FIRE ENGINEERS

SHOP 2 SQUATTERS RUN, THREDBO

FIRE ENGINEERING REPORT

DEVELOPED IN ACCORDANCE WITH
THE PERFORMANCE REQUIREMENTS OF THE BCA

- WIDTH OF PATH OF TRAVEL
- CEILING HEIGHT

DATE: 17 APRIL 2016
REPORT NO: 0197 - REV A
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REVISION STATUS

REPORT NO.	REVISION	DATE	STATUS	WRITTEN	REVIEWED
0198	REV A	17/04/16	FINAL	JA	JS

EXECUTIVE SUMMARY & RECOMMENDATIONS

J² Consulting Engineers have been commissioned to carry out a fire safety engineering analysis and assessment of the storage and workshop space at the rear of Shop 2 Squatters Run Thredbo. The proposed development involves the construction of a retaining wall to the rear of the room to provide structural adequacy and general upgrading of the space to comply with the Building Code of Australia applicable to the proposed use. It has been identified that elements of the proposed upgrade works cannot readily satisfy the Building Code of Australia's (BCA's) Deemed to Satisfy (DTS) provisions and therefore this report has been developed to provide a solution that satisfies the relevant performance requirements.

This report provides an Alternative Solution developed to permit the following deviations from the BCA prescriptive requirements. The Alternative Solutions proposed are as follows:

#	Alternative Solutions	BCA DTS Provision	BCA Performance Requirement	Assessment Methodology
1.	Develop an alternative solution to permit a path of travel between shelving units to have a clear path of travel width of less than 1m (640mm).	D1.6	DP4	Qualitative assessment demonstrating compliance with the performance requirements under A0.5(b)(i) via a performance based analysis under A0.9(b)(ii).
2.	Develop an alternative solution to permit a ceiling height in the workshop area to be less than 2.4m.	F3.1	FP3.1	Qualitative Assessment demonstrating compliance with the performance requirements under A0.5(b)(i) and via A0.9(b(ii) and A0.9(c).

REQUIREMENTS OF ALTERNATIVE SOLUTIONS

Considering the relevant provisions of the BCA, the Alternative Solution, subject to the provision of the following requirements, is considered to meet and comply with the Performance Requirements DP4 and FP3.1:

1. Smoke detection in accordance with AS 1670.1-2004 shall be installed in the storage space. The detector/s shall be connected to the building's Fire Indicator Panel and building occupant warning system in accordance with AS 1670.1-2004. Where subject to spurious signals the detector/s install may be thermal type. Audible waring within the space must comply with AS 1670.1 such that occupants of the space must be able to hear the general building alarm in the event of activation.
2. Emergency lighting is required to be provided within the building in accordance with AS 2293.1-2005 to illuminate the path of travel to the exit.
3. A partition wall is to be constructed between the workshop area and the area containing electrical conduits. A service door is to be installed in the wall. The door is to be keyed for access by Kosciuszko Thredbo personnel only.
4. Where services or other building elements encroach into the space below 2.2m they are to be highlighted. In order to highlight these reduced head height areas, a strip of high visibility warning tape is to be installed at the lower edge of the services where applicable. This tape will provide warning to very tall occupants that the head height at the bulkhead is low.
5. The recommendations of this report must form part of the essential safety provisions for the building to ensure the recommendations of this report are complied with throughout the building operation.

The Alternative Solution has been developed using comparison with the Deemed-to-Satisfy Provisions and a qualitative assessment, and is considered to comply with BCA Performance Requirements DP4 and FP3.1. The BCA recognises these Assessment Method as acceptable methods for determining that the Alternative Solution satisfies the Performance Requirement in accordance with BCA Clauses A0.5(b)(i), A0.5(b)(ii), A0.9(b)(ii) and A0.9(c).

1.0 INTRODUCTION

J² Consulting Engineers have been commissioned to carry out a fire safety engineering analysis and assessment of the storage and workshop space at the rear of Shop 2 Squatters Run Thredbo. The proposed development involves the construction of a retaining wall to the rear of the room to provide structural adequacy and general upgrading of the space to comply with the Building Code of Australia applicable to the proposed use. It has been identified that elements of the proposed upgrade works cannot readily satisfy the Building Code of Australia's (BCA's) Deemed to Satisfy (DTS) provisions and therefore this report has been developed to provide a solution that satisfies the relevant performance requirements.

