GUNUMA LODGE
SMIGGIN HOLES NSW

FIRE SAFETY UPGRADE MASTER PLAN
DEVELOPED FOR CERTIFYING AUTHORITY REVIEW

DATE: 28 AUGUST 2019
REPORT NO: 0997 – REV B _ FINAL
PREPARED FOR: GUNUMA LODGE PTY
PREPARED BY: J² CONSULTING ENGINEERS | **FIRE SAFETY ENGINEERING**

J Squared Engineering Pty. Ltd. ACN 605 793 986
FIRE SAFETY ENGINEERING | ESSENTIAL SERVICES MAINTENANCE MANAGEMENT | BUILDING SERVICES DESIGN
NSW Office - PO Box 169, Jindabyne NSW 2627, Phone: 02 6456 1285, Mobile: 0427 571 420
SA Office - PO Box 146, Magill SA 5072, Phone: 08 8390 0462, Mobile: 0412 882 122
NSW Office – PO Box 320, Harbord NSW 2096, Phone: 0405 424 676
info@jsquared.com.au www.jsquared.com.au

CONTENTS

REVISION STATUS

REPORT NO.	REVISION	DATE	STATUS	WRITTEN	REVIEWED
0997	REV A	23/10/18	FINAL	JA	JS
0997	REV B	28/08/19	FINAL	JA	JS

EXECUTIVE SUMMARY & RECOMMENDATIONS

J² Consulting Engineers have been commissioned to carry out a review of the development application for proposed alterations and additions to the existing Gunuma Lodge accommodation building located at Smiggin Holes NSW and to develop a master plan outlining the proposed strategies for upgrade for submission to Dept. of Planning.

The works discussed in this fire safety upgrade report are proposed as a fire safety upgrade strategy for the existing building and proposed alterations and additions. The objective of the upgrade strategy is to improve the fire safety features of the building and demonstrate that the fire protection and structural capacity of the building will be appropriate to the building's proposed use and that there is a restriction of fire spread from the building to other buildings such that the relevant legislative requirements are satisfied.

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 Hazard Properties** Permit the internal wall linings to remain timber pine clad	C1.10	CP4	Qualitative assessment demonstrating compliance with the relevant performance requirements under A2.2(1)(a) and A2.2(2)(b)(ii) and (c)
2.	**Bounding Construction** a) Permit the bounding walls of SOUs to not achieve the requirements of C1.1 Table 5 b) Permit the bounding walls of corridors to not achieve the requirements of C1.1 Table 5 c) Permit the load bearing walls supporting fire resisting elements to not require an FRL. d) Permit the floor/ceiling separation between ground floor and level one to not achieve the required FRL throughout. **e)** Permit the ceilings of the upper level to not achieve the required resistance to insipient spread of fire of 60 minutes.	C1.1 Table 5	CP2	Qualitative assessment demonstrating compliance with the relevant performance requirements under A2.2(1)(a) and A2.2(2)(b)(ii) and (c)
3.	**Thresholds** Permit the doors from the northern and southern corridors leading into the common lounge area to have a step closer to the doorway than the width of the door leaf.	D2.15	DP2	Qualitative assessment demonstrating compliance with the relevant performance requirements under A2.2(1)(a) and A2.2(2)(b)(ii) and (c)

Fire Safety Upgrade Measures

The performance solution demonstrates compliance with the above performance requirements providing the following requirements are adhered to:

Fire Safety Strategy Upgrade and Performance Solution Measures	Completion Date
1. A copy of manufacturers testing and compliance for the existing carpet installed as per the requirements of Specification 1.10 clause 3 of the BCA. 2. The wall linings are primarily pine timber lining boards and do not comply with specification C1.10-4. a) Install protective covers to all timber lined walls and ceilings (excluding SOU's, public corridors and public lobbies) to achieve (i) a smoke growth rate index not more than 100; or (ii) an average specific extinction area less than 250m2/kg **Sprinkler alternative** As an alternative to completing item 1 and 2 above, a residential sprinkler system complying with AS 2118.4 is to be installed throughout the building.  Figure 1 – first floor lounge area  Figure 2- Ground floor games room 3. Fire resisting construction for type C buildings a) Install one layer of 16mm thick fire rated plasterboard to the inside face of all timber walls bounding the sole occupancy units on level one and two of the building b) Install one layer of 16mm thick fire rated plasterboard to the inside face of all timber walls bounding public corridors, public lobbies and the like. c) Install on layer of 16mm thick fire rated plasterboard to the inside face of all timber walls bounding the internal stairs. d) Install 1 layer of 16mm fire rated plasterboard all the ceilings on the ground floor to achieve a FRL of 30/30/30 e) Install 1 layer of 16mm thick fire rated plasterboard and 1 layer of 13mm thick fire rated plasterboard to all ceilings of SOU's and public corridors on the first floor to achieve a resistance to the incipient spread of fire (RISF) of not less than 60 minutes. It was apparent during the site inspection that some lining works had been completed to the downstairs games and TV room. Compliance would need to be confirmed that the lining works completed achieve the required FRL of 30/30/30 **Sprinkler alternative** As an alternative to completing item 3 above, a residential sprinkler system complying with AS 2118.4 is to be installed throughout the building.	**Prior to winter 2020** **Prior to winter 2020**

Figure 3 – First floor corridor first floor

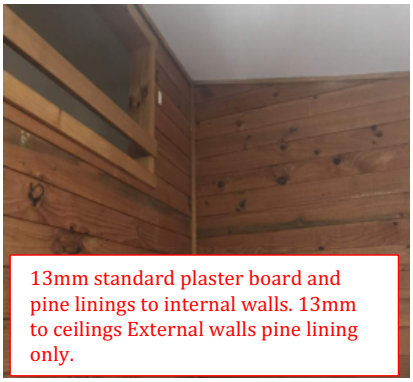


Figure 4 – Bedroom

4. Enclosure of space under stair or ramp

The storage area under the stairs is to be lined with 1 layer of 16mm fire check plasterboard and a fire door and jamb achieving a rating of – /60/30. It was apparent during the inspection that some lining works had been performed in this area, but confirmation is required that works completed achieves the required FRL 60/60/60.

