Fire Engineering Brief Questionnaire (FEBQ)

1 Document control

Applicant reference number 29212 **FRNSW reference number** FRN17/753

Ver.	Author	Organisation	Status	Date
01	Lloyd Wilkinson	Wood & Grieve Engineers	Initial submission	27/08/2019
02	Paul Diab Jason Wang	FRNSW (BFS19/2856 #8699)	Response to V01	11/10/2019
03	Lloyd Wilkinson	Wood & Grieve Engineers	Response to comment	5/12/2019
04	Paul Diab	FRNSW (BFS19/4084 #9872)	Response to V03	10/01/2020
05	Lloyd Wilkinson	Wood & Grieve now part of Stantec	Response V04	17/03/2020
06	Paul Diab	FRNSW (BFS20/801 #10858)	Response to V05	21/04/2020
07	Jason Toh	Stantec	Response to V06	20/01/2022
08	Paul Diab	FRNSW (BFS22/205 #19306)	Response to V07	15/02/2022
09	Jason Toh	Stantec	Response to V08	02/03/2022
10	Paul Diab	FRNSW (BFS22/840 #20517)	Response to V09	14/04/2022

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 12).
- 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 alternative 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).

FRNSW: No hydrant plan or schematic provided, FRNSW are unable to assess the operational suitability of the installed system in this building.

WGE: Hydrant schematic has been provided with this submission.

FRNSW Comment: Noted, hydrant schematic received.

Name of applicant	~~Lloyd Wilkinson~~ Jason Toh
Role of applicant	Fire safety engineer
Applicant phone number	~~0451 824 877~~ 0402 068 818
Applicant email address	~~lloyd.wilkinson@wge.com.au~~ jason.toh@stantec.com

2.2 Remittance advice information

Invoices will be issued based on the information provided below:

Company / vendor name	Pontiac Land (Australia) Pty Ltd		
Australian business number	30 611 224 269	Trading name	Pontiac Land (Australia) Pty Ltd
Remittance contact name	William Boneham		
Remittance street address	L12/52 Phillip Street, Sydney, 2000		
Remittance postal address	L12/52 Phillip Street, Sydney, 2000		
Remittance email address	william.boneham@pontiacland.com		
Remittance phone number	0429 236 466	Remittance fax number	NA
Purchase order ref. no.		Project code ref. no.	Unk.

3 Consultation

3.1 Stakeholders

Role	Name and BPB number	Organisation and phone	Email address
Fire safety engineer	~~Lloyd Wilkinson~~ Jason Toh ~~BPB 3284~~ BDC 3205	Wood & Grieve Engineers 0451824877	~~lloyd.wilkinson@wge.com.au~~ jason.toh@stantec.com
Certifying authority	Andrew Brohier BPB 2419 ABC 6	McKenzie Group 02 8298 6800	abrohier@mckenzie-group.com.au
FRNSW reviewers	SO Murray Mackne Paul Diab Jason Wang	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 hold a meeting with the applicant to discuss aspects of the proposed alternative solution. The meeting will be at the discretion of FRNSW.

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

4 Project details

4.1 Premises

Premises name	The Department of Lands Building
Primary street address	23-39 Bridge Street (Sandstone Precinct)
Secondary street address	23 – 33 Bridge Street (Lands Building)
Premises suburb	Sydney
Lot and DP numbers	1877/-/DP877000 (Lands Building), 56/-/DP729620 (Education Building)

FRNSW Comment: It is noted that the development address above is inconsistent with the provided BCA report. This is to be addressed to ensure consistency throughout the FEB process.

WGE: Noted. Address updated to match existing documentation.

FRNSW Comment: Noted.

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 amdt1

For existing buildings:
Approximate year of construction: 1892
Building code when constructed: Unknown

How many alternative solution issues are proposed in this FEBQ? 26

Note: The number of alternative 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)? YesYes

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

Identify if any previous alternative solution applies to the building:

As the building is considered as one united building with the adjacent Education Building, the FEBQ 06 completed by CORE Engineering Group applies:

FRN17/753

BFS19/879

Hydrant solutions will apply to the Lands building.

FRNSW Comment: It is noted that the abovementioned FEBQ document (BFS19/879) also includes four performance solutions (Issue Number 1 – Issue Number 4) which relate to the Lands building. The applicability and relevance of these performance solutions to this FEBQ document are to be clarified/confirmed.

WGE: All solutions relating to the Lands building aside from issue 7 of BFS19/879 are no longer applicable to the development. Issue 7 of BFS19/879 remains unchanged, outlining the fire service strategy for the united building. The safety measures required by this solution will be provided in the FER for the Lands building. Issues relating to the Education building remain unchanged.

FRNSW Comment: Noted and acknowledged.

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

NA

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.

TBC

FRNSW Comment: As the building is an existing building undergoing alterations and additions, where FRNSW comments contradict or are not consistent with any condition of development consent, further consultation with FRNSW is required to refine the proposed fire safety strategy.

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	6	Other occupancy classes	9b
Type of construction	A	Largest fire compartment (m^2)	2614

Effective height (m)	>25m	Ground floor area (m^2)	2614
Rise in storeys	11 (Education Building)	Total floor area (m^2)	12000
Levels contained	14 (Education Building)	Total volume (m^3)	74,845

Outline any additional building characteristics:

The Department of Lands building is a heritage-listed[2] state government administrative building of the Victorian Renaissance Revival architectural style located in Bridge Street in the Sydney central business district of New South Wales, Australia. The large three-storey public building was designed by Colonial Architect James Barnet and built in different stages, with Walter Liberty Vernon and William Edmund Kemp designing various components of the building. The builder was John Young.[1]

The building was initially occupied by the NSW Department of Lands, which has a long association with the public life of New South Wales, especially the rapid expansion of settlement during the later part of the 19th century. The building is currently occupied by the NSW Office of Environment & Heritage. It was added to the New South Wales State Heritage Register on 2 April 1999. In the late 1980s, the building was earmarked by the NSW Government as one of the possible sites for conversion into a casino. A permanent conservation order covering the premises was passed by the Heritage Council of New South Wales in order to protect the building from unsympathetic development.

The basement has three entrances: the main entrance in Bridge Street, and two others in Gresham Street (one originally used for carriage). The façades are of dressed Pyrmont sandstone with cornices and balusters at each floor level, with a dome and tower tops made from copper.[1] The four façades are all richly decorated with classical motifs and statuettes and are dissimilar to each other. Barnet's mix of the orders and their integration into the building is significant. For example, the lowest level of the building is adorned with Doric and Ionic pilasters, whereas Corinthian and Ionic ones are used above. The clock tower has an 'onion' copper dome which was influenced by Sir Henry Parkes's water carafe.[5]

The ground, first, and second floors have pilasters and entablatures of the Doric, Ionic and Corinthian orders respectively, each standing on appropriate pedestals. The pitched roof is behind a balustraded parapet. A large copper dome 17 metres (55 ft) square at the base changing to an octagon at the top and carrying an octagonal lantern with revolving copper dome roof rises above the Bridge Street facade.[1]

The centre compartments of Gresham and Loftus Streets have pediments backed up by high mansard roofs. A clock tower with copper "onion" top closes the vistas in Bent and Spring Streets. The elevations have arched windows and verandah openings, and niches for statuary. There is delicately formed cast iron work to the entrance gates and window grilles, and large flights of stairs and cantilevered balconies and bridges around the courtyards.[1]

The internal walls are of brick with reinforced concrete floors and ceiling, iron girders and iron-framed roofing. Externally, the building's original facade is unchanged.[1][3]

[Sourced from Wikipedia: https://en.wikipedia.org/wiki/Department_of_Lands_building]

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 of the occupants that can be expected in the building when undertaking Fire Engineering Analysis, as highlighted in the IFEG [2].

The principal occupant characteristics for the building are listed in Table 1, using Table 2 of BS 9999 [7].

Table 1 - Occupant Characteristics

Type	Description	Category
Staff	Staff including admin, cleaners, bar and kitchen workers, maintenance staff, etc.	Awake and familiar
Patrons/Guests	Patrons who occupy the buildings facilities	Awake and unfamiliar

5 Hazards

Outline any hazards unique to the building:

The building contains heritage wooden window frames and door frames throughout. Examples of the extent of the wooden façade elements are shown below.

- ☐ 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: Combustible façade elements.

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).

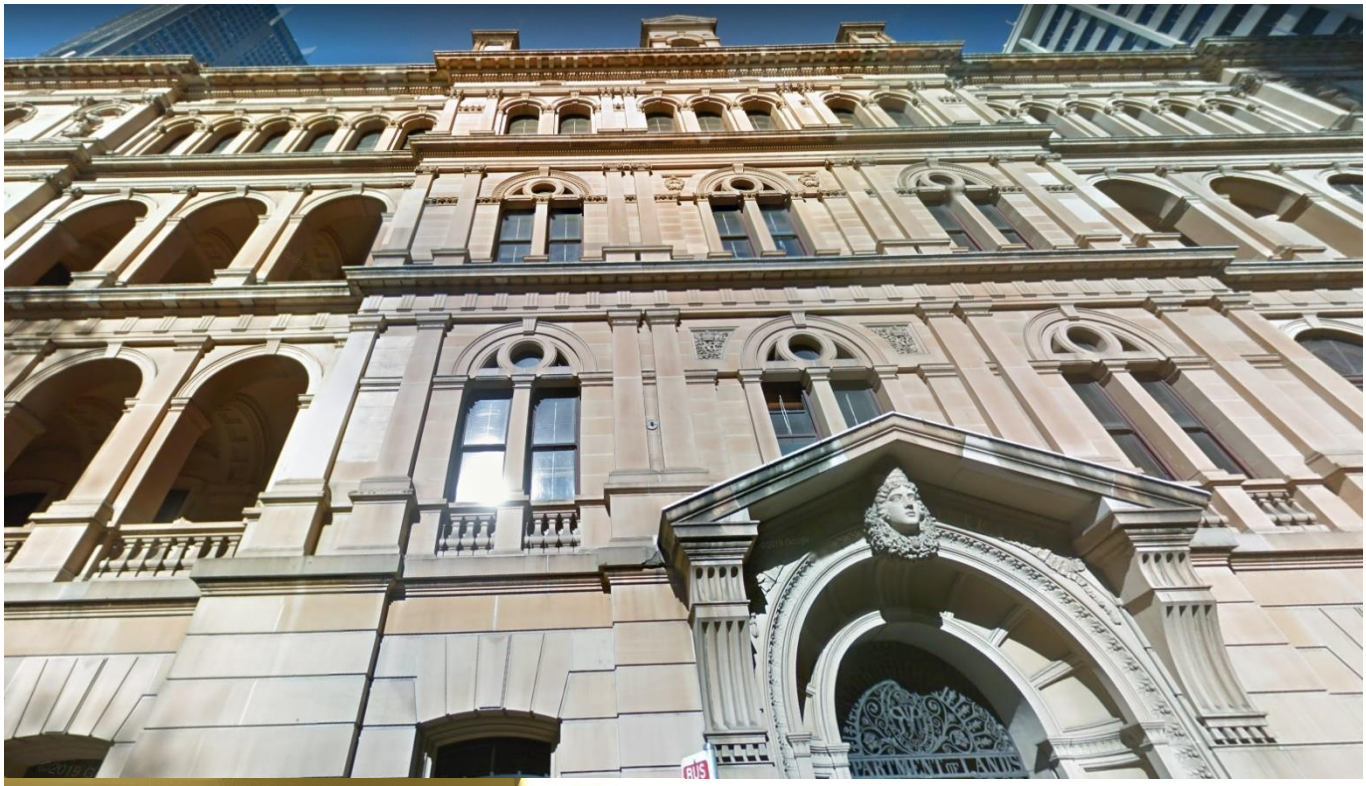
FRNSW Comments are as follows:

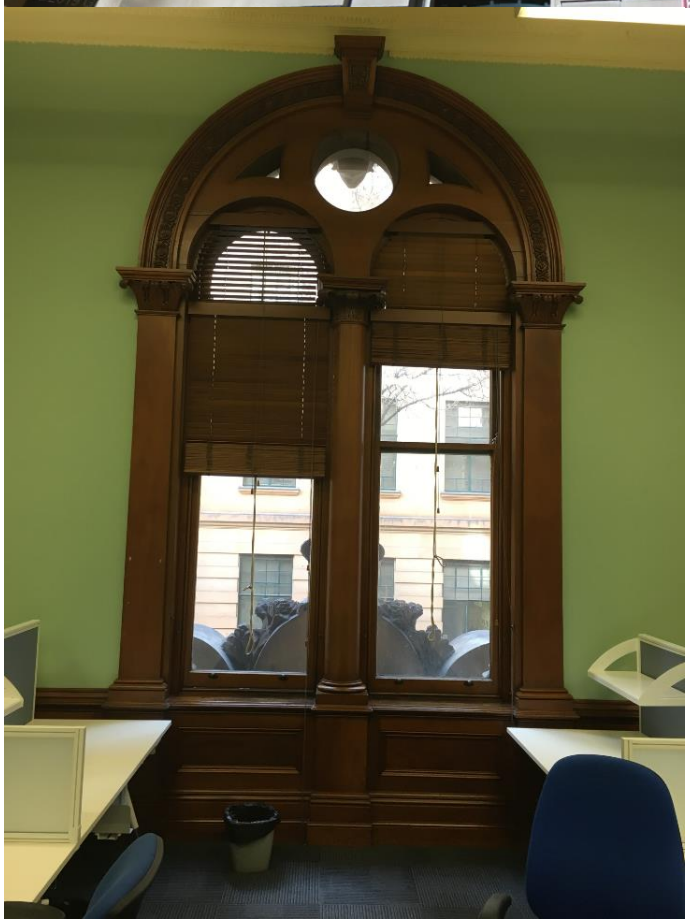
- It is recommended that additional details be provided regarding the abovementioned “Other” hazard that has been selected, no information has been provided.
- It is noted that the performance solution related to Issue Number 2 within this FEBQ refers to the use of combustible materials on the façade of the development, however the above hazard has not been selected. This is to be addressed.

WGE: Hazards updated to include combustible façade elements.

Examples of the timber façade elements are show below.

FRNSW Comment: Noted, refer to the comments provided by FRNSW on Issue Number 2 of this FEBQ.





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 alternative solution.

Occupant warning system	**Signage**	**Facilities for emergency services**
☐ Building occupant warning	☑ Emergency lighting	☐ Emergency lifts
☐ EWIS	☑ Exit and direction signs	☐ Fire control centre
☑ SSISEP	☑ Warning and operational signs	☑ Fire control room
☐ Break glass unit	**Hydrant system**	☑ Perimeter vehicular access
☐ Visual / tactile alarm devices	☐ AS 2419.1-2017	☐ Standby power supply system
Smoke hazard management	☑ AS 2419.1-2005	**Firefighting equipment**
☐ Zone smoke control	☐ AS 2419.1-1994 (existing building)	☑ Portable fire extinguishers
☐ Purge system (existing building)	☐ Ordinance 70 (existing building)	☑ Fire hose reels
☑ Smoke and heat vents	☑ External hydrants	**Water supply**
☐ Smoke exhaust	☑ Internal hydrants	☑ Grade 1
☐ Smoke baffles	☐ Internal dry-riser (for FPAA101D)	☐ Grade 2
☐ Ridge vents	☐ Street hydrant coverage only	☐ Grade 3
☐ Stair pressurisation	☑ Hydrant booster assembly	☐ Onsite storage tank
☐ Impulse / jet fans (in carpark)	☑ Pumpset	☐ Dual supply
☐ Other: (provide details)	☐ Other: (provide details)	**Protection** of openings
Detection system	**Suppression system**	☑ Fire doors
☐ AS 3786:2014	☐ CA16 (existing building)	☑ Smoke doors
☐ AS 3786-1993 (existing building)	☑ AS 2118.1-2017	☑ Solid core doors
☑ AS 1670.1:2018	☐ AS 2118.1-2006	☑ Fire windows
☐ AS 1670.1:2015 (existing building)	☐ AS 2118.1-1999 (existing building)	☐ Fire shutters
☐ AS 1668.1:2015	☐ AS 2118.2-2010 (wall-wetting)	☐ Wall-wetting sprinklers
☐ AS 1670.3-2018 (monitored)	☐ AS 2118.3-2010 (deluge)	☐ Fire curtain
☐ AS 1670.3-2004 (existing building)	☐ AS 2118.4-2012 (residential)	☐ Smoke curtain
☐ Smoke alarms	☐ AS 2118.5-2006 (domestic)	☐ Safety curtain for openings
☐ Heat alarms	☑ AS 2118.6-2012 (combined)	☑ Fire dampers
☐ Smoke detectors	☐ FPAA101D (class 2 or 3)	☑ Smoke dampers
☑ Heat detectors	☐ FPAA101H (class 2 or 3)	☑ Fire seals (intumescent)
☐ Flame detectors	☐ Fast response heads	☐ Hot smoke seals (>200ºC)
☐ CO detectors	☐ ESFR	☑ Medium temp. smoke seals
☐ Multi-criteria fire detectors	☐ Storage mode sprinklers	
☐ Aspirated smoke detection	☐ Gaseous suppression system	
☐ Beam detection	☐ Water mist system	
☐ Other: (provide details)	☐ Other: (provide details)	

Additional information:

Fire Safety Measures (The Lands Building)

6.1 Suppression

Automatic sprinkler protection is proposed to be installed throughout the building in accordance with BCA Clause E1.5 and AS2118.1-2017 with the exception of following and applicable Performance Solutions in the Lands Building:

- Removal of sprinklers to switchroom
- ~~Removal sprinkler protection to the underside of spiral stairs~~

6.2 Detection

An automatic detection system is to be provided in the building in accordance with BCA Spec. E2.2a and AS 1670.1 ~~2015~~ 2018. Detection will be provided throughout on a 10m x 10m grid spacing.

Detectors have been omitted from concealed spaces throughout as per issue 13.

A detector is to be provided to serve the floor landing on each level of each fire stair. Activation of the detector is to lead to the activation of the AOV in the corresponding stair. Further detail is to be provided in the FER.

A detector is to be provided to serve each lift shaft at the top of the shaft. Activation of the detector is to lead to the activation of the AOV in the corresponding lift shaft. Further detail is to be provided in the FER.

Activation of the detection system anywhere within the building to automatically open the Lower Ground double doors (Bridge St and Gresham St) and Ground Floor double doors (Bent St and Loftus St).

Activation of the detection system is to lead to the opening of the automatically opening windows within the corresponding fire and smoke zones. Further detail is to be provided in the FER.

Appropriated detection will be used where false alarms are possible.

Activation of any detector or sprinkler systems within the Lands building (but not Education Building) is to immediately trigger the alarms within the Level 3 roof plant spaces and Level 3 Terrace.

Fire and smoke doors that are fitted with hold open devices are required to have the door release upon activation of the detection or sprinkler system in the building. Where these doors are used for egress, they will be freely accessible as per BCA DtS provisions.

Dedicated detectors are to be located 1.5m from each side of the tunnel door as shown in Figure 1 below. Activation of the detector on the Lands (West) side of the door is to trigger an evacuation signal in the Lands Basement levels, Lower Ground level and Level 3 Plant and terrace, and alert signal in the Lands Ground level. This is to also trigger evacuation procedure of the Education building. Activation of the detector on the Education (East) side of the door is to also trigger an evacuation signal in the Lands Basement levels, Lower Ground level and Level 3 Plant and terrace, and alert signal in the Lands Ground level. This is to also trigger evacuation procedure of the Education building.

FRNSW Comment: Noted, the abovementioned provisions are recommended to be adequately detailed within the FER.

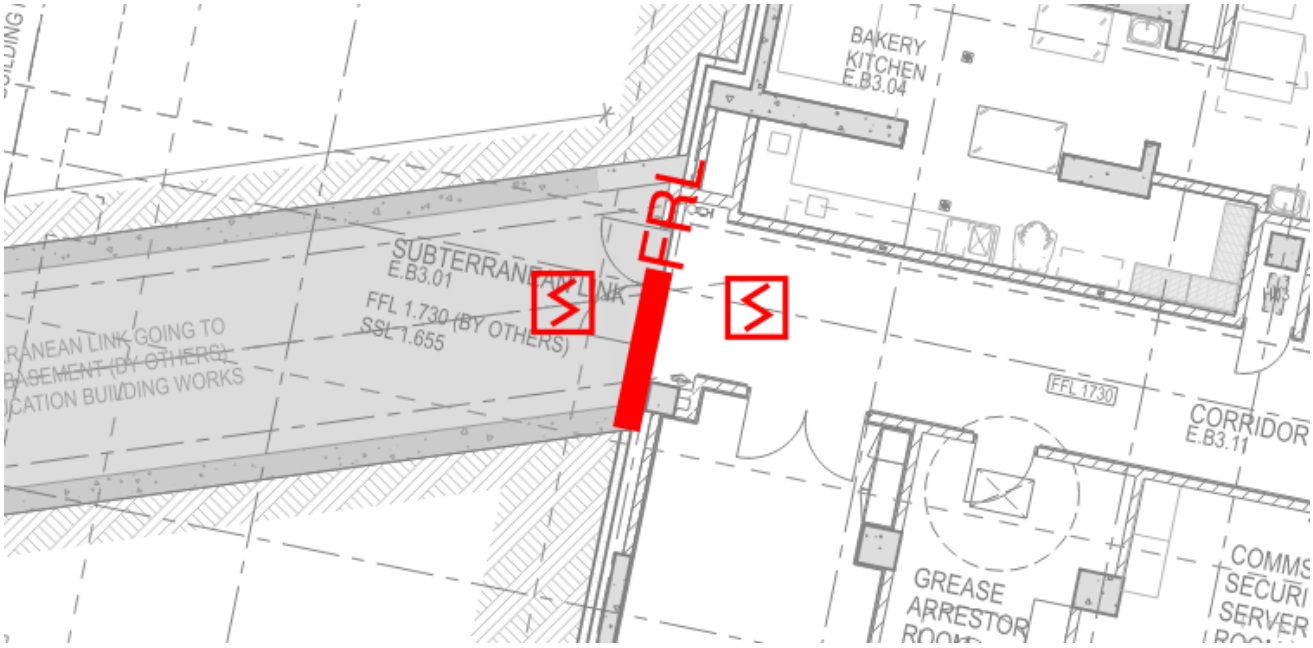


Figure 1: Basement 3 detection requirements.

6.3 Alarm

A Sound System and Intercom System for Emergency Purposes (SSISEP) is to be provided to the building in accordance with BCA Spec E2.2a Clause 6 and AS 1670.4 ~~2015~~ 2018.

A voice alarm directing people to egress will be used and designed appropriately to match the proposed evacuation zones.

It is proposed that the zone, then floor and subsequent floors will form part of phased evacuation strategy.

Upon activation of the alarm system the address of the building in alarm is to be transmitted such that the brigade is informed of which building, Lands or Education, that the fire is occurring in.

Upon activated of a single detector or a sprinkler head on Level 2, the Level 2 Mezzanine AHU room alarm is to trigger immediately.

Upon activation of a single detector or a sprinkler head on Level 3 or 4, the Level 4 Northern Dome and Terraces are to have their alarm trigger immediately.

FRNSW Comment: Noted, the abovementioned provisions are recommended to be adequately detailed within the FER.

6.4 Booster Assembly

The booster assembly is to be installed in accordance with AS 2419.1 – 2005 with exception of the following:

- The booster assembly is to be located within the loading dock of The Education Building on Loftus St, not within sight of the main entrance, as shown in Figure 2.

FRNSW; as discussed in FEBQ – BFS19/879 Version 06 (dated: 03/04/2019), access to the booster should not be hindered by security shutters or gates.

WGE: Noted.

- The booster assembly is to be connected to a wall within the building and not separated from the building by an FRL of at least 90/90/90 for a distance of not less than 2m each side of and 3m above the upper hose connections.

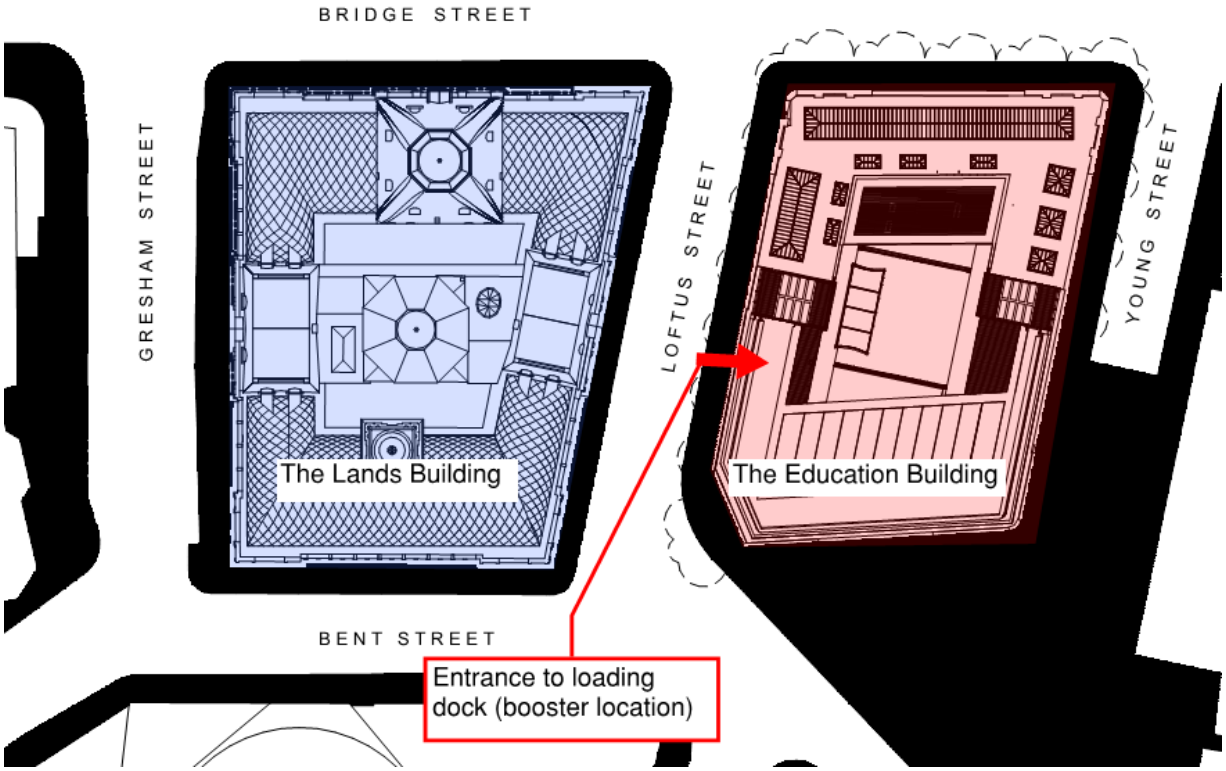


Figure 2 - Booster Location

Any aspect of the booster configurations that does not adhere to BCA DtS provisions has been assessed as part of the Education Building FEBQ – Version 06 (dated: 03/04/2019).

6.5 Ventilation

Automatically Opening Vents (AOVs) are proposed to be installed throughout the development as shown on the markups in Appendix 1 – General Compartmentation and Egress Strategy. AOVs are to open upon activation of the smoke detection/sprinkler system within their smoke zone. Further detail is to be provided within the FER.

~~Mechanical exhaust is proposed to be provided at the top of Stair L.02, as shown on the markups in Appendix 1 –~~ General Compartmentation and Egress Strategy. Further detail on activation is to be provided within the FER.

Automatically Opening Vents (AOVs) are proposed to be installed within the lift shafts that will open upon detection of a fire within the lift shaft.

6.6 Fire Hose Reels

~~Fire hose reels are to be provided in accordance with E1.4 of the BCA and AS 2441 – 2005.~~

Fire hose reels have been omitted from the development and replaced with appropriate fire extinguishers and extinguishants in accordance with AS 2444-2001. This has been justified in Issue number: 10.

6.7 Portable Extinguishers

Portable 4.5kg (ABE) fire extinguishers are to be installed throughout in accordance with BCA Clause E1.6 and AS2444-2001.

6.8 Fire Control Centre

Fire control centre is to be located in ~~the Bent St entrance on Upper Ground Level of the Lands Building~~. the Farrar Place entrance to the Education building. A sub-FIP is now to be located within the Loftus Street entrance of the Lands building due to space constraints within the Bent Street entrance.

FRNSW Comment: Clarification is required on the abovementioned Fire Control Centre, as the following discrepancies are noted:

- The provided BCA Report notes that due to the provisions of a United Building in accordance with Clause A4 of the BCA, a single FCC will be provided, however;
  - The abovementioned notes the location of the FCC on the Upper Ground of the Lands Building.
  - The prior FEBQ V06 (as referenced within this FEBQ) notes the FCC is to be located Ground Floors of the Education Building.

The abovementioned discrepancies are to be addressed.

WGE: The above has been amended to be in line with existing documentation. A sub-FIP is to be located at the Loftus Street entrance to the Lands building with the FCC for the united building being within the Farrer Street entrance to the Education building. The sub-FIP has been relocated due to space constraints within the originally proposed Bent Street entrance.

FRNSW Comment: Noted.

6.9 Construction

The FRLs within the development are to achieve the following levels;

- 120 FRL for all ~~back of house area ceilings~~ areas serving essential services consistent with BCA DtS provisions. This will be achieved through the application of fire rated board to the ceiling.
- 90 FRL for all Class 6 area ceilings from below. This will be achieved through application of intumescent paint to ceilings and exposed steel construction. Coverage is to extend to appropriately adhere to any bounding walls.
- 90 FRL for all construction required to be fire rated within Class 6 areas to maintain fire separation between different classification (Class 9b) .

FRNSW Comment: Refer to comments provided by FRNSW on Issue Number 1 of this FEBQ.

- Intumescent paint is to be applied to all corridors and Front of House ceilings to achieve an FRL of 60 minutes (Class 9b) from below. The intumescent paint is to be applied to the underside of the ceiling and any exposed steel structural beams/elements. The intumescent paint is to be applied to achieve complete coverage of the ceiling and to appropriately adhere to any bounding walls.
- All other elements within the development required by BCA ~~2016 amendment 1~~ 2019 Amendment 1 Specification C1.1 to have a fire rating are to achieve an FRL of 60.
- FRL of existing heritage fabric/structure does not meet the requirements of Specification C1.1, including the use of timber elements for window architraves in the external walls on the existing heritage areas.

6mm toughened glazing is to be installed in windows surrounding the external void spaces.

Omission of FRLs to the top parts (non-occupied spaces) of the northern dome and tempiettos. The occupied spaces of the northern dome and tempiettos are to achieve a minimum FRL of 60 minutes at the following locations:

- The structural elements within the space
- Underside of floor serving the non-occupied spaces
- Tempietto walls facing towards the fire-isolated stairs as part of the performance solution to permit deletion of fire rating to the lid of fire-isolated stairs.

As part of Performance Solution to permit deletion of sprinkler protection to switchroom, the switchroom bounding construction is to achieve a minimum FRL of 120 minutes.

Fire walls and smoke separation are proposed to be installed separating floors into fire/smoke compartments under 2000m^2 and facilitating the horizontal evacuation of occupants. Mark-ups have been provided in Appendix 1 – General Compartmentation and Egress Strategy which details the proposed locations of these walls.

Windows surrounding external void spaces are to be fitted with automatic closing devices that activate and close the windows in the event of activation of the alarm system.

The Lower Ground double doors (Bridge St and Gresham St) and Ground Floor double doors (Bent St and Loftus St) are to be fitted with devices that are to automatically open the doors upon activation of the detection or sprinkler system within the Lands Building.

6.10 Signage and Lighting

Provide emergency lighting and exit signage in accordance with AS2293.1-~~2005~~ 2018.

A block plan is to be provided at the mimic FIP clearly illustrating the location of the booster assembly.

Signage is to be provided at the mimic FIP with text at least 20mm in height on a colour contrasting background stating, “BOOSTER ASSEMBLY IS LOCATED WITHIN THE EDUCATION BUILDING LOADING DOCK ON LOFTUS ST. THE ENTRANCE TO THE LOADING DOCK IS ADJACENT TO THE EASTERN SIDE OF THE LANDS BUILDING”. Signage is to be a minimum of 1.5m FFL.

Signage is to be provided at the floor landing on Upper Ground of stairs L.02 and L.03, with the text “EXIT BUILDING ON THIS LEVEL”. The signage is to be at a height of 1.75 – 2 m FFL, with the wording not less than 50 mm high on a colour contrasting background.

Signage is to be provided at in the basement lift lobby, basement stair discharge within the tunnel and, at minimum every 20m in the basement tunnel. The text is to read “NO STORAGE THROUGHOUT THIS AREA”. The signage is to be at a height of 1.75 – 2 m FFL, with the wording not less than 20 mm high on a colour contrasting background.

Signage is to be provided at the FCC, FIP, booster and at the level 3 hydrant informing the brigade that 2 hoses are required to fully cover the clocktower. Similarly, signage is required at the FCC, FIP, booster and Lower Ground Floor hydrants informing the brigade that 2 hoses are required to fully cover the Lower Ground Floor Mezzanine level. The signage is to state “Two Hose Lengths Required for Coverage to [Level 4 or Lower Ground Mezzanine]” or similar.

The following provisions are required in the north and south roof plant spaces:

- Signage is to be provided at the first instance of reduced clear height in each egress path stating “LOW HEAD CLEARANCE” or similar.
- Hazard strips are to be provided to obstructions at all areas with reduced clear height, marking obstructions at the floor level and at head height.

6.11 Management in Use

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.

A no smoking policy is to be implemented in all public 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.

An emergency management plan should be provided for the building complying with AS 3745-~~2002~~ 2010.

General house-keeping must be undertaken to maintain the egress paths and exits clear in order to allow unimpeded travel in particular the areas with the spiral stairs.

The discharge passageways of all fire stairs from the building are to be classified as a sterile area with all combustible materials limited and the temporary/permanent storage of combustible material prohibited. All relevant employees are required to be informed of the requirements and regular inspection by building management is to ensure these requirements are adhered to. This requirement is to be included as part of the annual fire safety schedule.

Any person who requires access to the Level 2 Mezzanine, ~~Southern~~ Level 3 roof plant spaces or Southern Roof Terraces or top part of the Level 4 northern dome and tempiettos must understand and adhere to the following requirements and be inducted by building management. The management in use requirements are to be recommunicated to employees on a yearly basis and communicated to any new employees that these requirements apply to. Further, these measures are to be listed as an essential service on the fire safety schedule.

- Any person/s that accesses the Level 2 Mezzanine, Level 3 roof plant spaces or Southern Level 4 Roof Terraces must be able bodied.
- Any person that accesses the Northern and Southern Level 3 roof plant spaces or Southern Level 4 Roof Terraces must be accompanied by a member of building management or security.
- Each person is always required to be equipped with a radio and able to communicate with the other person via the radio.
- The building management / security staff must monitor the space for any fire risk while the other occupants are working. In the event of a fire or emergency requiring evacuation, the occupant must inform the others that evacuation is required at which point all occupants are to immediately evacuate into the fire stair and discharge from the building.

Management in use requirements are to be placed around the Lower Ground entrances from Bridge St and Gresham St, and the Ground entrances from Bent St and Loftus St. As the doors are to be fitted with a device that automatically opens the doors upon activation of the detection system, the area within the path of the doors is always to be kept clear of obstructions. The permanent/temporary storage of materials within the opening path of the doors is prohibited. This requirement is to be communicated to all relevant staff and enforced by building management. This requirement is to be included as part of the annual fire safety schedule.

Staff are to be appropriately trained to safely use portable fire extinguishers and be aware of the emergency procedures within the building.

6.12 Maintenance and Essential Services

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 Fire Safety Systems in accordance with the relevant section of AS 1851.
- Evacuation diagrams in accordance with AS 3745-2010 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.
- The temporary or permanent storage of combustible materials within the heritage stairs is strictly prohibited. Building management is required to communicate this requirement to all relevant staff and enforce it through regular inspection.
- No permanent storage is permitted within the basement tunnel and southern terrace areas.

6.13 Safety in Design

The Fire Engineering Analysis is conducted on the basis that any ramifications for “Safety in Design” will be covered by the Risk Management Reporting of the relevant consultants/disciplines responsible for detailed documentation of works recommended by these disciplines including, but not limited to, the Architect and the relevant building services consultants. We will not produce a separate, standalone Risk Management Report for this discipline. We note that the OH&S legislation places particular obligations on the developers and owners of property with respect to the management of OH&S issues arising from the construction, use, maintenance and demolition of plant and building

7 Departures from the Deemed-to-Satisfy provisions

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

Details of departures from DtS provisions:

The following FRLs are proposed to be rationalised:

- FRL of existing heritage structure does not meet the requirements of Specification C1.1
- FRL of the floor system from the underside only in lieu of being from both sides and the junctions between fire rated floors and walls above result in a gap between fire rated construction.
- Omission of FRLs from elements ~~of the domes over the Tempiettos (3.01 and 3.03), the Dome (3.02) and~~ the Strongroom (2.20).
- Lower Ground waste room, comms room and electrical room from 180 minute to 120 minute FRL
- Basement tunnel, basement lift shaft and basement stair shaft from 180 minute to 120 minute FRL
- Omission of FRLs to the underside and support structure of the Level 4 southern terrace
- Omission of fire rating to the floor and joists of the Level 2 mezzanine AHU rooms
- Rationalisation of fire separation between Lands and Education buildings in the link tunnel.
- Class 5 office areas permitted to achieve an FRL of 60 minutes in lieu of 120 minutes.
- Floor structure of the Level 4 mezzanine of the northern dome to achieve a minimum FRL of 60 minutes, achieved by the structural steel members only by intumescent paint protection to all sides.
- Omission of FRL to the existing steel to be maintained in the L03 roof space.

FRNSW Comment: FRNSW acknowledges the inclusion of the additional non-compliance outlined above. Refer to the comment provided at the end of Issue Number 1 in relation to these new non-compliances.

Stantec: Noted, we have provided our responses to each additional non-compliance at the end of Issue Number 1.

Applicable DtS provisions:	C1.1, C2.7, C2.8, C2.9, Spec C1.1	Performance requirements:	CP1, CP2, EP2.2

List key fire safety measures:

The FRLs within the development are to achieve the following levels;

- 120 FRL for all ~~back of house area ceilings~~ areas serving essential services consistent with BCA DtS provisions. This will be achieved through the application of fire rated board to the ceiling.
- 90 FRL from below for all Class 6 area ceilings. This will be achieved through application of intumescent paint to ceilings and exposed steel construction. Coverage is to extend to appropriately adhere to any bounding walls.
- 90 FRL for all construction required to be fire rated within Class 6 areas to maintain fire separation between different classification (Class 9b).
- Intumescent paint is to be applied to all corridors and Front of House ceilings to achieve an FRL of 60 minutes from below. The intumescent paint is to be applied to the underside of the ceiling and any exposed steel structural beams/elements. The intumescent paint is to be applied to achieve complete coverage of the ceiling and to appropriately adhere to any bounding walls.
- All other elements within the development required by ~~BCA 2016 amendment 1~~ BCA 2019 Amendment 1 Specification C1.1 to have a fire rating are to achieve an FRL of 60. This excludes essential services which is required to be in accordance with BCA DtS Provisions.

Proposed alternative solution:

BCA Comparison

BCA Clause C1.1 states the type of construction required by a building. Clause C2.7 states the requirements of FRLs to separate compartments and buildings. Clause C2.8 states the requirements of separation of classifications in the same storey. Clause C2.9 states the requirements of separation of classifications in different storeys. Specification C1.1 states the specific FRL requirement of each building element.

The intent of the BCA is to provide a building with element which will maintain the structural stability of a building during a fire and to avoid the spread of fire within and between buildings.

Quantitative Assessment

It is proposed to reduce the FRL of the building elements and quantitatively justify by way of a fire engineered solution.

The FRLs within the development are to achieve the following levels;

- 120 FRL for all ~~back of house area ceilings~~ areas serving essential services consistent with BCA DtS provisions. This will be achieved through the application of fire rated board to the ceiling.
- 90 FRL from below for all Class 6 area ceilings. This will be achieved through application of intumescent paint to ceilings and exposed steel construction. Coverage is to extend to appropriately adhere to any bounding walls.
- 90 FRL for all construction required to otherwise achieve a 180 FRL within Class 6 areas to maintain fire separation between different classification (Class 9b).
- Intumescent paint is to be applied to all corridors and Front of House ceilings to achieve an FRL of 60 minutes from below. The intumescent paint is to be applied to the underside of the ceiling and any exposed steel structural beams/elements. The intumescent paint is to be applied to achieve complete coverage of the ceiling and to appropriately adhere to any bounding walls.
- All other elements within the development required to have a fire rating are to achieve an FRL of 60. This excludes essential services which is required to be in accordance with BCA DtS Provisions.
- Omission of FRLs to the areas stated above and in Performance Solution 15.

Appendix 2 – Slab and Ceiling Design further details the requirements of proposed method to fire rate and treat ceilings of specific compartments within the development.

The performance solution is to be divided into three separate quantitative assessments. The below table summarise the assessments and the intent of the assessment.

Table 2 - Quantitative Assessment Summary

Quantitative Assessment Method	Intent
Time Equivalence Method	The time equivalence method is to be used to analyse the fuel load to opening relationship throughout the building to ensure that a complete burn out of a fire compartment will not exceed the fire resisting ability of the bounding construction.
Zone Modelling	Zone modelling is to be used to measure the temperatures reached within the compartments if a full burnout of the compartment occurs. These temperatures are to be used to assess the temperatures incident on structural elements, such as steel beams.
CFD modelling	CFD modelling is to be performed to measure the temperatures of the steel structural elements due to direct flame impingement to ensure that failure of the element will not occur. This modelling will determine the degree to which the steel elements are protected with intumescent paint.

Time Equivalence Method

An assessment is to be undertaken using calculations to evaluate the time-equivalence. 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 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. The minimum Fire Resistance Levels (FRLs) that would be expected to withstand a full burnout of the considered compartment will therefore be determined based on the result of the calculations.

This technique has existed for a long time and various means of calculating the equivalent period of fire exposure exist. These include Pettersson, Harmathy, Law, DIN 18230, CIB W14 and Eurocode 1. Although based upon experimental studies, Pattersson, Harmathy and Law techniques have been found to be limited either in their ease of use or scope of application. DIN 18230, CIB W14 and Eurocode a very 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 most applicable or current method of analysis.

Therefore, it is proposed to use the approach in the Eurocode 1, Law, and CIB for the Time Equivalent Method. The Eurocode assessment will consider multiple scenarios including 95% fractile FLED, sprinkler failure, 75% glazing failure and 50% glazing failure.

All rooms are to be considered within the building. Typical compartments will be selected with conservative input parameters to ensure the worst-case scenarios are assessed. A table is to be provided listing each room that has been assessed under the TE method and the typical compartments it represents. Further, each zone or fire compartment separated from other areas by fire rate construction is to be assessed to ensure that a full burnout of the compartment does not spread to other compartments. This will ensure the safety of occupants that pass into an adjacent fire compartment during evacuation. A mark-up of the compartments has been shown in Appendix 1 – General Compartmentation and Egress Strategy.

Conservative fuel load energy densities are to be used for each compartment, with refence made to the IFEG – 2005.

Zone Modelling

Analysis is to be conducted using a two-zone fire model called Ozone [Cadorin] on the large level 2 function rooms (2.02, 2.05 and 2.07). Ozone is a tool that has been developed to assist engineers in designing structural elements that are subjected to compartment fires.

Three spaces have been modelled to assess the temperature that these rooms are expected to experience during a typical fire scenario. The scenarios have assumed that all surfaces within the rooms are normal weight concrete with a thickness of 200mm, where it is noted that the subject masonry walls range in thickness from 250-500mm as shown in the figure below, and therefore an assumed thickness of 200mm is considered onerous.

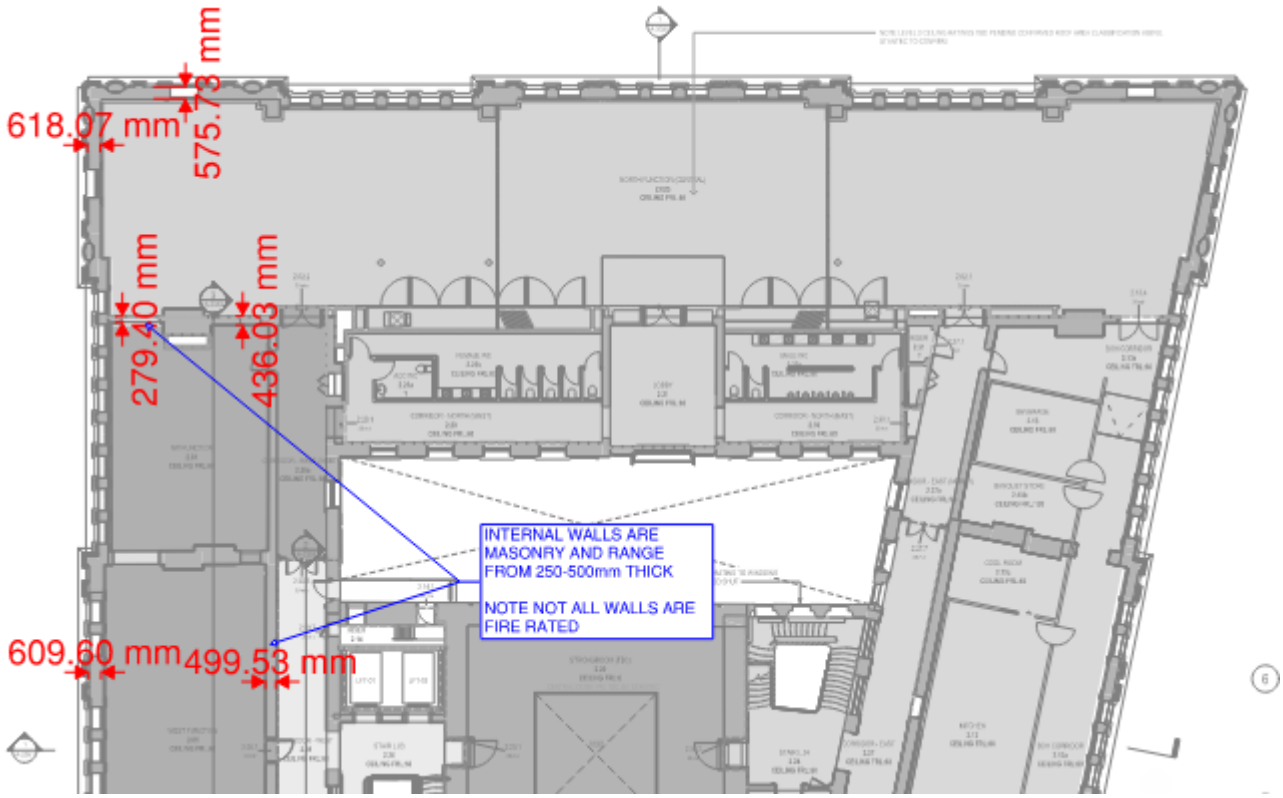


Figure 3 - Level 2 wall thickness

The modelled spaces have been illustrated in Figure 4.

As defined by C/VM2 Table 2.2 the FLED for exhibition halls and theaters is 800MJ/m^2. A fire growth rate of 150 seconds was used to simulate a fast fire. These values have been used for all scenarios.

Room 2.05 – West Function

The West Function room has an approximate floor area of 141m^2 with 7 external windows along the west wall, creating a potential opening size of around 21.5m^2.

Room 2.02 – North Function

The North Function room has an approximate floor area of 520m^2 with 25 external windows mainly along the north wall, creating a potential opening size of 65.5m^2.

Room 2.07 – Function

The Function room has an approximate floor area of 342m^2 with 18 external windows mainly along the south wall, creating a potential opening size of 56m^2.

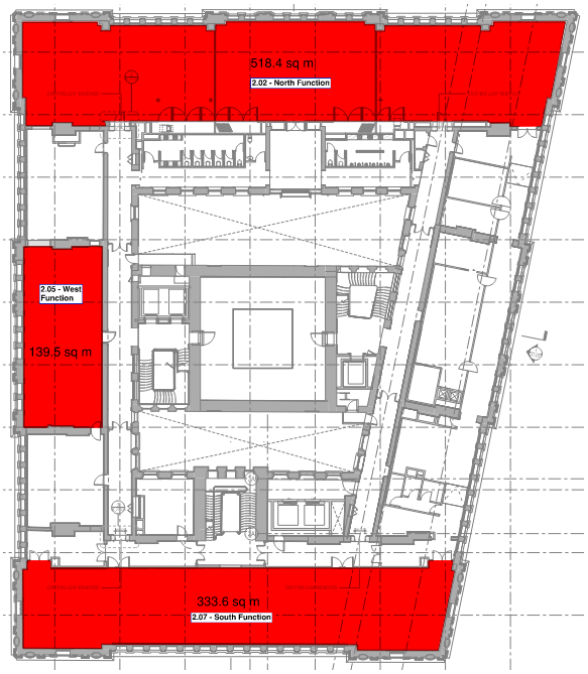


Figure 4 - Level 2 Floor Plan

The results are to be compared against the temperatures within the standard fire test shown in Figure 5 below and shown that a full burn out of the compartment will not exceed the FRL proposed.

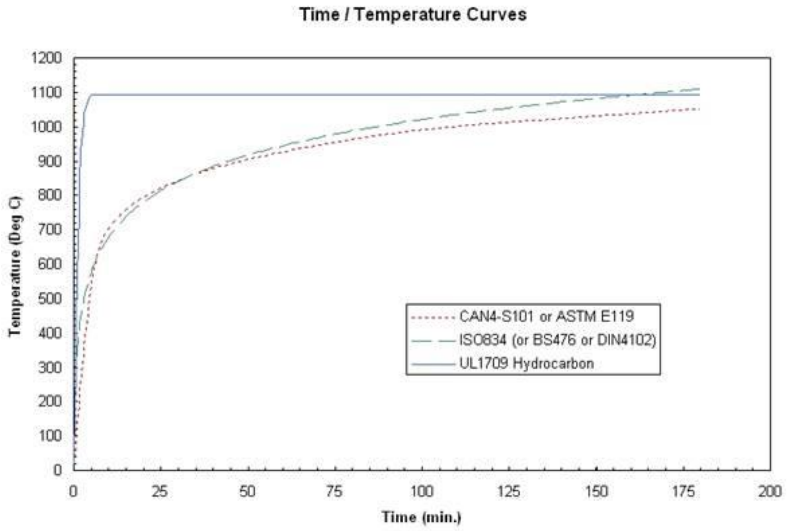


Figure 5 - Temperature curve in standard fire tests [AS1530.1 / ISO834]

CFD Modelling

A worst-case fire will be modelled in FDS under a steel beam, typical for compartments with exposed steel beams. The modelling assessment will show the effect of an unsprinklered fire within Level 2 compartments on the structural elements. The modelling results will allow us to determine the appropriate level of protection to the structural elements, dependent on the temperature and heat flux incident upon them. Forms of protection includes provision of intumescent paint on structural elements. The beams are to be assigned the characteristics of steel to accurately model the temperature reached by the beams in a worst case fire scenario.

The below table details the fire inputs to be used.

Scenario	HRR (MW)	Growth Rate	HRRPUA (kW/m2)	Position
Scenario 1	10	Instant	1000	Underneath structural steel beam. (Typical

				layout)

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 extinguish 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. The reliability and efficacy of sprinkler systems has been well researched and shall be further detailed in the FER.

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 a sprinkler system in Australia and New Zealand is generally significantly higher than in the US as researched by [Marryatt]. The FER shall contain further details of sprinkler system performance.

Furthermore, by controlling the fire size, the amount of smoke produced is correspondingly also 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, the threat to occupants, property damage and the attending fire brigade reduces. The high reliability and efficiency of fire sprinklers is also supported by fire tests and statistics on structural building fires. The associated benefits of sprinklers are to be discussed further in the FER.

The fire in a sprinkler failure scenario is expected to be significantly larger than that of the sprinkler-controlled fire scenario. In this situation the FRL is still expected to effectively prevent spread of fire, between the storage/retail areas and adjacent compartments, giving enough time for all occupants to evacuate safely. This is shown by the following quantitative analysis using Ozone modelling.

Qualitative Assessment

The heritage structure of the Level 4 domes contains exposed steel structural elements which will be unable to achieve the required FRLs without protection of these elements. To maintain the heritage nature of these elements, their required FRLs have been omitted. This is justified through the following qualitative considerations.

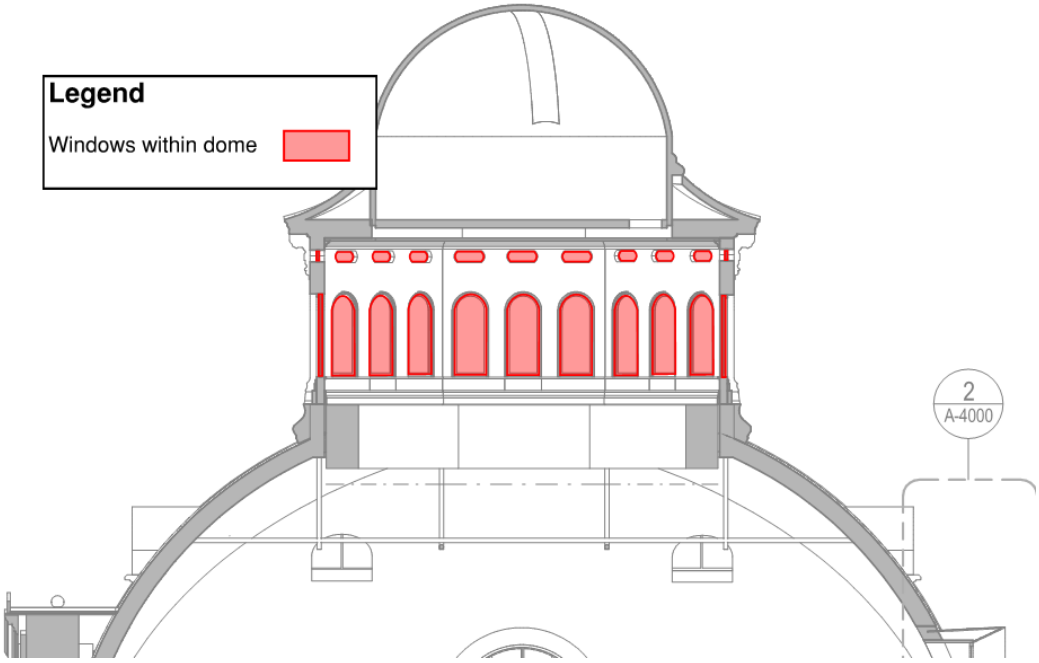
BCA Comparison

BCA 2019 Specification C1.1(3.5) provides a concession for a removal of the FRL for a roof. If the building is fitted with a compliant sprinkler system throughout then a roof need not comply with the relevant FRL provided that its covering is non-combustible. The BCA therefore recognises the effectiveness of sprinklers in controlling and reducing the size of fires to a level that will not compromise the roof. The dome roofs fulfil these requirements as they are constructed from non-combustible material and are protected throughout by a sprinkler system with the exception of the performance solutions identified in this project and the adjoining Education building. However, the construction of the dome roofs is such that the domes form both the wall and the roof for the rooms. It is considered that omission of an FRL to the “walls” of the rooms will be similarly protected by the sprinkler system and non-combustible construction.

Fire Scenario

All areas of the building that have dome roofs are provided with sprinkler protection throughout. The benefits of sprinklers have been outlined earlier in this solution and will be detailed further in the FER.

~~The construction of the domes also includes a large number of glazed openings towards the top of each dome as shown in Figure 6 below. In the event of a fire it is expected that as the temperature of the smoke builds up, it will cause these windows to crack and/or fall out. Based on research by Babrauskas in “Glass Breakage in Fires”, it is expected that a 6 mm thick glass window will fracture during a sudden temperature increase of around 110 ˚C, and fall out will typically occur when the temperature has reached approximately 450 ˚C, experiencing multiple fractures. Upon breakage of these windows the heat and smoke will be ventilated to the environment, reducing the heat that is transferred to the steel structure.~~



~~Figure 6: Typical openings in domes.~~

For a fire to occur that could compromise the structure of a dome, the sprinkler system would have to fail and allow the fire to grow uncontrolled near the steel elements. Such a fire is unlikely to occur, and any that did would not be provided with a fuel load to allow it to grow fast enough to threaten the structure before occupants would have evacuated from the area.

Occupant Egress

The omission of an FRL to dome elements presents the hazard that a fire may cause structural elements to fail and the dome roof to collapse before occupants have evacuated. As outlined above it is unlikely that a fire capable of this will occur in the building due to the sprinkler system limiting the size, spread and temperature of the fire. In the unlikely event that such a fire did occur, the safety of the building occupants would still be maintained as occupants are provided egress from the area before collapse would occur.

Structural failure of a dome roof is expected to cause it to collapse into the rooms they cover and not off the building. This will be verified by a structural engineer and provided in the FER. As such, the hazard of the structure failing only exists for occupants who are within the room that is compromised.

A fire initiating in proximity to structural elements of a dome roof will be visible to occupants in the area. Upon identifying the fire and smoke in the room, occupants will immediately begin evacuating. Given their early detection of the fire, likely before activation of the fire alarm, all occupants will have evacuated from the compromised room while the fire is in its infancy. It is expected that occupants from other compartments will either see occupants egressing from the compromised room or identify the smoke and fire in the room and not egress into the room, instead evacuating via an alternate exit.

As no occupants will be within the room after the initial evacuation, if the fire grows large enough to compromise the structure of the dome ceiling it will collapse into the room and not endanger the safety of egressing occupants.

FRNSW Comment: The abovementioned qualitative assessment is noted, and it is expected that structural failure be assessed by a structural engineer and to be adequately outlined within the FER (as noted above).

Stantec: As further discussed in Performance Solution 15, the omission of FRLs now only applies to the top parts of the northern dome and tempiettos. The structural elements supporting the main curved roof of the domes within the occupied spaces are to be fire rated achieving an FRL of 60 minutes. The top most parts of the domes and tempiettos are non-public spaces and only maintenance personnel access only for any lighting maintenance to the façade. No storage is allowed within these spaces.

L03 Roof Space

It is proposed to omit the FRL to the existing steel to be maintained in the L03 roof space. Issue number 23 of this FEBQ contains justification of elements within the roof space based on the fire safety provisions provided in the space, the occupant usage, the fuel load, and separation of the space from the levels below.

FRNSW Comment: Noted, refer to the comments provided within Issue Number 15 and 23 of this FEBQ.

Stantec: Refer to our responses within Issue Number 15 and 23 of this FEBQ.

Conclusion

The above quantitative assessments, including time equivalence, zone modelling and CFD modelling, to be completed for the FER are to thoroughly justify the rationalisation of FRLs within the development.

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 criteria is considered to be met if it is shown through the quantitative assessments that the FRL provided to construction elements is sufficient to resist the spread of fire within and between buildings. It must also be shown that safe occupant evacuation is provided for the period of time taken to evacuate the part of the building.

Fire scenarios and design fire parameters:

As per above and CFD form.

