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Proposed Residential Development 20 Sisley Street, Saint Lucia, QLD 4067

Fire Engineering Report

Date: 28/01/2026

Revision: 1

Confidential

PROJECT DETAILS

Project Number	J0878
Project Name	Proposed Residential Development
Project Address	20 Sisley Street, Saint Lucia, QLD 4067
Prepared for	ANE Properties Pty Ltd

REPORT DETAILS

Name	Revision	Date	Details
Performance Based Design Brief	1	11/12/2025	Draft for Review
Fire Engineering Report	1	28/01/2026	For Approval (updates in blue)

REPORT AUTHOR

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EXECUTIVE SUMMARY

Fire Engineers Australia has been appointed by ANE Properties Pty Ltd to undertake fire engineering services associated with the proposed residential building at 20 Sisley St, St Lucia, QLD 4067.

The proposed residential building at 20 Sisley Street will be a 4 storey building. The lower ground level will be a carpark, ground level and level 1 would accommodate four residential SOUs and Level 2 will accommodate two residential SOUs. The proposed building would require Type A construction in accordance with Clause C2D2 of BCA 2022 Volume 1. The effective height of the proposed building will be 8.9 m. The proposed building will have one stairway on every level and one lift shaft connecting all the levels.

The intent of this document is to address the non-compliances with the Deemed-to-Satisfy Provisions of the NCC as identified by the Building Certifier. The non-compliance issues addressed in this report are as follows:

Table 1. Non-compliance Issues

Item	Non-Compliance Issue	Non-Compliance Clause	Performance Clause
1	<p><u>Review of window openings within 3 m of the site boundary</u></p> <p>The window openings on the ground level, level 1 and level 2 are located at less than 3m from the site boundary. The openings are located at 2.5m from the site boundary.</p>	C4D3	C1P2, C1P4, C1P8
2	<p><u>Review of Extended Travel Distances in the lower ground level Carpark</u></p> <p>The travel distances to the exit on the lower ground level would be approximately 32 m, in lieu of 20 m.</p>	D2D5	D1P4, E2P2
3	<p><u>Review of Special Hazard - Provisions for Electric Vehicle Charging in the Carpark</u></p> <p>The building is assessed against BCA 2022 and therefore is required to be provided with provisions for EV charging. The provisions will include a distribution board to meet the EV requirements for the building. Due to the potential of EV vehicle charging and EV in the building carpark, the special hazard is assessed in the carpark.</p>	E1D17	C1P1, C1P2, C1P4, C1P7, C1P9, E2P2

Review of window openings within 3 m of the site boundary

The window opening to the SOUs on ground level and level 1 of the building will be located at 2.5m (in lieu of 3m) from the site boundary. The building is of Type A construction and therefore fire spread to and from the building must be analysed. Given the proximity of the openings to the site boundary the radiation received to the building would be 25 kW/m². In case of a fire in the building the radiation emitted to the boundary would be approximately 27.7 kW/m². To mitigate the risk of fire spread due to the proximity of the window openings to the site boundary, heat attenuation screens (Crimsafe, Invisi-Gard or the like) would be installed to the non-compliant windows (listed in Table 18).

Review of Extended Travel Distances in the lower ground level Carpark

The maximum travel distance to the exit on lower ground level will be approximately 32 m, in lieu of 20 m. However, the occupants in the lower ground level carpark are likely to be residents of the building and are likely to be knowledgeable about the exit stair location. The lower ground level carpark will be provided with fast-response sprinklers, (in lieu of standard response sprinklers) which will likely notify the occupants early in case of a fire event.

The increase in travel time due to the extended walking distance to the exit will be 15 sec. The reduction in sprinkler activation time by the use of fast response sprinklers would be 50 sec. Therefore, from the comparative assessment, the provision of fast-response sprinklers was found to compensate for the increase in extended travel distance. Hence, increased travel to the exit on the lower ground level carpark is unlikely to unduly impact the occupant evacuation in the building

Review of Special Hazard - Provisions for Electric Vehicle Charging in the Carpark

The car park is located on the lower ground level. To review the provision for charging of Electric Vehicles, seven aspects of the risk are analysed, based upon risks identified in the QFD position statement on electric vehicle charging. These aspects were: risk of ignition, flammable vapour, cloud production, toxic smoke production, rapid rate of fire spread and proximity of adjacent fuel loads, heat release rate of EV fires, risks to fire brigade intervention and risks to structural adequacy.

Reducing the risk of ignition relies primarily on occupants; therefore, signage is proposed to be installed at the vehicular entrance to reduce any severe collisions.

Through analysis of EV fire characteristics, it has been determined that the structural requirements of Type A construction would be adequate to withstand a fire event involving electric vehicles, as the fire brigade is located in proximity to the building and likely to arrive at the site on the receipt of notification to undertake the fire-fighting activities. The carpark will have direct access to the road via the driveway. Further the carpark will be fully fire sprinkler protected and have complete hydrant coverage. There would be no reduction in fire rating for the carpark.

This report presents Alternative Solutions which demonstrate compliance with the Performance Requirements of the BCA. All other fire life safety aspects of the design are assumed to be compliant with the DTS Provisions of the BCA except as modified in this report.

This report and the methodology described herein have been developed in accordance with the Australian Fire Engineering Guidelines (Australian Building Codes Board 2021) being cognizant of international best practice and are unique to the building.

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1 SCOPE OF THE PROJECT

1.1 Contractual Context

Fire Engineers Australia has been appointed by ANE Properties Pty Ltd to undertake fire engineering services associated with the proposed residential building at 20 Sisley St, St Lucia. The project will be a conventional design and a separate construction process.

1.2 Regulatory Framework

Applicable Legislation

This report is intended to meet the performance requirements as outlined in the National Construction Code (NCC) Version (NCC 2022) (Australian Building Codes Board 2022).

The maintenance of fire systems as documented in this report are to comply with the requirements of Queensland Development Code MP 6.1 (Department of Local Government and Planning 2011) and AS 1851-2012 (Committee FP-001 2012).

The below legislations are applicable to the building approval process. Specific details on how each of these legislations apply to this project can be sourced from the private certifier who is the Authority Having Jurisdiction.

- Planning Act 2016.
- Building Act 1975.
- Fire Services Act 1990.

Authorities

The regulatory authorities applicable to this project are as follows: -

- Certificate of Occupancy will be delivered by the Private Certifier.
- Queensland Fire Department (QFD) are an advice agency to the Private Certifier.

1.3 Fire Engineering Scope

The scope of the fire engineering service is to develop a performance based fire engineering solution for the non-compliances listed in Table 1. Non-compliance Issues.

All other aspects of the design, about fire and life safety, are assumed to be compliant with the prescriptive deemed to satisfy provisions of the NCC (Australian Building Codes Board 2022).

This report is for the use of our client and the design team appointed to this scheme. It should not be used in full or in part to support any other scheme and Fire Engineers Australia will not accept any responsibility for matters arising because of its misuse.

The findings and opinions expressed within this report are based on the conditions encountered and/or the information reasonably available at the date of issue of this document and shall be applicable only to the circumstances envisaged herein.

1.4 Fire Engineering Approvals Approach

This report is subject to formal approval from the private Certifier who is the Authority Having Jurisdiction. In accordance with the Australian Fire Engineering (Australian Building Codes Board 2021), Fire Engineers Australia submits a Performance-based design brief (PBDB) for formal agreement in principle with the project stakeholders as listed in Table 3. Stakeholders. The PBDB would include the objectives, proposed trial designs, methods of analysis, acceptance criteria's and expected conclusions of the fire engineering analysis.

After the approval of the PBDB, Fire Engineers Australia submits a Fire Engineering Report (FER). The FER would contain further calculations and justifications as needed to show that the design meets the performance requirements. Upon receiving approval from the project stakeholders, the FER will be submitted to the private Certifier for formal building approval purposes. The private certifier would lodge the FER with the Queensland Fire Department (QFD) for formal referral advice prior to issuing the building approval for the building.

1.5 Project Schedule

The below table describes the project schedule. The below dates are tentative and are subject to change.

Table 2. Project Schedule

Project Stage	Fire Engineering Stage	Status
Schematic Design	Preliminary Discussions	Completed
Design Development	Performance-Based Design Brief (PBDB)	Completed
Design Documentation	Fire Engineering Report (FER)	This document
Regulatory Acceptance	Formal approval of Fire Engineering Report	20 working days from lodgement with QFD
Construction	Response to queries regarding implementation of Fire Engineering strategies	As required
Commissioning and Handover	Site visit to observe implementation of fire engineering strategies and issue letter of general conformance	As required

1.6 Relevant Stakeholders

The below organisations have been involved in the formulation of the fire engineering strategies and hence form the fire engineering committee for this project.

Table 3. Stakeholders

Name	Organisation	Role	Contact
Jack Simpson	SCM Projects	Project Manager	0733 697 779
Alice Witt	ALTO Architects	Architect	0410 636 364
Tyson Lisha	SBA Consulting	Building Certifier	0478 005 908
Brendan Boyce	RCA Consulting	Mechanical Engineer	0410 520 976
Matt Slade	Westera partners	Structural Engineer	0405 987 827
Kleber Rocha	Civil Works Engineers	Civil Engineer	0731 958 180
Victor Cross	Chilton Woodward	Hydraulic Engineer	0732 624 322
TBA	Queensland Fire Department	Building Approvals Officer	TBA
Chris Sheeran	Fire Engineers Australia	Fire Engineer	0429 599 488

2 PRINCIPAL BUILDING CHARACTERISTICS

2.1 Site Location

The site is located at 20 Sisley Street, Saint Lucia, QLD 4067. The site location is provided below for ease of reference.



Figure 1 Site Location © Queensland Globe

2.2 Drawings

The lower open ground level will be a Class 7a carpark, with 17 carparking spaces. A refuse store and communal open space will be accommodated. Vehicle access to this level provided by the ramp connecting to the ground level on east side of the building. A stairway access to the ramp on the ground level on west side of the building. Lift connecting all the levels is proposed on this level for vertical circulation. The lower ground level will not be considered as a basement and it will be counted in a rise in storey calculation as per BCA 2022. (Please refer Section 2.4, for further information).

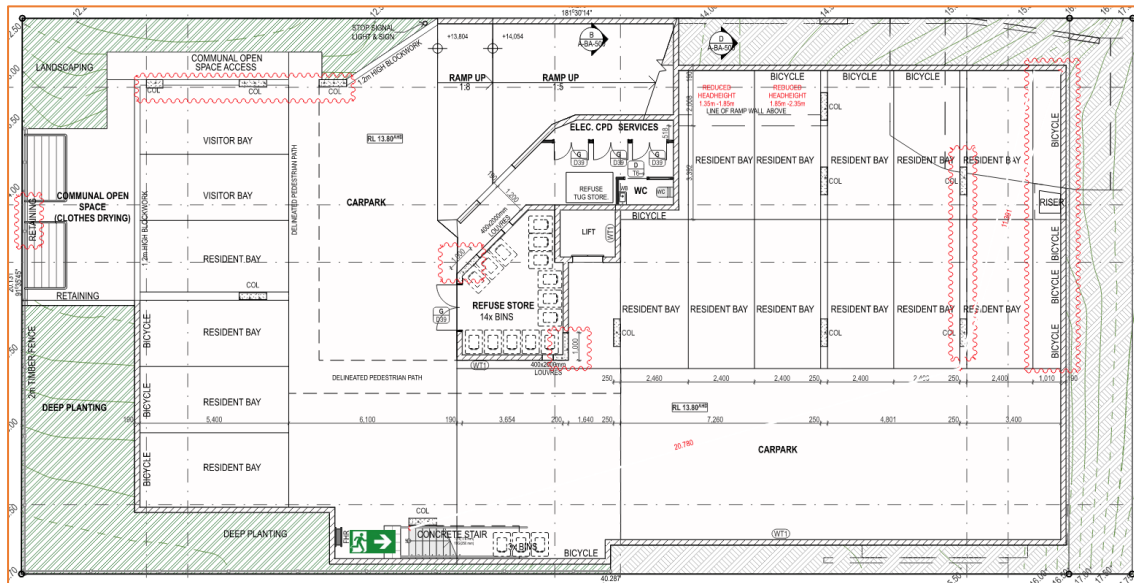


Figure 2: Lower Ground level

Ground level will be a residential level accommodating 4 SOUs. The ramp connecting Sisley Street on the western side of the building provides access to the Lower Ground level via a stairway, and to the Ground level via the lobby, which further provides access to the SOUs.

