Fire Engineering Brief Questionnaire (FEBQ)

1 Document control

Applicant reference number 301350239 **FRNSW reference number** FRNSW use only

Ver.	Author	Organisation	Status	Date
01	Ettienne Jordaan	Stantec	Initial submission	6/08/2021

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)
☐ Report extract of the trial design requirements/proposed fire safety measures (optional).

Name of fire engineer	Ettienne Jordaan	BPB number	BDC3185
Company name	Stantec		
Fire engineer's phone no.	+61 402 070 205		
Fire engineer's email	Ettienne.Jordaan@Stanec.com		

2.2 Remittance advice information

Invoices will be issued based on the information provided below:

ASIC company name	UCA - PYMBLE LADIES COLLEGE		
Australian business number	ABN 78 619 140 464	Trading name	Pymble Ladies College
Remittance contact name	Kate Bimson		
Remittance street address	Avon Road, Pymble, NSW 2073		
Remittance email address	kbimson@pymblelc.nsw.edu.au		
Remittance phone number	02 9855 7628 0412 322 206	Remittance fax number	**Remitter's fax no.**
Purchase order ref. no.	If applicable	Project code ref. no.	If applicable
Project leader contact name	Kate Bimson		
Project leader contact email	kbimson@pymblelc.nsw.edu.au		

3 Consultation

3.1 Stakeholders

Role	Name and BPB number	Organisation and phone	Email address
Architect	Nicholas Souksamrane	BVN	Nicholas_Souksamrane@bvn.com.au
BCA consultant	Andrew Rys & Andrew Lee	Steve Watson & Partners 0413 943 826	arys@swpartners.com.au
Certifier	Chris Michaels	City Plan +61 2 8270 3500	chrism@cityplan.com.au
FRNSW reviewers	FRNSW use only FRNSW use only	Fire and Rescue NSW 02 9742 7434	firesafety@fire.nsw.gov.au

3.2 Meeting details

In conjunction with the written comments provided in response to this FEBQ, FRNSW may at its discretion hold a meeting with the applicant to discuss aspects of the proposed performance solution.

Type of meeting preferred ☑ No meeting ☐ Telephone meeting ☐ Face-to-face meeting

4 Project details

4.1 Premises

Premises name	Pymble Ladies College Grey House Precinct
Primary street address	Avon Road, Pymble NSW 2073 Australia
Secondary street address	N/A
Premises suburb	Pymble
Lot and DP numbers	Lot 22, DP 7131 (Site Entrance)

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 2019

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

How many performance solution issues are proposed in this FEBQ? 6

Note: The number of performance solution issues must address all identified non-compliances.

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

Identify if any application has been/will be submitted under Clause 188 of the *Environmental Planning and Assessment Regulation 2000*:

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.

Not aware of any special conditions at this stage.

Will the premises 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.

4.3 Description of building occupancy

Main occupancy class	9b	Largest fire compartment (within the building)	Area (m²)	7 600 m²
Other occupancy classes	5		Volume (m³)	28 000 m³
Type of construction	A		Height (m)	~3 m
Effective height (m)	16.3 m	Ground floor area (m²)		1 400 m²
Rise in storeys	5	Total floor area (m²)		7 600 m²
Levels contained	5	Total volume (m³)		28 000 m³

Outline any additional building characteristics:

The subject building is a new construction on the grounds of Pymble Ladies College. The proposed development consists of a multiple purpose, 5 floor building (referred to as the PLC Grey House Precinct) that is intended to be used as an education, sports, recreation and performing arts building. The proposed development consists of the construction of a new home for Junior School Years 5 and 6, Out of School Hours Care, Dance, Health Services and an Early Learning Centre. The following figure is a rendering of the intended design of the building.

Figure 1: Grey House Precinct 3D rendering

List key occupant characteristics for the building:

Class	Description of space	Occupant characteristic
9b	Learning classrooms	Awake and familiar (students) Awake and familiar (Teaching Staff)
5	Offices	Awake and familiar (staff)

5 Hazards

Outline any hazards unique to the building:

Building design includes an atrium, housing a central stairway that interconnects a total of 4 storeys.

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

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	Detection system	Facilities for emergency services
☐ CA16 (existing building)	☐ AS 3786:2014	☐ Emergency lifts
☐ AS 2118.1-2017	☐ AS 3786-1993 (existing building)	☐ Fire control centre
☐ AS 2118.1-2006	☑ AS 1670.1:2018	☐ Fire control room
☐ AS 2118.1-1999 (existing building)	☐ AS 1670.1:2015 (existing building)	☐ Perimeter vehicular access
☐ AS 2118.2-2010 (wall-wetting)	☐ AS 1668.1:2015	☐ Standby power supply system
☐ AS 2118.3-2010 (deluge)	☐ AS 1670.3-2018 (monitored)	**Occupant warning system**
☐ AS 2118.4-2012 (residential)	☐ AS 1670.3-2004 (existing building)	☐ Building occupant warning
☐ AS 2118.5-2006 (domestic)	☐ Smoke alarms	☑ EWIS
☐ AS 2118.6-2012 (combined)	☐ Heat alarms	☐ SSISEP
☐ FPAA101D (class 2 or 3)	☑ Smoke detectors	☐ Break glass unit
☐ FPAA101H (class 2 or 3)	☐ Heat detectors	☐ Visual / tactile alarm devices
☐ Fast response heads	☐ Flame detectors	**Signage**
☐ ESFR	☐ CO detectors	☑ Emergency lighting
☐ Storage mode sprinklers	☐ Multi-criteria fire detectors	☑ Exit and direction signs
☐ Gaseous suppression system	☐ Aspirated smoke detection	☑ Warning and operational signs
☐ Water mist system	☐ Beam detection	**Protection of openings**
Hydrant system	**Water supply**	☐ Fire doors
☐ AS 2419.1-2017	☑ Reticulated town main	☑ Smoke doors
☑ AS 2419.1-2005	☐ Private water main	☐ Solid core doors
☐ AS 2419.1-1994 (existing building)	☐ Onsite storage tank	☐ Fire windows
☐ Ordinance 70 (existing building)	☐ Gravity tank/reservoir	☐ Fire shutters
☐ External hydrants	☐ Dual supply	☐ Wall-wetting sprinklers
☑ Internal hydrants	**Smoke hazard management**	☐ Fire curtain
☐ Internal dry-riser (for Class 2/3)	☐ Zone smoke control	☐ Smoke curtain
☐ Street hydrant coverage only	☐ Purge system (existing building)	☐ Safety curtain for openings
☑ Hydrant booster assembly	☐ Smoke and heat vents	☑ Fire dampers
☑ Pumpset	☐ Smoke exhaust	☑ Smoke dampers
Firefighting equipment	☐ Smoke baffles	☐ Fire seals (intumescent)
☑ Portable fire extinguishers	☐ Ridge vents	☐ Hot smoke seals (>200ºC)
☐ Fire hose reels	☐ Stair pressurisation	☑ Medium temp. smoke seals
	☐ Impulse / jet fans (in carpark)	

Additional information:

6.1 Smoke Detection and Alarm System

A smoke detection and alarm system is to be provided in accordance with BCA 2019 Amndt 1 and AS 1670.1 – 2018.

6.2 Fire Hydrant System

A fire hydrant system is to be provided in accordance with AS2419.1-2005.

6.3 Fire Extinguishers

Fire extinguishers are to meet the requirements of BCA 2019 and installed in accordance with AS 2444 – 2001 and in addition, if not already provided:

- In locations where FHRs would otherwise be required within the ELC Childcare and Wellness/Plantroom sections of the subject building.

6.4 Atrium Natural Ventilation

The north and south façade of the atrium space shall be provided with permanently open or auto opening louvres to vent smoke in the event of a fire. The louvres shall achieve a net free area of 50% of that of the façade and shall be equally distributed across the façade and on both the north and south side.

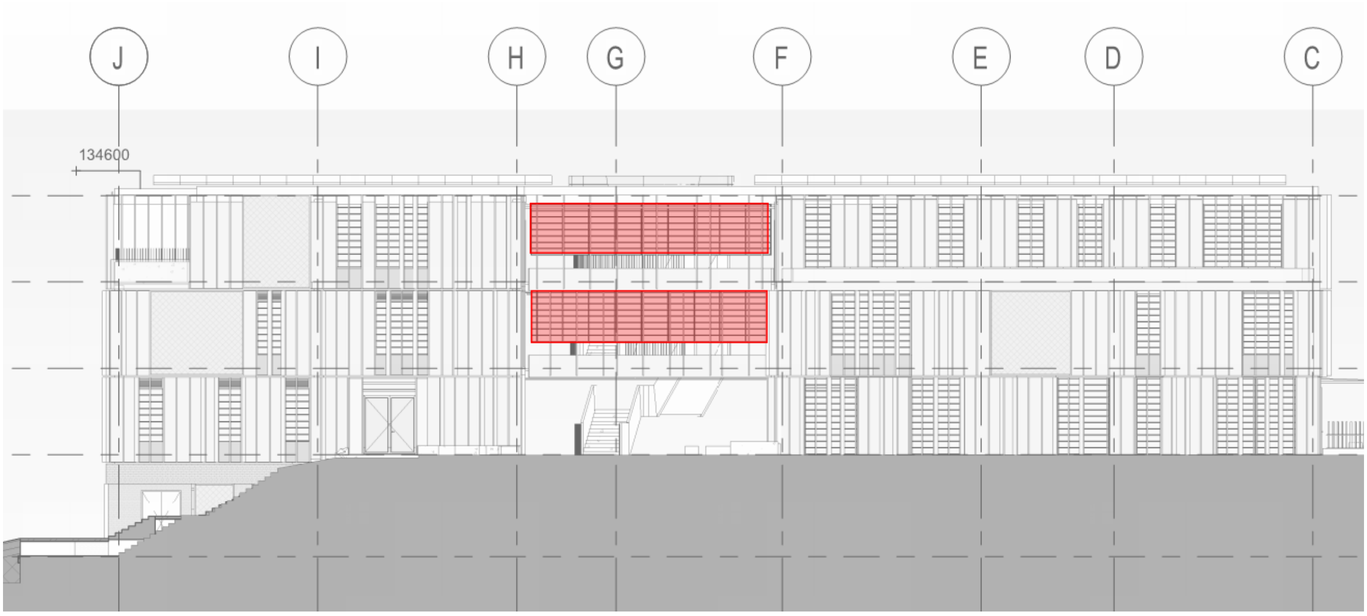


Figure 2: North Elevation – Louvred Vents

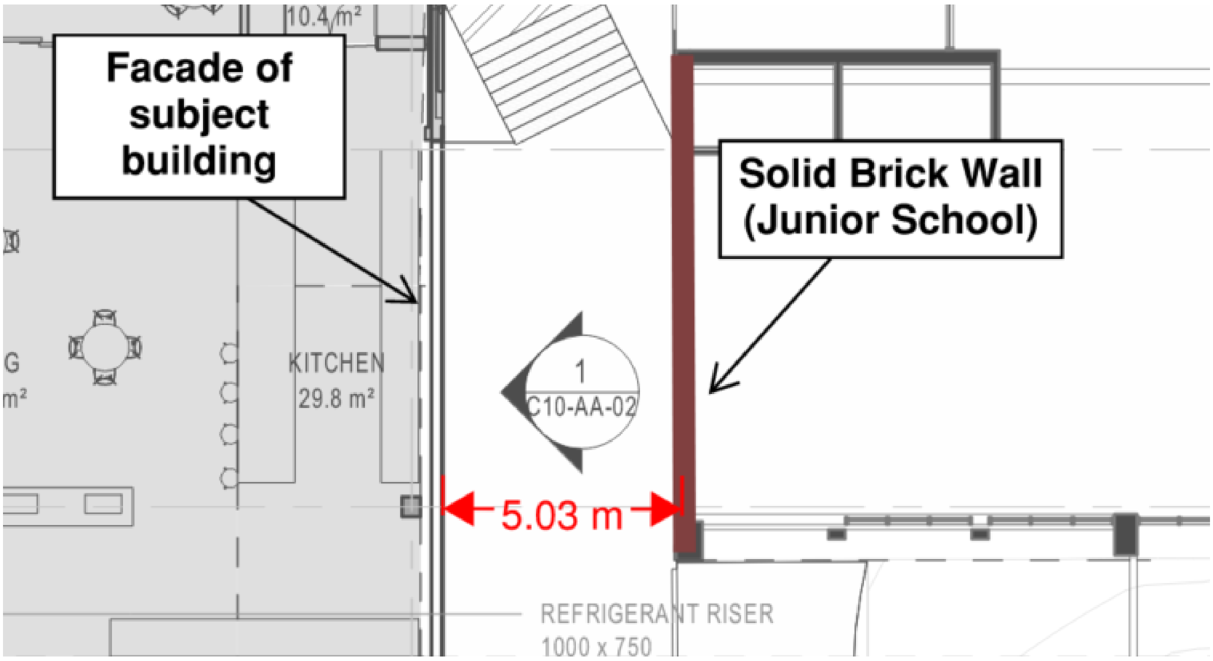
Figure 3: South Elevation – Louvred Vents

If the louvres are auto opening, they shall open upon detection of smoke within the building.

The circulation spaces within the atrium space shall be kept generally free of any significant amounts of combustible materials. Any furniture and fixtures are to comprise of low combustibility materials such as concrete, metals and hardwoods. Items are not be stored or left unattended within the atrium space.

6.5 Building Separation

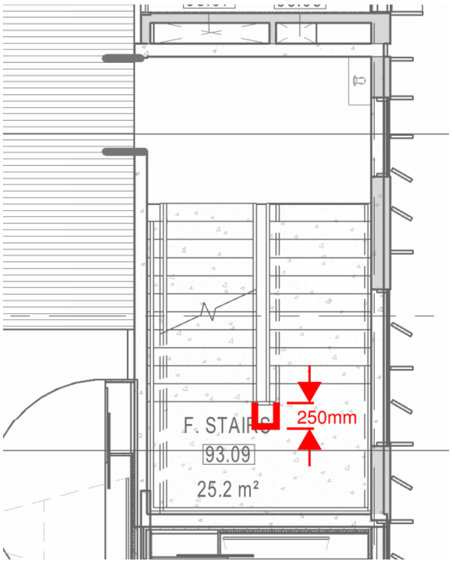
The external walls of the subject building shall be a minimum of 5m from the external walls of the adjacent Junior School Building.



The integrity of the Junior school brick wall is to be maintained to ensure the subject building will not be exposed to unprotected openings along that wall.

6.6 Egress Width

The two fire-isolated stairs shall achieve the required aggregate clear egress width of 3 m. Where the handrail extensions occur in the eastern stair, the egress width can be temporarily reduced by 250 mm at that location as shown below.



6.7 Signage and Block Plans

Signage and block plans shall be provided in order to highlight the location of the hydrant booster assembly at the FIP. The signage shall state “HYDRANT BOOSTER AT AVOND RD ENTRY” lettering is to be at least 25 mm high and of a colour contrasting the background. The signage is to be at a height of at least 1.75 FFL. The signage is to be located immediately adjacent to the FIP of the subject building, as described in issue 2.

6.8 Ongoing Maintenance and Management

The following is the management in use requirements which need to be understood by the building owners and operators and should be included as part of any management documentation and Annual Fire Safety Statement Certificate.

- A no smoking policy is to be implemented in all common areas.
- Regular evacuation drills to be conducted annually (minimum) within the building.
- General house-keeping must be undertaken to maintain the egress paths and exits clear in order to allow unimpeded travel.
- Building management must ensure that all fuel load restrictions placed upon the building by this fire engineering report are enforced, including regular checks and monitoring of subject areas to ensure compliance.

Commissioning and integrated function testing of all fire safety and protection systems including interfaces to ensure proper function must be undertaken.

The proposed Fire Engineering Strategy for the building imposes the following requirements on the eventual Building Managers:

- Maintain all active and passive Fire Safety Systems in accordance with the relevant section of AS 1851.
- Evacuation diagrams in accordance with AS 3745 to be provided. The standard emergency evacuation plans are to detail an accessibility specific emergency evacuation.
- Where services are modified as part of a Performance Solution, these must be included in the maintenance and annual certification.

6.9 Smoke Separation

Any doorways in the bounding walls separating the stairwell void discussed in this performance solution is to be self-closing or auto-closing in the event of a fire and shall be sealed with medium temperature smoke seals, and tested in accordance with AS 1530.7. The following figures illustrate the smoke separating boundary walls, in which all doorways are required to be installed with medium temperature smoke seals in order to maintain a smoke separation.