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 acceptance criteria is met.

The omission of FRL to the dome elements presents the hazard that by the time the brigade reaches the building, the fire could have grown large enough to compromise the structure of a dome roof. This presents the hazard that the ceiling may collapse while brigade members are in the area.

If by the time the brigade reaches the fire it has grown large enough to compromise the structural steel elements, they will identify the hazard and not directly attack the fire from within the room. Instead they will utilise alternate methods such as dousing from the street or other areas of the building.

As the brigade will not enter an area with such a fire, its is considered that the hazard to the brigade members is mitigated.

FRNSW Comment: Additional information is to be provided as to whether there will be any visual cues for Fire Brigade personnel to aid in identifying the structural adequacy of the dome structure and whether it is at risk of structural failure prior to Fire Brigade personnel entering the compartment in the event of a fire. Consultation and input by a structural engineer is also to be provided.

Stantec: As further discussed in Performance Solution 15, the omission of FRLs now only applies to the top parts of the northern dome and tempiettos. The structural elements supporting the main curved roof of the domes within the occupied spaces are to be fire rated achieving an FRL of 60 minutes. The top most parts of the domes and

tempiettos are non-public spaces and only maintenance personnel access only for any lighting maintenance to the façade. No storage is allowed within these spaces.

FRNSW Comment: Noted, refer to the comments provided within Issue Number 15 of this FEBQ.

Stantec: Refer to our responses within Issue Number 15 and 23 of this FEBQ.

Verification/validation analyses:

☑ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☐ None

TE:

- 90% Fractile FLED
- 75% glazing failure
- 50% glazing failure
- Sprinkler failure

Zone and FDS:

- Sprinkler failure

Provide details on proposed modelling/assessment tools:

As per CFD inputs form

FRNSW Comments are as follow:

- Calculations involving compartment sizes greater than 500m2 should include a range of sensitivity scenarios including the entire compartment and smaller areas such as half or quarter of the compartment, smaller portions (e.g. a room or other delineated space), which may differ with the amount of ventilation available.

WGE: Time Equivalence calculations will be done for both full compartments and typical rooms throughout the building.

FRNSW Comment: Noted.

- The preferred fuel load used in the calculations is a 95% fractile value as recommended in the IFEG (IFEG, 2005, p3.4-8). The average fire load densities listed in Table 3.4.1a of the IFEG are also acceptable following the methodology give on page 3.4-2 of the IFEG to determine the 90% fractile value. It is recommended that the fuel load densities to be utilised for the abovementioned assessment be outlined in a revised FEBQ document to allow FRNSW to undertake an informed review of the proposed performance solution.

WGE: Calculations include a sensitivity study accounting for 90% fractile FLED following the IFEG method outlined on page 3.4-2. Mean fuel loads have been taken as:

- Bar Areas – IFEG Liquor Store, 700 MJ/m^2 (IFEG-2005 Table 3.4.1a)
- Suites – IFEG Hotel, 300 MJ/m^2 (IFEG-2005 Table 3.4.1a)
- Restaurant/Retail – IFEG Food Store, 700MJ/m^2 (IFEG-2005 Table 3.4.1a)
- Function Room – IFEG Exhibition Hall, furniture including decorations, 500 MJ/m^2 (IFEG-2005 Table 3.4.1a)

An example TE calculation is provided below for a restaurant/retail area.

Input Parameter	Abbr.	
Height of firecell (m)	H	5.48
Floor area (m^2)	A_f	142.47
Vertical openings Area (m^2)	A_v	34.42
Horizontal openings Area (m^2)	A_h	0.00
Wall Perimeter Length (m)	m	54.40
Opening Height (m)	Hv	4.29
Fuel Load Density(MJ/m^2)	Qf	700.00
Lining Material		Concrete
Occupancy Type		Offices, etc

Heat of Combustion (MJ/kg)	ΔH_c	19
Sprinkler Protection		Yes

Results Table	Abbr.	
DtS FRL		~~60~~ 120
Proposed FRL		60
EUROCODE	t_e	25
X.1 - 90 % Fractile FLED	t_e	41
X.2 - Sprinkler Failure	t_e	41
X.3 - 75% Glazing Failure	t_e	30
X. 4 -50% Glazing Failure	t_e	**43**
CIB Formula	t_e	34
Law Formula	t_e	38
Pass/Fail		**Pass**

FRNSW Comment: Noted. The calculation and resulting FELD for the 90% FLED sensitivity scenario is to be outlined clearly within the FER.

- A sprinkler reduction factor of 0.5 may be used when assessing separating elements, i.e. – there is no structural application of the FRL.

WGE: Noted.

- A structural engineer should verify any assumptions made in the analysis on the performance of the structure and confirm that the proposed alternative solution has no other impacts on the structural design. The structural engineer should confirm that the structural design is consistent with and incorporates all requirements of the Alternative Solution.

WGE: Noted.

- The potential for catastrophic building collapse should also be discussed.

WGE: Noted. Will be addressed in FER.

FRNSW Comment: Noted, this is to be addressed in the FER.

- Clear justification of ventilation to equivalent fire severity calculation area is to be included. In this regard, consideration should be given to height of openings, the size of the openings and their relationship to the height of the external wall [e.g. in a full height window only the upper portion may fail (See CIB Publication 269 – Rational Fire Safety Engineering approach to Fire Resistance of buildings)]. For this reason, FRNSW recommend that a scenario with no more than 50% window breakage/failure be undertaken. Where it can be demonstrated that more than 50% breakage is likely to occur appropriate justification is to be included in the FER (e.g. modelling to demonstrate temperatures are sufficient to cause window breakage).

WGE: Calculations take into consideration the height of openings through calculation using CIB W14 method. Calculations also includes a sensitivity study accounting for both 75% and 50% Glazing failures using the Eurocode 1 method.

FRNSW Comment: Noted, FRNSW reiterates the recommendation for appropriate justification to be provided within the FER when assessing a scenario with more than 50% window breakage.

- The structure remains for the time which is commensurate to the hazard, risk and fuel load as well as the time taken to evacuate the occupants and for FRNSW to carry out search and rescue and firefighting operations (fire service intervention) unless otherwise justified.

WGE: Noted.

- Fire spread to other buildings and external fire attack needs are to be within acceptable BCA verification methods. Any reduction in FRL should also demonstrate that it is adequate to prevent fire spread to and from neighbouring buildings/compartments. The assessment should also demonstrate that the FRL is adequate to maintain structural adequacy under exposure from a fire in neighbouring buildings/compartments.

WGE: No risk of fire spread to or from other buildings as lot is on a block bounded by public roads on all 4 sides. The distance to the nearest fires source feature is in excess of 13m.

FRNSW Comment: Noted, to be outlined and appropriately justified in the FER.

- It is recommended that a data sheet/specification sheet outlining/confirming the performance of the intumescent paint is to be provided for FRNSW review.

WGE: Noted, data sheet has been provided with this submission.

FRNSW Comment: Noted The information on the supplied data sheet indicates a range of fire rated coated materials, some of which have not been tested in accordance with AS1530.4. It is assumed that the materials utilised in the development have been tested in accordance with AS1530.4, as the majority of materials listed that have a 60 minute FRL are noted to be tested in accordance with AS1530.4 by the CSIRO. However, this is to be confirmed and clearly outlined within a revised FEBQ document or FER submission.

FRNSW Comment: The abovementioned comment provided by FRNSW within V03 of the FEBQ process has not been addressed. It is assumed that this will be addressed within the FER.

- It is noted that a reduction in FRL of 50% or more may eventuate as certain members require an FRL of 180, in accordance with Table of the BCA for Type A construction (if these are to be constructed with a FRL of 60) as per the abovementioned performance solution. This is to be clarified and it should be noted that a reduction in the required FRLs of greater than 50% will not be supported by FRNSW.

WGE: Noted. Reduction of more that 50% will not be used. Where construction is otherwise required to achieve a 180 FRL, a minimum of 90 FRL will be provided.

FRNSW Comment: Noted, a reduction in FRL of 50% is not to be undertaken.

FRNSW Comment: On the basis that both smoke detection and sprinkler protection are provided, in principle support is provided subject to the following:

- All analysis inputs and assumptions being detailed in the FER and agreed upon by all relevant stakeholders, and the analysis demonstrating compliance with the Performance Requirements of the NCC.
- The comments provided by FRNSW being addressed satisfactorily.

FRNSW Comment: As noted above, FRNSW acknowledge the inclusion of additional non-compliances within this FEBQ V7 submission, namely the following:

- Lower Ground waste room, comms room and electrical room from 180 minute to 120 minute FRL
- Basement tunnel, basement lift shaft and basement stair shaft from 180 minute to 120 minute FRL
- Omission of FRLs to the underside and support structure of the Level 4 southern terrace
- Omission of fire rating to the floor and joists of the Level 2 mezzanine AHU rooms
- Rationalisation of fire separation between Lands and Education buildings in the link tunnel.
- Class 5 office areas permitted to achieve an FRL of 60 minutes in lieu of 120 minutes.
- Floor structure of the Level 4 mezzanine of the northern dome to achieve a minimum FRL of 60 minutes, achieved by the structural steel members only by intumescent paint protection to all sides.
- Omission of FRL to the existing steel to be maintained in the L03 roof space.

However, it is noted that the justification provided as part of the performance solution above has remained the same as previously submitted during the FEBQ V5 submission (report ref: BFS20/801 #10858). As such, insufficient information has been provided to justify the newly-outlined performance solutions outlined above, with no new details as to how these non-compliances will be addressed. Therefore, the in principle support provided within the FEBQ V05 submission is limited to the non-compliances outlined within that revisions. In order to allow for an informed review to be undertaken on the newly-outlined non-compliances, additional justification is to be provided in a revised FEBQ document.

Stantec: Our proposed methodology assessment on the additional non-compliances as follows.

Lower Ground Waste Room, Comms Room and Electrical Room FRL reduction

Ozone modelling will be undertaken to demonstrate the calculated temperature conditions over time does not exceed the AS 1530.4 standard fire temperature curve. The proposed inputs to the Ozone modelling is presented in table below.

Location	Floor Area (m^2)	Lining material	Lining Thickness (mm)	Growth Rate	Heat Release Rate (kW/m^2)	FLED (MJ/m^2)
Wasteroom	66.3	Gypsum board	26	Fast	500	1200
Switch Room	48.7	Gypsum board	26	Fast	500	1200
Comms Room	18.9	Gypsum board	26	Fast	500	1200
References: All building: C/VM2 Verification Method Amendment 4 states that all buildings and storage stacks height of less than 3m is a fast $0.0469t^2$ growth rate and 500 kW/m^2.						

Further qualitative discussions of the uses of these associated areas, benefits of sprinklers system (where provided) and expected low occupant (based on BCA occupant density of $30m^2$ per person for plant spaces) use shall further justify the support of reduction of FRL to 120 minutes.

It should be noted the ozone calculations has conservatively assumed gypsum as the lining material, however the construction of the rooms are a combination of existing masonry walls and lightweight construction.

FRNSW Comment: In relation to the rationalisation of FRLs to the Lower Ground waste room, comms room and electrical room (utilising ozone modelling), the following comments are provided:

- FRNSW has concerns that the proposed solution may facilitate the occurrence of “backdraught” as a result of facilitating a design that consumes oxygen within a compartment. This is to be addressed.
- FRNSW is also aware that some form of ventilation may be required to be provided in compartments as per the requirements outlined in Section F of the NCC. Clarification/confirmation is to be provided.
- Where Section F of the NCC requires the subject compartment to be provided with ventilation, the supply of oxygen would not necessarily be depleted within the compartment and should then be taken into consideration as part of formulating the parametric fire curve.
- FRNSW note Ozone modelling requires the selection of one of the three combustion models, noting the comments provided above, while the temperature severity may be reduced compared to a standardized fire curve, the duration of the fire may theoretically be longer. It must be adequately demonstrated that the potential increased fire duration is indeed less severe on the fire resisting elements compared to a standard fire test curve.

<u>Basement tunnel FRL reduction and Rationalisation of fire separation between Lands and Education buildings</u>

A qualitative comparative assessment will be undertaken to demonstrate the reduction to 120 minutes FRL is acceptable for the Basement tunnel areas. Supporting arguments are as follows:

- The basement tunnel main use is for circulation space for staff and it is expected temporary retail storage when transferring goods to its relevant floor level.
- No permanent storage is provided within the basement tunnel. Appropriate signage within the basement tunnel is provided to manage this risk.
- Under the BCA, the 180 minute FRL for Class 6 applies to all Class 6 types i.e. large supermarket tenancies. When compared to the actual use in the Basement tunnel, it is reasonable to determine the 180 minute FRL is considered onerous. As mentioned above the tunnel is more a circulation space, any large storage of retail goods can impact the egress provisions within this space (i.e. egress widths). Hence the actual fuel loads within these spaces are further limited.
- Rationalisation of the fire separation between Lands and Education building is to adopt the higher FRL or at least 120 minute FRL.

FRNSW Comment: In relation to the rationalisation of the basement tunnel FRL as well as the fire separation between the Lands and Education buildings, the following comments are provided:

- The abovementioned signage is to be listed as an Essential Fire Safety Measure, to be included on the Fire Safety Schedule.
- FRNSW notes that the non-compliances in relation to the basement portion also refers to the basement lift shaft and stair shaft, however these have not been outlined above nor has there been any explanation as

to how these will be assessed. This is required to be clarified/addressed as part of the performance solution.

Omission of FRLs to the underside and support structure of the Level 4 southern terrace

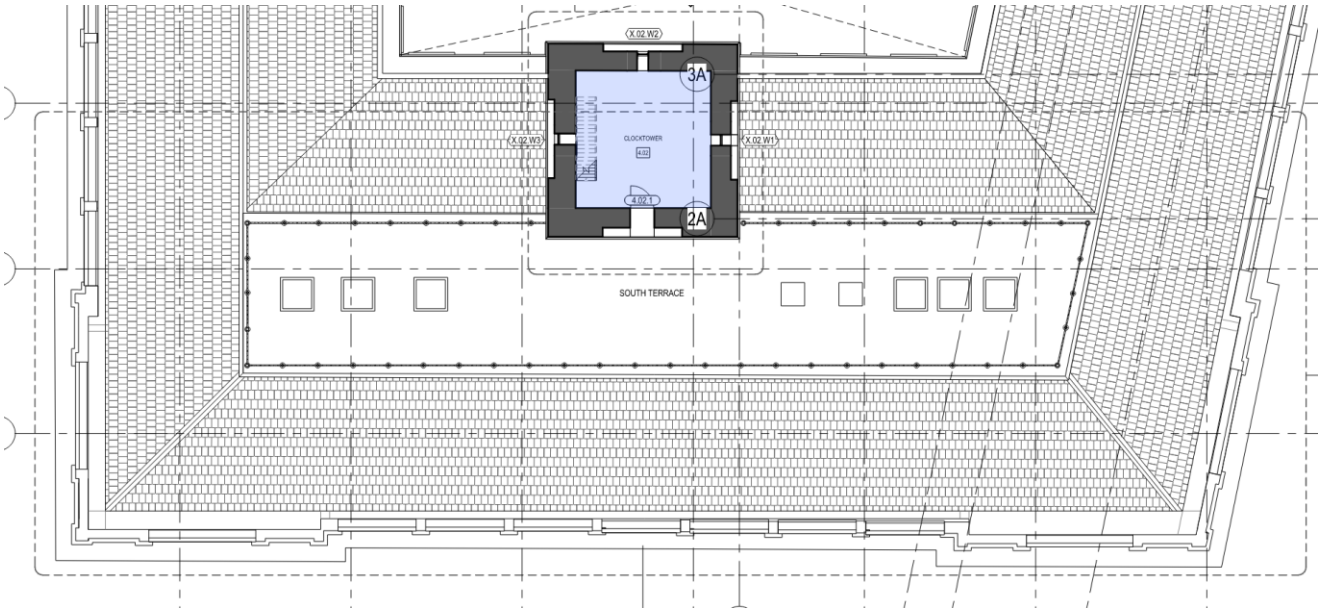


Figure 7 – Southern terrace location.

Qualitative assessment is proposed to be undertaken to demonstrate the omission of FRL to the Southern Terrace is acceptable based on the following fire safety measures:

- The southern terrace area is a restricted area where the public has no access and only maintenance/security personnel occupy this space. As such the expected number of occupants within these areas is very low and majority of the time the southern terrace is more a roof covering than an occupiable outdoor area. No storage is permitted on the southern terrace area and will be outlined as a management in use provisions.
- In conjunction with Performance Solution (issue 23) relating to combustible elements within the roof space, the southern terrace is fire separated from the lower levels occupied areas. The roof space below the southern terrace accommodates the plant equipment where these spaces are sprinkler protected and provided with smoke detection and alarm system.

FRNSW Comment: In relation to the omission of the FRLS to the underside and support structure of the Level 4 southern terrace, in principle support is provided subject to the following:

- The analysis in the FER demonstrating compliance with he Performance Requirements of the NCC
- A structural engineer should verify any assumptions made in the analysis on the performance of the structure and confirm that the proposed alternative solution has no other impacts on the performance of the rest of structure.
- The abovementioned Management In Use Provisions are to be listed as an Essential Fire Safety Measure, to be included on the Fire Safety Schedule.

Omission of FRLs to the floor and joists of the Level 2 mezzanine AHU rooms

Similar methodology to the Performance Solution permitting omission of FRLs to the southern terrace where a qualitative assessment is proposed on the following discussions:

- The Level 2 mezzanine is part of the Level 2 fire compartment.
- Level 2 AHU room does not serve any essential service triggering additional fire separation requirements.
- Low occupant use and restricted only to maintenance personnel
- Provisions of fire sprinkler system for suppression of fire
- Provisions of smoke detection and alarm system for early occupant warning.

- As the mezzanine floor is not fully non-combustible hence the assessment of this space as an Performance Solution. Other parameters relating to floor area complies with Clause 2.6 of Spec C1.1 of the BCA.

FRNSW Comment: In relation to the omission of the FRLs to the floor and joists of the Level 2 mezzanine AHU rooms, a structural engineer should verify any assumptions made in the analysis on the performance of the structure and confirm that the proposed alternative solution has no other impacts on the performance of the rest of structure. The FER is to also consider any possible impacts on the portion immediately below the Level 2 mezzanine, demonstrating that the rationalised/omitted FRLs will not result in any structural failure that may impede on the level(s) below.

Class 5 office areas FRL reduced to 60 minutes

A quantitative assessment is proposed to demonstrate an FRL of 60 minutes to Class 5 office areas is acceptable. Time equivalence calculations will be undertaken to demonstrate the calculated time does not exceed the proposed FRL for Class 5 office area. The proposed mean fuel load shall be in accordance with data presented in the IFEG. Sensitivity studies with 90th percentile fuel load with 50% opening will be undertaken.

Further occupant evacuation within these spaces will be reviewed to demonstrate the reduced FRL to 60 minutes does not adversely impact on occupant life safety. Fire safety measures to consider as follows:

- Provisions of fire sprinkler system and smoke detection and alarm system where the effectiveness of both systems are further discussed in the FER.
- The Class 5 office space areas are located on Lower Ground, where the office space opens out onto the outdoor covered stairway which leads to Lower Ground internal areas. The stairway leads to a smoke proof lobby and upon exiting out of the smoke proof lobby alternative pathways are available to reach a place of safety

FRNSW Comment: In relation to the rationalisation of the FRLs to the Class 5 office areas, in principle support is provided subject to the following:

- All analysis inputs and assumptions being detailed in the FER and agreed upon by all relevant stakeholders, and the analysis demonstrating compliance with the Performance Requirements of the NCC.
- The comments provided by FRNSW above (in relation to the expectations and validity of the assumed values for a fire severity analysis) being considered and implemented as part of the assessment satisfactorily. Refer to these comments which have been provided as part of the V02 FEBQ document.

Floor structure of the Level 4 mezzanine of the northern dome to achieve a minimum FRL of 60 minutes to the structural steel members only.

A quantitative assessment is proposed to demonstrate an FRL of 60 minutes to the Class 9b space is acceptable. This assessment methodology is consistent with the original methodology where fire severity calculations are to be undertaken based on the fuel load of a bar in the IFEG. Additional supportive discussions to be provided:

- Class 9b space is staff managed bar space where staff are trained during an emergency and to be able to safely assessed the situation to permit safe evacuation of occupants on the Level 4 mezzanine floor area.
- Staff are trained for early intervention to minimise the risk of the stairway being obstructed for occupant egress. Portable fire extinguisher are to be located in close proximity to stairway to allow for effective means of manual suppression
- Effectiveness of fire sprinkler system and smoke detection system is further discussed in the FER.

FRNSW Comment: In relation to the rationalisation of the FRLs to the Class 5 office areas, in principle support is provided subject to the following:

- All analysis inputs and assumptions being detailed in the FER and agreed upon by all relevant stakeholders, and the analysis demonstrating compliance with the Performance Requirements of the NCC.
- The comments provided by FRNSW above (in relation to the expectations and validity of the assumed values for a fire severity analysis) being considered and implemented as part of the assessment satisfactorily. Refer to these comments which have been provided as part of the V02 FEBQ document.

Omission of FRL to the existing steel to be maintain in the L03 roof space.

As discussed earlier in V07 revision, this assessment is in conjunction with Performance Solution 23 permitting combustible elements within the Level 03 roof space. The fire safety measures require adequate fire separation from the occupant Level 2 space and Level 03 roof space. In addition fire sprinker and smoke detection and alarm are installed within the Level 03 roof space.

FRNSW Comment: On the basis that appropriate compartmentation and sprinkler protection is provided to the subject roof spaces (as outlined within Issue Number 23), in principle support is provided subject to the analysis in the FER demonstrating compliance with the Performance Requirements of the NCC.

Issue number: 2 **Title:** Permit the use of combustible elements in the facade

Details of departures from DtS provisions:

To permit the existing timber elements for window architraves in the external walls on the existing heritage areas

Applicable DtS provisions:	C1.9, Spec C1.1	Performance requirements:	CP1, CP2, CP4, CP8

List key fire safety measures:

The building is sprinkler protected in accordance with AS 2118.1-2017 with the exception of the Performance Solutions identified within this document and Education Building.

The location of window openings are at an acceptable distance from the nearest fire source feature due to the roads bounding the subject building.

Proposed alternative solution:

BCA Comparison

BCA Clause C1.9 outlines the requirements for where building elements are to be of non-combustible construction. Part (a)(i) of this clause states that external walls and common walls are included in the list of elements highlighted. It has been proposed that the existing timber framed heritage frames are to remain in areas which may constitute external walls. The BCA Guide states that the intent of this clause is “To specify the non-combustibility for building elements and to permit the use of certain materials that are known to provide acceptable levels of fire safety where an element is required to be non-combustible”. The intent of this clause can be understood as ensuring acceptable levels of fire safety are met to ensure that the growth and spread of a fire is kept to an acceptable level such that occupants safety will not be put at risk

For performance requirement CP1 to be satisfied the building elements must maintain structural stability to the degree necessary. To satisfy this, the use of timber elements on the external walls are not to be used as a structural element. By doing so, the structural stability of the building should not be compromised during a fire scenario whilst occupant evacuation is being undertaken.

Performance requirements CP2 and CP4 require that the building is to have adequate resistance to fire spread and limit the generation of smoke and heat. CP8 requires that fire spread must be adequately resisted through openings, construction joints and penetrations for building services.

Qualitative Assessment

The building is to be sprinkler protected in accordance with AS2118.1-2017. 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 prevent the fire from spreading beyond the area of origin.

Timber typically does not ignite until it reaches a temperature of approximately 300ºC [6]. The sprinkler system provided is expected to limit the temperatures within the compartment to less than 200ºC as such it is not expected that the timber elements will ignite. Further detail on the effectiveness of sprinklers is to be provided in the FER.

~~Furthermore, as the timber elements are not used for structural purposes, the risk of timber elements in a fire is expected to be no higher than that of any timber furniture inside the compartments which are not forbidden under the requirements of the BCA.~~

FRNSW do not consider this an appropriate DtS comparison. As per Section 1.2.9.1 of the IFEG, in the comparative approach, the fire safety provided is compared to the level of fire safety that would be achieved in an identical building designed in compliance with the deemed-to-satisfy or prescriptive provisions. FRNSW do not support the assessment method.

WGE: Noted, comparative considerations have been removed and further qualitative assessment included:

The use of existing heritage timber as part of the façade does not facilitate spread of fire along the external walls of the building. The heritage wooden window and door frames that extend to the external façade of the building provide a very minimal fuel load and make up a small fraction of the façade elements as can be seen in the pictures at the end of this issue. None of the combustible façade elements provide a direct path between storeys, as such if these elements were to ignite, they do not enable the spread of fire any more than when the window breaks during a fire. As seen in the first image at the end of this issue, the majority of these windows are recessed into the external wall, preventing them from restricting the fire spread along the façade. Further, the building is isolated on a block surrounded by roads. The closest fire source feature is over 13m away and the nearest adjacent building even further. It is therefore considered that the combustible façade will not pose a risk of fire spread to or from the building. As the combustible façade elements will not facilitate the spread of fire, they are considered to meet the performance requirements.

FRNSW: Noted.

It is noted that the inclusion of timber may create an added source of fuel. All existing openings which are to contain timber elements are east or west facing and as such are approximately 180º from the neighbouring buildings or separated by a road. It is recognised in the BCA under Clause C3.3 that fire spread between parallel windows is unlikely and as such there is no requirement for these to be separated or protected. Therefore, it can be said that the additional fuel load which is present from the timber elements does not increase the risk of fire spread to neighbouring buildings over a DtS design.

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. The reliability and efficacy of sprinkler systems has been well researched and shall be further detailed in the FER.

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]. The FER shall contain further details of sprinkler system performance.

Furthermore, by controlling the fire size, the amount of smoke produced is correspondingly also 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. These and associated benefits are to be discussed in the FER.

Qualitative Assessment

It has been demonstrated above that the sprinkler system will act to prevent the ignition of the existing heritage timber elements. It has also been rationalised that the presence of the heritage timber presents little risk of fire spread between buildings due to the location of the building in relation to neighbouring buildings. ~~The presence of combustible materials has been compared to a DtS building with a high amount of combustible material internally, adjacent to openings~~. It can be considered that the performance solution has met the acceptance criteria.

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 building will appropriately resist fire and smoke spread for the necessary time for occupants to safely egress from the subject area. Beyond this time, fire and smoke spread would not be greater than a DtS design as a direct result of the combustible elements on the external walls.

Fire scenarios and design fire parameters:

A fire spreading to the façade has been assessed.

Describe how fire brigade intervention will be addressed or considered:

Fire brigade intervention is not considered to be impacted if the performance solution demonstrates that the façade does not contribute to fire spread more than a DtS design.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

NA

Provide details on proposed modelling/assessment tools:

NA

FRNSW Comments are as follows:

- As heavy reliance is place on the sprinkler system installed (in accordance with AS2118.1-2017), it is to be demonstrated how the reliability of the sprinkler system is to be increased and maintained throughout the life of the building.

WGE: Noted. To be discussed in FER.

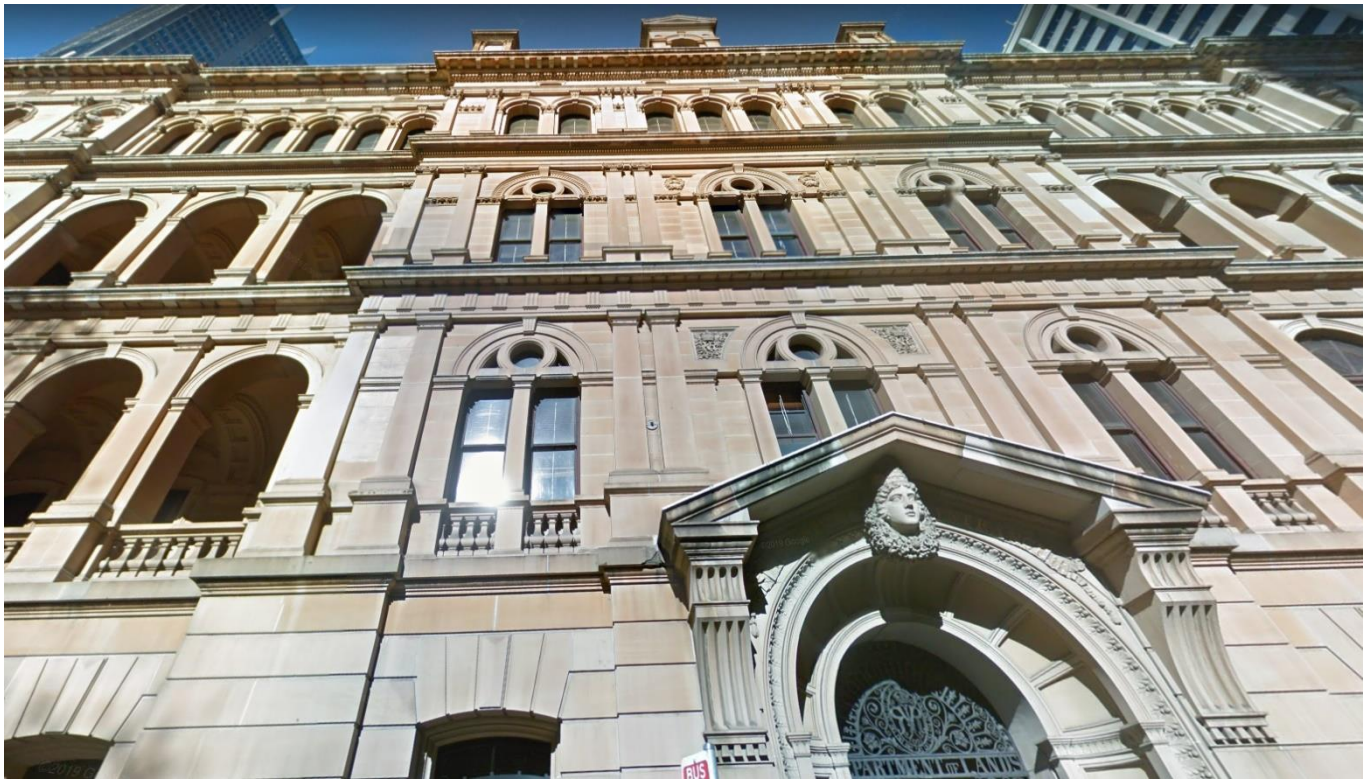
- Insufficient information is provided regarding the combustible timber elements, e.g. the locations and their fire hazard properties.
- FRNSW recommend pictorial representations be provided that highlight the regions in which the timber elements will be included. This will allow FRNSW to review the extent of coverage appropriately.

WGE: Timber elements are included as part of the heritage façade throughout the building. The majority of which is door and window frames. See WGE comment in qualitative assessment for further justification.

Examples of the timber façade elements are show below. The timber window and door frames provide a very low fuel load within the sandstone façade.

FRNSW Comment: In principle support is provided subject to the following:

- All FRNSW comments be adequately addressed.
- The analysis in the FER demonstrating compliance with the performance requirements of the NCC.



Issue number: 3 **Title:** ~~Rationalisation of Fire Control Centre~~

Details of departures from DtS provisions:

~~The requirements of the FCC are to be rationalised as access involves a change in level exceeding 300mm and is not from the 'front' of the building.~~

Applicable DtS provisions:	~~E1.8, Spec E1.8~~	Performance requirements:	~~EP1.6~~

List key fire safety measures:

~~A strobe is to be provided next to the adjacent to the Bent St building entrance. The strobe will activate upon activation of the alarm system. The location of the strobe is to be in a place that is protected from possible damage i.e. passing motor vehicles and pedestrians.~~

Proposed alternative solution:

~~BCA Comparison~~

~~BCA 2016 amendment 1 Clause E1.8 requires the development to be provided with a Fire Control Centre (FCC). Spec E1.8 lists the DtS provisions of a FCC. The location of the FCC must be located in a building so that egress from any part of its floor to a road or open space does not involve changes in level which in aggregate exceed 300mm. Further, the fire control room must be accessible via two paths of travel-~~

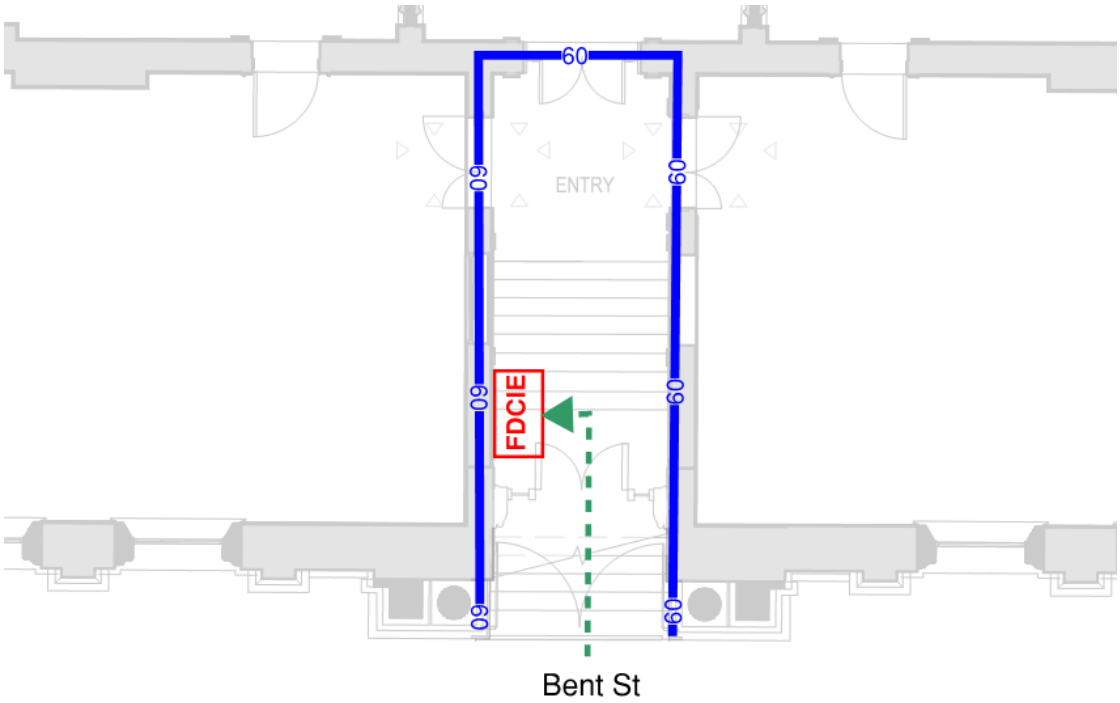
~~(i) One from the front entrance of the building; and~~

~~(ii) One direct from a public place or fire-isolated passageway, which leads to a public place and has a foor with an FRL of not less than -/120/30.~~

~~Performance requirement EP1.6 requires that suitable facilities must be provided to the degree necessary in a building to co-ordinate fire brigade intervention during an emergency.~~

~~Qualitative Assessment~~

~~The following qualitative assessment aims to show that the proposed design meets Performance Requirement EP1.6 and the intent of the BCA DtS requirements.~~



~~Figure 8 - FCC Location~~

~~The Lands building is provided with a FCC at the main on Bent St in the southern entry lobby. As shown in the figure above, the brigade is required to travel to the Bent St entrance and travel up the stairs with a change of level of greater than 300mm. The location of the FCC is considered to not meet the DtS provisions of the BCA as the change in level to the FCC is greater than 300mm and as there are multiple entrances to The Lands Building, the Bent St entrance cannot be considered as the main one.~~

~~Change in Level Exceeding 300mm~~

As stated above, the egress path from the Fire Control Centre changes in level by approximately 1000mm over 5 stairs. The intent of EP1.6 is to require convenient egress from the Fire Control Centre for the brigade and to facilitate them carrying their equipment. The excess change in level will have little to no impact on the egress of the brigade due to the below reasons.

As the horizontal distance required to travel by the brigade is approximately 5m from the street, the brigade will be able to egress to the street from the FCC quicker than possible DtS compliant designs. DtS compliant designs would allow for less convenient egress for the brigade with a compliant change in level of 300mm and a travel distance to the exit much longer than the distance required of the proposed design.

Further, the BCA does not require a FCC to be fire rated to any degree. The proposed design provides a fire rated compartment of 60 FRL for the brigade to conduct firefighting activities. The fire separation offers the brigade an additional degree of fire safety, allowing them to operate while separated from the effects of a fire in another compartment.

Access from Main Entrance

The FCC is required by the BCA to be located at the main entrance of the building. As the building has multiple entrances, none of which are the 'main', it is considered a technical BCA non-compliance. The FCC is located within the Bent St entrance as shown in Figure 8. The location of the FCC within the Bent St entrance is not expected to impede brigade operation. To ensure the brigade are able to locate the FCC, a strobe light is to be provided at the Bent St building entrance which will be clearly visible upon arrival.

Conclusion

The above qualitative assessment has adequately demonstrated compliance with the relevant performance requirements by showing that fire brigade intervention is adequately facilitated.

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 to have met the acceptance criteria if it is shown that brigade intervention has been facilitated in line with Performance Requirement EP1.3.

Fire scenarios and design fire parameters:

Fire brigade intervention is considered to be facilitated through the provision of a strobe indicating the location of the FCC.

Describe how fire brigade intervention will be addressed or considered:

Fire brigade intervention has been assessed above.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

~~NA~~

Provide details on proposed modelling/assessment tools:

~~NA~~

FRNSW Comment: In principle support is provided subject to the following:

- The analysis in the FER demonstrating compliance with the Performance Requirements of the NCC.
- The comment provided by FRNSW regarding clarification on the Fire Control Room discrepancies (Section 6.8 of this FEBQ) be addressed satisfactorily.
- The ASE should be programmed to send the Bent St entry as the brigade arrival address.

WGE: Solution removed, refer to section 6.8 above. FCC will be located in the Education building as per BFS19/879 with a sub-FIP at the Loftus Street entrance to the Lands building.

FRNSW Comment: FRNSW acknowledges the removal of the abovementioned performance solution. It is requested that the ASE send the address of the building in alarm to the monitoring company. Allowing the first responding appliance to be directed to the building in alarm as a priority.

Stantec: Noted.

Issue number: 4 **Title:** Number of exits

Details of departures from DtS provisions:

It is proposed to rationalise the provision of a single exit from the following areas;

- Level 3 roof plant spaces
- Southern Roof Terraces
- Plant on Level 2 Mezzanine
- The dome and Northern Roof Terrace on Level 4
- Male W/C on Lower Ground Mezzanine

Applicable DtS provisions:	D1.2	Performance requirements:	DP4, EP2.2

List key fire safety measures:

It is proposed to implement the following management in use requirements;

- Any person who requires access to the ~~Southern~~ Level 3 roof plant spaces or Roof Terraces must understand and adhere to the following requirements and be inducted by building management. The management in use requirements are to be recommunicated to employees on a yearly basis.
    - Any person/s that accesses the Plant Room, roof plant spaces or Roof Terraces must be able bodied.
    - Any person that accesses the Plant Room, roof plant spaces or Roof Terraces must be accompanied by a member of building management or security.
    - Each person is always required to be equipped with a radio and able to communicate with the other person via the radio.

The building management / security staff must monitor the space for any fire risk while the other occupants are working. In the event of a fire or emergency requiring evacuation, the occupant must inform the others that evacuation is required at which point all occupants are to immediately evacuate into the fire stair and discharge from the building.

Proposed alternative solution:

BCA Comparison

BCA ~~2016 amendment 1~~ 2019 Amendment 1 Clause D1.2 requires that in addition to any horizontal exit, not less than 2 exits must be provided from each storey.

Compartments that have only been provided with a single exit are shown in the figures below.

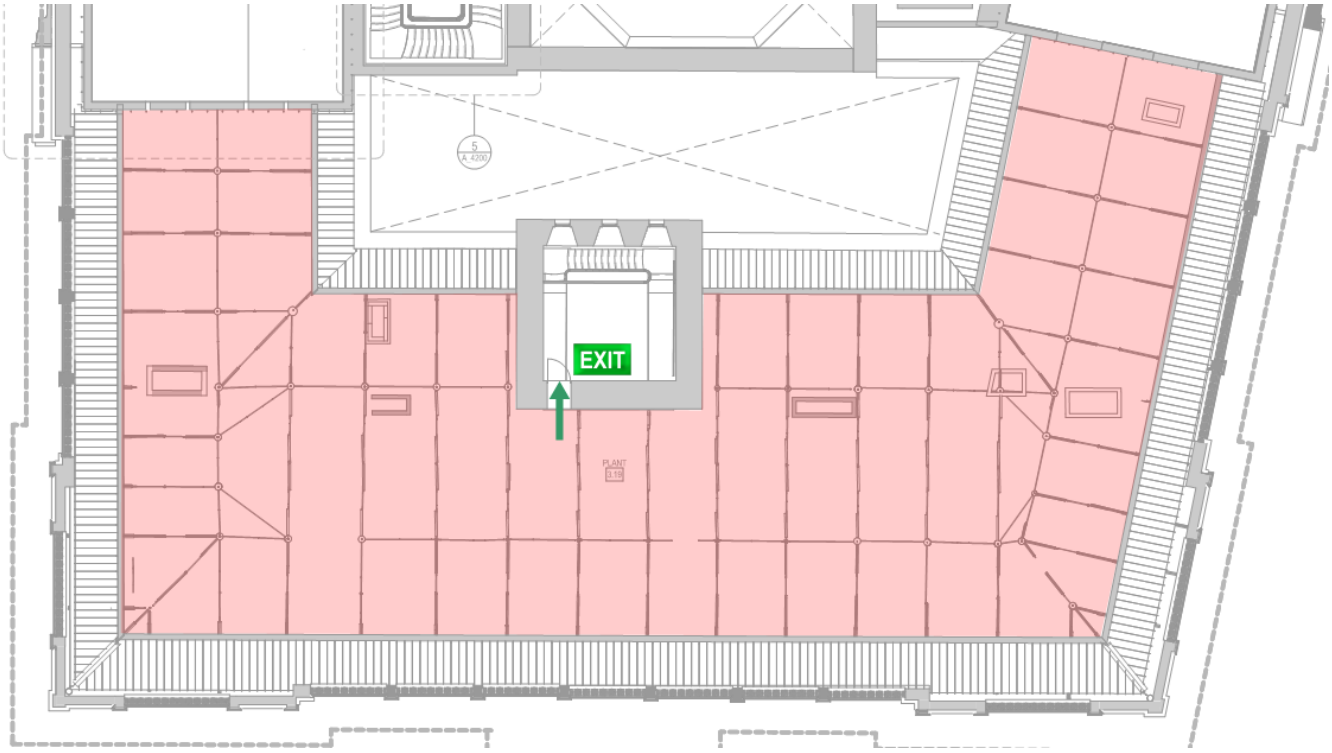


Figure 9 - level 3 ~~Plant Room~~ roof space

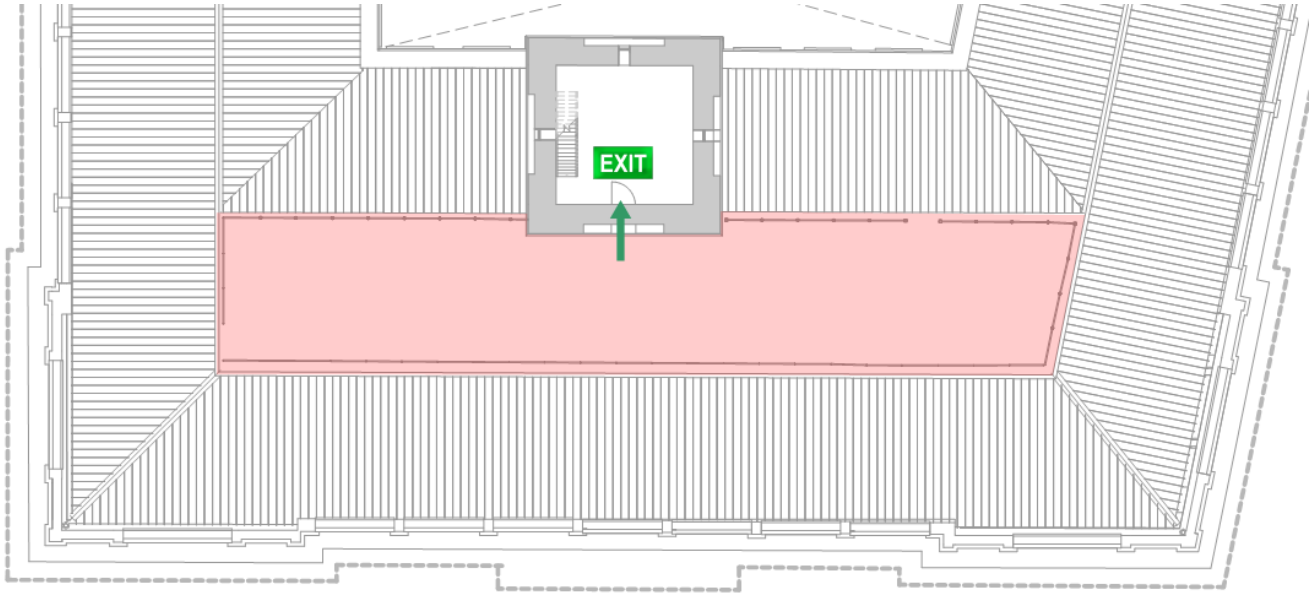


Figure 10 - Level 4 Roof Terrace.

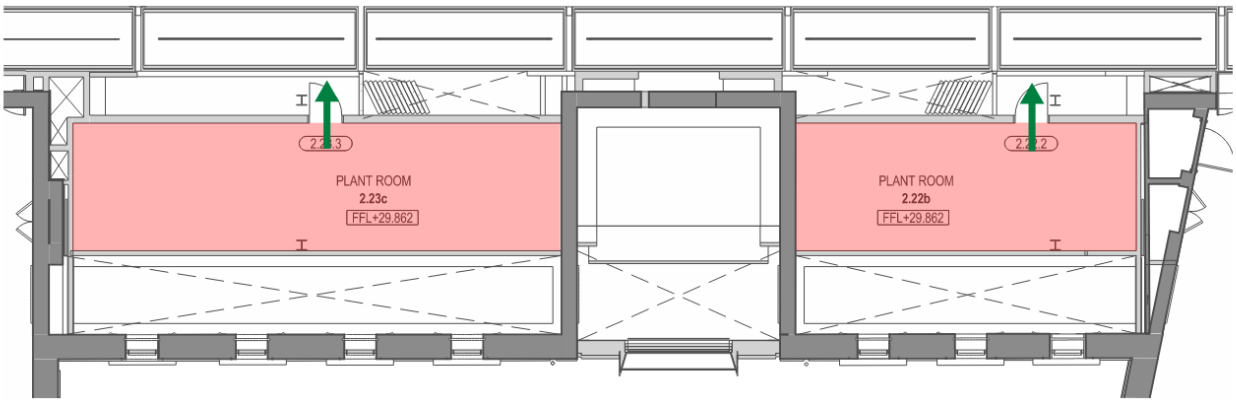


Figure 11 – Level 2 Mezzanine AHU room.

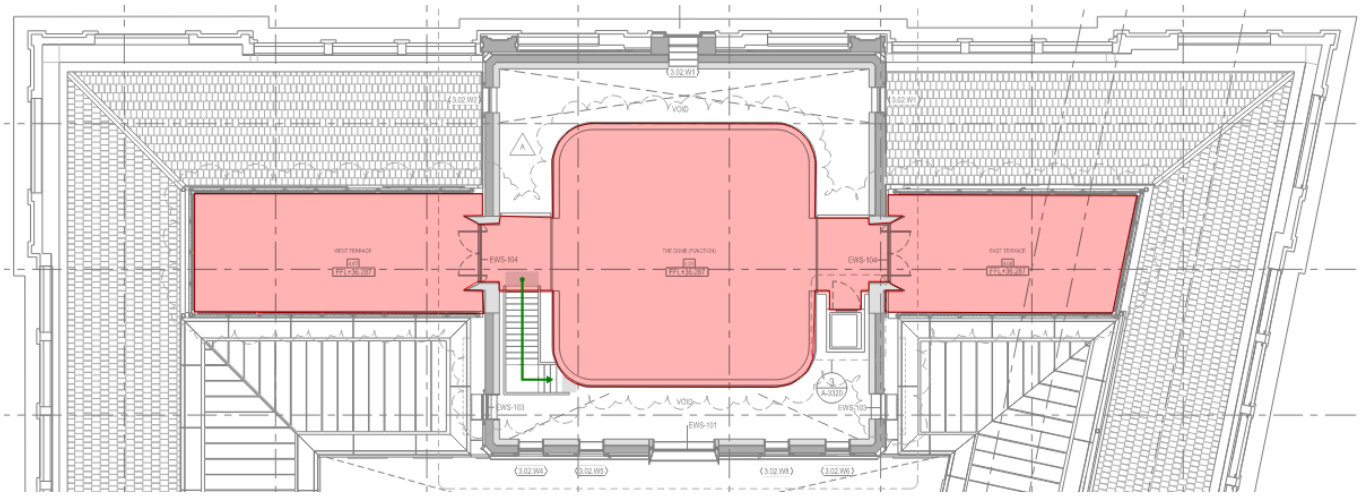


Figure 12 – Level 4 dome and terraces.

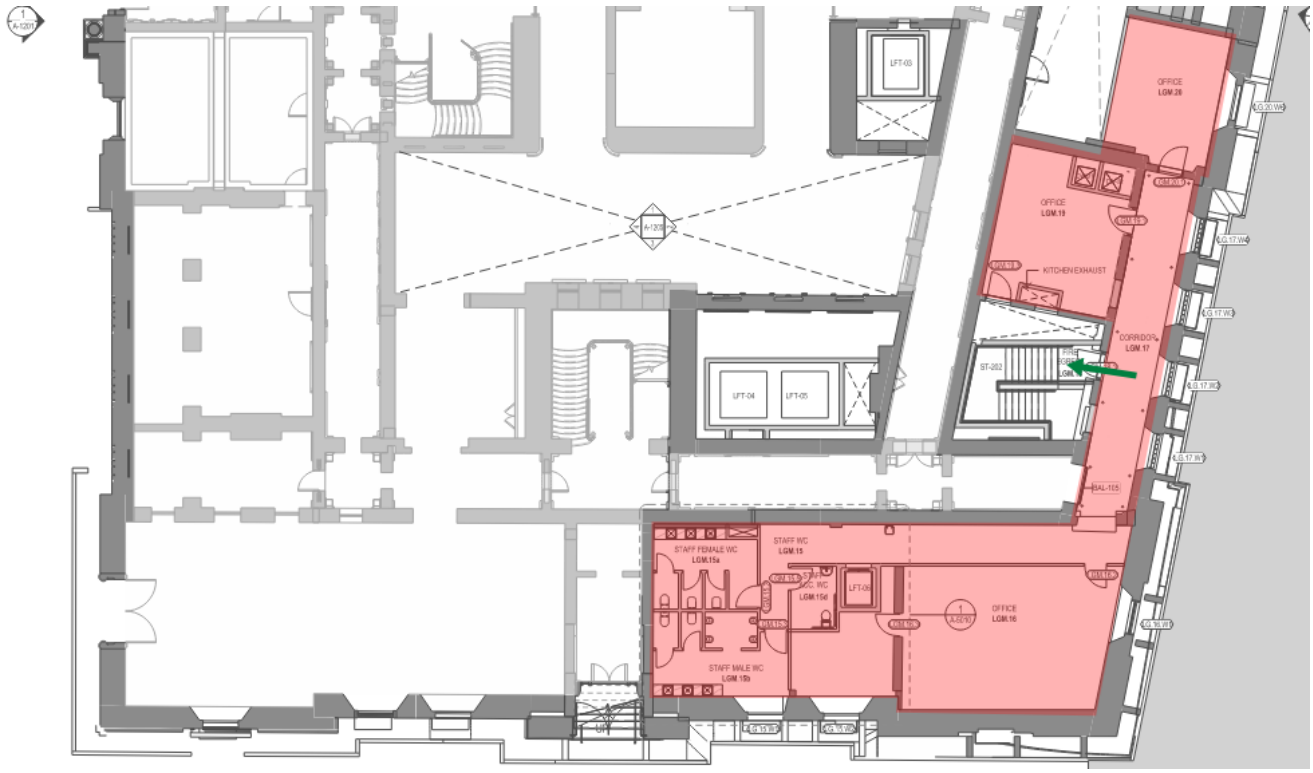


Figure 13 – Lower Ground Mezzanine.

Qualitative Assessment

A qualitative assessment will be performed to rationalise the provision of a single exit within the ~~Plant Room~~ roof space on Level 3 and the Roof Terrace. The assessment will consider the fire risk of the non-compliant area, the occupancy type and the egress provisions.

Performance requirement DP4 requires that exits are to be provided from a building to allow occupants to evacuate safely. Performance requirement EP2.2 states that in the event of a fire the conditions in any evacuation route must be maintained for the period of time occupants take to evacuate the part of the building.

Fire risk regarding compartment contents

The fire risk of the ~~Plant Room~~ roof space and Terrace is considered low. The contents of the ~~Plant Room~~ roof space include ~~boilers~~, air handling units, etc.

A credible risk is that the plant equipment (fans, boilers and air handling units) could catch on fire due to an electrical fault for example. Although, considering the equipment will mostly be constructed from metallic components, then it is reasonable to expect a fire not to sustain due to the lack of fuel loads.

The terrace is to be open to air and be largely free of combustible material. Due to the terrace being open to air, there is no risk that the occupant will be unable to locate the exit due to smoke.

Management in use requirements:

Both areas are not open to public. The ~~Plant Room~~ roof space and Terrace are strictly for maintenance staff and will only be occupied when work is required to be performed in the space.

It is proposed to implement the following management in use requirements;

- Any person who requires access to the ~~Southern~~ Level 3 ~~Plant Room~~ roof spaces or Roof Terraces must understand and adhere to the following requirements and be inducted by building management. The management in use requirements are to be recommunicated to employees on a yearly basis.
    - Any person/s that accesses the ~~Plant Room~~ roof space or Roof Terraces must be able bodied.
    - Any person that accesses the ~~Plant Room~~ roof space or Roof Terraces must be accompanied by a member of building management or security.
    - Each person is always required to be equipped with a radio and able to communicate with the other person via the radio.
    - The building management / security staff must monitor the space for any fire risk while the other occupants are working. In the event of a fire or emergency requiring evacuation, the occupant must inform the others that evacuation is required at which point all occupants are to immediately evacuate into the fire stair and discharge from the building.

Alarm:

In the event that a single detector is activated anywhere within the Lands Building, or a sprinkler head is activated, the Southern Level 3 ~~Plant Room~~ roof space alarm and Roof Terrace alarm is to trigger immediately.

FRNSW: Consideration should be given to the provision of visual alarm devices where the background environment noise may affect the fire alarm.

WGE: Noted.

Travel time and queuing:

As the ~~Plant Room~~ roof space and Roof Terraces will have very low populations, with the only occupants being able bodied security or maintenance staff, upon activation of the alarm or recognition of a fire, all occupants will be able to quickly begin evacuating to the fire stairs without the loss of time due to queuing or the onerous time restraints of possible disabled occupants.

This will allow occupants to evacuate during the fires infancy, without being exposed to potential fire risks of a larger fire.

Fire Scenarios:

Considering the above fire safety measures, possible fire scenarios dependent on occupant location are to be considered and it will be shown that the occupants within the ~~Plant Room~~ roof space and Roof Terrace are provided with a high degree of safety in the event of a fire.

1 In the event that all occupants are within the central southern end of the ~~Plant Room~~ roof space, all occupants are within close proximity to the exit and are considered to be safe due to the above-mentioned measures. If a fire is to initiate or spread within the central ~~Plant Room~~ roof space occupants will most likely visually detect the fire and smoke before the initiation of the alarm and evacuate into the stairs with no impact on occupant safety.

2 In the event that workers are required to occupy the eastern/western wings of the ~~Plant Room~~ roof space a member of building management or security will be accompanying them. They will remain in the central area of the ~~Plant Room~~ roof space with radio communication to the worker in the eastern/western wings of the ~~Plant Room~~ roof space. If a fire initiates within the area that the worker is occupying they will immediately recognise the fire in the early stages of development and evacuate. In the event that a fire initiates within the central area of the ~~Plant Room~~ roof space, the building management/security staff will visually recognise the fire upon initiation and alert the worker via the radio, who is to immediately evacuate. All occupants of the ~~Plant Room~~ roof space will enter the stair at which point they are able to travel down the stairs to discharge from the building. The visual recognition of fire initiation will occur before alarm and is therefore considered to be safer than a DtS design.

3 In the event that a fire initiates in any other area of the building, the alarm is to immediately activate in the ~~Plant Room~~ roof space, at which point all occupants are to evacuate from the ~~Plant Room~~ roof space and into the stair.

Level 4 Dome and Northern Roof Terraces:

The Level 4 dome and associated terraces are utilised in the building as part of the available function space. Egress from these areas requires occupants to travel to the central area and egress via the non-fire-isolated stairs into the level 3 dome area. From here occupants are provided with a point of choice from which they can travel to either the Western fire stair (Stair L-03) or Eastern fire stair (Stair L-04).

This area accommodates a maximum occupancy of 140 people, with the stairs from this area having an egress width complying with the BCA. As such there is expected to be minimal delay in occupants evacuating from these Level 4 areas.

FRNSW Comment: Although FRNSW acknowledge that the single exit will have DtS-compliant stair widths, has the assessment consider the provision of one exit (in lieu of two) and the impact this may have on queuing during occupant egress? This is to be addressed.

Stantec:

This will be further clarified in the FER. OSID detection is proposed within Level 3 and Level 4 that shall provide early detection within spaces that connects two storeys compared to traditional point type detectors.

Additional fire safety measures in locating portable fire extinguisher in close proximity to the single stair exit shall provide efficient means of early manual suppression of fires by trained staff members. The mezzanine space is not an enclosed space and is open to the main floor level below (Level 3) as such early cues (visual/olfactory) can be considered to occur where staff shall undertake appropriate emergency procedures to safely evacuate occupants on both Level 3 and Level 4 of the northern dome area.

FRNSW Comment: Noted, refer to the comment provided by FRNSW below.

Once within the level 3 dome occupants are provided with travel through a large open room to reach an exit. If there is a fire growing in this area the size of this space allows occupants to travel at a distance from the fire, avoiding its immediate effects. This provides occupants with a path of travel to an exit that is expected to be maintained as tenable for the initial period of a fire. Travel from the discharge of the stair is further rationalised in Issue Number 6 – Travel via fire-isolated exits.

To ensure occupants are provided with an early egress from these areas, upon activation of a single detector or a sprinkler head on Level 3 or 4, the Level 4 Northern Dome and Terraces are to have their alarm trigger immediately. This, combined with the reduced detector spacing throughout the building provides occupants with an alert to evacuate in the early stages of a fire, further decreasing their potential exposure to hazardous conditions.

FRNSW Comment: The assessment is to consider the provision of additional measures for initial attack on fire to allow the most disadvantaged occupant within the space to fight fire(s) that may block the single exit. Although it is acknowledged that occupants may be able to travel at a distance from the fire, it is to be outlined what measures are to be provided to allow for initial attack to be undertaken in the event that a fire is blocking the single exit.