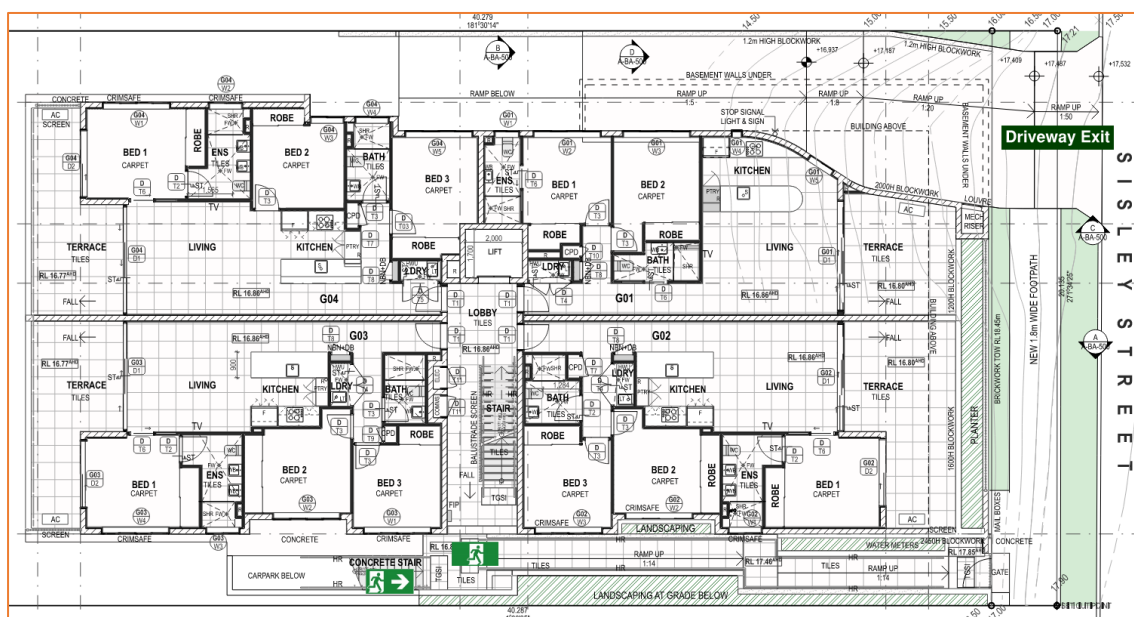


Figure 3: Ground level

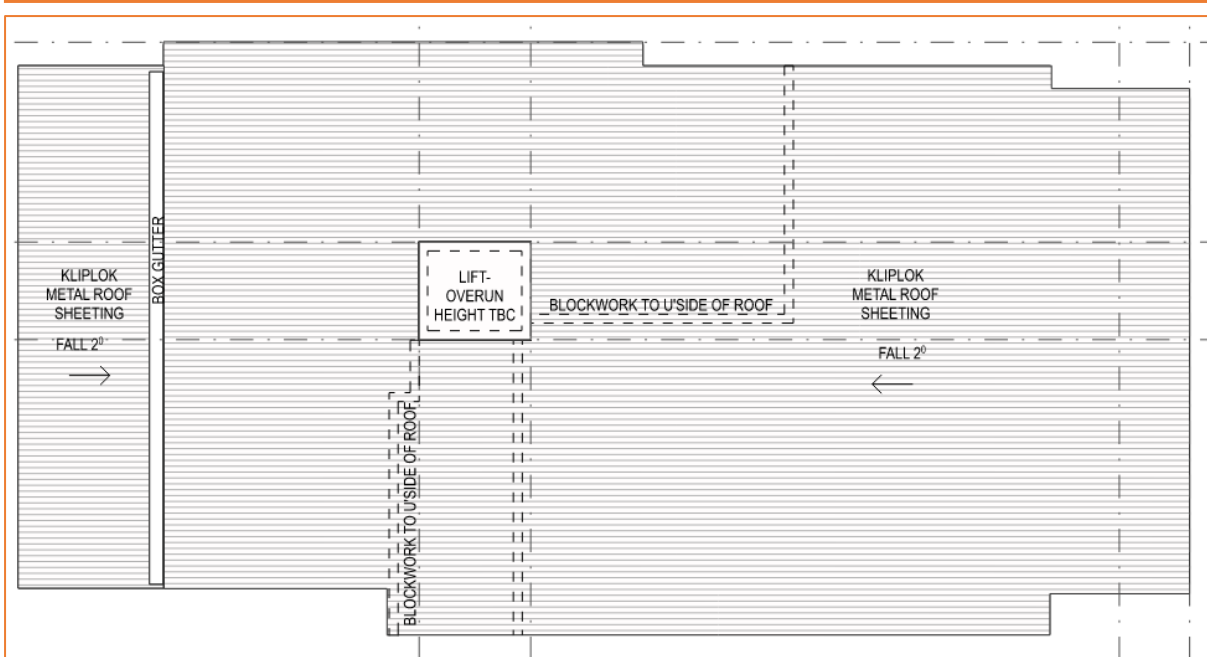


Figure 6: Roof Plan

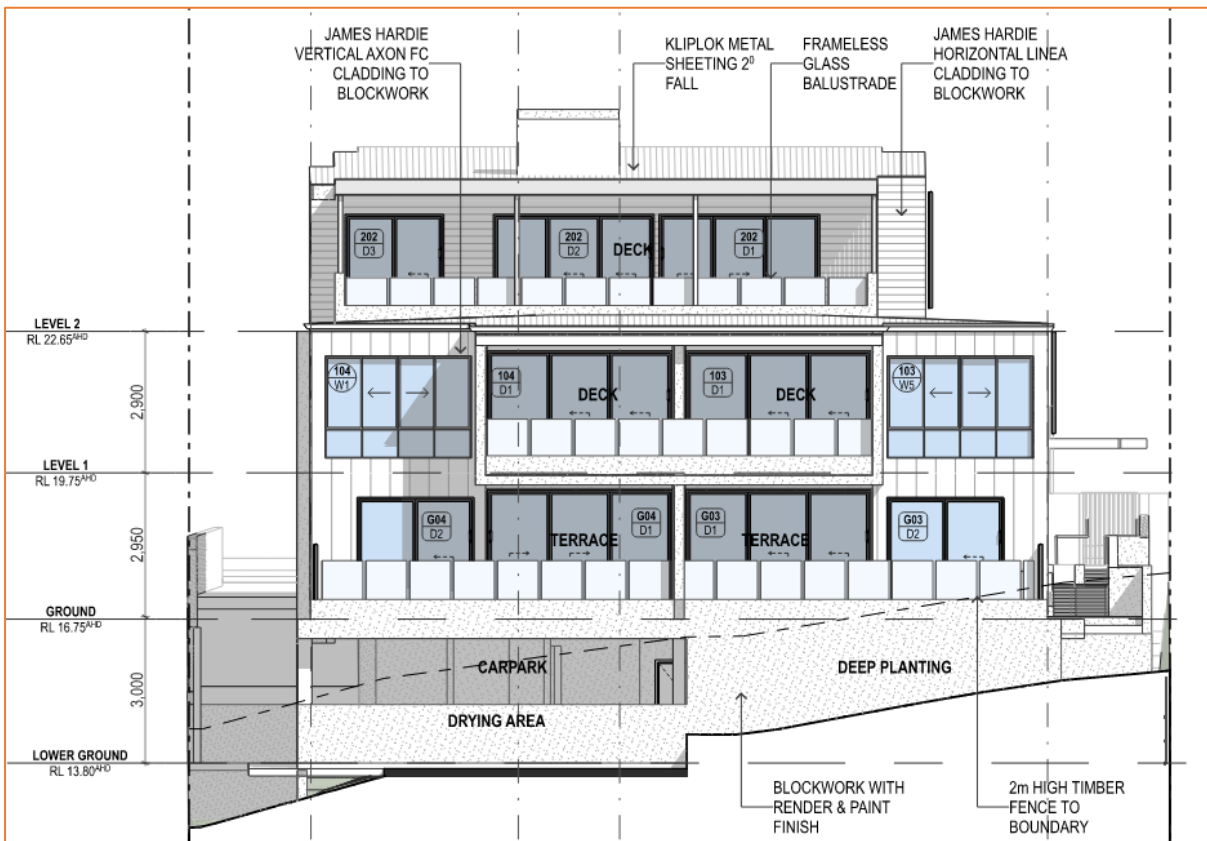


Figure 7: North elevation

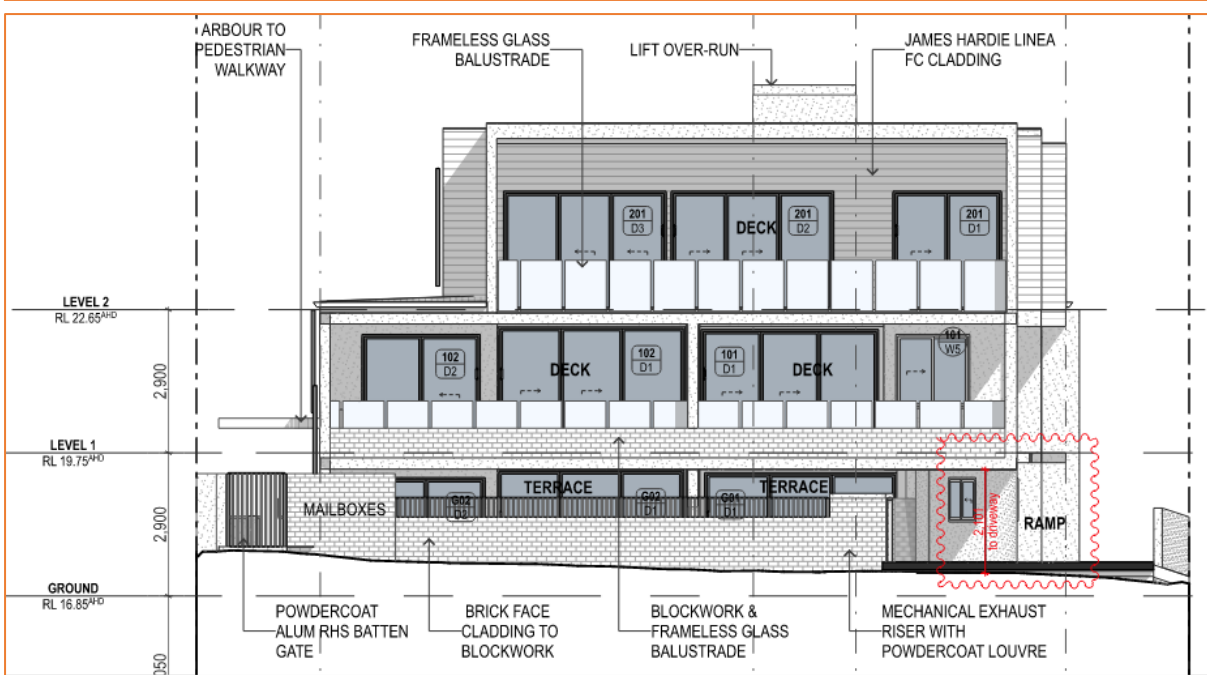


Figure 8: South elevation

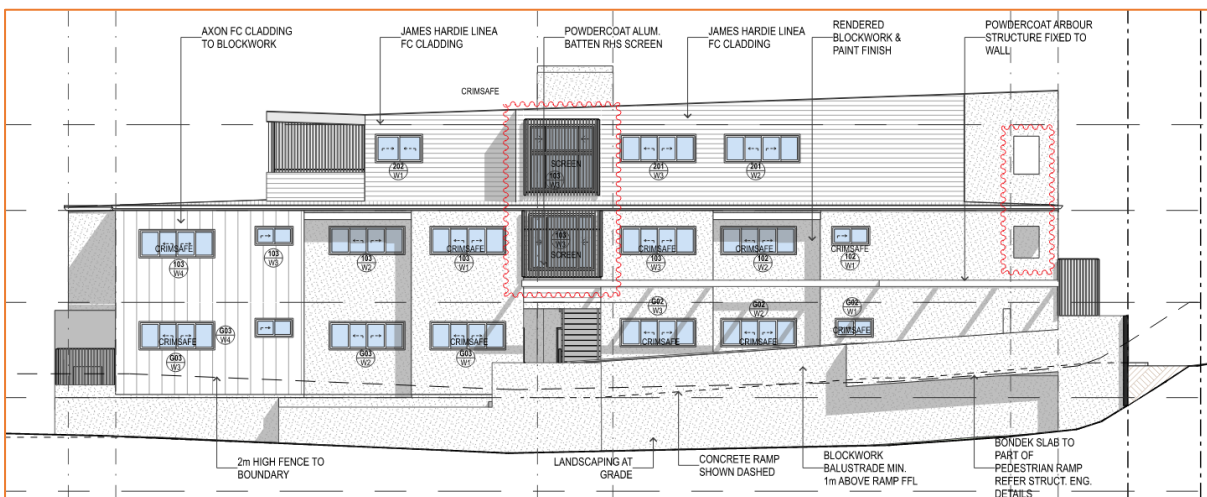


Figure 9: West elevation

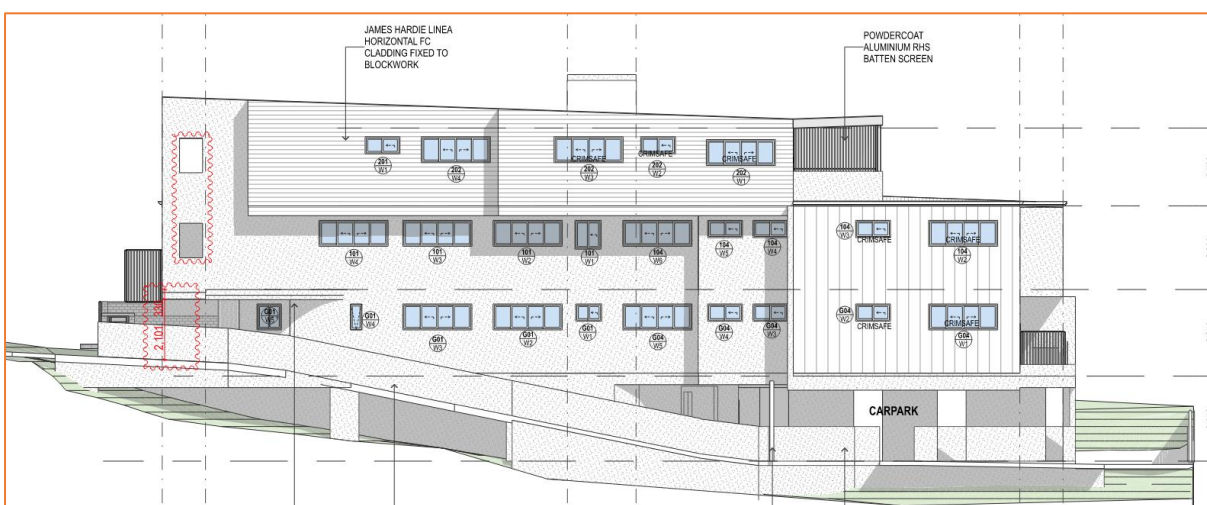


Figure 10: East elevation

2.3 Building Characteristics

To develop effective fire engineering strategies, it is important to understand the principal building characteristics under its normal mode of functioning. Following is a summary of the building characteristics.

Table 4. Building Description

Characteristics	20 Sisley St, St Lucia
Occupancy	Residential Building with carpark on lower ground level
Rise in Storeys	4
Number of Storeys	4
General Usage	Class 2 - Residential building Class 7a - Carpark
Structure	Type A construction (Australian Building Codes Board, 2022)
Effective height	Approximately 8.9 m.
Management in Use	The building will be managed by a representative nominated by the owner which will be responsible for the ongoing maintenance aspects of the fire safety systems as required under AS 1851.1 and QDC MP 6.1.
Environmental Considerations	Not in fire engineering scope
First Responding Fire Station	The first responding fire station is Taringa Fire and Rescue Service, located at 26 Whitmore St, Taringa, QLD 4068, at a distance of about 1.6 km, with a travel time of about 3 min.
Second Responding Fire Station	The second responding fire station is Roma street Fire and Rescue Service, located at 279 Roma St, Brisbane City, QLD 4000, at a distance of about 5.1 km, with a travel time of about 12 min.

2.4 Review of Rise in Storey

The carpark level will be counted in the rise in storey, because the part of external wall of carpark level on the north side of the building will be above the natural ground, as shown in Figure 12. Therefore, it will be counted in the rise in storey calculation, as per Clause C2D3 of BCA 2022 Volume 1.

C2D3	Calculation of rise in storeys	[2019: C1.2]
<p>(1) The <i>rise in storeys</i> is the sum of the greatest number of <i>storeys</i> at any part of the <i>external walls</i> of the building and any <i>storeys</i> within the roof space—</p> <p>(a) above the finished ground next to that part; or</p> <p>(b) if part of the <i>external wall</i> is on the boundary of the allotment, above the natural ground level at the relevant part of the boundary.</p>		

Figure 11: Extract of Clause C2D3 of BCA 2022 Volume 1

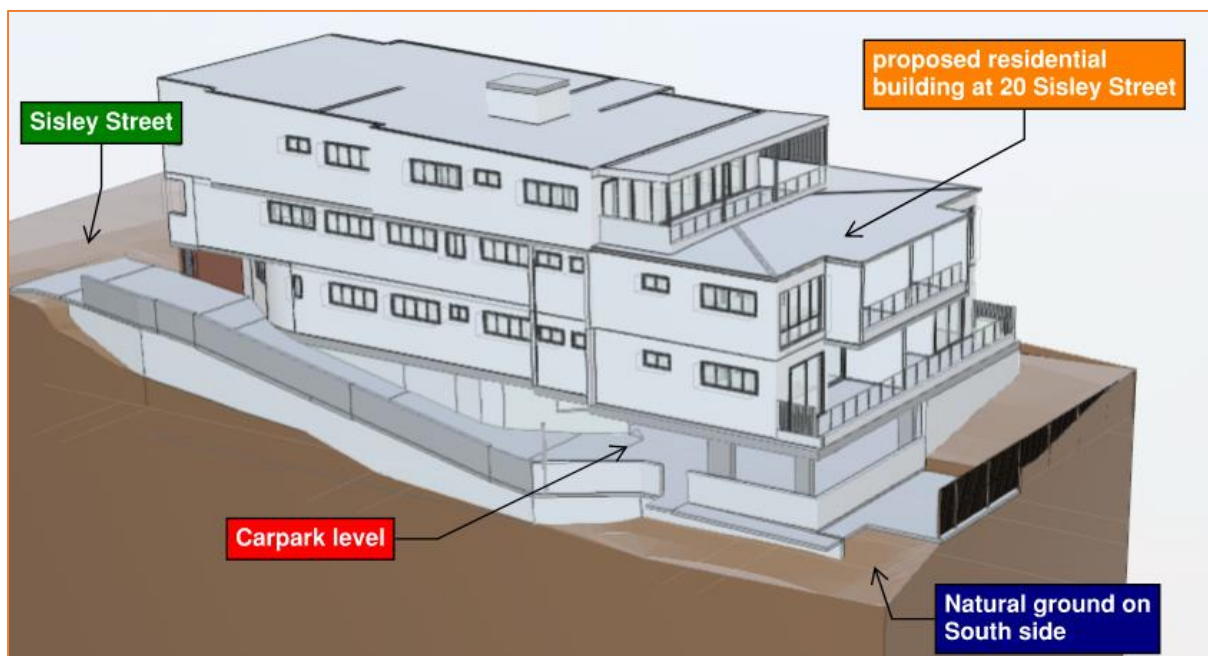


Figure 12: Carpark level overview

Hence, as per BCA 2022, the carpark level is not a basement, as it is counted in the calculation of rise in storey, as shown in the figure below. Therefore, the rise in storey of the building will be four(4).

Basements—D2D3(3)
<p>“Basement” is not defined in the BCA. A basement is regarded as a below-ground-level storey not counted in the rise in storeys.</p>

Figure 13: Extract of Guide for Clause D2D3(3) of BCA 2022 Volume 1

Hence, the provision of single exit on the carpark level is as per Clause D2D3 of BCA 2022 Volume 1.

D2D3	Number of exits required	[2019: D1.2]
<p>(1) All buildings — Every building must have at least one <i>exit</i> from each <i>storey</i>.</p> <p>SA D2D3 (2)</p>		

Figure 14: Extract of Clause D2D3 of BCA 2022 Volume 1

2.5 Review of window openings with reduced sill height

The ground level will have four window openings on the west side, which opens onto the walkway with sill height of less than 1.5 m. On the east side, one window will have a sill height of less than 1.5 m, and opens onto the driveway, as shown in the figures below.

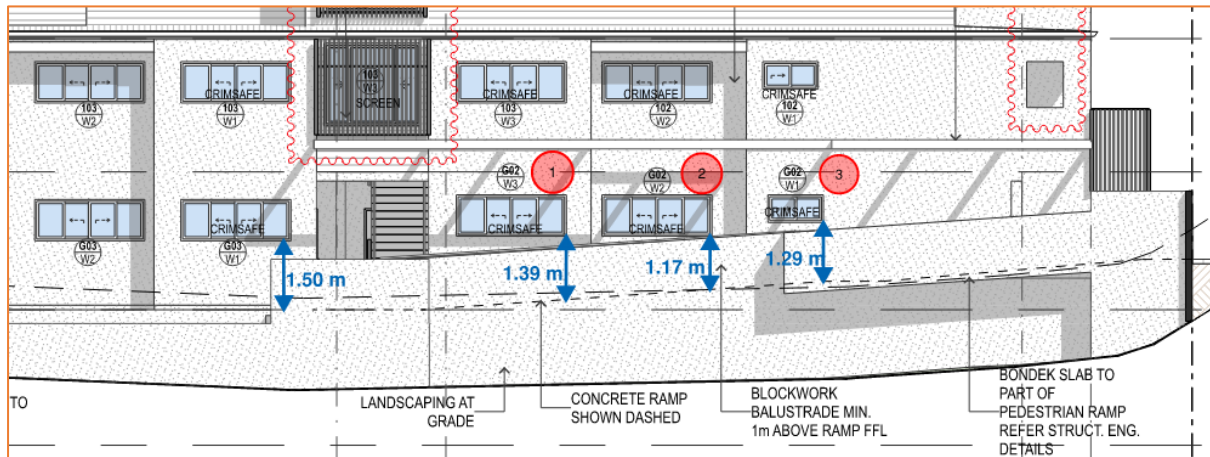


Figure 15: Window openings on the west side, alongside the walkway ramp

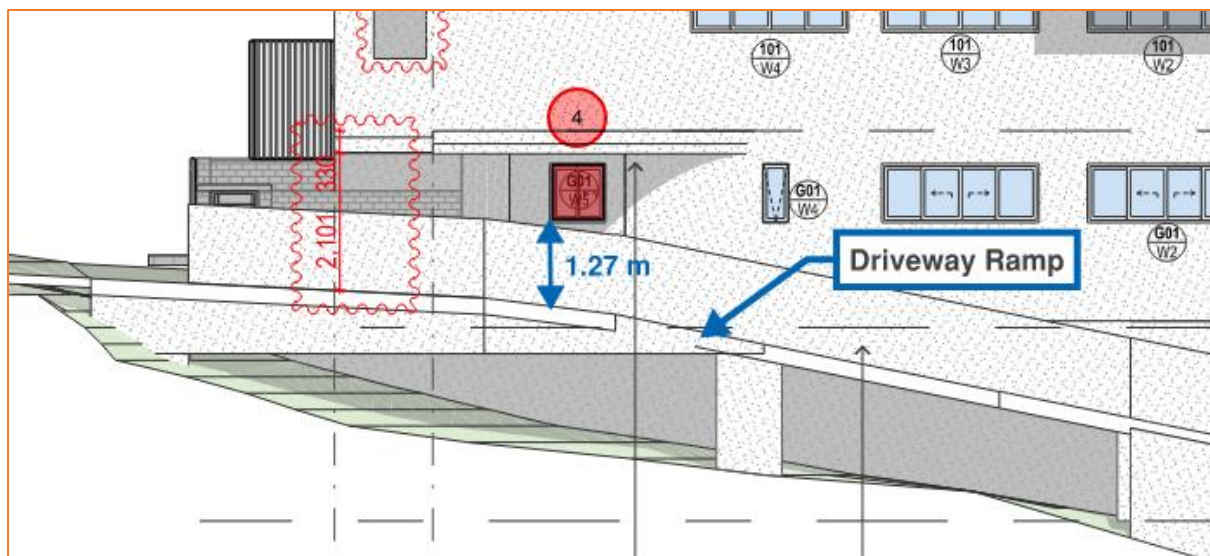


Figure 16: Window openings on the east side, alongside the driveway ramp

Summary of window locations with sill height less than 1.5 m is as follows in the table below.

Table 5: Summary of window locations with less than 1.5 m sill height

Sr. No	Window opening locations	Sill height
1	G02/W3 - Bed 3 section in SOU G02.	1.39 m
2	G02/W2 - Bed 2 section in SOU G02.	1.17 m
3	G02/W1 - Toilet section in SOU G02.	1.29 m
4	G01/W5 - Living room & kitchen section in SOU G01.	1.27 m

However, window openings in an external wall are required to be at least 1.5 m above the floor of the landing, which will be a non-compliance issue as per Clause C4D12 of BCA 2022 Volume 1.

- (8) The requirements of (9) apply in a Class 2 or 3 building where a path of travel to an *exit*—
- (a) does not provide a person seeking egress with a choice of travel in different directions to alternative *exits*; and
 - (b) is along an open balcony, landing or the like; and
 - (c) passes an *external wall* of—
 - (i) another *sole-occupancy unit*, or
 - (ii) a room not within a *sole-occupancy unit*.
- (9) The *external wall* mentioned in (8)(c) must—
- (a) be constructed of concrete or masonry, or be lined internally with a *fire-protective covering*, and
 - (b) have any doorway fitted with a *self-closing*, tight-fitting solid core door not less than 35 mm thick; and
 - (c) have any *windows* or other openings—
 - (i) protected internally in accordance with *C4D5*; or
 - (ii) located at least 1.5 m above the floor of the balcony, landing or the like.

Figure 17: Extract of Clause C4D12 of BCA 2022 Volume 1.

The walkway on the west side is the only exit available for occupants on all the levels of this building; therefore, it becomes critical to ensure the safety of occupants using this walkway. Therefore, the window openings of Bed 2, Bed 3 and Toilet section in SOU G02, which are located on external wall on west side, are required to be provided with a minimum sill height of 1.5 m and must be provided with heat attenuation screens.

Furthermore, The window openings of living room & kitchen section of SOU G01 on the east side of the building, will have a sill height of less than 1.5 m. However, it opens on the driveway ramp, which will have a slop of 1:5 which is steeper than 1:8 requirement of D2D15(3)(a) of BCA 2022 Volume 1. Hence, it should not be used as the egress path. Hence, the sill height of less than 1.5m is acceptable. However it should be provided with the heat attenuation screen to reduce the risk of fire spread to and from the window opening.

The summary of changes required to the window openings are listed below.

Table 6: Windows with required changes

Sr. No	Window opening locations	Required changes
1	G02/W3 - Bed 3 section in SOU G02.	Required a minimum sill height of 1.5 m and must be provided with heat attenuation screen.
2	G02/W2 - Bed 2 section in SOU G02.	
3	G02/W1 - Toilet section in SOU G02.	
4	G01/W5 - Living room & kitchen section in SOU G01.	Required heat attenuation screen

3 DOMINANT OCCUPANT CHARACTERISTICS

Understanding the likely nature of the building occupants is an important element of the fire engineering process. The dominant occupant characteristics that impact on the fire engineering analysis is outlined below for reference.

Table 7. Occupant Characteristics (Class 2 Residential Apartment)

Occupant Characteristic	20 Sisley St, St Lucia
Distribution	Evenly distributed throughout the building. Authorised personal and maintenance crew would also add to the occupant numbers in the building.
State	Asleep inside the residential units would be the worst-case scenario in the event of fire.
Physical Attributes	Occupants are assumed to be mobile; however, occupants with reduced mobility due to age or injury are also likely.
Familiarity with surroundings	The occupants, being residents, are assumed to be familiar with the building exit system. Visitors may not be familiar with the building exit layout; however, they are likely to be accompanied by a building resident occupant who would likely be familiar with the building exits.
Mental attributes	For this assessment, it is assumed that the occupants have an adequate level of understanding and can interpret a fire alarm to begin evacuation.
Level of assistance required	It is assumed that the occupants would not require assistance for evacuation purposes. However, elderly or injured occupants may require assistance from other occupants or the responding fire brigade.
Level of assistance available	Assistance from the fire brigade responding to a fire event.
Emergency Training	Occupants would be untrained.
Type of occupancy groups	Family Groups, Unrelated Occupants.
Activity at fire outbreak	Asleep inside the residential units would be the worst-case scenario in case of a fire event.

Table 8. Occupant Characteristics (Class 7a Carpark)

Occupant Characteristic	20 Sisley St, St Lucia
Distribution	<p>Evenly distributed throughout the carpark. Occupants will be either walking through the carpark to or from cars or travelling through the carpark in vehicles. Authorised personal and maintenance crew would also add to the occupant numbers in the area.</p> <p>The number of occupants accommodated in the carpark area would be 17, as per Table D2D18 of the BCA 2022 Volume 1, with an occupant density of 30 m²/person.</p>
State	Occupants will be awake at the time of the fire.
Physical Attributes	The predominant number of occupants is assumed to be mobile. Occupants with physical disability will also be part of the occupant group, hence mobility of these occupants may be hindered. The impact of occupants with reduced mobility may be reduced as occupants may be in vehicles.
Familiarity with surroundings	The occupants being residents are assumed to be familiar with the building exit system. Visitors may not be familiar with the building exit layout. However, they are likely to be accompanied by a building resident occupant who would likely be familiar with the building exits.
Mental attributes	The predominant number of occupants is assumed to have adequate hearing and visual ability. However, there may be some occupants with hearing and visual disability, who will also form part of the occupant group. Occupants are assumed to have the capability to respond to an evacuation signal and begin their evacuation to the exit.
Level of assistance required	Occupants who may be injured or have a disability at the time of fire will require assistance. Mobility-impaired occupants will likely be mobile and be assisted by friends, family, staff or emergency services. The impact of occupants with reduced mobility may be reduced as occupants may be in vehicles.
Level of assistance available	The intervening fire crew will provide assistance.
Emergency Training	Occupants would be untrained.

