Performance-Based Design Brief / Fire Engineering Brief Questionnaire (FEBQ)

1 Document control

Applicant reference number P00504 **FRNSW reference number** FRNSW use only

Ver.	Author	Organisation	Status	Date
01	Lloyd Wilkinson	E-LAB Consulting	Initial submission	**Select**

2 Applicant

2.1 Agreement

As the applicant, I confirm the following:

- I agree to pay Fire and Rescue NSW (FRNSW) the charges set out in Clause 46 of the *Fire Brigades Regulation 2014* (see Section 10).
- I agree to forward with this application the following documentation for FRNSW to review and provide advice on the assessment methods and acceptance criteria proposed for the given performance solution:

☑ Copy of proposed building plans and specifications
(e.g. relevant floor plans, elevations, site plan, section views, hydrant plan and schematic)
☑ BCA report or letter from an accredited certifier that identifies all non-compliances (if available)
☐ *CFD/zone modelling inputs form* (if applicable) (available on FRNSW website)
☑ *Performance solution summary table* (available on FRNSW website)

Name of fire engineer	Lloyd Wilkinson	Registration number	3284
Company name	E-LAB Consulting Pty Ltd		
Fire engineer's phone no.	0447 343 458		
Fire engineer's email	Lloyd.wilkinson@e-lab.com.au		

2.2 Remittance advice information

Invoices will be issued based on the information provided below:

ASIC company name	**Remitter's ASIC registered company name**		
Australian business number	**ABN (not ACN)**	Trading name	**Remitter's general trading name**
Remittance contact name	**Remitter's contact name**		
Remittance street address	**Remitter's street address**		
Remittance email address	**Remitter's email (i.e. accounts email for billing)**		
Remittance phone number	**Remitter's phone no.**	Remittance fax number	**Remitter's fax no.**
Purchase order ref. no.	If applicable	Project code ref. no.	If applicable
Project leader contact name	**Project leader contact name**		
Project leader contact email	**Project leader contact email**		

3 Consultation

3.1 Stakeholders

Role	Name and BPB number	Organisation and phone	Email address
BCA consultant	Arshdeep Mohi BDC3148	McKenzie Group Consulting (NSW) Pty Ltd 0433 204 102	arsh.mohi@mckenzie-group.com.au
Certifier	Enter name Registration number	Enter organisation name Phone no.	Enter email address
FRNSW reviewers	FRNSW use only FRNSW use only	Fire and Rescue NSW 02 9742 7434	firesafety@fire.nsw.gov.au

3.2 Meeting details

Record the details of any meetings undertaken with FRNSW on the project.

Meetings undertaken	Type of Meeting	Meeting Date	Attendees
N/A	N/A	N/A	N/A

4 Project details

4.1 Premises

Premises name	Cabramatta East Redevelopment
Primary street address	Corner of Broomfield Street and Cabramatta Road East, NSW 2166
Secondary street address	-
Premises suburb	Cabramatta
Lot and DP numbers	-
Is the premises considered a significant development or a unique building (e.g. Sydney Football Stadium, Sydney Opera House, Crown Towers, etc.)?	No

4.2 Proposed works

☑ New building
☐ Refurbishment of an existing building
☐ Extension of an existing building
☐ Change in use within an existing building
Other: (provide details)

Applicable NCC: NCC 2022

For existing buildings:
Approximate year of construction: N/A
Building code when constructed: N/A

What is the proposed approval pathway?:

☐ Complying Development Certificate (CDC) ☑ Construction Certificate (CC) ☐ Crown works
☐ Voluntary upgrade ☐ Other: (provide details)

How many performance solution issues are proposed in this FEBQ? 19

How many Performance Requirements are being assessed? 10

Do any of the Performance Solutions proposed pertain to works already constructed on site? No

Are any of the solutions proposed as a result of:

An issue of a notice of intention to issue a fire order on the subject premise	No
An issue of a fire order on the subject premise	No
An audit of the existing building that has identified an existing non-compliance	No
Not being able to sign off an annual fire safety statement	No
(provide details)	

Additional Questions

Does the proposal include a reduction in water supply to the fire hydrant or sprinkler system?	No
Does the proposal relate to fire hydrant system flows and/or pressures?	No
Would the DtS provisions require the provision of an active fire safety system that is not proposed as part of the performance solution (i.e. is the performance solution deleting an active fire safety system)? • Omission for sprinklers to minor ancillary areas, and high risk areas (i.e. switch rooms and the like) • Omission of zone smoke control system	Yes
If the proposal includes a waste management facility, does it comply with the current FRNSW Fire Safety in Waste Facilities Fire safety guideline?	No
Has there been any previous IFSR submission(s) under Part 3 Division 3 of the *Environmental Planning and Assessment (Development Certification and Fire Safety) Regulation 2021* pertaining to this development?	No

Will the premises likely be subject to a fire safety study, risk assessment or dangerous goods study? No

Note: Any study/risk assessment should be completed prior to submitting this FEBQ and should be attached to this application.

Have all departures from the deemed-to-satisfy (DtS) provisions of the *National Construction Code* (*NCC*) been identified for this proposed design (i.e. a BCA report or letter from an accredited certifier)? Yes

Note: Any advice given is subject to all non-compliances being identified. Any new DtS departures identified, including any from the certifier determining the application for construction certificate, may affect FRNSW advice in respect to this performance solution.

Identify if any previous performance solution applies to the building:

N/A – New Development

Identify if any application has been/will be submitted for a fire safety exemption under Clause 188 of the *Environmental Planning and Assessment Regulation 2000* or under Section 111 of the *Environmental Planning and Assessment (Development Certification and Fire Safety) Regulation 2021*:

N/A

Identify if the premises is or will be subject to any development application (DA) conditions or special regulatory approvals (e.g. BPB conditions, ministerial conditions, crown building works):

Note: FRNSW will not comment on existing buildings subject to voluntary upgrade or change of use prior to the issuing of any DA conditions of consent, or conditions of an existing consent have been modified (i.e section 4.55 of *Environmental Planning and Assessment Act 1979*). Comment will also not be provided if an order has been issued unless the Council agrees. The Council may seek advice during the DA review.

The subject development shall be approved via a Construction Certificate process.

4.3 Description of building

Main occupancy class	2	Largest fire compartment (within the building)	Area (m^2)	1652 (C-Level 1)
Other occupancy classes	5, 6, 7a, 7b, 9b		Volume (m^3)	5204
Type of construction	A		Height (m)	3.15
Effective height (m)	Tower A – 52.5 m Tower B – 49.4 m Tower C – 58.7 m	Ground floor area (m^2)		Tower A – 687 Tower B – 1223 Tower C – 1561
Rise in storeys	Tower A – 17 Tower B – 16 Tower C – 19	Total floor area (m^2)		Tower A – 13051 Tower B – 17902 Tower C – 19357
Levels contained	Tower A – 20 Tower B – 19 Tower C – 23	Total volume (m^3)		Tower A – 685,178 Tower B – 884,359 Tower C – 1,136,256
Does the building contain an early childhood centre?	Yes	Is the building or does the building contain a Data Centre?		No
Is the development a major hazard facility?	No			

Outline any additional building characteristics:

Building Location

The proposed development will be located at the corner of Cabramatta Road East and Broomfield Street, Cabramatta NSW 2166. The allotment site is primarily bounded by commercial buildings to the East and a multilevel carpark to the North. Refer to Figure 1 illustrating the allotment boundary and associated bounding streets.

Figure 1 – Allotment Boundary and Associated Bounding Streets

Building Description and Layout

The subject development features three separate Class 2 residential towers (A, B and C), with Class 6 retail tenancies on the ground floor, as shown in Figure 3. The towers are interconnected by three basement levels which contain Class 7a carparking and Class 7b storage, indicative layout in Figure 2. Level 1 is illustrated in Figure 4 where tower B contains Class 9b childcare and Class 5 offices, while tower C contains more retail. The towers also feature a mezzanine with only plant located on the floorplate. An indicative layout of the residential levels is shown in Figure 5 (level 3). Tower A contains residential apartments up to level 16, while tower B is up to level 15 and tower C is up to level 18 (Figure 6). The roof of each tower houses plant equipment and photovoltaic solar panels.

Figure 2: Basement 1 layout (indicative of all basement levels)

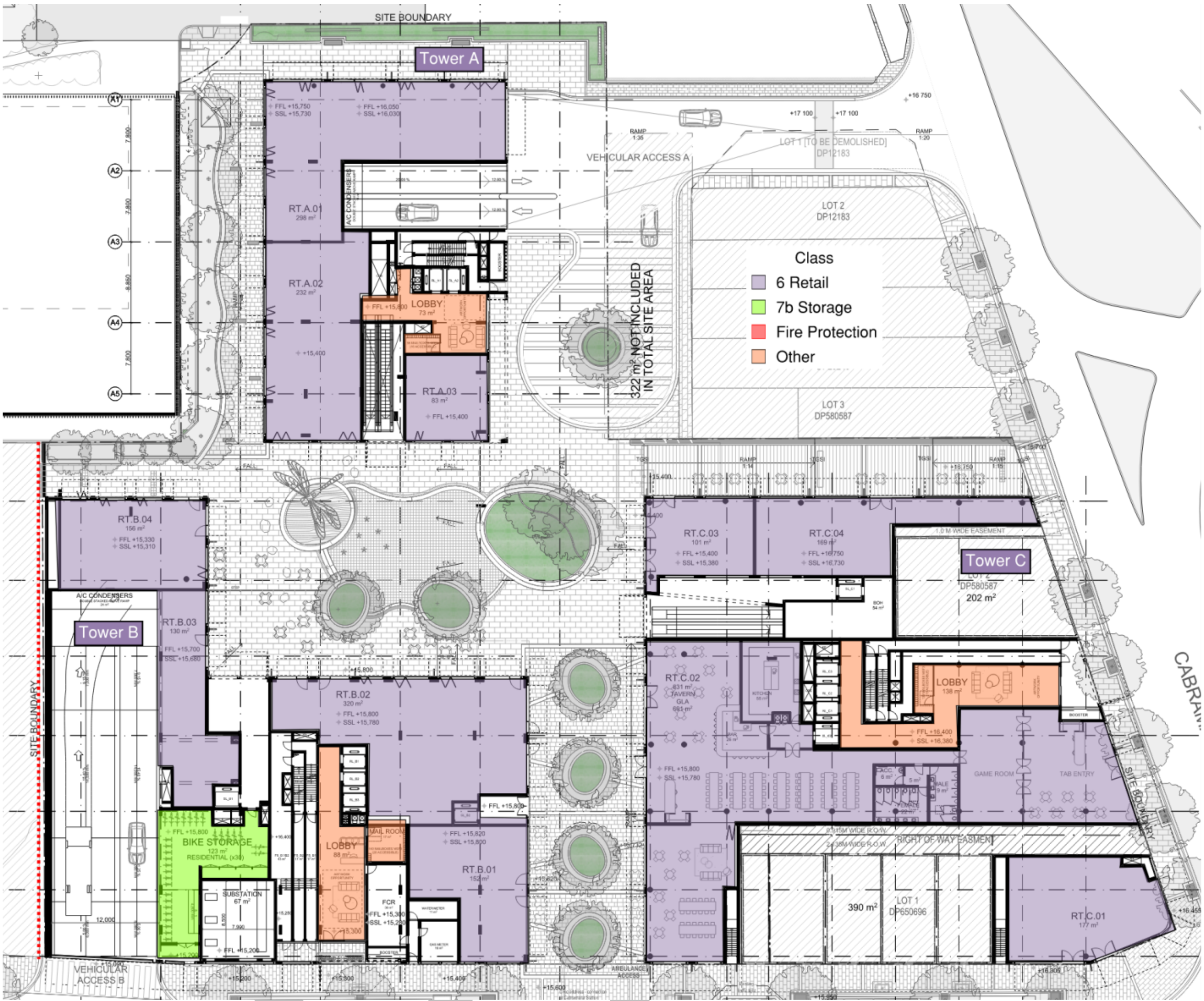

Figure 3: Ground floor layout

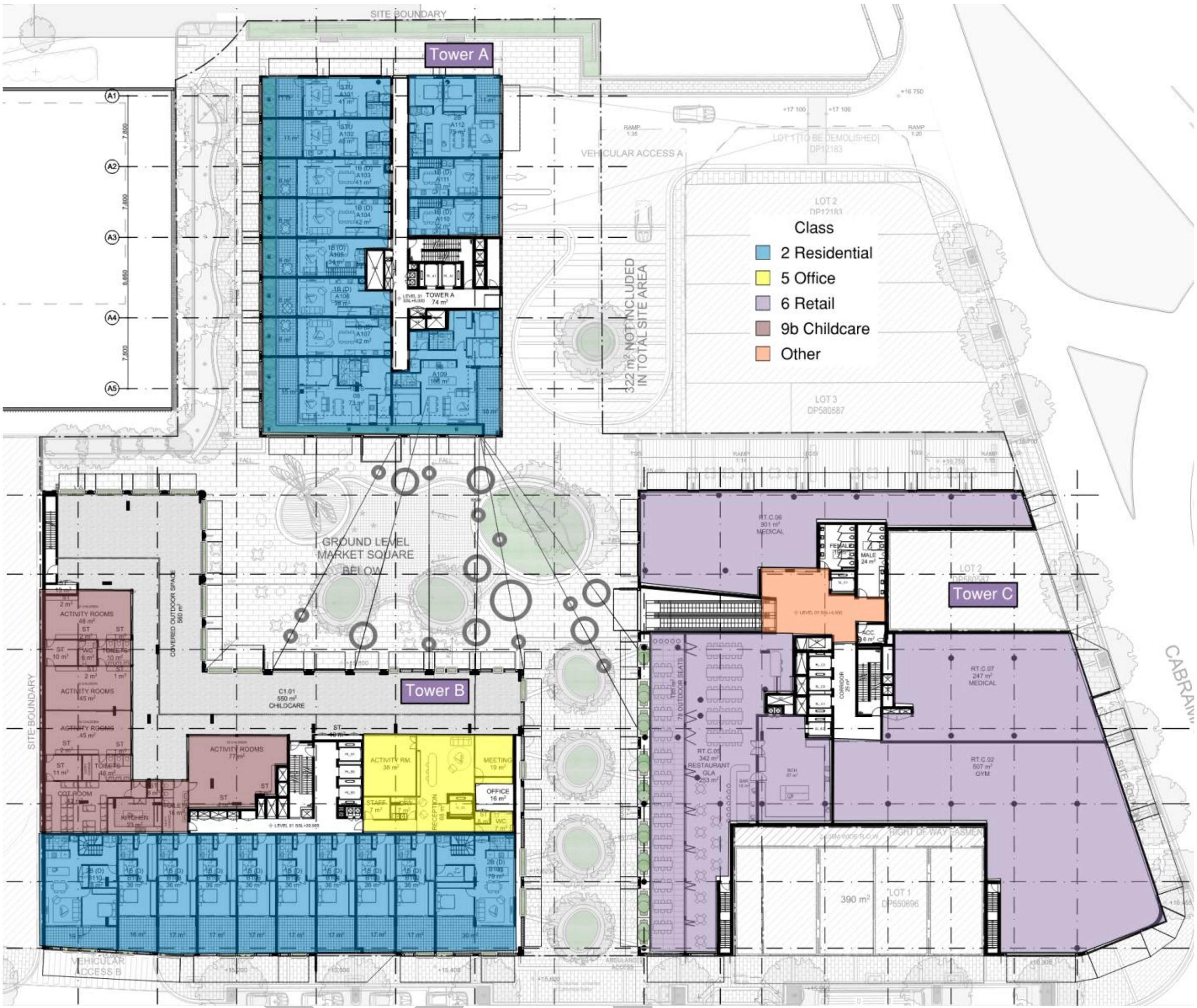

Figure 4: Level 1 layout

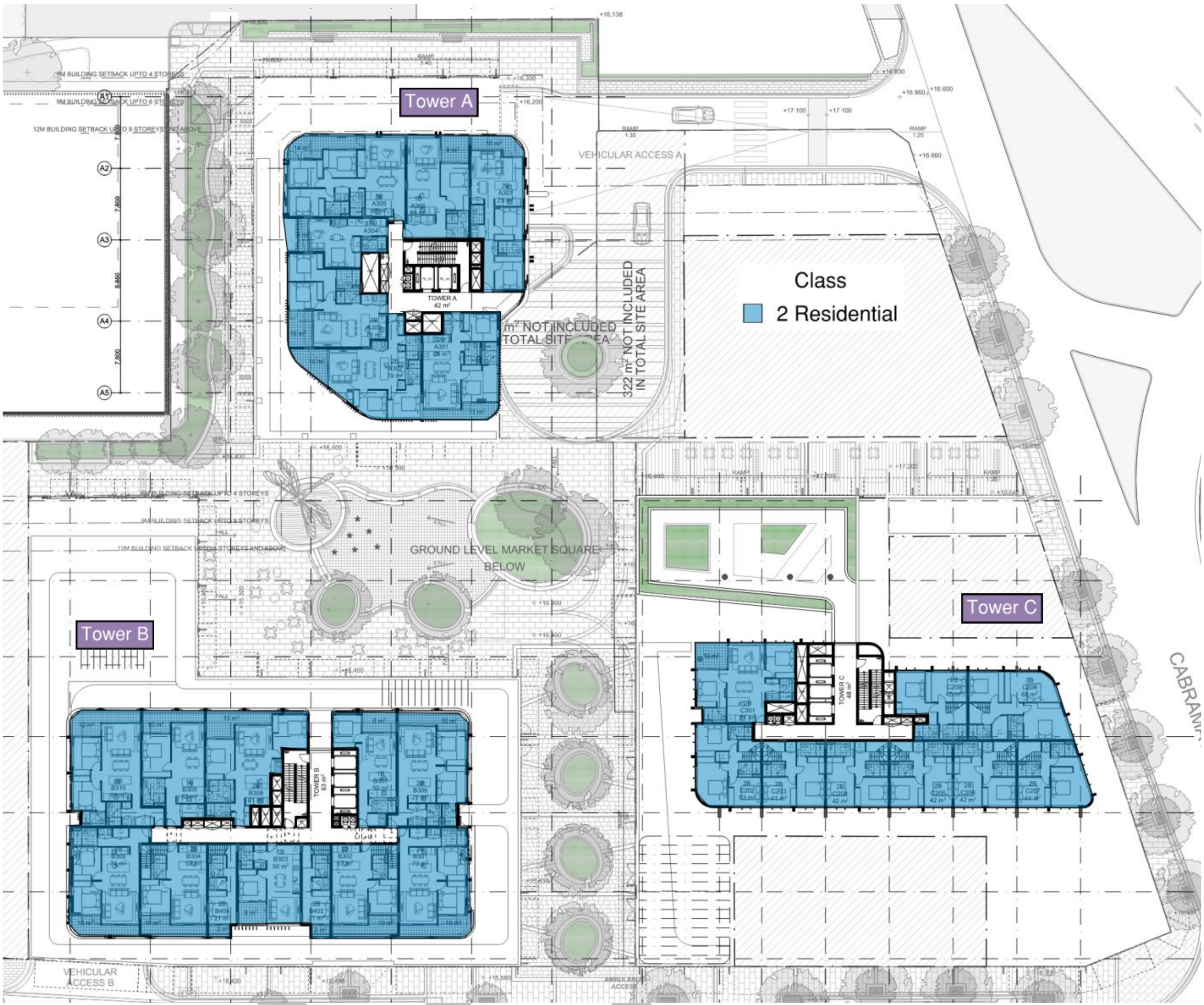

Figure 5: Level 3 layout (indicative of all residential levels except topmost)

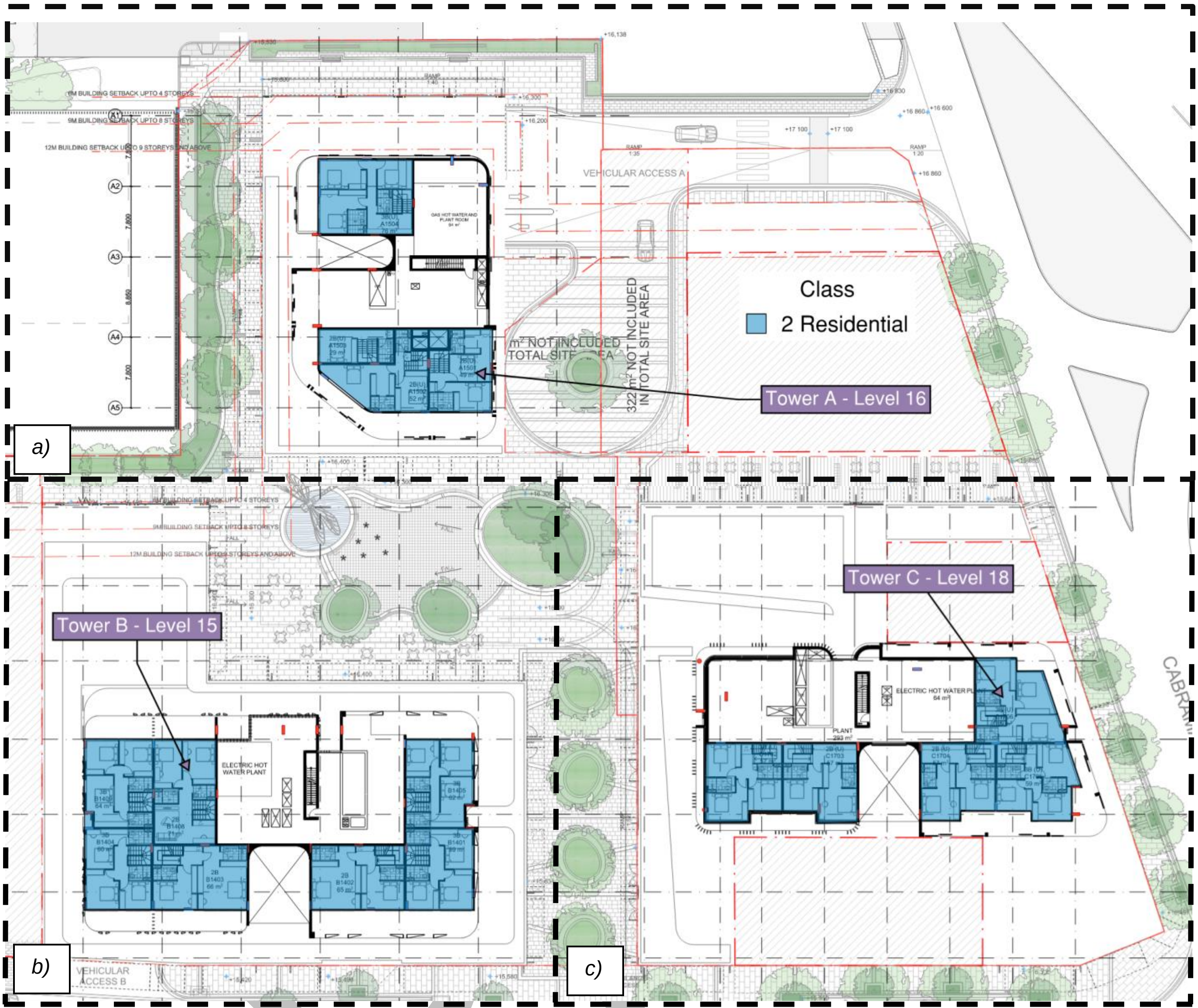

Figure 6: Topmost residential level layout – a) tower A at level 16, b) tower B at level 15, c) tower C at level 18

Building Egress Arrangement

Basement Level 1-3

Figure 7 shows the indicative egress and exit arrangement for all the basement levels, with the lowest (3) shown. The floorplate is divided into three areas with a single fire-isolated stairway servicing each of the three towers above which are centrally located within the tower footprint. Each stairway has two exits to egress the levels above and final egress to an open space on the ground floor. There are multiple locations, identical on each level, which have an extended travel distance to a point of choice. These shortfalls will be addressed in Performance Solution 8.

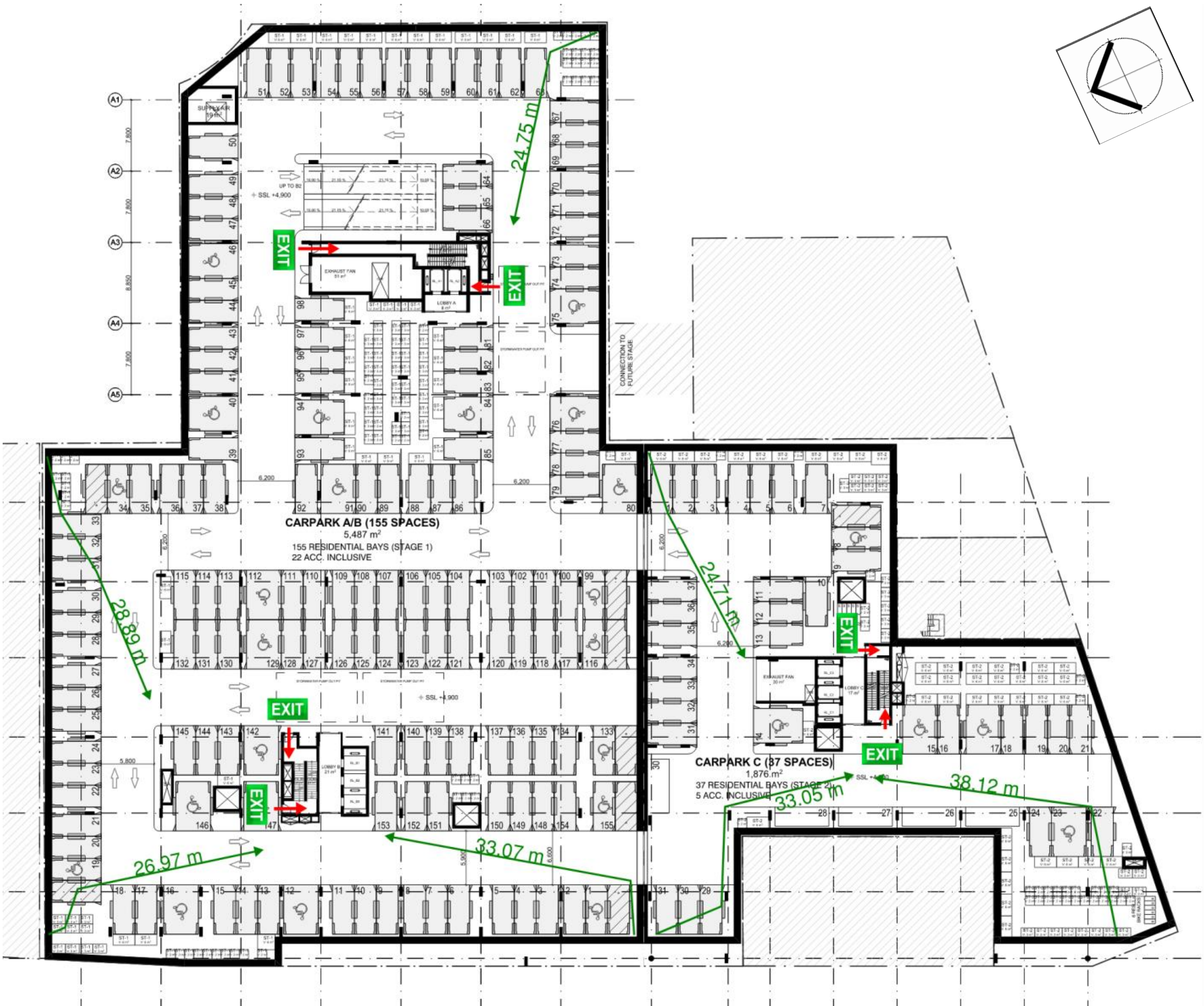

Figure 7: Egress and exits arrangement – basement 3 (indicative of all basement levels)

Ground Floor

The ground floor discharges occupants from the basement and levels above via the fire-isolated stairways servicing each tower. The retail tenancies have individual doors, sliding or bifold doors providing egress to the outside, from which occupants must follow paths of travel to Broomfield Street or Cabramatta Road East as the designated open spaces. Non-compliant doors will be assessed in Performance Solution 14. Refer to Figure 8 which details the exits layout and egress arrangement. Tower A occupants discharging from the stairway must follow the path of travel to Broomfield Street. Tower B has a separate fire-isolated stairway located in the Northeast corner which services level 1 via the mezzanine level. Tower C contains two non fire-isolated stairways servicing level 1 which discharge directly onto Broomfield Street.

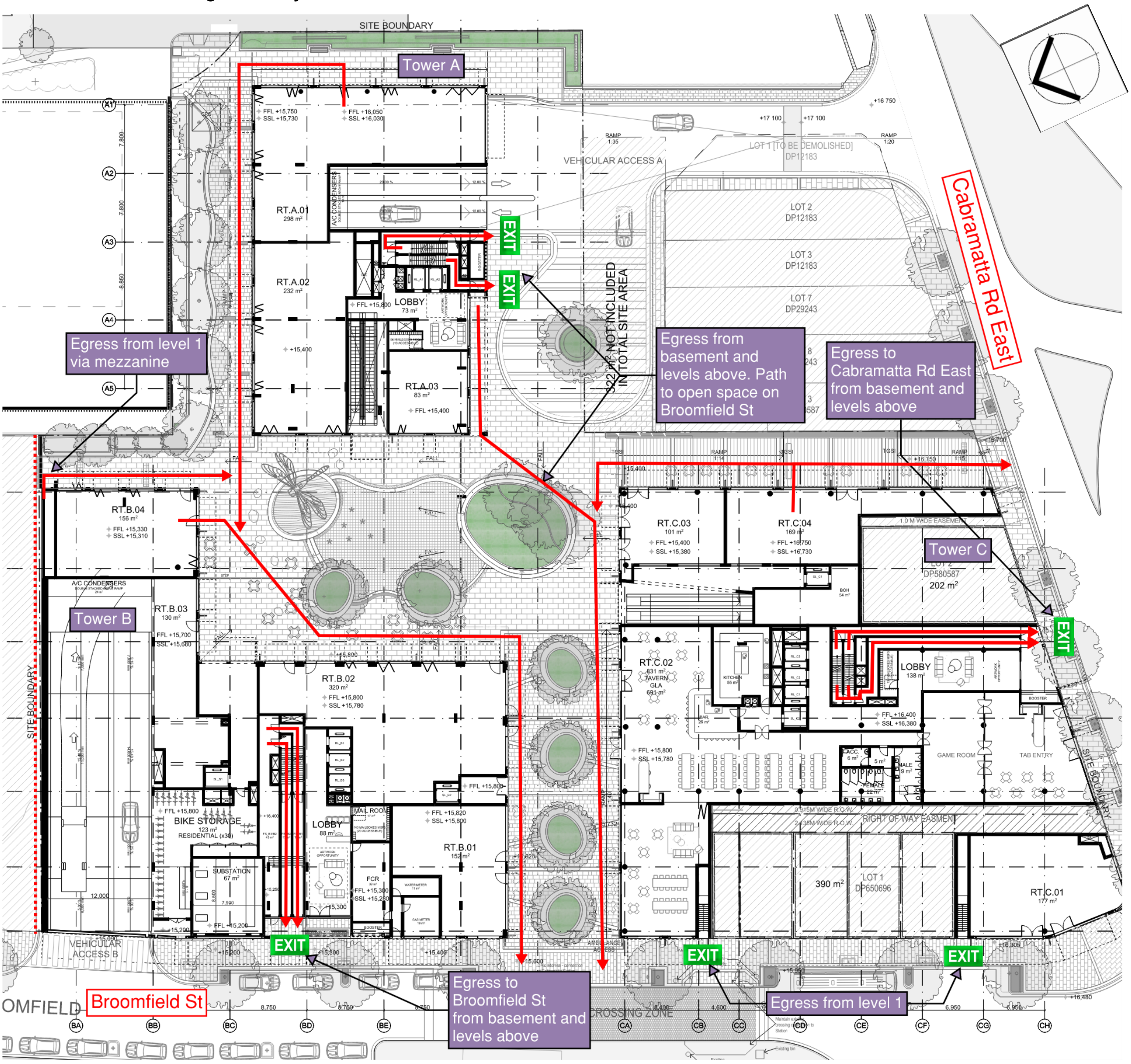

Figure 8: Egress and exits arrangement – ground floor

Level 1

Figure 9 shows the exits layout and egress arrangement level 1. Tower A only contains residential and as such the egress is via the common corridor and central fire-isolated stairway, which has two exits. Tower B utilises the central stairway for one exit and the Northeast stairway that discharges directly onto the ground. The childcare rooms have sliding doors to discharge to the outside patio, with occupants using either stairway. Tower C utilises two non fire-isolated stairway on the West side which discharge directly to Broomfield Street. The central stairway is accessed via multiple sliding doors within the retail complex and again leads to the ground, with two exits available. For all towers, the extended travel distances will be addressed in Performance Solution 8.

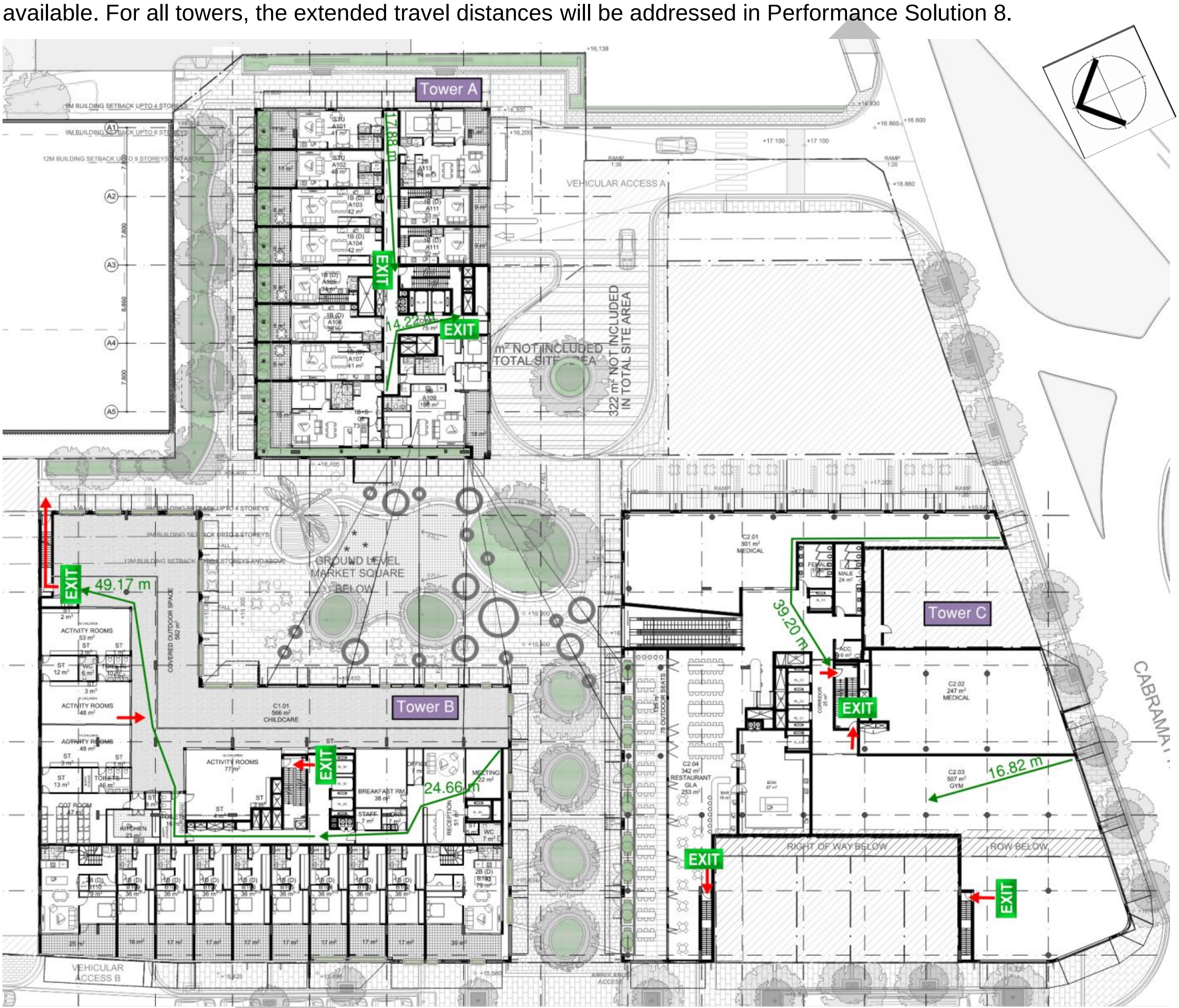

Figure 9: Egress and exits arrangement – level 1

Residential Levels 2-18

Figure 10 shows the exits and egress for the residential areas on level 2. All three towers utilise their centrally located fire-isolated stairway to egress to the ground. This level also contains outside terraces which have extended travel distance to the stairway inside. Levels 3-18 have similar layouts and all utilise the central stairway to egress onto ground level and travel to either Broomfield Street or Cabramatta Road East. There are multiple locations, identical on each level, which have an extended travel distance to a point of choice. These shortfalls will be addressed in Performance Solution 8.