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

1.1 Basis of the Report

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

- Building Code of Australia 2015, published by the Australian Building Codes Board (ABCB)
- International Fire Engineering Guidelines 2005, published by Australian Building Codes Board (ABCB)
- The Guide to the BCA 2015, published by the Australian Building Codes Board (ABCB)
- Architectural plan prepared by Elizabeth Pugh Building Design SK-01 dated March 2016.
- BCA report prepared by James Alexander and Associates P/L dated 5 Feb 2016.

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

- Develop an alternative solution to permit a corridor between shelving units to be reduced to 650mm.
- Develop an alternative solution to permit a head height to the workshop are to be less than 2.4m.

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

1.2 Purpose of the Report

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

The purpose of this report is to demonstrate that the proposed development will satisfy Performance Requirements DP4 and FP3.1 as the design is at least equivalent to the relevant Deemed-to-Satisfy provisions of the BCA and/or satisfies the Performance Requirement of the BCA.

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

1.3 Limitations of the Report

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

- Determining full compliance with the BCA, other than the matters identified in the executive summary of this report;
- Addressing any matters that are outside the scope or limitations of the BCA;
- Amendments to the Alternative Solution Brief due to design changes or incapacity to comply with the Trial Designs;

- Consideration of any fire services operations (including hydraulic, electrical or other systems);
- Consideration of any structural elements or geotechnical matters relating to the building, including any structural or other assessment of the existing fire resistance levels of the building;
- This report does not provide concessions for any Alternative Solution or exemptions from the requirements of the BCA, other than that identified in the Executive Summary of this report;
- Determining compliance with the Disability Discrimination Act 1992 or Part D3 of the BCA;
- Reporting on hazardous materials, OH&S matters or site contamination;
- Heritage Issues;
- Any energy efficiency assessment; however if necessary proposals can be obtained from suitably qualified and accredited assessors.

1.4 Assumptions of the Report

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

The report is provided on the basis that:

- The Alternative Solution only applies to property detailed in section 2.2.
- The Alternative 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 lessee, sub-lessee, consent authority following a site inspection. Given the minor nature of the assessment, no fire engineering brief was prepared.

2.1 Relevant Stakeholders

Stakeholder/Role	Name
Architect	Elizabeth Pugh
BCA Consultant	James Alexander
Lessee	Kosciuszko Thredbo
Sub-lessee	Jindabyne Sports

2.2 Building and Occupant Characteristics

General Building Characteristics

Building Characteristic	Description
Occupancy/Use Building Class/es: Type of construction: Effective Height:	Office and Shops Class 6 Type A <12m
Location: General description of development:	Shop 2 Squatters Run Thredbo The development involves the upgrading of the existing storage and workshop at the rear of Shop 2 to achieve BCA compliance.

Occupant Characteristics

Occupant Characteristic	Description
Type and number	Occupants would generally be expected to be awake and alert and generally independently being capable of caring for themselves consistent with community expectation. Access to the space is restricted to employees only during operational hours. Typically however, it is expected that employee numbers and occupancy of the space would not exceed 5 given the small size of the shop and storage area.
Occupant state	Building occupants are expected to be awake at all times. Occupants are generally expected to be sober but may be intoxicated to a certain degree. Occupants would be expected to have a reasonable level of mobility to comfortably negotiate the step entry to the space.
Physical and mental attributes	The majority of occupants are considered to be mobile and ambulatory consistent with the Australian population.
Assistance required/available	It will be likely that assistance will not be required as the occupants will be familiar with the location of the exits and the paths to the exits given the simple layout. Assistance may be provided from other able bodied occupants.
Training and Roles	Occupants are considered to have limited training given the commercial nature of the building.
Hazards	Kitchenette area. Workshop operations.

Occupant Characteristic	Description
	Failure of electrical equipment located within the building.

2.3 Hazards, Preventative and Protective Measures Available

The following hazards have been identified.

