Fire Safety Engineering Report

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Trinity Grammar School – Stages 3-5: The Renewal Project

Project Address: **119 Prospect Road, Summer Hill NSW**
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3-0	07/10/2022	Final Fire Safety Engineering Report (FSER) incorporating FRNSW comments on the FEBQ	Christopher Boyack	Parkan Behayeddin	Parkan Behayeddin

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Contents

0. Executive Summary

0.1 General

This executive summary has been prepared to provide a concise statement of the Performance Solution issues identified and addressed in the assessment. The details of the Building Solution so assessed are described in full.

The purpose is to provide a readily accessible source to the intent and outcomes of the assessment with respect to the Building Solution presented.

The FSER is intended to represent a transparent account of the assessment process and outcomes consistent with the documented PBDB process and reflects the discussions and agreements between SFS Australia Pty Ltd T/A Scientific Fire Services (SFS), the design team and the relevant authorities based on the information provided to date.

The Client is to ensure that the relevant stakeholders and services consultants that have been involved in the project are in agreement with the proposals made in this document. Furthermore, it is the responsibility of the other designers and consultants (not SFS) to complete the detailed design of the various active and passive fire safety systems in accordance with the relevant design and installation Australian Standards and in accordance with the requirements listed in this report.

The reader should note the sections of this document that outline the scope of works, the assumptions and limitations and the fire safety objectives documented in this report. The building owner should be made aware of these sections of the FSER.

The executive summary must always be read in the context of the report as a whole.

0.2 Brief Building Description

0.2.1 Site Overall

The subject site is the Trinity Grammar School (TGS) and is located at 119 Prospect Road, Summer Hill NSW. The TGS campus is approximately 65,550m^2 and consists of Junior School, Secondary School, Specialist & shared facilities. The site is bound by Seaview Street to the north, Prospect Road to the east, Victoria Street to the west and Yeo Park to the south. The principal campus entrance is situated along Prospect Road. Figure 0.1 depicts a site plan of the campus.

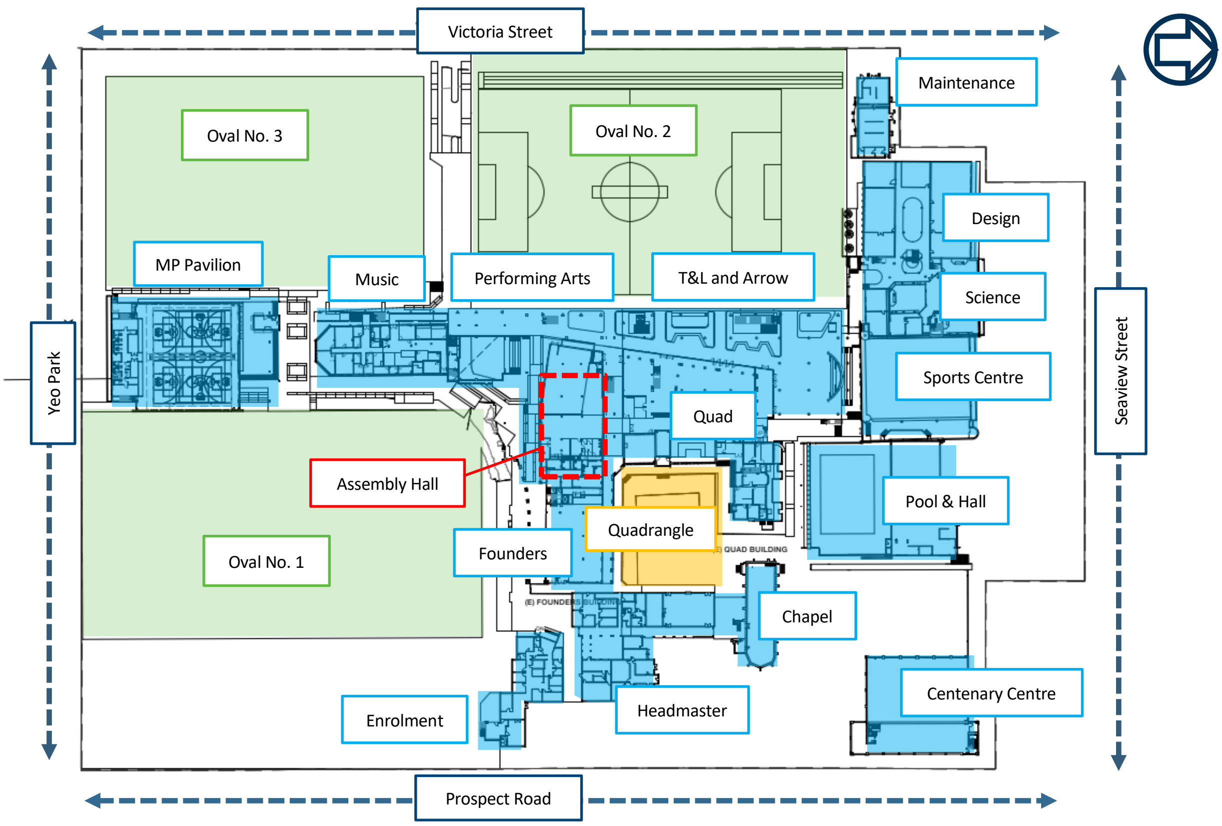


Figure 0.1: Site plan

0.2.2 Masterplan

The masterplan works have been developed in 5 stages to allow for the staged construction works, whilst maintaining the campus as operational. Stages 1-5 are broadly described as follows:

- Stage 1: Maintenance Building
  - New stand along maintenance building (2 storeys)
  - Demolition of Seaview Street properties No. 45-52 and Chapel Drive Ceremonial Axis landscaping upgrades
- Stage 2: Oval Carpark & Junior School Linkway
  - New Oval no. 3 carpark & sports field, ground area, back of house (BOH) and associated works to Yeo Park side driveway
  - Upgrade Junior School enclosed access path to connect to Oval 2 carpark
  - External tiered seating, paths and associated landscape works around Oval 1, external roadwork upgrade, intersection and footpath works.
- Stages 3-5: The Renewal Project
  - New five (5) storey teaching & learning facility
  - New performing arts precinct
  - New maintenance quarter
  - New multipurpose pavilion
  - Major improvement to on-site traffic
  - Refurbishment works to existing facilities incl. Founders Building, Music Building & Quadrangle Building

It is highlighted that the scope of fire safety engineering works under Stages 1-2 is documented within the Fire Engineering Report (FER) prepared by Arup Australia Pty Ltd (Report No. 281228, V01, dated 17 March 2022). The scope of fire safety engineering works under Stages 3-5 is documented herein. The staged works are indicative illustrated in Figure 0.2 & Figure 0.3.

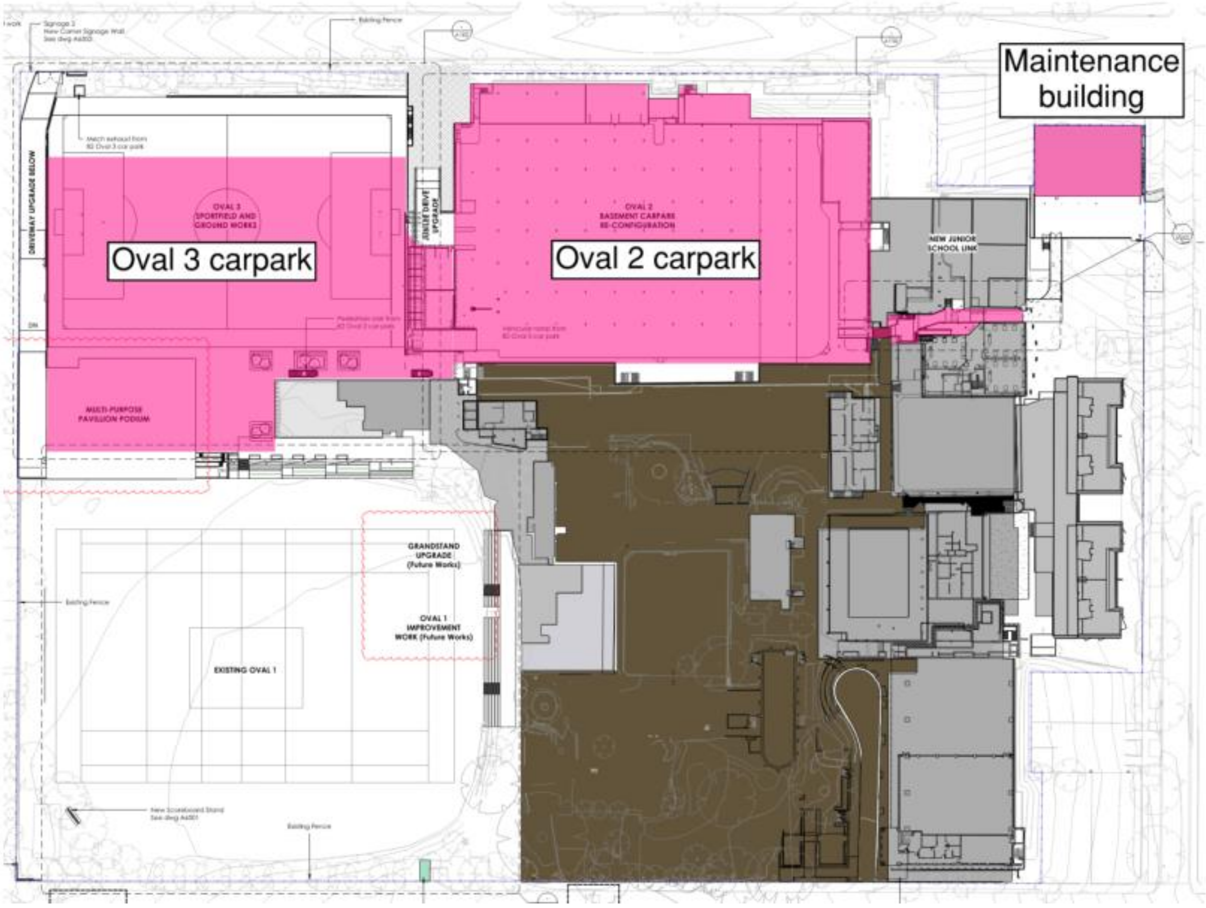


Figure 0.2: Stage 1 & 2 works (extracted from Figure 2 of Arup FER, Report No. Report No. 281228, V01, dated 17 March 2022)

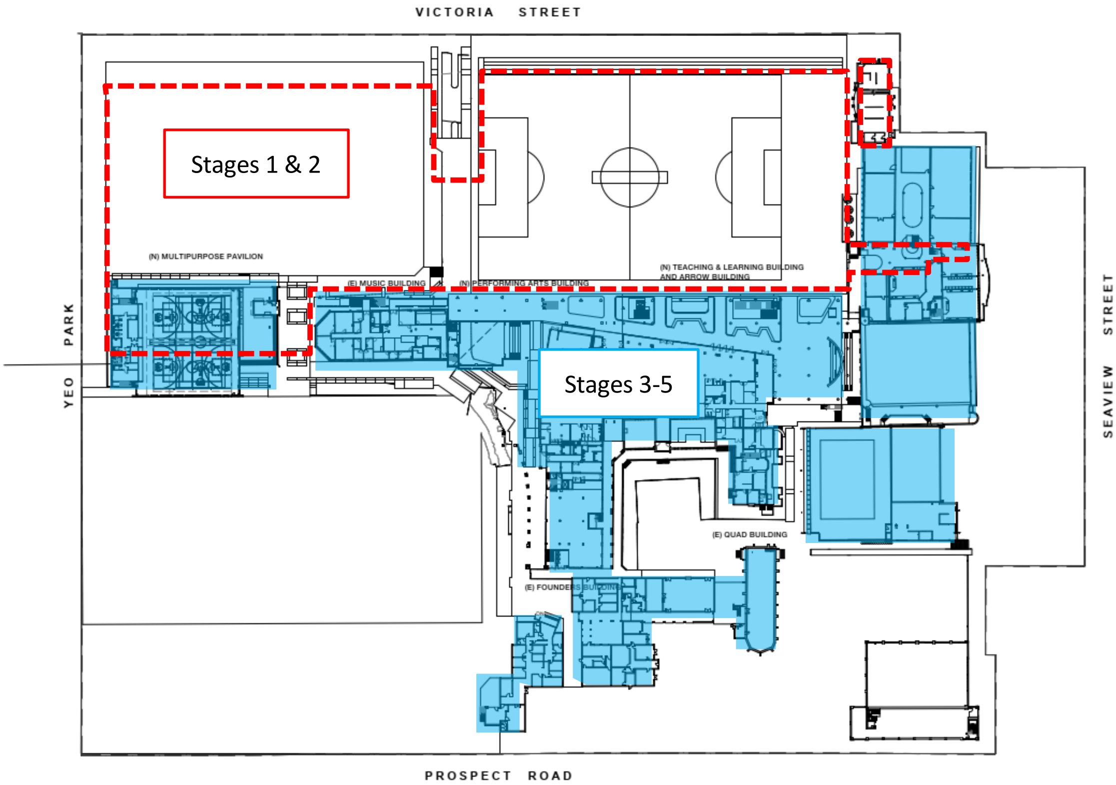


Figure 0.3: Indicative Stage 1 & 2 and Stage 3-5 works

0.2.3 Stage 3-5 Description

The Renewal Project shall generally involve alterations, additions and integration of new & existing building structures within the TGS campus. The emphasis is focused on providing contemporary learning spaces/facilities, improving circulation/connection within the campus and facilitate growth of the core student population to 2,100 (currently 1,680 secondary students). The key building characteristics associated with the Stages 3-5 works are detailed in Table 0.1.

Table 0.1: Building characteristics (Stages 3-5)

Precinct	Occupancy Use	Key Characteristics
Teaching & Learning	Teaching & Learning	• General learning areas (GLA's) & staff rooms • GLA's to be configured across the precinct to break out, seminar spaces to open onto a project space • Largest classroom to support capacity for up to 30 x students • Staff rooms centrally located with direct access to the Arrow Building (external walkways). Faculty space to contain desk/workstations, storage & break out furniture for collaborative work between staff & interaction with students • Main access via the Arrow Building (external walkways) with internal circulation also provided • Classrooms to be interconnected via operable walls • Amenities
	Library	• Situated within new civic space adjacent Agora • Two (2) levels comprising: – Ground floor: service counter, library staff space, learning areas, break away & reading nooks, central open stair, low bookshelves to demarcate functional zones – First floor: senior study space designed to accommodate groups of 20 in 2 or 3 acoustically separate spaces which can be merged
Performing Arts	Performing Arts	• New building proposed to interlink existing Music and Founders Buildings • Five (5) storeys overall with basement link to carpark

Precinct	Occupancy Use	Key Characteristics
	Black Box Theatre, B1 Founders Building	• The Black Box Theatre shall replace the existing ones situated within the B1 level of the Founders Building • The Black Box shall be openable to an outdoor fixed tiered seating space which transitions from ground level • Staff to have the ability to close the Black Box from the outdoor space to transform it into a rehearsal studio
	Assembly Hall & Lobby	• Multi-functional space situated on L1 proposed to operate under a number of modes including performance, concert & assembly • The assembly hall shall contain an upper-level mezzanine providing access to upper tiers and adjacent learning facilities in the precinct • Interconnection to Library & Founders Building via external walkway (Arrow Building) • Maximum occupant loading of 600
	Cafeteria & Canteen	• New cafeteria to be extended to occupy larger footprint • Commercial kitchen to cater for school functions and events
	Music building	• Existing Music Building to be refurbished and upgraded (incl. demolition of internal fire stairs) • Access to be provided externally via Arrow Building (external walkways)
Arrow Building	General	• The Arrow Building is an external walkway structure which connects both new precincts and existing buildings • Allows for students to circulate around the campus without the need to enter the building(s) • The external walkways shall be covered by undulating perforated metal screens
Sports Precinct	Multipurpose Pavilion	• Indoor sporting facility with spectator seating & amenities • The MP pavilion shall primarily accommodate the following: – 1/no. x full size championship basketball court with retractable tiered seating – 2/no. x training basketball courts for training only • Amenities & support facilities generally consisting of: – Retractable seating, mezzanine area, 2 x change rooms, 4 x WC's (students), 2 x WC's (staff/patrons), 2 x showers (students), 1 x accessible WC & shower, 1 x office/first-aid, chair store, cleaners & comms • Other functions to include school assemblies, speeches, primary school movie nights • Maximum occupant loading of 1,200
	Forecourt servery	• Simple servery for food and drinks with accommodation for BBQ area • Kitchen to allow heating and serving of preprepared food and drinks (not used for cooking) • Primarily used during weekend sport, but could also be used for special events
	Founders Building, B2 – Indoor Cricket	• B2 of Founders Building to be refurbished into new indoor sports, primarily for indoor cricket • Retractable netting allowing for double height space to be divided into practice areas
	Music Building, B1 – Sports Facilities	• B1 level of Music Building to be refurbished into new sports offices and amenities related to the school's outdoor ovals. • B1 level of the Music Building is to include: – Sports staff offices, sports storage, change room amenities, male WC, female WC, accessible WC & shower
Support Facilities	Reception & Administration	• The Agora will be the new arrival point for visitors coming from the carpark • Reception to be linked to senior leadership and administration offices situated in the refurbished Quadrangle Building.
	Staff Common Room	• Centrally located within Founders Building • Contemporary open plan environment facilitating staff socialisation & collaboration between staff members
	IT Support	• IT front of house to be situated within ground level of Library with additional ICT storage situated on B1.

Precinct	Occupancy Use	Key Characteristics
	Miscellaneous Storage	• Miscellaneous storage areas situated within B1 of Teaching & Learning. Storage contents shall generally be associated with the following: – Unform shop, Q store (cadet uniform), security office, ICT store, print room, textbook store, archives & art collection store and sports store

0.3 Building Design Issues and Performance Requirements

Table 0.2: Identified Design Issues

No.	Performance Solution Design Issues Addressed	BCA DtS Provision	Performance Requirement(s)	Performance Solution
1.	It is proposed to permit FRL's commensurate with Type C fire-resisting construction (non-combustible) in lieu of Type A fire-resisting construction for the Multipurpose Pavilion structure only (excluding the Basement Carpark).	Clause C1.1 & Specification C1.1	CP1 & CP2	A2.2(2)(d)
2.	It has been identified that the southern wall & openings of the Teaching & Learning block at L0 to L3 are situated approximately 5.8m from the northern wall & openings of the Founders/PA block without being protected in accordance with Clause C3.4.	Clause C2.7, Clause C3.3 & Table C3.3	CP2	A2.2(2)(b)(ii)
3.	It has been identified that the Teaching & Learning block abuts the existing Sports/Science/Aquatic blocks without being provided with a full-height fire wall which complies with Clause C2.7 as a result of glazed openings within the dividing wall. It is further noted that this dividing wall separates the sprinkler-protected T&L building/Carpark from the existing non-sprinkler protected Sports/Science/Aquatic block. It has also been identified that there are unprotected glazed openings forming part of the T&L block which are configured in a parallel orientation and within 6m of the subject dividing wall.	Clause C2.7, Clause C3.3, Table C3.3	CP2	A2.2(2)(b)(ii)

No.	Performance Solution Design Issues Addressed	BCA DtS Provision	Performance Requirement(s)	Performance Solution
4.	It is proposed to permit extended travel distances within various portions of the building as follows: **Teaching & Learning Precinct:** *Basement Level 1* • It is proposed to permit a travel distance to a point of choice of up to 26m in lieu of 20m; and • It is proposed to permit a travel distance to an exit where two exits are available of up to 67m in lieu of 40m; and • It is proposed to permit a distance of travel between alternative exits of up to 97m in lieu of 60m. *Level 2* • It is proposed to permit a travel distance to an exit where two exits are available of up to 47m in lieu of 40m; and • It is proposed to permit a distance of travel between alternative exits of up to 75m in lieu of 60m. *Level 3* • It is proposed to permit a travel distance to a point of choice of up to 26m in lieu of 20m; and • It is proposed to permit a travel distance to an exit where two exits are available of up to 42m in lieu of 40m. *Level 4* • It is proposed to permit a travel distance to a point of choice of up to 30m in lieu of 20m. **Performing Arts Precinct:** *Basement Level 2* • It is proposed to permit a travel distance to a point of choice of up to 25m in lieu of 20m; and *Level 1* • It is proposed to permit a travel distance to a point of choice of up to 23m in lieu of 20m; and *Level 3* • It is proposed to permit a travel distance to a point of choice of up to 21m in lieu of 20m; and • It is proposed to permit a travel distance to an exit where two exits are available of up to 45m in lieu of 40m. *Level 4* • It is proposed to permit a travel distance to a single exit of up to 45 m in lieu of 40m within the roof plant area.	Clause D1.4 & Clause D1.5	DP4, DP5 & EP2.2	A2.2(2)(d)
5.	It has been identified that the non-fire isolated stairways interconnect the following: Performing Arts Precinct: • Open stairway interconnects four (4) storeys in lieu of three (3) within sprinkler protected building Arrow Building (i.e. external walkway): • A number of open stairways which interconnect up to five (5) storeys in lieu of three (3) within sprinkler protected building.	Clause D1.3, Clause D1.7 & Clause D1.12	CP1, CP2 & DP5	A2.2(2)(d)
6.	It has been identified that a number of the non-fire isolated stairways serving the Teaching & Learning & Founders/PA blocks that do not afford a continuous means of egress by their own flights/landings.	Clause D1.9	DP4 & EP2.2	A2.2(2)(b)(ii)

No.	Performance Solution Design Issues Addressed	BCA DtS Provision	Performance Requirement(s)	Performance Solution
7.	The fire hydrant system is proposed to be designed & installed in accordance with the AS2419.1:2017 Australian Standard in lieu of AS2419.1:2005. *Note: This is consistent with the hydrant standard adopted for the design of Stage 1 and 2 prepared by Arup (Report No. 281228, V01, dated 17 March 2022).*	Clause E1.3 & AS2419.1:2005	EP1.3	A2.2(2)(d)
8.	It is proposed to omit the requirement to provide fire hose reels within the school building throughout (i.e. library, staff lounge etc, noting that classrooms & associated corridors are not required to be provided with fire hose reels).	Clause E1.4 & AS2441:2005	EP1.1	A2.2(2)(d)
9.	It is proposed to omit the requirement to provide automatic sprinkler protection within the main switch rooms within the Teaching & Learning and Founders/PA blocks.	Clause E1.5. Table E1.5, Specification E1.5 & AS2118.1:2017	EP1.4	A2.2(2)(b)(ii)

0.4 Methodologies

The following FSER has been undertaken generally in accordance with the Australian Fire Engineering Guidelines (AFEG) (ABCB, 2021). The assessment has considered the alternative solution to show compliance with the identified Performance Requirements of the BCA. The evaluation methodologies have been applied to demonstrate the Performance Requirements of the BCA as allowed under Clause A2.2 are complied with. The analysis has been undertaken by qualitative and quantitative analysis and system assessments as allowed under Clause A2.2 of the BCA. Specific methodologies adopted in relation to the identified design issues are further detailed in the body of this report.

0.5 Fire Safety Measures

The building incorporates a range of fire safety measures in accordance with the relevant Australian Standards. In summary, the BCA defines the fire safety measures and their applicable standards required to be installed within the building. Unless otherwise stated, the applicable standard of fire safety system installation (active and passive) must be compliant with the BCA and the relevant Australian Standards.

The other fire safety system features which are specific to the alternative solution proposed for this building are:

0.5.1 Stage 1 & 2 Performance Solution

1. Stage 1 & 2 parts of Trinity Grammar School were subject to a Performance Solution prepared by Arup Australia Pty Ltd (Report No. 281228, V01, dated 17 March 2022). The requirements in the aforementioned report do not have any impact on the proposed analysis, its assumptions and recommendations with the exception of the following:
    a. Fire hydrant system throughout the building in accordance with BCA Clause E1.3 and AS2419.1:2017.

In order to achieve a level of consistency across the Stage 3-5 parts of the Trinity Grammar School, the design proposes to maintain the hydrant installation in accordance with AS2419.1:2017.

0.5.2 Fire Resistance & Type of Construction – Stages 3-5

1. Building elements throughout shall be constructed in accordance with the minimum FRL's commensurate with Type A fire resisting prescribed in Part C from Volume One of the Building Code of Australia 2019 Amendment 1 unless otherwise identified herein; and
2. It is proposed to permit the Multipurpose Pavilion structure (excluding the Oval 3 basement level carpark) to be constructed in accordance with the minimum FRL's commensurate with Type C fire-resisting construction in lieu of Type A fire-resisting construction and inclusive of the following:
    a. The Multipurpose Pavilion structure shall consist of non-combustible construction. This performance solution relates to the applicable FRL's only; and
    b. The Multipurpose Pavilion shall be fire-separated from the basement level carpark via a fire-rated slab achieving a minimum FRL of 120-minutes in accordance with the DtS provisions of the BCA. Any services penetrations through the fire-rated floor slab shall be fire-stopped and must conform to a tested system in accordance with AS1530.4:2014; and
3. The non-fire isolated stairways interconnecting multiple storeys without the provision of a fire-isolated shaft shall be fire-separated at key levels as per the following:

a. The performing arts open stairway shall be fire-separated such that it does not interconnect more than three (3) consecutive storeys; and

b. Full-height solid bounding construction extending to the underside of the slab above (i.e. between L0 to L1 slab) and achieving a minimum FRL of 120-minutes from both sides. The doors serving the stairway shall be self-closing and achieve an FRL of -/120/30 fitted with medium temperature smoke seals. Refer to Figure 0.4; and

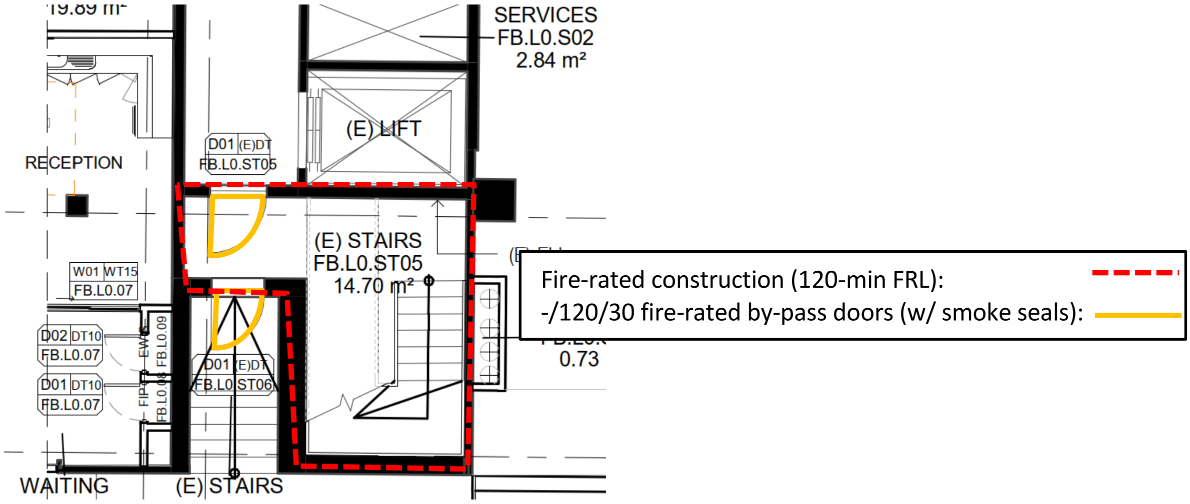


Figure 0.4: Fire separation at L0 stairway within Performance Arts/Founders

4. The stairway within the Performing Arts Building indicated in Figure 0.5 shall be located within a fire-isolated shaft and shall discharge directly to the outside at the lowest level; and
   a. Glazed elements within the external wall shall comply with Clause C3.8 of the BCA; and
   b. The northern wall of this stair shall consist of solid fire-rated construction achieving a minimum FRL consistent with the DtS provisions of the BCA; and

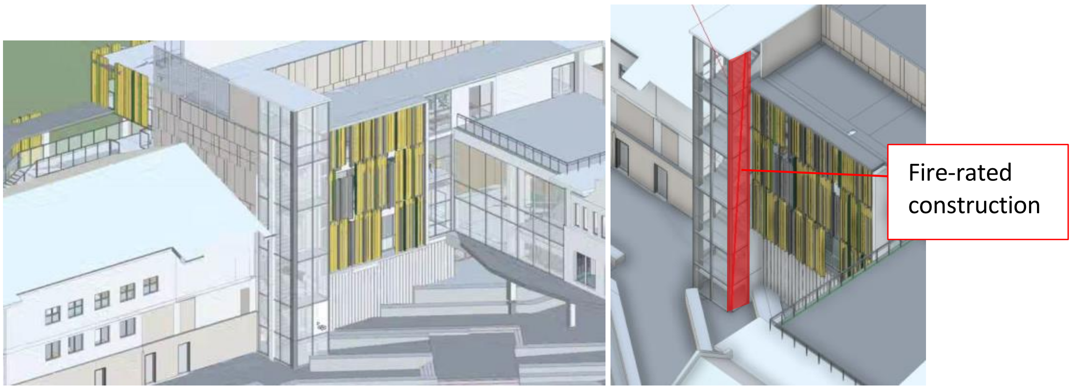


Figure 0.5: Stairway to generally be located within a fire-isolated shaft where glazed external construction shall comply with Clause C3.8

5. The main switch rooms situated within the Teaching & Learning and Performing Arts/Founders Buildings shall be bound by full-height, two-way fire-rated construction achieving a minimum FRL of 120-minutes and self-closing -/120/30 fire-rated doors; and
6. It has been identified that the southern wall & openings of the Teaching & Learning block at L0 to L3 are situated approximately 5.8m from the northern wall & openings of the Founders/PA block without being protected in accordance with Clause C3.4 (refer to Figure 7.1 & Figure 7.2); and
7. It has been identified that the Teaching & Learning block abuts the existing Sports/Science/Aquatic blocks without being provided with a full-height fire wall which complies with Clause C2.7 as a result of glazed openings within the dividing wall (refer to Figure 8.1 & Figure 8.2); and
   a. It has also been identified that there are unprotected glazed openings forming part of the Teaching & Learning block which are configured in a parallel orientation and within 6m of the subject dividing wall (refer to Figure 8.5); and
8. The tiered seating within the Agora area shall consist of non-combustible construction; and
9. The screens located along the elevations of the 'Arrow Building" walkway shall maintain a minimum open free-area of 50% with the exception of the following:

a. The screens outlined in red as indicated in Figure 0.6 below only may maintain a minimum open free-area of 20%; and