Occupant Characteristic	20 Sisley St, St Lucia
Type of occupancy groups	Family Groups, Unrelated Occupants.
Activity at fire outbreak	All occupants are likely to be awake. Occupants on Infants/Toddlers may be asleep in their stroller; however, they are assumed to be supervised by their guardian/parents.

4 GENERAL OBJECTIVES

The agreed fire safety objectives of this project are as follows: -

- Building regulatory objectives – Demonstrate compliance with the identified performance clauses of the NCC (Australian Building Codes Board 2022).
- There are no non-regulatory objectives to be satisfied for the project.

5 NON-COMPLIANCE ISSUES AND SPECIFIC OBJECTIVES OR PERFORMANCE REQUIREMENTS

The non-compliance issues against the NCC and the performance requirements applicable are identified below for ease of reference.

Table 9. NCC Non-Compliance Description

Issue No.	Non-Compliance Issue	Non-Compliance Clause	Performance Clause
1	<p><u>Review of window openings within 3 m of the site boundary</u></p> <p>The window openings on the ground level, level 1 and level 2 are located at less than 3m from the site boundary. The openings are located at 2.5m from the site boundary.</p>	C4D3	C1P2, C1P4, C1P8
2	<p><u>Review of Extended Travel Distances in the lower ground level Carpark</u></p> <p>The travel distances to the exit on the lower ground level would be approximately 32 m, in lieu of 20 m.</p>	D2D5	D1P4, E2P2

3	<p><u>Review of Special Hazard - Provisions for Electric Vehicle Charging in the Carpark</u></p> <p>The building is assessed against BCA 2022 and therefore is required to be provided with provisions for EV charging. The provisions will include a distribution board to meet the EV requirements for the building. Due to the potential of EV vehicle charging and EV in the building carpark, the special hazard is assessed in the carpark.</p>	E1D17	C1P1, C1P2, C1P4, C1P7, C1P9, E2P2
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6 HAZARDS AND PREVENTIVE AND PROTECTIVE MEASURES AVAILABLE

6.1 Hazards

The development has no specific hazards above that which would be normally expected. A review of the likely activities, ignition sources, fuel sources are outlined below for information purposes.

Table 10. Review Of Likely Hazards (Class 2 Residential Levels)

Category	Comment
General Layout	The four-storey residential building will have an effective height of approximately 8.9 m. Each level is provided with the a non-fire-isolated stairway and one lift. The occupants, being residents, are assumed to be familiar with the building exit system. Visitors may not be familiar with the building exit layout; however, they are likely to be accompanied by a building resident occupant who would likely be familiar with the building exits.
Activities	The building will be a residential building and hence normal family activities are expected. Activities such as disregarding safety procedures while using home equipment can cause ignition, and repair and maintenance work would need to be controlled via work permits to minimise the risk of a fire. Construction work - The fire precautions during construction must be in accordance with BCA 2022 clause E1D16.
Fuel Sources	Combustible furniture, curtains, mattress, bedding, paper materials, accumulated rubbish, oils, television, computers.
Fire Load Densities	Residential levels 780 MJ/m ² .
Ignition Sources	Potential ignition sources in the residential levels could range from electrical short circuits, overheating of electrical equipment, and open flames such as candles. Matches or cigarette lighters, major repair or maintenance work involving welding, cutting, etc.

Table 11. Review Of Likely Hazards (Class 7a Carpark)

Category	Comment
General Layout	The lower ground level will accommodate 17 car parking spaces, a refuse store room and electric services room. A driveway access is provided on the east side of the building. Stair located on west side provide access to open ramp on ground level which will further connect to Sisley Street.
Activities	A few key activities that can cause fire are vehicle collision and disregarding safety procedures, which may cause ignition. Repair and maintenance work - This must be controlled via work permits. Construction work - The fire precautions during construction must be in accordance with BCA 2022 clause E1D16.
Fuel Sources	In the carpark, the fuel source will be predominantly fuel stored in vehicles and batteries in EV vehicles.
Fire Load Densities	Vehicle 400 MJ/m ² .
Ignition Sources	Potential ignition sources in the carpark level could be Vehicle malfunction resulting in a car or bike fire. Electrical short circuit. Improper use of power tools, EV charging facility and other electrical equipment. Overheating of electrical equipment. Major repair and maintenance works involving welding, cutting etc. on all carpark levels. Arson.

6.2 Preventative and Protective Measures

The preventative and protective measures to address each of the sub systems as identified in the Australian Fire Engineering Guidelines (AFEG) (Australian Building Codes Board 2021) is outlined below for reference.

Table 12. Comments Against The AFEG Sub Systems

Sub System (Australian Building Codes Board 2021)	Comment
Sub-system A (SS-A) Fire initiation & development & control	Good housekeeping protocols implemented by the residents in the building would likely reduce the risk of fire ignition. The occupants in the building, disregarding the safety procedures, might act as a source of ignition in the building.
Sub-system B (SS-B) Smoke development, spread & control	<p>This residential building will be constructed as a Type 'A' construction building and therefore, the individual levels would be separated by deemed to satisfy fire-rated construction. Further, the individual SOUs will be separated by bounding construction of 90/90/90 for loadbearing elements and -/60/60 for non-load-bearing elements. Therefore, the risk of smoke spreading between the SOUs and between the levels in the building is unlikely.</p> <p>The lower ground-level carpark and the residential ground level will be separated by floor with an FRL of 120/120/120.</p>
Sub-system C (SS-C) Fire spread, impact & control	<p>This residential building will be constructed as a Type 'A' construction building and therefore, the individual levels would be separated by deemed to satisfy fire-rated construction. Further, the individual SOUs will be separated by bounding construction of 90/90/90 for loadbearing elements and -/60/60 for non-load-bearing elements. Therefore, the risk of fire spreading between the SOUs and between the levels in the building is unlikely.</p> <p>The window openings on the ground level, level 1 and level 2 are located at less than 3m distance from the site boundary, and this issue will be addressed in Section 9.1.</p> <p>Provisions for electric vehicles will be included in the building and will be addressed in Section 9.3.</p>

<p>Sub-system D (SS-D) Fire detection, warning & suppression</p>	<p>The building will be provided with a smoke detection system and occupant warning speakers that are compliant with the BCA 2022 and AS 1670.1 – 2018.</p> <p>The occupant warning system will have a minimum sound pressure level of 75 dB at the bedhead, with the bedroom door closed, and along the balcony with the balcony door closed. Further, the building will also likely to have portable fire extinguishers, which may be used by the occupants to intervene and control the fire growth when safe to do so.</p>
<p>Sub-system E (SS-E) Occupant evacuation & control</p>	<p>The entire building will be provided with fire sprinklers, which will activate the General Fire Alarm (GFA) in the building in the event of fire. This will notify the occupants to evacuate the building.</p> <p>The travel distances to the exit on the lower ground level would be approximately 32 m, in lieu of 20 m, and this issue will be addressed in Section 9.2.</p>
<p>Sub-system F (SS-F) Fire services intervention</p>	<p>The building will be provided with all the fire service systems as required by the BCA 2022. FIP will be located at the entrance of the lobby area on the ground level.</p>

7 APPROACH AND ASSESSMENT METHOD

The BCA under Clause A2G2 (Australian Building Codes Board 2022) outlines specific requirements for performance solutions.

A2G2	Performance Solution	[2019: A2.2]
<p>(1) A <i>Performance Solution</i> is achieved by demonstrating—</p> <ul style="list-style-type: none"> (a) compliance with all relevant <i>Performance Requirements</i>; or (b) the solution is at least <i>equivalent to the Deemed-to-Satisfy Provisions</i>. <p>(2) A <i>Performance Solution</i> must be shown to comply with the relevant <i>Performance Requirements</i> through one or a combination of the following <i>Assessment Methods</i>:</p> <ul style="list-style-type: none"> (a) Evidence of suitability in accordance with Part A5 that shows the use of a material, product, <i>plumbing and drainage product</i>, form of construction or design meets the relevant <i>Performance Requirements</i>. (b) A <i>Verification Method</i> including the following: <ul style="list-style-type: none"> (i) The <i>Verification Methods</i> provided in the NCC. (ii) Other <i>Verification Methods</i>, accepted by the <i>appropriate authority</i> that show compliance with the relevant <i>Performance Requirements</i>. (c) <i>Expert Judgement</i>. (d) Comparison with the <i>Deemed-to-Satisfy Provisions</i>. 		

Figure 18 Extract from BCA 2022 Clause A2G2

The approach and method of assessment for each of the performance solutions proposed is tabulated below.

Table 13. Approach And Methods Of Assessment

Item	Non-Compliance Issue	Approach	Assessment Method
1	<p><u>Review of window openings within 3 m of the site boundary</u></p> <p>The window openings on the ground level, level 1 and level 2 are located at less than 3m from the site boundary. The openings are located at 2.5m from the site boundary.</p>	Qualitative & Quantitative	A2G2 (2) (b) (ii) Other Verification Methods, accepted by the appropriate authority that show compliance with the relevant Performance Requirements.
2	<p><u>Review of Extended Travel Distances in the lower ground level Carpark</u></p> <p>The travel distances to the exit on the lower ground level would be approximately 32 m, in lieu of 20 m.</p>	Quantitative	A2G2 (2) (b) (ii) Other Verification Methods, accepted by the appropriate authority that show compliance with the relevant Performance Requirements.

3	<p>Review of Special Hazard - Provisions for Electric Vehicle Charging in the Carpark</p> <p>The building is assessed against BCA 2022 and therefore is required to be provided with provisions for EV charging. The provisions will include a distribution board to meet the EV requirements for the building. Due to the potential of EV vehicle charging and EV in the building carpark, the special hazard is assessed in the carpark.</p>	Qualitative	A2G2 (2) (b) (ii) Other Verification Methods, accepted by the appropriate authority that show compliance with the relevant Performance Requirements.
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8 ACCEPTANCE CRITERIA

The acceptance criteria for each of the performance solutions proposed is tabulated below.

Table 14. Acceptance Criteria

Issue No	Non-Compliance Issue	Acceptance criteria
1	<p><u>Review of window openings within 3 m of the site boundary</u></p> <p>The window openings on the ground level, level 1 and level 2 are located at less than 3m from the site boundary. The openings are located at 2.5m from the site boundary.</p>	<p>The window opening in proximity with site boundary should not unduly increase the risk of fire spread to or from the adjacent building.</p>
2	<p><u>Review of Extended Travel Distances in the lower ground level Carpark</u></p> <p>The travel distances to the exit on the lower ground level would be approximately 32 m, in lieu of 20 m.</p>	<p>The extended travel distances on the lower ground level to the exit should not unduly pose a threat to life safety of the occupants during evacuation.</p>
3	<p><u>Review of Special Hazard - Provisions for Electric Vehicle Charging in the Carpark</u></p> <p>The building is assessed against BCA 2022 and therefore is required to be provided with provisions for EV charging. The provisions will include a distribution board to meet the EV requirements for the building. Due to the potential of EV vehicle charging and EV in the building carpark, the special hazard is assessed in the carpark.</p>	<p>It is acceptable that provisions for electric vehicle charging be installed in the building if the criteria for safe fire brigade intervention found in the QFD position statement on electric vehicle charging are satisfied.</p>

9 PERFORMANCE SOLUTION ANALYSIS

9.1 Review of window openings within 3 m of the site boundary

9.1.1 NCC Review

The first step of developing a performance based solution is to undertake a NCC review as outlined below.

Table 15. NCC Review

Items	Comments
Non-compliance Issue	<u>Review of window openings within 3 m of the site boundary</u> The window openings on the ground level, level 1 and level 2 are located at less than 3m from the site boundary. The openings are located at 2.5m from the site boundary.
NCC Part	Part C4 - Protection of openings
Non-compliance Clause	C4D3 - Protection of openings in external walls
Performance Requirements from applicable NCC Part	C1P2 - Spread of fire C1P4 - Safe conditions for evacuation C1P8 - Fire protection of openings and penetrations
Performance Requirements from other NCC Part's	-
A2G2 – Performance Solution	A2G2 (2) (b) (ii) Other Verification Methods, accepted by the appropriate authority that show compliance with the relevant Performance Requirements.
AFEG Sub system	Sub-system C - Fire spread, impact & control

9.1.2 Intent of the BCA

The BCA 2022 under Clause C4D3 specifies the following regarding openings within 3m from the side boundary.

C4D3	Protection of openings in external walls	[2019: C3.2]
<p>(1) Subject to (2), openings in an external wall that is required to have an FRL must be protected in accordance with C4D5, and if wall-wetting sprinklers are used they must be located externally.</p> <p>(2) The requirements of (1) only apply if the distance between the opening and the fire-source feature to which it is exposed is less than—</p> <ul style="list-style-type: none"> (a) 3 m from a side or rear boundary of the allotment; or (b) 6 m from the far boundary of a road, river, lake or the like adjoining the allotment, if not located in a storey at or near ground level; or (c) 6 m from another building on the allotment that is not Class 10. <p>(3) Openings in an external wall that is required to have an FRL, if required to be protected under (1), must not occupy more than 1/3 of the area of the external wall of the storey in which it is located unless they are in a Class 9b building used as an open spectator stand.</p>		

Figure 19: Extract of Clause C4D3 of BCA 2022 Volume 1.

The intent of Clause C4D3 is "To require any opening in external walls to be protected, only where the wall is required to have an FRL, to prevent the spread of fire from the boundary of an adjoining allotment, or one building to another building on the same allotment".

As per Clause C4D3 of BCA 2022 Volume 1, any openings in an external wall required to have an FRL and within 3 m from the site boundary are required to be protected in accordance with C4D5 of BCA 2022 Volume 1.

9.1.3 Analysis

The window opening to the SOUs on ground level, level 1 and level 2 of the building will be located less than 3 m from the site boundary, as shown in the figures below. Therefore, it is identified as a non-compliance issue.

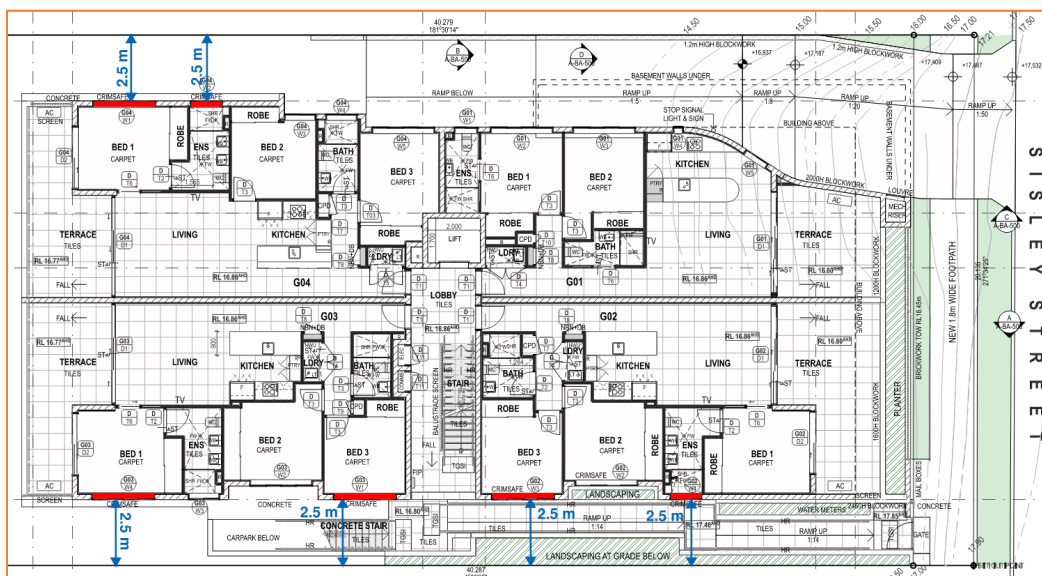


Figure 20: Location of opening within 3 m from the site boundary on ground level

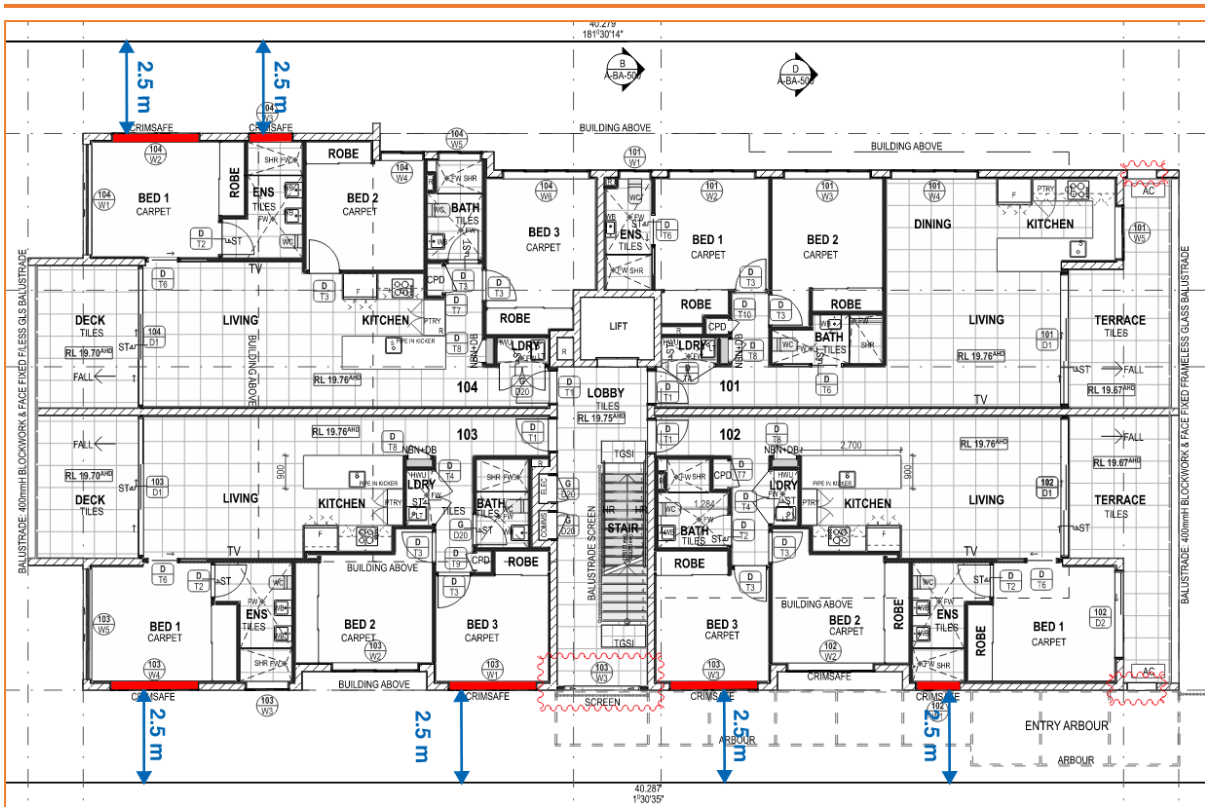


Figure 21: Location of opening within 3 m from the site boundary on level 1

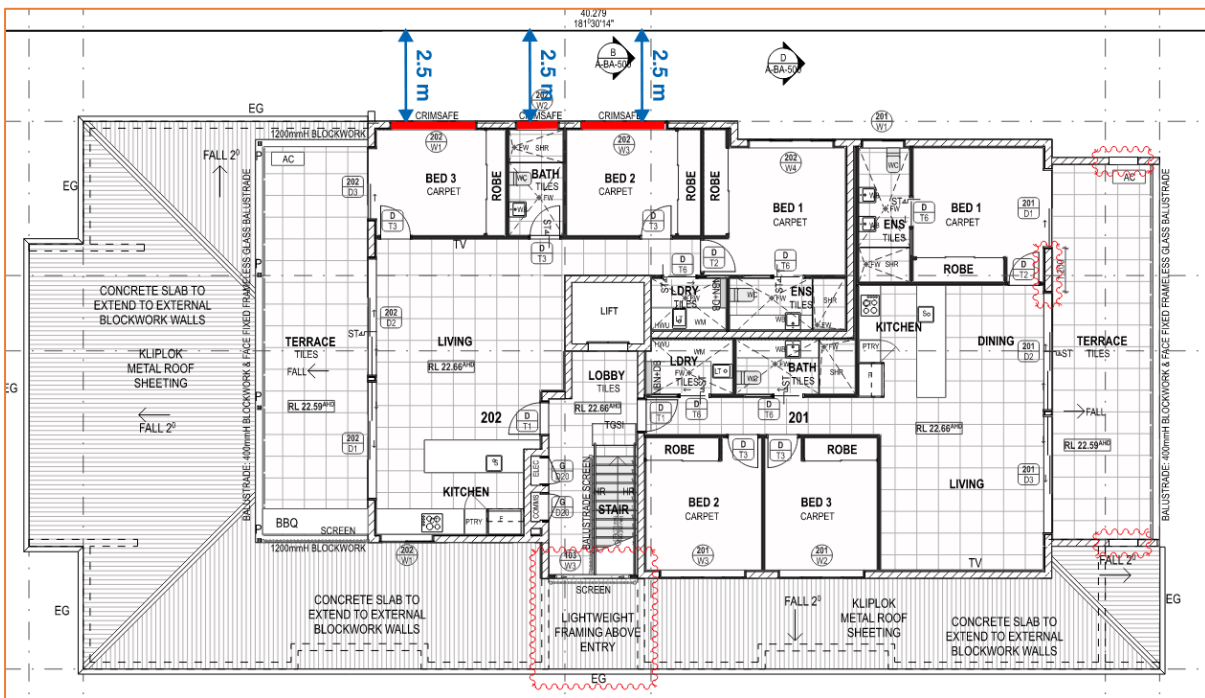


Figure 22: Location of opening within 3 m from the site boundary on level 2

The locations of window openings within 3 m from the site, along with window dimensions are specified in the table below.