Hazard	Details/Precaution
General Layout and Design	The main hazard relates to the use of the area as a workshop to adjust ski boots, ski bindings etc.
Activities	The space is used to store merchandise prior to sale, a small kitchenette for reheating food in a microwave or preparing tea and coffee. No cooking takes place. The building smoke detection system will be provide provide warning to simultaneously notify all occupants of a fire within the building.
Cooking	No cooking undertaken.
Smoking	The building is configured as a non-smoking building.
Electrical and workshop Equipment	Interconnected smoke alarms will be provided throughout the building configured to simultaneously notify all occupants of a fire within 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 load densities or heat release rates are not proposed to be in excess of a normal sports store. The hazards identified are considered to be of low risk where undertaken with a reasonable level of care.
B Smoke development, spread and control	Fire load densities, smoke development or heat release rates are not proposed to be in excess of a normal sports store.
C Fire spread, impact and control	The concrete slab separation between the sports store and residential units above is considered likely to achieve the required fire resistance to prevent vertical fire spread. Fire collars are proposed to PVC penetrations.
D Fire detection, warning and suppression	The building is proposed to be provided with a smoke detection system configured to simultaneously activate in the event of a fire.
E Occupant evacuation and control	The shop is provided with a single exit located with compliant travel distance from the most disadvantaged point.
F Fire services intervention	The building is served by full time fire brigades at Thredbo (approx. 500m) and therefore fire services intervention is likely to be better or at least equivalent to most areas in metropolitan Sydney areas.

*International Fire Engineering Guidelines 2005 (IFEG)

Sub-system A – Fire Initiation and Development and Control
Sub-system B – Smoke Development and Spread and Control
Sub-system C – Fire Spread and Impact and Control
Sub-system D – Fire Detection, Warning and Suppression
Sub-system E – Occupant Evacuation and Control
Sub-system F – Fire Services Intervention

2.4 Directly relevant IFEG Sub-Systems

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

IFEG Sub-System	Description	Symbol
Sub-system C Fire Spread and Impact and Control	• Separation of fuel • Separation of buildings • Fire resistive barriers • Fire resistive structural elements • Fire resistive air-handling ducts • Fire resistive dampers • Exposure protection	
Sub-system D Fire Detection, Warning and Suppression	• Automatic and manual detection equipment • Automatic and manual warning equipment • Surveillance equipment • Automatic suppression equipment • Manual suppression equipment	
Sub-system E Occupant Evacuation and Control	• Evacuation plans • Occupant training • Emergency communications • Egress signage • Egress routes (including fire isolated elements)	

3.0 ALTERNATIVE SOLUTION 1 – WIDTH OF PATH OF TRAVEL

An Alternative Solution has been developed to address the proposed deviation from the DTS provisions to permit a reduction in the required width of the path of travel to an exit from within the rear storage area of Shop 2 Squatters Run.

3.1 Deemed-to-Satisfy Provisions

Pursuant to A.0.10(a) of BCA the following DTS provisions have been identified as being subject to the alternative solution:

D1.6 - Dimensions of exits and paths of travel to exits
In a required exit or path of travel to an exit—

(a) *the unobstructed height throughout must be not less than 2 m, except the unobstructed height of any doorway may be reduced to not less than 1980 mm; and*

(b) *the unobstructed width of each exit or path of travel to an exit, except for doorways, must be not less than—*

- *(i)* *1m; or*
- *(ii)* *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*
- *(iii)* *in a public corridor in a Class 9c aged care building, notwithstanding (c) and (d)—*
  - *(A)* *1.5 m; and*
  - *(B)* *1.8 m for the full width of the doorway, providing access into a sole-occupancy unit or communal bathroom; and ...*

3.2 Details of Deemed-to-Satisfy Deviation

In accordance with D1.6(b)(i) above, a path of travel from any point in the building to an exit must have an unobstructed width of 1m or more. The proposed clear width between shelving units is reduced to 640mm. This can be seen in the figure below.

