FIRE ENGINEERS

PYGMY POSSUM LODGE, CHARLOTTE PASS

FIRE SAFETY UPGRADE MASTER PLAN

DEVELOPED FOR AUTHORITY REVIEW

DATE: 11 DECEMBER 2024

J Squared Engineering Pty. Ltd. ACN 605 793 986

FIRE SAFETY ENGINEERING | ESSENTIAL SERVICES MAINTENANCE MANAGEMENT | BUILDING SERVICES DESIGN

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CONTENT

REVISION STATUS

REPORT NO.	REVISION	DATE	STATUS	WRITTEN	REVIEWED
2244	REV A	11/11/21	DRAFT	JR	JA
2244	REV B	08/09/22	DRAFT	JR	JA
2244	REV C	14/03/23	DRAFT	JR	JA
2244	REV D	15/06/23	DRAFT – Update to BCA 2022	JR	JA
2244	REV D	17/07/23	FINAL – Update to BCA 2022	JR	JA
2244	REV E	10/05/24	DRAFT – Planning RFI	JR	JA
2244	REV E	20/05/24	FINAL	JR	JA
2244	REV F	15/11/24	DRAFT – Updates & PS3	JR	JA
2244	REV F	11/12/24	FINAL	JR	JA

EXECUTIVE SUMMARY & RECOMMENDATIONS

J² Consulting Engineers have been commissioned to carry out a review of the fire safety provisions associated with the existing Pygmy Possum Lodge accommodation building located at Charlottes Pass and to develop a master plan outlining the proposed strategies for upgrade to suit the legislative requirements of the Building Code of Australia 2022 Volume 1(BCA).

Whilst the current BCA was not legislated at the time that the existing developments were undertaken, the compliance assessment undertaken has been undertaken against this BCA as it represents a community accepted level of life safety. As the building is existing however, there are limitations associated with what upgrades are possible to be undertaken and this report therefore also provides a fire engineering assessment of a number of elements in order to achieve compliance with the Performance Requirements of the BCA. These 'Performance Solutions' can be summarised as follows:

#	Performance Solutions	BCA DTS Provision	BCA Performance Requirement	Assessment Methodology
1.	**Fire Resistance** It is proposed to develop a Performance Solution to permit the following non-compliances: • To allow ancillary parts of the external walls to the first and second floor to incorporate combustible building elements in contravention with the requirements of C2D10 of the BCA. In addition to this, the external walls do not achieve FRL 90/60/30 as required by Specification 5. • To allow the vertical separation of openings in external walls to be less than 900mm without the incorporation of a fire-resistant horizontal projection in contravention with the requirements of C3D7 of the BCA. • The enclosed concrete deck on ground floor and the verandahs on Level 1 incorporates what appears to be exposed structural steel hollow sections which have not been treated/cladding with a fire-resistant material. Subsequently, the structural adequacy of the columns shall not achieve the required FRL of 90/-/- as per Specification 5.	C2D10, C3D7 & Spec 5	C1P1, C1P2 & C1P4	Qualitative assessment demonstrating compliance with the performance requirements via a performance based deterministic approach.
2.	**Access and Egress** It is proposed to develop a Performance Solution to permit the following non-compliances: • To allow the omission of a DtS compliant fire-isolated stairway which serves three storeys within a Class 3 building and also discharges within the ground floor of the building thereby, deviating from D2D4 and D2D4. • To allow a reduced exit width of 900mm in lieu of 1m within both southern non-fire isolated stairway thereby deviating from D2D4 of the BCA.	D2D4, D2D8 & D3D14	D1P2, D1P4, D1P5 & D1P6	Quantitative assessment demonstrating compliance with the performance requirements via a performance based deterministic approach.

	• To permit winders in lieu of a landing for a change in direction within common stairways used as a path of travel to an exit thereby deviating from D3D14 of the BCA.			
3.	**Bounding Construction** To permit the existing fibreglass prefabricated bathroom pods to remain and the existing unprotected exhaust fan penetrations in each SOU to remain regardless of the non-compliance with BCA Clauses C2D11 and C4D12.	C2D11, C4D12	C1P1 & C1P2	Qualitative assessment demonstrating compliance with the performance requirements via a performance based deterministic approach.

REQUIREMENTS OF UPGRADE STRATEGY – PERFORMANCE BASED

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 Requirements C1P1, C1P2, C1P4, D1P2, D1P4, D1P5 and D1P6:

Performance Solution 1
Fire Spread Throughout the Building and to Adjoining Buildings

1. The installation of a AS2118.4-2012 compliant sprinkler system to the upper two residential levels of the subject building.

Vertical Separation of Openings in External Walls

2. The installation of a AS2118.4-2012 compliant sprinkler system to the upper two residential levels, inclusive of the non-fire-isolated stairs, of the subject building.

Non-Fire-Resistant Structural Steel to Ground and First Floor

3. Ground floor columns shall be fully encased with the PROMATECT 100 system 20mm thick board in a manner which forms a sealed shaft around the metal column and in accordance with the manufacturer's tested system.
4. First floor external columns are to be core filled with non-shrink structural grout. The grout mix must be equal to concrete core fill mix with a minimum strength of 20MPa. The grout must extend to the top cap of the column to ensure the grout takes the load of the column.

Performance Solution 2

1. An AS2118.4-2012 sprinkler system shall be installed throughout the upper two residential storeys inclusive of stairways. Installation of sprinklers to the lower level is optional.
2. Installation of a fire-resistant glazed panel to the non-fire-isolated stairway doors at ground level thereby, allowing occupants to determine the tenability of the ground floor and egressing open space.
3. Install Kilargo medium temperature smoke seals to all four sides of the doors leading from the non-fire-isolated stair to public corridors associated with SOUs, see figure below.

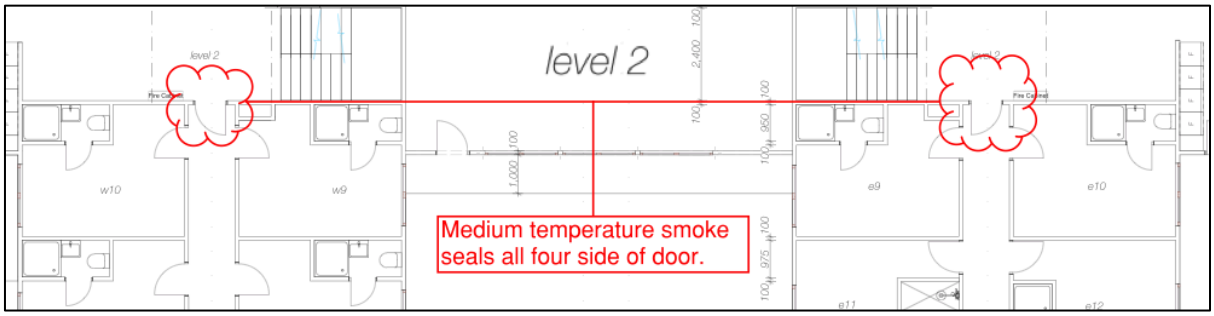


Figure A - Medium Temperature Smoke Seals to Corridor Doors on Level 2.

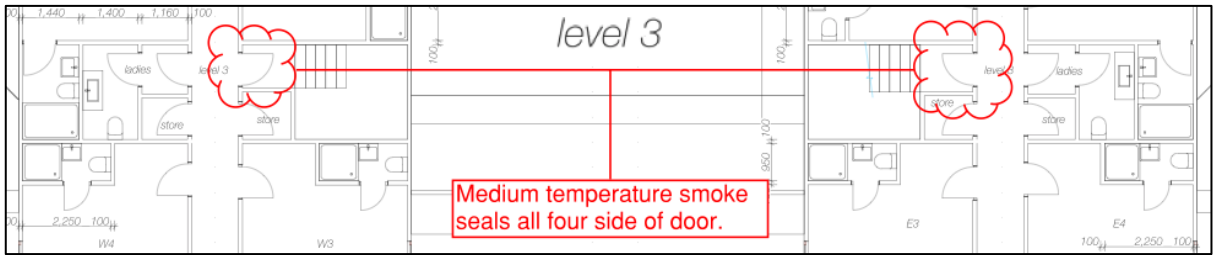


Figure B - Medium Temperature Smoke Seals to Corridor Doors on Level 3.

4. To ensure occupants are aware of the alternative exits located to the floors above it is proposed to install signage stating, "SHOULD CONDITIONS BE UNTENABLE USE ALTERNATIVE EXITS LOCATED ON FLOORS ABOVE". Signage shall be installed to the stair side of the door in a prominent position.
5. The installation of textured contrast strips at the end of each of the subject winders for the length of the winder being not less than 50mm in width and in a colour which contrasts to the stair surface.
6. The installation of signage which states "CAUTION WATCH YOUR STEP" in letters no less than 50mm in height and in a colour contrasting to the background, see figure below.

Figure C - Textured Contrast Strips and Signage to be Installed to Stair.

7. It is proposed to require a single evacuation route along the east of the development from the rear of the building as detailed below.

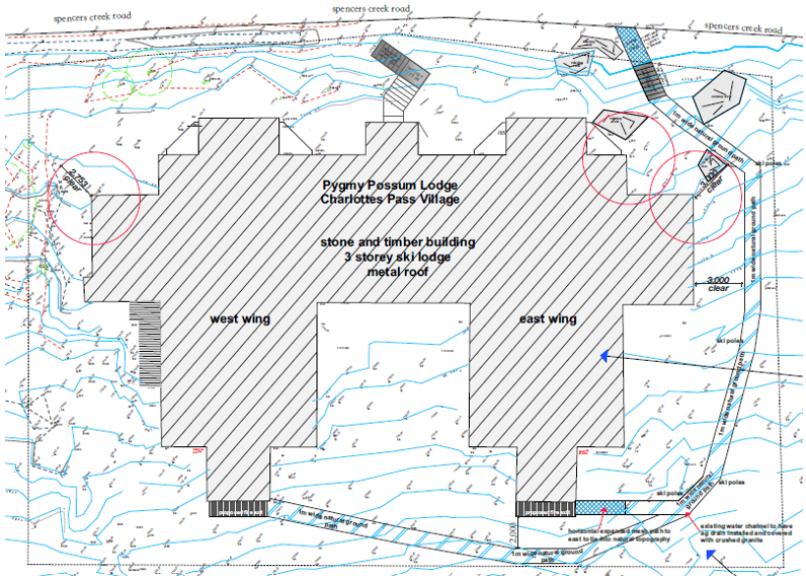


Figure D –Evacuation Routes from the Rear of the Building.

Performance Solution 3

1. An additional sprinkler head shall be installed to each of the bathrooms associated with the SOUs on Level 2 and 3.
2. The sprinkler is to be sidewall sprinkler head installed in a manner which provides sprinkler coverage to the entire room which they serve.
3. All Bathrooms associated with SOUs on Level 2 and 3 shall be installed with either of the following:

   (a) exhaust fans which are directly connected to the atmosphere via a non-combustible bulkhead/pipe.

   OR

   (b) existing exhaust fans are to be replaced with a fire damper, such as Kilargo intumescent IFD-0 series or similar, to maintain the fire-resistance level of the ceiling.

4. Where the exhaust fan has been removed the existing opening in the ceilings are to be infilled and sealed by a system which achieves a fire resistance of 60 minutes.

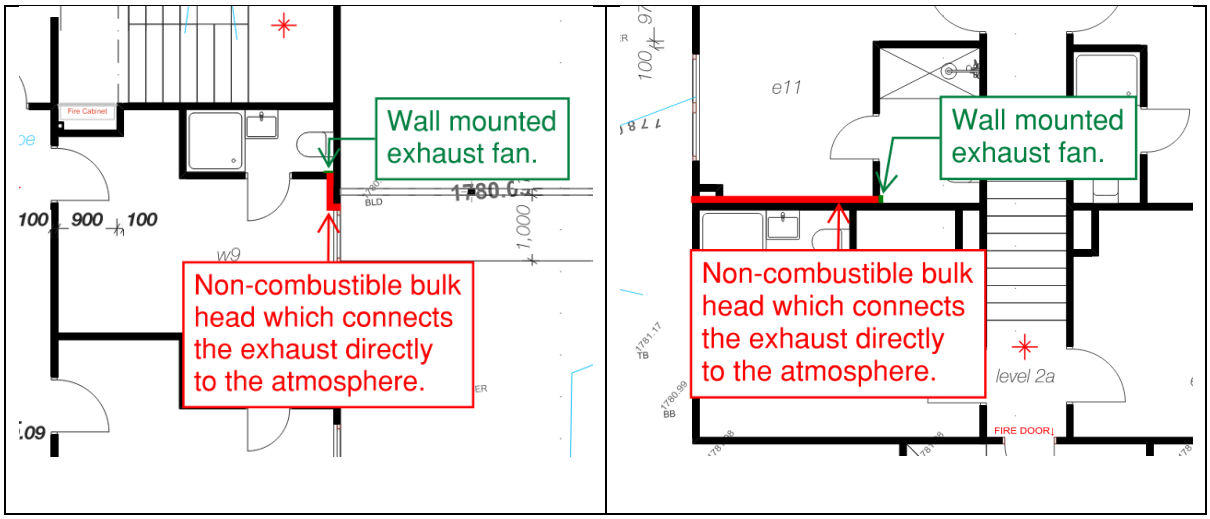


Figure E - Wall mounted exhaust fans and non-combustible bulkhead

REQUIREMENTS OF UPGRADE STRATEGY – DTS

In addition to the performance based upgraded strategy proposed the following deviations from the BCA's DtS provision have been identified with additional fire safety measure proposed which shall bring the existing building to partial compliance with the BCA.

C4D11 *(C3.11)* **Bounding Construction**
SOU Doors
The doors serving the SOUs throughout the building which are fitted with self-closing solid core doors whereas the BCA requires fire resistant door sets to SOUs in Type A construction. The inclusion of the solid core doors to the SOUs within the Class 3 is considered to be satisfactory subject to the installation of an AS2118.4-2012 compliant sprinkler system throughout the building.

Further to this, the ensuites associated with the SOU contain ceiling mounted exhaust fans which have not been installed with a fire-resistant system. Additionally, ensuites include a fibreglass shell in the showers which is considered to be a combustible lining. In this instance a Performance Solution has been sought to address these non-compliance.

C4D13 *(C3.12)* **Openings in Floors and Ceilings for Services**
PVC pipe penetrations through the first-floor slab have not been installed with a shaft complying with Specification 5.

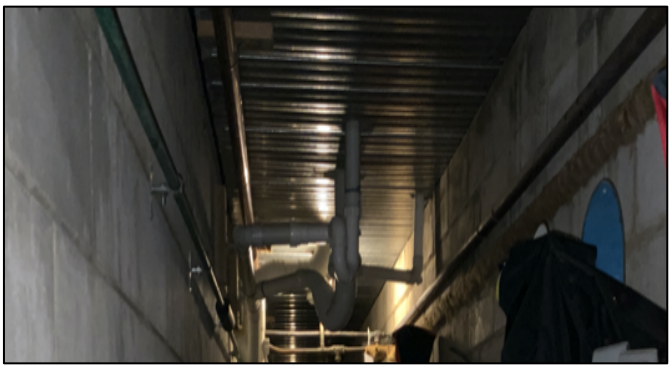


Figure G - PVC Penetrations through Floors and Ceilings.

It is proposed to retro fit fire-resistant collars as to maintain the FRL of 90/90/90 to the ground floor. Promaseal retrofit collars have been selected to be installed to the range of existing PVC pipe penetrations.

D2D3 *(D1.2)* **Number of Exits**
Level 2 of the subject building is not provisioned with the required number of exits, being two, from each storey therefore the building is non-compliant with D2D3. It is proposed to infill the existing doors and rely upon the existing doors located on the mid land between Levels 2 and 3.

The external path from the subject exits shall be upgraded to incorporate a covered walkway to prevent the build-up of snow to the evacuation route. This will ensure occupants are provided with an additional exit from Level 2 regardless of the environmental condition.

Exit signage to be reinstalled as to identify the available exits to the egressing occupants being installed in accordance with AS/NZS 2293.1-2018 and "OPEN INWARDS" signage shall be reinstated in accordance with G4D3 of the BCA.

D3D7 *(D2.7)* **Installations in Exits and Paths of Travel**
The dining and lounge areas of both wings incorporates electricity meters, distribution boards or ducts. The path of travel from the building requires occupants to pass by the dining and lounge areas thereby, being non-compliant with D3D7 of the BCA.

It is proposed to install an enclosing non-combustible construction or a fire-protective covering with

openings suitably sealed against smoke spreading from the enclosure.

D3D17 *(D2.16)* **Barriers to Prevent Falls**
The balustrade to the external exit stairway does not comply. The existing balustrade allows for a 150mm sphere to pass through the opening between the rail and the floors thereby deviating from the DtS requirements of D3D17.

Figure I - Balustrade to Stair Incorporates Openings which allow for a 150mm Sphere to Pass Through.

The elevated exits on Level 2 detailed above shall be removed and replaced with new exits which shall be constructed in a manner which complies with the relevant DTS provisions of the BCA.

Internal stair balustrade has been measured as 825mm in height in lieu of the required 865mm thereby, the existing balustrades to not comply with D3D17.

Figure J - Internal Stair Balustrades do not Achieve Height Requirement of 865mm.

Generally, the existing external balustrades to balconies and elevated walkways do not comply with the requirements of D3D17. Balcony barriers to be raised as to achieve a minimum height of 1m when measured from ground level.

Continuous barriers associated with trafficable surfaces 1m above surface beneath shall not allow a 125mm sphere to pass through any open and shall not incorporate any horizontal or near horizontal elements between 150mm and 760mm above the floor as to not facilitate climbing.

Figure K – External Barriers to be Upgraded as to Comply with D3D17.

It is proposed to require the existing barriers to be upgraded to be in accordance with D3D17.

D3D26 *(D2.21)* **Operation of Latch**
The doors serving as required exits do not have lever handle latches and are not considered to be readily openable from the inside by a single hand downward action.

It is proposed that all existing doors within the evacuation route be fitted with lever type hand latches which are openable from the inside by a single hand downward action in accordance with D3D26.

E1D3 & G4D7 *(E1.4 & G4.8)* **Fire Hose Reels**
Fire hose reels have been installed throughout the building in accordance with past versions of the BCA. Notably, the fire hoses reels, in some instances, are not located within 4m of an exit. Notably, the current BCA does not require the installation of fire hose reels however, their installation does impact upon the occupant life safety within the building.

Decommission fire hose reels which are not located within 4m of exit doors. Replace subject fire hose reels with applicable portable fire extinguishers in accordance with AS 2444-2001.

E1D14 *(E1.6)* **Portable Fire Extinguishers**
Portable fire extinguishers must be provided as listed in Table E1.6. In this instance, the location of extinguishers is not in accordance with AS 2444-2001.

Existing and proposed portable fire extinguishers shall be installed, selected and located in accordance with AS 2444-2001, see figure below.

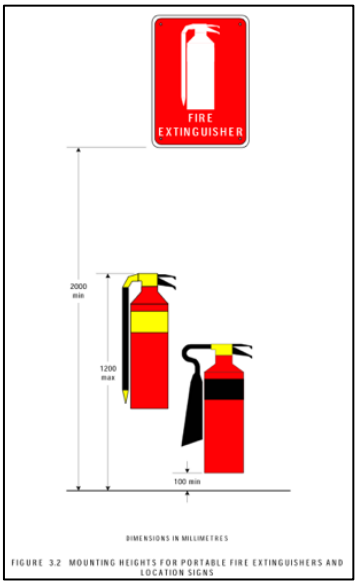


Figure L - Extract from AS 2444-2001 Figure 3.2 Mounting Heights for Portable Fire Extinguishers and Location Signs.