Table 16: Summary of window locations within 3 m from the site boundary

Sr. No.	Level	Window opening locations	Distance	Window dimensions		
				Height	Width	Area
1	Ground level	Bed 3 section in SOU G02.	2.5 m	0.9 m	2.4 m	2.16 m ²
2		Toilet section in SOU G02.	2.5 m	0.6 m	1.21 m	0.726 m ²
3		Bed 1 section in SOU G03.	2.5 m	0.9 m	2.4 m	2.16 m ²
4		Bed 3 section in SOU G03.	2.5 m	0.9 m	2.4 m	2.16 m ²
5		Bed 1 section in SOU G04.	2.5 m	0.9 m	2.4 m	2.16 m ²
6		Bed 2 section in SOU G04.	2.5 m	0.6 m	1.21 m	0.726 m ²
7	Level 1	Bed 3 section in SOU 102.	2.5 m	0.9 m	2.4 m	2.16 m ²
8		Toilet section in SOU 102.	2.5 m	0.6 m	1.21 m	0.726 m ²
9		Bed 1 section in SOU 103.	2.5 m	0.9 m	2.4 m	2.16 m ²
10		Bed 3 section in SOU 103.	2.5 m	0.9 m	2.4 m	2.16 m ²
11		Bed 1 section in SOU 104.	2.5 m	0.9 m	2.4 m	2.16 m ²
12		Bed 2 section in SOU 104.	2.5 m	0.6 m	1.21 m	0.726 m ²
13	Level 2	Bed 2 section in SOU 202.	2.5 m	0.9 m	2.4 m	2.16 m ²
14		Toilet section in SOU 202.	2.5 m	0.6 m	1.21 m	0.726 m ²
15		Bed 3 section in SOU 202.	2.5 m	0.9 m	2.4 m	2.16 m ²

These openings would therefore require protection as per Clause C4D3; however, protection in accordance with this clause will not be provided.

Hence, the risk of fire spread from this window openings to the site boundary and the risk of fire spread towards this building will be analysed further.

Review of fire spread from this building

The window openings within 3m from the site boundary will likely to increase the risk of fire spread from the building to the adjacent site boundary. Hence, the heat flux from the window openings will be analysed further, to check the compliance with C1P2 and it is verified by the verification method proposed in Clause C1V1 of BCA 2022 Volume 1.

The closest non-compliant opening of the external wall is located 2.5 m from the site boundary. However, as per Clause C1V1 of BCA 2022 Volume 1, a building should not cause heat flux in excess as mentioned in Table C1V1.

Table C1V1: Fire spread between buildings on adjoining allotments

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

Figure 23: Table C1V1 of BCA 2022 Volume 1

From Table C1V1, the opening located at 3 m from the boundary should not cause heat flux in excess of 20 kW/m². Hence, the window openings located on ground level and level 1 within 3m of the site boundary should not cause a heat flux in excess of 20 kW/m².

The largest window openings, which are within 3 m of the site boundary, will have a height and width of 0.9 m and 2.4 m, respectively, and are located 2.5 m from the site boundary. (Refer Table 16)

A fire source temperature of 1000°C has been assumed for this study. This model temperature has been determined by referring to the estimated fully developed fire enclosure room temperature on page 18 of the Enclosure Fire Dynamics text, which states:

"The average gas temperature in the enclosure during this stage is often very high, in the range of 700°C to 1200°C."

Additionally, reference has been made to the FIREWIND manual for validation of the temperature calculation. The FIREWIND manual states the following on page 92:

"Radiation is acutely temperature dependant (T to the fourth power) and therefore some care needs to be taken when deciding on the sources temperature. The effective black body temperatures of flames have been measured in many full-scale scale building fires and these have ranged typically from about 900°C to about 1100°C. A value of 1000°C (1273 K) is reasonably representative of building fires involving normal combustible materials". To be conservative in the assessment in determining the likelihood of fire spread to the adjacent allotment, a flame height of 1 m had been assumed in addition to the opening height. This would factor in the flame front projecting out of the opening under flashover conditions. This has been referenced from the Fire Engineering Guidelines – March 1996 – Appendix 10 A, page 5 – Calculating Radiant Heat Flux on Remote Combustible Materials. Heat radiation calculations have been carried out to better understand the radiation that will be received on the adjacent site, and the results of the calculations are shown in the figure below.

Radiation to Parallel Receiver

Fire Engineering Design Guide, Third Edition

Inputs

Tr	Temperature of radiator	1000 °C
Te	Temperature of emitter	20 °C
ε	Emissivity of radiator	1.00
a	Width of radiator body	2.4 m
b	Height of radiator body	1.9 m
c	Distance between radiator and receiver	2.5 m

Parameters

σ	Stefan-Boltzmann constant	5.67E-11 kW/m ² K ⁴
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Calculations

$$X = 0.4800$$

$$Y = 0.3800$$

φ	Configuration factor	0.1863
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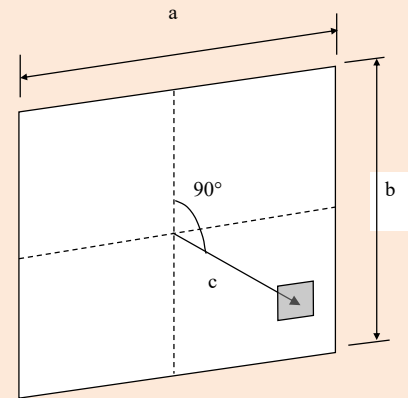
Output Results

Radiation emitted	148	kW/m ²
Radiation received	27.7	kW/m ²

This will be the radiation received at the non compliant opening due to a fire at the site boundary.

Impact of heat attenuation screen	11.3	kW/m ²
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This will be the radiation received at the opening after the installation of the heat attenuation screens to the non compliant window openings. The heat radiation will be less than 20kW/m² which is below the maximum permissible limit under C1V1.



$$\dot{q}_R'' = k_j \Phi \epsilon \sigma \left[(273 + T_r)^4 - (273 + T_c)^4 \right] \quad [7.4]$$

where k_j is the radiation reduction factor

Φ is the configuration factor (value between 0 and 1.0)

ϵ is the emissivity of emitter and absorptivity of receiving surface (value between 0 and 1.0). It is conservative to take $\epsilon = 1.0$.

σ is the Stefan-Boltzmann constant = 56.7×10^{-12} (kW/m² K⁴)

T_r is the temperature of emitting surface (maximum firecell temperature) (°C)

T_c is the temperature of receiving surface (°C)

Figure 24: heat flux calculation

The calculation above shows that the radiation received by the site boundary from window openings without a heat attenuation screen is 27.7 kW/m², which is more than the required maximum of 20 kW/m². However, when heat attenuation screens are attached to the window openings that are within 3 m from the site boundary, the heat radiation received at the boundary will only be 11.3 kW/m², which will be less than the specified 20 kW/m².

Furthermore, the building is proposed to be provided with the fast response sprinklers. The sprinklers are likely to suppress a fire and wet the area. This sprinkler system will assist in limiting the risk of fire spread from the proposed building. Therefore, the risk of fire spread from the proposed building to the adjacent site boundary, by means of the closest openings, is acceptable.

Review of fire spread to this building

The window opening within 3m from the site boundary are located on ground level and level 1 on both external wall along east and west side of the building. However, from Table C1V1 of BCA 2022 Volume 1, the opening located at 3 m from the site boundary should not be exposed to the heat flux in excess of 20 kW/m². Similarly, an opening located 1 m from the boundary should not be exposed to the heat flux in excess of 40 kW/m². By interpolation, we can state that openings located 2.5 m from the boundary should not be exposed to the a heat flux in excess of 25 kW/m², as shown in figure below.

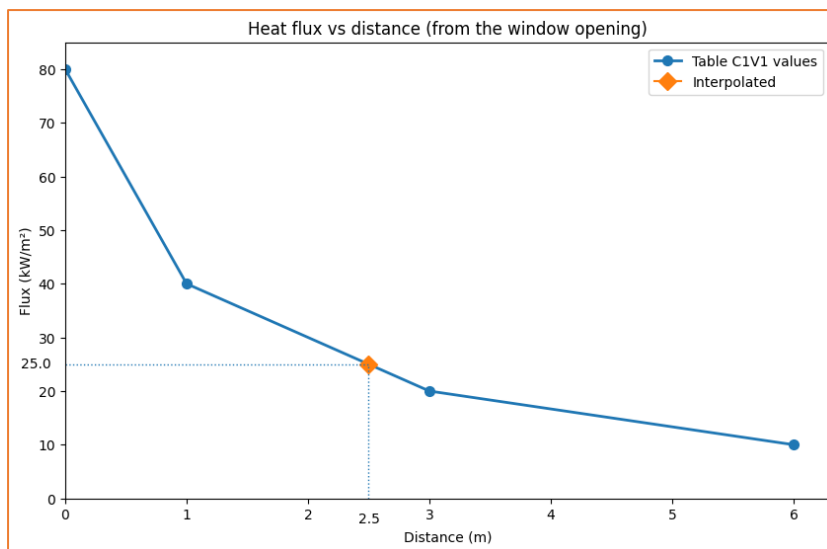


Figure 25: Heat Flux vs distance from the openings

The closest window opening from the site boundary is at 2.5m from the site boundary, hence, it will likely to receive a heat flux of 25 kW/m². The provision of heat attenuation screen to the window openings will likely to reduce the heat flux received inside the building.

Table 17: Radiation received on window openings

Expected radiation received	Impact of heat attenuation screen	Limit as per Table C1V1
25 kW/m ²	10.25 kW/m ²	20 kW/m ²

Hence, when heat attenuation screens are attached to the window openings that are within 3 m from the site boundary, the heat radiation received will only be 10.25 kW/m² which will be less than the specified 20 kW/m².

However, the provided heat attenuation screens (Crimsafe, Invisi-Gard or the like), must comply with the following requirements.

- a. Install heat attenuation screens with a minimum attention rating of 59% to all window openings within 3m of the allotment boundary that are not protected under a Deemed-to-Satisfy compliant manner.
- b. The heat attenuation screens installed must be provided with a test certificate from a registered testing authority.
- c. The heat attenuation screens must sit flush with the external window opening.
- d. The screens must be secured to the external wall using a minimum of 10 mm x 75 mm expandable mechanical anchors.
- e. All fixings must be stainless steel or mild steel.
- f. All fixings must be tamper-proof.
- g. All manufacturers' instructions on the installation of the heat attenuation screen must be followed.

- h. A permanent metal sign must be installed on the heat attenuation screen stating, "Fire Protection Screen – Do Not Remove".
- i. The heat attenuation screens must be subject to yearly maintenance.
- j. Installers of the heat attenuation screen must provide a Form 16 certification.

Hence, the provision of heat attenuation screens, will reduce the likelihood of fire spread to the building through these window openings from the adjacent site and also reduce the likelihood of fire spread to the adjacent site from the window openings.

Furthermore, the walkway on west side and driveway on east side which are located in between window openings and side boundary are transient space hence likely to have minimal fire load. From this, it is reasonable to state that the likelihood of the occurrence of fire spread between this building and the adjacent site boundary is unlikely. This is due to the lower heat flux from the non-compliant window opening that the proposed level in Table C1V1 of BCA 2022 Volume 1 and further provision of heat attenuation screens to the non-compliant window openings in this building.

The heat attenuation screens are required to be provided to the window openings listed below.

Table 18: Summary of window locations required to be provided with heat attenuation screen

Sr. No	Level	Window opening locations required to be provided with heat attenuation screen
1	Ground level	Bed 3 section in SOU G02.
2		Toilet section in SOU G02.
3		Bed 1 section in SOU G03.
4		Bed 3 section in SOU G03.
5		Bed 1 section in SOU G04.
6		Bed 2 section in SOU G04.
7	Level 1	Bed 3 section in SOU 102.
8		Toilet section in SOU 102.
9		Bed 1 section in SOU 103.
10		Bed 3 section in SOU 103.
11		Bed 1 section in SOU 104.
12		Bed 2 section in SOU 104.
13	Level 2	Bed 2 section in SOU 202.
14		Toilet section in SOU 202.
15		Bed 3 section in SOU 202.

Therefore, the provision of window openings within 3 m from the site boundary that are not protected in a Deemed-to-Satisfy manner is acceptable, subject to the provision of heat attenuation screens to the non-compliant windows as listed in Table 18.

9.1.4 Conclusion

In conclusion, from the review of the heat flux calculation performed for the openings in the external wall of this building, it is reasonable to state that the likelihood of the occurrence of fire spread due to the window openings in the external wall within 3 m from the site boundary is unlikely due to the provision of heat attenuation screens (Crimsafe, Invisi-Gard or the like). Which will prevent the spread of fire to or from the allotment boundary and thus, performance requirements of C1P2, C1P4 and C1P8 are met.

9.2 Review of Extended Travel Distances in the lower ground level Carpark

9.2.1 NCC Review

The first step in developing a performance-based solution is to undertake an NCC review, as outlined below.

Table 19. NCC Review

Items	Comments
Non-compliance Issue	<u>Review of Extended Travel Distances in the lower ground level Carpark</u> The travel distances to the exit on the lower ground level would be approximately 32 m, in lieu of 20 m.
NCC Part	Part D2 - Provision for escape
Non-compliance Clause	D2D5 - Exit travel distances
Performance Requirements from applicable NCC Part	D1P4 - Exits
Performance Requirements from other NCC Part's	E2P2 - Safe evacuation routes
A2G2 – Performance Solution	A2G2 (2) (b) (ii) Other Verification Methods, accepted by the appropriate authority that show compliance with the relevant Performance Requirements.
AFEG Sub system	Sub-system E - Occupant evacuation & control Sub-system F - Fire services intervention

9.2.1 Intent of the BCA

The Clause D2D5 of the BCA 2022 Volume 1 states the following, as shown below.

D2D5	Exit travel distances	[2019: D1.4]
<p>(1) Class 2 and 3 buildings —</p> <p>(a) The entrance doorway of any <i>sole-occupancy unit</i> must be not more than—</p> <p>(i) 6 m from an <i>exit</i> or from a point from which travel in different directions to 2 <i>exits</i> is available; or</p> <p>(ii) 20 m from a single <i>exit</i> serving the <i>storey</i> at the level of egress to a road or <i>open space</i>; and</p> <p>(b) no point on the floor of a room which is not in a <i>sole-occupancy unit</i> must be more than 20 m from an <i>exit</i> or from a point at which travel in different directions to 2 <i>exits</i> is available.</p>		
<p>(2) Class 4 parts of a building — The entrance doorway to any Class 4 part of a building must be not more than 6 m from an <i>exit</i> or a point from which travel in different directions to 2 <i>exits</i> is available.</p>		
<p>(3) Class 5, 6, 7, 8 or 9 buildings — Subject to (4), (5) and (6)—</p> <p>(a) no point on a floor must be more than 20 m from an <i>exit</i>, or a point from which travel in different directions to 2 <i>exits</i> is available, in which case the maximum distance to one of those <i>exits</i> must not exceed 40 m; and</p> <p>(b) in a Class 5 or 6 building, the distance to a single <i>exit</i> serving a <i>storey</i> at the level of access to a road or <i>open space</i> may be increased to 30 m.</p>		

Figure 26: Extract of Clause D2D5 of BCA 2022

The intent of Clause D2D5 is "to maximise the safety of occupants by enabling them to be close enough to an exit to safely evacuate".

9.2.1 Analysis

The building located at 20 Sisley Street has a carpark on the lower ground level. The maximum travel distance to the exit on lower ground level will be approximately 32 m, in lieu of 20 m, as shown in the figure below. This is identified as a non-compliance and will be addressed further.

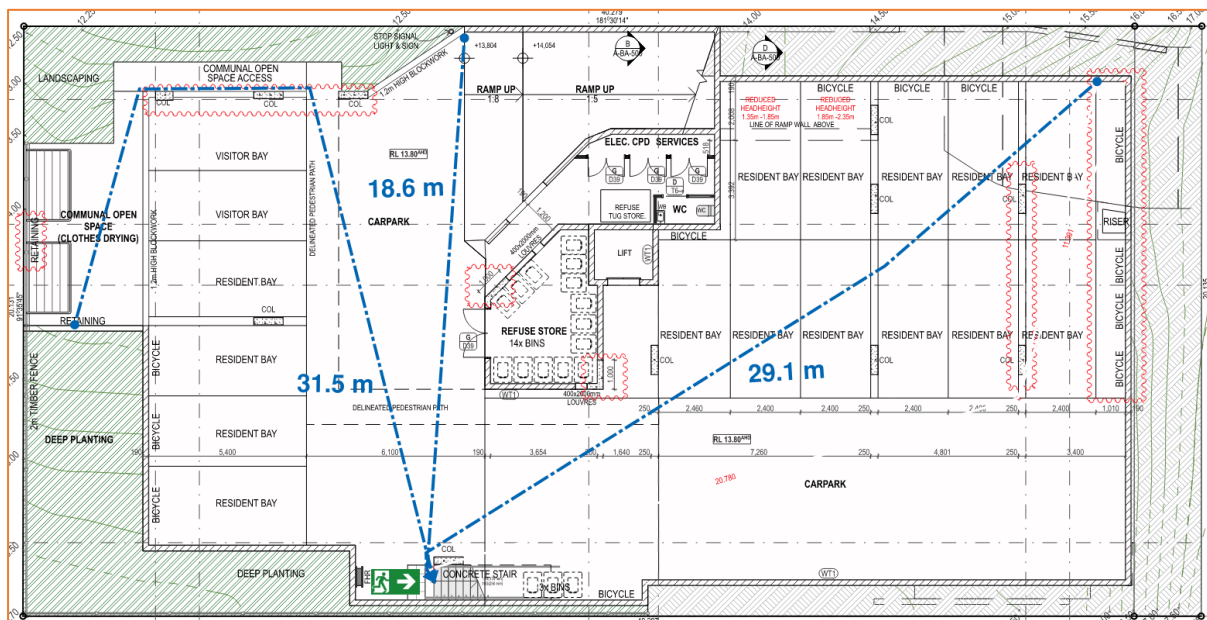


Figure 27: Extended travel distance on the lower ground level

The occupants in the lower ground-level carpark are likely to be residents of the Class 2 residential units. The occupants in the lower ground level carpark are likely to be awake and hence can respond

quicker to a fire event, and likely to reduce the travel time to the nearest exit. As the occupants are likely to be the residents of the building, they are likely to have knowledge of the exit system.

Further, the lower ground level carpark is recommended to be provided with fast response sprinkler systems with an RTI of 50 (ms)^{1/2}. This provision of the fast-response sprinklers will alert occupants at an early stage to initiate evacuation.

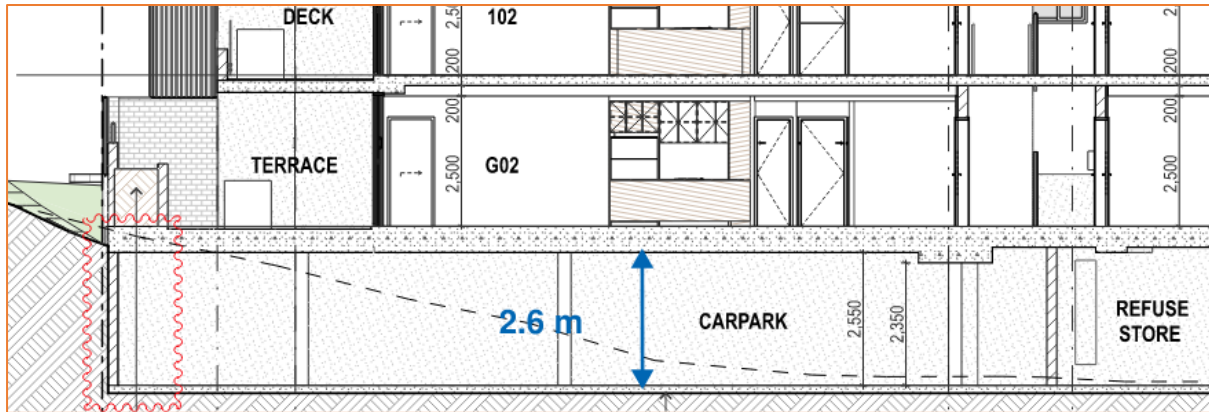


Figure 28: Ceiling Height on lower ground level

The ceiling height for the lower ground level is 2.6 m, as shown in the above figure.

A comparative study between the activation times of the fast response sprinklers and the standard response sprinklers is shown in the figures below for ease of reference.