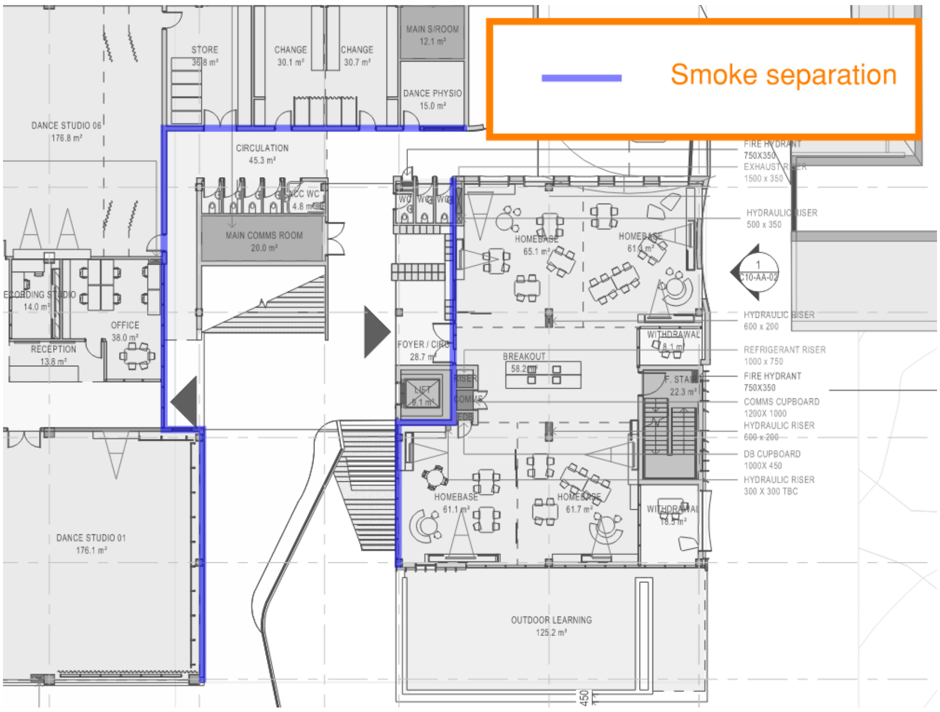


Figure 4: Smoke separation surrounding stairwell void – level 01

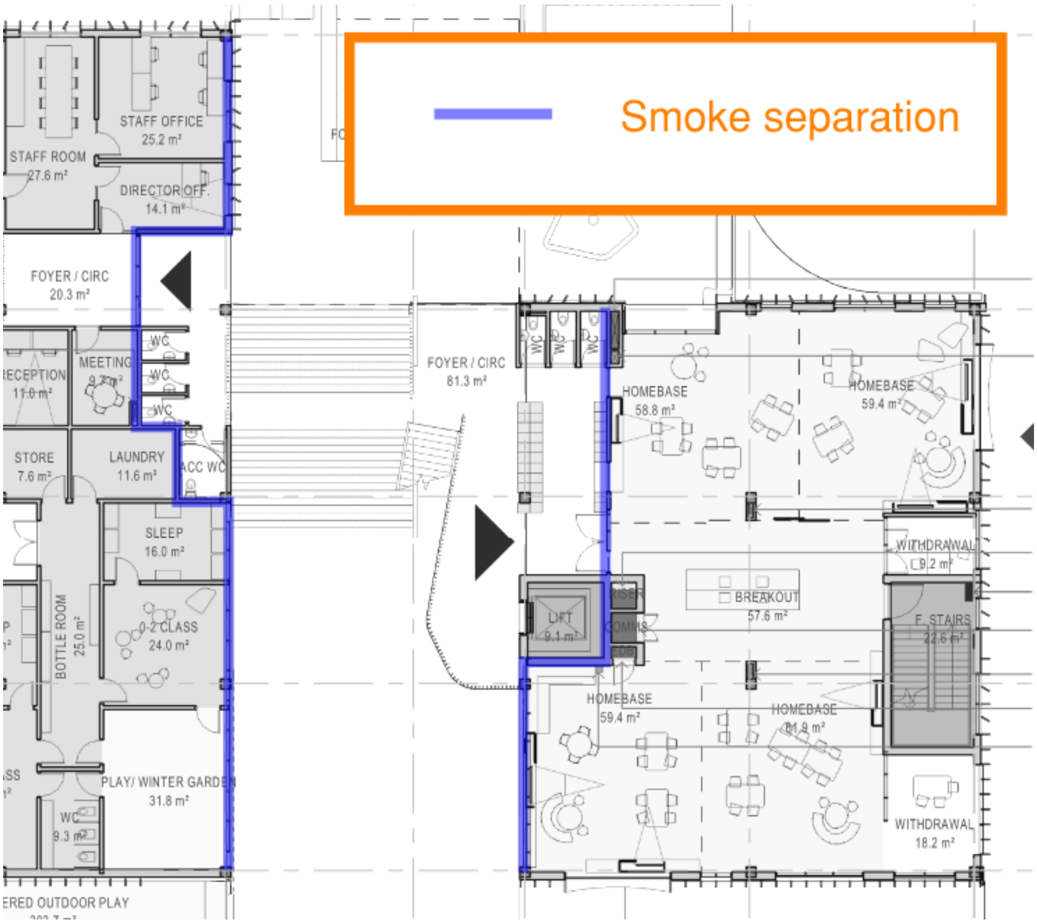


Figure 5: Smoke separation surrounding stairwell void – level 02

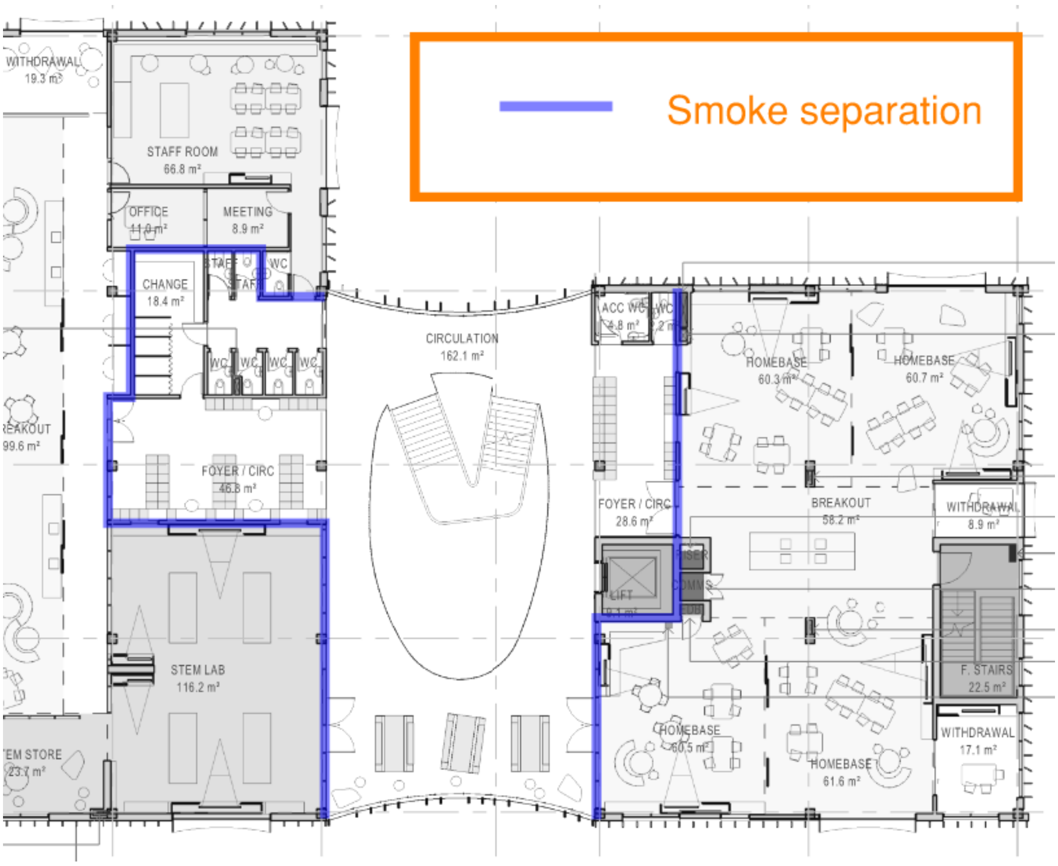


Figure 6: Smoke separation surrounding stairwell void – level 03

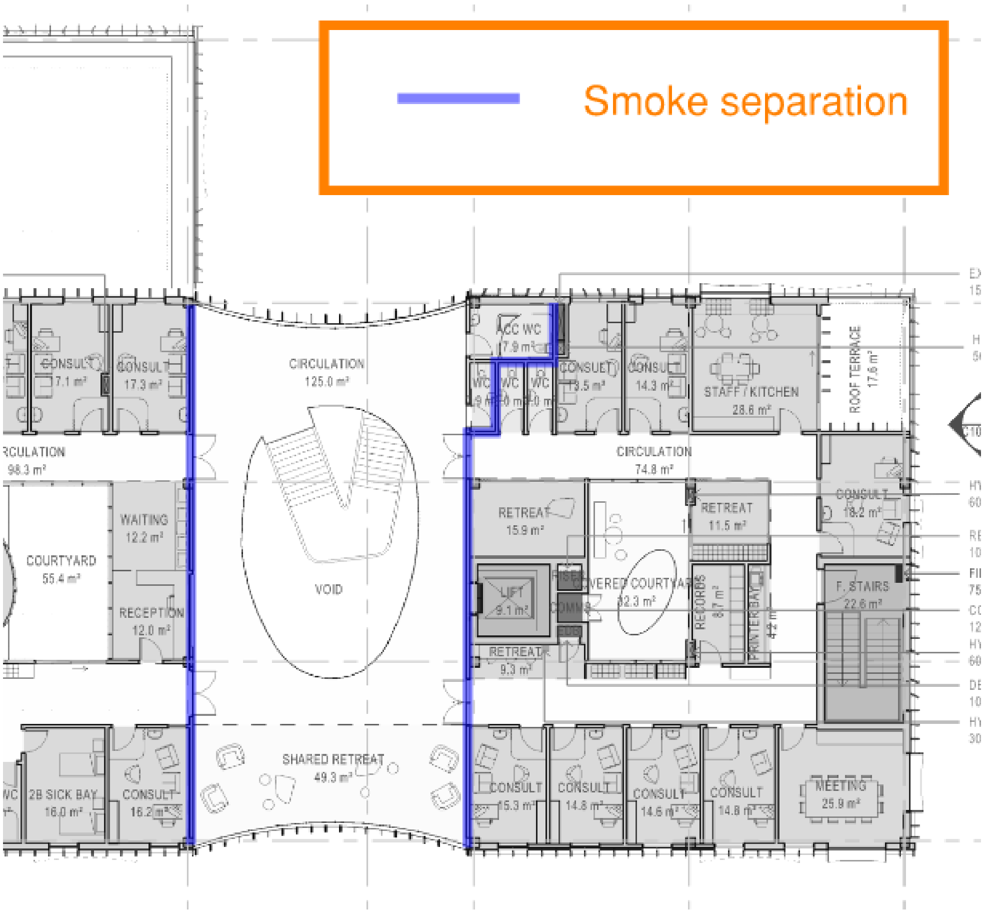


Figure 7: Smoke separation surrounding stairwell void – level 04

7 Departures from the Deemed-to-Satisfy provisions

Issue number: 1 **Title:** Separation of External Walls and Openings

Details of departures from DtS provisions:

Permit the distance between the non-fire rated external wall of the Junior School and the external wall of the main building to be less than 6 metres without protecting the openings. The non-compliant separation is illustrated in the figure below.

The proposed location of the building also deviates from the requirements of BCA Specification C1.1, specifically the FRL requirements of external walls in proximity to neighbouring structures.

The following figures illustrate the distance between the external walls of the proposed building and the existing Junior School, and the location of the external FRL rated walls and the openings within the proposed building.