E2D3 & G4D7 *(E2.2 & G4.8)* **Smoke Detection and Alarms**
The building is currently fitted with a smoke detection system addition to the system will be required to ensure compliance with BCA Spec 20.

Certification to be provided of required additions by a suitably qualified trades person.

E4D2 *(E4.2)* **Emergency Lighting Requirements**
Additional emergency lighting shall be provided to all external exits in accordance with AS/NZS 2293.1-2018. Shortfalls in compliance with AS/NZS 2293.1-2018 have been identified throughout the building. It is proposed to install emergency lighting throughout the building in accordance with AS/NZS 2293.1-2018.

F5D2 *(F3.1)* **Height of Rooms and Other Spaces**
The floor to ceiling heights within the internal stairs does not achieve the minimum height of 2m being measured as 1950mm.

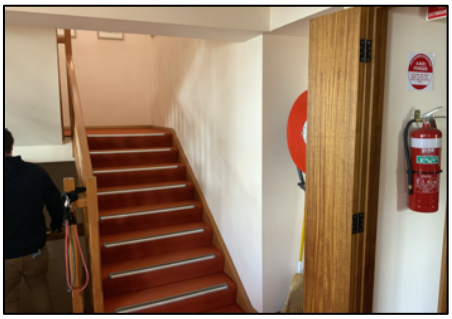


Figure M - Floor to Ceiling Heights within Internal Stairs do not Achieve 2m.

It is proposed to increase floor to ceiling heights at the bulkhead by 50mm to achieve the required 2m in accordance with F5D2 of the BCA.

G4D3 *(G4.3)* **External Doors**
Existing external doors throughout the subject building which are subject to the building up of snow and open inwards shall be marked "OPEN INWARDS" on the inside face of the door in letters not less than 75mm high in a colour contrasting with the background.

Figure N - Primary Entrance to have "OPEN INWARDS" Signage Installed.

It is proposed to install signage stating "OPEN INWARDS" on the inside face of the door in letters not less than 75mm high in a colour contrasting with the background.

G4D7 *(G4.8)* **Fire-fighting Services and Equipment**
The existing fire alarm system within the subject building shall be upgraded to comply with AS 1670.1-2018. Therefore, the existing alarm at the primary building entrance shall be upgraded to incorporate a strobe type visual alarm in accordance with AS 1670.1-2018.

Figure O - Existing Fire Alarm System to be Upgraded to Comply with AS 1670.1-2018.

G4D8 *(G4.9)* **Fire Orders**
The subject building has not been provisioned with Fire Orders in accordance with G4D8 of the BCA. Existing evacuation plans do not detail locations of PFEs and compliant FHRs. It is proposed to install Fire Orders in accordance with G4D8 of the BCA.

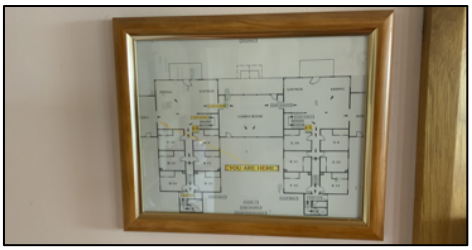


Figure P - Existing Evacuation Plans.

1.0 INTRODUCTION

J² Consulting Engineers have been commissioned to carry out a review of the fire safety provisions associated with the existing Pygmy Possum Lodge located at Charlottes Pass and to develop a master plan outlining the proposed strategies for upgrade to suit current legislative requirements as outlined in the BCA.

Whilst the current BCA was not legislated at the time that the existing development was approved and constructed, the compliance assessment undertaken has been undertaken against the BCA as it represents a community accepted level of life safety. As the building is existing however, there are limitations associated with what upgrades are possible to be undertaken and this report therefore also provides a fire engineering assessment of a number of elements in order to achieve compliance with the Performance Requirements of the BCA. The existing building is located within the Kosciusko National Park of NSW, see figure below.

Figure 1 - Pygmy Possum Lodge Located within the Kosciuszko National Park, Courtesy of Six Maps.

1.1 Basis of the Report

This report is based upon the following:

- Site inspection undertaken 21 October 2021.
- Condition Report (Reference MBM 1094) by Kevin Creed of MBMpl Pty Ltd (MBM) dated 11 May 2016.
- BCA Audit Report (Reference 1094-0001) by Sebastian Dorey and Stuart Brown of MBMpl Pty Ltd (MBM) dated 14 June 2016.
- Architectural drawings by Precision Planning as tabled below.

Title	Reference	Revision/Date
Cover Page – External Finishes and Materials	Project Reference: #220 Drawing No: #220 - 1	DA Issue - 06/06/2023
Site and Site Analysis Detail	Project Reference: #220 Drawing No: #220 - 2	DA Issue - 06/06/2023
Level 1 (ground floor) Floor Plan	Project Reference: #220 Drawing No: #220 - 3	DA Issue - 06/06/2023
Level 2 Floor Plan	Project Reference: #220 Drawing No: #220 - 4	DA Issue - 06/06/2023
Level 3 Floor Plan	Project Reference: #220 Drawing No: #220 - 5	DA Issue - 06/06/2023
West Wing Fire Escape	Project Reference: #220 Drawing No: #220 - 6	DA Issue - 06/06/2023
East Wing Fire Escape	Project Reference: #220 Drawing No: #220 - 7	DA Issue - 06/06/2023
Elevations - North and South and Façade Analysis	Project Reference: #220 Drawing No: #220 - 8	DA Issue - 06/06/2023
Elevations – East and West	Project Reference: #220 Drawing No: #220 - 9	DA Issue - 06/06/2023
Section – 1-1, 2-2	Project Reference: #220 Drawing No: #220 - 10	DA Issue - 06/06/2023
Sections - 3-3, 4-4	Project Reference: #220 Drawing No: #220 - 11	DA Issue - 06/06/2023
Sections – West Wing Fire Escape Detail	Project Reference: #220 Drawing No: #220 - 12	DA Issue - 06/06/2023
Sections – East Wing Fire Escape Detail	Project Reference: #220 Drawing No: #220 - 13	DA Issue - 06/06/2023
Perspectives 3D Renders of Proposal	Project Reference: #220 Drawing No: #220 - 14	DA Issue - 06/06/2023

1.2 Purpose of the Report

This report has been prepared to identify BCA non-compliance fire and life safety issues at the existing building, and to determine the optimum method of addressing each of these compliance issues through either a retrospective upgrade, Performance Solution or a combination of both.

The report also purports to outline the proposed upgrades and provide timelines for upgrade for the purposes of obtaining an agreed master plan with the relevant certifying and fire authorities moving forward.

1.3 Limitations of the Report

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

- 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;
- Any energy efficiency assessment; however, if necessary proposals can be obtained from suitably qualified and accredited assessors.
- Reimbursement of losses caused by business interruption.
- Protection of Property (other than directly adjoining property)
- Fires caused by arson (other than as a potential source of fire initiation) or terrorist attacks.
- Multiple ignition sources for fire initiation.
- Operational checks of the fire safety equipment unless specified in this report.

1.4 Assumptions of the Report

This report provides a Performance Solution for the Deemed-to-Satisfy deviations 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 client and is proposed to be provided to the Department of Planning for review and acceptance prior to implementation of the proposed fire and life safety upgrades. Given that the building is an existing building, a formal Fire Engineering Brief (FEB) has not been developed for this project. The basis of the solution was discussed with all stakeholders via a meeting.

2.1 Relevant Stakeholders

Stakeholder/Role	Name
Client	Elouera Ski Club – Jon Barber
Certifying Authority	TBC
Building Designers	Precision Planning – Daniel Sutton
Fire Engineer	J² Consulting Engineers – James Alexander

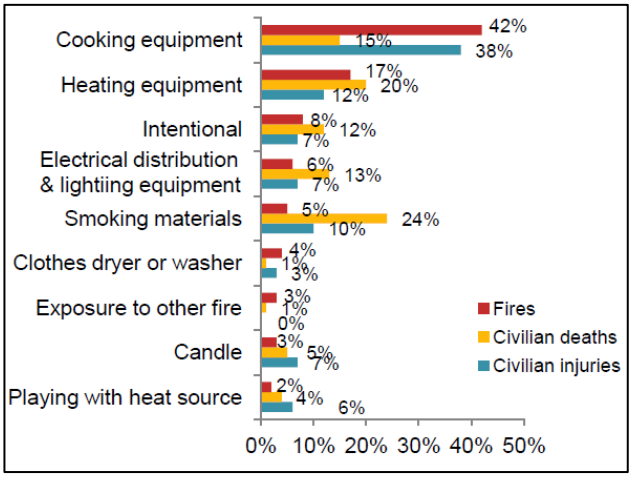
2.2 Building and Occupant Characteristics

General Building Characteristics

Building Characteristic	Description
Occupancy/Use Building Class/es: Rise in Storeys Type of construction: Effective Height:	Ski Club holiday accommodation Class 3 3 Type A Approximately 4.2m
Location: General description of development:	Pygmy Possum - Charlottes Pass Ski Resort – Kosciuszko National Park The building has three storeys and has an expected occupancy rate of 56 people based on 28 SOUs contained within the building. The floor area of each level is equal with a combined total less than 500m². The building has egress from all levels directly to open space or onto external ramps and stairs leading to open space. Spencer Creek Road is readily accessible from the open space however, occupants are required to navigate through the bush to reach the road. The ground floor, which is a ski and food store area, has been constructed of masonry blockwork with a bondex slab over. Concrete slabs are used throughout the building however, the roof structure, internal and external walls consist of timber frames thereby relying on the installation of fire-resistant linings to achieve a fire resistance level to the upper two levels.

Occupant Characteristics

Occupant Characteristic	Description
Type and number	The lodge is expected to sleep 56 persons this has been established based upon 2 people per SOU. It is unlikely that the subject building will exceed this number.

Occupant Characteristic	Description
Occupant state	Building occupants may be awake or asleep, intoxicated, sober or under the influence of other inhibiting substances consistent with community expectation.
Physical and mental attributes	Occupants would generally be mobile given the nature of the building and surrounding access to the road, however some occupants may be of limited mobility. This is unlikely given access to the lodge requires a person to descend uneven ground to the entry and stairs within the lodge to the sleeping accommodation, kitchen and dining areas. Children and mobility impaired persons are likely to be cared for by parents, relatives or friends. It is also expected that other mobile occupants or club members may be able to assist in the event of a fire.
Training and Roles	It is not expected that building occupants would be subject to any training specific to this building however once occupants have reached the door of their SOU, they are essentially in an open balcony with direct access to open space. Fire orders shall be posted on each level providing information relating the exits and fire safety systems.
Hazards	The primary fire hazards within the building would be consistent with those from typical residential dwellings given that the building is a Class 3, typically consisting of fires eventuating from cooking, electrical faults, heating equipment, saunas or smoking. Refer image below from the National Fire Protection Association in the USA (Ahrens 2011).  **Figure 2 - Major Causes of US Home Structure Fires 2006-2010 (Ahrens 2011)**

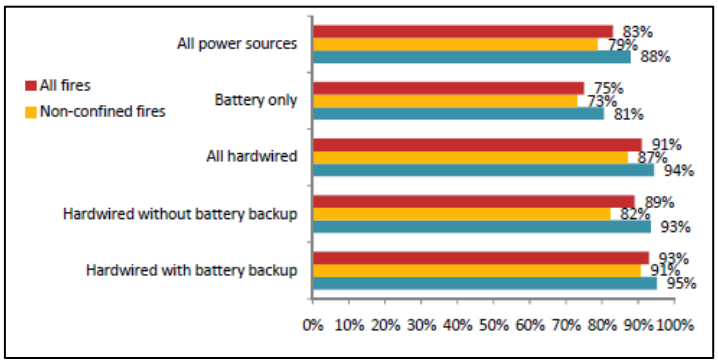
2.3 Hazards, Preventative and Protective Measures Available

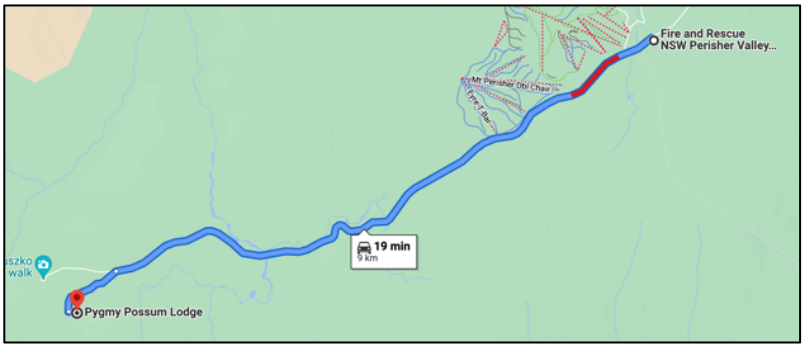
The following hazards have been identified.

Hazard	Details/Precaution
General Layout and Design	The subject building incorporates a non-fire-isolated stairway which connects all three storeys however, the installation of an AS2118.4-2012 sprinkler system and the provisions of exits on each storey which discharge directly to open space offset this issue.
Activities	Information is not available to suggest that activities outside those normally undertaken in a similar building will be undertaken. The subject building provides self-care cooking, dining, sleeping and storage facilities to the occupants. It is expected that occupants of the building

Hazard	Details/Precaution
	would be more familiar with their surroundings when compared to a standard Class 3 boarding house or hotel.
Cooking	The lodge provides two large self-care kitchens, one to each wing, which present as a primary fire hazard to the subject building. However, the inclusion of AS2118.4-2012 sprinkler system to the surrounding area and the incorporation of portable fire extinguishers shall reduce the hazard.
Smoking	Smoking is strictly not permitted within the building.
Electrical Equipment	Failure of heating and other electrical equipment present as another primary hazard to the building.
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 expected to be in excess of a typical Class 3 Ski Lodge building constructed at a similar time period. The proposal to install a AS2118.4-2012 sprinkler system shall provide a higher degree of control to any fire event originating within the building.
B Smoke development, spread and control	Smoke development and spread will not be inconsistent with that of a normal Class 3 Ski Lodge.
C Fire spread, impact and control	SOUs are provided with bounding construction which does not appear to achieve current BCA requirements. The intention behind the fire safety strategy is to ensure that occupants all evacuate simultaneously in the event of a fire through activation of the building occupant warning system designed to arouse sleeping occupants.
D Fire detection, warning and suppression	The building is provided with an AS1670.1 smoke detection and alarm system to provide occupant warning throughout the building configured to awake sleeping occupants. Little data is available on the reliability of smoke detectors however residential smoke alarms are considered to be reliable when they are properly maintained. Research indicates that the smoke alarm system has a reliability in the order of 93% for contained fires as per the figure below (Ahrens 2010). It is expected that the smoke detection system would have further increases in reliability.  **Figure 3 - Smoke Alarm Operation in Reported Home Fires 2003-2006 (Ahrens 2010).**

Sub-System	Present in Building/Requirements
E Occupant evacuation and control	Each level of the building is provided with two exits. The exits are linked by external balconies and stairs to both to the north and south. All SOUs (level 2) have additional exits directly outside on to external decks with stairs to open space. Level 2 kitchen and dining has an additional exit to external stairs on the western side of the building.
F Fire services intervention	The building is served by a retained fire brigade during the off-season and a full-time station at Perisher during the ski season. The fire station is located within 8.9km of the building. Notably, during the winter months access to Charlotte Pass is restricted to over snow vehicles which shall significantly increase the arrival of the attending fire brigade. Given that conditions may vary an exact response time to arrive at Pygmy Possum Lodge cannot be given however, it is expected that the travel time shall exceed 45 minutes.  **Figure 4 - Pygmy Possum Lodge 9km from Perisher Fire and Rescue Station.**

*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	• Fire resistive barriers • Fire resistive structural elements • Fire resistive services • Exposure protection	
Sub-system D Fire Detection, Warning and Suppression	• Automatic detection equipment • Automatic warning equipment • Surveillance equipment • Automatic suppression equipment • Manual suppression equipment	
Sub-system E Occupant Evacuation and Control	• Evacuation plans • Egress signage • Egress routes (including fire isolated elements)	

3.0 BCA COMPLIANCE REVIEW

The following assessment against current BCA provisions has been undertaken with any non-compliances listed and the proposed strategy for upgrade noted.

BCA Clause	Assessment	Status	Proposed Method of Upgrade
C2D10 *C1.9*	**Non- Combustible building elements** The following non-compliances were identified with the existing building elements throughout the subject building. • External walls to the first and second floor including all components incorporated in them and the façade covering, framing and insulation to be non-combustible The subject building incorporates combustible external walls including timber frame, combustible insulation and timber external cladding.	Non-compliant	Existing combustible cladding is to be replaced with a non-combustible metal sheeting. The inclusion of non-combustible sheeting shall prevent the spread of fire in an upwards manner.
C2D11 C1.10	**Fire hazard properties** The existing fibreglass prefabricated bathroom pods contain a polymer based resin which the BCA considers to be combustible. Due to the combustible nature of the fibreglass material, there is potential that the fire will spread from the ensuite to the rest of the SOU assisted by the combustibility of the fibreglass shell. The shell may deform preventing the sprinkler spray from providing coverage to the fire point of origin.	Non-compliant	A Performance Solution has been sought to address this DTS non-compliance. Installation of wall mounted sprinkler head to each ensuite associated with an SOU.
C3D7 *C2.6*	**Vertical Separation of openings in external walls** Distance from openings on adjoining levels has been measured as less than 900mm and no vertical projection has been incorporated into the design. Subsequently, the existing vertical separation does not comply with the DtS requirements of C3D7.  **Figure 5 - Vertical Separation between Openings in the External Wall of the Building.**	Non-compliant	A Performance Solution has been sought to address this DTS non-compliance. The installation of an AS2118.4-2012 compliant sprinkler system throughout the building shall prevent the spread of fire between storeys via the subject openings.
C4D3 *C3.2*	**Protection of Openings** The location of the allotment boundaries is not known. Adjacent buildings are located at a distance of more than 6m and therefore potential for spread of fire between openings is deemed to be acceptable by comparison to that permitted under C4D3.	Compliant	No upgrade required.

C4D12 *C3.11*	**(a) Bounding construction - Doorsets** The doors serving the SOUs throughout the building which are fitted with self-closing solid core doors whereas the BCA requires fire resistant door sets to SOUs in Type A construction.  **Figure 6 - Self-closing Solid Core Doors Existing Throughout the Building.**	Non-compliant	The installation of an AS2118.4-2012 compliant sprinkler system throughout the building shall prevent the spread of fire between SOUs. This is considered sufficient to offset the requirement for fire resistant door sets to SOUs.
	(b) Bounding construction – Exhaust Fan Penetrations The duct box of the exhaust fan within the SOU is constructed of PVC and penetrates the exiting double layer of fire-resistant plasterboard.  **Figure 7 - Existing Exhaust Fan Duct Box Penetrates SOU Ceiling.**	Non-compliant	All SOU exhaust fans are to be either directly connected to the atmosphere by way of a non-combustible pipe/bulkhead, or an intumescent damper is to be installed to replace the existing exhaust fan. Either option can be used depending on the requirements of the exhaust fan locations.
	(c) Bounding construction - Door sets to Quiet Lounge The existing Quiet Lounge door does not satisfy the requirements of C4D12 given that the door incorporates a glazed panel and is not a fire-resistant door set. Given that the solid core door has a glass panel it is expected that this will fail before the solid core door permitting smoke and fire to spread throughout the storey. In this regard, the proposed sprinkler system cannot be solely relied upon toi prevent fire spread.	Non-compliant	Replace existing glass door with a fire-resistant door set, minimum FRL 90/90/90, in accordance with C4D12 of the BCA.