Prior to winter 2020

Alternatively this issue can be addressed via the installation of the residential sprinkler system.

Figure 5 – Storage area under internal stairs

5. Handrails are required to be installed on stairs leading down from SOU corridors on both north and south wings leading to the lounge area and to external stair on the ground floor of the southern wing.

Prior to winter 2020

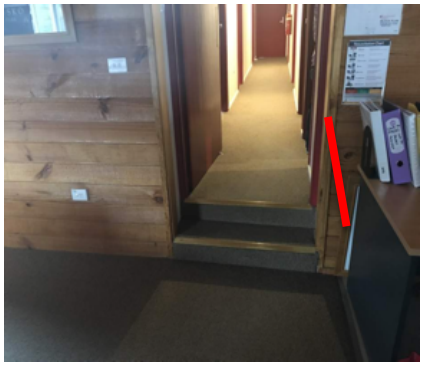


Figure 6 – Handrail to be installed to exit stair in stair for both Nth and Sth wings in compliance with D2.17

Figure 7 – Handrail to be installed to compliance with D2.17

6. The external stair on the ground floor of the southern wing requires a floor surface that consists of steel mesh or other suitable material to comply with BCA clause G.4	**Prior to winter 2020**

Figure 8 – Timber treads to exit stairs

7. The doors from the northern and southern corridors leading into the common lounge area on the first floor are to have <u>a step no closer to the doorway</u> than the width of the door leaf as required by BCA Clause D2.15. To satisfy performance requirement DP2 we propose the installation of signage in contrasting colours with letters no smaller the 40mm stating "CAUTION WATCH YOUR STEP" on either side of both the northern and southern first floor corridor doors accessing the lounge. In addition to this we propose contrasting in colour slip resistant nosing to be installed to stairs as a further warning to occupants to the potential trip hazard.	**Prior to winter 2020**

Figure 9 – Corridor door to close to threshold

Figure 10 – Signage required to both sides of door

8. The ground floor main exit door to the west towards Link Road requires a permanent "OPEN INWARDS" sign to be fixed. Currently a temporary sign affixed. Other exit doors should be checked and confirmed for compliance. Decal should be fixed to any glazing which could be confused for an open doorway.	**Prior to winter 2020**

 Figure 11 – Temporary open inwards sign to entry door	
9. Proposed bathroom Renovations On initiation of the proposed future bathroom renovations the bounding walls to SOU's and public areas must be lined with fire resistant plasterboard achieving and FRL of no less than 60/60/60 and ceilings 30/30/30	**Prior Winter 2021**
10. Proposed future electrical switchboard upgrade The proposed future works to the existing electrical switchboard is to be in accordance with AS 3000. Prior to works commencing information should be sought from a qualified electrical engineer to ensure compliance with BCA and Australian Standards	**Prior Winter 2021**

Where design changes occur or a change of occupancy occurs, subsequent to the measures mentioned above being provided, the validity of this fire safety upgrade analysis may be compromised, and further analysis will be required.

1.0 INTRODUCTION

J² Consulting Engineers have been commissioned to carry out a review of the fire safety provisions associated with the existing Gunuma Lodge in Smggin Holes 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 on as per the figure below.

Figure 1 –Aerial Image of Site (courtesy of google)

1.1 Basis of the Report

This report is based upon the following:

- Site inspection undertaken 18th October 2018

1.2 Purpose of the Report

This report has been prepared to identify BCA non-compliant 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	Gununa Lodge
Consent Authority	Dept. of Planning
Fire Engineer	J² Consulting Engineers

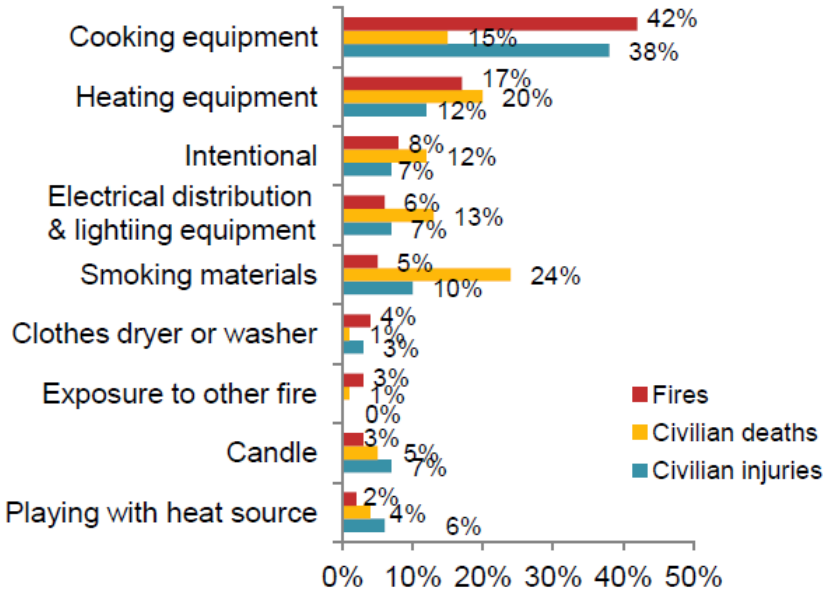
2.2 Building and Occupant Characteristics

General Building Characteristics

Building Characteristic	Description
Occupancy/Use Building Class/es: Type of construction: Effective Height:	Residential Accommodation Class 3 Type C (subject to C1.5) Less than 25m
Location: General description of development:	Link Road Smiggin Holes NSW • The building has two storeys and has a license for 40 beds. • Ground floor level: contains 10 SOUs, Sauna, Ski and drying rooms, games rooms and sanitary facilities. • Level one; contains a lounge area, kitchen and dining, 10 SOUs and sanitary facilities • The building is constructed on brick piers with block subfloor and two levels of timber framing with metal cladding. The roof structure is timber framed and metal clad. • The SOUs are separated 13mm standard plasterboard and pine lined. Doors serving the SOUs are solid core doors in metal jambs. • The building is constructed enabling egress from ground and level 1.