Stantec: Refer to above response.

FRNSW Comment: FRNSW acknowledge the inclusion of additional fire safety measures to allow occupants to undertaken initial attack on a fire that may block the single exit. As noted by FRNSW within the V08 FEBQ document, the assessment within the FER is to clearly demonstrate that (although the single exit will have DtS-compliant stair widths) the provision of one exit (in lieu of two) will not adversely impact occupant egress provisions by way of excessive queuing times. This is to be addressed satisfactorily within the FER.

Lower Ground Mezzanine South

The Lower Ground Mezzanine South is an area that is restricted to building staff, containing only offices and staff bathrooms. The storey has approximately 240m^2 of floor area including the bathrooms. BCA Clause D1.13 gives a population of 10m^2 per person for office type areas. This gives an onerous population for the area of 24 people including all areas including the bathrooms and corridors as office type areas.

Staff on this storey are expected to be familiar with travel through the mezzanine floor due to the frequent usage as part of their work. Combining this with the low population occupants on this storey are expected to quickly travel to the exit from the storey. The stairs from this storey provided an egress width of 1m which the DtS provisions could expect to serve up to 100 people. As such travel into the single stair is considered to not be impeded, allowing for quick travel into the stairs with minimal, if any, queuing at the door to the stairs.

Once in the Mezzanine stairs occupants are protected from a fire on the floorplate by the fire rated boundary construction. From here the occupants can choose to exit on the Lower Ground floor and travel out of the building if they deem it safe to do so, or if the discharge of the stair is compromised, they can choose to travel further down the stairs and egress into the Education building via the link tunnel. This is further discussed in Performance Solution 6.

FRNSW Comment: Similar to the comment provided above, although it is acknowledged that the adequate exit width is provided for occupants, the assessment is to consider the provision of the proposed single exit which does not exhibit a level of redundancy in the event that a fire scenario is blocking this single exit. As such, the assessment is to consider the provision of additional measures for initial attack on fire to allow the most disadvantaged occupant within the space to fight fire(s) that may block the single exit. This is to be addressed.

Stantec:

Noted. Additional fire safety measures in locating portable fire extinguisher in close proximity to the single stair exit shall provide efficient means of early manual suppression of fires by trained staff members. The Lower Ground Mezzanine South is occupied by staff only. As such the space is more highly managed than if the single exit serves a public space.

FRNSW Comment: Noted.

In principle support is provided subject to the analysis in the FER demonstrating compliance with the Performance Requirements of the NCC.

Conclusion

The above assessment has clearly demonstrated that through management in use requirements and the provision of an alarm system, that occupants within the ~~Level 3 Plant Room and Roof Terrace~~ identified areas listed above are able to egress safely in the event of a fire. It is considered that the provision of a single exit to the above mentioned areas has been justified.

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 criteria will be met if it is shown that safe occupant evacuation is facilitated through the management requirements.

Fire scenarios and design fire parameters:

As stated above in the qualitative assessment

Describe how fire brigade intervention will be addressed or considered:

Fire brigade intervention is not considered to be impacted if the solution is shown to meet the performance requirements.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

NA

Provide details on proposed modelling/assessment tools:

NA

FRNSW Comment: In principle support is provided subject to the following:

- The analysis in the FER demonstrates compliance with the Performance Requirements of the NCC.
- Management in Use procedures be implemented to ensure that both the Plant Room and Roof Terrace region remain free of combustibles and stored goods.
- FRNSW recommend an Essential Fire Safety Measure be nominated to ensure that the use of the roof terrace as shown in Figure 6 above be restricted/limited to the current use for the life of the building. This measure/restriction should be listed in the Fire Safety Schedule.

WGE: Noted.

FRNSW Comment: Refer to the comments provided by FRNSW above in relation to the newly-introduced non-compliances.

Issue number: 5 **Title:** Increased Occupant Numbers on Level 2

Details of departures from DtS provisions:

To permit an increase in population in relation to exit width for the following areas:

- Level 2 – ~~614~~ ~~688~~ 739 occupants (3m in lieu of ~~7~~ 6.5m)

~~To permit horizontal exits to be more than half the exits provided. Certain horizontal exits do not provide a required exit in the next compartment.~~

~~To permit heritage double doors to not have the required 850mm door leaf~~.

Applicable DtS provisions:	D1.6, ~~D1.11~~, D3.2	Performance requirements:	DP4, EP2.2

List key fire safety measures:

- Proposed compartmentation plans have been attached as part of Appendix 1 – General Compartmentation and Egress Strategy.

Proposed alternative solution:

BCA Comparison

BCA Clause D1.6 states in a required exit or path of travel to an exit, if the storey accommodates more than 200 persons, the aggregate unobstructed width, except for doorways, must be not less than 2 m plus 500 mm for each 60 persons (or part) in excess of 200.

~~Clause D1.11 (c) states that horizontal exits must not comprise more than half of the required exits from any part of a storey divided by a fire wall.~~

According to the Guide to the BCA, the main intention of establishing a minimum dimension of exits and paths of travel to exits is to require exits and paths of travel to an exit to have dimensions to allow all occupants to evacuate safely within a reasonable time.

The following performance requirements have been selected for this alternative solution in accordance with BCA Clause A0.7:

DP4

Exits must be provided from a building to allow occupants to evacuate safely, with their number, location and dimensions being appropriate to -

a) the travel distance; and

b) the number, mobility and other characteristics of occupants; and

c) the function or use of the building; and

d) the height of the building; and

e) whether the exit is from above or below ground level.

EP2.2

(a) 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.

Qualitative Assessment (Exit Width)

The compartmentation strategy positions fire and smoke walls throughout the floor plate to facilitate horizontal evacuation. In the event of a fire, an occupant located at any position within the building is afforded with time to recognise the alarm and travel into an adjacent fire compartment, at which point they are in a place of relative safety. Once the occupant has entered the adjacent fire/smoke compartment they can proceed to egress from the building, removed from the effects of the fire.

This strategy is considered to mitigate the reduced exit width non-compliance and meet Performance Requirement DP4 through providing safe egress for occupants.

Quantitative Assessment (Exit Width)

The following assessment will show quantitatively that although the vertical exit width provided is less than the width prescribed by the BCA, a horizontal evacuation strategy has been adopted and provides a combined horizontal exit width much larger than what is prescribed by the BCA.

The fire isolated stairways ~~horizontal exits~~ and egress routes are located as shown in Figure 14 for Level 2. ~~A horizontal exit egress strategy is integral to the safe evacuation of occupants. The proposed development has provided walls with a 60 FRL to separate the zones, with smoke separation and FRL protection applied to windows between zones. In the event of a fire, occupants will evacuate from the zone of fire origin through a horizontal exit and into an area of relative safety that is separated from the immediate dangers of the fire. Once the occupants have horizontally evacuated they will then be able to egress to a road or open space via a tenable path~~.

The proposed strategy is not to provide a DtS horizontal exit strategy, but to incorporate additional smoke and fire rated construction across the floorplate to create temporary areas of relative safety that act to prevent occupants from being exposed to the effects of a fire. The construction is not required for the purposes of allowing extended travel distances, or with the intention of staging the evacuation by prioritising certain compartments as is the case in aged care or healthcare buildings. These scenarios require a higher degree of protection as the evacuation of these building is much slower than a normal building with staff being required to move multiple occupants over several trips, requiring occupants to be staged in the adjacent compartments for extended periods of time.

An evacuation assessment will be performed to ensure that occupants are afforded with a high degree of safety while evacuating in the event of a fire. The requirement to address the exit width in relation to the proposed population on each floor will be carried out through a comparison to a DtS compliant exit width design. It will be shown in the assessment that through the implementation of a horizontal exit strategy, the horizontal exit width is to be equivalent if not larger than a DtS compliant design vertical exit width.

The egress strategy, shown in Appendix 1 – General Compartmentation and Egress Strategy, compartments each level into multiple zones. If a fire initiates within the building, occupants are to egress into adjacent zones past the smoke and fire separation. The alarm system and emergency exit lighting strategy will assist to co-ordinate the safe and timely evacuation of occupants away from the fire affected area.

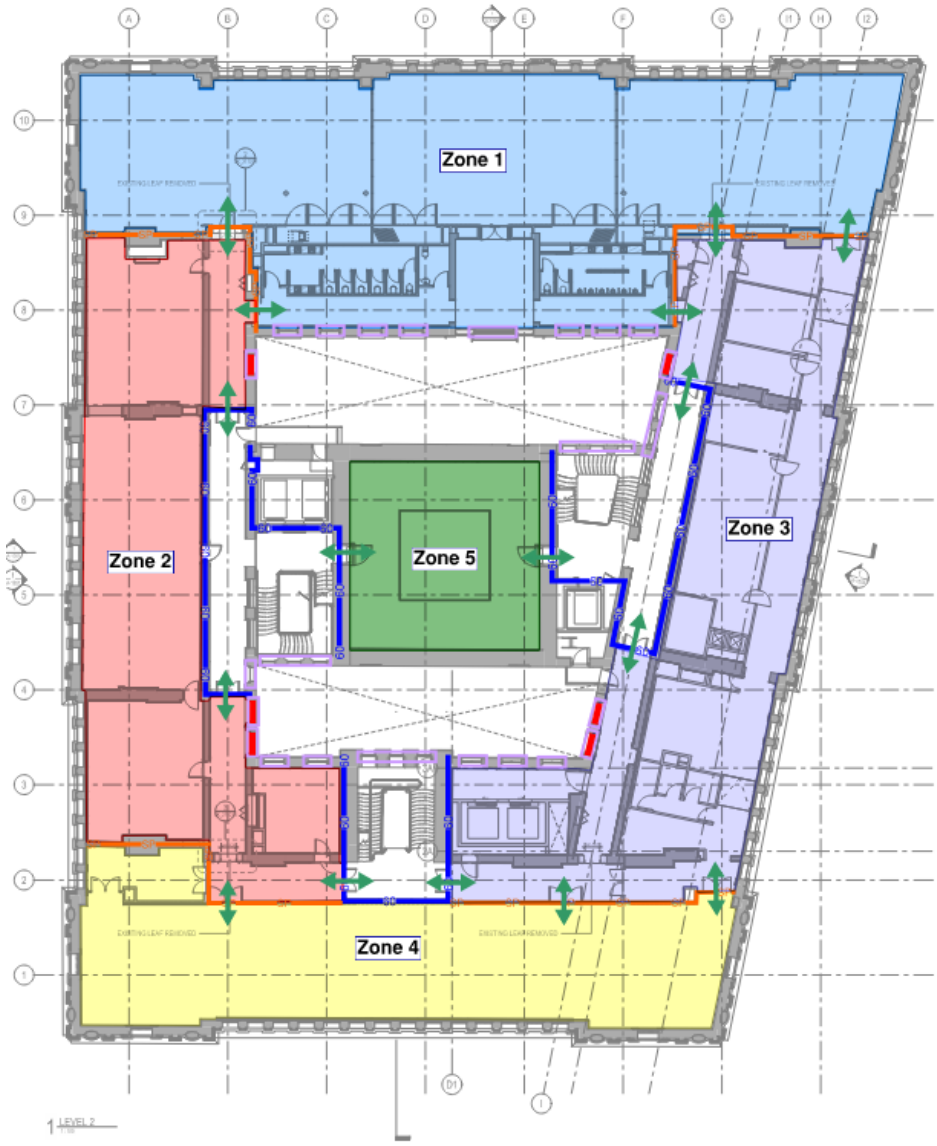


Figure 14 - Level 2 Egress Strategy

A DtS design would rely on the timely evacuation of occupants into a fire stair, at which point they will travel down/up the stairs to discharge from building. The proposed design provides an intelligent staged design that requires the occupants to travel into the adjacent zones, where they are then afforded enough time to enter a horizontal compartment or the stairs and subsequently discharge from the building.

FRNSW Comment: FRNSW notes that various contradictory arguments have been made as part of the performance solution. For one, several paragraphs above infers that a “horizontal exit strategy” is to be implemented, whereas an alternative paragraph outlies that “the proposed strategy is not to provide a DtS horizontal exit strategy.” Additionally, the paragraph above indicates that an “intelligent staged design” is to be implemented as part of the design, however the paragraph on page 40 of this FEBQ (in ref text) outlines that there is no “intention of staging the evacuation by prioritising certain compartments as is the case in aged care or healthcare buildings.” Please clarify.

Stantec:

Clarification in V07 was provided to clearly define the horizontal egress strategy between compartments on Level 2 is not a BCA DtS horizontal exit strategy (i.e. not complying with Clause D1.11 of the BCA). A horizontal exit in the BCA is defined as ‘a required doorway between 2 parts of a building separated from each other by a fire wall’. The proposed fire safety strategy does not proposed any fire compartments on Level 2 other than the fire-isolated stairs. Each zone is smoke separated as a minimum. The proposed strategy has not differed from previous FEBQ submission. The relevant changes in V07 provides further clarity on the definition of horizontal exit as requested by the Certifier and further updates to the proposed occupant numbers and available egress widths between each zone.

Our comment relating to no intention of staging the evacuation by prioritising certain compartments as is the case in aged care or healthcare buildings is to demonstrate the occupant profile in our subject building differs to other buildings where horizontal evacuation is used. Our subject building is not as heavily reliant on staff to ensure the safe evacuation of occupants. In hospital building, bed evacuation by staff may occur where the evacuation process requires staff to evacuate and retreat back into affected compartment to evacuate all patients in the affected compartment. For our subject building the horizontal evacuation is a more streamlined process where staff in Level 2 communicate to occupants of the safest egress path to a place of safety i.e. non-affected smoke compartment or adjoining fire-isolated stairs. It is considered in these scenarios where occupants require assistance would be conducted by family members or friends.

FRNSW Comment: Noted, refer to the comment(s) provided by FRNSW below.

The Below table compares the BCA required exit width against the proposed design for each compartment/zone to ensure that the proposed design facilitates evacuation of occupants. The preliminary analysis has been carried out for Level 2, which is considered a high population level largely designated as a function space. These principals will be applied to all non-compliant levels in the FER.

Populations used below have been obtained through the preliminary population estimates provided by the Architects (Hassell). BCA exit width requirements have been obtained from the BCA report.

Table 3 - Zone Exit Width

Level	Zone	Populations as per current design	Proposed ~~horizontal exit width~~ aggregate egress width between zones (m)	BCA Required width ~~per~~ zone (m)
2	1	~~~350~~ 368	~~9.5~~ 5.6	~~NA~~ 3.5
	2	~~~160~~ 171	~~14~~ 3.85 (7.75 including stair doors)	~~NA~~ 1.75
	3	~~~23~~ 27	~~13.8~~ 5.7 (8.6 including stair doors)	~~NA~~ 1.0
	4	~~~120~~ 138	~~11.5~~ ~~8.3~~ 5.85	~~NA~~ 1.5
	5	~35	1.8	~~NA~~ 1.0
	TOTAL	~~614~~ ~~688~~ 739	NA	~~6~~ 6.5 (3 m provided)

Note: the increase in occupant numbers per zone is the inclusion of staff numbers. Worst case scenario these are the maximum numbers per zone with staff. However staff may be in different zones during normal events.

The measurements are shown in the figure below.

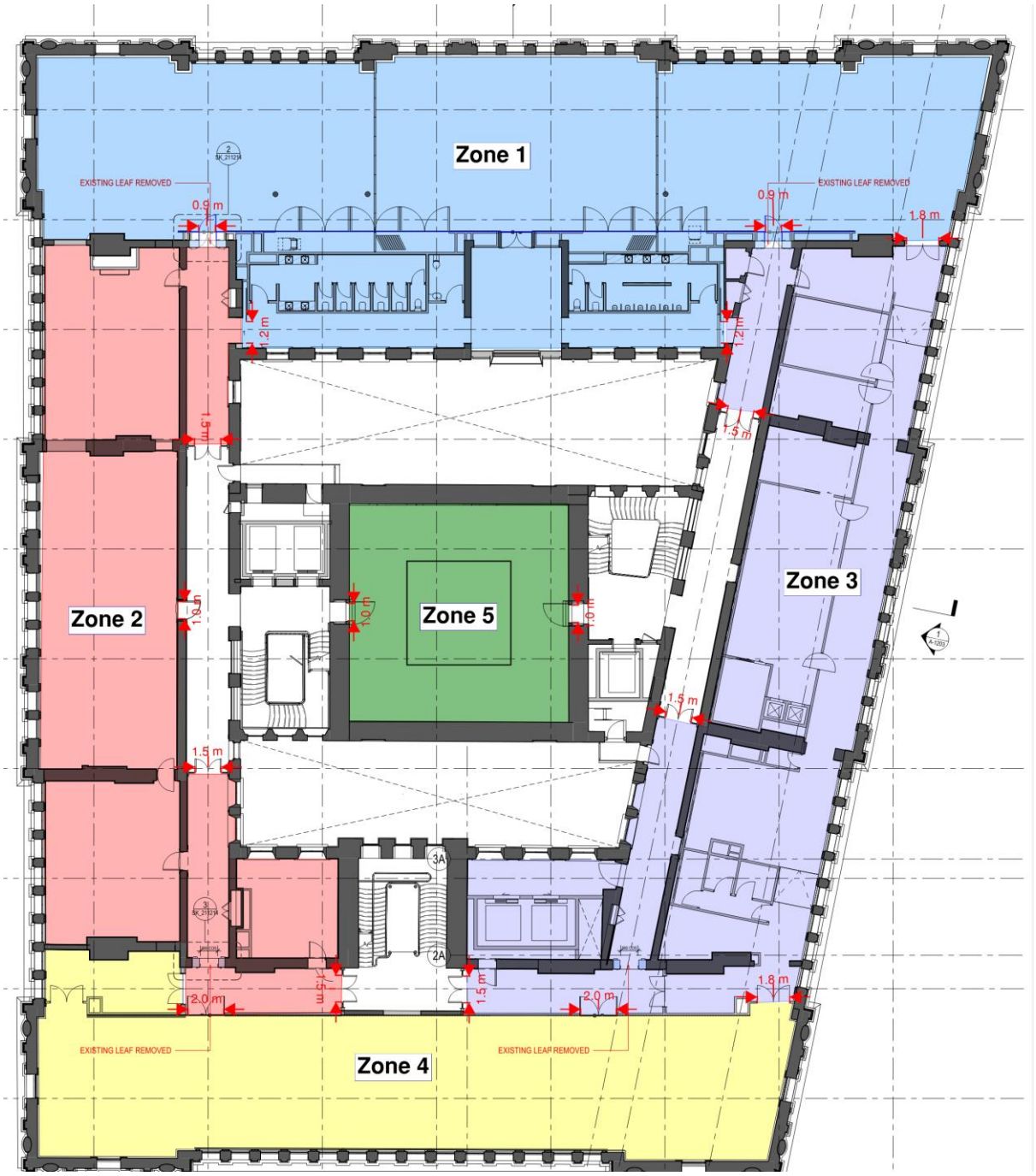


Figure 15 - Horizontal Exit Widths

Table 3 demonstrates that through the provision of fire and smoke compartmentation, the horizontal exit width provided to occupants is greater from each zone than the required exit width for the entire floor, except for the strongroom with 1.8m, which is considered sufficient for 35 occupants.

This argument will be extrapolated for each floor in the FER.

~~Horizontal Exits (D1.11)~~

~~It is required to address the non-compliance with D1.11, as more than half the exits provided from Upper Ground to Level 4 are horizontal exits. Further, certain horizontal exits do not pass directly into a compartment provided with a vertical exit.~~

~~The Guide to the BCA discusses the use of horizontal exits between fire compartments and notes that they are a viable design option in large fire compartments where they could be of used to overcome problems associated with excessive travel distances, or where people could have difficulty in evacuating owing to a physical handicap. As soon as occupants pass through the doorway into the adjacent fire compartment, they could be considered to have entered a 'place of safety'.~~

~~BCA Clause D1.11 states that no more than 50% of the required exits from any part of a storey divided by a fire wall can be horizontal exits. The intent of this clause to ensure that no more than 50% of the exits pass into a single adjacent fire compartment to avoid the possibility that fire could block the only egress route available. The use of horizontal exits as an evacuation strategy is only relevant when the second fire compartment is used as a place of relative safety – such as in a hospital or aged care facility where you may have a progressive horizontal evacuation strategy, or perhaps where justifying other deviations from the DtS Provisions such as extended travel distances. In those scenarios' occupants rely on the neighbouring compartment being safe and clear from smoke. This design mitigates the risk of occupants having to travel into a smoke logged compartments by providing continuous travel around the building in lieu of a single direction of travel through only one provided horizontal exit. In the event that an adjacent compartment is smoke logged occupants cant travel through other horizontal exits into a tenable fire compartment. Further, occupants who are within a fire compartment will not be required to travel through more than two horizontal compartments to reach a place of relative safety.~~

~~The ability for continuous travel around the building through horizontal exits mitigates the need for occupants to travel through many horizontal exits to reach a vertical exit and mitigates the risk of needing to travel through a fire effected compartment due to a horizontal exit.~~

~~Further, the intent of the fire compartmentation in this instance is to limit the extent of fire and smoke by providing passive fire protection to contain a potential fire to the room of origin in combination with providing active fire suppression throughout the facility.~~

~~The egress provisions are therefore considered to be acceptable.~~

Conclusion

It has been shown in the above assessment that the horizontal exit width provides occupants with a higher degree of safety than a DtS design, allowing occupants to evacuate from a zone of fire origin and enter a place of relative safety from which a safe evacuation can be made from. A more detailed assessment is to be performed within the FER.

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 occupant population and aggregate egress widths are considered reasonable if it can be demonstrated that occupants are afforded with at least an equivalent degree of safety in comparison with a DtS design.

Fire scenarios and design fire parameters:

NA

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 proposed design meets the acceptance criteria.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

NA

Provide details on proposed modelling/assessment tools:

NA

FRNSW Comments are as follow:

- It is recommended that it be shown that the reduced egress width is able to sufficiently provide safe egress to occupants without causing a blockage/bottleneck that may impede safe occupant egress, given the high occupant density.

WGE: Noted. Will be addressed through evacuation modelling in the FER.

FRNSW Comment: Noted, the facilitation of safe occupant egress is to be clearly outlined and demonstrated within the FER, especially given the increased population (688 in lieu of previously outlined 614) as well as the reduced egress width to 8.3m in lieu of 11.5m.

- It is assumed that Clause D1.13 has been utilised in determining the occupant density within the space, however if populations for the building are not based on Table D1.13 of the NCC, and these populations are used to justify a Performance Solution, then FRNSW recommends that the FER demonstrates how these population numbers will be maintained for the life of the building.

WGE: Finalised populations and non-compliant floors will be addressed in the FER. Where reduced populations are required, they will be included in management in use requirements, maintained by building management and communicated to relevant staff.

FRNSW Comment: Noted.

FRNSW Comment: In principle support is provided subject to the following:

- All analysis inputs and assumptions being detailed in the FER and agreed upon by all relevant stakeholders, and the analysis demonstrating compliance with the Performance Requirements of the NCC.
- The comments provided by FRNSW being addressed satisfactorily.

FRNSW Comments are as follows:

- Although FRNSW acknowledge the proposed compartmentation strategy for the development, additional clarity is required in relation to the proposed quantitative assessment methodology. As noted in Table 3, the assessment is to analyse the exit width available from each “zone” to demonstrate that occupants will provided with safe egress provisions. However, based on the non-compliance presented (i.e. – aggregate egress width), there is still a shortfall at the actual exits from each level. As such, how has the assessment considered the possibility of queueing at the exits from each level. Although it may be shown that occupants are able to evacuate from the respective zone they are located in, will there not be a bottleneck at the actual exit(s) based on the occupant loading? This is to be addressed.
- In conjunction with the possibility of queuing at the exits, where queueing is shown to occur, will occupant be provided with a “safe haven” such that they may que in a safe and effective manner, shielding from the impact of fire and/or smoke? FRNSW note that Figure 13 outlines fire separation at the stairs to Level 2, however the adequacy of this space has not been detailed. This is to be addressed.

Stantec:

A comparative quantitative assessment will be undertaken. As shown in Table 3, are the calculated required egress widths for the respective number of occupants in each zone on Level 2. This calculated aggregate egress width is compared to the available horizontal egress widths between each zone to demonstrate satisfactory width is available with a safety factor of at least 1.6. The horizontal egress widths discount the egress widths available to the three fire-isolated stairs.

In any fire scenario of each zone, at least two fire-isolated stairs are available (when assuming the most direct accessible fire stair is obstructed). Occupants will be travelling through multiple places of safety where smoke is separated from the fire origin. As such queuing to the two fire-isolated stairs can be considered to have minimal impact on occupant life safety when reaching the fire-isolated stairs. The zone with the highest occupant numbers (Zone 1) will have three fire-isolated stairs available for egress.

FRNSW Comment: FRNSW acknowledge the information and assessment method to be utilised as part of the performance solution. Based on the proposed quantitative assessment to be carried out, FRNSW reiterates the comments previously provided within the V08 FEBQ document where it is expected that the assessment considers the possibility of queuing at the exits given that there still remains shortfalls in the egress widths at the exits. As such, it is to be quantitatively demonstrated (for a worst-case credible fire scenario) that occupant queuing will not adversely impact on the ability for occupants to safely egress from each non-compliant level(s) given the expected number of occupants on each respective level of the development. This is to be addressed and considered in order to satisfactorily demonstrate that an equivalent or better-level of safety will be provided in comparison to a DtS-compliant design.

Issue number: 6 **Title:** Travel via fire-isolated exits

Details of departures from DtS provisions:

The following non-compliances are to be addressed;

Basement Stair:

- Stair 1 connects to the basement below and is not separated by Specification C2.5 rated construction.

Stair L.02:

- Unprotected windows located in external walls of the stairs are exposed to and within 6m of the building the stair is serving.
- ~~Lift L.01 is proposed to be in the same shaft as the stair.~~
- More than 2 doors open directly into the stair.
- Doors open directly to the stair in lieu of from a public corridor, lobby or the like.
  - Lower Ground First Aid Room
  - Level 1 Library
  - ~~Level 2 Function area~~
  - Level 3 roof plant spaces

Stair L.03:

- Stair discharges internally in lieu of direct to the outside.
- Door discharging from the stair into the corridor on Lower Ground swings against direction of egress.
- Windows are in the constructions separating the stairs from the remainder of the building.
- Unprotected windows are in the external wall of the stairs and are exposed to and within 6m of the building the stair is serving.
- Lift LFT-01 and LFT-02 ~~L.02 and L.03~~ are proposed to open directly into the fire stair.
- Doors open directly to the stair in lieu of from a public corridor, lobby or the like.
  - Lower Ground F&B retail
  - Ground Lounge and Strong Room
  - Level 1 Suite and Strong Room
  - Level 2 Function Room and Strong Room
  - Level 3 ~~Atelier Lounge~~ Tempietto West

Stair L.04:

- Stair discharges internally in lieu of direct to the outside.
- Door discharging from the stair into the corridor on Ground swings against direction of egress.
- No Separating construction is proposed between rising and descending flights of stairs.
- Windows are in the construction separating the stairs from the remainder of the building.
- Unprotected windows are in the external wall of the stairs and are exposed to and within 6m of the building the stair is serving.
- Lift ~~L.04~~ LFT-03 is proposed to open directly into the fire stair.
- Doors open directly to the stair in lieu of from a public corridor, lobby or the like.
  - Level 1 Suite and Strong Room
  - Level 2 ~~Kitchen and~~ Strong Room
  - Level 3 ~~Atelier Pantry~~ Tempietto East

Applicable DtS provisions:	Spec C2.5, C3.8, D1.7, D2.4, D2.11	Performance requirements:	CP2, CP6, CP8, DP4, DP5, EP2.2

List key fire safety measures:

- Automatic sprinkler protection is proposed to be installed throughout the building in accordance with BCA Clause E1.5 and AS2118.1-2017.
- Signage is to be provided at the floor landing on Upper Ground of stairs L.02 and L.03, with the text “EXIT BUILDING ON THIS LEVEL”. The signage is to be at a height of 1.75 – 2 m FFL, with the wording not less than 50 mm high on a colour contrasting background.
- The discharge passageways of all fire stairs from the building are to be classified as a sterile area with all combustible materials limited and the temporary/permanent storage of combustible material prohibited. All relevant employees are required to be informed of the requirements and regular inspection by building

management is to ensure these requirements are adhered to. This requirement is to be listed in the fire safety schedule.

- Automatically Opening Vents (AOVs) are proposed to be installed throughout the development as shown on the markups in Appendix 1 – General Compartmentation and Egress Strategy. AOVs are to open upon activation of the smoke detection/sprinkler system within their smoke zone. Further detail is to be provided within the FER.

Proposed alternative solution:

BCA Comparison

The below table summarises the relevant BCA Clauses in relation to the performance solution.

Table 4 - BCA Clause Summary

BCA Clause	
C3.8	Doorways that open to fire-isolated stairways, fire-isolated passageways or fire-isolated ramps, and are not doorways opening to a road or open space, must be protected by -/60/30 fire doors that are self-closing, or automatic closing.
D1.7	(a) A doorway from a room must not open directly into a stairway, passageway or ramp that is required to be fire isolated unless it is from a public corridor, SOU or an airlock. (b) Each fire-isolated stairway must provide independent egress from each storey served and discharge directly, or by way of its own fire-isolated passageway, to a road or open space or to a point in a storey within the building that is used only for pedestrian traffic and is open for at least 2/3 of its perimeter. Unimpeded travel, not further than 20m, is to be available to a road or open space. (d) If more than 2 access doorways, not from a sanitary compartment or the like, open to a required fire-isolated exit in the same storey a smoke lobby in accordance with D2.6 must be provided.
D2.4	If a stairway serving as an exit is required to be fire-isolated there must be no direct connection between a flight rising from a storey below and a flight descending from a storey above the level of egress.
D2.11	The enclosing construction of a fire-isolated passageway must have an FRL when tested for a fire outside the passageway in another part of the building of; (i) If the passageway discharges from a fire-isolated stairway or ramp – not less than that required for the stairway or ramp shaft; or (ii) In any other case – not less than 60/60/60.

The below table summarises the relevant BCA Performance Requirements in relation to the performance solution.

Table 5 - Performance Requirement Summary

BCA Clause	
CP2	A building must have elements which will, to the degree necessary, avoid the spread of fire.
CP6	A building must have elements which will, to the degree necessary, avoid the spread of fire from service equipment.
CP8	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 in relation to openings, construction joinings and penetrations for building services.
DP4	Exits must be provided from a building to allow occupants to evacuate safely.
DP5	To protect evacuating occupants from a fire in the building, exits must be fire-isolated to the degree necessary.
EP2.2	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.

Assessment

Basement Stair

BCA Clause D2.4 requires that if a stairway serving as an exit is required to be fire isolated there must be no direct connection between rising and descending flights of stairs. Further, 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 C2.5.

The intent of Clause D2.4 is to prevent occupants in the stair to travel pass the floor of discharge.

Stair 1 connects the Lower Ground Mezzanine to the basement below and is not separated by Specification C2.5 rated construction. The DtS required smoke separation intends to prevent the travel of occupants past the floor of egress and the spread of smoke between levels.

The Basement stair serves back of house areas only utilised by staff. Any occupant who uses the stairs will be highly familiar with the layout of the building and the function of the stair. Occupants will generally be with other staff that will also be familiar with the levels the stair serves. Therefore, it can be assumed that any occupant using those stairs in the event of a fire will not incidentally pass the level of discharge.

Further the stair connects only 3 levels. When considering smoke spread through the stair, the connection of 3 levels is considered facilitate smoke spread between levels and in the stair less than a DtS design which connects more than 3 levels.

Finally, the Basement stair provides the option to egress from Lower Ground Level or from Basement Level into the Education Building. If occupants do pass Lower Ground level while egressing, they have the option to continue through to the Basement level and travel through the tunnel that is connected to the Education building.

FRNSW Comment: Regarding the Basement stair mentioned above, in principle support is provided subject to the analysis in the FER demonstrating compliance with the Performance Requirements of the NCC.

WGE: Noted.

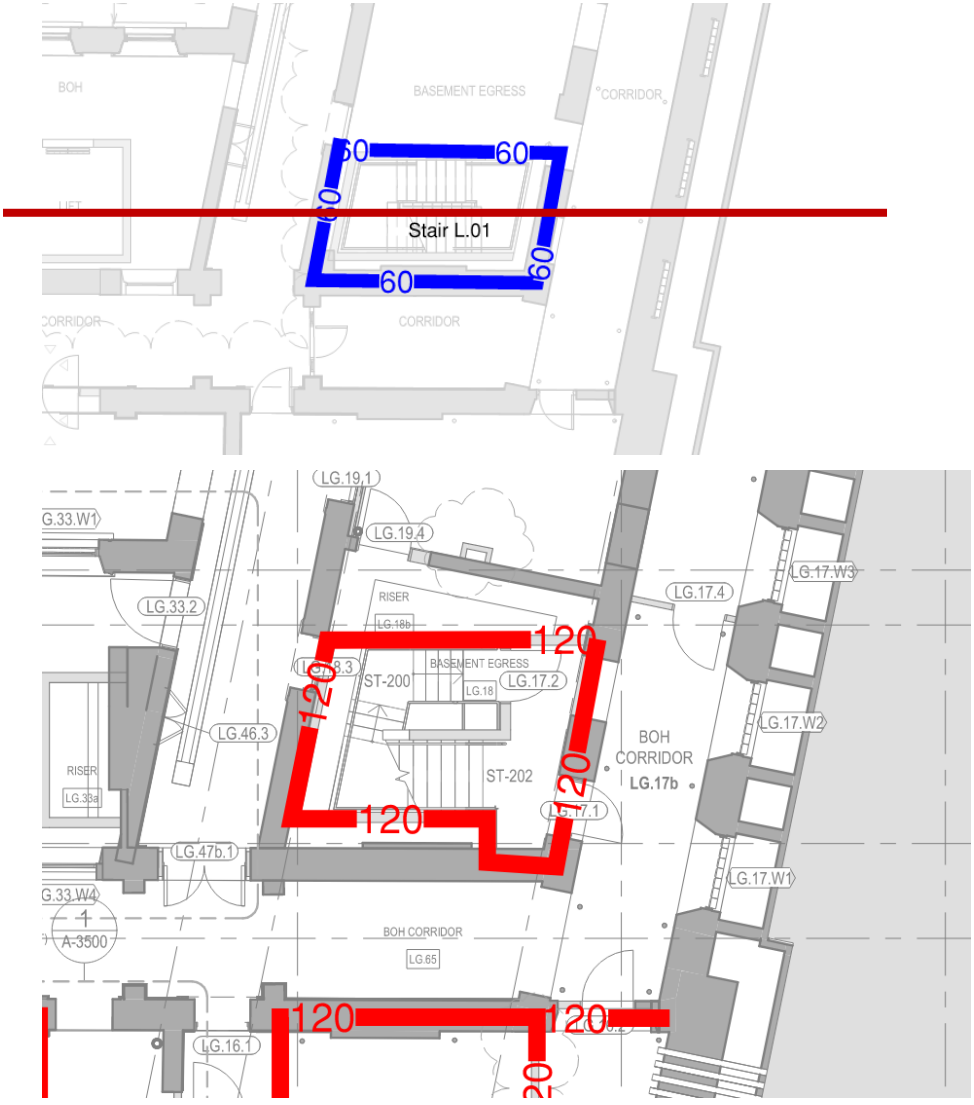


Figure 16 - Basement Stair (Stair ~~L.01~~ ST-202)

External Unprotected Windows in Stairs

Fire stairs L.02, L.03 and L.04 all include windows within the external wall and are exposed to and within 6m of the building the stair is serving. The fire risk associated with this DtS departure is the inhibition of occupant egress through the fire stair due to a fire on the Lower Ground Courtyard and from the hallways into the fire isolated stair through the external windows. Radiant heat incident on occupants could prevent safe occupant egress if the magnitude is high enough. The below figures show the possible fire scenarios that would lead to radiant heat transmission through the openings in the external unprotected windows in the fire stairs for Stair L.02, L.03 and L.04.

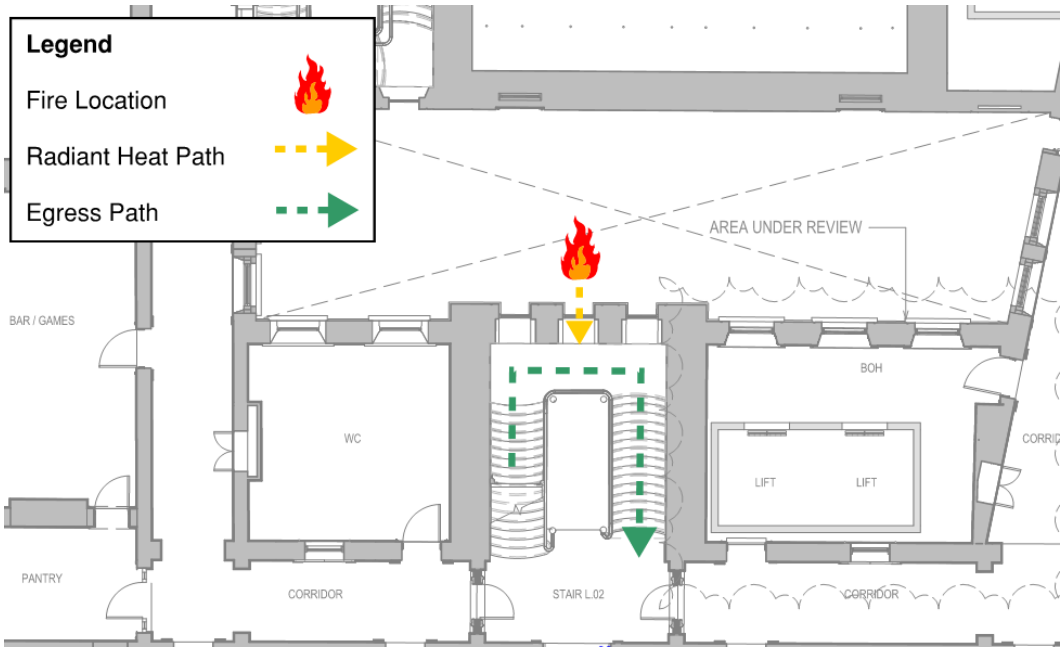


Figure 17 - UG Stair L.02

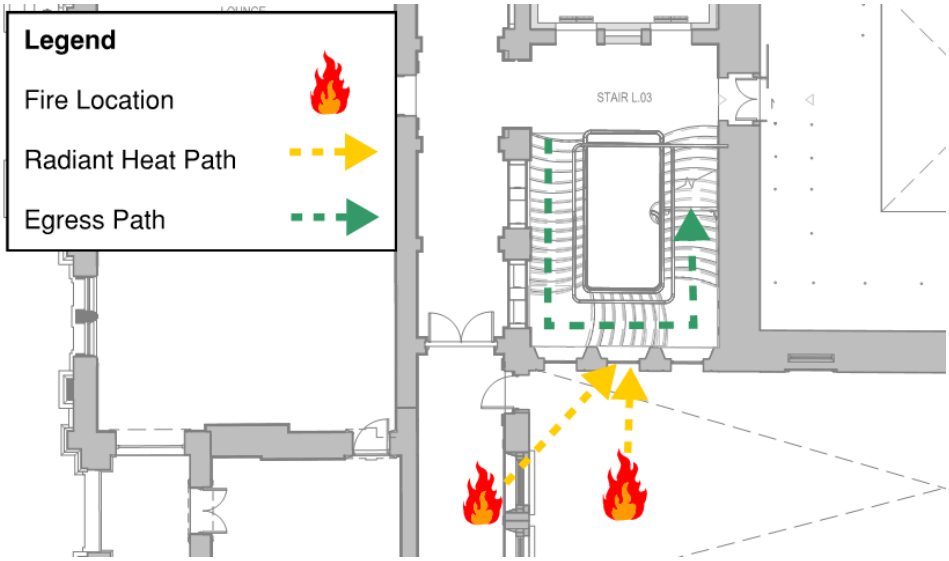


Figure 18 - UG Stair L.03

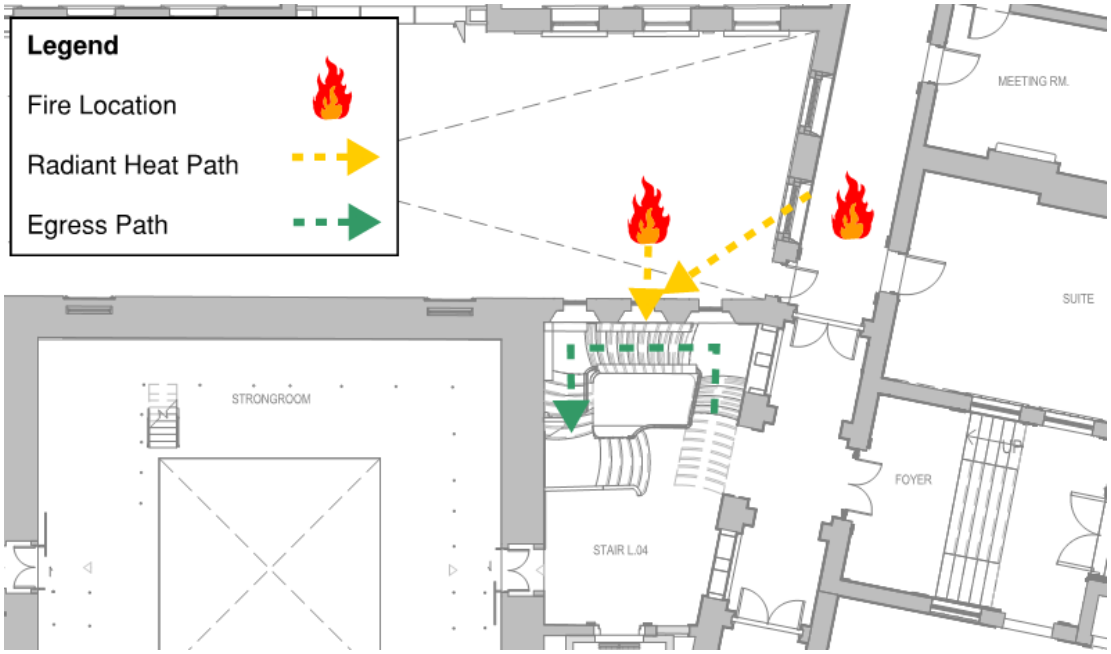


Figure 19 - UG Stair L.04

The worst-case scenario is considered to be a furniture fire located within the LG courtyard. This is due to the higher fuel load, close proximity and the direct angle between the stairs and the courtyard, which allows a higher transmission of radiant heat to be incident on egressing occupants.

A quantitative assessment is to be performed using radiant heat calculations and/or the FDS modelling software Pyrosim.

The radiant heat exposed to an occupant will be calculated and compared to the passing time to determine whether or not the occupant will feel the onset of pain. All calculations are to be based on the following inputs:

- 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;
- Occupants will egress at a speed of ~~1~~ 0.8 m/s (SFPE Handbook);

FRNSW: Consideration should be given to persons with impaired mobility who are likely to have a walking speed of less than 1 m/s.

WGE: Research by Proulx indicates a travel speed of 0.8m/s is appropriate for people with mobility issues. A travel speed of 0.8m/s will be considered in calculations.

FRNSW Comment: Noted, a travel speed of 0.8m/s is to be utilised in the abovementioned analysis.

Occupants can withstand heat fluxes below 2.5 kW/m^2 for relatively long periods of time (> 5 mins as per SFPE Handbook) as shown below. Above 2.5 kW/m^2, the time reduces rapidly but can still be tolerated.

Table 2-6.19 ***Limiting Conditions for Tenability Caused by Heat[106]***

Mode of Heat Transfer	Intensity	Tolerance Time
Radiation	<2.5 kW·m^{-2}	>5 min
	2.5 kW·m^{-2}	30 s
	10 kW·m^{-2}	4 s
Convection	<60°C 100% saturated	>30 min
	100°C <10% H_2O[a]	12 min
	120°C <10% H_2O	7 min
	140°C <10% H_2O	4 min
	160°C <10% H_2O	2 min
	180°C <10% H_2O	1 min

[a]v/v

Figure 20 - Conditions for tenability

The tolerance time t will be calculated for each scenario based on the following equations (SFPE Handbook) using the radiant heat flux determined q:

$$t_{Irad} = \frac{133}{q^{1.33}}$$

Dependent on the outcome of the analysis, appropriate fire safety measures will be incorporated into the design to ensure that occupants are afforded the ability to evacuate from the building safely. Design requirements to ensure occupant safety will be listed in the FER.

The below table details the input parameters to be used in the calculations and/or CFD modelling.

Heat Release Rate[1]	Growth Rate[2]	Heat Release Rate per Unit Area
5MW	0.0469 t^2	1000kW/m^2

References:

1. SFPE Handbook of Fire Protection Engineering 3rd Edition Figure 2-2.3 shows a maximum heat release rate of 3MW for a burning foam sofa. This furniture fire is considered to contain a higher fuel load in comparison to furniture within the LG marketplace. Further, this HRR will be used for the entire duration of the sample time after fire growth.
2. Fast t^2 fire growth – This is considered conservative as – Table 9.2 of the CIBSE guide E states fast growth rate for a shop and medium-fast for assembly hall seating, which are the most accurate scenarios mentioned.
3. Based on 5m^2 fire area.

FRNSW Comment: Regarding the external unprotected windows mentioned above, in principle support is provided subject to all analysis inputs and assumptions being detailed in the FER and agreed upon by all relevant stakeholders, and the analysis demonstrating compliance with the Performance Requirements of the NCC.

It should be noted that if the performance solution above does not satisfy the relevant Performance Requirements upon completing the quantitative analysis, the fire safety measures are to be reviewed by FRNSW and feedback is to be provided.

WGE: Noted.

Internal Unprotected Windows in Stairs

Figure 21 shows the locations of unprotected internal openings(windows) within the heritage stairs. The fire risk associated with the unprotected openings is a fire occurring outside the stairs and leading to the spread of fire within the stairs and preventing the safe egress of occupants down the stairs. The openings consist of heritage glass within heritage windows.

The fire stair is to be bounded by an FRL of 60 in all areas which extends into the corridor with all three doors leading into the corridor proposed to be fire doors. As the windows are within the fire rated bounding construction they are not considered to impact the fire isolation of the stairway. A fire is prevented from spreading to the corridor by the bounding FRL and therefore the unprotected openings do not pose a risk of allowing fire to spread into the fire isolated stair or impact the safety of occupants passing the opening.

FRNSW Comment: It is to be outlined what measures will be implemented to ensure that the fire rater doors leading into the fire stair regions will be kept in a closed position, without the risk of the door remaining ajar or held open. This will ensure that fire/smoke spread into the region bounded by an FRL of 60 is further minimised.

WGE: Fire doors are fitted with hold open devices that will close the fire and smoke doors upon detection of a fire.

FRNSW Comment: Noted, this is to be clearly outlined within the FER.

FRNSW Comment: Regarding the internal unprotected windows in the stairs, in principle support is provided subject to the following:

- The analysis in the FER demonstrating compliance with the Performance Requirements of the NCC.
- Management In Use procedures be implemented to ensure that the regions on either side of the unprotected openings (including within the fire stair and in the adjoining strongroom) remain free of combustibles and stored goods. This is to be listed as an Essential Fire Safety Measure, to be included on the Fire Safety Schedule.

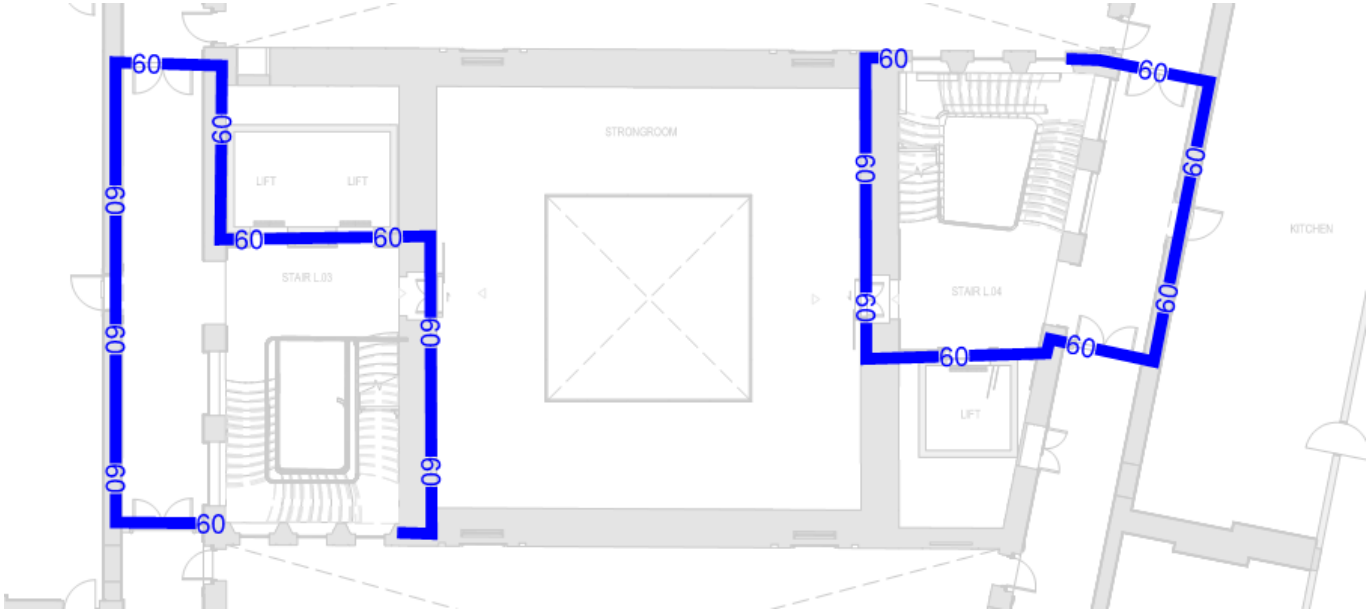


Figure 21 - Stair L.03 and L.04 (LG – Level 2)

Lift Doors in Stairs

Lift doors are to open directly into stairs L.03 and L.04, which is considered as departure from Clause C3.8. The lift doors are to have an FRL of -/60/-. The risk associated with lift doors in the stairs is that the FRL of the lift door does not meet the required insulation rating of -/60/30. In the event of a fire within the lift shaft or fire from the floor below breaking into the shaft, convective heat from the smoke could be conducted through the lift door and radiated on the side exposed to the stair. This presents the risk of impeding occupant evacuation and causing the unpiloted ignition of combustible material within the stair.

FRNSW Comment: It is assumed that the abovementioned “combustible material within the stair” refers to the construction of the fire stairs out of combustible materials (i.e. – wood) as outlined in Issue Number 8. This is to be addressed, with the storage of any other combustible products to be outlined to FRNSW for review.

WGE: Further information on the extent of combustible material within the fire stair has been provided in Issue 8.

FRNSW Comment: It is noted that reference made to the “combustible material within the stair” refers to the timber construction of the heritage stairs, as outlined in Issue Number 8. If there are additional combustible items, this is to be clearly outlined.

Stantec: Combustible elements within the fire-isolated relates to the heritage stair and existing timber window/door frames.

FRNSW Comment: Noted.

In the event that fire occurs within the lift shaft, the shaft is to be ventilated out of the top of the shaft through natural ventilation. This will prevent the build-up of smoke and heat within the shaft, preventing the heating of the lift doors.

In the unlikely event that a stair becomes untenable for occupant egress, the other stairs are to be unaffected. Occupants are afforded with adequate time to egress through the remaining two tenable stairs. Alternate egress paths ensure that a worst-case scenario will not compromise the safety of occupants.

As large population is proposed on Level 2 in issue number 5 with reduced exit width, loss of a fire stair would make safe evacuation more difficult on Level 2. FRNSW recommend the lift door openings be appropriately protected to ensure tenable conditions in the fire stair are maintained.

WGE: Noted.

FRNSW Comment: The above comment needs further input (i.e. – ways in which additional protection will be provided to the lift doors). This is to be provided in a future FEBQ submission for FRNSW review.

WGE: The lift shaft doors that open directly into the fire stairs are to be protected through use of natural ventilation in the form of either louvered openings or automatically opening vents at the top of the shafts. This will prevent the build-up of smoke and heat in the lift shaft, and consequently reduce the amount of smoke and heat that may be experienced by occupants in the fire stairs.

To demonstrate this, a CFD simulation will be undertaken as outlined in the CFD form. Two scenarios will be considered, a base case where the lift doors are closed and a sensitivity case where the doors remain open. This will show that the tenability of the fire stairs will be maintained in the event of a fire within the lift pit.

Based on the results of the simulation, the FER will include consideration of how occupant loading in the stairs will change due to a fire in the lift shaft. The effect of this on occupant egress and the possibility of the loss of a fire stair due to untenable conditions or fire spread will also be addressed.

Furthermore, qualitative considerations will also be explored. The lift shafts are protected by sprinklers at the top of the shaft. If a fire were to initiate within a lift shaft it is expected that the sprinkler system will supress, if not extinguish the fire. The benefits of sprinklers will be outlined further in the FER. Additionally, it is unlikely that a fire will initiate within the lift shaft due to the minimal fuel load present in the shaft and the limited ignition sources. These considerations strengthen the results from the simulation as they demonstrate the onerous situation presented in the simulation and the robustness of the result.

In a worst-case scenario where a fire causes a staircase to become unusable, the provision of alternate fire stairs and the provided compartmentation will maintain occupant safety. The three main fire stairs used for egress are distributed around the building and separated by fire rated construction and smoke sealed doors. As such if a stair does become compromised, it is expected that the smoke and heat will be contained within the stair and not endanger occupants. Further, the stairs are provided with ventilation that will reduce the build-up of smoke and heat, increasing the tenability of the stairs and reducing the likelihood of smoke spreading outside of the stairs. The additional egress time due to more occupants accessing the same stairs, causing queueing at the doors, will therefore not endanger occupants as they will be separated from the hazards of the fire and therefore able to egress calmly, with their egress route being maintained as tenable for the duration of their evacuation.

FRNSW Comment: The abovementioned quantitative/qualitative assessment is noted and is to be thoroughly outlined within the FER.

Effective ventilation of the lift shaft and alternate paths of travel are considered to provide tenable egress paths for occupants and in turn meets the relevant Performance Requirements.

FRNSW Comment: It is to be outlined what measures will be implemented to guide occupants in a safe and effective manner to the alternative egress path, in the event that one of the fire stairs becomes untenable and unsafe for occupant egress.

WGE: The Lands building is a highly staffed space that is predominately used for hosting of functions. In the event of a fire the staff are expected to direct people to appropriate exits which are marked by emergency signage. The high staff to client ratio and their knowledge of the multiple egress routes will facilitate egress to alternative exits.

Further, the horizontal egress strategy implemented throughout the Lands building provides occupants with additional safety while egressing. If occupants are not guided by staff and open a door into a compromised compartment, they will notice the smoke/fire and return to the safe compartment they were . As they are now separated from the fire, they are in a place of relative safety. Occupants are afforded extra time to locate an alternative within this compartment at minimal exposure to fire or smoke.

FRNSW Comment: The alternative paths of travel are to be illustrated on a marked-up figure, in order to aid FRNSW in undertaking an informed review.

FRNSW Comment: Clarification is required on the abovementioned natural ventilation provided to the lift shafts, and whether this is an automatically opening vent system or whether it is proposed to utilise a permanent opening at the top of the lift shaft.

WGE: Natural ventilation method is undecided at this stage, both AOVs and permanent openings are considered. Both options will provide the same level of smoke relief to maintain tenability within the fire stairs. Detail of finalised method will be provided in the FER.

FRNSW Comment: Noted.

FRNSW Comment: In regards to the lift doors opening into the stairs, in principle support is provided subject to all analysis inputs and assumptions being detailed within the FER and agreed upon by all relevant stakeholders, and the analysis demonstrating compliance with the Performance Requirements of the NCC.

Stairs Discharge Internally

Fire stairs L.02, L.03 and L.04 discharge internally within the building. The fire stairs discharge into a passageway that is surrounded by a 60 FRL. See Appendix 1 for General Compartmentation and Egress Strategy markups. Further, the passageway is to be classified as a sterile area with all combustible materials limited and the temporary/permanent storage of combustible material prohibited. These requirements are to be listed in the 'management in use' plan, enforced by building management and listed in the fire safety schedule.

Further, the largest distance from the stair to discharging from the building is approximately 12m. This short distance along a fire isolated path is not considered to pose significant risk to occupants.

These measures ensure that occupants are afforded with safe discharge from the fire stair and into a passageway that is removed from the effects of a fire within another compartment of the building.

FRNSW Comment: It is to be outlined what measures will be implemented to guide occupants in a safe and effective manner to the building discharge point. (Support subject to this).

WGE: When occupants egressing through fire stairs L.02, L.03 and L.04 reach the level of exit to open space, they direct line of sight from the landing to the exit to outside. Emergency signage is provided throughout the building in accordance with BCA Clause E4.5, requiring an exit sign at each exit to a road or open space. If there is a large occupant density that prevents an occupant from seeing the exit they will be able to see this signage or will be expected to follow the crowd to the exit. Signage is also provided in any stairwell that serves both ascending and descending occupants such that occupants will not pass the level of egress.

Further, once occupants have entered the fire stairs, egress takes them through a 60 FRL passage until they reach open space. Since they are removed from the effects of the fire, they will be able to safely locate the building discharge point.

FRNSW Comment: In principle support is provided subject to the analysis in the FER demonstrating compliance with the Performance Requirements of the NCC.

Door Swings Against Direction of Egress

Any doors which swings against the direction of egress are to be;

- reswung to swing in a compliant direction; or
- provided with a push to exit button that will automatically open the door.

The FER is to provide further detail as to which doors these measures will apply to.

Doors Opening Directly into Stair and More than Two Doors Open Directly into Stairs

Stairs L.02, L.03 and L.04 have doors that open directly into them from a compartment that is not a public corridor, SOU or airlock. Stair L.02 has more than two doors opening directly into the fire isolated stairs. There is an inherent risk that a fire within one of these adjacent compartments may cause smoke spread into the stair effecting the tenability of the stair and occupant safety.

All fire doors opening into the stairs will be automatically closing or fitted with magnetic hold open devices which are to release upon activation of the detection/sprinkler system. This measure will ensure that the fire doors are kept closed and are prevented from being wedged open, preventing smoke from entering the stairs.

The proposed to design is to be provided with automatically opening vents at the top of all stairs that will naturally ventilate the stairs if smoke enters. The vents are to be activated upon activation of the detection system within the stairs.

Further, two alternate fire isolated stairs are provided that will allow occupants to egress along a tenable path, unaffected by smoke spread.

FRNSW Comments are as follow:

- As heavy reliance is place on the automatically opening vents, it is to be demonstrated how the reliability of the ventilation system is to be increased and maintained throughout the life of the building.