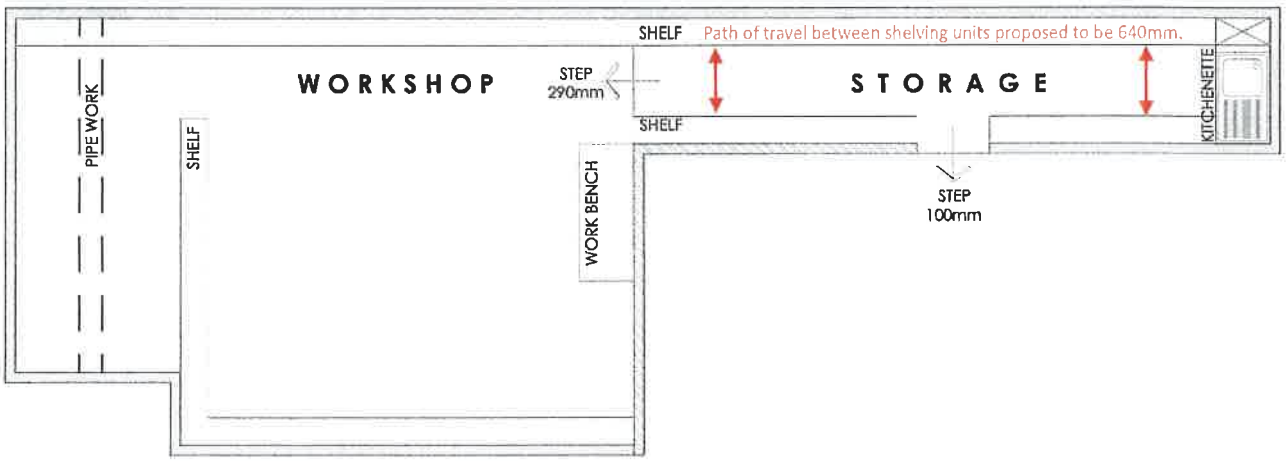

Figure 1 – Reduced path of travel indicated.

3.3 Relevant Performance Requirements

Pursuant to A0.10(b) of BCA performance requirement DP4 has been identified as being directly relevant to the DTS provisions identified in Section 3.1 above.

DP4
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.

3.4 Assessment Methodology

In order to address the provisions of the BCA, a qualitative performance based solution formulated in accordance with A.0.9(b)(ii) and A.0.5(b)(i) has been adopted to demonstrate the compliance of the Alternative Solution with the relevant Performance Requirements.

3.5 Acceptance Criteria

It must be demonstrated that the proposed trial design incorporating a reduced width of exits is sufficient to facilitate egress from the kitchenette and workshop areas by categorically satisfying each element of the relevant performance requirement DP4 through an absolute and qualitative assessment.

3.6 Qualitative Assessment

With respect to egress widths The Guide to the BCA states the intent of D1.6 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 D1.6(f)(iii) allows the typical exit or path of travel width of 1000-mm to be reduced by 250-mm to 750-mm at doorways. This measurement is considered to provide an exit width that will allow up to 100 occupants of 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 proposed building, the occupant density will be a maximum of 5 occupants at any one time. Given that this is significantly less than the 100 occupants permitted, it stands to reason that occupants should not need to pass by one another when moving to the exit. The proposed reduction in the corridor width between the shelving units, whilst rather substantial at a reduction of 36% of the DTS width, is still wide enough to evacuate occupants in single file.

In support of the above statement, 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 1971) 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 proposed stairway in question therefore provides more than adequate width to evacuate the 17 building occupants on the upper two levels of the building in the event of a fire.

On this basis it is considered that the proposed reduction in egress width to 640mm is adequate to permit evacuation via the corridor between the shelving.

3.7 Assessment against relevant Performance Requirement

The following is an assessment of the relevant Performance Requirement DP4.

DP4	
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	Travel distances are within DTS limitations with a maximum travel distance of approximately 18m in lieu of the DTS 30m permitted.
(b) the number, mobility and other characteristics of occupants; and	The low number of occupants ensures that the 360mm reduction in the available egress width does not significantly affect the ability for occupants to evacuate the building. The provision of increased occupant warning throughout the building and smoke detection system will expedite the evacuation of building occupants who will all be awake and familiar with the building layout.
(c) the function or use of the building; and	The shop is used as a retail and ski/boot fitting shop as such the hazard associated with the use is considered to be low risk.
(d) the height of the building; and	The subject are is single storey part of the building which is considered to have a rise in storeys of three and is afforded with a smoke detection system and occupant warning system throughout.
(e) whether the exit is from above or below ground level.	N/A to this assessment.