Occupant Characteristics

Occupant Characteristic	Description
Type and number	The lodge has a license to sleep forty persons. The occupancy is not expected to exceed this number.
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 roadway but some may be of limited mobility. This is unlikely given access to the lodge requires a person to descend the internal stair and movement within the lodge to the sleeping accommodation requires the use

Occupant Characteristic	Description
	of more stairs. 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 provided with a choice of exits via corridors to external stairs or the internal stair shaft. Fire orders are 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, typically consisting of fires eventuating from cooking, electrical faults, heating equipment. Smoking is not permitted within the building. Refer image below from the National Fire Protection Association in the USA (Ahrens 2011).  Major Causes of US Home Structure Fires 2006-2010 (Ahrens 2011)

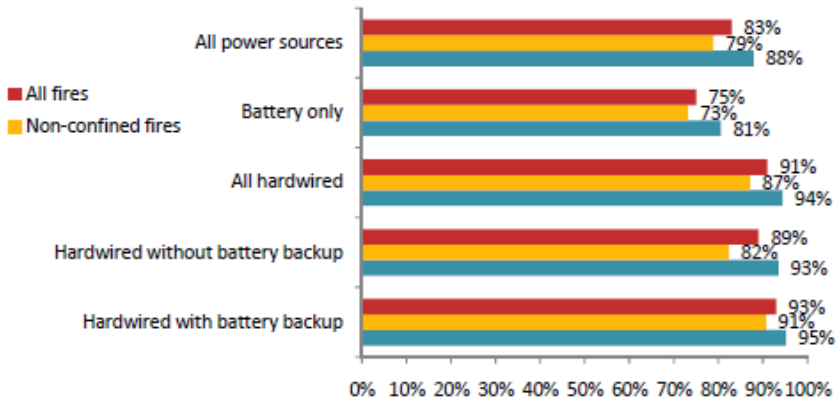
2.3 Hazards, Preventative and Protective Measures Available

The following hazards have been identified.

Hazard	Details/Precaution
General Layout and Design	No hazards identified with design.
Activities	Information is not available to suggest that activities outside those normally undertaken in a similar building will be undertaken.
Cooking	The lodge is provided with a large commercial type kitchen.
Smoking	Smoking is strictly not permitted within the building.
Electrical Equipment	Failure of heating equipment presents the largest risk other than the kitchen.
Multiple arson attack, malicious acts, and acts of terrorism.	The resulting impact of fires from these hazards has not been addressed in this report.

Hazard	Details/Precaution
Sauna	There is a sauna facility in the building located on the ground floor adjacent to the southern wing. Electrical malfunction, or items left on the heating element can cause fire. Regular servicing and appropriate signage for users can minimise this risk.

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

Sub-System	Present in Building/Requirements
A Fire initiation, development and control	Fire loads or heat release rates are not proposed to be in excess of a normal class 1 or 2 dwelling with the fire load within short term rentals equivalent to that of a class 3 dwelling.
B Smoke development, spread and control	Smoke development and spread will not be inconsistent with that of a normal class 3 dwelling.
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 and by a new automatic sprinkler system compliant to AS 2118.1 to minimise control spread of fire.
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.  Smoke Alarm Operation in Reported Home Fires 2003-2006 (Ahrens 2010)
E Occupant evacuation and control	Each level of the building is provided with at least one exit. The exits are linked by a network of external paths and stairs leading to either Link Road or Plum Pine Road

Sub-System	Present in Building/Requirements
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 2.2km of the building.  **Figure 1 – Gunuma Lodge is located within 2.2km of the Perisher Fire 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.	
Sub- system D- Fire detection, warning and suppression	Automatic and manual detection equipment Automatic and manual warning equipment Surveillance equipment Automatic suppression equipment	

3.0 BCA COMPLIANCE REVIEW

3.1 The Building Code of Australia

The BCA assessment included within this report has been undertaken with regards to items relating to fire and life safety, health and amenity of the building occupants. Items such as part B Structural Integrity and Part J Energy Efficiency have not been assessed.

This analysis has been undertaken to the currently legislated BCA 2019, which was not the legislated Building Code of Australia at the time of design or construction, however; the current legislation provides a benchmark that a building should be assessed against for any due diligence review by the building occupants.

3.2 General overview

This section of the report assesses the existing building in its current state, against current legislative requirements. Whilst there is no requirement to retrospectively upgrade the building (refer above for further details), the current BCA provides a community-accepted level of life safety for buildings. For the purposes of assessment, the building has been assessed in accordance with the BCA's prescriptive (Deemed to Satisfy) provisions.

BCA Section A – Building Classification
The existing building is a Class 3 building.

BCA Section B - Structure
The condition of the existing building in relation to the existing structure is outside the scope of this report.

Generally, the building appeared to be in a sound condition. As we were unable to undertake a thorough investigation of the internal parts of the building, we were unable to detect any structural issues. However, the exterior part of the building generally looked in sound condition with no obvious cracking or subsidence observed.

BCA Section C - Fire Resistance
The building, for purposes of this report, has been assessed as of Type "C" construction subject to section C1.5 in the BCA.

This requires bounding walls of SOUs and bounding walls and of public corridors to be of a minimum FRL of 60/60/60. This is not achieved with current construction as walls consist of 13mm non fire rated plasterboard with some including additional pine timber cladding fixed over the surface. The level one floor structure is timber framed and does not have a FRL of 30/30/30 or a fire protective covering on the underside of the floor. (13mm plasterboard installed) The first floor wall linings to not continue through to the underside of the metal roof cladding and the ceilings do not achieve a resistance to the incipient spread of fire (RISF) of not less than 60 minutes.

The external walls consist of metal clad timber frame and comply under the requirements of Table 5 in that the fire source features are set well back.

Due to the above non-compliances we have proposed a performance based solution referenced in the table 3.2 and detailed in section 4 Performance Solution 1 in this report.

BCA Section D – Access and egress
Each level is served by at least two exits. The corridors serving the SOUs on level 1 both have exits directly to the outside via stairs to the north and south. The corridors also access the lounge area which has and exit to the east onto Plum Pine Road and additional exit via internal stairs to the ground floor.

The lounge, kitchen and dining have exits to the east onto Plum Pine Road and west via the internal stairs to Link Road. On the ground floor the corridors serving the SOU's have an identical setup to level one exiting to the north and south. All other areas on the ground floor can exit via exit doors to the east and the west to Plum Pine Road and Link Road respectively.

