FIRE ENGINEERS

LOT 520 RIDGE CREEK 2 CRACKENBACK RIDGE, THREDBO

FIRE ENGINEERING REPORT

DEVELOPED IN ACCORDANCE WITH
THE PERFORMANCE REQUIREMENTS OF THE BCA

- PROVISION OF BOUNDING CONSTRUCTION

DATE: 8 November 2016
REPORT NO: 0340 - REV A
PREPARED FOR: RICHIE MURTON CONSTRUCTIONS PTY. LTD.
PREPARED BY: J² CONSULTING ENGINEERS | **FIRE SAFETY ENGINEERING**

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REVISION STATUS

REPORT NO.	REVISION	DATE	STATUS	WRITTEN	REVIEWED
0340	REV A	04/11/16	DRAFT	JS	JA

EXECUTIVE SUMMARY & RECOMMENDATIONS

J² Consulting Engineers have been commissioned to carry out a fire safety engineering analysis and assessment of the proposed internal refurbishment of the existing residence located at Lot 520 Ridge Creek 2 Crackenback Ridge, Thredbo. Discussions with the department of planning have determined that the proposed method of fire rating between the two adjacent dwellings needs to be addressed within a fire engineering performance solution.

This report provides a Fire Engineered Performance Solution developed to permit the following deviations from the BCA prescriptive requirements. The Performance Solution proposed is as follows:

#	Performance Solutions	BCA DTS Provision	BCA Performance Requirement	Assessment Methodology
1.	Develop a performance solution to permit the space between floor joists between the lower and upper storeys, bounding SOUs to be filled with sacrificial timber blocking in lieu of a fire rated building element.	3.7.1.8	P2.3.1	Qualitative assessment demonstrating compliance with the performance requirements under 1.0.3(a)(i) via a performance based analysis under 1.0.5(b)(ii).

REQUIREMENTS OF PERFORMANCE SOLUTIONS

Considering the relevant provisions of the BCA, the Performance Solution, subject to the provision of the following requirements, is considered to meet and comply with the Performance Requirement P2.3.1:

1. The space between the floor joist blocking pieces shall be provided with a 45mm thick sacrificial timber blocking piece to provide a total of 90mm of sacrificial timber within this space.
2. The building shall be provided with AS1670.1 smoke detectors throughout the building consisting of AS1670.1 spaced detectors configured to notify the fire brigade.
3. The remainder of the wall shall be upgraded to achieve a minimum FRL of 60/60/60. This must, at a minimum, involve removal of the timber panelling utilised on the lower section of the wall. Notably, to achieve the BCA required acoustic separation, a system such as the Gyprock CSR415 or CSR419 system may be considered appropriate.

Maintenance

4. The recommendations of this report must form part of the annual fire safety statement for the building to ensure the recommendations of this report are complied with throughout the building operation.

The Performance Solution has been developed using comparison with the Deemed-to-Satisfy Provisions and a qualitative assessment, and is considered to comply with BCA Performance Requirement P2.3.1. The BCA recognises these Assessment Method as acceptable methods for determining that the Performance Solution satisfies the Performance Requirement in accordance with BCA Clauses 1.0.3(a)(i) and 1.0.5(b)(ii).

1.0 INTRODUCTION

J² Consulting Engineers have been commissioned to carry out a fire safety engineering analysis and assessment of the proposed internal refurbishment of the existing residence located at Lot 520 Ridge Creek 2 Crackenback Ridge, Thredbo. Discussions with the department of planning have determined that the proposed method of fire rating between the two adjacent dwellings needs to be addressed within a fire engineering performance solution.

This report demonstrates that upon the adoption of suitable performance solutions, as detailed in the Executive Summary of the report, the relevant Performance Requirement of the Building Code of Australia (BCA) will be met.

1.1 Basis of the Report

This Performance Solution Report is based on a desktop assessment of the following documentation:

- Building Code of Australia 2016, published by the Australian Building Codes Board (ABCB)
- International Fire Engineering Guidelines 2005, published by Australian Building Codes Board (ABCB)
- The Guide to the BCA 2016, published by the Australian Building Codes Board (ABCB)
- Site inspection undertaken on 4 November 2016.

Preparation of the Assessment Report will be under the Performance Requirement of the BCA. The report will address the following deviations from the Deemed-to-Satisfy (DTS) provisions of the BCA:

- Develop a performance solution to permit the space between floor joists between the lower and upper storeys, bounding SOUs to be filled with sacrificial timber blocking in lieu of a fire rated building element.

No other aspects or parts of the building will be assessed and the remainder of the proposed development is assumed to comply with the relevant DTS provisions or the Performance Requirement of the BCA.

1.2 Purpose of the Report

This report has been prepared to address the deviations from the Deemed-to-Satisfy Provisions of the BCA (as tabled in the Executive Summary), and to provide a Performance Solution developed in accordance with the provisions of the BCA.

The purpose of this report is to demonstrate that the proposed development will satisfy Performance Requirement P2.3.1 as the design is at least equivalent to the relevant Deemed-to-Satisfy provisions of the BCA and/or satisfies the Performance Requirement of the BCA.

This report is prepared for the purposes of submitting to the Certifying Authority (CA) for acceptance prior to the issuing of an Occupation Certificate relevant to the proposal.