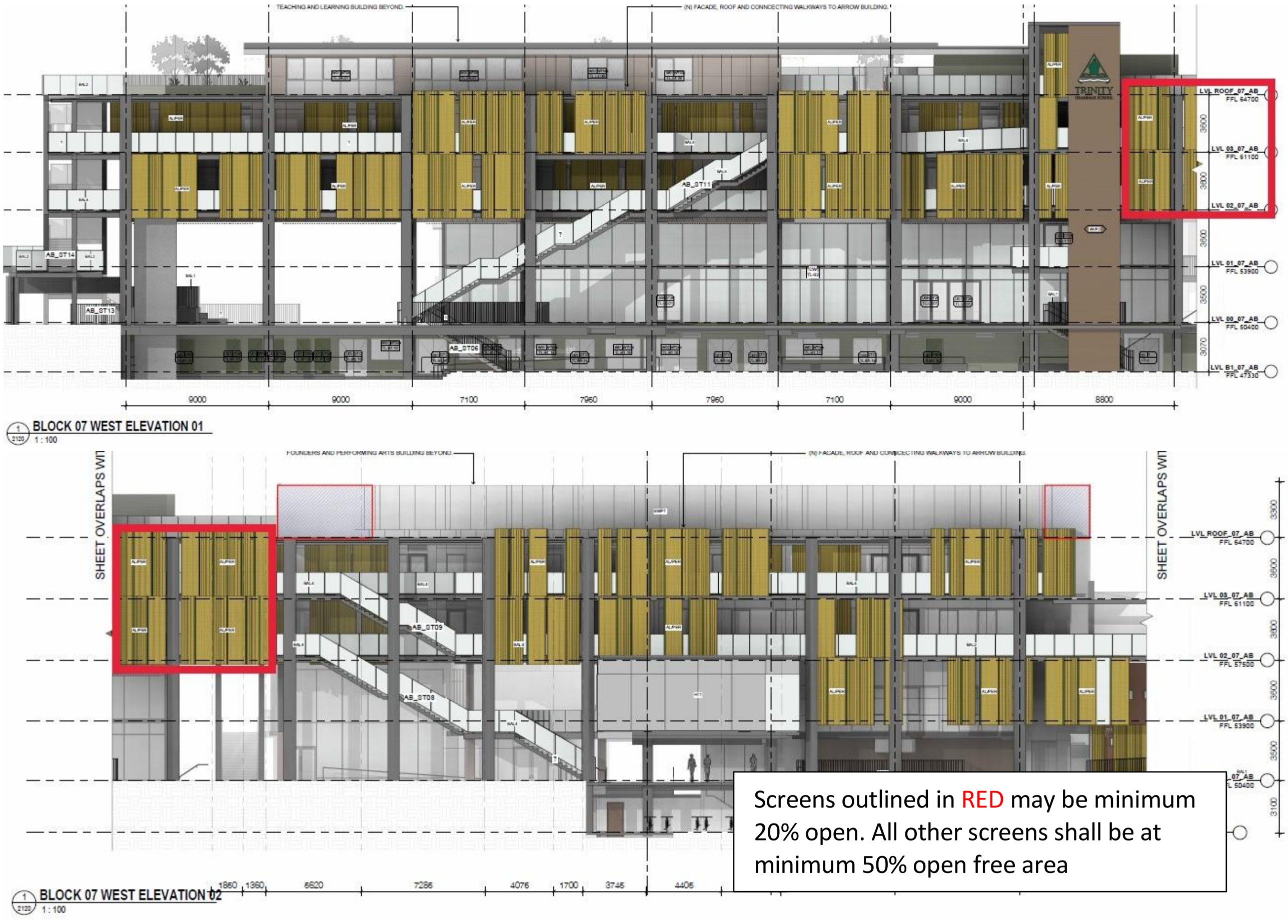


Figure 0.6: Screens located along elevations of Arrow Building

10. All components forming part of the external wall system serving the buildings (with the exception of the Multipurpose Pavilion) shall be non-combustible in accordance with Clause C1.9(a)(i); and
11. All fire compartment sizes (i.e. fire compartment area and volume) throughout the Stage 3-5 works shall comply the Deemed-to-Satisfy provisions of the BCA.

0.5.3 Occupant Egress Provisions – Stages 3-5

1. Occupant egress provisions shall comply with the DtS Provisions in Part D from Volume One of the Building Code of Australia 2019 Amendment 1 unless otherwise identified herein; and
2. Permit travel distances to a point of choice, to an exit and between alternative exits to exceed the maximum distances prescribed by the prescriptive provisions of the BCA as per the following:

Teaching & Learning Precinct:

Basement Level 1

a. It is proposed to permit a travel distance to a point of choice of up to 26m in lieu of 20m; and

b. It is proposed to permit a travel distance to an exit where two exits are available of up to 67m in lieu of 40m; and

c. It is proposed to permit a distance of travel between alternative exits of up to 97m in lieu of 60m (where measured through the point of choice).

Level 2

a. It is proposed to permit a travel distance to an exit where two exits are available of up to 47m in lieu of 40m; and

b. It is proposed to permit a distance of travel between alternative exits of up to 75m in lieu of 60m.

Level 3

a. It is proposed to permit a travel distance to a point of choice of up to 26m in lieu of 20m; and

b. It is proposed to permit a travel distance to an exit where two exits are available of up to 42m in lieu of 40m.

Level 4

a. It is proposed to permit a travel distance to a point of choice of up to 30m in lieu of 20m.

Performing Arts Precinct:

Basement Level 2

a. It is proposed to permit a travel distance to a point of choice of up to 25m in lieu of 20m; and

Level 1

a. It is proposed to permit a travel distance to a point of choice of up to 23m in lieu of 20m; and

Level 3

a. It is proposed to permit a travel distance to a point of choice of up to 21m in lieu of 20m; and
b. It is proposed to permit a travel distance to an exit where two exits are available of up to 45m in lieu of 40m.

Level 4

a. It is proposed to permit a travel distance to a single exit of up to 45 m in lieu of 40m within the roof plant area.

3. Permit the non-fire isolated stairs serving the Teaching & Learning and Performing Arts/Founders Buildings to provide discontinuous egress paths in lieu of continuous egress by their own flights/landings to road/open space; and
4. Permit non-fire isolated stairways to interconnect multiple storeys without the provision of a fire-isolated shaft as per the following:
   a. Performing Arts Precinct:
      i. Open stairway interconnects four (4) storeys in lieu of three (3) within sprinkler protected building
   b. Arrow Building (i.e. external walkway):
      i. A number of open stairways which interconnect up to five (5) storeys in lieu of three (3) within sprinkler protected building.

0.5.4 Fire Services & Equipment – Stages 3-5

1. Fire services & equipment shall comply with the DtS Provisions in Part E from Volume One of the Building Code of Australia 2019 Amendment 1 unless otherwise identified herein; and
2. Automatic sprinkler protection shall be provided throughout the building in accordance with BCA Clause E1.5, Specification E1.5 and AS2118.1:2017 with the inclusion of the following:
   a. Automatic sprinkler protection shall be installed to the following building locations (refer Appendix L):
      i. Teaching & Learning (incl. the Quadrangle building); and
         The underside of the Level 2 slab located above the Agora portion of the building shall be provided with sprinkler protection; and
      ii. Arrow Building (external walkways); and
      iii. Music Building; and
      iv. Performance Arts (incl. cafeteria & assembly hall); and
      v. Founders Building; and
   b. Sprinkler heads shall be fast response type heads having an actuation temperature of not greater than 68°C and RTI of not greater than $50m^{-0.5}s^{-0.5}$; and
   c. Activation of the sprinkler system shall initiate a General Fire Alarm (GFA) throughout the Trinity Grammar School campus; and
   d. Omit the requirement to provide automatic sprinkler protection within main switch rooms within the Teaching & Learning and Performing Arts/Founders Buildings; and
3. Where nominated glazed construction shall be protected by wall-wetting sprinkler protection designed and installed with the following requirements:
   a. The wall-wetting sprinkler system shall be designed and installed in accordance with AS2118.2:2010; and
   b. The wall-wetting sprinkler protected glazing shall be 6.0mm toughened or heat strengthened glass and fixed in the closed position. Horizontal mullions, vertical transoms or any other fixed obstructions/fixings/frame elements with may impede or block full wall-wetting sprinkler spray coverage are not permitted to the glazing system; and
   c. The nominated wall-wetting sprinkler system, shall be capable of providing full coverage to the entire glass panel; and
   d. Where glazing connectors or other fixed obstructions may impede water spray coverage to glazing, additional wall-wetting sprinkler heads may be required as per the manufacturer’s data sheet to ensure that the nominated system provides complete spray coverage to the entire glass panel; and

e. The maximum distance between any two (2) wall-wetting sprinklers shall be in accordance with the manufacturer's data sheet in order to provide sufficient and unimpeded coverage to the entire glass panel. It shall be noted that wall-wetting sprinkler protection is an acceptable method of protection commensurate with BCA Clause C3.4; and

f. The water is to be supplied by an independent isolation valve to the sprinklers in the same area (i.e. not valved from the same sprinkler zones where the glazing is located); and

g. The water supply for the wall-wetting sprinklers protecting the glazing may be fed from the fire hydrant system installation. A maximum of twelve (12) wall-wetting sprinkler heads shall be served by the fire hydrant service; and

h. Where glazing construction is above ceilings to the slab structure or false ceiling space, wall-wetting sprinklers shall also be provided within the ceiling space such that the glazing is provided with unobstructed water spray. Alternatively, the ceiling space above the wall-wetting sprinkler protected glazing shall be provided with fire-rated construction achieving a minimum FRL of 120-minutes such that a consistent fire barrier is provided between adjacent fire compartments; and

4. Any openable, glazed swing door sets provided forming part of the nominated fire separation shall be provided with the following:

   a. Minimum 6.0mm thickened toughened (tempered) or heat strengthened glass panels; and

   b. Glazed doors shall be fitted with self-closing device or magnetic hold-open devices which are set to close/release upon General Fire Alarm (GFA). Glazed doors shall not be sliding; and

   c. The door leaves shall be fitted with medium temperature smoke seals suitable for smoke up to 200°C; and

   d. The wall-wetting sprinkler protection shall be designed and installed in accordance with AS2118.2:2010 and the parameters in item 3 above; and

5. The glazed double-door set indicated in Figure 0.7 shall be provided with wall-wetting sprinkler protection; and

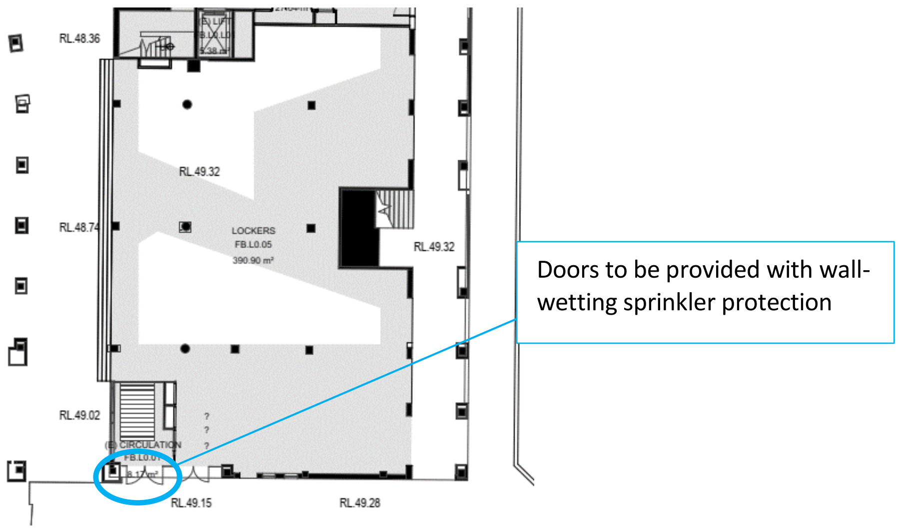


Figure 0.7: Doors to be provided with wall-wetting sprinkler protection

6. System monitoring to a fire station or fire station despatch centre shall be provided in accordance with AS1670.3:2018; and

7. Alarm Signalling Equipment (ASE) shall be provided with multiple outputs to designate the building of alarm origin; and

8. Automatic smoke detection shall be provided throughout all buildings of the Stage 3-5 portion in accordance with AS1670.1:2018 and with the inclusion of the following:

   a. The main switch rooms within the Teaching & Learning and Performing Arts/Founders Buildings shall be provided with centrally located smoke detectors; and

   b. The Basement Level 1 of the Teaching & Learning building shall be provided with a detection system on a reduced spacing of 8m x 8m in lieu of 10m x 10m; and

   c. Additional detectors shall be installed within the sports building within 1.5m of tilt glass panel at distances no greater than 10m along the width of the tilt panel. Activation of these detectors shall activate the EWIS within the T&L building; and

9. Provide a Building Occupant Warning System (BOWS) in accordance with BCA Specification E2.2a, AS1670.1:2018 which shall initiate on either sprinkler head or detector activation and with the inclusion of the following:

   a. The BOWS shall comprise a pre-recorded public address system; and

   b. The following buildings shall be provided with a BOWS:
      i. Multi-Purpose Pavilion; and
      ii. Music Building; and
      iii. Arrow Building; and
10. Provide an Emergency Warning & Intercommunication System (EWIS) in accordance with BCA Specification E2.2a and AS1670.4:2018 which shall initiate on either sprinkler head or detector activation to the following locations:
   a. Teaching & Learning; and
   b. Quadrangle Building; and
   c. Performing Arts; and
   d. Founders Building; and
11. As per Clause 5.2.1 of AS1668.1:2015, HVAC and air handling systems not designed to operate in fire mode shall shut down upon activation of GFA; and
12. The Trinity Grammar School campus shall be served by a number of Fire Indicator Panels (FIP's) generally configured and networked as follows (refer to Appendix K for details):
   a. The campus wide main FIP shall be situated at the entry of Oval 3 carpark (adjacent fire sprinkler/hydrant plant room and is closest to the booster assembly) and shall be connected to new FIP's on a high-level network which shall be located as follows:
      i. Multi-Purpose Pavilion FIP; and
      ii. Music Building FIP; and
      iii. Performance Arts Building FIP & EWIS Panel; and
      iv. Existing Hurlstone Building FIP (to be replaced with new FIP); and
      v. Teaching & Learning and Quadrangle Building FIP & EWIS Panel; and
      vi. Oval 2 Carpark FIP; and
      vii. Maintenance Building FIP; and
   b. Existing FIP's shall be connected to the main FIP at Oval 3 on a low-level simple interface and shall include the following locations:
      i. Existing pump room FIP; and
      ii. Existing Gym FIP; and
      iii. Existing Junior School FIP; and
      iv. Existing Science/IT FIP's & EWIS Panel; and
      v. Existing Delmar Gallery FIP; and
13. Provide strobe lights and alarm horn sounders at strategic locations where the most disadvantaged occupants shall be able to readily see the light(s) or hear the sounder(s). The strobe lights and sounders shall be set to activate upon General Fire Alarm (GFA). Strobes/sounders shall be provided as follows:
   a. Level B1 Store/Plant room. Refer to Figure 9.1 for indicative locations; and
   b. Level 4 Plant Deck. Refer to Figure 9.4 for indicative locations; and
14. Permit the fire hydrant system to be designed, installed & commissioned in accordance with AS2419.1:2017 in lieu of AS2419.1:2005 to be consistent with Stage 1 & 2; and
   a. The Stage 3-5 portion will be served by the site-wide booster assembly which is located on Victoria Street. This location was included as a Performance Solution within the Arup FER referenced in Section 0.5.1; and
      i. The booster shall be provided with a visual warning device (red strobe) in accordance with Clause 7.3.2 of AS2419.1:2017 and shall activate upon GFA; and
      ii. The block plans across the site (including at the booster assembly) shall be updated to reflect the Stage 3-5 works; and
   b. Hydrant outlet locations shall be located within 4.0m of an exit in accordance with the DtS provisions of the BCA throughout all buildings within the Stage 3-5 works; and
15. Couplings in the fire hydrant system (including fire hydrant booster assembly) shall be compatible with those of the fire appliances and equipment used by Fire and Rescue NSW. Fire hydrant booster assembly connections and all fire hydrant valves shall be fitted with Storz aluminium alloy delivery couplings manufactured and installed in accordance with the relevant Australian Standard; and
16. Block plans are to be provided at the Fire Indicator Panel (FIP), fire hydrant booster assembly & fire pump room in accordance with Section 7.11 of AS2419.1:2005, FRNSW Fire Safety Guideline – Emergency Services Information Package and Tactical Fire Plans (Version 02 dated 07/01/2019) and the inclusion of the following:

   a. The block plans should be orientated to reflect the aspect of the installation as it is presented to the reader; and
   b. The block plans across the site (including at the booster assembly) shall be updated to reflect the Stage 3-5 works; and
17. Omit the requirement to provide fire hose reel system school portions of the building with the inclusion of the following:
   a. Provide additional portable fire extinguishers located adjacent the required exit locations (i.e. within 4m) in lieu of fire hose reels; and
18. Portable fire extinguishers in accordance with BCA Clause E1.6 and AS2444:2001 with the inclusion of the following:
   a. Additional portable fire extinguishers shall be provided through school portions throughout as per the following:
      i. In these locations, a 9-litre water type extinguisher shall be provided which would be suitable toward Class A fires. Where kitchens or the like are situated an additional 4.5kg 40B:E Type Dry Chemical or 4.5kg 2A:4F Wet Chemical or 4.5kg 2A:20B:E Dry Chemical (without deep fryer) portable fire extinguisher shall be provided adjacent the exit and between 2-20m from the cooking area. Where electrical switchboards are situated within the school portions an additional 4.5kg 2A:20B:E Dry chemical portable fire extinguisher shall be provided between 2-20m from the electrical switchboard; and
      ii. Portable fire extinguishers may be placed within a metal cabinet in an accessible location (i.e. not within a locked cabinet) Portable fire extinguishers may be placed within a metal cabinet mounted to a wall and fitted with a break glass to limit the likelihood of damage, vandalism or theft; and
   b. In line with FRNSW comment, instructional signage shall be provided to staff rooms regarding fire extinguisher use. The signage shall include the following information as indicated in Figure 0.8; and

How to operate a fire extinguisher

There are a number of different types of portable fire extinguishers, each can be identified by the colour coding and labelling. Check that the extinguisher you intend to use is suitable for the type of fire encountered eg a water extinguisher must never be used on any fire involving electrical equipment.

There are four (4) basic steps for using modern portable fire extinguishers.

The acronym **PASS** is used to describe these four basic steps.

1. **Pull (Pin)**
   Pull pin at the top of the extinguisher, breaking the seal. When in place, the pin keeps the handle from being pressed and accidentally operating the extinguisher. Immediately test the extinguisher. (Aiming away from the operator) This is to ensure the extinguisher works and also shows the operator how far the stream travels
2. **Aim**
   Approach the fire standing at a safe distance. Aim the nozzle or outlet towards the base of the fire.
3. **Squeeze**
   Squeeze the handles together to discharge the extinguishing agent inside. To stop discharge, release the handles.
4. **Sweep**
   Sweep the nozzle from side to side as you approach the fire, directing the extinguishing agent at the base of the flames. After an A Class fire is extinguished, probe for smouldering hot spots that could reignite the fuel.

Figure 0.8: Fire Extinguisher Instructional Information to be incorporated in signage (Source: FRNSW website)

19. Emergency lighting and exit signage in accordance with AS2293.1:2018 with the inclusion of the following:
   a. External stair on Level 4 within Teaching & Learning shall discharge on Level 3 Arrow building before allowing occupants with three (3) paths of egress to an alternative stairway. Additional directional and static exit signage and evacuation map shall be provided on level 3 as per Figure 11.6; and
   b. Internal stair on Level 3 within Teaching & Learning shall discharge on Level 2 within Teaching & Learning before allowing occupants with two (2) paths of egress to an alternative stairway. Additional directional and static exit signage and evacuation map shall be provided on Level 2 as per Figure 11.7; and
   c. Internal stair on Level 3 within Founders/PA shall discharge on Level 2 within Founders/PA before allowing occupants with two (2) paths of egress to an alternative stairway. Additional directional and static exit signage and evacuation map shall be provided on Level 2 as per Figure 11.8; and
   d. Internal stair on Level 2 within Founders/PA shall discharge on Level 1 within Founders/PA before allowing occupants with three (3) paths of egress to an alternative stairway. Additional directional and static exit signage and evacuation map shall be provided on Level 1 as per Figure 11.9; and

20. All fire services and equipment for the Performance Hall must be in accordance with the DtS provisions of the BCA and/or to the satisfaction of the PCA.

0.5.5 Management in Use Requirements – Stages 3-5

1. Maintain paths of travel to an egress, stair entrances, vehicular access ramp, thoroughfares and lobby areas free of static storage and combustible materials at all times; and
   a. This Agora and Colonnade portions must also be kept clear of static storage and combustible materials at all times; and
2. Provide additional directional evacuation diagrams/mud-maps to the discharge landing of each non-fire isolated stairway affording discontinuous egress. The evacuation diagram shall depict the alternative egress paths available and be orientated to reflect the aspect as presented to the reader. The location of the additional directional evacuation diagrams/mud-maps shall be as per the following:
   a. External stair on Level 4 within Teaching & Learning shall discharge on Level 3 Arrow building before allowing occupants with three (3) paths of egress to an alternative stairway. Additional directional evacuation map shall be provided on level 3 as per Figure 11.6; and
   b. Internal stair on Level 3 within Teaching & Learning shall discharge on Level 2 within Teaching & Learning before allowing occupants with two (2) paths of egress to an alternative stairway. Additional directional evacuation map shall be provided on Level 2 as per Figure 11.7; and
   c. Internal stair on Level 3 within Founders/PA shall discharge on Level 2 within Founders/PA before allowing occupants with two (2) paths of egress to an alternative stairway. Additional evacuation map shall be provided on Level 2 as per Figure 11.8; and
   d. Internal stair on Level 2 within Founders/PA shall discharge on Level 1 within Founders/PA before allowing occupants with three (3) paths of egress to an alternative stairway. Additional evacuation map shall be provided on Level 1 as per Figure 11.9; and
3. Smoking shall not be permitted throughout the subject building; and
4. All fire safety measures and Management in Use requirements shall be incorporated into an Essential Services list. All fire safety measures shall be maintained in accordance with the requirements of AS1851 (or equivalent maintenance standard) as identified by Scientific Fire Services. Management in Use requirements shall be inspected and logged on an annual basis; and
5. An emergency management plan in accordance with AS3745:2010, including procedures for the safety of people in buildings, structures and workplaces during emergencies, the appointment of an Emergency Planning Committee and setting up an Emergency Control Organisation; and
6. Regular maintenance shall be undertaken of all fire safety systems as required by relevant Australian Standards; and
7. Fire training of staff and maintenance staff, including emergency evacuation procedures and use of firefighting equipment (where applicable) to be undertaken at regular intervals.

0.6 Brief Statement on Acceptability of Proposed Performance Solution

The basis of the following assessment, conditions, methodologies and acceptance criteria, the general and specific objectives, relevant hazards, preventative measures, the proposed trial design etc. are however, considered to be detailed within this report. The above requirements are not limiting. Schedules and records must be in accordance with AS1851-2012. There shall be evidence of all inspection whether maintenance was required or not. It is drawn to the client's attention that if this maintenance is not undertaken as per these instructions, the building owner may be fully liable to legal responsibilities and without the cover of insurance.

0.7 Fire & Rescue Comment to FEBQ Submission

Scientific Fire Services prepared the preceding Performance Based Design Brief (PBDB) prior to this formal assessment being undertaken. The Performance Based Design Brief (PBDB) (Ref. No.: 297622 v3.0 dated 10/06/2022) was issued to the design team, including the fire authority for comment. A Fire Engineering Brief Questionnaire (FEBQ) (Ref. No.: 297622 v1.0 dated 10/06/2022) was formally submitted to Fire and Rescue NSW (FRNSW) for formal comment.

Scientific Fire Services has consulted with the relevant stakeholders in relation to the general elements of the Fire Safety Engineering Report (FSER) and has documented the various elements of the FSER in accordance with agreements reached during the FEB and building design process.

Fire & Rescue NSW comments were received on 14/19/2022 to the formally submitted PBDB & FEBQ prepared by Scientific Fire Services (refer to Appendix N) (FRN22/1947, V02: BFS22/2770#21797). Scientific Fire Services has reviewed the aforementioned comments and have considered the recommendations (where appropriate) within this report or provided a response to the comments as detailed in Table 0.3.

Table 0.3: FRNSW comments and SFS response

No	FRNSW Comment (FEBQ v1.0)	SFS Response	FSER Section
1.	**Issue number: 1 - Type of Construction Required within Multi Purpose Hall** **FRNSW Comment:** In principle support is provided subject to the analysis in the FER demonstrating compliance with the performance requirements of the NCC.	**SFS Comment**: In line with FRNSW comment the analysis has demonstrated that the performance solution meets the Performance Requirements of CP1 & CP2.	N/A
2.	**Issue number: 2 - Separation of External Walls & Associated Openings in Different Fire Compartments** **FRNSW Comment 1:** FRNSW recommend the proposed separation be clearly marked up to permit a considered review. **FRNSW Comment 2:** Clarification of the emitter dimensions is required noting it appears the glazed façade extends beyond that marked up. **FRNSW Comment 3:** FRNSW recommend a management in use procedure be implemented to ensure these areas are maintained as required, this should be listed as an essential measure on the fire safety schedule. **FRNSW Comment 4:** Clarification is required whether any of the unprotected openings contain operable elements. If so, FRNSW consider that piloted ignition may be possible. The Guide to the BCA under Verification Method CV1 states that a value of 10 kW/m^2 is appropriate for curtain materials. AS1530.4 Table A3 details 13kW/m^2 as appropriate for piloted ignition of cotton material. **FRNSW Comment 5:** FRNSW comments above should be adequately addressed.	**SFS Comment 1**: Upon analysis it was found that the subject protection of openings within 6.0m of adjacent fire compartments was not required. The subject requirements have been removed. **SFS Comment 2**: The subject emitter dimensions have been defined as the glazed elements within 6.0m of the receiving opening. The glazed façade extending beyond the markup are elements beyond 6.0m from the adjacent opening. **SFS Comment 3**: In line with FRNSW comment, management in use procedures shall be implemented that the Agora and Colonnade portions are maintained clear of static storage as required. This shall further be listed as an essential measure on the fire safety schedule. **SFS Comment 4**: Given the 5.8m separation between openings, it is has been domonstated that piloted ignition will not occur. Referring to Appendix E, flame projection calculations have been undertaken to demonstrate that piloted ignition will not occur at distances of separation greater than 0.5 meters. Accordingly, the acceptance criteria for non-piloted ignition has been maintained. **SFS Comment 5:** Please refer to the above responses addressing FRNSW comments.	Refer to Section 0.5.5 Item 1a, Section 7, Section 8 & Appendix E
3.	**Issue number: 3 – Exit Travel Distance** **FRNSW Comment 1:** Whilst the inputs to determine detection time are noted, premovement times and travel times assumptions have not been discussed. FRNSW recommend these inputs and assumptions be provided to permit a complete review. Further, FRNSW recommends the assessment consider the extended travel to nearest exit and between exits holistically where the occur for the same path of travel. The comparative assessment should demonstrate that the provision of detection offsets the total travel distance compared to the DtS distance of 100m (40m + 60m). **FRNSW comment 2:** Whilst there is merit in this assessment, FRNSW comments above and in issue 4 should be adequately addressed.	**SFS Comment 1:** Pre-movement and travel times including assumptions have been provided and detailed in Section 9. Furthermore, and in line with FRNSW comment, the assessment has also considered the extended travel to a nearest exit and between exits holistically where these occur for the same path of travel. It is noted that where extended distances between exits occur, alternate paths of travel are available which bypass the point of choice and furthermore in the case of the levels where classrooms are located, alternate paths shall be within an external area (i.e. the external walkway 'Arrow Building'). **SFS Comment 2:** Refer to SFS comments above and furthermore, comments provided in Issue 4.	Section 9

No	FRNSW Comment (FEBQ v1.0)	SFS Response	FSER Section
4.	**Issue number :4 – Interconnection of Non-Fire Isolated Stairways** **FRNSW comment:** In consideration of the non-compliance also presented in issue 5, FRNSW do not support the above assessment. FRNSW recommend it be quantitatively demonstrated that occupants egressing via these stairs will not be exposed to untenable conditions prior to evacuation. FRNSW recommend issues 3, 4 and 5 be considered holistically.	**SFS Comment 1:** SFS notes that FRNSW objection relates to the proposed adoption of the qualitative methodology and is not an objection to the proposed design solution. Accordingly, and in line with FRNSW comment, SFS have adopted a quantitative approach incorporating FDS (CFD) fire modelling and Pathfinder evacuation modelling successfully demonstrating that the stairs within the external walkway 'Arrow Building' shall maintain sufficient ventilation for the venting of smoke in order to maintain tenable conditions within these areas for the duration of the evacuation process. In this instance, a fire scenario has been located within the staff room of the T&L building at Level 2 in order to assess the potential impact on the adjacent stair (i.e. AB_ST11 & AB_ST10). This portion of the Arrow Building has been selected as it additionally relates to issues 3, 4 & 5 as follows: • Stair TL_ST08 from L4 leading to L3 is a stair involving discontinuous egress, whereby occupants are then expected to egress via the subject selected stairs AB_ST11 & AB_ST10. Furthermore, occupants egressing from the discontinuous stair TL_ST07 are likely to either take the subject stairs or alternatively stair AB_ST14. Accordingly, the quantitative analysis has also considered the impact on occupants affected by discontinuous egress as outlined in Section 11. • The subject stairways AB_ST11 & AB_ST10 also serve as exits with regard to a number of extended travel distances to an exit & between alternate exits. Accordingly, the quantitative analysis also considers the impact on occupants affected by this extended travel distances as outlined in Section 9, and indicated in Figure 9.2 & Figure 9.3. It is further noted that the Level 2 staff room located adjacent to this area was selected as the lowest proximate internal location adjacent to these stairs i.e. L1 and GF library portions shall be set-back from these stairs resulting in a likely lower impact of smoke on the subject egress path. Refer to Section 10.8 for the subject assessment, which has also considered the design issues associated with issues 3, 4 and 5.	Refer to Section 10.8, Table 10.4, Table 10.5, Table 10.6, Figure 10.10, Figure 10.12, Appendix H, Appendix I
5.	**Issue number: 5 – Travel via Non-Fire Isolated Stairway – Discontinuous Egress Paths** **FRNSW comment:** Please refer FRNSW comments in issue 4.	**SFS Comment 1:** Please refer to SFS comments in Issue 4	Refer Item 4 above & Section 11
6.	**Issue number: 6 – Fire Hydrant System Design** **FRNSW Comment:** In principle support is provided subject to the analysis in the FER demonstrating compliance with the performance requirements of the NCC.	**SFS Comment 1:** In line with FRNSW comment the analysis has demonstrated that the performance solution meets the Performance Requirements of EP1.3.	Refer to Section 12

No	FRNSW Comment (FEBQ v1.0)	SFS Response	FSER Section
7.	**Issue number: 7 – Omission of Fire Hose Reels** **FRNSW Comment 1**: FRNSW recommend appropriate training also be provided such that staff are aware of the locations and how to use the extinguishers effectively. **FRNSW Comment 2:** In principle support is provided subject to: • the analysis in the FER demonstrating compliance with the performance requirements of the NCC. • FRNSW Comments being adequately addressed	**SFS Comment 1:** In line with FRNSW comment, appropriate instructional signage regarding fire extinguisher use shall be installed within school staff rooms. This signage shall form part of the management-in-use requirements and accordingly be listed in the fire safety schedule. **SFS Comment 2:** In line with FRNSW comment the analysis has demonstrated that the performance solution meets the Performance Requirements of EP1.1.	Refer to Section 0.5.4, Figure 0.8 & Section 13
8.	**Issue number: 8 – Omission of Sprinkler from Main Switch Rooms** **FRNSW Comment**: In principle support is provided subject to the analysis in the FER demonstrating compliance with the performance requirements of the NCC.	**SFS Comment 2:** In line with FRNSW comment the analysis has demonstrated that the performance solution meets the Performance Requirements of EP1.4.	Refer to Section 14

1. Introduction

1.1 General

This Fire Safety Engineering Report (FSER) has been prepared by Scientific Fire Services (SFS) for Hansen Yuncken Pty Ltd. The report details the fire safety engineering assessment that has been undertaken on the proposed design of Trinity Grammar School – Stages 3-5: The Renewal Project.