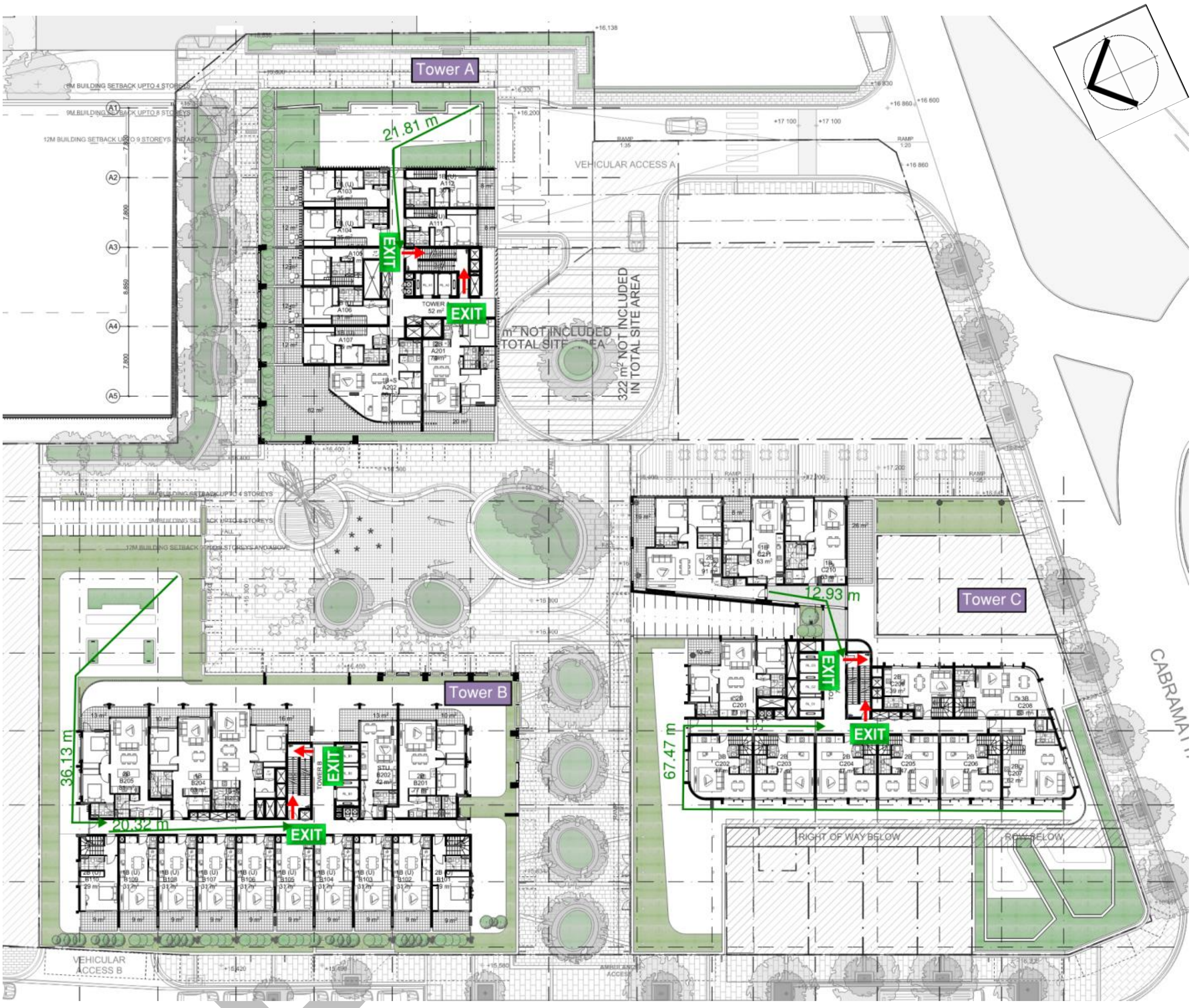

Figure 10: Egress and exits arrangement – level 2 (indicative of all residential levels except topmost)

Topmost Level

The topmost level of each tower has one exit to access the central fire-isolated stairway. The exit only service plant equipment and associated rooms. Residential areas on these levels have internal stairs within each apartment and hence egress on the level below.

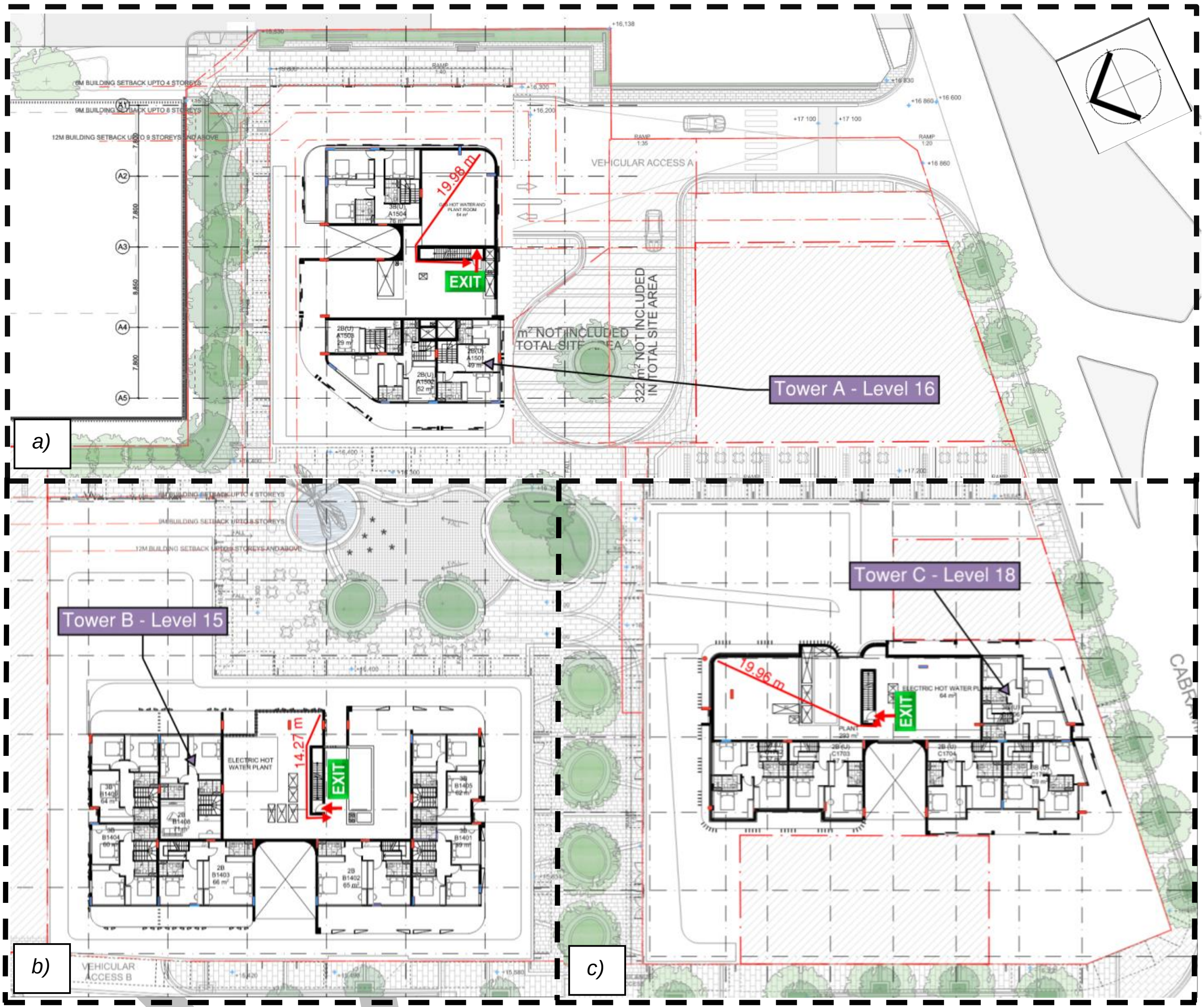

Figure 11: Egress and exits arrangement – Topmost residential– a) tower A at level 16, b) tower B at level 15, c) tower C at level 18

Outline the services provided for fire brigade / fire services intervention:

Fire brigade arrival and entry to the development will occur via Broomfield Street which is understood to have at least 4.5 m width along this road for general fire appliance access, including room for firefighters to exit/work with equipment pursuant to FRNSW Guideline “Access for fire brigade vehicles and firefighters”. Tower B is the designated main entry for all three towers as it contains the Fire Control Room. After assessment of the fire location within the development, the brigade can relocate fire appliances to Tower C and A via Cabramatta Road East. It is proposed to provide mimic control panels in all towers to ensure fast response when first arriving at the entrance. For each tower, the hydrant and sprinkler booster are adjacent to the building entrance and thereby favourably supporting brigade operations. Refer to Figure 12 detailing the location and orientation of associated brigade services.

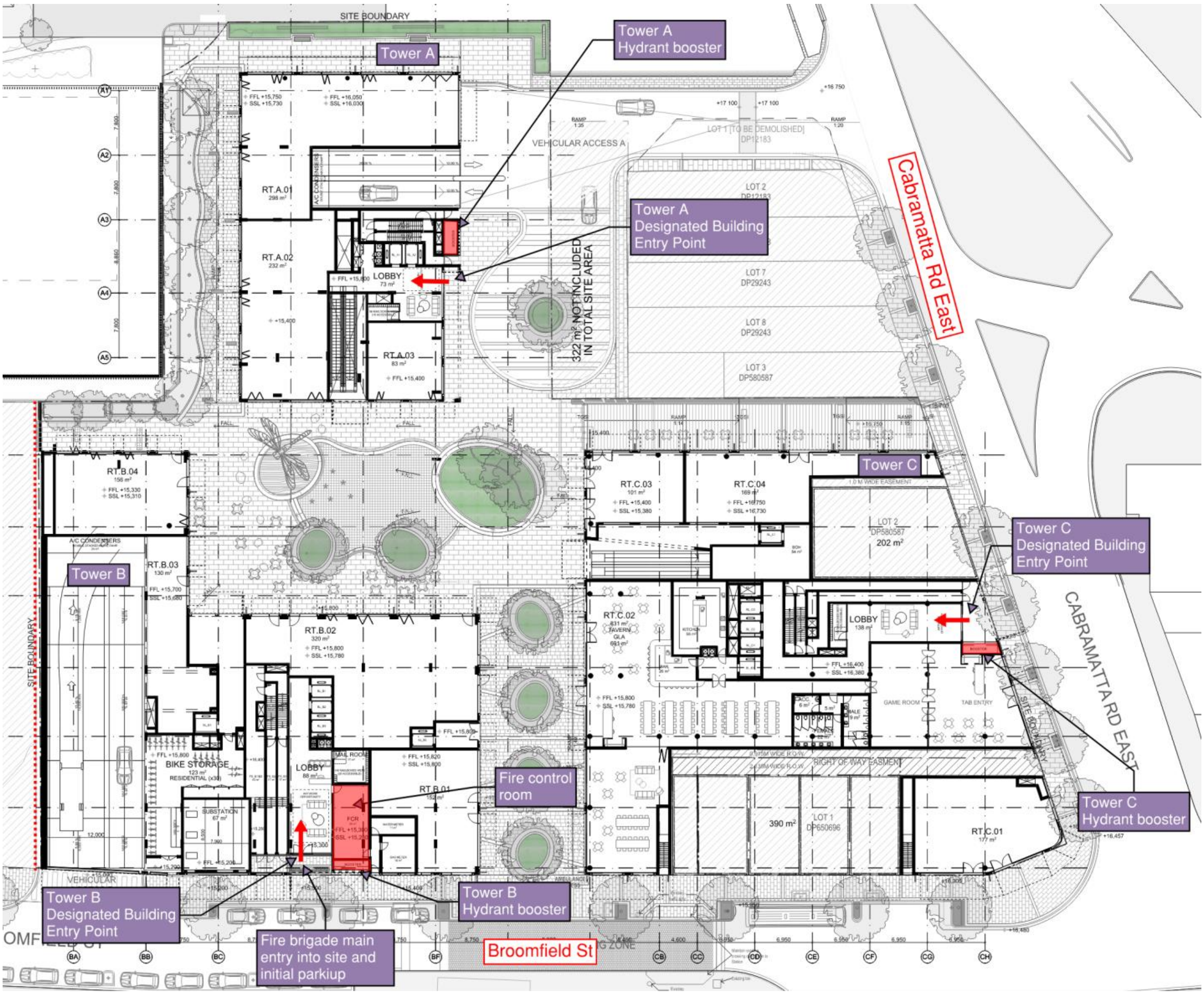

Figure 12 – Fire Brigade / Services Intervention

List key occupant characteristics for the building:

The characteristics of occupants and their corresponding interaction with the building environment, staff, queues and people around them is important when trying to understand the evacuation process. It is therefore necessary to consider the characteristics for the occupants that can be expected in the building when undertaking Fire Engineering Analysis, as highlighted in the IFEG [8]. The table below provides information on the expected condition of staff and occupants.

Table 1: Expected Staff and Occupant States

Occupant	State	Physical and mental attributes	Building familiarity and emergency training
Staff member (Retail and building management)	Conscious and sober	Able-bodied and mentally alert	Familiar with surroundings and appropriately fire safety trained to assist in occupant evacuation and first-aid firefighting.
Contractor (carrying out maintenance etc)	Conscious and sober	Able-bodied and mentally alert	Unamiliar with surroundings and appropriately fire safety trained. Follow building management plan and staff directions.
Childcare areas	Potentially asleep or conscious	Infants and children will not have the same physical mobility as adults and may require physical guidance and assistance during an emergency evacuation.	Not familiar with surroundings and no emergency training.
Residents	Potentially asleep or conscious	Able-bodied and mentally alert	Familiar with surroundings and able to self-evacuate or supervised by staff member to assist in evacuation.

Staff shall be provided with regular fire safety trainings sessions as part of the management strategy. These sessions shall discuss the evacuation procedures and highlight the actions to be taken in the event of an emergency. Periodic fire alarm testing shall be undertaken to check the systems and to familiarise staff with the evacuation signal.

Occupants are unlikely to be familiar with building. However, trained staff shall be able to provide patients and visitors with assistance to evacuate at the time of a fire incident.

5 Hazards

Outline any hazards unique to the building:

Building Applied Photovoltaic Panels (BAPV) are to line the roof of the subject development and is understood to form part of an alternative electrical generation system. Refer to Section 6.9 for additional fire safety measures pertinent to the intended BAPV system.

- ☐ Combustible external cladding
- ☑ Combustible waste (i.e. waste facility)
- ☑ Electricity supply system (e.g. substations)
- ☐ Battery system (e.g. BSS, BESS, ESS)
- ☑ Alternative electrical generation (e.g. solar, tri-gen)
- ☐ Electric vehicle charging
- ☐ Automatic storage and retrieval system (ASRS)
- ☐ Hazardous chemicals / dangerous goods (provide details)
- ☐ Other: (provide details)
- ☐ Insulated sandwich panels
- ☐ Podium type building
- ☑ A basement level
- ☐ An atrium (Part G3 of BCA)
- ☐ Car stacker
- ☐ Green wall

Note: Clauses E1.10 and E2.3 of the NCC should be addressed when special hazards exist (e.g. car stacker, hazardous chemicals/dangerous goods).

6 Preventative and protective measures

Identify fire safety measures that are, or will be, provided throughout the building, including anything undecided, which should be mentioned as part of the FEBQ review. Additional information may be added to the comments section below to better describe any systems or indicate systems that may be subject to a performance solution.

Suppression system

- ☐ CA16 (existing building)
- ☑ AS 2118.1-2017
- ☐ AS 2118.1-2006
- ☐ AS 2118.1-1999 (existing building)
- ☐ AS 2118.2-2021 (wall-wetting)
- ☐ AS 2118.2-2010 (wall-wetting)
- ☐ AS 2118.3-2010 (deluge)
- ☐ AS 2118.4-2012 (residential)
- ☐ AS 2118.5-2006 (domestic)
- ☑ AS 2118.6-2012 (combined)
- ☐ FPAA101D
- ☐ FPAA101H
- ☑ Fast response heads
- ☐ ESFR
- ☐ Storage mode sprinklers
- ☐ Gaseous suppression system
- ☐ Water mist system

Hydrant system

- ☑ AS 2419.1-2021
- ☐ AS 2419.1-2017
- ☐ AS 2419.1-2005
- ☐ AS 2419.1-1994 (existing building)
- ☐ Ordinance 70 (existing building)
- ☐ Dry fire hydrant system
- ☑ External hydrants
- ☑ Internal hydrants
- ☐ Street hydrant coverage only
- ☑ Hydrant booster assembly
- ☑ Pumpset

Firefighting equipment

- ☑ Portable fire extinguishers
- ☑ Fire hose reels

Detection system

- ☑ AS 3786:2014
- ☐ AS 3786-1993 (existing building)
- ☑ AS 1670.1:2018
- ☐ AS 1670.1:2015 (existing building)
- ☑ AS 1668.1:2015
- ☐ AS 1670.3-2018 (monitored)
- ☐ AS 1670.3-2004 (existing building)
- ☑ Smoke alarms
- ☑ Heat alarms
- ☑ Smoke detectors
- ☑ Heat detectors
- ☐ Flame detectors
- ☐ CO detectors
- ☑ Multi-criteria fire detectors
- ☐ Aspirated smoke detection
- ☐ Beam detection

Water supply

- ☑ Reticulated town main
- ☐ Private water main
- ☑ Onsite storage tank
- ☐ Gravity tank/reservoir
- ☐ Dual supply (sprinklers)
- ☐ Dual supply (hydrants)

Smoke hazard management

- ☐ Zone smoke control
- ☐ Purge system (existing building)
- ☐ Smoke and heat vents
- ☐ Smoke exhaust
- ☐ Smoke baffles
- ☐ Ridge vents
- ☐ Stair pressurisation
- ☑ Impulse / jet fans (in carpark)

Facilities for emergency services

- ☑ Emergency lifts
- ☐ Fire control centre
- ☑ Fire control room
- ☐ Perimeter vehicular access
- ☐ Standby power supply system

Occupant warning system

- ☐ Building occupant warning
- ☑ EWIS
- ☐ SSISEP
- ☐ Break glass unit
- ☐ Visual / tactile alarm devices

Signage

- ☑ Emergency lighting
- ☑ Exit and direction signs
- ☑ Warning and operational signs

Protection of openings

- ☑ Fire doors
- ☐ Smoke doors
- ☐ Solid core doors
- ☐ Fire windows
- ☐ Fire shutters
- ☐ Wall-wetting sprinklers
- ☐ Fire curtain
- ☐ Smoke curtain
- ☐ Safety curtain for openings
- ☑ Fire dampers
- ☐ Smoke dampers
- ☑ Fire seals (intumescent)
- ☑ Medium temp. smoke seals
- ☐ Fire collars
- ☐ Attenuation screens

Additional information:

6.1 Construction

6.1.1	The building elements within the nominated locations are to be rationalised as follows (subject to final design calculations): • Retail tenancies on ground floor and level 1 – 120 minutes in lieu of 180 minutes

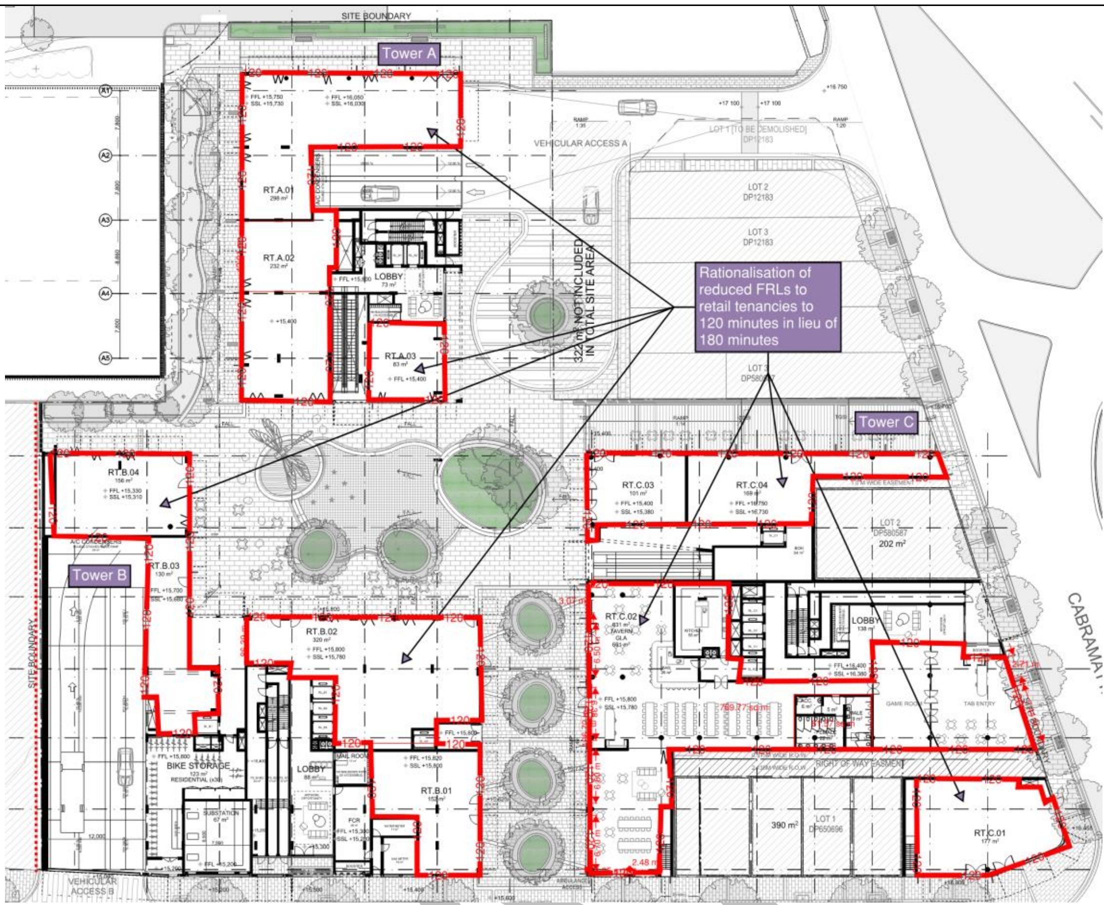

Figure 13: Rationalisation of reduced FRL – ground floor retail tenancies

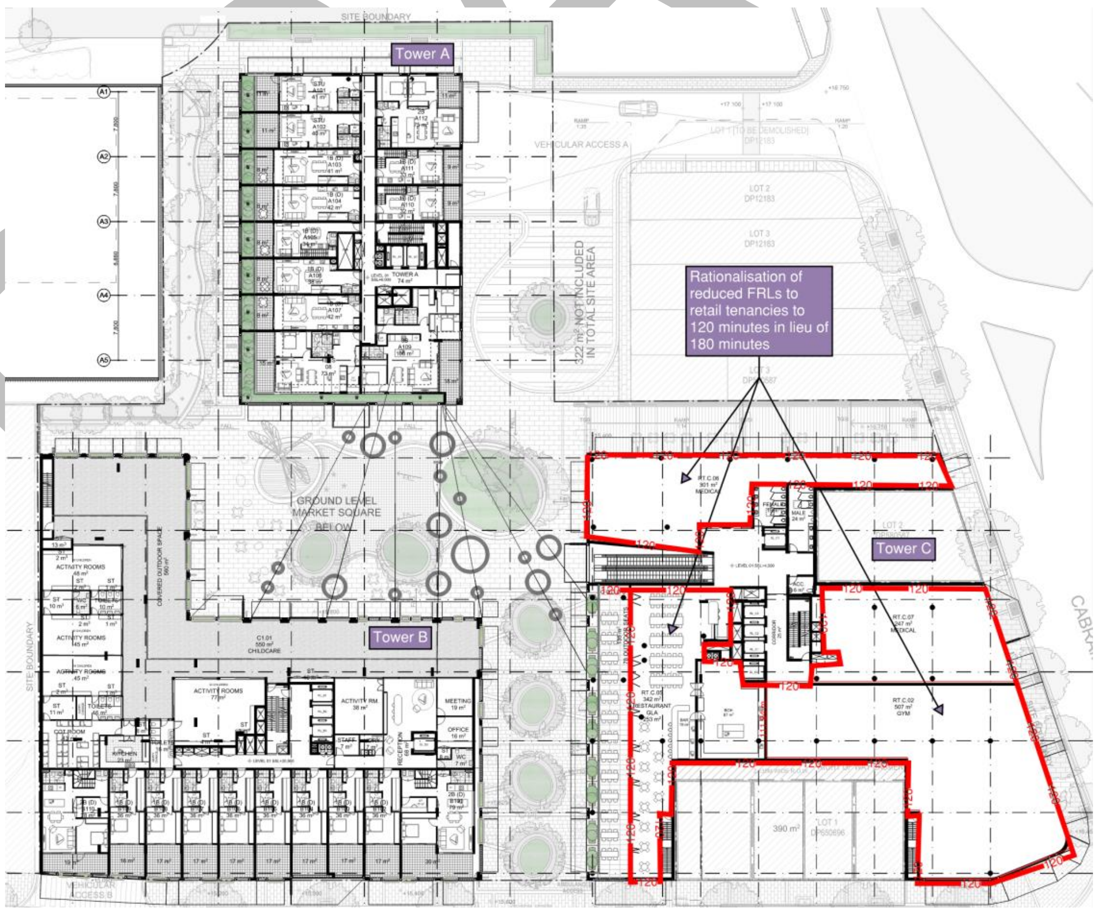

Figure 14: Rationalisation of reduced FRL – level 1 retail tenancies

6.1.2	The carpark level is fire separated from the retail portions above by construction achieving an FRL of 120/120/120.
6.1.3	The façade edge detail is permitted to be sealed on a performance basis. The performance-based slab edge to façade design shall be as follows: • Smoke flashing is to be permanently fixed from the slab edge to the façade wall. Smoke flashing is expected to be capable of withstanding 200˚C for 30 minutes. • The gap below the smoke flashing shall be packed with rockwool insultation. • Any gap unable to be packed with rockwool shall be sealed with intumescent mastic or fire rated sealant.
6.1.4	The FRL of the SOU wet areas and balcony areas may be reduced to a minimum FRL of 60/60/60 minutes in lieu of 90/90/90 minutes. This is only to be applied where the set down is above another Class 2 SOU. Where the set down is above a different classification such as those over the retail tenancies and childcare facilities, the BCA DtS FRL is to be achieved.
6.1.5	The combined hydrant and sprinkler system penetrations between the scissor stairs shall be fire and smoke sealed in accordance with Clause C3.15 of the BCA DtS Provisions.
6.1.6	The MSB & comms room shall be provided with 120/120/120 FRL enclosures required to form a fire rated box around the areas. The doors to these areas shall be self-closing fire doors (FRL -/120/30) and shall be fitted with fire and medium temperature smoke seals.
6.1.7	All doors connecting the SOUs to the public corridor with extended travel distances are to be fitted with medium temperature smoke seals.
6.1.8	All doorways which open into or otherwise provide access for the fire isolated discharge paths shall achieve an FRL of not less than -/60/30 and shall be provided with medium-temperature smoke seals.
6.1.9	All doorways from the fire isolated discharge paths shall be unlocked from the inside of the passageway, so that occupants are capable of re-entering the building.
6.1.10	The electrical conduits cast-in floor slabs shall be fire stopped on the riser side using fire-resistant sealant as per the manufacturer's guidelines
6.1.11	Roller shutters serving the carpark shall be connected to essential backup (e.g. local battery) such that on power failure to the building, the operation of the roller shutter is not impacted
6.1.12	The basement level shall incorporate lobbies surrounding lift shaft which are adjacent to carparking areas to reduce the risk of smoke spreading from a vehicle fire to the residential floors.
6.1.13	As part of the protection openings to the allotment boundary, the following openings are to be protected based on the mode of operation (subject to final design): ▪ For Fixed Openings – minimum 6 mm toughened glazing shall be installed; or ▪ For Operable Openings – fire attenuation screens and the like. The system shall: – Installed strictly in accordance with the test report provided by a National Association of Testing Authorities (NATA) accredited testing laboratory. – Labelling and maintenance requirements must conform with the relevant manufacturer's specification.

6.2 Suppression

6.2.1	An automatic fire suppression system is required to be installed within the building in accordance with AS 2118.6-2012, except where modified by this report. The sprinkler control valve assemblies for each level shall all be located within a single fire stair
6.2.2	A sprinkler system shall be provided throughout the building in accordance with AS2118.1-2017, and shall comprise fast response sprinkler heads with an RTI not exceeding 50 $(m \cdot s)^{1/2}$ in the following locations: • Basement level 1-3
6.2.3	Sprinkler heads are not required in the following locations: • Comms rooms • MSB
6.2.4	Tyco WS drencher system to be installed on fixed windows and glazed doors in accordance with data sheets in the following locations: • Basement level 1 and 2 retail lobby

6.3 Detection

6.3.1	Smoke alarms and detectors shall be installed accordance with the BCA DtS Provisions, AS3786-2014 and AS1670.1-2018 respectively as required. The detector spacing is required to be reduced to rationalised extended travel distances subject to detailed analysis (6x6 spacing is proposed) in the following locations: • Ground floor retail tenancies in tower A, B and C • Level 1 retail tenancies in tower C • Level 1 childcare and offices in tower B
6.3.2	Smoke detectors shall be installed in the MSB and comms room in which sprinklers are proposed to be omitted.
6.3.3	Multi-criteria detectors are to be installed within SOU's on with extended travel distances with the following specifications: ▪ Detection of smoke only will activate local alarm within the SOU only. ▪ Detection of heat rate of rise of no more than 10°C per minute by a multi-criteria detector is required to activate the EWIS and trigger immediate alert/evacuation tones and immediate occupant evacuation. Activation of the sprinkler system is to activate the EWIS and trigger immediate evacuation tones and initiate occupant evacuation.

6.4 Alarm

6.4.1	An Emergency warning and Intercom System (EWIS) system is required to be installed in accordance with AS1670.4-2018, except that: ▪ The dB levels within the balcony and wet areas/laundries shall not achieve full sound pressure. It is proposed to reduce these requirements from 75 db to being audible. The design criteria for audibility is based on the speaker predicted sound levels not being less than 10dB(A) below the background noise level. ▪ Speech intelligibility is not capable of being achieved within the basement carpark due to the nature of the space. It is proposed to provide Visual Alarm Devices (VADs) in order to visually alert occupants of the need to evacuate via strobes – in addition to the standard alarm tones.

6.5 Smoke Hazard Management

6.5.1	Zone smoke control in the following areas will be omitted: • Ground floor tower A – retail tenancies RT.A.01, RT.A.02, RT.A.03 • Ground floor tower B – retail tenancies RT.B.01, RT.B.02, RT.B.03, RT.B.04

	• Ground floor tower C – retail tenancies RT.C.01, RT.C.02, RT.C.03, RT.C.04

6.6 Hydrant System

6.6.1	A fire hydrant system shall be installed in accordance with AS 2118.6 – 2012 and AS 2419.1 – 2021, except as otherwise altered within this report.
6.6.2	Block plans are required to be installed at key locations e.g., at the FIP and mimic panels directing FRNSW members to key services on site.
6.6.3	A strobe light shall be provided at the booster assembly location to allow FRNSW to locate the service upon arrival.
6.6.4	Additional information shall be available at the FIP for wayfinding once FRNSW arrive to site.
6.6.5	Hydrant enclosure roller shutters shall be able to be opened manually under a force of not more than 110 N.

6.7 Emergency Lifts

6.7.1	Emergency lifts are required to be installed in the building in accordance with Clause E3.4 of the BCA.

6.8 Fire Hose Reel

6.8.1	Fire hose reels are required to be installed in the building in accordance with AS2441 – 2005 except where varied by the report.

6.9 Portable Fire Extinguisher

6.9.1	Portable fire extinguishers are required to be installed in the building in accordance with AS2444 – 2001.

6.10 Emergency Lighting and Exit Signage

6.10.1	Emergency Lighting and exit signs are required to be installed within the building in accordance with AS2293.1 – 2018.
6.10.2	Emergency Evacuation plans are to be provided in accordance with AS3745 – 2002.
6.10.3	Emergency exit signage shall be installed within the building in accordance with BCA DtS Clauses E4.5, E4.6, E4.8 and AS2293.1-2018.
6.10.4	Intelligent signage is to be provided to the fire isolated exits as detailed within the report, to direct occupants away from compromised discharge areas.
6.10.5	Additional directional exit signage is required within the central fire stairs, on the level of convergence between the rising and descending stairs, as well as on the mid landings above and below, as detailed below.

6.11 Solar Panels

6.11.1	Signage must be clearly displayed at the FIP identifying the presence and location of the alternative electrical generation system.
6.11.2	A block plan showing the location of all associated isolation switches, AC and DC isolators for the shut-off of generated electricity should be displayed at the FIP
6.11.3	If the alternative electrical generation system automatically isolates on fire trip, signage should be provided at the FIP detailing this provision that can clearly be identified by firefighters.

6.12 Maintenance and Management in Use

6.12.1	The following management requirements are placed on the eventual building owners and operators and are to be included in any management documentation.
6.12.2	Regular evacuation drills are to be conducted annually (minimum) within the building.

6.12.3	General housekeeping must be undertaken to maintain egress paths and ensure exits are operable to allow unobstructed travel.
6.12.4	A no smoking policy is to be implemented in all public areas.
6.12.5	The following maintenance requirements are to be placed on the eventual building managers.
6.12.6	Where services are modified as part of a performance solution, these must be included in the maintenance and annual certification.
6.12.7	Maintenance on all active Fire Safety Systems is to be in accordance with the relevant AS1851-2012 section.
6.12.8	Evacuation diagrams are to be provided in accordance with AS3745-2010.
6.12.9	A safety induction shall be provided for all maintenance personnel accessing the roof levels to make them aware and familiar with exits on these roof levels.
6.12.10	Signage shall be placed between the exits stating "DO NOT STORE MATERIALS IN CORRIDOR" with lettering to be at least 15 mm high, of a colour contrasting the background and fitted at 1.75m above floor level.
6.12.11	Signage shall be provided within the fire isolated passageways, which indicate which level occupants are currently on. This shall be further support by intelligent signage to convey is the discharge point of the exit has been compromised or not, giving occupants an alternative egress path within the fire stair as an improvement to the DtS requirements. The signage shall incorporate information related to the occupants position in the building, using signage on a contrasting background with lettering not less than 15 mm in size.
6.12.12	The retail lobby entry area on basement level 1 and 2 shall include management in use procedures to maintain a sterile region in proximity of the path of travel of occupants.

7 Departures from the Deemed-to-Satisfy provisions

Issue number: 1 **Title:** Rationalisation of FRL

Details of departures from DtS provisions:

The proposed reduction in FRLs have been tabulated below.

Table 2: FRL Reduction retail tenancies

AREA	BCA DTS FRL	PROPOSED FRL
Retail Ground floor – Tower A, B and C	180	120
Retail Level 1 – Tower C	180	120

Applicable DtS provisions (including clause excerpt):	Spec 5, C2D2, C3D8, C3D9, C3D10 *(BCA 2019 Spec C1.1, C1.1, C2.7, C2.8, C2.9)*	Applicable Performance Requirements:	C1P1, C1P2 *(BCA 2019 CP1, CP2)*

List key fire safety measures:

The building shall be sprinkler protected throughout in accordance with AS2118.1-2017.

Proposed performance solution:

BCA Intent

BCA Clause C2D2 and Specification 5 outline the minimum fire-resisting construction requirements for the various building elements.

BCA Clause C3D8 sets out the requirements for the construction of a firewall. These are to be in accordance with BCA Specification 5. The BCA Guide to this clause explains that buildings separated by a fire wall may be considered as a fire compartment or be regarded as separate buildings.

BCA Clause C3D9 sets out the requirements for fire separation of multiple classes located within the same storey. The Clause outlines the requirement for the higher FRL classification to be applied along the bounding construction separating different classes within the same storey. This is to minimize the risk of a fire in one classification on a storey causing the failure of building elements in another classification on the same storey. Clause C3D10 outlines the requirements in a similar way for the separation of classifications in different storeys.

Performance Requirement C1P1 states a building must have elements which will, to the degree necessary, maintain structural stability during a fire appropriate to the function or use of the building, the fire load, the potential fire intensity, the fire hazard, the height of the building, its proximity to other property any active fire safety systems installed in the building, the size of any fire compartment, fire brigade intervention, other elements they support and the evacuation time.

Performance Requirement C1P2 states a building must have elements that will, to the degree necessary, avoid the spread of fire. It should be noted that the Performance Requirements do not make reference of specific minimum fire resistance levels as being the performance requirement.

Analysis

This section contains the analysis used to validate that the proposed reduction in FRLs satisfies the relevant Performance Requirements.

In the event of fire in sprinkler protected areas, it is expected that the sprinkler system will activate and prevent fire growth and spread. In the unlikely event that the sprinkler system fails to operate in a fire scenario which originates in a compartment with reduced FRLs, then it is credible that the fire could grow and pose a risk of fire spread beyond the compartment.

The building shall be provided with an Automatic Fire Suppression System accordance with BCA Specification 17 and AS 2118.1 – 2017 Amdt 1, AS 2118.6-2012 (Combined Sprinkler & Hydrant).

The effectiveness of automatic fire sprinklers in limiting fire spread and growth is supported by studies undertaken into the effects of automatic fire sprinklers within buildings. These studies show that fire sprinkler systems operate and control fires in 81% to 99.5% of fire occurrences. The lower reliability estimates of 81.3% as well as some of the higher values of 87.6% appear to reflect significant bias in data in terms of small number of fire incidents and the lack of differentiation between fire sprinklers and other fire suppression systems. A number of the lower figures are results of dated studies.

It must be noted that the higher reliability of fire sprinklers reported of 99.5% reflect fire sprinkler systems where inspections, testing and maintenance exceeded normal expectations and applies to installations specifically in Australia and New Zealand. The statistical data from the paper titled “US Experience with Sprinklers” indicates that sprinklers with appropriate maintenance are highly effective in reducing the loss of life and limiting fire spread. The research demonstrates that the proposed automatic fire sprinkler system provides a high level of reliability in operation. The sprinkler system can reasonably be expected to operate in more than 96% of occasions.

The sprinkler system is expected to prevent a severe fire from occurring and possibly eliminate the risk of exposing the occupants and fire brigade to high temperatures and high levels of toxicity within the building. The sprinkler system will be connected to the Fire Indicator Panel (FIP). The fire safety system would also ensure early occupant and fire brigade notification.

The retail tenancies FRL reduction to 120 minutes will be calculated using the Time Equivalency methods. The time equivalence formula is defined as the time of exposure to the standard fire resistance test that would result in the same thermal impact as a complete burnout of the compartment in a real fire. Assemblies that are provided with a fire resistance equal to, or greater than, the equivalent structural fire severity, are generally expected to be able to withstand a complete burnout of the compartment. Therefore, the minimum Fire Resistance Levels (FRLs) that would be expected to withstand a full burnout of the considered compartment will be determined based on the result of the calculations. These calculations will ensure that a complete burn out of a fire compartment will not exceed the fire resisting ability of the bounding construction.

Several techniques exist for calculating the equivalent period of fire exposure, which includes include Patterson, Harmathy, Law, DIN 18230, CIB W14 and Eurocode 1. Although based upon experimental studies, Patterson, Harmathy and Law techniques have been found to be limited either in their ease of use or scope of application. Additionally, DIN 18230, CIB W14 and Eurocode are similar in their approach, differing only in the treatment of the individual parameters. The Eurocode is seen as the evolution of the DIN 1820 and CIB W14 approaches and the is the most applicable method of analysis.