3.8 Assessment Conclusion

The above assessment has demonstrated that the proposal to permit the egress stairway between the shelving units in the rear storage area to be of a reduced width of 640mm is acceptable and achieves compliance with the relevant performance requirement DP4.

3.9 Requirements of Alternative Solution

On the basis of the assessment contained above, it is considered that the relevant performance requirement DP4 is satisfied subject to the following upgrade measures:

1. Smoke detection in accordance with AS 1670.1-2004 shall be installed in the storage space. The detector/s shall be connected to the building's Fire Indicator Panel and building occupant warning system in accordance with AS 1670.1-2004. Where subject to spurious signals the detector/s install may be thermal type. Audible waring within the space must comply with AS 1670.1 such that occupants of the space must be able to hear the general building alarm in the event of activation.
2. Emergency lighting is required to be fitted in the building in accordance with AS 2293.1-2005 to illuminate the path of travel to the exit.

4.0 ALTERNATIVE SOLUTION 2 - REDUCED HEAD HEIGHT

An alternative solution has been developed to address the DTS non-compliance relating to low head height in the workshop part of the rear storage room of Shop 2 Squatters Run.

4.1 Assessment Methodology

In order to address the provisions of the BCA, a comparative and performance based solution formulated in accordance with A0.5(b)(i), A0.9(b)(ii) and A0.9(c) has been adopted to demonstrate the compliance of the Alternative Solution with the relevant Performance Requirements.

In accordance with BCA Clause A0.10 of the BCA, any alternative solution must consider all relevant performance requirements. Performance Requirement FP3.1 has been identified as being the relevant performance requirement.

4.2 Acceptance Criteria

It must be demonstrated that the low head height of the ceiling in the workshop area will not inhibit the function of the room due to it not being low enough to unduly interfere with the function of the room.

4.3 Deemed-to-Satisfy Non-compliance

The relevant DTS non-compliance is F3.1.

F3.1 Height of rooms and other spaces
The ceiling height must be not less than—

(a) in a Class 2 or 3 building or Class 4 part of a building—

(i) a kitchen, laundry, or the like 0 2.1m: and
(ii) a corridor, passageway or the like — 2.1 m; and
(iii) a habitable room excluding a kitchen — 2.4 m; and
(iv) in a room or space with a sloping ceiling or projections below the ceiling line within -

(A) a habitable room -
(aa) in an attic – a height not less than 2.2m for not less than two thirds of the floor area of then room or space: and
(bb) in other rooms – a height of not less than 2.4m for not then two thirds of the floor area of the room or space: and

(B) a non-habitable room — a height of not less than 2.1 m for not less than two thirds of the floor area of the room or space; and

when calculating the floor area of a room or space, any part that has a ceiling height of less than 1.5m is not included; and

(f) in any building—

(i) a bathroom, shower room, sanitary compartment, airlock, tea preparation room, pantry, store room, garage, car parking area, or the like — 2.1 m; and
(ii) a commercial kitchen — 2.4 m; and
(iii) above a stairway, ramp, landing or the like — 2 m measured vertically above the nosing line of stairway treads or the floor surface of the ramp, landing or the like.

4.4 Relevant Performance Requirement

Pursuant to A0.10(b) of BCA the following performance requirement has been identified as being directly relevant to the DTS provisions identified in 4.3 above:

FP3.1
A habitable room or space must have sufficient height that does not unduly interfere with its intended function.

4.5 Details of non-compliance

Due to the step up at the workshop area, and the location of services a clear head height/ceiling height of 2.4m is not achieved throughout.