1.3 Limitations of the Report

This report excludes any works not outlined above, however specifically excludes the following:

- Determining full compliance with the BCA, other than the matters identified in the executive summary of this report;
- Addressing any matters that are outside the scope or limitations of the BCA;
- Amendments to the Performance Solution Brief due to design changes or incapacity to comply with the Trial Designs;
- Consideration of any fire services operations (including hydraulic, electrical or other systems);
- Consideration of any structural elements or geotechnical matters relating to the building, including any structural or other assessment of the existing fire resistance levels of the building;
- This report does not provide concessions for any Performance Solution or exemptions from the requirements of

the BCA, other than that identified in the Executive Summary of this report;
- Determining compliance with the Disability Discrimination Act 1992 or Part D3 of the BCA;
- Reporting on hazardous materials, OH&S matters or site contamination;
- Heritage Issues;
- Any energy efficiency assessment; however, if necessary proposals can be obtained from suitably qualified and accredited assessors.

1.4 Assumptions of the Report

This report provides a Performance Solution for the Deemed-to-Satisfy deviation identified in the Executive Summary. The remainder of the building is assumed to comply with the Deemed-to-Satisfy Provisions of the BCA for the purpose of this report.

The report is provided on the basis that:

- The Performance Solution only applies to property detailed in section 2.2.
- The Performance Solution is applicable to the design documentation provided for assessment and as listed in Section 1.1. Any future alteration, enlargement or addition will require re-assessment to determine the application of this solution to those changes.
- The Building will generally comply with the Deemed-to-Satisfy Provisions of the BCA, except where modified specifically by this report.
- It is assumed that the building will be subject to ongoing annual maintenance and the fire safety measures required by this report and the BCA will be maintained to a standard not less than their installation standard.

2.0 FIRE ENGINEERING BRIEF

The development of this report follows a consultative process with the Certifying Authority and Developer's Representative. The basis of the solution was discussed with the stakeholders on site. Given the nature of the assessment no fire engineering brief was prepared, in consultation with all relevant stakeholders.

2.1 Relevant Stakeholders

Stakeholder/Role	Name
Private Certifier	NSW Department of Planning
Builder	Richie Murton Constructions Pty. Ltd.
Fire Safety Engineer	J² Consulting Engineers - James Sunjaya

2.2 Building and Occupant Characteristics

General Building Characteristics

Building Characteristic	Description
Occupancy/Use Building Class/es: Type of construction: Effective Height:	Three storey dwellings (two off) Class 1a N/A N/A
Location: General description of development:	Lot 520 Ridge Creek 2 Crackenback Ridge, Thredbo The development involves internal refurbishment of an existing attached townhouse dwelling located at Lot 520 Ridge Creek 2 Crackenback Ridge, Thredbo.

Occupant Characteristics

Occupant Characteristic	Description
Type and number	Occupants would generally be expected to be capable of caring for themselves consistent with residential housing use. It is not anticipated that more than 8 occupants would typically be located within each dwelling.
Occupant state	Building occupants will be both awake and asleep. Occupants may also be intoxicated or sober. Occupants on all levels would be expected to have a reasonable level of mobility to comfortably negotiate the internal stairs within their apartment on a day-to-day basis.
Physical and mental attributes	The majority of occupants are considered to be mobile and ambulatory consistent with the Australian population.
Assistance required/available	It will be likely that assistance will not be required as the occupants will be familiar with the location of the exits and the paths to the exits given the simple layout. The assistance available will be in the form of the Building Occupant Warning System to help occupants in an evacuation. Assistance may also be provided from other able bodied occupants.
Training and Roles	Occupants are considered to have limited training given the residential nature of the building.
Hazards	Kitchen cooking areas. Occupants smoking in apartments. Electrical equipment located in corridors providing electricity to the residential parts

Occupant Characteristic	Description
	as well as communications cabling and equipment. Fire located within garage area.

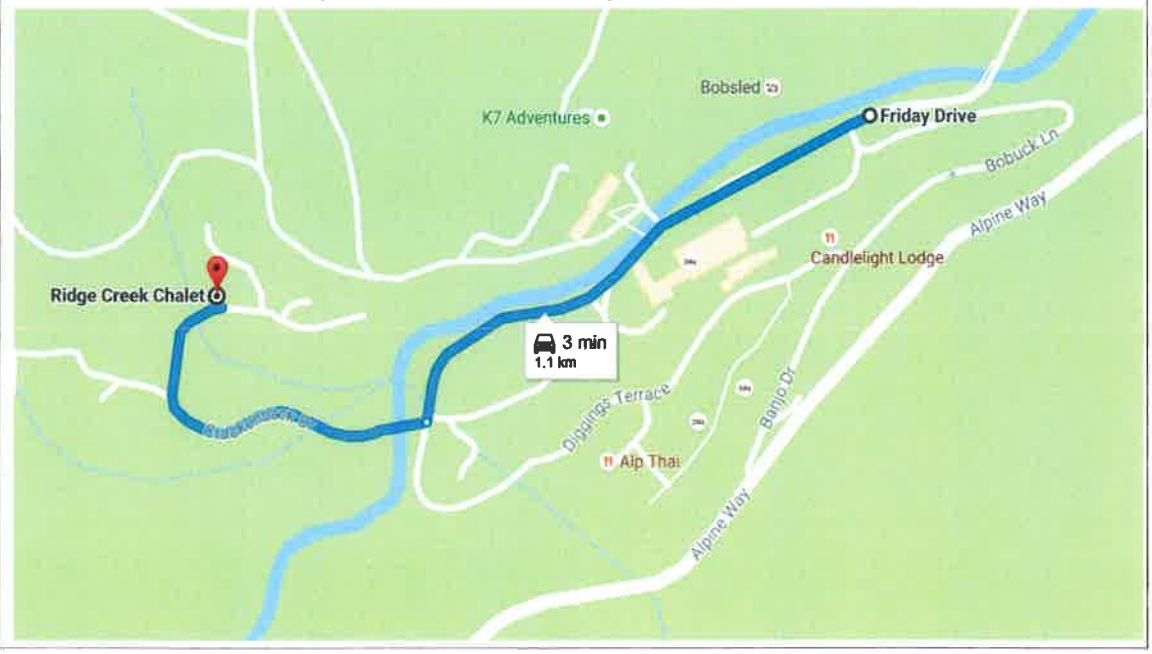
2.3 Hazards, Preventative and Protective Measures Available