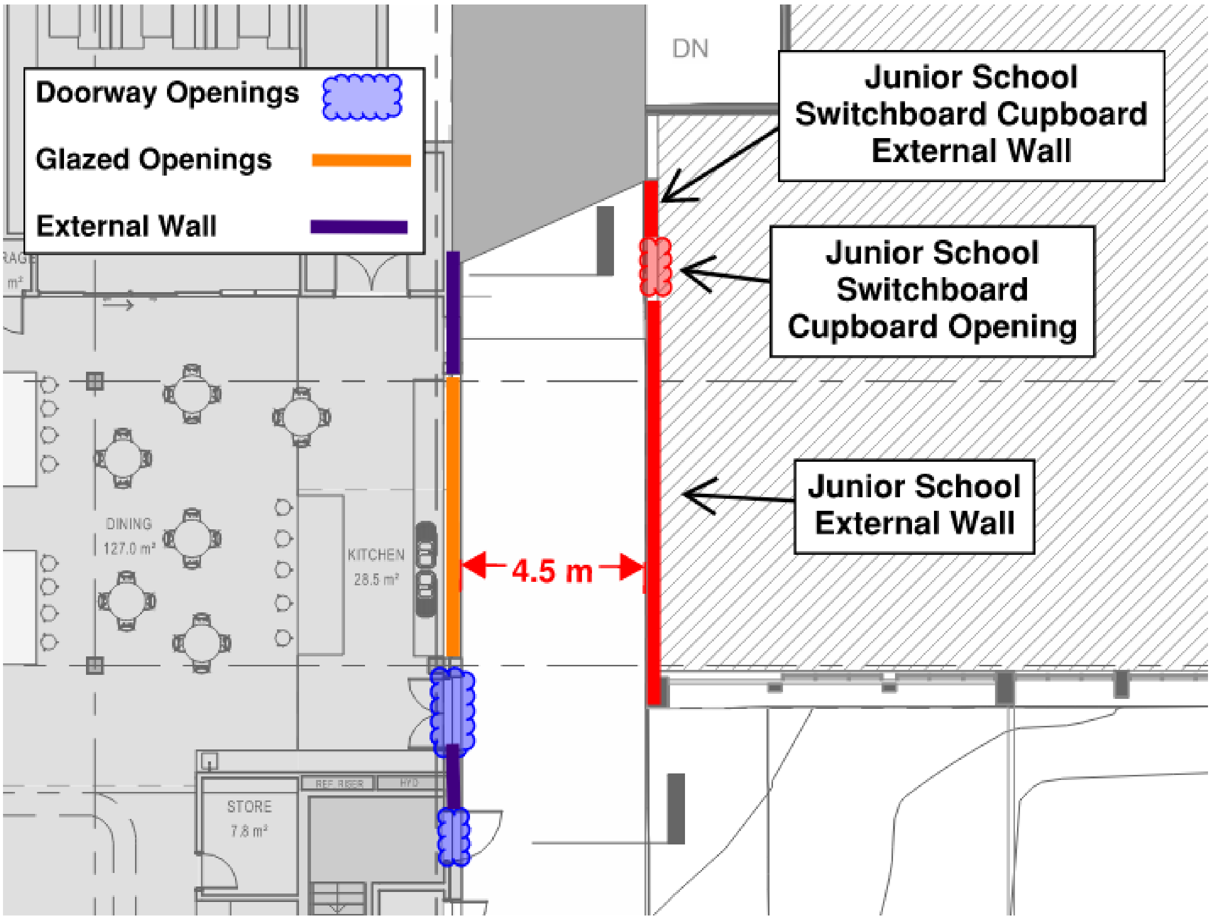


Figure 8: Non-compliant openings in proposed building – Level 0

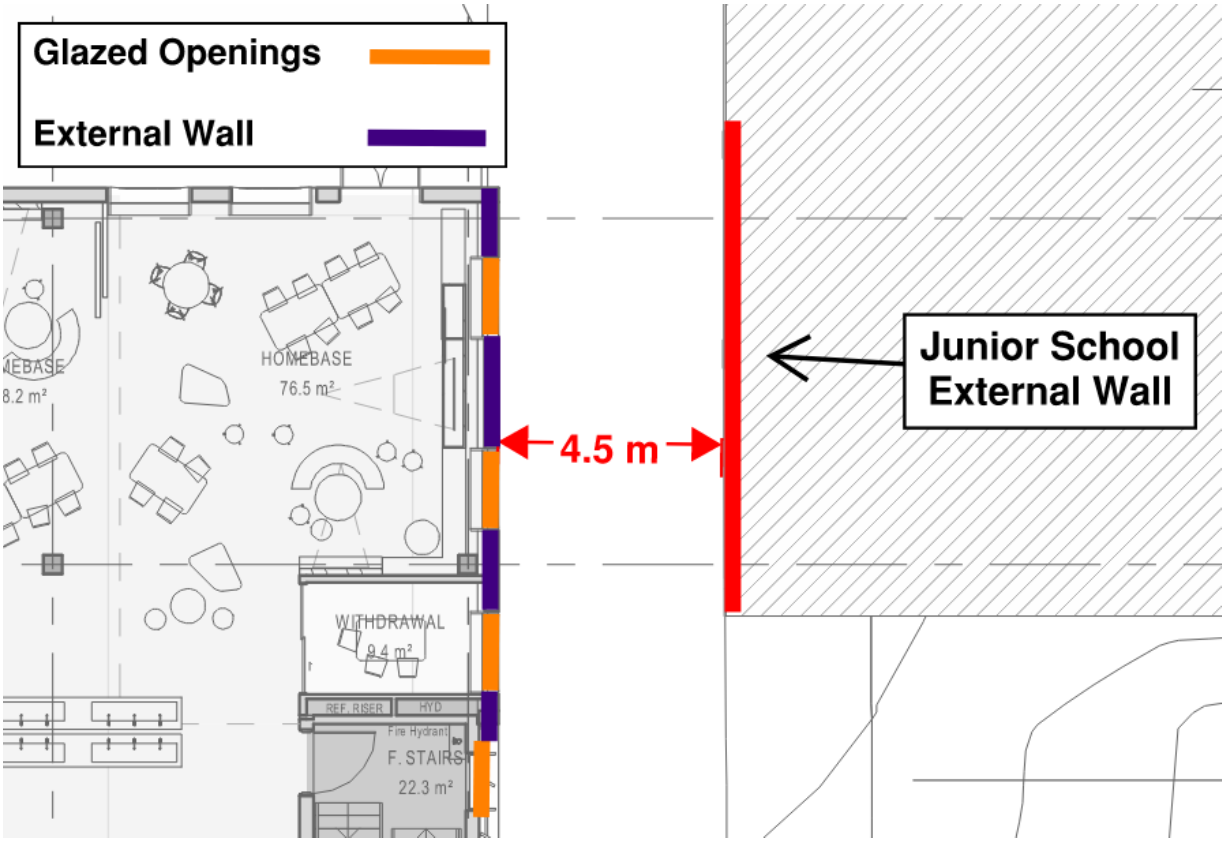


Figure 9: Non-compliant openings in proposed building – Level 1

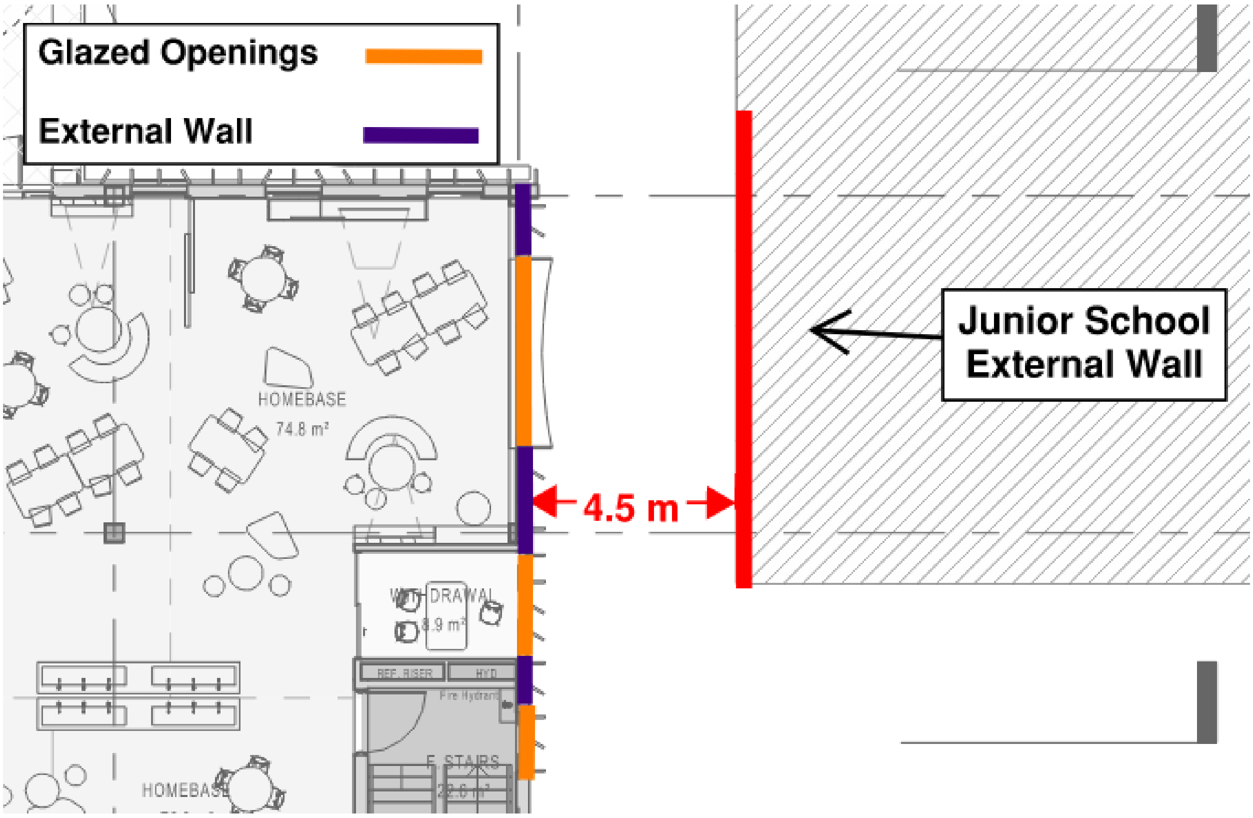


Figure 10: Non-compliant openings in proposed building – Level 2

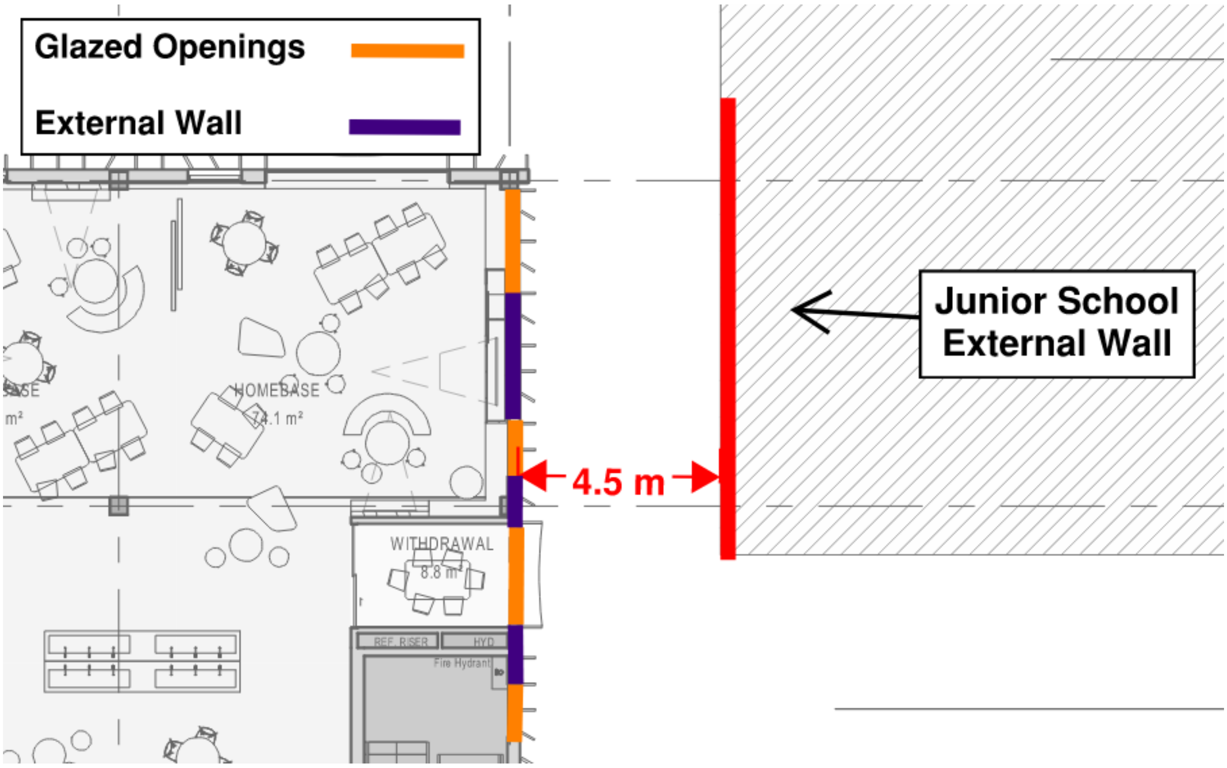


Figure 11: Non-compliant openings in proposed building – Level 3

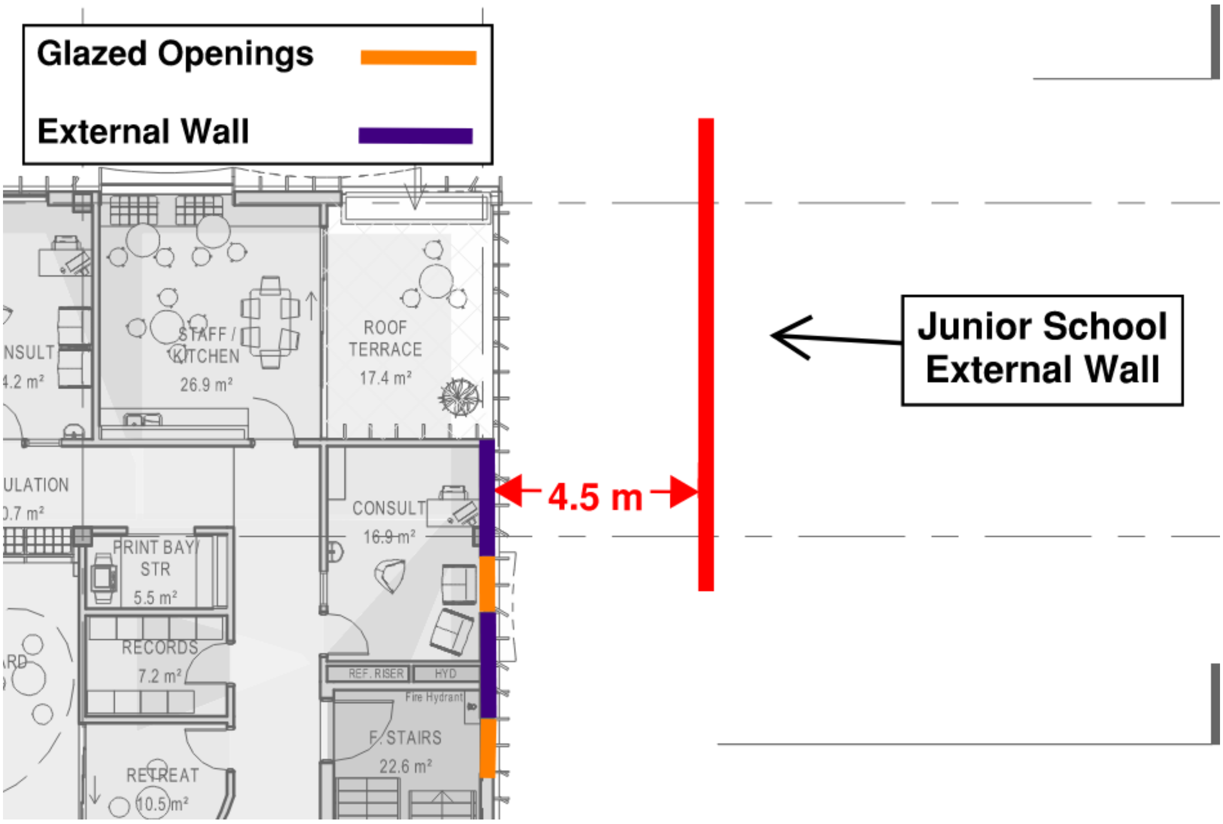


Figure 12: Non-compliant openings in proposed building – Level 4

Applicable DtS provisions:	Specification C1.1, C3.2	Performance requirements:	CP1, CP2, CP8

List key fire safety measures:

The external walls of the subject building shall be a minimum of 4.5m from the external walls of the adjacent Junior School Building.

The integrity of the Junior school brick wall is to be maintained to ensure the subject building will not be exposed to unprotected openings along that wall.

A smoke detection and alarm system is to be provided in accordance with BCA 2019 Amndt 1 and AS 1670.1 – 2018.

A fire hydrant system is to be provided in accordance with AS2419.1-2005.

Proposed performance solution:

BCA Intent

BCA Specification C1.1 dictates the requirements for the fire-resisting construction of building elements.

BCA Clause C3.2 states openings in an external wall that are required to have an FRL must be protected in accordance with C3.4 if the distance between the opening and another building to which it is exposed is less than 6m. Clause C3.4 outlines acceptable methods of protection for doorways, windows, and other openings.

The BCA Performance Requirement CP1 states that a building must have elements that will maintain structural stability during a fire.

Performance Requirement CP2 states that a building must have elements which will to the degree necessary avoid the spread of fire to exits, SOUs, public corridors, between buildings and in a building and is to be appropriate to the building function, fire load, proximity to other properties, any active fire safety systems and fire brigade intervention.

Performance Requirement CP8 requires any building element provided to resist the spread of fire must be protected, so that an adequate fire resistance is maintained.

Quantitative Analysis

The proposed solution will aim to demonstrate that the proximity of the Junior School and the proposed building will not result in the spread of fire to the proposed building, in the event of a fire within the Junior School. The proposed solution will undertake a radiant head analysis on the proposed building by considering several different fire scenarios, including a roof collapse, which is considered as a worst case scenario.

The radiant heat analysis will consider the incident heat upon the external wall of the proposed building, as well as the openings located in the external wall. The quantitative analysis will take into account the incident heat upon the openings and the external wall on all floors, up to a point 15 metres above the source of heat from the Junior School in order to account for radiation projection.

The solution aims to demonstrate that neither non-compliant FRL rated external walls, nor the openings facing the Junior School, will allow for the spread of fire given the incident radiant heat caused by a fire within the Junior School.

Junior School Fire Analysis

A worst case fire within the Junior School may present a danger of fire spread to the proposed building given the proximity of the two buildings. A worst case scenario fire within the Junior School will be considered in order to demonstrate the potential for fire spread is not exacerbated by the proximity of the two buildings.

In the event of a severe fire scenario where the roof of the junior school collapses, a radiant heat analysis will be undertaken in order to ensure that this fire scenario will not result in the spread of fire to the subject building. An emitter with dimensions equal to the width of the external Junior School wall, with a height of 2 metres (approximate height of flame venting from collapsed roof). This is assuming a heat flux of 63 kW/m^2 for the full height of the 2 m source, simulating an open flame temperature of 750^{o}C (Drysdale) for a full height of 2 m above the roof line. This is considered conservative given that if the roof fails, heat would dissipate rapidly into the atmosphere and would be distributed across the full extent of the roof area.

The impact of this fire will be assessed to a height of 15 metres up the façade of the subject building, in order to ensure that the spread of fire is not a possibility across the extent of the facade. Figure 13 below illustrates the position of the roof radiant heat emitter in order to best approximate the impact of a roof fire.

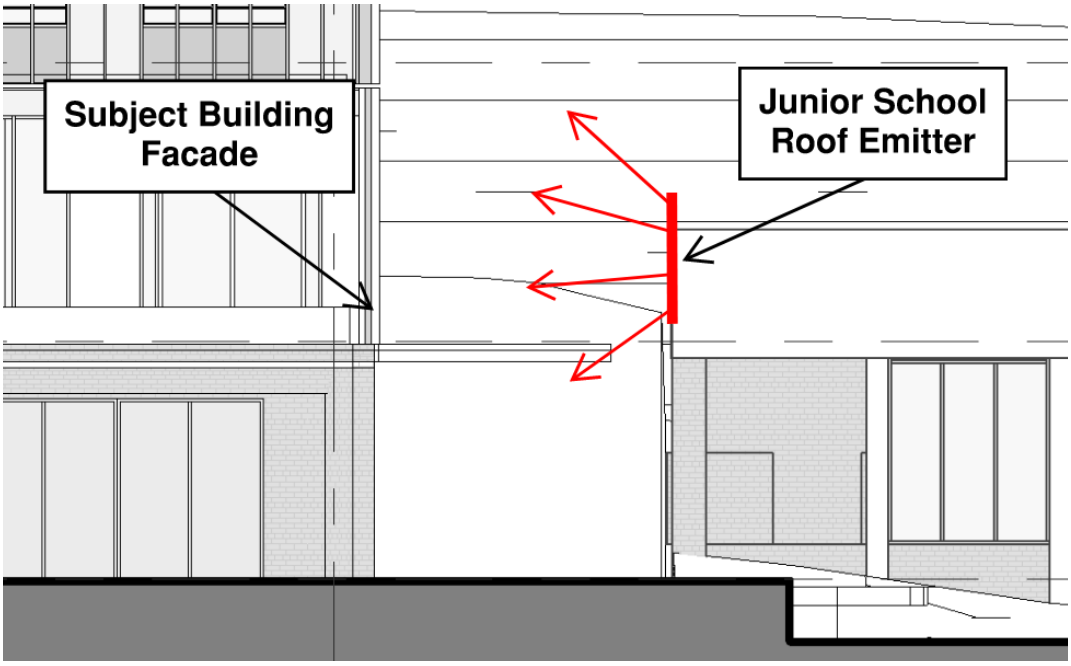


Figure 13: Junior School radiant heat emitter, approximating a fire resulting in a roof collapse

The radiant heat in this scenario will be analysed to a point 15 metres above the Junior School roof emitter. This takes into account the projection of the radiant heat across the extent of the proposed building external wall, as the proposed building happens to stand 15 metres higher than the Junior School roof emitter. The following figure illustrates the point 15 metres above the roof emitter, to which the radiant heat will be analysed.

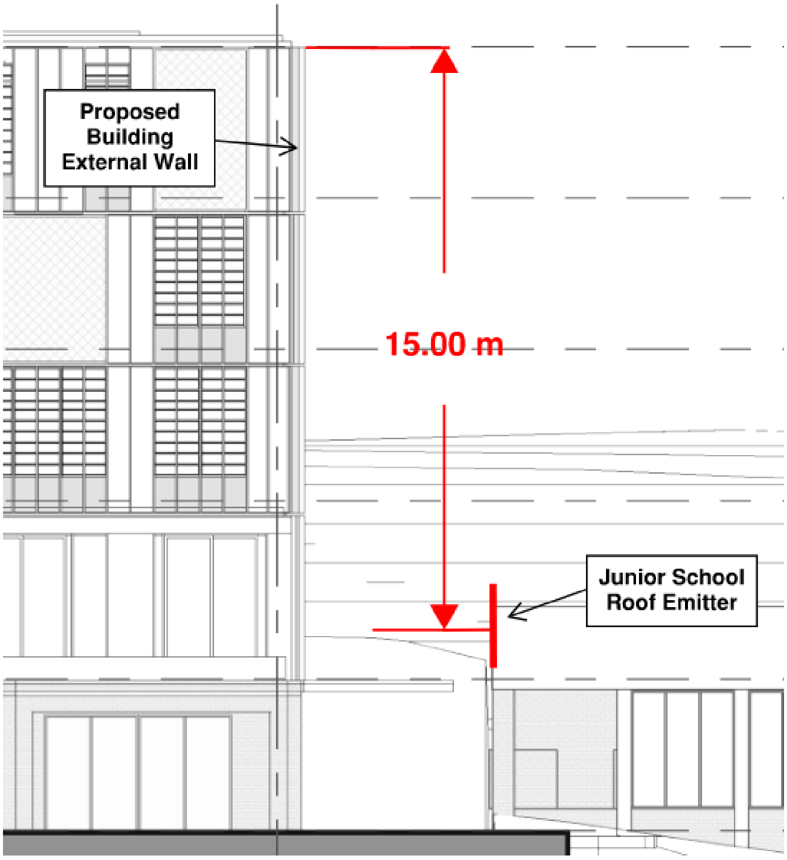


Figure 14: Projection of radiant heat 15 metres above Junior School roof emitter

The incident radiant heat on the external FRL rated wall, and openings within the wall will be analysed, in order to ensure that the risk of fire spread is not drastically exacerbated by the proximity of the two buildings.

Referenced information regarding the fire spread of certain materials, and the radiant heat to cause fallout of glazed openings will be used as a reference in order to determine the potential for fire spread across the two buildings.

The 2019 BCA guide notes that a radiative heat of 20kW/m^2 is typically required to cause piloted ignition of timber and 13kW/m^2 to cause piloted ignition of curtain material. As the external wall is constructed from non-combustible cladding and concrete, if the incident radiant heat is within is comparable to this range, it can be considered that the worst case heat flux will not be able to ignite the external walls or be sufficient to cause failure of the structural elements.

Research by Babrauskas indicates that the failure and fallout of glazed openings does not occur below a radiant heat exposure of approximately 35 kW/m^2. Fire spread via the external wall openings will be considered as an unlikely outcome if it can be demonstrated that the incident radiant heat is below this level.

Junior School Glazed Openings

The proposed solution will also analyse a fire venting from the openings of the Junior School, in order to demonstrate that this fire scenario will not cause a spread of fire to the external wall/openings highlighted in Figure 15 below.

the openings on the south side of the Junior school building with a quantitative radiant heat assessment, and show that the spread of fire is sufficiently limited to be in accordance with the relevant performance requirements. A fire scenario that involves a fire that has broken through the glazed openings will be considered, and the corresponding impact to the subject building will be addressed with the appropriate radiant heat calculations. below illustrates a fire venting from the opening, and the nature of the radiant heat caused by such a fire. Figure??? below illustrates the location of the emitter used, which can be considered as onerous as the emitter will represent a radiant heat equivalent to a compartment fire directly facing the proposed building. A fire venting from the opening however does not directly face the building, resulting in a lower incident heat flux. The emitter will protrude from the building by 1 metre, and will be 2 metres in height.

A radiant heat of 84 kW/m^2 will be used, as per the Building Regulations 1991, Section B4 – External Fire Spread recommendation of a temperature of 830°C for fires within residential, office, assembly, and recreational buildings.

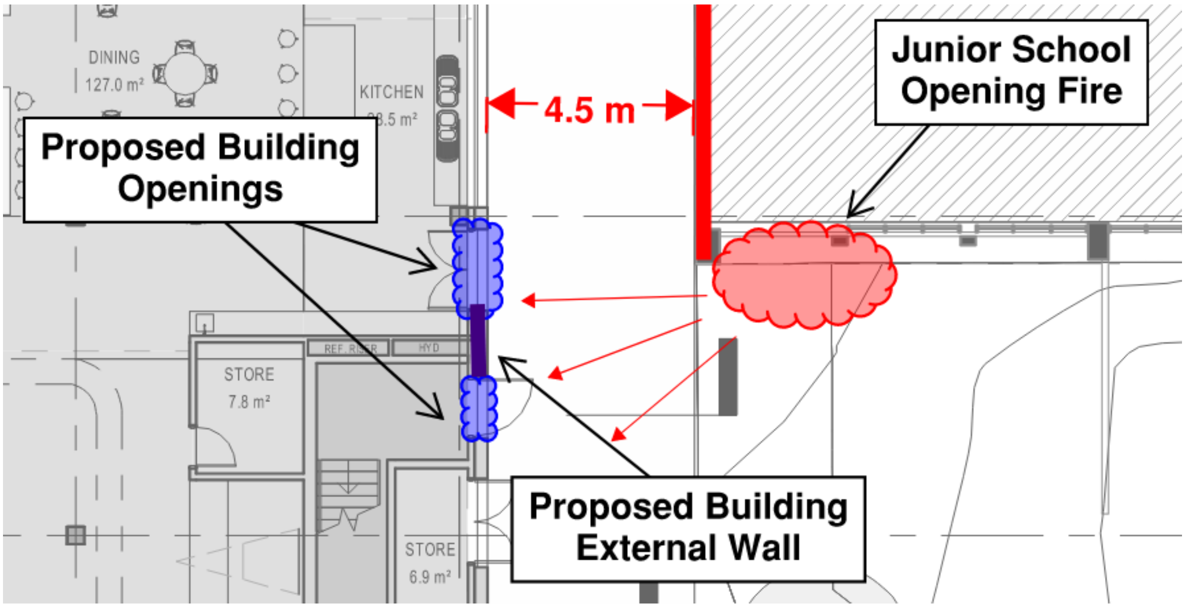


Figure 15: Radiant heat caused by fire venting from opening

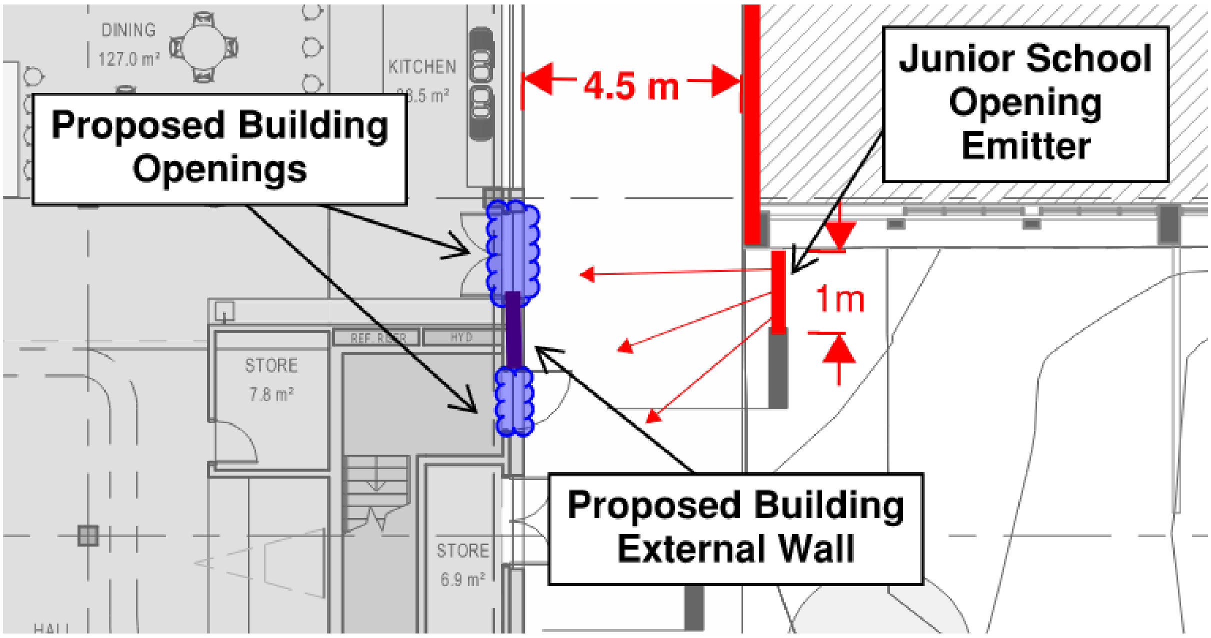


Figure 16: Junior School opening emitter, simulating fire venting from openings

Fire within the subject building

Radiant heat calculations will be carried out based on the openings on the subject building emitting a heat flux of 84 kW/m^2 onto the adjacent junior school building. This radiant heat is based on the Building Regulations 1991, Section B4 – External Fire Spread recommendation of a temperature of 830°C for fires within residential, office, assembly, and recreational buildings.

The assessment will aim to show that the radiant heat received at the junior school building is not sufficient to cause fire spread, especially considering the junior school building comprises mostly a solid brick wall and pedestrian pathways that contain no combustible materials.