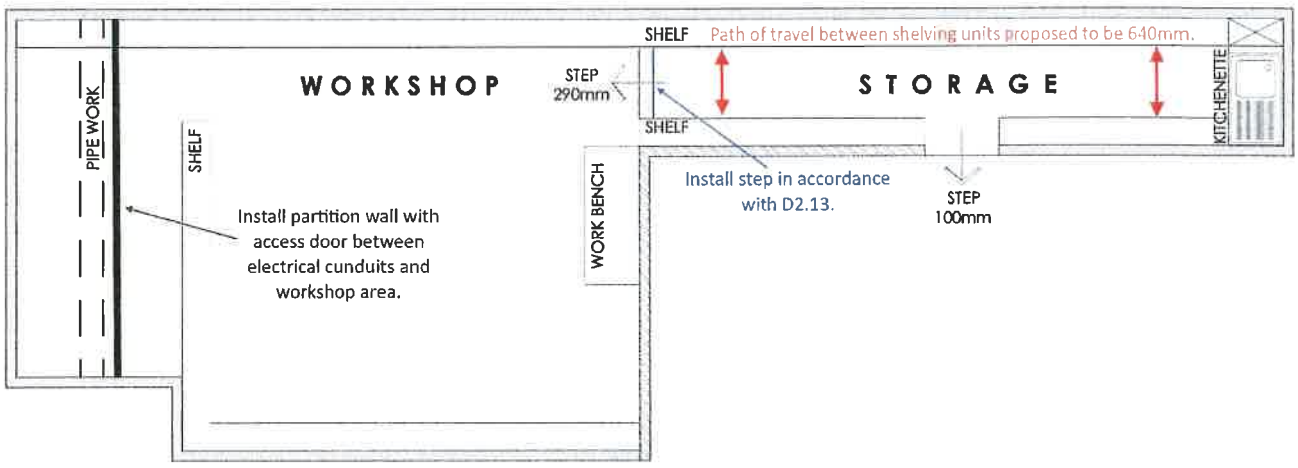

Figure 2 – The workshop area has a head height less than 2.4m

4.6 Qualitative Assessment

It is proposed to permit the reduction in ceiling height by comparison to that permitted under the BCA and an assessment of the use and occupant characteristics. The following is a commentary of this assessment:

- Whilst detailing minimum ceiling heights the BCA does not prohibit encroachments into ceiling spaces such as exposed beams or attachments such as light fittings. Such projections can be quite substantial at times, however the BCA leaves the acceptance to be determined by the judgment of the Principal Certifying Authority or other Approval Authority. This solution is based upon this principal.
- Part D1.6(a); permits a minimum of 2m of unobstructed head height with a further reduction in head heights for doorways to 1980mm.
- As noted above the DTS provisions of the BCA allow ceiling heights to be 2.1m for bathrooms, corridors, passageways, laundries and other non-habitable rooms such as storerooms. 2.1m is considered sufficient to allow the free passage of movement throughout a building by the occupants. The minimum ceiling height achieved in the workshop are is 2.2m and therefore this reduction from 2.4m would not interfere with the occupant's health or cause concern for any occupants hitting their head while passing through the room.
- The main issue of concern relates to the large electrical conduits which pass through the room at a height well below 2.1m and would therefore cause a hindrance to occupant movement. For this reason, it is a requirement of this solution that a partition wall be built across the space in which the conduits are located. An access door is to be located in the wall to enable service access for relevant trades.
- The requirement for minimum ceiling heights of 2.4m in habitable rooms is a consequence of the potential for occupants to spend long periods of time in these rooms. For example, bedrooms or offices. A low ceiling height in these rooms may cause illness due to the perceptions of being confined. The occupants of the workshop will

be shop staff whom use the space to adjust boots and skis on a spasmodic basis. The potential for confined space illness to occur is therefore not likely.

- Where services encroach into the space below 2.2m they are to be highlighted. In order to highlight these reduced head height areas a strip of high visibility warning tape is to be installed at the lower edge of the services where applicable. This tape will provide warning to very tall occupants that the head height at the bulkhead is low.

4.7 Assessment conclusion

From the above it can be concluded that the ceiling height proposed for the workshop area of 2.2m is sufficient for safe movement and the small number of occupants whom will be familiar with the space. The proposal to install highlight warning tape on any encroachments below 2.2m will provide warning of the reduced ceiling height. It can therefore be concluded that the reduced head height below 2.4m is not likely to cause an injury and not interfere with the intended function of the workshop space at the rear of Shop 2 Squatters Run Thredbo, thereby satisfying Performance Requirement FP3.1.