The following hazards have been identified.

Hazard	Details/Precaution
General Layout and Design	The main hazard relates to the proposed method of sealing between the floor joists spanning the loadbearing walls bounding the two adjoining class 1a residences.
Activities	Information is not available to suggest that activities outside those normally undertaken in residential dwellings will be carried out and hence the hazard is not considered to be increased.
Cooking - NSWFB statistical data indicates that these fires make up 33% of all reported residential fires. (NSWFB 2001/2002)	A smoke detection system would notify occupants of the fire affected residence to respond to cooking fire outbreaks if unattended. This is configured to activate the occupant warning bells/sounder/speakers on site.
Occupants smoking in Sole Occupancy Units (SOU's). NSWFB statistical data indicates that fires in sleeping areas make up 44% of all reported residential fires. These predominantly include smoking in bed and combustibles placed upon or near heaters. (NSWFB 2001/2002)	A smoke detection system would notify occupants of the fire affected residence to respond to smoking fire outbreaks if unattended. This is configured to activate the occupant warning bells/sounder/speakers on site.
Electrical Equipment	<u>SOU habitable space</u> A smoke detection system would notify occupants to respond to any electrical fire outbreaks in the building. If the outbreak develops beyond that which is controllable then occupants are required to evacuate. <u>Concealed spaces</u> The roof void hazard is limited to down lights and electrical wiring as an ignition source which makes up a very small percentage of the number fire starts according the NSWFB statistical data, hence the roof void hazard is considered low.
Multiple arson attack, malicious acts, and acts of terrorism.	The resulting impact of fires from these hazards has not been addressed in this report.

The hazards that are present in the building have been removed or reduced by six sub-systems of preventative and protective measures.

Sub-System	Present in Building/Requirements
A Fire initiation, development and control	Fire loads or heat release rates are not proposed to be in excess of a normal residential occupancy and hence fire development will not be abnormally fast.
B Smoke	Smoke development and spread will not be inconsistent with that of a residential building.

Sub-System	Present in Building/Requirements
development, spread and control	
C Fire spread, impact and control	Fire separation is subject to a performance solution. Generally, the bounding walls will achieve an FRL of 60/60/60 subject to minor deviations contained within performance solution 1 of this report.
D Fire detection, warning and suppression	Fire detection is provided within the building to provide a means of early notification to building occupants via the installed occupant warning bells/sounder/speakers and the fire brigade.
E Occupant evacuation and control	The building is provided with direct egress to open space from each unit.
F Fire services intervention	The building is served by a full time fire brigade (during ski season) at Thredbo (approx. 1.5km) and a retained fire brigade at Thredbo and Jindabyne during the remainder of the year and therefore fire services intervention is likely to be better or at least equivalent to most areas in metropolitan areas. 

*International Fire Engineering Guidelines 2005 (IFEG)
Sub-system A – Fire Initiation and Development and Control
Sub-system B – Smoke Development and Spread and Control
Sub-system C – Fire Spread and Impact and Control
Sub-system D – Fire Detection, Warning and Suppression
Sub-system E – Occupant Evacuation and Control
Sub-system F – Fire Services Intervention

2.4 Directly relevant IFEG Sub-Systems

The directly relevant IFEG sub-system (SS) for this analysis are:

IFEG Sub-System	Description	Symbol
Sub-system C Fire Spread and Impact and Control	• Separation of fuel • Separation of buildings • Fire resistive barriers • Fire resistive structural elements • Fire resistive air-handling ducts • Fire resistive dampers • Exposure protection	

3.0 PERFORMANCE SOLUTION 1 – PROVISION OF BOUNDING CONSTRUCTION

A performance solution has been developed to permit the use of timber blocking between timber floor joists supported by a load-bearing core-filled stud wall bounding the public corridor from the first floor section of the apartments.

3.1 Deemed-to-Satisfy Provisions

Pursuant to 1.0.10(a) of BCA the following DTS provisions have been identified as being subject to the performance solution:

3.7.1.8 Separating walls
(a) A wall that separates Class 1 dwellings, or separates a Class 1 building from a Class 10a building which is not appurtenant to that Class 1 building must have an FRL of not less than 60/60/60 and—

(i) commence at the footings or ground slab (see Figure 3.7.1.10); and

(ii) extend—

(A) if the building has a non-combustible roof covering, to the underside of the roof covering (see Figure 3.7.1.10 and Figure 3.7.1.11); or

(B) if the building has a combustible roof covering, to not less than 450 mm above the roof covering (see Figure 3.7.1.10).