Minor deviations with respect to handrails and signage were identified during the inspection are detailed in the table 3.2 below.

Observed, was non-compliance of clause D2.15 thresholds on the first floor corridors serving the SOU's. A performance solution has been proposed and is detailed in Section 5 – Performance solution2 of this report.

BCA Section E – Services and Equipment

The building is a two-storey class 3 and therefore is required under Table E2.2a to be provided with an automatic smoke detection and alarm system. The inspection identified that a smoke detection and alarm system was present.

Emergency lighting and exit signage is installed throughout and appears to generally comply with E4.2 and E4.4. Certification to be provided to confirm compliance with AS 2293.1-2005.

On inspection, the fire resistance requirements in BCA section C are not met, therefore requiring a performance solution involving the design and installation of an automatic sprinkler system complying with AS2118.4 throughout the building. This is detailed in Section 4 – Performance solution 1 of this report

Part F – Health and amenity

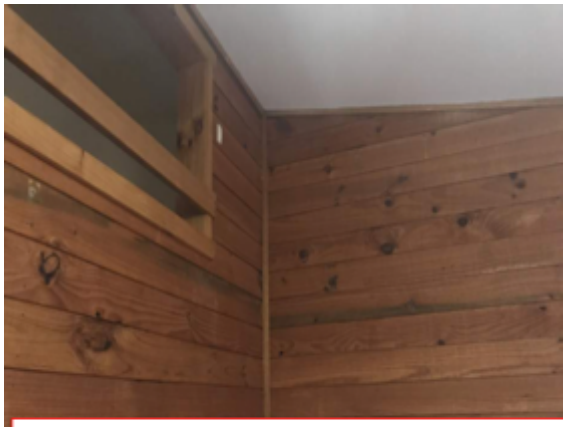
There were no health and amenity non-compliances observed during the inspection.

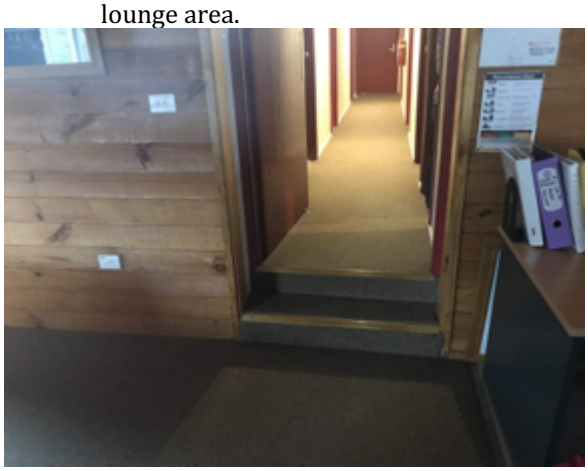
3.2 Table of deviations identified

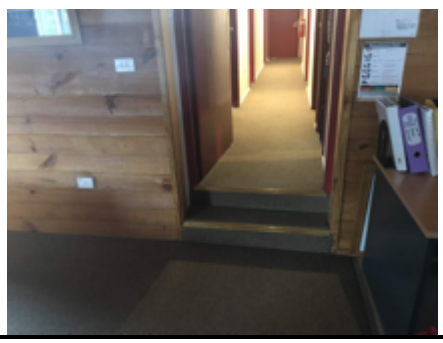
The following assessment against current BCA provisions has been undertaken with any non-compliances listed and the proposed strategy for upgrade noted. The assessment has been undertaken on the existing building and the proposed staged development works.

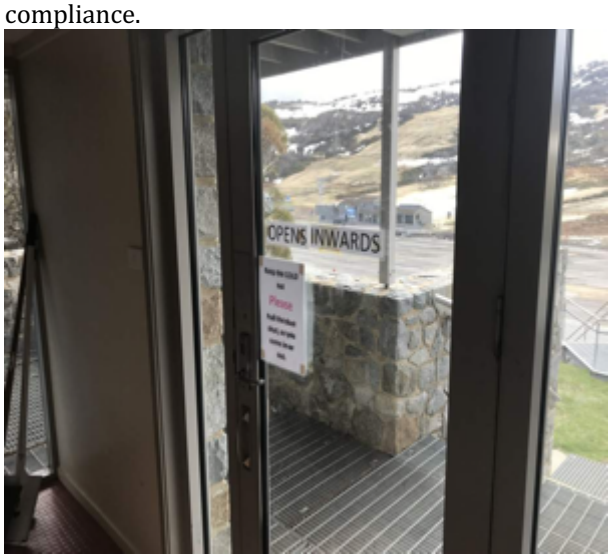
BCA Clause	Assessment	Status	Proposed Method of Upgrade
C1.1	**Type of construction** The building has a rise in stories of two making it Type C construction subject to condition C1.5. The construction is timber framed with internal linings mix of plasterboard and pine boards. The external is metal clad.	Note	No upgrade proposed
C1.10	**Fire hazard properties** a) The existing carpet linings are understood to be wool rich carpets.	Potentially non-compliant	Deemed to satisfy solution Supporting documentation to be supplied by carpet manufacturer to confirm compliance with BCA specification C1.10 Table 2. Critical Radiant Flux of 2.2 kW/m2 if building is fitted with a sprinkler system

	b) The wall lining are primarily pine timber lining boards and do not achieve the required Group number under Table 3 of Spec C1.10  Figure 1 – first floor lounge area  Figure 2- Ground floor games room	Non-Compliant	Deemed to satisfy solution. Install protective covers to all timber lined walls and ceilings (excluding SOU's, public corridors and public lobbies) to achieve a smoke growth rate index not more than 100; or an average specific extinction area less than 250m2/kg This can be achieved via a single layer of 10mm plasterboard. Or Performance solution proposed. Refer to Section 4 performance solution 1 in this report
C1.8	**Lightweight construction** The following non-compliances were identified with the existing lightweight construction. • The construction of the building, in particular the lightweight internal timber wall system, does not provide compliant bounding construction between SOUs and between SOUs and the common corridor. Subsequently, in the event of a fire, it is expected that fire would rapidly spread between SOUs and paths of travel. This issue has been addressed via an Alternative Solution. • The floor/ceiling system separating the ground floor from the upper level does not achieve an FRL of 30/30/30 as required by Clause 5.1 of Spec C1.1. • Some of the ceilings of the upper level, being timber lined, do not achieve the required	Non-Compliant	Deemed to satisfy solution Install one layer of 16mm thick fire rated plasterboard to the inside face of all timber walls bounding the sole occupancy units on level one and two of the building and; Install one layer of 16mm thick fire rated plasterboard