On the basis of the assessment contained above, it is considered that the relevant performance requirement FP3.1 is satisfied subject to the following upgrade measures:

1. A partition wall is to be constructed between the workshop area and the area containing electrical conduits. A service door is to be installed in the wall. The door is to be keyed for access by Kosciuszko Thredbo personnel only. Refer Figure 2 above.

2. Where services or other building elements encroach into the space below 2.2m they are to be highlighted. In order to highlight these reduced head height areas, a strip of high visibility warning tape is to be installed at the lower edge of the services where applicable. This tape will provide warning to very tall occupants that the head height at the bulkhead is low.

5.0 CONCLUSIONS

5.1 Conclusion

The Alternative Solutions have been developed using a quantitative assessment with the Deemed-to-Satisfy Provisions and is considered to comply with BCA Performance Requirements DP4 and FP3.1. The BCA recognises these Assessment Methods as acceptable methods for determining that the Alternative Solutions satisfy the Performance Requirements in accordance with BCA Clauses A0.5(b)(i), A0.5(b)(ii), A0.9(b)(ii) and A0.9(c).

Accordingly, based on the above, it is considered that the directly related Performance Requirements DP4 and FP3.1 have been met, provided the Alternative Solutions requirements listed in the executive summary are implemented.

5.2 Specification of the Final Trial Design

Considering the relevant provisions of the BCA and the above assessment, the Alternative Solution, subject to the provision of the Trial Design requirements, is considered to meet and comply with the Performance Requirements DP4 and FP3.1. The Trial Design requirements detailed in each solution and in the Executive Summary become the Alternative Solutions.

5.3 Maintenance Requirements

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

5.4 Requirements of the Alternative solution

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

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6.0 REFERENCES

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- Australian Building Codes Board, "The Building Code of Australia", Edition 2015, May 2015, Australia.
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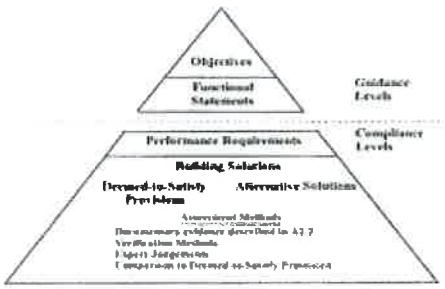
Appendix A – Data Relied upon in the FER Process

Common Abbreviations Used in Fire Engineering

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

Client Design and Building Regulatory Objectives

The client design objectives are to address the issues of deemed-to-satisfy non-compliance with the production of an alternative solution that meets the related Performance Requirement.
One of the purposes of this Fire Engineering Report is to provide the stakeholders with a document for consideration and to add further input with regards to the specific objectives.
The structure of the BCA is depicted in the following figure and is a hierarchal document with objectives, functional statements and Performance Requirement.



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

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

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

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

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

Methods of Analysis

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

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

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

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

A0.9(d) *Expert judgement*

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

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

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

Relevant IFEG Sub-Systems

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

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

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

Acceptance Criteria and Factors of Safety for the Analysis

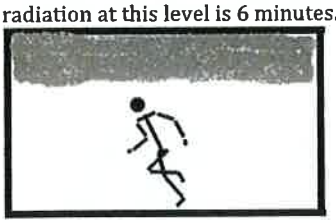
Qualitative Assessments

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

"Both comparative and absolute approaches may be adopted in the analysis strategy. The methods chosen will be appropriate to the approach used.

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

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



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

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

Summary of Tenability Failure Criteria:

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

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

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

	Routine Condition	Hazardous Condition	Extreme Condition	Critical Condition
Maximum Time, min	25	10	1	<1
Maximum Temperature, °C	100	120	160	235
Maximum Radiation, kW/m²	1	3	4 - 4.5	>10

Approaches and Methods of Analysis

Approach

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

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

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

Comparative vs. Absolute Approach

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

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

Analysis Approaches

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

Approach	Definition
	evaluation of a building design. This use of multiple scenarios and their combination through probabilistic techniques is the key feature of some of the methods.

Construction and Commissioning Requirements

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

- The management of the building must be aware of the Alternative Solution contained within the building, as well as the required measures for maintenance.
- The Building Management System, must incorporate maintenance measures to ensure satisfactory maintenance, testing and inspection of all fire safety measures.

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

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

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

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

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

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