The project is located at 119 Prospect Road, Summer Hill NSW and can be described as being comprised of the following BCA classifications.

Occupancy Use	BCA Classification
Administration & Offices	Class 5 (Administration & Office)
School	Class 9b (School)
Assembly Hall	Class 9b (Assembly Hall: School-use only – not to be hired out to other 3rd party)

The Building Solution proposed for this project, which is required to comply with the Performance Requirements of the National Construction Code 2019, Vol. 1, Building Code of Australia (BCA) (ABCB 2019), is a combination of Performance Solution and Deemed-to-Satisfy Solution elements in accordance with Clause A2.2 of the BCA.

Where requested, a Performance Based Design Brief (PBDB) would be prepared. The PBDB is the Performance-based Design Brief with specific reference to fire safety and is developed in collaboration with key stakeholders as part of the performance-based design and approval process.

A PBDB, 297622, 10.05.2022, v3.0 was prepared for this project in accordance with the guidance of the Australian Fire Engineering Guidelines (AFEG)(ABCB 2021). Preceding the Performance Based Design Brief (PBDB) and prior to this formal assessment being undertaken the PBDB and the Fire Engineering Brief Questionnaire (FEBQ) (Ref. No.: 297622, v1-0 dated 10/06/2022) was formally submitted to Fire and Rescue NSW (FRNSW) for formal comment. This FSER includes the basis of the PBDB and has taken into consideration relevant comments from the stakeholders.

1.2 Supporting Documentation

The assessment described in this report has been based on the referenced drawings prepared by Tanner Kibble Denton Architects Pty Ltd. The drawings to which this assessment applies are listed in Appendix A.

The project issues, the proposed Building Solution and the intended assessment methodologies have been presented to and discussed with the relevant Fire Authority. Their comments and responses arising from these consultations are detailed in the subsequent Fire Safety Engineering Report.

There are no other matters related to the Performance Solution and the proposed assessment methodologies that require Fire Authority consultation or approvals.

Documentation from the Building Certifier/Building Code Consultant identifying issues in regard to the proposed project design relevant to the fire safety engineering assessment are included in Appendix C.

1.3 Scope

1.3.1 Regulatory Framework

The National Construction Code is a uniform set of technical provisions for the design and construction of buildings and other structures and plumbing and drainage systems throughout Australia. It allows for variations in climate and geological or geographic conditions.

The BCA is given legal effect by building regulatory legislation in each State and Territory. This legislation consists of an Act of Parliament and subordinate legislation which empowers the regulation of certain aspects of buildings and structures and contains the administrative provisions necessary to give effect to the legislation.

Each State and Territory's legislation adopts the BCA subject to the variation or non-requirement of some of its provisions, or the addition of extra provisions. These provisions are contained in Appendices to the BCA.

Any provision of the BCA may be overridden by, or subject to, State or Territory legislation. The BCA must therefore be read in conjunction with that legislation.

In accordance with BCA Clause A0.2, compliance with the BCA is achieved by satisfying the Performance Requirements.

The *Performance Requirements* can only be satisfied by a—

(a) *Performance Solution*; or

(b) *Deemed-to-Satisfy Solution*; or

(c) combination of (a) and (b).

In accordance with BCA Clause A0.3, a Performance Solution must comply with the BCA.

(a) A *Performance Solution* must—

  (i) comply with the *Performance Requirements*; or

  (ii) be at least *equivalent* to the *Deemed-to-Satisfy Provisions*,

  and be assessed according to one or more of the Assessment Methods.

(b) A *Performance Solution* will only comply with the BCA when the *Assessment Methods* used satisfactorily demonstrate compliance with the *Performance Requirements*.

A Performance Solution will only comply with the BCA when the Assessment Methods used satisfactorily demonstrate compliance with the Performance Requirements.

The relevant Performance Requirements against which the Performance Solution is assessed must be established in accordance with Clause A0.7 of the BCA.

Any Deemed-to-Satisfy Solution component of the project complying with the Deemed-to-Satisfy Provisions is deemed to comply with the Performance Requirements.

From Clause A0.5 of the BCA any of the following Assessment Methods may be used to show that a Performance Solution complies with the Performance Requirements:

The following *Assessment Methods*, or any combination of them, can be used to determine that a *Performance Solution* or a *Deemed-to-Satisfy Solution* complies with the *Performance Requirements*, as appropriate:

(a) Evidence to support that the use of a material or product, form of construction or design meets a *Performance Requirement* or a *Deemed-to-Satisfy Provision* as described in **A2.2**.

(b) *Verification Methods* such as—

  (i) The *Verification Methods* in the BCA; or

  (ii) such other *Verification Methods* as the *appropriate authority* accepts for determining compliance with the *Performance Requirements*.

(c) *Expert Judgement*.

(d) Comparison with the *Deemed-to-Satisfy Provisions*.

1.3.2 Australian Fire Engineering Guidelines

The AFEG document has been published by the ABCB for the purpose of providing guidance to experienced fire safety practitioners in the process and methodologies needed to demonstrate that a Performance Solution complies with the Performance Requirements.

AFEG is widely recognized as the appropriate document to be used as the basis of fire safety engineering assessments in Australia and other jurisdictions.

Since AFEG is a guideline document, the processes and methodologies adopted in an assessment may vary from those described in AFEG. However, any FEB and FSER documents prepared for a project should incorporate the essential information alluded to in AFEG.

1.3.3 General Objectives

The building regulatory objectives, though not explicitly stated in the BCA, are concerned with the issues of occupant life safety, fire services ability to perform their necessary tasks and protect adjoining properties. It is accepted that these objectives are satisfied by a Building Solution meeting the relevant Performance Requirements of the code.

The Fire Authority objectives are enshrined in State or Territory legislation. However, where appropriate, the Performance Requirements of the BCA require consideration of fire brigade intervention in the assessment process. In undertaking the appropriate assessment of fire brigade intervention and showing compliance with the Performance Requirements, it can be taken that the objectives of the relevant Fire Authority will be met.

SFS have not been advised of any additional regulatory objectives that were required to be considered during the assessment process for this project.

1.3.4 Client Objectives

The client has not identified any additional objectives for this project over and above those arising from the provisions of the BCA.

1.4 Stakeholders

The parties included in Table 1.1 have been identified as relevant stakeholders in this project.

The preparation of the FSER involves a consultative process. Input and collaboration has been sought from appropriate stakeholders as required.

Table 1.1: Project Stakeholders

Role	Company/Organisation	Representative
Building Owner	Trinity Grammar School	Tim Bowden Scott Swann Stephen Heanly
Client	Hansen Yuncken Pty Ltd	Richard O'Sullivan Sasha Vuckovic Matthew Coelho Michael El Sharoony James Nielson
Project Manager	Bloompark Consulting	Peter Brogan Shaun Diamond Tim Russell
Architect	Tanner Kibble Denton Architects Pty Ltd	Peter Valencic Anna Harris Tye McBride Emily Su Heiron Chan
Building Certifier	Group DLA Pty Ltd	Lindsay Dodds Brett Clabburn
BCA Consultant	Design Confidence Pty Ltd	Luke Sheehy Ryan Dillon
Fire Authority	Fire & Rescue NSW (FRNSW)	Fabio Perri
Fire Safety Engineer	SFS Australia Pty Ltd (T/A Scientific Fire Services)	Parkan Behayeddin Christopher Boyack Andrew Barnett
Fire Services Engineer	JHA Consulting Engineers Pty Ltd	Tom Hamer Chris Hadjiyiannis
Structural Engineer	Northrop Consulting Engineers Pty Ltd	Jonathan Low

1.5 Role of Scientific Fire Services

AFEG recognizes that the fire engineering process may be considered to be used for two purposes, namely in the design of fire safety systems and components or, in the evaluation of a given fire safety system or systems. In the former case, experienced fire safety engineers may contribute to the project design process by assisting in the development and selection of effective and efficient fire safety systems. Once the design process has progressed to the point where a possible Building Solution has been developed, the fire safety engineer may then undertake the assessment of the proposed design in the manner prescribed by AFEG.

The above process is considered to be consistent with the 'application of the process' defined in the AFEG document.

In this project, Scientific Fire Services have not contributed to the detailed design development of the project in the preparation of the Building Solution offered for assessment.

1.6 Qualifying Statements

1. This FSER relates to the design detailed in the referenced drawings identified in Appendix A. These drawings have been relied upon to be an accurate representation of the project buildings. Any changes to the design aspects of the project for which a Performance Solution is supplied, subsequent to the issuance of this report must be referred to the Fire Safety Engineer for further assessment to ensure the continued compliance of the Building Solution with the Performance Requirements.
2. Scientific Fire Services has relied on the Building Certifier/BCA consultant to identify all the issues of non-compliance with the Deemed-to-Satisfy provisions of the BCA. Apart from these design issues listed in this report, it is taken that the proposed design meets all other Deemed-to-Satisfy provisions. It is also assumed that all other regulatory requirements have been met unless these have been specifically identified for assessment and inclusion in the FSER.
3. Where a building has previously included a Performance Solution it is presumed, unless specifically identified otherwise, that the prior Performance Solution has been appropriately approved.
4. Unless otherwise stated, the assessment does not address any issues that are outside the requirements of the BCA.
5. All fire services and equipment for the Performance Hall must be in accordance with the DtS provisions of the BCA and/or to the satisfaction of the PCA; and
6. The outcomes of the assessment of the Building Solution stated in the FSER do not apply to any other parts of the building not included in the assessment, nor to any other building projects unless so identified by Scientific Fire Services.
7. The fire safety engineering assessment methodologies have been based on the assumption of a single ignition and fire source, which is the expectation of a natural fire start. The assessment does not consider multiple fire start scenarios arising from arson or other such events such as bushfire.
8. Analysis of emergency incidents such as bomb threats or other such occurrences, requiring partial or total evacuation of the building does not form part of this assessment.
9. The provisions for fire safety in this building, as incorporated into the Building Solution, have been assessed purely from the perspective of fire safety and their usage under any other circumstances is beyond the scope of this assessment.
10. Unless it has been specifically identified as an issue to be considered, this assessment does not include any consideration of losses arising directly or indirectly from a fire in respect of buildings, contents, business interruption, environmental damages or other consequential losses
11. The FSER and the subsequent recommendations are considered to reflect the reasonable and practical efforts of Scientific Fire Services. The extent to which the fire safety requirements are implemented will affect the probability of achieving adequate fire safety margins.
12. The outcomes of the fire safety assessment are conditional upon the required fire safety systems being installed, commissioned, operational and maintained as required by the relevant regulations, standards and specifications.
13. It is important to note, however, that there can be no guarantee that fire ignition and fire damage will not occur. No liability is accepted for any losses arising from a fire in this facility.
14. The assessment undertaken for this project is concerned only with the final completed and functional building. The assessment does not address any issues arising during construction, partial usage, renovation or demolition unless these aspects have been specifically identified for assessment.
15. The fire safety assessment undertaken is based entirely on the usage of the building/tenancy as described in the report. Any subsequent deviation from the usage as described will render this assessment invalid until a review by a qualified Fire Safety Engineer has been carried out.
16. Any occupant numbers used in the assessment have been derived in accordance with the provisions of BCA Clause D1.13 and, where appropriate, in collaboration with key stakeholders. Any increase in the occupant numbers above that designated in the report will render this assessment invalid until a review by a qualified Fire Safety Engineer has been carried out.
17. Any changes to the occupant characteristics, arising from such aspects as variations or changes to the building usage, to those designated in the report will render this assessment invalid until a review by a qualified Fire Safety Engineer has been carried out.
18. Issues associated with workplace Occupational Health and Safety have not been considered as part of this fire safety assessment.
19. This FSER has been prepared for the client identified in the report. The report is not transferable to another client without both the client identified in the report and SFS consent.
20. No liability is accepted for the accuracy of the documents and drawings supplied upon which this FSER is based.
21. Changes to the design, as shown in the drawings listed, subsequent to this report date will require fire safety engineering review to ensure ongoing compliance with the Performance Requirements.

22. Fires involving explosive components do not form part of this assessment.
23. The storage, usage, handling and transport of any listed Dangerous Goods in this facility have not been considered in the fire safety assessment undertaken. It is presumed that all such matters relating to Dangerous Goods are dealt in accordance with all relevant regulations.
24. SFS has no role or responsibility in the use and management of the facility.
25. This FSER has been developed specific to the Stages 3-5: The Renewal Project part of Trinity Grammar School.
26. SFS are not responsible for the Stage 1 and 2 portions of the development.

2. Building Description and Occupant Profiles

2.1 Building Description

2.1.1 Site Overall

The subject site is the Trinity Grammar School (TGS) and is located at 119 Prospect Road, Summer Hill NSW. The TGS campus is approximately 65,550m^2 and consists of Junior School, Secondary School, Specialist & shared facilities. The site is bound by Seaview Street to the north, Prospect Road to the east, Victoria Street to the west and Yeo Park to the south. The principal campus entrance is situated along Prospect Road. Figure 2.1 depicts a site plan of the campus.

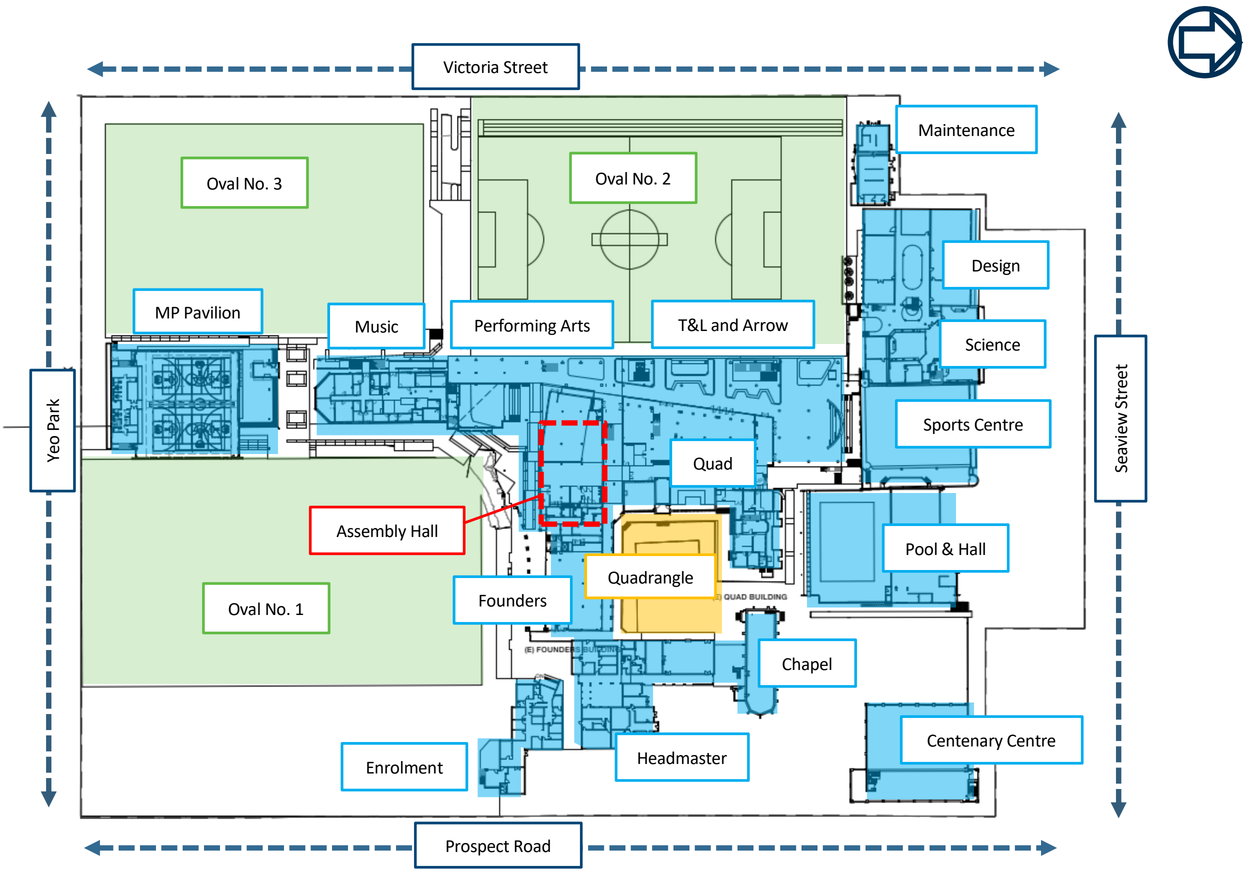


Figure 2.1: Site plan

2.1.2 Masterplan

The masterplan works have been developed in 5 stages to allow for the staged construction works, whilst maintaining the campus as operational. Stages 1-5 are broadly described as follows:

- Stage 1: Maintenance Building
  - New stand along maintenance building (2 storeys)
  - Demolition of Seaview Street properties No. 45-52 and Chapel Drive Ceremonial Axis landscaping upgrades
- Stage 2: Oval Carpark & Junior School Linkway
  - New Oval no. 3 carpark & sports field, ground area, back of house (BOH) and associated works to Yeo Park side driveway
  - Upgrade Junior School enclosed access path to connect to Oval 2 carpark
  - External tiered seating, paths and associated landscape works around Oval 1, external roadwork upgrade, intersection and footpath works.
- Stages 3-5: The Renewal Project
  - New five (5) storey teaching & learning facility
  - New performing arts precinct
  - New maintenance quarter
  - New multipurpose pavilion
  - Major improvement to on-site traffic

- Refurbishment works to existing facilities incl. Founders Building, Music Building & Quadrangle Building

It is highlighted that the scope of fire safety engineering works under Stages 1-2 is documented within the Fire Engineering Report (FER) prepared by Arup Australia Pty Ltd (Report No. 281228, V01, dated 17 March 2022). The scope of fire safety engineering works under Stages 3-5 is documented herein. The staged works are indicative illustrated in Figure 2.2 & Figure 2.3.

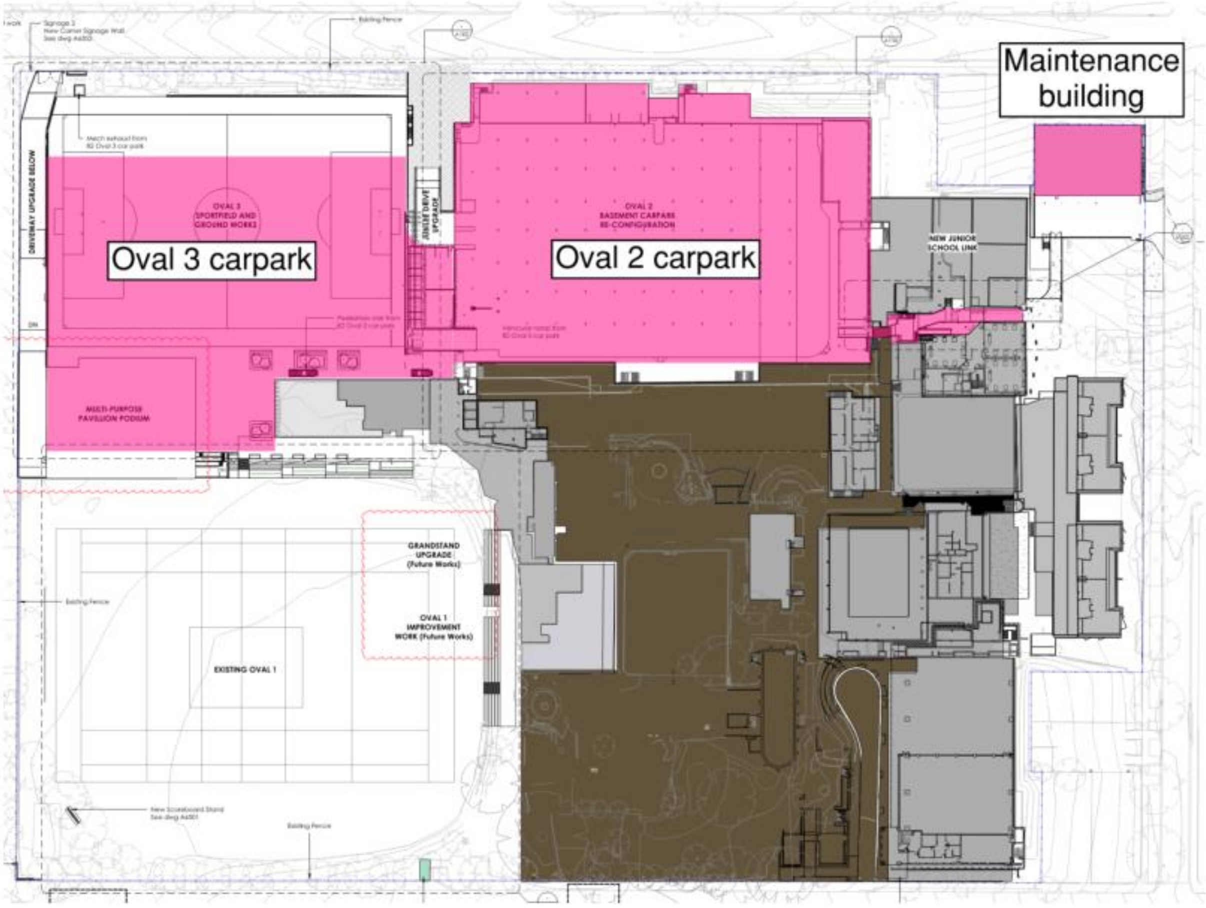


Figure 2.2: Stage 1 & 2 works (extracted from Figure 2 of Arup FER, Report No. Report No. 281228, V01, dated 17 March 2022)

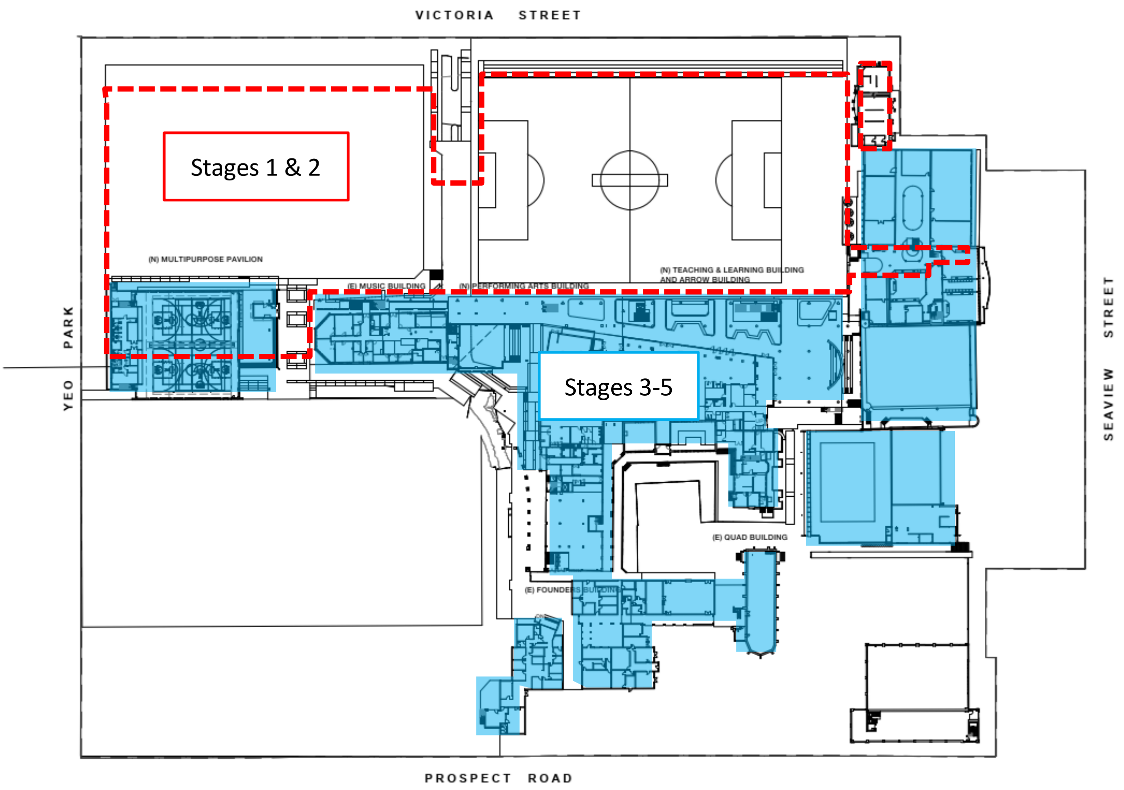


Figure 2.3: Indicative Stage 1 & 2 and Stage 3-5 works

2.1.3 Stage 3-5 Description

The Renewal Project shall generally involve alterations, additions and integration of new & existing building structures within the TGS campus. The emphasis is focused on providing contemporary learning spaces/facilities, improving circulation/connection within the campus and facilitate growth of the core student population to 2,100 (currently 1,680 secondary students). The key building characteristics associated with the Stages 3-5 works are detailed in Table 2.1 and depicted in Figure 2.4 to Figure 2.10.