	resistance to insipient spread of fire (RISF) of 60 minutes. • Bathrooms linings adjacent to bedrooms and common areas do not comply.  Figure 3 – First floor corridor  Figure 4 – Bedroom first floor		to the inside face of all timber walls bounding public corridors, public lobbies and the like. And; Install on layer of 16mm thick fire rated plasterboard to the inside face of all timber walls bounding the internal stairs. And; Install 1 layer of 16mm fire rated plasterboard all the ceilings on the ground floor to achieve a FRL of 30/30/30 And; Install 1 layer of 16mm thick fire rated plasterboard and 1 layer of 13mm thick fire rated plasterboard to all ceilings of SOU's and public corridors on the first floor to achieve a resistance to the incipient spread of fire (RISF) of not less than 60 minutes. or Performance solution proposed. Refer to Section 4 performance solution 1 in this report
D2.8	**Enclosure of space under stairs and ramp**	Non-Compliant	Deemed to satisfy solution.

	The storage area under the internal stairs was enclosed and appeared to be insufficiently lined and requires a fire door FRL -/60/60  Figure 5 – Enclosure under stairs no FRL		The storage area under the stairs is to be lined with 1 layer of 16mm fire check plasterboard and a fire door and jamb achieving a –/60/30 rating needs to be fitted. Install sprinkler system as alternative.
D2.17	**Handrails** a) Handrails are required to be installed on stairs leading down from SOU corridors on both north and south wings leading to the lounge area.  Figure 6 – Stair requires handrail	Non-Compliant	Deemed to satisfy solution Handrails are required to be installed on stairs leading down from SOU corridors on both north and south wings leading to the lounge area complying with D2.17

	b) Handrail to be installed to external stair on the ground floor of the southern wing.  Figure 7 – Stair requires handrail	Non-Compliant	Deemed to satisfy solution Handrail to be installed to external stair on the ground floor of the southern wing complying with D2.17
G4.7	**External trafficable structures** The external stair on the ground floor of the southern wing requires a floor surface that consists of steel mesh or other suitable material.  Figure 8 – Timber treads to exit stairs	Non-Compliant	Deemed to satisfy solution Install stair treads with a surface that consists of steel mesh or other suitable material.
	Thresholds The doors from the northern and southern corridors leading into the common lounge area have a step closer to the doorway than the width of the door leaf. 		

D2.15	Figure 9 – step closer to the doorway than the width of the door leaf	Non-Compliant	Performance solution proposed. Refer to Section 5 performance solution 2
G4.3	**External doorways** The round floor main exit door to the west towards Link Road requires a permanent "OPEN INWARDS" sign to be fixed. Currently a temporary one there. Other exit doors should be checked and confirmed for compliance.  Figure 11 – Temporary open inwards sign to entry door	Non-Compliant	Deemed to satisfy solution requires a permanent "OPEN INWARDS" sign to be fixed. Other exit doors should be checked and confirmed for compliance.
E1.3 & G4.8	**Fire Hydrants** Fire hydrant coverage is required 500m2	Potential non-Compliance	
E1.4 & G4.8	**Fire Hose Reels** Fire hose reels were required and installed under the superseded requirements of G4.8.	Compliant	No upgrade proposed
E1.6	**Portable Fire Extinguishers** Extinguishers are required to provide protection to the building and appear to be provided.	Compliant	No upgrade proposed
E2.2 & G4.8	**Smoke Detection and Alarms** The building is currently fitted with a smoke detection system in accordance with AS 1670.1. A manual call point is also provided at the FIP and in corridors to SOUs. Audible alarms have been installed on all levels.	Compliant	No upgrade required
E4.5	**Exit Signs** Illuminated exit signage is provided throughout.	Compliant	No upgrade required
E4.5 & G4.4	**Emergency Lights** The exits from the building are provided with external emergency lighting in accordance with G4.4(c). Internal emergency as observed in corridors leading to exits	Compliant	No upgrade required
G4.9	**Fire Orders** Fire Orders are posted on both levels of the building.	Compliant	No upgrade proposed.

4.0 PERFORMANCE SOLUTION 1 – FIRE RESISTING CONSTRUCTION

It is proposed to develop and alternative solution to permit the following non-compliances:

- The lightweight internal timber and plasterboard wall system which does not provide compliant bounding construction between SOUs and between SOUs and the common corridor.
- The floor/ceiling system separating the ground floor from the upper level does not achieve an FRL of 30/30/30 as required by Clause 5.1 of Spec C1.1.
- The ceilings of the upper level, being timber lined, do not achieve the required Resistance to Incipient Spread of Fire (RISF) of 60 minutes.
- Fire hazard properties, in particular smoke growth rate and average specific extinction area of wall and ceiling linings in the public corridors.

4.1 Deemed-to-Satisfy Deviations

Pursuant to A2.2(3) of BCA the following DTS provisions have been identified as being subject to the performance solution:

C1.1 Type of construction required

(a) The minimum Type of fire-resisting construction of a building must be that specified in Table C1.1 and Specification C1.1, except as allowed for—

(i) certain Class 2, 3 or 9c buildings in C1.5; and

(ii) a Class 4 part of a building located on the top storey in C1.3(b); and

(iii) open spectator stands and indoor sports stadiums in C1.7.

*(iv) * * * * **

(b) Type A construction is the most fire-resistant and Type C the least fire-resistant of the Types of construction.