Qualitative Analysis

Switchboard Cupboard External Wall

The proposed solution aims to qualitatively demonstrate that the switchboard cupboard opening/external wall (as illustrated in Figure 8) will not pose a significant risk of fire spread to the proposed building in the event of a fire within the Junior School.

The roof of the Junior School extends to the switchboard cupboard on the northern side of the Junior School external wall, as seen in the following figures:

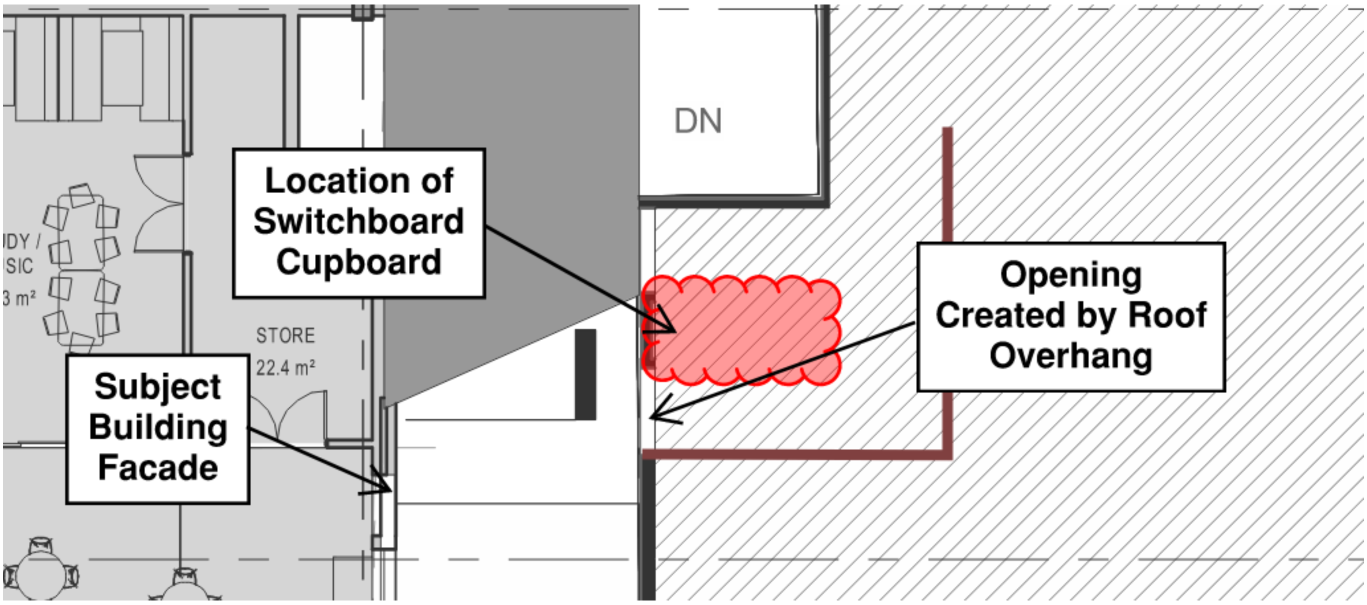


Figure 17: Junior School radiant heat emitter, approximating a fire resulting in a roof collapse

Figure 18: Switchboard Cupboard opening, as seen from outside opening

Figure 19: Switchboard Cupboard opening, as seen from within opening

The opening created by the roof overhang (seen in and) constitutes an area of low fuel load, with the switchboard cupboard housing electrical equipment for the Junior School.

The switchboard cupboard also has an external wall that is less than the required distance to the proposed building. The solution will aim to qualitatively demonstrate that the switchboard cupboard will not add significant fuel load to a fire within the area, and therefore will not pose a significant risk of fire spread to the proposed building. The justification will rely on the fact that the switchboard cupboard houses a small amount of electrical equipment which is not considered as combustible, and is housed in a small structure that does not amount to a significant fuel load, therefore not resulting in a high impact and risk of fire spread to the proposed building.

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 solution will be deemed acceptable if it can be shown that fire spread between neighbouring buildings is not facilitated by the non-compliant distance between the external walls. The radiant heat flux incident on both buildings shall not exceed the following:

- 13 kW/m^2 where piloted ignition can occur (i.e. openable openings with lightweight curtains);
- 20 kW/m^2 where only non-piloted ignition can occur (i.e. fixed closed openings where embers cannot pass).

Fire scenarios and design fire parameters:

A fire within both the neighbouring junior school and the subject building will be considered.

Describe how fire brigade intervention will be addressed or considered:

Fire Brigade intervention will be equivalent to a DtS design if it is demonstrated that fire spread between compartments / buildings is limited in accordance with the performance requirements.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

Provide details on proposed modelling/assessment tools:

The assessment will utilise empirical calculations to determine radiant heat flux. The following inputs and assumptions will be considered during the calculations:

- Emissivity of the body is 1. This is supported by information published within the book titled “An introduction to Fire Dynamics” by Drysdale D which states that the emissivity may range from 0.05 to 0.81. For hydrocarbon flames, an emissivity of 1 is recommended.
- A heat flux of 84 kW/m^2 is used for the radiant heat calculations, based on the Building Regulations 1991, Section B4 – External Fire Spread recommendation of a temperature of 830°C for fires within residential, office, assembly, and recreational buildings.

The radiation received at the opposing opening will be calculated using the following equations:

Equation 1 $q_p = F_{1-2} q_e$

$Where,$

$q_p = radiant\ heat\ flux\ perceived\ by\ nearby\ objects\ (kW/m^2)$

$F_{1-2} = view\ factor\ configuration$

$q_e = radiant\ heat\ flux\ emitted\ by\ fire\ shutter (kW/m^2)$

Equation 2 $$\boldsymbol{F_{d1-2} = \frac{1}{2\pi}\left(tan^{-1}(YCos\theta_i) + tan^{-1}(XCos\theta_j) + \frac{XCos\theta_k - Cos\theta_i}{\sqrt{1+X^2}} tan^{-1}\frac{Y}{\sqrt{1+X^2}} + \frac{YCos\theta_k - Cos\theta_j}{\sqrt{1+Y^2}} tan^{-1}\frac{X}{\sqrt{1+Y^2}}\right)}$$

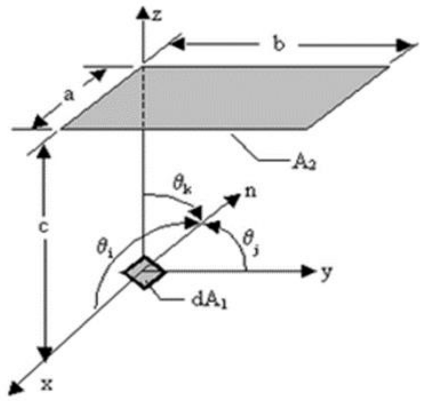


Figure 20**: View factor configuration Angled Receiver**

Issue number: 2 **Title:** Hydrant Booster Location

Details of departures from DtS provisions:	

Allow for the external hydrant booster to be located in a position that is not immediately visible from the main entrance to the building.

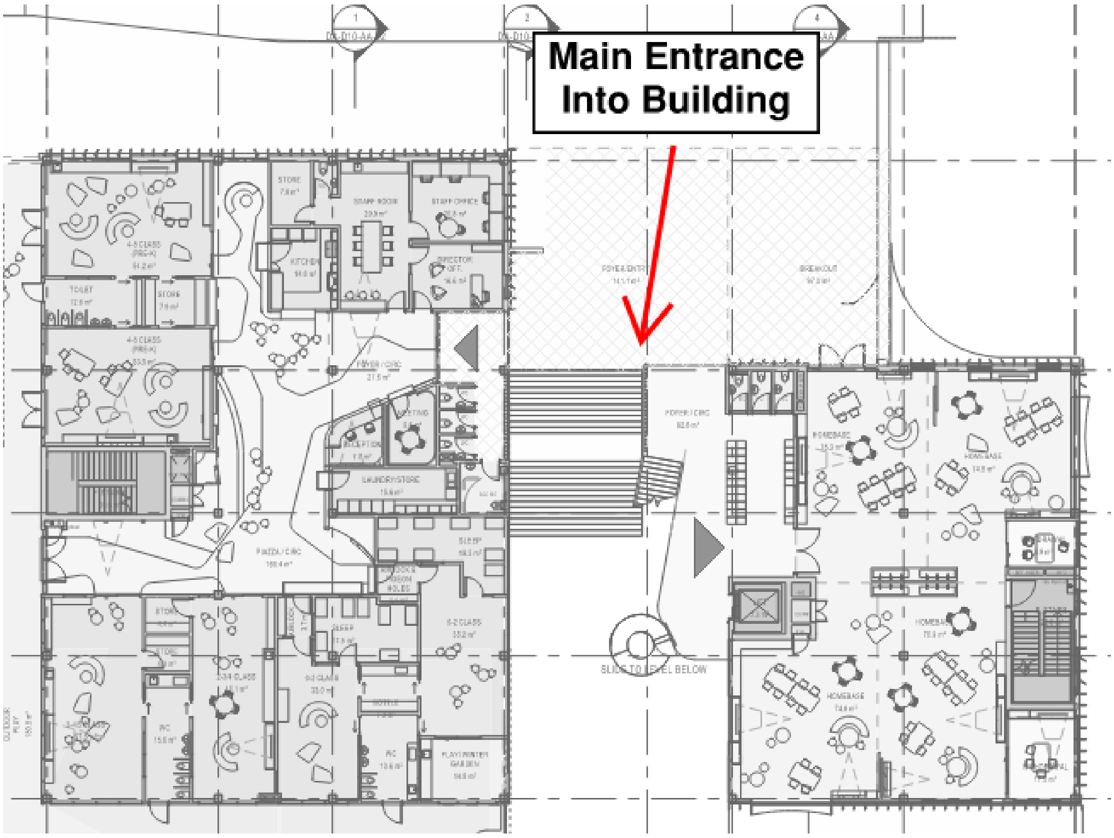


Figure 21: Hydrant booster serving entire site, adjacent to main entrance from Avon Road – Main entrance from Level 02

Applicable DtS provisions:	E1.3, AS 2419.1	Performance requirements:	EP1.3

List key fire safety measures:

Signage and block plans shall be provided in order to highlight the location of the hydrant booster assembly at the FIP, located on Level 02 of the proposed building. The signage shall state "HYDRANT BOOSTER AT AVOND RD ENTRY" lettering is to be at least 25 mm high and of a colour contrasting the background. The signage is to be at a height of at least 1.75 FFL. The signage is to be located immediately adjacent to the FIP of the subject building.

Proposed performance solution:

BCA Intent

Clause E1.3 of the BCA and AS2419.1-2005 require that a hydrant booster be located in an area that is visible from the main entrance to the building. The intent of this clause is to allow the fire brigade to quickly locate and access the necessary fire fighting equipment without hinderance upon arriving on site.

Performance Requirement EP1.3 states that a fire hydrant system must be provided to the degree necessary to facilitate the needs of the fire brigade.

Qualitative Analysis

It is proposed to provide a site block plan noting the location of the hydrant booster at the building's Fire Indicator Panel. The following figure highlights the approximate location of the hydrant booster on site in relation to the location of the subject building, and the path taken by the fire brigade in between the two locations.

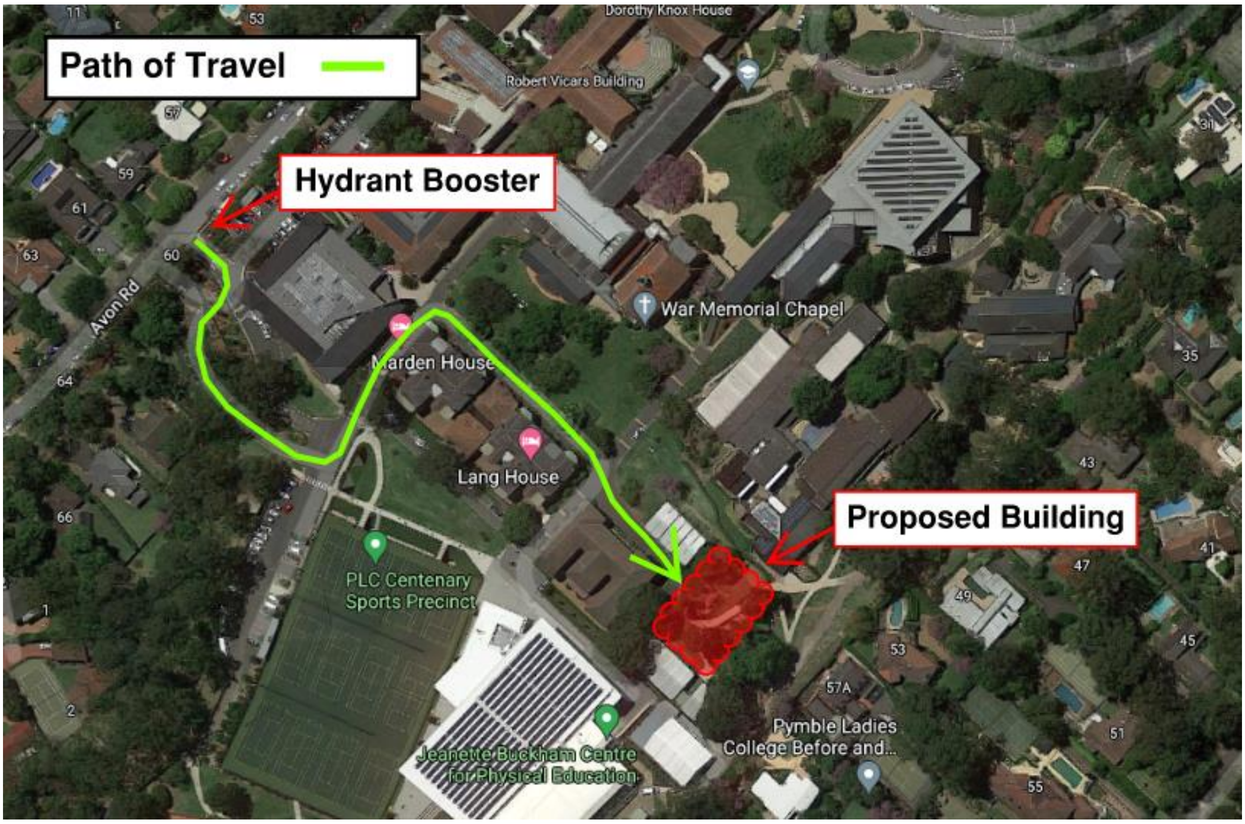


Figure 22: Location of hydrant booster and proposed building, and path of travel

Upon notification of a fire scenario the attending fire brigade will be directed to this location, where they can then undertake the necessary fire-fighting operations. Furthermore, the hydrant booster is located directly adjacent to the main entrance into the school site from Avon Road, as seen in Figure 23 below. The hydrant booster is immediately visible upon arriving on site, the attending fire brigade will be able to identify the booster location without having to view the proposed signage and blockplans at the subject building.

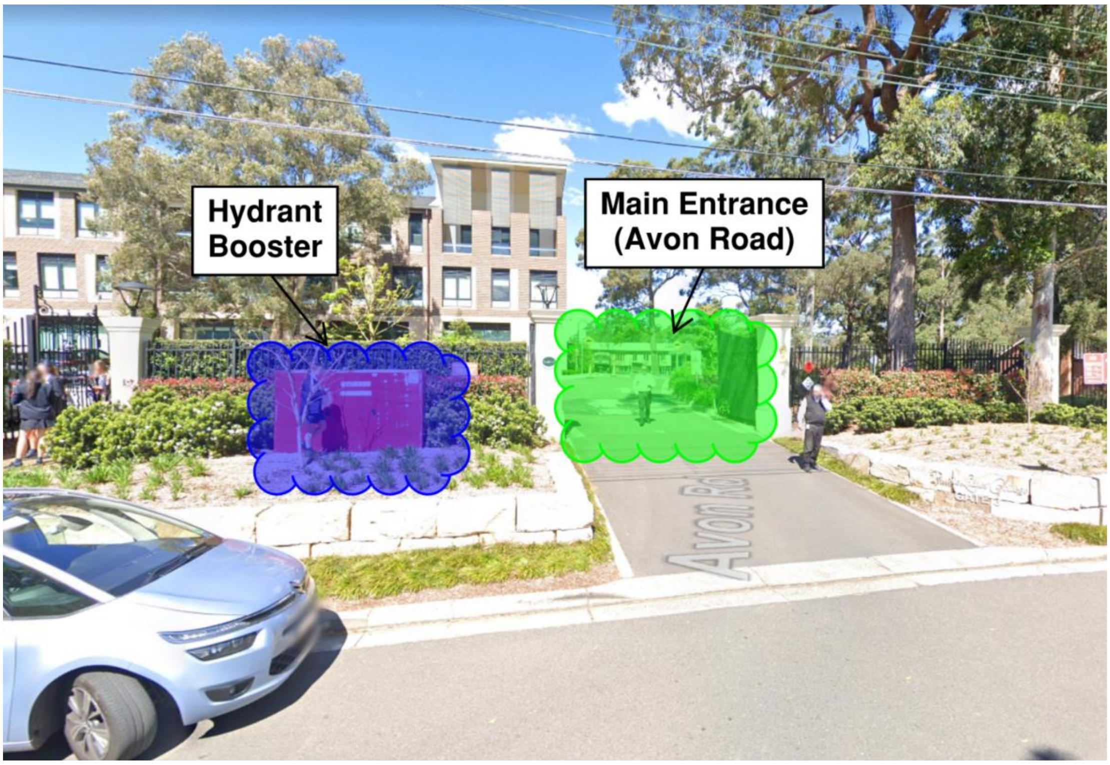


Figure 23: Hydrant booster serving entire site, adjacent to main entrance from Avon Road

Figure 24: Hydrant booster serving entire site, adjacent to main entrance from Avon Road

In the event that the attending fire brigade do not immediately identify the hydrant booster upon arrival, they will be informed via signage and blockplans upon investigation of the FIP (Level 02).

Based on the current location of the booster being readily visible from a main vehicle entry for the school site and the provided signage and blockplans, it is considered that the attending fire brigade would be able to locate the hydrant booster without any significant delay that would impede their intervention. Therefore, it is considered that compliance with Performance Requirement EP1.3 would 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 location of the booster shall not impede fire brigade intervention.

Fire scenarios and design fire parameters:

Fire within the subject building.

Describe how fire brigade intervention will be addressed or considered:

As per the assessment above. The proposed performance solution requires additional signage and blockplans indicating the location of the hydrant booster, minimising the time required by the fire brigade to access necessary fire fighting equipment.

Verification/validation analyses:

☐ Sensitivity studies ☑ Redundancy studies ☐ Uncertainty studies ☐ None

The assessment will consider a scenario whereby the attending fire brigade are unable to identify the location of the booster as they pass through the main vehicle entry.

Provide details on proposed modelling/assessment tools:

N/A

Issue number: 3 **Title:** Omission of Fire Hose Reels

Details of departures from DtS provisions:

Permit the use of fire extinguishers in lieu of fire hose reel systems for the ELC Childcare on Level 2 and Wellness Centre on Level 4 sections of the subject building. The figures below illustrate the areas relevant to the proposed performance solution.