	 **Figure 8 - Doorway Leading to Public Corridor from Lounge.**		
C4D13 *C3.12*	**Openings in Floors and Ceilings for Services** PVC pipe penetrations through first floor slab have not been installed with a shaft complying with Specification 5.  **Figure 9 - PVC Penetrations through Floors and Ceilings.**	Non-compliant	Deemed to satisfy approach proposed. Retro fit fire-resistant collars as to maintain the fire resistance level of the ceiling.
Spec 5	**Specification 5 Fire-resisting Construction** The enclosed concrete deck on ground floor incorporates what appears to be exposed structural steel hollow sections which have not been treated/cladding with a fire-resistant material. Subsequently, the structural adequacy of the columns shall not achieve the required FRL of 90/-/- as per Specification 5.	Non-compliance to be confirmed by engineer	Confirmation to be provided from structural engineer that the existing steel is no longer engaged as a structural element. Should the columns be structural fire-resistant plasterboard should be installed to achieve a FRL of 90/-/-.
Spec 5	**Ceilings with a resistance to insipient spread** The bathrooms comprise of fibreglass pods. The ceilings therefore do not achieve a resistance to insipient spread of fire for 60 minutes.	Non-compliant	A Performance Solution has been sought to address this DTS non-compliance. The installation of an AS2118.4-2012 compliant sprinkler system with sprinkler heads in the wet areas is the main offset measures to prevent fire spread.
D2D3 *D1.2*	**Number of Exits** Currently, egress via the exit doors at the rear of each wing on Level 2 have had egress restricted due to unsafe conditions outside the exit.	Note	Deemed to satisfy approach proposed. A new exit shall be installed at the rear of each wing

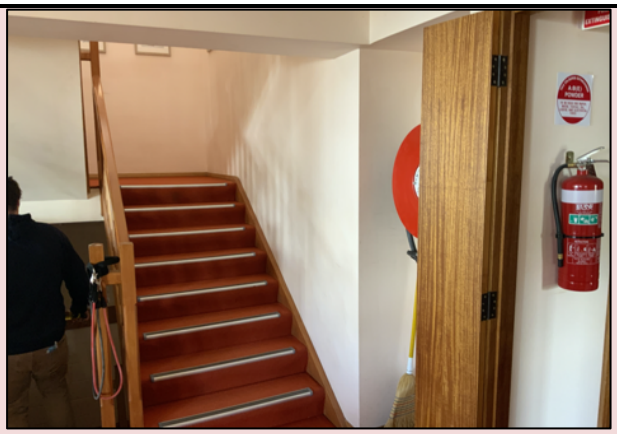
	 **Figure 10 – Existing exit Doors on Level 2.** Exit signage to be reinstalled as to identify the available exits to the egressing occupants.		on Level 2. The new exits shall be installed with covered exit porticos which will provide protection against the build-up of snow. This will ensure adequate widths and heights shall be maintained within the evacuation route in close proximity to the building. The new exit signs shall be installed with exit signage designed and operated in accordance with AS/NZS 2293.1-2018.
D2D4 *D2D4*	**When fire isolated stairways and ramps are required** In a Class 3 building every stairway serving as a required exit must be fire isolated if passing through more than 2 consecutive storeys. In this instance, the subject building incorporates a non-fire isolated stairway which connects three storeys thereby, being non-compliant with D2D4 of the BCA.	Non-Compliant	A Performance Solution can be arranged to address this non-compliance. The Performance Solution shall require the installation of an AS2118.4-2012 sprinkler system throughout the upper two residential storeys inclusive of stairways, fire-resistant glazed panel to the non-fire-isolated stairway doors at ground level and Kilargo medium temperature smoke seals to all four sides of the doors leading from the non-fire-isolated stair to public corridors associated with SOUs.
D2D7 *D1.6*	**Dimensions of exit and paths of travel** Exit widths within the non-fire-isolated stairways do not achieve a minimum of 1m being measured as 970mm. Notably, the inclusion of an additional handrail shall exacerbate this issue further.	Non-compliance	A Performance Solution can be arranged to address this non-compliance. The Performance Solution details that the reduced exit widths are considered to be sufficient to allow occupant egress. Therefore, addition fire safety measures shall not be required to address this DTS non-compliance.

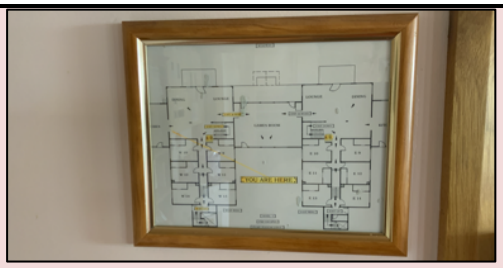
	 **Figure 11 - Unobstructed width of 970mm between Existing Handrail and Wall.**		
D2D9 *D2D12*	**Travel via fire-isolated exits** Each fire-isolated stairway must provide independent egress from each storey served and discharge to a road or open space. In this instance, the internal fire-isolated stairways, central to each wing, discharges within the lowest floor of the building therefore not providing independent egress from each storey to open space or a road.	Non-compliance	A Performance Solution can be arranged to address this non-compliance. The Performance Solution shall require the installation of an AS2118.4-2012 sprinkler system throughout the upper two residential storeys inclusive of stairways, fire-resistant glazed panel to the non-fire-isolated stairway doors at ground level and Kilargo medium temperature smoke seals to all four sides of the doors leading from the non-fire-isolated stair to public corridors associated with SOUs.
D3D8 *D2.7*	**Installations in Exits and Paths of Travel** The dining and lounge areas of both wings incorporates electricity meters, distribution boards or ducts. The path of travel from the building requires occupants to pass by the dining and lounge areas thereby, being non-compliant with D3D8 of the BCA.  **Figure 12 - Installations in Exits and Paths of Travel.**	Non-compliance	Deemed to satisfy approach proposed. Install an enclosing non-combustible construction or a fire-protective covering with openings suitably sealed against smoke spreading from the enclosure.

D3D14 *D3D14*	**Goings and Risers** The base of the non-fire-isolated stairway on Level 2 of the building incorporates winders in lieu of a landing.  **Figure 13 - Winders in Lieu of a Landing have been Incorporated to a Required Exit Stair.**	Non-compliance	A Performance Solution can be arranged to address this non-compliance. It is proposed to retain the existing winders subject to the installation of textured contrast strips at the end of each winder and the installation of signage which states "CAUTION WATCH YOUR STEP" in letters no less than 50mm in height and in a colour contrasting to the background, see figure below.  **Figure 14 - Textured Contrast Strips and Signage to be Installed to the Stair.**
D3D17 *D2.16*	**Barriers to prevent falls** Internal stair balustrade has been measured as 825mm in height in lieu of the required 865mm thereby, the existing balustrades to not comply with D3D17.  **Figure 15 - Internal Stair Balustrades do not Achieve Height Requirement of 865mm.** Existing external balustrades to balconies and elevated walkways do not comply with the requirements of D3D17. Balcony barriers to be raised as to achieve a minimum height of 1m when measured from ground level. Continuous barriers associated with trafficable surfaces 1m above surface beneath shall not allow a 125mm sphere to pass through any open and shall not incorporate any horizontal or near horizontal elements between 150mm and 760mm above the floor as to not facilitate climbing.	Non-Compliance	Deemed to Satisfy approach proposed. Existing barriers to be upgraded to be in accordance with D3D17 of the BCA.

	 Figure 16 - Non-compliant Balustrades to Balconies and Elevated Walkways.		
D3D26 *D2.21*	**Operation of Latch** The doors serving as required exits do not have lever handle latches and are not considered to be readily openable from the inside by a single hand downward action.  Figure 17 - Exit Doors have not been Fitted with Compliant Door Fittings.	Non-Compliance	Deemed to Satisfy approach proposed. Existing door latches fitted to exit doors shall be replaced with lever type which are openable from the inside by a single hand downward action.
E1D2 & G4D7 *E1.3 & G4.8*	**Fire Hydrants** Fire hydrant coverage is required and provided from Kosciuszko National Park hydrant system.	CP/ NPWS street hydrant system	Compliance certification confirming that the pressures and flows of the existing hydrant system are sufficient to achieve the required flow of 10 L/s at pressure of 250 kPa as required by AS2419.1-2021.
E1D3 & G4D7 *E1.4 & G4.8*	**Fire Hose Reels** Fire hose reels have been installed throughout the building in accordance with past versions of the BCA. Notably, the fire hoses reels, in some instances, are not located within 4m of an exit.	Note	Deemed to Satisfy approach proposed. Decommission fire hose reels which are not located within 4m of exit

	Notably, the current BCA does not require the installation of fire hose reels however, their installation does impact upon the occupant life safety within the building.		doors. Replace subject fire hose reels with applicable portable fire extinguishers in accordance with AS 2444-2011.
E1D14 *E1.6*	**Portable Fire Extinguishers** Portable fire extinguishers must be provided as listed in E1D14. In this instance, the location of extinguishers is not in accordance with AS 2444-2001.  **Figure 18 - Non-compliant Portable Fire Extinguishers throughout the Building.**	Non-compliance	Deemed to satisfy approach proposed. Existing and proposed portable fire extinguishers shall be installed, selected and located in accordance with AS 2444-2001.
E2D3 & G4D7 *E2.2 & G4.8*	**Smoke Detection and Alarms** The building is currently fitted with a smoke detection system Additions to the system will be required to ensure compliance with BCA Spec 2.2a Certification to be provided.	Non-Compliance	Upgrade proposed to satisfy the requirements of the Performance Solution. Certification to be provided.
E4D2 *E4.2*	**Emergency Lighting Requirements** Emergency lighting to external exit stairs is not present thereby deviating from the DtS requirements of E4D2.  **Figure 19 - External Emergency Lighting is not Present.** The existing emergency lighting system is outdated and does not provide sufficient lighting throughout the building to allow the safe evacuation of occupants during a fire event.	Non-compliance	Deem to satisfy approach proposed. Install additional compliant lighting to the front entrance area. Install emergency lighting to the building in accordance with AS/NZS 2293.1-2018 and E4.2 of the BCA.
E4D5 *E4.5*	**Exit Signs** Exit signage shall be installed to the reinstated exit doors on level 2 of the subject building.	Non-compliance	Deemed to satisfy approach proposed. Install exit signage as per E4D5.
F5D2 *F3.1*	**Height of Rooms and Other Spaces** The floor to ceiling heights within the internal stairs does not achieve the minimum height of 2m being measured as 1950mm.	Non-compliance	Deemed to satisfy approach proposed. Increase head height over final nosing of stair flight

	 **Figure 20 - Floor to Ceiling Heights within Internal Stairs do not Achieve 2m.**		to achieve minimum 2m height.
G4D3 *G4.3*	**External doors** Existing external doors throughout the subject building which are subject to the building up of snow and open inwards shall be marked "OPEN INWARDS" on the inside face of the door in letters not less than 75mm high in a colour contrasting with the background.  **Figure 21 - Primary Entrance to have "OPEN INWARDS" Signage Installed.**	Non-compliance	Deemed to satisfy approached proposed. Install signage stating "OPEN INWARDS" on the inside face of the door in letters not less than 75mm high in a colour contrasting with the background.
G4D7 *G4.8*	**Fire-fighting Services and Equipment** The existing fire alarm system within the subject building shall be upgraded to comply with AS 1670.1-2018. Therefore, the existing alarm at the primary building entrance shall be upgraded to incorporate a strobe type visual alarm.  **Figure 22 - Existing Fire Alarm System to be Upgraded to Comply with AS 1670.1-2018.**	Non-compliance	Deemed to satisfy approach proposed. Install external strobe to primary building entrance façade.
G4D8 *G4.9*	**Fire Orders** The subject building has not been provisioned with Fire Orders in accordance with G4D8 of the BCA. Existing evacuation plans do not detail locations of PFEs and FHRs.	Non-compliance	Deemed to satisfy approach proposed. Install fire orders throughout the building

	 **Figure 23 - Existing Evacuation Plans.** Fire orders to be located at FIP near primary entrance to building.  **Figure 24 - Fire Indicator Panel at Primary Entrance to Subject Building.**		in accordance with G4D8 of the BCA.

4.0 PERFORMANCE SOLUTION 1 – FIRE RESISTANCE

It is proposed to develop a Performance Solution to permit the following non-compliances:

- To allow the external walls to the first and second floor to incorporate combustible building elements in contravention with the requirements of C2D10 of the BCA. In addition to this, the external walls do not achieve FRL 90/60/30 as required by Specification 5.
- To allow the vertical separation of openings in external walls to be less than 900mm without the incorporation of a fire-resistant horizontal projection in contravention with the requirements of C3D7 of the BCA.
- The enclosed concrete deck on ground floor and the first-floor veranda incorporates what appears to be exposed structural RHS columns which have not been treated/cladding with a fire-resistant material. Subsequently, the structural adequacy of the columns shall not achieve the required FRL of 90/-/- as per Specification 5.

4.1 Deemed-to-Satisfy Non-compliance

Pursuant to A2G2(1) of BCA the following DTS provisions have been identified as being subject to the Performance Solution:

C2D10 Non-combustible building elements

(1) In a building required to be of Type A or B construction, the following building elements and their components must be non-combustible:
- *(a) External walls and common walls, including all components incorporated in them including the facade covering, framing and insulation.*
- *(b) The flooring and floor framing of lift pits.*
- *(c) Non-loadbearing internal walls where they are required to be fire-resisting.*

(2) A shaft, being a lift, ventilating, pipe, garbage, or similar shaft that is not for the discharge of hot products of combustion, that is non-loadbearing, must be of non-combustible construction in—
- *(a) a building required to be of Type A construction; and*
- *(b) a building required to be of Type B construction, subject to C3D11, in—*
  - *(i) a Class 2, 3 or 9 building; and*
  - *(ii) a Class 5, 6, 7 or 8 building if the shaft connects more than 2 storeys.*

(3) A loadbearing internal wall and a loadbearing fire wall, including those that are part of a loadbearing shaft, must comply with Specification 5.

(4) The requirements of (a) and (b) do not apply to the following:
- *(a) Gaskets.*
- *(b) Caulking.*
- *(c) Sealants.*
- *(d) Termite management systems.*
- *(e) Glass, including laminated glass.*
- *(f) Thermal breaks associated with—*
  - *(i) glazing systems; or*
  - *(ii) external wall systems, where the thermal breaks—*
    - *(A) are no larger than necessary to achieve thermal objectives; and*
    - *(B) do not extend beyond one storey; and*
    - *(C) do not extend beyond one fire compartment.*
- *(g) Damp-proof courses.*
- *(h) Compressible fillers and backing materials, including those associated with articulation joints, closing gaps not wider than 50 mm.*
- *(i) Isolated—*
  - *(i) construction packers and shims; or*
  - *(ii) blocking for fixing fixtures; or*
  - *(iii) fixings, including fixing accessories; or*
  - *(iv) acoustic mounts.*
- *(j) Waterproofing materials applied to the external face, used below ground level and up to 250 mm above ground level.*
- *(k) Joint trims and joint reinforcing tape and mesh of a width not greater than 50 mm.*

(l) *Weather sealing materials, applied to gaps not wider than 50 mm, used within and between concrete elements.*
(m) *Wall ties and other masonry components complying with AS 2699 Part 1 and Part 3 as appropriate and associated with masonry wall construction.*
(n) *Reinforcing bars and associated minor elements that are wholly or predominately encased in concrete or grout.*
(o) *A paint, lacquer or a similar finish or coating.*
(p) *Adhesives, including tapes, associated with stiffeners for cladding systems.*
(q) *Fire-protective materials and components required for the protection of penetrations.*

(5) *The following materials, when entirely composed of itself, are non-combustible and may be used wherever a non-combustible material is required:*
(a) *Concrete.*
(b) *Steel, including metallic coated steel.*
(c) *Masonry, including mortar.*
(d) *Aluminium, including aluminium alloy.*
(e) *Autoclaved aerated concrete, including mortar.*
(f) *Iron.*
(g) *Terracotta.*
(h) *Porcelain.*
(i) *Ceramic.*
(j) *Natural stone.*
(k) *Copper.*
(l) *Zinc.*
(m) *Lead.*
(n) *Bronze.*
(o) *Brass.*

(6) *The following materials may be used wherever a non-combustible material is required:*
(a) *Plasterboard.*
(b) *Perforated gypsum lath with a normal paper finish.*
(c) *Fibrous-plaster sheet.*
(d) *Fibre-reinforced cement sheeting. Pre-finished metal sheeting having a combustible surface finish not exceeding 1 mm thickness and where the Spread-of-Flame Index of the product is not greater than 0.*
(f) *Sarking-type materials that do not exceed 1 mm in thickness and have a Flammability Index not greater than 5.*
(g) *Bonded laminated materials where—*
(i) *each lamina, including any core, is non-combustible; and*
(ii) *each adhesive layer does not exceed 1 mm in thickness and the total thickness of the adhesive layers does not exceed 2 mm; and*
(iii) *the Spread-of-Flame Index and the Smoke-Developed Index of the bonded laminated material as whole do not exceed 0 and 3 respectively; and*
(iv) *when located externally, are fixed in accordance with C2D15.*

C3D7 Vertical separation of openings in external walls

(1) *If in a building of Type A construction, any part of a window or other opening in an external wall is above another opening in the storey next below and its vertical projection falls no further than 450 mm outside the lower opening (measured horizontally), the openings must be separated by—*
(a) *a spandrel which—*
(i) *is not less than 900 mm in height; and*
(ii) *extends not less than 600 mm above the upper surface of the intervening floor; and*
(iii) *is of non-combustible material having an FRL of not less than 60/60/60; or*
(b) *part of a curtain wall or panel wall that complies with (i); or*
(c) *construction that complies with (i) behind a curtain wall or panel wall and has any gaps packed with a non-combustible material that will withstand thermal expansion and structural movement of the walling without the loss of seal against fire and smoke; or*
(d) *a slab or other horizontal construction that—*
(i) *projects outwards from the external face of the wall not less than 1100 mm; and*
(ii) *extends along the wall not less than 450 mm beyond the openings concerned; and*

(iii) is non-combustible and has an FRL of not less than 60/60/60.

(2) The requirements of (a) do not apply to—

(a) an open-deck carpark; or

(b) an open spectator stand; or

(c) a building which has a sprinkler system (other than a AS2118.4-2012 or FPAA101H system) complying with Specification 17 installed throughout; or

(d) openings within the same stairway; or

(e) openings in external walls where the floor separating the storeys does not require an FRL with respect to integrity and insulation.

(3) For the purposes of C3D7, window or other opening means that part of the external wall of a building that does not have an FRL of 60/60/60 or greater.