Table C1.1 TYPE OF CONSTRUCTION REQUIRED

Rise in storeys	*Class of building*	
	2, 3, 9	*5, 6, 7, 8*
4 OR MORE	*A*	*A*
3	*A*	*B*
2	*B*	*C*
1	*C*	*C*

Table 5 Spec C1.1	**Fire Resistance Level Type C**				**Comments**
Building Element	Class 2, 3 & 4 parts	Class 5, 7a, or 9	Class 6	Class 7b or 8	
EXTERNAL WALL (distance to fire source feature)					
Less than 1.5m	90/90/90	NA	NA	NA	NA
1.5 to less than 3m	-/-/-	NA	NA	NA	NA
3m or more	-/-/-	NA	NA	NA	✓

EXTERNAL COLUMN					
Less than 3m	90/-/-	NA	NA	NA	NA
1.5 to less than 3m	-/-/-	NA	NA	NA	NA
3m or more	-/-/-	NA	NA	NA	NA
COMMON WALLS & FIRE WALLS	90/90/90	NA	NA	NA	NA No fire walls
INTERNAL WALLS		NA	NA	NA	
Internal walls bounding public corridors and the like:	60/60/60	NA	NA	NA	**X Lightweight construction to walls between SOUs and corridor on level one does not achieve FRL 60/60/60**
Internal walls between or bounding sole occupancy units	60/60/60	NA	NA	NA	**X Lightweight construction to walls between SOUs on level one does not achieve FRL 60/60/60**
Bounding stairway if required to be rated	60/60/60	NA	NA	NA	**X Lightweight construction to walls between SOUs and stair on level one does not achieve FRL 60/60/60**
Ceilings of SOU's and corridors and rooms bounding SOU's.	Resistance to incipient spread of fire 60minutes	NA	NA	NA	**X Ceilings to SOUs do not achieve an RISF of 60 minutes.**
ROOF	-/-/-	NA	NA	NA	✓

C1.10 Fire hazard properties

(a) The fire hazard properties of the following internal linings, materials and assemblies within a Class 2 to 9 building must comply with ***Specification C1.10****:*
(i) Floor linings and floor coverings.
(ii) Wall linings and ceiling linings.

4.2 Relevant Performance Requirements

Pursuant to A2.2(3) of BCA the following performance requirements have been identified as being directly relevant to the DTS provisions identified above:

CP2
(a) A building must have elements which will, to the degree necessary, avoid the spread of fire -
- *(i) to exits; and*
- *(ii) to sole-occupancy units and public corridors; and*
- *(iii) between buildings; and*
- *(iv) in a building*

(b) Avoidance of the spread of fire referred to in (a) must be appropriate to -
- *(i) the function or use of the building; and*
- *(ii) the fire load; and*

(iii) the potential fire intensity; and
(iv) the fire hazard; and
(v) the number of storeys in the building; and
(vi) its proximity to other property; and
(vii) any active fire safety systems installed in the building; and
(viii) the size of any fire compartment; and
(ix) fire brigade intervention; and
(x) other elements they support; and
(xi) the evacuation time.

CP4
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 performance-based solution formulated in accordance with A2.2(2)(c) and (d) has been adopted to demonstrate the compliance of the Performance Solution with the relevant Performance Requirements.

In accordance with BCA Clause A2.2(3) of the BCA, any alternative solution must consider all relevant performance requirements. Performance Requirement CP2 and CP4 have been identified as being the relevant performance requirements.

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 Requirement CP2 and CP4.

4.5 Qualitative Assessment

Sprinkler Protection alternative
As an alternative to the above proposed passive fire resisting construction noted in **Fire Safety Strategy Upgrade and Performance Solution Measures** in the executive summary at the beginning of this report it is a reasonable option to install a residential sprinkler system throughout the building in accordance with AS 2118.4. 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 associated with the timber wall construction.

Clause 3.10 of Spec C1.1 permits sprinkler systems to be installed as a means of satisfying CP2 in lieu of passive protection in class 3 buildings up to 3 storeys in height. The proposal is therefore comparable to that permitted under the DTS.

With respect to the fire hazard properties, the pine cladding coated with a clear finish does not achieve compliance with Spec C1.10, the fire hazard properties of wall and ceiling linings in a class 3 building. The

critical temperatures for ignition, the toxicity of the smoke generated and the likely hood of accelerated flame spread resulting from the installation combine to cause a hazardous arrangement. It would be necessary to cover the cladding with fire rated plasterboard, as detailed above in all paths of travel and common areas.

The proposal to install a residential sprinkler system would eliminate this non-compliance as pine claddings are permitted in sprinkler protected class 3 buildings.

4.6 Assessment against relevant Performance Requirement

The following is an assessment of the relevant Performance Requirement CP2 and CP4.

CP2	
(a) A building must have elements which will, to the degree necessary, avoid the spread of fire -	
(i) to exits; and	There are 2 or more exits from both levels 1 and 2 that open directly to open space from all levels.
(ii) to sole occupancy units and public corridors; and	Solid core doors and automatic closers achieve Type C compliance An addressable smoke detection system will provide early warning to occupants including additional manual call points in each corridor serving SOU's. The addition of an AS2118.4 compliant automatic sprinkler system will enable early fire suppression reducing the spread of fire.
(iii) between buildings; and	NA to this solution.
(iv) in a building.	The proposed sprinkler system will restrict the spread of fire by comparison to that permitted under Clause 4.10 of Spec C1.1.
(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-	
(i) the function and use of the building; and	The proposed building use does not differ from a DTS arrangement.
(ii) the fire load; and	The addition of an AS2118.4 compliant automatic sprinkler system will create early fire suppression will assist in reducing the fire load
(iii) the potential fire intensity; and	The proposed fire intensity does not differ from a DTS arrangement.
(iv) the fire hazard; and	The proposed fire hazard does not differ from a DTS arrangement.
(v) the number of storeys in the building; and	The proposed number of storeys does not differ from a DTS arrangement.
(vi) its proximity to other property; and	Not applicable to this performance solution.
(vii) any active fire safety systems installed in the building; and	The buildings fire safety systems will comply with the DTS provisions.
(viii) the size of the fire compartment; and	The fire compartment size does not differ from a DTS arrangement.
(ix) fire brigade intervention; and	The building is fitted with a smoke detection system with detectors spaced in accordance with AS1670.1 throughout all areas, and connection to a dispatch centre will ensure that the fire brigade located 2.2km away will arrive within a short period of time during winter months when the lodge is mostly occupied.
(x) other elements they support; and	Not applicable to this performance solution.
(xi) the evacuation time.	The building is afforded with a full AS1670.1 smoke detection system throughout and this will ensure all occupants of the building are notified simultaneously in the event of a fire alarm.