(b) A separating wall of lightweight construction must be tested in accordance with Specification C1.8 of the BCA Volume One.

3.2 Details of Deemed-to-Satisfy Deviation

The existing building has been constructed in a manner that does not comply with the DTS provisions of the BCA in terms of fire separation. Currently the floor joists sit on the walls however this includes the fire rated wall which extends through all three storeys of the building. For this reason the fire rated wall separating the two adjacent dwellings is discontinuous and is breached where the floor joists but into the fire rated wall structure. This can be seen in the figure below. This results in a point of weakness where the fire may travel through the timber floor joist in order to reach the adjoining residence prior to the 60 minute period having elapsed.

Further to this timber panelling has been provided which is directly fixed to the studwork on the party wall. This is not considered to comply and is proposed to be removed such that the bounding wall achieves a minimum FRL of 60/60/60 as a tested system with the exception of the deviations where affected by the above floor joists.

The solution proposed involves the use of sacrificial timber in order to provide a level of protection to the existing timber floor joists supporting the upper storey of the building. This proposal to use sacrificial timber blocking between the timber floor joists is consistent with the methods outlined within the Wood Solutions Timber Framed Construction Design Guide. It is proposed to provide two 45mm thick solid timber blocking pieces to box in the timber floor joists as can be seen in the figure below.

Figure 1 – Timber floor joists running parallel with the wall breach the fire rating of the stud wall and are subject to this performance solution

Figure 2 – Proposed Timber Blocking attached to face of timber floor joists between normal blocking

3.3 Relevant Performance Requirement

Pursuant to 1.0.10(b) of BCA the following Performance Requirement have been identified as being directly relevant to the DTS provisions identified in Section 3.1 above:

P2.3.1 Protection from the spread of fire

(a) A Class 1 building must be protected from the spread of fire from—
(i) another building other than an associated Class 10 building; and
(ii) the allotment boundary, other than a boundary adjoining a road or public space.

3.4 Assessment Methodology

In order to address the provisions of the BCA, a qualitative and quantitative assessment will be undertaken to determine compliance with the relevant Performance requirement P2.3.1. The assessment will discuss each of the proposed deviations in detail to determine whether or not the proposed trial design is capable of satisfying the relevant performance requirement P2.3.1.

3.5 Acceptance Criteria

The performance solution will be considered to achieve the performance requirements of the BCA if it can be considered to categorically satisfy each element of the relevant performance requirement P2.3.1.

3.6 Qualitative and Quantitative Assessment

The Wood Solutions Timber-Framed Construction Technical Design Guide published by the Forest and Wood Products Australia, provides a series of details for providing sacrificial timber construction for the purposes of protecting load-bearing timber elements. Each of these sacrificial timber members are not considered to be load-bearing and are allowed to ignite and form a protective charring layer to protect the critical load-bearing timber elements within. One example provided below indicates that the use of a 45mm thick timber element either side of the floor joist would provide sufficient protection to a 45mm timber floor joist running parallel to a load-bearing wall to provide an FRL of 60 minutes.

It is proposed therefore to use the same system which utilised a single 45mm thick timber floor blocking piece connected directly to the side of the timber floor joist to provide an FRL of 60 minutes. In further support of the above, the Eurocode for timber framed construction provides a charring rate of timber at 0.64mm/minute. A 45mm thick sacrificial timber board will therefore produce at least 70 minutes of protection in this instance which is considered to be capable of withstanding the effects of fire for at least 60 minutes thus satisfying the required performance in this instance.

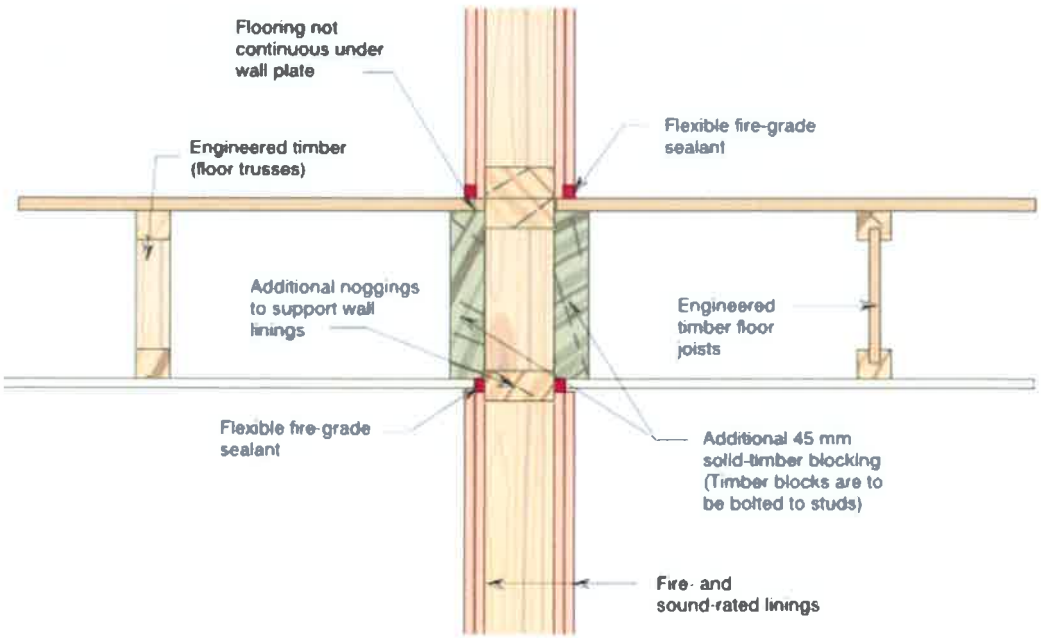


Figure 3 – Excerpt from design guide showing joist parallel to wall with single wall stud continuous through junction with timber blocks providing an FRL of 60 minutes