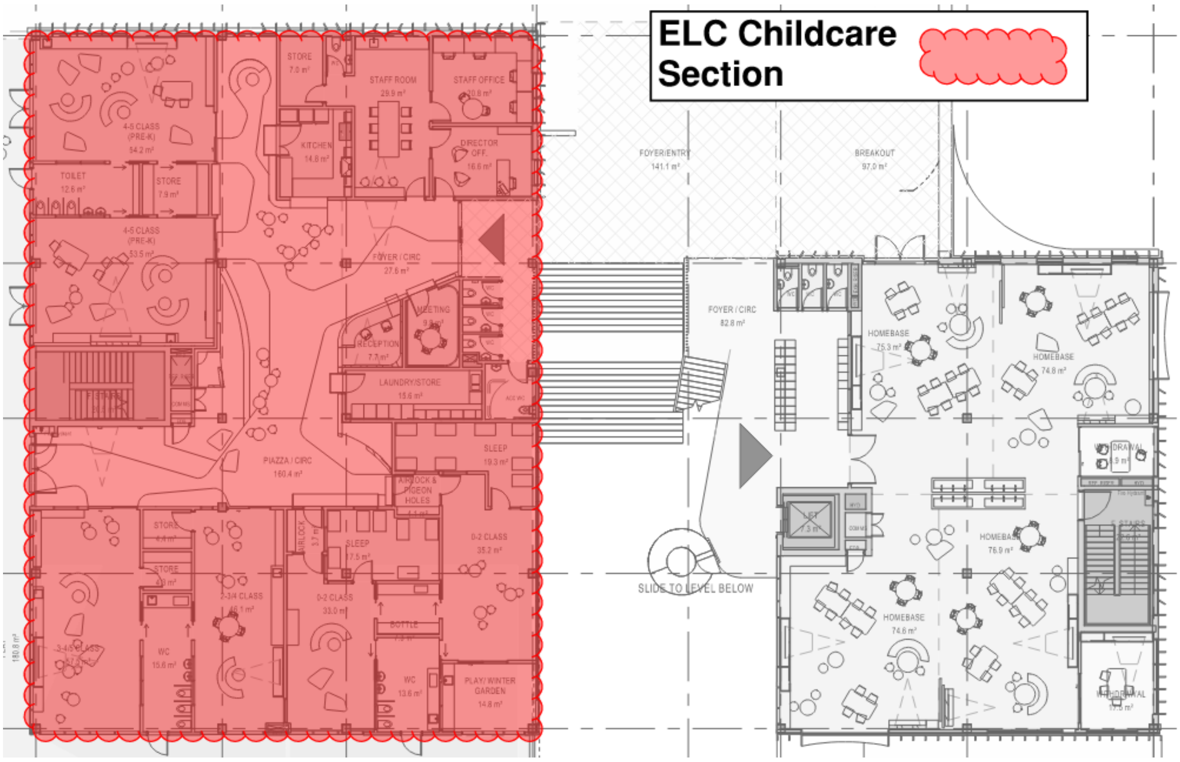


Figure 25: ELC Childcare section of the subject building (Level 02)

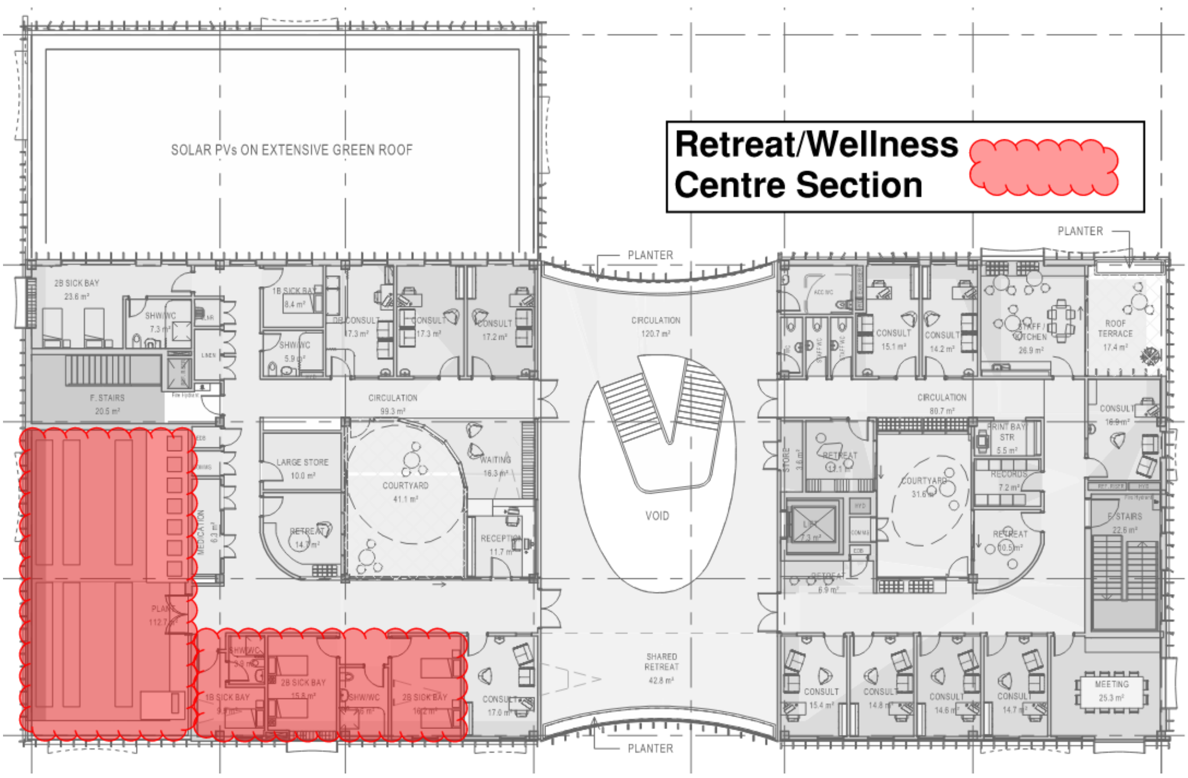


Figure 26: Retreat/Wellness Centre sections of the subject building (Level 04)

Applicable DtS provisions:	E1.4	Performance requirements:	EP1.1

List key fire safety measures:

A smoke detection and alarm system is to be provided in accordance with BCA 2019 Amndt 1 and AS 1670.1 – 2018.

Portable fire extinguishers to be provided throughout the building in accordance with AS 2444.

Additional smoke compartmentation shall be provided to separate the building into 3 main smoke compartments.

Proposed performance solution:

BCA Intent

The intent of BCA Clause E1.4 as per BCA Guide is to require the installation of suitable fire hose reel systems to enable, where appropriate, a building's occupants to undertake initial attack on a fire. It is noted that a similar intent also applies to fire extinguishers.

It is noted that majority of the spaces within the building are classroom or admin / office spaces which under the BCA DtS requirements do not require FHRs.

Performance Requirement EP1.1(a) states a fire hose reel system must be installed to the degree necessary to allow occupants to safely undertake initial attack on a fire appropriate to the size of the fire compartment.

It will be demonstrated that the inclusion of fire extinguishers in lieu of fire hose reel will not pose any additional risk to the life safety of occupants and will provide adequate facilities for occupants to undertake an initial fire attack in Class 9b compartments in what is mostly a school classroom / admin building.

Qualitative Analysis

Occupant Fire Fighting Behaviour

In order to qualify the risk to occupants, it is important to acknowledge how occupants respond to a fire. Occupants having responded to a fire cue or alarm signal may either decide to evacuate or attempt to fight a fire.

Based on research as discussed by Bryan [1] a correlation is drawn upon for various occupancy types and the percentage of occupancies in which fire-fighting was utilized. It is evident from the figure below that the use of fire-fighting equipment in buildings other than dwellings and smaller apartments is limited, accounting for less than 5% of incidents.

It should be noted that the figure below represents a total of 64 incidents across all occupancy types listed.

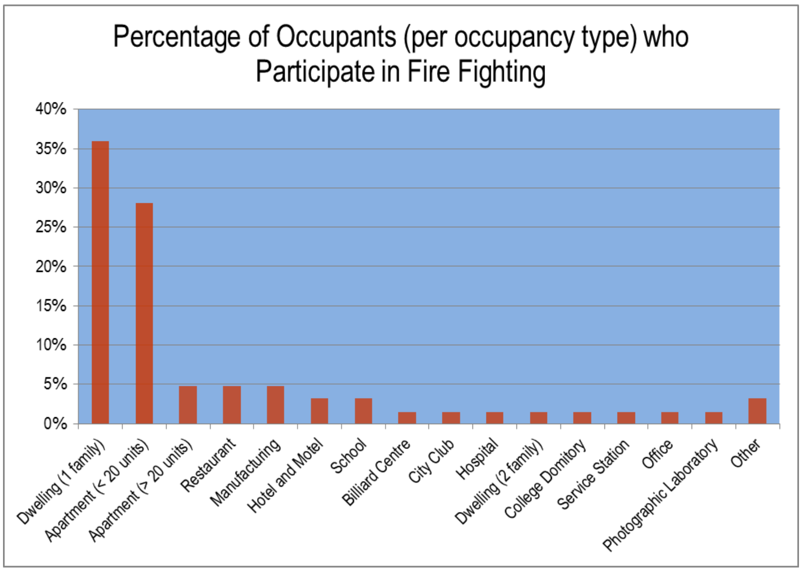


Figure 27: Occupants participating in fire-fighting

Occupants are expected to use fire hose reels when they consider it is safe to do so, in the early stage of a fire development. Therefore, heat and smoke from the fire are expected to be limited when occupants are trying to fight the fire.

If the fire is noticed at an early stage both fire hoses and fire extinguishers provide sufficient means for undertaking an initial attack. If the fire is noticed at a later stage it could have developed to a size where it is beyond the capabilities of a fire extinguisher. A fire hose might be sufficient, but due to the larger fire size the risk to occupants will have increased as well.

It is not considered appropriate under such conditions for occupants to attempt to extinguish such a fire. If the fire is too large to extinguish with a portable extinguisher it is growing at an increasing rate. Due to the fact that occupants are not experienced setting up a fire hose reel there will likely be a time delay before the use can be undertaken; allowing the fire to grow even larger. Even if the amount of water during use is indefinite, occupants will have to fight the fire without any personal protective equipment or breathing apparatus. In addition to heat from the fire and toxic gas, occupants could also be harmed by the steam produced when applying water to the fire.

Therefore, if the fire is too large to extinguish with a portable fire extinguisher, occupants should evacuate the building instead of undertaking an initial attack.

Fire extinguishers complying with Australian Standards are marked with a classification and rating, determined in accordance with the relevant hazard that is likely to be present within the space. These are classified according to Class A through Class F as shown in the table below.

Table 1: Summary of Performance Solution 1

Fire Extinguisher Type	Type of Fire, Class and Suitability
Class A	Wood, paper, plastics, etc.
Class B	Flammable liquids
Class C	Flammable gases
Class D	Metal fires
Class E	Energized electrical equipment
Class F	Cooking oils and fats

Given the nature and use of the Class 9b spaces for Childcare and a Wellness Centre, it is reasonable to assume that staff should prioritise the evacuation of occupants from the compartment of fire origin out of the building rather than undertaking initial fire-fighting should the fire grow beyond the extinguishing capacity of a PFE. It is proposed to provide appropriate fire extinguishers and extinguishants in accordance with the Australian Standard AS2444-2001.

Extinguishers also have the benefit of being considerably lighter than fire hose reels, meaning that they can be used by a wider range of building occupants.

It is further noted that if an occupant does not manage to control the fire, he/she may flee with the risk of leaving the hose edged against a door, leaving it open and allowing the fire to spread into other areas of the building. This compromises the fire or smoke compartmentation within a building and creates a path for fire and smoke to readily spread to the egress path as well as to be trained in the use of fire hose reels and therefore would likely put themselves at a higher risk of injury than simply evacuating.

Compartment Analysis

The BCA Clause E1.4 does not apply to the *"classrooms and associated corridors in a primary or secondary school"*, meaning that fire hose reels need not be installed in these sections of the building. The ELC Childcare and Wellness Centre sections of the building are comparable to primary and secondary classrooms in terms of fuel load, fire hazards and also occupant characteristics, it is therefore reasonable to extend the fire hose reel non-requirement to the non-compliant areas discussed above.

In the event of a fire the primary intent for students is to evacuate the building safely, for this reason students are assumed to evacuate instead of undertaking fire-fighting activities. Providing students with access to a fire hose reel may encourage them to attempt to undertake fire-fighting operations.

When analysing occupant characteristics in a fire scenario, students are assumed to be awake and unfamiliar. Staff members in these areas have a duty of care to ensure that students are guided to safety in an emergency. For this reason, in a fire scenario staff are expected to direct students throughout the duration of egress.

Office, admin and maintenance staff who are not in student occupied areas may elect to attempt to extinguish a fire in its early stages. The subject building is to be provided with Fire Extinguishers throughout as per Clause E1.6 of the BCA, providing staff in these areas the ability to attempt to extinguish a fire in its early stages. If unsuccessful occupants are expected to abandon the fire extinguisher and evacuate the premises.

As such, given the similarities between the childcare / wellness centre and classrooms and office spaces respectively, it is considered that portable fire extinguishers would provide an adequate means of undertaking an initial attack on a fire that is appropriate for the actual use of the spaces as per the intent of the BCA.

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:

It will be demonstrated that the ability of occupants to extinguish or control a fire in its infancy will not be diminished by the inclusion of fire extinguishers in lieu of Fire Hose Reels within the Childcare and Wellness Centre parts of the building.

Fire scenarios and design fire parameters:

Fire within the childcare and wellness centre spaces.

Describe how fire brigade intervention will be addressed or considered:

This non-compliance relates mainly to early occupant intervention as the fire brigade ae provided with a more appropriate hydrant system to fight fires.

Verification/validation analyses:

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

Provide details on proposed modelling/assessment tools:

N/A

Issue number: 4 **Title:** Atrium Construction

Details of departures from DtS provisions:

Allow design of stairwell atrium to deviate from what is required by Part G3 of the BCA.

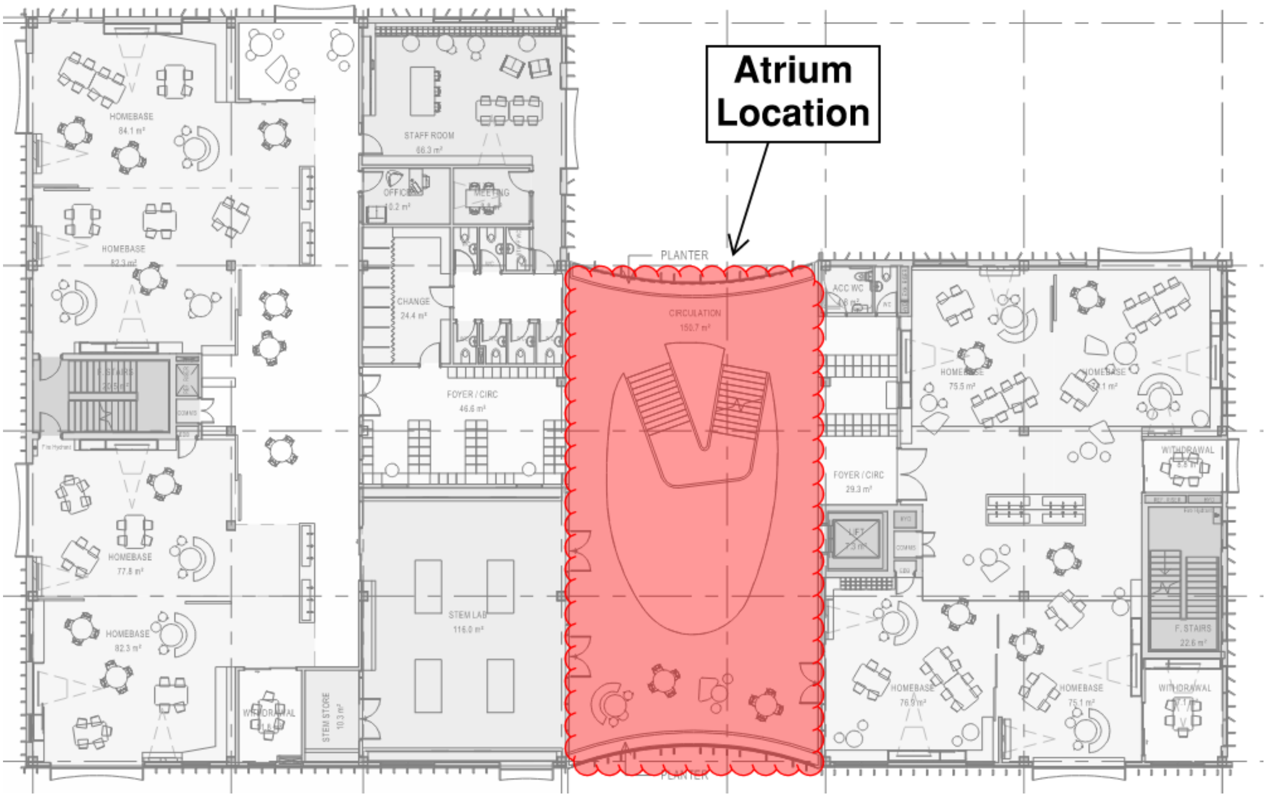


Figure 28: Atrium location – Level 03

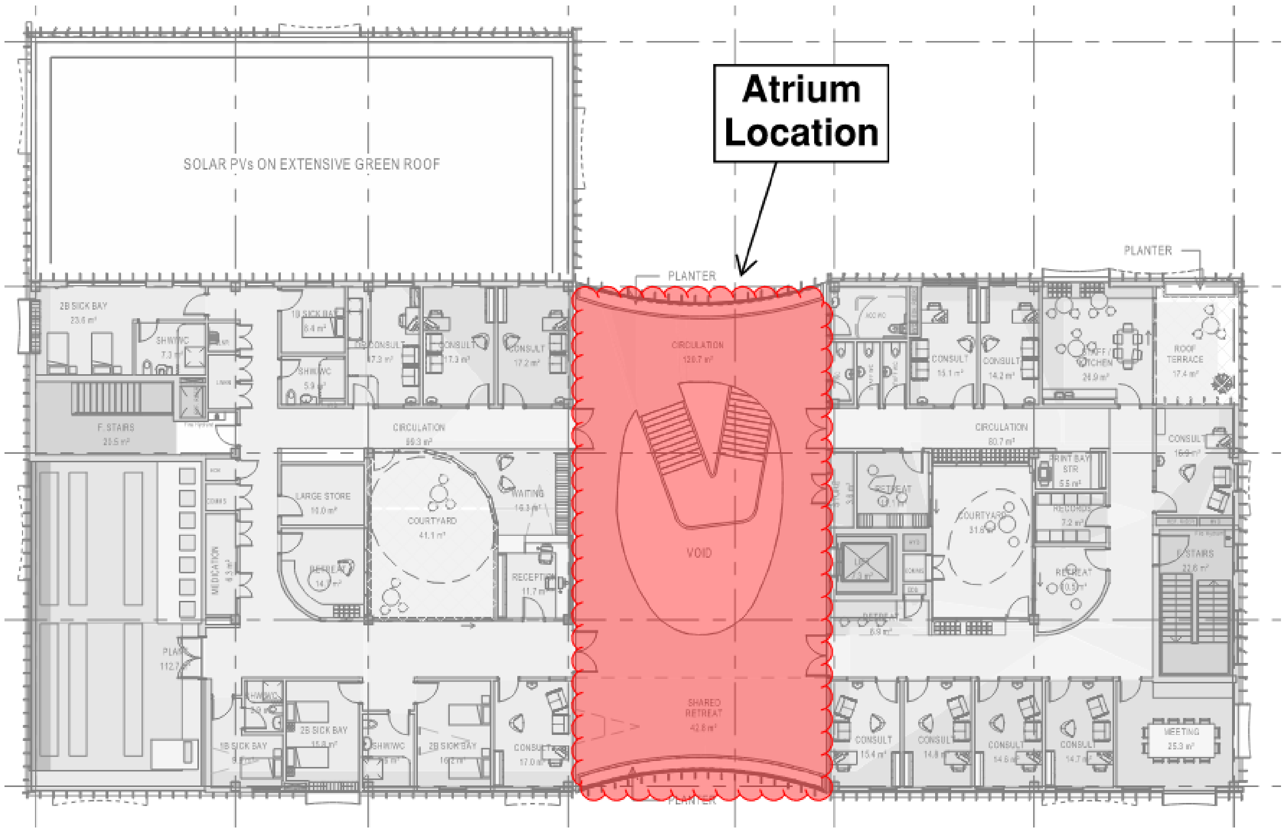


Figure 29: Atrium location – Level 04

Applicable DtS provisions:	G.3.1 – G3.8	Performance requirements:	CP2, EP1.4, EP2.2

List key fire safety measures:

The bounding walls surrounding the atrium provide a smoke separation from the atrium space. Doorways through bounding walls separating atrium space from surrounding occupant compartments are to be provided with medium temperature smoke seals and tested in accordance with AS 1530.7.

A smoke detection and alarm system complying with AS 1670.1-2018 will be installed in the development.

The north and south façade of the atrium space shall be provided with permanently open or auto opening louvres to vent smoke in the event of a fire. The louvres shall achieve a net free area of 50% of that of the façade and shall be equally distributed across the façade and on both the north and south side.