Specification 5 Type A Construction: FRL of Building Elements

Tables S5C11a-S5C11g of Spec 5	Fire Resistance Level Type A		Comments
Building Element	Class 2, 3 & 4 parts	Class 7b or 8	
EXTERNAL WALL (distance to fire source feature)			
For loadbearing parts-			
Less than 1.5m	90/90/90	NA	NA
1.5 to less than 3m	90/60/30	NA	NA
3m or more	90/60/30	NA	**X – External walls consists of combustible insulation and framing.**
For non-loadbearing parts -			
Less than 1.5m	-/90/90	NA	NA
1.5 to less than 3m	-/60/60	NA	NA
3m or more	-/-/-	NA	**ü**
EXTERNAL COLUMN (not incorporated in external wall)			
For loadbearing columns	90/-/-	NA	**X – Internal steel columns to balcony structure do not achieve required FRL of 90/-/-**
For non-loadbearing column	-/-/-	NA	**ü**
COMMON WALLS & FIRE WALLS	90/90/90	NA	NA No fire walls
INTERNAL WALLS			
Fire resisting lift and stair shafts			
Load bearing	90/90/90	NA	
Non-loadbearing	-/90/90	NA	
Internal walls bounding public corridors and the like:			
Loadbearing	90/90/90	NA	**ü**
Non-loadbearing	-/90/90	NA	
between or bounding sole occupancy units			
Loadbearing	90/90/90	NA	**ü**
Non-loadbearing	-/60/60	NA	
FLOORS	90/90/90	NA	**ü**
ROOF	90/60/30	NA	**ü - S5C15**

4.2 Relevant Performance Requirements

Pursuant to A2G2(c) of BCA the following Performance Requirements have been identified as being directly relevant to the DTS provisions identified above:

C1P1 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

C1P2 Spread of fire

(1) A building must have elements which will, to the degree necessary, avoid the spread of fire—
- *(a) to exits; and*
- *(bi) to sole-occupancy units and public corridors; and*
- *(c) between buildings; and*
- *(d) in a building.*

(2) Avoidance of the spread of fire referred to in (a) must be 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 number of storeys in 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.*

C1P4 Safe conditions for evacuation

To maintain tenable conditions during occupant evacuation, a material and an assembly must, to the degree necessary, resist the spread of fire and limit the generation of smoke and heat, and any toxic gases likely to be produced, appropriate to-

(a) the evacuation time; and
(b) the number, mobility and other characteristics of occupants; and
(c) the function or use of the building; and
(d) any active fire safety systems installed in the building.

4.3 Assessment Methodology

In order to address the provisions of the BCA, a qualitative, deterministic and absolute assessment will be undertaken to determine compliance with the relevant Performance Requirements C1P1, C1P2 and C1P4. 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 Requirements C1P1, C1P2 and C1P4.

4.4 Acceptance Criteria

It must be demonstrated that the proposed trial design reduces the potential for;

- fire spread within the building;
- the impact of a fire on the structure; and
- the impact of fire on the tenability of paths of travel to exits,

to a level considered acceptable to satisfy the relevant Performance Requirements C1P1, C1P2 and C1P4.

4.5 Qualitative Assessment

Performance requirements C1P1 and C1P2 are generally related to ensuring that a building has appropriate elements, to the degree necessary, to restrict the spread of fire within the building and to prevent progressive collapse due to the failure of structural elements.

With respect to the use of the term "to the degree necessary" in Performance Requirements C1P1 and C1P2 the Guide to the BCA states the following:

C1P1 and C1P2 use the term "to the degree necessary". This word usage is designed to provide flexibility in the way this provision is implemented. The intended meaning of the term "to the degree necessary" in C1P1 and other Performance Requirements, is explained in A1.7.

It means that the BCA recognises that different building elements require differing degrees of structural stability during a fire. The expression is intended to allow the appropriate authority to determine the degree of compliance necessary in each particular case.

Any decision made in this context can extend to not requiring an item to be installed or a particular level of performance to be achieved, if that is the appropriate action to be taken.

1) Fire Spread Throughout the Building and to Adjoining Buildings

It was identified that the external walls on the ground, first and second floors of the subject building contain combustible elements. The BCA requires that for Type A construction that the external walls be composed of non-combustible building elements and achieve a fire resistance of no less than FRL 90/60/30.

Figure 25 - Existing External Walls Consist of Combustible Elements.

The intention of requiring a fire resistance level to both sides of the external wall is to ensure that a fire within and a fire on an adjoining building does not readily spread to the subject building. Notably, the closest adjoining building to the subject building is located a minimum of 21m.

Should a flashover event occur resulting in the entire adjoining building forming part of the fire scenario the radiant heat received by a 1000°C fire would not be sufficient to cause piloted ignition from airborne embers therefore, fire spread in this manner is deemed to be improbable. Subsequently, a fully developed fire within the subject building would require a similar degree of radiant heat to the adjoining building resulting in fire spread in this manner being improbable.

In light of the above, the inclusion of fire-resistant external walls shall assist with isolating a fire event in a residential type building by containing the fire to a single Sole-occupancy unit (SOU) for a specified period generally being 60 or 90 minutes. By omitting the fire resistance level, the fire event may breach the SOU spreading throughout the building by way of the external combustible cladding or internals. Subsequently, a fire event shall spread more readily throughout the origin storey and those located above resulting in a reduced degree of occupant life safety throughout the building.

Sprinkler Protection
As an alternative to the above proposed passive fire resisting construction stated in point 1, it is a reasonable option to install a residential sprinkler system throughout all levels in accordance with AS2118.4-2012. The reliability (refer Appendix A) of sprinkler systems and ability to control and/or extinguish a fire in its early growth stage will offset against the potential for fire spread throughout the building associated with the non-compliant fire resistance levels to the external walls.

The AS2118.4-2012 sprinkler system would be required to be installed to Levels 2 and 3, being the residential classifications, of the subject building. A fire within these parts of the building would be suppressed by the activation of the sprinkler system and would be contained to the storey of origin for a minimum period of 90 minutes. Sprinkler protection is considered to not be required to the ground floor given that the existing construction consists of masonry block work and concrete slab over resulting in a minimum fire resistance level of 90 minutes. Additionally, the upper two storeys are provisioned with two exits from each storey therefore, occupants shall not be required to egress via the ground floor should the point of origin be on the ground floor.

Notably, the majority of the external combustible cladding is to be removed and replaced with a non-combustible cladding being Klip Lok metal sheeting. The installation of this system satisfies the DTS requirements of C2D10 with regards to combustibility of the external cladding however, the internal frame and insulation remain combustible.

2) Vertical Separation of Openings in External Walls
The omission of compliant vertical separation shall promote the spread of fire from the first to the second floor should the fire event occur within the affected SOUs. The inclusion of the combustible external walls shall further exacerbate this arrangement resulting in fire spreading via the façade of the building, see figure below.

Figure 26 - Non-compliant Vertical Separation of Openings in External Walls.

Sprinkler Protection
The installation of the AS2118.4-2012 sprinkler system, as discussed above, shall control and/or extinguish a fire in its early growth stage will offset against the potential for fire spread throughout the building associated with the omission of the vertical separation between openings in external walls.

Fire & Rescue NSW have undertaken research into the suitability of the FPAA101D sprinkler system in residential type building with results focusing upon temperature and toxicity. The results of the fire tests indicated that the peak temperature achieved was 372°C well below the lower temperature rages, being 500°C, for flashover conditions to occur and that in most cases the operation of only two sprinkler heads was sufficient to prevent the fire event from spreading from the point of origin (F&R NSW, 2017). Considering the above, a fire event contained within the sprinkler protected part of the building would not achieve flashover and the fire event would be isolated to its origin or may be extinguished. It is expected that the proposed AS2118.4-2012 sprinkler system shall outperform the FPAA101D system given that the AS2118.4-2012 has more comprehensive requirements than the FPAA101D system.

Therefore, should a fire event occur within a AS2118.4-2012 sprinkler protected building the fire would be contained to the point of origin. Further to this, the existing internal non-combustible plasterboard shall assist in preventing the fire interacting with the combustible elements of the external walls and

spread via the façade. Subsequently, the installation of the AS2118.4-2012 sprinkler system throughout Level 2 and 3 shall satisfy the relevant Performance Requirements C1P1, C1P2 and C1P4.

Ground Floor Fuel Load
The ground floor of the building is considered to be a Class 7b storage given the food, maintenance and ski stores on this level. The area used for storage is limited to less than 50% of the floor given the ground floor incorporates the main entrance to the building as well as multiple staircases therefore, a large portion of the floor is reserved for circulation space for occupants.

Additionally, the use as a storage results in the use being considered as a non-habitable space therefore, the provision of natural light is not required. Due to this the Ground Floor is primary provisioned with openings to the main entrance and the storerooms are not served with openings.

In the event of a fire within the storerooms the fuel load is expected to be considerably lower than that of a typical Class 7b building used primarily for storage with the same floor area due to the circulation space. It is noted that floor area of the Ground Floor is well within the floor area and volume limitations permitted by Table C3D3 being 5,000m^2 and 30,000m^3 of the BCA. In this regard the storage rooms are considered to be small according to Table C3D3 and have a fuel load which is consistent with storage rooms which are appurtenant to a typical Class 3 building.

Further to this, the omission of window openings to the storage areas on the ground floor shall also limit the oxygen supply to any fire event to oxygen being provided by the gaps around the internal door openings. Therefore, the fire would likely to develop more slowly due to be being oxygen starved and the considerable low fuel load within the storage area when compared to a DTS compliant Class 7b building.

In this regard, the existing Bondek slab and proposed fire collars to penetrations in the slab shall ensure a minimum fire resistance level of 90 minutes as required by Specification 5 shall be achieved. The small storage areas on the ground floor shall not increase the risk to occupant life safety when compared to a DTS compliant Class 7b building with a DTS permissible floor area and volume.

This upgrade strategy report does not require the installation of sprinklers to Level 1 however, the report does not prevent the sprinkler system being extended to Level 1 of the building should this be arranged by the client.

3) Non-Fire Rated Structural Steel Columns Ground and First Floor

<u>Ground and First Floor Columns</u>
Table S5C11g of Specification 5 requires that internal loadbearing columns achieve a FRL of 90/-/-. Notably, the structural adequacy component of the FRL relates to the ability of the building elements to maintain stability and adequate loadbearing capacity as determined in accordance with AS 1530.4. In this instance, the building element is a simple square hollow section which is not expected to achieve the required FRL.

The non-fire rated structural steel columns on the Ground and First Floor provide support to the floors and roof structure located above therefore, should a fire event occur the integrity of the steel columns shall be impacted potentially resulting in the structural collapse of the floors above. Notably, structural collapse throughout the building shall have tangible impacts to the spread of fire throughout the building and to occupant life safety given that fire resistant barriers shall penetrated, and paths of egress potentially may be untenable to egressing occupants, see figure below.

Figure 27 - Structural Steel Columns at Ground and First Floor.

In the interest of conservatism, the assessment of the Level 1 has been undertaken without the provision of a sprinkler system therefore, the impacts of a fully developed fire event shall be considered within the assessment.

A full-scale fire test undertaken by the Building Research Establishment (BRE) at Cardington to assess the effects of a fire on a structural steel frame were undertaken. Two tests were undertaken by BRE and four tests undertaken by British Steel these tests are summaries below.

British Steel Test 2 – Plane Frame test, involved heating of the entire length of the building to determine the effects on unprotected steel members. The exposed structural steel members (supporting a concrete slab) were exposed to temperatures of 750˚C. The tests undertaken indicated that the unprotected column was squashed by 180mm and the connections failed. Photos of the above can be seen in the figure below.

Figure 28 - Cardington Fire Test - British Steel Test 2 - Buckling of Unprotected Column.

Figure 29 - Cardington Fire Test - British Test 2 - Failure of Steel Connections.

In another test (British Steel Test 1) a beam was subjected to increase heat however the furnace was arranged such that the columns and connections were not heated. In this case buckling of the beam occurred at the interface between the heated steel and the non-heated steel due to the high temperature gradients between the highly restrained expanding hot beam. In most cases, bolts or the plates forming the connections failed as can be seen in the figure below.

Figure 30 - Cardington Fire Test - British Test 1 - Buckling of Beam at Protected/Unprotected Interface.

On the basis of the results of this test, the conditions experienced by the subject square hollow section during a flashover event is considered to be sufficient to degrade the structural integrity of the building element. The additional weight due to the levels located above will further exacerbate the potential for structural collapse should the columns be left without fire resistant construction. Therefore, it is proposed to require the installation of additional measures to achieve the required FRL of 90/-/-.

It is therefore considered that the deviations from the DtS provisions of the BCA have been adequately addressed to satisfy the relevant Performance Requirements C1P1, C1P2 and C1P4.

4.6 Assessment against relevant Performance Requirement

The following is an assessment of the relevant Performance Requirement C1P1, C1P2 and C1P4.

C1P1 Structural Stability During a Fire & C1P2 Spread of Fire
(1) A building must have elements which will, to the degree necessary, avoid the spread of fire -

C1P1 Structural Stability During a Fire & C1P2 Spread of Fire	
(a) to exits; and	Occupants with each level of the building have access to at least 2 exits at all time. Should the additional measures proposed within the assessment be installed it is expected that at least 1 of these exits shall remain tenable for the period required for occupants to egress from the building.
(b) to sole occupancy units and public corridors; and	The existing fire-resistant construction to SOUs and public corridors is sufficient to prevent the spread of fire between these areas.
(c) between buildings; and	Given the distance between adjoining properties fire spread between buildings shall not occur.
(d) in a building.	The installation of either the AS2118.4-2012 sprinkler system or non-combustible external wall and wall-wetting internal sprinklers to level 2 shall ensure that a fire cannot readily spread throughout the subject building.
(b) Avoidance of the spread of fire referred to in (a) must be appropriate to the following and a building must have elements which will, to the degree necessary, maintain structural stability during a fire appropriate to-	
(a) the function and use of the building; and	The subject building is deemed to be a typical Class 3 ski lodge building.
(b) the fire load; and	The fire load contained within the subject building is considered to be typical of a Class 3 ski lodge building.
(c) the potential fire intensity; and	The fire intensity within the subject building is considered to not differ from a typical Class 3 ski lodge building.
(d) the fire hazard; and	The expected fire hazard within the subject building does not differ from a typical Class 3 ski lodge building.
(e) the number of storeys in the building; and	The subject building has a rise in storeys of 3 with a minimum of 2 exits available from each storey.
(f) its proximity to other property; and	The subject building is located 21m from the nearest building resulting in fire spread being unlikely to occur.
(g) any active fire safety systems installed in the building; and	The buildings fire safety systems will comply with the DTS provisions. It is recommended that the non-required AS2118.4-2012 sprinkler system be installed to Levels 1 and 2 within the residential and kitchen areas.
(h) the size of the fire compartment; and	The fire compartment size does not differ from a DTS arrangement.
(i) fire brigade intervention; and	The provision of a smoke detection system with detectors spaced in accordance with AS1670.1 throughout all areas ensure early notification to occupants and the ability of the installed sprinkler system shall assist in ensuring occupants time to safely evacuate and the fire to be suppressed / controlled until the local fire brigade arrives. All levels of the building shall be in reach of a FRNSW aerial appliance.
(j) other elements they support; and	The installation of the Promatect 100 system to create a fire-resistant shaft surrounding the steel column shall achieve the required FRL of 90/-/-.
(k) the evacuation time.	The proposed sprinkler system install throughout the build will assist in suppressing any fire flashover area ensuring structural adequacy of the building enabling safe evacuation of all occupants. Further this, the proposed upgrade with a full AS1670.1 smoke detection system throughout will ensure all occupants of the

C1P1 Structural Stability During a Fire & C1P2 Spread of Fire	
	building are notified simultaneously in the event of a fire alarm.

C1P4 Safe Conditions for Evacuation	
To maintain tenable conditions during occupant evacuation, a material and an assembly must, to the degree necessary, resist the spread of fire and limit the generation of smoke and heat, and any toxic gases likely to be produced, appropriate to—	
(a) the evacuation time; and	The proposed additional fire safety measures shall ensure that a fire event shall not spread beyond the storey of origin for the period occupants take to egress from the building.
(b) the number, mobility and other characteristics of occupants; and	It is expected that occupants within the building will generally be able to care for themselves. Should assistance be required it is likely that fellow occupants shall render assistance and any available staff shall direct occupants to exits. The use as a medium 28 bed club lodge assumes occupants will be familiar with the exit pertain to their SOU. Any guests are expected to be either accompanied or will follow exit and evacuation signage as appropriate.
(c) the function or use of the building; and	The subject building is considered to be typical of a Class3 ski lodge building.
(d) any active fire safety systems installed in the building.	The buildings fire safety systems will comply with the DTS provisions. It is recommended that the non-required AS2118.4-2012 sprinkler system be installed to Levels 2 and 3 within the residential and kitchen areas.

4.7 Assessment Conclusion

The above assessment demonstrates qualitative analysis that the trial design proposed satisfies the relevant Performance Requirements C1P1, C1P2 and C1P4 subject to the additional fire safety measures proposed below:

Fire Spread Throughout the Building and to Adjoining Buildings

1. The installation of a AS2118.4-2012 compliant sprinkler system to the upper two residential levels of the subject building.

Vertical Separation of Openings in External Walls

2. The installation of a AS2118.4-2012 compliant sprinkler system to the upper two residential levels, inclusive of the non-fire-isolated stairs, of the subject building.

Non-Fire-Resistant Structural Steel to Ground and First Floor

3. Ground floor columns shall be fully encased with the PROMATECT 100 system 20mm thick board in a manner which forms a sealed shaft around the metal column and in accordance with the manufacturer's tested system.
4. First floor external columns are to be core filled with non-shrink structural grout. The grout mix must be equal to concrete core fill mix with a minimum strength of 20MPa. The grout must extend to the top cap of the column to ensure the grout takes the load of the column.

5.0 PERFORMANCE SOLUTION 2 – ACCESS AND EGRESS

It is proposed to develop a Performance Solution to permit the following non-compliances:

- To allow the omission of a DtS compliant fire-isolated stairway which serves three storeys within a Class 3 building and also discharges within the ground floor of the building thereby, deviating from D2D4 and D2D12.
- To allow a reduced exit width of 900mm in lieu of 1m within both southern non-fire isolated stairway thereby deviating from D2D8 of the BCA.
- To permit winders in lieu of a landing for a change in direction within common stairways used as a path of travel to an exit thereby deviating from D3D14 of the BCA.

5.1 Deemed-to-Satisfy Non-compliance

Pursuant to A2G2(3) of BCA the following DTS provisions have been identified as being subject to the Performance Solution:

D2D4 When fire-isolated stairways and ramps are required

(1) Class 2 and 3 buildings — The following applies:

(a) Subject to (b), every stairway or ramp serving as a required exit must be fire-isolated unless it connects, passes through or passes by not more than—

(i) 3 consecutive storeys in a Class 2 building; or

(ii) 2 consecutive storeys in a Class 3 building.

(b) Notwithstanding (a), one extra storey of any classification may be included if—

(i) it is only for the accommodation of motor vehicles or for other ancillary purposes; or

(ii) the building has a sprinkler system (other than a FPAA101D system) complying with Specification 17 installed throughout; or

(iii) the required exit does not provide access to or egress for, and is separated from, the extra storey by construction having—

(A) an FRL of –/60/60, if non-loadbearing; and

(B) an FRL of 90/90/90, if loadbearing; and

(C) no opening that could permit the passage of fire or smoke.