WGE: The AOVs throughout the building are in most locations secondary to the compartmentation plan. The fire and smoke walls serve to contain the fire and smoke to a small area such that the rest of the building remains tenable. If occupants attempt to enter a compromised compartment, they will identify the smoke within the compartment and not enter. The AOVs in the corridors prolong the tenability of these area to minimise the smoke that may enter adjacent compartments or fire stairs when their doors are opened. Other AOVs such as those provided in the top of fire stairs are also secondary as they serve to prevent any smoke that enter the stairs as occupants enter the stairs from building up and compromising the stairs.

Although the AOVs are mostly secondary to the egress strategy of the building, they will be maintained through regular maintenance in accordance with AS1851.

FRNSW Comment: Noted.

- It is to be outlined what measures will be implemented to guide occupants in a safe and effective manner to the alternative egress path, in the event that one of the fire stairs becomes untenable and unsafe for occupant egress.

WGE: As above. The Lands building is a highly staffed space as it is predominately used for hosting of functions. The staff are expected to direct people to appropriate exits which are marked by emergency signage. The high staff to client ratio and their knowledge of the multiple egress routes will facilitate egress to alternative exits.

Further, the horizontal egress strategy implemented throughout the Lands building provides occupants with additional safety while egressing. If occupants are not guided by staff and open a door into a compromised compartment, they will notice the smoke/fire then remain in their current compartment. As they are now separated from the fire, they are in a place of relative safety. Occupants are afforded extra time to locate an alternative within this compartment at minimal exposure to fire or smoke.

FRNSW Comment: Refer to comment provided by FRNSW above (i.e. – provided mark-up images of alternative paths of travel).

- In order to satisfy Performance Requirement EP2.2, it is recommended that all doors that open into the fire stairs are provided with smoke seals, as well as to further ensure occupant tenability is maintained within the fire stairs during occupant egress. This is especially important as there is the high likelihood that the fire doors will be frequently opened during occupant evacuation, therefore minimising smoke spread into the fire stairs is imperative.

WGE: Noted. Doors that open directly into the fire stairs will be provided with smoke seals.

FRNSW Comment: Noted.

Separation of Rising and Descending Flights

The intent of the BCA as stated by the BCA guide and performance requirements DP4 and DP2, is to minimise the risk to occupants mistakenly passing the lowest storey providing escape when evacuating.

It is proposed to omit the separation of rising and descending flights on Upper Ground level of discharge for stair L.02 and L.04. The proposed design incorporates the provision of signage at the floor landing on Upper Ground, with the text “EXIT BUILDING ON THIS LEVEL”. The signage is to be at a height of 1.75 – 2 m FFL, with the wording not less than 50 mm high on a colour contrasting background.

Occupants on the Lower Ground floor and Level 1 will enter the stair and travel to Upper Ground at which point they will pass the exit door. During hours of high occupant density occupants will most probably notice other occupants directly exiting the building through the entry lobby and will follow them to exit without passing the floor of discharge.

In the event that minimal occupants are within the building, occupants will reach the Upper Ground level and see the signage stating “EXIT BUILDING ON THIS LEVEL”. The signage will inform the occupant that they do not need to travel further up/down the stairs and they will exit the building safely.

Conclusion

The above performance solution aims to show via a quantitative and qualitative analysis that although the proposed design is non-compliant with DtS provisions, the discharge from the fire-isolated stairs would be safely facilitated to a degree that meets the relevant performance requirements.

FRNSW Comment: Regarding the separation of rising and descending flights mentioned above, in principle support is provided subject to the analysis in the FER demonstrating compliance with the Performance Requirements of the NCC.

WGE: Noted.

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 to meet the acceptance criteria if it is shown that the proposed design is in line with all appropriate BCA performance requirements or is considered at least equivalent to the DtS provisions, dependant on DtS departure addressed above.

Fire scenarios and design fire parameters:

As per above.

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 performance solution meets the acceptance criteria.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

NA

Provide details on proposed modelling/assessment tools:

Detail on modelling tools has been provided above. CFD inputs form has also been provided.

FRNSW Comment: Refer to the comments provided by FRNSW relating to each issue.

WGE: Responses are given above.

FRNSW Comment: See comments provided by FRNSW.

Issue number: 7 **Title:** Non-fire-isolated exits

Details of departures from DtS provisions:

The following non-compliances are to be addressed;

Stair L.01 (LG Mezzanine Stair):

- Stair does not discharge at a point that is less than 40m to the nearest exit.

Stair L.07:

- Egress via this stair is discontinuous and does not take occupants to the level of road or open space via its own flights.
- Occupants are required to travel via fire isolated stair from the point of discharge of the stair to the level of road or open space.

Applicable DtS provisions:	D1.9	Performance requirements:	DP4, DP5, EP2.2

List key fire safety measures:

Automatic sprinkler protection is proposed to be installed throughout the building in accordance with BCA Clause E1.5 and AS2118.1-2017.

The discharge passageways of all fire stairs from the building are to be classified as a sterile area with all combustible materials limited and the temporary/permanent storage of combustible material prohibited. All relevant employees are required to be informed of the requirements and regular inspection by building management is to ensure these requirements are adhered to.

FRNSW Comment: It is recommended that the provisions to ensure that the fire stairs remain free of combustibles at all times be implemented as part of a Management in Use Procedure, to be listed as an Essential Fire Safety Measure for the building and be listed in the Fire Safety Schedule.

WGE: Noted, will be included in the FER.

FRNSW Comment: Noted, to be included within the FER.

Automatically Opening Vents (AOVs) are proposed to be installed throughout the development as shown on the markups in Appendix 1 – General Compartmentation and Egress Strategy. AOVs are to open upon activation of the smoke detection/sprinkler system within their smoke zone. Further detail is to be provided within the FER.

Proposed alternative solution:

BCA Comparison

The following performance solution addresses the following departures for Clause D1.9.

Stair L.01 (LG Mezzanine Stair):

- Stair does not discharge at a point that is less than 40m to the nearest exit.

Stair L.07:

- Egress via this stair is discontinuous and does not take occupants to the level of road or open space via its own flights.
- Occupants are required to travel via fire isolated stair from the point of discharge of the stair to the level of road or open space.

The below table summarises the relevant BCA Performance Requirements in relation to the performance solution.

Table 6 - Performance Requirement Summary

BCA Clause	
DP4	Exits must be provided from a building to allow occupants to evacuate safely.
DP5	To protect evacuating occupants from a fire in the building, exits must be fire-isolated to the degree necessary.
EP2.2	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.

Assessment

Stair L.01

Stair L.01 does not discharge at a point that is less than 40m to the nearest exit. The stair discharges from Lower Ground Mezzanine on the Lower Ground level into the eastern corridor. The travel distance to the nearest exit on the same level is approximately 65m.

This extended travel distance is mitigated through the provision of multiple egress routes and fire compartmentation. The travel distance to pass through the L.02 Stair fire wall is approximately 30m. Once the occupant has passed the firewall they are in place of relative safety at which point they can travel down through to the LG western exit or they can travel up stair L.02 to discharge from the UG southern exit.

Stair L.01 provides access to LG from the Basement and LG mezzanine levels. Any occupant that uses stair L.01 is either a staff member or maintenance staff that will be familiar with the layout of the building and will have knowledge of multiple egress routes available.

Finally, an RSET/RSET assessment is to be performed to compare the proposed design against a DtS compliant design.

Research by [Proulx], indicates a travel speed of 1.0 – 1.3 m/s for able-bodied people in moderately crowded situations, and 0.8 m/s for people with mobility disabilities. As a reasonable design parameter, the unimpeded walking speed of a person has been taken as 0.8 m/s to assess travel time, in order to account for a real case scenario.

The proposed design with 10 x 10 m detector spacing will be compared to the DtS design with 15 x 15 m detector spacing in circulation spaces using Alpert's correlation to find the difference in alarm time. This calculation will subtract the change in detection time from the additional evacuation travel time in order to show that the non-compliant travel distances will meet the intent of the BCA as time taken to travel to a point of choice and to the nearest exit from the initiation of a fire will be less than or equal to that of a DtS design.

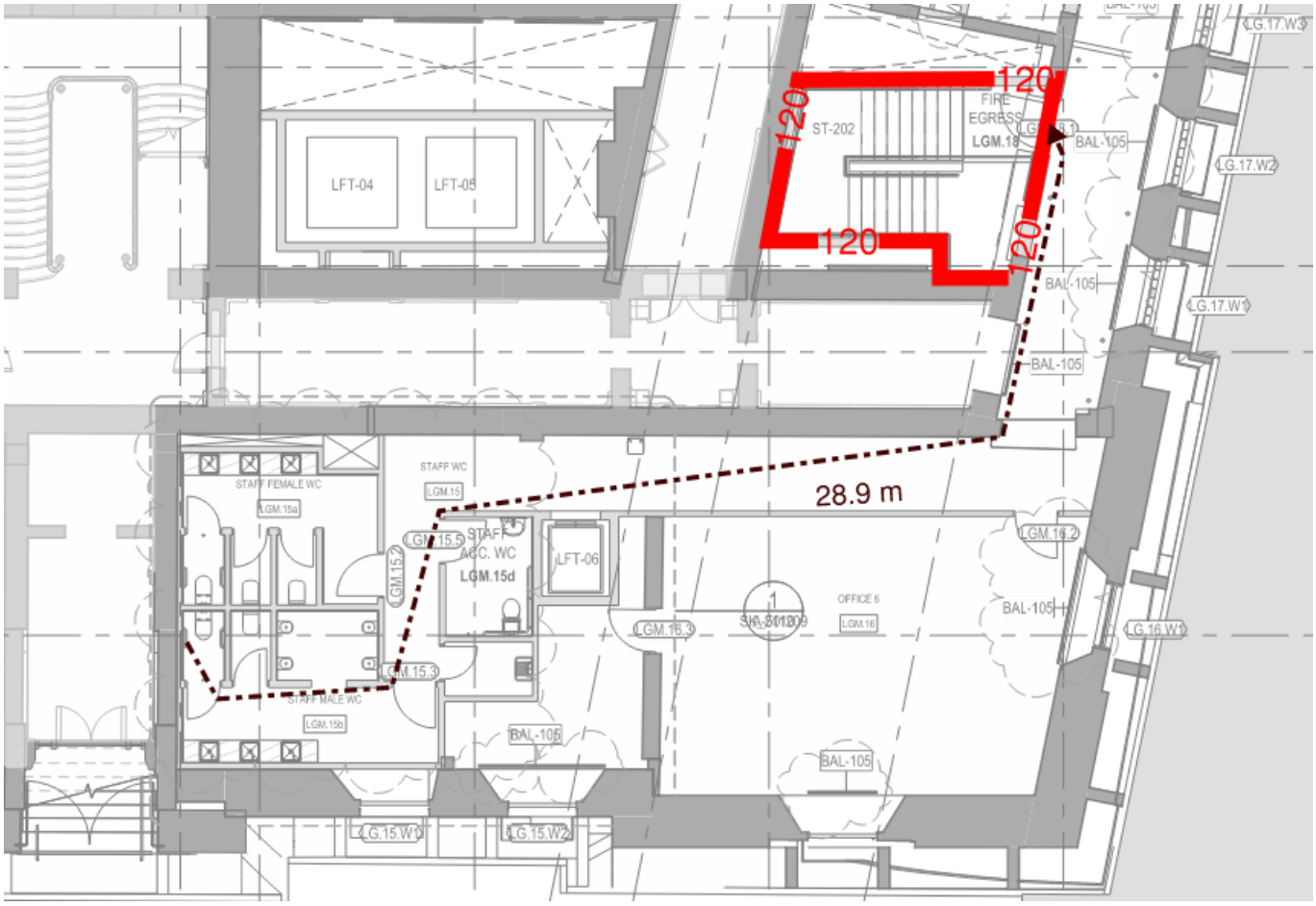


Figure 22 - Stair L.01

Stair L.07

Stair L.07 extends from Level 4 to the Level 3 Dome. Occupants on level 4 are required to travel down L.07 to the Dome and are then afforded with two alternate paths to either Fire Stair L.04 or Fire Stair L.03.

Decreased detection spacing of 10 x 10m is to be provided throughout, which will provide occupants on Level 4 with an early warning of a fire. Upon activation of the alarm they will travel down stair L.07 and travel approximately 32m to Fire Stair L.04. If L.04 is compromised, occupants are able to travel through the corridor to Fire Stair L.03 with tenable conditions for safe egress.

The fire compartmentation shown in the figure below demonstrates that fire and smoke spread throughout level 4 will be limited through the provision of 60 minute FRL walls. Once occupants pass from the compartment of fire through the fire wall they are considered to be in a place of relative safety, at which point they can egress from the building removed from the effects of the fire.

The additional detector provisions, low travel distance and provision of alternate routes justifies compliance with Performance Requirements DP4, DP5 and EP2.2 providing occupants with safe provisions for egress and tenable conditions.

The figure below details the egress routes from Stair L.07.

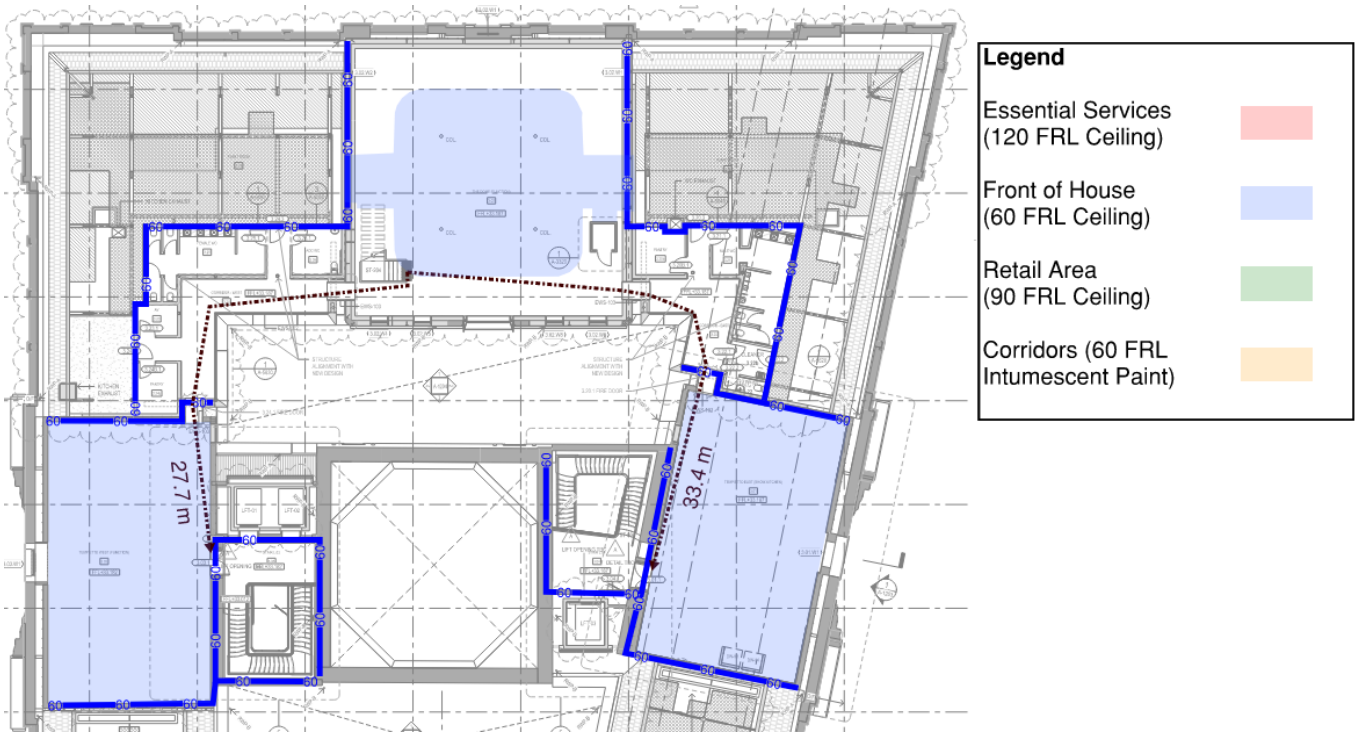


Figure 23 - Stair L.07 Level 3 Egress Routes

Conclusion

The above assessment has demonstrated that safe occupant evacuation is facilitated to a sufficient degree through the use of active and passive fire safety measures.

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 to meet the acceptance criteria if it is shown that safe occupant evacuation is facilitated to a sufficient degree.

Fire scenarios and design fire parameters:

~~Discussed above.~~ NA

FRNSW Comment: The design fire scenarios and associated values/assumptions have not been outlined within the abovementioned performance solution. These are to be outlined to allow FRNSW to undertake an informed review and ensure the assumed parameters are appropriate.

WGE: There is no particular fire scenario utilised in this solution.

FRNSW Comment: The abovementioned performance solution proposes a RSET/RSET comparative assessment. As such, a design fire scenario must be considered to undertake this analysis. As such this is to be outlined for FRNSW review.

Stantec: Refer to Issue Number 16 Extended Travel Distances

FRNSW Comment: Noted.

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 performance solution meets the acceptance criteria.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☐ None

RSET of the proposed design is to be greater than or equal to the RSET of DtS compliant design.

Provide details on proposed modelling/assessment tools:

NA

FRNSW Comment: In principle support is provided subject to the following:

- All inputs and assumptions being detailed in the FER and agreed upon by all relevant stakeholders, and the analysis demonstrating compliance with the Performance Requirements of the NCC.
- The comment(s) provided by FRNSW being addressed satisfactorily.

WGE: Noted.

FRNSW Comment: The in principle support noted above is subject to the comment provided by FRNSW regarding the design fire scenario being addressed satisfactorily.

Issue number: 8 **Title:** Fire-isolated stairways

Details of departures from DtS provisions:

Material of the existing heritage stairs are required to be non-combustible.

Applicable DtS provisions:	D2.2, D2.3	Performance requirements:	DP5

List key fire safety measures:

- The 'management in use' is required to state the following. The temporary or permanent storage of combustible materials within the heritage stairs is strictly prohibited. Building management is required to communicate this requirement to all relevant staff and enforce it through regular inspection.

FRNSW Comment: The abovementioned Management in Use procedure is recommended to be listed as an Essential Fire Safety Measure, and be included on the Fire Safety Schedule.

WGE: Noted, will be included in FER.

FRNSW Comment: Noted, to be included within the FER.

- Automatically Opening Vents (AOVs) are proposed to be installed throughout the development as shown on the markups in Appendix 1 – General Compartmentation and Egress Strategy. AOVs are to open upon activation of the smoke detection/sprinkler system within their smoke zone. Further detail is to be provided within the FER.
- ~~Mechanical exhaust is proposed to be provided at the top of Stair L.02, as shown on the markups in Appendix 1 – General Compartmentation and Egress Strategy. Further detail on activation is to be provided within the FER.~~

Proposed alternative solution:

BCA Comparison

BCA ~~2016 amendment 1~~ 2019 Amendment 1 Clause D2.2 states that a stairway that is required to be within a fire-resisting shaft must be constructed of non-combustible material and not cause structural damage to the shaft if there is local failure. Clause D2.3 states that in a building having a rise in stories of more than 2, non-fire isolated stairs must be constructed according to D2.2.

Performance Requirement DP5 states that to protect evacuating occupants from a fire in the building, exits must be fire isolated to the degree necessary.

Qualitative Assessment

The heritage stairs do not meet the DtS provisions listed above as they are constructed of combustible material such as wood. The following qualitative assessment will address the low probability of fire initiation within the stairs, the spread of flames to and from the stairs and the safe egress of occupants.

Combustible elements within the heritage stairs include:

- Partly timber/polymer hand rail
- Timber components in stairs
- Timber doors
- Timber bounding construction

The likelihood of a fire initiating within the stairs is considered low. The combustible material that the stairs are constructed from include hardwood. Further, the permanent/temporary storage of combustible materials within the stairs is strictly prohibited and is to be listed in the 'management in use' requirements and communicated to all relevant staff. Although hardwood is considered a combustible material, it generally requires more flammable substances to promote combustion.

Possible ignition sources within the stairs has been limited to electrical fixtures such as lighting. For the lighting to cause the ignition of a fire it would require a more flammable material to ignite first, leading to the fire spreading to the heritage hardwood.

Another ignition source which relates to the stairs are the lift doors opening directly into the stair shaft. A fire within the lift shaft could lead to the lift doors radiating heat into the stair shaft. This fire risk has been combatted through the proposed installation of an automatically opening vent (AOV) at the top of all lift shafts to vent smoke and heat outside of the lift shaft, which will prevent heat to building up on the lift doors.

The risk of fire initiating within the stairs has been largely mitigated through 'management in use' requirements prohibiting the storage of combustible materials within the stairs and the installation of an automatically opening vent within the lift shaft, which will vent heat and smoke upon activation of the detection system.

In the event that a fire initiates within the stairs, the 60 FRL fire separation bounding the stairs will prevent the fire spreading throughout the building. As continuous paths of travel are provided around the building, occupants are then able to take an alternate route in a fire compartment separated from the effects of the fire.

Reference should be made to Appendix 1 – General Compartmentation and Egress Strategy to illustrate the comprehensive egress provisions.

Conclusion

It has been shown that safe occupant evacuation is facilitated to a sufficient degree and that fire initiation and spread within the fire-stairs is prevented through the fire safety measures and management in use requirements.

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 to meet the acceptance criteria if it is shown that safe occupant evacuation is facilitated to a sufficient degree and that fire initiation and spread within the fire-stairs is prevented through the fire safety measures and management in use requirements.

Fire scenarios and design fire parameters:

As stated above.

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 performance solution meets the acceptance criteria.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

NA

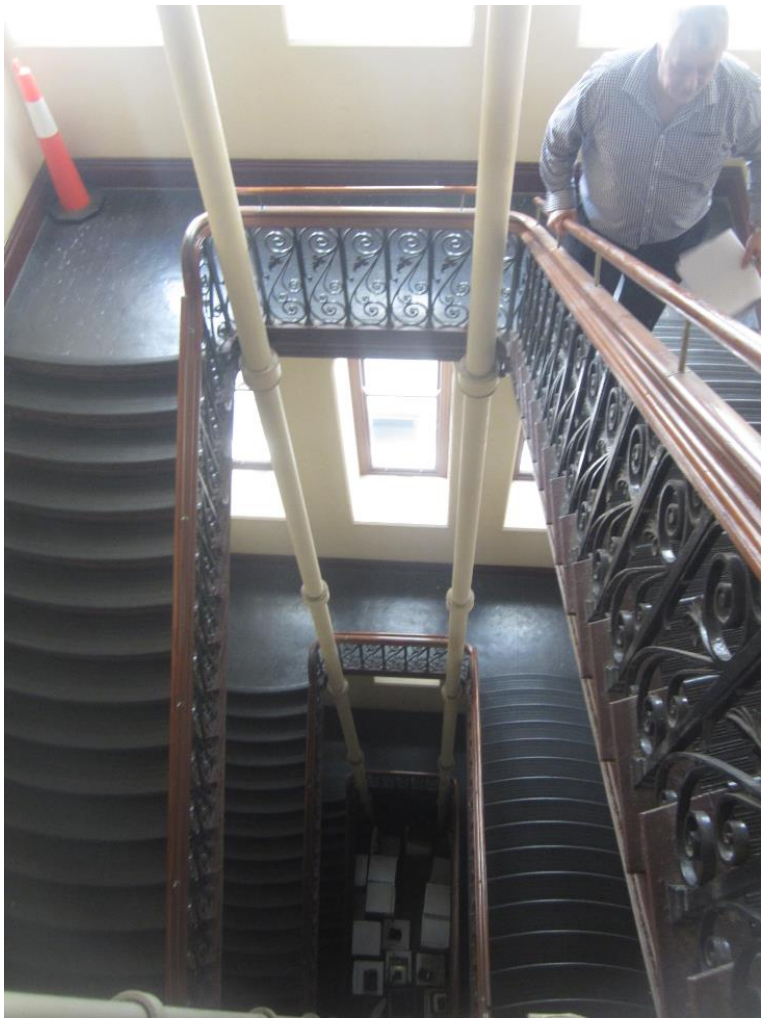
Provide details on proposed modelling/assessment tools:

NA

FRNSW Comments are as follow:

- A pictorial reference illustrating the extent and locations of the timber heritage stairs throughout the building is recommended to be included, as it is unclear whether the abovementioned performance solution refers to all fire stairs or only a select few. This will allow FRNSW to undertake an informed review.

WGE: The timber construction within the fire stairs is mainly the handrails, door frames and window frames which are constructed of hardwood. The extent of the timber construction can be seen in the figures below.



- It is to be outlined what measures will be implemented to guide occupants in a safe and effective manner to the alternative egress path, in the event that one of the fire stairs becomes untenable and unsafe for occupant egress.

WGE: As in Issue 6. The Lands building is a highly staffed space as it is predominately used for hosting of functions. The staff are expected to direct people to appropriate exits which are signed. The high staff to client ratio and their knowledge of the multiple egress routes will facilitate egress to alternative exits.

Further, the horizontal egress strategy implemented throughout the Lands building provides occupants with additional safety while egressing. If occupants are not guided by staff and open a door into a compromised compartment, they will notice the smoke/fire then remain in their current compartment. As they are now separated from the fire, they are in a place of relative safety. Occupants are afforded extra time to locate an alternative within this compartment at minimal exposure to fire or smoke. The building is provided with emergency signage throughout in accordance with AS2293.1-2005, which will assist in guiding occupants to alterative exits.

FRNSW Comment: The alternative paths of travel are to be illustrated on a marked-up figure, in order to aid FRNSW in undertaking an informed review.

- Consideration should also be given to the comments provided by FRNSW on Issue Number 6, where relevant.

WGE: Noted.

- Consideration is to be given to the structural adequacy of the proposed heritage stairs, and whether the stairs provide a sufficient level of safety and appropriately facilitate occupant egress and Fire Brigade intervention in the event of a fire scenario.

WGE: Noted, will be addressed in FER.

FRNSW: In principle support is provided subject to the following:

- All FRNSW comments be adequately addressed.
- The analysis in the FER demonstrating compliance with the performance requirements of the NCC.

Issue number: 9 **Title:** Smoke hazard management

Details of departures from DtS provisions:

Rationalise the omission of smoke hazard management, including:

- Omission of zone smoke control.
- Omission of Stair Pressurisation of Stair L.02

FRNSW: Clarification is required on whether other fire stairs are required to be provided with a stair pressurization system. It appears from Figure 30 in Appendix 1 that AVOs are provided at the top of other fire stairs.

Applicable DtS provisions:	E2.2, Spec E2.2a, Spec E2.2b	Performance requirements:	EP2.2

List key fire safety measures:

- Automatically Opening Vents (AOVs) are proposed to be installed throughout the development as shown on the markups in Appendix 1 – General Compartmentation and Egress Strategy. AOVs are to open upon activation of the smoke detection/sprinkler system within their smoke zone. Further detail is to be provided within the FER.
- ~~Mechanical exhaust is proposed to be provided at the top of Stair L.02, as shown on the markups in Appendix 1 – General Compartmentation and Egress Strategy. Further detail on activation is to be provided within the FER.~~

FRNSW: FRNSW concerns that the provision of mechanical exhaust at the top of a fire stair may draw smoke into the exit.

Stantec: Mechanical Exhaust at top of Stair L.02 has been removed. The strategy is relied upon the AOV along the public corridor to minimize the risk of smoke spread into Stair L.02.

FRNSW Comment: Noted, this strategy is recommended to be outlined and further detailed within the FER.

- Automatically Opening Vents (AOVs) are proposed to be installed within the lift shafts that will open upon detection of a fire within the lift shaft.

Proposed alternative solution:

BCA Comparison

As detailed in the BCA report and BCA Table E2.2a, the building is required to be provided with a zone smoke control system. Further, Stair L.02 is required to be provided with a stair pressurisation system.

However, the performance solution addressed herein demonstrates that the proposed smoke hazard management system is to provide a level of safety that reflects the intent of BCA Specification E2.2b, AS/NZS 1668.1 and Performance Requirement EP2.2.

Qualitative Assessment

It is proposed to not provide the building with zone smoke control or stair pressurisation due to the restrictions of the building's heritage fabric.

As per BCA NSW table E2.2a, any class 6 or 9b building that is not a school and has a rise in stories of more than two and has more than one fire compartment is to be provided with a zone smoke control system in accordance with AS/NZS 1668.1. This in effect requires these areas to be provided with a zone pressurization system.

It is considered that the proposed fire safety measures coupled with simplistic evacuation routes provides a level of safety that reflects the intent of BCA Specification E2.2(b).

BCA Specification E2.2(b) prescribes requirements on the buildings smoke control system, with the intent of enabling safe occupant evacuation. Following this intent, the following fire safety provisions are proposed:

- The provision of sprinkler protection will control the fire, and if not suppress it
- Detection at a reduced spacing will provide occupants with earlier detection of a fire and egress at an earlier stage of fire development
- Egress routes are provided with multiple exit points and therefore occupants will not have to queue within these spaces. Where egress widths are reduced as outlined in Issue number 5 – Reduced Exit Width, occupants are provided with additional fire and smoke compartmentation to allow occupants to increase their safety while queueing
- Any smoke leakage from the subject smoke zones to another will be dealt with by the natural ventilation system in that smoke zone.
- Smoke seals to fire doors that open into the fire stairs

As shown in Appendix 1 – General Compartmentation and Egress Strategy, ~~mechanical smoke exhaust is provided to Fire Stair L.02 and~~ Automatically Openings Vents (AOVs) are to be provided to ventilate Fire Stair L.03 and L.04. This will maintain the tenability within these stairs if smoke leakage from an adjacent compartment is to occur. Further, the continuous travel provided around levels LG to Level 3 allows occupants to safely egress along alternate routes into other fire/smoke zones in the event that one becomes untenable due to the effects of a fire.

The Lower Ground Level has openings within the corridor that will naturally vent smoke within the corridors into the central void spaces and into the environment.

Levels Upper Ground to Level 3 are provided with AOVs within the corridors that will naturally vent any smoke within the corridor into the central void spaces and into the environment.

Further, the compartmentation strategy shown in Appendix 1 – General Compartmentation and Egress Strategy will prevent the spread of fire and smoke from the compartment of fire origin to adjacent compartments and levels above and below.

The natural ventilation strategy in conjunction with the compartmentation strategy and sprinkler system provides a sufficient degree of smoke hazard management that is considered to meet Performance Requirement EP2.2.

The risk of not providing a zone smoke control and stair pressurisation is considered to be mitigated by the fire safety measures mentioned above.

Quantitative Assessment

CFD modelling will be undertaken to demonstrate that fire and smoke spread between floors will not occur. The zone smoke control would act to positively pressurise the floor above and below the floor of fire origin to prevent smoke spread. It is proposed to omit zone smoke control due to the provision of a compartmentation and ventilation strategy that will prevent smoke travelling between levels. The only path available for smoke to travel between levels is through the stairs that connect the levels. All stairs have been fire or smoke separated to prevent smoke spread between levels, as shown in Appendix 1 – General Compartmentation and Egress Strategy. Further, the stairs and corridors have been provided with ventilation that will activate upon activation of the detection system dedicated to that vent.

A worst case fire scenario is considered to be within the corridor that is adjacent to the fire stair. In the event that a fire occurs within the corridor or a room adjacent to corridor in the same smoke zone, there is a risk that smoke will spill into the fire stairs and spread to levels above.

In the event that smoke spill into a corridor, occupants will not travel down the smoke affected path. Instead occupants are afforded with continuous travel around the building and alternate paths to non-fire affected stairs. Therefore, as occupants will not open any doors into a fire affected compartment, the risk of smoke spread is largely mitigated.

The CFD model aims to demonstrate through modelling a fire in the corridor, that upon activation of the opening windows within the corridor, the corridor will be adequately ventilated to prevent the build up of smoke. It will be shown through steady state conditions that no smoke build up occurs after the initial growth period.

The below figure illustrates the modelled space. This is considered to be worst case for corridors due to low volume and single automatically opening window, in lieu of a large volume and two automatically opening windows.

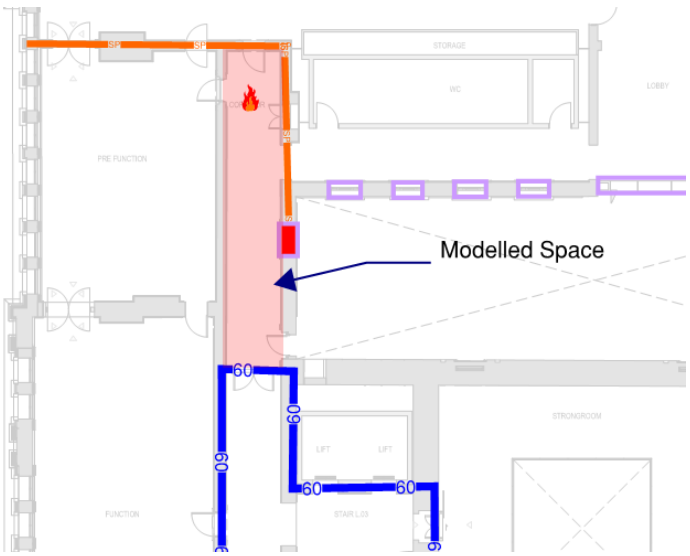


Figure 24 - Level 2 North-Western Corridor

The below table outline the fire parameters to be used.

Parameter	Input
Fire Size (MW)[1]	1.0
Growth Rate[2]	Instant
HRRPUA (kW/m^2) [3]	4000
Sample Time	Until model reaches steady state

1. Considered conservative to represent the fuel load within the corridor (typically a bin fire)
2. An instant growth rate to represent steady state conditions
3. Highly conservative HRRPUA value for a bin sized 0.5 m x 0.5 m to reach a 1MW fire size

Visibility slices will be used to measure the soot density within the corridor.

Conclusion

It will be shown in the above analysis through modelling a worst-case scenario fire in the corridor that smoke is adequately vented from the corridor through the automatically opening windows, preventing smoke spread between levels. It will demonstrated that performance requirement EP2.2 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 performance solution is considered to meet the acceptance criteria if it is shown that the proposed design is in line with performance requirement EP2.2. The acceptance criteria will be met if it is shown through modelling a worst-case fire in the corridor that smoke build up within the corridor does not occur.

Fire scenarios and design fire parameters:

As stated above

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 performance solution meets the acceptance criteria.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

NA

Provide details on proposed modelling/assessment tools:

NA

FRNSW Comments are as follow:

- It is unclear whether a steady-state or transient simulation is proposed to be undertaken. This is to be clarified in order to allow FRNSW to undertake an informed review.

WGE: Simulation will be run until it reaches steady state conditions. See comment below.

FRNSW Comment: Noted, see FRNSW comment below.

- Appropriate justification for utilising a soot yield value of 0.07kg/kg (as per the provided CFD inputs form) is to be provided for FRNSW review.

WGE: This value will be justified in the FER. The soot yield value has been chosen as per C/VM2 Table 2.1 – Pre-flashover design fire characteristics.

FRNSW Comment: Noted, this is to be clearly outlined within the FER.

- The table above indicates that the sample time will be up until the simulation reaches a steady state (i.e. – steady state simulation until convergence is achieved), where as the CFD inputs form outlines a simulation time of 7200 seconds (presumably for a transient case). This is to be addressed and clarified in order for FRNSW to undertake an informed review and assess the appropriateness of the proposed methodology.

WGE: The 7200 second simulation is used for the zone model for issue 1 only. The CFD modelling for issue 9 is to be run until the simulation reaches a steady state.

FRNSW Comment: Noted, it is understood that a *transient* simulation will be run until convergence within the computational domain is achieved. This is crucial, in order to accurately model the characteristics of fire/smoke spread. This is to be clearly outlined within the FER.

- The tenability criteria that the proposed computational simulation will be compared against has not been outlined for FRNSW review. This is to be addressed.

WGE: The tenability criteria being considered are outlined in the table below.

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	

FRNSW Comment: The tenability criteria outlined above is to be clearly outlined within the FER.

Issue number: 10 **Title:** Omission of Fire Hose reels

Details of departures from DtS provisions:

It is proposed to permit the use of fire extinguishers in lieu of Fire Hose reels throughout the building.

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

List key fire safety measures:

- Automatic Fire Suppression System ~~with fast response heads~~ is to be installed throughout the building, designed and installed in accordance with AS2118.1 – 2017.
- Portable 4.5kg (ABE) fire extinguishers are to be installed in accordance with BCA Clause E1.6 and AS2444-2001.

Proposed alternative solution:

Discussion and Comparison with the BCA

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 will be demonstrated the inclusion of fire extinguishers in lieu of fire hose reel will not pose any additional risk to the life safety of occupants who undertake initial fire attack.

Qualitative Assessment

Statistics on Occupants Fire-fighting

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.

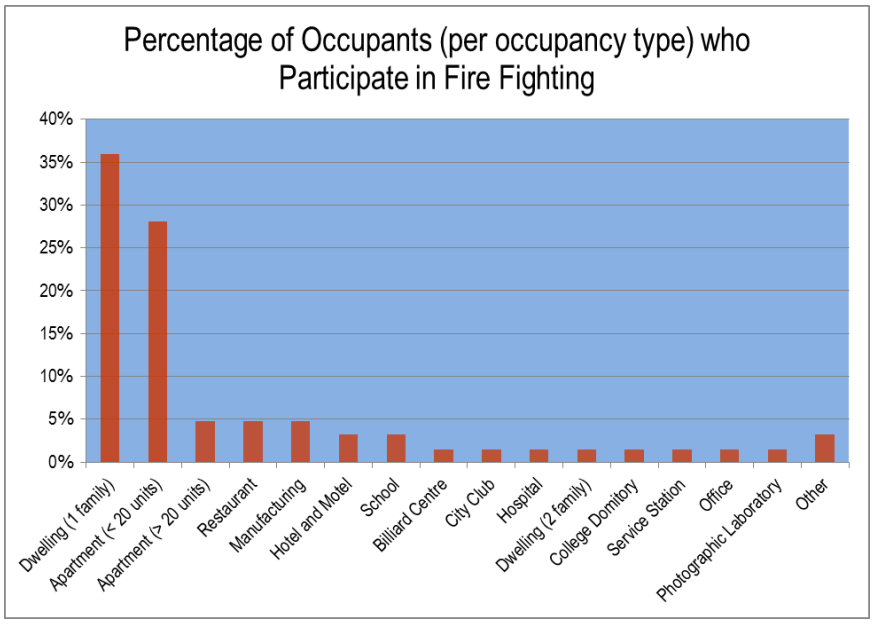


Figure 25 - Occupants who participate in firefighting

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.

Fire hose reels are connected to the water main and therefore supplies an indefinite amount of water. As such, fire hoses provide enough water for extinguishing relatively large fires. On the other side, the amount of extinguishing agent in a portable fire extinguisher is limited and there may be fires that are too large to extinguish with it. 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 7 - Categories of fire extinguishers

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 6 and 9b spaces, it is reasonable to assume that building staff should prioritise the evacuation of occupants from the compartment of fire origin to adjacent safe compartments or out of the building rather than undertaking initial fire-fighting. 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 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 the simply evacuating. The same risk is not applicable to Fire Extinguishers.

BCA Provisions

In 2017 the Australian Building Codes Board (ABCB) published their assessment of the provision fire hose reels to class 5 buildings. The ABCB concluded that the risks associated with the use of fire hose reels in office buildings outweighed the possible first-aid firefighting benefits. This is due to the change in life safety strategy over the past decades, with a clear trend toward evacuation rather than fire suppression by occupants. This is further supported by BCA 2019, which allows for the omission of FHR to Class 5 areas. In terms of fire risk, Class 6 and 9b areas demonstrate comparable occupant characteristics, fuel sources and cause of fires. An additional major cause of fire in Class 6 and 9b is kitchen fires, which are commonly oil based. A fire extinguisher with oil fire capabilities is considered more appropriate as fire fighting tool in comparison to a fire hose reel.

It was also noted that the most common cause of fire in office buildings are electrical faults and fire hose reels are not effective in combating electrical fires and as such the provision of an extinguisher which is capable of fighting such a fire is of much greater use.

Their final recommendations were to remove the requirement to install fire hose reels in new office buildings and replace with the requirement to install fire extinguishers in accordance with AS2444.

Robustness or Safety Factor

There is no safety factor specifically utilized in this design as the solution is primarily based on demonstrating equivalence to DtS, in that the provision of portable fire extinguishers enables suppression of a fire in its early stages. As noted above, extinguishants are to be provided in accordance with AS 2444 Clause 4.2.1, noting the risk level within the subject building. Given the characteristics of this extinguisher type, the risk of using the wrong type of extinguisher for a particular fire scenario is mitigated considerably.

Information on the benefits of sprinklers will be included in the FER.

Conclusion

The above assessment shows that the provision of fire extinguishers in lieu of fire hose reels provides a higher level of life safety than would be found in a DtS compliant building. As a result, Performance Requirement EP1.1 is satisfied.

Performance solution:

☑ A0.3(a)(i) - Comply with the performance requirements
☐ A0.3(a)(ii) - Be at least equivalent to the DtS provisions

Assessment methods:

☐ A0.5(a) - Evidence of suitability
☐ A0.5(b)(i) - Verification methods in the NCC
☑ A0.5(b)(ii) - Other verification methods
☐ A0.5(c) - Expert judgement
☑ A0.5(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:

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.

Fire scenarios and design fire parameters:

NA

Describe how fire brigade intervention will be addressed or considered:

Fire brigade intervention is not required to be assessed by performance requirement EP1.1, furthermore this performance solution is focused on first aid fire-fighting rather than brigade involvement.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None
NA

Provide details on proposed modelling/assessment tools:

NA

FRNSW Comment: In principle support is provided subject to the analysis in the FER demonstrating compliance with the Performance Requirements of the NCC.

WGE: Noted.

Issue number: 11 **Title:** Rationalisation of the emergency lift

Details of departures from DtS provisions:

It is proposed to omit the requirement for an emergency lift to serve the clocktower of the Lands Building.

~~Further, passenger lifts are not provided with the appropriate stretcher facilities.~~

Applicable DtS provisions:	~~Part E3, E3.2,~~ E3.4	Performance requirements:	~~EP3.1,~~ EP3.2

List key fire safety measures:

Proposed alternative solution:

BCA Comparison

BCA 2019 Amendment 1 Part E3 EP3.2 states that an emergency lift is required to serve each floor served by the lifts in a building, installed to facilitate the activity of emergency personnel. EP3.2 only applies to a building with an effective height of greater than 25m.

~~Further, E3.2 states that if an emergency lift is not provided at least one of the passenger lifts serving any storey above an effective height of 12m must be provided with stretcher facility.~~

The intent of the BCA is to facilitate emergency services evacuate sick or injured occupants and to assist in transporting brigade and paramedic equipment, in buildings with an effective height greater than 25m. ~~The emergency lift is required to have dimensions that accommodate a stretcher.~~

The performance solution will aim to demonstrate through a qualitative and comparative assessment that emergency services are facilitated to an equivalent degree of a DtS design with an effective height of under 25m. ~~that does not require an emergency lift.~~

The proposed design incorporates multiple lifts, the tallest of which travel from Lower Ground to Level 3, a vertical distance of 24.2 m. Due to its heritage nature and small size of the clocktower it is proposed to not include any passenger or emergency lifts in this area.

~~Qualitative Assessment~~

~~The building has an effective height of >25m and <50m. Although, the level at which the brigade will enter the building in the event of a fire is dependent on what street they approach from. The maximum vertical travel distance for each stair has been listed in the table below.~~

~~Table 8 - Stair Height~~

~~Stair~~	~~Maximum Levels Travelled by Brigade~~	~~Vertical Travel Distance (m)~~
~~L.02~~	~~Upper Ground to Level 3~~	~~18.4~~
~~L.03~~	~~Lower Ground to Level 3~~	~~24.2~~
~~L.04~~	~~Upper Ground to Level 3~~	~~18.4~~
~~Dome Stair~~	~~Level 3 to Level 4~~	~~3.0~~
~~BOH Stair~~	~~Basement to Lower Ground Mez~~	~~9.9~~

~~As shown in the table above, regardless of what entrance/stair the brigade utilises, they will not be required to travel a vertical distance of greater than 25m up a single stair, as the maximum is 24.2 m. Further, no lift within the building is to travel a vertical distance of greater than 25m.~~

~~The above can be compared to a DtS design with an effective height of 24.9 m with a stair that requires a vertical travel distance of 24.9 m to the top storey, which would not require an emergency lift under the BCA. This DtS scenario would require the brigade to travel a vertical distance greater than that of the proposed design. A comparison of maximum vertical travel distance for the brigade shows 24.2 m is 0.7 m less than a DtS design of 24.9m.~~

~~The intent of an emergency lift is to assist emergency services travel up large flights of stairs and transport patients from the building. Transporting a patient using a stretcher can required a high degree of physical exertion in large~~

~~stairs. The proposed design is considered to require less physical exertion by the brigade than the DtS compliant design discussed due to the smaller vertical distance required to be travelled.~~

~~Further, the proposed stair design incorporates landings and mid-landings with a larger length and width than a DtS design, which would facilitate the dimensions of a stretcher and the transport of patients to a higher degree than a DtS design.~~

Qualitative Assessment

BCA ~~2016~~ 2019 Amendment 1 Table D3.1 outlines that a Class 9b assembly building must be accessible "*To and within all other areas normally used by occupants*". The clocktower of the Lands Building from level 3 up is not accessed in normal operation of the building and is only used by maintenance personnel when servicing equipment such as sprinklers in the tower, or machinery in the ~~plant room~~ roof space or roof terrace. As such these areas are not required to be accessible under the BCA and therefore do not require access via passenger lifts.

Further, the 2016 BCA guide for E3.4 states:

"*An emergency lift must serve all the floors in a building served by passenger lifts but is not required to serve other floors such as those containing only plant and equipment.*"

And for EP3.2 states:

"*Emergency lifts must service the same floors as any other lift. Therefore, if a level such as a plant-room level does not have any lifts serving it, there is no necessity to provide an emergency lift service to that plant-room level.*"

Since the clocktower is not normally accessed by day to day occupants and is only accessed for maintenance work it is considered comparable to a ~~plant room~~ roof space and therefore is not required to be accessible via an emergency lift.

Conclusion

It has been shown that due to the usage and population of the clocktower, the omission of an emergency lift to this area is comparable to a DtS ~~plant room~~ roof space. As such, emergency service operations are considered to be facilitated to an equivalent degree to a DtS design and thus performance requirement EP3.2 has been met.

~~It has been shown through a comparative and qualitative assessment that the design offers an equivalent or higher degree of safety to a DtS design in terms of facilitating emergency services intervention. Therefore, it can be considered that an emergency lift or passenger lift stretcher facility is not required in the proposed development.~~

Performance solution:

☑ A0.3(a)(i) - Comply with the performance requirements
☑ A0.3(a)(ii) - Be at least equivalent to the DtS provisions

Assessment methods:

☐ A0.5(a) - Evidence of suitability
☐ A0.5(b)(i) - Verification methods in the NCC
☐ A0.5(b)(ii) - Other verification methods
☐ A0.5(c) - Expert judgement
☑ A0.5(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 to have met the acceptance criteria if it is shown that emergency services are facilitated to evacuate sick or injured building occupants. ~~without an emergency lift.~~

Fire scenarios and design fire parameters:

NA

Describe how fire brigade intervention will be addressed or considered:

~~A scenario to be considered is the ability of emergency services to evacuate an injured or sick occupant from the upper most floor.~~

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

NA

Provide details on proposed modelling/assessment tools:

NA

FRNSW Comments are as follow:

- It is noted that Lower Ground access to the site is possible via both Bridge St and Gresham St, hence the worst case vertical travel distance for Fire Brigade personnel would in fact be 27.2m (up to Level 4). As a result, the proposed comparative assessment is not deemed appropriate in justifying the performance solution.
- The reliance on the fire stairs to facilitate Fire Brigade services for the abovementioned performance solution must also consider the implications and comments relating to Issue Number 6, 8 and 9 of this FEBQ, which relate to fire stair construction and various fire safety provisions to be rationalised. This is to be addressed, and it is to be demonstrated that Fire Brigade intervention will not be further impeded.
- The various fire safety properties of the existing lift system is to be outlined for FRNSW review (i.e. – FRL of constructions, fire safety measures implemented, fire separation etc.).
- It is to be outlined what the procedure concerning the lift system will be in the event of a fire scenario (i.e. – will the lifts return to a particular level, will they be inaccessible during a fire alarm etc.). It should also be demonstrated that if a specific procedure to be implemented, occupants which may be immobile are able to egress safely and in an effective manner.

WGE: Lift facilities have been updated such that LFT-01, LFT-02 and LFT-03 are emergency lifts with stretcher facilities. The solution above has been updated to address the omission of emergency lifts from the clocktower.

FRNSW Comment: Noted, it is acknowledged that LFT-01, LFT-02 and LFT-03 are now emergency lifts with appropriate stretcher facilities.

In principle support is provided subject to the analysis in the FER demonstrating compliance with the performance requirements of the NCC.

Issue number: 12 **Title:** Door Swing

Details of departures from DtS provisions:

It is proposed to rationalise the inward swing of the following discharge doors due to their heritage nature;

- Lower Ground double doors facing Bridge Street
- Lower Ground double doors facing Gresham Street
- Ground Floor double doors facing Bent Street
- Ground Floor double doors facing Loftus Street

Further, some of the ~~horizontal exit~~ doors in the compartment on Level 2 ~~along fire walls~~, are required to swing in both directions but only swing in one direction.

Strongroom exit doors on Ground Floor to Level 2 are permitted to swing against the direction of egress

Applicable DtS provisions:	D2.20, D2.21	Performance requirements:	DP4

List key fire safety measures:

- The Lower Ground double doors (Bridge St and Gresham St) and Ground Floor double doors (Bent St and Loftus St) are to be fitted with devices that are to automatically open the doors upon activation of the detection or sprinkler system within the Lands Building.
- Management in use requirements are to be placed around the Lower Ground entrances from Bridge St and Gresham St, and the Ground entrances from Bent St and Loftus St. As the doors are to be fitted with a device that automatically opens the doors upon activation of the detection system, the area within the path of the doors is always to be kept clear of obstructions. The permanent/temporary storage of materials within the openings path of the doors is prohibited. This requirement is to be communicated to all relevant staff and enforced by building management.

Proposed alternative solution:

BCA Comparison

BCA clause D2.20 requires doors to swing in the direction of egress. The intent of Clause D2.20 and D2.21 is to reduce the risk of injury to occupants and provide unobstructed egress paths during evacuation. If the door was to swing against the direction of egress and large numbers of occupants were evacuating simultaneously along the same route, the pressure of people against the door could cause congestion and the door could not be opened.

A performance solution will meet the BCA performance requirements DP4 if it is demonstrated that occupants are able to egress safely through the discharge doors listed above.

Qualitative Assessment

Discharge Doors

The proposed fire strategy of the building is highly dependent on the provision of an intelligent compartmentation strategy. The strategy is demonstrated in Appendix 1 – General Compartmentation and Egress Strategy. The compartmentation will facilitate a horizontal egress strategy by dividing the building into ‘zones’. In the event that a fire initiates, occupants will evacuate away from the fire by either travelling into a fire stair or into an adjacent zone, either separated by fire or smoke rated construction, at which point they will be in a place removed from the immediate dangers of the fire. As occupants will be in a place of relative safety, they are afforded with the ability to undergo an evacuation that will not be panicked or rushed. Occupants will not be at any immediate danger of the fire once in a fire stair or adjacent fire zone.

The intent of the BCA is largely directed toward occupants who are in a place within the building that is exposed to the effects of the fire. If a fire initiates in a densely populated compartment with doors that swing against the direction of egress, there is a high risk that occupants could become trapped in a compartment effected by the fire.

The proposed development has been compartmented to allow for the calm evacuation of occupants.

The double doors mentioned above are all to be fitted with devices that will automatically open the doors upon activation of the detection system or sprinkler system. ‘Management in Use’ requirements stated above are to prevent the blocking or jamming of the discharge doors.

These measures are considered to sufficient to facilitate the efficient evacuation of occupants. Due to these measures, the risk of the door being unable to open has been mitigated as the doors will open immediately before egress has begun.

~~Horizontal Exit~~ Egress Doors between compartments in Level 2

It is expected that the final building design will have some ~~horizontal~~ egress exits that have doors swinging against the direction of egress. The part of the building is required to have doors swinging in the direction of egress if they serve a part of the building with a floor area of more than 200m^2. Most of the existing doors are to be reswung to swing in the compliant direction. Any door integral to the horizontal egress strategy is to swing in the correct direction. Any door that does not meet the requirement is to accommodate small populations or have other exits with compliant swing direction.

The swinging of the door against the direction of egress will increase the risk that the door may delay a person evacuating and could result in the first person to reach the door not being able to open it due to crowding behind them which could delay evacuation. This is generally considered to be due to the density and population of the crowd attempting to use the exit, and may also be influenced by the state of the occupants.

The hazard is that occupants may become trapped inside or crushed against the closed door if it is unable to release quickly when a large number of occupants attempt to evacuate simultaneously. However, in cases where number of occupants is low such as less occupant dense rooms, the exit door swing direction will have little or no effect on the ability of occupants to evacuate as crushing is usually the result of high population density rushing towards the exits.

Any area served by an exit that has a horizontal exit swinging against the egress direction is to be low occupant density or have multiple other exits with compliant swing direction. The density in front of the door is expected to be limited by the relatively low number of occupants.

The nature of the building will mean that the occupant movement to the exit is more likely to be staggered and dispersed over multiple exits, thereby lessening the numbers of person present at any door. Therefore, it is unlikely that a high crowd loading would occur at the inward swinging door.

A comparison of the BCA requirements in terms of direction of door swing with the American guidance document [NFPA] has been undertaken. Clause 7.2.1.4.2 of the [NFPA], stipulates that “Doors required to be of the side-hinged or pivoted-swinging type shall swing in the direction of egress travel where serving a room or area with an occupant load of 50 or more “. It is expected that not all of the compartment occupants will mobilise to the same door when the alarm sounds since occupants are afforded with multiple horizontal exits from each compartment.

The FER is to identify any door which is unable to meet the requirements of D2.20 and is to specifically address the compartment type and population and why it is considered to meet the intent of the BCA and the relevant performance requirements ensuring safe occupant evacuation.

Strongroom exit doors

The strongroom exit doors on Ground Floor to Level 2 opens directly into fire-isolated stair (L03 and L04) as illustrated in figure below.

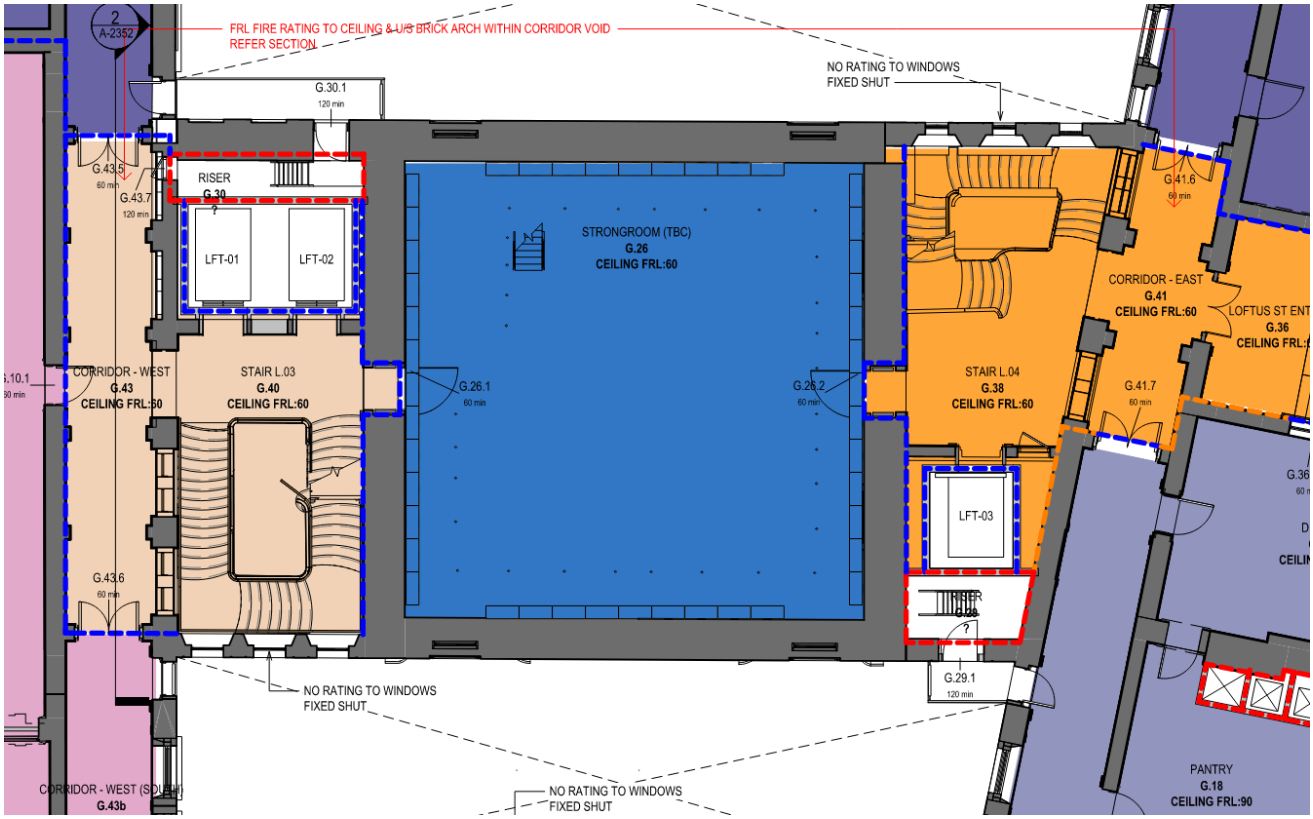


Figure 26 – Strongroom exit doors on Ground Floor (typical on Level 1 and Level 2)

One of the main concerns/hazards identified by BCA Clause D2.20 is the possibility of too many occupants being located behind the initial person opening the door thus leading to a 'crushing' effect or a high population pressure at a single point thus preventing a person from opening the door.

When taking into consideration that the strongroom area of the building, it is noted that the first person to approach the door will not be impeded by a large number of occupants following given that the population within the strong room per level is no more than 40 and not a high density compared to other function areas. It is also acknowledged that occupants will be aware and alert at all times in addition to the area being staff managed who will be familiar with the uses of the exit door of Strongroom.

In order to aid occupants regardless of whether they are familiar with the operation of the door, signage is required on the internal face of the inward swinging door stating "PULL TO EXIT". The signage should be visible within the Strongroom and in clear, capital lettering, no less than 20mm high, in a colour contrasting to the door or wall surface. Occupants approaching the door will be made aware that the doors must be pulled against the direction of egress when evacuating. This additional signage is therefore expected to minimise delays in occupant evacuation.

FRNSW Comment: In principle support is provided subject to the analysis in the FER demonstrating compliance with the Performance Requirements of the NCC.

Conclusion

As demonstrated by the qualitative and absolute assessment above, performance requirement DP4 of the BCA is considered to be met.