Proposed performance solution:

BCA Intent

Although the central stair void is technically defined as an atrium under the BCA, the design of the space is such that it is more of an external circulation space that is generally sterile in nature and is open to the outside along the north and south façade. The intent being to provide occupants the ability to travel between the two main parts of the building via external circulation areas. These circulation areas are to be protected from the weather and this results in the space being partially enclosed and it being defined as an atrium.

Part G3 of the BCA dictates the requirements of a building that is to be constructed with an atrium space, pertaining to dimensions of the atriums space, surrounding construction, egress availability and fire and smoke control systems.

The intent of Performance Requirement CP2 is to set requirements for building elements to avoid the spread of fire.

The intent of Performance requirement EP1.4 is to ensure measures are in place to adequately control the development and spread of a fire.

Performance Requirement EP2.2 states that evacuation routes must remain safe for use for a period of time long enough to allow building occupants to safely evacuate.

Qualitative Analysis

Smoke Separation

The hazards associated with the presence of an atrium structure is that a fire scenario has the potential to exacerbate the impact of a fire, as it is a large non-compartmented space that has the potential to be subjected to smoke spread across multiple storeys.

The proposed solution relies on the smoke separation of the surrounding FRL rated bounding walls, which separate the surrounding occupant compartments from the open atrium space. Additionally, it is proposed that any door separating the atrium and surrounding occupant spaces be self-closing and installed with medium temperature smoke seals in order to maintain the smoke separation across bounding wall openings. This separation means that in a worst-case scenario fire, in which a fire starts within the central void within the building (as illustrated in the figures below) and causes smoke to rise up through the atrium, the smoke and hot gases will not spread to the adjoining compartments where the required egress stairs are located. Occupants in all areas of the building will be able to evacuate without having to egress through the atrium, as the building is provided with two fire protected stairs on either side of the atrium, as illustrated in the figures below.

The smoke separation and smoke sealed doorways will also work to prevent smoke from entering the atrium from the surrounding compartments, should a fire start in one of the compartments adjacent to the atrium space.

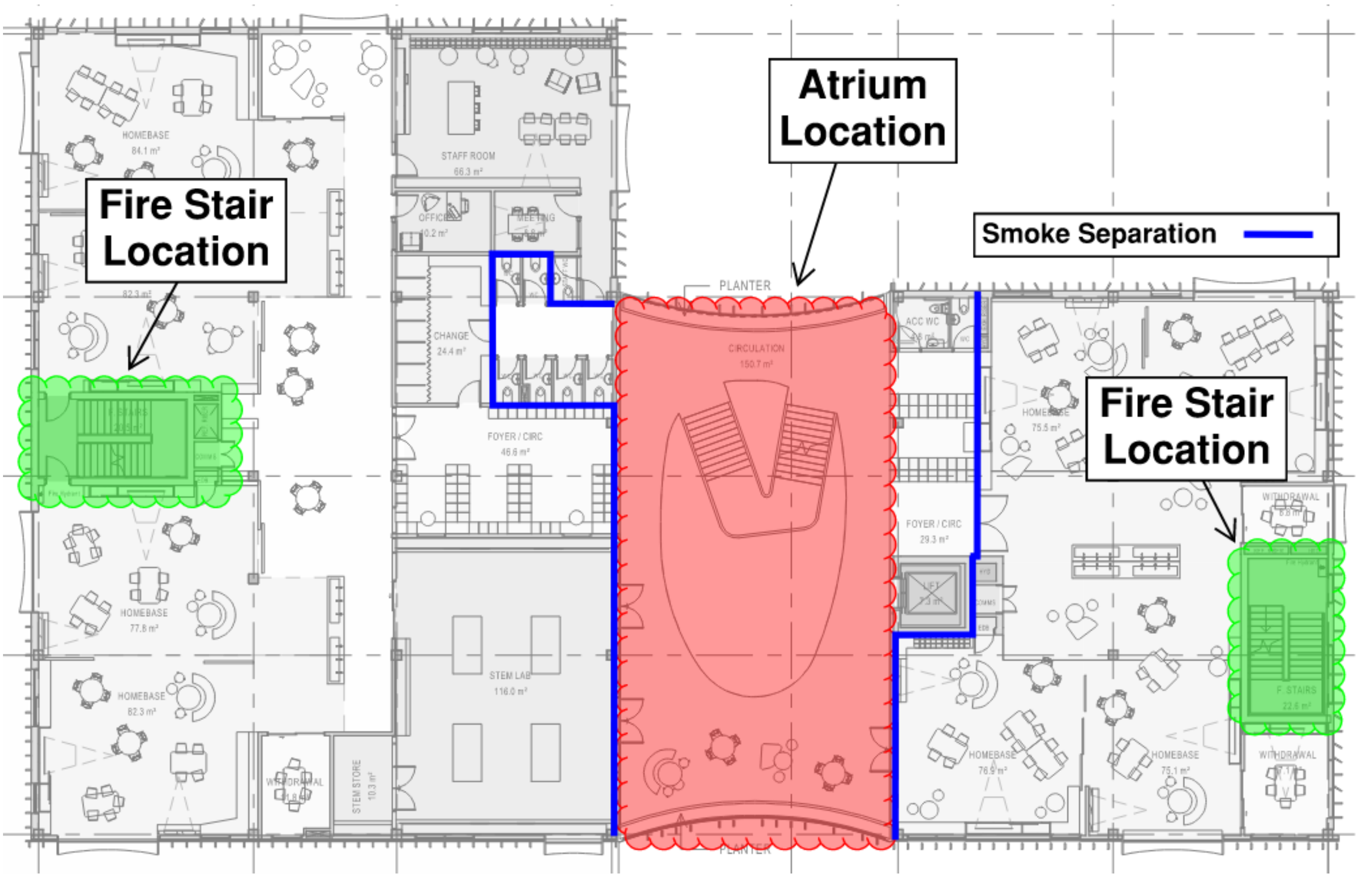


Figure 30: Smoke separation and fire stair location – level 03

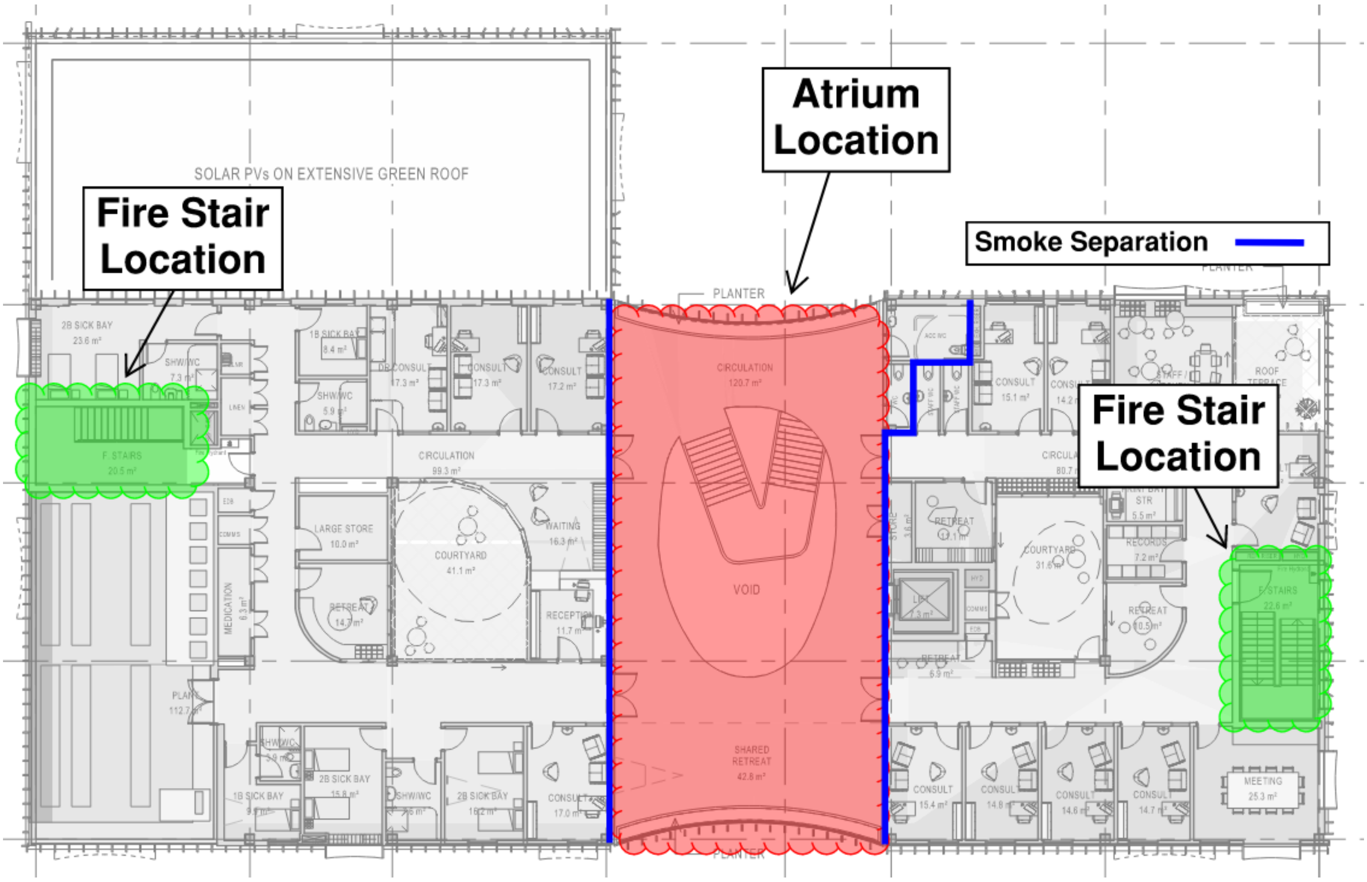


Figure 31: Smoke separation and fire stair location – level 04

Atrium Space Analysis

The atrium has been designed in such a way that it consists of a large open space, and given the use of the area will primarily be occupant thoroughfare with a small amount of public furniture at the southern end (see figures above), the atrium is therefore expected to have a low fuel load at all times. The impact of a fire within the atrium space and the corresponding volume of smoke produced will therefore pose a minimal risk of fire and smoke spread throughout the atrium, and will not endanger occupants by creating untenable egress conditions.

Furthermore, occupants are afforded access to two sets of fire stairs, meaning that occupants present on level 3 and level 4 will be able evacuate without having to egress through the atrium space, safely exiting the building without being subject to any hazardous conditions that may be present.

The atrium will also be constructed with louvres on both the north and south ends, allowing for any smoke and hot gasses to be expelled out to atmosphere. This further mitigates the risk posed by the presence of an atrium, allowing occupants to safely evacuate without being subject to a hazardous build up of smoke.

To demonstrate the above is adequate for occupant safety, CFD analysis will be carried out for fires both in the atrium as well as the spaces adjoining the atrium. Further details regarding the CFD analysis is provided below.

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 solution will be deemed acceptable if it can be demonstrated that the hazards posed to occupant evacuation and safety by the presence of an atrium within the building are sufficiently mitigated.

The solution will be deemed acceptable from a fire spread standpoint if it can be demonstrated that the presence of the atrium structure will not allow for the spread of fire across multiple levels.

The acceptance criteria is therefore as follows:

Design Fire Scenario:

- Available Safe Egress Time (ASET) > Required Safe Egress Time (RSET) x 1.5 Safety Factor

Sensitivity Fire Scenario:

- Available Safe Egress Time (ASET) > Required Safe Egress Time (RSET)

Fire scenarios and design fire parameters:

See details on fire scenarios below.

Describe how fire brigade intervention will be addressed or considered:

Given the smoke separation between the atrium space and the surrounding occupant compartments, and the location of the fire stairs within the building, it will be demonstrated that occupants will be able to safely evacuate in the event of a fire, allowing the attending fire brigade to concentrate on firefighting activities, instead of the rescue of trapped occupants.

The solution aims to demonstrate that the atrium does not pose undue risk of fire spread across multiple levels. The impact on the fire brigade will be considered as mitigated, as the fire brigade will not be faced with a fire that has spread vertically throughout the building.

The limited amount of combustible materials within the atrium space means the fire would remain small and with the extensive natural ventilation provided on the north and south sides, smoke would vent out to the atmosphere instead of accumulating within the space.

In a worst case fire causing smoke spread through all levels of the atrium (i.e. fire on the lowest level), the risk to the attending fire brigade would be minimised by the following:

- The fire being on the ground floor which is readily accessible from safe space outside for fire fighting;
- Limited combustibles in the atrium space means the fire brigade would only be presented with a small fire contained to a single level as it would not be able to produce a sufficient amount of heat to cause materials on other levels to ignite;
- The significant amount of openings allowing the smoke and heat to vent out to the atmosphere.

Verification/validation analyses:

☑ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☐ None

The assessment will ignore the benefits from wind in terms of inducing venting the atrium space. The assessment will also consider a larger fire in the adjoining classroom spaces which then breaks into the atrium.

Provide details on proposed modelling/assessment tools:

A quantitative CFD ASET/RSET assessment is to be undertaken using FDS to determine the tenability in the building, and to understand the impact that the interconnection of 4 storeys via the central stairway/atrium will have. This assessment will consider a fire in central stairway void on the lowest level, as well as a fire in the adjacent compartments.

The table below outlines the fire scenarios to be assessed within the CFD quantitative assessment.

Table 2: Fire Scenarios

Scenario	Fire Size	Growth Rate	Description
Base Case	1.0 MW [1]	Medium [2]	The scenario considers a fire originating in the central stairway void on the lowest level of the atrium to induce the most entrainment and hence volume of smoke. The fire size has been considered based on the limited amount of combustibles permitted within the atrium space (i.e. unattended belongings, display boards, plants etc.).
Sensitivity Case	5 MW [3]	Medium [2]	The model considers a fire originating in an adjoining compartment on the lowest level which then breaks into the atrium upon glazing failure at 300ºC [4]. The fire size is based on Table E2.2b of the BCA which states a smoke exhaust system must be capable maintaining tenable conditions for a 5 MW fire in an unsprinklered Class 9 building. It is noted that preliminary evacuation analysis shows that evacuation is complete prior to fire reaching 5MW. Therefore, a fire beyond 5MW in size is not expected to worsen the impact on occupant evacuation.
Reference: **[1] SFPE Handbook 2003 – Heat Release Rates**			

[2] Practice Note for Design Fire, Society of Fire Safety, Version 1.1

[3] Table E2.2b of the BCA 2019 Amndt 1

[4] Conservative temperature for consideration of glass breakage (Babrauskas – Glass Breakage in Fires)

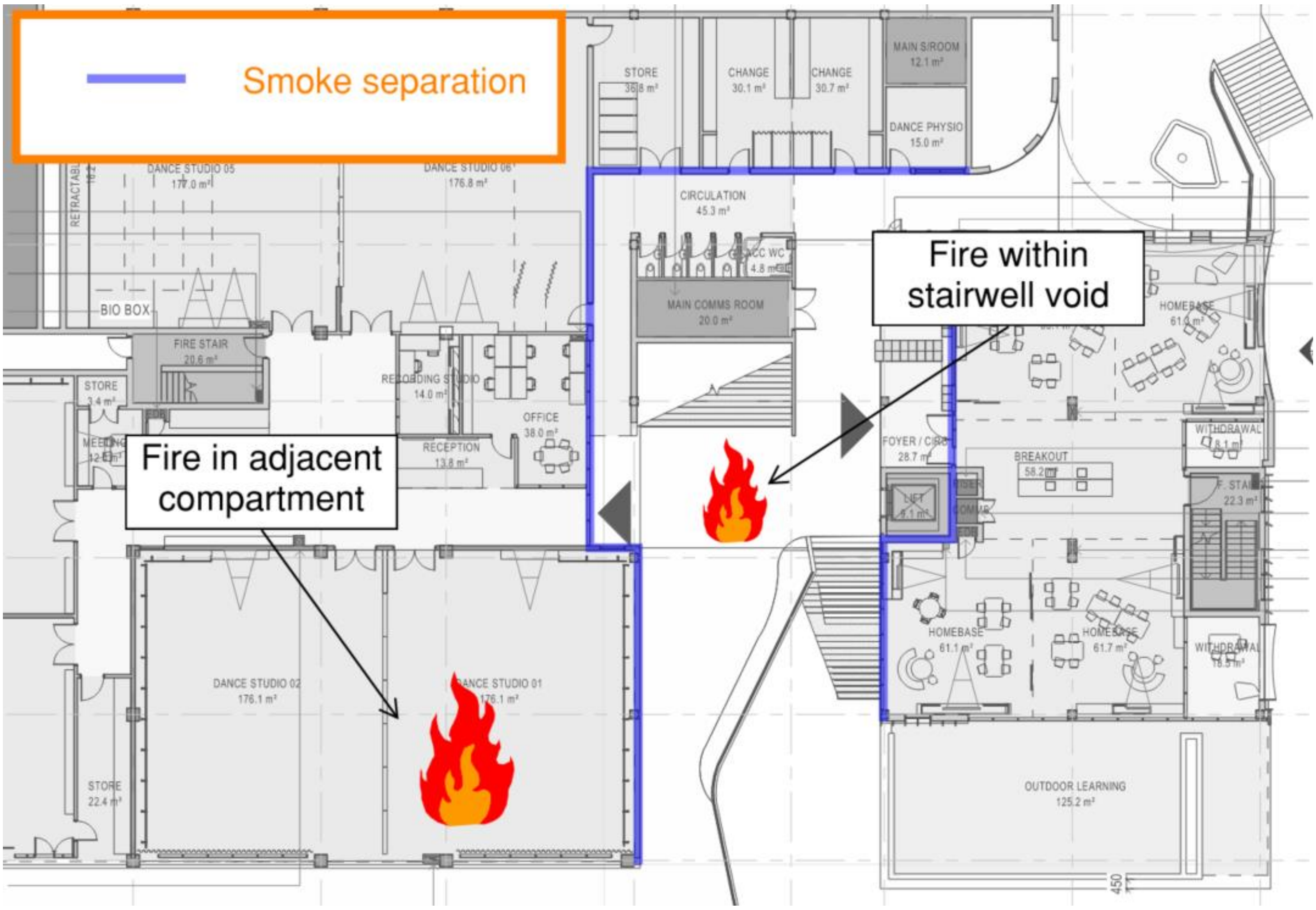


Figure 32: Simulated fire locations – level 01

The CFD analysis will simulate the behaviour of the building occupants as follows:

- Occupant movement speed 0.8m/s (SFPE handbook), which accounts for the mobility impaired.
- Detection time to be calculated using Alpert's Correlation, as outlined below.
- Pre-movement time 120 s (SFPE handbook)
- Tenability criteria, as outlined in the table below.

Table 3: Fire Modelling Acceptance Criteria

Occupant Tenability Criteria		Reference
Convective heat	Temperature < 60 °C when smoke layer is below 2.0 m	BS 7974: PD 6
Radiant heat exposure	Radiant flux < 2.5 kW/m^2 at 2.0 m, or smoke layer temperature < 200 ºC when smoke layer is at or above 2.0 m	
Visibility	Visibility > 10m when the smoke layer is below 2.0m in large spaces and >5m when the in small spaces and queues	
FED	0.3	

Issue number: 5 **Title:** Doors opening directly into a fire stair

Details of departures from DtS provisions:

Permit doorways in classroom areas to open directly into fire-isolated stairways. The following figures illustrate the details of the non-compliance.