D2D8 Width of exits and paths of travel to exits

(1) The unobstructed width of each required exit or path of travel to an exit, except for ladders provided in accordance with D2D21, D3D23 or I3D5, and doorways, must be not less than—

(a) 1 m; or

(b) 1.8 m in a passageway, corridor or ramp normally used for the transportation of patients in beds within a treatment area or ward area; and

(c) in a public corridor in a Class 9c aged care building, notwithstanding (2) and (3)—

(i) 1.5 m; and

(ii) 1.8 m for the full width of the doorway, providing access into a sole-occupancy unit or communal bathroom.

D3D14 Goings and risers

(1) A stairway must have—

(a) not more than 18 and not less than 2 risers in each flight; and

(b) going (G), riser (R) and quantity (2R + G) in accordance with Table D3D14, except as permitted by (b) and (c); and

(c) constant goings and risers throughout each flight, except as permitted by (b) and (c), and the dimensions of goings (G) and risers (R) in accordance with (a)(ii) are considered constant if the variation between—

(i) adjacent risers, or between adjacent goings, is no greater than 5 mm; and

(ii) the largest and smallest riser within a flight, or the largest and smallest going within a flight, does not exceed 10 mm; and

(d) risers which do not have any openings that would allow a 125 mm sphere to pass through between the treads; and

(e) treads which have—

(i) a surface with a slip-resistance classification not less than that listed in Table D2.14 when tested in accordance with AS 4586; or

ii) a nosing strip with a slip-resistance classification not less than that listed in Table D2.14 when tested in accordance with AS 4586; and

(f) treads of solid construction (not mesh or other perforated material) if the stairway is more than 10 m high or connects more than 3 storeys; and

(g) in a Class 9b building, not more than 36 risers in consecutive flights without a change in direction of at least 30°; and

(h) in the case of a required stairway, no winders in lieu of a landing.

5.2 Relevant Performance Requirements

Pursuant to A2G4(3)(b) of BCA the following Performance Requirements have been identified as being directly relevant to the DTS provisions identified above:

D1P2 Safe movement to and within a building

So that people can move safely to and within a building, it must have—

(a) walking surfaces with safe gradients; and

(b) any doors installed to avoid the risk of occupants—

(i) having their egress impeded; or

(ii) being trapped in the building; and

(c) any stairways and ramps with—

(i) slip-resistant walking surfaces on—

(A) ramps; and

(B) stairway treads or near the edge of the nosing; and

(ii) suitable handrails where necessary to assist and provide stability to people using the stairway or ramp; and

(iii) suitable landings to avoid undue fatigue; and

(i) landings where a door opens from or onto the stairway or ramp so that the door does not create an obstruction; and

(ii) in the case of a stairway, suitable safe passage in relation to the nature, volume and frequency of likely usage

D1P4 Exits

Exits must be provided from a building to allow occupants to evacuate safely, with their number, location and dimensions being appropriate to—

(a) the travel distance; and

(b) the number, mobility and other characteristics of occupants; and

(c) the function or use of the building; and

(d) the height of the building; and

(e) whether the exit is from above or below ground level.

D1P5 Fire-isolated exits

To protect evacuating occupants from a fire in the building exits must be fire-isolated, to the degree necessary, appropriate to—

(a) the number of storeys connected by the exits; and

(b) the fire safety system installed in the building; and

(c) the function or use of the building; and

(d) the number of storeys passed through by the exits; and

(e) fire brigade intervention.

D1P6 Paths of travel to exits

So that occupants can safely evacuate the building, paths of travel to exits must have dimensions appropriate to—

(a) the number, mobility and other characteristics of occupants; and

(b) the function or use of the building

5.3 Assessment Methodology

In order to address the provisions of the BCA, a qualitative, deterministic and absolute assessment will be undertaken to determine compliance with the relevant Performance Requirements D1P2, D1P4, D1P5 and D1P6. 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 Requirements D1P2, D1P4, D1P5 and D1P6.

5.4 Acceptance Criteria

It must be demonstrated that the proposed trial design is better than or at least equivalent to the DtS compliant building in that;

- occupants seeking to egress from the building are able to reach the discharge point without passing through untenable conditions within an exit or path of travel to an exit;
- the reduced exit width is sufficient to facilitate egress for the occupant type and density within the building; and
- the incorporation of winders in lieu of a landing to facilitate a change in direction of stair flights shall not cause undue risk to occupants in their day-to-day activities and when egressing during a fire event.

Should the above be demonstrated it is considered that the proposed Trial Designs shall satisfy the relevant Performance Requirements D1P2, D1P4, D1P5 and D1P6.

5.5 Qualitative Assessment

Performance Requirements D1P2, D1P4, D1P5 and D1P6 are generally related to ensuring that a building has appropriate elements to ensure that occupants within the building can move in conditions which are deemed safe whether that be in day-to-day tasks or egressing from the building during an emergency.

Non-fire Isolated Stairway
The subject building consists of a three-storey ski lodge with the ground floor containing Class 7b storage and the upper two levels containing Class 3 residential areas. The building contains two non-fire isolated stairways which are central to each wing of the building, provide one of two paths of travel to an exit for both residential levels and connect three storeys, see figure below.

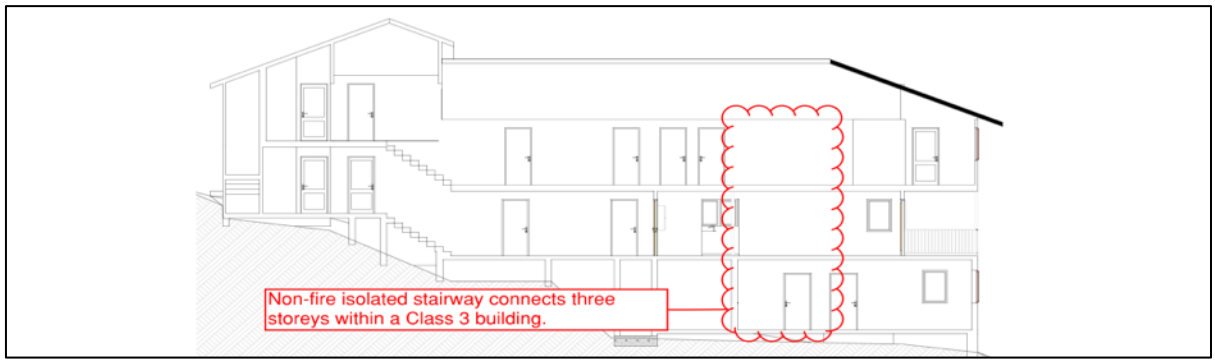


Figure 31 - Existing Non-fire-isolated Stairway Connecting Three Storeys in a Class 3 Building.

D2D4 of the BCA specifies that every stairway serving as a required exit must be fire-isolated unless it connects 2 consecutive storeys in a Class 3 building and one extra storey of any classification may be included if it is only for the accommodation of motor vehicles or for other ancillary purposes associated with the accommodation of motor vehicles; or the building is served by a sprinkler system, other than a AS2118.4-2012 system, complying with Specification 18 installed throughout.

The existing storey is a Class 7b part which does not satisfy the requirements of D2D4 of the BCA. The above Performance Solutions indicate the incorporation of a AS2118.4-2012 sprinkler system which D2D4 specifically notes as being insufficient to allow the concession to apply. The Performance Solution

shall justify the use of the AS2118.4-2012 system to the degree necessary to allow the concession granted by D2D4 to be applicable.

The intention of D2D4 is *to indicate when fire-isolated stairways and ramps are required to enable safe egress in case of a fire*. The omission of fire-isolated exits impact upon the ability of the building occupants to evacuate safely passed the fire affected storey, the attending fire brigade to carry out operations such as search and rescue and fight fighting, and the distance occupants must travel in a fire affected area before they are able to access a "safe place" or discharge from the exit to open space. Considering this, the separation of the occupants and fire brigade from the fire affected part of the building is paramount to ensuring a satisfactory degree of occupant life safety.

The ground floor of the existing building is separated from the residential floors above by construction which achieves a FRL of 90/90/90 therefore, should a fire event originate within the ground floor occupants of the floors above shall be separated from the fire for a minimum period of 90 minutes. Performance Solution 1 seeks to install a AS2118.4-2012 sprinkler system throughout the residential storeys, inclusive of the subject stairway, of the building. As previously discussed, the AS2118.4-2012 sprinkler system shall prevent the spread of fire from the origin point of the fire and has the potential to extinguish the fire event.

In support of this, the fire testing undertaken by Fire and Rescue NSW indicated that emergency evacuation was possible at all times, at 1 metre in all areas, even in peak temperatures however, Test 3 indicated that the tenability from the bedroom to the SOU door was untenable requiring occupants to skirt around extending the evacuation route. However, at 1m peak temperature was 33°C resulting in the potential for occupants to crawl or crouch to remain in tenable conditions rather than egressing via the extended travel route.

Consideration has been given to the layout and size of the test structure measured as 60.48m^2 and containing a kitchen, lounge, lounge annexe, bathroom and two bedrooms. In this instance, each SOU within the Class 3 building contains a bedroom and an associated bathroom significantly reducing the distance required to be travelled and increases occupant familiarity within their own SOU when compared to a larger SOU similar to that used as the test structure. Additionally, the furnishing within the Class 3 SOU is more conservative permitting better sprinkler coverage and a reduced likelihood of obstructions thereby, providing conditions conducive to the extinguishing the fire.

Therefore, occupants within the SOUs of the subject building regardless of their transient nature will be egressing in an environment which is comparatively familiar to their own home given the simple layout of the SOU, via an evacuation route which will remain tenable and once egressing from their SOU be separated from the fire by construction achieving a minimum FRL specified by Specification 5 of the BCA.

Should a fire event occur within the building the omission of a fire isolated stairway shall contribute to the free passage of smoke and gases being the products of combustion throughout the building. Research undertaken by Rakic indicates that the provisions of Lorient medium temperature smoke seals on solid core doors is considered to decrease the amount of smoke migration through a door set by factors of between 17 and 35 (Rakic, 2006). Notably, it is proposed to utilise the Kilargo IS8010si and Kilargo IS7087si medium temperature smoke seals in place of the Lorient which are expected to yield similar results, see Appendix B for Specification. It is assumed that the incorporation of Kilargo medium temperature smoke seals to the doorways of corridors associated with the SOUs would demonstrate a similar degree in the decrease of smoke migration.

Therefore, to prevent the ingress of smoke to the corridors associated with SOUs and SOUs it is proposed to install Kilargo medium temperature smoke seals to all four sides of the doors leading from the non-fire-isolated stair to public corridors associated with SOUs, see figure below.

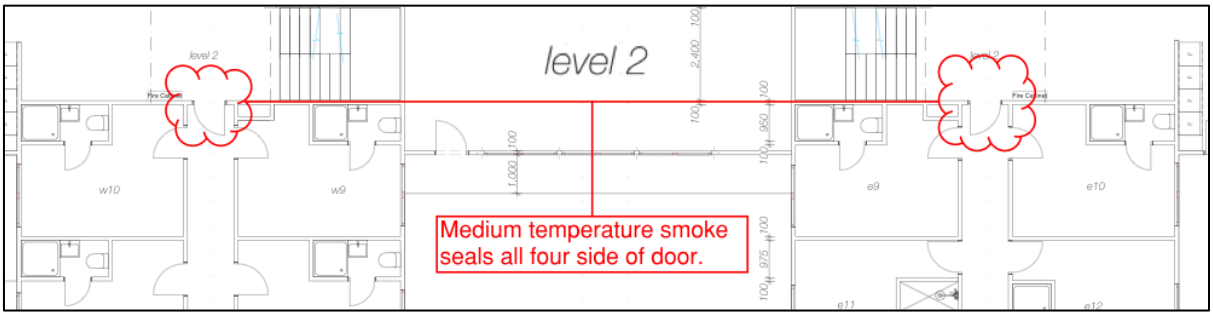


Figure 32 - Medium Temperature Smoke Seals to Corridor Doors on Level 2.

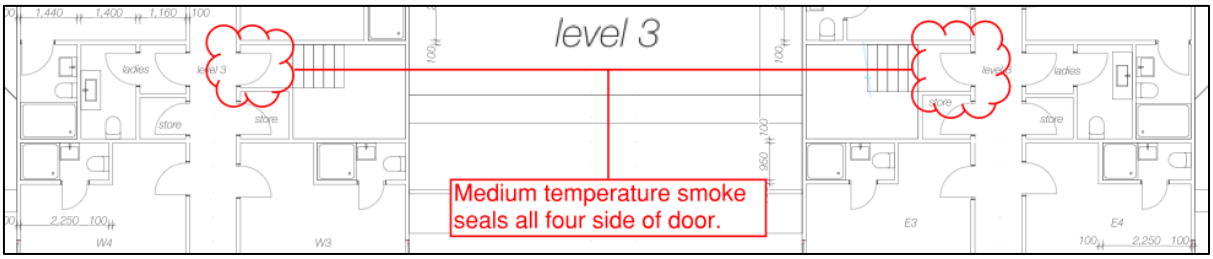


Figure 33 - Medium Temperature Smoke Seals to Corridor Doors on Level 3.

In addition to this, the non-fire-isolated stairway discharges within the ground floor of the building which does not comply with D2D12 of the BCA. By discharging within the building occupants will potentially be exposed to effects of fire for a prolonged period of time. Subsequently, it is proposed to require the installation of a fire-resistant glazed panel to the non-fire-isolated stairway doors at ground level thereby, allowing occupants to determine the tenability of the ground floor and egressing open space. To ensure occupants are aware of the alternative exits located to the floors above it is proposed to install signage stating, "SHOULD CONDITIONS BE UNTENABLE USE ALTERNATIVE EXITS LOCATED ON FLOOR ABOVE".

It is therefore considered that the deviations from the DtS provisions of the BCA have been adequately addressed to satisfy the relevant Performance Requirements D1P2, D1P4, D1P5 and D1P6.

Path of Travel Widths

With respect to egress widths The Guide to the BCA states the intent of D2D7 is to *'require exits and paths of travel to an exit to have dimensions to allow all occupants to evacuate within a reasonable time'.*

Clause D2D9(c) allows the typical exit or path of travel width of 1000mm to be reduced by 250mm to 750mm at doorways. This measurement is considered to provide an exit width that will allow up to 100 occupants within a building to evacuate in a reasonable time, as referred to in the *Guide to the BCA*.

It is considered that in the case of the subject building, the occupant density from the upper levels is approximately 32 persons based on 2 persons per room.

Due to the installation of a handrail to both sides of the stairway the width of egress is reduced throughout the flight of stairs. If we liken this reduced width on the stairway and egress path to a doorway then by comparison, we can consider the concession afforded by D2D9(c) allowing the width of the area to be reduced by 250mm to 750mm which is less than the proposed width of 900mm above.

In support of the above, anthropometric data from Fairweather Et Al (Fairweather) based on British and American adult men 19-65 years of age and shows that the 95th Percentile of the studied population did not exceed a shoulder breadth of 510mm and 515mm respectively (Fairweather 1977). According to the study, the 95th percentile of adult British and American women did not exceed a hip breadth of 435mm and 440mm respectively, noting that hip breadth is considered the limiting factor in women.

Research conducted by A. Damon (Damon) indicates that a reasonable design minimum egress width for public corridors is 530mm; this is adequate for all but the largest 1% of the population. The restricted area exceeds this amount and it is therefore considered that the egress width provided only marginally restricts

egress in localised areas of the building which will have limited effect on the overall ability of occupants to safely evacuate the building (Damon 1971).

Human behaviour in fire emergencies (NFPA 2003) states that the major axis across the shoulders of a body ellipse used to develop egress systems is 609mm. Another consideration is the sway width of shoulders when walking or evacuating a building in an emergency. Based on NFPA's anthropometric data as shown in the below detail, the sway width for adult male shoulders ranges from 510 to 760mm (NFPA 2012).

The reduced clear width of 900mm is therefore considered sufficient to accommodate this movement.

Via the above assessment the subject reduced width on the stairway of 900mm is considered to be sufficient to facilitate evacuation of the occupants likely to be located in these areas. On this basis, the performance solution is considered to comply with D1P2, D1P4 and D1P6 subject to the assessment contained below.

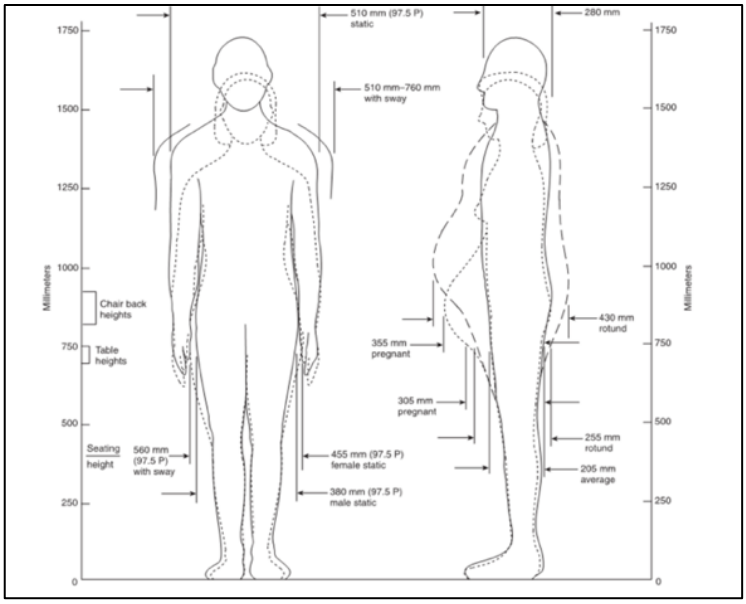


Figure 34 - Anthropometric data for adults, males and females, some dimensions apply to maximum range at the 97.5 percentile.

Winders in Lieu of a Landing

The internal non-fire-isolated stair at the south end of the Eastern wing incorporates two winders in lieu of a landing to facilitate a change of direction within the stair thereby deviating from D3D14 of the BCA. In this instance, winders have been used in lieu of a landing due to the split level of the first floor which compensates for the topography of the site, see figure below.

Figure 35 - Winder in Lieu of a Landing to Facilitate a Change of Direction Mid Flight.

Whilst the BCA permits the inclusion of winders within a SOU their use throughout public areas of the building is considered to pose too significant of a risk and hazard to occupants. Occupants of a Class 3 building, given their transient nature, shall be unfamiliar with exits and paths of travel to exits therefore it is considered appropriate to incorporate goings and risers which are constant.

Notably, the winders are not contained within an exit or path of travel to an exit and the subject stair fairly removed from the remainder of the building. Considering this it is expected that only occupants moving between first and second storey shall be using this stair which results in relatively low foot traffic when compared to the centrally located stairways. Subsequently, it is proposed to retain the existing winders subject to the installation of textured contrast strips at the end of each winder and the installation of signage which states "CAUTION WATCH YOUR STEP" in letters no less than 50mm in height and in a colour contrasting to the background, see figure below.

Figure 36 - Textured Contrast Strips and Signage to be Installed to the Stair.

Discharge to Open Space

Schedule 1 Definitions of the BCA defines *Open Space* as a means of space on the allotment, or roof or similar part of a building adequately protected from fire, open to the sky and connected directly with a public road. Schedule 1 Definitions of the BCA defines an *Exit* as any, or any combination of the following if they provide egress to a road or open space by an internal or external stairway, a ramp, a fire-isolated passageway and/or a doorway opening to a road or open space.