Performance solution:

☑ A0.3(a)(i) - Comply with the performance requirements
☐ A0.3(a)(ii) - Be at least equivalent to the DtS provisions

Assessment methods:

☐ A0.5(a) - Evidence of suitability
☐ A0.5(b)(i) - Verification methods in the NCC
☑ A0.5(b)(ii) - Other verification methods
☐ A0.5(c) - Expert judgement
☐ A0.5(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 considered to meet the Performance Requirements if it is demonstrated that the swing of doorways not in the direction of egress poses no additional risk to the building occupants in the event of egress.

Fire scenarios and design fire parameters:

The assessment considers the safety of egressing occupants in the event of a fire and the possibility of blocked egress routes

Describe how fire brigade intervention will be addressed or considered:

Fire brigade intervention is not considered to be impacted if the solution meets the acceptance criteria.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None
NA

Provide details on proposed modelling/assessment tools:

NA

FRNSW Comments:

- It is to demonstrated that in any regions which may not facilitate door swing in a DtS-compliant direction, occupants which may be immobile are able to safely and effective egress and operate the doors in a safe manner.

WGE: Noted. Details will be provided in FER.

- In the event of a power failure, it is to be demonstrated what measures are in place to ensure that the operation of the automatic opening double doors remain effective.

WGE: Will be provided in FER.

FRNSW Comment: In principle support is provided subject to the analysis in the FER demonstrating compliance with the Performance Requirements of the NCC.

Issue number: 13 **Title:** Omission of fire detection from concealed spaces

Details of departures from DtS provisions:

To permit the omission of fire detection from concealed spaces as required by AS1670.1.

Applicable DtS provisions:	E2.2, Spec E2.2a	Performance requirements:	EP2.1, EP2.2

List key fire safety measures:

- Automatic Fire Suppression System ~~with fast response heads~~ is to be installed throughout the building, designed and installed in accordance with AS2118.1 – 2017.

Proposed alternative solution:

BCA Comparison

BCA Spec E2.2a requires that Class 6 and Class 9 buildings are required to have a smoke detection system that complies with AS1670.1-2018. AS1670.1-~~2015~~ 2018 Clause 3.27.4.1 specifies that detection must be provided in all concealed spaces. The intent of this clause is to provide occupants with early warning of a fire occurring within a concealed space within the building.

Qualitative Assessment

It is proposed to omit smoke detectors from concealed spaces throughout the Lands building. The existing heritage design of the building includes concealed spaces formed by construction of ceilings that are separated from the floor of the storey above. Examples of typical concealed spaces above corridors are shown in Figure 27 below. Concealed spaces with similar construction are also present within various rooms throughout the building. The majority of these concealed spaces are present in the existing heritage design.

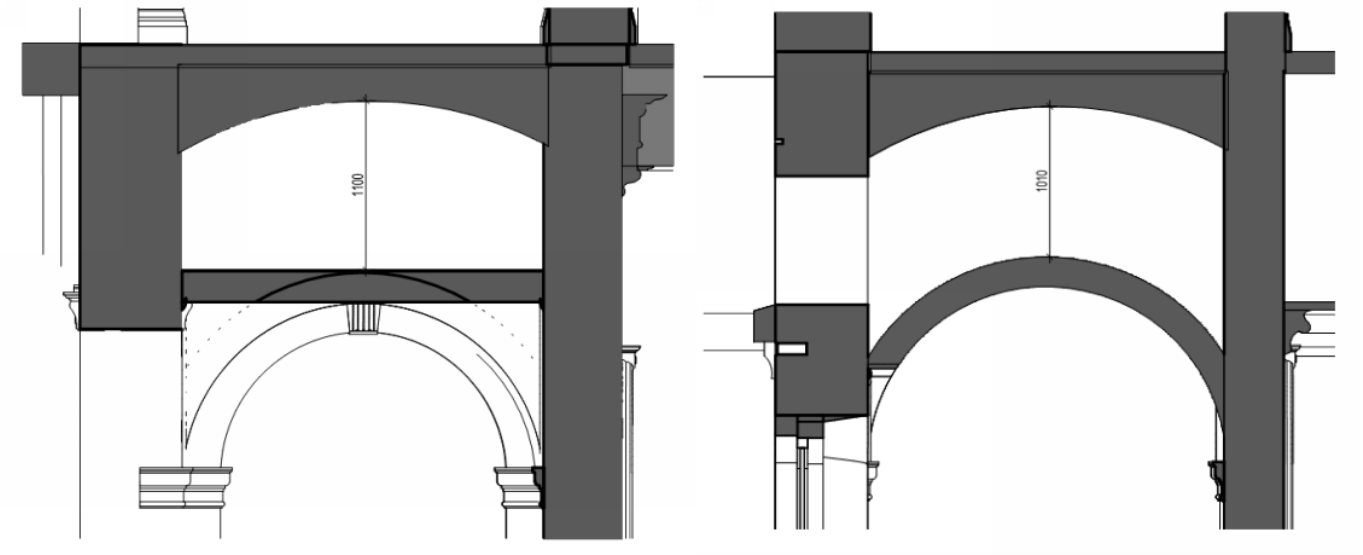


Figure 27: Typical corridor concealed spaces.

Fire Hazard

The concealed spaces throughout the building are only used for housing of utilities such as sprinkler mains, power/data reticulation and mechanical pipes and/or ducts. These areas are not used by building occupants and are not accessed unless maintenance staff are undertaking work on the utilities. The spaces contain a very low fuel load, with the largest source of combustible material being the power and data wiring running through them. The fire rating of the boundary construction of the concealed spaces is not known due to its heritage nature, however is generally composed of a combination of non-combustible materials including brickwork, concrete and sandstone blocks.

If a fire were to occur in a concealed space it would be detected upon smoke spreading into an adjacent room where it will activate a detector, triggering the building alarm as normal. Considering these factors, the omission of concealed spaces throughout the Lands building are not considered to present additional risk to occupants of the building.

Fire Safety Measures

The proposed building is to be provided with a sprinkler system throughout, including concealed spaces. 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. The reliability and efficacy of sprinkler systems has been well researched and shall be further detailed in the FER.

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]. The FER shall contain further details of sprinkler system performance.

Furthermore, by controlling the fire size, the amount of smoke produced is correspondingly also 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. These and associated benefits are to be discussed in the FER.

Conclusion

The above qualitative solution has shown that there is a low risk of a fire initiating within any of the concealed spaces. If a fire were to start in one of these spaces, it will be small in size due to the lack of fuel load and likely controlled or extinguished by the concealed space sprinklers. Consequently, the delay in alarm activation due to omission of smoke detectors is not considered to present additional risk to occupants.

Performance solution:

- ☑ A0.3(a)(i) - Comply with the performance requirements
- ☐ A0.3(a)(ii) - Be at least equivalent to the DtS provisions

Assessment methods:

- ☐ A0.5(a) - Evidence of suitability
- ☐ A0.5(b)(i) - Verification methods in the NCC
- ☑ A0.5(b)(ii) - Other verification methods
- ☐ A0.5(c) - Expert judgement
- ☐ A0.5(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 solution will be considered to meet the acceptance criteria if it is demonstrated that occupant safety is maintained to an acceptable level.

Fire scenarios and design fire parameters:

A scenario where a fire ignites within a concealed space has been considered.

Describe how fire brigade intervention will be addressed or considered:

NA

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

NA

Provide details on proposed modelling/assessment tools:

NA

FRNSW Comment: In principle support is provided subject to the following:

- The analysis in the FER demonstrating compliance with the Performance Requirements of the NCC.
- Management In Use procedures be implemented to ensure that the concealed spaces remain free of combustibles and stored goods. This is to be listed as an Essential Fire Safety Measure, to be included on the Fire Safety Schedule.

Issue number: 14 **Title:** Hydrant Provisions

Details of departures from DtS provisions:

To permit the provision of a single fire hydrant to serve multiple storeys. It is proposed to omit hydrants from levels 4 and above of the clocktower and to have the hydrant on level 3 service these storeys.

To permit hydrants that are not located within fire stair as per AS2419.1.

To permit the use of two hose lengths to achieve full coverage to the Level 4 terrace areas.

To permit the use of two hose lengths to achieve full coverage to lower ground mezzanine areas from hydrants on the lower ground floor.

Applicable DtS provisions:	E1.3	Performance requirements:	EP1.3, ~~EP1.6~~

List key fire safety measures:

- Automatic Fire Suppression System ~~with fast response heads~~ is to be installed throughout the building, designed and installed in accordance with AS2118.1 – 2017.

Proposed alternative solution:

BCA Comparison

BCA Clause E1.3 states:

> ***(b) The fire hydrant system –***
>
> ***(i) Must be installed in accordance with AS 2419.1,*** *except a Class 8 electricity network substation need not comply with clause 4.2 of AS 2419.1*
>
> ***(ii) where internal hydrants are provided, they must serve only the storey on which they are located*** *except that a sole-occupancy unit.*

The intent of this clause as outlined in the 2016 BCA guide is to require installation of suitable fire hydrant systems to facilitate the fire brigade's firefighting operations.

AS 2419.1 -2005 clause 3.2.3.2 requires that hydrant be provided in each fire-isolated exit at each storey.

Qualitative Assessment

Hydrants Located Outside of Fire Stairs

The proposed design does not provide hydrants within stair L.02 at any storey due to space constraints within the stairs. To maintain coverage hydrants are provided on each storey in the east and west wings of the building, within 13m of stair L.02. The figure below shows the typical location of fire hydrants around this stair.

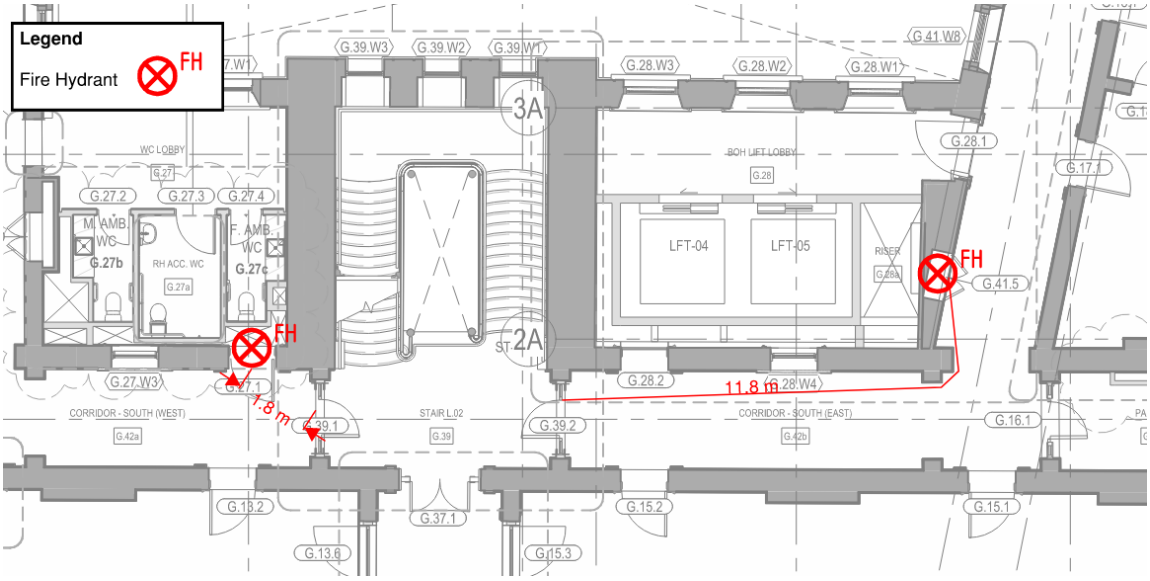


Figure 28: Typical hydrant locations, Ground Level.

The non-compliant location of these hydrants presents the risk that a fire will occur in the vicinity of one of the unprotected hydrants, preventing brigade members from being able to access it for firefighting.

The risk of this is mitigated through the provision of overlapping hydrant coverage. The compliant hydrants within stair L.03 and L.04 provide coverage to the entire southern corridor between these two stairs as shown in Figure 29 below.

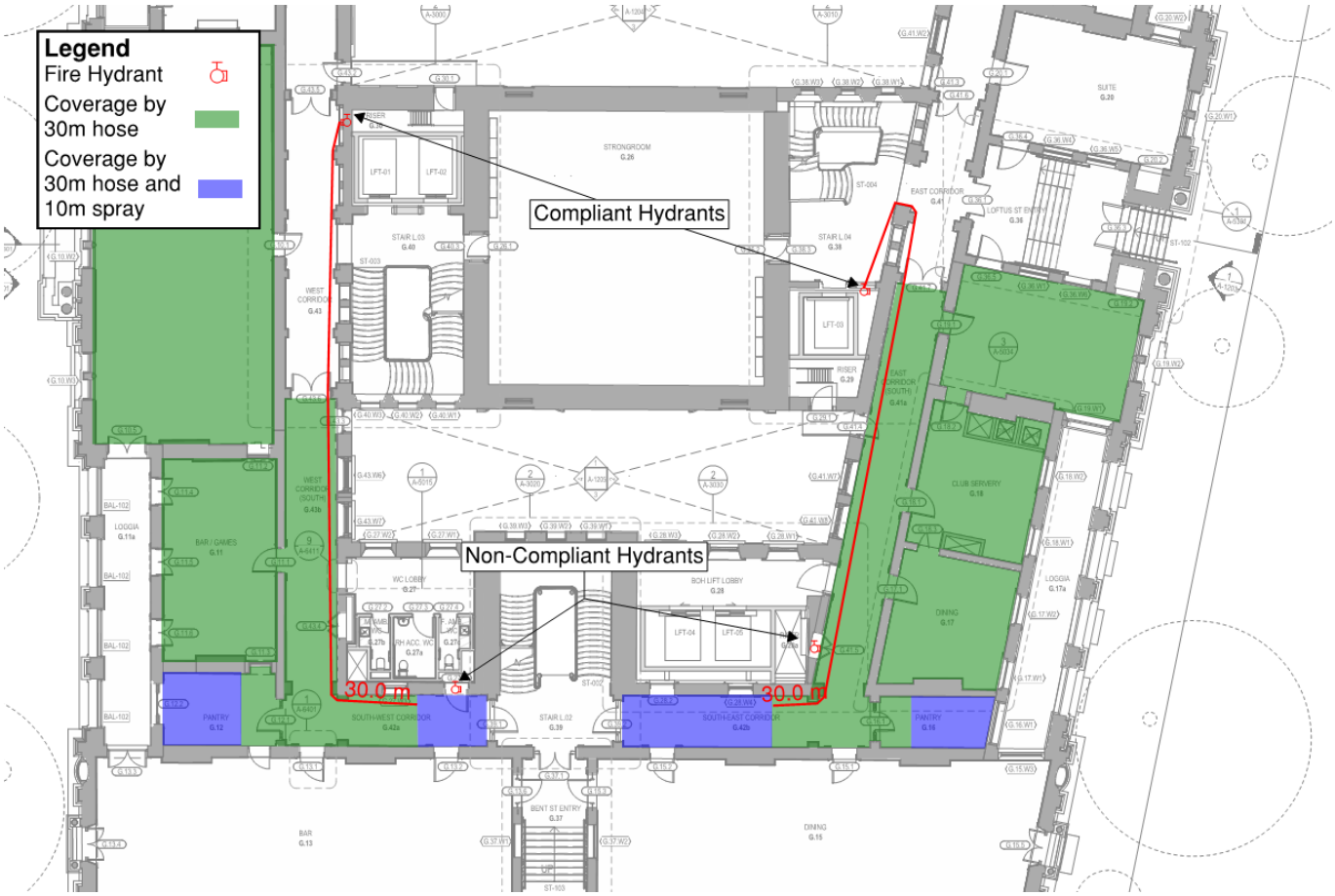


Figure 29: Compliant hydrant coverage - Ground Floor.

In the event that a fire within these corridors, the brigade will be able to connect to a complaint hydrant and use it to extinguish it, restoring access to the non-complaint hydrants. As these could now be made safe to use, the brigade could move the hose to this hydrant and continue extinguishing any other fires. Alternatively, If the hydrant was unusable due to damage from a fire, the brigade could decide to attach a second hose. With 60m of hose, equivalent coverage would be achieved.

Further, there are several additional factors that increase the robustness of this solution:

- Fuel load in the vicinity of the non-compliant hydrants is minimal due to being in a corridor. The worst-case fuel load is expected to be composed of carpet and minimal wooden furniture. As such, it is unlikely that a fire will start in a location that makes the hydrants unusable.
- In a worst case scenario, coverage of areas that cannot be reached by a single length of hose from stair L.03 or L.04 can be covered by using one of the non-compliant hydrant to cover the other by passing the hose through the fire stars as shown in Figure 30 below. This scenario, while not ideal due to the potential exposure of fire stairs to smoke and, is considered safe as the stairs are ventilated from the top and evacuation of occupants will be complete by this stage.

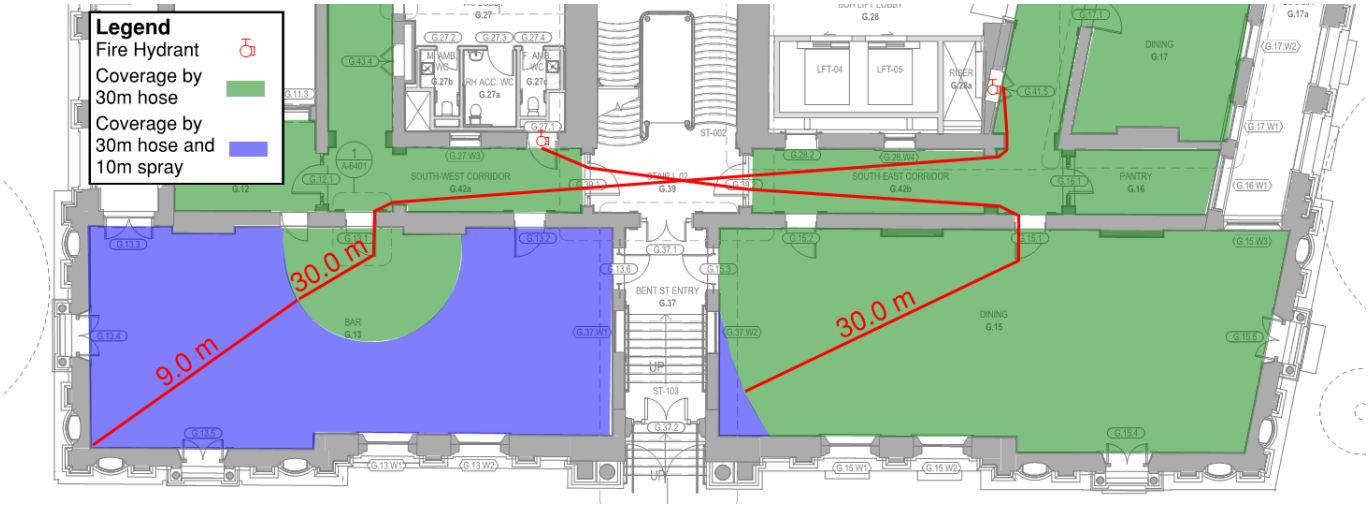


Figure 30: Non-compliant hydrant coverage.

As the brigade is provided multiple methods to provide coverage to the same areas as would be covered by a compliant hydrant in stair L.02, the relocation of the hydrant to outside the fire stair is considered to appropriately facilitate brigade operations.

Hydrant Provision for clocktower

The proposed design does not provide a fire hydrant on level 4 or above of the clocktower, instead having the hydrant on level 3 provide coverage to these storeys. To cover the most disadvantaged point on the top floor of the clocktower requires a hose lay of 56m, requiring the use of two 30m hoses. The layout of the clocktower is shown below in Figure 31.

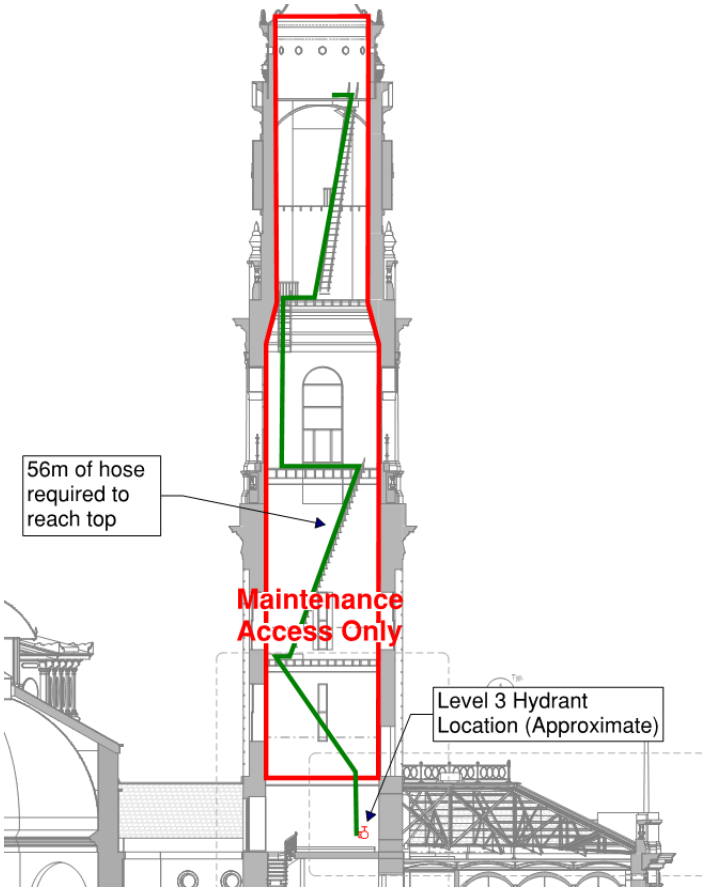


Figure 31: Hydrant coverage in clocktower. Hose length accounts for 3D path of the hose determined from floor plans.

Fire Hazard

The clocktower presents a minimal fire hazard due to its minimal fuel load, limited ignition sources and low occupancy. The entire clocktower from level 3 up is not accessed during normal building operation, only being occupied when maintenance work is required in the area. Fuel loads within the clocktower are minimal and restricted to temporary storage of material during maintenance work and the heritage wooden floors. Further, the only ignition source present in the tower is electrical equipment such as lighting. Therefore, it is considered unlikely that a fire would initiate within the clocktower and any that did would be small, presenting minimal danger to occupants.

FRNSW Comment: It is recommended that Management In Use procedures be implemented to ensure that the clocktower region remains free of combustibles and stored goods. This is to be listed as an Essential Fire Safety Measure, to be included on the Fire Safety Schedule.

Stantec: Noted.

Two (2) hose length of coverage to Level 4

Location

As illustrated in figure below, the location of the fire hydrant on Level 3 are within the fire-isolated stairs and within the Level 3 northern area.

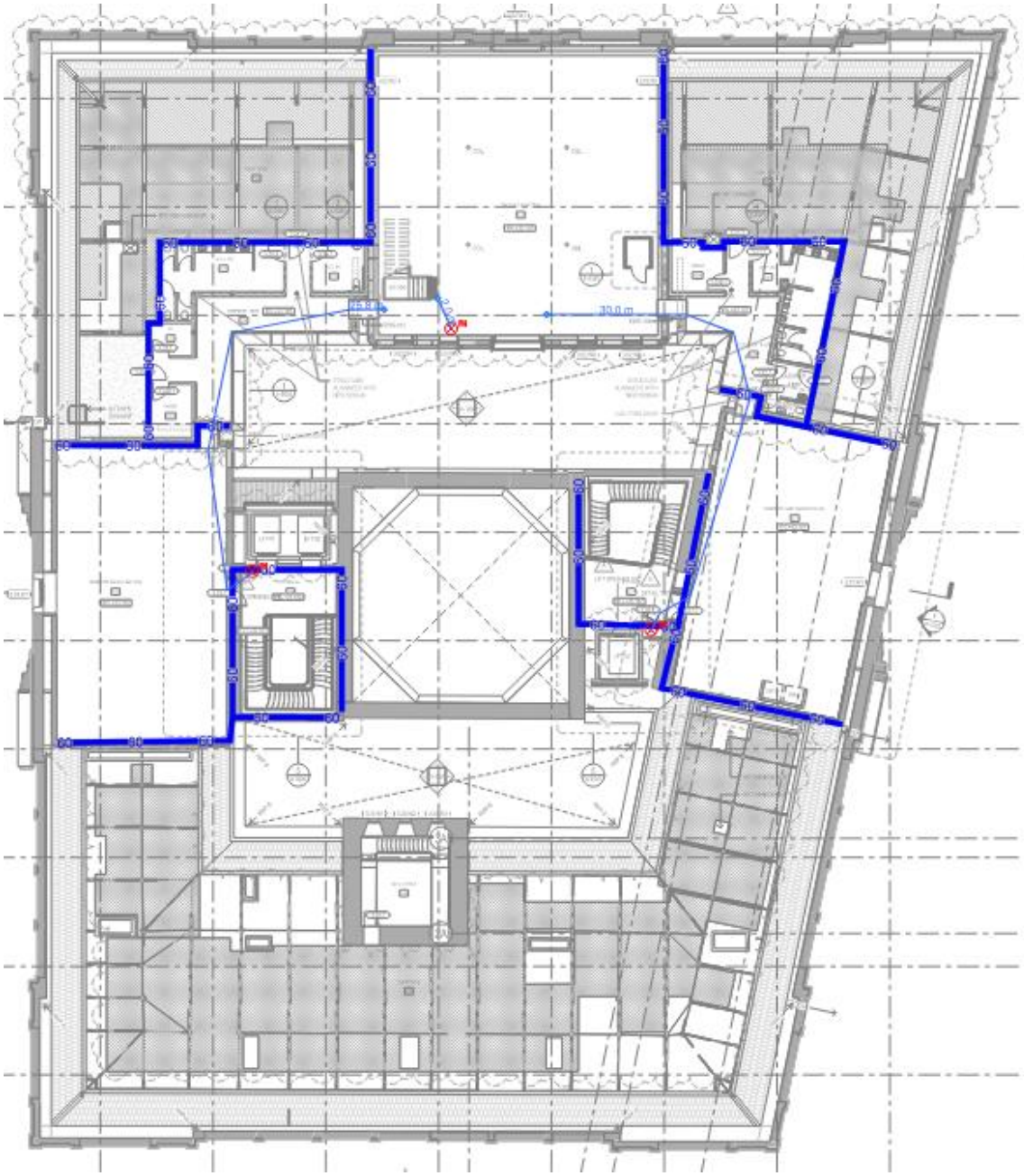


Figure 32: Hydrant locations on Level 3

In order to achieve full coverage to the Level 4 northern area, it is proposed for two (2) lengths of hose as shown in the figure below. The primary fire hydrants located within the two fire-isolated stairs provide coverage to the secondary internal hydrant within Level 3 northern area. This is achieved with one (1) hose length from either fire-isolated stair. At this point of location fire brigade personnel can safely set up two (2) lengths of hose to perform full coverage to Level 4 areas of the building. It is noted a single (1) hose length from the secondary internal hydrant shall provide full coverage to the internal areas of Level 4 and the additional hose length is to provide full coverage to the open east terrace areas.

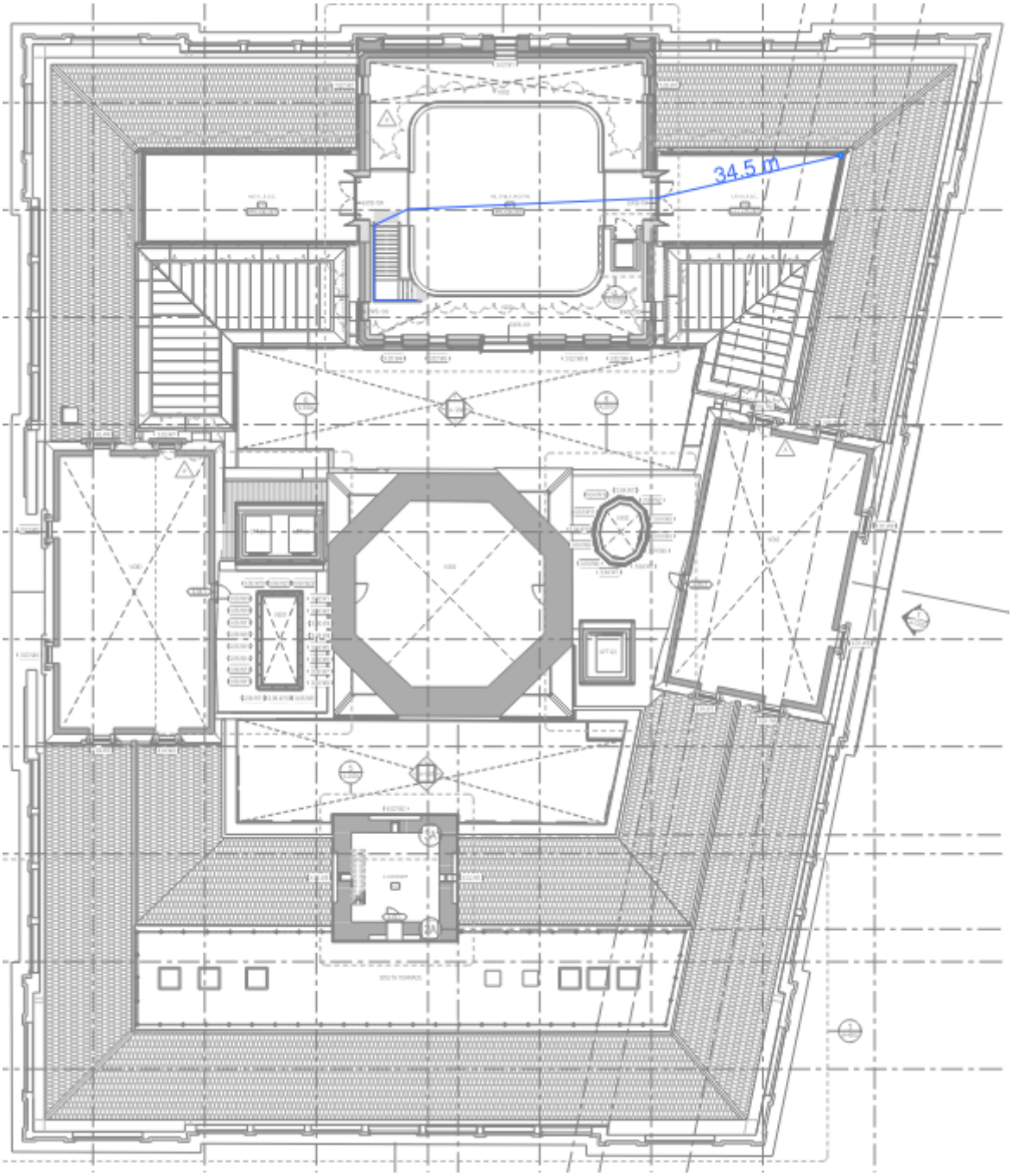


Figure 33: Two lengths of hose coverage to Level 4 most remote location (eastern terrace)

As part of the Performance Solution, the following fire safety measures are to be proposed:

- Appropriate signage at the FCC, FIP, Booster and secondary internal hydrant stating “Two Hose Lengths Required for Coverage to Level 4” or similar;
- Limitation of the type of furnishing to the open terrace areas i.e. standing function furnishing only. No combustible couches or the like at the terrace areas.

The above fire safety measures provides appropriate notification for the fire brigade to undertake intervention activities to safely extinguish the fire on Level 4 area. Further the limitation of the outdoor furnishing minimise the risk of severe fire development to areas that are open and not sprinkler protected.

FRNSW recommends that floor specific block plans (minimum A3 in size) should be installed adjacent to the hydrants on level 3 which are considered the first accessible attack hydrants. The sole purpose of these floor specific block plans is to assist fire-fighters to locate the additional internal hydrant within the northern area.

The floor specific block plans should be permanently mounted and oriented in such a manner so as to reflect the aspect of the installation as it is presented to the reader and be incorporated into the fire safety schedule.

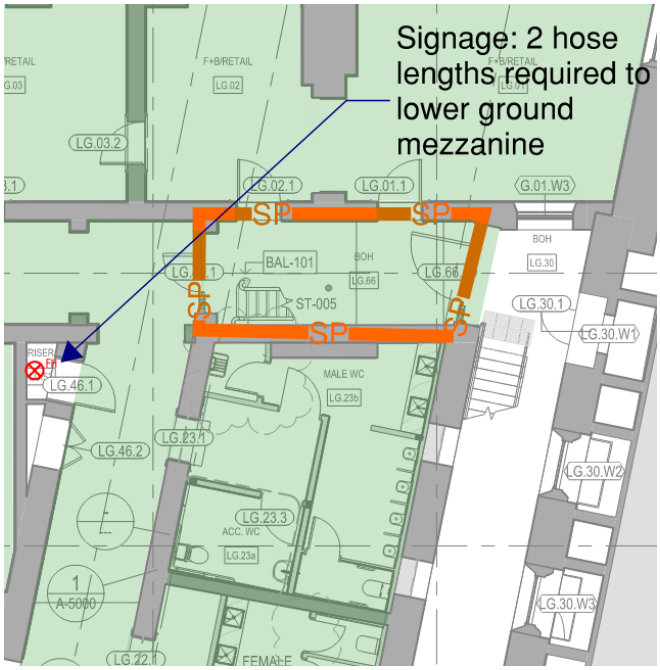
Stantec: Noted these recommendations will be included in the FER.

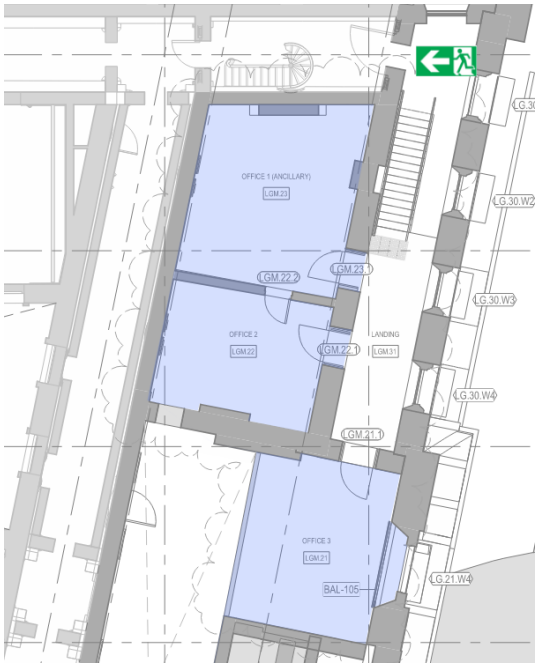
FRNSW Comment: Noted, to be adequately outlined within the FER.

Two (2) hose length of coverage to Lower Ground Mezzanine

Location

As illustrated in the figures below, the subject fire hydrant on Lower Ground level serve the lower ground mezzanine level above, and require two hose lengths for full coverage.





Two lengths of hose coverage to Lower ground mezzanine most remote location

Signage is required at each of the hydrants to inform the brigade that 2 hoses are required to fully cover the Lower Ground Mezzanine. In the event of a fire on the mezzanine level, the attending brigade will locate the hydrants where they will be alerted to the requirement for two hoses. The brigade is afforded to opportunity to set up the hoses while removed from a fire in the mezzanine level by way of the smoke and fire separation respectively, as marked in the figures above.

Fire Safety Measures

Signage

Signage is to be provided at the FCC, FIP and at the level 3 hydrant informing the brigade that 2 hoses are required to fully cover the clocktower. Similarly, signage is required at the FCC, FIP and Lower Ground Floor hydrants informing the brigade that 2 hoses are required to fully cover the Lower Ground Floor Mezzanine level.

Benefits of Sprinklers

The proposed building is to be provided with a sprinkler system throughout, including full coverage of the clocktower. 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. The reliability and efficacy of sprinkler systems has been well researched and shall be further detailed in the FER.

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]. The FER shall contain further details of sprinkler system performance.

Furthermore, by controlling the fire size, the amount of smoke produced is correspondingly also 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. These and associated benefits are to be discussed in the FER.

Fire Rated Construction

Brigade members attending a fire within the clocktower are provided unimpeded access to the Level 3 hydrant as the ceiling above the Level 3 landing achieves a 120 FRL.

Conclusion

The above qualitative analysis has examined the fire hazards and fire safety measures provided within the throughout the Lands building. It has been shown that the altered hydrant provisions will facilitate the brigade in extinguishing a fire within these areas, and thus the acceptance criteria has been met.

Performance solution:

☑ A0.3(a)(i) - Comply with the performance requirements
☐ A0.3(a)(ii) - Be at least equivalent to the DtS provisions

Assessment methods:

☐ A0.5(a) - Evidence of suitability
☐ A0.5(b)(i) - Verification methods in the NCC
☑ A0.5(b)(ii) - Other verification methods
☐ A0.5(c) - Expert judgement
☐ A0.5(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 criteria for this solution is that fire brigade operations in the clock tower are adequately supported by the buildings hydrant system.

Fire scenarios and design fire parameters:

A scenario to be considered is the ability of emergency services to supress a fire occurring on the upper most floor of the clocktower.

Describe how fire brigade intervention will be addressed or considered:

Upon arrival to the buildings the brigade is informed by signage at the FCC and sub FIP that they will require two hoses for a fire within the clocktower. Brigade members attending a fire within the clocktower are provided unimpeded access to the Level 3 hydrant as the ceiling above the Level 3 landing achieves a 120 FRL. The fire rated ceiling provides the brigade with protection from any fire or debris that may otherwise fall onto the Level 3 landing, compromising fire brigade access to the hydrant. As fire fighters are protected from a fire occurring within the clocktower, they will be able to safely set up any required equipment, including two hoses if required to travel to the top of the clocktower. They can then systematically travel up the clocktower as required.

In the event of a fire on the mezzanine level, the attending brigade will locate the hydrants where they will be alerted to the requirement for two hoses. The brigade is afforded to opportunity to set up the hoses while removed from a fire in the mezzanine level by way of the smoke and fire separation respectively.

As discussed earlier, the above fire safety measures provides appropriate notification for the fire brigade to undertake intervention activities to safely extinguish the fire on Level 4 area. Further the limitation of the outdoor furnishing minimise the risk of severe fire development to areas that are open and not sprinkler protected.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

Provide details on proposed modelling/assessment tools:

NA

FRNSW Comment: In principle support is provided subject to the analysis in the FER demonstrating compliance with the performance requirements of the NCC.

Issue number: 15 **Title:** Omission of FRLs to top part of Northern Dome and Tempiettos

Details of departures from DtS provisions:

~~To permit the omission of FRLs to the floor and secondary elements of the Level 4 Dome room (4.01).~~ To permit the omission of FRLs to the top part of the Northern Dome and Tempiettos.

Applicable DtS provisions:	C1.1, Spec C1.1	Performance requirements:	CP1, CP2, EP2.2

List key fire safety measures:

- Automatic Fire Suppression System is to be installed throughout the building, designed and installed in accordance with AS2118.1 – 2017 with the exception of the Performance Solutions identified within this document and Education Building.

Proposed alternative solution:

BCA Comparison

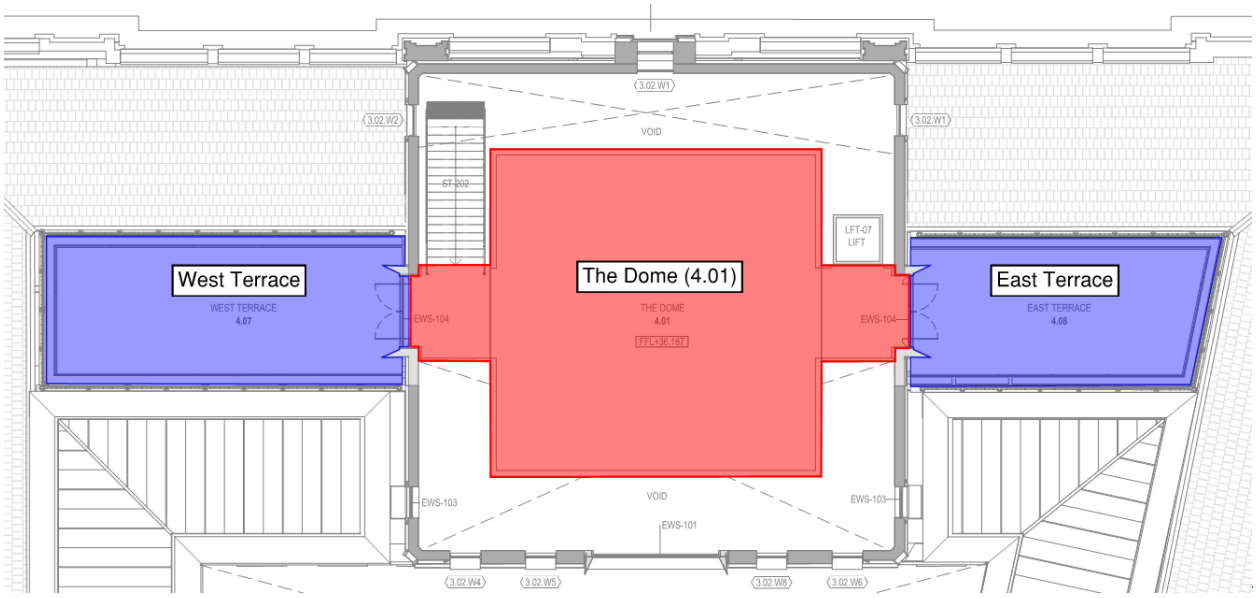
The following BCA Clauses apply to this performance solutions:

- Clause C1.1 defines the type of construction required by the building.
- Specification C1.1 outlines the specific FRL requirements for each building element.

The intent of these clauses is to provide a building with elements which will maintain the structural stability of the building during a fire and to avoid the spread of fire within and between buildings.

Qualitative Assessment

~~The design of The Dome (Room 4.01, referenced upper dome from here) is such that it is entirely contained within the room below, The Dome (Room 3.02, referenced as the lower dome from here), and connected by a perimeter void space with access to the adjacent terraces as seen below in Figure 34 below.~~



~~Figure 34: The Dome (4.01) location.~~

~~This performance solution permits the omission of an FRL from the secondary elements and floor of the upper dome through a qualitative analysis. The primary structural elements and columns are to be constructed to be DtS, fire rated in accordance with BCA Specification C1.1.~~

~~The hazard associated with removal of these FRLs is the potential increase in fire spread to or from the room and the potential that occupant egress may become compromised. These hazards are addressed in the qualitative considerations outlined below.~~

As illustrated in Figure 35, room 3.02 and 4.02 are enclosed by the northern dome of the Lands building. This dome enclosure is deemed to be the lower part of the northern dome. Above the lower part consists of a small top dome with multiple window openings along the external wall. The top dome consists of another room where it is not a public space for any Class 9b use. The area is restricted only to maintenance personnel where it is limited to

maintenance works of electrical services in this space. The space is not used for any storage and will be listed as a management in use provisions for no storage within the top parts of the northern dome.

FRNSW Comment: The abovementioned Management In Use Procedure to prohibit storage within the top dome structure is to be listed as an Essential Fire Safety Measure, to be included on the Fire Safety Schedule.

Stantec: Noted, will include under Management in Use provisions.

FRNSW Comment: Noted.

The existing construction of the top dome consists of sandstone external walls with existing timber wall linings and floor structure. The top dome is provided with fire sprinkler protection and the extent of sprinkler protection terminates at the point where the top dome roof begins i.e. no sprinkler protection to the underside of the top dome roof.

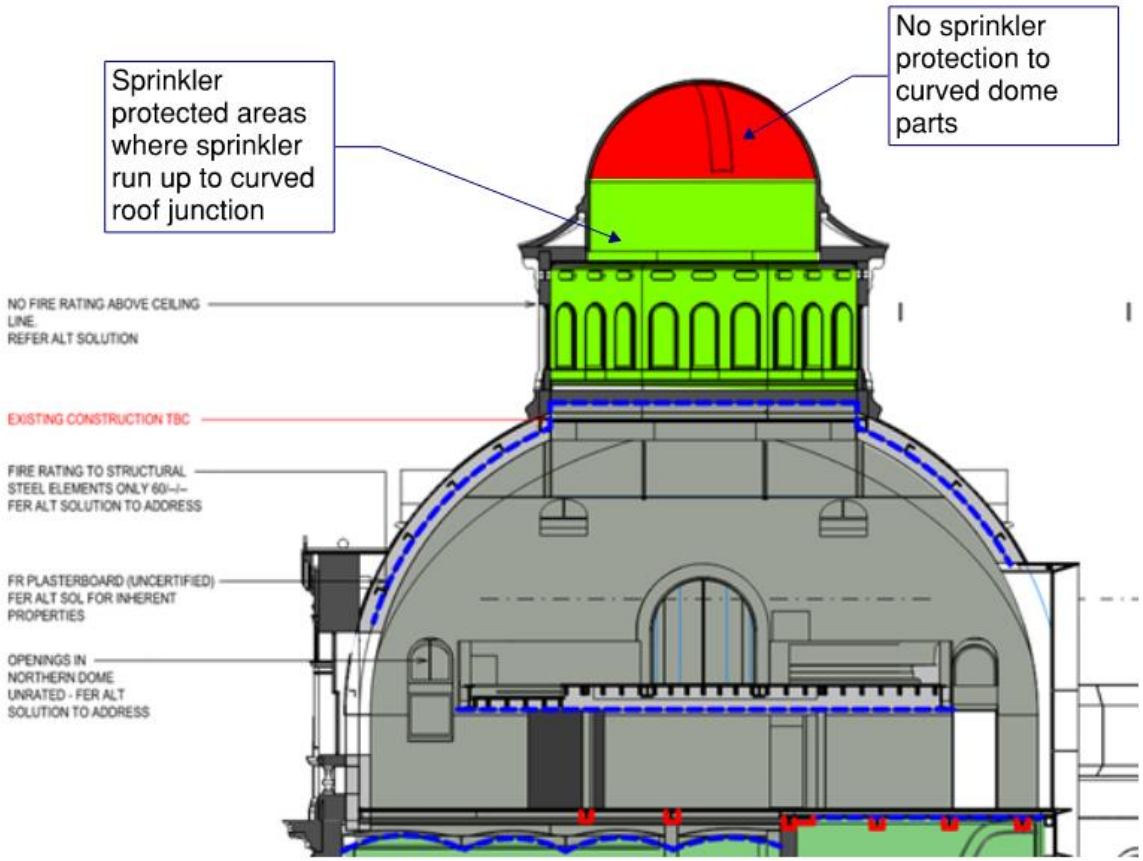


Figure 35 – Northern dome section view

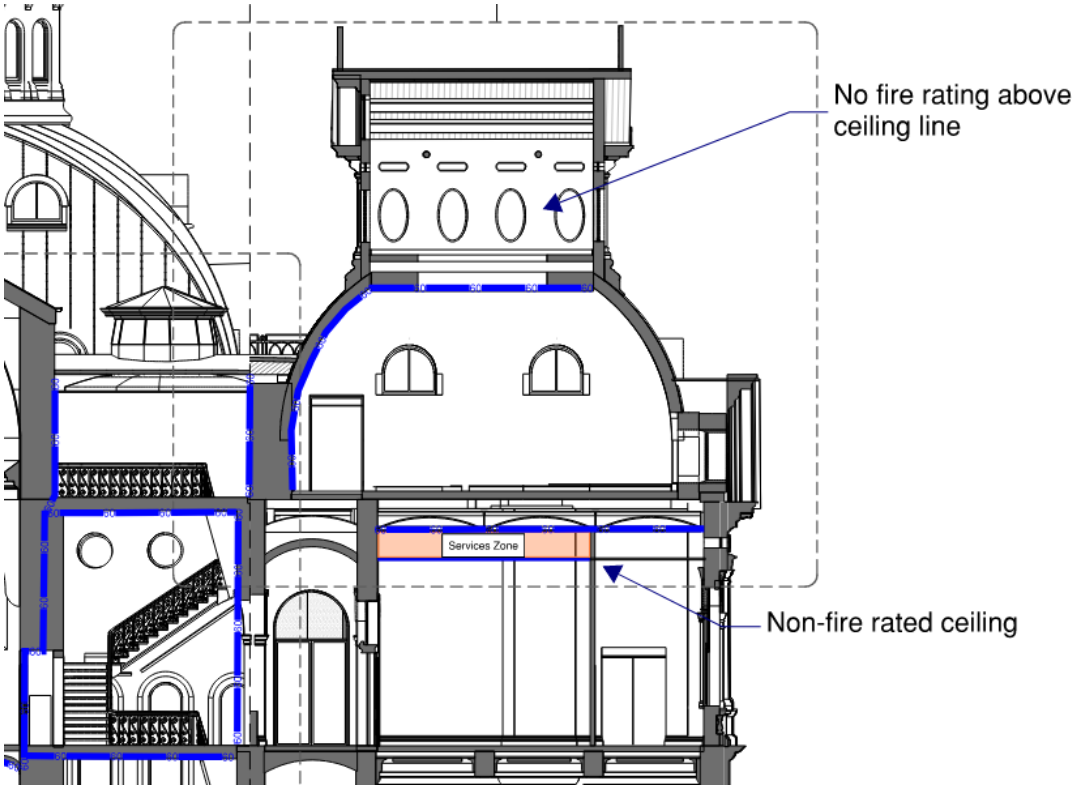


Figure 36 – East tempietto section view

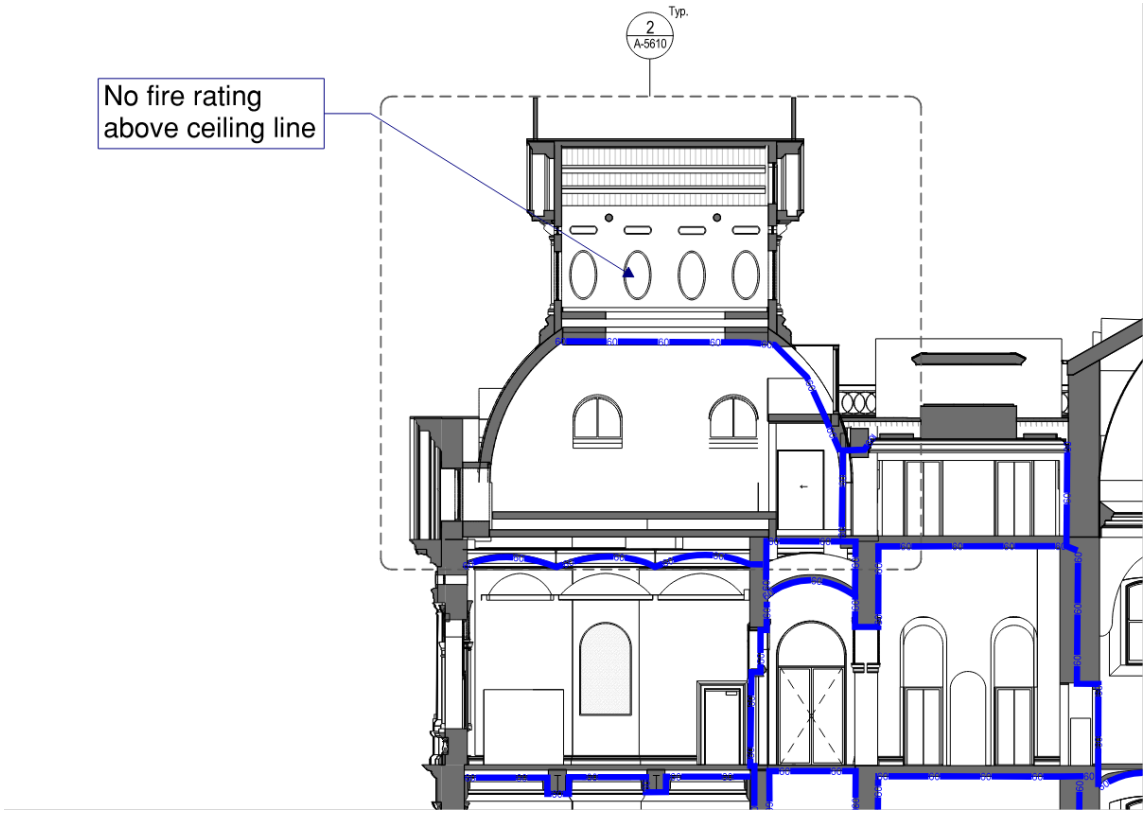


Figure 37 – West tempietto section view

The structural elements of the lower part of the dome and tempiettos and Level 4/mezzanine floor are required to achieve a minimum FRL of 60 minutes (consistent with the rationalisation of FRLs to Class 9b parts of the building). In addition as part of the Performance Solution to support the deletion of FRLs to the top part of the northern dome and tempiettos, a 60 minute FRL fire-rated ceiling to the underside of the top part floor structure is required. The proposed fire rating to structural steel elements and ceiling structure provides a level of fire separation between the occupied spaces and non-occupied spaces of the northern dome. Passive separation and

active suppression are provided limited the risk of fire spread from areas of higher fire risk (occupied zone) to the areas of lower fire risk (unoccupied no storage top part of the northern dome). It is recognised with the management in use provisions and restricted access to the top part of the dome, the risk of fire spread from the top part of the dome to the lower part is considered minimal.

Fire Scenario

~~Both~~ Occupied areas of Level 4 northern dome and tempiettos ~~rooms~~ are sprinkler protection throughout with the exception of the top part of the northern dome where it is partially sprinkler protected, and other areas identified within this document, reducing the growth and impact of a fire. The benefits of providing sprinkler are outlined below.

Benefits of Sprinklers

The proposed building is to be provided with a sprinkler system throughout, including full coverage of the clocktower with the exception of identified Performance Solutions within this document and Education Building. 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. The reliability and efficacy of sprinkler systems has been well researched and shall be further detailed in the FER.

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]. The FER shall contain further details of sprinkler system performance.

Furthermore, by controlling the fire size, the amount of smoke produced is correspondingly also 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. These and associated benefits are to be discussed in the FER.

Occupant Egress

~~The omission of FRLs to the secondary elements and floor of the upper dome presents the hazard that a fire may grow large enough that it either spreads fire to the room above or compromises a structural element, affecting egress from Level 4. As explored above it is unlikely that a fire capable of this will occur due to the sprinkler system in the building limiting the size and temperature of the fire. In the unlikely event that such a fire did occur, the safety of the building occupants would still be maintained as occupants are provided egress from the area before collapse would occur.~~

As discussed earlier, the top part of the northern dome and tempiettos is a restricted area to maintenance personnel only. As such, the expected number of occupants within these areas can be considered to be no more than two occupants. As part of the management-in-use provisions, any persons requiring accessing to these restricted areas are to be trained to be aware of the emergency protocols within these areas. Maintenance personnel are to be equipped with a two way radio for any communication with other personnel i.e. security. This measures provides an appropriate means of notification of any emergency incidents within the northern dome, tempiettos or any part of the building where the alarm may not have been cascaded to the relevant areas of the building. The early means of notification provides the occupant within the top part of the northern dome and tempiettos to safely evacuate the area and reach a place of safety on Level 4.

A fire initiating in the area under the upper dome will be visible to occupants in both rooms. Occupants will identify the fire and smoke and immediately begin evacuating. Given their early detection of the fire, all occupants will have evacuated from the area while the fire is in its infancy. It is expected that occupants from other compartments will not travel into the compromised area as both adjacent compartments have direct access to a fire stair. Any that do travel into the compromised compartment will identify the smoke and fire and not egress through the room, instead traveling to an alternate exit.

FRNSW Comments are as follows:

- It is recommended that the assessment considers fire spreading in both directions (i.e. from the upper to the lower dome portions, and vice versa) in order to adequately address Performance Requirement CP1 within the performance solution.

- It is assumed that the reference to a fire in the upper dome being visible to "both rooms" refers to the upper and lower dome compartment. This is to be clarified. In the event that the rooms referred to are in fact the upper and lower dome portions, it is to be outlined how a fire in the upper dome will become apparent to occupants on the lower dome given that there are only void portions around the perimeter.

As no occupants will be within the room after the initial evacuation, if a fire grows large enough to compromise the structure of the upper dome it will not endanger any occupants.

FRNSW Comment: Given the potential for secondary elements to catch fire, it is to be outlined whether there will be any additional provisions for occupants situation on either the West or East Terrace to undertake initial attack on the fire. This is to be addressed.

Stantec: This will be further discussed in Performance Solution addressing additional hose length providing coverage to the West and East Terrace area.

FRNSW Comment: Noted.

Fire Brigade Intervention

The omission of FRL to the ~~floor and secondary support elements of the upper dome~~ top part of the northern dome presents the hazard that by the time the brigade reaches the building, the fire could have grown large enough to compromise the structure of ~~the room~~ the top part of the northern dome. This presents the hazard that travel onto level 4 may be compromised, preventing brigade members from accessing the area.

If by the time the brigade reaches the fire it has grown large enough to compromise the ~~structure of the upper dome~~ accessibility to the top part of the northern dome, they will identify the hazard from a fire of this size and not directly attack the fire from within the room. Instead they will utilise alternate methods such as dousing from the street or other areas of the building.

As the brigade will not enter an area with such a fire, it is considered that the hazard to the brigade members is mitigated.

Conclusion

The qualitative consideration above shows that the omission of a FRLs from the ~~floor and secondary elements of the upper dome~~ top parts of the northern dome will not endanger occupants or the brigade and as such compliance with performance requirement CP1 and EP2.2 is achieved.

Performance solution:

- ☑ A0.3(a)(i) - Comply with the performance requirements
- ☐ A0.3(a)(ii) - Be at least equivalent to the DtS provisions

Assessment methods:

- ☐ A0.5(a) - Evidence of suitability
- ☐ A0.5(b)(i) - Verification methods in the NCC
- ☑ A0.5(b)(ii) - Other verification methods
- ☐ A0.5(c) - Expert judgement
- ☐ A0.5(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 criteria for this solution is that the omission of the FRLs does not compromise occupant evacuation or brigade intervention.

Fire scenarios and design fire parameters:

The solution considers a fire in the lower dome causing fire spread to the underside of the upper dome.

Describe how fire brigade intervention will be addressed or considered:

As discussed above, a fire large enough to compromise the structure of the level 4 dome will be identified by the brigade who will use alternate methods such as dousing from the street or other areas of the building to fight the fire.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

Provide details on proposed modelling/assessment tools:

NA

FRNSW Comments are as follows:

- Given that the performance solution relies heavily on the operation of the abovementioned sprinkler system, it is to be adequately outlined how the reliability of the sprinkler system will be increased/maintained, such that correct functionality of the sprinkler system is ensured in the event of a fire scenario.
- Based on the architectural drawings received with the V01 FEBQ (drawings ref: V04 :Draft Coordination Issue" dated 07/08/2019) it is noted that occupants from the West and East Terrace would be required to travel into the upper Dome region to access the fire stair leading to Level 3 below. As such, the ability for occupants to safely egress in the event of a fire on either the upper or lower dome portion is to be addressed within the performance solution, in order to adequately satisfy the applicable Performance Requirements.
- In regards to the structural adequacy of the dome and secondary structures, it is recommended that a structural engineer verify any assumptions made in the analysis on the performance of the structure and confirm that the proposed Alternative Solution has no other impacts on the structural design. The Structural Engineer should also confirm that the structural design is consistent with and incorporates all requirements of the Alternative Solution

Stantec: The proposed performance solution now address the deletion of FRL to the top part of the northern dome and tempiettos . All occupied areas will achieve a minimum FRL of 60 minutes for Class 9b use areas. Occupants throughout Level 3 areas including the East and West terrace are afforded with a minimum FRL of 60 minutes and sprinkler protection to safely evacuate the floor level.