Therefore, it is proposed to use the approach in the Eurocode 1, CIB and Law, when utilising the Time Equivalent Method. The Eurocode assessment considers multiple scenarios including 90% fractile Fire Load Energy Density (FLED), sprinkler failure, 75% glazing failure and 50% glazing failure. The worst-case results of all sensitivity cases investigated will be used to determine the required FRL.

Figure 15 and Figure 16 contain the markups of the relevant locations analysed. All retail tenancies are to be considered within the building. However typical compartments were selected with conservative input parameters to ensure the worst-case scenarios have been assessed. The worst-case scenario chosen are listed in Table 3 and the corresponding FLED values used in the analysis, these compartments exhibit minimal openings which would provide ventilation of a fire. The FLED values are derived from Tables 3.4.1a and 3.4.1b of the IFEG. Where multiple uses exist within the same compartment the fuel load of the different areas is averaged based on their relative floor areas. In calculating the 90% fractile FLED, the IFEG methodology is utilised whereby for a well defined area, the 90% percentile is 1.65 times the average FLED value.

Table 3: Retail tenancies – Reduced FRL Scenarios

SCENARIO	LOCATION	FLED (MJ/m^2)	90TH PERCENTILE FLED (MJ/m^2)	REFERENCE
1	Ground floor, tower A – room RT.A.02	600 (Shops)	1100	IFEG Table 3.4.1b
2	Ground floor, tower B – room RT.B.02	600 (Shops)	1100	IFEG Table 3.4.1b
3	Ground floor, tower C – room RT.C.02	600 (Shops)	1100	IFEG Table 3.4.1b
4	Level 1, tower C – room RT.C.08	600 (Shops)	1100	IFEG Table 3.4.1b

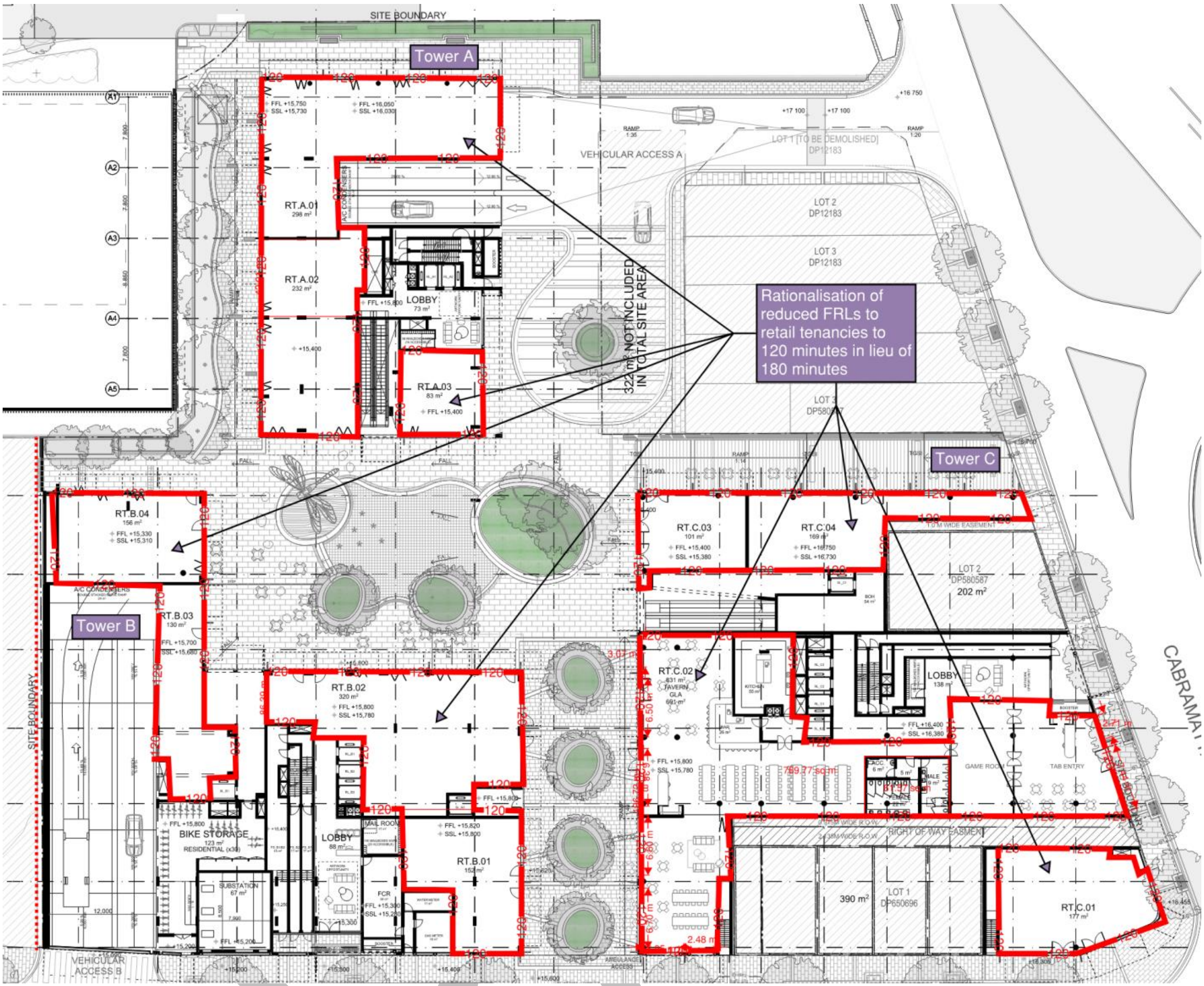

Figure 15: Rationalisation of reduced FRL to 120 minutes – ground floor retail tenancies

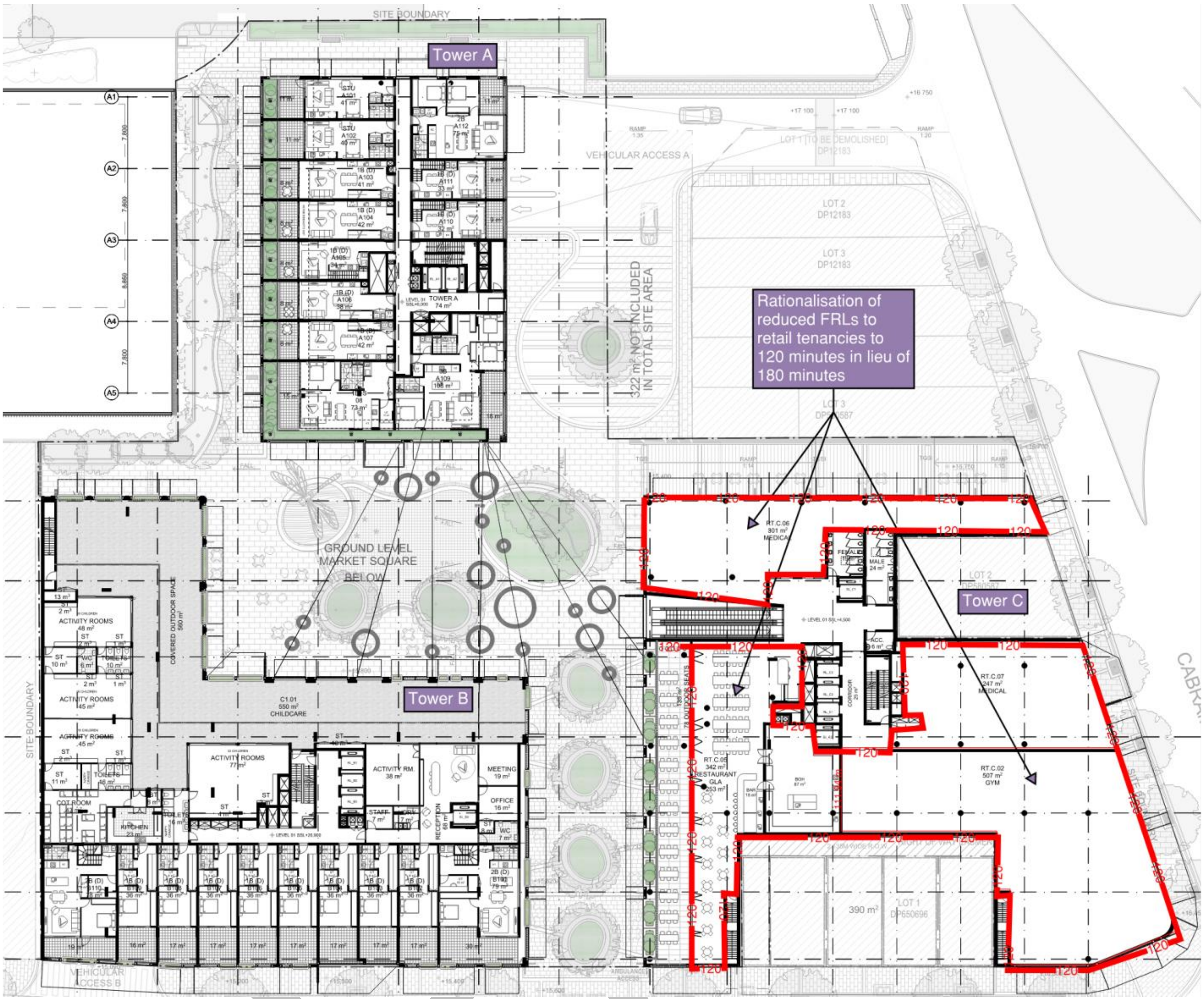

Figure 16: Rationalisation of reduced FRL to 120 minutes – level 1 retail tenancies

Table 4 shows the considered scenarios, as well as the input parameters used in the assessment. The occupancy type is an indicator of the risk of fire activation.

Table 4: Time Equivalence Input Parameters – retail tenancies

INPUT PARAMETER		SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4
Height of fire cell (m)	H	3.15	3.15	3.15	3.15
Floor area (m^2)	A_f	232	320	770	507
Vertical openings Area (m^2)	A_v	83.475	96.71	144.49	102.94
Horizontal openings Area (m^2)	A_h	0	0	0	0
Wall Perimeter Length (m)	m	68	86	197	112
Opening Height (m)	Hv	3.15	3.15	3.15	3.15
Fuel Load Density (MJ/m^2)	Q_f	600	600	600	600
Compartment Lining Factor	k_b	Gypsum	Gypsum	Gypsum	Gypsum
Heat of Combustion (MJ/kg)	ΔH_c	20	20	20	20
Sprinkler Protection		Yes	Yes	Yes	Yes

As part of the analysis, a 90% Fractile FLED is considered, accounting for a situation where a higher amount of combustible material is stored in the area than anticipated.

Furthermore, the glazing failure scenarios consider events where not all the openings within the fire compartment fail. A 75% and 50% glazing failure scenario has been considered as part of this assessment. The sprinklers within the compartment are likely to suppress if not extinguish the fire. The scenario that presents the highest risk of the FRL failing is one in which the sprinkler system fails to operate. In the event that the sprinkler system fails, the temperature of the compartment will lead to the failure of a majority of the glazing.

Temperatures within a compartment that is exposed to conditions similar to the standard fire curve, able to cause failure of the fire rated elements, reaches a temperature of approximately 945°C at 60 minutes. This temperature will lead to the failure of much higher than 25% of the glazing, as justified by the above-mentioned studies. Finally, the Eurocode does not require the use of the glazing failure scenarios in order to justify the suitability of an FRL for a compartment using the time equivalence method. The glazing failure scenario is considered to be above and beyond the requirements of bodies that advocate the TE method.

The building is to be provided with a sprinkler system throughout. In the event of a fire the sprinkler system is expected to control, if not suppress the fire. The sprinkler system acts to cool the upper smoke layer and wet adjacent combustibles and partitions helping to prevent the fire from spreading beyond the area of origin.

Where the sprinkler system operates successfully the fire resistance of building elements is largely irrelevant as the fire is not expected to grow large enough to compromise the structural integrity of the building. In this regard it is noted that the efficacy of sprinklers is recognised in the [C/VM2], which permits a 50 % reduction in FRL if sprinklers are installed, and in the UK ([PD6688-1-2] & [Eurocode 1]) which permits a reduction of 39 %. From this it is concluded that a reduction factor in FRL of 0.5 to 0.61 is internationally accepted if sprinklers are installed. This reflects the very low probability of a very high Fire Load Energy Density (FLED) at the same time that the sprinkler system fails.

Table 5 contains the results obtained from the Time Equivalence assessment calculations.

Table 5: Time Equivalence Results – retail tenancies

RESULTS TABLE		SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4
Proposed FRL		120	120	120	120
Eurocode	t_e	25	31	38	36
X.1 - 90 % Fractile FLED	t_e	41	52	63	59
X.2 - Sprinkler Failure	t_e	41	52	62	59
X.3 - 75% Glazing Failure	t_e	25	33	49	45
X. 4 - 50% Glazing Failure	t_e	31	46	67	63
CIB Formula	t_e	40	44	56	55
Law Formula	t_e	31	34	43	42
Pass/Fail		**Pass**	**Pass**	**Pass**	**Pass**

The table above demonstrates that the proposed FRLs in each scenario assessed would be suitable to withstand a complete burnout of the compartment, according to all three methods of calculation. The results demonstrate the proposed FRLs are more than adequate when considering the 90% fractile FLED. Multiple sensitivity studies have been conducted in the calculations above, including increased fuel loads, sprinkler failure and glazing failure to ensure that the results can be considered robust. By successfully passing these sensitivity studies, the results demonstrate robustness for 90% of the possible compartment configurations.

Conclusion

From the quantitative analysis undertaken above, it has been demonstrated that the nominated FRLs would be expected to withstand a full burnout of the compartment after an FRL reduction. Consequently, it is considered that BCA Performance Requirements C1P1 and C1P2 have been satisfied in terms of the BCA DtS non-compliances assessed.

Performance solution:

☑ A2.2(1)(a) - Comply with all relevant performance requirements

☐ A2.2(1)(b) - Be at least equivalent to the DtS provisions

Assessment methods:

- ☐ A2.2(2)(a) - Evidence of suitability
- ☑ A2.2(2)(b)(i) - Verification methods provided in the NCC
- ☑ A2.2(2)(b)(ii) - Other verification methods accepted by the appropriate authority
- ☐ A2.2(2)(c) - Expert judgement
- ☑ A2.2(2)(d) - Comparison with the DtS provisions

Assessment approach:

☐ Comparative	☑ Qualitative	☑ Deterministic
☑ Absolute	☑ Quantitative	☐ Probabilistic

IFEG sub-systems used in the analysis:

☑ A – Fire initiation and development and control	☑ D – Fire detection, warning and suppression
☑ B – Smoke development and spread and control	☑ E – Occupant evacuation and control
☑ C – Fire spread and impact and control	☐ F – Fire services intervention

Acceptance criteria and factor of safety:

The proposed FRLs shall be capable of withstanding a full burnout of the compartment based on the expected fire severity.

Fire scenarios and design fire parameters:

Assessment considers a fire in the subject compartments with reduced FRLs.

Describe how fire brigade intervention will be addressed or considered:

The fire severity calculations have demonstrated that the reduction in FRLs will maintain the integrity of the subject fire compartment. It is expected that the bounding construction will be able to contain that fire for an appropriate time where by the fire brigade are able to arrive on site and begin intervention and fight the fire if it is not extinguished by the sprinklers.

Verification/validation analyses:

☑ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☐ None

Provide details on proposed modelling/assessment tools:

N/A

Issue number: 2 **Title:** Fire separation of carparks and retail lobby

Details of departures from DtS provisions:

The construction separating the retail lobby and carpark on basement level 1 and 2 are proposed to be drenched glazed in lieu of fire rated construction. The locations are shown in Figure 17 and Figure 18.

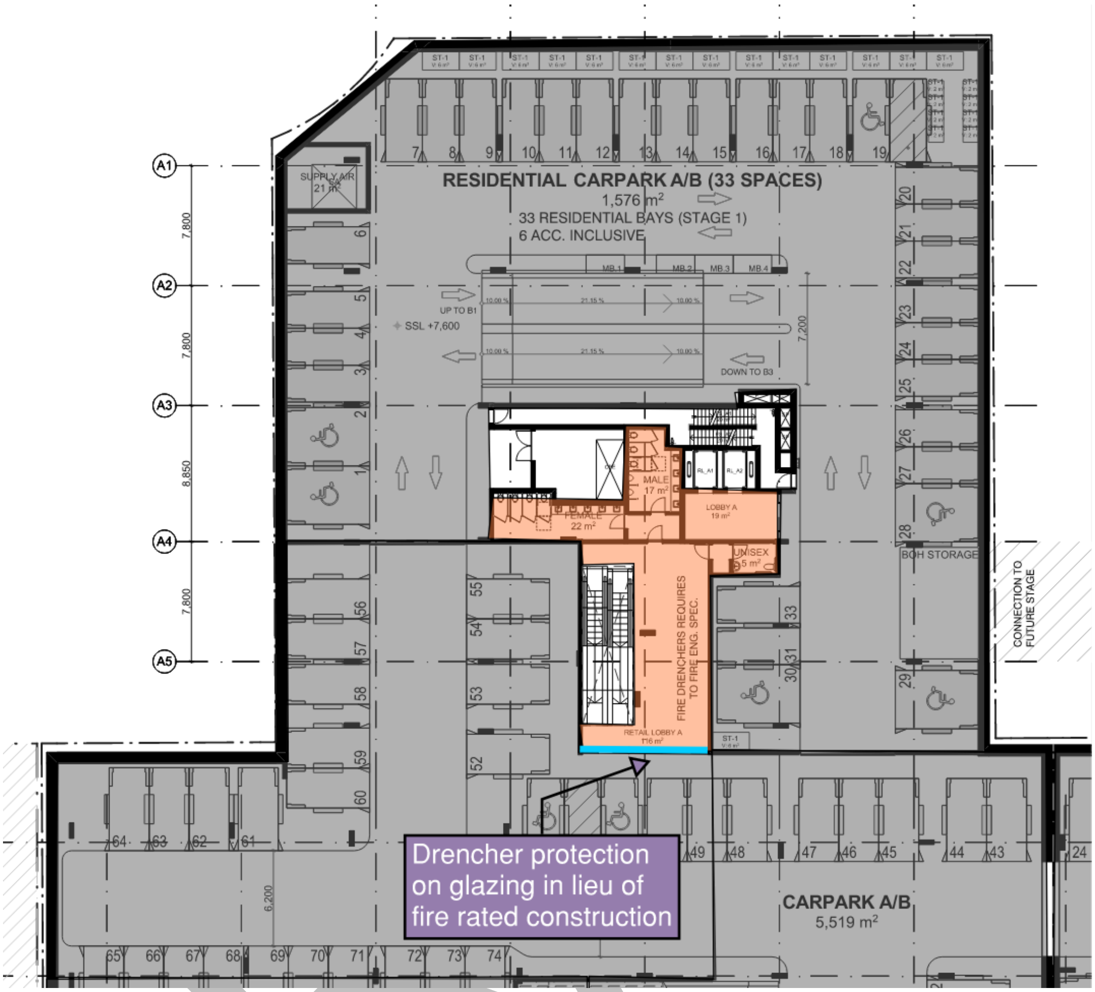

Figure 17: Separation of retail lobby and carpark – basement 2

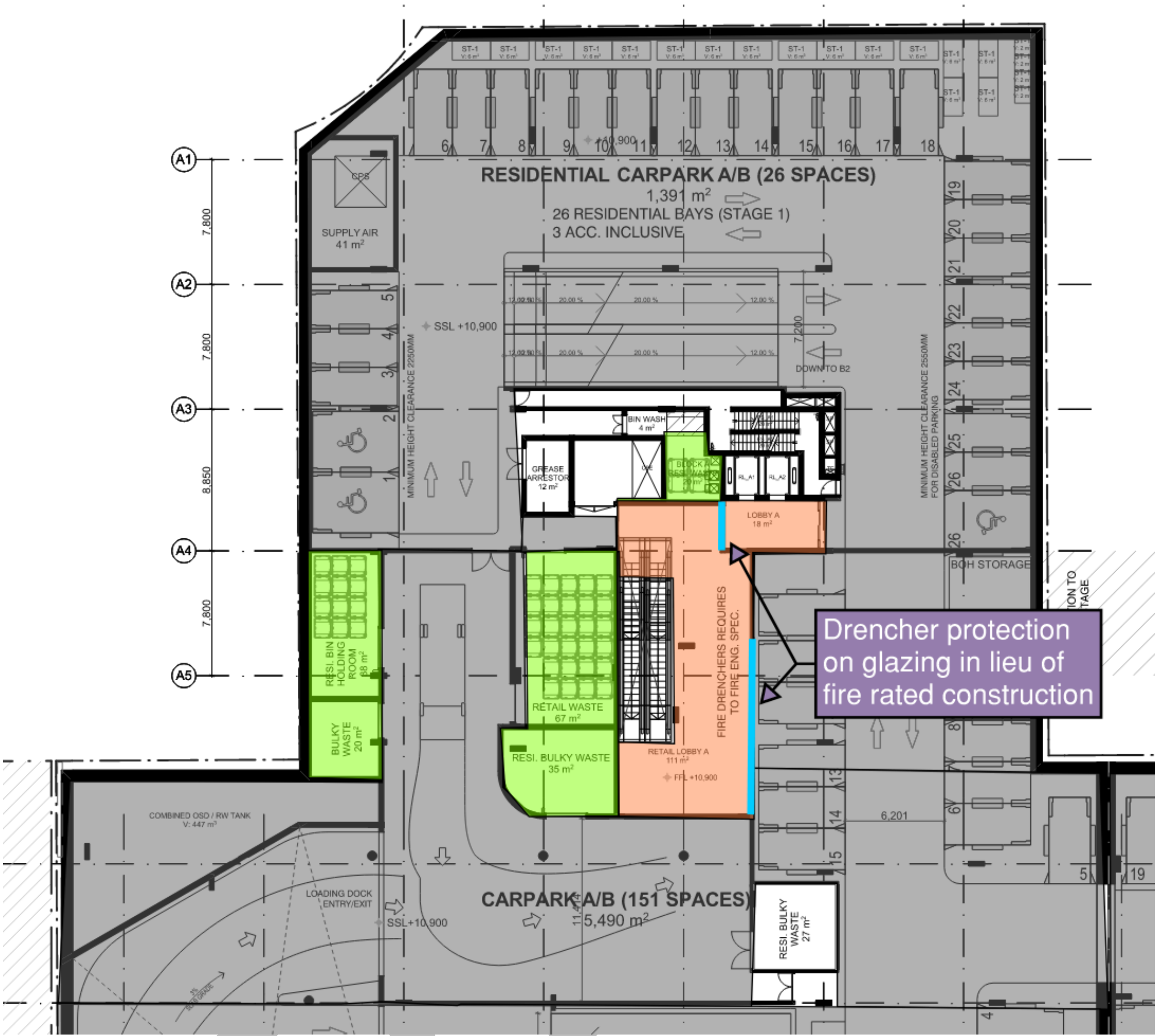

Figure 18: Separation of retail lobby and carpark – basement 1

Applicable DtS provisions (including clause excerpt):	Spec 5, C2D2, C3D8, C3D9 *(BCA 2019 Spec C1.1, C1.1, C2.7, C2.8)*	Applicable Performance Requirements:	C1P1, C1P2 *(BCA 2019 CP1, CP2)*

List key fire safety measures:

- An automatic fire suppression system is to be installed in conformance with BCA Spec 17 and AS 2118.1 – 2017 and AS 2118.6 - 2012.
- Fast response sprinkler heads are required throughout the basement levels.
- An automatic fire detection and alarm system is to be installed in conformance with AS 1670.1 – 2018.
- Tyco WS drencher system to fixed windows and glazed doors in accordance with data sheets
- Toughened 6 mm glazing with metallic or frameless construction.
- Push button activation of the glazed doors in fire mode or a glazed breakout door.
- Detectors compliant with AS1670.1 to be provided in front of the automatically closing glazed doors.

Proposed performance solution:

BCA Intent

BCA Clause C2D2 and Specification 5 outline the minimum fire-resisting construction requirements for the various building elements.

BCA Clause C3D8 sets out the requirements for the construction of a firewall. These are to be in accordance with BCA Specification 5. The BCA Guide to this clause explains that buildings separated by a fire wall may be considered as a fire compartment or be regarded as separate buildings.

BCA Clause C3D9 sets out the requirements for fire separation of multiple classes located within the same storey. The Clause outlines the requirement for the higher FRL classification to be applied along the bounding construction separating different classes within the same storey. This is to minimize the risk of a fire in one classification on a storey causing the failure of building elements in another classification on the same storey.

Performance Requirement C1P1 states a building must have elements which will, to the degree necessary, maintain structural stability during a fire appropriate to the function or use of the building, the fire load, the potential fire intensity, the fire hazard, the height of the building, its proximity to other property any active fire safety systems installed in the building, the size of any fire compartment, fire brigade intervention, other elements they support and the evacuation time.

Performance Requirement C1P2 states a building must have elements that will, to the degree necessary, avoid the spread of fire. It should be noted that the Performance Requirements do not make reference of specific minimum fire resistance levels as being the performance requirement.

Analysis

It is proposed that the retail lobbies serving the basement level 1 and 2 be separated from the car park through glazed construction only and as such not meet the requirements of C2D2 and C3D9. Where the glazed construction can be seen as a single large opening, it is not proposed to comply with the requirements of C3D8. The retail lobbies contain escalators which egress to an open area on the ground floor of tower A.

The risk associated with the removal of fire rated construction is that smoke and fire may spread between the two adjacent compartments allowing fire to spread that may hinder fire brigade intervention.

Drenchers will be provided with AS 2118.2 compliant water supply from the site's fire pump. This supply pipework is to be individually valved from the hydrant system supply, to enable the drenchers to be isolated while the hydrant system is still in operation. Pressures and flows supplied to the drencher heads shall be as per the Tyco WS sprinkler head spec sheets. The location of the isolation valves and the wall wetting sprinklers shall be shown on all building block plans. Furthermore, the lobby entry area shall include management in use procedures to maintain a sterile region in proximity of the path of travel of occupants.

<u>Floor Layout</u>

The BCA specifies 120-minute ratings for carparks, although retail requires 180 minutes, the lobbies within the basements make up less than 10% of the floor area. In the proposed design, the lobby is connected directly to the car park as shown in the figures above. The intent is that the visitors to the retail tenancies and parking would be via the car park, from where occupants would enter the lobby and travel up the escalators to the ground floor. Given this arrangement and the lack of functional space in the retail lobby it is considered that the lobby is for circulation only containing a minimal fuel load. As the ground floor is open to external air it would not be expected that significant levels of smoke and heat from the fire load above will travel downward to where the drenched glazing is proposed on the Class 6 side. It is more feasible that the glazing will be exposed to fire risk from the carpark side, as such providing protection in accordance with a 120-minute rating to the lobby area is appropriate.

Additionally, there is no concession for a reduction in FRL's with the provision of sprinklers to the carpark which would heavily supress and contain a fire on all levels.

Given the above, it is only proposed to protect the carpark side of the glazing with drenchers that can provide adequate protection for 120 minutes.

<u>Compartmentation</u>

Drenched glazing will be used to provide sufficient compartmentation, meeting the life safety objectives. Drenchers are expected to be activated well after the escape period and maintain separation between the two compartments. Toughened 6 mm glazing with TYCO WS Drenchers can provide a mechanical equivalent rating of up to 120 minutes.

Drenching of the glazing will protect occupants who may be egressing past the glazing from the effects of excessive radiant heat exposure. According to Richardson and Oleszkiewicz, windows protected with automatic sprinklers can achieve radiant heat attenuation of up to 90%. A similar level of radiant heat attenuation was achieved by Moulen and Grubits in tests undertaken by the Australian Department of Housing and Construction in 1975.

<u>Quantitative – Drencher activation</u>

The number of drencher heads active, water consumption and the required water quantity necessary can be addressed in the FER using CFD analysis, being sufficient to provide protection equal to that of DtS compliant construction.

Performance solution:

☑ A2.2(1)(a) - Comply with all relevant performance requirements
☐ A2.2(1)(b) - Be at least equivalent to the DtS provisions

Assessment methods:

☐ A2.2(2)(a) - Evidence of suitability
☐ A2.2(2)(b)(i) - Verification methods provided in the NCC
☑ A2.2(2)(b)(ii) - Other verification methods accepted by the appropriate authority
☐ A2.2(2)(c) - Expert judgement
☑ A2.2(2)(d) - Comparison with the DtS provisions

Assessment approach:

☑ Comparative ☑ Qualitative ☑ Deterministic
☑ Absolute ☑ Quantitative ☐ Probabilistic

IFEG sub-systems used in the analysis:

☐ A – Fire initiation and development and control
☐ B – Smoke development and spread and control
☑ C – Fire spread and impact and control
☐ D – Fire detection, warning and suppression
☐ E – Occupant evacuation and control
☐ F – Fire services intervention

Acceptance criteria and factor of safety:

The performance solution will be said to have met the acceptance criteria if it can be shown that the glazing elements could be expected to survive complete burn out of a fire while maintaining the FRL proposed and provide adequate separation between the two compartments.

Fire scenarios and design fire parameters:

Refer to CFD/Zone Modelling if required.

Describe how fire brigade intervention will be addressed or considered:

Fire brigade members should not be exposed to any additional risk given that glazing elements could be expected to survive complete burn out of a fire, while maintaining, integrity and insulation for the FRL proposed.

Verification/validation analyses:

☑ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☐ None

Provide details on proposed modelling/assessment tools:

Refer to CFD/Zone Modelling if required.

Issue number: 3 **Title:** Discharge onto basement roof as an open space

Details of departures from DtS provisions:

Egress from the residential levels of tower A discharge onto the carpark roof (basement 1), where the roof is considered open space. The pathways along this open space require occupants to pass within 3 m of unprotected openings or service penetrations in the carpark roof.

Applicable DtS provisions (including clause excerpt):	Spec 5, D3D13 *(BCA 2019 Spec C1.1, D2.12)*	Applicable Performance Requirements:	C1P2, D1P4, D1P5 *(BCA 2019 CP2, DP4, DP5)*

List key fire safety measures:

The building shall be protected throughout with automatic fire suppression system (AS 2118.1 – 2017) with fast response heads, except as otherwise denoted in this report.

The building shall be protected throughout with an automatic fire detection and alarm system (AS 1670.1 – 2018) except as otherwise denoted in this report.

The building shall be protected by both internal and external fire hydrants for use by FRNSW in the event of an emergency.

A combination of Fire Hose Reels and Portable Fire Extinguishers shall be provided to facilitate first instance firefighting by occupants.

Proposed performance solution:

BCA Intent

Clause D3D13 states that if an exit discharges to a roof of a building, the roof must not have any roof lights or other openings within 3m of the path of travel of persons using the exit to reach a road or open space.

The intent of Performance Requirement C1P2 is to avoid the spread of fire to exits as required.

The intent of Performance Requirement D1P4 is to provide exits at a location to allow occupants to evacuate safely.

The intent of Performance Requirement D1P5 is to protect evacuating occupants in an exit or open space from a fire within the building.

From the above it is evident that it must be demonstrated that evacuating occupants will be adequately protected from the effects of a fire from the point at which they discharge on the roof or open space until they reach a road.

Analysis

Occupants when discharging from the residential levels onto the carpark roof, will need to pass within 3m of unprotected openings or service penetrations in the carpark roof, as shown in Figure 19.

Where an occupant identified a hazard along their egress path, they are capable of turning back and utilising another path to the road, limiting their exposure to the effects of fire and heat if a fire occurs in the basement carpark. For this analysis, it is expected that uncontrolled fire and smoke spread is adequately prevented due to the use of fast response heads, producing less heat and smoke compared to a DtS AS 2118.6 sprinkler system and therefore the effects of fire and smoke is to affect one opening at a time.

All building discharges are offered a point of choice, to which are not exposed to any openings within 3m. Occupants can choose the closest path to a road and due to the open space layout, can easily identify smoke billowing out an opening and choose to return back to the point of choice and egress via another path to open road. This is highlighted in Figure 19, where alternative egress paths are highlighted as dashed lines.

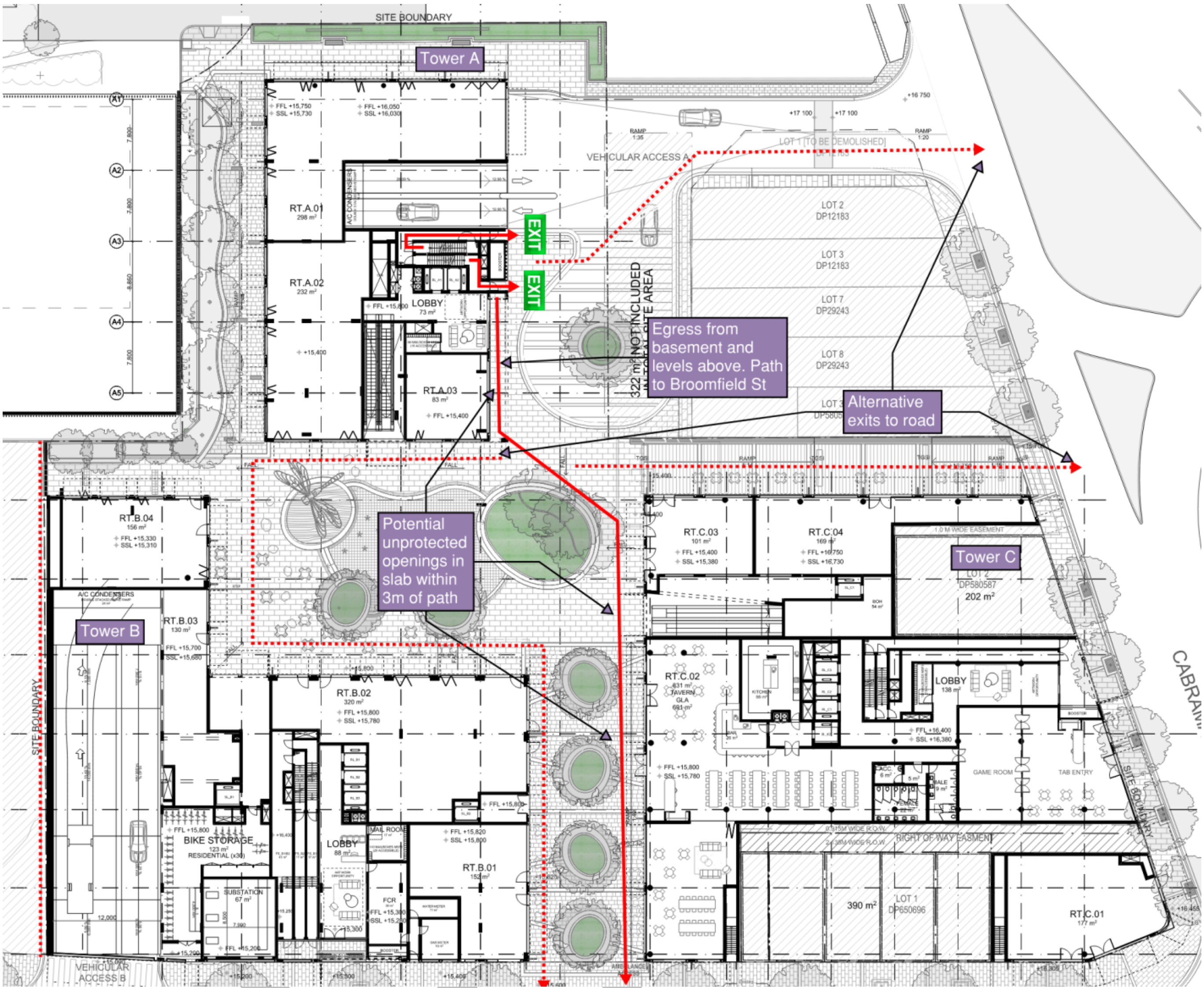

Figure 19: Egress from tower A past unprotected openings in carpark roof

Conclusion

The Performance Solution has qualitatively shown that the existence of alternative travel paths, as well as addition of sprinklers which would control the temperatures of a fire, ensure that occupants would experience safe conditions in an evacuation. Consequentially, Performance Requirements C1P2, D1P4 and D1P5 have been met.

Performance solution:

☑ A2.2(1)(a) - Comply with all relevant performance requirements
☐ A2.2(1)(b) - Be at least equivalent to the DtS provisions

Assessment methods:

☐ A2.2(2)(a) - Evidence of suitability
☐ A2.2(2)(b)(i) - Verification methods provided in the NCC
☑ A2.2(2)(b)(ii) - Other verification methods accepted by the appropriate authority
☐ A2.2(2)(c) - Expert judgement
☐ A2.2(2)(d) - Comparison with the DtS provisions

Assessment approach:

☐ Comparative	☑ Qualitative	☑ Deterministic
☑ Absolute	☐ Quantitative	☐ Probabilistic

IFEG sub-systems used in the analysis:

☐ A – Fire initiation and development and control
☐ B – Smoke development and spread and control
☑ C – Fire spread and impact and control
☑ D – Fire detection, warning and suppression
☑ E – Occupant evacuation and control
☐ F – Fire services intervention

Acceptance criteria and factor of safety:

Evacuating occupants shall be adequately protected from the effects of a fire from the point at which they discharge on the roof until they reach a road or open space.

Fire scenarios and design fire parameters:

A fire within the basement carpark has been considered, as the floor is the fire rated element subject to this solution.

Describe how fire brigade intervention will be addressed or considered:

FRNSW are unlikely to be affected by this solution, as it has been demonstrated that occupants are capable of traversing the roof of the basement carpark to escape the building.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

Provide details on proposed modelling/assessment tools:

N/A

Issue number: 4 **Title:** Rationalise wet area slab thickness

Details of departures from DtS provisions:

It is proposed to permit a localised reduction of the FRL from 90/90/90 to 60/60/60 in the following locations:

- SOU wet areas

This will only be applied where the set down is above another Class 2 SOU. Where the set down is above a different classification such as those over the retail tenancies and childcare facilities, the BCA DtS FRL is to be achieved.

Relevant markups have been included below.

Figure 20: Areas with reduced FRLs (Level 3 tower B shown)

Applicable DtS provisions (including clause excerpt):	Spec 5, C2D2 *(BCA 2019 Spec C1.1, C1.1)*	Applicable Performance Requirements:	C1P1, C1P2 *(BCA 2019 CP1, CP2)*

List key fire safety measures:

The FRL of the SOU wet areas and balcony areas may be reduced to a minimum FRL of 60/60/60 minutes in lieu of 90/90/90 minutes.