Table 2.1: Building characteristics (Stages 3-5)

Precinct	Occupancy Use	Key Characteristics
Teaching & Learning	Teaching & Learning	• General learning areas (GLA's) & staff rooms • GLA's to be configured across the precinct to break out, seminar spaces to open onto a project space • Largest classroom to support capacity for up to 30 x students • Staff rooms centrally located with direct access to the Arrow Building (external walkways). Faculty space to contain desk/workstations, storage & break out furniture for collaborative work between staff & interaction with students • Main access via the Arrow Building (external walkways) with internal circulation also provided • Classrooms to be interconnected via operable walls • Amenities
	Library	• Situated within new civic space adjacent Agora • Two (2) levels comprising: – Ground floor: service counter, library staff space, learning areas, break away & reading nooks, central open stair, low bookshelves to demarcate functional zones – First floor: senior study space designed to accommodate groups of 20 in 2 or 3 acoustically separate spaces which can be merged
Performing Arts	Performing Arts	• New building proposed to interlink existing Music and Founders Buildings • Five (5) storeys overall with basement link to carpark

Precinct	Occupancy Use	Key Characteristics
	Black Box Theatre, B1 Founders Building	• The Black Box Theatre shall replace the existing ones situated within the B1 level of the Founders Building • The Black Box shall be openable to an outdoor fixed tiered seating space which transitions from ground level • Staff to have the ability to close the Black Box from the outdoor space to transform it into a rehearsal studio
	Assembly Hall & Lobby	• Multi-functional space situated on L1 proposed to operate under a number of modes including performance, concert & assembly • The assembly hall shall contain an upper-level mezzanine providing access to upper tiers and adjacent learning facilities in the precinct • Interconnection to Library & Founders Building via external walkway (Arrow Building) • Maximum occupant loading of 600
	Cafeteria & Canteen	• New cafeteria to be extended to occupy larger footprint • Commercial kitchen to cater for school functions and events
	Music building	• Existing Music Building to be refurbished and upgraded (incl. demolition of internal fire stairs) • Access to be provided externally via Arrow Building (external walkways)
Arrow Building	General	• The Arrow Building is an external walkway structure which connects both new precincts and existing buildings • Allows for students to circulate around the campus without the need to enter the building(s) • The external walkways shall be covered by undulating perforated metal screens
Sports Precinct	Multipurpose Pavilion	• Indoor sporting facility with spectator seating & amenities • The MP pavilion shall primarily accommodate the following: – 1/no. x full size championship basketball court with retractable tiered seating – 2/no. x training basketball courts for training only • Amenities & support facilities generally consisting of: – Retractable seating, mezzanine area, 2 x change rooms, 4 x WC's (students), 2 x WC's (staff/patrons), 2 x showers (students), 1 x accessible WC & shower, 1 x office/first-aid, chair store, cleaners & comms • Other functions to include school assemblies, speeches, primary school movie nights • Maximum occupant loading of 1,200
	Forecourt servery	• Simple servery for food and drinks with accommodation for BBQ area • Kitchen to allow heating and serving of preprepared food and drinks (not used for cooking) • Primarily used during weekend sport, but could also be used for special events
	Founders Building, B2 – Indoor Cricket	• B2 of Founders Building to be refurbished into new indoor sports, primarily for indoor cricket • Retractable netting allowing for double height space to be divided into practice areas
	Music Building, B1 – Sports Facilities	• B1 level of Music Building to be refurbished into new sports offices and amenities related to the school's outdoor ovals. • B1 level of the Music Building is to include: – Sports staff offices, sports storage, change room amenities, male WC, female WC, accessible WC & shower
Support Facilities	Reception & Administration	• The Agora will be the new arrival point for visitors coming from the carpark • Reception to be linked to senior leadership and administration offices situated in the refurbished Quadrangle Building.
	Staff Common Room	• Centrally located within Founders Building • Contemporary open plan environment facilitating staff socialisation & collaboration between staff members
	IT Support	• IT front of house to be situated within ground level of Library with additional ICT storage situated on B1.

Precinct	Occupancy Use	Key Characteristics
	Miscellaneous Storage	• Miscellaneous storage areas situated within B1 of Teaching & Learning. Storage contents shall generally be associated with the following: – Unform shop, Q store (cadet uniform), security office, ICT store, print room, textbook store, archives & art collection store and sports store

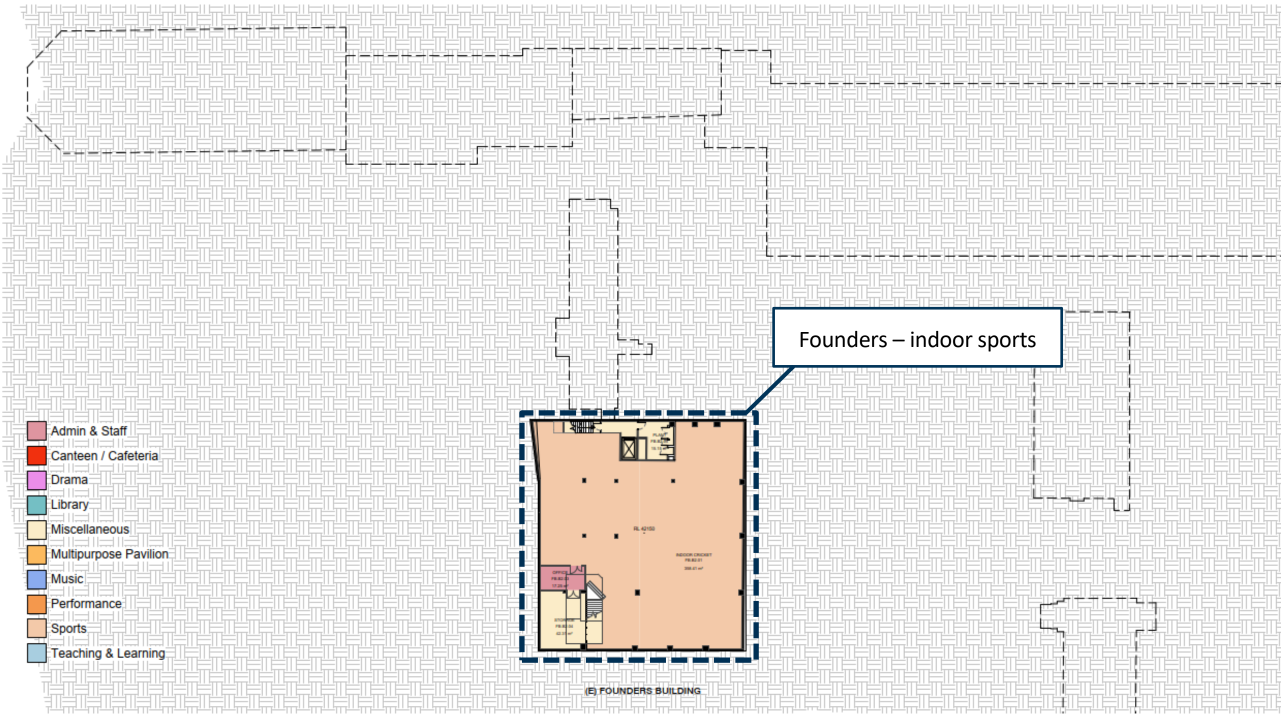


Figure 2.4: B2 Floor Plan (B2)

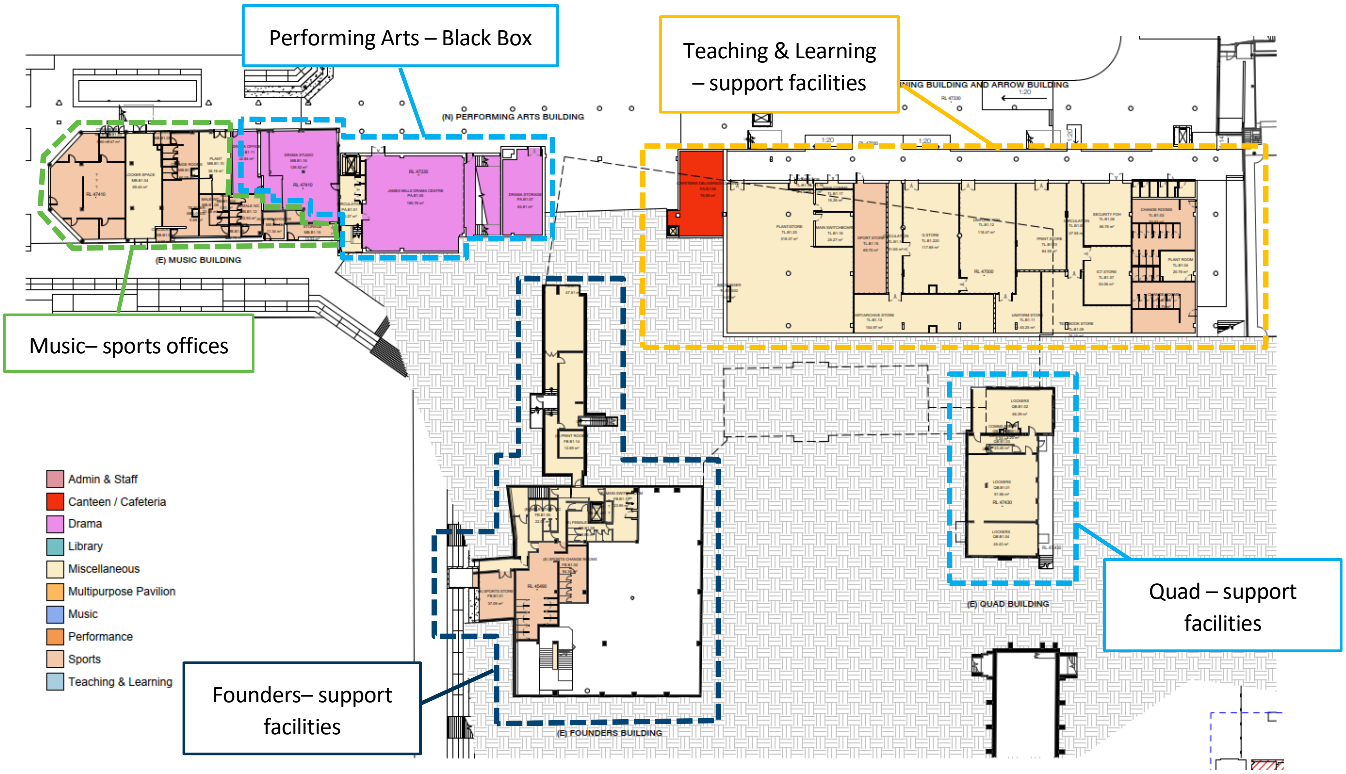


Figure 2.5: B1 Floor Plan (B1)

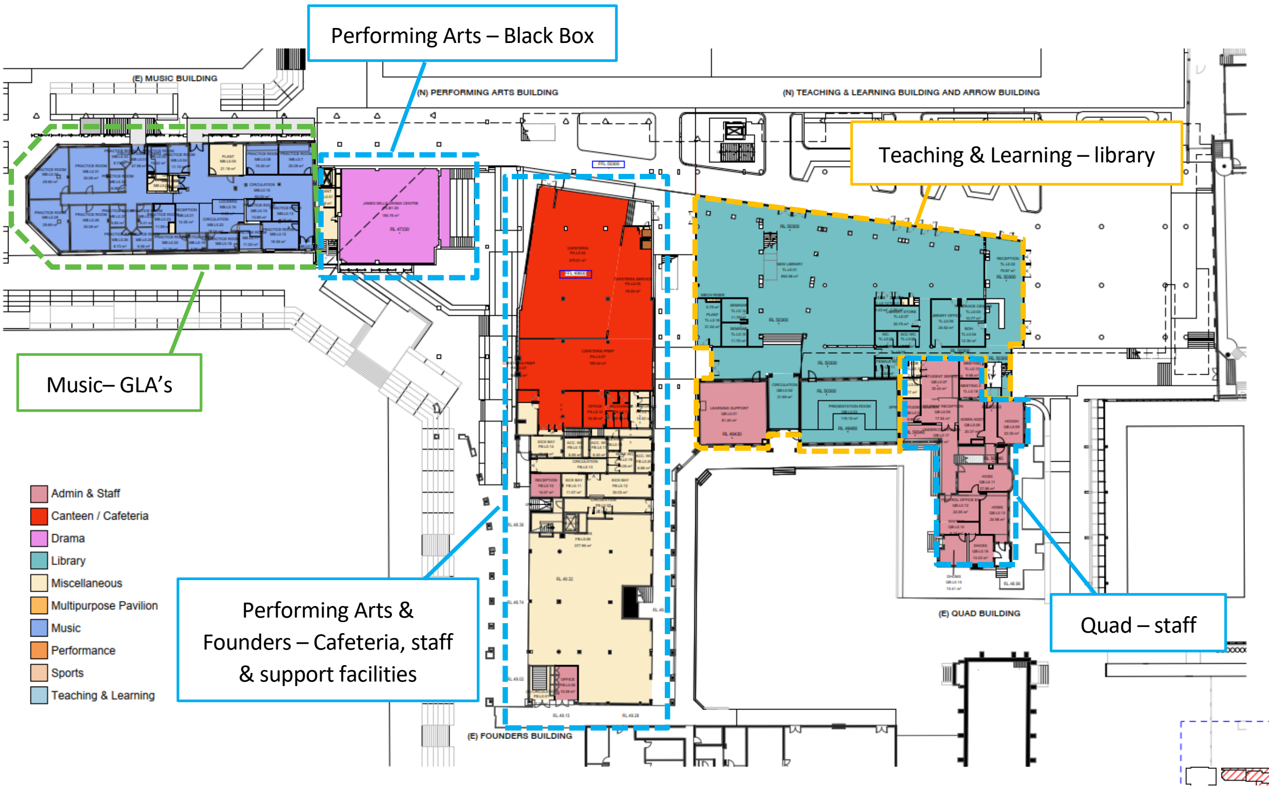


Figure 2.6: L0 Floor Plan (L0)

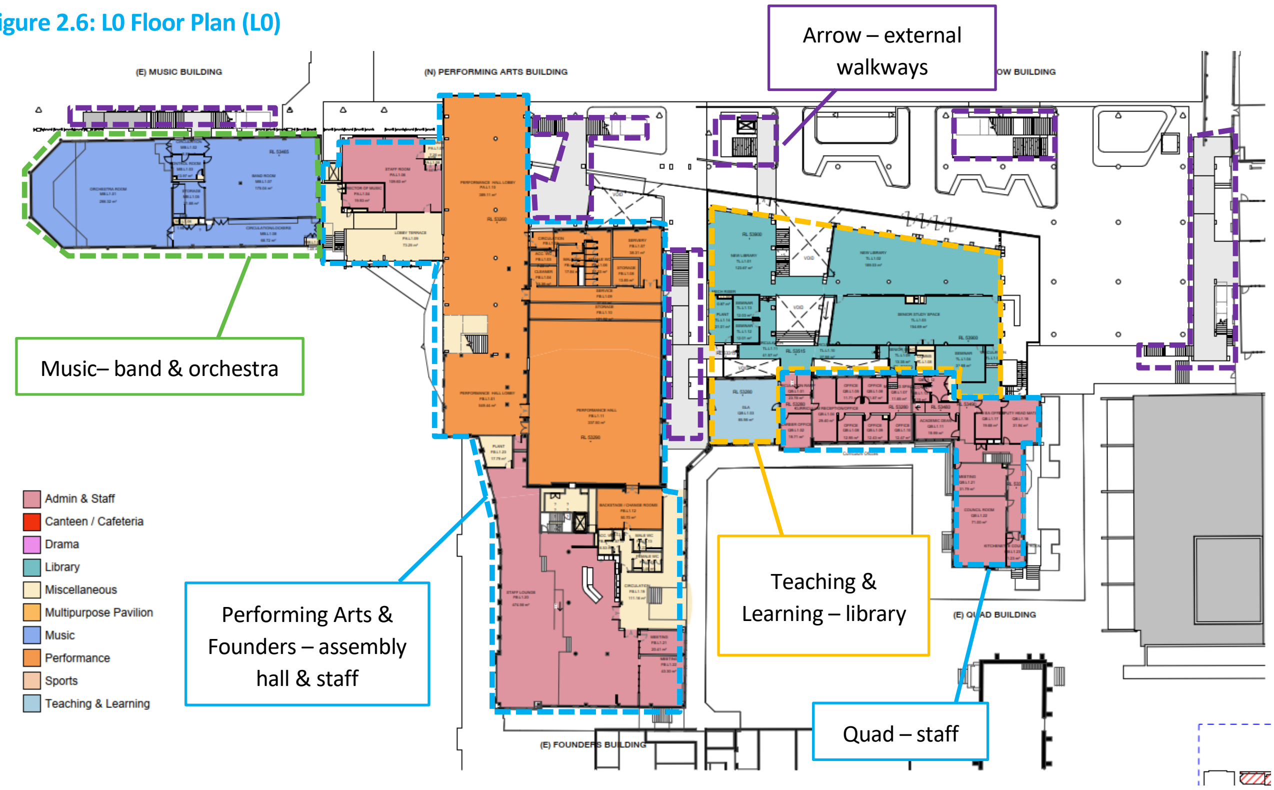


Figure 2.7: L1 Floor Plan (L1)

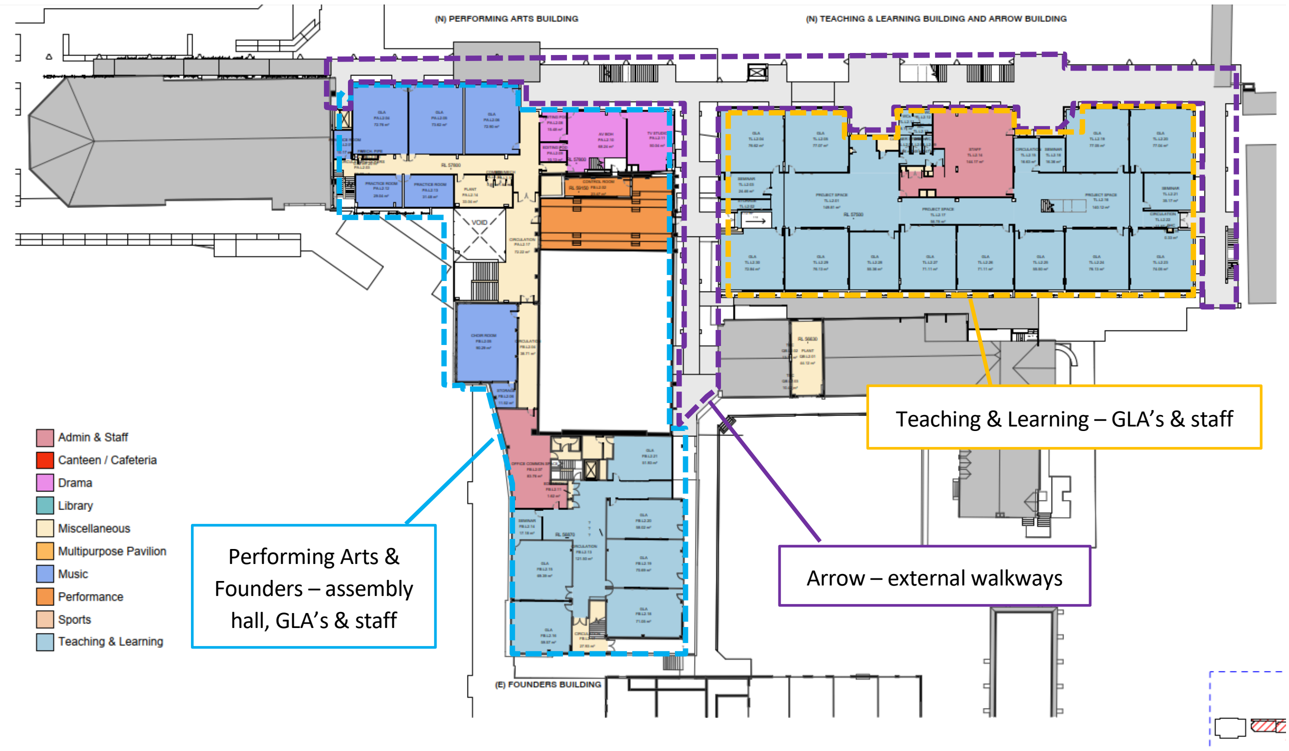


Figure 2.8: L2 Floor Plan (L2)

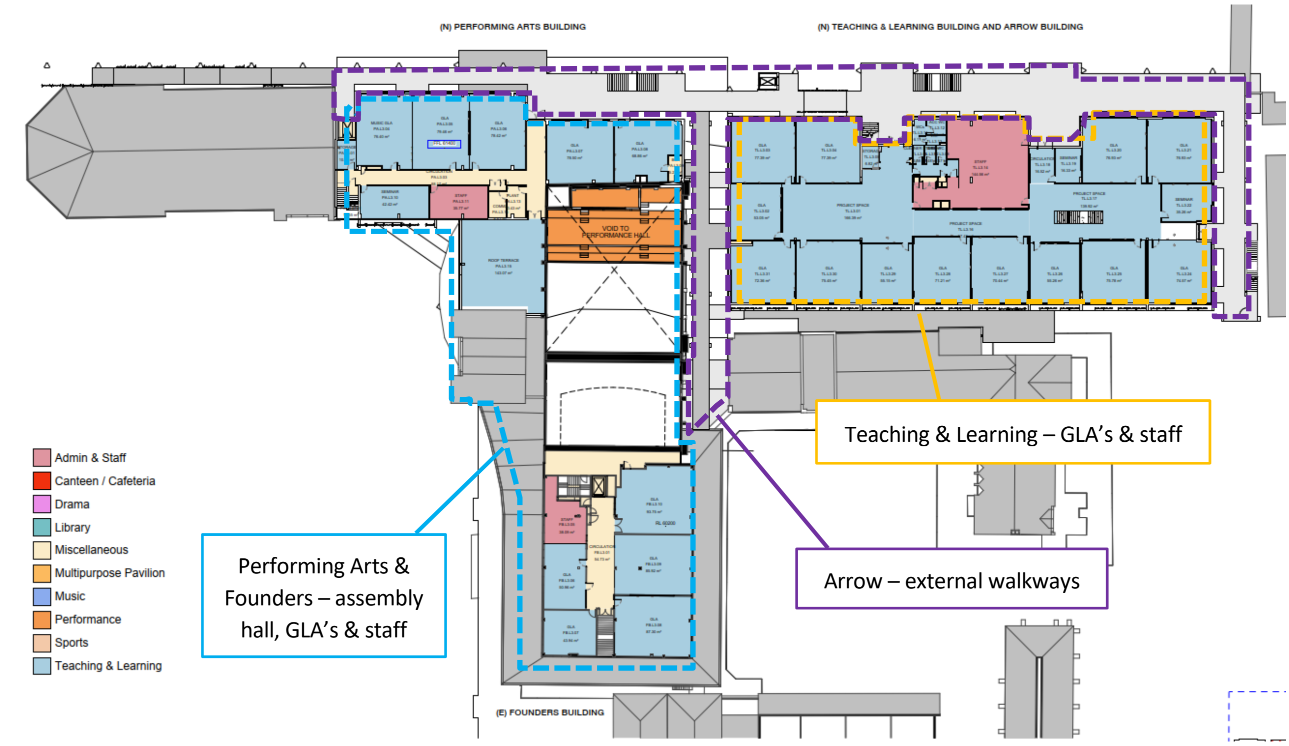


Figure 2.9: L3 Floor Plan (L3)

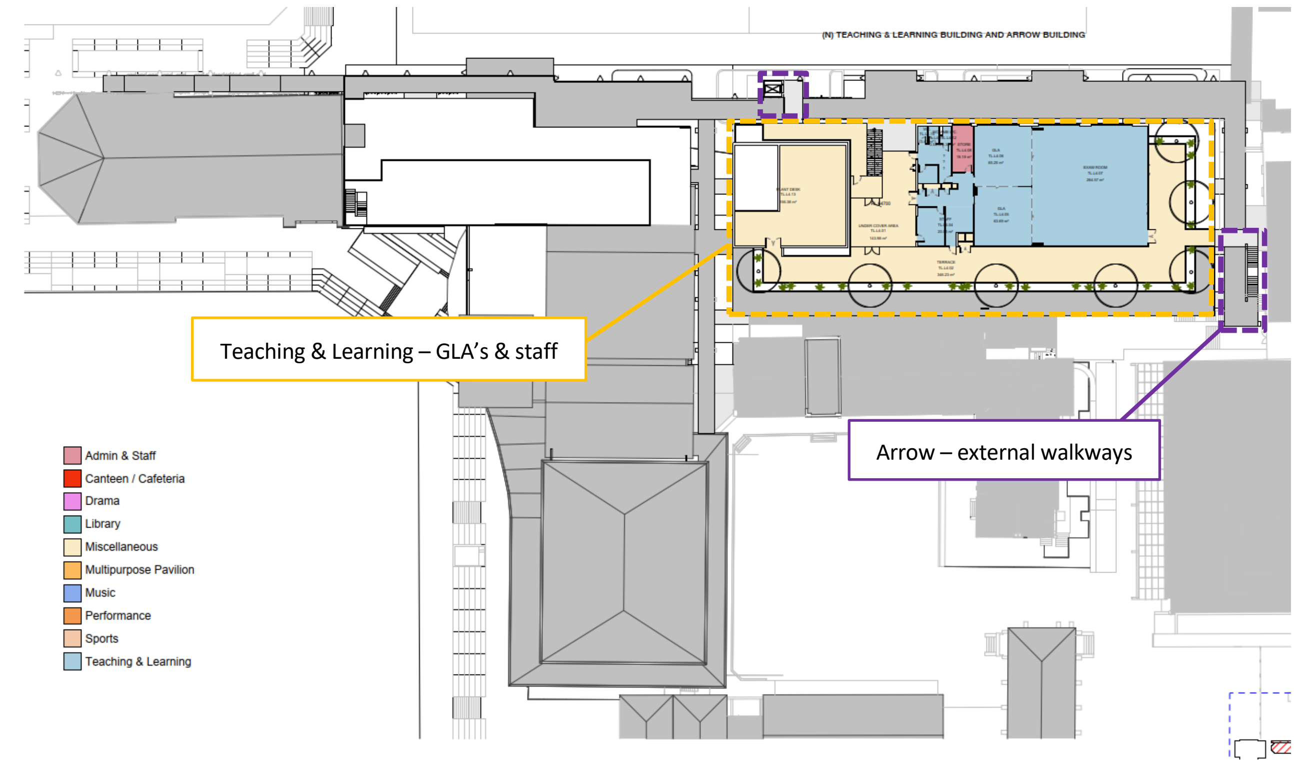


Figure 2.10: L4 Floor Plan (L4)

The building description based on the BCA classification system is provided in Table 2.2.

Table 2.2: BCA Description of building

Summary of Building/Tenancy	
Building Classification(s):	Class 9b (School), Class 9b (Assembly Hall) & Class 5 (Administration & Office)
Number of Storeys Contained:	Seven (7)
Rise in Storeys:	Five (5)
Effective Height:	Less than 25m
Required Type of Construction:	Type A fire-resisting construction – All buildings excluding Multi-purpose Pavilion Type A fire-resisting construction – Multi-purpose pavilion (proposed to be constructed in accordance with Type C fire resisting construction)

2.2 Occupant Profiles

2.2.1 Occupant Characteristics

Understanding the likely behaviour of the building's occupants is an important element of the analyses of life safety in a building fire. Where there are a number of occupants involved, there are many characteristics relating to these occupants and their probable behaviour in a fire emergency that can be identified. Hence, making complete characterisation of individual occupants is a complex and difficult task.

However, for the purposes of analysis only a limited number of 'dominant occupant groups' may be considered, as these have been shown to have the greatest impact on the outcome of evacuation modelling. Characteristics therefore need only be developed for these dominant occupant groups

Guidance provided by AFEG (2005), the Engineering Guide: Human Behaviour in Fire (SFPE 2003) and Proulx (2003) has been considered in the determination of dominant occupant characteristics for this fire safety engineering evaluation.

2.2.1.1 Class 5 (Administration & Offices)

Within the subject administration & office portions there will be two major occupant groups. One group, the staff can be regarded as permanent and therefore likely to be familiar to a significant degree with the overall layout of the subject building. The other group, the clientele and/or visitors can be considered as transient and therefore less familiar with the buildings. There is no proposed usage of the buildings that would indicate that the gender mix and proportion of persons with disabilities would be significantly different from the general national population norms. The characteristics (response capability, coping capability, and evacuation/avoidance capability) of the occupants are taken as those which are typical to office occupancy where the occupants are familiar with their surrounds.

The occupant characteristics of offices and workspaces are to be taken as typical of those found in this class of building. There are no other identified activities associated with this development other than those normally associated with an office. The characteristics (response capability, coping capability, and evacuation/avoidance capability) of the occupants within the office building can be assumed to be any member of the general public and therefore, have characteristics similar to the general population. The essential occupant characteristics are assumed to be:

- Occupants would be familiar with building layout and evacuation procedures,
- Occupants are considered to be awake and coherent due to the nature of the building.

2.2.1.2 Class 9b (School)

Students will be in the majority and have various degrees of familiarity. Teachers, while few in number will be familiar having the natural tendency to take charge in an event such as a fire emergency directing students to safely evacuate. Students would be expected to wait to be given instructions typical for the age and the teacher student relationship and generally begin to evacuate from the building as directed by the staff/teacher occupant group to a designated safe area.

There is no proposed usage of the building that would indicate that the proportion of persons with disabilities would be significantly different from the general national population norms. However, it should be noted, that in the event of an emergency evacuation able-bodied occupants are likely to be altruistic and assist the small proportion of disabled occupants, if any (Proulx 2002). The characteristics (response capability, coping capability, and evacuation/avoidance capability) of the occupants are taken as those which are considered to be typical for educational type occupancy, where the occupant is familiar with their surrounds and understands the cues of a fire alarm.

The proposed building(s) will not accommodate sleeping quarters for occupants therefore, the occupants would be considered to be alert, awake and coherent.

The evaluation shall consider the occupant characteristics identified and the usage of the building(s) as noted. Any changes in the building usage(s) and consequent potential change to the occupant characteristics will require a re-evaluation of the fire safety systems.

2.2.1.3 Class 9b (Assembly Hall)

As the building is to contain an assembly hall, the occupants are expected to comprise a combination of students, teachers and members of the general public who are there to attend a performance, production or social function. Therefore, we can essentially classify the occupants into two (2) major groups: transient (i.e. the public, students) and permanent (i.e. staff). Therefore, the occupants would comprise persons from all gender and of age groups. It is considered that the occupant characteristics of the public are consistent with the general population.

The transient occupant sub-group would have a varying degree of familiarity of the public access areas. However, it is expected only a minority will be unfamiliar given the simple floor plan and open nature of the building as the exits are visible. Given the nature of public access areas, it is expected from time to time that there may be large crowds and also people focused on tasks. So, it would be expected that the permanent staff members are likely to be knowledgeable of the specific evacuation process and aid other occupants so effective evacuation from the building can be undertaken.

The construction of the assembly hall shall comply with the DtS provision of the BCA unless otherwise to the satisfaction of the BCA consultant and PCA.

2.2.2 Occupant Numbers

The subject building shall operate on a daily non-continuous basis consistent with typical school/business hours. Maximum occupant numbers are based on the information provided by the client who has identified a total of 2,100 occupants within the TGS campus overall.

For the purposes of the evacuation analysis number of occupants has been based on Table D1.13 of Volume One of the BCA.

2.2.3 Summary of Building Occupant Egress Strategy

The design principle captured within the design drawings for the subject building is that when occupants are confronted with an emergency fire situation the building occupants make their way to a place of safety without being unduly exposed to the effects of fire, heat and smoke. Similarly, the occupants using the paths of travel to the numerous emergency fire exits are protected by the effects of fire during evacuations.