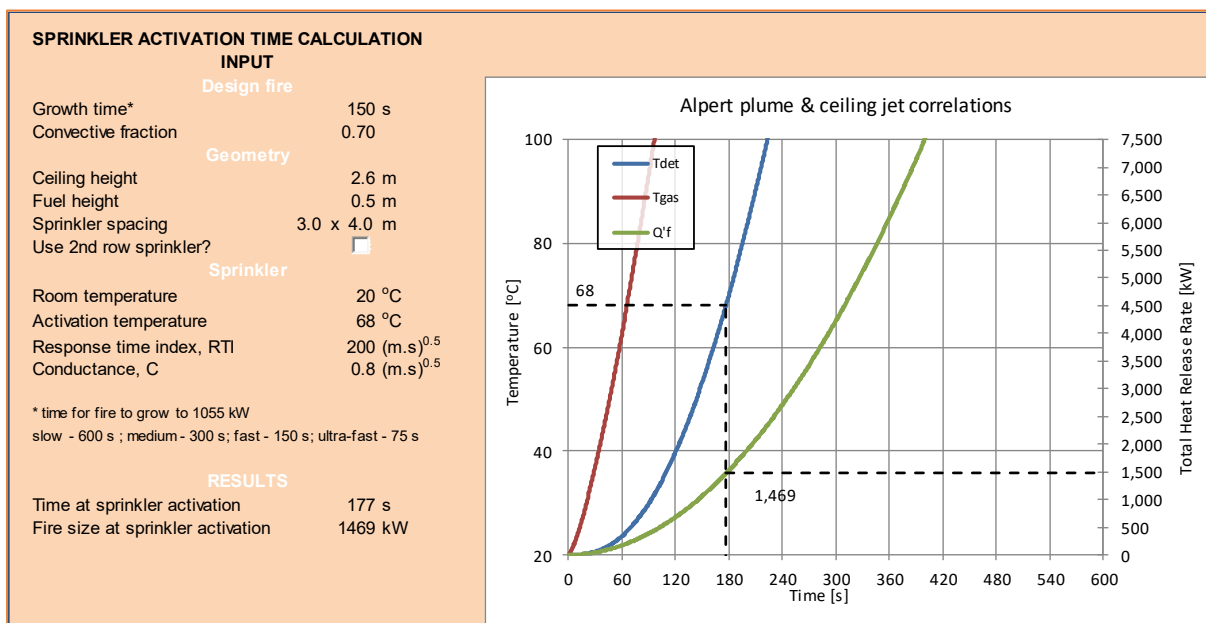


Figure 29: Activation time for Standard Response Sprinkler on lower ground level carpark.

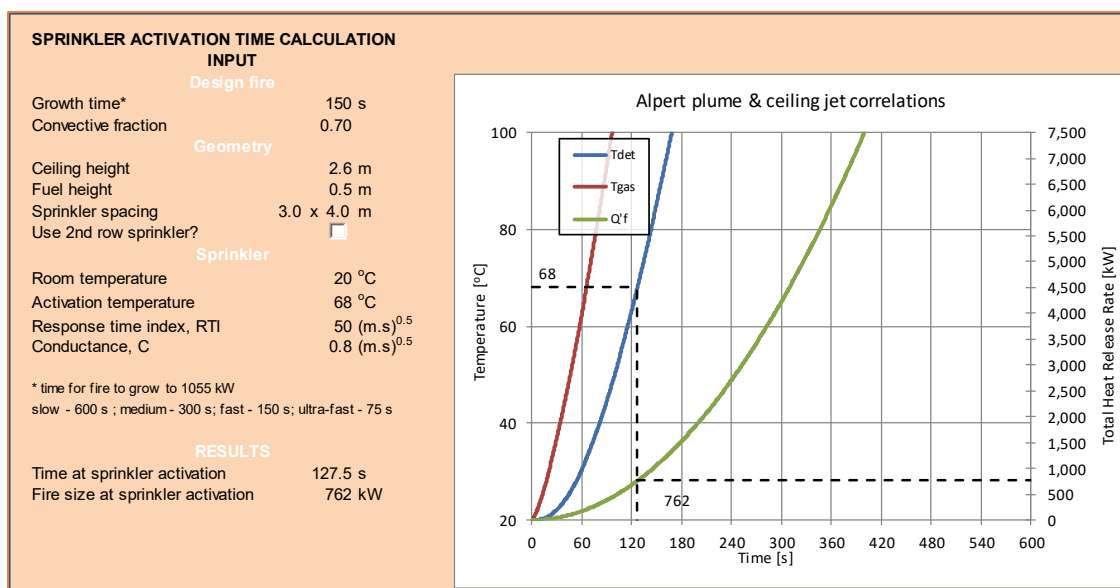


Figure 30: Activation time for Fast Response Sprinkler on lower ground level carpark.

The comparative calculation assessment that compares the decrease in the detection time afforded by the fast response sprinklers with the increase in travel time resulting from the extended travel distance is provided in the table below. The maximum travel time for the occupants to reach the exit is calculated by using a conservative occupant travel speed of 0.8 m/s. The rationale for using the occupant movement velocity of 0.8 m/s is justified as follows:

The speed with which the occupants will travel as they evacuate in case of a fire event is of critical importance since it has a direct impact on the total evacuation times. British Standard 7974-6:2004 under Annex D provides guidance on travel speeds. It states the following: -

"Based on the work done by Thompson and Marchant on analysing video footage of crowd movement they derived a method of modelling the movement of occupants based on the distance between occupants along the egress route. For a distance of 1.6 m between occupants, the unimpeded walking speeds were found to be approximately 1.7 m/s for males and 0.8 m/s for females. The median travel speed being 1.4 m/s". Hence, as a conservative approach occupants travel speed of 0.8 m/s can be considered.

Table 20: DTS vs Performance Solution Comparison for lower ground level carpark

	Deemed-to-satisfy Requirements	Performance Solution	Difference in Time
Sprinkler Type	Standard Response	Fast Response	49.5 s
Activation Time	177 s	127.5 s	
Maximum travel distance to reach the exit			
Distance	20 m	32 m	15 s
Occupant movement velocity	0.8 m/s	0.8 m/s	
Time to reach the exit	25 s	40 s	

The maximum extended travel distance of approximately 32 m on the lower ground level carpark to the exit, in lieu of 20 m, will result in an increased travel time of 15 seconds ($40\text{ s} - 25\text{ s} = 15\text{ s}$).

However, the provision of fast-response sprinklers in place of standard-response sprinklers would result in an earlier notification time of 49.5 seconds ($177\text{ s} - 127.5\text{ s} = 49.5\text{ s}$), thereby compensating for the increased travel distance.

Hence, increased exit travel distance to the exit on the lower ground level carpark is unlikely to unduly increase the risk to occupant evacuation.

9.2.1 Conclusion

Based on the above analysis, the occupants in the lower ground-level carpark are likely to be residents of the building and are likely to be knowledgeable about the exit locations. The lower ground-level carpark will be provided with fast-response sprinklers, which will likely notify the occupants early in case of a fire event. Further, from the comparative assessment, the provision of fast-response sprinklers was found to compensate for the increase in extended travel distance. Hence, increased travel to the exit on the lower ground level carpark is unlikely to unduly impact the occupant evacuation in the building and thus, performance requirements of D1P4 and E2P2 are met.

9.3 Review of Special Hazard - Provisions for Electric Vehicle Charging in the Carpark

9.3.1 NCC Review

The first step of developing a performance based solution is to undertake a NCC review as outlined below.

Table 21. NCC Review

Items	Comments
Non-compliance Issue	<u>Review of Special Hazard - Provisions for Electric Vehicle Charging in the Carpark</u> The building is assessed against BCA 2022 and therefore is required to be provided with provisions for EV charging. The provisions will include a distribution board to meet the EV requirements for the building. Due to the potential of EV vehicle charging and EV in the building carpark, the special hazard is assessed in the carpark.
NCC Part	Part E1 - Fire fighting equipment
Non-compliance Clause	E1D17 - Provision for special hazards
Performance Requirements from applicable NCC Part	C1P1 - Structural stability during a fire C1P2 - Spread of fire C1P4 - Safe conditions for evacuation C1P7 - Fire protection of emergency equipment C1P9 - Fire brigade access
Performance Requirements from other NCC Part's	E2P2 - Safe evacuation routes
A2G2 – Performance Solution	A2G2 (2) (b) (ii) Other Verification Methods, accepted by the appropriate authority that show compliance with the relevant Performance Requirements.
AFEG Sub system	Sub-system A - Fire initiation & development & control Sub-system B - Smoke development, spread & control Sub-system C - Fire spread, impact & control Sub-system D - Fire detection, warning & suppression Sub-system E - Occupant evacuation & control Sub-system F - Fire services intervention

9.3.2 Intent of the BCA

The presence of an electric vehicle charging station in the building is considered a special hazard and requires a suitable additional provision, as per Clauses E1D17 and E2D21 of the BCA 2022 Volume 1, as shown in the figure below.

E1D17	Provision for special hazards	[2019: E1.10]
Suitable additional provision must be made if special problems of fighting fire could arise because of—		
<ul style="list-style-type: none"> (a) the nature or quantity of materials stored, displayed or used in a building or on the allotment; or (b) the location of the building in relation to a water supply for fire-fighting purposes. 		

Figure 31: Extract of Clause E1D17 of BCA 2022

The intent of Clause E1D17 is "To require the installation of additional fire safety measures where special hazards exist."

E2D21	Provision for special hazards	[2019: E2.3]
Additional smoke hazard management measures may be necessary due to the—		
<ul style="list-style-type: none"> (a) special characteristics of the building; or (b) special function or use of the building; or (c) special type or quantity of materials stored, displayed or used in a building; or (d) special mix of classifications within a building or <i>fire compartment</i>, 		
which are not addressed in <i>E2D4</i> to <i>E2D20</i> .		

Figure 32: Extract of Clause E2D21 of BCA 2022

The intent of Clause E2D21 is "To state that some special hazards may require additional smoke hazard management measures."

The QFD (Queensland Fire Department), formerly QFES – Queensland Fire and Emergency Services, position statement Electric vehicle carparks and electric vehicle charging stations states that electrical distribution installations for electric vehicle charging should be addressed as a special hazard under Clause E1D17 and E2D21 of the BCA 2022 Volume 1, as shown in Figure 33. This is due to the toxic smoke produced, flammable vapour cloud production, rapid rate of fire spread, abnormal heat release rate, proximity of other vehicles and difficulties in fire crew intervention.

<p>NCC 'Special Hazard' Provisions</p> <p>QFD considers EVs and EV charging equipment to be special hazards requiring specific consideration under NCC 2022 Clause E1D17 (provision for special hazards – firefighting), which states that.</p> <p style="padding-left: 40px;"><i>Suitable additional provision must be made if special problems of fighting fire could arise because of — (a) the nature or quantity of materials stored, displayed or used in a building or on the allotment; or (b) the location of the building in relation to a water supply for fire-fighting purposes.</i></p> <p>As the fire authority and agency responsible for fire brigade intervention in Queensland, QFD confirms that an EV-related fire incident has significant potential to cause special problems for firefighting.</p> <p>Additionally, QFD considers that NCC clause E2D21 (provision for special hazards – smoke hazard management) should also be considered due to the presence of EVs and EV charging equipment.</p>
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Figure 33: QFD's positive statement on Electric Vehicle

Introduction

The inclusion of modern EVs (including hybrids) into building car parks introduces an additional fire hazard for building occupants and firefighters. The presence of lithium-ion batteries in these vehicles means their fire hazards differ from those associated with traditional internal combustion engine vehicles.

Given the absence of specific 'Deemed-to-Satisfy' (DTS) provisions in the National Construction Code (NCC) addressing EV fire hazards, Queensland Fire Department (QFD) requests that EVs be considered under NCC Clauses E1D17 and E2D21 (special hazard provisions).

QFD endorses the Australasian Fire and Emergency Service Authorities Council (AFAC) position on [Electric Vehicles \(EV\) and EV charging equipment in the built environment \(v1.5, 2 October 2023\)](#) as appropriate guidance for relevant stakeholders, including those who design and certify any building incorporating EVs and EV charging equipment.

Figure 34: QFD's positive statement on Electric Vehicle

The QFD position statement endorses the Australasian Fire and Emergency Service Authorities Council (AFAC) position on Electric Vehicles (EV) and EV charging equipment in the built environment, that emergency shutdown controls, block plans showing EV charging stations, EV distribution boards and shutdown controls, and vehicle impact protection for EV stations be considered where EV charging will be implemented. Extracts from the position statement are shown in the figure below:

Considerations for EV and EV charging equipment within the built environment

AFAC recognises that all buildings are unique. The considerations below should be discussed with relevant stakeholders, including the fire authorities, during the planning and design phase for the introduction of EVs within the built environment.

Considerations include, but are not limited to:

- Establishing that the appropriate fire resistance level (FRL) is applied to building material, elements and systems.
- Suitability of fire safety systems and their location in proximity to the risk, including fire hydrants, fire detection systems, occupant warning systems, automatic fire sprinkler systems, and ventilation and smoke hazard management systems.
- The adequacy of vehicle separation to prevent fire spread with respect to directional flame jetting in EV fires. This includes special considerations for vehicle access in stacked parking arrangements or automatic vehicle parking systems.
- Intervention capabilities of the local fire authority.
- Potential for contaminated firewater run-off.

Additional considerations for electric vehicle charging equipment within the built environment

Where EV charging equipment is installed, the following considerations should be discussed with relevant stakeholders, including the fire authorities, during the planning and design phase for the implementation of EV charging equipment.

- Location of EV charging stations and the proximity to other vehicles, exits, other fire safety systems, building utilities and critical infrastructure. Note: open air or external charging points should always be considered before installation of internal charging points.
- Provision of remote emergency shutdown controls and/or automatic shutdown for EV charging stations.
- Vehicle impact protection (e.g. bollards) for EV charging stations.
- Application of any best practice standards for EV charging equipment.
- Implementation of a regular maintenance schedule for EV charging equipment.

Figure 35: AFAC position statement for considerations for EV and EV charging within the built environment

9.3.3 Analysis

The building is assessed against BCA 2022 and therefore it is required to be provided with provisions for EV charging. The provisions will include a distribution board to meet the EV requirements for the building. Due to the potential of EV vehicle charging and EV in the building carpark on lower ground level, the special hazard is assessed in the carpark.

The AFAC position on Electric Vehicles (EVs) and EV charging equipment in the built environment states that there are hazards associated with electric vehicles that need to be analysed in the building, as shown in figure below.

Hazards with electric vehicles

Whilst failure events are currently reported to be occurring at a low frequency, the potential risks that can eventuate from a thermal runaway event may be of high consequence.

The increase in the uptake of EVs is anticipated to incrementally impact the frequency of failure events.

A failure event within an EV battery (such as mechanical, thermal abuse, rapid discharge, or internal cell failure) has the potential to lead to a thermal runaway event within the EV battery, which may pose significant challenges for firefighters in the management of the incident.

The types of hazards that may be represented at a failure event include but are not restricted to the following;

- Potential for the fire event to impact on the structural integrity of the structure.
- Exposure to high voltage direct current (DC) and alternating current (AC) electricity.
- Toxic and combustible vapour production.
- Potential for vapour cloud explosion.
- Potential for a rapid rate of fire spread.
- Significant fire duration (four or more hours) and protracted incident.
- Potential for secondary ignition.
- Potential for stranded electrical energy.
- Potential for contaminated run-off from firefighting water streams.
- Post-fire management of potentially hazardous waste material.

Figure 36: Potential hazards specified in AFAC position statement on EV and EV charging in the built environment

Hence, further risk analysis is done to analyse the potential hazards in the building.

Risk Analysis

To ensure that adequate measures are implemented to reduce the risk posed by electric vehicle charging in the building, seven (7) aspects of the risk have been analysed. These aspects are the risk of ignition, flammable vapour cloud production, toxic smoke production, rapid rate of fire spread and proximity of adjacent fuel loads, heat release rate of EV fires, risks to fire brigade intervention and risks to structural adequacy; and will be reviewed in the following sections.

➤ **Risk of Fire Ignition**

The primary way to reduce the impact of EV fires is to prevent them from igniting. This is complicated by the charging of electric vehicles, which increases the risk of fire initiation due to electrical faults or battery failure. To reduce the risk of electrical faults, all EV chargers used in the building must comply with the requirements of AS/NZS 3820 and must also be tested and tagged in accordance with AS/NZS 3760, In-service safety inspection and testing of electrical equipment. This testing must be performed yearly.

Damaged batteries pose both a short-term and long-term risk of battery failure and fire ignition. Therefore, parking electric vehicles that have been in a collision will not be permitted within the building before repair can commence. To prevent collisions and subsequent ignitions within the building, a maximum speed limit of 5 km/h will be implemented, and any collisions in the building are to be reported to building management.

Measures will be taken to protect electric vehicle chargers from being damaged by vehicles. Regardless of the position of electric vehicle chargers, bollards, and wheel stops will be required to reduce the risk of collision.

➤ *Flammable Vapor Cloud Production*

The materials contained within an EV vehicle pose a risk of producing products that form a flammable vapour cloud during combustion. Moreover, occupants in the building are likely to be residents, staff and visitors. The residents and the staff in the building are likely to be aware of the exit system in the building. Visitors may not be familiar with the building exit layout; however, they are likely to be accompanied by a building resident occupant who would likely be familiar with the building exits.

The ceiling height of the lower ground level car park is approximately 2.7 m. However, as per Clause F5D2 (1)(b), the DtS ceiling height in the car park is about 2.1m. Therefore, this additional ceiling height is likely to act as a smoke reservoir, providing extra time for occupant evacuation. Therefore, the time required by the smoke layers to fall below 2 m will be comparatively higher for carpark levels of the building. Moreover, it is expected to enhance visibility for occupants and maintenance staff, enabling them to reach an exit without being unduly impacted by fire.

➤ *Toxic Smoke Production*

The materials contained within an EV vehicle have the capacity to produce toxic smoke that may impact intervening fire crews. However, the carpark has open space on the north-east side and a ramp providing access to Sisley Street on the east side. Hence, smoke is likely to spill out of these openings in the car park during an EV fire event, thereby reducing the level of toxicity. Furthermore, the occupants in the building are likely to be residents, staff and visitors. The residents and staff (body corporate staff) are likely to have knowledge of the exit system in the building. Moreover, visitors are also expected to be part of the occupants. However, they are likely to be assisted by the known building residents.

➤ *Rapid Rate of Fire Spread and Proximity of Adjacent Fuel Loads*

The floor separating the lower ground level carpark and residential level above will have an FRL of 120/120/120 (as per Table S5C11g under Clause S5C11 of BCA 2022 Volume 1). The presence of a fire-rated slab is likely to restrict the risk of fire spread across the floor. Moreover, due to the proximity of the fire brigade (Taringa Fire and Rescue Service station is located 1.6 km from the site, with travel time approx. 3 min.), it is likely to arrive at the site to undertake the fire-fighting activities.

The building will be provided with a fast response sprinkler system with a maximum RTI of 50 ms^{-1/2}. The general fire alarm is likely to be triggered when the sprinkler system is activated. It is likely to notify occupants at an early stage of fire growth. The building will be equipped with a fire sprinkler system, which will be activated in the event of a fire and is likely to mitigate the risk of fire spread.

Moreover, the building will be provided with a compliant fire hydrant system. Hence, fire brigade intervention is unlikely to be unduly impacted.

➤ *Heat Release Rate of EV Fires*

The paper *Characterisation and assessment of fire evolution process of electric vehicles placed in parallel* gives heat flux data for full-scale EV fire experimentation. This data comes from five heat flux meters labelled H1 to H5 in the figure below:

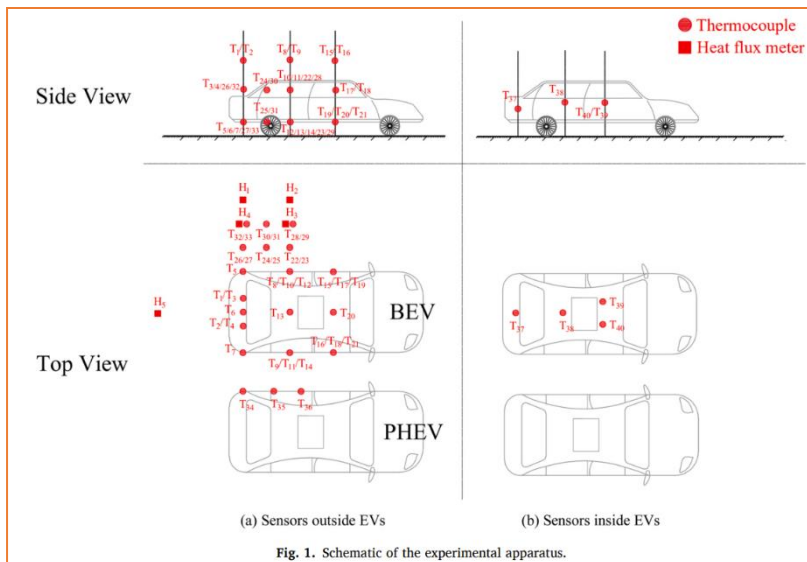


Fig. 1. Schematic of the experimental apparatus.