FRNSW Comment: FRNSW acknowledge the inclusion of passive and active measures as part of the performance solution, namely the inclusion of a 60-minute FRL for the Class 9b use areas as well as sprinkler protection throughout the occupied levels.

FRNSW Comment: In principle support is provided subject to the following:

- The analysis in the FER demonstrating compliance with the Performance Requirements of the NCC.
- The comments provided by FRNSW above being addressed satisfactorily.

Issue number: 16 **Title:** Extended Travel Distances

Details of departures from DtS provisions:

To permit the following extended travel distances:

- Lower Ground Club Kitchen – up to 22m to a point of choice and no more than 41m to the nearest exit
- Lower Ground Mezzanine Male W/C – up to 30m to a single exit
- Level 3 – up to 32m to a single exit
- Ground, Level 1 and Level 3 – up to 62m between alternative exits.
- Level 4 outdoor spaces

FRNSW Comment: The exact non-compliant extended travel distance from the Level 4 outdoor spaces is to be detailed within the FER.

Stantec: Noted. Refer to figure below of updated figure with travel distance. Level 4 outdoor space has an extended exit travel distance of up to 27m to the exit.

FRNSW Comment: Noted, this is to be adequately outlined as part of the FER.

Applicable DtS provisions:	D1.4, D1.5	Performance requirements:	DP4, EP2.2

List key fire safety measures:

- Automatic Fire Suppression System is to be installed throughout the building, designed and installed in accordance with AS2118.1 – 2017 with the exception of Performance Solutions identified within this document and Education Building.
- An automatic detection system is to be provided in the building in accordance with BCA Spec. E2.2a and AS 1670.1–2018 and the following:
  - Reduced 10m x 10m grid spacing to below ceiling smoke detectors

Proposed alternative solution:

Qualitative Assessment

Level 4 outdoor spaces

The following qualitative assessment addresses the extended travel distances from the Level 04 outdoor spaces, indicated on Figure 38 below.

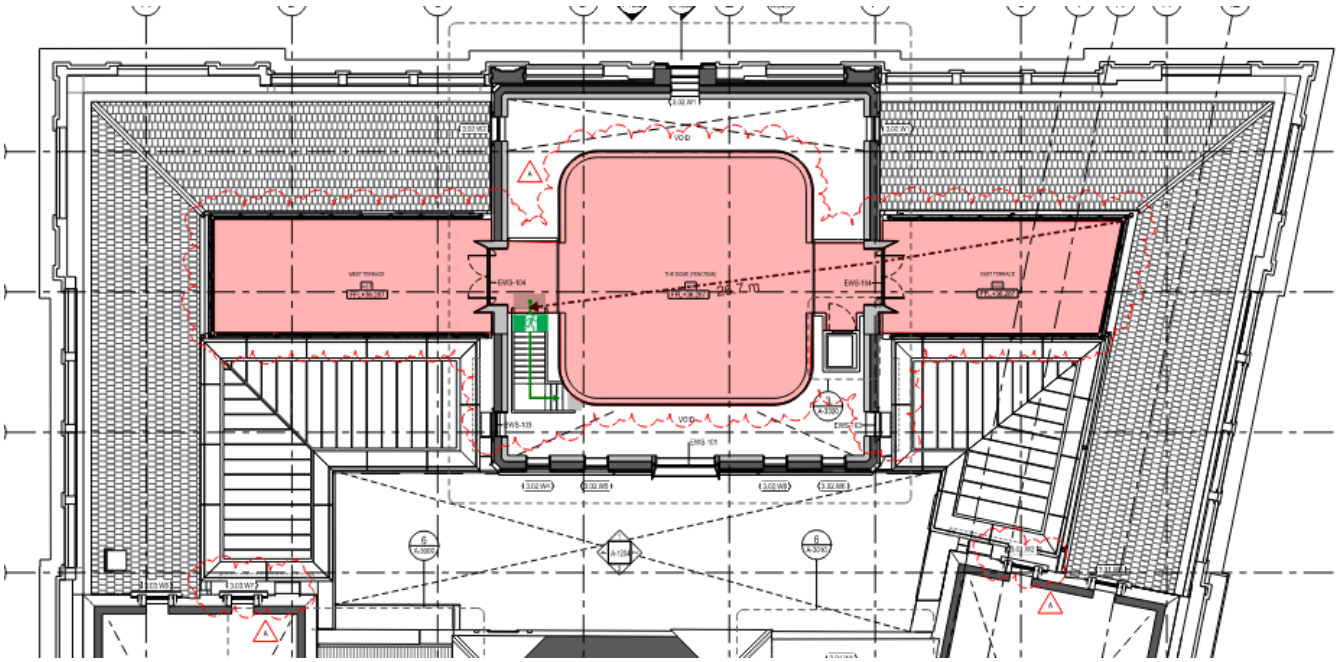


Figure 38 – Level 04 extended travel distances

Stantec: figure above updated highlighting 27m to the single exit from the outdoor terrace space.

As shown in the figure above, extended travel distances exist in the outdoor areas of Level 04. Due to the outdoor nature of the spaces, any heat and smoke from a fire in these areas will vent away to the environment and away from the egress path, thereby preventing heat and smoke from accumulating and causing untenable conditions for occupants. Occupants are provided with clear sight lines to the exit, and will be familiar with the egress path as they would have used to the stairs to access the outdoor space. Furthermore, while the travel distances is extended, the queue times at exits will not be increased. Therefore, it is considered that the egress from the Level 04 outdoor areas meets the intent of Performance Requirements DP4 and EP2.2, given that occupants will not be exposed to untenable conditions during egress.

FRNSW Comment: In principle support is provided subject to the following:

- The analysis in the FER demonstrating compliance with the Performance Requirements of the NCC.
- The comments provided by FRNSW within Issue Number 4 being addressed satisfactorily.

Quantiative Assessment

General Building Areas

The following quantitative assessment will perform an RSET/RSET analysis to show that through the provision of decreased detector spacing in comparison to a DtS design the proposed design compensates for the extended travel distance through an earlier alarm. It has been shown that by providing an earlier alarm upon the initiation of a fire, occupants are afforded with an equivalent degree of safety in comparison to a DtS design. The assessment meets the performance requirements if it is shown that the RSET (Required Safe Evacuation Time) of the proposed design is less than or equal to the RSET of a DtS design. The maximum travel distance is to be used for each area to account for a worst-case scenario.

Research by Proulx (SPFE, 2016), indicates a travel speed of 1.0 – 1.3 m/s for able-bodied people in moderately crowded situations, and 0.8 m/s for people with mobility disabilities. As a reasonable design parameter, the unimpeded walking speed of a person has been taken as 0.8 m/s to assess travel time, in order to account for a worst case scenario.

To justify the increases in travel time due to lay out across the levels of the proposed development smoke detection is provided over a grid spacing of 10 x 10 m throughout the building. Further, the distance of the opening of the sensing element shall be within 25 – 50 mm from the ceiling. Alpert's ceiling jet correlation will be used to calculate the activation times for both the DtS and proposed designs. The input parameters for smoke detection are documented in Table 9 and Table 11 below. Two scenarios are calculated to rationalise the extended travel distances, one assessing a fire on the Lower Ground Floor Mezzanine and one assessing a fire in the general building spaces. The general building spaces calculation uses the ceiling height of the club kitchen to provide a worst case result in increased detection time as it has the lowest ceiling height of the extended travel areas. It is noted however that most areas of the building have ceiling heights exceeding 4m and will produce large difference in travel time than those calculated below, providing additional egress time for occupants.

The additional time provided to activation will be shown to offset the additional time for an occupant to travel to an exit thus maintaining equivalent egress conditions along the egress route as a DtS design ($RSET_{proposed} \leq RSET_{DtS}$).

Table 9 - Input Parameters for Lower Ground Mezzanine detector activation

	DtS Design	Proposed Design
Detector Spacing[1] (m)	15 x 15	10 x 10
Fire Growth Time[2] (s)	300	
Ceiling Height[1] (m)	2.0	
Fuel Height[3] (m)	0.5	
Ambient Temperature[4] (°C)	20	
Detector Activation Temperature[5] (°C)	33	33
Detector Activation Time[5] (s)	79	65

1. Based on proposed design and building plans.
2. Based on a medium growth rate fires time to grow to 1055kW fire. CIBSE Guide E suggests a medium growth rate for Office areas.
3. A standard 0.5m FFL 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

Table 10 - Input Parameters for Lower Ground Club Kitchen detector activation

	DtS Design	Proposed Design
Detector Spacing[1] (m)	15 x 15	10 x 10
Fire Growth Time[2] (s)	150	
Ceiling Height[1] (m)	3.3	
Fuel Height[3] (m)	0.5	
Ambient Temperature[4] (°C)	20	
Detector Activation Temperature[5] (°C)	33	33
Detector Activation Time[5] (s)	55	45

1. Based on proposed design and building plans.
2. Based on a fast growth rate fires time to grow to 1055kW fire. CIBSE Guide E suggests a fast growth rate for retail areas.
3. A standard 0.5m FFL 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

As can be seen in the results below, the proposed design offers a faster detector activation, and therefore alarm times, than a comparable DtS compliant design. The table below compares the RSET for both a DtS compliant design and the proposed design. The proposed design provides occupants with a greater egress time than in a DtS design.

Table 11 - Comparison of RSET between DtS and proposed design

Location		Detector activation (sec)	Travel Time (sec) (0.8 m/s)	Pre Movement Time	RSET (s)
Lower Ground Mezzanine	DtS design (20m)	79	25	Same for both cases	104
	Proposed design (30m)	65	37.5		102.5
Lower Ground Clubs Kitchen – To a Point of Choice	DtS design (20m)	55	25	Same for both cases	80
	Proposed design (22m)	45	27.5		72.5
Lower Ground Clubs Kitchen – To an Exit	DtS design (40m)	55	50	Same for both cases	105
	Proposed design (41m)	45	51.25		96.25
Ground, Level 1 and Level 3 – Between Exits	DtS design (60m)	55	75	Same for both cases	130
	Proposed design (62m)	45	77.5		122.5

Level 3 Plant Roof space

The areas on Level 3 from which the extended travel distances stem are used solely as plantroom type areas for the housing of equipment and machinery used for the operation of the building. The occupants in these areas are therefore expected to only be maintenance workers and contractors who are working on the machinery located within. Due to the nature of maintenance work, it is reasonable to assume that the occupants will be able bodied, mobile and awake. The plant roof space is only expected to be in use during scheduled maintenance and is not open to the public or general staff of the building. As such, the expected population density will also be low and therefore queueing at egress door or within paths of travel is considered to be highly unlikely.

The risk presented to egressing occupants of the extended travel distance between alternate exits is the low possibility of one exit becoming blocked or untenable. However, the nature of plantrooms indicates a low fuel load density as most of the components are made up of metal. Therefore, a fire being sustained within the plantroom is unlikely to occur. Should a fire occur, occupants would recognise the danger if it were in their immediate surroundings or be alerted by the detection and alarm system installed throughout the development and move towards an exit before conditions became untenable along the egress path.

Research by Proulx (SPFE, 2016), indicates a travel speed of 1.0 – 1.3 m/s for able-bodied people in moderately crowded situations, and 0.8 m/s for people with mobility disabilities. As a reasonable design parameter, the unimpeded walking speed of an occupant within the roof space has been taken as 1 m/s to assess travel time, to account for a real case scenario.

The design with 10 x 10 m detector spacing is compared to the DtS design with 15 x 15 m detector spacing in circulation spaces using Alpert's correlation to find the difference in alarm time. This calculation subtracts the change in detection time from the additional evacuation travel time in order to show that the non-compliant travel distances meet the intent of the BCA as time taken to travel to a point of choice and to the nearest exit from the initiation of a fire will be less than or equal to that of a DtS design.

Table 12 - Input Parameters for Level 3 roof space detector activation

	DtS Design	Proposed Design
Detector Spacing[1] (m)	15 x 15	10 x 10
Fire Growth Time[2] (s)	150	
Ceiling Height[1] (m)	2.6	
Fuel Height[3] (m)	0.5	
Ambient Temperature[4] (°C)	20	
Detector Activation Temperature[5] (°C)	68	68
Detector Activation Time[5] (s)	51	42

1. Based on proposed design and building plans.
2. Based on a fast growth rate fires time to grow to 1055kW fire.
3. A standard 0.5m FFL 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

As can be seen in the results below, the proposed design offers a faster detector activation, and therefore alarm times, than a comparable DtS compliant design. The table below compares the RSET for both a DtS compliant design and the proposed design. The proposed design provides occupants with a greater egress time than in a DtS design.

Table 13 - Comparison of RSET between DtS and proposed design

Location		Detector activation (sec)	Travel Time (sec) (1 m/s)	Pre Movement Time	RSET (s)
Level 3 Plant	DtS design (20m)	51	25	Same for both cases	76
	Proposed design (32m)	42	32		74

Furthermore, as required in throughout this document, the following management in use requirements are to be implemented for the Level 3 roof space;

Any person who requires access to the Level 3 plant roof spaces or Roof Terraces must understand and adhere to the following requirements and be inducted by building management. The management in use requirements are to be recommunicated to employees on a yearly basis.

- Any person/s that accesses the Plant roof spaces or Roof Terraces must be able bodied.
- Any person that accesses the Plant roof spaces or Roof Terraces must be accompanied by a member of building management or security.
- Each person is always required to be equipped with a radio and able to communicate with the other person via the radio.
- The building management / security staff must monitor the space for any fire risk while the other occupants are working. In the event of a fire or emergency requiring evacuation, the occupant must inform the others that evacuation is required at which point all occupants are to immediately evacuate into the fire stair and discharge from the building.

Conclusion

The quantitative analysis above uses comparative verification to show that the design is capable of providing egress within the same time as a comparable DtS design. As such, it can be said that Performance Requirements DP4 and EP2.2 have been met.

Performance solution:

☑ A0.3(a)(i) - Comply with the performance requirements
☐ A0.3(a)(ii) - Be at least equivalent to the DtS provisions

Assessment methods:

☐ A0.5(a) - Evidence of suitability
☐ A0.5(b)(i) - Verification methods in the NCC
☑ A0.5(b)(ii) - Other verification methods
☐ A0.5(c) - Expert judgement
☐ A0.5(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 will be said to have met the acceptance criteria if it is able to be shown that either:

- Occupants are able to egress within the equivalent time of a DtS compartment; and
- Occupants are not subject to untenable conditions during egress.

Fire scenarios and design fire parameters:

The fire hazard relating to this performance solution is the exposure of occupants to untenable egress conditions due to an increased evacuation time in the areas where extended travel distances are required.

Describe how fire brigade intervention will be addressed or considered:

It is expected that occupants are able to evacuate in a time whereby tenable conditions are maintained and so it is unlikely that the brigade will be required to conduct search and rescue within the identified areas.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

Provide details on proposed modelling/assessment tools:

NA

FRNSW Comment: In principle support is provided subject to all analysis inputs and assumptions being detailed in the FER and agreed upon by all relevant stakeholders, and the analysis demonstrating compliance with the Performance Requirements of the NCC.

Issue number: 17 **Title:** Rationalisation of sprinkler system

Details of departures from DtS provisions:

To permit the removal of sprinklers to following locations:

- Switchrooms.
- Top half of northern dome

Applicable DtS provisions:	E1.5	Performance requirements:	CP2 and EP1.4

List key fire safety measures:

- Automatic Fire Suppression System is to be installed throughout the building, designed and installed in accordance with AS2118.1 – 2017 with the exception of switchroom
- An automatic detection system is to be provided in the building in accordance with BCA Spec. E2.2a and AS 1670.1–2018 and the following:
  - Reduced 10m x 10m grid spacing to below ceiling smoke detectors
- Switchroom is to be fire separated from the remainder of the building achieving a minimum FRL fo 120 minutes.

Proposed alternative solution:

Qualitative Assessment

Location and use

As shown in the figure below, the switchroom is located on Lower Ground Floor at the south east corner of the building. The switchroom is accessible via two locations and the bounding construction of the switchroom is to achieve a minimum FRL of 120 minutes.

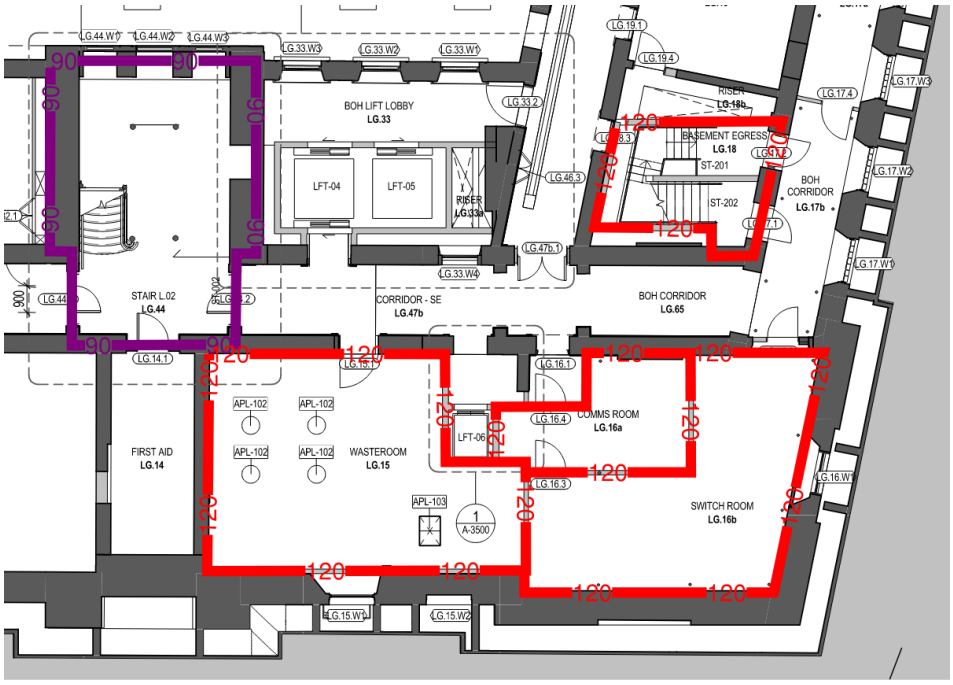
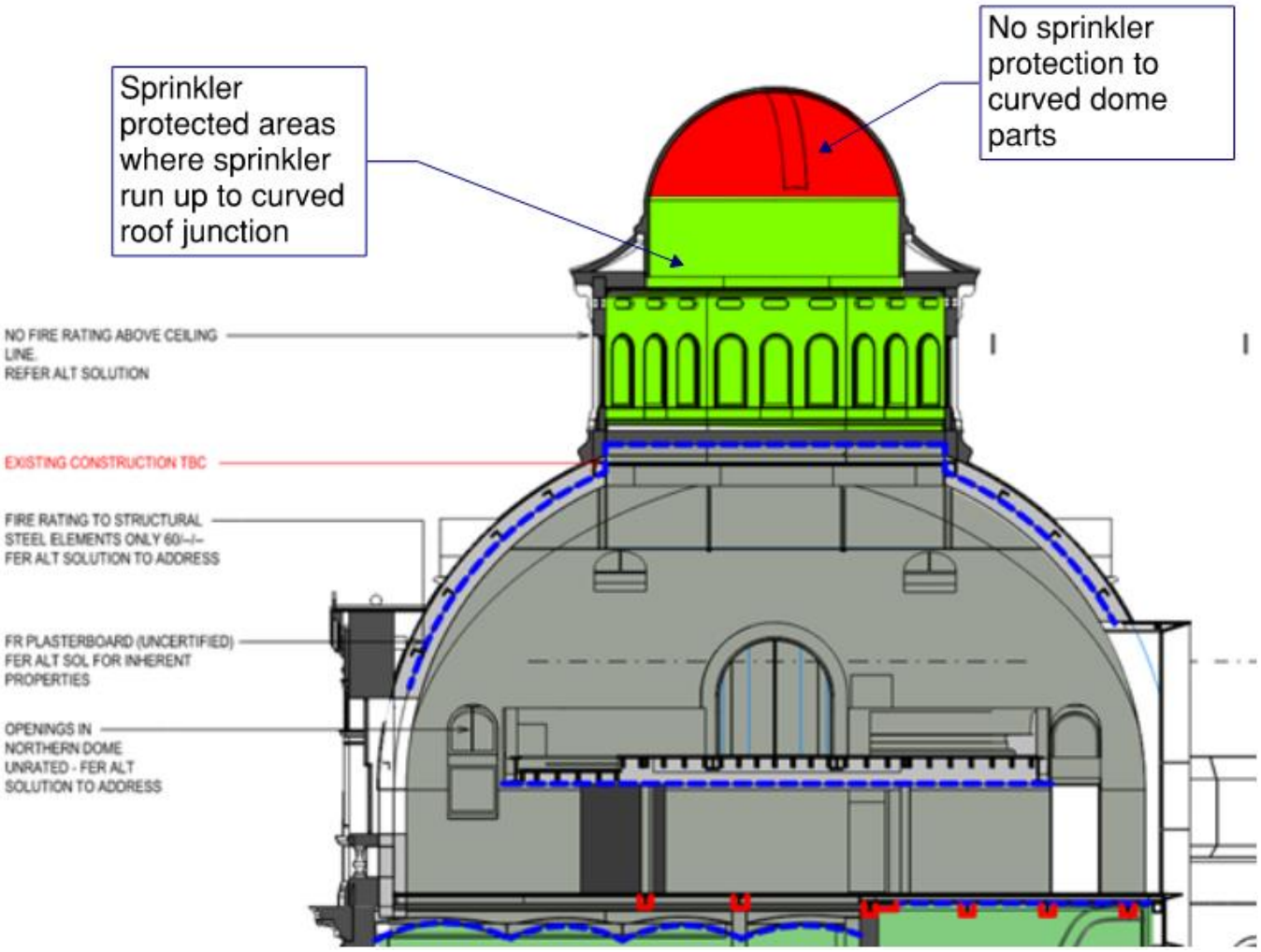


Figure 39 – Switchroom on Lower Ground

The top dome is provided with fire sprinkler protection and the extent of sprinkler protection terminates at the point where the top dome roof begins i.e. no sprinkler protection to the underside of the top dome roof.



Northern dome section view

Fuel Load

The expected fire load within the services rooms with the exception of the specific equipment is very low. The main combustible fuel load expected within the services room is the electrical components, which also act as potential ignition sources. Rubbish and other combustible materials are not expected to accumulate due to the sterile nature of the services rooms. In the event of a fire within any of the services rooms, the risk of fire spread to the remainder of the floorplate is expected to be low given the required level of fire separation and unlikely for fire spread to the adjoining areas where it will over-ride the sprinkler system. However, there is a potential for smoke to spread via the doorways. The risk of smoke spread is equivalent to a Deemed-to-Satisfy solution. In this instance and as part of the Performance Solution, the identified rooms will be provided with a smoke detection system in lieu of a sprinkler system.

By extending the automatic fire detection system into the affected areas, a developing fire would be expected to be detected in a manner over and above what a high-level sprinkler head would detect a fire, since the system is addressable. The automatic detection system is interconnected to the Emergency Warning and Intercom System (EWIS). Upon fire detection, the EWIS shall provide a General Fire Alarm (GFA) which will alert occupants and initiate call out to the fire brigade.

As noted in AS 2444, water must not be used in electrical fires. This is primarily due to the conductivity of water and the increased risk of electric shock to any occupants or fire brigade personnel. As such, a regular sprinkler system is inappropriate in this application.

As discussed in detail in Issue Number 15, the existing construction of the top dome consists of sandstone external walls with existing timber wall linings and floor structure. The top dome is provided with fire sprinkler protection and the extent of sprinkler protection terminates at the point where the top dome roof begins i.e. no sprinkler protection to the underside of the top dome roof.

Occupant numbers

Table D1.13 of the BCA states the expected density of occupants within a plant room area is 30 m2 per person. Using this density, it can be found the maximum population expected within the identified rooms is up to two (2). Considering the low population anticipated within these areas, it would be expected there would be no queuing at the exit door of the identified rooms. As discussed earlier occupants are afforded with multiple paths of egress to reach the available fire-isolated exits. Occupants would therefore be expected to be able to safely evacuate the level before the limits of tenability were reached in the case of a fire within the switchroom.

As discussed in Issue number 15, the top part of the northern dome is a restricted area to maintenance personnel only. As such, the expected number of occupants within these areas can be considered to be no more than two occupants. As part of the management-in-use provisions, any persons requiring accessing to these restricted areas are to be trained to be aware of the emergency protocols within these areas. Maintenance personnel are to be equipped with a two way radio for any communication with other personnel i.e. security. These measures provides an appropriate means of notification of any emergency incidents within the northern dome. The early means of notification provides the occupant within the top part of the northern dome to safely evacuate the area and reach a place of safety on Level 4.

Fire Brigade Intervention

The locations of the switchroom without sprinkler protection is located in close proximity to the fire-isolated stairs. As such fire brigade intervention is considered to not be adversely impacted with the deletion of sprinkler protection to the switchroom. The switchroom is fire separated from adjoining areas whereby fire brigade intervention activities can be safely coordinated and attacked.

As discussed in Issue number 15, if by the time the brigade reaches the fire it has grown large enough to compromise the accessibility to the top part of the northern dome, they will identify the hazard from a fire of this size and not directly attack the fire from within the room. Instead they will utilise alternate methods such as dousing from the street or other areas of the building.

As the brigade will not enter an area with such a fire, it is considered that the hazard to the brigade members is mitigated.

Conclusion

It is demonstrated that the risk of fire spread between non-sprinkler protected and sprinkler protected areas is mitigated through the inclusion of the passive measures and smoke detection. Therefore the Relevant Performance Requirements CP2 and EP1.4 is considered satisfied.

Performance solution:

☑ A0.3(a)(i) - Comply with the performance requirements
☐ A0.3(a)(ii) - Be at least equivalent to the DtS provisions

Assessment methods:

☐ A0.5(a) - Evidence of suitability
☐ A0.5(b)(i) - Verification methods in the NCC
☑ A0.5(b)(ii) - Other verification methods
☐ A0.5(c) - Expert judgement
☐ A0.5(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 can be demonstrated that the risk of fire developing and spread from the main comms room, main switchboard room and substation is not increased by the removal of fire sprinkler protection and sufficient warning is provided.

Fire scenarios and design fire parameters:

The fire hazard relating to this performance solution is the risk of fire spread from the switchroom to the adjoining areas due to the removal of fire sprinkler protection. Associated impact to occupant life safety is considered with the removal of fire sprinkler system to switchroom.

Describe how fire brigade intervention will be addressed or considered:

Due to the proposed fire rated construction to the switchroom, appropriate fire brigade activities can be undertaken prior to attacking the area of fire origin i.e. switchroom.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

Provide details on proposed modelling/assessment tools:

NA

FRNSW Comments are as follows:

- In relation to the omission of sprinklers to the switchrooms, in principle support is provided subject to the following:
    - The analysis in the FER demonstrating compliance with the Performance Requirements of the NCC.
    - The doors to the switchrooms being provided with appropriate smoke sealing, to ensure that the ingress of smoke from the switchrooms (in the event of a worst-case credible fire scenario) to the remaining portion(s) of the floorplate is appropriately mitigated.
- In relation to the omission of sprinklers to the top half of the northern dome, in principle support is provided subject to the following.
    - The analysis in the FER demonstrating compliance with the Performance Requirements of the NCC.
    - The comments provided by FRNSW within Issue Number 15 being addressed and considered satisfactorily.

Stantec: Noted. Smoke seals will be provided to the doors to the switchroom.

FRNSW Comment: Noted, to be adequately outlined within the FER.

Issue number: 18 **Title:** Lower Ground and Lower Ground Mezzanine connection

Details of departures from DtS provisions:

To permit the south eastern end of Lower Ground with open connection to the Lower Ground Mezzanine areas without the required floor fire separation.

Applicable DtS provisions:	C1.1, Spec C1.1	Performance requirements:	CP1 and CP2 FRNSW Comment: It is recommended that Performance Requirement EP2.2 also be addressed given the nature of the non-compliance. Stantec: Noted EP2.2 will be assessed against to in the FER. FRNSW Comment: Noted.

List key fire safety measures:

- Automatic Fire Suppression System is to be installed throughout the building, designed and installed in accordance with AS2118.1 – 2017 with the exception of Performance Solutions identified within this document and Education Building
- An automatic detection system is to be provided in the building in accordance with BCA Spec. E2.2a and AS 1670.1–2018 and the following:
    - Reduced 10m x 10m grid spacing to below ceiling smoke detectors
- Lower Ground Mezzanine floor structure to achieve a minimum FRL of 60 minutes

Proposed alternative solution:

Qualitative Assessment

Location and use

As shown in the figure below, the lower ground mezzanine is proposed to be of Class 5 use throughout. The south east parts of the lower ground mezzanine is provided with internal connection to the Lower Ground due to the existing conditions of the building. This is further illustrated in Figure 40 and Figure 41 where the open connection is due to the window openings of the external walls and an internal opening looking down to the Lower Ground corriodr . These locations occur along the public corridor spaces of both Lower Ground and Lower Ground Mezzanine areas.

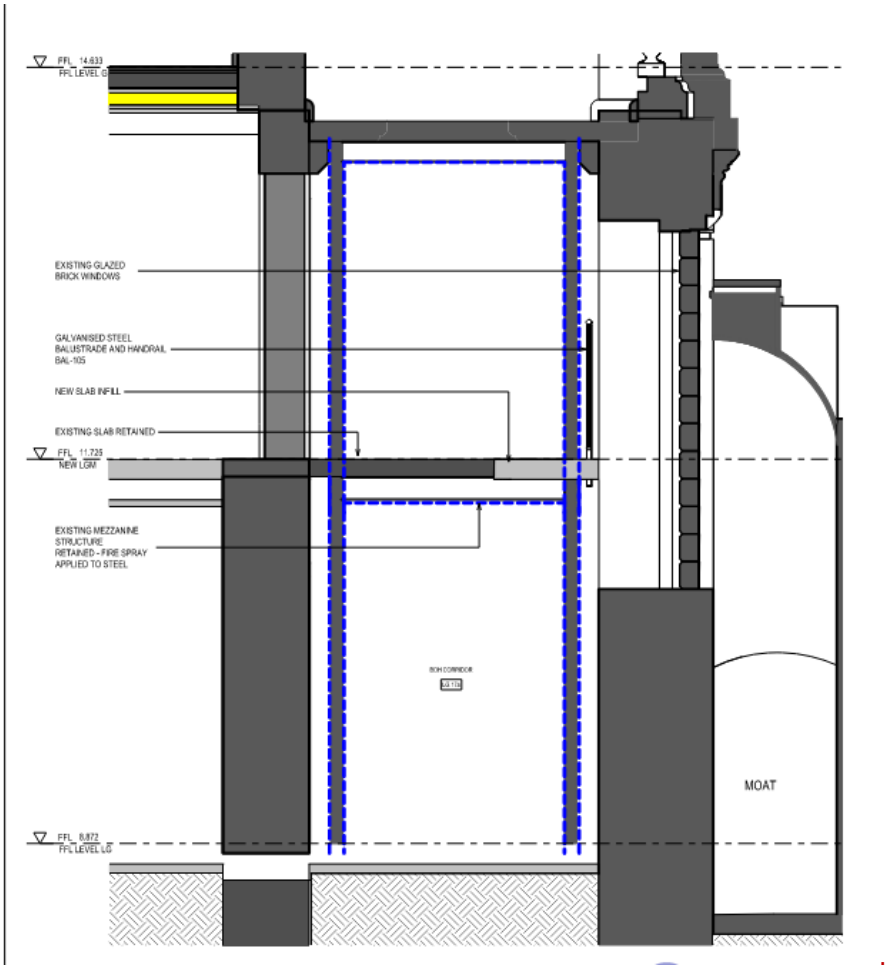


Figure 40 – Lower Ground Mezzanine south east end section view

Figure 41 – Lower Ground Mezzanine uses

Fuel Load

As discussed earlier, the associated uses where the connection between levels occurs are the public corridor spaces. As these spaces are mainly utilised for pedestrian movement, it is expected no storage or the like to occur where it will impede on the daily movements of the building. As such the likelihood of fire spread between levels can be considered low. This is further mitigated with the provisions of fire sprinkler system installed throughout these areas where severe fire development is not expected to occur.

FRNSW Comment: It is recommended that Management In Use Procedures be implemented to ensure that the public corridor spaces remain free of combustibles and/or stored goods. This is to be listed as an Essential Fire Safety Measure, to be included on the Fire Safety Schedule.

Stantec: Noted, in addition portable fire extinguisher will be located in close proximity to exit for efficient means of early manual suppression.

FRNSW Comment: Noted, to be adequately outlined within the FER.

BCA DtS Provisions

It is to be noted in a BCA Dts building of the like i.e. Class 5 or 9b building, connection between the levels is permitted via an non-required non fire-isolated stair as per BCA Clause D1.12 and/or void connection of no more than two levels that does not trigger atrium provisions. It can be considered the open connection via the existing window details of the external wall and internal opening to public corridor below, the fire spread risk characteristic is at an similar acceptable level to a BCA DtS building with an non-required non-fire-isolated stair or two storey

atrium. The total floor area with the two levels connected will not exceed the maximum allowable fire compartment area and volume sizes for Class 5 or Class 6 uses.

Fire Safety Measures

As part of the Performance Solution, the floor of the Lower Ground Mezzanine is to achieve a minimum FRL of no less than 60 minutes. This provides an acceptable level of safety whereby occupants on Lower Ground Mezzanine can safely reach the single exit in addition to the improvements of smoke detection spacing to allow for early warning. The associated performance solutions of extended exit travel distances and single exit is addressed in Issue Number 4 and Issue Number 16 respectively.

Conclusion

It is demonstrated that the risk of fire spread between Lower Ground and Lower Ground Mezzanine is at an level similar to a BCA DtS building where it is permitted to be connected with an non-required non fire isolated stair and/or an atrium connecting no more than two levels. Therefore, the Relevant Performance Requirements CP1 and CP2 is considered satisfied.

Performance solution:

☑ A0.3(a)(i) - Comply with the performance requirements
☐ A0.3(a)(ii) - Be at least equivalent to the DtS provisions

Assessment methods:

☐ A0.5(a) - Evidence of suitability
☐ A0.5(b)(i) - Verification methods in the NCC
☑ A0.5(b)(ii) - Other verification methods
☐ A0.5(c) - Expert judgement
☐ A0.5(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 can be demonstrated the risk of fire spread between Lower Ground and Lower Ground Mezzanine is at an level similar to a BCA DtS building where it is permitted to be connected with an non-required non fire isolated stair and/or an atrium connecting no more than two levels.

Fire scenarios and design fire parameters:

The fire hazard relating to this performance solution is the risk of fire spread from open connections between Lower Ground and Lower Ground Mezzanine.

Describe how fire brigade intervention will be addressed or considered:

Due to the proposed fire-isolated stair serving Lower Ground and Lower Ground Mezzanine, appropriate fire brigade activities can be undertaken prior to attacking the area of fire origin.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

Provide details on proposed modelling/assessment tools:

NA

FRNSW Comment: In principle support is provided subject to the following:

- The analysis in the FER demonstrating compliance with the Performance Requirements of the NCC.
- The comment provided by FRNSW being addressed satisfactorily.

Issue number: 19 **Title:** Lower Ground Mezzanine East Office Space Extended Travel Distance

Details of departures from DtS provisions:

To permit extended exit travel distance of up to 27.5m to a point of choice on Lower Ground Mezzanine East Office areas.

Applicable DtS provisions:	D1.4	Performance requirements:	DP4, EP2.2

List key fire safety measures:

- Automatic Fire Suppression System is to be installed throughout the building, designed and installed in accordance with AS2118.1 – 2017 with the exception of Performance Solutions identified within this document and Education Building
- An automatic detection system is to be provided in the building in accordance with BCA Spec. E2.2a and AS 1670.1–2018 and the following:
  - Reduced 10m x 10m grid spacing to below ceiling smoke detectors
- Lower Ground Mezzanine east office area opens into the open space where smoke ventilation to outside is available
- Lower Ground east spiral stair room is smoke separated from adjoining areas.

Proposed alternative solution:

Qualitative Assessment

Location and use

As shown in the figure below, the lower ground mezzanine east area is proposed to be of Class 5 use throughout. Each office room opens directly to the external areas of the building and access to lower ground is via the non-fire-isolated stair. The travel distance from the most remote location on Lower Ground Mezzanine to the point choice of choice on Lower Ground is no more than 27.5m. Occupants on Lower Ground Mezzanine are required to travel through the external area of the building, re-enter on Lower Ground to the spiral stair room and once exiting the spiral stair room, occupants are afforded a point of choice to the available exits on Lower Ground.

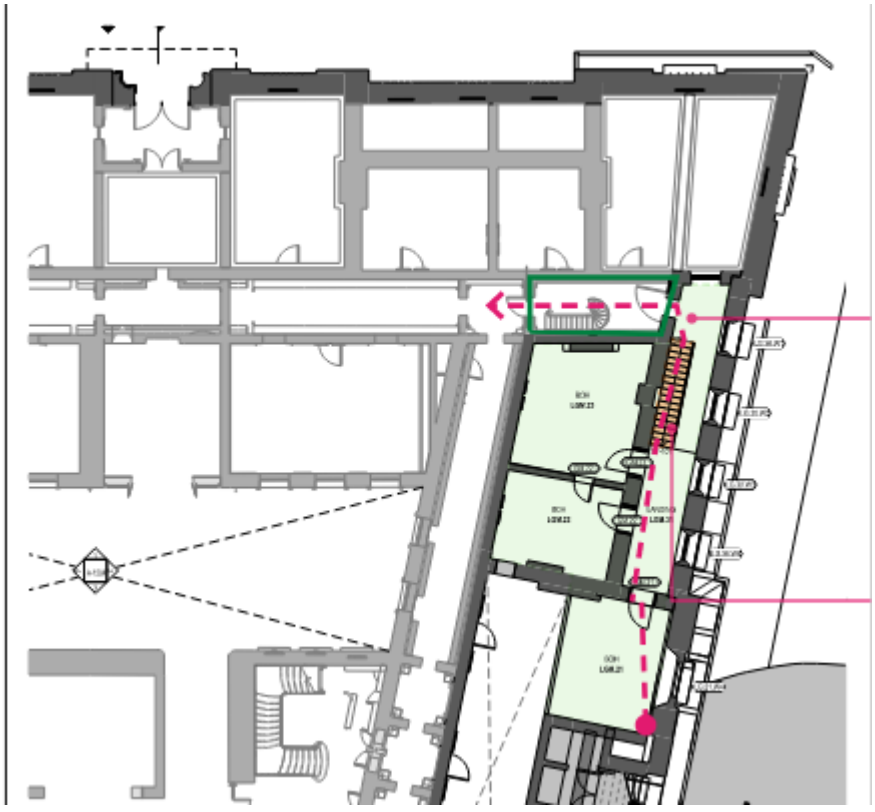


Figure 42 – Lower Ground Mezzanine east areas

Egress Provisions

Occupants on Lower Ground Mezzanine are required to travel through the external area of the building, re-enter on Lower Ground to the spiral stair room and once exiting the spiral stair room, occupants are afforded a point of choice to the available exits on Lower Ground. As part of the Performance Solution, the spiral stair room is to be smoke separated from the adjoining areas on Lower Ground. As such, the associated travel distances from Lower Ground Mezzanine to the spiral stair room is no more than 20m. It is considered the smoke separated room as place of safety from occupants on Lower Ground Mezzanine when evacuating in an emergency event. As such the associated occupant life safety risk can be considered to be reduced with these fire safety measures in addition to the inherent open external area of the building.

The number of occupants within Lower Ground Mezzanine east office area is expected to be low due to the small floor area. Further these occupants would mainly consist of staff members who are familiar with the building layout and are aware of the available egress paths to the available exits of the building. As such the associated increase of up to 8m to a point of choice can be considered to not significantly impact on the occupant life safety risk to familiar occupants.

Fuel Load

As discussed earlier, the spiral stair is majority of non-combustible construction with the exception of the timber handrails and is therefore not expected to result or contribute to an overall increased fire load within the building. Any storage is unlikely to occur as it will impede on the daily pedestrian movements within these spaces.

Conclusion

It is demonstrated that the increased in travel distance to a point of choice is unlikely to impact on occupant life safety and result in evacuation conditions at least equivalent to the Performance Requirements of the BCA. Therefore the Relevant Performance Requirements DP4 and EP2.2 is considered satisfied.

Performance solution:

- ☑ A0.3(a)(i) - Comply with the performance requirements
- ☐ A0.3(a)(ii) - Be at least equivalent to the DtS provisions

Assessment methods:

- ☐ A0.5(a) - Evidence of suitability
- ☐ A0.5(b)(i) - Verification methods in the NCC
- ☑ A0.5(b)(ii) - Other verification methods
- ☐ A0.5(c) - Expert judgement
- ☐ A0.5(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 can be demonstrated that the increased in travel distance to a point of choice is unlikely to impact on occupant life safety and result in evacuation conditions at least equivalent to the Performance Requirements of the BCA.

Fire scenarios and design fire parameters:

The fire hazard relating to this performance solution is the exposure of occupants to untenable egress conditions due to an increased evacuation time in the areas where extended travel distances are required.

Describe how fire brigade intervention will be addressed or considered:

It is expected that occupants are able to evacuate in a time whereby tenable conditions are maintained and so it is unlikely that the brigade will be required to conduct search and rescue within the identified areas.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

Provide details on proposed modelling/assessment tools:

NA

FRNSW Comment: In principle support is provided subject to the analysis in the FER demonstrating compliance with the Performance Requirements of the NCC.

Issue number: 20 **Title:** Egress from plant roof space

Details of departures from DtS provisions:

Path of travel to exits through the Level 3 plant roof space do not achieve the egress width and height requirements for BCA Clause D1.6.

FRNSW Comment: The exact reductions/shortfalls in egress width(s) and height(s) are to be details within the FER.

Stantec: Noted.

Applicable DtS provisions:	D1.6	Performance requirements:	DP6, EP2.2

List key fire safety measures:

It is proposed to implement the following management in use requirements;

- Any person who requires access to the Level 3 roof plant spaces or Roof Terraces must understand and adhere to the following requirements and be inducted by building management. The management in use requirements are to be recommunicated to employees on a yearly basis.
    - Any person/s that accesses the roof plant spaces or Roof Terraces must be able bodied.
    - Any person that accesses the roof plant spaces or Roof Terraces must be accompanied by a member of building management or security.
    - Each person is always required to be equipped with a radio and able to communicate with the other person via the radio.
    - The building management / security staff must monitor the space for any fire risk while the other occupants are working. In the event of a fire or emergency requiring evacuation, the occupant must inform the others that evacuation is required at which point all occupants are to immediately evacuate into the fire stair and discharge from the building.
- An automatic detection system is to be provided in the building in accordance with BCA Spec. E2.2a and AS 1670.1–2018 and the following:
    - Reduced 10m x 10m grid spacing to below ceiling smoke detectors
- Automatic Fire Suppression System is to be installed throughout the building, designed and installed in accordance with AS2118.1 – 2017 with the exception of Performance Solutions identified within this document and Education Building.
- The roof spaces are provided with emergency lighting and exit signage in accordance with AS2293.1-2018.
- Signage is to be provided at the first instance of reduced clear height in each egress path stating “LOW HEAD CLEARANCE” or similar.
- Hazard strips are to be provided to obstructions at all areas with reduced clear height, marking obstructions at the floor level and at head height.

Proposed alternative solution:

BCA Comparison

BCA Clause D1.6 states that in a required exit or path of travel to an exit –

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

(b) The onobstructed width of each exit or path of travel to an exit, except for doorways, must be not less than –

(i) 1 m;

The guide to the BCA states that the intent of Clause D1.6 is to require exits and paths of travel to an exit to have dimensions to allow all occupants to evacuate safely within a reasonable time.

The following performance requirements have been selected for this alternative solution:

DP6

So that occupants can safely evacuate the building, paths of travel to exits must have dimensions appropriate to -

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

b) the function or use of the building;

EP2.2

a) 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.

The proposed design of the Level 3 North and South roof plant spaces does not achieve the height or width requirements for a path or travel to an exit as per BCA Clause D1.6 due to plant equipment, roof slant and structural steel trusses (in the Southern roof only). The hazard associated with reduced clearances along paths of travel is that in the event of a fire, egress off occupants in the area is delayed, potentially exposing them to untenable conditions. The assessment herein will demonstrate that the proposed roof plant spaces design facilitates occupant egress to an appropriate degree considering the usage of the space and the characteristics of occupants who occupy the roof space.

Qualitative Assessment

Location and egress path

The subject roof plant spaces are located on Level 03 as indicated in the figure below. Access to the roof plant spaces is provided via Stair L.02, Stair L.03 and Stair L.04. The design of the northern and southern roof spaces is similar, however the existing structural steel trusses in the southern roof are being retained, and therefore the assessment herein addresses egress through the southern roof space as the worst-case egress path. The assessment is therefore considered applicable to the less onerous northern roof space.

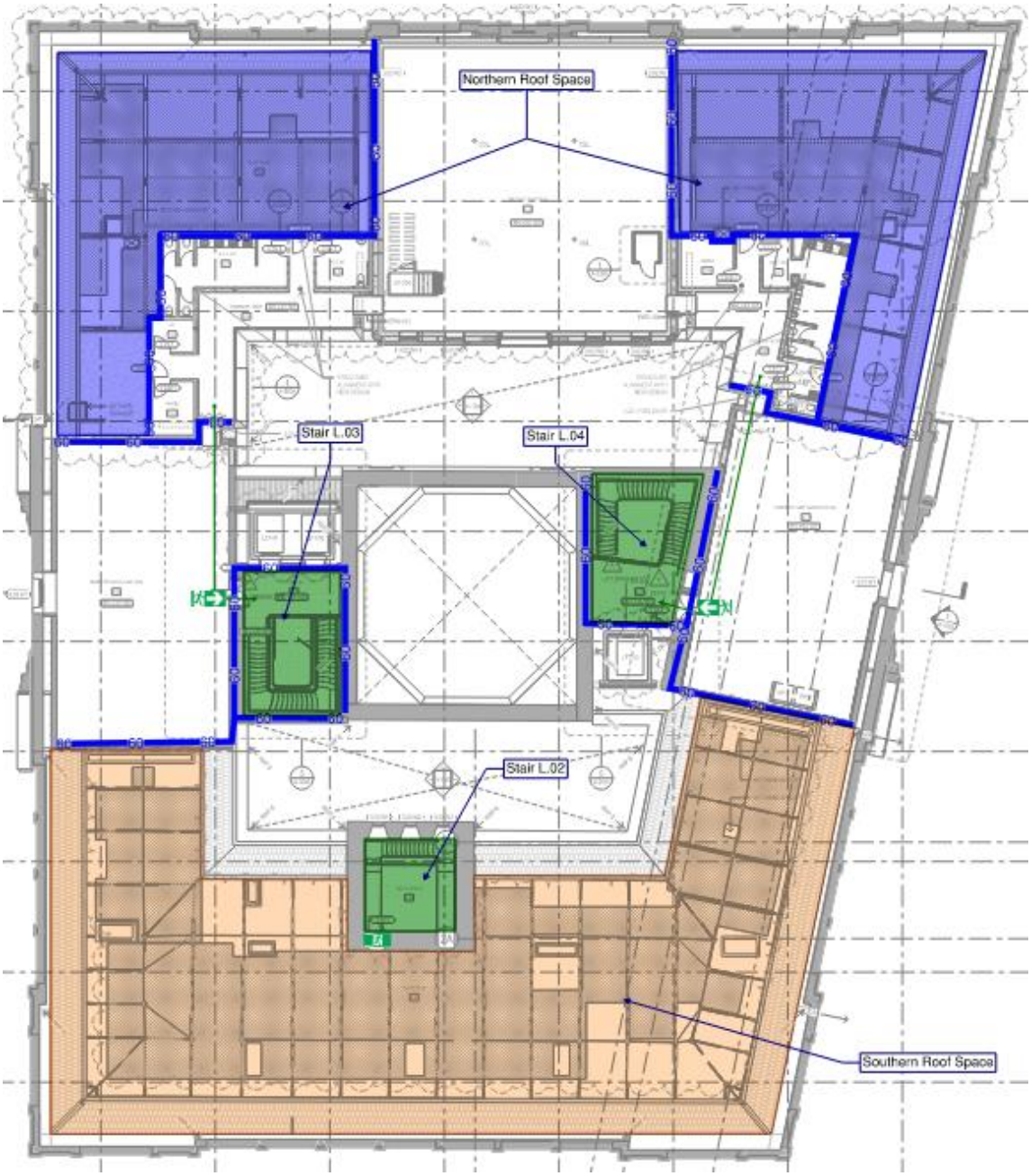


Figure 43 – Location of roof spaces – Level 03

A memorandum titled Level 03 – Roof space assessment has been issued by Stantec on the 8th of October 2021, with the intent to provide an overview of the services within the L3 roof space as information to assist with the BCA classification of the space. Figure 44 below demonstrates the egress path through the roof space as indicated by the red zone. The same assessment is applicable to the north roof spaces.

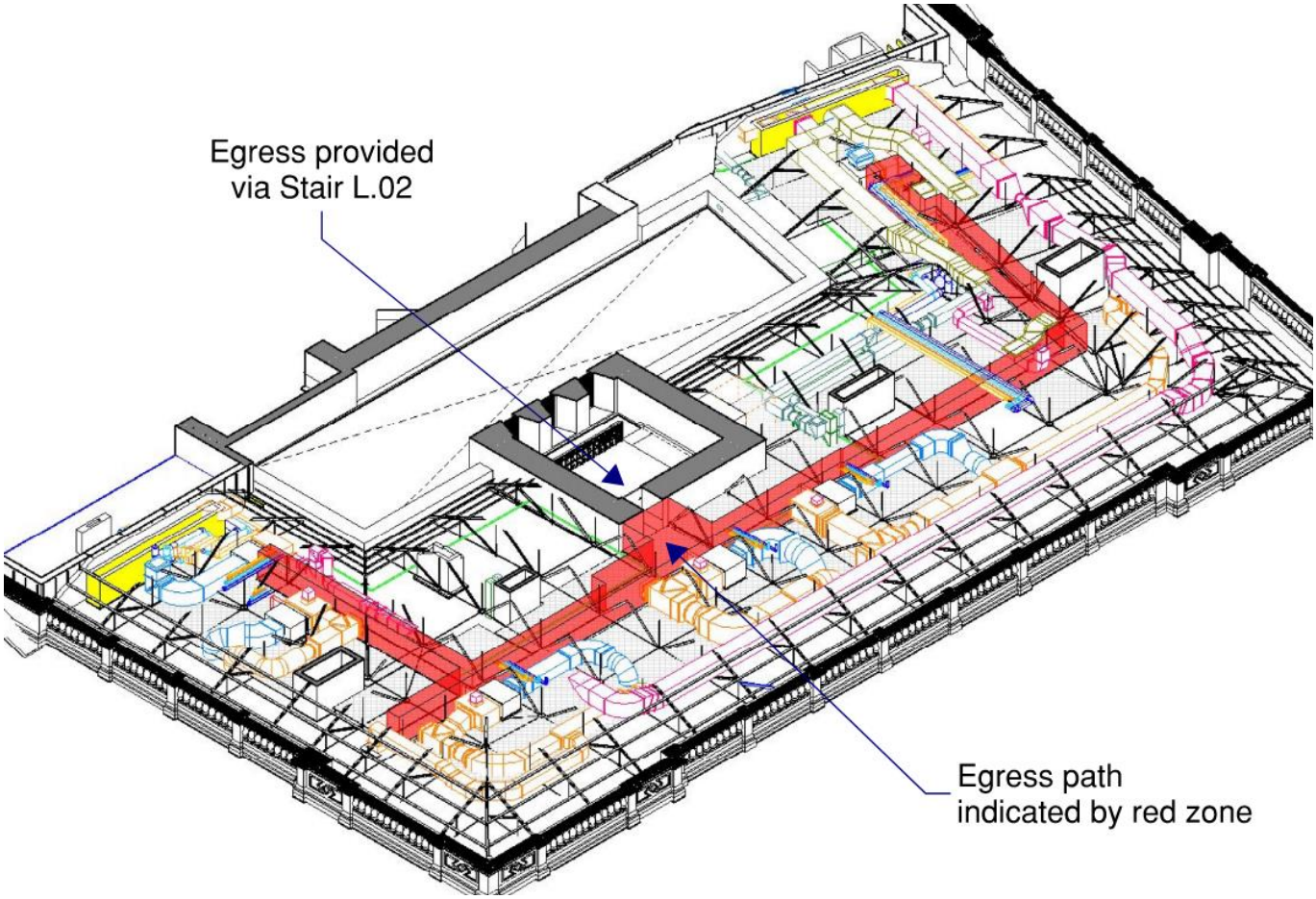


Figure 44 – Egress path through southern roof space, indicative of north roof space – Level 03 perspective

Areas required for egress are marked in red hashed area in Figure 45 below. The following obstructions in the egress through the roof space are also indicated on the figure:

- Reduced head clearance due to existing roof pitch, indicated in light green
- Restricted clearance point due to new services locations, indicated in orange
- Restricted clearance point (foot and head) due to existing truss, indicated in blue

The obstructions listed above will require occupants to duck their heads, step over obstacles and travel sideways at various points in the egress path. Occupants will be familiar with these obstructions in the egress path given the induction requirements, and that being the only access path, occupants will have travelled past the obstructions in order to reach their destination in the roof space.

The travel distance from the most remote location in the Level 03 southern roof space to Stair L.02 is 32m as addressed previously in this FEBQ.

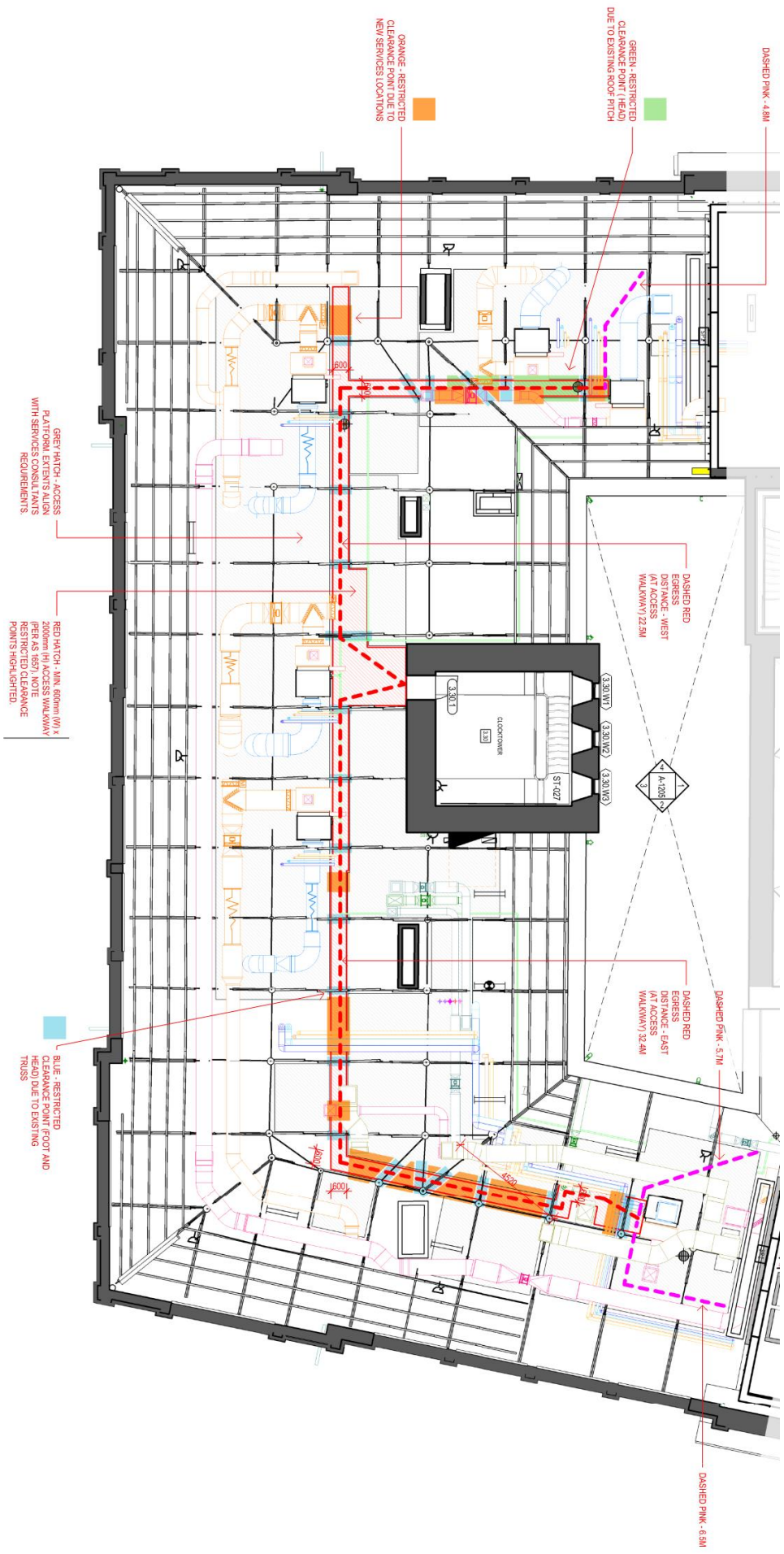


Figure 45 – Egress path through southern roof space, indicative of north roof space – Level 03 plan

Occupancy

Table 14 below provides a summary of the services in the roof space, and the frequencies in which they are accessed as stated in the memorandum.

Table 14 – Level 03 roof space – services and access frequencies

Services	Access Frequencies
Mechanical air handling units	6 Monthly
Mechanical fan coil units	6 Monthly
Mechanical ventilation fan system (i.e. Exhaust, supply and relief)	6 Monthly
Kitchen exhaust fan system	6 Monthly
Non-essential mechanical switchboards	Yearly
Lightings, LED battens and weatherproof exist sign	Yearly
Sprinklers	Yearly
Detectors	Yearly
Speakers	Yearly

As can be seen in the table above, the roof space is only occupied periodically throughout the year for routine maintenance of services. The roof space is not accessible by the public, and is only accessed by maintenance staff. The following requirements are incumbent on occupants of the Level 3 roof spaces:

- Any person who requires access to the Level 3 roof plant spaces or Roof Terraces must understand and adhere to the following requirements and be inducted by building management. The management in use requirements are to be recommunicated to employees on a yearly basis.
    - Any person/s that accesses the roof plant spacesor Roof Terraces must be able bodied.
    - Any person that accesses the roof plant spaces or Roof Terraces must be accompanied by a member of building management or security.
    - Each person is always required to be equipped with a radio and able to communicate with the other person via the radio.
- The building management / security staff must monitor the space for any fire risk while the other occupants are working. In the event of a fire or emergency requiring evacuation, the occupant must inform the others that evacuation is required at which point all occupants are to immediately evacuate into the fire stair and discharge from the building.