The proposed building configuration/layout comprises of fire exits that are distributed within the building directly to an area of relative safety or to outside the building. The intent behind the egress provisions provided throughout the subject building is to enable occupants to identify logical and obvious escape routes which lead to places of safety.

2.3 Conditional Statement

change would require a re-assessment of the fire safety levels. The evaluation has considered the occupant characteristics identified and the usage of the building as noted. Any changes in the building usage and consequent potential change to the occupant characteristics will require a re-evaluation of the fire safety systems.

3. Performance Solution Design Issues

The Building Certifier/BCA Consultant has identified the following design aspects of this project that do not comply with the Deemed-to-Satisfy provisions of the BCA. For each of these issues an alternate Performance Solution has been presented and is the subject of the assessment herein to demonstrate compliance with the relevant Performance Requirements.

Table 3.1 lists the Performance Solution design issues to be addressed in the assessment, the applicable BCA DtS provision to which the Performance Solution applies, the Performance Requirement(s) to be satisfied and the Assessment Method to be adopted in accordance with Clause A2.2 of BCA.

Table 3.1: BCA design issues pertinent to the proposed Performance Solution

No.	Performance Solution Design Issues Addressed	BCA DtS Provision	Performance Requirement(s)	Performance Solution
1.	It is proposed to permit FRL's commensurate with Type C fire-resisting construction (non-combustible) in lieu of Type A fire-resisting construction for the Multipurpose Pavilion structure only (excluding the Basement Carpark).	Clause C1.1 & Specification C1.1	CP1 & CP2	A2.2(2)(d)
2.	It has been identified that the southern wall & openings of the Teaching & Learning block at L0 to L3 are situated approximately 5.8m from the northern wall & openings of the Founders/PA block without being protected in accordance with Clause C3.4.	Clause C2.7, Clause C3.3 & Table C3.3	CP2	A2.2(2)(b)(ii)
3.	It has been identified that the Teaching & Learning block abuts the existing Sports/Science/Aquatic blocks without being provided with a full-height fire wall which complies with Clause C2.7 as a result of glazed openings within the dividing wall. It is further noted that this dividing wall separates the sprinkler-protected T&L building/Carpark from the existing non-sprinkler protected Sports/Science/Aquatic block. It has also been identified that there are unprotected glazed openings forming part of the T&L block which are configured in a parallel orientation and within 6m of the subject dividing wall.	Clause C2.7, Clause C3.3, Table C3.3	CP2	A2.2(2)(b)(ii)

No.	Performance Solution Design Issues Addressed	BCA DtS Provision	Performance Requirement(s)	Performance Solution
4.	It is proposed to permit extended travel distances within various portions of the building as follows: **Teaching & Learning Precinct:** *Basement Level 1* • It is proposed to permit a travel distance to a point of choice of up to 26m in lieu of 20m; and • It is proposed to permit a travel distance to an exit where two exits are available of up to 67m in lieu of 40m; and • It is proposed to permit a distance of travel between alternative exits of up to 97m in lieu of 60m. *Level 2* • It is proposed to permit a travel distance to an exit where two exits are available of up to 47m in lieu of 40m; and • It is proposed to permit a distance of travel between alternative exits of up to 75m in lieu of 60m. *Level 3* • It is proposed to permit a travel distance to a point of choice of up to 26m in lieu of 20m; and • It is proposed to permit a travel distance to an exit where two exits are available of up to 42m in lieu of 40m. *Level 4* • It is proposed to permit a travel distance to a point of choice of up to 30m in lieu of 20m. **Performing Arts Precinct:** *Basement Level 2* • It is proposed to permit a travel distance to a point of choice of up to 25m in lieu of 20m; and *Level 1* • It is proposed to permit a travel distance to a point of choice of up to 23m in lieu of 20m; and *Level 3* • It is proposed to permit a travel distance to a point of choice of up to 21m in lieu of 20m; and • It is proposed to permit a travel distance to an exit where two exits are available of up to 45m in lieu of 40m. *Level 4* • It is proposed to permit a travel distance to a single exit of up to 45 m in lieu of 40m within the roof plant area.	Clause D1.4 & Clause D1.5	DP4, DP5 & EP2.2	A2.2(2)(d)
5.	It has been identified that the non-fire isolated stairways interconnect the following: Performing Arts Precinct: • Open stairway interconnects four (4) storeys in lieu of three (3) within sprinkler protected building Arrow Building (i.e. external walkway): • A number of open stairways which interconnect up to five (5) storeys in lieu of three (3) within sprinkler protected building.	Clause D1.3, Clause D1.7 & Clause D1.12	CP1, CP2 & DP5	A2.2(2)(d)
6.	It has been identified that a number of the non-fire isolated stairways serving the Teaching & Learning & Founders/PA blocks that do not afford a continuous means of egress by their own flights/landings.	Clause D1.9	DP4 & EP2.2	A2.2(2)(b)(ii)

No.	Performance Solution Design Issues Addressed	BCA DtS Provision	Performance Requirement(s)	Performance Solution
7.	The fire hydrant system is proposed to be designed & installed in accordance with the AS2419.1:2017 Australian Standard in lieu of AS2419.1:2005. *Note: This is consistent with the hydrant standard adopted for the design of Stage 1 and 2 prepared by Arup (Report No. 281228, V01, dated 17 March 2022).*	Clause E1.3 & AS2419.1:2005	EP1.3	A2.2(2)(d)
8.	It is proposed to omit the requirement to provide fire hose reels within the school building throughout (i.e. library, staff lounge etc, noting that classrooms & associated corridors are not required to be provided with fire hose reels).	Clause E1.4 & AS2441:2005	EP1.1	A2.2(2)(d)
9.	It is proposed to omit the requirement to provide automatic sprinkler protection within the main switch rooms within the Teaching & Learning and Founders/PA blocks.	Clause E1.5. Table E1.5, Specification E1.5 & AS2118.1:2017	EP1.4	A2.2(2)(b)(ii)

4. Hazard Analysis

4.1 Introduction

The AFEG (2005) states that a systematic review should be conducted to establish potential fire hazards (both normal and special) of the facility under evaluation. A hazard is the outcome of a particular set of circumstances that has the potential to give rise to unwanted consequences. In regard to a building fire, a fire hazard means the danger in terms of potential harm and degree of exposure arising from the start and spread of fire and the smoke and gases that are thereby generated.

The fire related hazards in a facility can arise from the layout of the building including its location with respect to adjoining properties, the construction materials, the activities undertaken in the facility, the possible ignition sources and the fuel sources.

One of the first stages in reviewing potential fire hazards for a project is to examine available fire incident data for facilities having the same or very similar form and usage. This data may be international in origin and therefore must be used with care in order to establish possible hazards and a realistic measure of the possible unwanted consequences of fire.

Every hazard has a risk associated with it. The risk arising from a hazard is the frequency of an event involving that hazard, times, the expected consequences. A hazard may be eliminated, but there will always be an event frequency of occurrence and therefore always a positive value of risk associated with the hazard.

Fire safety engineering is essentially a risk management process wherein the outcome is to minimize the overall fire risk associated with a facility by mitigating or eliminating serious hazards, or by reducing the frequency of hazardous events.

The risk assessment process, of which hazard analysis forms part, is the means by which those hazardous events with the most serious consequences are identified. This then enables the most appropriate fire scenarios related to these events to be defined. This process then allows the analyses to be carried out to ensure that the fire safety systems and strategies employed are sufficient to satisfy the Performance Requirements.

Whilst the frequency of hazardous events (probability) is considered during the hazard analysis, the consequent analyses for the evaluation of the resultant fire scenarios are deterministic.

The following sections provide data specific to the occupancies involved in this assessment.

4.2 Summary of Project Specific Hazards

A thorough and comprehensive analysis of the fire hazards associated with the subject building has been provided in Appendix B of this PBDB. A summary of the fire hazard analysis is provided in the following sub-sections presented below.

4.2.1 Summary of Hazards Specific to Class 5 (Administration & Office)

In relation to the Class 5 (Administration & Office) portions of the building, the hazard analysis undertaken illustrates a number of consistent observations. These observations are summarised below:

- While there is very little usable Australian fire statistics available, there are plenty of international sources of data (see Section B.2.2), and these overseas sources are relevant to the Australian built environment, so can be used with care to inform fire engineering and design in Australia.
- While it is largely impossible to define or regulate fire loads in office properties, most studies find a mean fuel load in the range of 300-700 MJ/m^2 (see Table B.1). Most of the fuel load in offices is in the form of paper or wood, but there are significant quantities of plastics and electronics present as well (see Table B.2).
- The ignition sources that produce the most frequent fires in offices are cooking equipment and, to a lesser extent, electrical equipment (see Figure B.7). This is even more the case for high-rise offices. The sources that produce the most fire-related property damage are arson and fires in adjacent properties.
- Statistics worldwide indicate that an office building rates relatively low with respect to the risk of fire when compared to buildings of other occupancies (see Section B.2.5).
- While (typically non-sprinkler-protected) mid- or low-rise offices are quite low risk, this is even more true of (typically sprinkler-protected) high-rise office properties (see Figure B.13).
- Offices are one of the occupancies with the lowest fire fatality risk (see Section B.2.6).
- Automatic sprinkler systems are very effective at reducing the severity of fires in office properties (Lougheed, 1997).
- Offices are an occupancy of low overall risk, and in particular have a significantly below-average risk to life.

4.2.2 Summary of Hazards Specific to Class 9b (School)

In relation to the Class 9b (School) portions of the building, the hazard analysis undertaken illustrates a number of consistent observations. These observations are summarised below:

- Many education department officers cannot recall any deaths in school fires; hazard to life safety is low.
- On average, a school fire with losses exceeding one million dollars occurs every two weeks in Australia. However, this loss is less than 0.1% of school assets.
- Most fires are small; most of the loss is due to only a small proportion of all fires.
- Most of the losses appear to be due to arson. However, statistics on this matter are unclear. Arson is sometimes interpreted as burglary.
- Arson fires are consistently the single most significant source of fire starts (54% of school fires in NSW, 60% in UK, and 52% in USA)”
  - Arson in a school is a risk however it is considered to be more related to security of the building. Many security practices not only reduce burglary but also reduce arson.
  - Mitigating the risk of arson is a delicate balance between onerous security which may be problematic and management. As such minimising waste and good storage of combustibles whilst maintaining clear travel paths result in low accessible fuel loads.
- In view of the multi-use school building(s) it is anticipated that there will be some sources of ignition. The ignition sources that are primarily related to the proposed building(s) include:
  - Electrical switch assemblies;
  - Lighting
  - Electronic audio/video (e.g. stage equipment)
  - Occasional special effects equipment for staged performances
  - Arson.
- In view of the variable nature of activities associated with the subject building(s) it is anticipated that the likely fuel loads will consist of seating and some office furnishings within the multi-use spaces. The adjacent classrooms, store rooms, offices and kitchenette present a separate potential fuel load of which the combustible content of the proposed building(s) shall include:
  - Furniture (e.g. tables, chairs, cabinets & shelving arrangements)
  - Storage contents (e.g. boxed items, books, folders and the like)
  - Audio/Visual/computer equipment
  - Electrical equipment
  - Seating and/or table arrangements
  - Ovens
- It can be summarised that the risk to occupants within school facilities is very low. This is outlined in both the national and international results collated and when compared to other types of building classifications. The subject building is considered to be comparative for use, size and occupants with the data compiled for the above results obtained.

4.2.3 Summary of Hazards Specific to Class 9b (Assembly Hall – School use only)

In relation to the Class 9b (Assembly Hall) portions of the building, the hazard analysis undertaken illustrates a number of consistent observations. These observations are summarised below:

- The fire load of the stage area is expected to primarily consist of performance props/decorations, and audio/visual equipment. The fire load of the auditorium area is expected to primarily consist of seating.
- The ignition sources that are primarily related to the proposed building include:
  - electrical switch assemblies
  - lighting
  - electronic audio/video stage equipment
  - Occasional special effects equipment for staged performances

5. Fire Brigade Intervention

Fire brigade intervention is required to be analysed to determine the potential impact on the activities of the fire brigade. This relates primarily to the potential risk with respect to fire spread and the likely impact on building elements. Fire Brigade Intervention is also required to be reviewed with respect to occupant and firefighter tenability limits with respect to the time required for fire brigade intervention activities.

5.1 Fire Services Infrastructure and Equipment

Fire safety services are generally based on the level of risk. The height and use of the building are the key criteria when considering the level of risk associate within a building. Based on the minimum provisions required according to the DtS provisions from Volume One of the BCA, the subject building is required to afford a suite of fire services. The fire services incorporated in the building design are as follows and refer to mark-up in Figure 5.1

- Automatic fire sprinkler system in accordance with AS2118.1:2017; and
- Automatic smoke detection system in accordance with AS1670.1:2018; and
- An Early Warning & Intercommunication System (EWIS) or Building Occupant Warning System (BOWS) shall be provided as per Section 0.5.4; and
- Fire Brigade monitoring of the BOWS/EWIS for automatic notification and dispatch of Fire Brigade resources; and
- The main Fire Detection Control and Indication Equipment (FDCIE) (i.e. main Fire indicator Panel (FIP)) shall be located adjacent the oval 3 carpark ; and
  - Sub-FIP shall be provided in all buildings on subject site; and
- Internal fire hydrants serving all levels; and
- Hydrant/sprinkler plantroom serving the site shall be located at the entry of the oval 3 carpark adjacent main FIP; and
- The fire hydrant booster assembly shall be located along Victoria Street; and
- Fire Brigade arrival is assumed to be along Victoria Road, and access shall be provided from possible from Prospect Road and Seaview Street as well; and
- The site and building are afforded fire hydrants, fire hose reels and fire extinguishers generally in accordance with Volume One of the BCA and the relevant Australian Standard unless otherwise approved by the FRNSW.

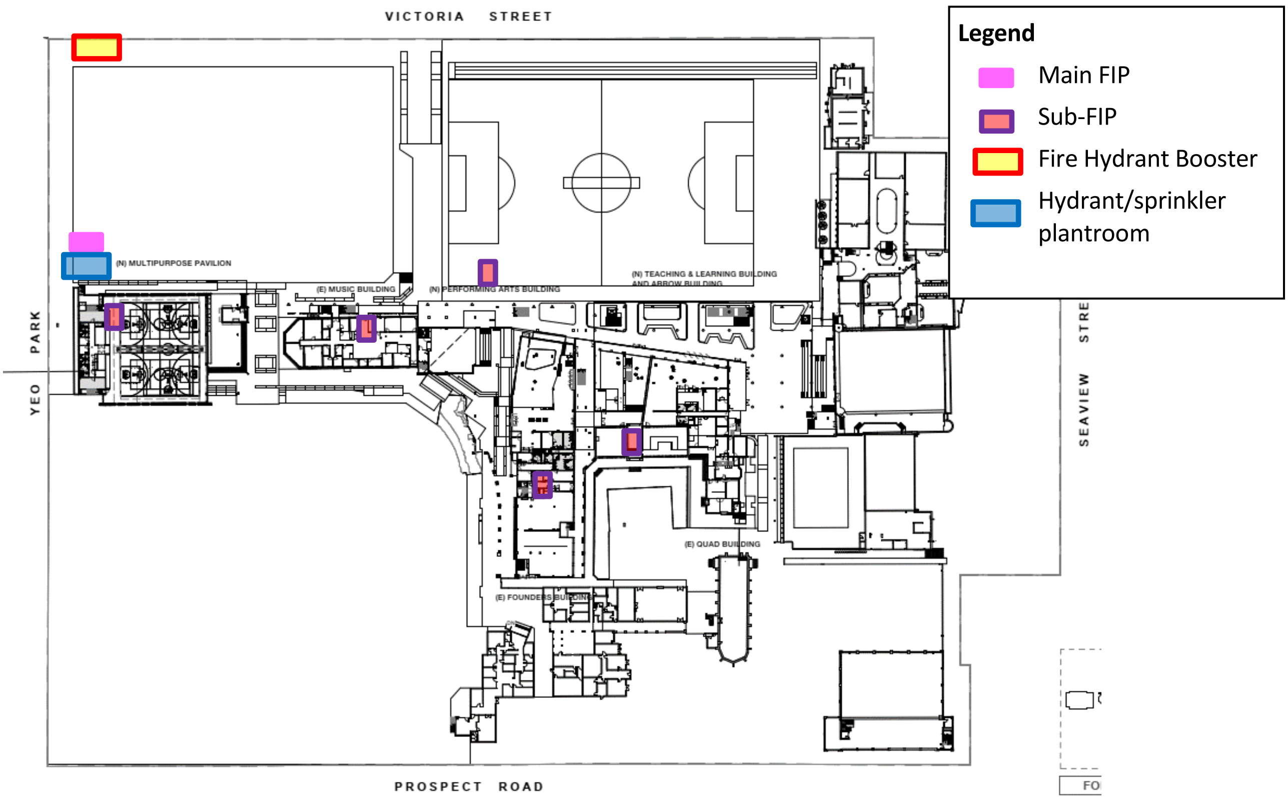


Figure 5.1: Fire Services Infrastructure serving subject building (indicative)

5.2 Fire Brigade Intervention Model (FBIM)

5.2.1 Responding Stations

For the purpose of determining a time at which the local fire brigade would attend a potential fire located at the subject building, a Fire Brigade Intervention Model (AFAC, 2020) has been undertaken. The Fire Brigade Intervention Model (FBIM) is an event-based methodology which quantifies Fire Brigade activities from the point of Fire Brigade notification through to search, rescue, fire control and extinguishment and overhaul activities.

The approximate Fire Brigade arrival time and commencement of intervention activities has been estimated and assessed whereby Fire Brigade arrival and/or fire-fighting operations is listed as sub-requirements of the relevant Performance Requirements of the BCA.

The nominated responding fire stations to the subject site via road travel have been illustrated in Figure 5.2. The subject site is within the FRNSW response area with the nominated fire stations as follows:

Table 5.1: Responding FRNSW stations

Fire Station	Address	Distance
Ashfield Fire Station	16 Victoria St, Ashfield NSW 2131	1.1km
Marrickville Fire Station	309 Marrickville Rd, Marrickville NSW 2204	3.4km

Figure 5.2: Responding Fire Stations

5.2.2 Assumptions and Parameters

In this instance, a FBIM was undertaken from notification to commencement of water application at the designated fire scenario. The following assumptions and parameters were also adopted to determine Fire Brigade Intervention:

- Based on information provided by FRNSW, the nominated fire stations are manned as follows:
  - Ashfield Fire Station: Permanent firefighter staff.
  - Marrickville Fire Station: Permanent firefighter staff.
- The FBIM timeline has been adjusted to accommodate the staffing circumstances of the nominated fire stations

  - As the fire stations are fully manned, the FBIM timeline has adopted an additional 90 seconds to account for "time to dress, assimilate information and depart";
- Google Maps TM has been used to identify the appropriate travel time from the nominated stations to the subject site.
- Firefighters including the Officer in Charge (OIC) would require time to don BA gear and gather necessary information.
- The attending crew would be expected to receive information about the location of the fire via the main Fire Indicator Panel (FIP) if it was visible upon arrival.
- Occupants are expected to be evacuated and/or in the process of evacuation from the building so forced entry is not expected to be required.
- Fire crews shall be equipped with BA and equipment suitable to allow entry to fire affected area.
- Firefighter tenability is to be maintained and fire crews are unlikely to be exposed to extra ordinary hazards.
- Firefighters travel to the subject site and set up in the most practical area for the fire brigade appliances.
- Multiple fire appliances are expected to attend a fire event at the subject site and communications between attending crews are expected to facilitate the coordination and positioning of fire crews and appliances.
  - One appliance is expected to be located on Victoria Street to connect to the hydrant booster, another appliance is expected to be positioned along Prospect Road to allow easier access to the subject building.
- The time to reposition fire appliances shall be based on a speed of 8km/hr for travel on internal roads within the subject site and the designated speed limit on any public road (i.e 40km/hr in this instance).

5.2.3 FBIM Outcomes

The activities performed by the attending fire crews, the time associated per activity and the cumulative time from fire initiation until the commencement of water application onto the fire is tabulated in Appendix F: Table F.8. The FBIM timeline indicates the following:

- From fire initiation the cumulative time taken for the closest and second closest fire appliances to reach the fire scene (kerb side) are as follows:
  - Closest (Ashfield Fire Station): **608 seconds** or approximately 10.1 minutes; and
  - Second Closest (Marrickville Fire Station): **1,028 seconds** or approximately 17.1 minutes;
- Having arrived at the fire scene (kerb side), the time taken for fire crews to gain entry, gather information, assess the situation and set-up water supplies ready for the commencement of water control/extinguishment activities is an additional **1,114 seconds** or approximately 18.6 minutes;
- From fire initiation to the commencement of water control/extinguishment activities the cumulative time take for the closest & second closest responding fire stations is as follows:
  - Closest (Ashfield Fire station): **1,722 seconds** or approximately 28.7 minutes; and
  - Second Closest (Marrickville Fire Station): **2,142 seconds** or approximately 35.7 minutes

In line with the AFAC FBIM Model Manuel (Version 3.0, dated 14/04/2020) the total time taken for fire brigade intervention is based upon the second closest fire station. In this regard, attending fire crews from Marrickville Fire Station are expected to conduct water control/extinguishment activities within **2,142 seconds** or approximately 35.7 minutes.

6. Type of Construction Required within Multi-Purpose Hall

6.1 Background to the Issue

Clause C1.1 from Volume One of the BCA provides the Type of Construction Required for buildings based upon the rise in storeys and the associated building classification as defined under the BCA. Referring to Table C1.1 from Volume One of the BCA, the subject building is required to be constructed from Type A, fire resisting construction due to the rise-in-storeys of two (2) based on the configuration of the building including the location of the carpark below the building.

As part of the design and based on the existing nature of the subject building, it is proposed to permit and rationalize the Type of Construction to the Pavilion portion of the building (i.e. excluding the carpark underneath) of this structure which is a deviation from Clause C1.1 and Specification C1.1. The identified area has been illustrated in Figure 6.1 and Figure 6.2.

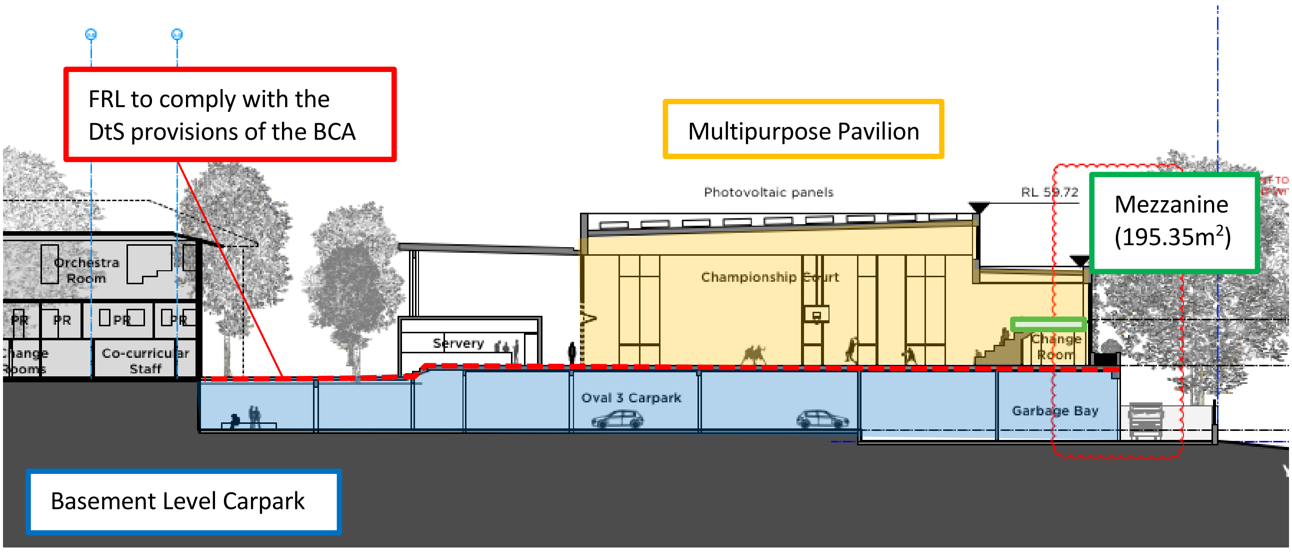


Figure 6.1: Section depicting Type of Construction of the Multipurpose Pavilion

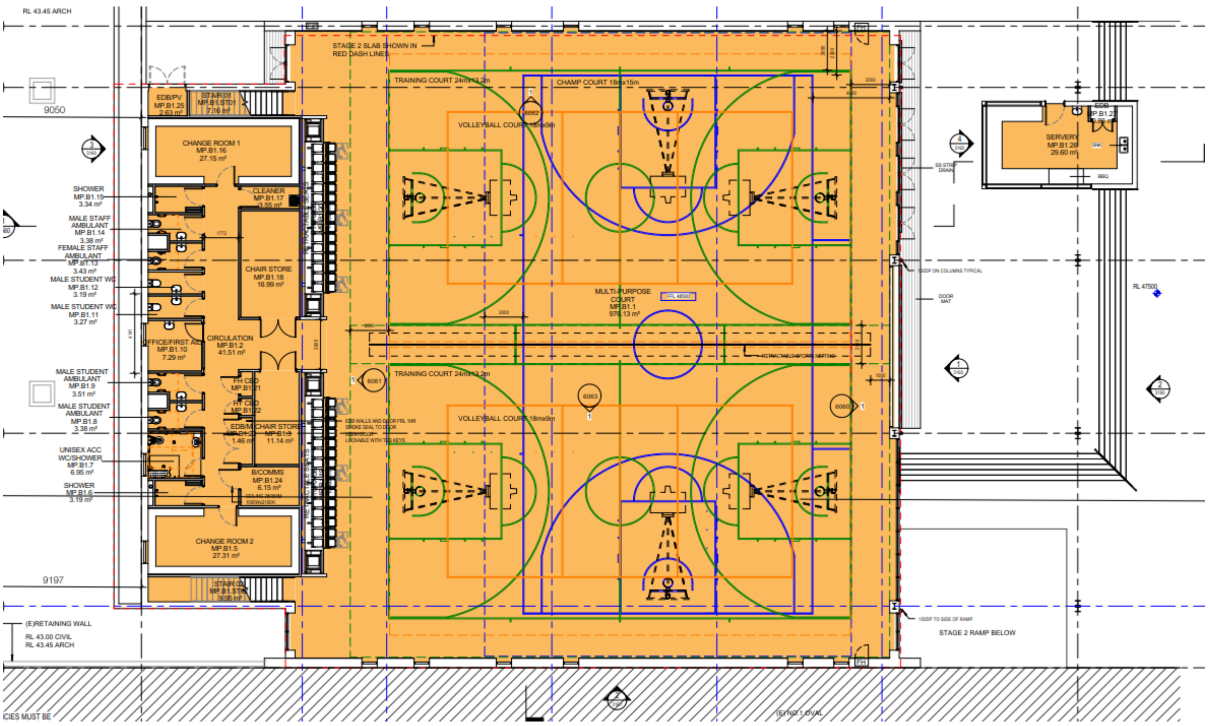


Figure 6.2: Plan of Multipurpose Pavilion Building (Level 0 - GF)

6.2 Performance Solution

In accordance with the BCA Clause A2.2 *Performance Solution* the following assessment method have been adopted to determine that the *Building Solution* has met the relevant *Performance Requirements CP1 and CP2.*

Table 6.1: Methods of Analysis

Identified Design Issue	BCA Assessment Method	AFEG Method of Analysis
To permit FRL's commensurate with Type C fire-resisting construction (non-combustible) in lieu of Type A fire-resisting construction for the Multipurpose Pavilion structure only (excluding the Basement Carpark).	A2.2(2)(d) Comparison with the Deemed-to-Satisfy Provisions	A qualitative approach has determined that the Performance Solution is comparable to a deemed-to-satisfy compliant design.

6.3 Hazard Specific to the Type of Construction Required

The Guide to the BCA (ABCB, 2019) states that the intent associated with prescribing a required FRL is "to establish the minimum fire-resisting construction is to maintain an adequate level of structural stability and minimise fire spread". It is therefore considered that the main hazard associated with the identified design issue relates to:

- The potential for the structural adequacy of the subject building associated with the Type C portions of the building to impact the overall development in the event of a fire scenario;
- The proposed FRL may potentially have a negative impact on the life safety and occupants and Fire Brigade Intervention.

6.4 Hazard Mitigation to the Type of Construction Required

The Guide to the BCA (ABCB, 2019) identifies the potential for occupants to encounter unsafe conditions as fire may spread or the structural stability of the structure may be impacted upon. Therefore, by providing a suitable FRL, occupant life safety is still maintained to the degree necessary. In this regard the following hazard mitigation systems, requirements and features of the design are noted:

- It is proposed to permit the Multipurpose Pavilion structure (excluding the basement level carpark) to be constructed in accordance with the minimum FRL's commensurate with Type C fire-resisting construction in lieu of Type A fire-resisting construction and inclusive of the following:
  - The Multipurpose Pavilion structure shall consist of non-combustible construction. This performance solution relates to the applicable FRL's only; and
  - The Multipurpose Pavilion shall be fire-separated from the basement level Oval 3 carpark via a fire-rated slab achieving a minimum FRL of 120-minutes in accordance with the DtS provisions of the BCA. Any services penetrations through the fire-rated floor slab shall be fire-stopped and must conform to a tested system in accordance with AS1530.4:2014; and
- Aside from being located atop the carpark separating floor slab, the subject multi-purposes pavilion building is a separate building from any other building on the site; and
- The Oval 3 carpark below the multi-purpose pavilion structure shall be protected by automatic sprinkler protection; and
- Egress provisions from the pavilion floor shall be provided on-grade to an open space and are independent from the carpark egress provisions. It is not proposed to have any interconnecting stairways between the carpark portion and the pavilion portion; and
- A fire detection and alarm system shall be provided throughout the Multipurpose Pavilion structure in accordance with Specification E2.2a and AS1670.1:2018; and
- Permanent occupants are expected to be familiar with the building layout and paths of egress.