This is only to be applied where the set down is above another Class 2 SOU. Where the set down is above a different classification such as those over the retail tenancies and childcare facilities, the BCA DtS FRL is to be achieved.

The building shall be sprinkler protected throughout in accordance with AS2118.1-2017.

Proposed performance solution:

BCA Intent

BCA Specification C1.1 requires separating floor slabs in a Class 2 building of Type A construction to meet an FRL of 90/90/90.

The intent of BCA Performance Requirements CP1 and CP2 are to establish the minimum fire-resisting construction for the respective portions of the building. Thereby, the structural stability of the building is maintained to allow occupant evacuation prior to structural collapse.

However, CP1 does not refer to a fire resistance level (FRL). FRLs are only included as part of the Deemed-to-Satisfied Provisions. It may be found by a building proponent using a Performance Solution that FRLs to building elements are not necessary as other means, such as the use of active systems, satisfy the Performance Requirements, as stated in the Guide to the BCA.

The proposed design contains set downs throughout the Class 2 SOUs that locally reduce the slab thickness to below that required to meet a 90/90/90 FRL. It is proposed to reduce the FRL in these areas to a 60/60/60 FRL to permit the reduced slab thickness. The structural engineer is to advise on the minimum slab thicknesses permitted based on the 60/60/60 FRL.

This will only be applied where the set down is above another Class 2 SOU. Where the set down is above a different classification such as those over the retail tenancies and childcare facilities, the BCA DtS FRL is to be achieved.

Analysis

This section contains the analysis used to validate that the proposed reduction in FRLs satisfies the relevant Performance Requirements.

In the event of fire in sprinkler protected areas, it is expected that the sprinkler system will activate and prevent fire growth and spread. In the unlikely event that the sprinkler system fails to operate in a fire scenario which originates in a compartment with reduced FRLs, a fire could grow uncontrolled to a point of flashover where the entire compartment may be involved in the fire. This fire scenario is further considered below.

Time Equivalency (TE) Calculations

The time equivalence formula calculates an equivalent time of exposure to the standard test fire, based on known fuel load and ventilation conditions. Assemblies that are provided with a fire resistance equal to, or greater than, the equivalent structural fire severity, are generally expected to be able to withstand a complete burnout of the compartment. Therefore, the minimum Fire Resistance Levels (FRLs) that would be expected to withstand a full burnout of the considered compartment will be determined based on the result of the calculations. These calculations indicate that a complete burn out of a fire compartment will not exceed the fire resisting ability of the bounding construction.

Several techniques exist for calculating the equivalent period of fire exposure, which includes include Patterson, Harmathy, Law, DIN 18230, CIB W14 and Eurocode 1. Although based upon experimental studies, Patterson, Harmathy and Law techniques have been found to be limited either in their ease of use or scope of application. Additionally, DIN 18230, CIB W14 and Eurocode are similar in their approach, differing only in the treatment of the individual parameters. The Eurocode is seen as the evolution of the DIN 1820 and CIB W14 approaches and the is the most applicable method of analysis.

Therefore, it is proposed to use the approach in the Eurocode 1, CIB and Law, when utilising the Time Equivalent Method. The Eurocode assessment considers multiple scenarios including 90% fractile Fire Load Energy Density (FLED), sprinkler failure, 75% glazing failure and 50% glazing failure. The worst-case results of all sensitivity cases investigated will be used to determine the required FRL.

Table 6 contains the scenarios analysed, and the corresponding FLED values used in the analysis. Figure 21 below contain the markups of the relevant locations analysed. All SOUs are to be considered within the building. However typical compartments were selected with conservative input parameters to ensure the worst-case scenarios have been assessed. The worst-case scenario chosen is apartment 1B B303 on level 3 of tower B, this compartment exhibits minimal openings which would provide ventilation of a fire. The FLED values are derived from Tables 3.4.1a and 3.4.1b of the IFEG. Where multiple uses exist within the same compartment the fuel load of the different areas is averaged based on their relative floor areas. In calculating the 90% fractile FLED, the IFEG methodology is utilised whereby for a well defined area, the 90% percentile is 1.65 times the average FLED value.

A summary is provided below, listing each room that has been assessed under the T-E method and the typical compartments it represents.

Table 6: Wet Slab Scenarios

SCENARIO	LOCATION	FLED (MJ/m²)	90TH PERCENTILE FLED (MJ/m²)	REFERENCE
1	Sole-occupancy Units (SOU) Level 3 of tower B – room 1B B303	400	495	IFEG Table 3.4.1a

Figure 21: Areas with reduced FRLs (Time-Equivalence Model)

Table 7 shows the considered scenarios, as well as the input parameters used in the assessment. The occupancy type is an indicator of the risk of fire activation.

Table 7: Time Equivalence Input Parameters

INPUT PARAMETER		SCENARIO 1
Height of fire cell (m)	H	3.15
Floor area (m²)	A_f	50
Vertical openings Area (m²)	A_v	27.41
Horizontal openings Area (m²)	A_h	0
Wall Perimeter Length (m)	m	31
Opening Height (m)	Hv	3.15
Fuel Load Density (MJ/m²)	Q_f	400
Compartment Lining Factor	k_b	Gypsum
Heat of Combustion (MJ/kg)	ΔH_c	20
Sprinkler Protection		Yes

As part of the analysis, a 90% Fractile FLED is considered, accounting for a situation where a higher amount of combustible material is stored in the area than anticipated.

Furthermore, the glazing failure scenarios consider events where not all the openings within the fire compartment fail. A 75% and 50% glazing failure scenario has been considered as part of this assessment. The sprinklers within the compartment are likely to suppress if not extinguish the fire. The scenario that presents the highest risk of the FRL failing is one in which the sprinkler system fails to operate. In the event that the sprinkler system fails, the temperature of the compartment will lead to the failure of a majority of the glazing.

Temperatures within a compartment that is exposed to conditions similar to the standard fire curve, able to cause failure of the fire rated elements, reaches a temperature of approximately 945°C at 60 minutes. This temperature will lead to the failure of much higher than 25% of the glazing, as justified by the above-mentioned studies. Finally, the Eurocode does not require the use of the glazing failure scenarios in order to justify the suitability of an FRL for a compartment using the time equivalence method. The glazing failure scenario is considered to be above and beyond the requirements of bodies that advocate the TE method.

The building is to be provided with a sprinkler system throughout. In the event of a fire the sprinkler system is expected to control, if not suppress the fire. The sprinkler system acts to cool the upper smoke layer and wet adjacent combustibles and partitions helping to prevent the fire from spreading beyond the area of origin.

Where the sprinkler system operates successfully the fire resistance of building elements is largely irrelevant as the fire is not expected to grow large enough to compromise the structural integrity of the building. In this regard it is noted that the efficacy of sprinklers is recognised in the [C/VM2], which permits a 50 % reduction in FRL if sprinklers are installed, and in the UK ([PD6688-1-2] & [Eurocode 1]) which permits a reduction of 39 %. From this it is concluded that a reduction factor in FRL of 0.5 to 0.61 is internationally accepted if sprinklers are installed. This reflects the very low probability of a very high Fire Load Energy Density (FLED) at the same time that the sprinkler system fails.

Table 8 contains the results obtained from the Time Equivalence assessment calculations.

Table 8: Time Equivalence Results

RESULTS TABLE		SCENARIO
Proposed FRL		60
Eurocode	t_e	17
X.1 - 90 % Fractile FLED	t_e	27
X.2 - Sprinkler Failure	t_e	27
X.3 - 75% Glazing Failure	t_e	17
X. 4 - 50% Glazing Failure	t_e	17
CIB Formula	t_e	18
Law Formula	t_e	15
Pass/Fail		**Pass**

The table above demonstrates that the proposed FRLs in each scenario assessed would be suitable to withstand a complete burnout of the compartment, according to all three methods of calculation. The results demonstrate the proposed FRLs are more than adequate when considering the 90% fractile FLED. Multiple sensitivity studies have been conducted in the calculations above, including increased fuel loads, sprinkler failure and glazing failure to ensure that the results can be considered robust. By successfully passing these sensitivity studies, the results demonstrate robustness for 90% of the possible compartment configurations.

Conclusion

The solution above has shown that a 60/60/60 FRL is sufficient to withstand a full burnout of an SOU compartment. It is therefore considered that a local reduction to 60/60/60 FRL in the subject locations will not compromise the fire compartmentation of the buildings. Performance requirements C1P1 and C1P2 are therefore considered to have been met.

Performance solution:

☑ A2.2(1)(a) - Comply with all relevant performance requirements

☐ A2.2(1)(b) - Be at least equivalent to the DtS provisions

Assessment methods:

☐ A2.2(2)(a) - Evidence of suitability
☐ A2.2(2)(b)(i) - Verification methods provided in the NCC
☑ A2.2(2)(b)(ii) - Other verification methods accepted by the appropriate authority
☐ A2.2(2)(c) - Expert judgement
☐ A2.2(2)(d) - Comparison with the DtS provisions

Assessment approach:

☐ Comparative ☑ Qualitative ☑ Deterministic
☑ Absolute ☑ Quantitative ☐ Probabilistic

IFEG sub-systems used in the analysis:

☑ A – Fire initiation and development and control
☑ B – Smoke development and spread and control
☑ C – Fire spread and impact and control
☐ D – Fire detection, warning and suppression
☑ E – Occupant evacuation and control
☐ F – Fire services intervention

Acceptance criteria and factor of safety:

The proposed FRLs shall be adequate for the expected fire severity of the spaces below to ensure fire spread is mitigated to the degree necessary.

Fire scenarios and design fire parameters:

The solution considers an uncontrolled fire that results in a full burnout of the compartment.

Describe how fire brigade intervention will be addressed or considered:

By demonstrating that the compartment is able to withstand a full burnout and the fire is contained to the compartment of fire origin, it can be said that the impact on fire brigade intervention is adequately addressed with respect to this BCA DtS departure.

Firefighting would be limited to the compartment of fire origin as the risk of fire spread and structural collapse has been minimised by determining the appropriate FRL based on the expected fire severity within that compartment.

Verification/validation analyses:

☑ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

The TE calculations outlined above include various sensitivity studies.

Provide details on proposed modelling/assessment tools:

TE calculations as detailed above.

Issue number: 5 **Title:** Slab edge design to façade junction

Details of departures from DtS provisions:

The gap between the slab edge and the outer face of the external wall is to be fire and smoke sealed on a performance basis in lieu of using a tested system. An indicative diagram of the proposed configuration is shown below which comprises of aluminium or steel smoke flashing and Rockwool (or approved equivalent fire rated insulation batt / board). The Rockwool shall be at least 120 mm in depth along the gap.

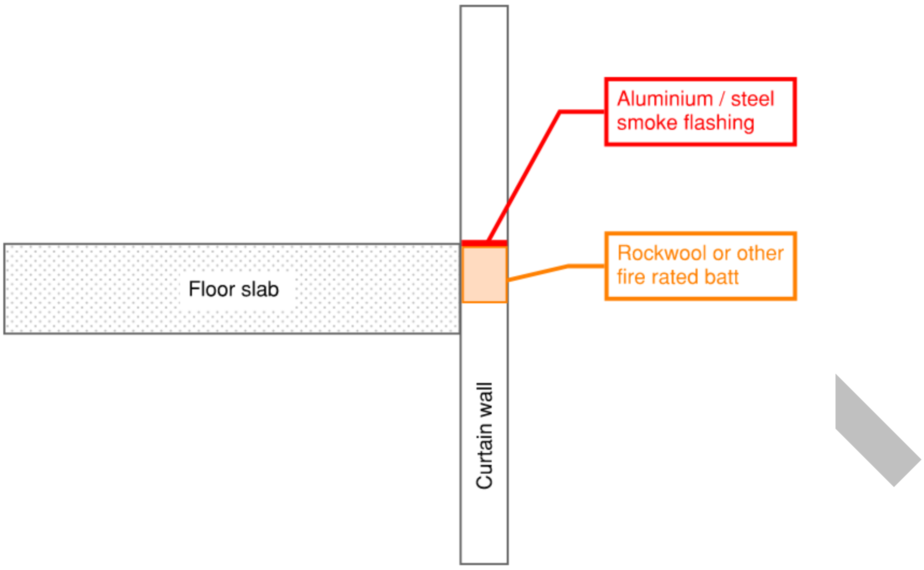

Figure 22: Slab Edge Detail – Performance based fire separation

Applicable DtS provisions (including clause excerpt):	Spec 5, C2D2, C3D8, C3D9, C3D10 *(BCA 2019 Spec C1.1, C1.1, C2.7, C2.8, C2.9)*	Applicable Performance Requirements:	C1P2, C1P8 *(BCA 2019 CP2, CP8)*

List key fire safety measures:

Performance based fire stopping detail to suit slab edge design. Documented within this performance solution.

The building shall be protected throughout with automatic fire suppression system (AS 2118.1 – 2017) with fast response heads, except as otherwise denoted in this report.

The building shall be protected throughout with an automatic fire detection and alarm system (AS 1670.1 – 2018) except as otherwise denoted in this report.

Proposed performance solution:

BCA Intent

Specification 5 of the BCA outlines the requirements for the fire-resisting construction of building elements. For Class 5, 7a and 9 buildings, Specification C1.1 requires floors between levels to achieve an FRL of 120/120/120. While Class 2 buildings require 90/90/90 and Class 6 require 180/180/180.

C3D8 outlines the requirements for the separation of construction of buildings and fire compartments by fire walls.

C3D9 outlines the requirements for separating classifications in the same story and C3C10 for different storeys.

Performance Requirement C1P2 states a building must have elements that will, to the degree necessary, avoid the spread of fire. It should be noted that the performance requirements do not make reference of specific minimum fire resistance levels as being the performance requirement.

Performance Requirement C1P8 states any building element provided to resist the spread of fire must be protected, to the degree necessary, so that an adequate level of performance is maintained where openings, construction joints and the like occur, and where penetrations occur for building services.

Based on the above, it is evident that the intent of the BCA in this instance is to limit fire spread between levels via the gaps between the slab edge and outer wall to ensure occupants can safely evacuate and fire brigade intervention is facilitated.

Analysis

The construction of the curtain wall in the proposed design creates a gap in the fire separation provided by the floor between the slab edge and the outer face of the curtain wall. This gap is proposed to be protected by a metallic smoke seal and fire rated batts. An indicative configuration is shown in Figure 22. This configuration is not in accordance with a tested prototype. The façade edge seal design shall be provided on a performance basis in lieu of a DtS tested system. The performance-based slab edge to façade design shall be as follows:

- Smoke flashing is to be permanently fixed from the slab edge to the façade wall. Smoke flashing is expected to be capable of withstanding 200˚C for 30 minutes.
- The gap below the smoke flashing shall be packed with rockwool insultation.
- Any gap unable to be packed with rockwool shall be sealed with intumescent mastic or fire rated sealant.

Whilst Fire rated insulation batt or other fire rated batts will provide fire resistance, it has not been officially tested to achieve an FRL of 120/120/120 in the proposed configuration. As such, it must be demonstrated that the in the proposed configuration, the fire separation would adequately limit fire spread between levels to the degree necessary.

The building is sprinkler protected throughout which is expected to limit and control the size of a fire which may initiate throughout the building. Compartment temperatures associated with sprinkler-controlled fires generally do not exceed 200°C. In such a scenario the metallic smoke seals would be considered sufficient to form a barrier against fire and smoke between the levels given that the materials are expected to maintain their integrity at such temperatures. The BCA also recognises the suitability of sprinkler systems for maintaining vertical fire compartment separation as spandrels are not required in buildings with sprinkler systems.

In the unlikely scenario where the sprinkler system fails and the fire grows large enough in proximity to the curtain wall to potentially affect the seal, the high temperature from the large fire will cause the adjacent glazing to fail before the non-combustible Rockwool. Research undertaken by Babrauskas in his paper 'Glass breakages in fire' shows a 6mm thick glass panel is expected to fracture when subjected to a sudden temperature increase of 110°C. However, fallout was not experienced until multiple fractures had occurred and will typically occur at temperatures around 450°C, below the expected temperatures in an uncontrolled fire. The failure of the glazing would allow hot gases and smoke to spill out the openings to the outside. The Rockwool in this instance is expected to maintain its integrity across the gap and fire spread between levels is more likely to occur due to external fire spread via openings. However, due to the provision of sprinklers throughout, the BCA implies this is a low risk by omitting requirement for fire rated spandrels.

Furthermore, the smoke detection and alarm system provided will notify occupants on the levels above of a fire event, allowing them to evacuate prior to the fire spreading to the level above in the sprinkler failure scenario described above. As a result, occupant evacuation is considered to be facilitated prior to any significant fire spread between levels.

It should also be noted that Rockwool tested in other configurations has shown the ability to achieve an FRL of up to -/120/120 and therefore, whilst not achieving an official FRL in this configuration, it is expected to maintain a fire resisting barrier appropriate for a gap between the floor slab and the outer façade face.

In terms of fire brigade intervention, due to Rockwool's non-combustible material properties and ability to resist fire spread through the gaps, the risk of fire spread and a fire growing beyond the original fire compartment is not increased and as a result would not hinder fire brigade intervention.

Conclusion

The assessment has demonstrated that the proposed slab edge seal adequately limits fire spread to the degree necessary in order to facilitate the safe evacuation of occupants and fire brigade intervention. As such, compliance with Performance Requirement C1P2 and C1P8 is considered to be achieved.

Performance solution:

☑ A2.2(1)(a) - Comply with all relevant performance requirements
☐ A2.2(1)(b) - Be at least equivalent to the DtS provisions

Assessment methods:

☐ A2.2(2)(a) - Evidence of suitability
☐ A2.2(2)(b)(i) - Verification methods provided in the NCC
☑ A2.2(2)(b)(ii) - Other verification methods accepted by the appropriate authority
☐ A2.2(2)(c) - Expert judgement
☐ A2.2(2)(d) - Comparison with the DtS provisions

Assessment approach:

☐ Comparative
☑ Absolute
☑ Qualitative
☐ Quantitative
☑ Deterministic
☐ Probabilistic

IFEG sub-systems used in the analysis:

☐ A – Fire initiation and development and control
☐ B – Smoke development and spread and control
☑ C – Fire spread and impact and control
☑ D – Fire detection, warning and suppression
☐ E – Occupant evacuation and control
☐ F – Fire services intervention

Acceptance criteria and factor of safety:

Fire and smoke spread shall be adequately limited between levels via the g ap between the slab edge and outer face of the façade. Fire and smoke spread must be limited to the degree necessary to facilitate occupant evacuation and fire brigade intervention.

Fire scenarios and design fire parameters:

A fire on a tower floorplate has been considered in this assessment.

Describe how fire brigade intervention will be addressed or considered:

Fire brigade intervention is not considered impacted if it is shown that the slab edge is suitably protected during a fire scenario.

Verification/validation analyses:

☐ Sensitivity studies
☐ Redundancy studies
☐ Uncertainty studies
☑ None

Provide details on proposed modelling/assessment tools:

N/A

Issue number: 6 **Title:** Extended public corridors in residential areas

Details of departures from DtS provisions:

The following corridors exceed 40 m and are proposed to not be provided with smoke separation as required by the BCA DtS Provisions:

- Level 1 tower A – Up to 43 m in lieu of 40 m
- Level 2 tower B – Up to 52 m in lieu of 40 m
- Level 2 tower C – Up to 55 m in lieu of 40 m

The extended corridors are indicated on the figure(s) below.

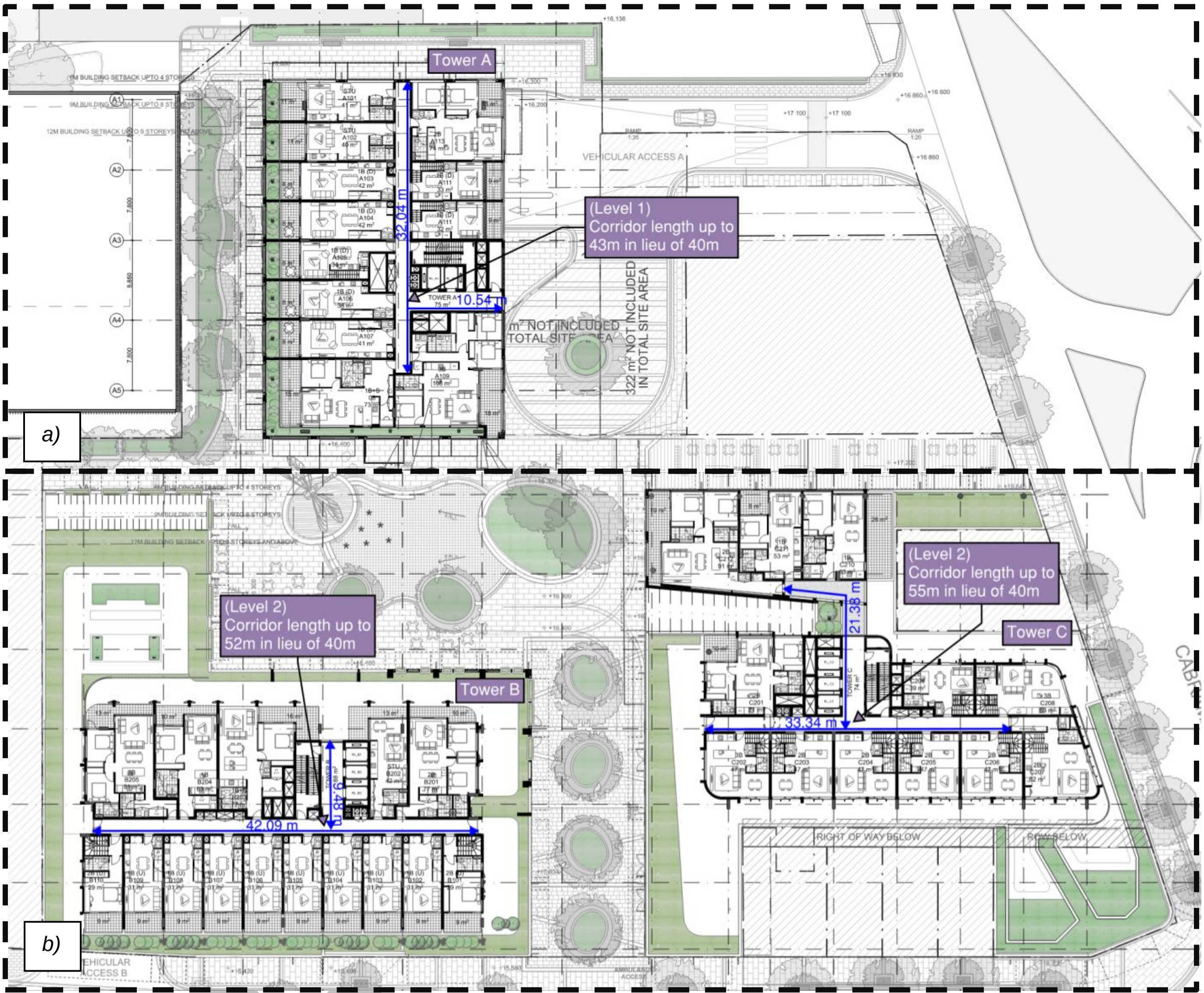

Figure 23: Extended public corridor lengths – a) Level 1 tower A, b) Level 2 tower B and C

Applicable DtS provisions (including clause excerpt):	C3D15, Spec 11 *(BCA 2019 C2.14, Spec C2.5)*	Applicable Performance Requirements:	C1P2, E2P2 *(BCA 2019 CP2, EP2.2)*

List key fire safety measures:

The building shall be protected throughout with automatic fire suppression system (AS 2118.1 – 2017) with fast response heads, except as otherwise denoted in this report.

The building shall be protected throughout with an automatic fire detection and alarm system (AS 1670.1 – 2018) except as otherwise denoted in this report.

All doors opening into the corridors on the residential levels shall be protected with Medium Temperature smoke seals tested in accordance with AS1530.7.

Proposed performance solution:

BCA Intent

Clause C3D15 states in a Class 2 or 3 building, a public corridor if more than 40m in length, must be divided at intervals of not more than 40m with smoke-proof walls complying with Clause 2 of Specification 11.

Performance Requirement C1P2 states a building must have elements which will, to the degree necessary, avoid the spread of fire to exits, to sole occupancy units, and public corridors.

Performance Requirement E2P2 states in the event of a fire in a building the conditions in any evacuation route must be maintained for the period of time occupants take to evacuate the part of the building so that the temperature will not endanger human life, the level of visibility will enable the evacuation route to be determined and the level of toxicity will not endanger human life.

The guide to the BCA states the measurement of the length of the public corridor includes the sum of all connected corridor lengths that are continuous within a separate storey, smoke compartment or fire compartment. Due to the measurement method the public corridor throughout the residential tower exceeds the 40m length requirement. The intent of C3D15 is to minimise the risk of large portions of the public corridors becoming smoke logged.

Analysis

The extended corridor lengths could potentially increase the distance an occupant has to travel within a smoke logged corridor. To minimise smoke spread into the corridor, the SOU doors shall be fitted with smoke seals to reduce the smoke leakage into a corridor, thus maintaining tenable conditions longer compared to a BCA DtS compliant design.

According to research conducted by CIBSE and Warrington the upper layer temperature is not likely to exceed 100°C in a sprinkler suppressed fire or 200°C in a sprinkler-controlled fire (for example when a shielded fire continues to burn but does not grow). This suggests that medium temperature smoke seals will be appropriate given the protection offered by the sprinklers in this building.

Research by Rakic suggests that fire doors compliant with specification C3.4 of the 2019 BCA are not sufficient in preventing the leakage of smoke at elevated temperatures. The results from his findings are tabulated below:

Table 9: Leakage rates of fire doors with and without smoke seals

PRESSURE DIFFERENTIAL	LEAKAGE WITHOUT SMOKE SEALS	LEAKAGE WITH SMOKE SEALS	PERCENTAGE OF DTS LEAKAGE
12.5	172.2 m^3/hour	5.1 m^3/hour	2.96 %
25	214.84 m^3/hour	8.31 m^3/hour	3.87 %
50	254.28 m^3/hour	12.43 m^3/hour	4.88 %
75	307.69 m^3/hour	16.52 m^3/hour	5.36 %

It is noted that the above results were conducted with one particular kind of smoke seals and smoke leakage rates are expected to differ between brands and makes of seals. AS 6905 requires a maximum leakage rate of 40m^3/hour in single leaf smoke doors when tested at 200˚C for 30 minutes. Even assuming a high-pressure differential, it is still clear that the provision of medium temperature smoke seals reduces smoke leakage rates by very large amounts, leaving the common corridor area with higher visibility than expected in a DtS compliant building.

The comparison has assumed a constant pressure differential of 25 Pa, the leakage rate of a door without smoke seals as per the research discussed above and the maximum leakage rate permitted by AS 6905.

Table 10: Amount of smoke leaking into a corridor with and without smoke seals, assuming a pressure differential of 25 Pa

TIME (MINUTES)	SMOKE VOLUME (NO SEALS)	SMOKE VOLUME (SEALS)
10	35.8 m^3	1.39 m^3
20	71.6 m^3	2.77 m^3

30	107.4 m^3	4.16 m^3
60	214.8 m^3	8.31 m^3

As can be seen from the above results, where smoke seals are installed the amount of smoke leaking into the corridor is significantly reduced. In reality it can be expected that the actual smoke leakage will be less as the pressure differential across a door in a sprinkler building can be expected to be below 12.5 Pa (as discussed in [NFPA 92]), whereas 25 Pa was used in the above analysis.

As such, given the minor increase in corridor length (up to additional 15 m) and the provision of smoke seals, it is considered that smoke spread throughout the corridor would be limited to a degree better than or at least equivalent to that of a BCA DtS compliant design.

Further, the number of occupants across each floor plate is considered to be low compared to the DtS expected population densities. There is a maximum of 15 single SOUs in tower B when a 1.5 times multiplier is used to account for sporadic guests the total number of occupants would be 23. Compared to the BCA population density of 15 m^2/per-person for a boarding house with the largest tower floor area approximately 994m^2, which would be 66 occupants on the floor plate. Even with the uncertainty multiplier of 1.5x the expected occupancy density for the proposed floor plan is still less than the BCA population density. The proposed design has fewer occupants allowing for faster egress into the fire stairs due to lower queueing times at the door.

Additionally, the building is fitted with a compliant suppression system that is expected to maintain conditions in the compartment of fire origin limiting smoke production and fire spread. The building detection system provides occupants with a fast alarm activation time alerting occupants to evacuate.

Conclusion

This assessment has qualitatively demonstrated that the proposed design with extended corridor lengths results in better or equivalent conditions along the corridor during an evacuation when compared to the BCA DtS design, thereby providing an equivalent level of safety. Therefore, Performance Requirements CP2 and EP2.2 are considered to be met on an equivalence basis.

Performance solution:

- ☑ A2.2(1)(a) - Comply with all relevant performance requirements
- ☐ A2.2(1)(b) - Be at least equivalent to the DtS provisions

Assessment methods:

- ☐ A2.2(2)(a) - Evidence of suitability
- ☐ A2.2(2)(b)(i) - Verification methods provided in the NCC
- ☑ A2.2(2)(b)(ii) - Other verification methods accepted by the appropriate authority
- ☐ A2.2(2)(c) - Expert judgement
- ☑ A2.2(2)(d) - Comparison with the DtS provisions

Assessment approach:

☐ Comparative	☑ Qualitative	☑ Deterministic
☑ Absolute	☐ Quantitative	☐ Probabilistic

IFEG sub-systems used in the analysis:

☐ A – Fire initiation and development and control	☐ D – Fire detection, warning and suppression
☑ B – Smoke development and spread and control	☑ E – Occupant evacuation and control
☐ C – Fire spread and impact and control	☐ F – Fire services intervention

Acceptance criteria and factor of safety:

The performance solution is considered acceptable if it is shown that the extended corridor lengths do not increase the risk to life safety presented to occupants and maintains tenable conditions within the evacuation routes.

Fire scenarios and design fire parameters:

A fire within an SOU of the residential levels has been considered.

Describe how fire brigade intervention will be addressed or considered:

Fire brigade intervention is not considered impacted if it is shown that the extended corridor lengths do not create untenable conditions to traverse on the floorplate.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

Provide details on proposed modelling/assessment tools:

N/A

Issue number: 7 **Title:** Protection of openings to allotment boundary

Details of departures from DtS provisions:

The following external openings are within the BCA minimum distances and are not proposed to be protected in accordance with BCA Clause C4D3. As shown in the below figure the distance from the opening to the side of the allotment boundaries is less than 3m. The North-eastern corner on the ground floor of tower B has a bifold door servicing retail tenancy T1.08 which has part of the opening within 3 m of the boundary.

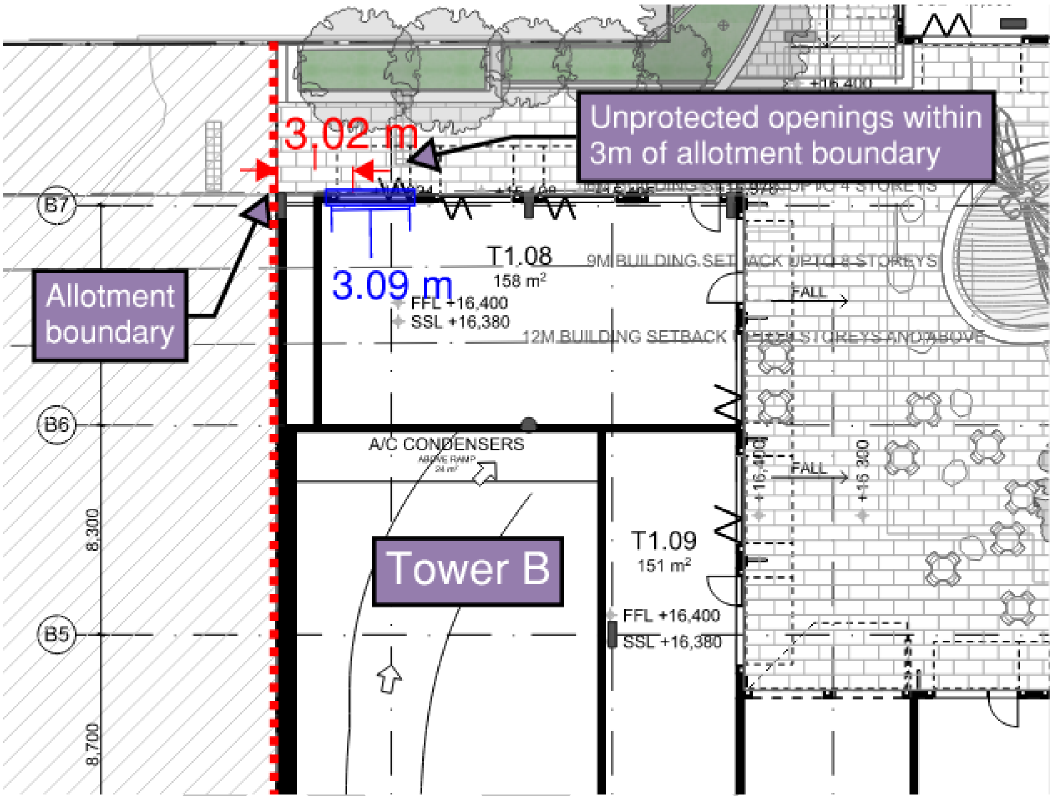

Figure 24: Unprotected opening within 3 m of boundary – ground floor of tower B

Applicable DtS provisions (including clause excerpt):	C4D3 *(BCA 2019 C3.2)*	Applicable Performance Requirements:	C1P2 *(BCA 2019 CP2)*

List key fire safety measures:

Openings are to be protected with minimum 6 mm toughened glazing.

Proposed performance solution:

BCA Intent

Clause C4D3 states openings in an external wall that is required to have an FRL must be protected in accordance with C4D5, if the distance between the opening and the fire source feature to which it is exposed is less than those specified in the table below.

Table 11: Clause C4D3 BCA Requirements

Minimum Distance	Fire-source feature
3 m	From a side or rear boundary of the allotment
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
6 m	From another building on the same allotment that is not Class 10

Performance Requirement C1P2 states a building must have elements which will, to the degree necessary, avoid the spread of fire between buildings. The intent of C1P2 in this case is to minimise the risk of fire spread from one building to another via the subject openings.

Analysis

The fire risk associated with this non-compliance is a fire initiating within the subject development and growing to a size that causes breakout of the glazing, which could lead to radiant heat from the fire to cause fire spread to adjacent buildings.

Quantitative analysis has been conducted to verify that fire spread between the subject building and the adjoining allotments is not facilitated by the unprotected openings. The analysis was conducted in accordance with Verification Method C1V1 of the BCA. C1V1 states that compliance with C1P2(a)(iii) to avoid the spread of fire between buildings on adjoining allotments is verified when it is calculated that:

a building will not cause heat flux in excess of those set out in Column 2 of Table 12 at the location on an adjoining property set out in Column 1 of Table 12; and

when located at the distances from the allotment boundary set out in Column 1 of Table 12, a building is capable of withstanding the heat flux set out in Column 2 of Table 12 without ignition

The quantitative assessment will show that the openings are located a sufficient distance from the adjacent buildings (future potential in this case) such that the emitted radiant heat will be within the limits deemed acceptable by Table 12. Another assessment has also been carried out to demonstrate that the subject openings can withstand the heat flux received as nominated in Table 12.

Table 12: C1V1 Acceptance Criteria

DISTANCE BETWEEN BUILDINGS ON ADJOINING ALLOTMENTS (M)	HEAT FLUX (KW/M^2)
On boundary	80
1 m from boundary	40
3 m from boundary	20
6 m from boundary	10

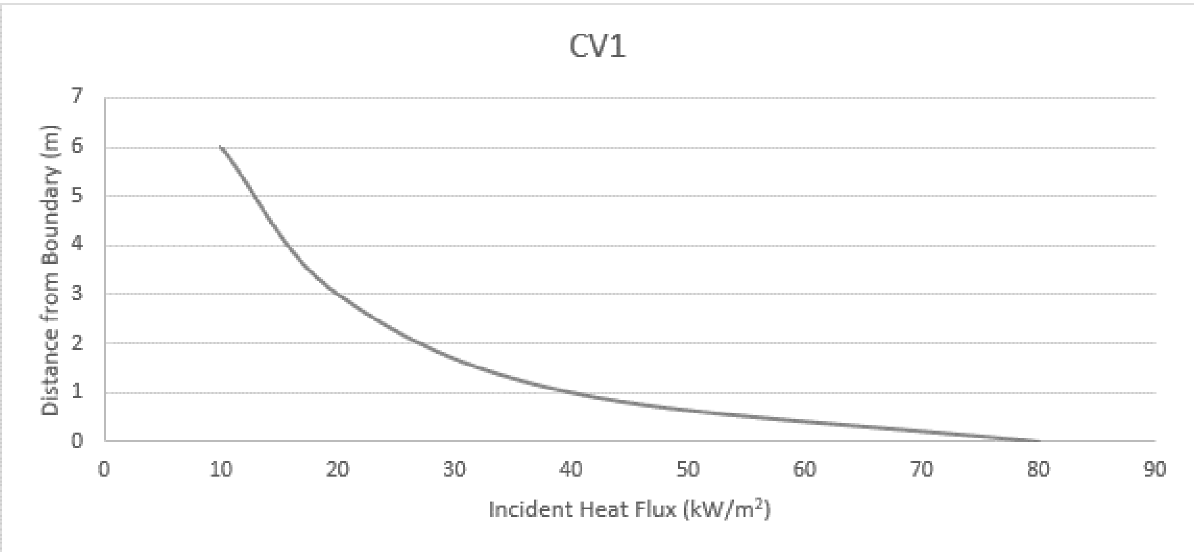

Figure 25: C1V1 Heat Flux vs Distance from Boundary

Fire Spread to the Allotment Boundary

The radiation calculations for the openings have been carried out utilising the equations from SFPE Handbook. Based on the works of Law [1] which concluded for fully ventilated fires:

- The mean wood equivalent fire load in excess of 25 kg/m2 could achieve a peak compartment temperature of 1040 °C which correlates to a radiant heat flux at the opening of 168 kW/m2.