The above requirements ensure that maintenance staff accessing the Level 03 roof space are able-bodied and accompanied with a building management / security staff member who will monitor the space and provide early warning in the unlikely event of a fire.

Fuel Load

As presented in Table 14 above, the roof space is used for plant equipment which is primarily constructed from metallic components. Due to the limited floor space and required access zones, the roof spaces will not be used for the storage of combustible materials. The Level 03 ceiling to the roof space is to achieve a minimum FRL of 60 minutes due to the Class 9b use below as part of Performance Solution 1.

Fire Scenario

As discussed above, the subject roof areas are unlikely to be occupied given the maintenance frequencies of the non-essential plant equipment. The management in use requirements limit access to the roof space to able-bodied maintenance staff who must be accompanied with a building management or security staff who must monitor the space for fire risks. In the unlikely event that a fire breaks out in the roof space during maintenance operations, the attending staff member will alert the maintenance worker to the fire who will immediately begin evacuating from the roof space. The maintenance worker will be aware of the obstructions in the egress path as they would have

walked through past the obstructions in order to access their current location, the provided signage and hazard strips, and as they would been inducted in accordance with the requirements above. Being able bodied, the maintenance worker will be able to egress past the obstructions to the exit. Furthermore, the roof space is provided with sprinklers, smoke detectors and emergency lighting that are all expected to activate in the event of a fire in the space, providing suppression, detection and ease of wayfinding to the exit.

Conclusion

It is therefore considered that the prosed design complies with Performance Requirements DP6 and EP2.2 as it has been demonstrated that occupants can safely evacuate in a timely manner from the subject roof spaces given that the dimensions of the path to the exit are appropriate to the number, mobility and other characteristics of occupants, and the function and use of the space.

Performance solution:

- ☑ A0.3(a)(i) - Comply with the performance requirements
- ☐ A0.3(a)(ii) - Be at least equivalent to the DtS provisions

Assessment methods:

- ☐ A0.5(a) - Evidence of suitability
- ☐ A0.5(b)(i) - Verification methods in the NCC
- ☑ A0.5(b)(ii) - Other verification methods
- ☐ A0.5(c) - Expert judgement
- ☐ A0.5(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 can be demonstrated that the decrease in clearance to the subject path of egress is unlikely to impact on occupant evacuation such that occupants are provided with appropriate access to exits in accordance with Performance Requirements DP6 and EP2.2.

Fire scenarios and design fire parameters:

The fire hazard relating to this performance solution is the exposure of occupants to untenable egress conditions due to an increased evacuation time in the areas with reduced clearances in paths of egress.

Describe how fire brigade intervention will be addressed or considered:

It is expected that occupants are able to evacuate in a time whereby tenable conditions are maintained and so it is unlikely that the brigade will be required to conduct search and rescue within the identified areas.

Verification/validation analyses:

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

Provide details on proposed modelling/assessment tools:

NA

FRNSW Comment: In principle support is provided subject to the analysis in the FER demonstrating compliance with the Performance Requirements of the NCC.

Issue number: 21 **Title:** Emergency lighting provisions

Details of departures from DtS provisions:

Permit lighting in fire stairs to not be provided with motion sensor activation in accordance with Specification J6, noting that the emergency lighting in the stair wells is activated during fire mode.

Applicable DtS provisions:	J6.3	Performance requirements:	DP4

List key fire safety measures:

Provide emergency lighting and exit signage in accordance with AS2293.1 2018.

Proposed alternative solution:

BCA Comparison

BCA Clause J6.3 (f) states that artificial lighting in a fire-isolated stairway, fire-isolated passageway or fire-isolated ramp, must be controlled by a motion detector in accordance with Specification J6.

The guide to the BCA states that the intent of Clause J6.3 is to set the minimum requirements for switches and other lighting control devices.

The following performance requirements have been selected for this alternative solution:

DP4

Exits must be provided from a building to allow occupants to evacuate safely, with their number, location and dimensions being appropriate to –

(a) The travel distances; and

(b) The number, mobility and other characteristics of occupants; and

(c) The function or use of the building; and

(d) The height of the building; and

(e) Whether the exit is from above or below ground level.

Qualitative Assessment

The proposed design of the fire stair lighting does not comply with Clause J6.3(f) as activation of the fire stair lighting is not controlled by PIR motion sensors to meet the requirements of Specification J6. The hazard associated with lighting requirements in emergency exits is that occupant evacuation may be delayed due to poor visibility conditions inside the exit. It is noted that due to the use of the stairs as access stairs during normal operation of the building, motion activated emergency lighting would not be suitable for the space.

Emergency lighting in the fire stairs is automatically activated during fire mode in lieu of activation via motion detectors. This ensures that the emergency lighting will always be on in the event of a fire, while providing appropriate lighting during normal operation of the building. In comparison to a DtS design where motion detection could be blocked/damaged, it is considered that the proposed design is at least equivalent as emergency lighting will always be on during fire mode.

Conclusion

The proposed emergency lighting design in the fire stairs throughout the building will activate in fire mode in lieu of via motion detectors in the fire stairs. It is therefore considered the proposed design is at least equivalent to a DtS design.

Performance solution:

☑ A0.3(a)(i) - Comply with the performance requirements
☐ A0.3(a)(ii) - Be at least equivalent to the DtS provisions

Assessment methods:

☐ A0.5(a) - Evidence of suitability
☐ A0.5(b)(i) - Verification methods in the NCC
☑ A0.5(b)(ii) - Other verification methods
☐ A0.5(c) - Expert judgement

☐ A0.5(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 can be demonstrated emergency lighting is provided inside the fire stairs to facilitate the safe evacuation of occupants.

Fire scenarios and design fire parameters:

The assessment considers a fire inside the building.

Describe how fire brigade intervention will be addressed or considered:

Fire brigade can utilise their own torches and headlights to increase visibility in the stairs if required.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

Provide details on proposed modelling/assessment tools:

NA

FRNSW Comment: In principle support is provided subject to the analysis in the FER demonstrating compliance with the Performance Requirements of the NCC.

Issue number: 22 **Title:** Reduced exit width

Details of departures from DtS provisions:

To permit reduced egress widths in the following egress paths:

- Stair L-03
- Stair L-04
- Stair ST-005
- Level 4 South terrace
- Clocktower

Applicable DtS provisions:	D1.6	Performance requirements:	DP4, DP6, EP2.2

List key fire safety measures:

- Proposed compartmentation plans have been attached as part of Appendix 1 – General Compartmentation and Egress Strategy.

Proposed alternative solution:

BCA Comparison

BCA Clause D1.6 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 1m apart.

According to the Guide to the BCA, the main intention of establishing a minimum dimension of exits and paths of travel to exits is to require exits and paths of travel to an exit to have dimensions to allow all occupants to evacuate safely within a reasonable time.

The following performance requirements have been selected for this alternative solution in accordance with BCA Clause A0.7:

DP4

Exits must be provided from a building to allow occupants to evacuate safely, with their number, location and dimensions being appropriate to -

a) the travel distance; and

b) the number, mobility and other characteristics of occupants; and

c) the function or use of the building; and

d) the height of the building; and

e) whether the exit is from above or below ground level.

DP6

So that occupants can safely evacuate the building, paths of travel to exits must have dimensions appropriate to-

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

(b) the function or use of the building.

EP2.2

(a) 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.

Qualitative Assessment

The following figures depict areas with reduced egress widths.

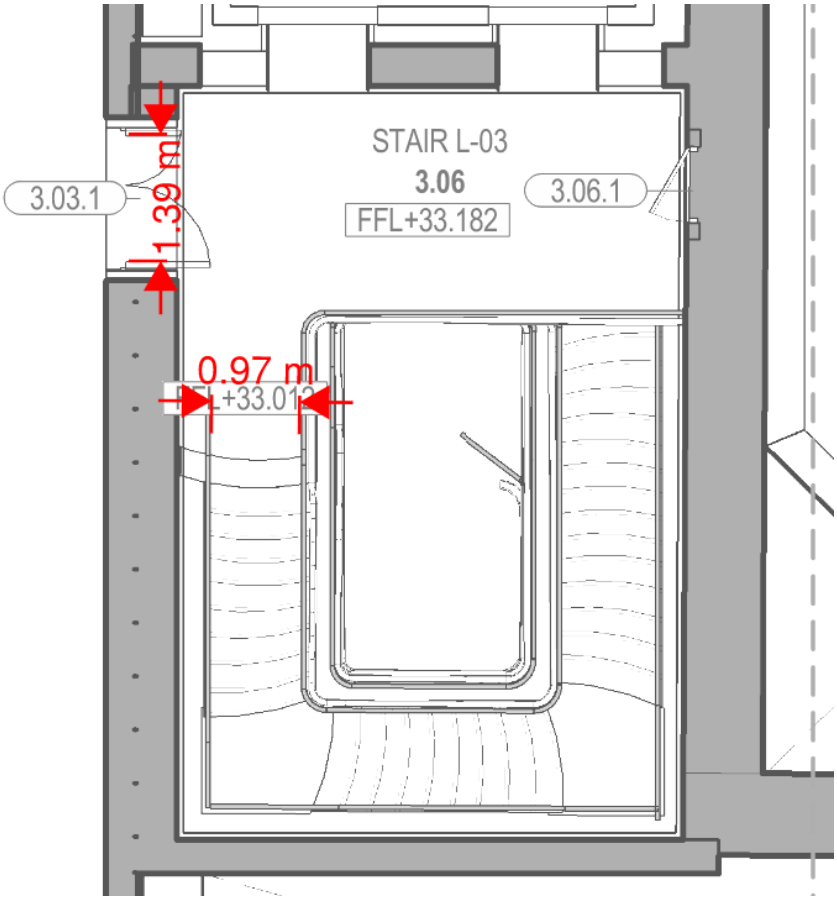


Figure 46 – Reduced egress width – Stair L-03

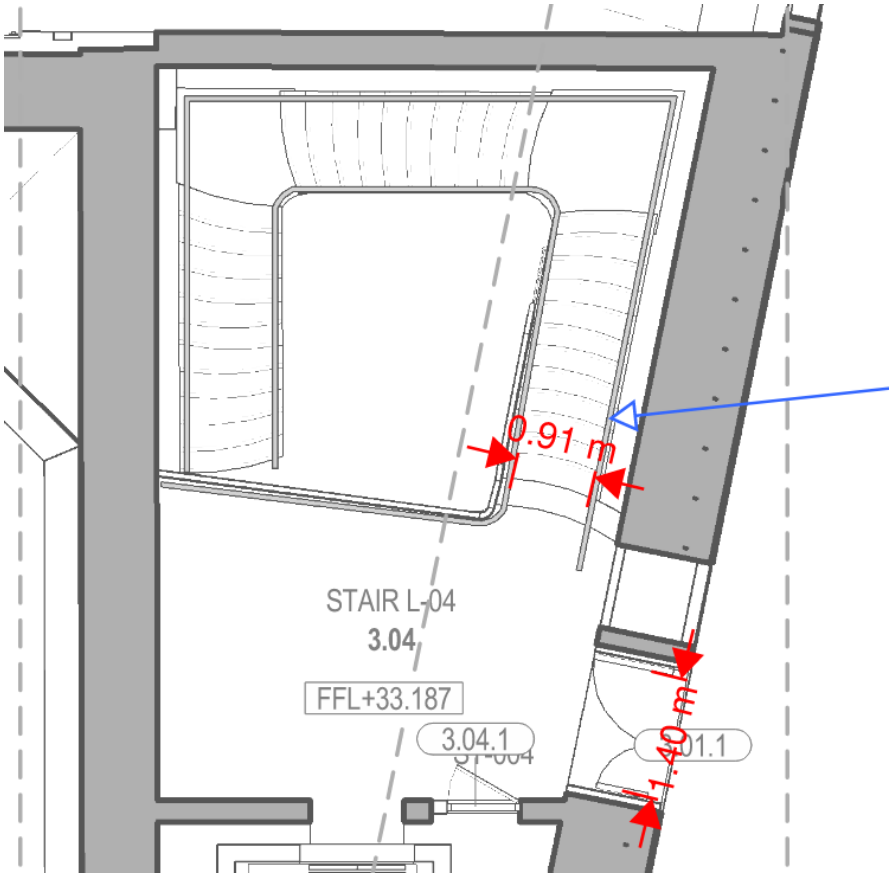
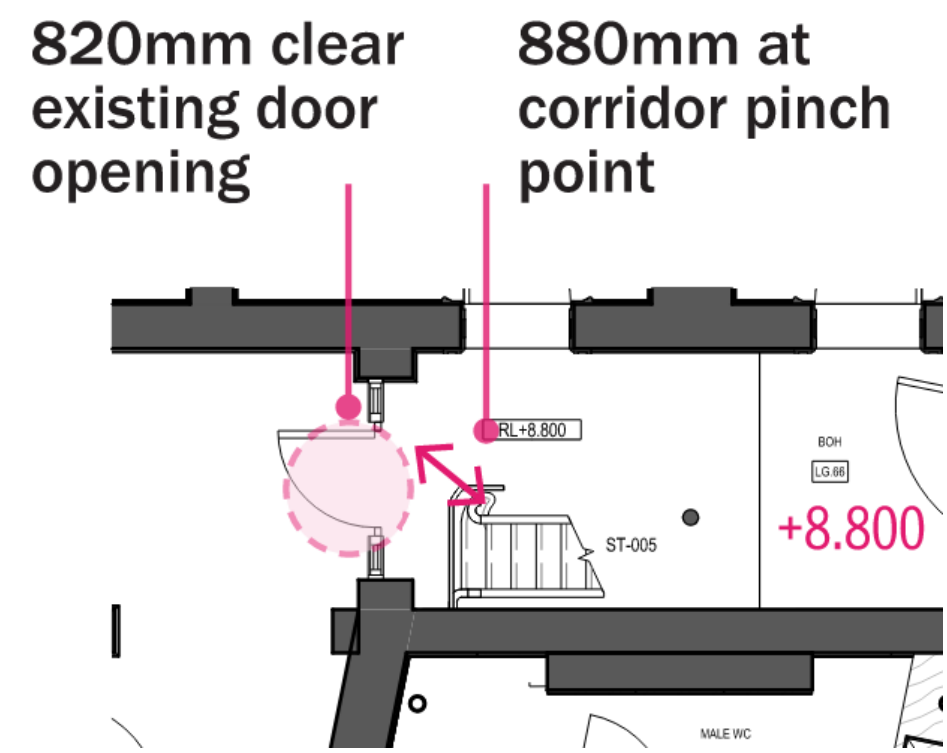


Figure 47 – Reduced egress width – Stair L-04



Reduced egress width – ST-005

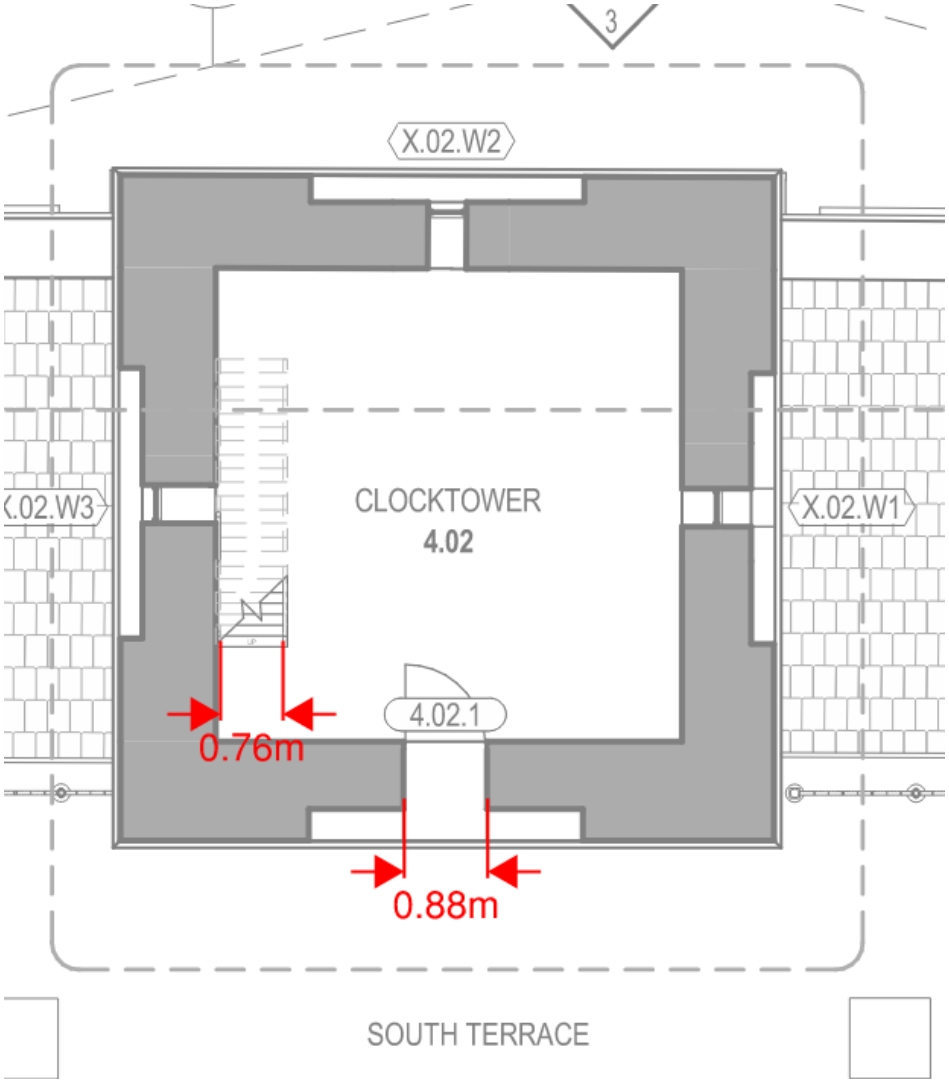


Figure 48 – Reduced egress width – Level 4 South Terrace and Clock Tower

The hazard specific to this solution is by reducing the width of the exit path there is an increased risk that occupants may take a longer time to evacuate.

The existing heritage stairs with reduced clear egress widths is compared with a BCA compliant design stair which has the appropriate clear width of 1 m as required by BCA Clause D1.6(b)(i). It is noted that the Clocktower egress width of 0.76m in the stair is the greatest reduction in egress width, however as discussed previously, the clocktower of the Lands Building from level 3 up is not accessed in normal operation of the building and is only used by maintenance personnel when servicing equipment such as sprinklers in the tower, or machinery in the roof space or roof terrace. It is considered that with these low occupant numbers, the reduced egress width to the clocktower is justified as per the assessment herein, however the assessment will assess the reduced egress width in Stair L-04 of 0.91m as more applicable to normal operation of the building.

Anthropometric Data reproduced from NFPA 101, as illustrated in Figure 49, indicates that the 97.5 percentile largest body dimensions of an adult (male or female) is 0.51 m, hence the reduced width of 0.91 m of the existing heritage stairs provides an additional width of 0.40 m (or approx. 78%).over and above the 95th percentile width adult.

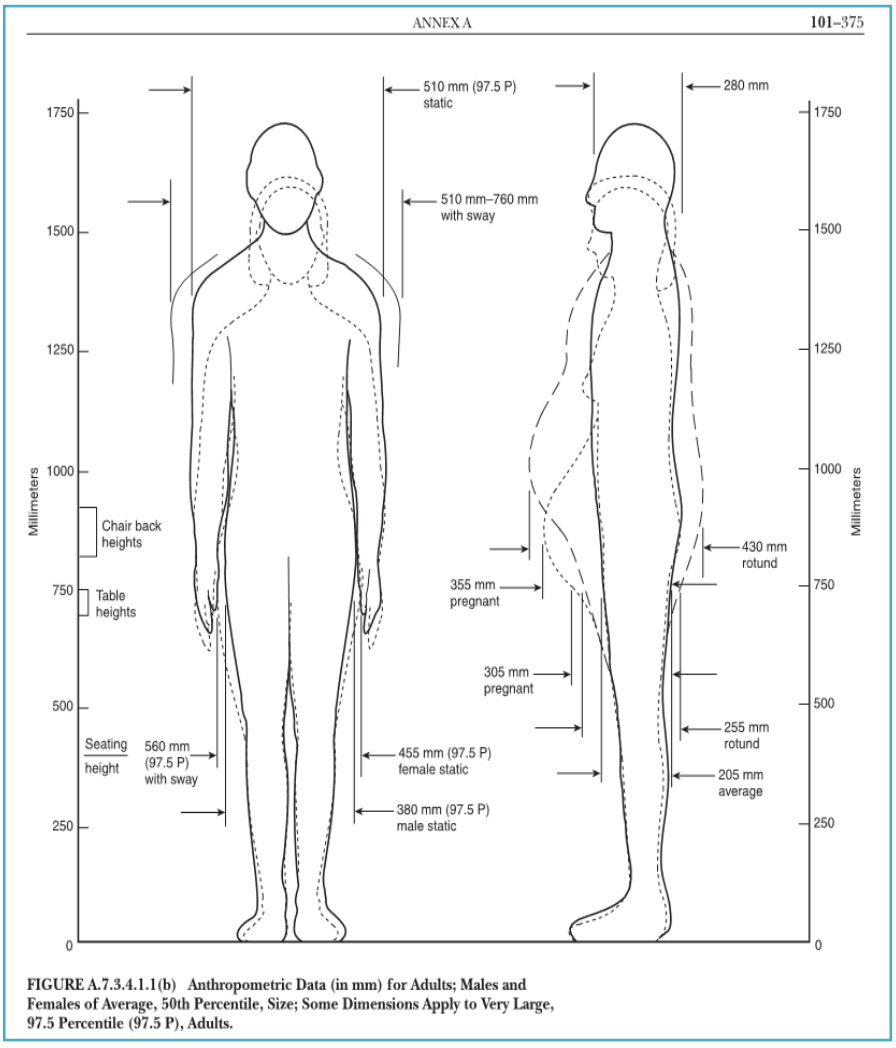


FIGURE A.7.3.4.1.1(b) Anthropometric Data (in mm) for Adults; Males and Females of Average, 50th Percentile, Size; Some Dimensions Apply to Very Large, 97.5 Percentile (97.5 P), Adults.

Figure 49: Anthropometric Data reproduced from NFPA 101

Neither an exit stair having a width or 1 m in accordance with BCA Clause D1.6 or a stair width of 0.91 m is sufficient for two adults to egress side by side. They must be staggered in effectively single file as they pass though such paths of travel. It is therefore noted that a reduction to 0.91 m in the stair should not have a significant impact on the total escape time as occupants are expected to still be evacuating in single file. The staggered single file spacing is illustrated in Figure 50 (note that this is not to scale and is meant to illustrate the concept only).

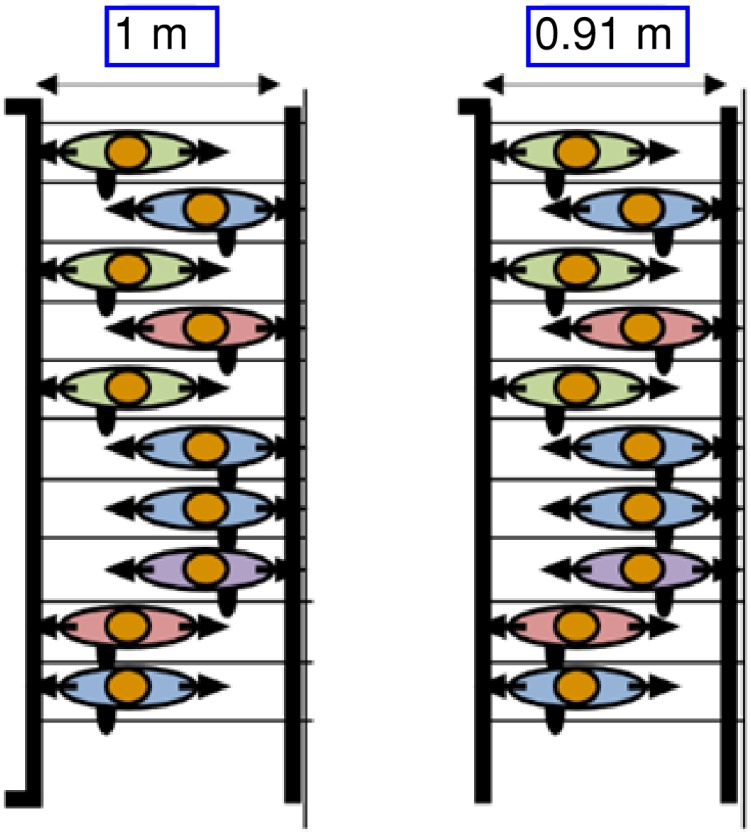


Figure 50: Staggered stair egress (not to scale, for illustrative purposes only)

Further to the above, when walking down a stair, occupants naturally move towards the inner rail of the stair especially on approach to the stair landings as they descend. This is because it is the shortest path of travel and, in a 1 m wide fire stair, the only side with a handrail. Therefore it is unlikely that occupants would be slowed by a small restriction in width in this location. Hence the reduced stair width of existing heritage stairs should not significantly affect the occupant speed on the stairs.

The above analysis addresses means of egress and evacuation in the event of a fire and does not address or intend to address any other requirements such as DDA or other third party certification / requirements.

Conclusion

It has been shown in the above assessment that the horizontal exit width provides occupants with a higher degree of safety than a DtS design, allowing occupants to evacuate from a zone of fire origin and enter a place of relative safety from which a safe evacuation can be made from.

Performance solution:

☐ A0.3(a)(i) - Comply with the performance requirements
☑ A0.3(a)(ii) - Be at least equivalent to the DtS provisions

Assessment methods:

☐ A0.5(a) - Evidence of suitability
☐ A0.5(b)(i) - Verification methods in the NCC
☑ A0.5(b)(ii) - Other verification methods
☐ A0.5(c) - Expert judgement
☑ A0.5(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 occupant population and aggregate egress widths are considered reasonable if it can be demonstrated that occupants are afforded with at least an equivalent degree of safety in comparison with a DtS design.

Fire scenarios and design fire parameters:

NA

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 proposed design meets the acceptance criteria.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

NA

Provide details on proposed modelling/assessment tools:

NA

FRNSW Comment: In principle support is provide subject to the following:

- The analysis in the FER demonstrating compliance with the Performance Requirements of the NCC.
- Given that Fire Brigade personnel are likely to be wearing PPE and breathing apparatus (which may increase their effective width in a fire scenario), the FER is to clearly demonstrate that they are adequately facilitated given the reduced egress width as per above.

Stantec: Noted. We will include discussions relating to typical widths of fire brigade personnel with breathing apparatus. These studies will be sourced from US where samples of personnel with and without gear are collated and presented.

FRNSW Comment: Noted, to be adequately outlined within the FER.

Issue number: 23 **Title:** Combustible elements in roof spaces

Details of departures from DtS provisions:

Permit the following elements in the Level 03 roof space to not achieve the required FRL:

- Existing roof trusses
- Douglas Fir timber boards
- New/existing timber battens

Applicable DtS provisions:	C1.1, C1.10, Spec C1.1, Spec C1.10	Performance requirements:	CP1, CP2

List key fire safety measures:

- The Level 03 ceiling to the roof space is to achieve a minimum FRL of 60 minutes from below.
- Automatic sprinkler protection is proposed to be installed throughout the building in accordance with BCA Clause E1.5 and AS2118.1-2017 with the exception of the Performance Solutions identified within this document and Education Building.
- An automatic detection system is to be provided in the building in accordance with BCA Spec. E2.2a and AS 1670.1–2018 and the following:
    - Reduced 10m x 10m grid spacing to below ceiling smoke detectors

Proposed alternative solution:

BCA Comparison

BCA Clause C1.1 states the type of construction required by a building. Specification C1.1 states the specific FRL requirement of each building element.

BCA Clause C1.10 states the fire hazard properties of certain building elements must comply with Specification C1.10.

Clause 3.1(a) of Specification C1.1 states that each building element listed in Table 3 and any beam or column incorporated in it, must have an FRL not less than that listed in the Table for the particular Class of building concerned, where Table 3 of Specification C1.1 requires loadbearing floors in Class 6 buildings to achieve an FRL of 180/180/180, and roofs to achieve an FRL of 180/60/30.

It is proposed to allow for the existing roof trusses to not achieve the required FRL. In addition, it is proposed to allow timber boards and battens in the roof space which are considered combustible elements.

The intent of performance requirement CP1 is to ensure that building elements provide structural stability in the event of a fire. The intent of CP2 is to address the spread of fire both within and between buildings.

The intent of the BCA is to provide a building with element which will maintain the structural stability of a building during a fire and to avoid the spread of fire within and between buildings.

The hazard with construction elements not meeting the required FRL is that in the event of a fire, structural elements may fail to provide the required structural stability, or to facilitate the spread of fire. The solution herein will qualitatively demonstrate that the design of the roof space prevents the spread of fire from the levels below and is provided with adequate protection measures such that the design complies with the intent of Performance Requirements CP1 and CP2.

Qualitative Assessment

Fire safety provisions

The roof spaces are served by an automatic fire suppression system in accordance with AS2118.1-2017, and an automatic detection system in accordance with AS 1670.1-2018 but with reduced detector spacing of 10 m x 10 m as per this document.

The sprinkler system is expected to activate in the unlikely event of a fire, and control if not supress the fire in its infancy. The efficacy of sprinkler systems in preventing fires has been discussed throughout this document and further analysis will be contained in the FER.

Fuel Load

As presented in Table 14 above, the roof space is used for plant equipment which is primarily constructed from metallic components. Due to the limited floor space and required access zones, the roof spaces will not be used for the storage of combustible materials.

Fire behaviour of Timber

Douglas fir timber flooring has been identified inside the roof space. In addition, new and existing timber battens are to be provided where the timber type is considered to be a softwood specie such as pine. Douglas fir is also considered a softwood specie.

Hoop pine, which is a softwood, achieves a Group number of 3. As per Warrington Fire Research Pty Ltd, 20181 timber species generally available in Australia achieve a Group Number of 3 under AS 5637.1:2015 40.

Using timber elements inside the roof space raises the concern that in the event of a fire flames could spread to the timber element. To investigate this concern, the properties of timber and its ability to char is assessed.

As wood burns, the surface layers char. This charring process produces a charcoal layer that reduces the timber strength but forms an insulating layer that retards further burning in the virgin timber below. The main drivers of the rate of charring is timber moisture content, density and the contraction of wood. For instance, Australian Blackbutt timber is a hardwood and has an average density of 880kg/m3 and noted by the BS 5368-4.1:1978 achieves a charring rate of 0.5mm per minute [42]. In comparison, timber with lower densities, like Pine, have reduced charring performances of 0.7mm per minute.

Table 1 — Notional rate of charring for the calculation of residual section

Species	Charring in 30 min	Charring in 60 min
	mm	mm
a) All structural species listed in Appendix A of BS 5268-2:1989 except those noted in items b) and c)	20	40
b) Western red cedar	25	50
c) Hardwoods having a nominal density not less than 650 kg/m^3 at 18 % moisture content	15	30

Figure 51: Charring rates of timber

In the event of fire, timber cladding may catch alight and burn to form a char layer which will insulate the virgin timber below, retarding further burning [46]. In order to further burn the virgin wood, the burning process requires sustained heat, which is unlikely to be provided to the timber element due to inherent low thermal feedback of the burning process.

Moreover, due to the charring effect of the timber, it is reasonable to state that the timber is unlikely to facilitate rapid fire spread via the roof space. This is further supported by the fact that the identified timber is only installed within the roof spaces.

Fire compartmentation

As discussed previously, the subject roof plant spaces are located on Level 03 as indicated in the figure below. Access to the roof plant space is provided via Stair L.02, Stair L.03 and Stair L.04. The design of the northern and southern roof spaces is similar, however the existing structural steel trusses in the southern roof are being retained. The roof spaces contain plant equipment presented in Table 14, and are only occupied periodically throughout the year for routine maintenance of services. The roof space is not accessible by the public and is only accessed by maintenance staff under operational requirements contained in this FEBQ.

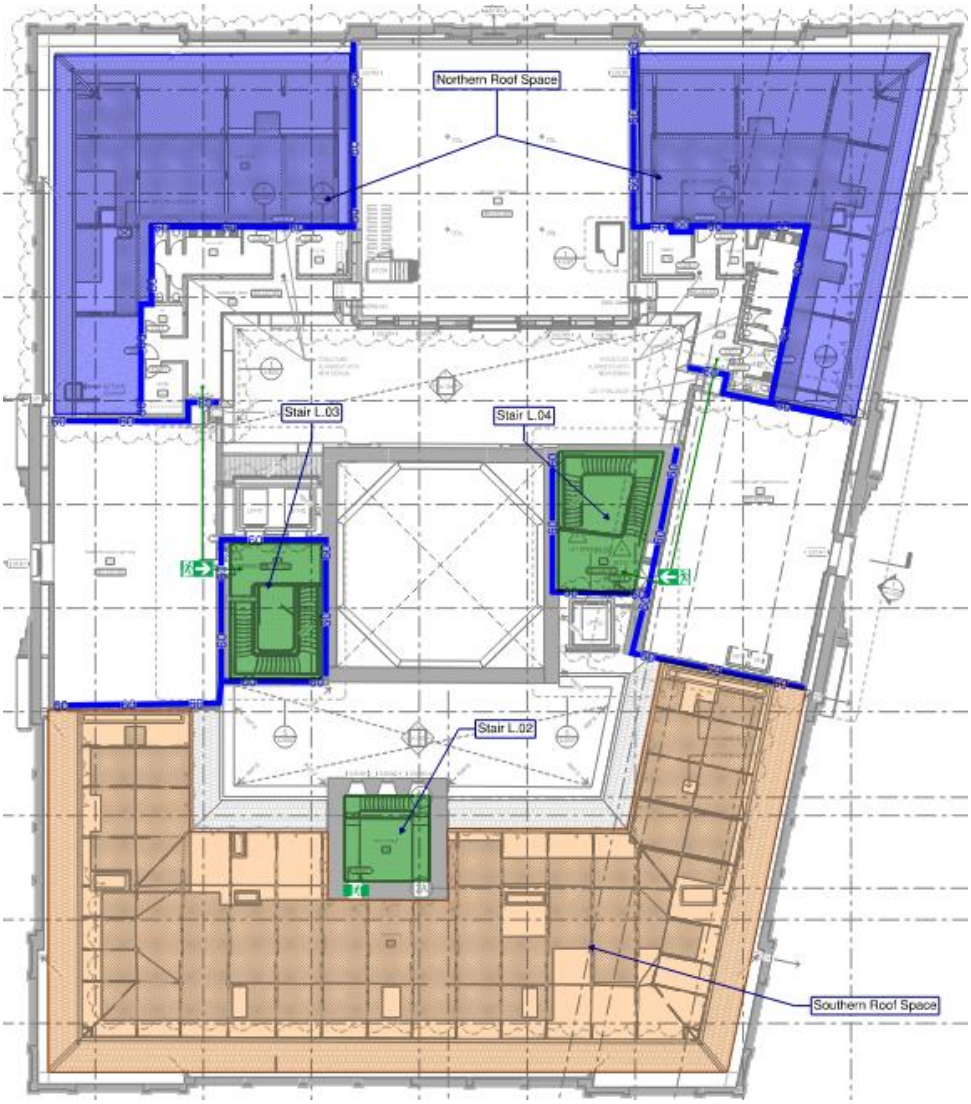


Figure 52 – Location of roof spaces – Level 03

Figure 53 below demonstrates the compartmentation strategy for the building, where the Level 03 roof spaces are separated by the ceiling of the level below achieving a minimum FRL of 60. In addition, where the vertical walls of building rise above the Level 03 roof space, those walls are required to achieve an FRL of 60 minutes or 120 minutes as indicated below depending on its relevant uses.

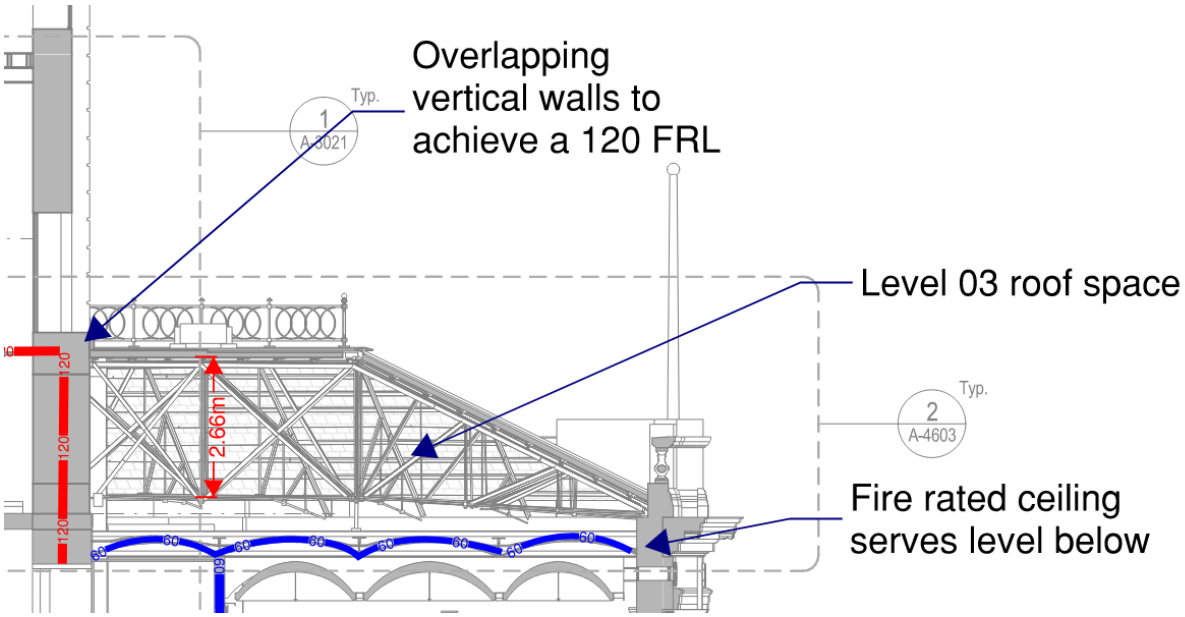


Figure 53 – Separation of roof spaces

The compartmentation strategy will protect the subject building elements from the spread of fire from the levels below. In addition, the fire rating provided to the overlapping walls will prevent the spread of fire from the roof spaces to the adjoining sections of the building. Further assessment regarding the reduction of FRLs is contained in Issue Number 1. Furthermore, due to the elevated location of the roof spaces, heat and smoke from a fire in these areas will vent into the surrounding environment.

Conclusion

It is therefore considered that the proposed design complies with Performance Requirements CP1 and CP2 as it has been demonstrated that the fire safety provisions provided, the fuel load and usage of the roof spaces results in a low risk of fires inside the roof space, and the separation provided from adjoining areas of the building will prevent the spread of fire. It is therefore considered that the proposed design complies with performance requirements CP1 and CP2.

Performance solution:

☑ A0.3(a)(i) - Comply with the performance requirements
☐ A0.3(a)(ii) - Be at least equivalent to the DtS provisions

Assessment methods:

☐ A0.5(a) - Evidence of suitability
☐ A0.5(b)(i) - Verification methods in the NCC
☑ A0.5(b)(ii) - Other verification methods
☐ A0.5(c) - Expert judgement
☐ A0.5(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 can be demonstrated that the timber elements within the roof plant spaces does not adversely increase the risk of fire spread and associated impact on occupant life safety.

Fire scenarios and design fire parameters:

The fire hazard relating to this performance solution is the combustible elements within the roof spaces.

Describe how fire brigade intervention will be addressed or considered:

It is expected that occupants are unlikely to be within the roof spaces and if so management in use provisions are proposed to mitigate the fire risk in plant areas. Therefore it is unlikely that the brigade will be required to conduct search and rescue within the identified areas.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

Provide details on proposed modelling/assessment tools:

NA

FRNSW Comment: On the basis that appropriate compartmentation and sprinkler protection is provided to the subject roof spaces (as outlined above), in principle support is provided subject to the analysis in the FER demonstrating compliance with the Performance Requirements of the NCC.

Issue number: 24 **Title:** Combustible roof cladding elements

Details of departures from DtS provisions:			
Permit timber lining boards and battens in the roof cladding of the northern dome on Level 3, noting this applies to existing elements.			
Applicable DtS provisions:	C1.1, C1.10, Spec C1.1, Spec C1.10	Performance requirements:	CP2

List key fire safety measures:

- Two layers of 13mm fire-rated plasterboard or equivalent system achieving an equivalent FRL of 60 minutes from below (based on it fire-resistance characteristics) is to be fixed to the underside of the roof cladding systems with timber cladding.
- The structural elements of the Level 3 northern dome is to achieve an minimum FRL of 60 minutes.
- Automatic sprinkler protection is proposed to be installed throughout the building in accordance with BCA Clause E1.5 and AS2118.1-2017 with the exception of the Performance Solutions identified within this document and Education Building.
- An automatic detection system is to be provided in the building in accordance with BCA Spec. E2.2a and AS 1670.1–2018 and the following:
    - Reduced 10m x 10m grid spacing to below ceiling smoke detectors

Proposed alternative solution:

BCA Comparison

BCA Clause C1.1 states the type of construction required by a building. Specification C1.1 states the specific FRL requirement of each building element.

BCA Clause C1.10 states the fire hazard properties of certain building elements must comply with Specification C1.10.

The intent of CP2 is to address the spread of fire both within and between buildings.

The intent of the BCA is to provide a building with element which will maintain the structural stability of a building during a fire and to avoid the spread of fire within and between buildings.

The hazard with construction elements not meeting the required FRL is that in the event of a fire, structural elements may fail to provide the required structural stability, or to facilitate the spread of fire. The solution herein will qualitatively demonstrate that the design of the roof space prevents the spread of fire from the levels below and is provided with adequate protection measures such that the design complies with the intent of Performance Requirements CP1 and CP2.

Qualitative Assessment

The proposed protection of the roof cladding systems with timber cladding is depicted in Figure 54 below, where two layers of 13mm fire-rated plasterboard or equivalent system achieving an equivalent FRL of 60 minutes from below (based on its fire-resistance properties) is to be fixed to the underside of the ceiling.

The inherent properties of the fire-rated plasterboard shall provide a fire protective barrier to minimise the ignitibility and fire spread risk to the timber elements.

Sprinkler protection in accordance with AS2118.1-2017 is provided to the areas serving the combustible roof cladding elements within the Level 3 northern dome. As discussed throughout this document, the effectiveness of sprinkler system is expected to at least minimise any severe fire development and possibility extinguish the fire.

As discussed earlier, the building is provided with automatic smoke detection and alarm system with reduced spacing of no more than 10m x 10m. Earlier activation of smoke detectors promotes earlier warning to occupant to safely evacuate away from fire origin and to a place of safety i.e. fire-isolated stair. As such it can be expected occupants to safely evacuate away from fire origin to prior to any risk associated where the ignition of timber roof cladding may occur.

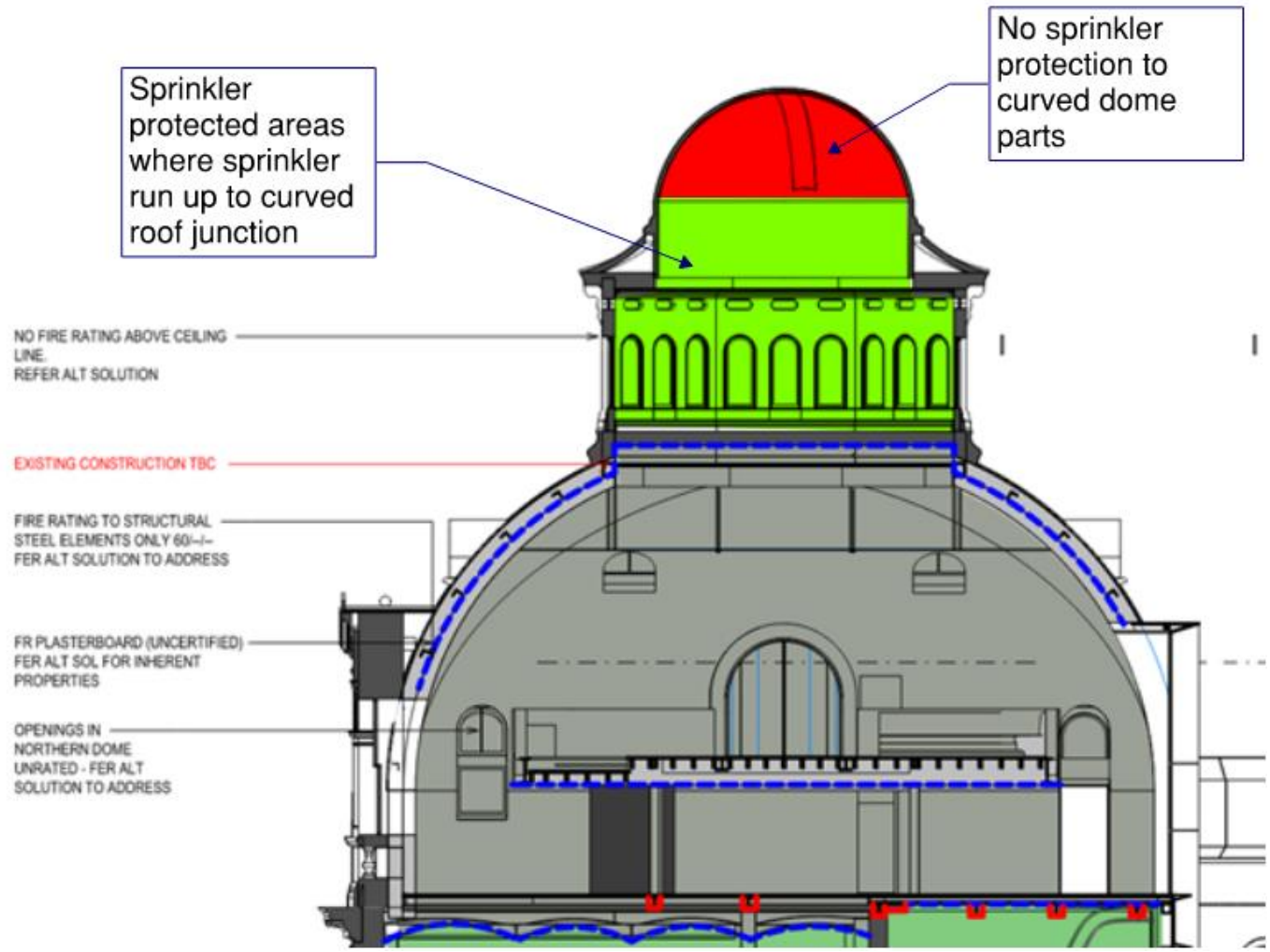


Figure 54 – Northern dome section view

Conclusion

It is therefore considered that the proposed design complies with Performance Requirements CP2 as it has been demonstrated that the fire safety provisions provided, will prevent the spread of fire via the timber elements. It is therefore considered that the proposed design complies with performance requirements CP2.

Performance solution:

☑ A0.3(a)(i) - Comply with the performance requirements
☐ A0.3(a)(ii) - Be at least equivalent to the DtS provisions

Assessment methods:

☐ A0.5(a) - Evidence of suitability
☐ A0.5(b)(i) - Verification methods in the NCC
☑ A0.5(b)(ii) - Other verification methods
☐ A0.5(c) - Expert judgement
☐ A0.5(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
☑ C – Fire spread and impact and control
☑ E – Occupant evacuation and control
☐ F – Fire services intervention

Acceptance criteria and factor of safety:

The Performance Solution is considered acceptable if it can be demonstrated that the associated fire risk to timber cladding to the Level 3 northern dome is not adversely impacted.

Fire scenarios and design fire parameters:

The fire hazard relating to this performance solution is the ignitibility of timber cladding in Northern dome promoting fire spread and impact on occupant life safety.

Describe how fire brigade intervention will be addressed or considered:

It is expected that occupants are able to evacuate in a time whereby tenable conditions are maintained and so it is unlikely that the brigade will be required to conduct search and rescue within the identified areas. As such fire brigade intervention can be attacked from outside of Level 3 northern dome area.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

Provide details on proposed modelling/assessment tools:

NA

FRNSW Comment: Although FRNSW acknowledge the fire safety measures outlined above as part of the performance solution, additional clarification is to be provided on the exact location of the combustible roof cladding elements given that it is not clearly highlighted on Figure 53 above. It is assumed that the non-compliant elements subject to the performance solution are located on the exterior of the northern dome section (to be clarified). If this is the case, then the assessment is also to consider the possibility of a worst-case credible fire scenario in the region(s) below the dome structure, and the ability for fire spread through any openings in close proximity. For example, it is noted that there openings situated below the northern dome (as shown in Figure 53), therefore the assessment is to consider whether fire spread may occur from such openings. This is to be addressed.

Stantec: Noted. Assessment of fire spread via the openings in the northern dome will be undertaken in the FER.

For further clarity the roof composition breakdown is as follows:

- Outer layer – copper sheet face
- Inner layer – existing timber cladding
- Secondary roof support – existing timber framing
- Primary roof support – existing steel roof beams
- Ceiling lining – fire-rated plasterboard (Performance Solution)

Figure 55 – Existing roof composition breakdown

FRNSW Comment: FRNSW acknowledge the information presented above in relation to the roof composition, however as noted by FRNSW's comment within the V08 FEBQ document, additional clarification is to be provided on the exact location of the combustible roof cladding. In conjunction with this, the assessment is to consider the possibility of a worst-case credible fire scenario in the region(s) below the dome structure, and the ability for fire spread through any openings in close proximity. This is to be considered satisfactorily within the FER. Based on the information provided within this V09 FEBQ document, no further comments on the adequacy of the proposed assessment may be provided.

Title: Deletion of fire rating to the lid of fire-isolated stair (L-03 and L-04)

Details of departures from DtS provisions:

To permit the deletion of fire rating to the lid of fire-isolated stair (L-03 and L-04).

Applicable DtS provisions:	C1.1, Spec C1.1 2.7	Performance requirements:	CP1, CP2

List key fire safety measures:

- The walls bounding the fire-isolated stair is to achieve a minimum FRL of 60 minutes and extend to the roof line of the fire-isolated stair.
- Automatic sprinkler protection is proposed to be installed throughout the building in accordance with BCA Clause E1.5 and AS2118.1-2017 with the exception of the Performance Solutions identified within this document and Education Building.

Proposed alternative solution:

BCA Comparison

BCA Specification C1.1 specifies that shafts are required to have an FRL must be enclosed at the top and bottom by construction having an FRL not less than that required for the walls of a non-loadbearing shaft in the same building, except that these provisions need not apply to—

- the top of a shaft extending beyond the roof covering, other than one enclosing a fire-isolated stairway or ramp; or
- the bottom of a shaft if it is non-combustible and laid directly on the ground.

According to the Guide to the BCA, the intent of this requirement is to establish the minimum fire-resisting construction.

Qualitative Assessment

Locations

The existing conditions of fire-isolated stair (L-03 and L-04) consist of a roof with window openings as shown in the figure below.

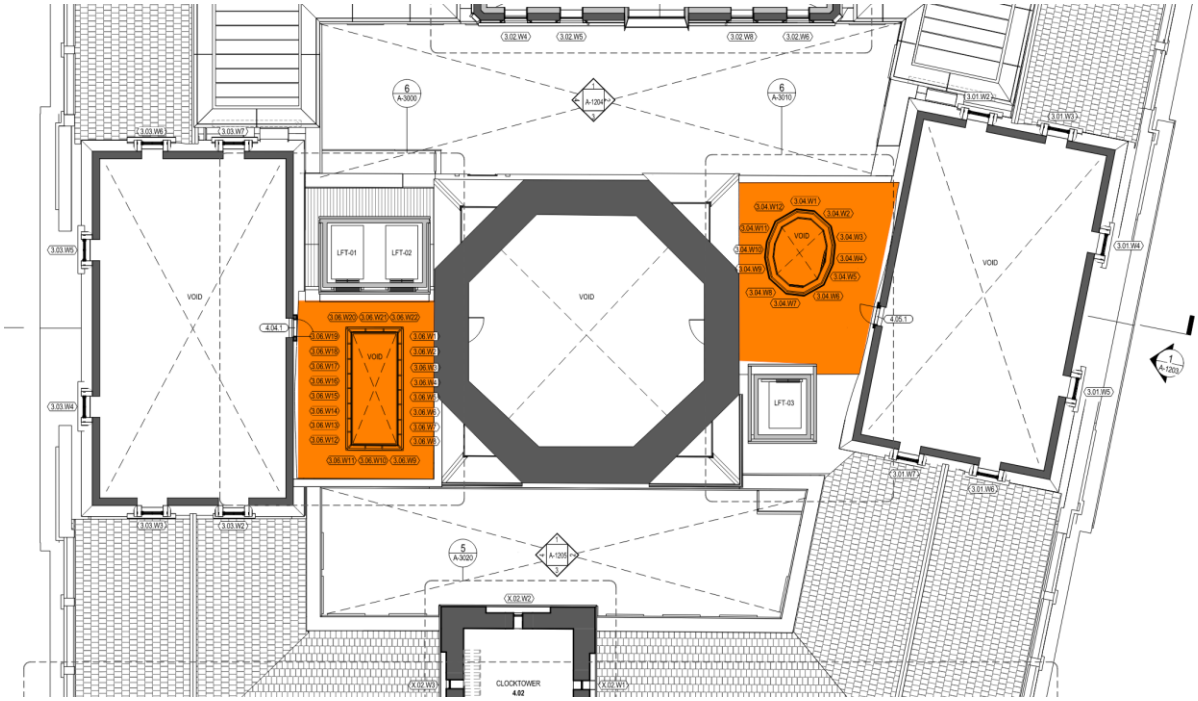


Figure 56 – Existing conditions of fire-isolated stair roof lid

Figure 57 below further illustrates the existing conditions of fire-isolated stair L-04.

Figure 57 – Existing conditions of fire-isolated stair roof lid

Performance Solution

As part of the performance solution it is proposed to permit the deletion of fire rating to the lid of the fire-isolated stairs based on the following fire safety measures:

- The bounding walls to the fire-isolated stair along the eastern and western ends of each stair is to achieve a minimum FRL of 60 minutes and extend past the roof line of the fire isolated stair to provide a fire barrier preventing fire spread into the stair from adjoining areas. This is depicted in Figure 58 below.
- Fire sprinkler system installed in accordance with AS 2118.1-2017 with the exception of the performance solutions identified within this document and in the Education building.

The risk of fire spread from within the fire-isolated stair is considered low due to the associated use of the stairway for pedestrian movement. No storage is expected within these areas which will likely impact on the daily movements of the building. As such the main fire spread risk is from the adjoining areas to the fire-isolated stair.

Fire sprinkler system

As discussed earlier, when an automatic fire sprinkler system operates, it not only controls or limits the fire development, but statistics show that in most cases, the fire is extinguished before the fire brigade arrives to the subject building. The effectiveness of sprinkler system mitigates the risk of fire spread and in this case the risk of fire spread into the fire-isolated stairs.

Passive fire separation

As illustrated in Figure 58, the tempietto bounding walls to the lower parts is to achieve an FRL of at least 60 minutes. Further the fire rated wall extends past the roof line of the fire-isolated stair. The intent of this passive fire separation provides a redundancy in minimising the risk of fire spread into the associated fire-isolated stair. As the roof line of the tempiettos curved the associated likely projection of fire is towards outside and not directly in line to

the roof of fire-isolated stair. As such it can be considered a low likelihood of fire spread returning into the fire-isolated stair.

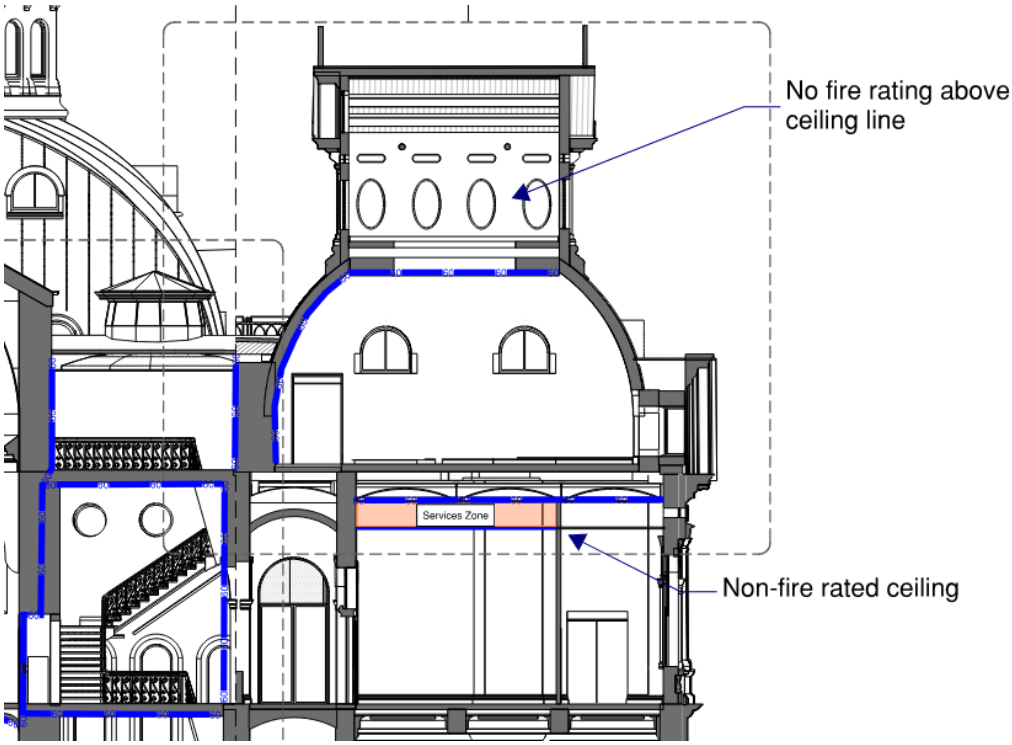


Figure 58 – example of fire-rated bounding walls to fire-isolated stair extending pass roof line

As discussed in Performance 15, the top parts of the tempietto is proposed to not achieved an FRL based on the non-occupied use in these spaces and management in use provisions not permitting any storage in these spaces. These measures minimises the risk of fire ignition and is further supported with the existing fire sprinkler system within these spaces.

Conclusion

It is therefore considered that the proposed design complies with Performance Requirements CP2 as it has been demonstrated that the fire safety provisions provided, the fuel load and usage of the roof spaces results in a low risk of fires inside the roof space, and the separation provided from adjoining areas of the building will prevent the spread of fire. It is therefore considered that the proposed design complies with performance requirements CP1 and CP2.

Performance solution:

☑ A0.3(a)(i) - Comply with the performance requirements
☐ A0.3(a)(ii) - Be at least equivalent to the DtS provisions

Assessment methods:

☐ A0.5(a) - Evidence of suitability
☐ A0.5(b)(i) - Verification methods in the NCC
☑ A0.5(b)(ii) - Other verification methods
☐ A0.5(c) - Expert judgement
☐ A0.5(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 can be demonstrated that the risk of fire spread to the non-fire rated lid of fire-isolated stair shall not adversely increase the life safety risk of occupants with considered of the proposed fire safety measures.