Further to this, if the blocking piece were to fail, however unlikely, the provision of interconnected smoke detectors throughout both SOUs is considered to be beyond the requirements of the BCA, will provide early activation of the

occupant warning system throughout the building (consisting of bells, sounders or speakers) which would result in rapid evacuation of the building prior to fire spread to the common area occurring.

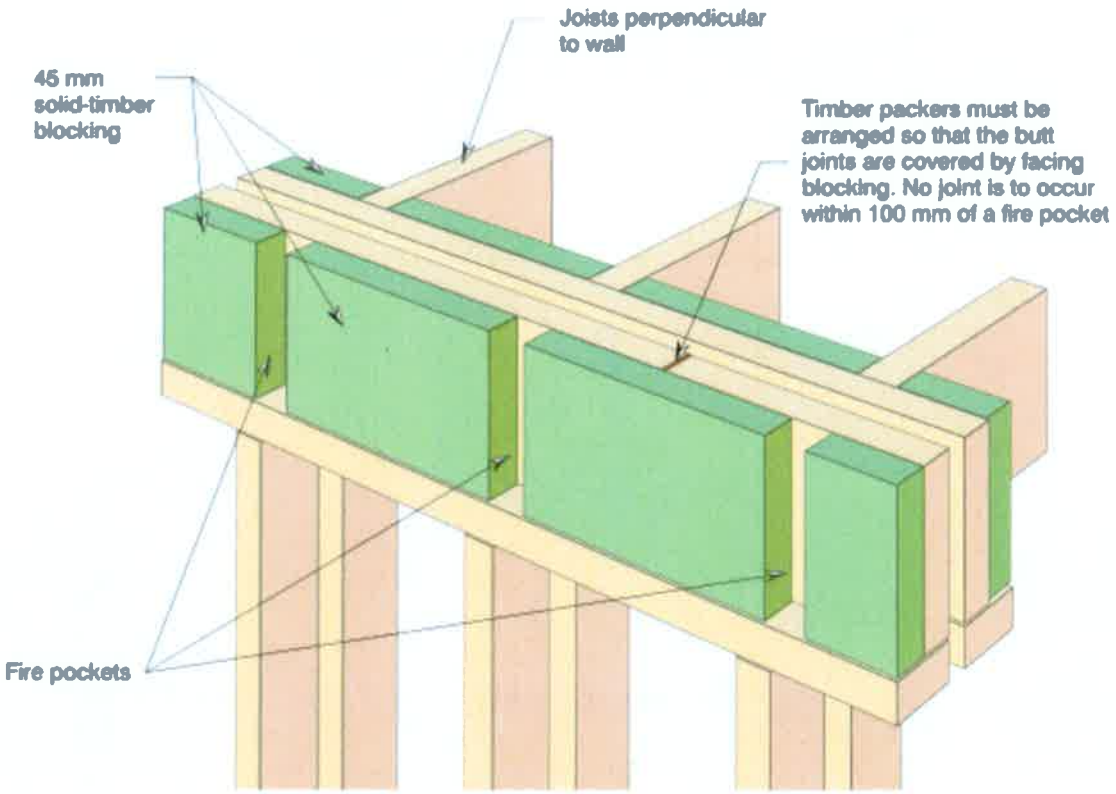


Figure 4 – Fire pockets in fire and sound-rated wall providing an FRL of 60 minutes

On the basis of the above discussion, it is considered that the proposed trial design as outlined above satisfies the relevant performance requirement P2.3.1 subject to the assessment against the relevant performance requirements as outlined in the following section of this report.

3.7 Assessment against relevant Performance Requirement

The following is an assessment of the relevant Performance Requirement P2.3.1.

P2.3.1	
(a) A Class 1 building must be protected from the spread of fire from—	
(i) another building other than an associated Class 10 building; and	The provision of sacrificial timber blocking to protect the timber floor joists is considered to be an adequate solution to provide a minimum FRL of 60 minutes as detailed within the discussion above as the timber is likely to resist fire for approximately 60 minutes.
(ii) the allotment boundary, other than a boundary adjoining a road or public space.	Not applicable to this alternative solution.

3.8 Assessment Conclusion

As per the performance solution above it is considered that the proposal to provide a single 45mm solid timber blocking piece between each timber blocking, fixed to the timber floor joist is more than adequate to resist fire spread through the 60 minute fire rated wall. It is considered therefore that the relevant performance requirement P2.3.1 has been satisfied through an absolute, quantitative and qualitative assessment.

3.9 Requirements of Performance Solution

The performance assessment has determined that the Trial Design requirements of the proposed Performance Solution satisfy the relevant Performance Requirements CP1 and CP2 subject to the following requirements:

1. The space between the floor joist blocking pieces shall be provided with a 45mm thick sacrificial timber blocking piece to provide a total of 90mm of sacrificial timber within this space.
2. The building shall be provided with AS1670.1 smoke detectors throughout the building consisting of AS1670.1 spaced detectors configured to notify the fire brigade.
3. The remainder of the wall shall be upgraded to achieve a minimum FRL of 60/60/60. This must, at a minimum, involve removal of the timber panelling utilised on the lower section of the wall. Notably, to achieve the BCA required acoustic separation, a system such as the Gyprock CSR415 or CSR419 system may be considered appropriate.