	The addition of an AS2118.4 compliant automatic sprinkler system will sound the occupant warning system again assisting evacuation times.
CP4	
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 addition of an AS2118.4 compliant automatic sprinkler system will enable early fire suppression again assisting evacuation times
(b) the number, mobility and other characteristics of occupants; and	The proposed building use does not differ from a DTS arrangement.
(c) the function or use of the building; and	The proposed building use does not differ from a DTS arrangement.
(d) any active fire safety systems installed in the building.	The proposed building use does not differ from a DTS arrangement.

4.7 Assessment Conclusion

The above assessment demonstrates via quantitate and qualitative analysis that the trial design proposed satisfies the relevant performance requirement CP2 and CP4 and the trial design forms the Performance Solution detailed in the executive Summary of this report.

5.0 PERFORMANCE SOLUTION 2– THRESHOLDS

A performance solution has been developed to permit the doors from the northern and southern corridors leading into the common lounge area have a step closer to the doorway than the width of the door leaf on the two access doors serving the SOU corridors on the first floor

5.1 Deemed to Satisfy Provisions

The following DTS provisions have been identified as being subject to the alternative solution:

D2.15 Thresholds

The threshold of a doorway must not incorporate a step or ramp at any point closer to the doorway than the width of the door leaf unless—

(a) in patient care areas in a Class 9a health-care building, the door sill is not more than 25 mm above the finished floor level to which the doorway opens; or

(b) in a Class 9c building, a ramp is provided with a maximum gradient of 1:8 for a maximum height of 25 mm over the threshold; or

(c) in a building required to be accessible by Part D3, the doorway—

(i) opens to a road or open space; and

(ii) is provided with a threshold ramp or step ramp in accordance with AS 1428.1; or

(d) in other cases—

(i) the doorway opens to a road or open space, external stair landing or external balcony; and

(ii) the door sill is not more than 190 mm above the finished surface of the ground, balcony, or the like, to which the doorway opens.

5.2 Details of Deemed-to-Satisfy Deviation

In accordance with D2.15 above, a doorway threshold cannot incorporate a step or ramp at any point closer to the doorway than the width of the door leaf. As can be seen in the figures below, there is a non-compliance with the above.

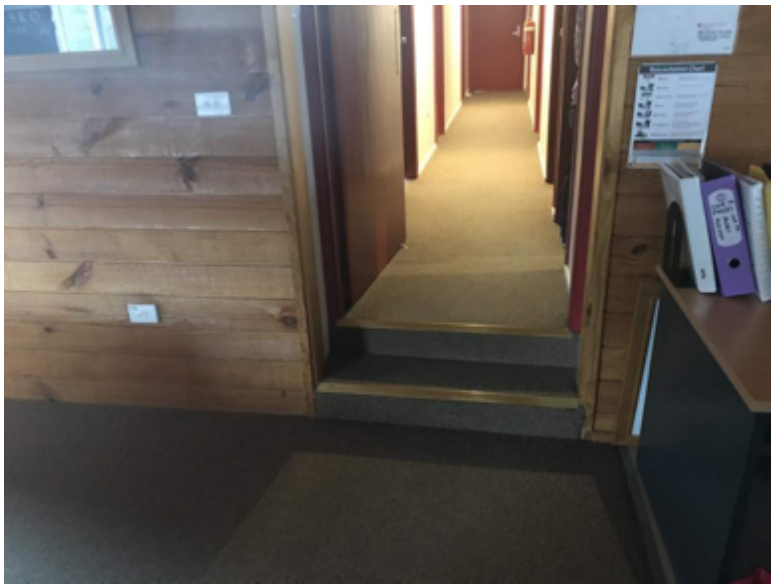


Figure 9 – step closer to the doorway than the width of the door leaf

5.3 Relevant Performance Requirements

In accordance with A2.2(3) of the BCA, the following performance requirement has been identified as being relevant to the performance solution.

DP2

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
(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.

5.4 Assessment Methodology

In order to address the provisions of the BCA, an absolute assessment has been formulated in accordance with A2.2(1)(a) and A2.2(2)(b)(ii) and(c) has been adopted to demonstrate the compliance of the Alternative Solution with the relevant Performance Requirements.

In accordance with BCA Clause A2.2(3) of the BCA, any alternative solution must consider all relevant performance requirements. Performance Requirement DP2 has been identified as being the relevant performance requirement. The relevant IFEG sub-systems (SS) is SS-E.

5.5 Acceptance Criteria

The alternative solution will be considered to satisfy the relevant performance requirement DP2 if it can be categorically demonstrated that the alternative solution achieves each element of the relevant performance requirement by way of a qualitative assessment.

5.6 Qualitative Assessment

In regard to the doorways depicted and described in Section 5.2 we propose the following in order to ensure that, as per DP2, people can move safety to and within a building.

The major risk of the depicted situation is of a trip hazard by occupants exiting and entering the SOU corridors form the lounge area. It is assumed, that being a club lodge, occupants are familiar with the layout of the building.

To reduce this risk, it is proposed to install signage to either sides of the corridor doors in a contrasting colour with letters no less than 40mm high stating “CAUTION WATCH YOUR STEP”. Additionally, it is proposed to install nosing’s to the stairs in a contrasting colour in order to further inform occupants of the potential trip hazard. See figures 9 and 10 below.

There is a required deemed to satisfy solution in this report requiring a handrail to be installed to these stairs in turn increasing the safety to the occupants.