- The mean wood equivalent fire load less than 25 kg/m2 could achieve a peak compartment temperature of 830 °C which correlates to a radiant heat flux at the opening of 84 kW/m2.

For the subject retail tenancy, the evaluated mean wood equivalent fire load (based on a wood calorific value of 17 MJ/kg) is 35.3 kg/m2 [3] thereby corresponding to a peak compartment temperature of 1040 °C. Subsequent radiant and receiver panels have been measured in accordance with the dimensions of the nominated openings to the allotment boundary with an emissivity of 0.9 [4]. Refer to Figure 26 for the fire load density taken for a residential type occupancy.

Occupancy	Fire load (MJ/m^2)	Wood equivalent (kg/m^2)
Dwelling	780	45.9
Hospital	230	13.5
Hospital storage	2000	117.6
Hotel bedroom	310	18.2
Libraries	1500	88.2
Manufacturing	300	17.6
Manufacturing and storage	1180	69.4
Offices	420	24.7
Schools	285	16.8
Shops	600	35.3

Figure 26: PD 7974-1:2003 Excerpt of Fire Load Density for Different Occupancies [2]

The results from the radiant heat analysis are summarised below.

Table 13: C1V1 Results

DISTANCE BETWEEN BUILDINGS ON ADJOINING ALLOTMENTS (M)	HEAT FLUX PERMITTED (KW/M^2)	HEAT FLUX EMITTED (KW/M^2)
On boundary	80	7.2
1 m from boundary	40	4.8
3 m from boundary	20	2.6
6 m from boundary	10	1.3

The results from the table above show that for a fire within the subject building, the expected radiant heat flux emitted onto and beyond the boundary via the subject openings, are within the limiting criteria of BCA Verification Method C1V1. Therefore, compliance with Performance Requirement C1P2 is achieved in terms of fire spread to the allotment boundary.

Fire Spread from the Allotment Boundary

Fire Spread from the allotment boundary was assessed by applying the values of C1V1 as the radiant heat received at the subject openings to determine whether the openings can withstand such a heat flux and avoid fire spread. At 3 m from the boundary, the heat flux that the openings are required to withstand is approximately 19 kW/m^2. Table A3 from AS1530.4 states that a heat flux of 13 kW/m^2 or greater is required to cause the piloted ignition of cotton fabric after a long time. As such, given that the radiant heat flux received at the subject openings is 19 kW/m^2, piloted ignition without protection could occur within the subject building and hence, fire spread to the subject building. As such the following Fire Safety Requirement shall be used, with the type of opening (fixed or operable) subject to final design:

Fixed Opening - Toughened Glazing

Studies by Babrauskas [5] have demonstrated that 6 mm thick glass will require a heat flux of 35 kW/m^2 for fall out to occur. As such, it is considered that the glazing would remain in place when exposed to the 19 kW/m^2. The studies also show that glass transmits approximately 33% of the incident radiant heat flux resulting in heat flux of 6.3 kW/m^2 inside the building. Given that the glazing provides a barrier against embers, the non-piloted ignition requires a heat flux greater than 25 kW/m^2 (AS1530.4), suggesting that fire spread would not occur. Therefore, compliance with Performance Requirement C1P2 is achieved in terms of fire spread from the allotment boundary.

Operable Opening – Attenuation Screen

If the subject openings are to be protected by radiant heat attenuating stainless steel mesh screens (i.e. Invisi-gard or equivalent). Testing demonstrated that the radiant heat attenuating screens attenuate radiant heat by 55%. This would result in a reduced heat flux of 9.5 kW/m^2 at the opening. Given that the mesh screen provides a barrier against embers, the non-piloted ignition requires a heat flux greater than 25 kW/m^2 (AS1530.4), suggesting that fire spread would not occur. The screens shall be generally installed in accordance with the tested prototype. The steel mesh screens shall be fixed to the surrounding fire rated substrate using steel screws and steel angles where necessary. Therefore, compliance with Performance Requirement C1P2 is achieved in terms of fire spread from the allotment boundary.

The following should also be included in the design:

- Installed strictly in accordance with the test report provided by a National Association of Testing Authorities (NATA) accredited testing laboratory.
- Labelling and maintenance requirements must conform with the relevant manufacturer's specification.

Conclusion

Based on the aforementioned discussion and protection methods, it has been demonstrated through the use of radiant heat calculations that the nominated openings nearing the allotment boundaries will not unduly cause fire spread based on the acceptance criteria set out in BCA DtS Clause C1V1(a) and C1V1(b).

References

[1] Law, M, Heat radiation from fires and building separation. Technical Paper 5. London, HMSO, 1963

[2] British Standards. PD 7974-1:2003, Application of fire safety engineering principles to the design of buildings Part 1: Initiation and development of fire within the compartment of origin. UK: British Standards Institution, 2003.

[3] Chitty, R, External fire spread – Building separation and boundary distances. IHS BRE Press. Berkshire, England, 2014.

[4] Spearpoint, M, Fire Engineering Design Guide. Third Edition. New Zealand Centre for Advanced Engineering, Christchurch, New Zealand, 2008.

[5] Babrauskas, V. "Glass Breakage in Fires"

Performance solution:

☑ A2.2(1)(a) - Comply with all relevant performance requirements
☐ A2.2(1)(b) - Be at least equivalent to the DtS provisions

Assessment methods:

☐ A2.2(2)(a) - Evidence of suitability
☑ A2.2(2)(b)(i) - Verification methods provided in the NCC
☐ A2.2(2)(b)(ii) - Other verification methods accepted by the appropriate authority
☐ A2.2(2)(c) - Expert judgement
☐ A2.2(2)(d) - Comparison with the DtS provisions

Assessment approach:

☐ Comparative ☑ Qualitative ☑ Deterministic
☑ Absolute ☑ Quantitative ☐ Probabilistic

IFEG sub-systems used in the analysis:

☐ A – Fire initiation and development and control
☐ B – Smoke development and spread and control
☑ C – Fire spread and impact and control
☐ D – Fire detection, warning and suppression
☑ E – Occupant evacuation and control
☑ F – Fire services intervention

Acceptance criteria and factor of safety:

The acceptance criterion is met if it is demonstrated that the nominated openings within the external walls of the development will not unduly cause fire spread based on the verification method set out in BCA DtS Clause C1V1(a) and C1V1(b).

Fire scenarios and design fire parameters:

N/A

Describe how fire brigade intervention will be addressed or considered:

The building is provided with a sprinkler system with fast response sprinkler heads which will assist in limiting the fire spread within the building and facilitate fire brigade intervention. The sprinklers shall be connected to a fire alarm monitoring system in accordance with AS 2118.1–2017 to notify the fire station or fire station dispatch centre.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

Provide details on proposed modelling/assessment tools:

N/A

Issue number: 8 **Title:** Extended travel distances

Details of departures from DtS provisions:

Numerous extended travel distances have been identified in the design. The worst-case extended travel distances as identified by the project team are detailed in the table below.

Table 14: BCA DtS Departures

SCENARIO ID	LOCATION	TRAVEL TYPE	PROPOSED TRAVEL DISTANCE (M)	DTS TRAVEL DISTANCE (M)	DISTANCE DIFFERENCE (M)	ASSESSMENT APPROACH
Basement 1-3						
1	Western corner of carpark A/B	Point of choice	45	20	25	RSET/RSET
Level 1						
2	Tower C - medical C2.01	Point of choice	40	20	20	RSET/RSET
Level 2 (Residential)						
3	Tower B - room 2B (U) B110	Point of choice	21	6	15	Mechanical ventilation / Smoke exhaust

Additionally, the figures below contain markups of all the extended travel distances.

Figure 27: Extended travel distances – basement levels (basement 3 shown is indicative of other levels)

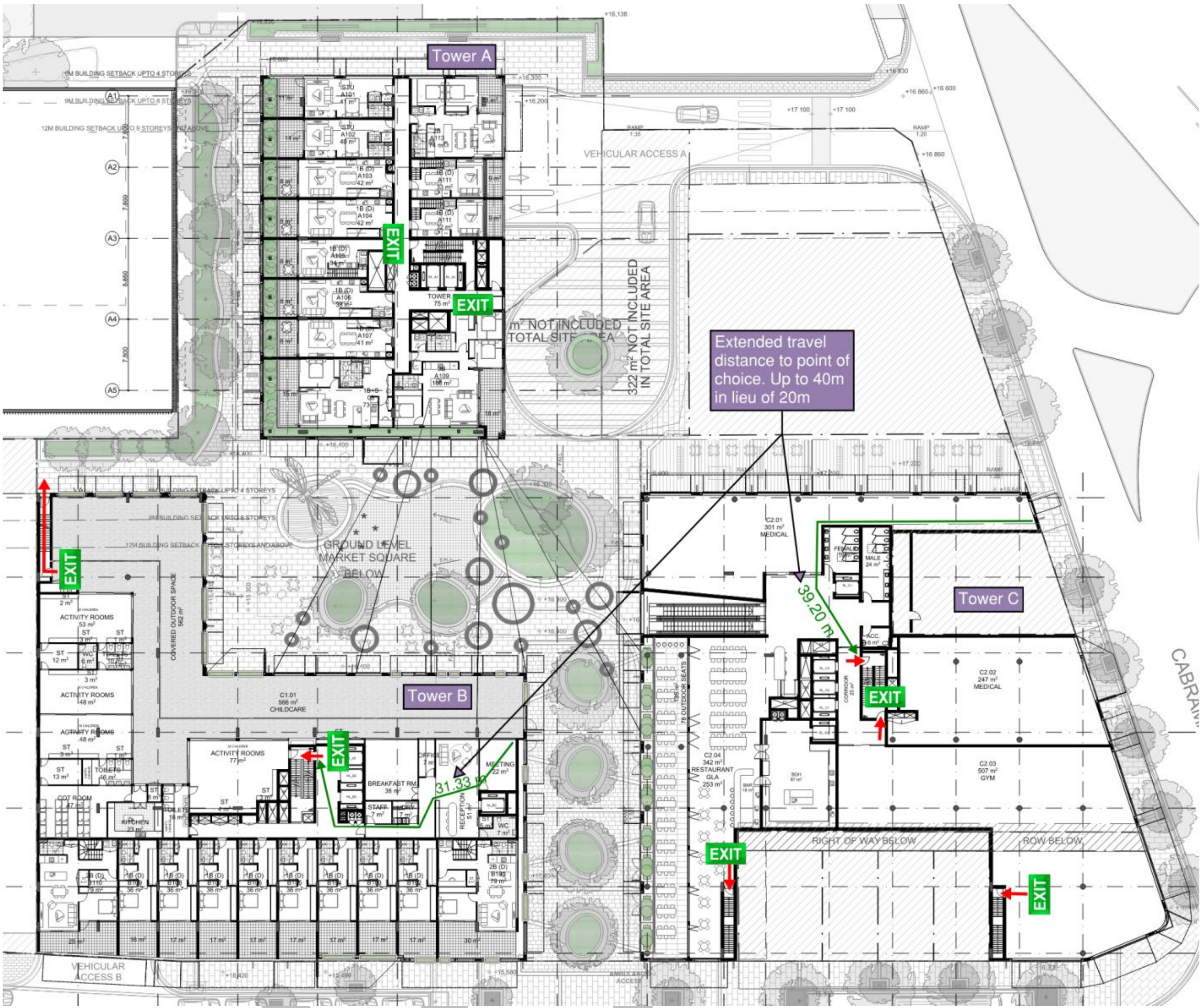

Figure 28: Extended travel distances – level 1

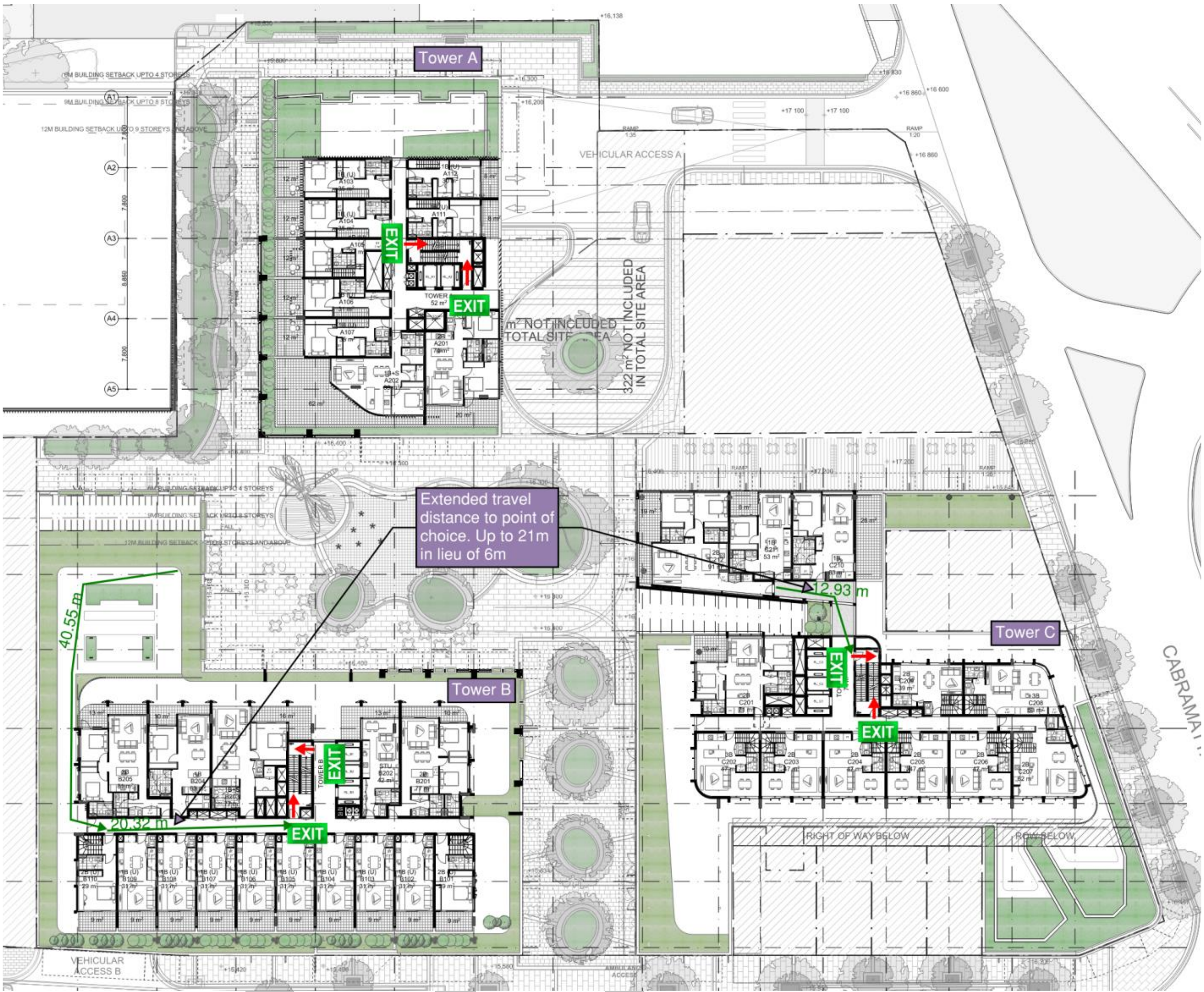

Figure 29: Extended travel distances – residential levels (level 2 shown is indicative of other levels)

Applicable DtS provisions (including clause excerpt):	D2D5, D2D6 *(BCA 2019 D1.4, D1.5)*	Applicable Performance Requirements:	D1P4, E2P2 *(BCA 2019 DP4, EP2.2)*

List key fire safety measures:

Reduced detection spacing /and the use of fast response sprinklers shall be provided to offset the evacuation times.

Proposed performance solution:

BCA Intent

Clause D2D5 states the maximum that travel distances to a point of choice, to a single exit and to a nearest exit.

The BCA Guide states that the intent of Clause D2D5 is to maximize the safety of occupants by enabling them to be close enough to an exit to safely evacuate. Similarly, Clause D2D6 is such that if in an event an exit becomes inaccessible, access to any required exit must be available within a reasonable distance.

Performance requirement D1P4 states exits must be provided from a building to allow occupants to evacuate safely, with their number, location and dimensions being appropriate to the travel distance, number and characteristics of occupants, function of the building, and height of the building.

Performance requirement E2P2 states that in the event of a fire the conditions along any evacuation route must be maintained for the period of time it takes to evacuate that part of the building. This includes ensuring that the temperature and level of toxicity will not endanger human life, as well as that the level of visibility will enable the evacuation route to be determined.

The intent of the BCA is to protect occupant life safety by ensuring all occupants are afforded with tenable egress conditions during an evacuation. This is achieved by imposing a standard travel distance throughout common buildings regardless of different design features.

Therefore, to meet the Performance Requirements, the proposed design with extended travel distances must allow occupants to evacuate safely.

Analysis

The extended travel distances to a point of choice, the nearest exit or between alternative exits, beyond that allowed by the BCA DtS could increase occupant travel time. As such, this has the potential to expose occupants to untenable evacuation conditions due to increased smoke build up and toxicity levels during an evacuation. However, it should be noted that the building is sprinkler protected, which is expected to control or suppress the fire, reducing the potential for untenable evacuation conditions to arise.

Non-Residential Areas

The solutions in the carparking, retail and childcare areas quantitatively show that by improving the sprinkler response time or reducing smoke detector spacing, the fire alarm is activated earlier. This alerts occupants to a fire earlier than a BCA DtS compliant design, and thus offsets any additional travel time due to the extended travel distance. The non-residential areas will be assessed using RSET/RSET analysis.

RSET/RSET Analysis

A quantitative comparative assessment has been carried out to show that the proposed design with extended travel distances can facilitate safe egress to a degree at least equivalent to that of a BCA DtS compliant design. The Required Safe Evacuation Time (RSET) of the proposed design with high-density smoke detection in conjunction with the extended travel distances, has been compared to the RSET of a BCA DtS compliant base case design.

To be considered acceptable, the RSET of the proposed design shall be less than the RSET of the BCA DtS compliant design.

- RSET (Proposed Design) ≤ RSET (BCA DtS Compliant Design)

There are three main components of an RSET that was used in this comparison as follows:

- Alarm Time – Time when sprinklers / smoke detectors activate to sound an alarm.
- Response Time – Time taken by occupants to assess the situation before deciding to move towards an exit (ignored for this comparison given this component would be identical in both cases).
- Travel Time – Time taken by occupants to reach an exit or a point of choice.

Response Time

The response time is the time taken by the occupants to respond to the alarm and begin moving towards the exit. The response time has been ignored for this comparison, given the occupancy type and building geometry are identical between the DtS and proposed designs. As such, the proposed design will have no impact on the response time, relative to the DtS design.

Travel Time

Guidance provided by SFPE handbook and IFEG indicates an appropriate walking speed for able-bodied occupants is between 1-1.3 m/s in a moderately crowed area, and 0.8 m/s for occupants with mobility issues. In calculating the travel time, a walking speed of 0.8 m/s has been applied to all occupants within the subject development, to ensure a worst-case scenario is considered. Table 15 below shows the calculation results for the travel time under the DtS and proposed designs for each scenario.

Table 15: Travel Times

SCENARIO ID	LOCATION	DTS TRAVEL TIME (S)	PROPOSED DESIGN TRAVEL TIME (S)
1	Basement levels 1-3	16	36
2	Level 1, Tower C medical room C2.01	16	32

Alarm Time

Table 16 lists the method used to reduce the alarm time and thus to achieve equivalent RSET with DtS.

Table 16: RSET/RSET Analysis Scenarios

SCENARIO ID	LOCATION	DTS DEPARTURE	ALARM TIME REDUCTION METHOD
1	Basement levels 1-3	Up to 45 m to point of choice in lieu of 20 m	Fast response sprinklers
2	Level 1, Tower C medical room C2.01	Up to 40 m to point of choice in lieu of 20 m	Reduced detection spacing

Scenario 1 – Basement

The calculation inputs used in the RSET/RSET analysis for the basement levels with fast response sprinklers is shown in Table 17. Using Alpert's ceiling jet correlation, the results show that the use in fast response heads in lieu of standard response sprinklers, reduces the sprinkler activation time.

Table 17: Sprinkler activation time - fast response vs standard response sprinklers

Parameters	Standard Response Heads	Proposed Fast Response Heads
Sprinkler Spacing[1] (m)	4 x 3 (2.5 m radial distance)	
Fire Growth Time[3] (s)	150	
Ceiling Height[2] (m)	3.15	
Fuel Height[4] (m)	0.5	
Ambient Temperature[5] (°C)	20	
Sprinkler Activation Temperature[5] (°C)	68	68
Response Time Index – RTI[6] $(m.s)^{0.5}$	135	50
Conductance[6] $(m.s)^{0.5}$	0.85	0.65
Travel speed (m/s)	0.8	
Sprinkler Activation Time (s)	178	147

1. As per ordinary hazard under AS2118.1-2017
2. Based on proposed design and building plans.
3. Based on a fast growth rate (0.0469 kJ/s^3) fires time to grow to 1055kW fire (CISBE Guide E 3rd Edition)
4. A standard 0.5m FFL fire height will be used (reference Verification Method C/VM2 Page 26).
5. Standard ambient room temperature (reference Verification Method C/VM2).
6. The Fire Engineering Design Guide 3rd Edition Ch 8

Scenario 2 – Level 1

The calculation inputs used in the RSET/RSET analysis for level 1 of tower C with reduced detector spacing is shown in Table 18. As shown in the table using Alpert's ceiling jet correlation, the decrease in detector spacing decreases the detector activation time.

Table 18: Extended travel distance - smoke detector activation

Parameters	DtS Design	Proposed Design
Detector Spacing[1] (m)	10 x 10 (radial distance 7.1 m)	6 x 6 (radial distance 4.26 m)
Fire Growth Time[2] (s)	300	
Ceiling Height[1] (m)	3.15	
Fuel Height[3] (m)	0.5	
Ambient Temperature[4] (°C)	23	
Detector Activation Temperature[5] (°C)	36	36
Detector Activation Time[5] (s)	122	96

1. Based on proposed design and building plans
2. Based on a medium growth rate fire (reference CIBSE Guide E Table 6.2 for office fire).
3. A standard 0.5m AFFL fire height will be used (reference Verification Method C/VM2 Page 26).
4. Standard ambient room temperature (reference Verification Method C/VM2).
5. Based on Alpert's Correlation

RSET Comparison with DtS

Table 19 compares the RSET for the proposed designs with the BCA DtS compliant design. It shows that despite the proposed design having extended travel distances, the proposed design has an RSET lower than that of the comparable BCA DtS design due to the reduced detector activation time.

Table 19: RSET/RSET analysis results - Reduced Detector Spacing

SCENARIO ID	DESIGN	DETECTOR ACTIVATION (S)	TRAVEL TIME (S)	RSET[1] (S)
1	DtS (Standard Response Sprinklers)	178	16	194
	Proposed (Fast Response Sprinklers)	147	36	183
2	DtS (10x10 Smoke Detector Spacing)	122	16	138
	Proposed (6x6 Smoke Detector Spacing)	96	32	128

1. Premovement time is considered to be the same in both scenarios.

It has been demonstrated through a comparative RSET analysis that the proposed fast response sprinklers in the basement level 1-3 and reduced smoke detector spacing in the ground and level 1 retail tenancies, provides occupants with an earlier warning in the event of a fire when compared to a BCA DtS compliant design. The faster detector activation time allows occupants to evacuate earlier in a fire scenario and offset any potential delay caused by the extended travel distances.

Analysis – Residential Areas

An extended travel distance of 21 m in lieu of 6 m exists within the residential portion of the development. For these worst case scenarios a quantitative analysis will be required, the options are discussed later in this Performance Solution. However, for minor departures of less than 14 m difference between the design and DtS provision, a qualitative assessment is provided.

Qualitative

It is proposed that the SOU doors shall be fitted with smoke seals to reduce the smoke leakage into a corridor, thus maintaining tenable conditions longer compared to a DtS compliant design.

According to research conducted by CIBSE and Warrington the upper layer temperature is not likely to exceed 100°C in a sprinkler suppressed fire or 200°C in a sprinkler-controlled fire (for example when a shielded fire continues to burn but does not grow). This suggests that medium temperature smoke seals will be appropriate given the protection offered by the sprinklers in this building.

Research by Rakic suggests that fire doors compliant with specification C3.4 of the 2019 BCA are not sufficient in preventing the leakage of smoke at elevated temperatures. The results from his findings are tabulated below:

Table 20: Leakage rates of fire doors with and without smoke seals

PRESSURE DIFFERENTIAL	LEAKAGE WITHOUT SMOKE SEALS	LEAKAGE WITH SMOKE SEALS	PERCENTAGE OF DTS LEAKAGE
12.5	172.2 m^3/hour	5.1 m^3/hour	2.96 %
25	214.84 m^3/hour	8.31 m^3/hour	3.87 %
50	254.28 m^3/hour	12.43 m^3/hour	4.88 %
75	307.69 m^3/hour	16.52 m^3/hour	5.36 %

It is noted that the above results were conducted with one particular kind of smoke seals and smoke leakage rates are expected to differ between brands and makes of seals. AS 6905 requires a maximum leakage rate of 40m^3/hour in single leaf smoke doors when tested at 200˚C for 30 minutes. Even assuming a high-pressure differential, it is still clear that the provision of medium temperature smoke seals reduces smoke leakage rates by very large amounts, leaving the common corridor area with higher visibility than expected in a DtS compliant building.

The comparison has assumed a constant pressure differential of 25 Pa, the leakage rate of a door without smoke seals as per the research discussed above and the maximum leakage rate permitted by AS 6905.

Table 21: Amount of smoke leaking into a corridor with and without smoke seals, assuming a pressure differential of 25 Pa

TIME (MINUTES)	SMOKE VOLUME (NO SEALS)	SMOKE VOLUME (SEALS)
10	35.8 m^3	1.39 m^3
20	71.6 m^3	2.77 m^3
30	107.4 m^3	4.16 m^3
60	214.8 m^3	8.31 m^3

As can be seen from the above results, where smoke seals are installed the amount of smoke leaking into the corridor is significantly reduced. In reality it can be expected that the actual smoke leakage will be less as the pressure differential across a door in a sprinkler building can be expected to be below 12.5 Pa (as discussed in [NFPA 92]), whereas 25 Pa was used in the above analysis.

These smoke seals are expected to delay the onset of untenable conditions within the corridors.

Quantitative

Two quantitative assessments have also been proposed to demonstrate a safe occupant evacuation safely in conditions that are considered better than or at least equivalent to that of a BCA DtS compliant design. The simulations assess the effectiveness of smoke exhaust or natural ventilation provided within the corridors of the proposed design to determine the Available Safe Evacuation Time (ASET). These results are then compared against the Required Safe Evacuation Time (RSET). An ASET / RSET comparison is then undertaken to demonstrate occupants are provided with an equivalent level of safety during an evacuation when compared to a BCA DtS compliant design.

Option 1 – Smoke Exhaust CFD

A CFD assessment analyses that the corridor smoke exhaust system adequately limits the spread of smoke to degree necessary, for occupants to evacuate. The CFD modelling analyses the smoke development and movement through the building. The Fire Dynamics Simulator (FDS) program developed by NIST is used for this analysis.

Option 2 – Ventilation

The residential corridors can be provided with permanently open natural ventilation or mechanically automated opening vents. This would involve a zone modelling assessment to be carried out using the software B-Risk to compare the tenability of the corridor for the proposed design against a BCA DtS compliant design in the event of a fire within an SOU adjoining the extended travel path.

Performance solution:

- ☐ A2.2(1)(a) - Comply with all relevant performance requirements
- ☑ A2.2(1)(b) - Be at least equivalent to the DtS provisions

Assessment methods:

- ☐ A2.2(2)(a) - Evidence of suitability
- ☐ A2.2(2)(b)(i) - Verification methods provided in the NCC
- ☑ A2.2(2)(b)(ii) - Other verification methods accepted by the appropriate authority
- ☐ A2.2(2)(c) - Expert judgement
- ☐ A2.2(2)(d) - Comparison with the DtS provisions

Assessment approach:

- ☑ Comparative
- ☐ Absolute
- ☑ Qualitative
- ☑ Quantitative
- ☑ Deterministic
- ☐ Probabilistic

IFEG sub-systems used in the analysis:

- ☐ A – Fire initiation and development and control
- ☐ B – Smoke development and spread and control
- ☐ C – Fire spread and impact and control
- ☑ D – Fire detection, warning and suppression
- ☑ E – Occupant evacuation and control
- ☐ F – Fire services intervention

Acceptance criteria and factor of safety:

Occupant evacuation shall be safely facilitated to a degree better than or at least equivalent to that of a BCA DtS compliant design.

Specifically, the Required Safe Egress Time (RSET) of the proposed design shall be less than the RSET for a BCA DtS compliant design.

RSET (Proposed Design) < RSET (BCA DtS Compliant Design)

Fire scenarios and design fire parameters:

Medium growth t2 fire occurring along the extended travel paths.

Describe how fire brigade intervention will be addressed or considered:

If it is shown that occupant evacuation is facilitated to a similar degree to that of a BCA DtS compliant design, then it is considered that the impact on fire brigade intervention would be negligible.

Fire brigade personnel are provided with compliant hydrant coverage for the affected levels. Should the area of concern become filled with smoke the brigade will be able to follow the hose back into the fire stair and egress from this point.

Verification/validation analyses:

- ☐ Sensitivity studies
- ☐ Redundancy studies
- ☐ Uncertainty studies
- ☑ None

Provide details on proposed modelling/assessment tools:

Non-Residential Areas – Empirical calculations, Alpert's Ceiling Jet Correlation

Residential Areas – Modelling, smoke exhaust CFD or ventilation zoning

Issue number: 9 **Title:** Distance between alternative exits on ground

Details of departures from DtS provisions:

The centrally located fire-isolated stairway servicing tower C is designed throughout the entire building so the distance between its alternative exits is 8.3 m in lieu of 9 m as prescribed by BCA DtS Clause D2D6. Figure 30 shows the non-compliance.

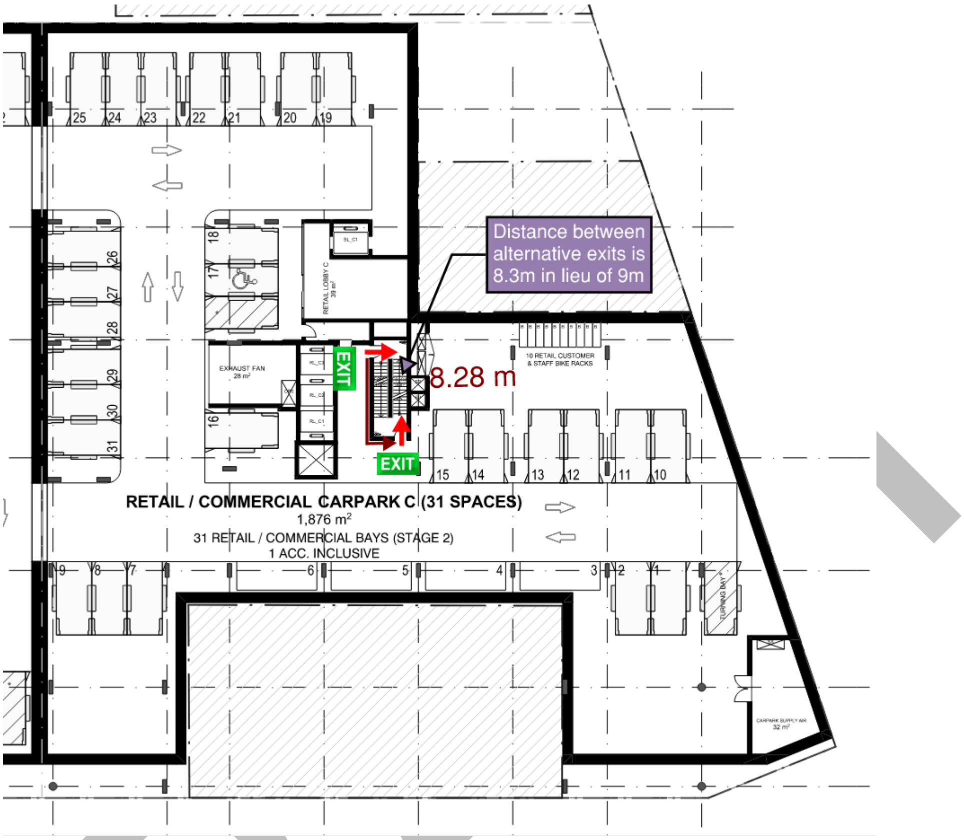

Figure 30: Distance between alternative exits – tower C (basement 2 shown is indicative of the whole building)

Applicable DtS provisions (including clause excerpt):	D2D6 *(BCA 2019 D1.5)*	Applicable Performance Requirements:	D1P4 *(BCA 2019 DP4)*

List key fire safety measures:

The building shall be protected throughout with automatic fire suppression system (AS 2118.1 – 2017) with fast response heads, except as otherwise denoted in this report.

The building shall be protected throughout with an automatic fire detection and alarm system (AS 1670.1 – 2018) except as otherwise denoted in this report.

Proposed performance solution:

BCA Intent

BCA DtS Clause D2D6 states that exits required as alternative means of egress must be not less than 9 m apart.

The intent of BCA DtS Clause D2D6 is to require that if an exit is inaccessible, access to any required alternative must be available within a reasonable distance. The BCA Guide further elaborates that the requirement maximises the choices of a person evacuating, in case on exit becomes blocked. The minimum distance of 9 m between alternative exits also reduces the risk of fire spreading to block the alternative exit.

Analysis

The Performance Solution will be an absolute, quantitative and deterministic assessment, based on the evaluation of risk associated with the reduced distance between alternative exits and the nominated fire safety measures pertinent to the design departure. The departure is assessed against the flame radiation of a case fire.

In assessing the risk of fire spread between alternative exits, a 600 kW (2 x 300 kW) waste bin fire [1][1] will be examined despite the unlikelihood of such fuel load occupying within the corridor space. The location of the fire source will be within the mid-point of both exits for the most onerous received radiant heat flux is achieved.

The acceptance criterion will be based on the maximum human pain exposure threshold of 4 kW/m^2 in accordance with AS 1530.4:2014 Table A3. Refer to Table 22 for an excerpt of AS 1530.4:2014 Table A3.

With the exception of pool fires, Modak [2] postulated that an originating fire can be approximated as an isotropic radiative point source. Modak's method in computing the radiant heat flux to a remote target is given by:

$$\dot{q}'' = \frac{\chi_r \dot{Q}}{4\pi {R_0}^2}$$

Where:

$\dot{q}''$ = Radiant heat flux received from remote target (kW/m^2).

χ_r = Fraction of total energy radiated (0.15 for low sooting fuels to 0.60 for high sooting fuels).

$\dot{Q}$ = Energy release rate (kW).

R_0 = Distance to remote target from centre of flame point source (m).

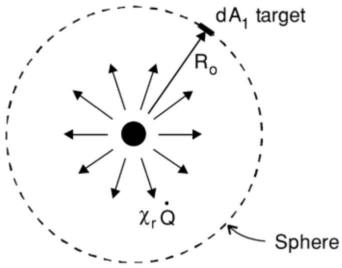

Figure 31 – Isotropic Radiative Source – Modak's Method [3]

Refer to Figure 31 and Figure 32 illustrating an isotropic radiative source based on Modak's in interpretation and the location of the fire source relative between the two alternative exits respectively.

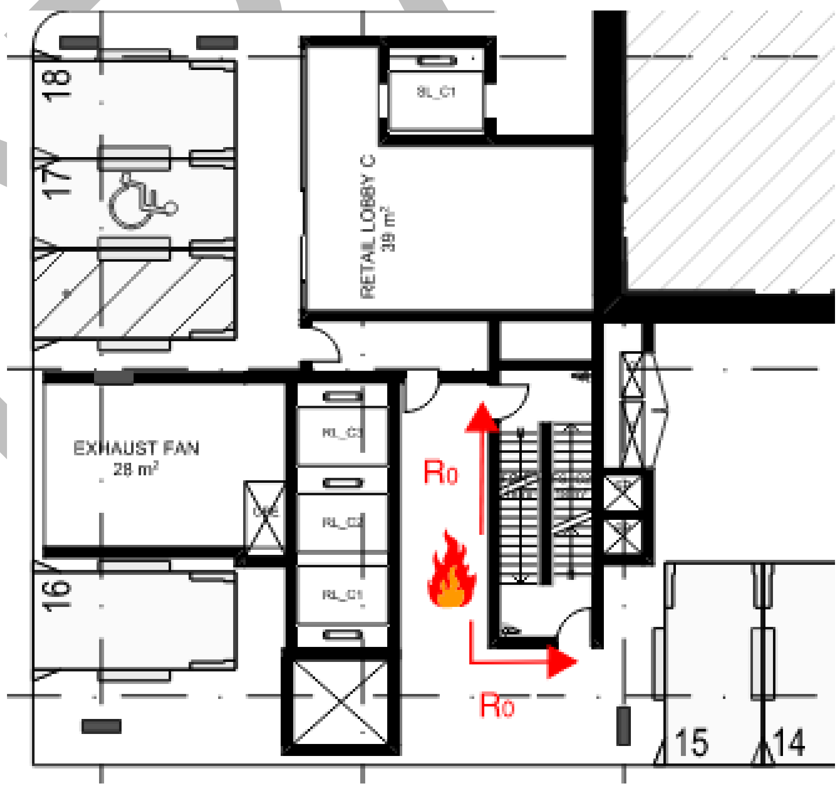

Figure 32: – tower C fire scenario at fire-isolated stairway

Table 22 – Modak's Method Input Parameters

Parameter	Input	Radiant Heat Flux Received ($\dot{q}''$)	4 kW/m^2 Threshold (AS 1530.4:2014)
Energy Release Rate ($\dot{Q}$)	600 kW (2 x 300 kW)		
Fraction of Total Energy Radiated (χ_r)	0.61 (Worst Credible Fraction)	1.69 kW	Received radiant heat flux received within limits
Distance to Remote Target (R_0)	8.3/2 = 4.15 m		

TABLE A3

TYPICAL RADIANT HEAT INTENSITIES FOR VARIOUS PHENOMENA

Phenomena	kW/m^2
Maximum for indefinite exposure for humans	
Pain after 10 s to 20 s	4
Pain after 3 s	10
Piloted ignition of cotton fabric after a long time	13
Piloted ignition of timber after a long time	13
Non-piloted ignition of cotton fabric after a long time	25
Non-piloted ignition of timber after a long time	25
Non-piloted ignition of gabardine fabric after a long time	27
Non-piloted ignition of black drill fabric after a long time	38
Non-piloted ignition of cotton fabric after 5 s	42
Non-piloted ignition of timber in 20 s	45
Non-piloted ignition of timber in 10 s	55

Figure 33 – Table A3 excerpt from AS 1530.4:2014 For Typical Radiant Heat Intensities [4]

Preliminary calculations based on Modak's Method has indicated a received radiant heat flux of 1.69 kW which remained below the 4 kW/m^2 maximum human pain exposure threshold. Occupants are therefore expected to adequately evacuate into an alternative exit should the other become compromised. It is also worth noting that sufficient aggregate unobstructed egress widths are provided on all floors and prolonged exposure as a result of queueing at the exits is not anticipated to arise.