Fire scenarios and design fire parameters:

The fire hazard relating to this performance solution is adjoining areas with higher fuel loads contributing to the risk of fire spread into the fire-isolated stairs.

Describe how fire brigade intervention will be addressed or considered:

Fire brigade intervention can safely be achieved within the fire-isolated stair based on the proposed fire safety measures in this Performance Solution.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

Provide details on proposed modelling/assessment tools:

NA

FRNSW Comment: In principle support is provided subject to the analysis in the FER demonstrating compliance with the Performance Requirements of the NCC.

Issue number: 25 **Title:** Services penetration and connection joints through non AS 1530.4 tested fire-rated system

Details of departures from DtS provisions:

To permit the interface between the existing wall/ceiling system and service penetrations / connection joints where it has not been tested to AS 1530.4.

Applicable DtS provisions:	C1.1, Spec C1.1, C3.15, C3.16	Performance requirements:	CP2 and CP8

List key fire safety measures:

- Automatic sprinkler protection is proposed to be installed throughout the building in accordance with BCA Clause E1.5 and AS2118.1-2017 with the exception of the Performance Solutions identified within this document and Education Building.
- Passive fire separation throughout where required as part of the holistic fire safety strategy for the Lands Building

Proposed alternative solution:

BCA Comparison

BCA Specification C1.1 specifies the FRL requirement of each building element. BCA Clause C3.15 states that where an electrical, electronic, plumbing, mechanical ventilation, air-conditioning or other service penetrates a building element (other than an external wall or roof) that is required to have an FRL with respect to integrity or insulation or a resistance to the incipient spread of fire, that installation must comply with any one of the following:

(c) Tested systems

i. The service, building element and any protection method at the penetration are identical with a prototype assembly of the service, building element and protection method which has been tested in accordance with AS 4072.1 and AS 1530.4 and has achieved the required FRL or resistance to the incipient spread of fire.

ii. It complies with (i) except for the insulation criteria relating to the service if—

(A) the service is a pipe system comprised entirely of metal (excluding pipe seals or the like); and

(B) any combustible building element is not located within 100 mm of the service for a distance of 2 m from the penetration; and

(C) combustible material is not able to be located within 100 mm of the service for a distance of 2 m from the penetration; and

(D) it is not located in a required exit.

(d) Ventilation and air-conditioning — In the case of ventilating or air-conditioning ducts or equipment, the installation is in accordance with AS/NZS 1668.1.

According to the Guide to the BCA, the intent of Clause C3.15 is “to maintain the fire performance of a building elements by limiting fire spread by way of service penetrations.”

C3.15 sets out a number of requirements for protection of service openings, which in this instance include:

- The use of tested prototypes in accordance with AS 4072.1 and AS 1530.4 (3.15(a))
- Ventilation and air-conditioning ducts complying with AS 1668.1 (C3.15(b))

C3.15 only applies to an element that is required to have an FRL with respect to integrity and insulation as it only considers the protection for opening in elements that are provided a barrier to the spread of fire.

According to the Guide to the BCA, the intent of this requirement is to establish the minimum fire-resisting construction.

Clause C3.16(a) states that construction joints, spaces and the like in and between building elements required to be fire-resisting with respect to integrity and insulation must be protected in a manner identical with a prototype tested in accordance with AS 1530.4 to achieve the required FRL.

According to the Guide to the BCA, the intent of Clause C3.16 is to limit the spread of fire between building elements that are required to be fire-resisting. To avoid the spread of fire between fire compartments, in this case

between floors and adjoining fire compartments, construction joints between building elements are normally packed with fire retardant material. As stated in the Guide to the BCA, a number of proprietary products are suitable for this purpose, having previously been tested in accordance with AS 1530.4 to demonstrate they have achieved the required FRL.

Existing conditions of Lands Building

As discussed earlier in this document, the Lands building is a heritage listed building where a large extent is to remain as existing conditions. As such, elements of the external walls, internal walls, ceilings and floor shall remain with opportunity to improve the fire resistance performance where possible i.e. intumescent paint or similar. Inherently some of the existing wall conditions will achieve a level of fire resistance which is to be confirmed by an appropriate consultant in the team.

It has been identified the main type of passive systems in the building are as follows:

- Sandstone wall
- Brickwork wall
- Lathe & Plaster Ceiling
- Coke Breeze ceiling
- Structural elements
- New service risers

The above identified passive system will vary at each location where the thickness of the wall and composition will differ where inherently some walls/ceiling will achieve a greater FRL than others. Some elements above will not achieve an inherent fire rating and additional fire protective measures i.e. intumescent paint or similar are to be implemented to achieve the required FRL in the BCA or performance based solution (as presented in Performance Solution 1).

The construction interface between the passive systems and the new services penetration / construction joints are required to be considered in the assessment. The typical service penetrations applicable for the Lands building are as follows:

- Electrical/comms cabling
- Hydraulic piping
- Fire services piping
- Chilled water piping
- Fire dampers
- Fire doors

The typical connection joints applicable for the Lands building are as follows:

- Fire-rated wall to floor
- Fire-rated wall to non-fire-rated walls
- Service risers to wall / ceiling systems

The intent for this performance solution is to capture the main construction interfaces as the benchmark in the development of the FER.

Pathway to demonstrate compliance

Due to complex nature of the construction works for the development, an assessment methodology has been developed to address the potential non-compliances with the above identified passive systems in achieving the equivalent required FRL in the BCA and performance-based solutions. This pathway of compliance is presented in the figures below.

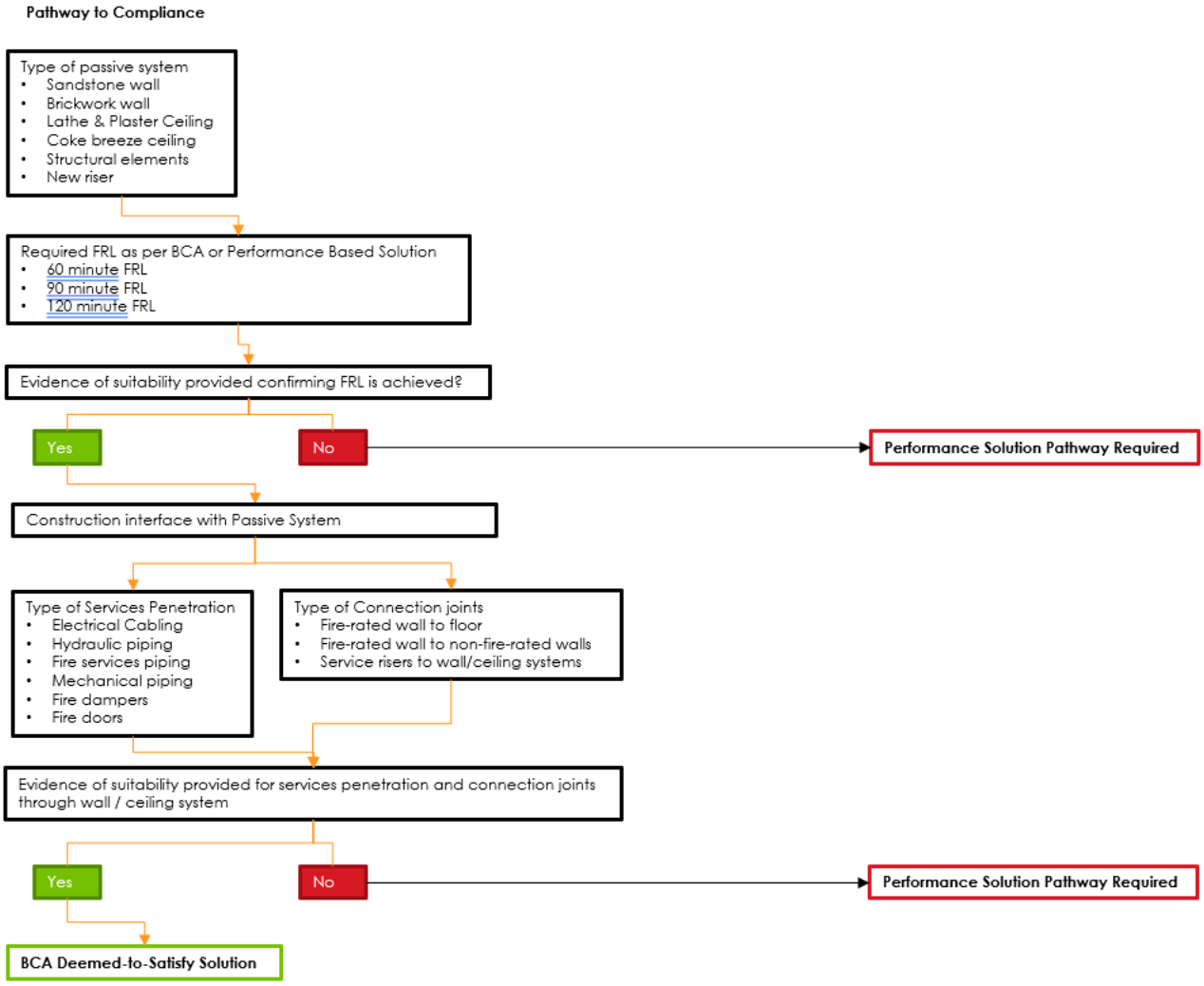


Figure 59 – Pathway to compliance

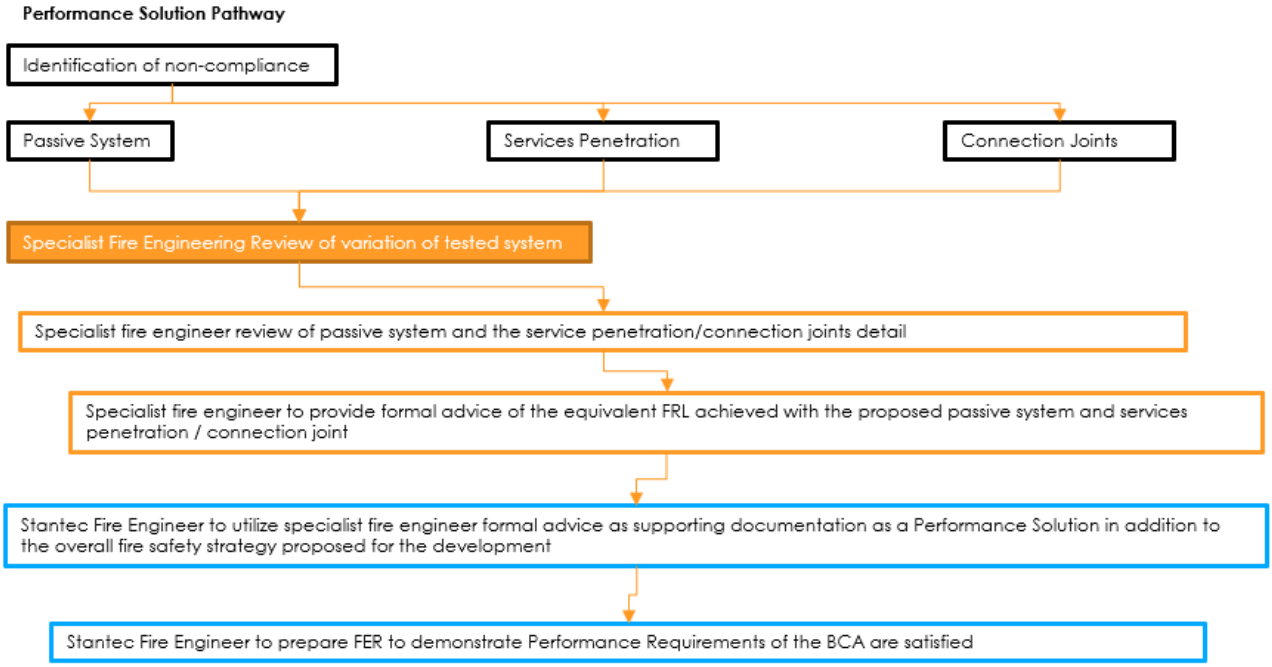


Figure 60 – Performance solution pathway

A holistic review of the passive systems and the associated inherent fire rating will be undertaken. This is supported by a specialist fire engineer providing professional advice on the fire resistance characteristics of the passive system. Further a review of the type of service penetrations and connection joints will be undertaken with support from the specialist fire engineer and relevant fire test report demonstrating a level of equivalent fire rating when tested to similar systems to the passive systems at the Lands Building. The assessment shall be a combination of professional advice from specialist fire engineer and comparison to fire test reports of services penetration and connection joints to typical fire-rated systems. In conjunction consideration of the overall fire safety strategy for the Lands building and the associated effectiveness of the active fire safety system will be further discussed in the FER.

This FEBQ outlines the general assessment methodology to be utilised to address the fire rating performance of service penetrations and connection junction details. As the project progresses, further information will be provided and addressed within the FER. The intent of this strategy is to appropriately identify the potential non-compliances relating to service penetrations and connection details where it can be appropriately addressed in the FER when further specific information is provided. This strategy alleviates the requirements for another FEBQ revision to be submitted to FRNSW whenever new information is identified.

Conclusion

Based on the proposed assessment methodology, the analysis to be undertaken in the FER shall demonstrate the proposed passive systems and its interface with service penetrations and connection joints will achieve an equivalent level of FRL satisfying the relevant Performance Requirements CP2 and CP8.

Performance solution:

- ☑ A0.3(a)(i) - Comply with the performance requirements
- ☐ A0.3(a)(ii) - Be at least equivalent to the DtS provisions

Assessment methods:

- ☐ A0.5(a) - Evidence of suitability
- ☐ A0.5(b)(i) - Verification methods in the NCC
- ☑ A0.5(b)(ii) - Other verification methods
- ☐ A0.5(c) - Expert judgement
- ☑ A0.5(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 can be demonstrated that the risk of fire spread via the services penetration and connection joints to the passive systems shall not adversely increase the life safety risk of occupants.

Fire scenarios and design fire parameters:

The fire hazard relating to this performance solution are the fire rating performance of the passive systems and its associated interface with services penetration and connection joints.

Describe how fire brigade intervention will be addressed or considered:

Fire brigade intervention can safely be achieved based on the proposed fire safety measures in this Performance Solution.

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

Provide details on proposed modelling/assessment tools:

NA

FRNSW Comment: FRNSW notes that the information provided above outlines the general assessment methodology to be undertaken, however no specific details have been provided as to how the relevant Performance Requirements of the NCC will be satisfied. Additionally, no specific details have been provided on the exact location(s) of the non-compliances to be address, as it appears these are to be identified and assessed on an ad-hoc basis. As such, insufficient information has been provided to allow for an informed review to be undertaken and no further comments can be provided at this stage.

Stantec:

This assessment methodology is in accordance with IFEG and AFEG, where the approach and acceptance criteria are defined when we are addressing services penetration and construction joints deviating from a tested AS 1530.4 system. Full analysis is undertaken in the FER phase.

This performance solution requires a lengthy investigative process in identifying the locations where this Performance Solution applies. Destructive testing is required to understand the composition of the existing walls of the building to determine the equivalent fire resisting performance. The type of service penetration and construction joint is work in progress.

The identification of actual location and specific details shall be undertaken in the FER phase of the project. Unfortunately we are unable to provide all the requested information, if so the FEBQ process will be a lengthy process with multiple revisions. Our approach has identified the key wall types and key services penetration and joints for the project. Each scenario will be reviewed by Stantec, specialist fire engineer, PCA and design team to validate the fire resisting performance of each scenario.

To further clarify these services penetration and joints will be fire protected i.e. fire collars, fire sealant and the like. The main deviation is these services penetration and joints may not have been tested to a sandstone wall or others identified in this document which inherently achieves a FRL. We are unaware of any testing with these configurations, as such the Performance Solution pathway methodology proposed to address this matter. The fire resisting performance of each service penetration is assessed based on relevant test reports with similar configurations or in some instances absolutely assessed. The assessment identifies the main deviations from the tested system and demonstrates how fire spread via these services penetration is minimised.

FRNSW Comment: Although FRNSW acknowledge the information and explanation provided above, given the lack of information in relation to specific details on the assessment method and how the Performance Requirements of the NCC will be satisfied, insufficient information has been provided to allow for an informed review of the performance solution to be undertaken. No further comments will be provided at this stage.

8 Appendix 1 – General Compartmentation and Egress Strategy

Refer to the Compartmentation and Egress mark-ups submitted alongside the FEBQ.

Figure 61 - Lower Ground

Figure 62 - Lower Ground Mezzanine

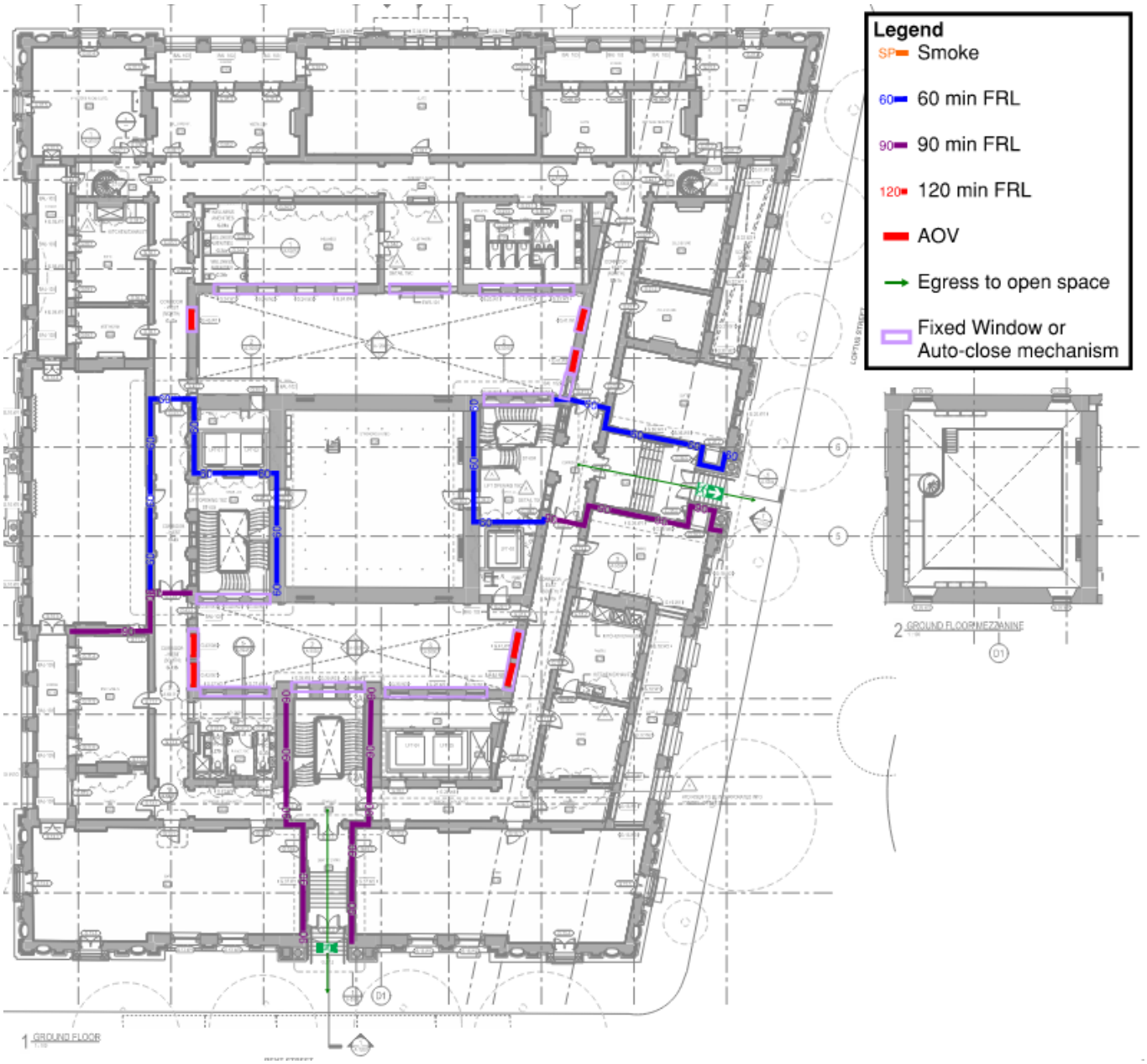


Figure 63 - Upper Ground

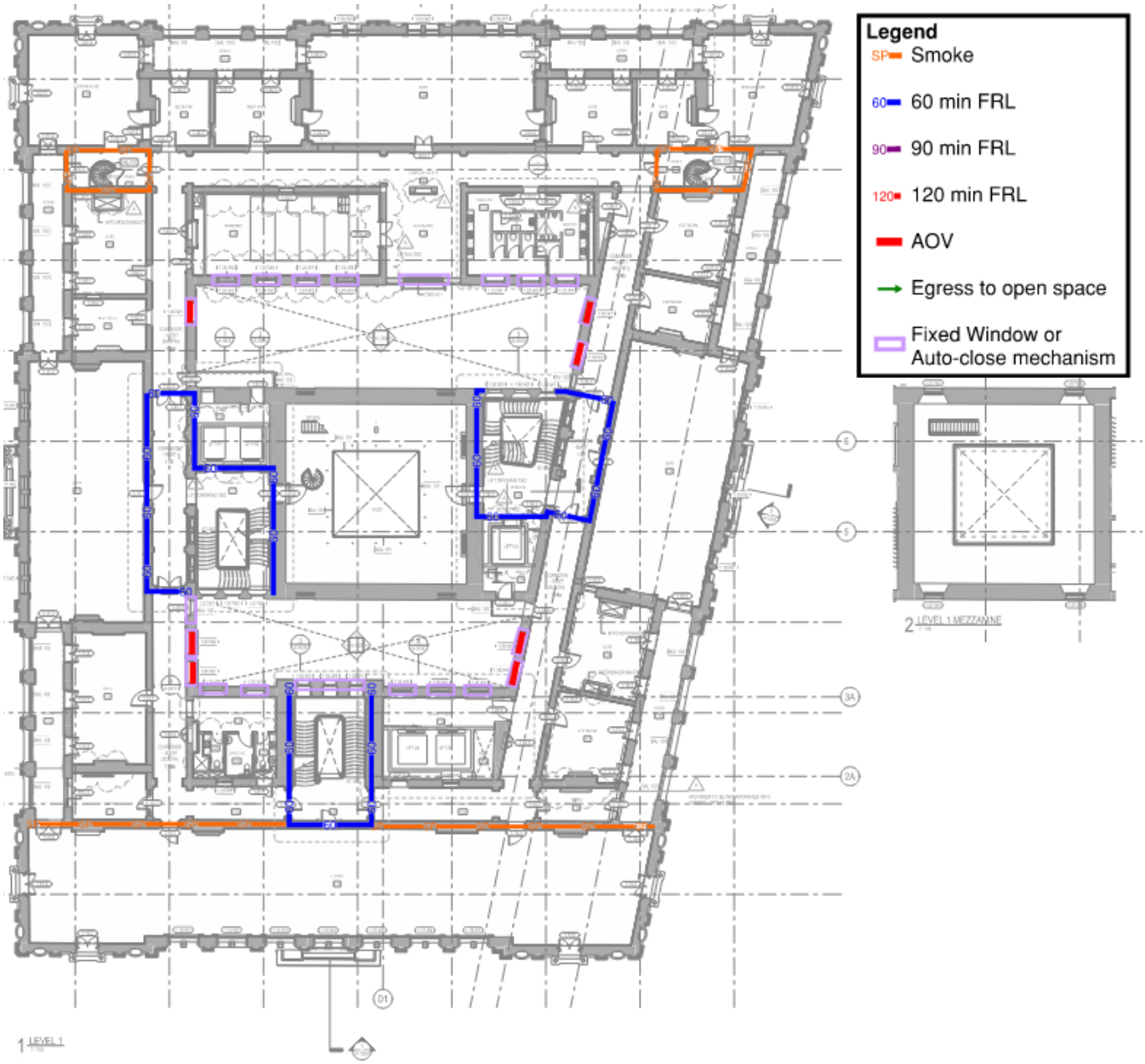


Figure 64 - Level 1

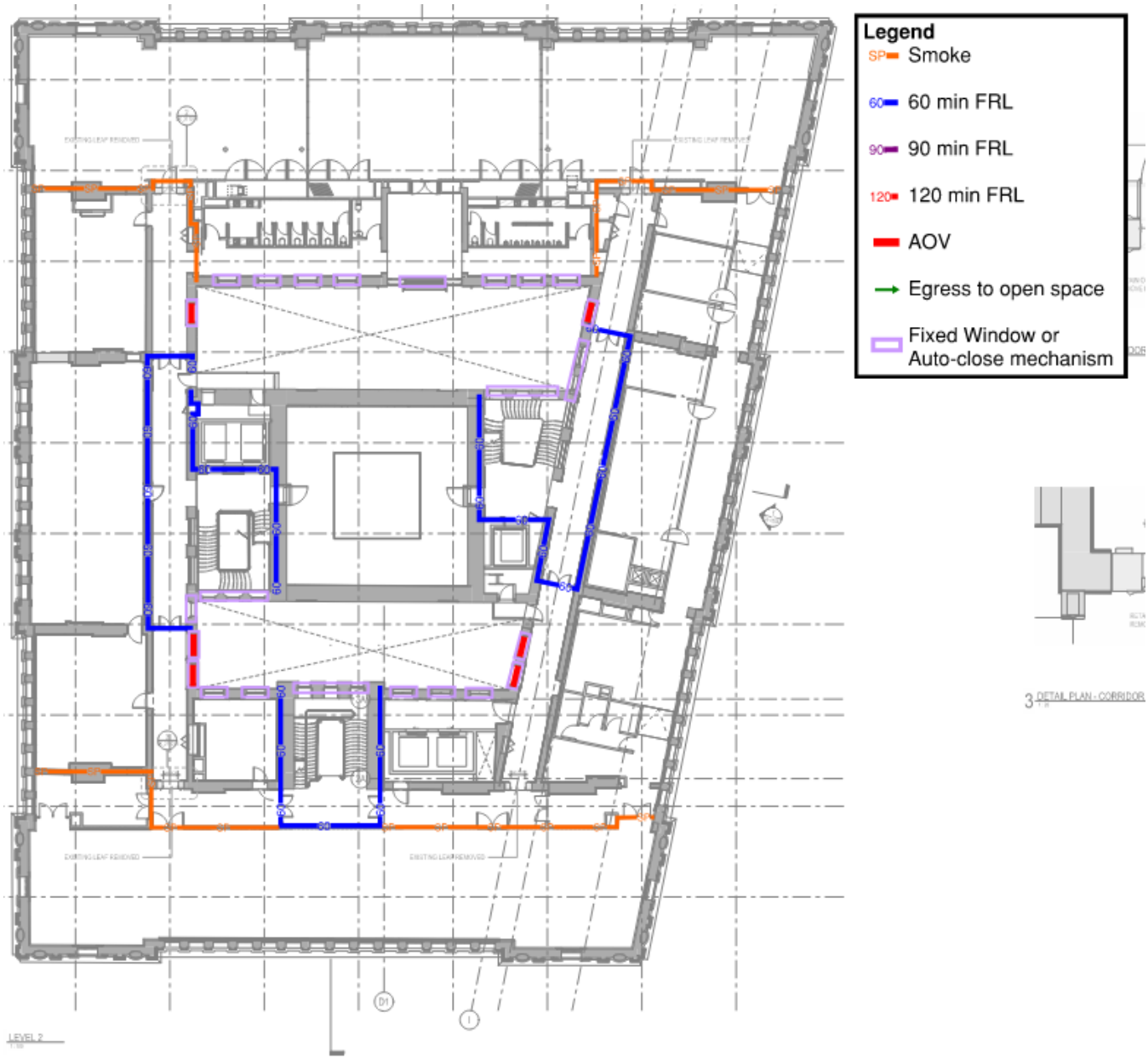


Figure 65 - Level 2

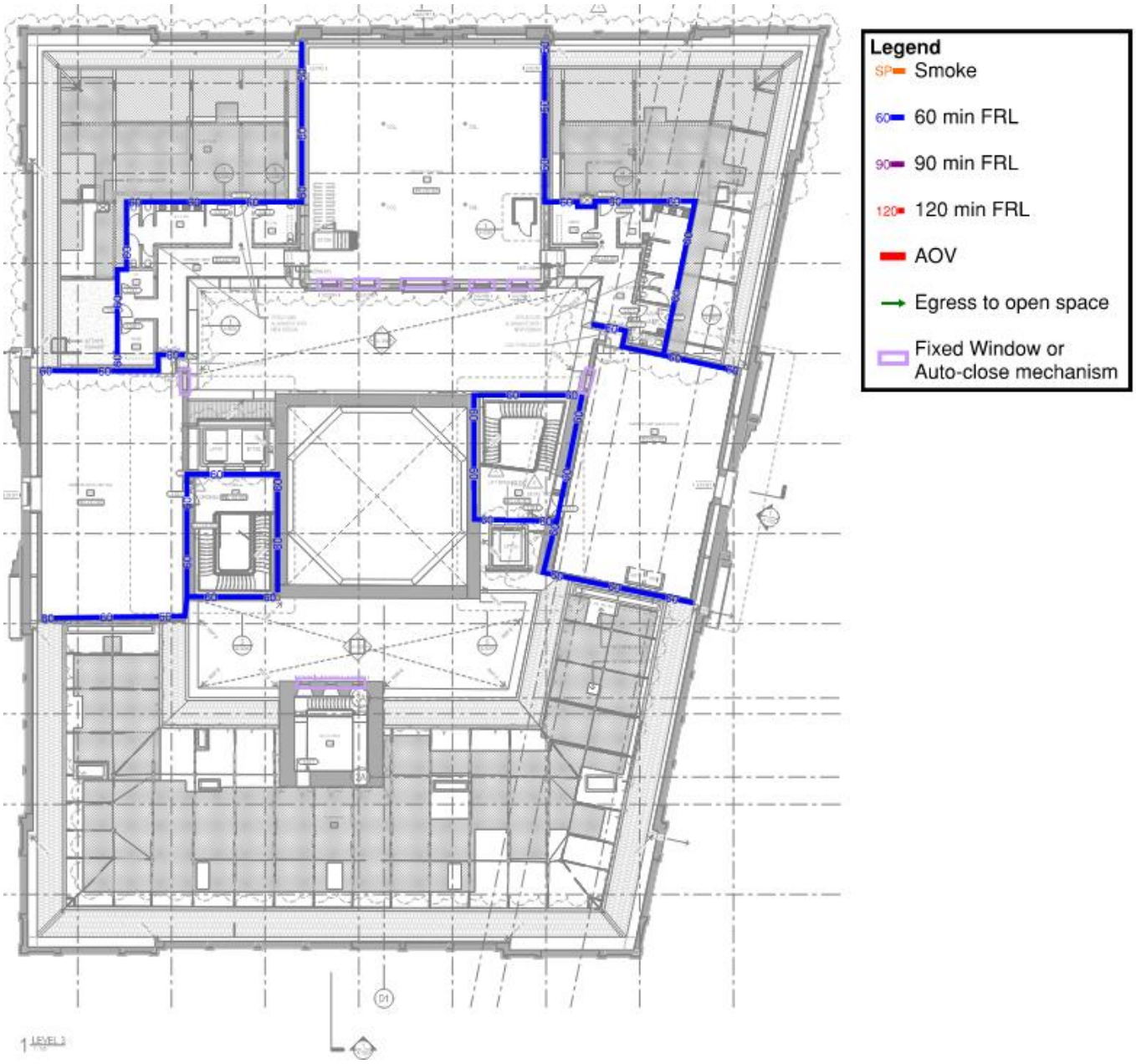


Figure 66 - Level 3

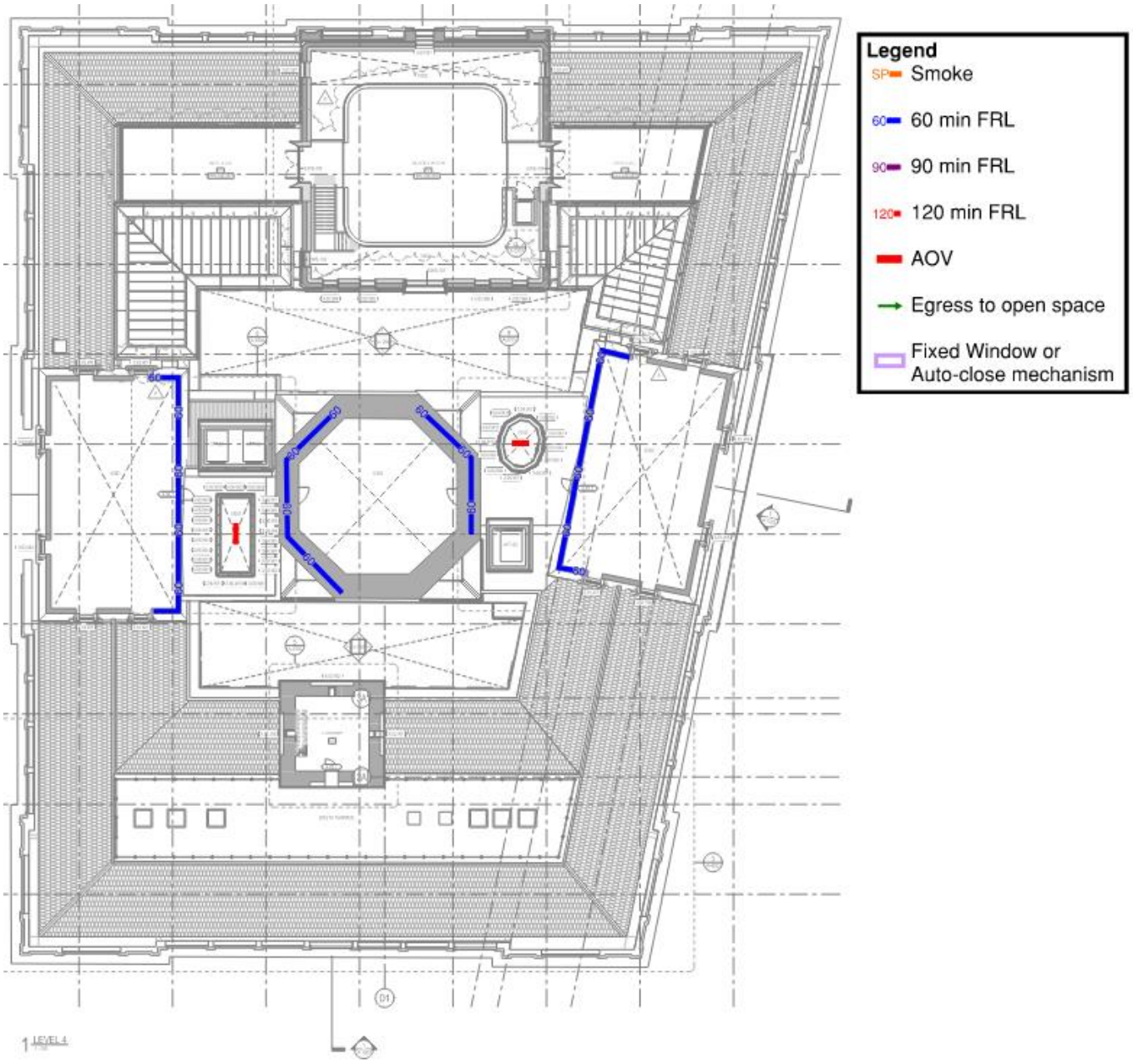


Figure 67 - Level 4

9 Appendix 2 – Slab and Ceiling Design

The below figures demonstrate the approach to be taken to achieving the required fire ratings to the ceilings and floor slabs. Note that the fire rating is to be achieved from below only.

Figure 68 - Lower Ground

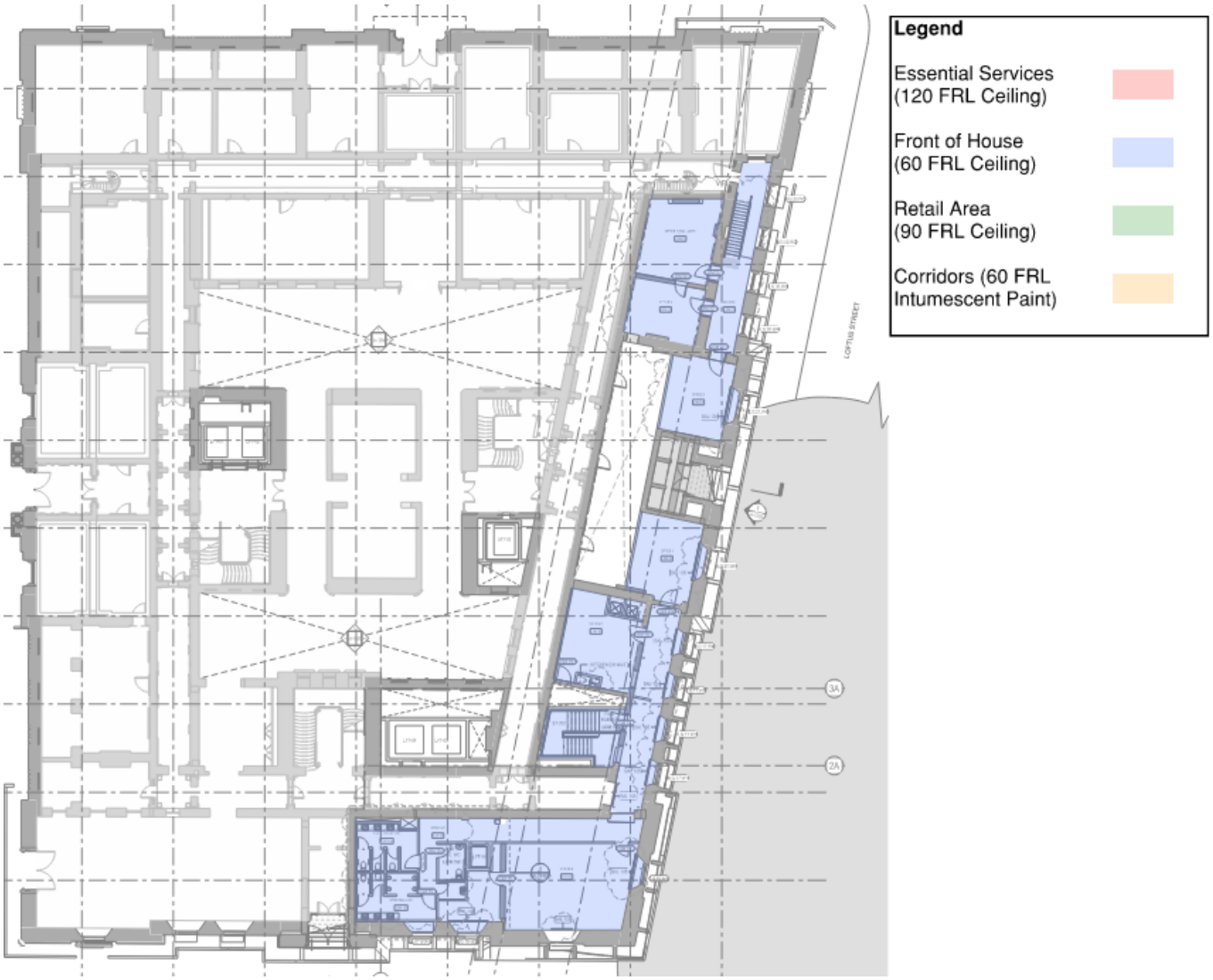


Figure 69 - Lower Ground Mezzanine

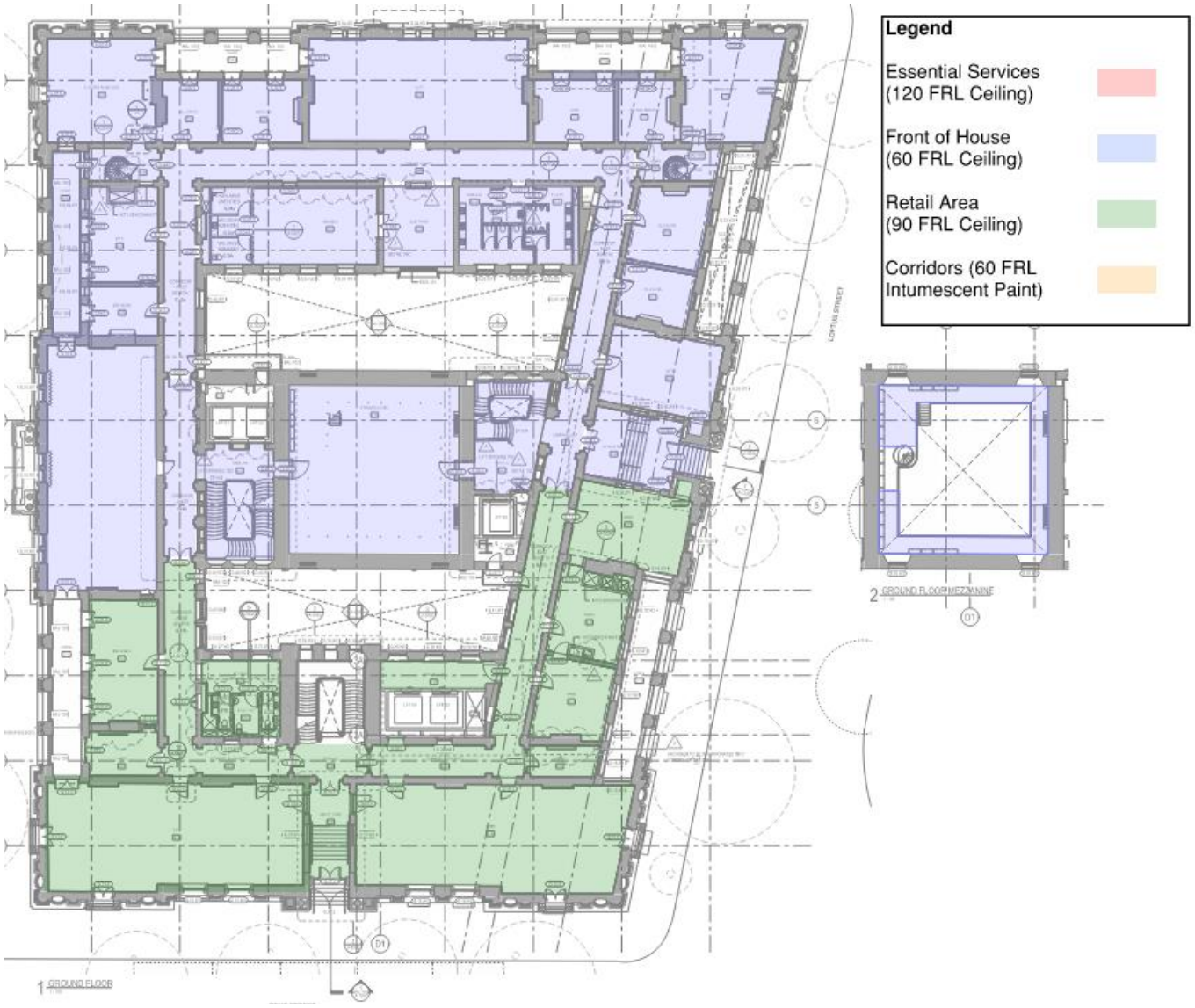


Figure 70 - Upper Ground

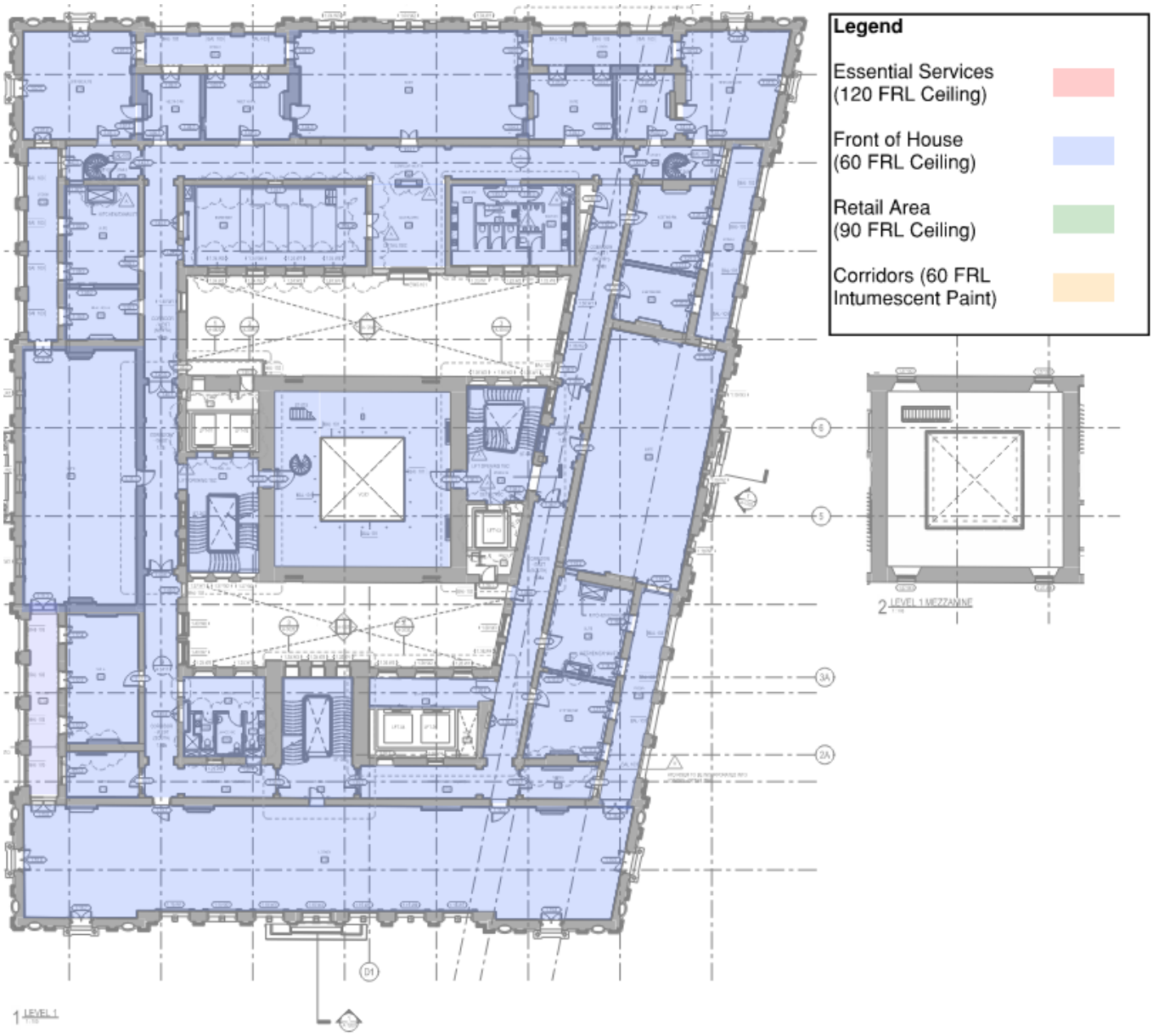


Figure 71 - Level 1

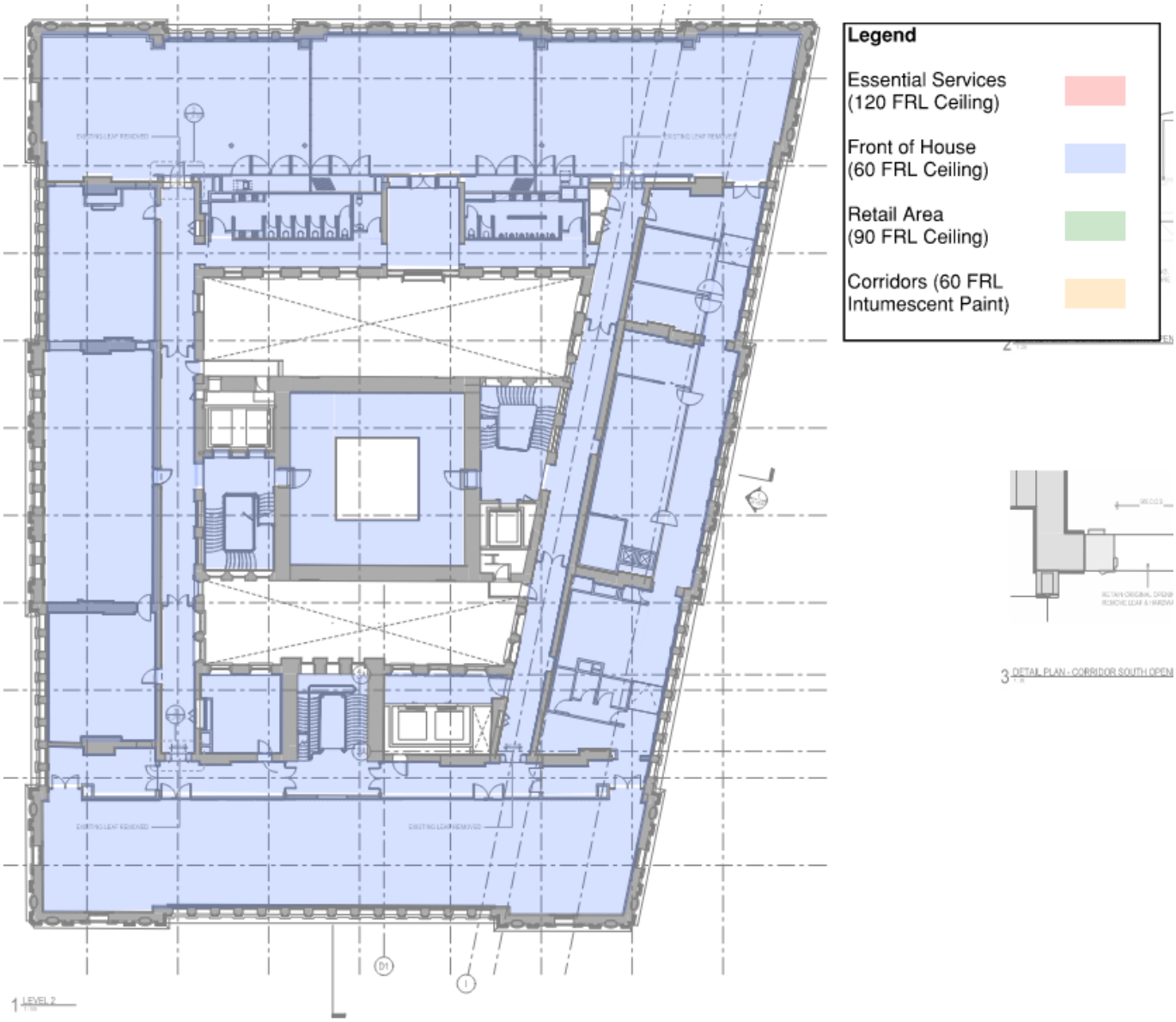


Figure 72 - Level 2

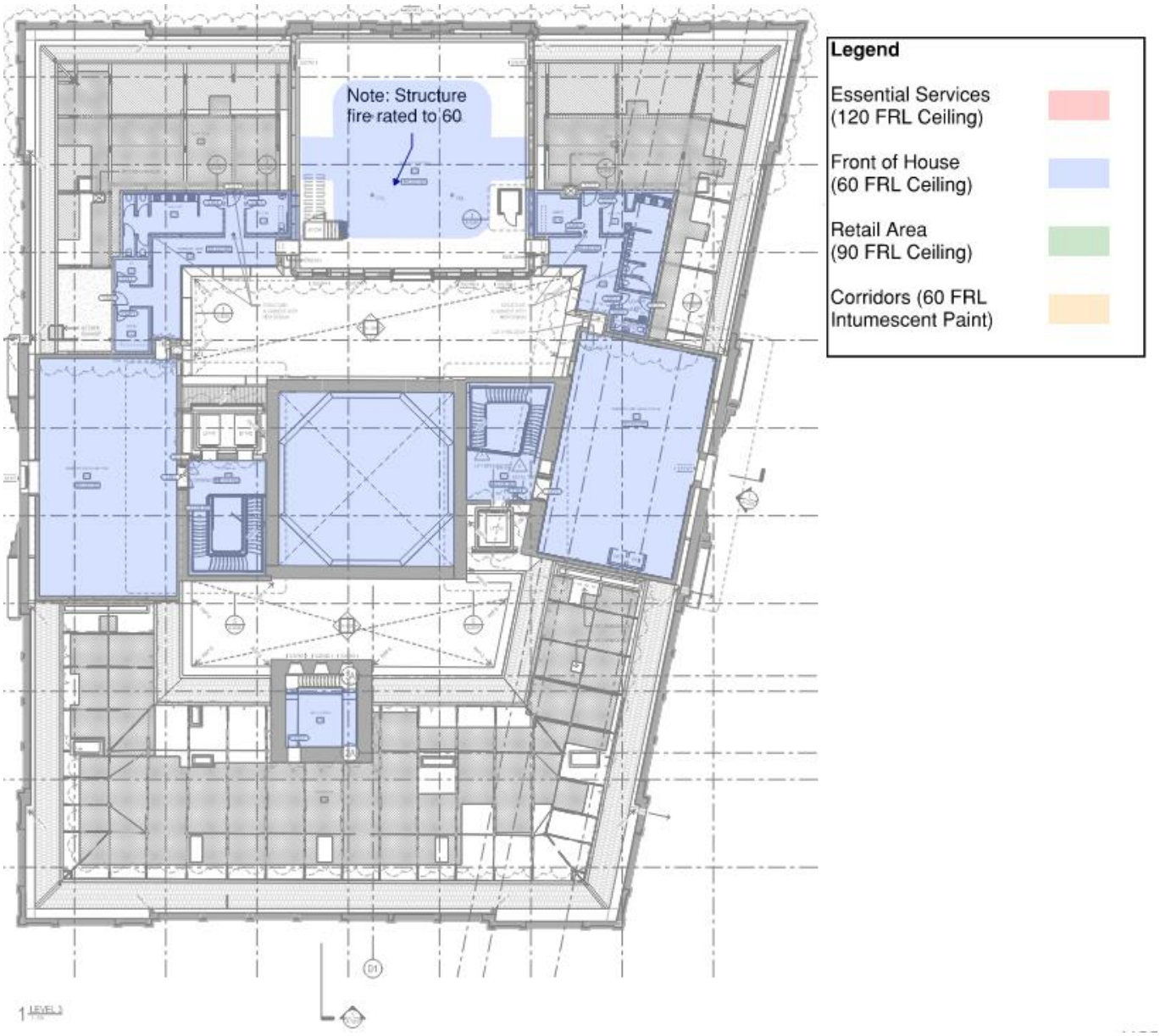


Figure 73 - Level 3

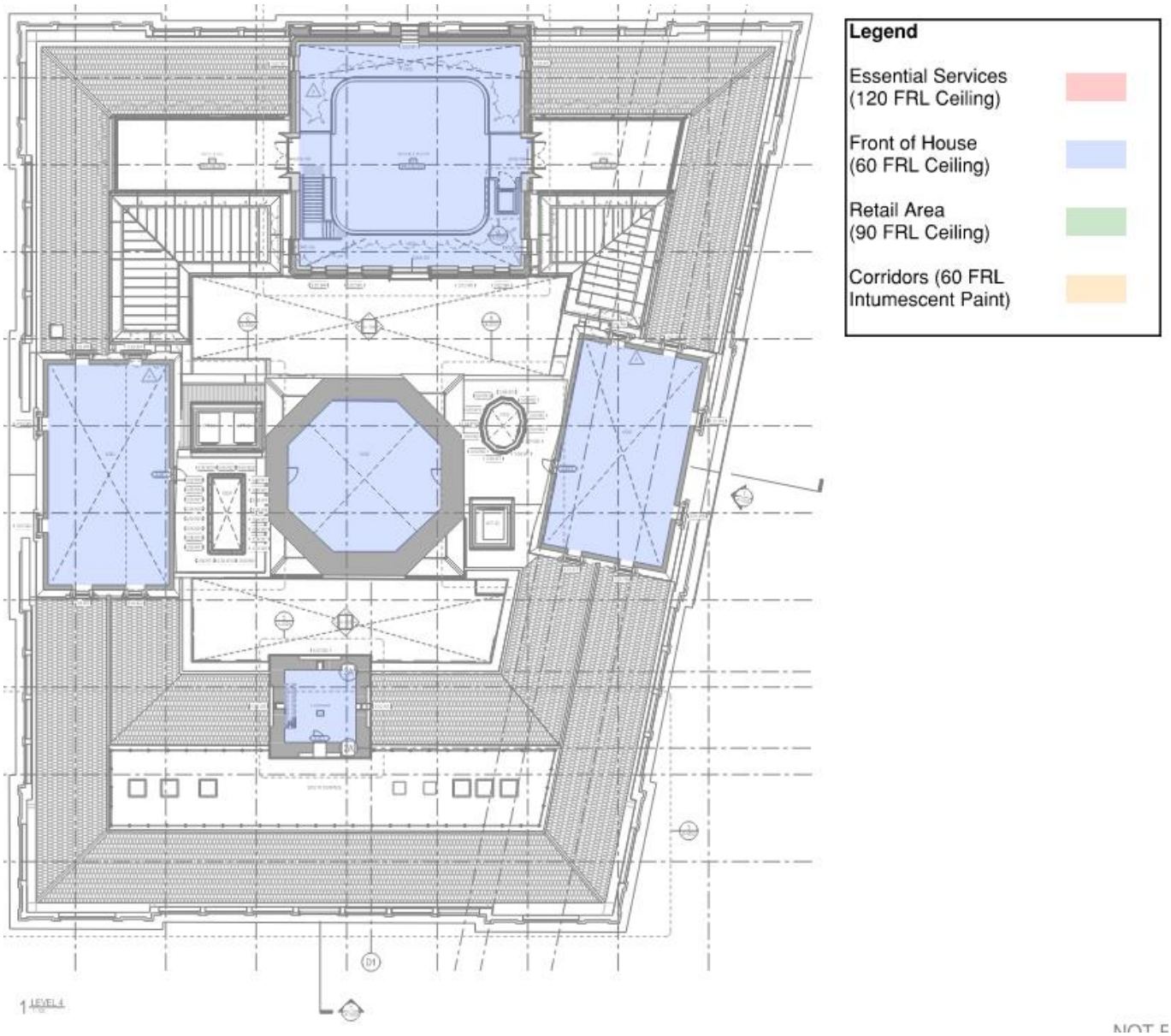


Figure 74 - Level 4

10 Construction, commissioning, management, use and maintenance

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

The heritage listing of the development impacts the possible fire safety measures implemented and installation of the measures must first consider the heritage impact they may have.

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

All systems are to be compliant with the current BCA with exception to any non-compliance addressed by way of a fire engineered performance based solution.

How will the alternative 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)?

Impacts of the alternative solutions on the management and use are listed under the 'management in use' heading of the preventative and protective measures section.

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

Restrictions on fuel loads have been listed in the 'management in use' and 'maintenance of essential services' headings of the preventative and protective measures section.

How will the alternative 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)?

As above.

11 Additional comments

NA

Note: Any in principle support extended for alternative 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.

12 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.

13 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.

14 Contact us

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