Figure 37 Experimental setup

The graph below shows the results from the heat flux meters surrounding the electric vehicle when a fire event was initiated:

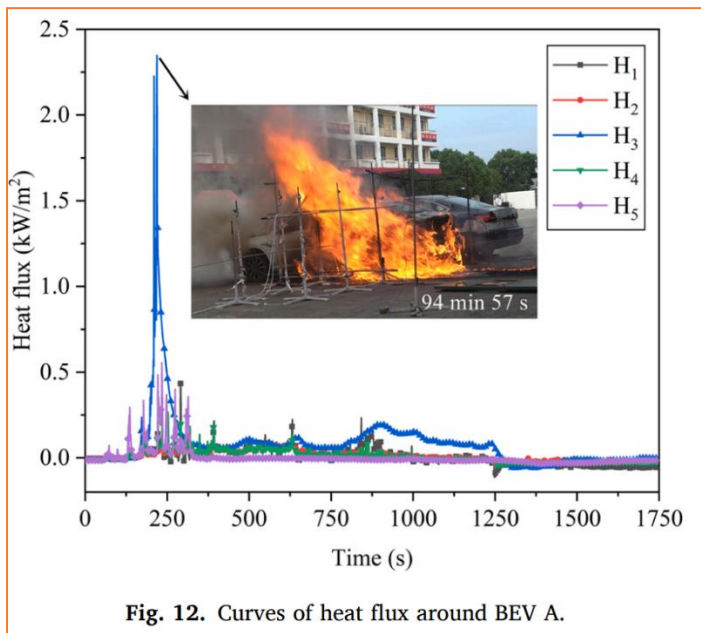


Fig. 12. Curves of heat flux around BEV A.

Figure 38 Experimental heat flux data

To determine the falloff of received heat radiation at a given distance from an EV fire, the peak heat flux of 2.347 kW/m² at 1m from the car and 0.434 kW/m² at 1.4m from the car, was received at H3 and

H2, respectively. It is known that the heat radiation from a fire decreases with distance following an inverse-square relationship. The known datapoints were then plotted, and an inverse-square trendline was calculated to define the function for heat flux received at a given distance. This trendline and function are shown in the figure below:

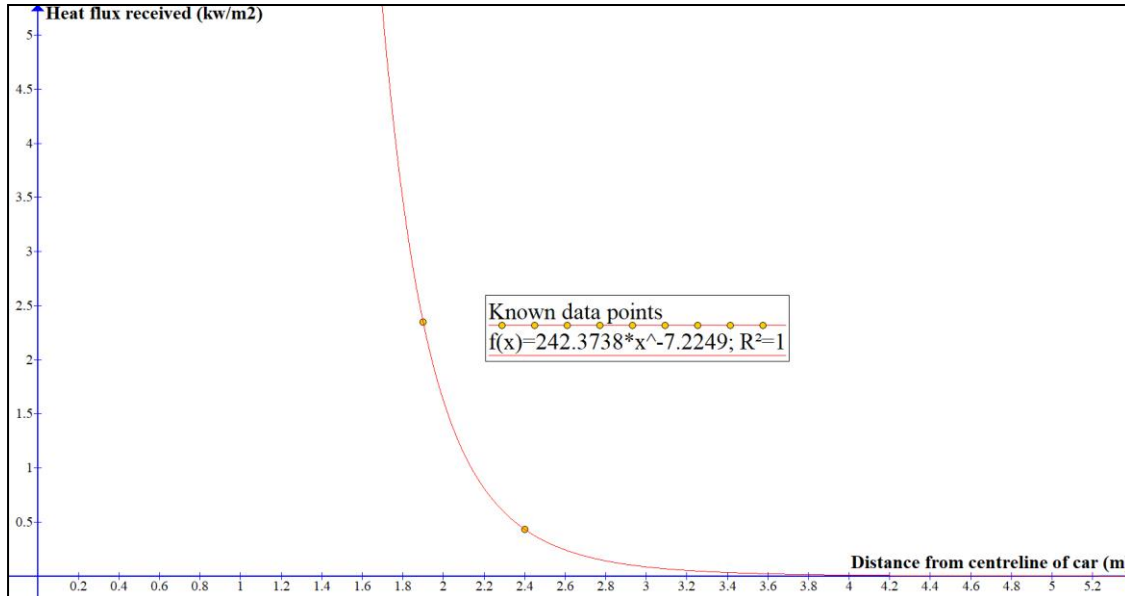


Figure 39 Trendline and function for known data points

To assess the impact of the heat flux emitted from multiple EV fires, a scenario has been envisaged where three 1.8m wide cars are parked adjacent to one another with 2.5 m spacing, 2.5 m being the spacing of car parks in the proposed building. The heat flux received at intervals between the cars was then calculated using the formula for the above trendline.

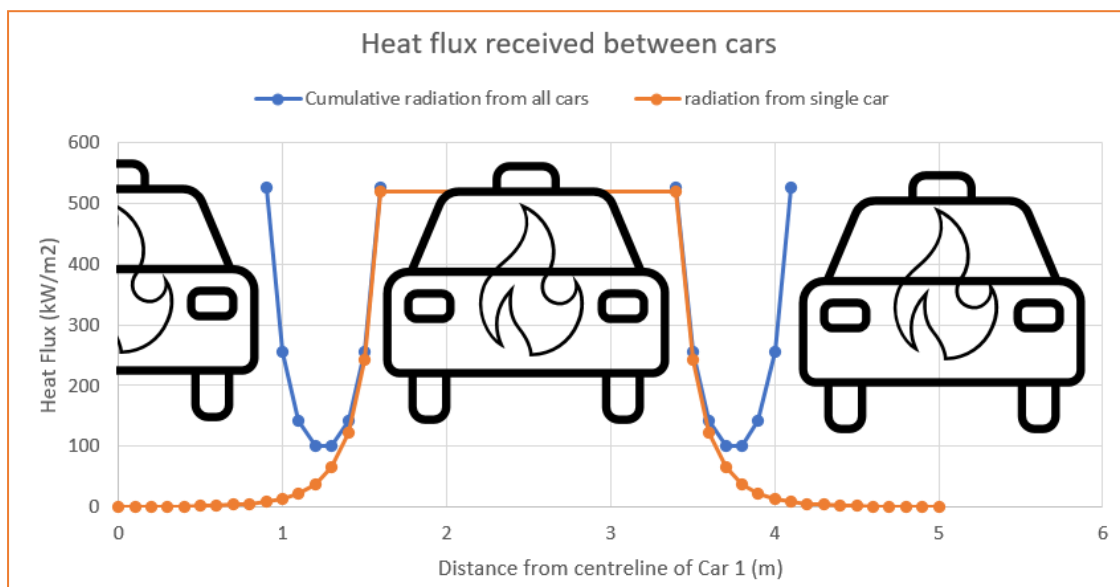


Figure 40 Heat flux received in the fire scenario.

From the figure above, the cumulative radiation received at any point between the cars was not significantly higher than the radiation emitted by a single car EV fire. If the falloff of radiation occurred

at a lesser rate, the compounding heat radiation around the centre car would have been significantly higher than a single car, as demonstrated below:

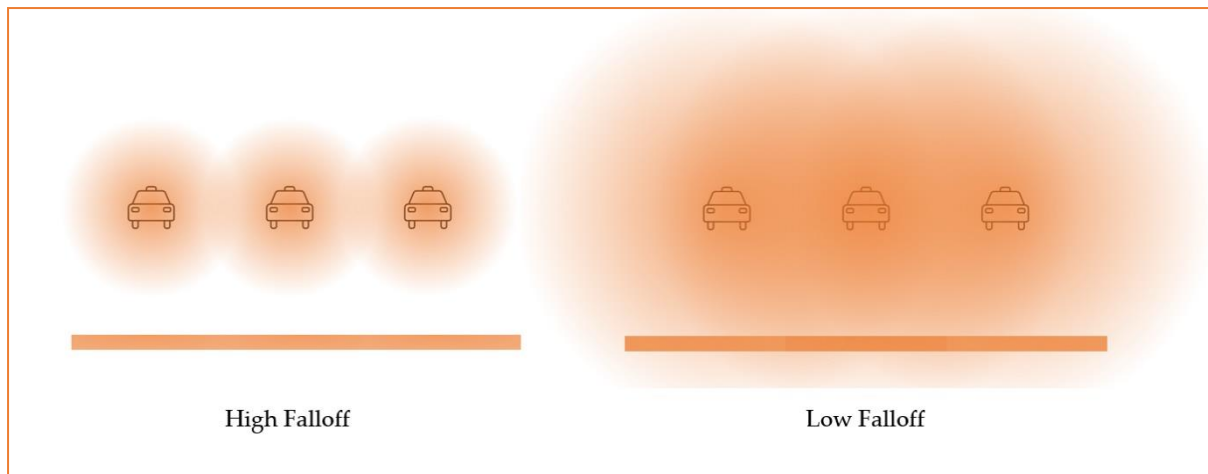


Figure 41 Falloff visualisation

However, the floor slabs separating the lower ground level carpark and the residential level above will have an FRL of 120/120/120 (as per Table S5C11g of Clause S5C11 under BCA 2022 Volume 1). The FRL of building elements on carpark levels will not be reduced. It is likely to mitigate the risk of fire spreading across the floors. The building is to be provided with a compliant occupant warning system and fire sprinkler system. It is likely to notify occupants at an early stage of fire growth. Hence, occupants in the building are likely to evacuate the building before the arrival of the fire brigade.

Moreover, Class 2 residential units will be present from the ground level and above. The occupants in the lower ground carpark are likely to be residents of the Class 2 residential units. The occupants in the lower ground level carpark are likely to be awake and hence can respond quicker to a fire event, and likely to reduce the travel time to the nearest exit. As the occupants are likely to be the building's residents, they are likely to be familiar with the exit system.

Visitors may not be familiar with the building exit layout; however, they are likely to be accompanied by a building resident, who would likely be familiar with the building exits.

Moreover, the building will be provided with a fire hydrant system. Hence, fire brigade intervention is unlikely to be unduly impacted.

➤ ***Fire Brigade Intervention***

In addition to the aforementioned measures that will assist with fire brigade intervention, the recommended items from the QFD position statement on electric vehicle charging will be implemented. These are the shutdown controls for electric vehicle charging points in close proximity to the main-FIP in building and the location of charging points, charging distribution boards and charging shutdown controls to be shown on block plans. This would allow fire crews to reduce the electrical hazard risk and allow fire crews to identify points of interest when fighting an EV fire. Moreover, the fire brigade

will be able to access the lower ground level carpark from Sisley Street using the connecting walkway on the ground floor. The nearest responding fire station, Taringa Fire and Rescue Service, is located 1.6 km from the site, with an approximate travel time of 3 min. They are likely to arrive at the site promptly upon receipt of notification about the fire in the building.

Given the safety measures implemented in the building, the risk to fire crews is unlikely to be unduly increased by the presence of EV charging in the building, nor has intervention been unduly limited.

➤ **Structural Adequacy**

Heat radiation emitted by an EV fire event is therefore more likely to impact the structure of the building. The building structure will be built to the requirements of Type A construction with a slab separating the lower ground level carpark and residential level above, with an FRL of 120/120/120 (as per Table S5C11g under Clause S5C11 of BCA 2022 Volume 1). To determine if the FRLs of building elements in the proposed building will be suitable, given the risk of EV fires, the characteristics of an EV fire will be compared with the standard time-temperature curve used in furnace testing, defining the FRL of an element.

The FRL of a building element is found by furnace testing in accordance with AS 1530.4, which requires that the temperature in the furnace follow the graph, shown in the figure below. The FRL is then determined by the time at which the structural capacity, integrity and insulation capacity fail.

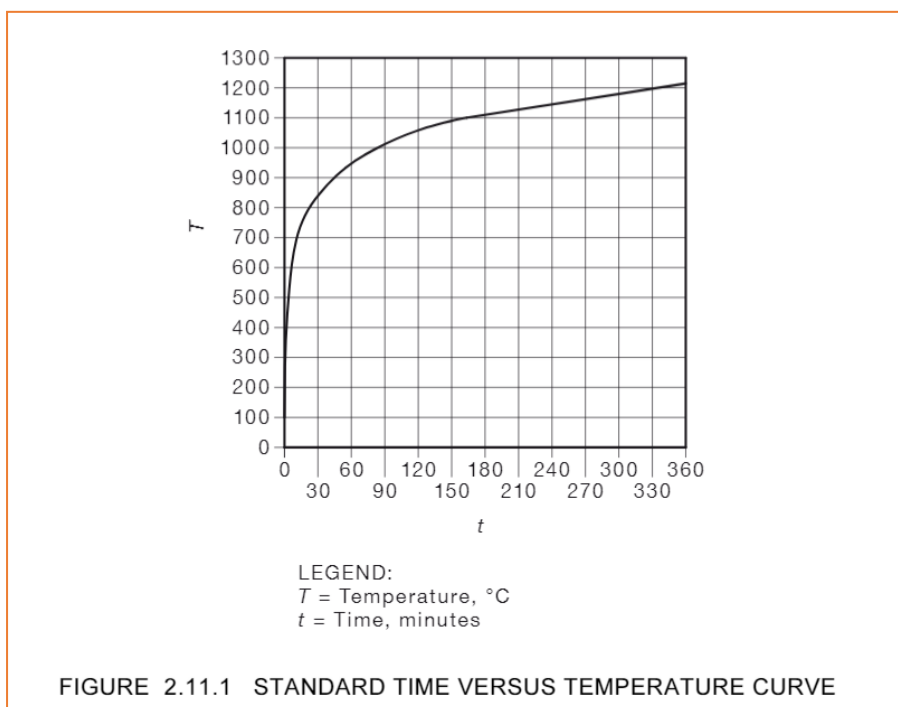


Figure 42 Standard time temperature curve from AS 1530.4

The paper *Full-scale fire testing of battery electric vehicles* details experimentation performed involving measuring the characteristics of full-scale electric vehicle fires. Temperature data was gathered using 6 thermocouples in close proximity to the vehicle, marked at TC in the figure below:

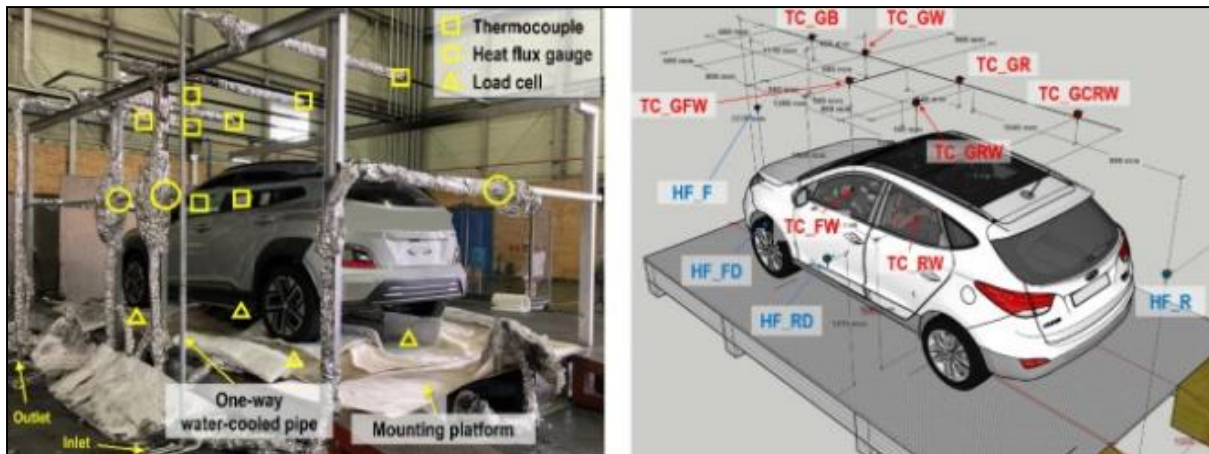


Figure 43 Experimental setup

The data from these thermocouples for the worst-case experiment is shown in the figure below, along with the standard time-temperature curve from AS 1530.4:

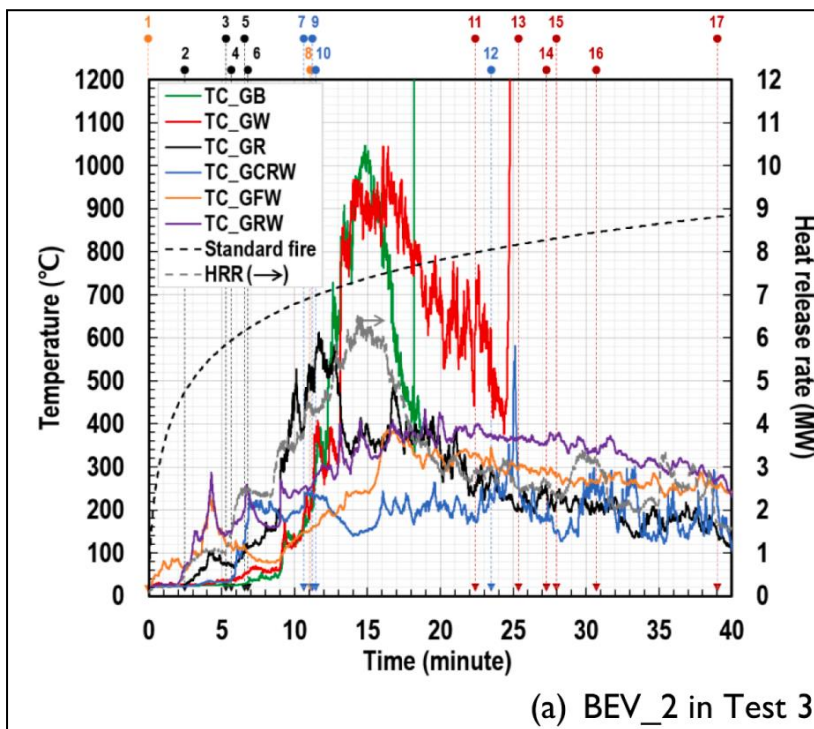


Figure 44 Thermocouple data

It can be seen that the temperature at some thermocouples peaked at a temperature greater than the time temperature curve. However, the markup below shows that the area under the temperature readings of thermocouple GW did not exceed the area under the time-temperature curve at any given time (Thermocouple GW recording the greatest exceedance of the standard-time temperature curve and failed at approximately 25 min). This means that the total heat released is less than what an element would be exposed to during a standard furnace test.

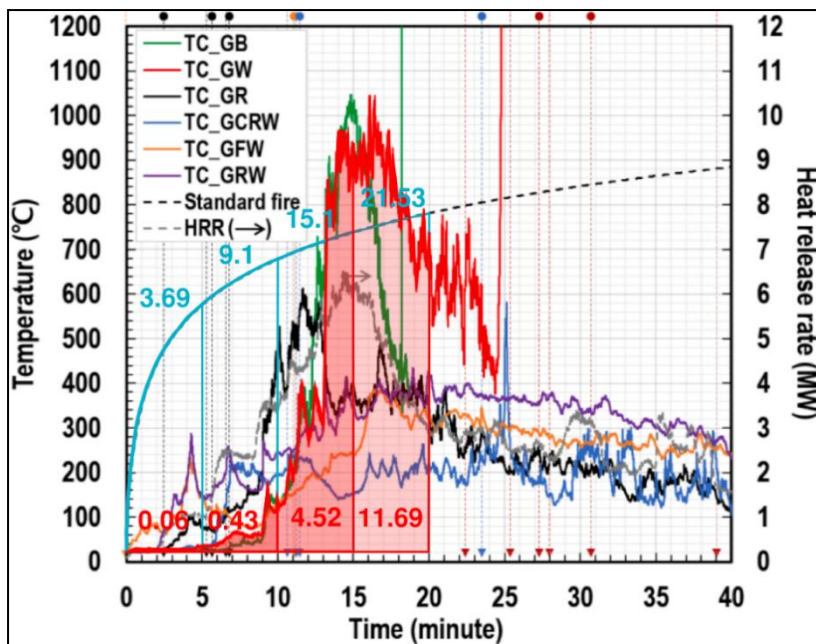


Figure 45 Area under time-temperature curve and thermocouple results

As the total heat released by an EV fire is less than that used for furnace testing to determine FRL's, it is therefore likely that the FRL required for a building would be sufficient to withstand an EV fire and maintain structural adequacy.

To determine the impact of multiple EV fires occurring and determine if the above conclusion remains valid in a carpark where multiple EV cars are likely to be present, the falloff of emitted radiation has been analysed. As discussed above on heat release from EV fires, the heat radiation from a fire decreases with distance following an inverse-square relationship. From the assessment on multiple vehicle fires, the cumulative radiation received at any point between the cars was not significantly higher than the radiation emitted by a single car EV fire. If the falloff of radiation occurred at a lesser rate, the compounding heat radiation around the centre car would have been significantly higher than that of a single car.

However, as the peak heat flux has been shown to be equivalent to a single car EV fire, it is therefore appropriate that the characteristics of a single car EV fire be used to analyse the structural adequacy in the proposed building. Subsequently, as the structure has been demonstrated to likely be adequate in the event of an EV fire, it is acceptable that the structure of the building need to comply with the requirements of Type A construction with floor separating lower ground level carpark and residential level above with an FRL of 120/120/120 (as per Table S5C11g under Clause S5C11 of BCA 2022 Volume1).

Therefore, the electric vehicle charging units in the building are unlikely to unduly impact occupant evacuation, fire brigade intervention and fire safety of the building.

Recommendations

Provision of electric vehicle charging is acceptable, provided that the following requirements are met before the installation of electric vehicle charging in the carpark.

