch resources and travel to fire scene					
Integraph dispatches initial response appliances		30 s	1	30.0 s	30.0 s
firefighters dress, assimilate information and depart station	FF1-6	480 s	1	480.0 s	510.0 s
Initial response appliance travel times to arrival on scene					
- Pumper 1	FF1-3	60 kph	10 km	600 s	1110 s
- Pumper 2	FF4-6	60 kph	10 km	600 s	1110 s
Initial access to site and fire assessment					
P1 & P2 travel through security gate to fire area	FF1-6	8 kph	0 km	16 s	1126 s
OIC investigates fire affected area and assesses exposures	FF1	1 m/s	100 m	83 s	1210 s
radio for additional resources	FF1			30 s	1240 s
additional resources dispatched		60 s	1	60 s	1300 s
OIC discusses building layout and access with security personnel	FF1 & security	90 s	2	240 s	1480 s
Dispatch of additional resources					
firefighters dress, assimilate information and depart station	FF8-12	480 s	1	480 s	1780 s
2 nd alarm response appliance travel times to arrival on scene					
- Water tanker 1	FF8-12	60 kph	20 km	1200 s	2980 s
- Rescue 1	FF13-16	60 kph	20 km	1200 s	2980 s
- Pumper 3	FF17-20	60 kph	20 km	1200 s	2980 s
Prepare for firefighting & lay hose lines					
firefighters dismount appliance P1 and don BA	FF2-3	133 s		133 s	1259 s
connect 65mm diameter feed hose from hydrant to P1 and charge	FF2	99 s	1	99 s	1358 s
remove and connect 65mm diameter hose from P1 to branch	FF3	62 s	1	62 s	1321 s
dismount appliance 2 and don BA	FF4-6	133 s		133 s	1259 s
connect 65mm diameter feed hose from hydrant to P2 and charge	FF5	99 s	1	99 s	1358 s
remove and connect 2 off 65mm diameter hose from P2 to branch	FF5-6	62 s	1	62 s	1420 s
prepare monitor of P2	FF6	30 s	1	30 s	1450 s
Apply water to exposures and fire					
charge delivery hoses from P1	FF2	37 s	1	37 s	1395 s
maintain control of P1	FF2	duration of fire			
protect exposures of building with hose lines	FF3-4	duration of fire			
charge delivery hoses from P2	FF5	37 s	1	37 s	1457 s
maintain control of P2	FF5	duration of fire			
maintain P2 monitor	FF6	duration of fire			
Arrival of additional 2nd alarm resources					
WT1 travels through security gate	FF7-9	2 kph	0 km	36 s	3016 s
R1 travels through security gate	FF10-12	2 kph	0 km	36 s	3016 s
P3 travels through security gate	FF13-15	2 kph	0 km	36 s	3016 s
firefighters dismount appliance WT1 and don BA	FF7-9	133 s		133 s	3149 s
firefighters dismount appliance R1 and don BA	FF10-12	133 s		133 s	3149 s
firefighters dismount appliance P3 and don BA	FF13-15	133 s		133 s	3149 s
provide hose lines for exposure protection and undertake water relay to ensure supply	FF7-15	duration of fire			