On the basis that signage and contrasting nosing's are provided, it is considered this will sufficiently offset the trip hazard for occupants using the building

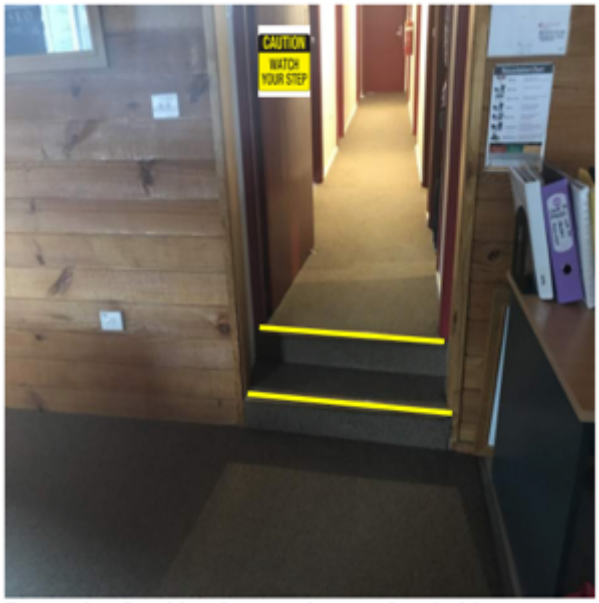


Figure 9 – Corridor door to close to threshold

Figure 10 – Signage required to both sides of door

5.7 Assessment against relevant Performance Requirement

DP2	
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 alternative solution
(b) any doors installed to avoid the risk of occupants—	
(i) having their egress impeded; or	Not applicable to this alternative solution
(ii) being trapped in the building; and	Not applicable to this alternative solution
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	The addition of signage and contrasting nosing's to the threshold areas described above and the fact building occupants will be familiar with the areas minimises this risk.
(ii) suitable handrails where necessary to assist and provide stability to people using the stairway or ramp; and	Additionally, handrails are required on the stairs as per a deemed to satisfy solution in this report which will add another means to assist occupants to ascend and descend the stairs safety
(iii) suitable landings to avoid undue fatigue; and	Not applicable to this alternative solution
(iv)landings where a door opens from or onto the stairway or ramp so that the door does not create an obstruction; and	The addition of signage and contrasting nosing's to the threshold areas described above and the fact building occupants will be familiar with the areas minimises this risk.
(v) in the case of a stairway, suitable safe passage in relation to the nature, volume and frequency of likely	Not applicable to this alternative solution

DP2	
usage.	

5.8 Assessment Conclusion

The above discussion has demonstrated that the proposed adoption of additional measures as outlined above ensure that the Performance Requirements DP2 can be satisfied through an absolute and qualitative assessment.

On this basis, it is considered that the proposed performance solution is satisfied where the requirements of the solution are installed as follows:

1. Installation of signage (as prescribed above) to both sides of the doors leading to the northern and southern corridors serving SOUs on the first floor.
2. Installation of contrasting nosing's to both sets of stairs leading to the northern and southern corridors serving SOUs on the first floor.

6.0 INSPECTION, MAINTENANCE & COMMISSIONING

6.1 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

6.2 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.

6.3 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.

6.4 Fire safety schedule

Measure	Design/Installation Standard	Comment/strategy
Automatic Fire Detection & Alarm System including manually operated fire alarm system with call points	BCA Spec. E2.2 and G4.8, BCA Spec E2.2 & AS 1670.1-2004	Existing and although not required is fitted with ASE
Automatic fire suppression system (sprinkler system)	AS 2118.4-2012	Required by J² upgrade strategy 0997
Emergency Lighting	BCA Clause E4.2, E4.4 & G4.4 AS/NZS 2293.1 - 1998	Existing
Exit Signs	BCA Clauses E4.5, E4.6 & E4.8 AS/NZS 2293.1 - 1998	Existing
Fire Blankets	AS 2444 – 1995	Existing
Fire dampers	AS/NZS 1668.1-1998	Not identified in building
Fire hydrants	BCA clause E1.3, G4.8 & AS 2419.1	NPWS street system coverage
Hose Reel system	BCA Clause E1.4 & AS 2441 - 2005	Existing – hose reels not located within 4m of exits
Fire orders	BCA Clause G4.9	Existing

Fire alarm communication link	BCA Spec E2.2A clause 7 & AS 1670.3-2018	Required by required under J² Upgrade Strategy 0997 connected to sprinkler system
Lightweight construction	BCA clause C1.1, C1.8 & Spec C1.8	Existing and not compliant, to be addressed via sprinkler system
Manual Call Points	BCA Clause G4.8 & AS 1670.1 -2004	Existing
Paths of travel	Part D	Existing
Portable Fire Extinguishers	BCA Clause E1.6 & AS 2444 – 1995	Existing
Solid core doors with self closers	BCA Clause NSW C3.11 and D2.21	Existing and D2.21 not relevant to doors serving SOUs
Warning and operational signs	BCA Clause G4.3 and G4.9	Existing

A fire safety schedule was on display as was a Fire Safety Statement. The Statement did not contain the measures listed on the Fire Safety Schedule.

7.0 CONCLUSIONS

7.1 Conclusion

The Performance solutions proposed as part of this Fire Safety Upgrade Master Plan Report have been developed using the techniques outlined within Clauses A2.2(1)(a) and A2.2(2)(b)(ii) and (c)of the BCA and demonstrate compliance with the relevant performance requirements DP2, CP2 and CP4 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 DP2, CP2 and CP4 have been met, provided the Performance solution requirements listed below are implemented.

7.2 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 DP2, CP2 and CP4:

The Performance solution has been developed using absolute assessments utilising qualitative and quantitative techniques, and is considered to comply with BCA Performance Requirement DP2, CP2 and CP4. The BCA recognises these Assessment Method as acceptable methods for determining that the Performance solution satisfies the Performance Requirement in accordance with BCA Clauses A2.2(1)(a) and A2.2(2)(b)(ii) and (c)

7.3 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.

7.4 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.

James Sunjaya
Director
MFSE, B.Eng. (Elec.), B.Med.Sci.
BPB Accredited Fire Engineer Grade C10
VIC Registered Building Practitioner (Fire Safety)
TAS Registered Building Practitioner (Fire Safety, Building Services)
Registered Professional Engineer Queensland
NPER and CPEng (Fire Safety, Building Services)

James Alexander
Director
B. App.Sci (Bldg), Grad Dip (Disp Res), ME(Fire safety), Grad Dip (Bldg Surv)
AIBS Nationally Accredited Level 1 Building Surveyor
BPB Grade A1 Accredited Certifier and PCA
Fire Safety Engineer

8.0 REFERENCES

1. Australian Building Codes Board (2005), “International Fire Engineering Guidelines”, Australia.

2. Australian Building Codes Board (2019), “The Building Code of Australia”, Australia.

3. Australian Building Codes Board (2019), “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.

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 was 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%.