By the definitions presented above, the BCA requires that the exits from the East and West Wings at the rear of the property be directly connected, by way of a formed path, to a road. Notably, this could be achieved by a single pathway which connects to the road via the eastern side of the building. In this instance, occupants would be required to egress from the rear of the building via the same route. A conservative scenario where occupants of the West Wing have egressed via the rear exit, due to the East Wing being fire affected, would then be required to egress past openings which may expose occupants to excessive radiant heat rendering the evacuation route untenable.

Whilst connecting the two evacuation routes at the rear of the building would provide the occupants with an alternative means of egress the existing site conditions prevent this from occurring. Given the layout of the building, which forms a "horseshoe" shape, consecutive heavy snow falls have the potential to become trapped and build up. Should this occur the path which connects the East and West Wing external pathways may become blocked resulting in the alternative evacuation route being rendered unsuable.

The Performance Solution above relies on the ability for occupants to readily evacuate via the rear exits of each wing as detailed below.

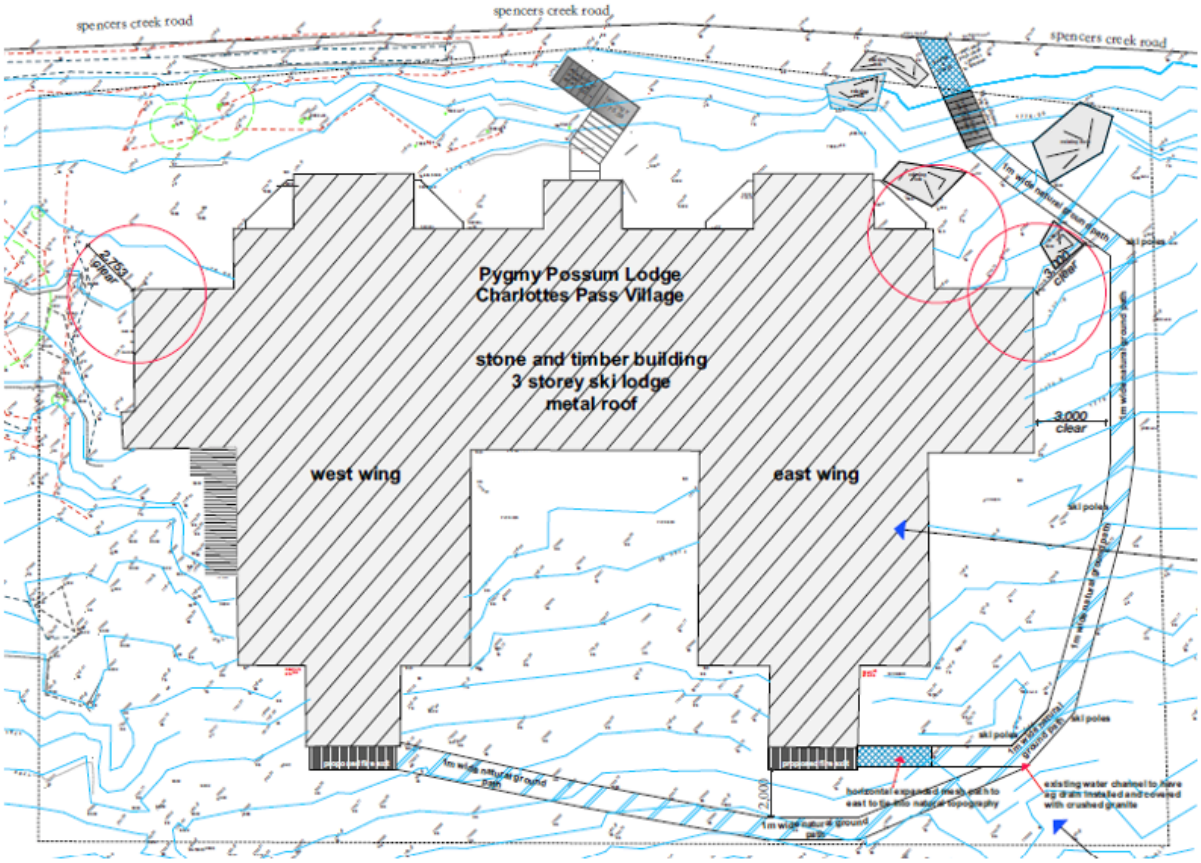


Figure 37 - Evacuation route from rear of the building

The evacuation routes shall, where able to be, setback a minimum distance of 3m from the subject building to provide separation from the fire affected building. Notably, this may require the evacuation path to be located outside of the allotment boundaries however, this deemed necessary to ensure occupant life safety when egressing from the building.

On the basis of the above, it is not considered that the proposed winders shall not impact upon the safe movement of occupants within the subject building. On the basis, of the above analysis it is considered that compliance with D1P2, D1P4, D1P5 and D1P6 is achieved subject to the assessment contained below.

5.6 Assessment against relevant Performance Requirement

The following is an assessment of the relevant Performance Requirements D1P2, D1P4, D1P5 and D1P6.

D1P2 Safe movement to and within a building	
So that people can move safely to and within a building, it must have—	
(a) walking surfaces with safe gradients; and	Not applicable to this performance solution.
(b) any doors installed to avoid the risk of occupants— *(i) having their egress impeded; or* *(ii) being trapped in the building; and*	Not applicable to this performance solution.
(c) any stairways and ramps with— *(i) slip-resistant walking surfaces on—* *(A) ramps; and*	Due to the inclusion of winders in the stair, it is proposed to provide textured contrast strips and signage to offset the increased risk of occupant tripping or falling.

(B) stairway treads or near the edge of the nosing; and *(ii) suitable handrails where necessary to assist and provide stability to people using the stairway or ramp; and* *(iii) suitable landings to avoid undue fatigue; and* *(iv) landings where a door opens from or onto the stairway or ramp so that the door does not create an obstruction; and* *(v) in the case of a stairway, suitable safe passage in relation to the nature, volume and frequency of likely usage.*	Signage shall be installed in a prominent position as to be visible occupants seeking to use the stair.

D1P4 Exits	
Exits must be provided from a building to allow occupants to evacuate safely, with their number, location and dimensions being appropriate to—	
(a) the travel distance, and	Not applicable to this performance solution.
(b) the number, mobility and other characteristics of occupants; and	Occupants of the Class 3 ski lodge are expected to be consistent with the national average. Occupants are expected to be capable of caring for themselves, however, should assistance be required staff and occupants would render assistance.
(c) the function or use of the building; and	The building is used as a Class 3 ski lodge type building with an associated storage Class 7b part. The function and use are considered to be typical of a Class 3 and associate Class 7b part building.
(d) the height of the building; and	The height of the building is less than 12m therefore, a Fire and Rescue aerial appliance shall be able to reach all storeys of the building.
(e) whether the exit is from above or below ground level.	Exits from the building are provided at each of the three storeys and the building does not contain any basement levels, therefore, exits from the building are generally from above.

D1P5 Fire isolated exits	
To protect evacuating occupants from a fire in the building exits must be fire-isolated, to the degree necessary, appropriate to—	
(a) the number of storeys connected by the exits; and	The two subject stairs connect all three storeys of the building however, as per the assessment above the installation of the AS2118.4-2012 sprinkler system to the two upper storeys and the existing fire resistance construction throughout the building shall ensure occupants can egress in tenable conditions.
(b) the fire safety system installed in the building; and	The building shall be provisioned with DtS required fire safety systems. A non-required AS2118.4-2012 sprinkler system shall be installed to the upper two residential storeys inclusive of stairways.
(c) the function or use of the building; and	The building is used as a Class 3 ski lodge type building with an associated storage Class 7b part. The function and use are considered to be typical of a Class 3 and associate Class 7b part building.

D1P5 Fire isolated exits	
(d) the number of storeys passed through by the exits; and	The height of the building is less than 12m therefore, a Fire and Rescue aerial appliance shall be able to reach all storeys of the building.
(e) fire brigade intervention.	Given the good means of egress from the subject building it is expected that fire brigade interventions would be assisted.

D1P6 Paths of travel to exits	
So occupants can safely evacuate the building, paths of travel to exits must have dimensions appropriate to-	
(a) the number, mobility and other characteristics of occupants; and	Occupants of the Class 3 ski lodge are expected to be consistent with the national average. Occupants are expected to be capable of caring for themselves, however, should assistance be required staff and occupants would render assistance.
(b) the function or use of the building; and	The building is used as a Class 3 ski lodge type building with an associated storage Class 7b part. The function and use are considered to be typical of a Class 3 and associate Class 7b part building.

5.7 Assessment Conclusion

The above assessment demonstrates qualitative analysis that the trial design proposed satisfies the relevant Performance Requirements D1P2, D1P4, D1P5 and D1P6 subject to the following measures:

1. An AS2118.4-2012 sprinkler system shall be installed throughout the upper two residential storeys inclusive of stairways. Installation of sprinklers to the lower level is optional.
2. Installation of a fire-resistant glazed panel to the non-fire-isolated stairway doors at ground level thereby, allowing occupants to determine the tenability of the ground floor and egressing open space.
3. Install Kilargo medium temperature smoke seals to all four sides of the doors leading from the non-fire-isolated stair to public corridors associated with SOUs, see figure below.

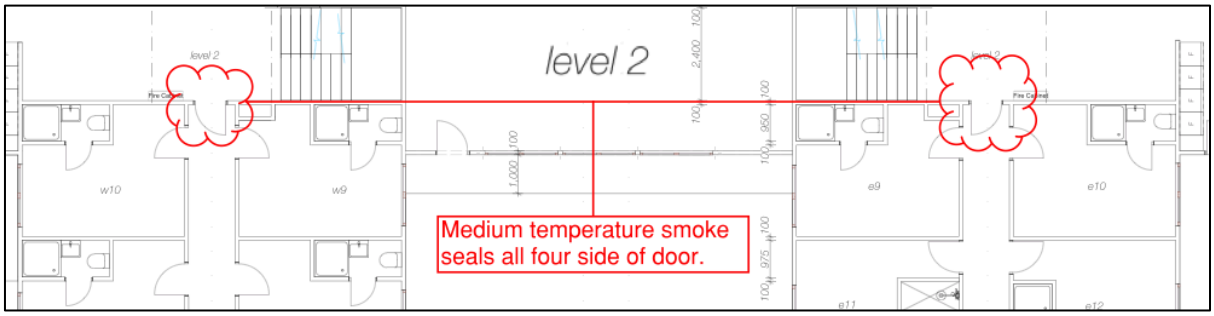


Figure 38 - Medium Temperature Smoke Seals to Corridor Doors on Level 2.

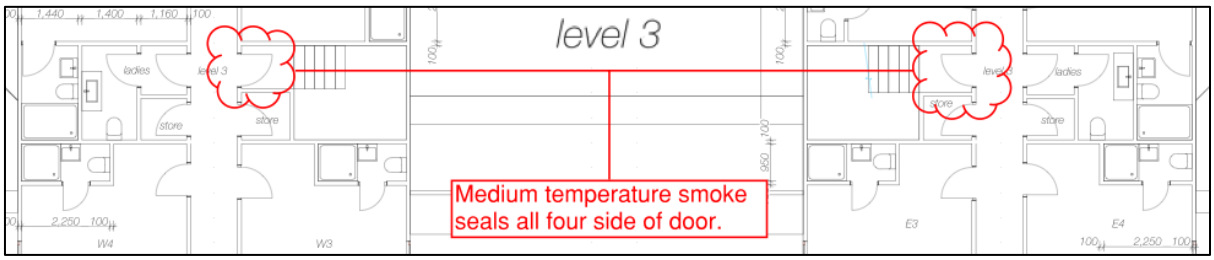


Figure 39 - Medium Temperature Smoke Seals to Corridor Doors on Level 3.

1. To ensure occupants are aware of the alternative exits located to the floors above it is proposed to install signage stating, “SHOULD CONDITIONS BE UNTENABLE USE ALTERNATIVE EXITS LOCATED ON FLOORS ABOVE”. Signage shall be installed to the stair side of the door in a prominent position.
2. The installation of textured contrast strips at the end of each of the subject winders for the length of the winder being not less than 50mm in width and in a colour which contrasts to the stair surface.
3. The installation of signage which states “CAUTION WATCH YOUR STEP” in letters no less than 50mm in height and in a colour contrasting to the background, see figure below.

Figure 40 - Textured Contrast Strips and Signage to be Installed to Stair.

4. It is proposed to require itwo separate evacuation routes from the rear of the building as detailed below.

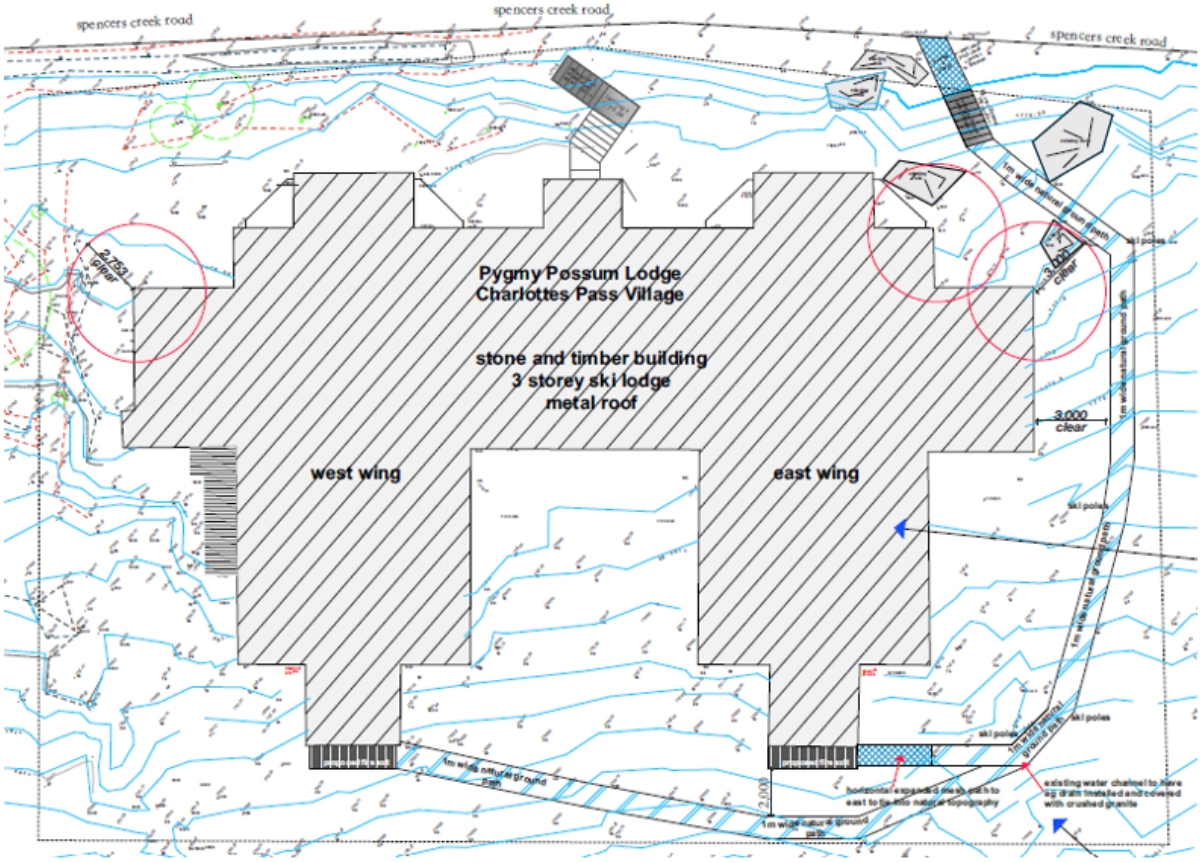


Figure 41 - Evacuation route

6.0 PERFORMANCE SOLUTION 3 – BOUNDING CONSTRUCTION

It is proposed to develop a Performance Solution to permit the existing fibreglass prefabricated bathroom pods to remain and the existing unprotected exhaust fan penetrations in each SOU to remain regardless of the non-compliance with BCA Clauses C2D11 and S5C11.

6.1 Deemed-to-Satisfy Non-compliance

Pursuant to A2G2(3) of BCA the following DTS provisions have been identified as being subject to the Performance Solution:

C2D11 Fire hazard properties

(1) The fire hazard properties of the following internal linings, materials and assemblies within a Class 2 to 9 building must comply with Specification 7:

- *(a) Floor linings and floor coverings.*
- *(b) Wall linings and ceiling linings.*
- *(c) Air-handling ductwork.*
- *(d) Lift cars.*
- *(e) In Class 9b buildings used as a theatre, public hall or the like—*
  - *(i) fixed seating in the audience area or auditorium; and*
  - *(ii) a proscenium curtain required by Specification 32.*
- *(f) Escalators, moving walkways and non-required non fire-isolated stairways or pedestrian ramps subject to Specification 14.*
- *(g) Sarking-type materials.*
- *(h) Attachments to floors, ceilings, internal walls, common walls, fire walls and to internal linings of external walls.*
- *(i) Other materials including insulation materials other than sarking-type materials.*

S5C11 Type A fire resisting construction – fire resistance of building elements

(1) In a building required to be of Type A construction—

(a) each building element listed in Tables S5C11a, S5C11b, S5C11c, S5C11d, S5C11e, S5C11f and S5C11g, and any beam or column incorporated in it, must have an FRL not less than that listed in those Tables for the particular class of building concerned; and

(b) any internal wall required to have an FRL with respect to integrity and insulation must extend to—

(i) the underside of the floor next above; or

(ii) the underside of a roof complying with Table S5C11g; or

(iii) if under S5C15 the roof is not required to comply with Table S5C11g, the underside of the non-combustible roof covering and, except for roof battens with dimensions of 75 mm x 50 mm or less or sarking-type material, must not be crossed by timber or other combustible building elements; or

(iv) a ceiling that is immediately below the roof and has a resistance to the incipient spread of fire to the roof space between the ceiling and the roof of not less than 60 minutes; and

6.2 Relevant Performance Requirements

Pursuant to A2G4(2)(d) of BCA the following Performance Requirements have been identified as being directly relevant to the DTS provisions identified above:

C1P1 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

C1P2 Spread of fire

(1) A building must have elements which will, to the degree necessary, avoid the spread of fire—
- *(a) to exits; and*
- *(bi) to sole-occupancy units and public corridors; and*
- *(c) between buildings; and*
- *(d) in a building.*

(2) Avoidance of the spread of fire referred to in (a) must be 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 number of storeys in 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.*

6.3 Assessment Methodology

In order to address the provisions of the BCA, a qualitative, deterministic and absolute assessment will be undertaken to determine compliance with the relevant Performance Requirements C1P1 and C1P2. 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 Requirements C1P1 and C1P2.

6.4 Acceptance Criteria

It must be demonstrated that the proposed trial design is better than or at least equivalent to a building with DtS compliant bounding construction and fire hazard properties of building materials.

Should the above be demonstrated it is considered that the proposed Trial Designs shall satisfy the relevant Performance Requirements C1P1 and C1P2.

6.5 Qualitative Assessment

Performance Requirements C1P1 and C1P2 are generally related to ensuring that a building has appropriate elements to ensure that a fire does not unduly spread throughout the building and that the building remains structurally adequate for the duration of the fire.