4.0 CONCLUSIONS

4.1 Conclusion

The Performance Solutions have been developed using a qualitative and quantitative assessment with the Deemed-to-Satisfy Provisions and is considered to comply with BCA Performance Requirement P2.3.1. The BCA recognises these Assessment Methods as acceptable methods for determining that the Performance Solutions satisfy the Performance Requirements in accordance with BCA Clauses 1.0.3(a)(i) and 1.0.5(b)(ii).

Accordingly, based on the above, it is considered that the directly related Performance Requirement P2.3.1 has been met, provided the Performance Solutions requirements listed in the executive summary are implemented.

4.2 Specification of the Final Trial Design

Considering the relevant provisions of the BCA and the above assessment, the Performance Solution, subject to the provision of the Trial Design requirements, is considered to meet and comply with the Performance Requirement P2.3.1. The Trial Design requirements detailed in each solution and in the Executive Summary become the Performance Solutions.

4.3 Maintenance Requirements

The recommendations of this report must form part of the annual fire safety statement for the building to ensure the recommendations of this report are complied with throughout the building operation.

4.4 Requirements of the Performance solution

The discussions undertaken have demonstrated compliance with the relevant performance requirements via the proposed design and installation of offset measures. The offset measures required as part of this Performance Solution are listed in the Executive Summary and must be fully implemented in order for compliance to be achieved.

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5.0 REFERENCES

- Australian Building Codes Board, "Fire Safety Engineering Guidelines", Edition 2001, November 2001, Australia.
- Australian Building Codes Board, "The Building Code of Australia", Edition 2015, May 2015, Australia.
- Australian Building Codes Board, "The Guide to the Building Code of Australia", Edition 2015, May 2015, Australia.
- IFEG (2005). International Fire Engineering Guidelines 2005, ABCB.

Appendix A – Data Relied upon in the FER Process

Common Abbreviations Used in Fire Engineering

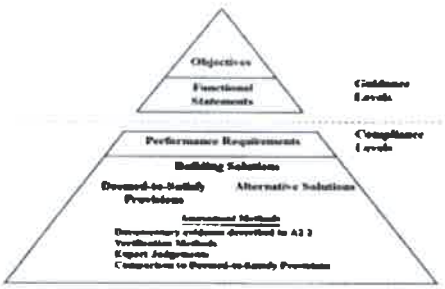
Abbreviation/Term	Meaning
AFAC	Fire and Emergency Service Authorities Council
AS	Performance Solution
ASB	Performance Solution Brief - identical to FEB. ASB will not be used other than to relate this term to the Fire Engineering Brief.
ASR	Performance Solution Report - identical to FEB. ASR will not be used other than to relate this term to the Fire Engineering Report.
BCA	Building Code of Australia.
CFD	Computational Fluid Dynamics – Used to describe the fire modelling for a building
Comparative	A methodology used for a fire engineering analysis that uses a comparison with the deemed to satisfy provisions of the BCA. This methodology shows that the performance solution is equivalent to the DTS provisions of the BCA and is often referred to as the equivalence approach.
DTS	Deemed-To-Satisfy - Representing the deemed to satisfy provisions set out in the BCA.
Equivalence	The equivalence approach is a fire engineering approach using a comparison to the DTS provisions of the BCA.
FEB	Fire Engineering Brief - identical to ASB. FEB is used throughout the report.
FER	Fire Engineering Report - identical to ASR. FER is used throughout the report.
FDS	Fire Dynamics Simulator – The software program used to perform fire modelling on buildings
FRL	Fire Resistance Level
FRNSW	Fire and Rescue New South Wales
IFEG	International Fire Engineering Guidelines
NFPA	National Fire Protection Authority
SAMFS	South Australian Metropolitan Fire Service
SFPA	Society of Fire Protection Engineers.

Client Design and Building Regulatory Objectives

The client design objectives are to address the issues of deemed-to-satisfy non-compliance with the production of an performance solution that meets the related Performance Requirement.

One of the purposes of this Fire Engineering Report is to provide the stakeholders with a document for consideration and to add further input with regards to the specific objectives.

The structure of the BCA is depicted in the following figure and is a hierarchal document with objectives, functional statements and Performance Requirement.



The primary objectives of the BCA are to protect the life safety of occupants by allowing them to exit the building without being exposed to hazardous or untenable conditions, the protection of adjacent buildings from collapse or fire spread and protection of the life safety of fire fighters by giving reasonable time for the emergency personnel to perform their duties.
The Performance Requirement are the only section of the BCA to which a design must comply, with objectives and functional statements given as guidance to explain the intent of the Performance Requirement. Satisfying the Performance Requirement can be achieved through one of three ways:

a) Complying with Deemed-To-Satisfy (DTS) provisions of the BCA
b) Formulating an Performance Solution which complies with the Performance Requirement
c) Combination of a) and b)

For this particular project the means of compliance to the BCA will be shown by complying to a/b/c above.
BCA clause A0.9 provides the following assessment methods to determine that a building solution complies with the BCA Performance Requirement:

a) Evidence to support that the use of a material, form of construction or design meets a Performance Requirement or a Deemed-to-Satisfy Provision
b) Verification Methods such as—
    i) The verification methods in the BCA; or
    ii) Such other verification methods as the appropriate authority accepts for determining compliance with the Performance Requirement
c) Comparison with the Deemed-to-Satisfy Provisions
d) Expert Judgement

The assessment methods that will be adopted for this project are in accordance with A0.9 above and the specific methods are detailed in the performance solution sections.