6.5 Methodology

The methodology adopted to address the proposed adoption of FRL's commensurate with Type C fire-resisting construction in lieu of Type A fire-resisting construction for the building has been a qualitative comparative assessment. The Multipurpose Pavilion structure has been compared to a standalone structure with consideration of the function and use of the building, the proposed fire separation of the carpark and the independent access/egress provisions afforded to both occupants and attending fire brigade personnel. Specifically, the risk of fire-spread throughout the Multipurpose Pavilion building and the ability for occupants to discharge directly to a road/open space and similarly the ability for attending fire brigade personnel when undertaking their operations has been compared to a comparable deemed-to-satisfy design.

It should be noted that under the deemed-to-satisfy provisions (where considered independently) the Multipurpose Pavilion is a standalone building with a rise in storeys of one (1) based on its classification and use would only be required to be constructed in accordance with Type C construction requirements including the permissibility of combustible construction.

The qualitative aspect of the evaluation has also considered the proposed fire safety measures (i.e. provision of smoke detection being an enhancement).

6.6 Acceptance Criteria

The acceptance criterion has been met by demonstrating that the fire separation and access/egress provisions for this building is comparable building with a rise-in-storeys of one (1), thus comparable to a building that would otherwise be required to achieve Type C construction as prescribed for a DtS compliant design. The benefit of the provision of smoke detection to this building (not required by the DTS provisions) has also been considered.

6.7 Qualitative Evaluation

6.7.1 Function and Use

As part of the sports precinct of the school development it is proposed to construct a multi purpose pavilion to provide indoor sporting facility with spectator seating & amenities. The multi purpose pavilion shall primarily accommodate the following:

- 1/no. x full size championship basketball court with retractable tiered seating
- 2/no. x training basketball courts for training only
- Amenities & support facilities generally consisting of retractable seating, mezzanine area, office/first-aid, chair store, cleaners and comms room
- Other functions to include school assemblies, speeches, primary school movie nights

The dominant occupant groups will be teachers and students and also to a lesser extent the general public. The largest of these groups will be students when the school has general assemblies and also sporting classes. In some cases, the general public will be the predominant occupant group.

Students will be in the majority and have various degrees of familiarity. Teachers, while few in number will be familiar having the natural tendency to take charge in an event such as a fire emergency directing students to safely evacuate. Students would be expected to wait to be given instructions typical for the age and the teacher student relationship and generally begin to evacuate from the building as directed by the staff/teacher occupant group to a designated safe area. It is assumed that occupant numbers within this building shall be 1200 maximum. As such the sufficient exits and aggregate egress widths have been provided to ensure that the potential for queuing at the exits leading to slow evacuation is mitigated.

6.7.2 Fire Hazards

It should be noted that even though the multi purpose pavilion is classified as Class 9b School, the hazards associated with the sports facility is not in line with typical school hazards (i.e. teaching areas, classrooms, administration). As such the hazards have to be more specific to sporting centres and leisure centres.

The hazards that pertain to this building are no different to any other indoor porting complex comprising basketball courts. The basketball court areas are essentially sterile wet areas with timber floors and an open court environment. The court areas do not contain any significant ignition sources (limited to light fitting etc.) or fuel loads (limited to bags, towels etc.). They are essentially sterile areas with presence of low fire hazards as there are limited fuel loads and ignition sources. The main fuel loads that may be present would be sports equipment, hard plastics, rubber mats and foam (padded seating). The activities on the basketball courts are identified as non-hazardous activities. It also should be noted that during the periods when the courts area cleaned and/or maintenance work is carried out, the courts are not expected to be utilised.

The combustible content within the areas of concern are identified as follows:

- Towels
- Storage of chairs
- Clothing
- Carry-bags and packs
- Rubbish bins

It should also be noted that the proposed building is a non-smoking venue and therefore the risk of fire ignition caused by a discarded or misplaced cigarette is considered to be negligible.

Figure 6.3: Example of Basketball/Netball Courts

Based on the analysis undertaken it can be inferred that the in the event of a fire within the sports facility, fire hazards and the potential fire intensity can be deemed to be comparable to leisure centre and not a Class 9b school (i.e. teaching spaces, school laboratories, library, etc.) which has higher fuel loads and ignition sources.

6.7.3 Fire Safety Measures

6.7.3.1 Passive Measures

In order to consider the multi-purpose pavilion to be stand-alone building and permit Type C fire-resisting construction in lieu of Type A fire-resisting construction it is proposed to fire separate it from the basement level car park. This shall be achieved via the following (refer to Figure 6.4):

- The Multipurpose Pavilion structure shall consist of non-combustible construction. This performance solution relates to the applicable FRL's only; and
- The Multipurpose Pavilion shall be fire-separated from the basement level carpark via a fire-rated slab achieving a minimum FRL of 120-minutes in accordance with the DtS provisions of the BCA. Any services penetrations through the fire-rated floor slab shall be fire-stopped and must conform to a tested system in accordance with AS1530.4:2014; and

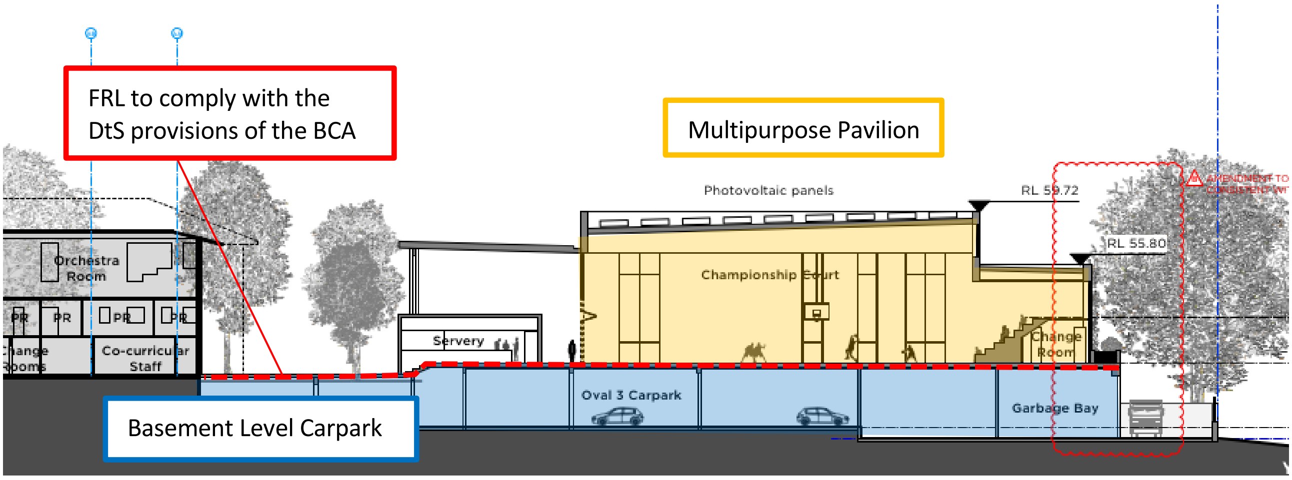


Figure 6.4: Fire Separating Construction of the Multipurpose Pavilion

Aside from being located atop the carpark separating floor slab as shown in to Figure 6.4 the subject multi-purposes pavilion building is considered a separate building from any other building on the site.

6.7.3.2 Active Measures

In order to enhance occupant notification, automatic smoke detection shall be provided throughout the multi-purpose pavilion in accordance with AS1670.1:2018. The provision of smoke detection to the multi-purpose pavilion is not required by the DTS provisions and as such is considered an enhancement to the design. Providing early detection shall ensure that the occupants investigate the fire during the early stages of fire development. This would allow for possible early intervention, if safe to do so, assist staff to direct students with early evacuation. The multi-purpose pavilion shall be provided with emergency lighting and exit signage to assist in way-finding during an evacuation.

Further to the proposed passive fire separation between the basement car park and multi-purpose pavilion, the Oval 3 carpark below the multi-purpose pavilion structure shall be protected by automatic sprinkler protection. From the information presented in Appendix D, in the majority of cases where a sprinkler system is present and activates accordingly, the fires are generally confined to the object or area of fire origin. The presence of sprinklers within this space shall ensure that the fire shall be contained within the basement car park coupled with the proposed fire separating construction.

6.7.4 Occupant Egress

Egress provisions from the multi-purpose pavilion floor shall be provided on-grade to an open space and are independent from the basement level carpark egress provisions. As such it is not proposed to have any interconnecting stairways between the carpark portion and the multi-purpose pavilion. As such a fire within the basement level car park will have a negative impact on the ability for occupants within the multi-purpose pavilion to evacuate.

As noted in the previous sections it is assumed that occupant numbers within this building shall be 1200 maximum. As such the sufficient exits and aggregate egress widths have been provided to ensure that the potential for queuing at the exits leading to slow evacuation is mitigated. It should be noted that the exit travel distances within multi-purpose pavilion are all deemed to comply with the DtS provisions from Volume One of the BCA.

Based on occupant cues (i.e. visual and incendiary cues) and the expectation that occupants would be awake and alert whilst within the sports facility, occupants are expected to evacuate the multi-purpose pavilion in a timeframe no less than what would be expected for a DtS building solution. However, as part of the Performance Solution and to further enhance occupant warning and notification, the multi-purpose pavilion shall be provided with an automatic fire detection and alarm system as described in Section 6.7.3.2.

As such the adoption of Type C construction to multi-purpose pavilion is not considered to increase the risk to occupant life safety based on the inclusion of an automatic fire detection and alarm system, proposed passive fire separation between the basement car park and multi-purpose pavilion and the basement carpark shall be protected by automatic sprinkler protection.

6.7.5 Fire Brigade Intervention

Based on the average fire authority response times described in Section 5, the approximate time for the closest fire station, Ashfield and Marrickville Fire Station fire appliance to reach kerb side is approximately 1,028 seconds or approximately 17 minutes. As noted in the previous sections the multi-purpose pavilion predominantly consists of sterile sports playing areas (i.e. indoor stadium) and hence, does not contain high-rack or palletised storage.

From a Fire Brigade Intervention perspective, the multi-purpose pavilion is unlikely to present a significant risk to fire crews and hence, the efficacy of fire-fighting operations is unlikely to be reduced for a fire in this building. Further to the proposed passive fire separation between the basement car park and multi-purpose pavilion, the basement carpark shall be protected by automatic sprinkler protection. The presence of sprinklers within this space shall ensure that the fire shall be contained within the basement car park coupled with the proposed fire separating construction. This shall further reduce the impact on fire brigade personnel based on a fire originating from the basement car park.

Therefore, the proposed Type Construction is not considered to increase operational risk to fire-fighting personnel. In the event that fire brigade intervention is required as a result of a fire originating within the multi-purpose pavilion the arriving fire brigade personnel are provided with compliant fire hydrant locations and hydraulic performance. The risk to firefighting crews from a fire originating within the multi-purpose pavilion is considered to be low.

6.7.6 Comparison to DtS Provisions

As described in the previous sections the proposed multi-purpose pavilion has a rise-in-storeys of two (2) based on the configuration of the building including the location of the carpark below the building. As such the multi-purpose pavilion is required to be constructed in accordance with Type A fire resisting construction. As part of the design it is proposed to permit Type C fire resisting construction to the multi-purpose pavilion portion of the building (i.e. excluding the carpark underneath).

In order to demonstrate that the proposed design is equivalent to the DtS provisions of the BCA, the multi-purpose pavilion needs to be considered as a standalone building with a rise in storeys of one (1) which based on its classification and use would only be required to be constructed in accordance with Type C construction FRL requirements only (i.e. does not include the permissibility of combustible construction).

In order to achieve this intent, the following measures, as described in Section 6.7.3, have been relied upon:

- The Multipurpose Pavilion structure shall consist of non-combustible construction; and
- The Multipurpose Pavilion shall be fire-separated from the basement level carpark via a fire-rated slab achieving a minimum FRL of 120-minutes; and
- In order to enhance occupant notification, automatic smoke detection shall be provided throughout the multi-purpose pavilion in accordance with AS1670.1:2018; and
- The basement carpark below the multi-purpose pavilion structure shall be protected by automatic sprinkler protection.

Based on the presence of passive (i.e. fire separating construction) and active (i.e. detection and sprinklers) the multi-purpose pavilion can be considered as a standalone building with a rise in storeys of one (1) which based on its classification and use can be constructed in accordance with Type C construction fire resisting construction.

6.8 Discussion of Assessment Outcomes

Based on the hazard analysis presented within this assessment, the risk of fire initiating within the proposed multi-purpose pavilion is not likely to occur. The qualitative comparative risk based assessment has demonstrated that the presence of fire separating construction between multi-purpose pavilion and basement level carpark (i.e. 120 minutes), sprinkler protection within basement level carpark, fire detection system within multi-purpose pavilion shall support the adoption of Type C fire resisting construction to the multi-purpose pavilion.

Furthermore, staff/teachers within the building are regarded as permanent and therefore likely to be familiar to a significant degree with the overall layout of the building. The staff/teachers are expected to be aware of the location of the emergency exits and play a dominant role in the full evacuation in an emergency fire situation. From a Fire Brigade Intervention perspective, the multi-purpose pavilion is unlikely to present a significant risk to fire crews and hence, the efficacy of fire-fighting operations is unlikely to be reduced for a fire in this building

Therefore, the *Performance Solution* is considered to satisfy the performance requirements CP1 & CP2 from Volume One of the BCA. This conclusion is contingent on the requirements detailed in Section 15.2 being implemented into the design.

7. Separation of External Walls & Associated Openings T&L and Founders/PA Blocks

7.1 Background to the Issue

It has been identified that there are a number of external walls and openings and that are associated with different fire compartments and are situated within close proximity to each other as follows:

- The southern wall & openings of the Teaching & Learning block at L0-L3 are situated approximately 5.8m from the northern wall & openings of the Founders/PA block.

The proposed design forms a deviation from Clause C2.7 of the BCA which prescribes the external wall construction of the different fire compartments to be fire-rated. The design also deviates from Clause C3.3 & Table C3.3 of the BCA which prescribes openings within different fire compartments to be suitably protected. Figure 7.1 & Figure 7.2 depict the different fire compartment proximities.

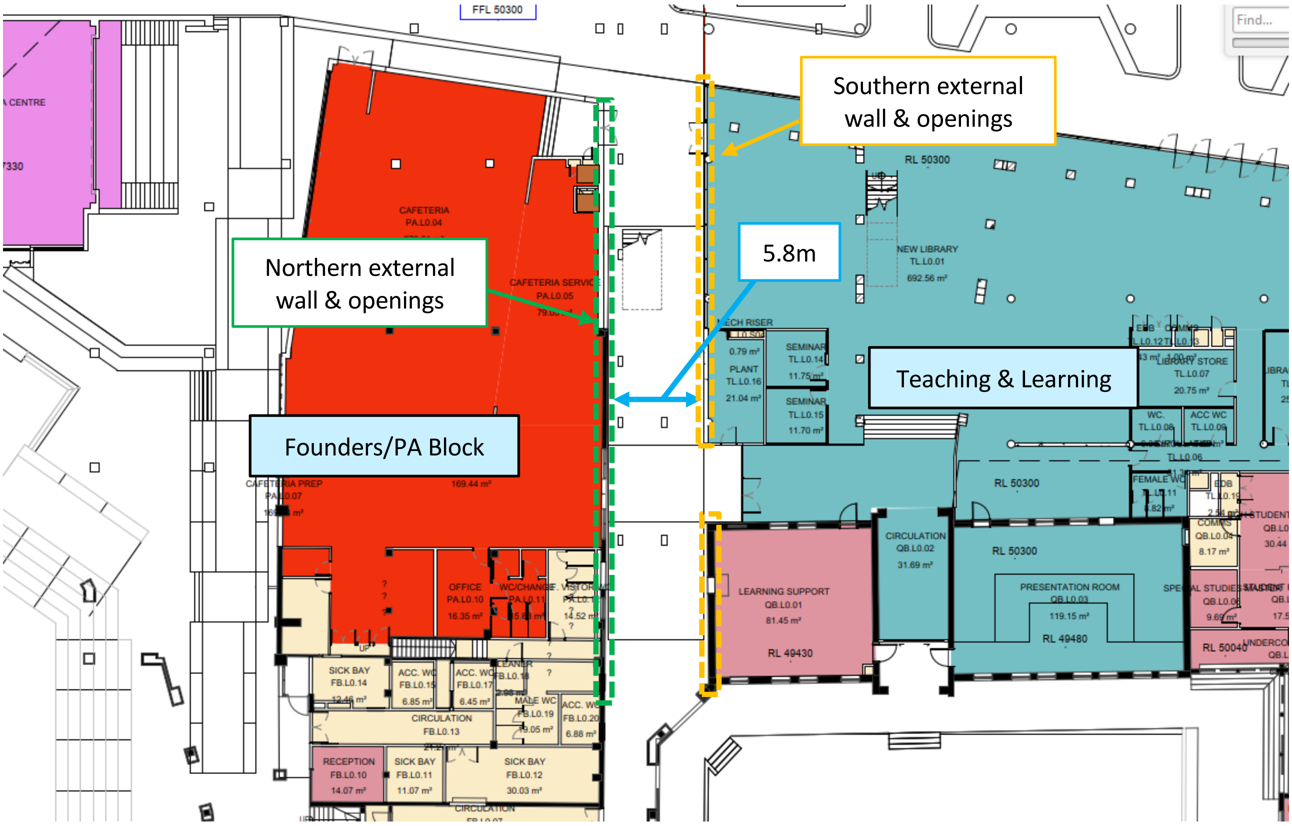


Figure 7.1: T&L and Founders/PA fire compartments (L0)

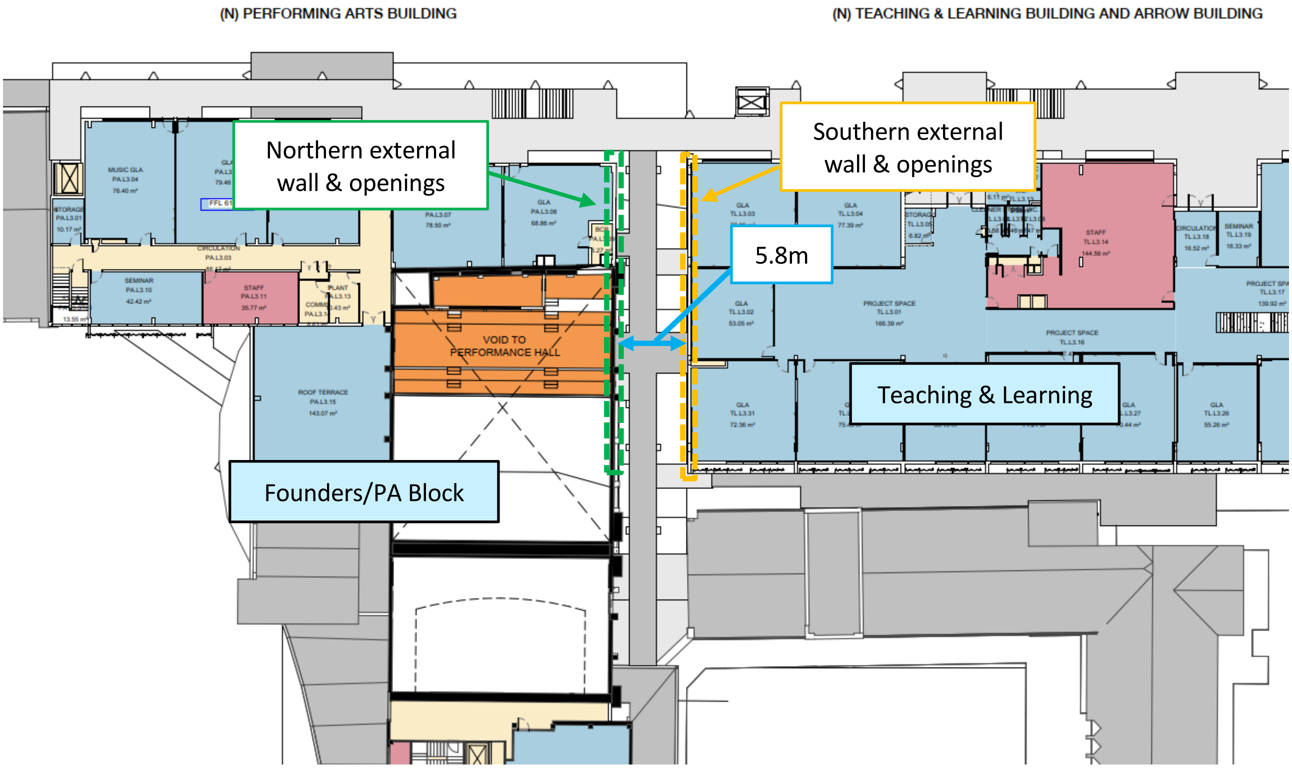


Figure 7.2: T&L and Founders/PA fire compartments (L3 shown – L1 & L2 similar)

7.2 Performance Solution

In accordance with the BCA Clause A2.2 *Performance Solution* the following assessment method has been adopted to demonstrate that the *Performance Solution* has met the relevant *Performance Requirements of CP2.*

Table 7.1: Method of Analysis

Identified Design Issues	Performance Solution	AFEG Method of Analysis
It has been identified that the southern wall & openings of the Teaching & Learning block at L0 to L3 are situated approximately 5.8m from the northern wall & openings of the Founders/PA block without being protected in accordance with Clause C3.4.	A2.2(2)(b)(ii) Other *Verification Methods*, accepted by the *appropriate authority* that show compliance with the relevant *Performance Requirements.*	A qualitative & quantitative 'deterministic' approach demonstrating that the proposed design satisfies the *Performance Requirements* of the BCA.

7.3 Hazards Specific to Separation of External Walls & Associated Openings in Different Fire Compartments

The 'Guide to the BCA' (ABCB, 2019) states that the intent associated with prescribing minimum setback distance between openings of different fire compartments as being *"To limit the spread of fire between fire compartments through external walls and openings in them".* It is therefore considered that the main hazard associated with the identified design issue relates to:

- The potential for fire to spread to/from adjacent fire compartments via unprotected openings and walls.

7.4 Hazard Mitigation

The 'Guide to the BCA' (ABCB, 2019) identifies the potential for fire to spread as a result of unprotected openings/walls associated with different fire compartments being situated within minimum setback distances. In this regard, the following hazard mitigation systems, requirements and features of the design are noted:

- The openings serving the T&L building and Founders/PA block shall be situated within 5.8m in lieu of 6.0m from each other and remain unprotected; and
- Automatic smoke detection shall be provided throughout all buildings of the Stage 3-5 portion in accordance with AS1670.1:2018 and as outlined herein.

7.5 Methodology

The methodology adopted to address the design issue relative to openings in adjacent fire compartments has been based upon a quantitative 'deterministic' evaluation.

The quantitative aspect of the evaluation has conducted a radiant heat exposure analysis based on the size & location of glazed openings to determine the potential for fire spread between adjacent fire compartments. The potential for fire spread shall be calculated utilising a radiant heat transfer calculation (Drysdale, 1999) (refer to Appendix E for further details of the radiant heat transfer methodology):

Radiant Heat Transfer: $q_r = \emptyset \sigma \varepsilon T_f^4$ [1]

where,

q_r = radiant heat flux level (kW/m^2)

$\emptyset$ = configuration factor

σ = Stefan-Boltzman constant (5.68 x 10^{-8} W/m^2/K^4)

ε = emissivity of the fire source (0.9, Drysdale 1999)

T = Temperature (900°C sprinkler failure fire scenario)

7.6 Acceptance Criteria

The quantitative acceptance criterion has been met by demonstrating that the radiant heat flux levels emitted/received by the adjacent fire compartments are less than 20kW/m^2 which is the minimum radiant heat flux required to ignite curtain material in the absence of a spark (i.e. non-piloted ignition).

7.7 Quantitative Evaluation

As identified above, the external wall/openings serving the Teaching and Learning Building is situated within 6.0m (5.8m) of the external wall/openings serving the Founders/PA Block. As the separation between adjacent fire compartments is less than the minimum prescribed distance of 6m there is the potential for fire spread to occur between the adjacent fire compartments. Figure 7.3 depicts a worst-case (i.e. largest openings) configuration/arrangement of fire source features associated with adjacent fire compartments.

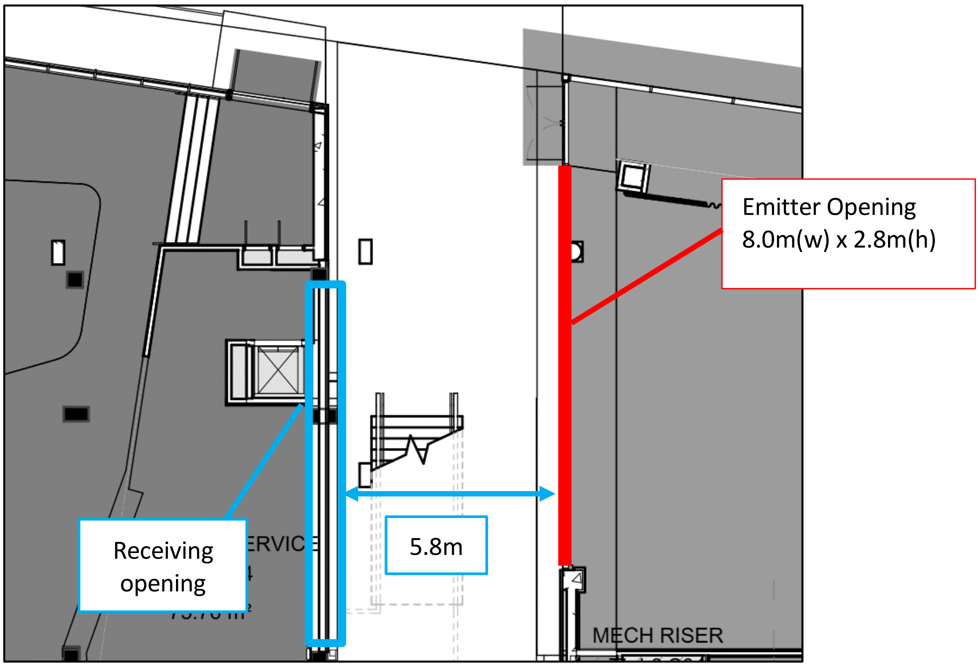


Figure 7.3: Fire source feature configuration (L0 T&L building)

From the input parameters identified in Section 7.5, the radiant heat flux calculation as detailed in Appendix E has been utilised to calculate the radiant heat flux levels emitted/received by the adjacent fire compartments. Table 7.2 provides a summary of the results.

Table 7.2: Summary of results

Opening ID	Dimensions	Setback	Temperature	Emissivity	Radiant Heat Flux Level Emitted	Acceptance Criteria Satisfied
T&L Library opening	8.0m (w) x 2.8m (h)	5.8m	900°C	0.9	15.31 kW/m^2	YES

From the results presented above, the radiant heat flux levels emitted/received from the adjacent fire compartments are calculated to be up to 15.31kW/m^2. This is noted to be less than the stated acceptance criterion of 20kW/m^2 to result in fire spread to ignite curtain material in the absence of a spark (i.e. non-piloted ignition). The calculated radiant heat flux levels are also noted to be significantly less than the criteria of 40-20kW/m^2 for distances ranging between 2m-6m as set out in Column 2 of Table CV2.

Based on the quantitative analysis undertaken above it is therefore concluded that the potential for fire spread as a result of radiant heat transfer is suitably mitigated by virtue of the 5.8m setback distance. Therefore, the openings situated within 6m (5.8m) between fire compartments can remain unprotected.

7.8 Discussion of Assessment Outcome

With regards to the separation between the T&L Building and Founders/PA block, the evaluation undertaken above has considered the potential for fire spread between adjacent fire. The quantitative analysis calculated radiant heat flux levels received by adjacent fire compartments to range up to 15.31 kW/m^2 which was significantly less than the acceptance criterion of 20kW/m^2. As such it was determined that suitable setback distance of 5.8m between fire compartments was provided to mitigate fire spread as a result of radiant heat transfer.

Based on the rationale presented above it is therefore considered that the proposed design satisfies the Performance Requirement of CP2 of the BCA. This conclusion is contingent on the requirements detailed in Section 15.2 being implemented into the design.

8. Fire Wall separation of Existing Sports Building

8.1 Background to the Issue

It has been identified that the proposed configuration of the intersection incorporating the existing sports/science/aquatic blocks and the new Agora and T&L portions shall not be provided with a full-height fire wall as a result of the incorporation of glazed openings, including a tilt-up glazed door. It is further noted that this dividing wall separates the sprinkler-protected T&L building/Carpark from the existing non-sprinkler protected Sports/Science/Aquatic block. The proposed design forms a deviation from Clause C2.7 of the BCA which prescribes the subject wall be a fire wall.

The glazed openings shall be located directly adjacent to the Agora portion which shall primarily incorporate circulation/thoroughfare space. Substantial ventilation is also available at this located. Refer to Figure 8.1 to Figure 8.2 for the subject configuration.