Despite the favourable quantitative demonstration that the received radiant heat flux at the fire exits will not exceed 4 kW/m^2 for a worst credible fire, a building management in use plan shall be implemented where fuel load restrictions will be applied to the nominated areas for an added level of safety. Signage shall also be provided in multiple locations along the length of the corridor noting the following 20 mm high text:

Sterile Area

No goods are to be left or stored in this corridor

Quarterly inspections (i.e. every 3 months) are to be undertaken by building management to ensure that the accessways/corridor are kept free of combustible fuel loads and ignition sources at all times. The fuel load restriction requirement shall be noted on the Essential Services Schedule and Annual Fire Safety Statement for the building.

Conclusion

Based on the aforementioned discussion, it has been demonstrated that the risk of fire spread between alternative exits and subsequent entrapment will not occur. In conjunction to the pertinent fire safety measures, occupants are expected to adequately vacate the floor using an alternative exit should one become compromised.

References

[1] Stroup, D and Madrzykowski, D. Heat Release Rate Test of Plastic Trash Containers, Heat Release Rate Tests of Plastic Trash Containers, National Institute of Standards and Technology, 2003.

[2] Modak, A. Radiation from Products of Combustion, FMRC No. OAOE6.BU-1, Factory Mutual Research Crop., Norwood, MA, 1978.

[3] Karlsson, B and Quintiere, J. Enclosure Fire Dynamics, CRC Press LLC, Florida, USA, 2000.

[4] Standards Australia, Methods for fire tests on building materials, components and structures, Part 4: Fire-resistance tests of elements of construction, AS 1530.4:2014, FP-018, Sydney, Australia, 2014.

Performance solution:

- ☑ A2.2(1)(a) - Comply with all relevant performance requirements
- ☐ A2.2(1)(b) - Be at least equivalent to the DtS provisions

Assessment methods:

- ☐ A2.2(2)(a) - Evidence of suitability
- ☐ A2.2(2)(b)(i) - Verification methods provided in the NCC
- ☑ A2.2(2)(b)(ii) - Other verification methods accepted by the appropriate authority
- ☐ A2.2(2)(c) - Expert judgement
- ☐ A2.2(2)(d) - Comparison with the DtS provisions

Assessment approach:

☐ Comparative	☐ Qualitative	☑ Deterministic
☑ Absolute	☑ Quantitative	☐ Probabilistic

IFEG sub-systems used in the analysis:

☑ A – Fire initiation and development and control	☑ D – Fire detection, warning and suppression
☑ B – Smoke development and spread and control	☑ E – Occupant evacuation and control
☑ C – Fire spread and impact and control	☐ F – Fire services intervention

Acceptance criteria and factor of safety:

The acceptance criterion is met if the reduced distance between alternative exits at the fire-isolated stairway in tower C will not cause entrapment due to fire spread and thereby adversely impacting on the safe evacuation occupants.

Fire scenarios and design fire parameters:

N/A

Describe how fire brigade intervention will be addressed or considered:

The building is provided with a sprinkler system with fast response sprinkler heads which will assist in limiting the fire spread within the building and facilitate fire brigade intervention. The sprinklers shall be connected to a fire alarm monitoring system in accordance with AS 2118.1–2017 to notify the fire station or fire station dispatch centre.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

Provide details on proposed modelling/assessment tools:

N/A

Issue number: 10 **Title:** Egress widths in basement levels

Details of departures from DtS provisions:

The following exits paths have been identified to have a width of less than 1 m:

- Basement 3 – Both exits to fire-isolated stairway serving all three towers are 0.92 m in lieu of 1 m.
- Basement 2 – Both exits to fire-isolated stairway serving all three towers are 0.92 m in lieu of 1 m.
- Basement 1 – Both exits to fire-isolated stairway serving all three towers are 0.92 m in lieu of 1 m.

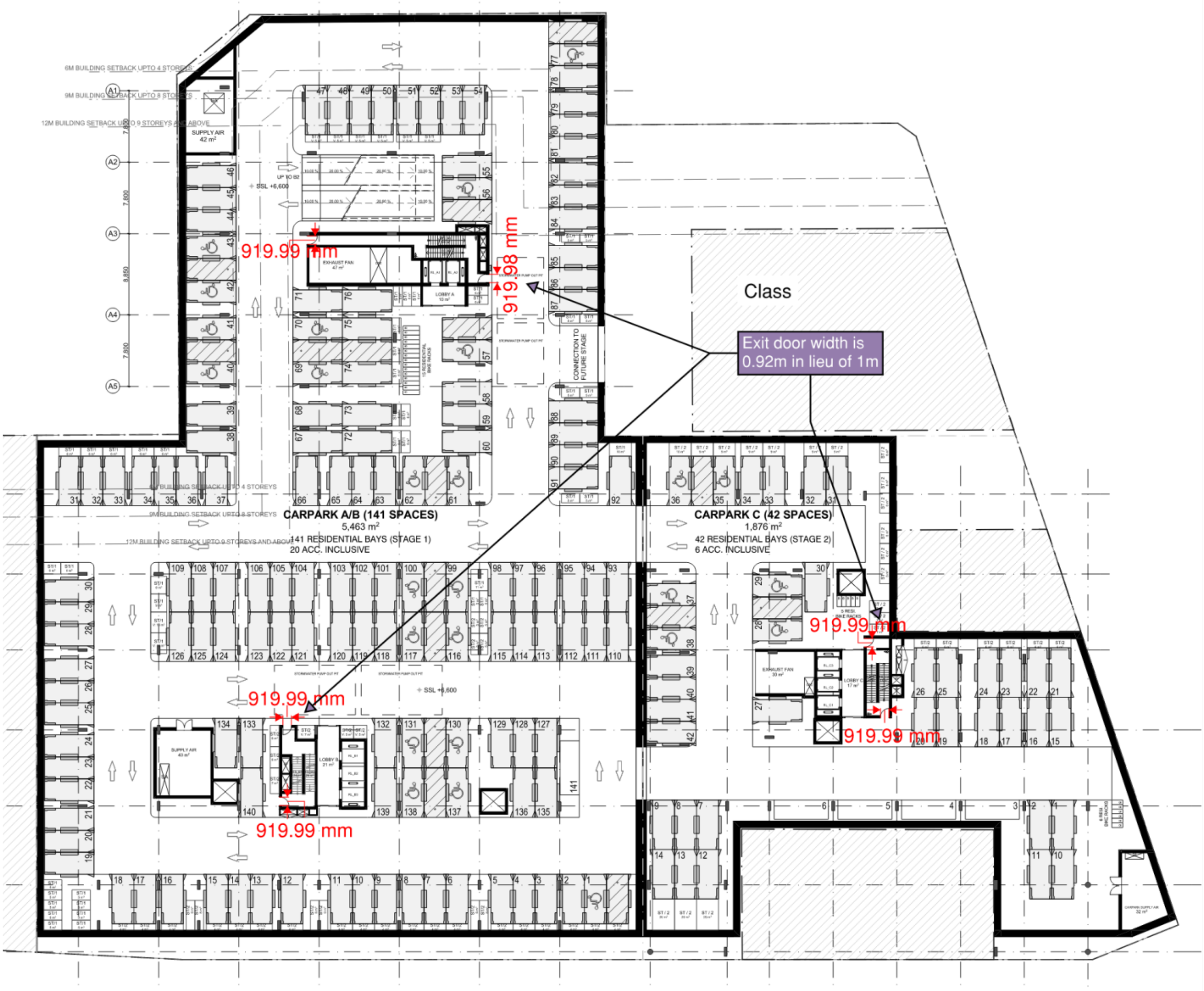

Figure 34: Egress width in basement levels (basement 3 shown indicative of other levels)

Applicable DtS provisions (including clause excerpt):	D2D8 *(BCA 2019 D1.6)*	Applicable Performance Requirements:	D1P4, D1P6, E2P2 *(BCA 2019 DP4, DP6, EP2.2)*

List key fire safety measures:

A suppression system is installed in accordance with AS 2118.6-2012, with fast response heads and as per the requirements of the FER.

A detection and alarm system shall be provided to the building in accordance with AS1670.1-2018 & AS 1670.4-2018 respectively.

Proposed performance solution:

BCA Intent

Clause D2D8(1)(a) states in a required exit or path of travel to an exit the unobstructed width of each exit or path of travel to an exit, except for doorways, must be not less than 1 m. D2D9(c) states the unobstructed width of each exit provided to comply with (b), (c), (d), (e), minus 250mm. It should also be noted that the required width of a stairway or ramp must be measured clear of all obstructions such as handrails, projecting parts of barriers and the like.

Performance Requirement D1P4 states exits must be provided from a building to allow occupants to evacuate safely, with their number, location and dimensions being appropriate to the travel distance, number and characteristics of occupants, function of the building, and height of the building.

Performance Requirement D1P6 states so that occupants can safely evacuate the building, paths of travel to exits must have dimensions appropriate to the number, mobility and other characteristics of occupants, and the function or use of the building.

Performance Requirement E2P2 states in the event of a fire in a building the conditions in any evacuation route must be maintained for the period occupants take to evacuate the part of the building so that the temperature will not endanger human life, the level of visibility will enable the evacuation route to be determined and the level of toxicity will not endanger human life.

Analysis

Inadequate widths in a path of travel create a potential risk that occupant evacuation is delayed, thus exposing them to hazardous egress conditions. The identified paths of travel in the proposed design have a minimum reduced with of 920 mm, which is less than the BCA DtS requirement of 1000 mm.

However, anthropomorphic data from NFPA 101 life safety code indicates that the 97.5 percentile body dimensions of an adult is approximately 510 mm in shoulder width as shown in the figure below. The shoulder width is considered to be the constricting factor when determining required egress widths. It should be noted that under the building evacuation strategy, occupants are expected to evacuate in a single direction along the subject travel paths. Therefore, occupants are not expected to be required to pass or travel side by side at any point along the travel path.

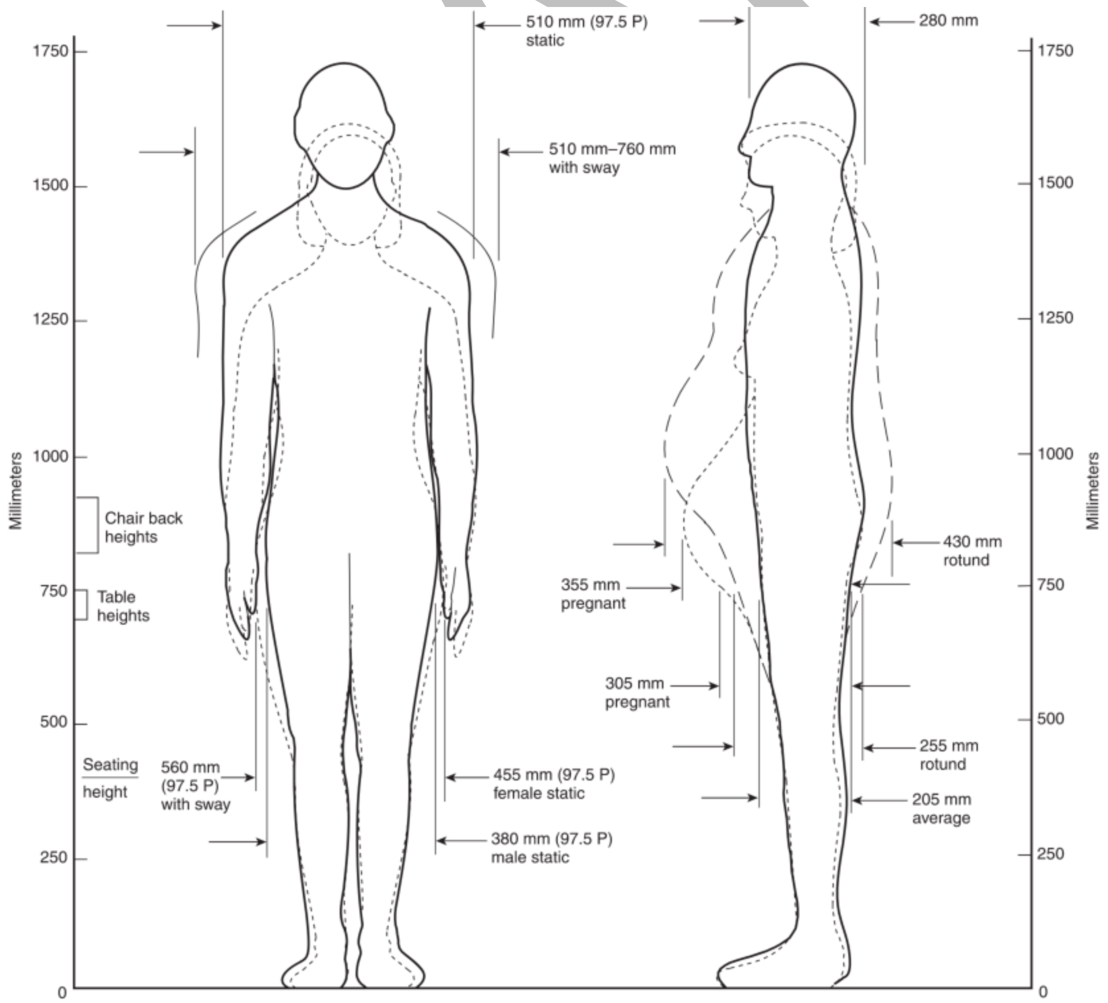

Figure 35: NFPA Figure A7.3.4.1.1(b) Anthropomorphic data for adults

The data above demonstrates that the reduced width of 0.92 mm in lieu of 1 m will still facilitate occupant egress in single file. The NFPA data also includes a typical width that accounts for the swaying motion of walking occupants, 760mm, which is still less than the proposed reduced width.

It is noted that neither a passageway width of 1000 mm in accordance with BCA Clause D2D8(1)(a) nor the passageway width of 920 mm of the proposed design is sufficient for two adults to egress side by side. They must be staggered in effectively single file as they pass through such travel path. Therefore, it is considered that a reduction to 920 mm should not have any noticeable impact on the total escape time as occupants are expected to still be evacuating in single file. The staggered single file spacing is depicted in the figure below (not to scale). The reduced width is also sufficient to accommodate the 510 mm width with sway (760 mm), so it is reasonable to assume that the rate of travel will not be affected by the reduced width.

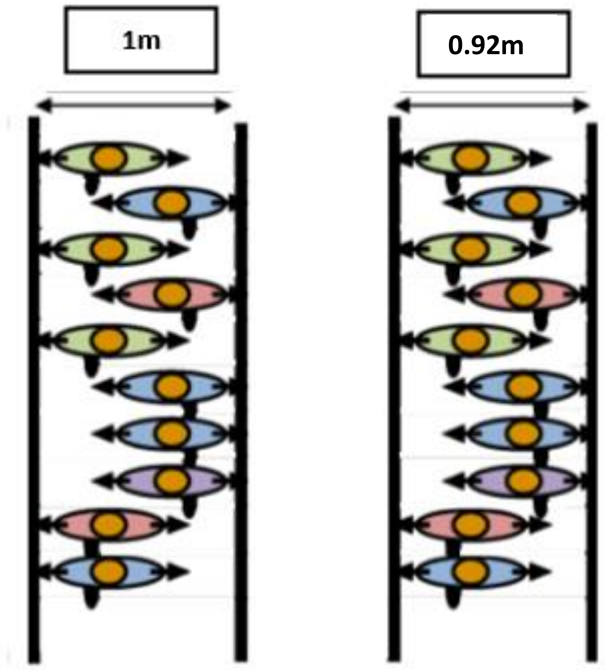

Figure 36: Egress through passageway (not to scale)

Furthermore, the occupancy density of the basement levels floorplate is considered low reducing the queueing time experienced accessing the fir-isolated stairs. Clause D2D18 provides an estimate for the expected occupancy density of the carparks as 30 m² per person. The expected population outlined by the BCA is approximately 245 people in total, however it must be noted the egress is distributed between the three fire-isolated stairways on each level. Although people in carpark do not dwell for long periods and typically pass through the area, the highest number of car bays available is on basement 3 totalling 183. People accessing these car bays will be sporadic and high likelihood to only account for 1 person per bay. Therefore the realistic population density could be lower than the estimated BCA population further reducing the risk of an occupant experiencing queueing at the stair.

Conclusion

Whilst the proposed paths of travel do have reduced widths, the anthropomorphic data has demonstrated that it is still of sufficient width to accommodate single file travel of occupants, and thus will facilitate occupant egress. Therefore, Performance Requirements D1P4, D1P6, E2P2 are considered to have been satisfied.

Performance solution:

- ☑ A2.2(1)(a) - Comply with all relevant performance requirements
- ☐ A2.2(1)(b) - Be at least equivalent to the DtS provisions

Assessment methods:

- ☐ A2.2(2)(a) - Evidence of suitability
- ☐ A2.2(2)(b)(i) - Verification methods provided in the NCC
- ☑ A2.2(2)(b)(ii) - Other verification methods accepted by the appropriate authority
- ☐ A2.2(2)(c) - Expert judgement
- ☐ A2.2(2)(d) - Comparison with the DtS provisions

Assessment approach:

☐ Comparative ☑ Qualitative ☑ Deterministic
☑ Absolute ☐ Quantitative ☐ Probabilistic

IFEG sub-systems used in the analysis:

☐ A – Fire initiation and development and control
☑ B – Smoke development and spread and control
☑ C – Fire spread and impact and control
☐ D – Fire detection, warning and suppression
☑ E – Occupant evacuation and control
☐ F – Fire services intervention

Acceptance criteria and factor of safety:

Occupant egress shall not be delayed or impeded by the reduced widths long the path of travel.

Fire scenarios and design fire parameters:

A fire occurring in the room and/or vicinity of the identified reduced widths has been considered for this assessment.

Describe how fire brigade intervention will be addressed or considered:

Brigade intervention is not considered to be impacted by the reduced widths as all occupants are expected to egress out of the building upon brigade arrival. In addition, the reduced widths are still adequate for safe and timely fire brigade access.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

Provide details on proposed modelling/assessment tools:

N/A

Issue number: 11 **Title:** Discharge of fire-isolated stairs

Details of departures from DtS provisions:

Egress from the central fire-isolated stairway servicing tower A discharges onto the ground level open space whereby the path of travel to Broomfield Road requires occupants to pass within 6 m of unprotected openings in retail tenancies.

Applicable DtS provisions (including clause excerpt):	D2D12 *(BCA 2019 D1.7)*	Applicable Performance Requirements:	D1P4, D1P5, E2P2 *(BCA 2019 DP4, DP5, EP2.2)*

List key fire safety measures:

The building shall be protected throughout with automatic fire suppression system (AS 2118.1 – 2017) with fast response heads, except as otherwise denoted in this report.

The building shall be protected throughout with an automatic fire detection and alarm system (AS 1670.1 – 2018) except as otherwise denoted in this report.

The building shall be protected by both internal and external fire hydrants for use by FRNSW in the event of an emergency.

A combination of Fire Hose Reels and Portable Fire Extinguishers shall be provided to facilitate first instance firefighting by occupants.

Proposed performance solution:

BCA Intent

Clause D2D12 states that where a path of travel from the point of discharge of a fire-isolated exit necessitates passing within 6 m of any part an external wall of the same building, measured horizontally at right angles to the path of travel, that part of the wall must have any openings protected internally in accordance with C4D5.

The intent of Performance Requirement D1P4 is to provide exits at a location to allow occupants to evacuate safely.

The intent of Performance Requirement D1P5 is to protect evacuating occupants in an exit or open space from a fire within the building.

Performance Requirement E2P2 states in the event of a fire in a building the conditions in any evacuation route must be maintained for the period of time occupants take to evacuate the part of the building so that the temperature will not endanger human life, the level of visibility will enable the evacuation route to be determined and the level of toxicity will not endanger human life.

From the above it is evident that it must be demonstrated that evacuating occupants will be adequately protected from the effects of a fire from the point at which they discharge to open space until they reach a road.

Analysis

Occupants when discharging from the residential levels and basement carpark of tower A onto the ground floor, will need to pass within 6 m of unprotected openings in the retail tenancies, as shown in Figure 19.

However, the compartments to which the occupants are exposed to are sprinkler protected. In the event of a fire within these spaces, the sprinkler system would activate to extinguish or at least control the development of a fire. Studies [Mawhinney, J.R., 1994, "Effects of automatic sprinkler protection on smoke control", National Research Council, Canada] have shown that compartment temperatures associated with sprinkler-controlled fires generally do not exceed 200°C. At such temperatures, the maximum radiant heat flux emitted from the opening would be 2.84 kW/m^2 based on the Stefan-Boltzmann equation converting temperature into radiant heat flux. Given the size of the openings and the distance occupants would be from the openings, this is expected to result in a heat flux less than 2.5 kW/m^2 which is within the tenability criteria for occupants. As such, in this scenario it is considered that the occupants would be able to safely pass by the openings.

In the event that the sprinkler system fails to operate, the radiant heat may become excessive and hinder safe evacuation past the affected opening. However, as can be seen in Figure 19, occupants have the option to travel in an alternative direction away from the subject opening and can therefore reach Cabramatta Road East or open space safely.

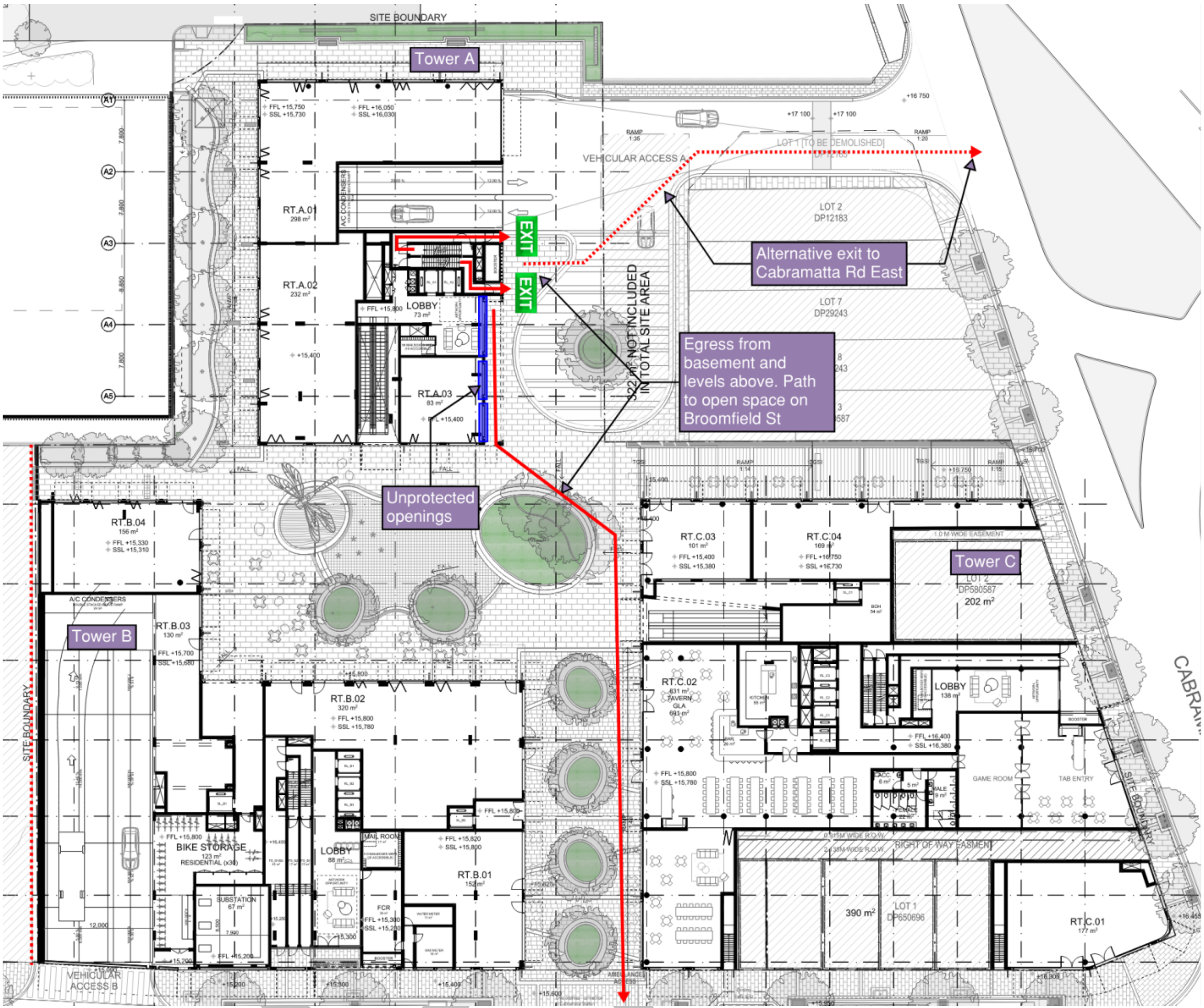

Figure 37: Egress past unprotected openings – tower A

Conclusion

The Performance Solution has qualitatively shown that the existence of alternative travel paths, as well as addition of sprinklers which would control the temperatures of a fire, ensure that occupants would experience safe conditions in an evacuation. Consequentially, Performance Requirements D1P4, D1P5 and E2P2 have been met.

Performance solution:

- ☑ A2.2(1)(a) - Comply with all relevant performance requirements
- ☐ A2.2(1)(b) - Be at least equivalent to the DtS provisions

Assessment methods:

- ☐ A2.2(2)(a) - Evidence of suitability
- ☐ A2.2(2)(b)(i) - Verification methods provided in the NCC
- ☑ A2.2(2)(b)(ii) - Other verification methods accepted by the appropriate authority
- ☐ A2.2(2)(c) - Expert judgement
- ☐ A2.2(2)(d) - Comparison with the DtS provisions

Assessment approach:

☐ Comparative	☑ Qualitative	☑ Deterministic
☑ Absolute	☐ Quantitative	☐ Probabilistic

IFEG sub-systems used in the analysis:

☐ A – Fire initiation and development and control
☐ B – Smoke development and spread and control
☑ C – Fire spread and impact and control
☑ D – Fire detection, warning and suppression
☑ E – Occupant evacuation and control
☐ F – Fire services intervention

Acceptance criteria and factor of safety:

Evacuating occupants shall be adequately protected from the effects of a fire from the point at which they discharge from tower A until they reach a road or open space.

Fire scenarios and design fire parameters:

A fire within the retail tenancies of tower A has been considered.

Describe how fire brigade intervention will be addressed or considered:

FRNSW are unlikely to be affected by this solution, as it has been demonstrated that occupants are capable of traversing with alternative routes to escape the building.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

Provide details on proposed modelling/assessment tools:

N/A

Issue number: 12 **Title:** Separation of rising and descending stair flights

Details of departures from DtS provisions:

It is proposed to permit rising and descending stairwells to not be smoke separated in accordance with D3D5 of the BCA.

Applicable DtS provisions (including clause excerpt):	D3D5, Spec 11 *(BCA 2019 D2.4, Spec C2.5)*	Applicable Performance Requirements:	D1P4, E2P2 *(BCA 2019 DP4, EP2.2)*

List key fire safety measures:

Additional directional exit signage is required within the central fire stairs, on the level of convergence between the rising and descending stairs, as well as on the mid landings above and below, as detailed below.

Proposed performance solution:

BCA Intent

BCA Clause D3D5 sets the minimum requirements for the separation of rising and descending stair flights. The following are the DtS compliant requirements:

- There must be no direct connection between –
  - A flight rising from a storey below the lowest level of access to a road or open space; and
  - A flight descending from a storey above that level; and
- Any construction that separates or is common to the rising and descending flights must be –
  - Non-combustible; and
  - Smoke proof in accordance with Clause 2 of Specification 11

The intent of this requirement is to ensure occupants do not mistakenly pass the final discharge level of the exit.

Performance requirement D1P4 states exits must be provided from a building to allow occupants to evacuate safely, with their number, location and dimensions being appropriate to the travel distance, number and characteristics of occupants, function of the building, and height of the building.

Performance requirement E2P2 states in the event of a fire in a building the conditions in any evacuation route must be maintained for the period occupants take to evacuate the part of the building so that the temperature will not endanger human life, the level of visibility will enable the evacuation route to be determined and the level of toxicity will not endanger human life.

Analysis

In the absence of smoke separation and with inadequate signage, occupants evacuating via a converging staircase, may mistakenly pass the final discharge level, thereby inhibiting or delaying the overall building evacuation. The figures below depict the converging stairs of each tower as they discharge onto the ground floor.

To mitigate the likelihood of occupants missing the discharge level and continuing to move up or down the fire stairs, it is proposed to provide additional exit signage within the fire stair directing occupants toward the final discharge door. When occupants are approaching the final discharge level, they will be able to observe the directional signage and be led towards the discharge door. Additional signage shall also be provided on the discharge doors on this level stating “EXIT TO OUTSIDE”. Furthermore, wayfinding signage shall be provided within the stairway at the level of discharge. The signage shall read “EXIT AT THIS LEVEL” with arrow symbol pointing towards the final discharge door. The signage will be located 1.5 m off the FFL and have a font size not less than 30 mm with a contrasting background. This signage will provide a clear visual indication to occupants that they are on the discharge floor when moving upwards or downwards along the fire stairs. Therefore, by providing a clear visual indicator, occupants are expected to discharge on the correct level, and not pass the discharge level accidently.

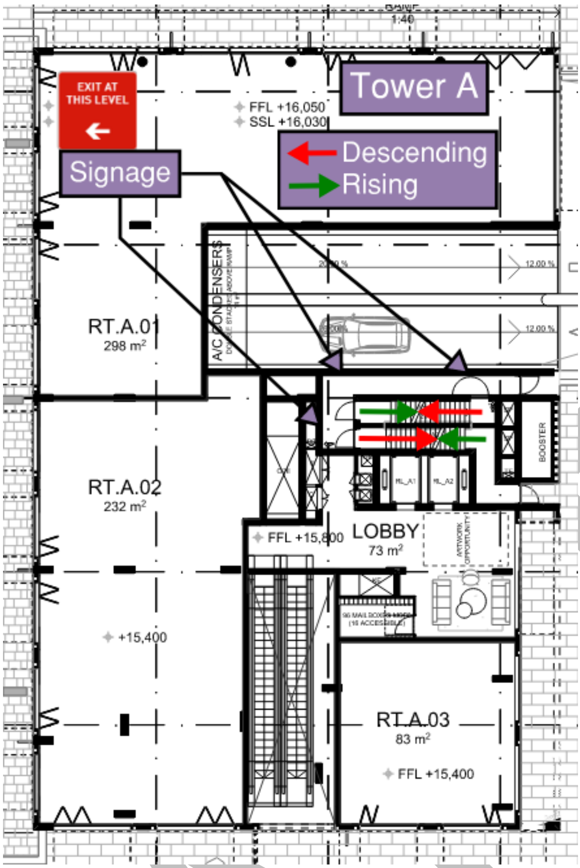

Figure 38: Tower A ground floor – Location of converging stairs and additional exit signage

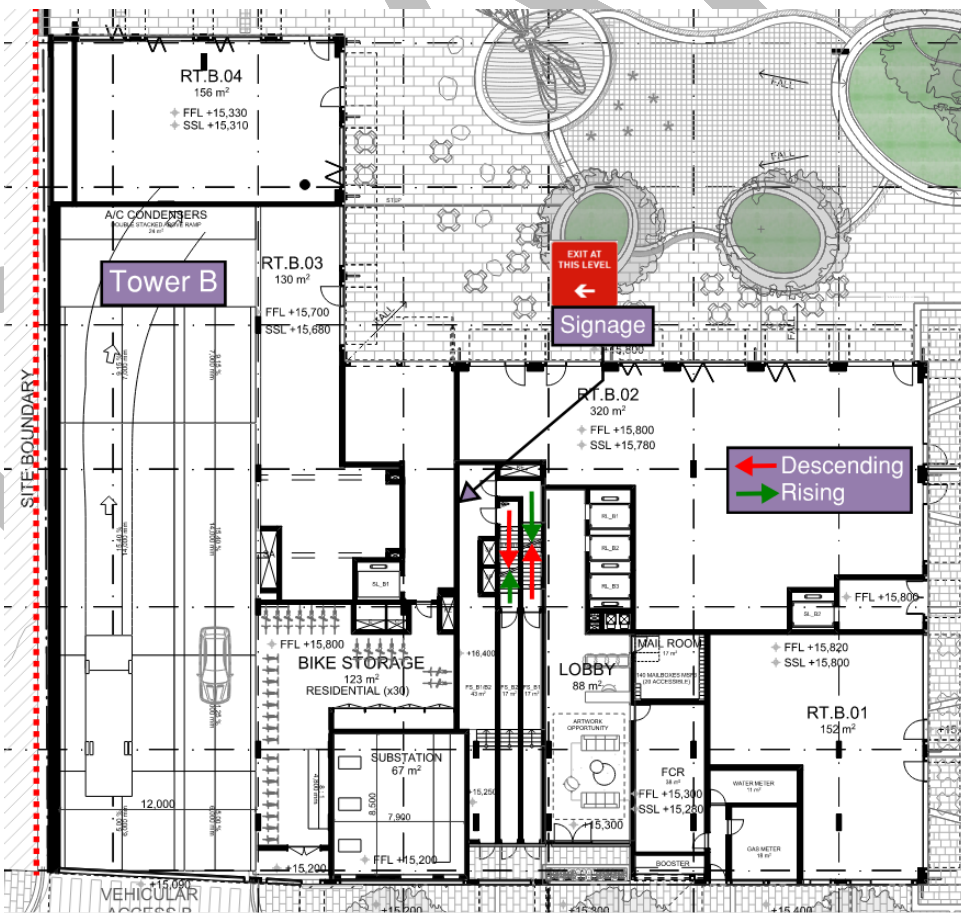

Figure 39: Tower B ground floor – Location of converging stairs and additional exit signage

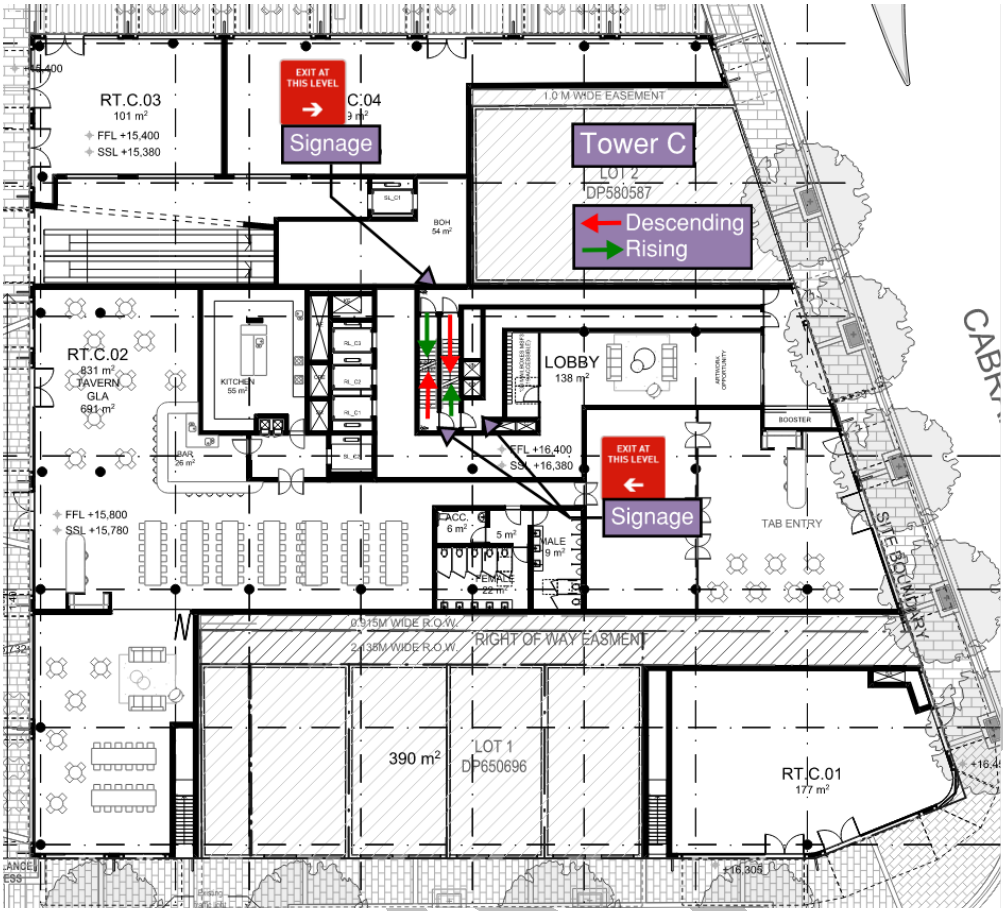

Figure 40: Tower C ground floor – Location of converging stairs and additional exit signage

However, in the scenario where occupants do miss the discharge level, signage is to be provided on the mid-landings above and below the discharge level, alerting occupants to the location of the discharge point on the stairs. This will prevent them from continuing to move in the wrong direction in the fire stairs. At the floor landing above the level of discharge, a sign is to be provided with the text “TRAVEL DOWN TO EXIT”. The floor landing below the level of discharge is also to be provided with signage stating, “TRAVEL UP TO EXIT”. This signage serves as a redundancy measure, immediately alerting occupants to the fact they have passed the discharge level in the unlikely event that they miss the exit signage on the discharge level. The lettering shall be at least 50mm tall and of a colour contrasting the background, serving as a clear visual indicator for building occupants.