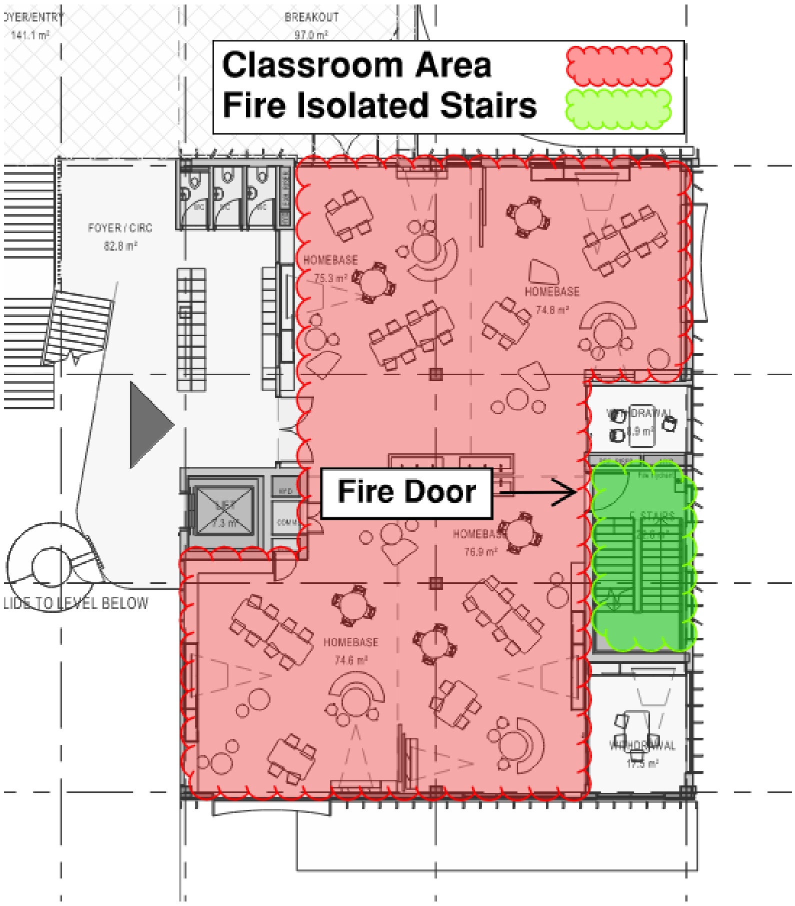


Figure 33: Classroom fire door opening directly into fire isolated stairs – typical of levels 1, 2 and 3

Applicable DtS provisions:	D1.7	Performance requirements:	DP5, EP2.2

List key fire safety measures:

A smoke detection and alarm system is to be provided in accordance with BCA 2019 Amndt 1 and AS 1670.1 – 2018.

Proposed performance solution:

BCA Intent

BCA Clause D1.7 states that *"A doorway from a room must not open directly into a stairway, passageway or ramp that is required to be fire-isolated".* The intent of this clause as per the BCA Guide is "*to limit the number of entry points into a fire-isolated exit to retain its fire-resisting performance*".

The intent of Performance Requirement DP5 is to ensure that exits are fire-isolated to the degree necessary to ensure occupants are adequately protected from a fire whilst in an exit. The intent of Performance Requirement EP2.2 of the BCA is to ensure tenable conditions are maintained along egress routes such as fire-isolated exits.

As such, in order to satisfy the relevant Performance Requirements, the assessment must demonstrate that the fire-resisting performance of the subjects exits is not compromised by the doors opening directly from a classroom.

Qualitative Analysis

Fire-resisting Performance

As mentioned above, intent of the BCA clause D1.7(a) is to limit the number of entry points into a fire stair. Doors into stairs are considered weak points in what is a continuous fire-isolated shaft as they are more susceptible to failure, obstruction and leakage of smoke.

In the proposed design however, the stairs are limited to only one entry point on these levels since these spaces form large combined open plan spaces. As such, the subject stairs would maintain a fire-resisting performance that is equivalent to that of the BCA DtS compliant design.

Whilst it is noted that access from a public lobby may present a lower fire hazard to the stair door, the BCA DtS Provisions also permit direct entry from any sole-occupancy unit that occupies the entire storey. This implies that the BCA does not see the use of the space as the risk, but rather considers the need for multiple entry points into the stair as the risk.

Therefore, it is considered that the subject design would adequately protect occupants within the stair from the effects of a fire, to a degree considered equivalent to that of a BCA DtS compliant design.

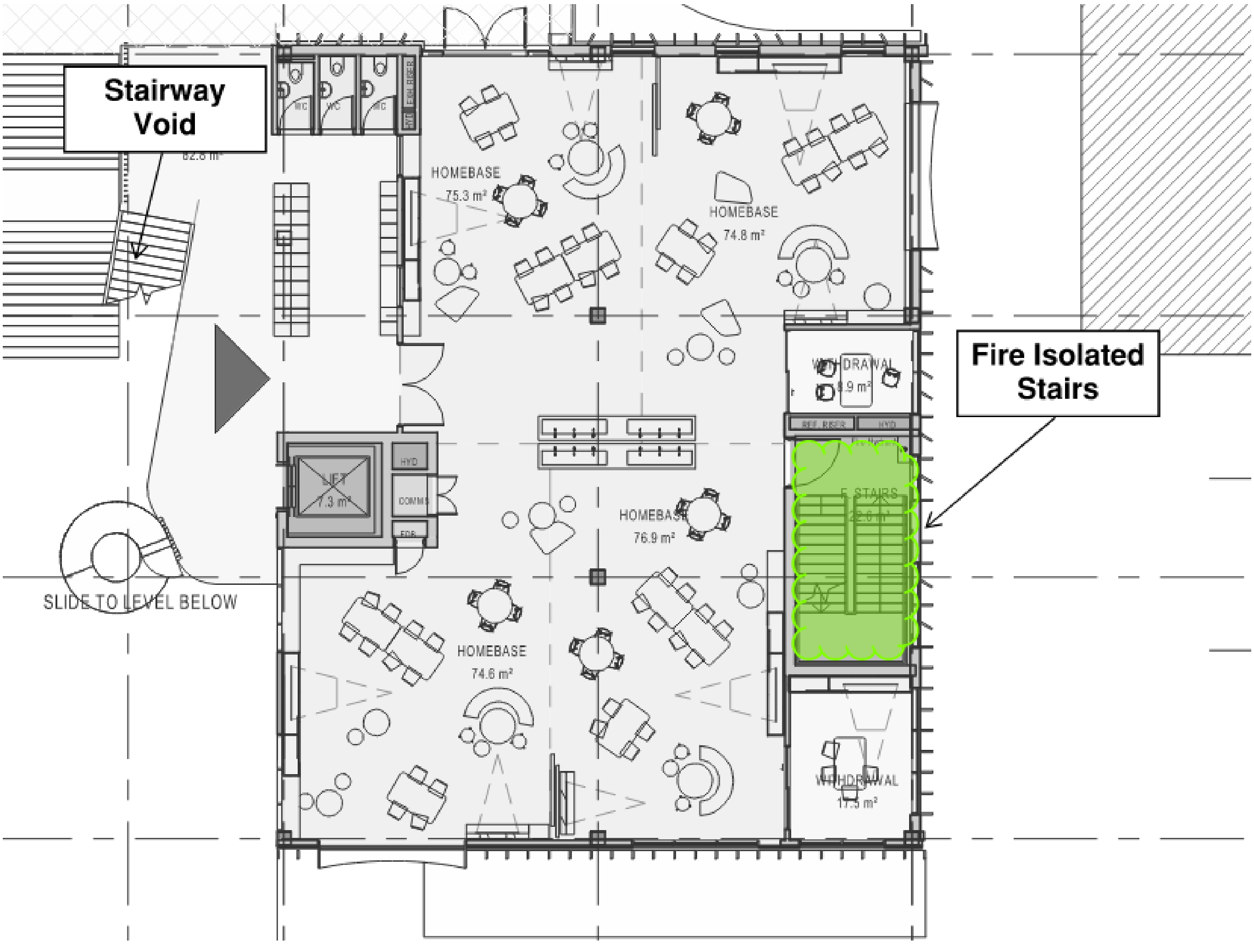


Figure 34: Fire isolated stairs serving the classroom area – typical of level 1, 2 and 3

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 subject fire stairs shall provide occupants with adequate protection from the effects of a fire to a degree that is at least equivalent to that of a BCA DtS compliant design.

Fire scenarios and design fire parameters:

Fire within the classroom space adjoining the subject fire stairs.

Describe how fire brigade intervention will be addressed or considered:

Similar to occupant evacuation, the attending fire brigade seeking access or egress via the subject stairs, would also be protected from the effects of a fire to a degree that is at least equivalent to that of a BCA DtS compliant design.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

Provide details on proposed modelling/assessment tools:

N/A

Issue number: 6 **Title:** Reduced Egress Width

Details of departures from DtS provisions:

Permit the reduction of egress widths within the eastern fire-isolated stair due to the requirement of stairwell handrail extensions. The following figure illustrates the egress width reduction.

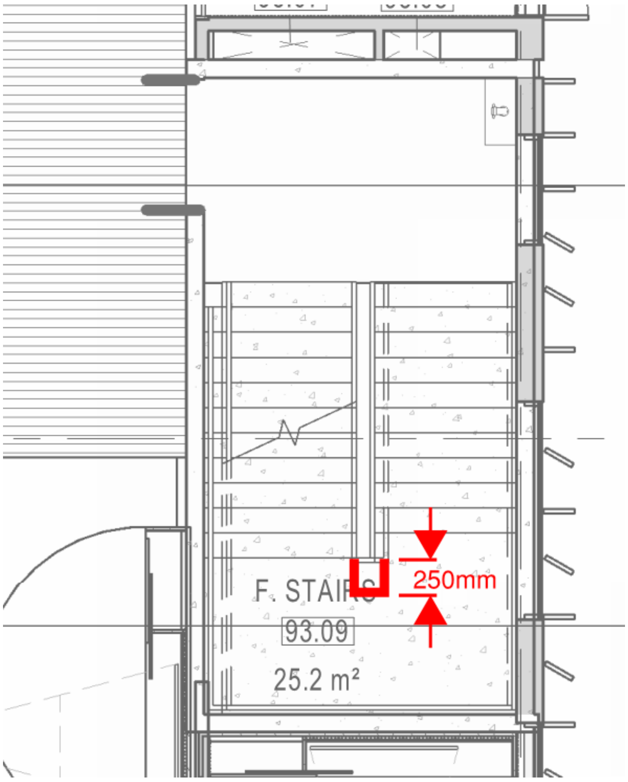


Figure 35: Area of reduced egress width within the eastern fire-isolated stairway

Applicable DtS provisions:	D1.6	Performance requirements:	DP4

List key fire safety measures:

A smoke detection and alarm system is to be provided in accordance with BCA 2019 Amndt 1 and AS 1670.1 – 2018.

The north and south façade of the atrium space shall be provided with permanently open or auto opening louvres to vent smoke in the event of a fire. The louvres shall achieve a net free area of 50% of that of the façade and shall be equally distributed across the façade and on both the north and south side.

The north and south façade of the atrium space shall be provided with permanently open or auto opening louvres to vent smoke in the event of a fire. The louvres shall achieve a net free area of 50% of that of the façade and shall be equally distributed across the façade and on both the north and south side.

Proposed performance solution:

BCA Intent

BCA Clause D1.6 deals with dimensions of exits and paths of travel to exits. The intent of this clause is to require exits and paths of travel to an exit to have dimensions to allow all occupants to evacuate within a reasonable time.

Performance requirement DP4 requires that exits be provided, appropriate to:

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

(b) the function or use of the building.

Qualitative Analysis

Anthropomorphic Analysis

Anthropometric Data reproduced from NFPA 101 Life Safety Code as illustrated in Figure 36, indicates that the 97.5 percentile largest body dimensions of an adult (male or female) is 0.51 m. The reduced egress width from 1.5 m to 1.25 m therefore does not restrict the ability of the majority of occupants to move side by side through the fire isolated stairway. As the required width of 1.5 metres does not allow for 3 people to walk abreast, the temporary reduction to 1.25 metres will not hinder the effectiveness of the fire isolated stairs.

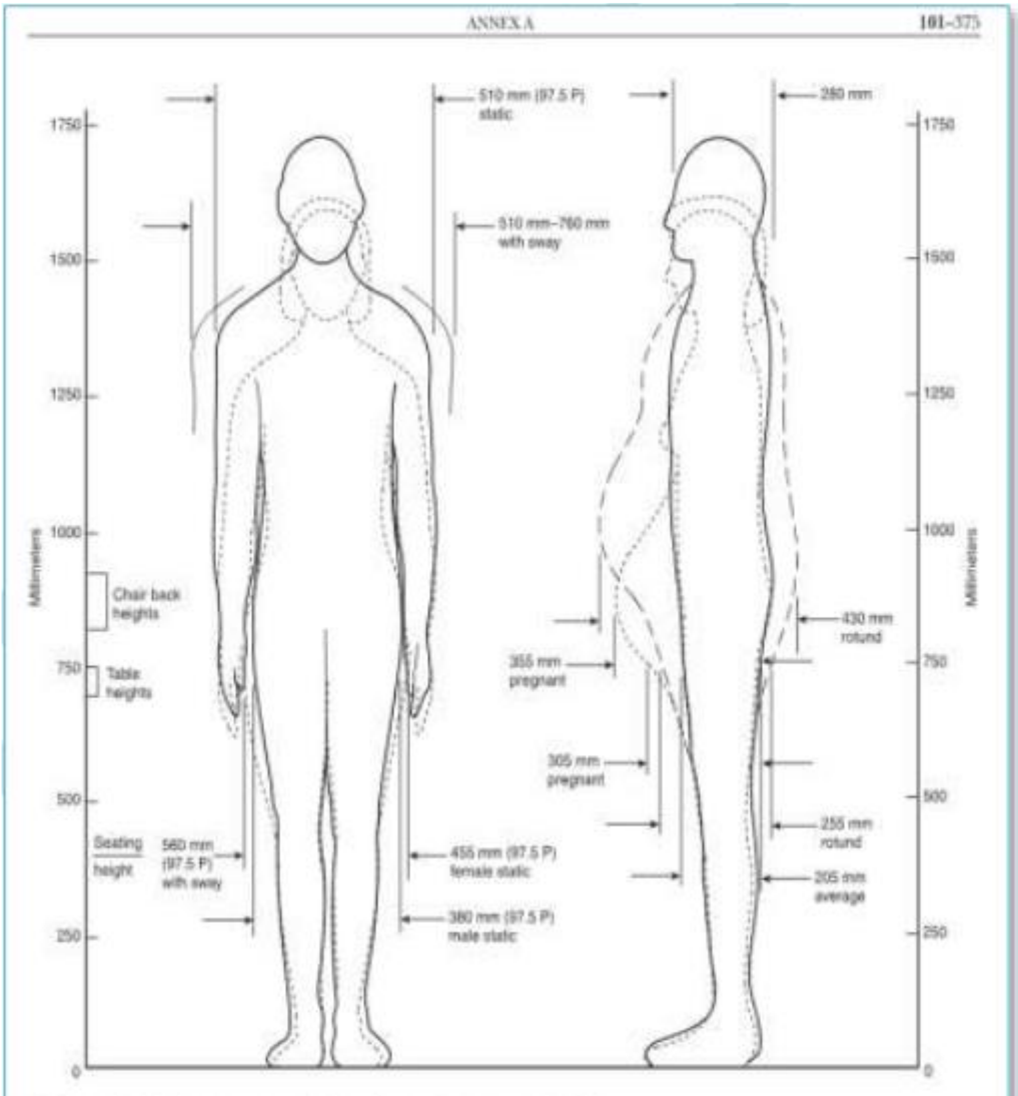


FIGURE A.7.3.4.1.1(b) Anthropometric Data (in mm) for Adults; Males and Females of Average, 50th Percentile, Size; Some Dimensions Apply to Very Large, 97.5 Percentile (97.5 P), Adults.

Figure 36: Anthropomorphic data reproduced from NFPA 101

Compartment Analysis

The BCA requires that an egress width of 1.5 metres be maintained throughout the fire isolated stairway, however this does not take into account the design of the surrounding building. The building consists 2 fire isolated stairs on the eastern and western side of the building, and a stairwell that connects all floors situated in the middle of the building. The central stairway is smoke separated from the surrounding compartments, and is to be provided with smoke sealed doorways – the following figure illustrates the location of the fire isolated stairs and the central stairway, and the corresponding smoke sealed construction.

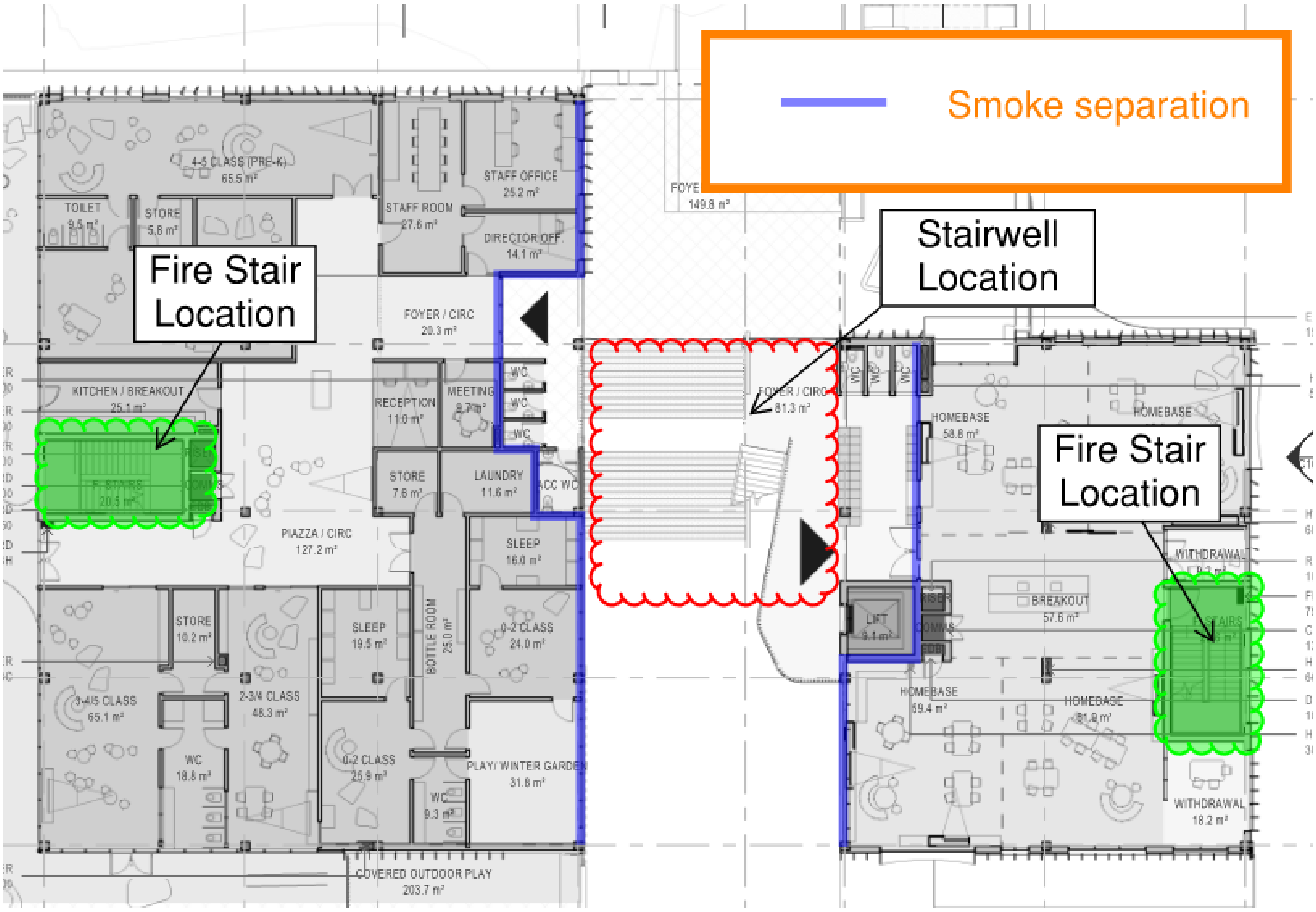


Figure 37: Fire isolated stairs and central stairway location

While the central stairway is not fire isolated and is not defined as one of the buildings protected evacuation routes, it will provide additional egress space in the event of a fire breaking out in one of the adjacent compartments. In a worst-case scenario arise, where a fire breaks out in one of the compartments on either side of the central stairway that blocks the use of one of the fire isolated stairs, occupants will exit the section of building where the fire is located and enter the central stairway (see Figure 38 below for reference).

In this fire scenario, once occupants enter the central stairway space, they will then have a choice of using the central stairway to evacuate, or proceed through the neighbouring compartments and evacuate through the fire isolated stairway. The entirety of the population of the floorspace will not be required to use the single fire isolated stairs.

Furthermore, the smoke separation within the building means that smoke and hot gases produced by the fire will be contained to the compartment in which the fire begins during the early stages of a fire. This means that occupants will have more time to enter the fire isolated stairs before hazardous conditions arise, which effectively offsets the potential delay caused by a reduction in egress width.