To prevent the spread of fire and the impact to the structural adequacy during a fire event the subject building is to be installed with an AS2118.4-2012 compliant sprinkler system. The AS2118.4 sprinkler system is deemed suitable to provide sufficient protection to prevent the spread of fire throughout the building.

Notably, the AS2118.4 sprinkler system is based upon the AS2118.1 sprinkler system however, allowances are permitted given the fire hazards and risks associated with the low-rise residential use. The omission of sprinkler coverage to toilets and bathrooms is one of the exceptions permitted by the AS2118.4 system. The exception is permitted due to the reduced fuel load and reduced points of fire origin associated with toilets and bathrooms.

In support of the exceptions noted above, Performance Requirements E1P4 of the BCA “An automatic fire suppression system must be installed to the degree necessary to control the development and spread of fire appropriate to; the size of the fire compartment, the function or use of the building, the fire hazard, and the height of the building”. The Guide to the BCA notes that the use of the term “to the degree necessary” recognises that not all buildings require the same degree of automatic fire suppression. Further to this, this perspective can be applied to require or omit certain elements of a specific sprinkler system due to the particular level of performance required for the subject building.

In this case, the use of the fibreglass shell for the bathrooms associated with the SOUs on Level 2 and 3 is considered to be non-compliant with C2D11 due to the combustible nature of the fibreglass material. The softening point of fibreglass began at a temperature of 100°C with a mass loss of 12% recorded once a temperature of 350°C being primarily chemically absorbed water whilst 79% mass loss was recorded as occurring between 350°C and 600 °C (Chulikavit, 2023). Notably the peak mass loss rate for the secondary thermal degradation step was at approximately 418°C, see table below.

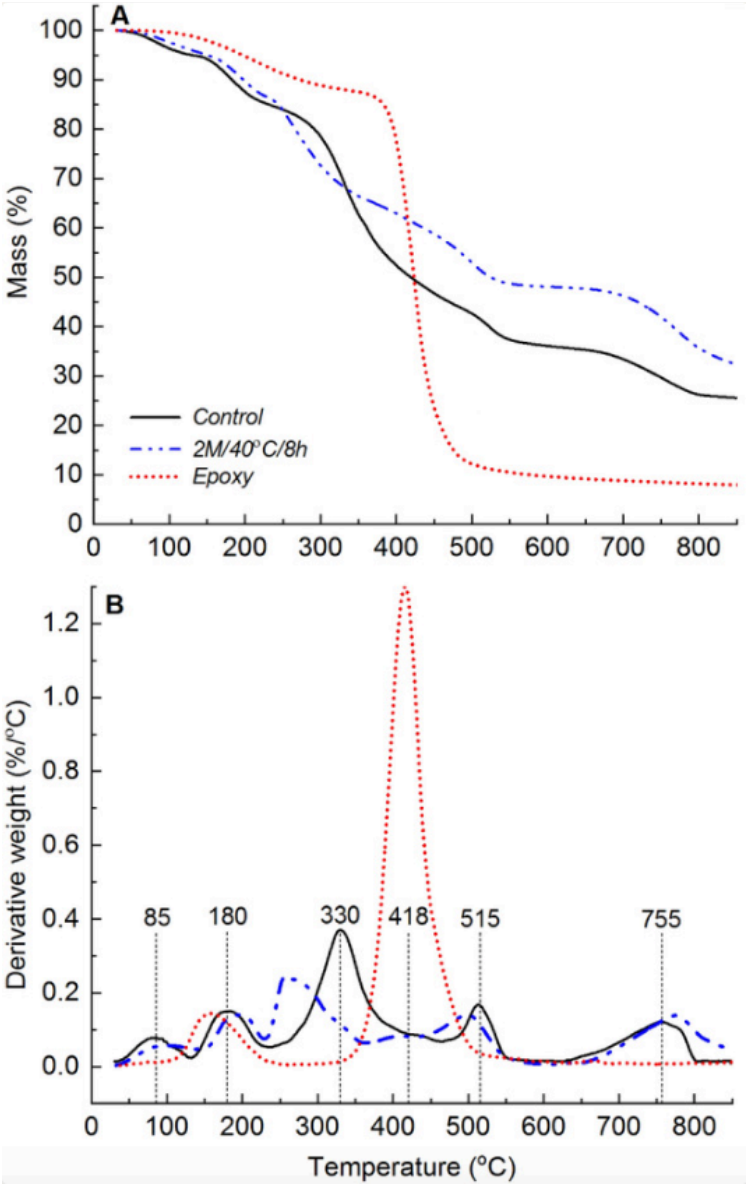


Figure 42 – Thermal degradation behaviour of epoxy, and unmodified (control) and deacetylated mycelium

Temperatures of over 100°C will be achieved should a fully developed fire which achieves a maximum temperature of 1,000°C be present in the bathroom. Should this occur the fibreglass is expected to soften and lose its structural integrity. Once the fibreglass softens, and the structural integrity fails the potential for the sprinkler spray pattern to be interrupted and the fire to become shielded from the spray is high. In this regard, the current arrangement would permit the spread of fire at an expediated rate when compared to a DtS compliant construction.

As described above, sprinkler heads are omitted to bathrooms when installing an AS2118.4-2012 compliant system. However, the installation of a single sprinkler head to the bathrooms associated with the SOUs on Level 2 and 3 would reduce the temperature within the upper smoke layer to a temperature less than 200°C, as detailed below, and would assist in preventing the development of a fire within this area.

Fire tests undertaken by NRCC that showed that the temperatures in a compartment, after sprinkler activation, are in the order of 100ºC as opposed to 1000ºC for an unsprinklered fire in flashover. Where sprinklers were unable to reach the seat of the fire, they were still able to significantly reduce the hot layer

temperature. For example, in a shielded fire, the temperatures were found to be 145ºC as opposed to 360ºC when unprotected (Lougheed).

This research is further supported by Technical Memoranda TM19:19958, which states, "For design purposes the rate of heat release may be assumed as steady after operation of the first sprinkler, i.e. no further items of fuel ignite after operation and therefore it may be assumed that the sprinklers cool most of the smoke layer to below the operating temperatures of the sprinklers. With conventional heads, it is considered that an average smoke layer temperature of 1000ºC may be assumed in calculations, while they are operating".

A report on full-scale testing of shielded fires in sprinklered office buildings, undertaken by the National Research Council Canada states, "The highest temperature (up to 325ºC [617ºF] was measured at the ceiling in the immediate area of the fire for a duration of less than one minute. After this initial high temperature spike the temperature increase at the ceiling was less than 200ºC (392ºF) and, in many cases, less than 100ºC (212ºF) even in the immediate fire area."

Fibreglass is a composite material combining glass shards and a polyester resin or epoxy. The glass shards themselves will be capable of withstanding temperatures greater than 1,000ºC and therefore do not contribute to the structural failure of the fibreglass. The fibreglass shell is expected to retain 50% of its room temperature tensile strength at a temperature of 370ºC (PFH, 2024). Whilst the fibreglass will experience a softening effect the reduction in structural integrity may not be linear but shall decrease with the increased in temperature.

Therefore, based on the literature data, it would be expected that the maximum temperature in a fire where the sprinklers were activated would be 200ºC in the vicinity of the fire and would be greatly reduced further away from the fire location. Given the nature of the room as a bathroom and the small floor area combustible furnishing shall be limited and sparse to a point that the fuel load would be considered to be very low. Additionally, the fire hazards would be restricted to electrical equipment which would be limited due to the small floor area of the SOUs associated with the bathroom.

Using the principal that the maximum sustained temperature of the upper layer would be in the order of 200ºC, it is considered that the fibreglass shell would experience only a minor reduction in strength, insufficient to cause failure. Therefore, sprinkler protection of the bathroom pods enables the pods to prevent fire spread to the roof cavity, i.e., to act as compliant bounding construction and does not significantly impact on the fire intensity within the bathroom.

When the room is sprinkler protected the fire intensity would be reduced once the sprinkler head had activated and based on the above studies the sprinkler would reduce the temperature in the room to approx. 200ºC. Once activated the sprinkler would also act to wet any other combustible material in the room and as such the fire would not be likely to reach flashover conditions. Therefore, the proposed arrangement is considered to be a net positive as the conditions for a fully developed fire to achieve flashover are not present in the proposed arrangement regardless of the inclusion of the fibreglass shell but are in a DtS compliant arrangement.

Further to this, the fibreglass shell is not directly mounted to the timber framed bounding walls. An existing layer 16mm fire resistant plasterboard is present which shall further prevent the passage of fire from the SOU to the public corridor for a minimum period of 60 minutes. Therefore, regardless of the inclusion of the sprinkler system, and as a measure of sprinkler failure redundancy, fire shall not spread from the subject bathroom to the public corridors or adjoining SOUs for a minimum of 60 minutes. With the inclusion of sprinklers to Level 2 and 3 the resistance to the spread of fire is expected to greatly exceed the minimum 60 minutes provided by the 16mm fire rated plasterboard.

<u>Exhaust Fan Penetrating SOU Ceiling</u>
A number of ceiling mounted exhaust fans within the SOU bathrooms have been installed on Levels 1 and 2 which do not incorporate fire resistant construction being non-compliant with C4D12 of the BCA.

Should the non-compliant exhaust fans be permitted to remain the potential for fire to spread between adjoining SOUs, to public corridors, between Level 2 and 3, and via the Level 3 roof space is greatly

increased. The exhaust fans shall permit hot gases and smoke at the early stages of a fire event prior to the activation of the sprinkler to spread into the ceiling void and potentially spread to the timber framing contained within. Notably, once the sprinkler system has activated the potential risk associated with fire spread via the ceiling openings is greatly reduced due to the lower temperature of the smoke and other gases.

To prevent the passage of smoke and gases to the ceiling void it is proposed to require the exhaust fans identified above to be wall mounted and to discharge directly outside via a bulkhead of non-combustible construction. The existing opening is to be sealed by fire resistant construction which provides a minimum of 60 minutes fire resistance, see figures below.

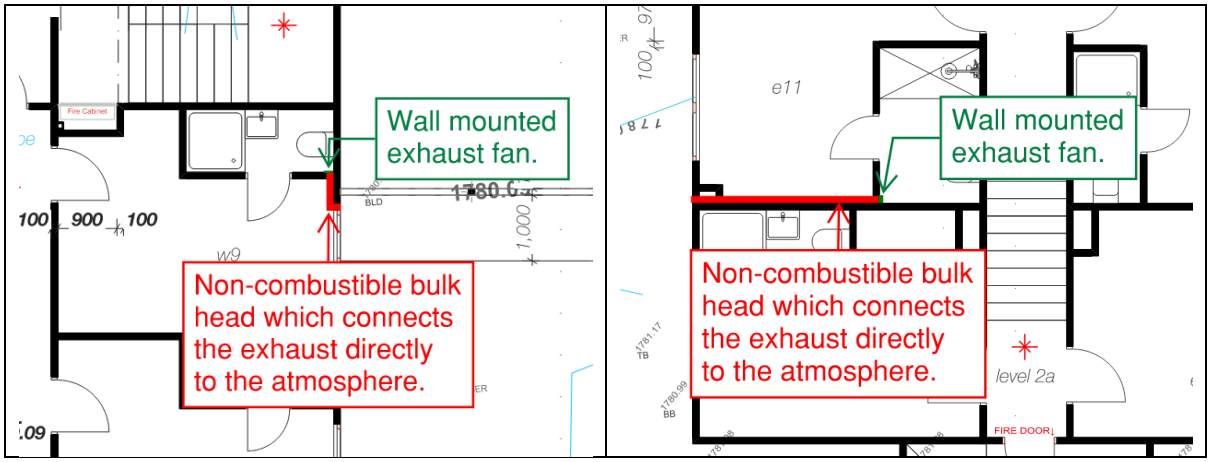


Figure 43 – Wall mounted exhaust fans and non-combustible bulkhead

On the basis of the above, it is not considered that the inclusion of the fibreglass shell and the exhaust fan shall impact the fire-resistant nature of the existing bounding walls between SOUs and public corridors.

On the basis of the above analysis, it is considered that compliance with C1P1 and C1P2 is achieved subject to the assessment contained below.

6.6 Assessment against relevant Performance Requirement

The following is an assessment of the relevant Performance Requirements C1P1 and C1P2.

C1P1 Structural Stability During a Fire	
(1) A building must have elements which will, to the degree necessary, maintain structural stability during a fire appropriate to—	
(a) the function and use of the building; and	The subject building is deemed to be a typical Class 3 ski lodge building.
(b) the fire load; and	The fire load contained within the subject building is considered to be typical of a Class 3 ski lodge building.
(c) the potential fire intensity; and	The fire intensity within the subject building is considered to not differ from a typical Class 3 ski lodge building.
(d) the fire hazard; and	The expected fire hazard within the subject building does not differ from a typical Class 3 ski lodge building.
(e) the height of the building; and	The subject building has a rise in storeys of 3 with a minimum of 2 exits available from each storey.
(f) its proximity to other property; and	The subject building is located 21m from the nearest building resulting in fire spread being unlikely to occur.
(g) any active fire safety systems installed in the building; and	The buildings fire safety systems will comply with the DTS provisions. It is recommended that the non-required AS2118.4-2012 sprinkler system be installed with an additional sprinkler

C1P1 Structural Stability During a Fire	
	head to all bathrooms associated with the SOUs on Levels 1 and 2.
(h) the size of the fire compartment; and	The fire compartment size does not differ from a DTS arrangement.
(i) fire brigade intervention; and	The provision of a smoke detection system with detectors spaced in accordance with AS1670.1 throughout all areas ensure early notification to occupants and the ability of the installed sprinkler system shall assist in ensuring occupants time to safely evacuate and the fire to be suppressed / controlled until the local fire brigade arrives. All levels of the building shall be in reach of a FRNSW aerial appliance.
(j) other elements they support; and	Not applicable to the subject performance solution.
(k) the evacuation time.	The proposed sprinkler system installed throughout the building will assist in suppressing any fire from achieving flashover and ensuring structural adequacy of the building enabling safe evacuation of occupants, given exits are located within compliant distances of the SOUs. Further this, the proposed upgrade with a full AS1670.1 smoke detection system throughout will ensure all occupants of the building are notified simultaneously in the event of a fire alarm.

C1P2 Spread of fire	
(1) A building must have elements which will, to the degree necessary, avoid the spread of fire -	
(a) to exits; and	The inclusion of the additional sprinkler head to each of the bathrooms associated with SOUs shall ensure that public corridors remain tenable for the period for occupants to egress from the building.
(b) to sole-occupancy units and public corridors; and	The existing fire-resistant construction to SOUs and the installation of additional sprinkler heads shall prevent the spread of fire for the period required for occupants to egress from the building.
(c) between buildings; and	Given the distance between adjoining properties fire spread between buildings shall not occur.
(d) in a building.	The existing fire-resistant construction to SOUs and the installation of additional sprinkler heads shall prevent the spread of fire for the period required for occupants to egress from the building.
(2) Avoidance of the spread of fire referred to in (a) must be appropriate to -	
(a) the function or use of the building; and	The subject building is deemed to be a typical Class 3 ski lodge building.
(b) the fire load; and	The fire load contained within the subject building is considered to be typical of a Class 3 ski lodge building.
(c) the potential fire intensity; and	The fire intensity within the subject building is considered to not differ from a typical Class 3 ski lodge building.
(d) the fire hazard; and	The expected fire hazard within the subject building does not differ from a typical Class 3 ski lodge building.
(e) the number of storeys in the building; and	The subject building has a rise in storeys of 3 with a minimum of 2 exits available from each storey.
(f) its proximity to other property; and	The subject building is located 21m from the nearest building resulting in fire spread being unlikely to occur.
(g) any active fire safety systems installed in the building; and	The buildings fire safety systems will comply with the DTS provisions. It is recommended that the non-required AS2118.4-

C1P2 Spread of fire	
	2012 sprinkler system be installed with an additional sprinkler head to all bathrooms associated with the SOUs on Levels 1 and 2.
(h) the size of any fire compartment; and	The fire compartment size does not differ from a DTS arrangement.
(i) fire brigade intervention; and	The provision of a smoke detection system with detectors spaced in accordance with AS1670.1 throughout all areas ensure early notification to occupants and the ability of the installed sprinkler system shall assist in ensuring occupants time to safely evacuate and the fire to be suppressed / controlled until the local fire brigade arrives. All levels of the building shall be in reach of a FRNSW aerial appliance.
(j) other elements they support; and	Not applicable to the subject performance solution.
(k) the evacuation time.	The proposed sprinkler system install throughout the build will assist in suppressing any fire flashover area ensuring structural adequacy of the building enabling safe evacuation of all occupants. Further this, the proposed upgrade with a full AS1670.1 smoke detection system throughout will ensure all occupants of the building are notified simultaneously in the event of a fire alarm.

6.7 Assessment Conclusion

The above assessment demonstrates qualitative analysis that the trial design proposed satisfies the relevant Performance Requirements C1P1 and C1P2 subject to the following measures:

1. An additional sprinkler head shall be installed to each of the bathrooms associated with the SOUs on Level 2 and 3.
2. The sprinkler is to be sidewall sprinkler head installed in a manner which provides sprinkler coverage to the entire room which they serve.
3. All Bathrooms associated with SOUs on Level 2 and 3 shall be installed with either of the following:

   (a) exhaust fans which are directly connected to the atmosphere via a non-combustible bulkhead/pipe.

   OR

   (b) existing exhaust fans are to be replaced with a fire damper, such as Kilargo intumescent IFD-0 series or similar, to maintain the fire-resistance level of the ceiling.

4. Where the exhaust fan has been removed the existing opening in the ceilings are to be infilled and sealed by a system which achieves a fire resistance of 60 minutes.

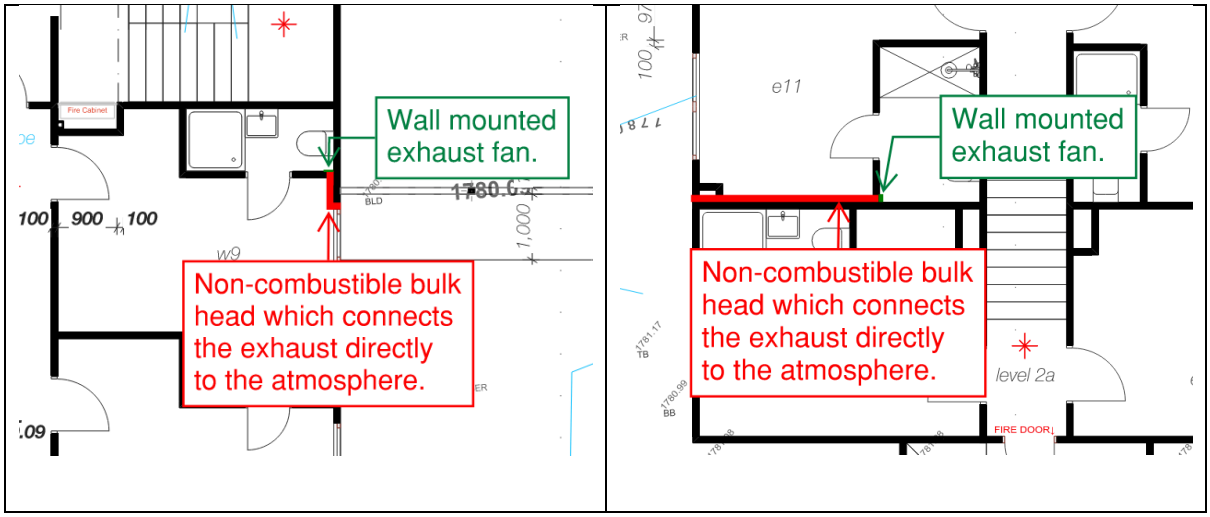


Figure 44 - Wall mounted exhaust fans and non-combustible bulkhead

7.0 INSPECTION, MAINTENANCE & COMMISSIONING

7.1 Good housekeeping

The ongoing management of the building should ensure good housekeeping procedures. The following matters should be considered by building management:

- 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 firefighting equipment.