Methods of Analysis

The methods of analysis used in the development of performance solutions are detailed in BCA Clause A0.9, and include

A0.9(b)(i) *Verification Methods, such as the Verification methods in the BCA*

A0.9(b)(ii) *Verification Methods, other than those in the BCA that the appropriate authority accepts for compliance with the Performance Requirement*

A0.9(c) *Comparison to the* deemed-to-satisfy provisions of the BCA

A0.9(d) *Expert judgement*

In order to satisfy BCA Clause A0.5 - Meeting the Performance Requirement

(b) *formulating an Performance Solution which -*
(i) *complies with the Performance Requirement; or*
(ii) *is shown to be at least equivalent to the Deemed-to-Satisfy Provisions;*

The specific assessment methods used for the analysis are detailed in performance solution section for each issue.

Relevant IFEG Sub-Systems

The relevant IFEG sub-systems (SS) for this analysis are:

IFEG Sub-System	Description	Symbol
Sub-system A Fire Initiation and Development and Control	Limitation of ignition sources Limitation of nature and quantity of fuel Arrangement and configuration of fuel Separation of ignition sources and fuel Management of combustibles including housekeeping measures Electrical safety equipment Regular plant maintenance	

IFEG Sub-System	Description	Symbol
	Adherence to procedures for 'hot work' (e.g. welding)	
Sub-system B Smoke Development and Spread and Control	Smoke barriers Natural smoke venting Mechanical smoke management	
Sub-system C Fire Spread and Impact and Control	Separation of fuel Separation of buildings Fire resistive barriers Fire resistive structural elements Fire resistive air-handling ducts Fire resistive dampers Exposure protection	
Sub-system D Fire Detection, Warning and Suppression	Automatic and manual detection equipment Automatic and manual warning equipment Surveillance equipment Automatic suppression equipment Manual suppression equipment	
Sub-system E Occupant Evacuation and Control	Evacuation plans Occupant training Emergency communications Egress signage Egress routes (including fire isolated elements)	
Sub-system F Fire Services Intervention	Type of fire services available (full-time/permanent or volunteer). Characteristics of fire services capability and resources Fire service access to the site and to the building Water supplies and infrastructure	

Acceptance Criteria and Factors of Safety for the Analysis

Qualitative Assessments

The acceptance criteria for qualitative assessments are the equivalence to a deemed to satisfy solution (preferred) or the collective agreement of the stakeholders. The IFEG allows both qualitative and quantitative approaches and states that -
"the methods chosen will be appropriate to the approach used".
The IFEG states -
"In the minority of cases, qualitative analysis may be agreed during the FEB process to be sufficient for the consideration of a single non-compliance issue. The basis (logic) on which this approach is used should be documented with appropriate references. A "Delphi" approach may also be appropriate in certain circumstances, where a group of suitably qualified expert professionals reach consensus agreement regarding the suitability of a particular solution."
The IFEG further states -
"Both comparative and absolute approaches may be adopted in the analysis strategy. The methods chosen will be appropriate to the approach used.

Comparative approach:
Typically, the fire safety provided by one element, or a sub-system, or the complete fire safety system, is compared to the level of fire safety that would be achieved in an identical building in which that element, sub-system or system is designed in compliance with the deemed-to-satisfy or prescriptive provisions identified in Section 1.2.8. If the analysis is carried out on such a comparative basis, it will involve the same assumptions, models, calculations and input data for the proposed trial design and the deemed-to-satisfy or prescriptive design.
A comparative approach aims to determine whether the performance solution is equivalent to (or better than) the deemed-to-satisfy or prescriptive design. The comparative approach is often referred to as an "equivalence" approach."

Quantitative Assessments
The following acceptance criteria are proposed for the assessment of the performance solutions compliance with the Performance Requirement of the BCA.
The acceptance criteria will be to demonstrate that fire safety is not adversely affected and that the occupants may safely evacuate the building and/or the fire will not spread to adjacent property and/or will allow fire fighters to safely perform their duties.
Heat Radiation - The limiting condition for radiation is assumed to be in the range 1.57 to 6.3kW/m2. The tolerance time for radiation at this level is 6 minutes.

$I < 1.57 kW/m^2$ to $6.3 kW/m^2$

Fire Brigade Intervention:
In considering the role of the fire brigade in attacking a fire, it is important to estimate the time at which the brigade will be effective in limiting the spread of the fire and reducing the heat output of the fire in the enclosure of fire origin. However this response time is variable and is a function of the time at which the alarm is received at the fire station, the travel time to the building, the setting-up time once the fire brigade has arrived and the time to impact the fire.
While the fire brigade will be available to assist evacuation through search and rescue of occupants, this action is not relied upon for occupant evacuation. The fire safety assessment is therefore conservative in this regard.
The conditions that define the tenability criteria for fire brigade personnel will be considered if the occupants cannot be shown to have sufficient available egress time prior to onset of untenable conditions. In certain instances the fire brigade intervention times will be required to be determined and tenability for the fire fighters assessed i.e. deletion of sprinklers from a carpark. The time for the fire brigade to arrive and commence fire fighting operations will be determined using the Fire Brigade Intervention Model or literature data on the fire brigade response time to fires.