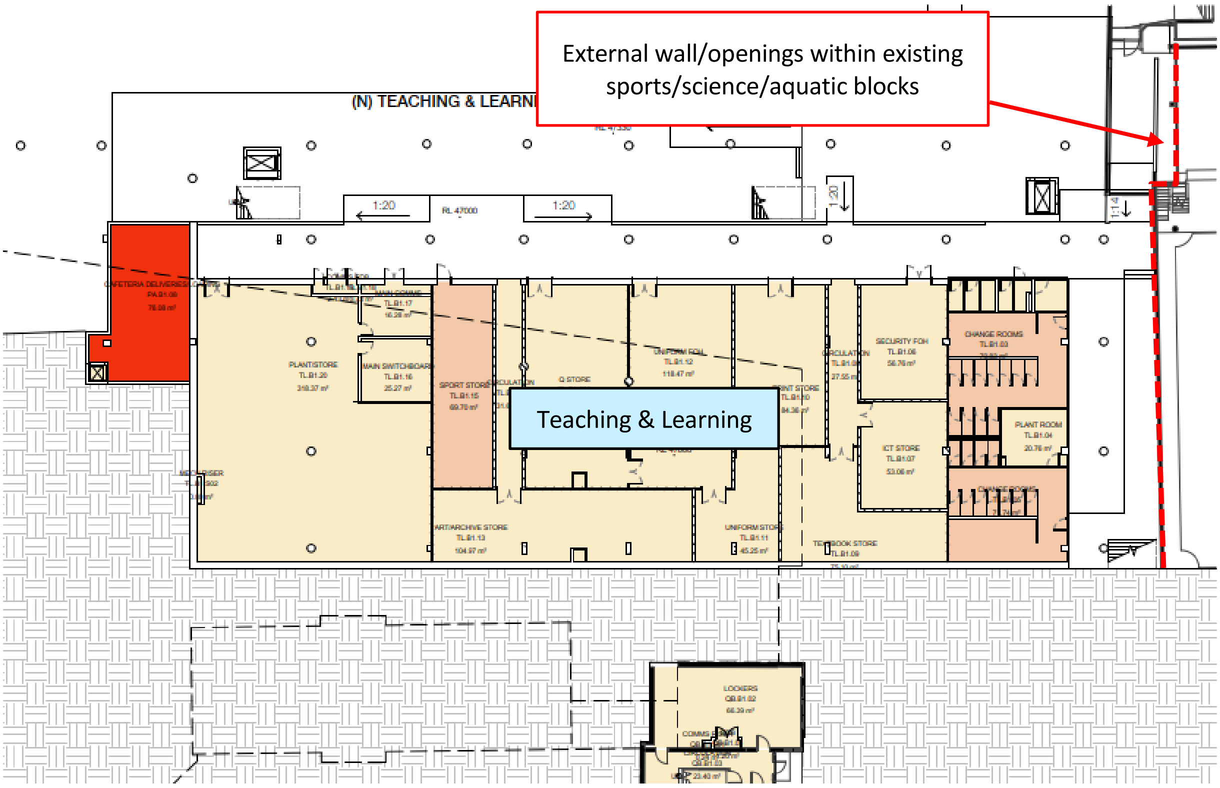


Figure 8.1: T&L and existing fire compartments (B1)

Figure 8.2: 3D Architectural Render of the proposed Agora Intersection with Sports Building

8.2 Performance Solution

In accordance with the BCA Clause A2.2 *Performance Solution* the following assessment method has been adopted to demonstrate that the *Performance Solution* has met the relevant *Performance Requirements of CP2.*

Table 8.1: Method of Analysis

Identified Design Issues	Performance Solution	AFEG Method of Analysis
It has been identified that the Teaching & Learning block abuts the existing Sports/Science/Aquatic blocks without being provided with a full-height fire wall which complies with Clause C2.7 as a result of glazed openings within the dividing wall. It is further noted that this dividing wall separates the sprinkler-protected T&L building/Carpark from the existing non-sprinkler protected Sports/Science/Aquatic block. It has also been identified that there are unprotected glazed openings forming part of the T&L block which are configured in a parallel orientation and within 6m of the subject dividing wall.	A2.2(2)(b)(ii) Other *Verification Methods*, accepted by the *appropriate authority* that show compliance with the relevant *Performance Requirements.*	A qualitative & quantitative 'deterministic' approach demonstrating that the proposed design satisfies the *Performance Requirements* of the BCA.

8.3 Hazards Specific to Fire Wall Separation of existing Sports Building

The 'Guide to the BCA' (ABCB, 2019) states that the intent associated with prescribing minimum setback distance between openings of different fire compartments as being *"To limit the spread of fire between fire compartments through external walls and openings in them".* It is therefore considered that the main hazard associated with the identified design issue relates to:

- The potential for fire to spread to/from adjacent fire compartments via unprotected openings and walls.

8.4 Hazard Mitigation

The 'Guide to the BCA' (ABCB, 2019) identifies the potential for fire to spread as a result of unprotected openings/walls associated with different fire compartments being situated within minimum setback distances. In this regard, the following hazard mitigation systems, requirements and features of the design are noted:

- Automatic smoke detection shall be provided throughout all buildings of the Stage 3-5 portion in accordance with AS1670.1:2018 and with the inclusion of the following:
  - Additional detectors shall be installed within the sports building within 1.5m of tilt glass panel at distances no greater than 10m along the width of the tilt panel. Activation of these detectors shall activate the EWIS within the T&L building; and
- It is proposed to omit the protection specified in above to the 'tilt-up' glazed door within the wall separating the Agora space and the sports centre building. It is proposed that this door remain unprotected; and
- The Sports/Science/Aquatic building portion located adjacent to the subject Agora portion shall be utilised as a basketball court. The subject basketball court is considered to be a very low fire hazard area as a result of the absence of any significant fuel loads within this space. Refer to Figure 8.3.

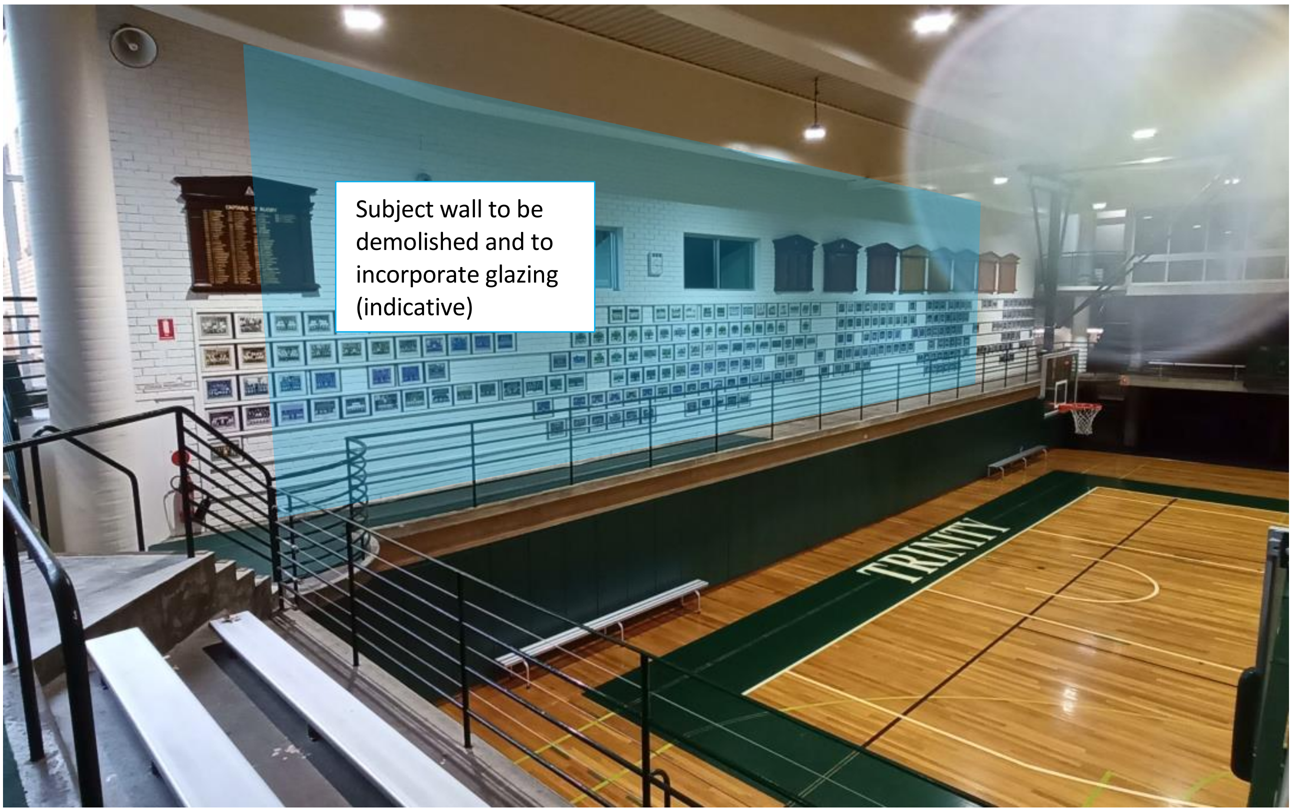


Figure 8.3: Existing condition of Sports Building portion

8.5 Methodology

The methodology adopted to address the design issue relative to fire wall separation of the existing sports building from the Agora has been based upon a qualitative evaluation. The qualitative aspect has considered the different compartments with respect to the function/use, fire hazard and proposed ventilation available within the Agora area. Specifically, the fuel loads within both the Agora and sports building has been considered in relation to the risk of fire spread across this glazed barrier, with further consideration to the voids above the Agora portion providing the ability for smoke to vent directly to atmosphere.

8.6 Acceptance Criteria

The basic objective and intent of the analysis pertains to fire spread between adjacent fire compartments. Thus, the primary acceptance criterion has been met by demonstrating that the external nature of this agora area and the low fuel loads of the subject areas can mitigate the risk of fire spread between separate fire compartments.

8.7 Qualitative Evaluation

8.7.1 Agora Portion

It has been identified that the new agora space of the Teaching & Learning block abuts the existing sports/science/aquatic blocks. In this instance, it has been identified that there are non-protected openings as follows:

- L0: tilt-up glazed door between the agora and existing sports centre (refer to Figure 8.4)
- L2-L4: glazed openings configured in a parallel orientation and situated within 6m of the Sports building (refer to Figure 8.5)

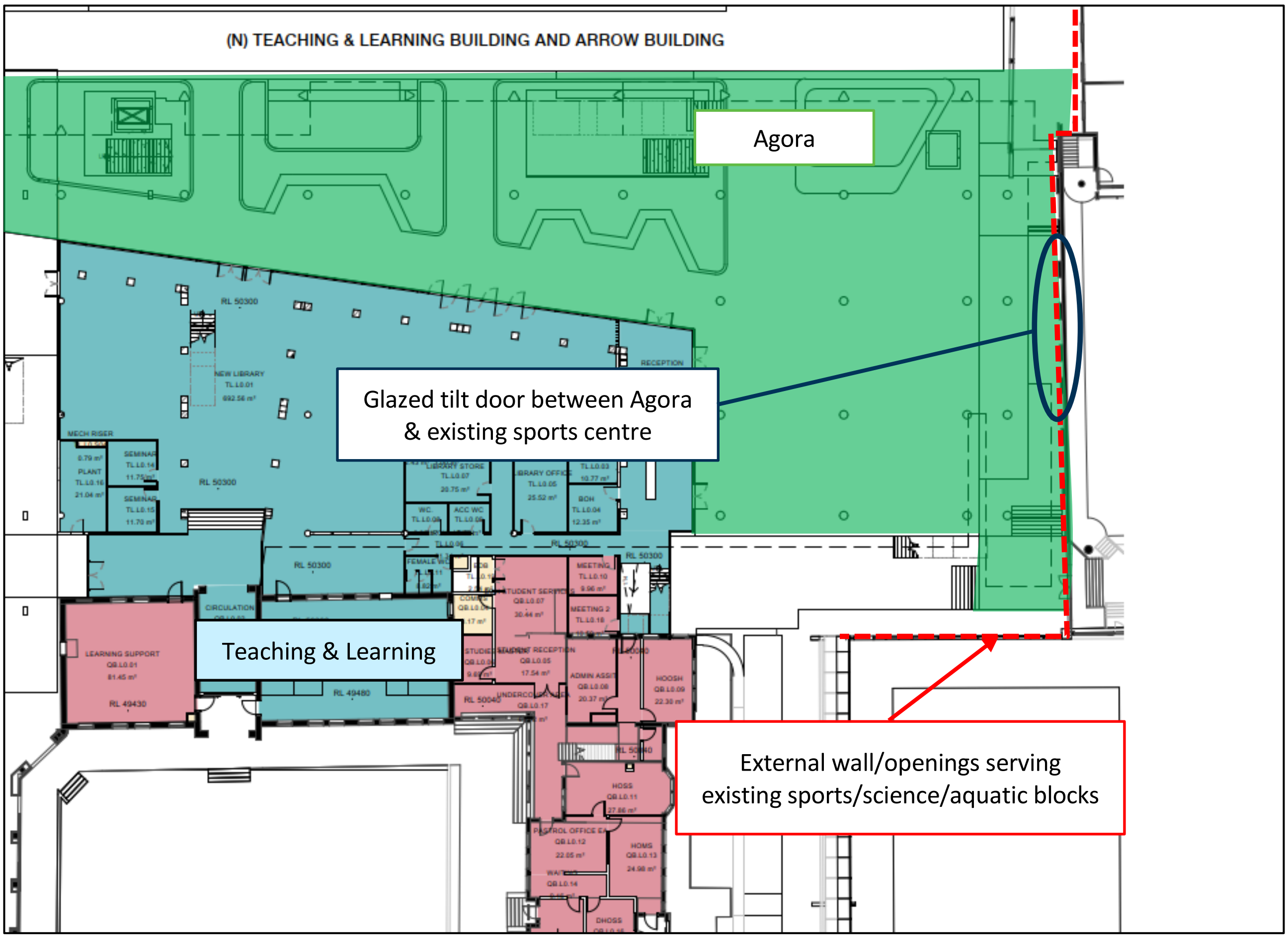


Figure 8.4: T&L and existing fire compartments (L0)

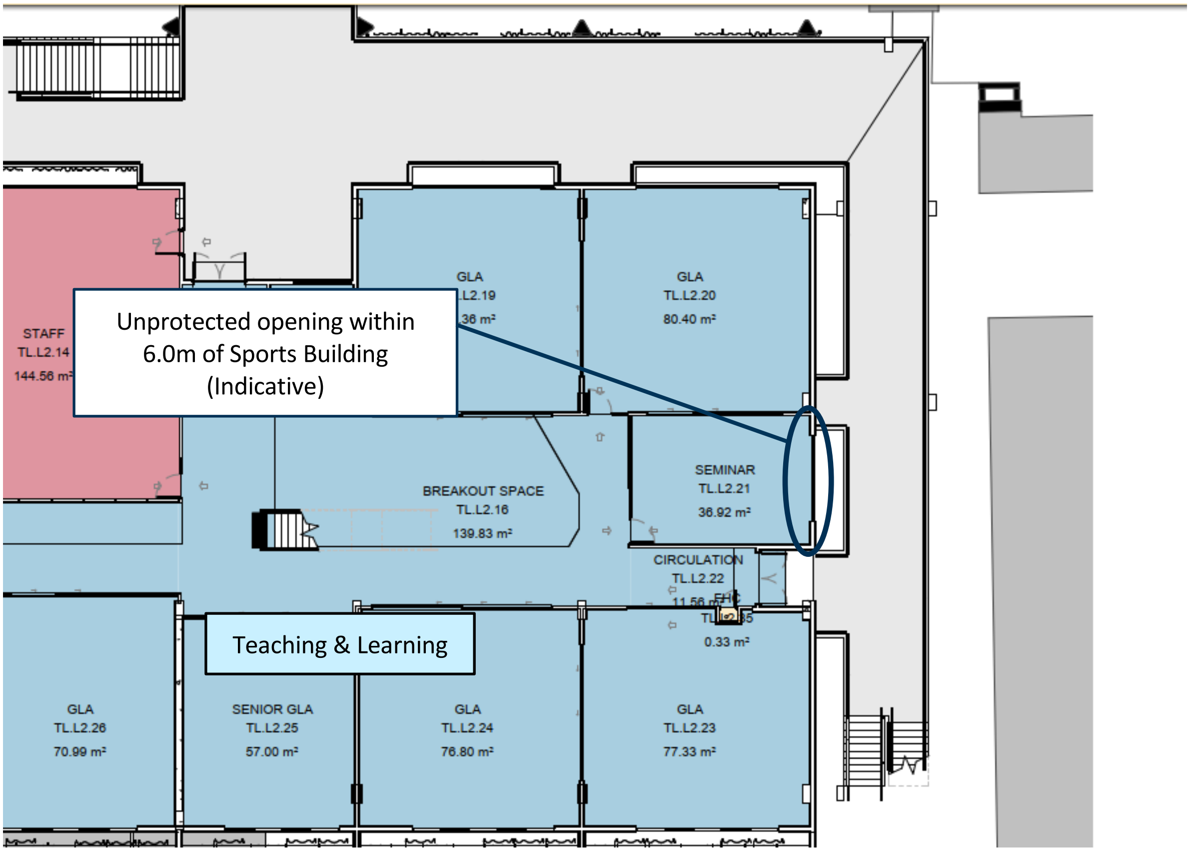


Figure 8.5: T&L unprotected openings within 6m of Sports building (L2 shown)

It is noted that the Arrow Building shall function as an external walkway structure which connects both new precincts and existing buildings. The Arrow building also allows students to circulate around the campus without the need to enter the building(s). In this instance, it can be said that the Arrow building is of transient nature. The Agora portion shall furthermore be utilised primarily as a thoroughfare/circulation space and shall also incorporate tiered seating which shall be non-combustible and therefore not contribute to a potential fuel load.

Accordingly, with the functionality of these areas being circulation spaces/walkway, it shall be noted that there shall be minimum fuel load present within the area. Therefore, the likelihood of fire ignition or spread via this space is considered to be low.

It was also noted that the Agora portion is afforded with a substantial amount of natural ventilation due its open/external nature, with the adjacent L0 Agora portion also consisting of a double volume space. In this instance of a fire within this space, hazardous smoke can naturally ventilate into the atmosphere via the openings available, thus providing tenable conditions to evacuating occupants.

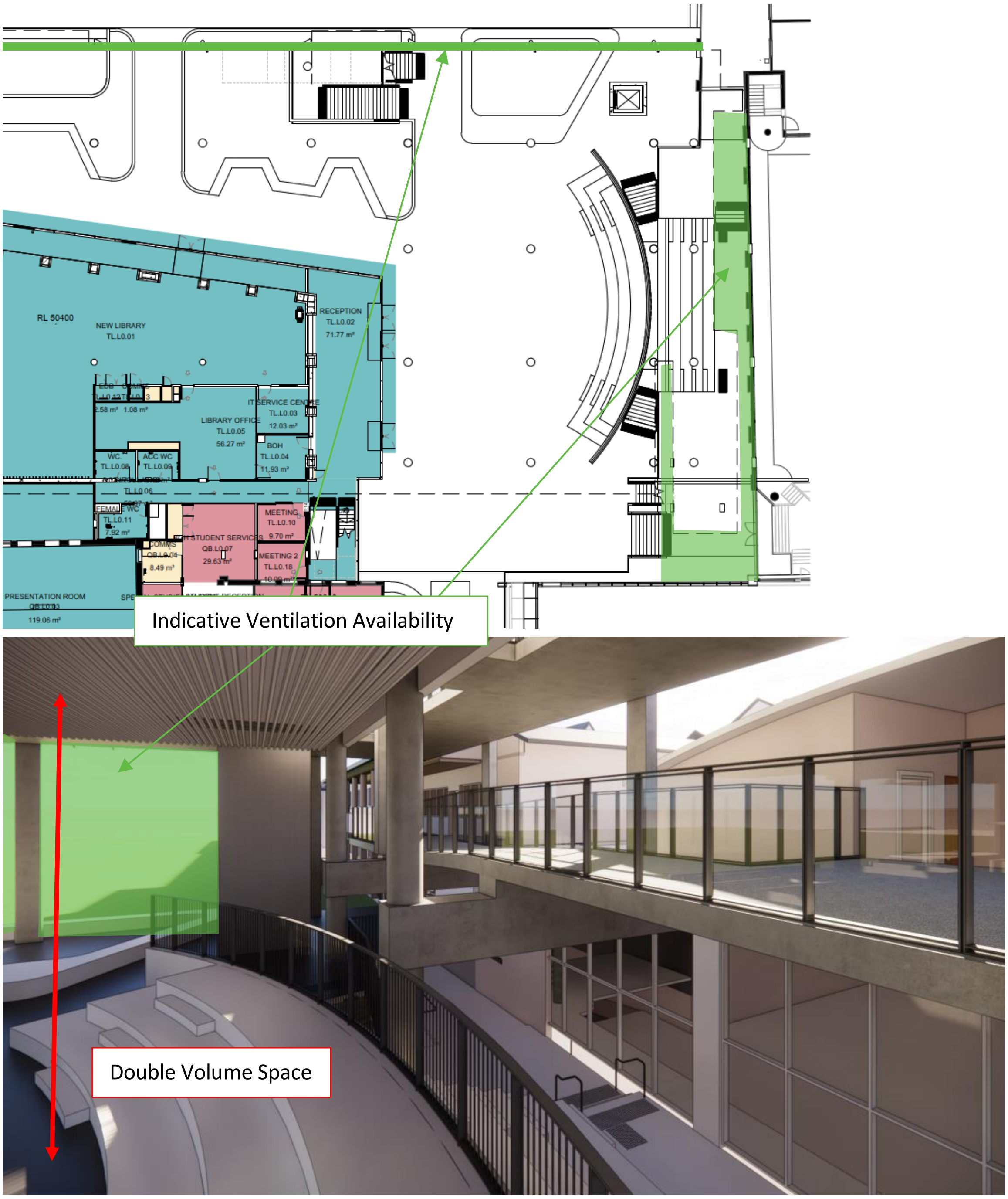


Figure 8.6: 3D Architectural Render of the proposed Agora Intersection with Sports Building

Furthermore, the colonnade thoroughfare area leading to the Junior School Link portion is provided with substantial ventilation at high level and significant separation distance between these sprinkler-protected and non-sprinkler protected areas. Accordingly, the risk of smoke spread to/from the Junior School portion is considered to be suitably mitigated as smoke would generally be expected to vent to atmosphere in the event of a fire within these adjacent portions. Furthermore, the use of this colonnade space being circulation space/thoroughfare shall mitigate the risk of fire ignition or spread within this space.

Figure 8.7: Architectural Render of the proposed Colonnade link to the Junior School portion

With regards to the glazed tilt door separating the existing sports building from the Agora portion (refer to Figure 8.8), additional smoke detectors shall be installed within the sports building within 1.5m of tilt glass panel at distances no greater than 10m along the width of the tilt panel. In the instance of a fire within either the Agora or within the existing sports building, the detectors shall activate the EWIS connected within the T&L building providing occupants with an early notification.

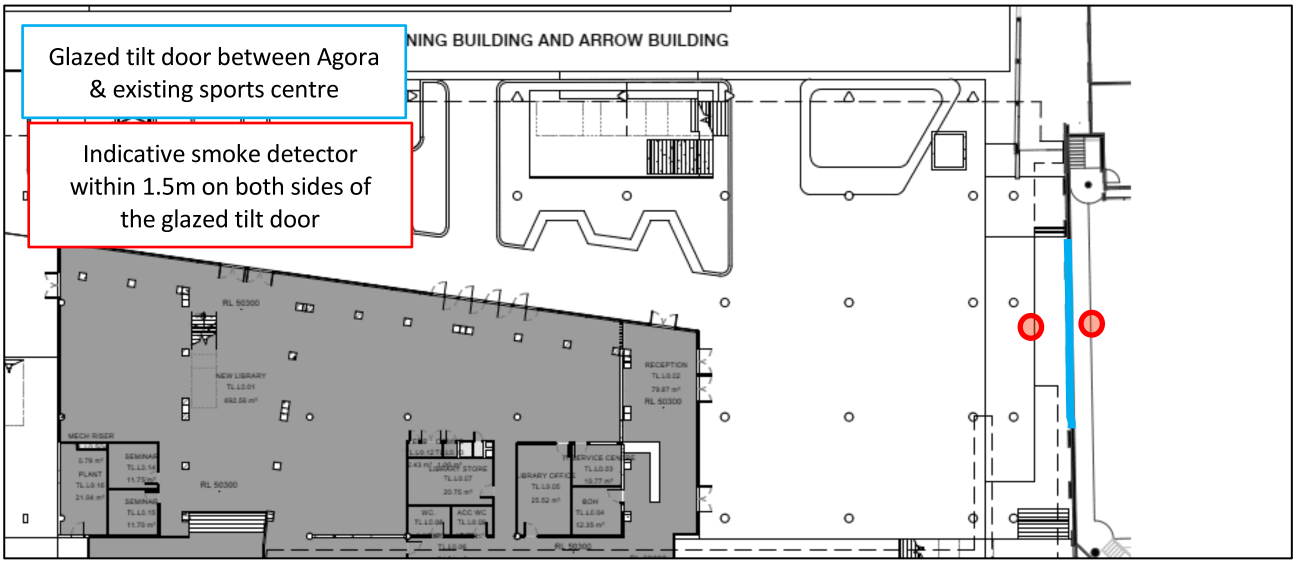


Figure 8.8: Indicative smoke detection and alarm system location serving the glazed tilt door

8.7.2 Sports Building portion

As noted above, the sports building portion located adjacent to the subject glazed openings shall be utilised as a basketball court (refer to Figure 8.9. The hazards that pertain to this building are no different to any other indoor porting complex comprising basketball courts. The basketball court areas are essentially sterile wet areas with timber floors and an open court environment. The court areas do not contain any significant ignition sources (limited to light fitting etc.) or fuel loads (limited to bags, towels etc.). They are essentially sterile areas with presence of low fire hazards as there are limited fuel loads and ignition sources. The main fuel loads that may be present would be sports equipment, hard plastics, rubber mats and foam (padded seating). The activities on the basketball courts are identified as non-hazardous activities. It also should be noted that during the periods when the courts area cleaned and/or maintenance work is carried out, the courts are not expected to be utilised.

The combustible content within the areas of concern are identified as follows:

- Towels
- Storage of chairs
- Clothing
- Carry-bags and packs
- Rubbish bins

It should also be noted that the proposed building is a non-smoking venue and therefore the risk of fire ignition caused by a discarded or misplaced cigarette is considered to be negligible.

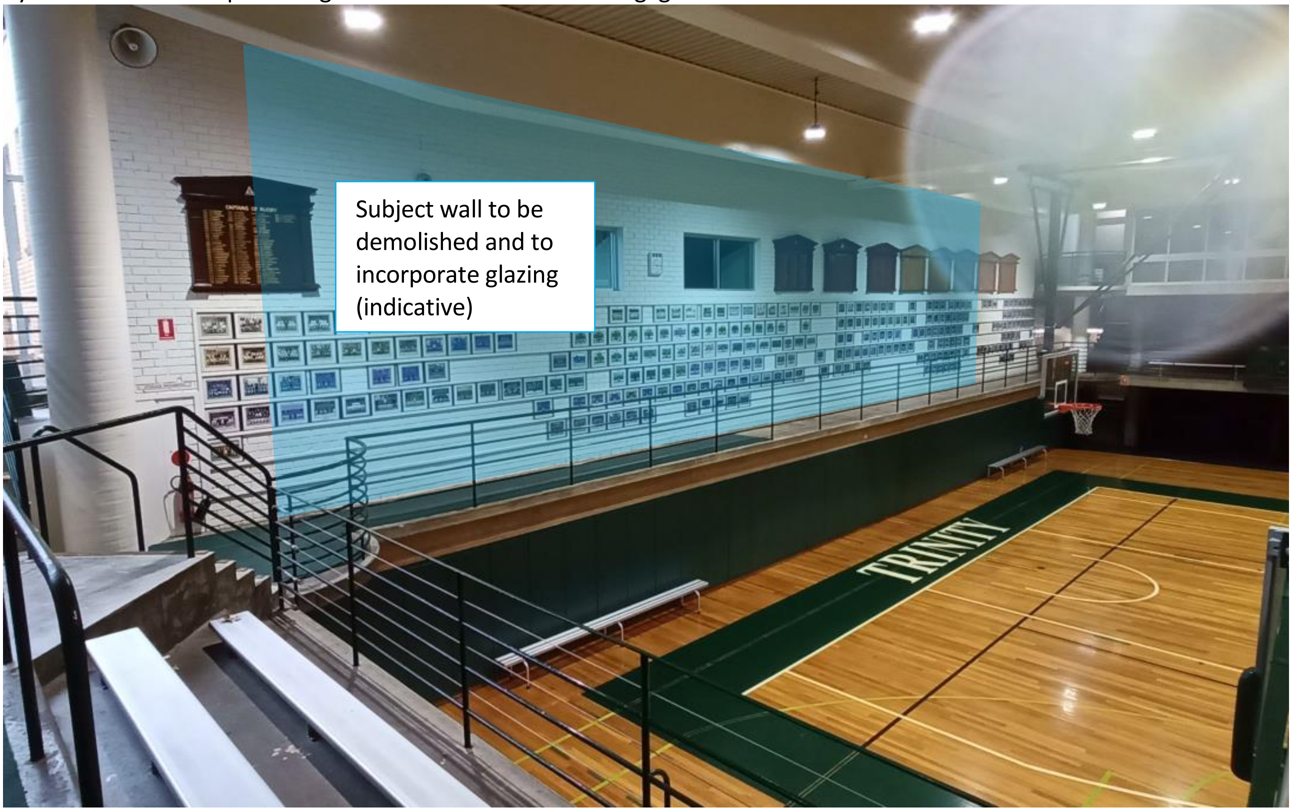


Figure 8.9: Existing condition of Sports Building portion

8.8 Discussion of Assessment Outcome

With regards to the separation between the Agora from the existing sports building, the qualitative evaluation has considered the transient and sterile nature of both areas directly adjacent to the fire wall to be of low fire risk. In the event of a fire, then open nature of the agora building can naturally ventilate hazardous smoke into the atmosphere, providing evacuating occupants with tenable conditions. Furthermore, the provisions of smoke detectors to both sides of the glazed tilt panel separating the existing sports building from the agora can provide occupants with an early notification in the instance of a fire.

Based on the rationale presented above it is therefore considered that the proposed design satisfies the Performance Requirement of CP2 of the BCA. This conclusion is contingent on the requirements detailed in Section 15.2 being implemented into the design.