Conclusion

The assessment has shown that occupants are provided with adequate means to identify the final discharge level using appropriate signage, avoiding the scenario where they accidentally pass the final discharge level. As such, compliance with Performance Requirements D1P4 and E2P2 is considered to be achieved.

Performance solution:

- ☑ A2.2(1)(a) - Comply with all relevant performance requirements
- ☐ A2.2(1)(b) - Be at least equivalent to the DtS provisions

Assessment methods:

- ☐ A2.2(2)(a) - Evidence of suitability
- ☐ A2.2(2)(b)(i) - Verification methods provided in the NCC
- ☑ A2.2(2)(b)(ii) - Other verification methods accepted by the appropriate authority
- ☐ A2.2(2)(c) - Expert judgement
- ☐ A2.2(2)(d) - Comparison with the DtS provisions

Assessment approach:

☐ Comparative	☑ Qualitative	☑ Deterministic
☑ Absolute	☐ Quantitative	☐ Probabilistic

IFEG sub-systems used in the analysis:

☐ A – Fire initiation and development and control	☑ D – Fire detection, warning and suppression
☑ B – Smoke development and spread and control	☑ E – Occupant evacuation and control
☐ C – Fire spread and impact and control	☐ F – Fire services intervention

Acceptance criteria and factor of safety:

Occupants shall be provided with an adequate means to identify the final discharge level to avoid accidentally passing it.

Fire scenarios and design fire parameters:

The performance solution is qualitative in nature and as such no fire parameters have been specified.

Describe how fire brigade intervention will be addressed or considered:

The additional signage will also assist the attending fire brigade personnel in locating the final exits.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

Provide details on proposed modelling/assessment tools:

N/A

Issue number: 13 Roller shutters and sliding doors in path of travel

Details of departures from DtS provisions:

It is proposed to install roller shutters in the basement levels 1-3 as shown in Figure 41, which will not be manually operable with a force no greater than 110N.

Additionally, it is proposed to install sliding doors on level 1 within tower C which form a path of travel to exit from retail tenancies to the fire-isolated stairway. As such these sliding doors do not lead directly to a road or open space and will not be manually operable with a force no greater than 110N.

Both of these installations will be non-compliant with BCA clause D3D24.

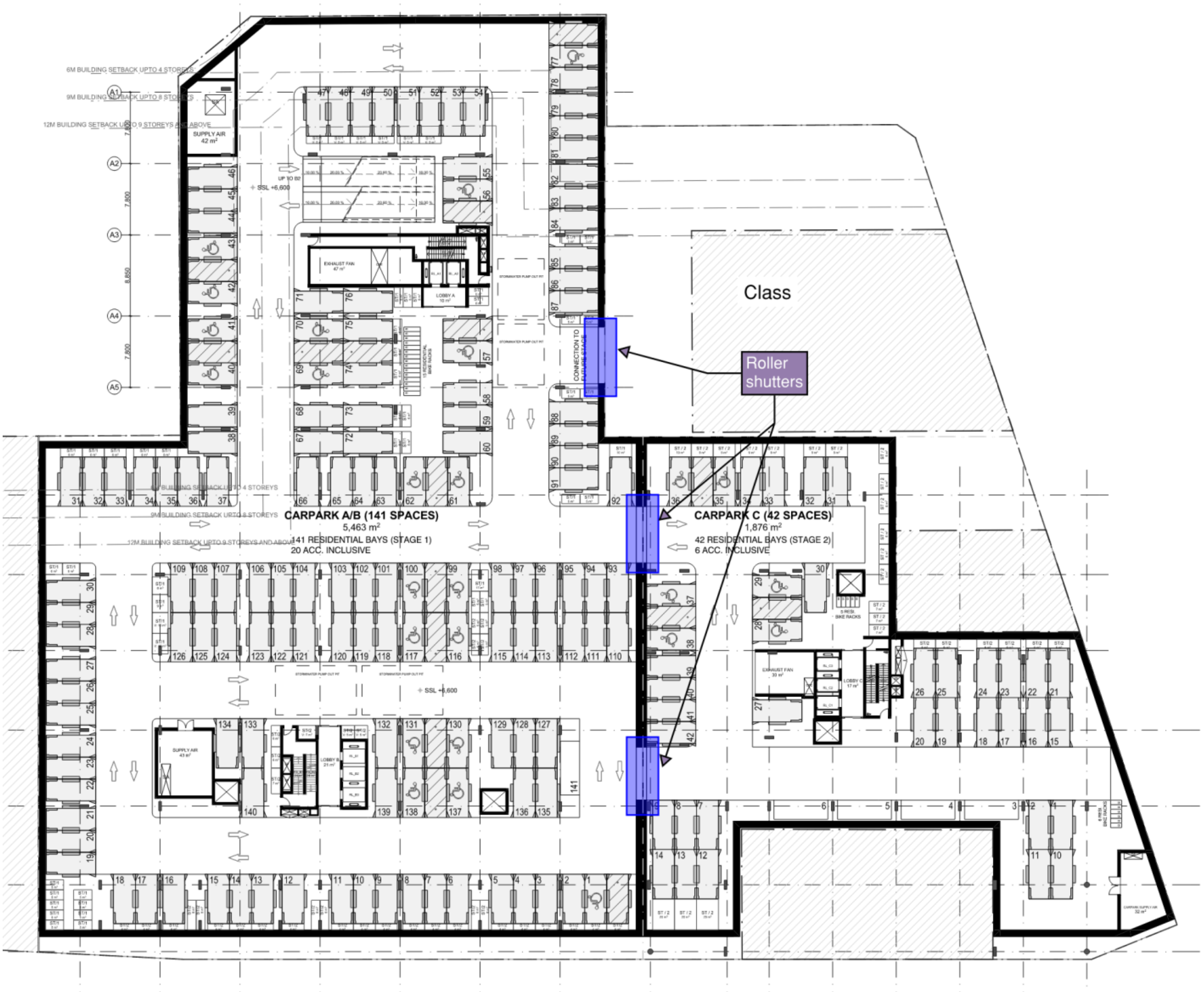

Figure 41: Basement use of roller shutters (basement 3 shown indicative of other levels)

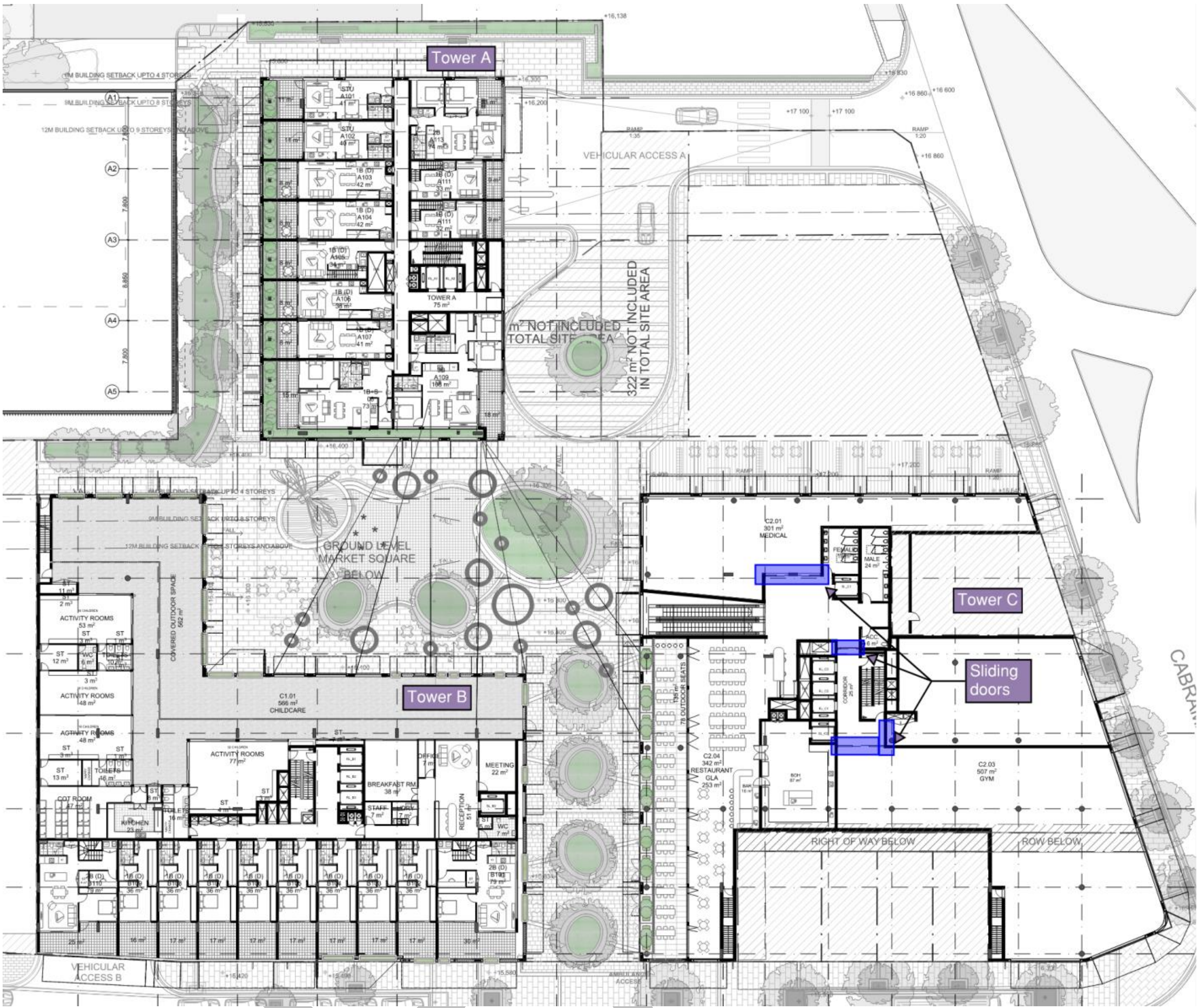

Figure 42: Level 1 tower C use of sliding doors

Applicable DtS provisions (including clause excerpt):	D3D24 *(BCA 2019 D2.19)*	Applicable Performance Requirements:	D1P2, D1P4, E2P2 *(BCA 2019 DP2, DP4, EP2.2)*

List key fire safety measures:

Upon activation of the fire alarm within the building, the sliding doors shall automatically open.

The roller shutter and sliding doors shall be provided with a green push button (at least 30mm in diameter) with signage stating “PUSH/PRESS TO EXIT” and shall cause the doors to automatically open to allow egress. The push button is to be located on the side facing occupants seeking egress within 1.5 m of the door. Letters shall be a minimum 6mm high on a contrasting background. The auto open function of the door and associated push button shall be powered of the essential services board or shall be provided with battery back-up.

The roller shutters and sliding doors shall be connected to essential backup (e.g. local battery back-up) such that on power failure to the building, the operation of the door is not impacted. The backup should allow for a minimum of 10 opening/closing cycles.

Controls shall be provided at the FIP so that fire brigade can operate the shutters and sliding doors.

Proposed performance solution:

BCA Intent

D3D24 states that a doorway serving as a required exit or forming part of a required exit, must not be:

- fitted with a roller shutter unless:

(A) it serves a Class 6, 7 or 8 building or part with a floor area not more than 200 m2; and

(B) the doorway is the only required exit from the building or part; and

(C) it is held in the open position while the building or part is lawfully occupied

- fitted with a sliding door unless:

  (A) is leads directly to a road or open space; and

  (B) the door is able to be opened manually under a force of not more than 110 N

The intent of this clause is to prevent an exit doorway from being compromised due to an obstruction. In this case, a roller shutter or sliding door could be closed and could impede occupant egress.

Performance Requirement DP2 states "so that people can move safely to and within a building, it must have walking surfaces with safe gradients; and any doors installed to avoid the risk of occupants having their egress impeded; or being trapped in the building."

Performance Requirement DP4 states exits must be provided from a building to allow occupants to evacuate safely, with their number, location and dimensions being appropriate to the travel distance, number and characteristics of occupants, function of the building, and height of the building.

Performance Requirement EP2.2 states in the event of a fire in a building the conditions in any evacuation route must be maintained for the period occupants take to evacuate the part of the building so that the temperature will not endanger human life, the level of visibility will enable the evacuation route to be determined and the level of toxicity will not endanger human life.

Therefore, to meet the Performance Requirements, the proposed roller shutter and sliding door design must not present as a potential obstacle to occupant egress.

Analysis

An exit doorway that is fitted with a roller shutter or sliding door presents a risk that occupants will be unable to open the devices in a timely manner, thus delaying their egress and potentially exposing them to hazardous fire and smoke conditions.

<u>Basement Roller Shutters</u>

The roller shutters in the three basement levels will be provided with a manual push button control adjacent to the shutter, which will be installed such that it is prominent against the surrounding surface and therefore easily identifiable to the occupants leaving the space. This push button will enable occupants to easily open the roller shutters via the push button, and therefore egress the area in a timely manner.

Additionally, the roller shutter shall be connected to essential backup (eg. local battery) such that in the event of power failure, the roller shutter will not be impacted, and will still be operable via the mechanical push button.

It should also be noted that given the use of the affected areas (bulk storage, garbage storage, garage), they are not expected to be frequently occupied, or will have a low population at any given time. As such, in a fire scenario, occupants are expected to be able to egress the area quickly without the need to queue.

It is anticipated the roller shutters will be in the open position for the majority of time, so cars bays in carpark C can be accessed at during most periods of the day.

<u>Level 1 Tower C Sliding Doors</u>

The proposed sliding doors accessing retail tenancies in level 1 of tower C will be installed with an auto open feature. Therefore, upon the activation of the building fire alarm, the doors will automatically open. This will ensure that the sliding doors are open at the commencement of occupant egress, thus not delaying occupant evacuation.

Additionally, the sliding doors shall be connected to essential backup (eg. local battery) such that in the event of power failure, these doors will not be impacted, and will still automatically open on a fire trip.

This design of sliding doors is required due to the anticipated high population from the combined retail tenancies. The number of persons accommodated can be determined according to Clause D2D18 of the BCA. Individual occupancies are detailed in Figure 43, with a calculated floorplate total of 426 people.

It should also be noted that there are alternative egress paths for the affected areas, as shown in the markup in Figure 43.

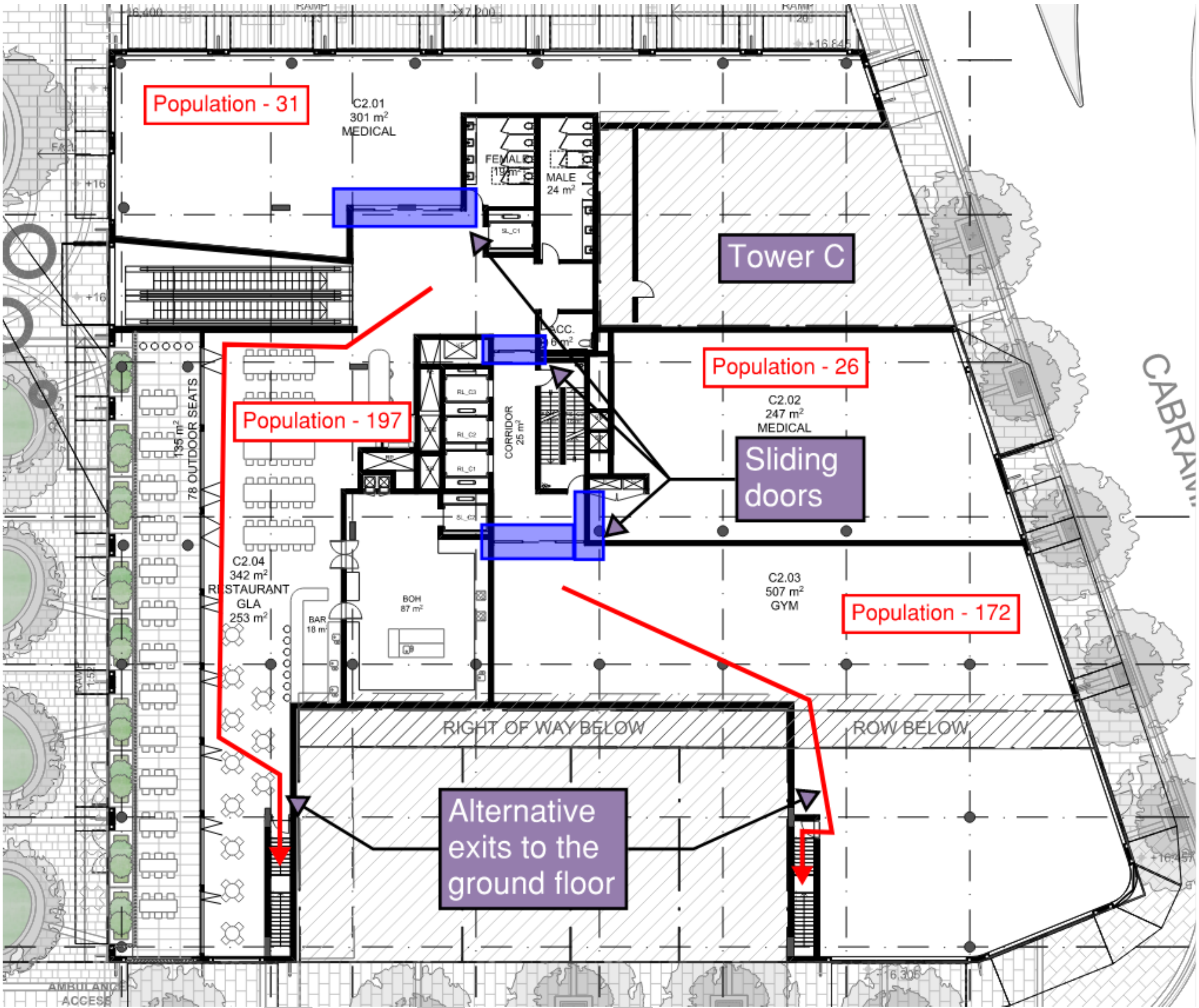

Figure 43: Level 1 tower C – population and alternative exits to ground floor

Conclusion

The assessment has qualitatively demonstrated that by inclusion of a manual push to open button/automatic opening features for the subject doors, along with an override button at the FIP, occupant egress and fire brigade intervention are not expected to be impeded. As such, Performance Requirements D1P2, D1P4 and E2P2 are considered to be satisfied.

Performance solution:

- ☑ A2.2(1)(a) - Comply with all relevant performance requirements
- ☐ A2.2(1)(b) - Be at least equivalent to the DtS provisions

Assessment methods:

- ☐ A2.2(2)(a) - Evidence of suitability
- ☐ A2.2(2)(b)(i) - Verification methods provided in the NCC
- ☑ A2.2(2)(b)(ii) - Other verification methods accepted by the appropriate authority
- ☐ A2.2(2)(c) - Expert judgement
- ☐ A2.2(2)(d) - Comparison with the DtS provisions

Assessment approach:

☐ Comparative
☑ Absolute
☑ Qualitative
☐ Quantitative
☑ Deterministic
☐ Probabilistic

IFEG sub-systems used in the analysis:

☐ A – Fire initiation and development and control
☐ B – Smoke development and spread and control
☐ C – Fire spread and impact and control
☑ D – Fire detection, warning and suppression
☑ E – Occupant evacuation and control
☑ F – Fire services intervention

Acceptance criteria and factor of safety:

Occupant egress shall not be impeded by the roller shutters and sliding doors

Fire scenarios and design fire parameters:

Occupant egress via the roller shutters and sliding doors has been considered. As such, no specific fire scenario has been considered.

Describe how fire brigade intervention will be addressed or considered:

Brigade intervention is not considered to be impacted due to the suitable egress provisions provided to building occupants.

Verification/validation analyses:

☐ Sensitivity studies
☐ Redundancy studies
☐ Uncertainty studies
☑ None

Provide details on proposed modelling/assessment tools:

N/A

Issue number: 14 **Title:** Use of bifold from retail areas

Details of departures from DtS provisions:

Permit the use of bifold doors in lieu of swing doors to serve as exits for ground floor retail tenancies in tower A as shown in Figure 44.

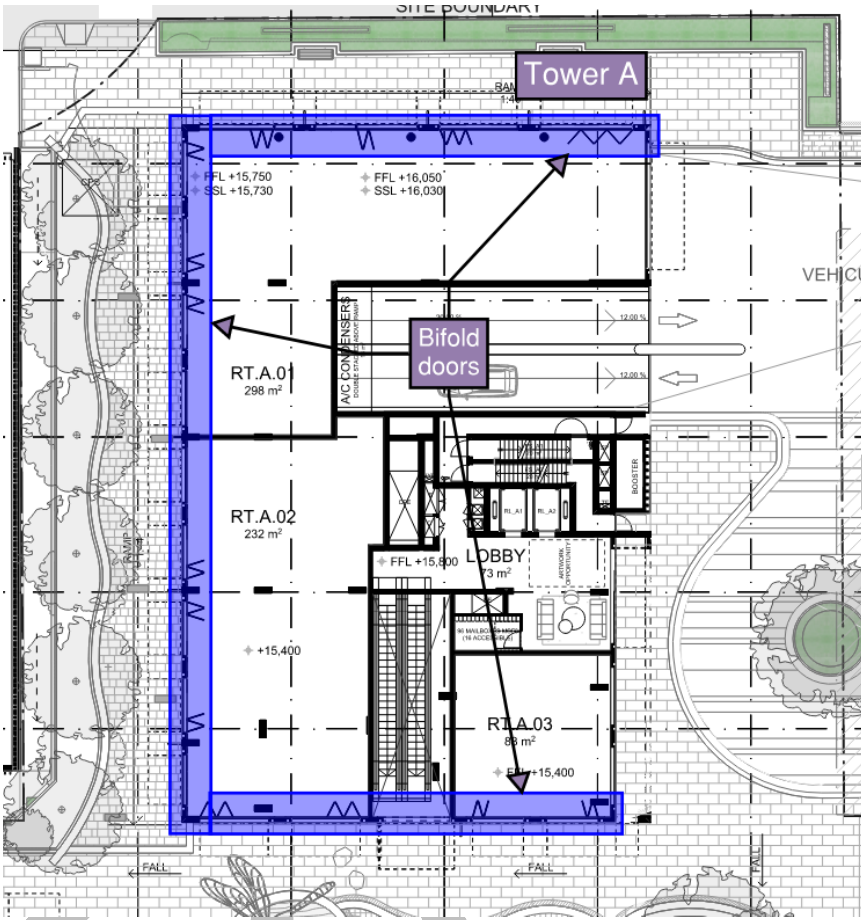

Figure 44: Tower A ground floor – Use of bifold doors to exit retail tenancies

Applicable DtS provisions (including clause excerpt):	D3D26 *(BCA 2019 D2.21)*	Applicable Performance Requirements:	D1P4 *(BCA 2019 DP4)*

List key fire safety measures:

Plan of management to be developed so that the bifold doors serving the retail tenancies are held in the open position during active trading hours.

Proposed performance solution:

BCA Intent

The intent of BCA Clause D3D26 is to minimise the risk that evacuation will be delayed by the operation of a door latch.

Performance requirement D1P4 states exits must be provided from a building to allow occupants to evacuate safely, with their number, location and dimensions being appropriate to the travel distance, number and characteristics of occupants, function of the building, and height of the building.

Analysis

The retail tenancies in tower A shall be provided with bifold door systems to provide access to the ground floor open space, which is not proposed to be provided with door hardware which complies with the 'single downward action' requirement of the BCA to open the door.

To facilitate fast and efficient egress, a plan of management shall be developed whereby the operators of the retail stores shall keep the bifold doors in the held open position as often as practicable during hours of business. If a fire occurs during business hours, the open bifold door will operate like a set of held open swing doors and will not impede egress. During the times when the bifold doors are closed staff will be at hand to operate the doors. The staff are familiar with the layout of the building, in an evacuation scenario they will be aware of the bifold doors which don't open with a latch design, thus minimising any delay in the opening of the door. This reduces the likelihood of crowding and congestion at an exit door, mitigating the hazard of occupants becoming trapped against a closed door. The familiarity of the occupants and the relatively low population numbers will minimise the risk of panic typically caused by large crowds that are unfamiliar with the space. A building management plan and site induction as part of employment should also highlight this design. Thus it is deemed the risk is low in impeding the safe evacuation.

Outside of trading hours, the tenancies are expected to contain only staff and maintenance personnel, who will be inducted into the workspace and familiar with the door operation. During a worst case scenario where a fire occurs while the bifold doors are closed, the small number of staff members present will be capable of self-evacuation despite not having a simple door mechanism.

Conclusion

As a result, it has been determined that the use of a bifold door system on ground floor shall facilitate efficient egress, when used in coordination with a management in use plan which requires the door to be held open during normal operating hours. Therefore, performance requirements D1P4 has been met.

Performance solution:

- ☑ A2.2(1)(a) - Comply with all relevant performance requirements
- ☐ A2.2(1)(b) - Be at least equivalent to the DtS provisions

Assessment methods:

- ☐ A2.2(2)(a) - Evidence of suitability
- ☐ A2.2(2)(b)(i) - Verification methods provided in the NCC
- ☑ A2.2(2)(b)(ii) - Other verification methods accepted by the appropriate authority
- ☐ A2.2(2)(c) - Expert judgement
- ☐ A2.2(2)(d) - Comparison with the DtS provisions

Assessment approach:

☐ Comparative	☑ Qualitative	☑ Deterministic
☑ Absolute	☐ Quantitative	☐ Probabilistic

IFEG sub-systems used in the analysis:

☐ A – Fire initiation and development and control	☐ D – Fire detection, warning and suppression
☐ B – Smoke development and spread and control	☑ E – Occupant evacuation and control
☐ C – Fire spread and impact and control	☐ F – Fire services intervention

Acceptance criteria and factor of safety:

The solution is considered acceptable if it demonstrated that occupants are capable of evacuating from the ground floor retail compartment of the development.

Fire scenarios and design fire parameters:

A scenario within the retail tenancies where occupants are required to leave the area.

Describe how fire brigade intervention will be addressed or considered:

Fire brigade are not considered to be affect by the performance solution, due to the occupant's ability to self-evacuate from the fire affected space.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

Provide details on proposed modelling/assessment tools:

N/A

Issue number: 15 **Title:** Fire hydrant and sprinkler booster location and doors

Details of departures from DtS provisions:

The proposed development will have multiple building entrances to each tower, without the development containing a 'main' entrance. Therefore, it is not possible for all the booster assemblies to be located within line sight of the main entrance to the development.

The location of the hydrant/sprinkler booster assemblies has been provided below in Figure 45.

Additionally it is proposed to permit the use of roller shutters in lieu of swing doors on the hydrant booster enclosure.

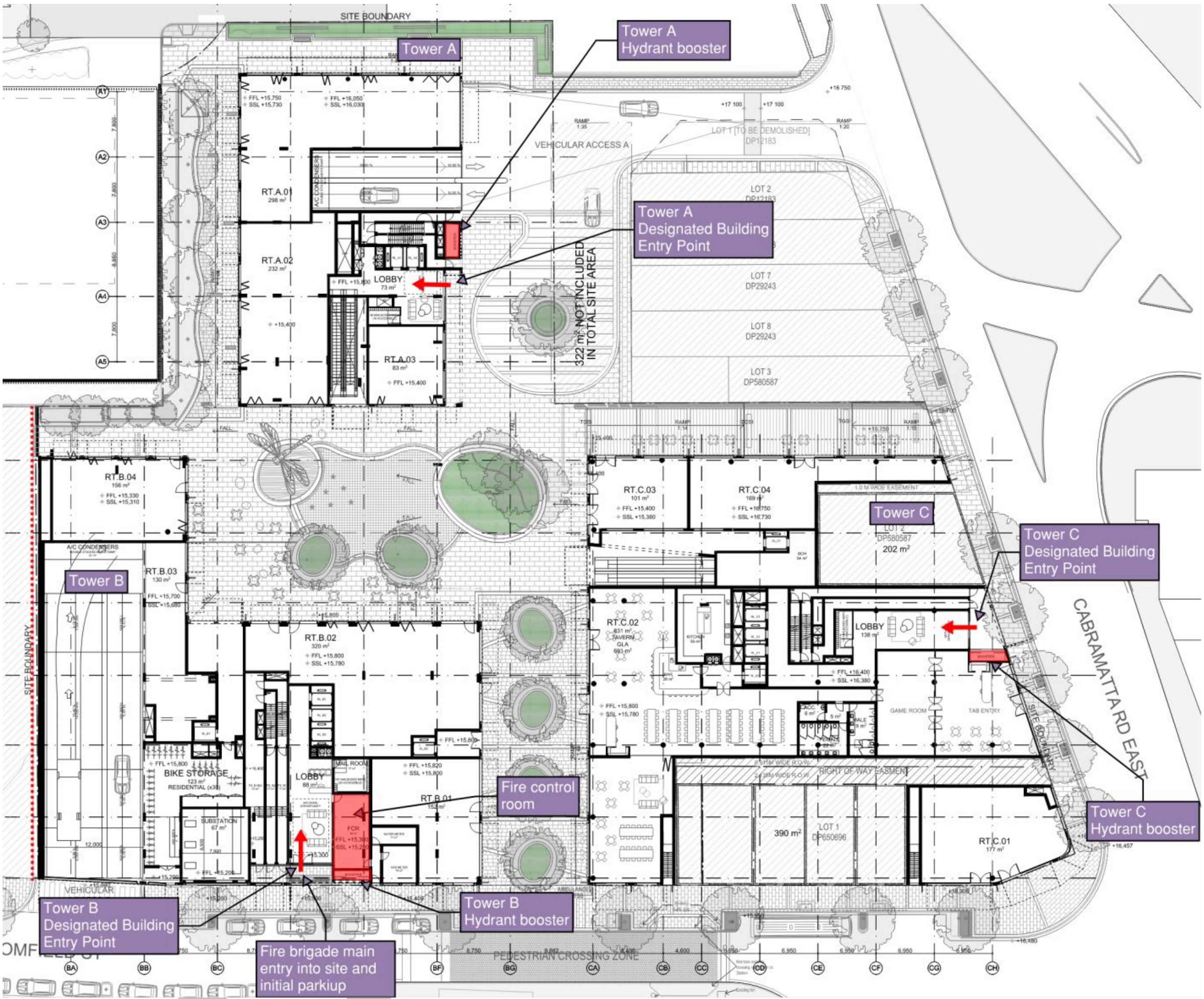

Figure 45: Building fire hydrant and booster locations

Applicable DtS provisions (including clause excerpt):	E1D2 *(BCA 2019 E1.3)*	Applicable Performance Requirements:	E1P3 *(BCA 2019 EP1.3)*

List key fire safety measures:

The building shall be protected by both internal and external fire hydrants for use by FRNSW in the event of an emergency.

The block plan provided to the site shall indicate the location of all significant fire services required for fire brigade intervention.

Additional information shall be available at the FIP for wayfinding once FRNSW arrive to site.

Hydrant enclosure roller shutters shall be able to be opened manually under a force of not more than 110 N.

Proposed performance solution:

BCA Intent

Clause E1.3 states the fire hydrant system must be installed in accordance with AS2419.1-2005. The standard states that the booster assembly must be readily accessible and if the booster assembly is within or affixed to the external wall of the building the booster shall be within sight of the main entrance to the building.

Performance solution EP1.3 states fire hydrant systems must be provided to the degree necessary to facilitate the needs of the fire brigade appropriate to fire fighting operations, the floor area of the building, and the fire hazard.

AS2419.1-2021 states that fire brigade booster assembly enclosures shall be fitted with the following:

(a) Doors that, when open, do not encroach on exits or inhibit access to other firefighting equipment.

(b) Doors that are—

(i) side-hung swing door(s) with each door fitted with hinges of stainless steel or copper alloy and a device capable of securing the door in not less than a 90° open position; or

(ii) lift-off panel(s) not larger than 1500 mm high by 1200 mm wide, weighing not more than 20 kg and fitted with not less than two D-handles near the top of the panel.

(c) Doors having—

(i) a lever type handle;

(ii) a lock compatible with fire brigade operational procedures/requirements; and

(iii) signage affixed to or painted on the door (or doors) in accordance with the requirements of Clause 11.3.1.1.

The intent of the BCA is to ensure brigade operations are facilitated upon arrival to an emergency without excessive delay.

Analysis

The booster for each tower is proposed to be located adjacent to the respective ground floor lobby entrances. Due to there being multiple main entrances throughout the development, the boosters for all towers are not located within line of sight of all the main entrances, thus not meeting the DtS requirements.

As such, there is the potential for fire brigade intervention to be delayed due to difficulty in locating the boosters. However, as highlighted in Figure 46, all the boosters are in close proximity to the principal vehicle entrance to each tower. It is anticipated the fire brigade will park up outside tower B to access the fire control room. If the fire location is in tower A or C, the brigade appliance will be relocated along Broomfield Street heading South and turning East onto Cabramatta Road East. The boosters are generally located along the vehicle path for the attending fire brigade. However, the booster for tower C is not in direct line of sight heading East, as such to notify the fire brigade, signage shall be provided stating, “TOWER C BOOSTER LOCATION”. Hence, each booster is expected to be readily visible to the fire brigade upon arrival, preventing any delay in fire brigade intervention.

To further provide visual aid to the fire brigade in locating the booster, a strobe will be installed above the booster assembly which is to trigger upon activation of the building alarm. This will provide a strong visual indicator to the intervening fire brigade, further assisting them in locating the booster and preventing a delay in brigade intervention.

In the event that the fire brigade do not identify the booster upon their arrival, it is also proposed to include block plans at the FIP or within the fire control room and any mimic panels in other towers, indicating the location of the booster for each tower to fire brigade personnel. The incorporation of block plans and a strobe light into the design will allow FRNSW to quickly locate the booster assembly if it has not already been located upon arrival.

The hydrant boosters will be housed within enclosures that are fitted with roller shutters in lieu of side-hung swing doors, as such they will be no compliant with AS2419.1. This may impede the fire brigade form accessing the firefighting equipment in a timely manner. The booster roller shutter design shall have the following specifications at a minimum:

- Constructed using interlocking galvanised steel slats of 100 x 1.0mm in thickness.
- Vertical guide tracks 2mm thick with “L” shape fixing lugs of not more than 550mm centres apart.
- Manually openable under a force of not more than 110 N.
- D-shaped lifting handles to the inside and outside

- a lock compatible with fire brigade operational procedures/requirements
- signage affixed to or painted on the door (or doors) in accordance with the requirements of Clause 11.3.1.1 of AS2419.1-2021.

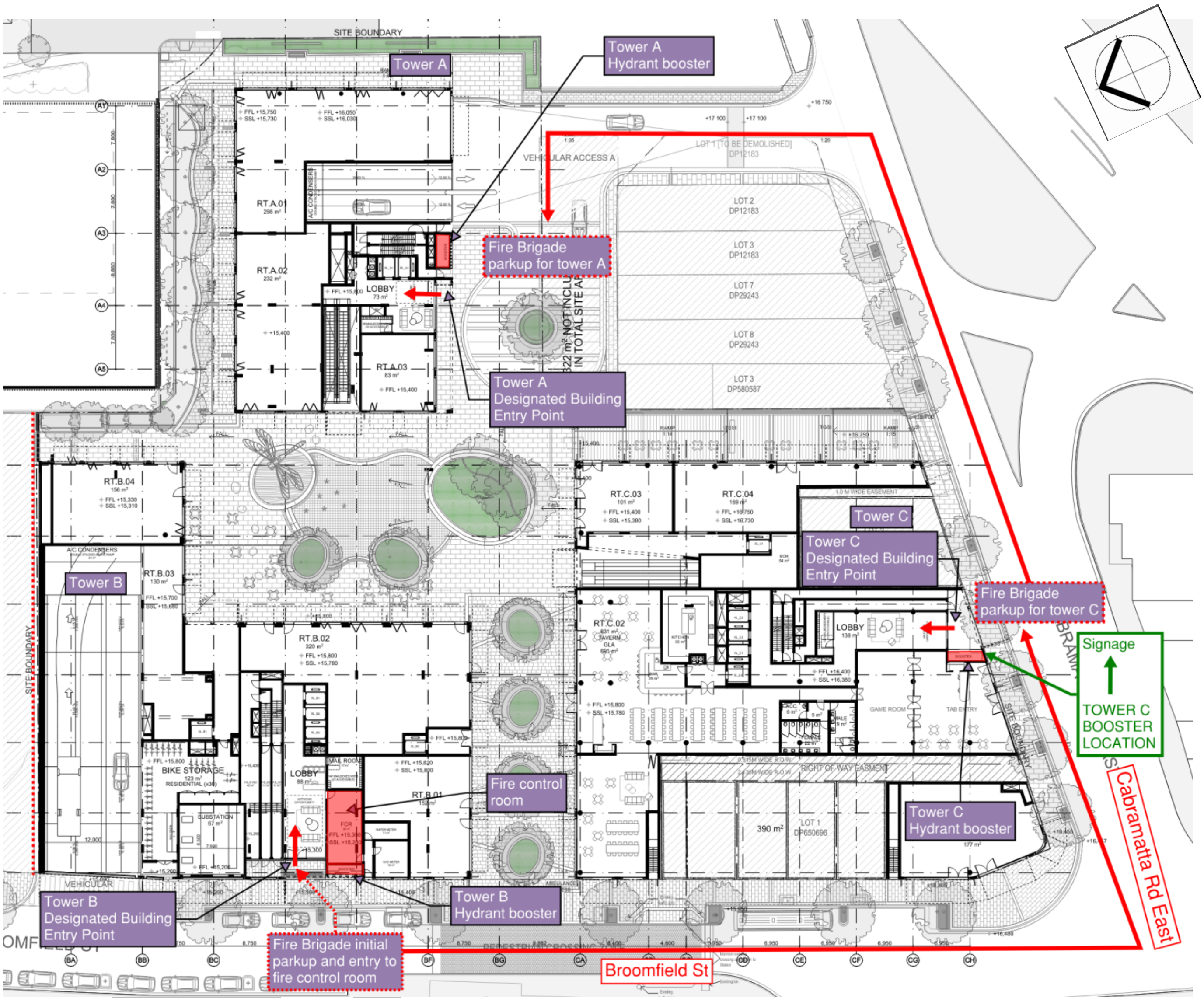

Figure 46: Fire brigade expected path to all towers

Conclusion

The Performance solution has qualitatively demonstrated that the inclusion of additional wayfinding at the site is expected to aid fire brigade intervention upon arrival. As such, Performance Requirement E1P3 is considered to be satisfied.