Summary of Tenability Failure Criteria:

Condition	Criteria
Convective heat	Temperature > 60°C when smoke layer is below tenability height.
Radiant heat exposure	2.5kW/m² at head height or smoke layer temperature exceeds 200°C when above tenability height of 2.1m.
Visibility	10m when smoke layer is below tenability height of 2.1m for large rooms or 5m for small rooms.
Toxicity	OD > 0.1m-1 (10dB/m) when smoke layer is below tenability height of 2.1m, but not accessed if visibly acceptable.

The following table is an overview of the tenability's as accepted by the Fire and Emergency Service Authorities Council (AFAC)[1].

	Routine Condition	Hazardous Condition	Extreme Condition	Critical Condition
Maximum Time, min	25	10	1	<1
Maximum Temperature, °C	100	120	160	235

[1] Weng Poh 'Tenability in building fires: Limits and design criteria'. Fire Australia, 2010, No. 3,. pp 24-26

Maximum Radiation, kW/m^2	1	3	4 - 4.5	>10

Approaches and Methods of Analysis

Approach

Fire engineering design can involve the use of a number of approaches including:

- Comparative or Absolute
- Qualitative or Quantitative
- Deterministic or Probabilistic

The IFEG gives descriptions of each type of approach, where it can be noted that a deterministic or probabilistic approach can only be applied to a quantitative analysis. The differences between a comparative and absolute approach and typical examples of acceptance criteria are depicted in the following table (reproduced from UK Fire Engineering Guidelines PD7974-0).

Comparative vs. Absolute Approach

	Fire Safety Objectives	
Analysis Method	**Deterministic**	**Probabilistic**
Comparative	Time available for escape is at least equal to that in an equivalent code compliant building	Level of risk of life equivalent to a code compliant building
Absolute	The time available for escape exceeds the time to untenable conditions	Expected number of casualties per year

A definition of each type of approach is outlined in the following table, which has been adopted from the IFEG. The type of approach adopted will depend on the type of compliance issue in question and subsequent methods of analysis will be prepared.

Analysis Approaches

Approach	Definition
Comparative	A comparative approach aims to determine whether the performance solution is equivalent to (or better than) the deemed-to-satisfy or prescriptive design. The comparative approach is often referred to as an "equivalence" approach.
Absolute	In an absolute approach, results of the analysis are matched directly against the Performance Requirement of the BCA, using agreed acceptance criteria.
Qualitative	A qualitative analysis may be agreed during the FEB process to be sufficient for the consideration of minor stand-alone compliance issues. The basis (logic) on which this approach is used should be documented with appropriate references.
Quantitative	The complexity of the compliance issues will often require a quantitative approach. This entails the use of one or more of the many analysis methods available The quantitative methods will often be supported by additional qualitative arguments.
Deterministic	Deterministic analyses are based on physical relationships derived from scientific theories and empirical results. Characteristically, for a given set of initial boundary conditions, a deterministic methodology will always produce the same outcome. They do not, however, indicate the probability of that outcome being realized.
Probabilistic	Probabilistic approaches use a variety of risk based methodologies. These methods generally assign reliabilities to the performance of the various fire protection measures and assign frequencies of occurrence of events. They may analyse and combine several different scenarios as part of a complete fire engineering evaluation of a building design. This use of multiple scenarios and their combination through probabilistic techniques is the key feature of some of the methods.

Construction and Commissioning Requirements

The fire safety measures shall be designed, installed and commissioned in accordance with the relevant Australian Standards.

- The management of the building must be aware of the Performance Solution contained within the building, as well as the required measures for maintenance.

- The Building Management System, must incorporate maintenance measures to ensure satisfactory maintenance, testing and inspection of all fire safety measures.

All fire safety measures are to be commissioned and tested prior to occupation of the building. The fire services contractor must provide certification of the installation and commissioning of the fire services required by this report, including but not limited to:

- Fire Hydrant Systems
- Smoke detection
- Fire doors and acoustic seals
- Exit signage & emergency lighting
- Appropriate door hardware and door swing

The fire safety measures within the building must be maintained to ensure correct operation at all times that the building is occupied. All fire fighting equipment should be tagged when tested/inspected and log books kept up-to-date for all smoke detection, warning systems and sprinkler systems (where installed).

An Form 3 fire safety certificate must be submitted to the local council each year indicating satisfactory performance of the fire safety measures contained within the building.

The correct operation and maintenance of the buildings fire safety measures is critical in affording an adequate level of fire safety. Other items identified in the FEB/R that will need to be incorporated into the management in use of the facility include:

- No smoking policy is to be implemented in all public areas.
- Commissioning and integrated function testing of all fire safety and protection systems including interfaces to ensure proper function.
- All essential services are to be maintained and tested in accordance with BCA and Australian Standard AS1851.
- Ensure exits and paths of travel to exits remain unobstructed (in particular stairways).
- Avoid storage of materials in unoccupied areas.
- Limit storage of flammable/combustible materials to designated and approved areas.
- Prevent chocking open fire/smoke doors.
- Prevent storage of materials that could hinder access to fire fighting equipment.