- a) Signage having a font with a minimum height of 40 mm and on a colour contrasting background must be provided at each pedestrian and vehicle entry to the carpark, stating the following requirements:
 - i. The maximum speed limit in this carpark is 5km/h.
 - ii. All electric vehicle chargers used in this carpark must comply with the requirements of AS/NZS 3820.
 - iii. All electric vehicle chargers used in this carpark must be tested in accordance with AS/NZS 3760 yearly.
 - iv. Electric vehicles involved in a collision are not to be parked in this carpark until repairs have been completed.
 - v. All collisions in this carpark are to be reported to building management.

This signage must be provided at the vehicle entrance to the building. The proposed location of the signage is shown in the figure below.

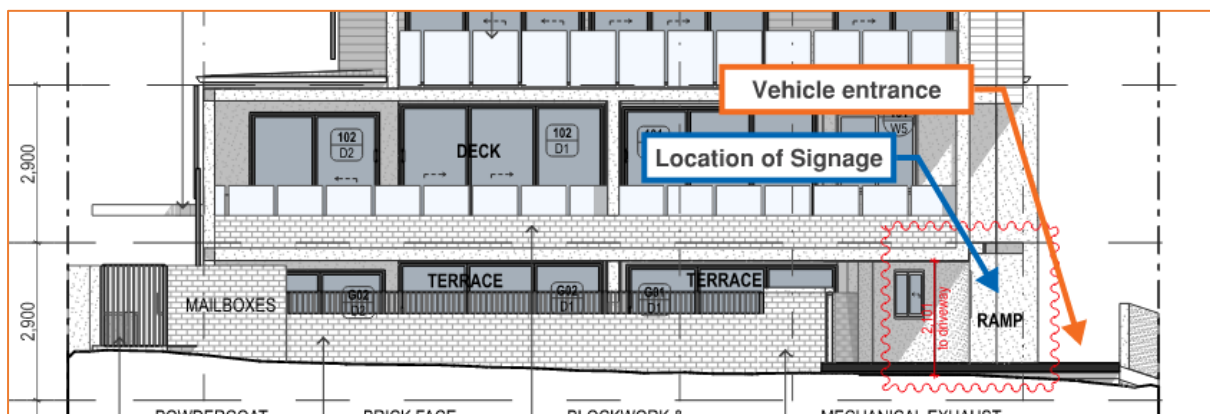


Figure 46: Location of signage

- b) Electric vehicle chargers must be offset from the car park they serve, in between car parks, if possible. Bollards and wheel stoppers must be implemented to protect the electric vehicle chargers from collision impact.
- c) A fast response sprinkler system, with a maximum RTI of 50 ms^{-1/2}, will be provided on carpark levels.
- d) Shutdown controls for electric vehicle charging points are to be present in close proximity to the Fire Indicator Panel.
- e) The location of electric vehicle charging points is to be marked on block plans.
- f) The location of electric vehicle charging shutdown controls is to be marked on block plans.
- g) The location of electric vehicle charging distribution boards is to be marked on block plans.

9.3.4 Conclusion

In the above analysis, seven aspects of the risk are analysed, based upon risks identified in the QFD position statement on electric vehicle charging. These aspects were: risk of ignition, flammable vapour cloud production, toxic smoke production, rapid rate of fire spread and proximity of adjacent fuel loads, heat release rate of EV fires, risks to fire brigade intervention and risks to structural adequacy. Reducing the risk of ignition relies primarily on occupants; therefore, signage is proposed to be installed at the vehicular entrance to reduce any severe collisions.

Fire spread, the density of fuel loads and the heat release rate of an EV fire will be addressed via provision of fire rated floor slab separating the floor of lower ground level car park and residential level above with an FRL of 120/120/120 and the provision of fire detection system is likely to early notify the occupants in case of any fire event in the building.

Through analysis of EV fire characteristics, it has been determined that the structural requirements of Type A construction would be adequate to withstand a fire event involving electric vehicles, as the fire brigade is located in proximity to the building and likely to arrive at the site on the receipt of notification to undertake the fire-fighting activities.

Based on the fire safety measures implemented, the provisions for electric vehicle charging in the building are acceptable, as electric vehicle charging is unlikely to unduly impact building occupants during evacuation and fire brigade intervention.

10 FIRE ENGINEERING REQUIREMENTS

A Building Solution is a design complying with the BCA Performance Requirements and can be either a Deemed-to-Satisfy Solution, a performance solution or a combination of both options.

Fire safety systems that are required for this building that have not been specifically identified and varied in this report must be implemented in accordance with the BCA Deemed-to-Satisfy requirements.

10.1 Part C – Fire Resistance

The stability, compartmentation and design of the building are to meet the BCA Deemed-to-Satisfy requirements, with the following exceptions: -

1. The building elements and any attachments to the external walls must comply with the specifications outlined in this document for a Type 'A' Construction.
2. Window openings within 3m of the allotment boundary on the ground level, level 1 and level 2, located within 3 m of the allotment boundary, as shown in Figure 47, Figure 48 and Figure 49, also on the ground level, the window opening on the east side in living section of SOU G01, which will have a sill height of less than 1.5 m, as shown in Figure 50, must be provided with heat attenuation screens.

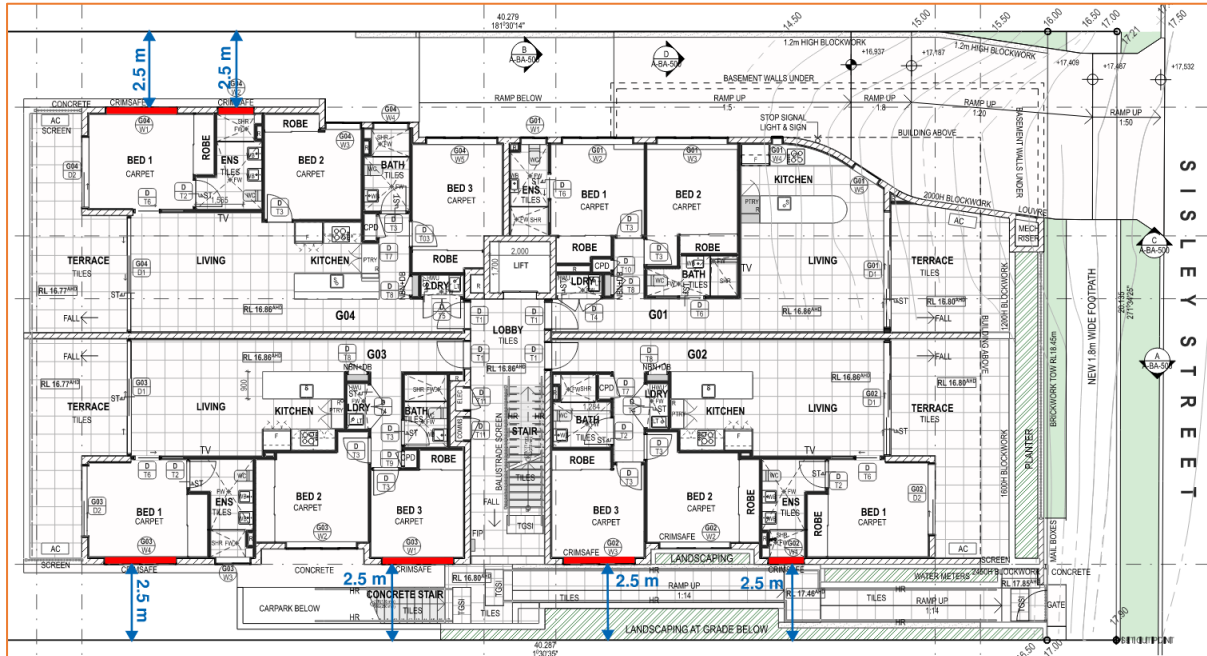


Figure 47: Location of opening within 3 m from the site boundary on ground level

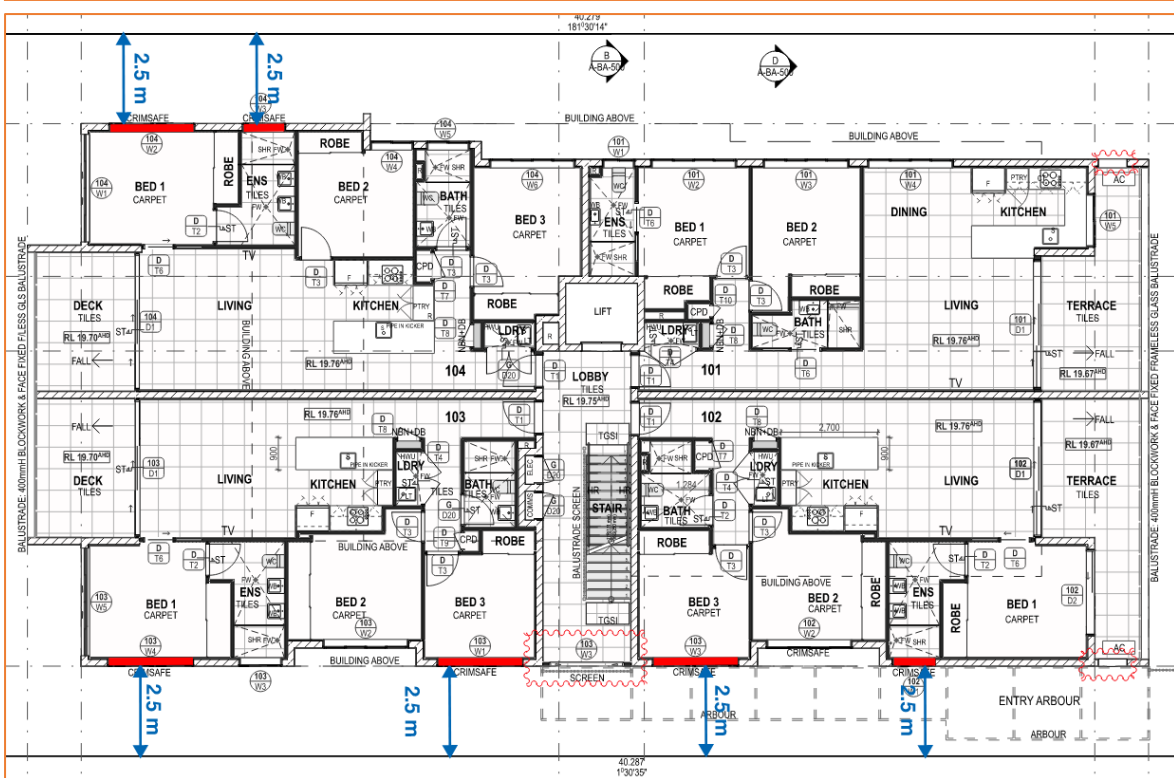


Figure 48: Location of opening within 3 m from the site boundary on level 1

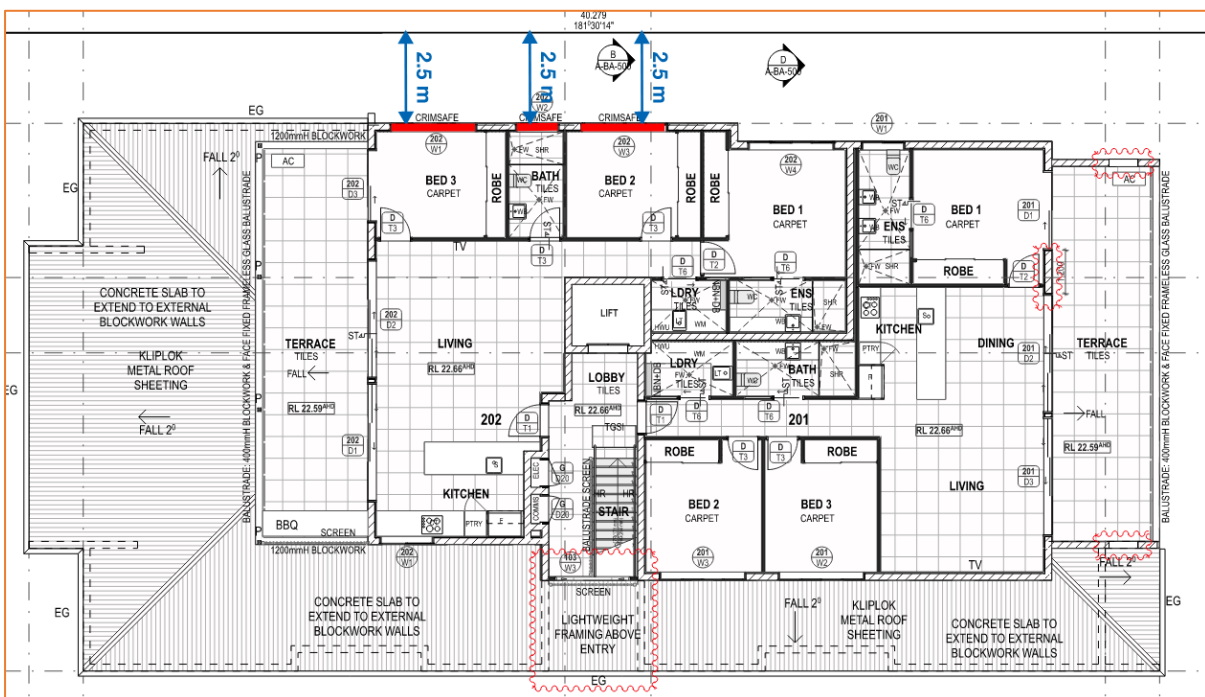


Figure 49: Location of opening within 3 m from the site boundary on level 2

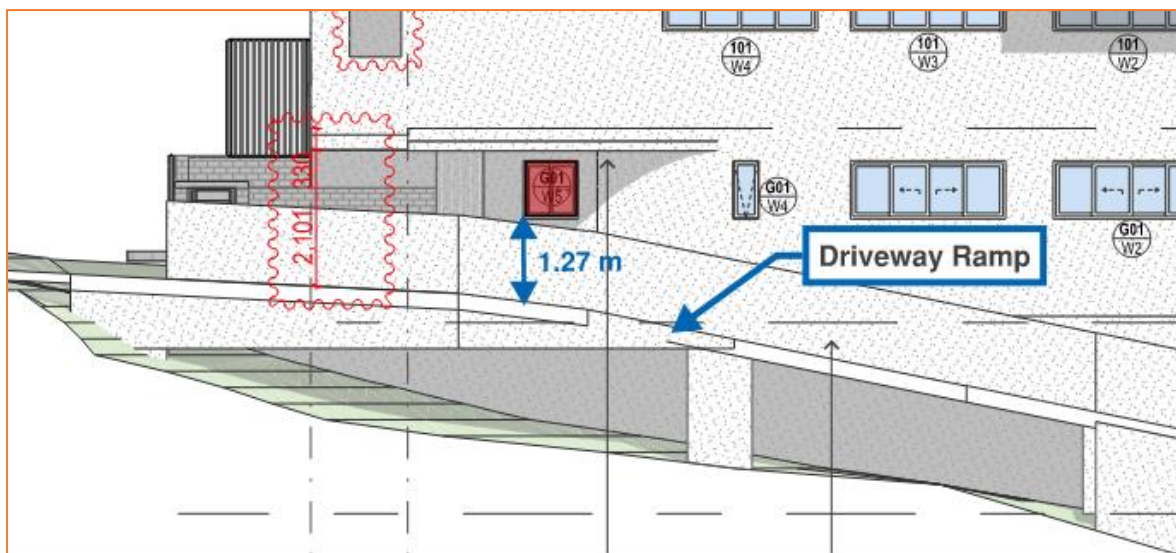


Figure 50: Window openings on the east side, alongside the driveway ramp

The heat attenuation screens are required to be provided to the window openings listed below.

Table 22: Summary of window locations required to be provided with heat attenuation screen

Sr. No	Level	Window opening locations required to be provided with heat attenuation screen
1	Ground level	Living room & kitchen section in SOU G01.
2		Bed 3 section in SOU G02.
3		Toilet section in SOU G02.
4		Bed 1 section in SOU G03.
5		Bed 3 section in SOU G03.
6		Bed 1 section in SOU G04.
7		Bed 2 section in SOU G04.
8	Level 1	Bed 3 section in SOU 102.
9		Toilet section in SOU 102.
10		Bed 1 section in SOU 103.
11		Bed 3 section in SOU 103.
12		Bed 1 section in SOU 104.
13		Bed 2 section in SOU 104.
13	Level 2	Bed 2 section in SOU 202.
14		Toilet section in SOU 202.
15		Bed 3 section in SOU 202.

- The window opening on the west side located in as listed below and as shown in figure below, must have a minimum sill height of 1.5 m and must be provided with heat attenuation screens.

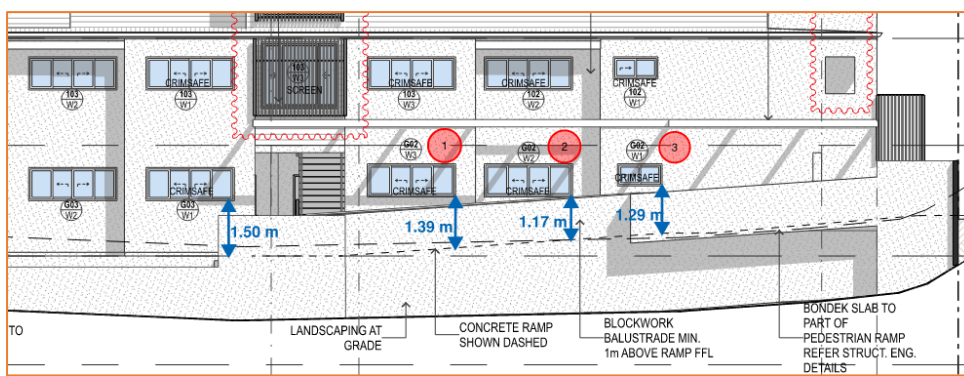


Figure 51: Window openings on the west side, alongside the walkway ramp

The list of window locations required to be provided with minimum sill height of 1.5 m and must be provided with heat attenuation screens, is as follows in the table below.

Table 23: window locations required to be provided with 1.5 m sill height and heat attenuation screens

Sr. No	Window opening locations required to be provided with 1.5 m sill height and heat attenuation screen.
1	G02/W3 - Bed 3 section in SOU G02.
2	G02/W2 - Bed 2 section in SOU G02.
3	G02/W1 - Toilet section in SOU G02.

4. Heat attenuation screens provided must comply with the following requirements:
 - Install heat attenuation screens with a minimum attention rating of 59% to all window openings within 3m of the allotment boundary that are not protected under a Deemed-to-Satisfy compliant manner.
 - The heat attenuation screens installed must be provided with a test certificate from a registered testing authority.
 - The heat attenuation screens must sit flush with the external window opening.
 - The screens must be secured to the external wall using a minimum of 10 mm x 75 mm expandable mechanical anchors.
 - All fixings must be stainless steel or mild steel.
 - All fixings must be tamper-proof.
 - All manufacturers' instructions on the installation of the heat attenuation screen must be followed.
 - A permanent metal sign must be installed on the heat attenuation screen stating, "Fire Protection Screen – Do Not Remove".
 - The heat attenuation screens must be subject to yearly maintenance.
 - Installers of the heat attenuation screen must provide a Form 16 certification.

10.2 Part D – Access and Egress

The access and egress requirements of the building are to meet the BCA Deemed-to-Satisfy requirements with the following exception: -

5. The maximum travel distance to the exit on the lower ground level would be approximately 32m, in lieu of 20 m, and it is acceptable.

10.3 Part E – Service and Equipment

The following fire safety services are proposed to be included within the building design; to facilitate the proposed performance solutions. These measures are additions to and/or modification of the fire safety measures required under the BCA Deemed-to-Satisfy requirements: -

6. Fire Hydrant
 - The building must be provided with a fire hydrant system compliant with BCA 2022 Clause E1D2 and AS 2419.1 – 2021.
7. Fire Sprinklers
 - The building must be provided with fire sprinklers that are compliant with BCA 2022 Clause E1D5. The sprinklers must be fast-response sprinklers with an RTI less than 50 (m.s)^{1/2}.
8. Fire Extinguishers
 - The building must be provided with portable fire extinguishers compliant with the BCA 2022 Clause E1D14 and AS 2444 – 2001.
9. Fire Hose Reels
 - Except for the residential portion and roof area, the class 7a carpark of the building must be provided with fire hose reels compliant with the BCA 2022 Clause E1D3 and AS 2441 – 2005.
10. Fire Hydrant System
 - The fire hydrant system in the building must be compliant with AS 2419.1-2021. However, fire hydrant coverage in the building must be in accordance with hydrant coverage measurement method outlined in AS 2419.1-2005.
11. Fire Indicator Panel (FIP)
 - The Fire Indicator Panel (FIP) must be located at the entrance to the lobby on ground floor, as shown in the image below:

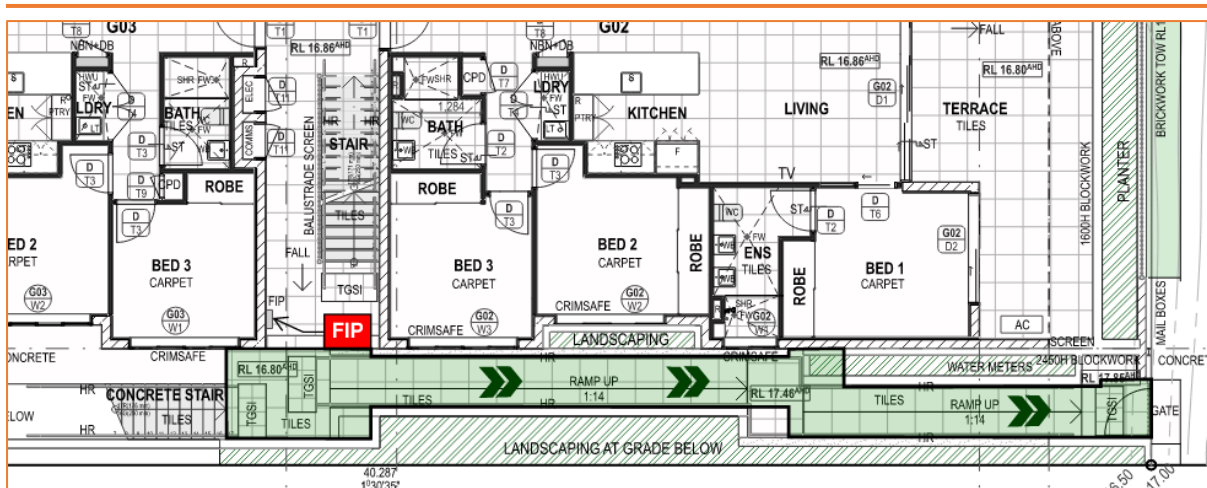


Figure 52: Location of FIP on ground floor

12. Smoke Detection and Occupant Warning System

- The building is required to have a smoke detection and occupant warning system that is compliant with the BCA 2022 Clause E2D5, S20C5 and AS 1670.1 - 2018.
- This building is required to be provided with occupant warning speakers compliant with the BCA 2019 A1 Clause E2.2 and AS 1670.1 – 2018.
- A sound pressure level of 75 dB(A) is required to be achieved at the bedroom bed head with the door closed, and along the balcony with the balcony door closed.