7.2 Installation & commissioning

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 and attached Annual Fire Safety Statement.

7.3 Building management & maintenance

The management of the building must be aware of the upgrade strategies applicable to the building, as well as the required measures for maintenance.

Management measures must be in place to ensure satisfactory maintenance, testing and inspection of all fire safety measures.

8.0 CONCLUSIONS

8.1 Conclusion

The Performance Solutions proposed as part of this Fire Safety Upgrade Master Plan Report have been developed using the techniques outlined within BCA Clauses A2G2(1)(a) and A2G2(2)(c), and demonstrate compliance with the relevant performance requirements C1P1, C1P2, C1P4, D1P2, D1P4, D1P5 and D1P6 and through adoption of the trial design which deviates from the prescriptive DTS provisions of the BCA.

Accordingly, based on the above, it is considered that the directly related Performance Requirements C1P1, C1P2, C1P4, D1P2, D1P4, D1P5 and D1P6 have been met, provided the Performance Solution requirements listed above are implemented.

8.2 Specification of the Final Trial Design

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 C1P1, C1P2, C1P4, D1P2, D1P4, D1P5 and D1P6.

The Performance Solution has been developed using absolute assessments utilising qualitative techniques and is considered to comply with BCA Performance Requirement C1P1, C1P2, C1P4, D1P2, D1P4, D1P5 and D1P6. The BCA recognises these Assessment Methods as acceptable methods for determining that the Performance Solution satisfies the Performance Requirement in accordance with BCA Clauses A2G2(1)(a) and A2G2(2)(c).

8.3 Maintenance Requirements

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

8.4 Proposed Programme for Upgrade Measures

Based upon items contained within this report, the measures detailed in the table in the Executive Summary of this report form the Performance Solution.

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MFSE, B.Eng. (Elec.), B.Med.Sci.
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TAS Registered Building Practitioner (Fire Safety, Building Services)
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BPB Grade A1 Accredited Certifier and PCA
Fire Safety Engineer

9.0 REFERENCES

1. Australian Building Codes Board (2021), “International Fire Engineering Guidelines”, Australia.

2. Australian Building Codes Board (2022), “The Building Code of Australia”, Australia.

3. Australian Building Codes Board (2022), “The Guide to the Building Code of Australia”, Australia.

4. White, R. H., Charring Rates of Different Wood Species (Ph.D. thesis), Univ. Wisconsin, Madison (1988).

5. The Institution of Engineers, 1989

6. Australian Building Codes Board AS 3959-2009 Construction of buildings in bushfire prone areas

7. Chulikavit, Nattanan, Thermal degradation and flame spread characteristics of epoxy polymer composites incorporating mycelium, RMIT (2023).

APPENDIX A - SPRINKLERS AS AN ALTERNATIVE TO PASSIVE PROTECTION

Sprinklers are subject to failures, but so are passive systems. In general, however, statistical data shows that sprinklers are more effective in reducing fire spread than passive fire protection system i.e. fire rated construction.

"Effectiveness of Fire Safety Components and Systems", I R Thomas [6] details nine to thirteen years of data from 1983 from the USA National Fire Incident Reporting System (NFIRS) database for a range of occupancies. These studies indicate:

- that the proposal is to install a sprinkler system instead of the fire rated construction to the level required by the BCA DTS provisions,
- that sprinklers give at least twice the reduction in fire spread than that required by the BCA.
- that the number of fire fighter and civilian casualties and estimated property losses for offices and retail show that sprinklers are more effective than the fire rated construction resulting in lower fire fighter injuries, fire fighter fatalities, civilian injuries, civilian fatalities and property loss except in one case, the civilian injuries in retail.

Sprinkler System Reliability

Data for reliability has also been compiled by Johansson [8] from a range of sources. Probabilities for a combination of the sprinkler system to activate and thereafter control or extinguish the fire were recorded. This data is summarised in the Table below.

Table 1. Reliability data for sprinkler systems (Johansson)

Source	Time Period	Reliability (%)
Industrial Risk Insurers	1975-1992 full sprinkler protection	98
NFPA	1925-1969	96.2
Department of Energy (DOE)	1952-1980	98.2
Australian and New Zealand data	1886-1968	99.8
Australian and New Zealand data	1968-1977	99.3
England (fire and loss statistics)	1965-1969	91.8
England (fire and loss statistics)	1966-1972	78.2

Similar data was also presented in a study by Edward and as summarised in Table 2 below for general occupancies.

Table 2 – Reliability data for sprinkler systems (Edward and Budnick)

Reference and Publication Year	Reliability (%)
Building Research Est., 1973	92.1
Miler, 1974	95.8
Miler, 1974	94.8
Powers, 1979	96.2
Richardson, 1985	96
Finucane et al, 1987	96.9-97.9
Maryat, 1988	99.5

Statistical analysis of sprinkler protection records in Australia and New Zealand between 1886 and 1986 has been undertaken by Marryatt [1].

With regards to health-care buildings (comprising hospitals), the statistics indicate that 100% of 157 fires were controlled by the successful operation of the installed sprinkler systems. The statistics indicate:

- 84 % of fires were controlled by the activation of 1 sprinkler head;
- 97 % of fires were controlled by the activation of 2 sprinkler heads;
- 100% of fires were controlled by the activation of 3 sprinkler heads;

A 100% record of fire control is idealistic, and is probably a consequence of the number of fires that have been recorded in the analysis.

However, in as represented by the above statistics sprinklers have an excellent record for controlling fires when they are installed and maintained properly, such that they activate successfully and perform as designed in a fire incident.

It is worth noting that the terminology "sprinkler-controlled fire" does not mean that the fire has been extinguished. Rather, it means that the fire growth rate and spread has been controlled by the sprinkler activation. This acknowledges the fact that objects in the room may protect the seat of fire, such that the water discharge by the sprinkler system is unable to make direct contact with the combustible fuel surface(these are referred to as shield fires). Such a situation may occur with a fire beneath a table or behind furniture.

Marryatt (1) provides one of the most widely referenced studies of sprinkler system reliability on a 100-year study of fires in automatic sprinkler protected buildings in Australia and New Zealand. The statistical data shows that for a total of 9,022 recorded fires in 231 occupancies types, the following key facts were reported:

- Sprinklers controlled 99.46% of all fires reported
- Five or fewer sprinklers controlled over 90% of reported fires.
- In institutional and residential occupancies, there were three fire deaths in the 100-year period. In these cases, the deceased was "intimate with the source of ignition."

It is also worth mentioning that in all of the 9,022 recorded fires, standard sprinkler heads were used. The NFPA Handbook (2) has summarised statistics from 2,860 fire incidents where fire sprinklers were provided (refer 6-10A). Of these fire incidents, 74% of them were controlled by the action of 6 or less sprinkler heads and only 6 fires occurred where it activated more than 26 sprinkler heads.
The Fire Engineering Safety Guidelines (3) suggests the failure rate for new sprinkler heads to operate correctly has been estimated at 3.1% (reliability = 96.9%) and for old sprinklers at 5.1% (reliability = 94.9%).

Powers (4) provides the sprinkler reliability of success to be 98.8% for high-rise office buildings only in New York City, other than office buildings is 98.4% and for low-rise buildings is 95.8%.
For further information on the reliability of automatic sprinkler systems, Koffell (5) has produced a paper regarding sprinkler reliability based on NFPA data. The paper analyses 273,400 actual fires occurred between 1989-1999 where sprinklers were present. In 83.6% of fires sprinklers operated, it is noted that in a number of the remaining cases the fire was too small to operate the sprinklers.

The following are possible reasons why there may not be water at the sprinkler head:

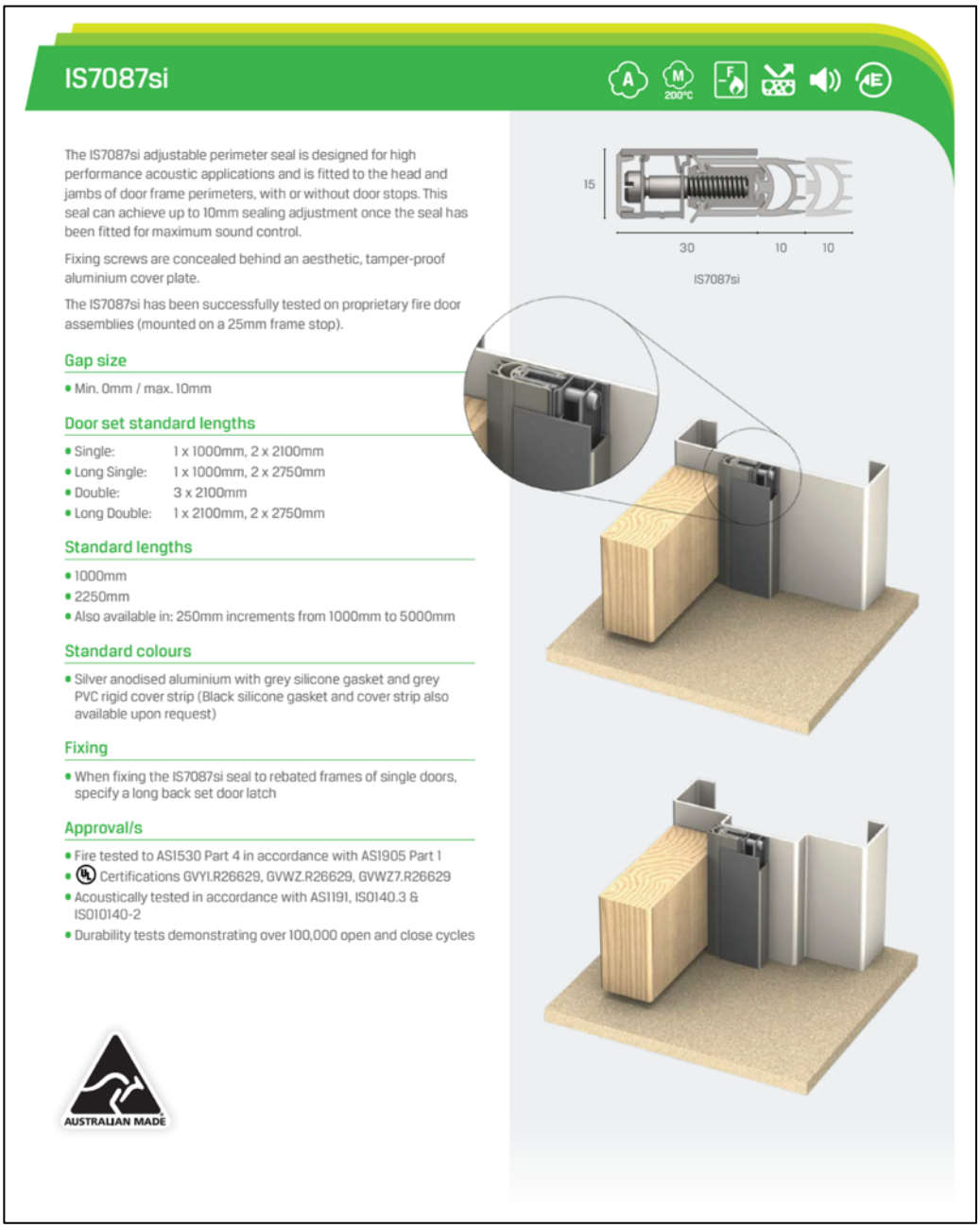
- No water to the building due to mains breakdown or total isolation
- Blockages within pipe work such that a sprinkler branch is isolated. Provided the system is adequately commissioned and subsequent tenancy work undertaken by qualified and competent fitters it is considered that the likelihood of this occurrence is extremely small. The use of end-of-line testing could further provide a check on this matter.
- Sprinkler head operates but debris introduced into pipe work blocks this isolated sprinkler head. Again, this is considered to be extremely unlikely especially if proper commissioning and

maintenance has taken place. Additionally, the chance of two adjacent heads being blocked in this manner, will be close to zero.

- System has been unintentionally or intentionally isolated at stop valve.
- Part or all of the sprinkler system is isolated for tenancy upgrades. It is this last factor that has the biggest influence on reliability. Minimising the area isolated and the period of isolation would be important management issues.
- The above discussion illustrates that sprinklers are very effective in mitigating fires as supported by the statistical data listed above and that the probability of a sprinkler system failure is considered low.

According to the Fire Safety Engineering Guidelines [3] it can be assumed that the probability for a sprinkler system to activate is 95% for a flaming non flashover fire and 99% for a flashover fire. The probability of sprinkler control after sprinkler activation is estimated to be 99%.

APPENDIX B – KILARGO SPECIFICATION



IS7087si

The IS7087si adjustable perimeter seal is designed for high performance acoustic applications and is fitted to the head and jambs of door frame perimeters, with or without door stops. This seal can achieve up to 10mm sealing adjustment once the seal has been fitted for maximum sound control.

Fixing screws are concealed behind an aesthetic, tamper-proof aluminium cover plate.

The IS7087si has been successfully tested on proprietary fire door assemblies (mounted on a 25mm frame stop).

Gap size

- Min. 0mm / max. 10mm

Door set standard lengths

- Single: 1 x 1000mm, 2 x 2100mm
- Long Single: 1 x 1000mm, 2 x 2750mm
- Double: 3 x 2100mm
- Long Double: 1 x 2100mm, 2 x 2750mm

Standard lengths

- 1000mm
- 2250mm
- Also available in: 250mm increments from 1000mm to 5000mm

Standard colours

- Silver anodised aluminium with grey silicone gasket and grey PVC rigid cover strip (Black silicone gasket and cover strip also available upon request)

Fixing

- When fixing the IS7087si seal to rebated frames of single doors, specify a long back set door latch

Approval/s

- Fire tested to AS1530 Part 4 in accordance with AS1905 Part 1
- Certifications GVYI.R26629, GVWZ.R26629, GVWZ7.R26629
- Acoustically tested in accordance with AS1191, ISO140.3 & ISO10140-2
- Durability tests demonstrating over 100,000 open and close cycles

AUSTRALIAN MADE

IS8010si

A medium duty, concealed automatic door bottom seal which is mortised into the bottom edge of single action doors. It operates automatically by a spring loaded mechanism which lifts the seal clear of the floor as soon as the door is opened.

Mounted into a 35mm deep x 15mm wide machined groove, the seal is screwfixed back into the door stiles via stainless steel end plates, holding the seal in place. The seal operates automatically by pressure against the door jamb on its adjustable strike button. The seal contains a high efficiency mechanism to assist with the closing force requirements detailed in AS1428/1 (Design for Access and Mobility).

Gap size

- Min. 3mm / max. 15mm

Standard lengths

- 380mm
- 600mm
- 820mm
- 920mm
- 1070mm
- 1220mm

(*Longer lengths available to special order).

IS8010si maximum allowable cut-back sizes:

- 380mm seal cuts to 275mm
- 600mm seal cuts to 380mm
- 820mm seal cuts to 600mm
- 920mm seal cuts to 820mm
- 1070mm seal cuts to 920mm
- 1220mm seal cuts to 1070mm

(*Seals can be cut on site for exact dimension).

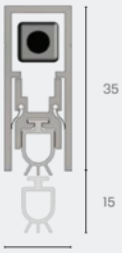
Standard colours

- Silver anodised aluminium with stainless steel end plates, grey silicone gasket. (Black silicone gasket also available upon request.)

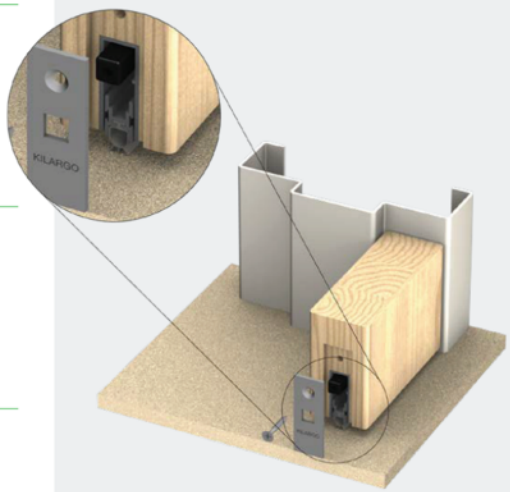
Approval/s

- Fire tested to AS1530 Part 4 in accordance with AS1905 Part 1
- Certifications GVYI.R26629, GVWZ.R26629, GVWZ7.R26629
- Medium temperature smoke leakage approvals to AS1530 Part 7, compliant with AS6905 on proprietary door assemblies
- Conforms with BCA Specification C3.4 smoke sealing requirements
- Acoustically tested in accordance with AS1191, ISO140.3 and ISO10140-2
- Durability tests demonstrating over 1,000,000 open and close cycles

*Note: Radiused stainless steel end plates also available upon request.



IS8010si



APPENDIX C – TABLE D2.16A BARRIER CONSTRUCTION

Table D2.16a Barrier construction

1. Barrier heights

Deemed-to-Satisfy Provisions

Location		Minimum height
(a)	Stairways or ramps with a gradient of 1:20 or steeper.	865 mm
(b)	Landings to a stair or ramp where the barrier is provided along the inside edge of the landing and does not exceed 500 mm in length.	
(c)	In front of fixed seating on a *mezzanine* or balcony within an auditorium in a Class 9b building, where the horizontal projection extends not less than 1 m outwards from the top of the barrier.	700 mm
(d)	In all other locations.	1 m
Notes:		
1.	Heights are measured vertically from the surface beneath, except that for stairways the height must be measured above the nosing line of the stair treads.	
2.	A transition zone may be incorporated where the barrier height changes from 865 mm on a stair *flight* or ramp to 1 m at a landing or floor.	
2. Barrier openings		
Location		**Maximum opening**
(a)	*Fire-isolated stairways*, *fire-isolated ramps* and other areas used primarily for emergency purposes, excluding— (i) external stairways; and (ii) external ramps.	A 300 mm sphere must not be able to pass through any opening; or where rails are used—
(b)	Class 7 (other than *carparks*) and Class 8 buildings.	(i) a 150 mm sphere must not be able to pass through the opening between the nosing line of the stair treads and the rail or between the rail and the floor of the landing, balcony or the like; and (ii) the opening between rails must not be more than 460 mm.
(c)	In all other locations.	A 125 mm sphere must not be able to pass through any opening.
Note: The maximum 125 mm barrier opening for a stairway, such as a non *fire-isolated stairway*, is measured above the nosing line of the stair treads.		
3. Barrier climbability		
Location		**Requirement**
(a)	*Fire-isolated stairways*, *fire-isolated ramps* and other areas used primarily for emergency purposes, excluding— (i) external stairways; and (ii) external ramps.	No requirement.
(b)	Class 7 (other than *carparks*) and Class 8 buildings.	
(c)	For floors more than 4 m above the surface beneath in all other locations.	Any horizontal or near horizontal elements between 150 mm and 760 mm above the floor must not facilitate climbing.