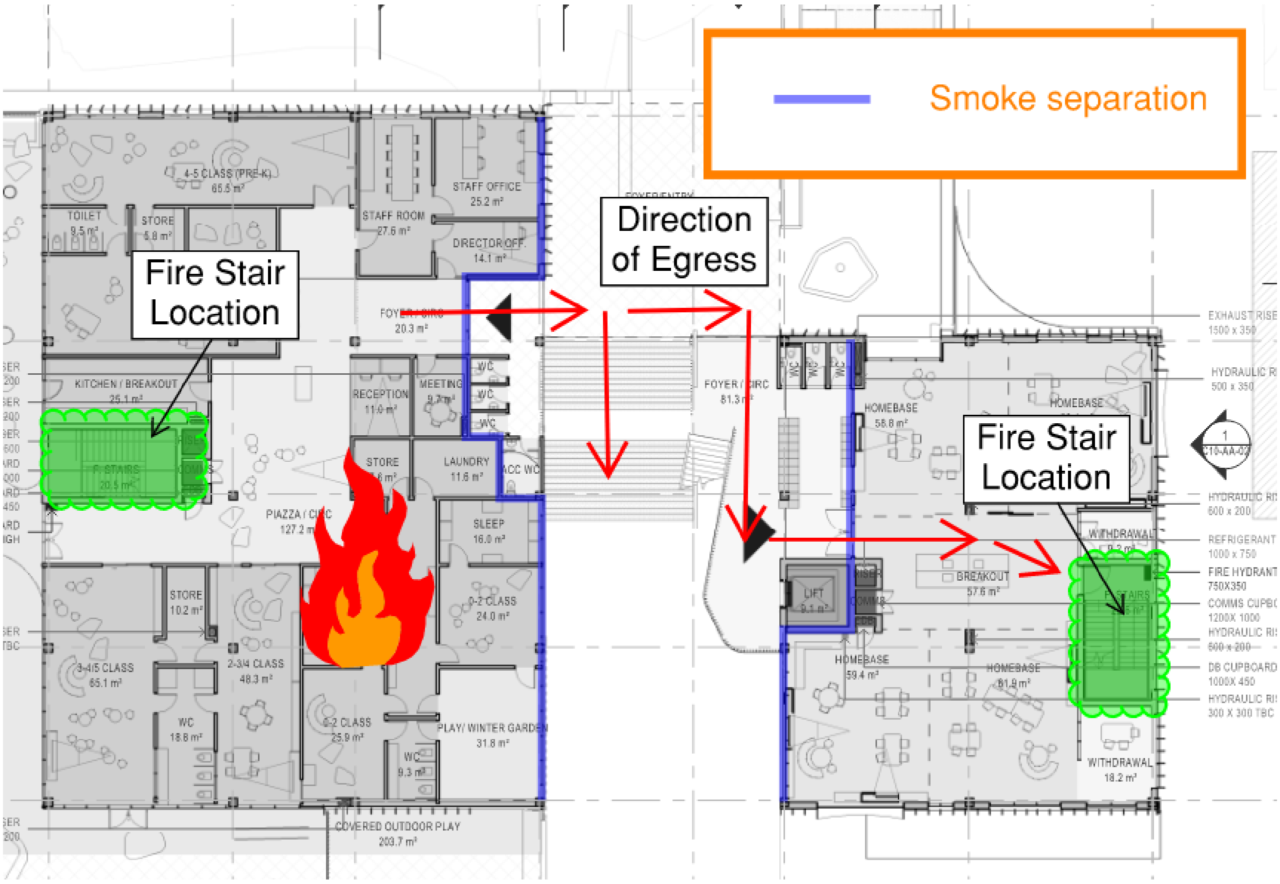


Figure 38: Direction of egress, should one fire exit be blocked

Should a fire arise within the central stairway that blocks the use of this evacuation route, both fire isolated stairs on the opposite ends of the building will remain safe for use to all occupants. As discussed above, the central stairway is smoke separated from the surrounding compartments, meaning that smoke within the stairwell void will not spread into the adjacent compartments. Occupants will be expected to evacuate via the closest fire isolated stairs, dividing the population of the floorspace between the two fire stairs. Furthermore, in this fire scenario the smoke separation will also allow additional time for occupants to enter the fire isolated stairs, as the smoke will not enter the compartment space and create hazardous conditions within the area. The following figure illustrates the paths of evacuation in the event of a fire within the central stairwell.

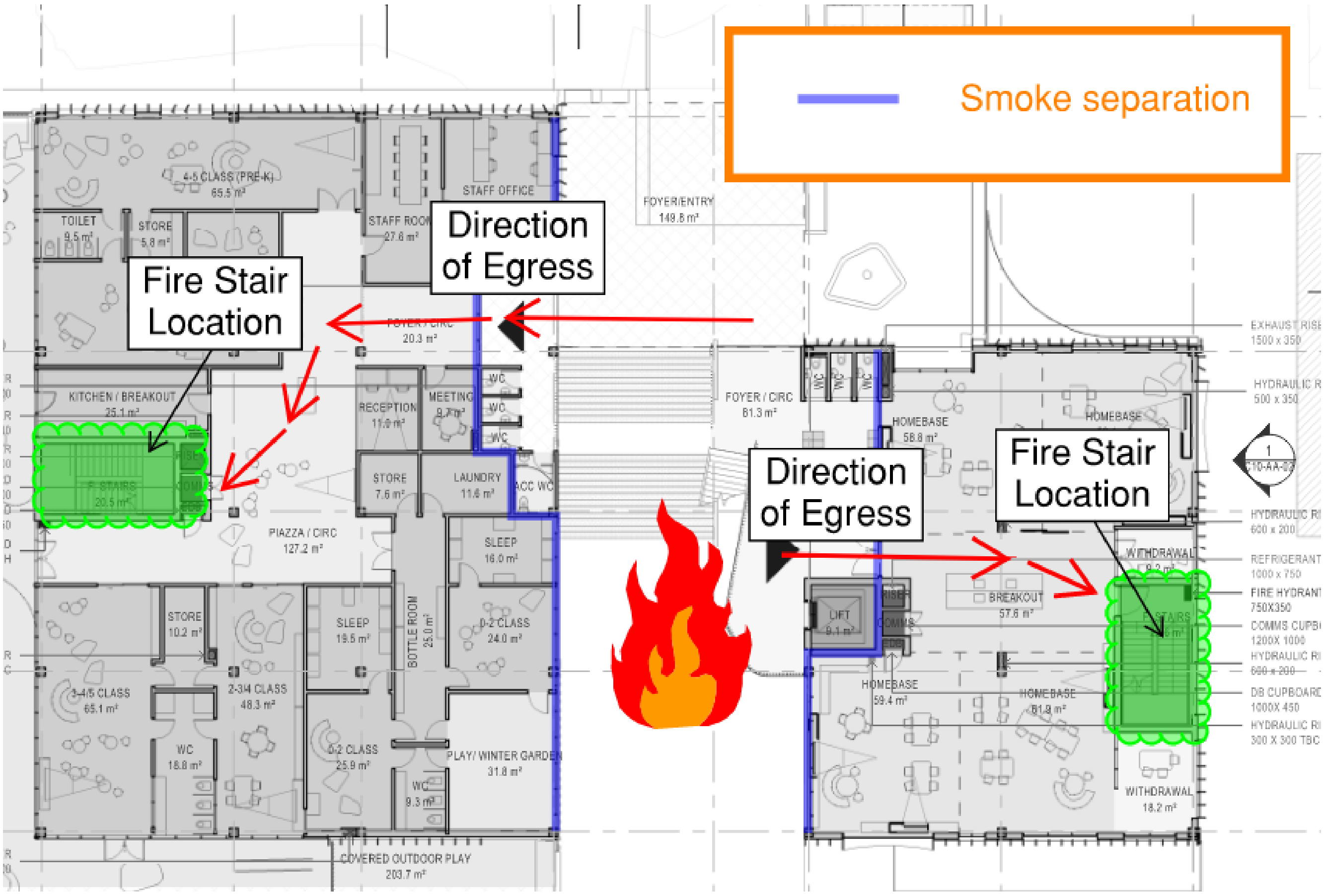


Figure 39: Direction of egress, should one fire exit be blocked

Additionally, it should be noted that doorways providing access to fire stairs are permitted under the BCA to have a dimension of 250 mm less that the required egress width of that stair, a similar reduction as presented by the handrail extension. As such, the handrail extensions are not expected to further increase the delay of evacuation beyond that already imposed by the compliant dimensions of the doorway into the stair.

As such, it is considered that the temporary reduction in egress width caused by the handrail extensions, is not considered to impede occupant egress.

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 solution will be deemed acceptable if it is able to be demonstrated that the reduction in egress width does not negatively impact occupant evacuation, and is in accordance with the appropriate performance requirements.

Fire scenarios and design fire parameters:

Fires generally considered in various locations throughout the building.

Describe how fire brigade intervention will be addressed or considered:

Fire Brigade intervention is not considered to be impacted by this performance solution, as the performance solution aims to demonstrate that occupant evacuation is not impacted by the BCA deviation. The fire brigade do not require the additional egress width compromised by the handrail extensions.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

Provide details on proposed modelling/assessment tools:

N/A

Issue number: 7 **Title:** Bounding Construction

Details of departures from DtS provisions:

Permit the use of glazed openings to be located within walls that separate neighbouring fire compartments.

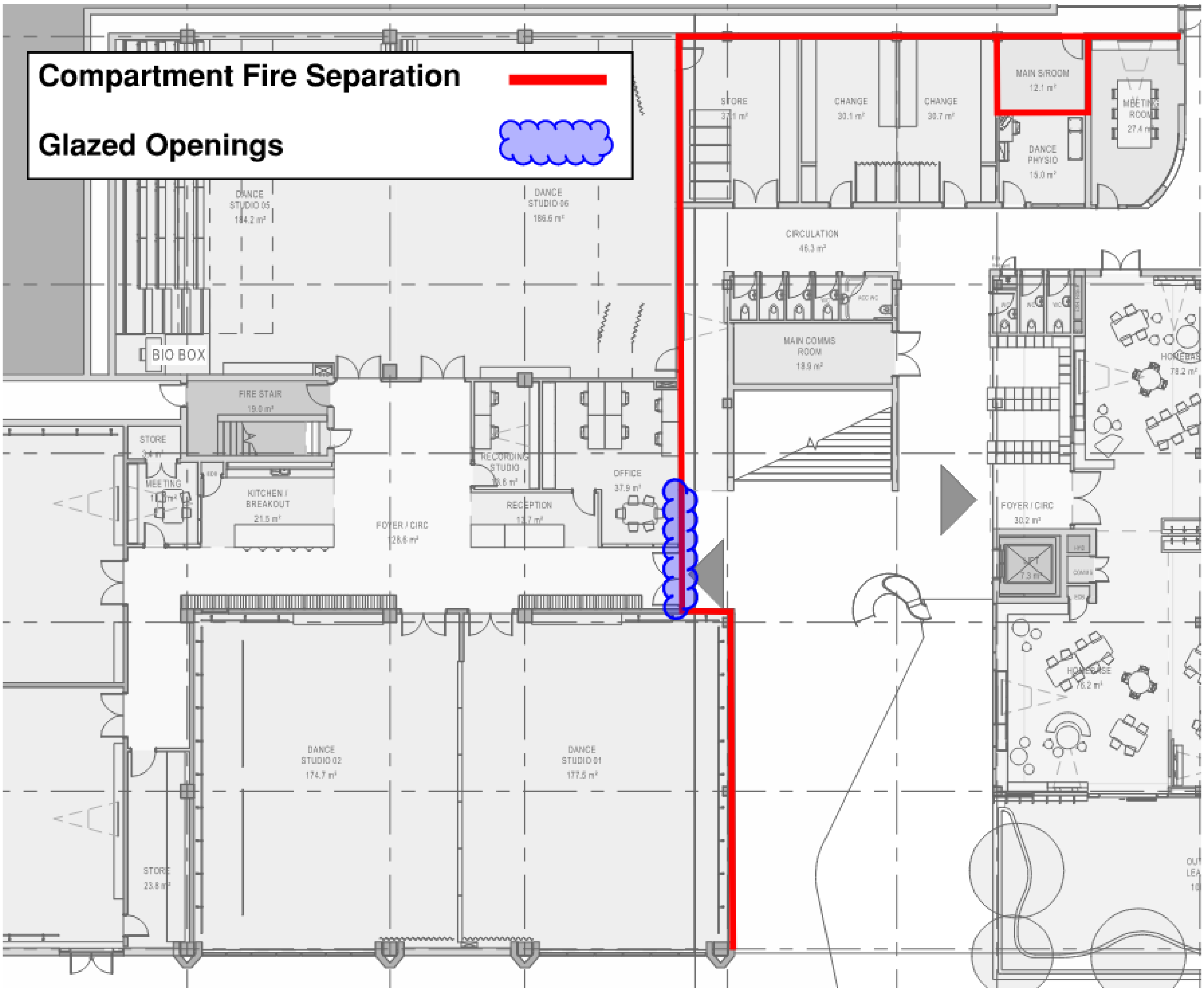


Figure 40: Location of glazed openings within fire separating walls

Applicable DtS provisions:	Specification C1.1	Performance requirements:	CP2

List key fire safety measures:

The building management must ensure that the surrounding areas are maintained as a sterile space. Building management must ensure that all fuel load restrictions are enforced, including regular checks and monitoring of subject areas to ensure compliance.

The glazed doorway is to be installed with medium temperature smoke seals, and tested in accordance with AS 1530.7

Proposed performance solution:

BCA Intent

BCA Clause Specification C1.1 dictates the requirements of fire separating walls within a building of Type A construction, stating that internal walls be FRL rated to 120/120/120.

Performance Requirements CP2 states that a building must have elements that will avoid the spread of fire to an appropriate degree.

Qualitative Analysis

Compartment Analysis

The proposed solution aims to demonstrate that the glazed openings highlighted in Figure 40 above will not defeat the fire separation within the building by qualitatively describing the surrounding area, and the low risk of fire spread in the surrounding vicinity.

The deviations from Specification C1.1 lie in the entrance into the dance/office area, and a small section of the office, as illustrated in Figure 41 below.

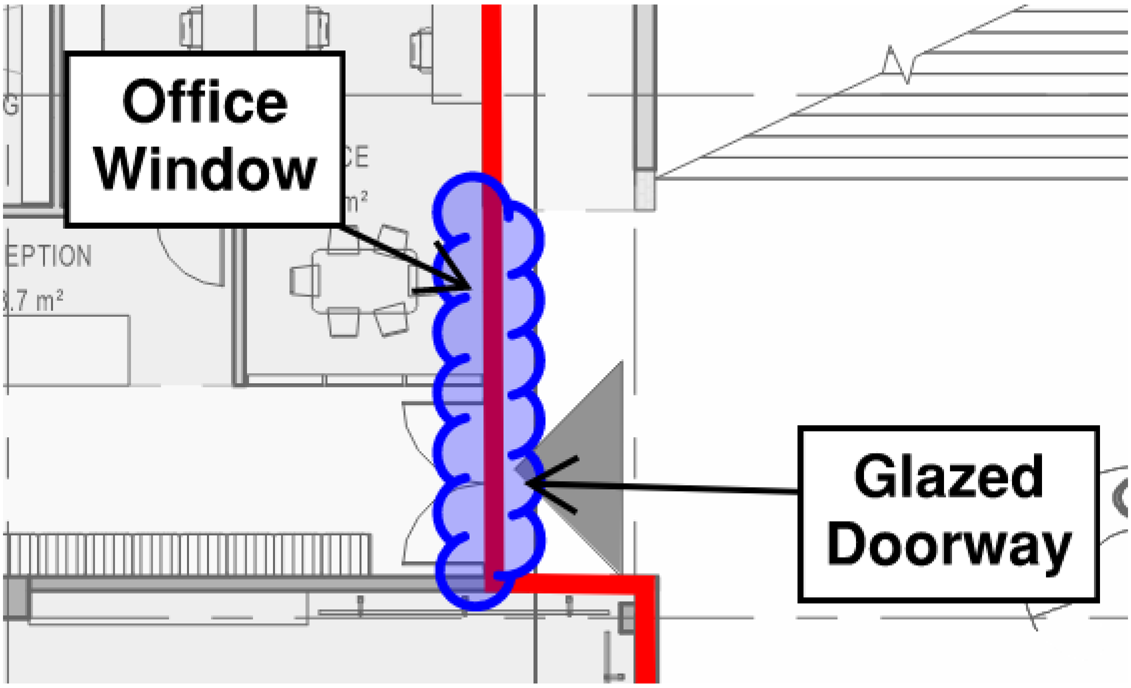


Figure 41: Areas surrounding glazing within compartment fire separation

The deviations doorway separates a walkway that is solely intended for occupant thoroughfare, and as such the areas on either side of the doorway will not house any significant levels of fuel load. Consequently, a fire within the area will not grow to a size that will endanger the integrity of the glazing. High levels of radiation are not expected to transmit through the glass, given the low fuel loads in the area.

The proposed solution will recommend the installation of medium temperature smoke seals installed on the doorway, which will be sufficient to limit the spread of smoke and hot gases throughout the building. This will effectively act as a continuation of the fire separation highlighted in Figure 40 above, as the glazed doorway will not be subject to temperatures high enough to cause premature failure, and will allow for the safe evacuation of all occupants from within the building.

The office space has the potential to house a higher fuel load than the walkway in which the doorway is separated. A worst case scenario fire would be one that originates in this area of the building. The provision of sprinklers within the space will suppress a fire within and limit fire growth and the specified proximity for a row of sprinklers to be installed within 300 mm of the glazing will provide additional protection to the glazing whereby smoke passing towards the window will be cooled and limit the radiation that passes through the glass wall into the adjacent public corridor.

Moreover, the detectors within the space once activated will trigger the alarm which will prompt occupants to evacuate at early stage of fire development.

It is expected that with the combination of detectors, sprinklers and smoke seals ensure that occupants are able to evacuate at an early stage of fire development and tenable conditions are maintained within public corridor.

In the unlikely event that a fire initiates within this space and sprinklers fail to operate then a fire could experience uncontrolled growth. Such a failure scenario is comparable to a DtS design which relies on drencher protection of openings, as drenchers in the same space would also fail in this scenario. Therefore, the failure of the sprinkler protecting the glazed wall is considered to pose an equivalent risk to life safety as a DtS design.

Benefits of Sprinklers

Studies of glazing failure have shown that whilst fracture may occur at approximately 150ºC, fallout does not occur until around 450ºC, further information regarding glazing failure will be provided in the FER. Studies by Mawhinney have shown that compartment temperatures associated with sprinkler-controlled fires generally do not exceed 200°C, as such glazing failure is not expected to occur.

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.

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 systems in Australia and New Zealand is generally significantly higher than in the US, as researched by [Marryatt]. Further details on the efficacy of sprinklers will be detailed in the FER.

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 permit glazing failure. Moreover, the activation of the sprinkler system is expected to limit the temperature within the compartment to below 200ºC.

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 internal glazing does not facilitate fire spread. Tenable egress conditions are maintained for occupants undergoing evacuation past the internal glazing.

Fire scenarios and design fire parameters:

A fire within the office space adjacent to the glazing, and a fire within the occupant walkway in which the glazed doorway is located.

Describe how fire brigade intervention will be addressed or considered:

It is assumed that the fire hydrant coverage would provide fire brigade with the equipment necessary to undertake firefighting activities and is not affected by the glazing.

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?

N/A

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 is a new development and therefore will be issued with 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)?

- Maintain all active Fire Safety Systems in accordance with the relevant section of AS 1851.
- Regular evacuation drills to be conducted annually (minimum) within the building.
- Sterile spaces to be inspected monthly.
- Occupants to be inducted on egress routes

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')?

- General housekeeping must be undertaken to maintain the egress paths and exits clear in order to allow unimpeded travel.
- Evacuation diagrams in accordance with AS 3745 to be provided. The standard emergency evacuation plans are to detail an accessibility specific emergency evacuation.

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 solutions shall be included on the fire safety schedule
- Where services are modified as part of a performance solution, these must be included in the maintenance and annual certification.

9 Additional comments

N/A

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.