13. Exit Signs and Emergency Lighting

- The building must be provided with emergency lights and exit signs that are compliant with the BCA 2022-part E4 and AS 2293.1 – 2018.

14. Provision for electric vehicle charging

Provision of electric vehicle charging is acceptable, provided that the following requirements are met before the installation of electric vehicle charging in the carpark.

- a) Signage having a font with a minimum height of 40 mm and on a colour contrasting background must be provided at each pedestrian and vehicle entry to the carpark, as shown in figure below stating the following requirements:
 - i. The maximum speed limit in this carpark is 5km/h.
 - ii. All electric vehicle chargers used in this carpark must comply with the requirements of AS/NZS 3820.
 - iii. All electric vehicle chargers used in this carpark must be tested in accordance with AS/NZS 3760 yearly.
 - iv. Electric vehicles involved in a collision are not to be parked in this carpark until repairs have been completed.
 - v. All collisions in this carpark are to be reported to building management.

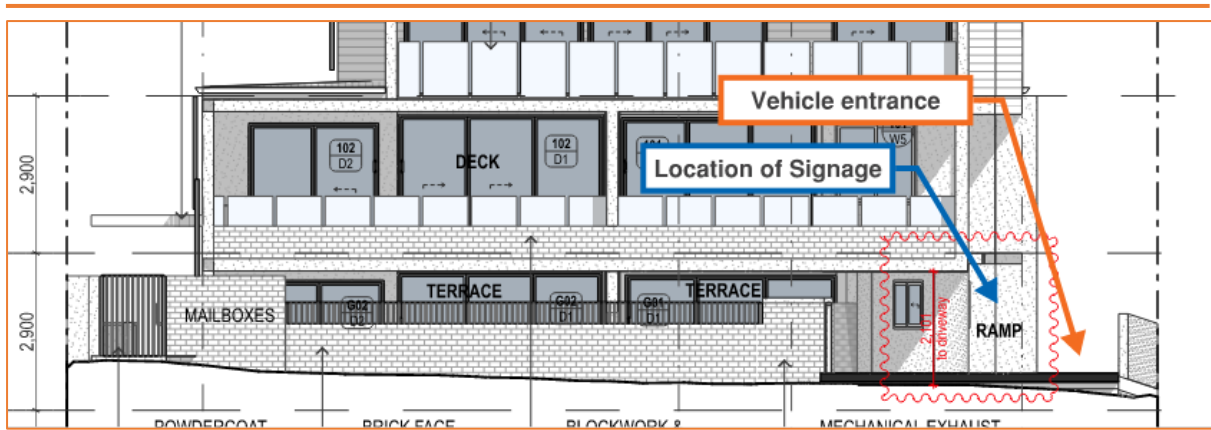


Figure 53: Location of signage

- b) Electric vehicle chargers must be offset from the car park they serve, in between car parks, if possible. Bollards and wheel stoppers must be implemented to protect the electric vehicle chargers.
- c) A fast response sprinkler system, with a maximum RTI of 50 (m.s.)^{0.5}, will be provided on carpark levels.
- d) Shutdown controls for electric vehicle charging points are to be present in close proximity to the Fire Indicator Panel.
- e) The location of electric vehicle charging points is to be marked on block plans.
- f) The location of electric vehicle charging shutdown controls is to be marked on block plans.
- g) The location of electric vehicle charging distribution boards is to be marked on block plans.

11 STANDARDS OF CONSTRUCTION, COMMISSIONING, MANAGEMENT, USE AND MAINTENANCE

The BCA applicable for this project is 2022. All standards used for construction, commissioning, management, use and maintenance referenced in the aforementioned BCA version are applicable. All building work must comply with the prescriptive requirements of the BCA unless it has been specifically varied under fire engineering or by the building Certifier. A general overview of the standards of construction required are tabulated below for ease of reference.

Table 24. Construction and Maintenance Standards

Fire Safety Provisions	Standards Of Construction	Standards For Maintenance
Construction	Comply with BCA Spec C2D2	Comply with AS 1851 and QDC MP 6.1
Fire doors	Comply with BCA 2022 Spec S12C2 and AS 1905.1	
Fire hydrants	Comply with BCA 2022 Clause E1D2 and AS 2419.1	
Fire hose reels	Comply with BCA 2022 Clause E1P1 and AS 2441	
Fire extinguishers	Comply with BCA clause E1D14 and AS 2444	
Sprinklers	Comply with E1D5	
Fire detection and occupant warning systems	Comply with BCA 2022 Clause E2D5, S20C5 and AS 1670.1	
Exit Signs	Comply with BCA 2022 Clause E4D5 and AS 2293.1	
Emergency lighting	Comply with BCA 2022 Clause E4D5 and AS 2293.1	

12 REFERENCES

- Australian Building Codes Board. 2021. Australian Fire Engineering Guidelines 2021. Canberra: Australian Building Codes Board.*
- . 2022. National Construction Code Series. Vol. One. Canberra: Australian Building Codes Board.
- Buchanan, A H. 2008. Fire Engineering Design Guide. 3rd. Christchurch: Centre for Advanced Engineering.*
- . 2001. Fire Engineering Design Guide. 2nd. Christchurch: Centre for Advanced Engineering.
- Committee FP-001. 2012. AS 1851 Maintenance of Fire Protection Systems and Equipment. Sydney: Standards Australia.*
- Department of Local Government and Planning. 2011. Queensland Development Code Mandatory Part MP 6.1 - Maintenance of Fire Safety Installations. Brisbane: Department of Local Government and Planning.*
- McGrattan, Kevin, Simo Hostikka, Randall McDermott, Jason Floyd, and Marcos Vanella. 2013. Fire Dynamics Simulator User's Guide. Gaithersburg: National Institute of Standards and Technology .*
- NRCC; ICC; DBH; ABCB. 2005. International Fire Engineering Guidelines. 2005. Canberra: Australian Building Codes Board.*
- Queensland Fire and Emergency Service. 2020. Guide to the Referral of Performance Solutions. Queensland Fire and Emergency Service.*
- Society of Fire Protection Engineers. 2016. SFPE Handbook of Fire Protection Engineering. 5th. Quincy: Springer.*

12.1 Drawings Referenced

The below list of documents/drawings is referenced in this report.

Table 25. Reference Documents/Drawings List

Level	Draw No.	Revision	Date	Author
Lower Ground Plan	A-BA-200	E	21/01/2026	AW
Ground Level	A-BA-201	E	21/01/2026	AW
Level 01	A-BA-202	E	21/01/2026	AW
Level 2	A-BA-203	E	21/01/2026	AW
Roof Plan	A-BA-204	E	21/01/2026	AW
Elevation	A-BA-400	E	21/01/2026	AW
Sections	A-BA-500	E	21/01/2026	AW

Appendix 1

ASSUMPTIONS AND LIMITATIONS

Table 26. Assumption And Limitation List

Items	Comments
1.	All codes and standards referred to are assumed to be the current version at the time of design and installation, or an alternative approved edition.
2.	There are no combustible composite panels in the building.
3.	All Essential Safety Measures are maintained to the operational capacity to which they were designed, installed, commissioned and certified
4.	This report only addresses compliance with the Performance Requirements of the National Construction Code (NCC).
5.	No liability is accepted for the use of the findings of this report outside the set design criteria of this report, or use by any party not engaged to undertake design, construction or commissioning work associated with this development
6.	No liability is accepted for the accuracy of the design documents provided by others which form the basis of the analysis.
7.	Changes to the building in the future may invalidate the findings of this report. Changes are to be referred to the building certifier as per the normal approval requirements.
8.	Drawings referred to or incorporated in this document may change resulting from design variations. Readers must ensure that they observe the referenced project related drawings, and verify that the latest fire engineering documentation is being used.
9.	The report content is limited to the consideration of the objectives outlined in the NCC. Issues relating to protection of the owner's property, or business continuity are outside the scope of this report.
10.	Acts of malicious intent, arson or acts of terrorism are outside the scope of this report.
11.	Liability for re-installation and costs of any damages caused by fire is beyond the reports scope of responsibility and that of Fire Engineers Australia.
12.	The fire-engineered document, in this case, does not include for stock loss, goodwill, environmental impact or any loss of trade or business interruption associated directly or indirectly with a fire in these premises.
13.	Where not specifically mentioned, the design is expected to meet the requirements of the NCC, relevant codes and legislation at the time of construction and/or at the time of production of this report.

Items	Comments
14.	The subject building must not be used for other activities apart from those described in this report; any change in use of the building in the future must be reassessed and approved by a fire safety engineer in relation to the assessment in this report.
15.	The client has been involved in the initial planning process for determining the appropriate fire engineering requirements, so that they understand the risk involved with the works and the risk to be insured. The client has a duty of disclosure to their insurers in relation to the scope of work adopted for this project and it is the owner's responsibility to advise their insurers in this regard. It is not responsibility of Fire Engineers Australia to advise insurers in relation to the level of loss required to be insured.
16.	The client is to take all reasonable steps to comply with the certificate of classification requirements. Owners and occupiers need to be aware of, and follow, any restrictions on the building's use as well as the requirements of alternative solutions generally so that safety standards are effectively maintained for the life of the building. This will also help ensure the day to day use of the building and any future modifications do not compromise compliance with the building code's performance requirements

Appendix 2

RESUME

CHRIS SHEERAN

*Fire Engineers Australia
Unit 10; 531 Sandgate Rd,
Clayfield QLD 4011
(61) 429 599 488 (61) 7 3048 1435
chris@fireengineersaustralia.com.au*

Career Summary

I am the Principal Fire Engineer and Managing Director of Fire Engineers Australia. I have worked in the Queensland construction industry delivering bespoke fire engineering solutions for **15+ years**. My local knowledge and experience provide a clear advantage to my clients. Equipped with a master's degree in mechatronics and fire engineering, my fire safety engineering skills are strongly founded on technical knowledge and practical project applications. I have developed considerable expertise with building fire safety design for residential developments, shopping centres, warehouses, offices, casinos and the like. I participate in all types of projects ensuring quality and innovation is maintained to a standard of excellence.

Professional Qualifications

Registered Chartered Professional Engineer (Fire Safety Engineering), Engineers Australia

National Engineering Register (Fire Safety Engineering), Engineers Australia

Registered Chartered Engineer (Fire), Institution of Fire Engineers, UK.

Registered Professional Fire Engineer, Queensland, RPEQ No 11900

Chartered Engineer with Engineering New Zealand

Education and Training

Master of Fire Safety Engineering, University of Western Sydney.

Master of Mechatronics Engineering, Vellore Institute of Technology, India.

Bachelor of Mechanical Engineering, University of Madras, India.

Language Skills

English – Fluent. Tamil – Fluent

Professional Memberships

Member, Institution of Fire Engineers

Member, Engineers Australia

Member, Engineering New Zealand

Work Experience (15 years+)

Fire Engineers Australia – July 2017 - Present (2 years 8 months) Brisbane, Australia

I am the Managing Director and Principal Engineer at Fire Engineers Australia. I started the business in 2017. I am a Registered Chartered Engineer and a Registered Professional Engineer in Queensland in the field of fire engineering.

I have a working knowledge of the Building Code of Australia, Queensland building regulations & Australian Standards that pertain to fire safety. I have strong customer service skills and have developed effective working relationships with clients, approval authorities and fire brigade.

My Fire Engineering Briefs & Fire Engineering Reports adhere to the procedures set out in the International Fire Engineering Guidelines – Edition 2005. With an effective working relationship built over 15+ years with prominent stakeholders in the building industry I am aware of the subtle skills that need to be included into the fire engineering documentation. I use a hands-on approach for all my projects from start to finish. This allows me to deliver exceptional service to my clients, provide mentoring to my team, quality control, reduce risk exposure and have a profitable project.

Queensland Building and Development Dispute Resolution Committee General

Referee - November 2015 - Present (4 years 4 months)

I serve as a general referee for the Queensland Building and Development dispute resolution committee as a general referee.

WSP in Australia & New Zealand Fire Engineer July 2013 - June 2017 (4 years)

Brisbane, Australia

Building Design Magazine 2015 has ranked WSP the best service engineer and joint-second for structural engineering by the top 100 global architects. Predominantly the projects were for Tier 1 developers which was very exciting.

I joined WSP as a senior engineer specifically to gain exposure to National and International projects. In October 2014, I was promoted to Associate within the specialist division of WSP. Working as part of the global company, I was exposed to the latest and best international practises in fire engineering design.

For projects that I was the responsible as the professional engineer, I lead and managed the technical content of the project, the financial aspects to ensure profitability of the project, managed the client relationship and ensure successful project completion. To enable successful project delivery, I ensured that my colleagues that I supervise were provided with leadership necessary for them to reach their best performance. Hence my focus is first to take care of my team which in turn results in a successful project.

Fire Check Consultants Fire Engineer March 2005 - July 2013 (8 years 5 months)

Brisbane, Australia

I started my professional career as a Graduate Engineer at this boutique small business consultancy in Brisbane. The projects ranged from small sub \$10M developments to \$400M+ developments like Indooroopilly Shopping Centre here in Brisbane. The projects were predominantly Tier 2 & Tier 3 with periodic projects which were Tier 1. In May 2010, I was promoted to Senior Associate within the company. In April 2011, I was promoted to Director of Engineering Services. The business had approx. 7 staff.

Selected Relevant Project Experience

Residential

- South City Development, Woolloongabba, Queensland, Australia.
- Jewel, Queensland, Australia.
- Vision city hotel development, Port Moresby, PNG
- Ocean Pacific, Broad beach, Queensland, Australia
- Tennyson Reach Apartments, Queensland, Australia
- Nirvana by the Sea, Kirra Beach, Queensland, Australia
- Mona Vie, 16 Prince Edward Pde, Redcliffe, Queensland, Australia
- Pavilions on 5th, Palm Beach, Gold Coast, Queensland, Australia
- 3-7 Helen Street, Newstead, Queensland, Australia
- Solito North, South and Central towers, Carindale, Queensland, Australia
- Signature View Apartments, 79 Dengate Lane, Taringa, Queensland, Australia
- 19 Hercules Street, Hamilton, Queensland, Australia
- Eclipse Apartments, Broad beach, Queensland, Australia
- Sisters of Mercy, 45 O'Connor Street, Tugan, Queensland, Australia
- The Peak, St. Lucia, Queensland, Australia
- Stafford Height Retirement Village, Stafford, Queensland, Australia
- Pure Kirra, 28 Musgrave Street, Coolangatta, Queensland, Australia
- 200 person mining accommodation camp, Adani Carmichael, Queensland, Australia.
- 127 Charlotte Street, Brisbane, Queensland, Australia
- Port of Airlie, Building G, Queensland, Australia.
- Lennon's Hotel, Brisbane, Queensland, Australia

Retail

- Grand Central Development, Toowoomba, Queensland, Australia.
- Calamvale Central Shopping Centre, Calamvale, Queensland, Australia

-
- Westfield Stage 5 & David Jones, Westfield Shopping Centre, Chermside, Queensland, Australia
 - Myer, Westfield Shopping Centre, North Lakes, Queensland, Australia
 - Mt. Ommaney Shopping Centre, Mt Ommaney, Queensland, Australia
 - Stockland Shopping Centre, Townsville, Queensland, Australia
 - Castle Town Shopping Centre, Townsville, Queensland, Australia
 - Willows Shopping Town, Townsville, Queensland, Australia
 - Westfield Shopping Centre, Carindale, Queensland, Australia
 - Indooroopilly Shopping Centre, Brisbane, Queensland, Australia
 - Kippa Ring Shopping Centre, Kippa Ring, Queensland, Australia
 - Stockland Shopping Centre, Hervey bay, Queensland, Australia

Office Buildings

- 43 Peel Street, South Brisbane, Queensland, Australia
- 123 Sandgate Road, Albion, Queensland, Australia
- 25 Evelyn Street, Newstead, Queensland, Australia
- 179 North Quay, Brisbane, Queensland, Australia
- 33 Queen Street, Brisbane, Queensland, Australia
- Synergy, Kelvin Grove, Queensland, Australia
- 3 Days Road, Wilston, Brisbane, Queensland, Australia
- 236 Old Cleveland Road, Coorparoo, Queensland, Australia
- McDonnell & East Building Redevelopment, Brisbane, Queensland, Australia
- St. John Cathedral Webber Annex building, Brisbane, Queensland, Australia

Warehouse/Industrial

- 100 South link Street, Parkinson, Queensland, Australia
- DHL Warehouse Facility, Browns Plains, Brisbane, Queensland, Australia
- Metcash Warehouse Stage 2, Marsden Industrial Estate, Brisbane, Queensland, Australia
- 605 Zillmere Road warehouse buildings, Aspley, Queensland, Australia
- IPS Logistics – Warehouse 3 & 4, Fisherman Island, Brisbane, Queensland, Australia
- Metcash warehouse, 111-137 Magnesium Drive, Crestmead, Queensland, Australia
- ABS Heavy Engineering Extension, Mackay, Queensland, Australia.
- Komatsu, Mackay, Queensland, Australia
- River gate Ferry maintenance terminal, Brisbane, Queensland, Australia
- Target Warehouse, 250 South pine Road, Brendale, Queensland, Australia
- Self-Storage, 128 Gerler Road, Hendra, Queensland, Australia
- Melco self-storage, Kunda Park, Queensland, Australia

-
- Storage King, Cleveland, Queensland, Australia
 - Marland mushroom farm, Staplyton, Queensland, Australia

Health and Aged Care

- St. Patricks aged care hostel, Gympie, Queensland, Australia
- St. Pauls Villa aged care, Rainworth, Queensland, Australia
- Prescare Hopetoun aged care facility, Cordina, Queensland, Australia
- Madonna Villa, Oxford park aged care, Mitchelton, Queensland, Australia
- St. Joseph's Villa, Oxford park aged care, Mitchelton, Queensland, Australia
- The Monastery, Oxford park aged care, Mitchelton, Queensland, Australia
- Sunset Lodge, Sunnymead Nursing Home, Caboolture, Queensland, Australia
- Wheller Gardens aged care, Chermside, Queensland, Australia
- Aminya Nursing home, Caloundra, Queensland, Australia
- Sunrise Way Therapeutic Centre, Toowoomba. Queensland, Australia
- Clayfield house supported accommodation, 8 London road, Clayfield, Queensland, Australia

Assembly

- Caloundra RSL – Stage 6, Caloundra, Queensland, Australia
- Waterford Place, St Joseph's College, Springhill, Brisbane, Queensland, Australia
- James Cook University, Brisbane campus, 349 Queen Street, Brisbane, Queensland, Australia
- Rural Medical School, University of Queensland, Toowoomba, Queensland, Australia
- Gold Coast TAFE, Coomera, Queensland, Australia
- Perry Park Redevelopment, Bowen Hills, Queensland, Australia.
- Fitness First Gymnasium, 116 Adelaide Street, Brisbane, Queensland, Australia
- State Equestrian Centre, Caboolture, Brisbane, Queensland, Australia
- Alliance FIFO Terminal, 12 Boronia Road, Eagle Farm, Queensland, Australia
- JIST training facility, 460 Beaudesert Road, Salisbury, Brisbane, Queensland, Australia
- Yungaba Development, Stage 1 – Multicultural Centre, Kangaroo Point, Queensland, Australia

Fire Safety Audits

- Centro Shopping Centre, Surfers Paradise, Queensland, Australia
- The Pines Shopping Centre, Elanora, Queensland, Australia
- Valley Metro shopping centre, Fortitude Valley, Queensland, Australia
- Australia post mail distribution Centre, Northgate, Queensland, Australia
- The Broadway hotel, 93 Logan Road, Woolloongabba, Queensland, Australia
- The Design Centre, 46 Douglas St, Milton, Queensland, Australia

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