Performance solution:

☑ A2.2(1)(a) - Comply with all relevant performance requirements
☐ A2.2(1)(b) - Be at least equivalent to the DtS provisions

Assessment methods:

☐ A2.2(2)(a) - Evidence of suitability
☐ A2.2(2)(b)(i) - Verification methods provided in the NCC
☑ A2.2(2)(b)(ii) - Other verification methods accepted by the appropriate authority
☐ A2.2(2)(c) - Expert judgement
☐ A2.2(2)(d) - Comparison with the DtS provisions

Assessment approach:

☐ Comparative ☑ Qualitative ☑ Deterministic
☑ Absolute ☐ Quantitative ☐ Probabilistic

IFEG sub-systems used in the analysis:

☐ A – Fire initiation and development and control
☐ B – Smoke development and spread and control
☐ C – Fire spread and impact and control
☐ D – Fire detection, warning and suppression
☐ E – Occupant evacuation and control
☑ F – Fire services intervention

Acceptance criteria and factor of safety:

The performance solution is considered acceptable if it is shown that brigade intervention is facilitated, and the booster identification is not significantly delayed.

Fire scenarios and design fire parameters:

N/A

Describe how fire brigade intervention will be addressed or considered:

Block plans and a strobe light has been required to facilitate brigade intervention and guide attending FRNSW members to key firefighting services located on site.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

Provide details on proposed modelling/assessment tools:

N/A

Issue number: 16 **Title:** Vertical ring main pass through fire-isolated scissor stairway

Details of departures from DtS provisions:

Due to the scissor stair arrangement in the building, the vertical portions of the ring main pass through the other stair at alternate levels rather than remain in a single fire-isolated stair shaft.

Applicable DtS provisions (including clause excerpt):	E1D5, Specification 17 *(BCA 2019 E1.5, Spec E1.5)*	Applicable Performance Requirements:	E1P3, E1P4 *(BCA 2019 EP1.3, EP1.4)*

List key fire safety measures:

The building shall be protected throughout with automatic fire suppression system (AS 2118.6 – 2012) with fast response heads, except as otherwise denoted in this report.

The building shall be protected throughout with an automatic fire detection and alarm system (AS 1670.1 – 2018) except as otherwise denoted in this report.

The building shall be protected by both internal and external fire hydrants for use by FRNSW in the event of an emergency.

A combination of Fire Hose Reels and Portable Fire Extinguishers shall be provided to facilitate first instance firefighting by occupants.

Proposed performance solution:

BCA Intent

Where a hydrant and sprinkler system are to be combined, they are to meet the requirements set out in BCA Clause E1D5 and Specification 17, and hence in turn be designed to the standards of AS2118.6-2012. Clause 2.6.2 of AS2118.6-2012 states:

“The vertical portions of the ring mains shall be located within separate fire-rated exits (stairways) or fire rated riser shafts.”

Performance Requirement E1P3 states a hydrant system must be provided to the degree necessary to facilitate the needs of the fire brigade appropriate to fire-fighting operations and the floor area of the building and the associated fire hazard of the building.

Furthermore, Performance Requirement E1P4 states that the intent of sprinkler installation is to control the development and spread of fire. The fire suppression system must be installed to the degree necessary to control the development and spread of fire.

Analysis

AS2118.6-2012 requires the vertical portions of a ring main to be located in separate fire stairs or fire rated risers. It is considered that the intent of this requirement is to provide protection, redundancy and safe access to this portion of the system. In the proposed design, whilst still contained fully within a fire rated stair shaft, the vertical portion of the ring main passes between the two scissor stairs on every level. As such, it must be demonstrated that in this configuration, protection, redundancy and safe access is still provided to the degree necessary. These three elements are discussed further below.

<u>Protection of Vertical Ring Mains from a Fire</u>

The vertical portions of the ring main are contained fully within a fire-isolated stair and therefore would be protected from a fire on the general floorplate. The internal parts of the scissor stair would be considered sterile areas free of combustible materials as required by the BCA DtS Provisions. As such, a fire originating within the stairs is not a credible scenario. The lack of combustible materials within the stair would not be able to facilitate a fire of a size that would threaten the integrity of the ring main.

In terms of the additional penetrations between the stairs, the vertical ring main passes through the fire isolated scissor stairs where the scissor stairs are considered two separate fire compartments. In order to prevent fire and smoke spread between stairs via penetrations, these penetrations are to be fire and smoke sealed as per BCA Clause C4D15. In a worst-case scenario where one of the fire stairs forming the scissor stairs becomes fire or smoke affected, the provisions of fire and smoke seals impedes the spread of fire and smoke from an affected fire stair to the other, unaffected fire stair. This ensures that the fire stairs remain fire isolated from one another.

<u>Reliability</u>

The discussion above considers the impediment of fire spread through separate fire compartments in a scenario whereby one of the fire stairs becomes smoke or fire affected. It is further rationalized that these spaces are highly unlikely to become fire affected due to the bounding construction at the perimeter of the stair, and the sterile nature of the space.

The fire stairs are a sterile space and are served by a sterile lobby area. Due to the low fuel load present within these areas, it is highly unlikely that a fire would initiate within this space given the lack of ignition sources (restricted to the electrical lighting), the most likely source of fire is expected to occur within an SOU / on the general floorplate which are separated by fire rated construction.

In a worst-case scenario where any smoke or hot gases from a fire travel towards the fire stairs, the stair pressurisation system serving the fire stairs will further prevent any gases entering the stairs. As such it is not expected that a fire will affect the vertical ring mains.

As such, given that fire spread to and within the fire stairs is not expected to occur, a single fire affecting both vertical portions of the ring main is not considered a credible scenario and as a result, the reliability of the system would be maintained to the degree necessary.

Fire Brigade Access

Whilst the ring main does pass between two alternative stairways, it should be noted that the sprinkler connection on each level to the ring main is accessed from a single fire isolated stairway only, allowing fire brigade personnel to access the sprinkler valves without the need to travel from one stairway to another.

It is shown that the fire brigade would be able to access the sprinkler valves on each level through a single fire isolated path. To facilitate fire brigade wayfinding, the access to the sprinkler valves will be indicated by signage at the FIP and at the booster assembly which will state “SPRINKLER VALVE ACCESS VIA CENTRAL FIRE STAIRS” and should incorporate lettering that is at least 20 mm in height and of a colour contrasting the background. Fire stairs shall be identified with signage on the access door where the fire brigade would enter the stair “FIRE STAIR - SPRINKLER VALVE ACCESS”.

Through the provision of signage, the fire brigade will be aware of the location of the sprinkler control valves and will know to enter the building via the fire stairs in each tower.

Conclusion

The assessment has demonstrated that the proposed ring main configuration provides adequate protection, redundancy and safe access in order to facilitate the operation of the combined hydrant and sprinkler system and fire brigade intervention. As such, compliance with Performance Requirements E1P3 and E1P4 is considered to be achieved.

Performance solution:

- ☑ A2.2(1)(a) - Comply with all relevant performance requirements
- ☐ A2.2(1)(b) - Be at least equivalent to the DtS provisions

Assessment methods:

- ☐ A2.2(2)(a) - Evidence of suitability
- ☐ A2.2(2)(b)(i) - Verification methods provided in the NCC
- ☑ A2.2(2)(b)(ii) - Other verification methods accepted by the appropriate authority
- ☐ A2.2(2)(c) - Expert judgement
- ☐ A2.2(2)(d) - Comparison with the DtS provisions

Assessment approach:

☐ Comparative	☑ Qualitative	☑ Deterministic
☑ Absolute	☐ Quantitative	☐ Probabilistic

IFEG sub-systems used in the analysis:

☐ A – Fire initiation and development and control	☐ D – Fire detection, warning and suppression
☐ B – Smoke development and spread and control	☐ E – Occupant evacuation and control
☐ C – Fire spread and impact and control	☑ F – Fire services intervention

Acceptance criteria and factor of safety:

The Performance Solution is said to meet the acceptance criteria if it can be shown that fire brigade intervention would not be impacted by the layout of the vertical ring main.

Fire scenarios and design fire parameters:

N/A

Describe how fire brigade intervention will be addressed or considered:

The fire brigade would be able to access the sprinkler valves on each level through a single fire isolated path. To facilitate fire brigade wayfinding, the access to the sprinkler valves will be indicated by signage.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

Provide details on proposed modelling/assessment tools:

N/A

Issue number: 17 **Title:** Omission of sprinklers to MSB and comms rooms

Details of departures from DtS provisions:

It is proposed to omit sprinkler coverage from comms rooms and MSB rooms as highlighted in Figure 47 and Figure 48.

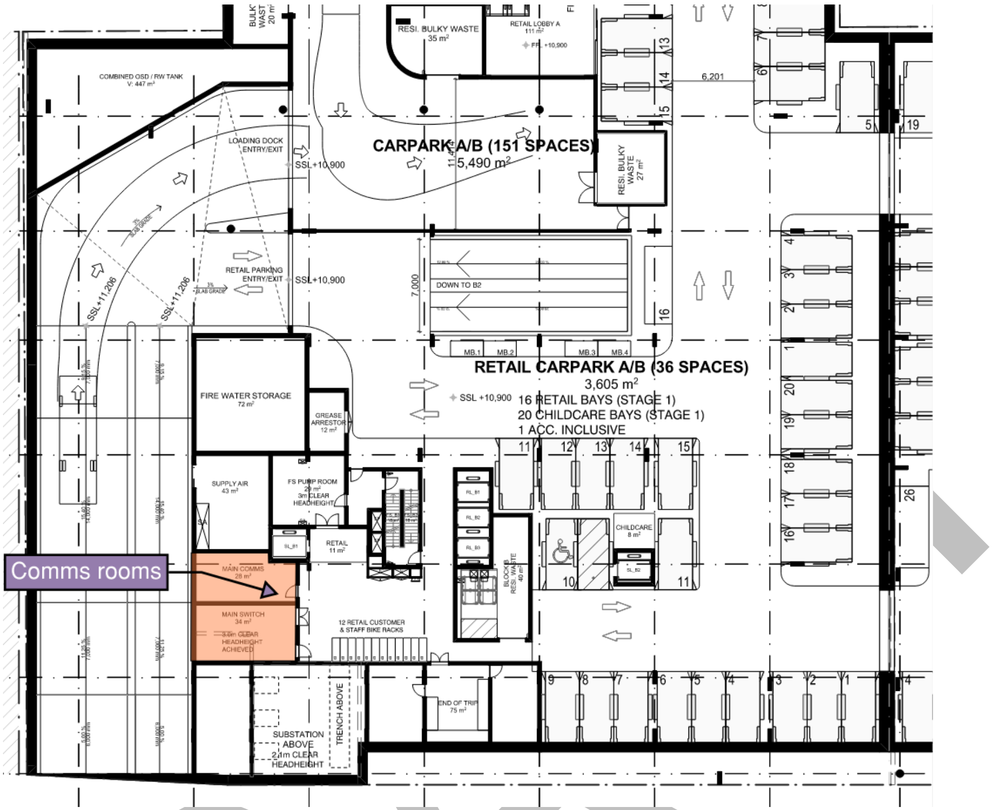

Figure 47: Basement 1 tower B – comms rooms

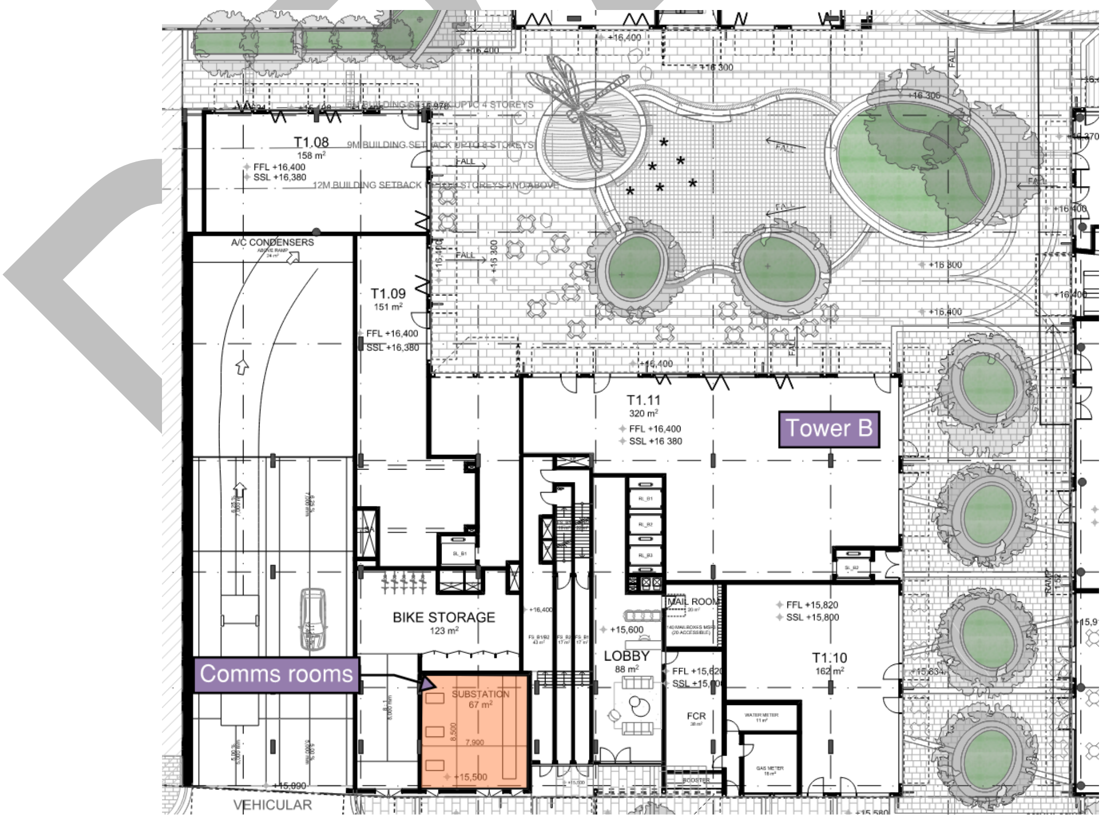

Figure 48: Ground floor tower B – comms rooms

Applicable DtS provisions (including clause excerpt):	E1D4, Specification 17 *(BCA 2019 E1.5, Spec E1.5)*	Applicable Performance Requirements:	E1P4 *(BCA 2019 EP1.4)*

List key fire safety measures:

The comms room and MSB room shall be fire separated from the rest of the building by construction achieving an FRL of 120/120/120. Any doors shall be self-closing fire doors that achieve an FRL of -/120/30. The doors shall be protected with Medium Temperature perimeter smoke seals tested to resist smoke at 200°C for 30 minutes as per AS1530.7.

A sprinkler system shall be provided throughout the building in accordance with AS2118.1-2017 with the exception that they may be omitted from the comms room and MSB rooms.

Proposed performance solution:

BCA Intent

Clause E1D4 states a sprinkler system must be installed in a building or part of a building when required by Table E1.5 and comply with Specification 17 and Specification 18 as applicable. The intent of E1D4 is to require the installation of suitable fire sprinkler systems where necessary to address specific hazards.

Performance Requirement E1P4 states an automatic fire suppression system must be installed to the degree necessary to control the development and spread of fire appropriate to, the size of the fire compartment; and the function or use of the building; and the fire hazard; and the height of the building.

Clause 3.1.3 of AS2118.1-2017 states that sprinklers can be omitted for reasons of safety or incompatibility to high-voltage, normally unoccupied areas such as rooms used for no purposes other than to contain transformers, electrical switch, or control gear (non-oil filled), bounded by walls or other barriers to resist the spread of fire and fitted with multiple controls for alarm purposes or a detection and alarm system installed in accordance with AS1670.1-2018.

The intent of the BCA is to ensure buildings are provided with suitable life safety systems to protect building occupants.

Analysis

The comms room and MSB room located throughout the building are expected the be equipped with electrical equipment sensitive to water. It is therefore proposed to omit sprinkler coverage from these spaces under a Performance Solution.

A fire scenario in the comms rooms /and MSB is an unlikely event. These locations are expected to contain minimal fuel loads as they are not storage areas with the majority of the room used for housing electrical or IT equipment, which are typically constructed from mostly non-combustible materials. The primary ignition source in one of these rooms are electrical faults. Therefore, sprinkler activation may cause further risk to life safety due to the electrical fault with the potential to electrify the water, which could present a significant risk to evacuating occupants or the attending fire brigade.

However, in the unlikely event, that a fire does occur in a comms room or MSB room, the minimal fuel load located within these spaces is expected to limit a fire from growing to a size that threatens the life safety of the building.

Furthermore, in the scenario that a fire does originate in one of these locations and is sustained, the adjacent compartments are expected to be protected through several measures. To ensure life safety is maintained, the comms rooms and MSBs will be enclosed in 120/120/120 FRL construction in line with AS2118.1-2017 clause 3.1.3 guidance and be provided with AS1670.1-2018 detection coverage. Medium Temperature smoke seals and a self-closing fire door rated to -/120/30 shall also be included to protect the doorway. This fire rated construction and smoke seals are expected to prevent fire and smoke spreading to adjacent compartments.

As such, given the minimal fuel, the fire separation provided would adequately control the development and spread of fire from these areas.

Furthermore, if the fire were to spread into adjacent compartments, these compartments are required to be sprinkler protected. Therefore, it is expected that the sprinkler system would control the fire and prevent further spread of the fire throughout neighbouring compartments.

Conclusion

The analysis has shown that that the non-sprinkler protected comms room and MSB room does not increase the risk of fire spread from the compartment due to the low fuel load and limited ignition sources. Additionally, in the event a fire does occur in the comms / MSB room, the enclosing FRL construction and surrounding sprinkler coverage is expected to contain and control the fire. Therefore, it is considered that Performance Requirement E1P4 has been satisfied.

Performance solution:

☑ A2.2(1)(a) - Comply with all relevant performance requirements
☐ A2.2(1)(b) - Be at least equivalent to the DtS provisions

Assessment methods:

☐ A2.2(2)(a) - Evidence of suitability
☐ A2.2(2)(b)(i) - Verification methods provided in the NCC
☑ A2.2(2)(b)(ii) - Other verification methods accepted by the appropriate authority
☐ A2.2(2)(c) - Expert judgement
☑ A2.2(2)(d) - Comparison with the DtS provisions

Assessment approach:

☐ Comparative ☑ Qualitative ☑ Deterministic
☑ Absolute ☐ Quantitative ☐ Probabilistic

IFEG sub-systems used in the analysis:

☑ A – Fire initiation and development and control
☐ B – Smoke development and spread and control
☑ C – Fire spread and impact and control
☑ D – Fire detection, warning and suppression
☐ E – Occupant evacuation and control
☐ F – Fire services intervention

Acceptance criteria and factor of safety:

The development and spread of a fire from these areas shall be adequately limited.

Fire scenarios and design fire parameters:

A fire in a comms room with sprinklers omitted has been considered.

Describe how fire brigade intervention will be addressed or considered:

The brigade are able to fight a fire in the subject rooms with sprinklers omitted, with the additional protection of the fire-separating construction assisting their operations. The limited fuel load and thus fire size of the main switch room is expected to reduce the severity of the fire, and therefore assist the brigades fire fighting.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

Provide details on proposed modelling/assessment tools:

N/A

Issue number: 18 **Title:** Location of Fire Control Room

Details of departures from DtS provisions:

The fire control centre/room (FCC) is proposed to be located adjacent to the lobby entrance of tower B on the ground floor as shown in the markup below. Due to the proposed location, the design departs for DtS provisions as the FCC is not in line of sight of main entrance (technical non-compliance due to multiple main entrances).

Figure 49: Proposed fire control centre location

Applicable DtS provisions (including clause excerpt):	E1D15 *(BCA 2019 E1.8)*	Applicable Performance Requirements:	E1P6 *(BCA 2019 EP1.6)*

List key fire safety measures:

The building shall be protected by both internal and external fire hydrants for use by FRNSW in the event of an emergency.

The block plan provided to the site shall indicate the location of all significant fire services required for fire brigade intervention.

Additional information shall be available at the FIP for wayfinding once FRNSW arrive to site.

Proposed performance solution:

BCA Intent

BCA Specification E1D15 establishes the DtS provisions for a Fire Control Centre, with the intent to ensure that the fire control centre is suitable to facilitate fire brigade operations. S19C4 of Specification 19 states that a fire control room must be so located in a building so that egress from any part of its floor, to open road or open space, does not involve changes in level which exceed 300mm. The intent of this specification as stated in the BCA guide is to require that a fire control centre be conveniently placed to allow egress.

Performance Requirements E1P6 requires that suitable facilities must be provided to the degree necessary in a building to co-ordinate fire brigade intervention during an emergency.

Analysis

The fire control centre/room (FCC) is proposed to be located adjacent to the lobby entrance of tower B on the ground floor as shown in the markup below. Due to the site having multiple main entrances to each of the three towers, a technical non-compliance arises as the fire control room is not in the line of sight of all the tower entrances.

It is anticipated the fire brigade will park up outside tower B on Broomfield Steet as this is the proposed designated entrance to the development, therefore the FCC is expected to be readily visible to the fire brigade upon arrival, preventing any delay in fire brigade intervention.

However, the fire brigade may arrive at the entrance to tower A or C along Cabramatta Road East. To offset any delay that may arise from the brigade not being able to see the FCC from this entrance it is proposed to include block plans at the FIP and booster location within each three towers, indicating the location of fire brigade equipment and services within the building necessary to undertake brigade operation. The incorporation of block plans into the design will allow fire brigade personnel to quickly locate the FCC if it has not already been located upon arrival.

To provide further visual aid in locating the FCC from tower A and C, mimic panels will be provided in the lobbies of all three towers which will provides statuses and similar information provided within the FCC. This will provide a strong visual indicator to the intervening fire brigade, further assisting them in locating the fire and preventing a delay in brigade intervention.

Conclusion

Access for the fire brigade to the Fire Control Centre in the proposed design has been demonstrated in the assessment that it will not impede or delay fire brigade intervention. Therefore, compliance with Performance Requirements E1P6 is considered to be met.

Performance solution:

☑ A2.2(1)(a) - Comply with all relevant performance requirements
☐ A2.2(1)(b) - Be at least equivalent to the DtS provisions

Assessment methods:

☐ A2.2(2)(a) - Evidence of suitability
☐ A2.2(2)(b)(i) - Verification methods provided in the NCC
☑ A2.2(2)(b)(ii) - Other verification methods accepted by the appropriate authority
☐ A2.2(2)(c) - Expert judgement
☐ A2.2(2)(d) - Comparison with the DtS provisions

Assessment approach:

☐ Comparative ☑ Qualitative ☑ Deterministic
☑ Absolute ☐ Quantitative ☐ Probabilistic

IFEG sub-systems used in the analysis:

☐ A – Fire initiation and development and control
☐ B – Smoke development and spread and control
☐ C – Fire spread and impact and control
☐ D – Fire detection, warning and suppression
☐ E – Occupant evacuation and control
☑ F – Fire services intervention

Acceptance criteria and factor of safety:

Access for the fire brigade to the Fire Control Room shall not impede or delay fire brigade intervention.

Fire scenarios and design fire parameters:

N/A

Describe how fire brigade intervention will be addressed or considered:

Block plans and mimic panels has been required to facilitate brigade intervention and guide attending FRNSW members to key firefighting services located on site.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

Provide details on proposed modelling/assessment tools:

N/A

Issue number: 19 **Title:** Omission of smoke control zone to ground retail areas

Details of departures from DtS provisions:

Permit the omission of zone smoke control in the following areas:

- Ground floor tower A – retail tenancies RT.A.01, RT.A.02, RT.A.03
- Ground floor tower B – retail tenancies RT.B.01, RT.B.02, RT.B.03, RT.B.04
- Ground floor tower C – retail tenancies RT.C.01, RT.C.02, RT.C.03, RT.C.04

Markups of the relevant areas are included in Figure 50.

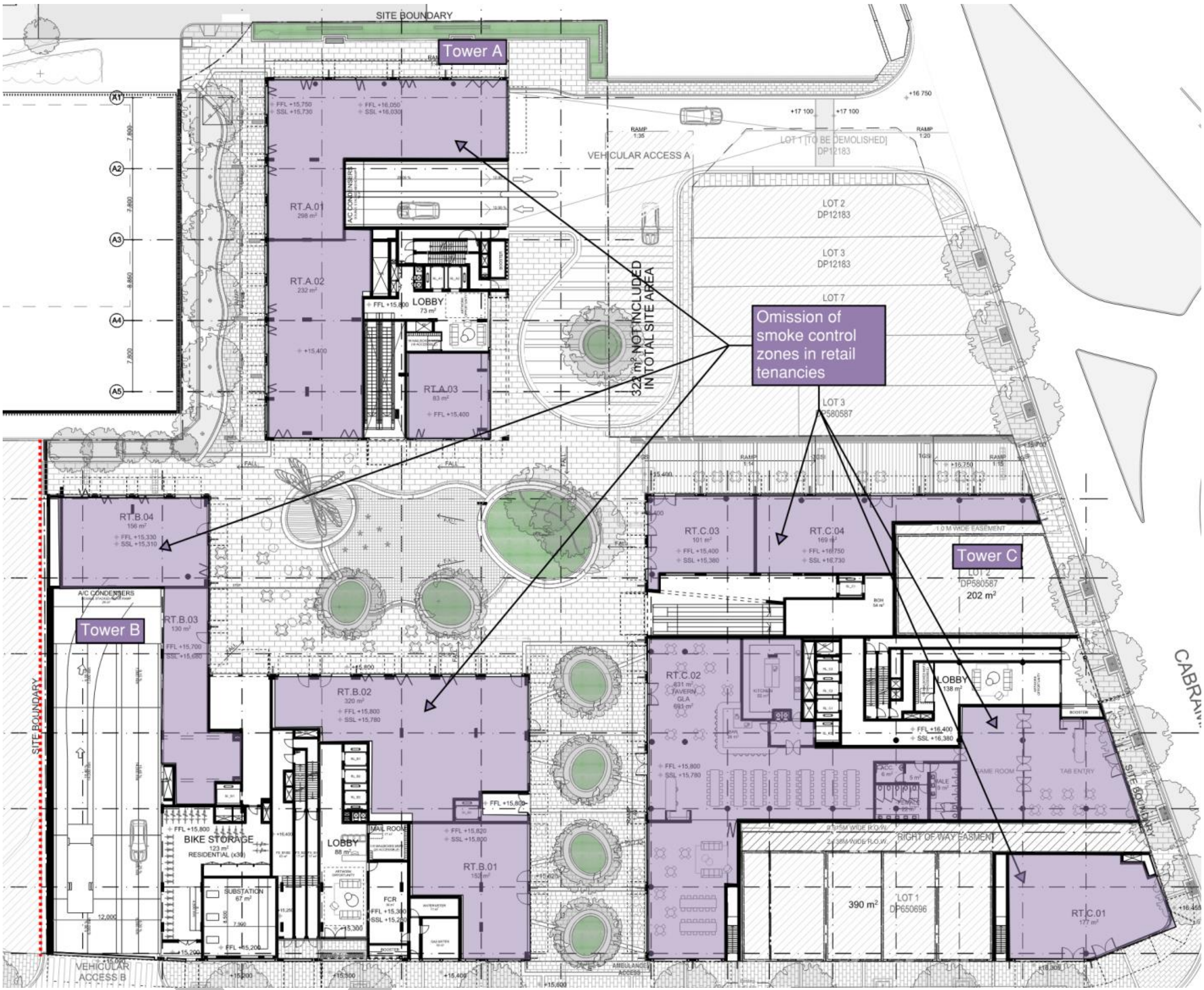

Figure 50: Areas where zone smoke control is to be omitted – Ground floor

Applicable DtS provisions (including clause excerpt):	E2D6 *(BCA 2019 Table E2.2a)*	Applicable Performance Requirements:	E2P2 *(BCA 2019 EP2.2)*

List key fire safety measures:

The building shall be protected throughout with automatic fire suppression system (AS 2118.6 – 2012) with fast response heads, except as otherwise denoted in this report.

The building shall be protected throughout with an automatic fire detection and alarm system (AS 1670.1 – 2018) except as otherwise denoted in this report.

Proposed performance solution:

BCA Intent

As detailed in BCA Table E2D6, the building is required to be provided with a zone smoke control system. Zone pressurization systems aim to minimize the vertical smoke spread between levels in an attempt to contain the smoke to the compartment / level of fire origin.

The intent of Performance Requirement EP2.2 is the maintain safe conditions along egress routes to ensure occupants are able to evacuate safely.

As such, it is evident that to satisfy the intent of the BCA, the assessment must demonstrate the smoke spread to and from the subject areas are adequately minimized such that occupants can evacuate safely.

Analysis

A qualitative absolute analysis has been conducted to demonstrate that smoke spread would be adequately limited between compartments. The intent of a zone pressurisation system is to prevent vertical smoke spread between storeys. This is most relevant and applicable in high-rise office buildings and the like. However for this development the retail tenancies comprises of a small percentage of the total building floor area, and only being located on the ground floor and level 1. It is considered that the omission of zone smoke control to the areas identified above will not affect occupant egress for the following reasons:

- All of the subject compartments have minimal floor areas (<2000 m^2), with short travel distances to their respective exits. In the event of a fire in one of these compartments, occupants will instantly identify the fire and smoke visually, before the alarm is triggered. As such, occupants can egress from the compartment in a short period of time before tenability is compromised by smoke spread.
- Occupants in the subject compartments have direct access to Broomfield Road or an open space with a direct path of travel to the road, minimising the risk of exposing occupants to untenable conditions during an evacuation.
- Occupants in adjacent compartments will begin to evacuate upon activation of the alarm. As the alarm is to be triggered by the smoke detectors, it is expected that the alarm will be triggered much earlier than the time it takes for smoke to spread between the compartments.
- The suppression system installed within the building is expected to contain a fire to the compartment of origin when activated. The sprinkler system will control the growth and size of a fire limiting the amount of smoke produced. The inclusion of a sprinkler system is considered to enhance life safety within the building. The benefits of sprinklers has been noted below.
- All penetrations between the subject compartments are to be fitted with smoke and fire seals to prevent the passage of smoke between levels.
- The building is provided with an immediate evacuation strategy which is not the typical office building strategy, the typical large office building evacuation strategy would be a phased evacuation strategy which inherently has longer overall evacuation time. The extended evacuation times therefore require zone smoke control systems to ensure tenable conditions are maintain throughout the building to protect evacuating occupants.
- Stair pressurisation systems act to maintain the tenability of the fire stairs.
- A 2-hour fire separation is to be provided throughout all subject areas, compartmenting these spaces to floor areas of less than 2000m^2. All fire walls will have an integrity rating, which will prevent the passage of flames and smoke between compartments.
- The egress paths used by the fire stairs are protected by suitable fire rated construction, to maintain tenability of egress.

It is noted that zone pressurisation is only required to prevent smoke spread vertically to separate fire compartments above and below. As such, given that smoke proof construction in addition to fire resisting construction is proposed to separate these areas from other compartments above and below, smoke spread would be adequately limited to allow occupants to evacuate safely.

Benefits of sprinklers

The proposed building is to be provided with a sprinkler system throughout. In the event of a fire, the sprinkler system is expected to control, if not suppress the fire. The sprinkler system acts to cool the upper smoke layer and wet adjacent combustibles and partitions helping to prevent the fire from spreading beyond the area of origin.

Statistics from the National Fire Protection Association (NFPA), as published by [Hall], provides recorded statistics on buildings fitted with automatic fire sprinkler systems between the years 2003-2007 in the United States. Based on the NFPA data, when sprinklers operate, they are effective 97 % of the time, resulting in a combined performance of operating effectively in 89 % of all reported fires where sprinklers were present in the fire area and the fire was large enough to activate them. The reliability of sprinkler system in Australia and New Zealand is generally significantly higher than in the US as researched by [Marryatt].

Furthermore, by controlling the fire size, the amount of smoke produced is limited. Hence the provision of sprinklers in a building dramatically enhances life safety, property protection and fire brigade intervention. Where the sprinkler system operates successfully, occupant and fire fighter safety and the integrity of the building elements reduces the threat to occupants, property damage and the attending fire brigade. The high reliability and efficiency of fire sprinklers is also supported by fire tests and statistics on structural building fires.

<u>Afforded Area of Glazing</u>

The retail tenancies and main lobby are provided with a relatively large area of frontage glazing. Therefore, in the event of flashover, the glass frontage would break and act as a means of natural ventilation by free venting smoke directly into the atmosphere. However, noting that the building is sprinkler protected, it is unlikely that a fire would reach flashover.

As these areas is bound vertically by fire-rated slabs, and horizontally there is no need for separation as a solution is already being provided to reduce retail FRLs to 120 minutes (thereby negating the need for separation of classifications), the likelihood of fire spread into adjacent compartments is minimal. Furthermore, the risk of smoke seeping through any services penetrations is expected to be no greater than what is deemed acceptable under the DtS provisions, as all services penetrations are to be smoke and fire sealed in accordance with the DtS requirements.

In addition to the above, compartment temperatures expected during a post-flashover fire (i.e. a non-sprinkler protected building) are likely to reach a uniform enclosure temperature of 600-800°C.

With non-fire-rated glass having a failure temperature of 200-500 °C (dependent on the type of glass) it can be expected that the shopfront glazing would break and fail prior to reaching flashover conditions, allowing for the free venting of smoke into the atmosphere. Furthermore, if the glazing does not break, it can be assumed that temperatures are adequately low to have minimal impact on the glazing, as well as occupant evacuation.

<u>Separation Construction</u>

As part of the Performance Solution, the internal bounding walls of the retail tenancies and main lobby area must achieve smoke separation from other parts of the building in accordance with BCA Clause S11C2 [2019 Specification C2.5] Clause (a), (d) and (e) which outlines the following:

- Smoke-proof walls are to be non-combustible and extend to the underside of the floor above.
- All openings around penetrations and junctions of the smoke-proof wall and the remainder of the building stopped with non-combustible material to prevent the free passage of smoke.
- Incorporate smoke dampers where air-handling ducts penetrate the wall unless the ducts forms part of a smoke hazard management system required to continue air movement through the duct during a fire.

The walls being of smoke-proof construction is anticipated to prevent the smoke ingress to vertically separated compartments and would passively achieve the same intent as a zone pressurisation system. The main entrance doorway is not required to be fitted with smoke doors in accordance with BCA DtS Specification 12 [2019: Spec C3.4].

Performance solution:

☑ A2.2(1)(a) - Comply with all relevant performance requirements
☐ A2.2(1)(b) - Be at least equivalent to the DtS provisions

Assessment methods:

☐ A2.2(2)(a) - Evidence of suitability
☐ A2.2(2)(b)(i) - Verification methods provided in the NCC
☑ A2.2(2)(b)(ii) - Other verification methods accepted by the appropriate authority
☐ A2.2(2)(c) - Expert judgement
☐ A2.2(2)(d) - Comparison with the DtS provisions

Assessment approach:

☐ Comparative	☑ Qualitative	☑ Deterministic
☑ Absolute	☐ Quantitative	☐ Probabilistic

IFEG sub-systems used in the analysis:

☐ A – Fire initiation and development and control	☑ D – Fire detection, warning and suppression
☑ B – Smoke development and spread and control	☑ E – Occupant evacuation and control
☐ C – Fire spread and impact and control	☐ F – Fire services intervention

Acceptance criteria and factor of safety:

The performance solution is considered acceptable if it is shown that occupants are afforded with tenable egress out of the subject compartments where zone smoke control has been omitted.

Fire scenarios and design fire parameters:

A fire occurring in one of the subject compartments has been qualitatively considered for the omission of the zone smoke control requirement.

Describe how fire brigade intervention will be addressed or considered:

Fire brigade intervention is not considered to be impacted if it is shown that the design suitably manages smoke.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

Provide details on proposed modelling/assessment tools:

N/A

8 Construction, commissioning, management, use and maintenance

What considerations does the performance solution require during the construction phase?

Staging of the development will require ongoing consultancy in order to ensure that the safety of occupants within occupied buildings are not compromised while adjacent buildings are being developed.

How will the performance solution affect commissioning of the systems (e.g. listed on fire safety schedule as essential or critical measure, combined new and old installations)?

The development will be issued with a new fire safety schedule; the schedule will include fire safety measures that are proposed in the FER.

How will the performance solution be addressed for ongoing building management and use (e.g. details to be provided in a 'fire safety management plan' for the building manager)?

Any ongoing building management requirements will be documented within the management-in-use plans and will form part of the building's fire safety schedule.

How will any restrictions on fuel load/use/populations within the performance solution be managed and enforced (e.g. details to be provided in 'fire safety management plan')?

N/A

How will the performance solution be addressed for maintenance (e.g. details included on fire safety schedule, location of fire engineering report on site, plain English summary adjacent to FIP)?

Details of the Performance Solution shall be included in the fire safety schedule. Where services are modified as part of a Performance Solution, they must be included in the maintenance plan and annual certification.

9 Additional comments

Provide any additional comment relevant to the FEBQ

Note: Any in principle support extended for performance solution issues through consultation is contingent upon all assumptions, analyses and conclusions in the fire engineering report being fully justified, and referenced as appropriate, to demonstrate how the relevant performance requirements have been satisfied to the extent required by the agreed acceptance criteria.

10 Scheduled charges

FRNSW charge for the provision of services performed in connection with statutory fire safety as per the schedule of charges identified in clause 46 and schedule 3 of the *Fire Brigades Regulation 2014*.

The charge applicable is $2,600 for each day (or part of a day) spent by the Commissioner or a fire brigade member providing advisory, assessment or consultancy services.

Note: For a full description of the charges applicable including terms, payment options, applying for a waiver or reduction of the charges, please refer to the FRNSW website at firesafety.fire.nsw.gov.au.

11 Submission of this form

This completed form is to be emailed to firesafety@fire.nsw.gov.au.

All plans and specifications required by FRNSW for assessment are to be attached to the email (or sent separately if necessary due to file size). Refer to Submitting plans and specifications to FRNSW for further information.

12 Contact us

For further information contact the Fire Safety Branch on (02) 9742 7434 or email firesafety@fire.nsw.gov.au.