9. Exit Travel Distance

9.1 Background to the Issue

Based on the existing and proposed floor plate configuration, it has been identified that the distance of travel to a point of choice, to an exit and between alternative exits from the most disadvantaged locations within the identified buildings do not comply with the DtS provisions of the BCA.

As part of the assessment, it is proposed to permit travel distances as per the following:

Teaching & Learning Precinct:

Basement Level 1

- It is proposed to permit a travel distance to a point of choice of up to 26m in lieu of 20m; and
- It is proposed to permit a travel distance to an exit where two exits are available of up to 67m in lieu of 40m; and
- It is proposed to permit a distance of travel between alternative exits of up to 97m in lieu of 60m (where measured through the point of choice).

Level 2

- It is proposed to permit a travel distance to an exit where two exits are available of up to 47m in lieu of 40m; and
- It is proposed to permit a distance of travel between alternative exits of up to 75m in lieu of 60m.

Level 3

- It is proposed to permit a travel distance to a point of choice of up to 26m in lieu of 20m; and
- It is proposed to permit a travel distance to an exit where two exits are available of up to 42m in lieu of 40m.

Level 4

- It is proposed to permit a travel distance to a point of choice of up to 30m in lieu of 20m.

Performing Arts Precinct:

Basement Level 2

- It is proposed to permit a travel distance to a point of choice of up to 25m in lieu of 20m; and

Level 1

- It is proposed to permit a travel distance to a point of choice of up to 23m in lieu of 20m; and

Level 3

- It is proposed to permit a travel distance to a point of choice of up to 21m in lieu of 20m; and
- It is proposed to permit a travel distance to an exit where two exits are available of up to 45m in lieu of 40m.

Level 4

- It is proposed to permit a travel distance to a single exit of up to 45m in lieu of 40m within the roof plant area.

This is noted to form a deviation from Clause D1.4 & Clause D1.5 of the BCA which prescribes a maximum travel distance of travel to a point of choice to be no more than 20m, to an exit where two exits are available no more than 40m, and between alternative exits of no more than 60m. Figure 9.1 to Figure 9.8 illustrates the indicative locations where the egress provisions do not meet the DtS provisions of the BCA.

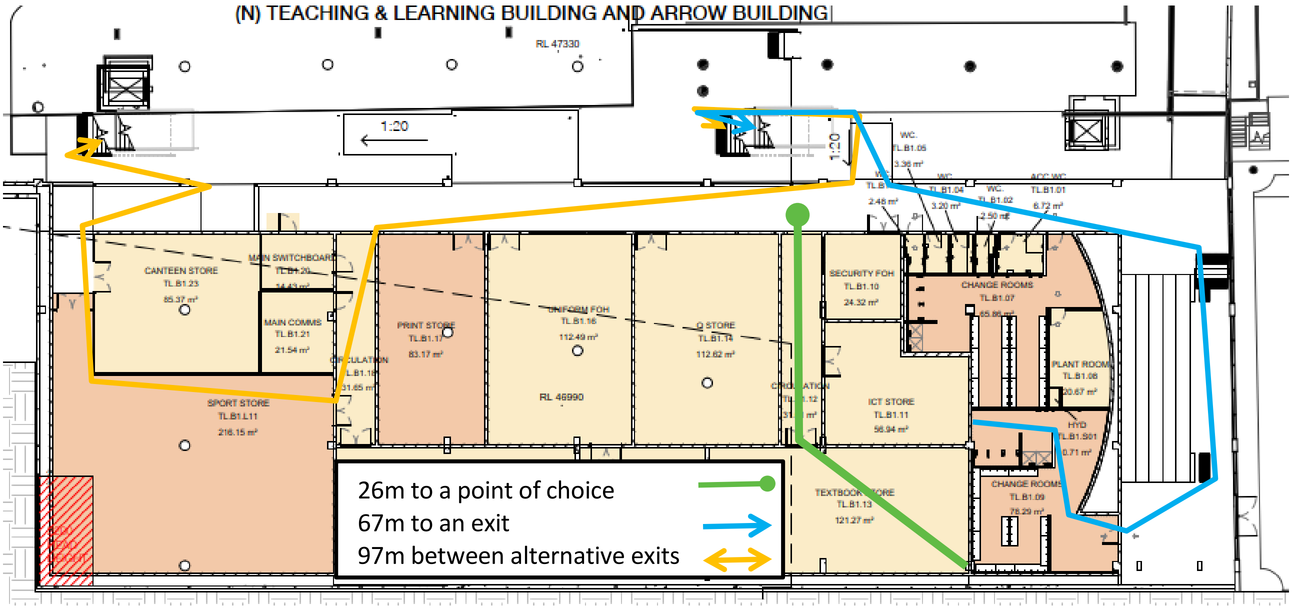


Figure 9.1: Extended Travel Distance within T&L Precinct (Level B1)

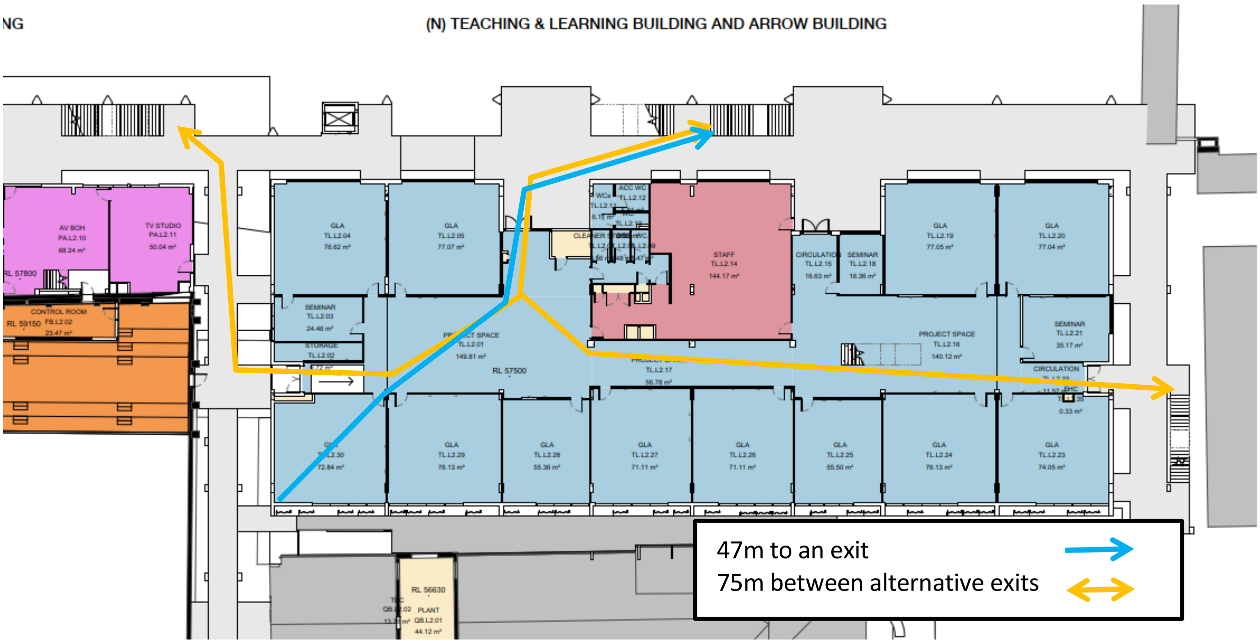


Figure 9.2: Extended Travel Distance within T&L Precinct (Level L2)

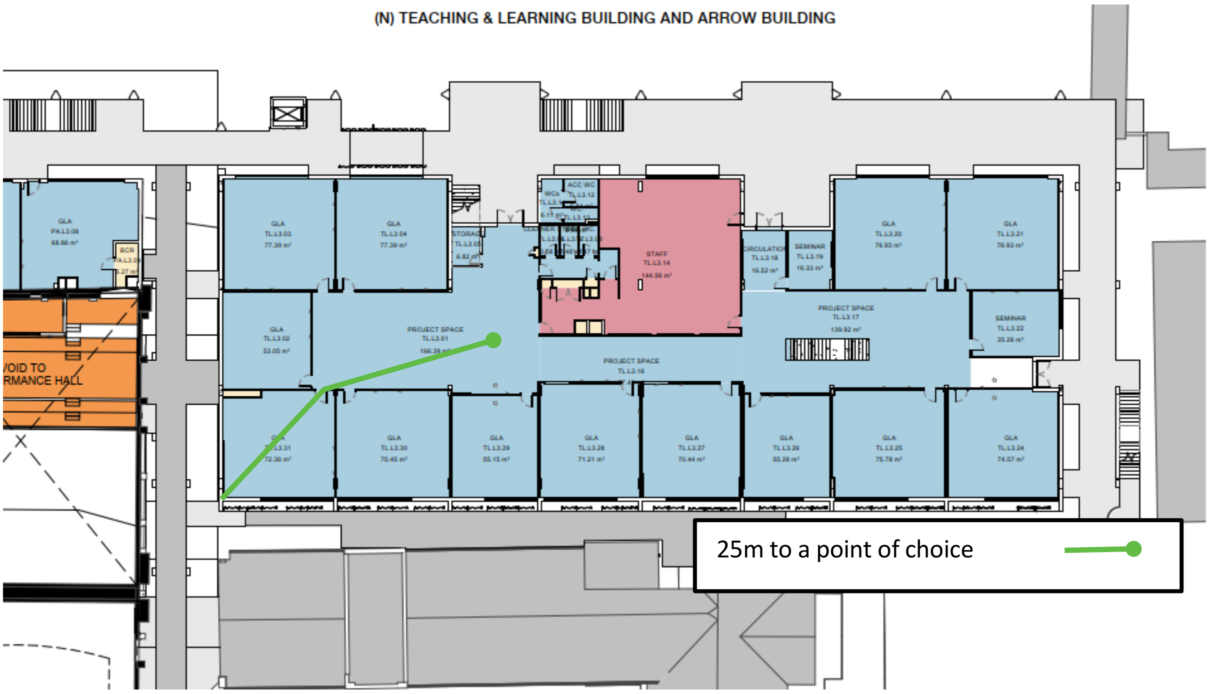


Figure 9.3: Extended Travel Distance within T&L Precinct (Level L3)

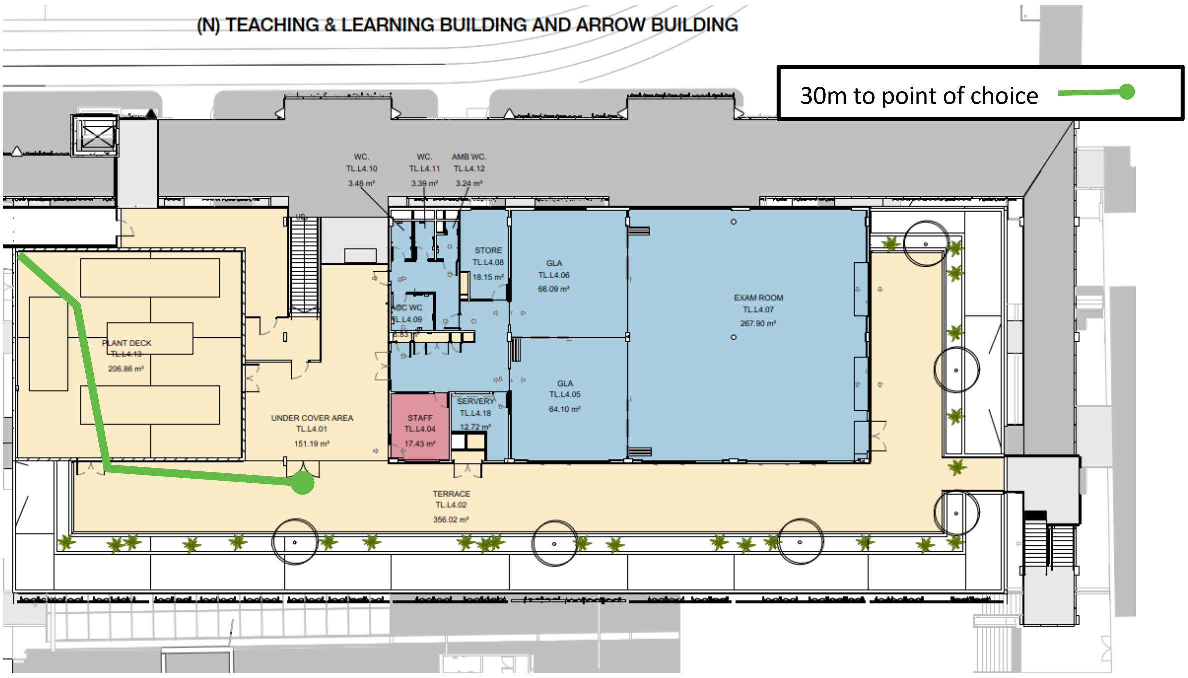


Figure 9.4: Extended Travel Distance within T&L Precinct (Level L4)

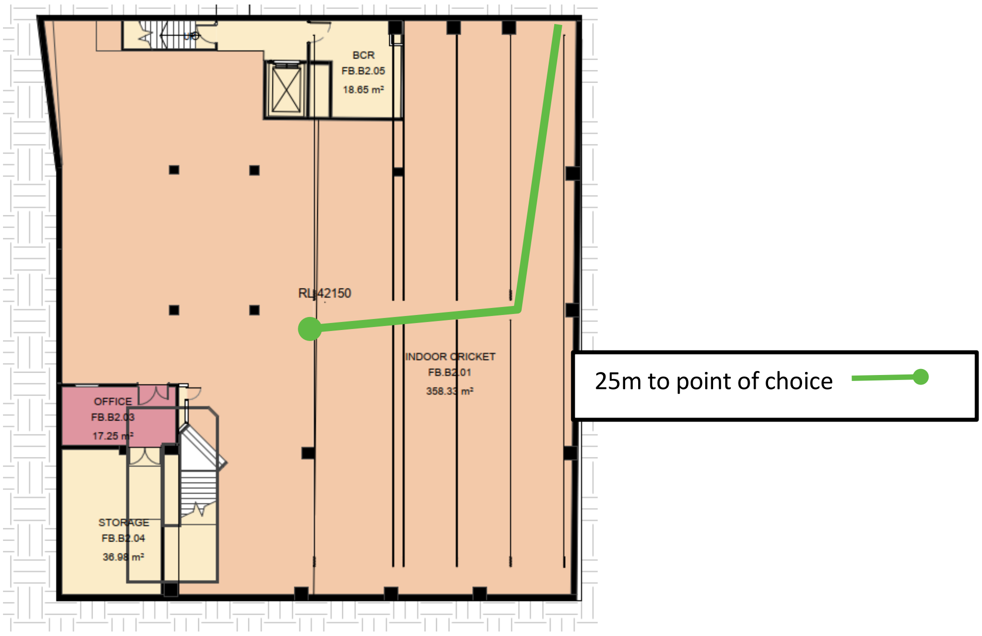


Figure 9.5: Extended Travel Distance within Performing Arts Precinct (Basement Level 2)

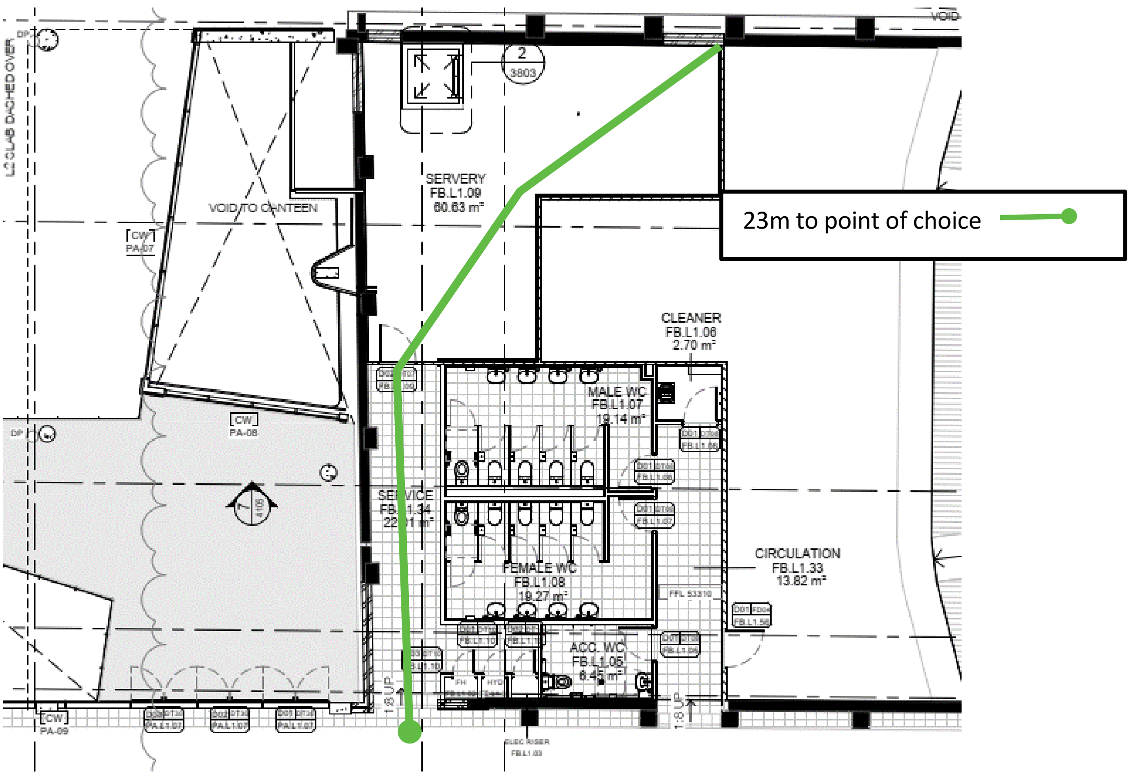


Figure 9.6: Extended Travel Distance within Performing Arts Precinct (Level 1)

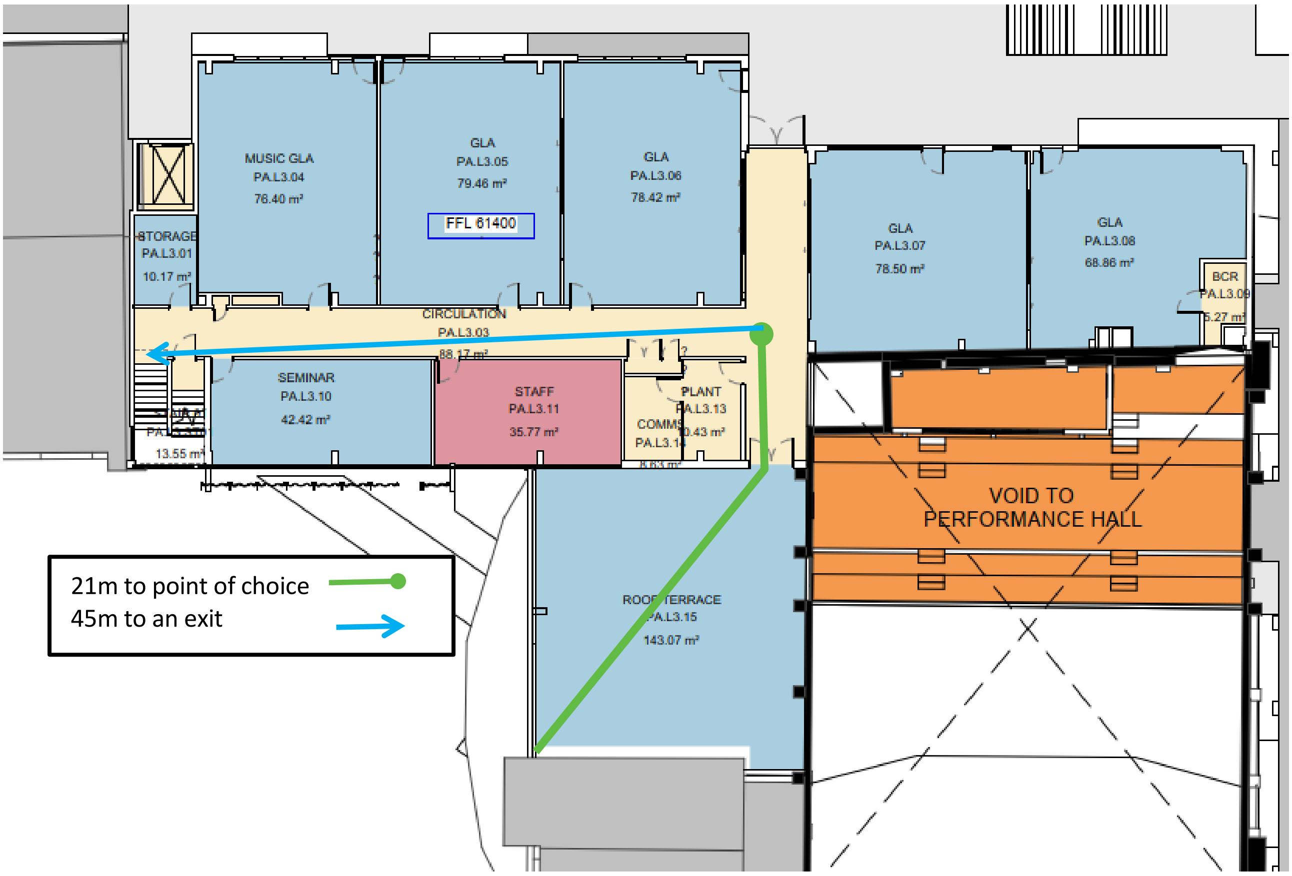


Figure 9.7: Extended Travel Distance within Performing Arts Precinct (Level 3)

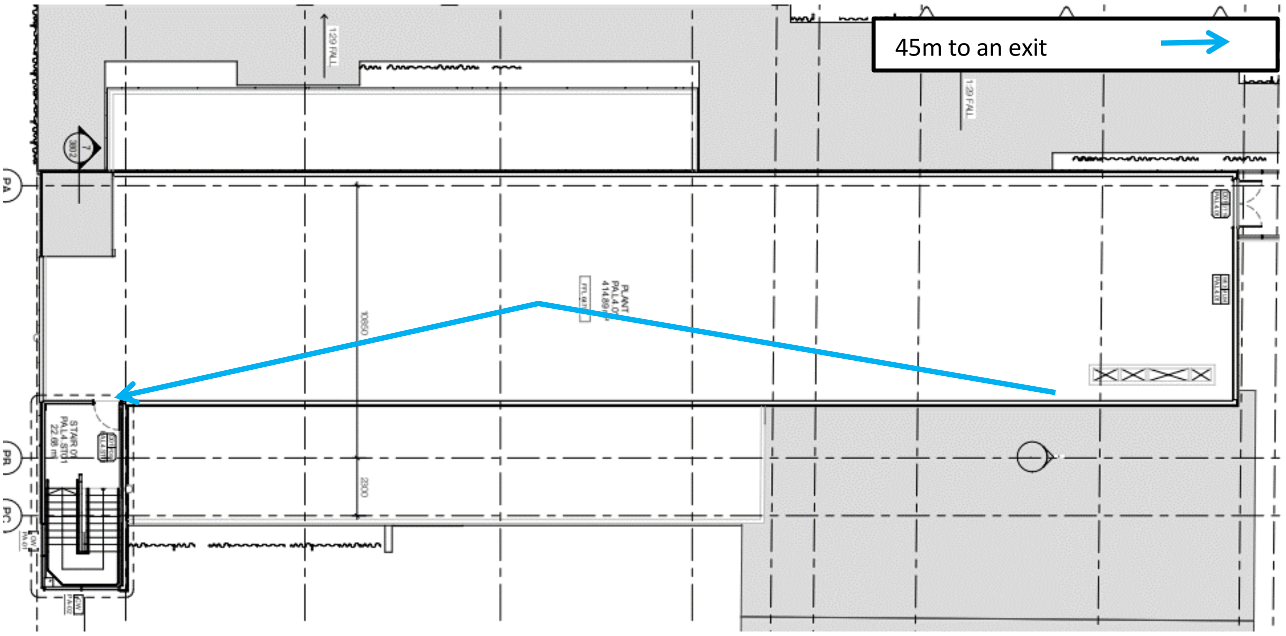


Figure 9.8: Extended Travel Distance within Performing Arts Precinct – Rooftop Plant (Level 4)

9.2 Performance Solution

In accordance with the BCA Clause A2.2 *Performance Solution,* the following assessment method has been adopted to demonstrate that the *Building Solution* has met the relevant *Performance Requirement of DP4, DP5 & EP2.2.*

Table 9.1: Methods of Analysis

Identified Design issue	Performance Solution	AFEG Method of Analysis
It is proposed to permit extended travel distances within various portions of the building as follows: **Teaching & Learning Precinct:** *Basement Level 1* • It is proposed to permit a travel distance to a point of choice of up to 26m in lieu of 20m; and • It is proposed to permit a travel distance to an exit where two exits are available of up to 67m in lieu of 40m; and • It is proposed to permit a distance of travel between alternative exits of up to 97m in lieu of 60m. *Level 2* • It is proposed to permit a travel distance to an exit where two exits are available of up to 47m in lieu of 40m; and • It is proposed to permit a distance of travel between alternative exits of up to 75m in lieu of 60m. *Level 3* • It is proposed to permit a travel distance to a point of choice of up to 26m in lieu of 20m; and • It is proposed to permit a travel distance to an exit where two exits are available of up to 42m in lieu of 40m. *Level 4* • It is proposed to permit a travel distance to a point of choice of up to 30m in lieu of 20m. **Performing Arts Precinct:** *Basement Level 2* • It is proposed to permit a travel distance to a point of choice of up to 25m in lieu of 20m; and *Level 1* • It is proposed to permit a travel distance to a point of choice of up to 23m in lieu of 20m; and *Level 3* • It is proposed to permit a travel distance to a point of choice of up to 21m in lieu of 20m; and • It is proposed to permit a travel distance to an exit where two exits are available of up to 45m in lieu of 40m. *Level 4* • It is proposed to permit a travel distance to a single exit of up to 45 m in lieu of 40m within the roof plant area.	A2.2(d) Comparison with the *Deemed-to-Satisfy Provisions*.	A qualitative & quantitative 'comparative' approach to demonstrate that the proposed design is at least equivalent to a DtS building solution.

9.3 Hazard Specific to the Distance of Travel to an Exit

The Guide to the BCA (ABCB, 2019) states that the intent behind providing a maximum travel distance of 40m to reach an exit is *"To maximise the safety of occupants by enabling them to be close enough to an exit to safely evacuate."* With respect to the intent behind providing a maximum travel distance between exits of 60m is "*To* ensure that *if an exit is inaccessible, access to any required alternative exit is available within a reasonable distance* and more specifically *to minimise the need for occupants to travel to far to an exit".*

It is therefore, considered that the main hazards specific to the design issues requiring assessment are:

- Increase in travel time associated with the additional distance of travel; that is time to evacuate will be increased from that of the BCA prescriptive design.
- Increase in potential obstructions within the path of travel to the alternative exit within the path of travel.
- Potential for fire by-products (smoke and toxic gasses) to restrict the path of travel where distance of travel is extended (i.e. potential for tenability limits to be exceeded within the path of travel).
- Increase in travel time associated with the additional distance of travel to an alternative exit after already travelling in the direction to an exit; that is time to evacuate will be increased from that of a prescriptive design.

9.4 Hazard Mitigation

The 'Guide to the BCA' (ABCB, 2019) identifies the potential for occupants to encounter unsafe conditions whilst they evacuate from the building and hence prescribes *"what is a reasonable distance for occupants to travel to an exit".* In this regard the following hazard mitigation systems, requirements and features of the design are noted:

- Automatic sprinkler protection shall be provided throughout the building in accordance with BCA Clause E1.5, Specification E1.5 and AS2118.1:2017 with the inclusion of the following:
  - Automatic sprinkler protection shall be installed to the following building locations:
    - Teaching & Learning (incl. Quadrangle building); and
    - The underside of the Level 2 slab located above the Agora portion of the building shall be provided with sprinkler protection; and
    - Arrow Building (external walkways); and
    - Music Building; and
    - Performance Arts (incl. cafeteria & assembly hall); and
    - Founders Building; and
  - Sprinkler heads shall be fast response type heads having an actuation temperature of not greater than 68°C and RTI of not greater than $50m^{-0.5}s^{-0.5}$; and
  - Activation of the sprinkler system shall initiate a General Fire Alarm (GFA) throughout the Trinity Grammar School campus; and
  - Omit the requirement to provide automatic sprinkler protection within main switch rooms within the Teaching & Learning and Performing Arts/Founders Buildings; and
- Automatic smoke detection shall be provided throughout all buildings of the Stage 3-5 portion in accordance with AS1670.1:2018 and with the inclusion of the following:
  - The main switch rooms within the Teaching & Learning and Performing Arts/Founders Buildings shall be provided with centrally located smoke detectors; and
  - The Basement Level 1 of the Teaching & Learning building shall be provided with a detection system on a reduced spacing of 8m x 8m in lieu of 10m x 10m; and
  - Additional detectors shall be installed within the sports building within 1.5m of tilt glass panel at distances no greater than 10m along the width of the tilt panel. Activation of these detectors shall activate the EWIS within the T&L building; and
- Travel distances include travel through the external covered walkway (i.e. Arrow Building) portions which shall contain low fuel loads, be provided with sprinkler protection and have substantial ventilation along the perimeter of the walkways such that smoke in this area would be expected to vent to atmosphere; and
- Provide strobe lights and alarm horn sounders at strategic locations where the most disadvantaged occupants shall be able to readily see the light(s) or hear the sounder(s). The strobe lights and sounders shall be set to activate upon General Fire Alarm (GFA). Strobes/sounders shall be provided as follows:
  - Level B1 Store/Plant room. Refer to Figure 9.1 for indicative locations; and
  - Level 4 Plant Deck. Refer to Figure 9.4 for indicative locations; and
- Provide a Building Occupant Warning System (BOWS) in accordance with BCA Specification E2.2a, AS1670.1:2018 which shall initiate on either sprinkler head or detector activation and with the inclusion of the following:
  - The BOWS shall comprise a pre-recorded public address system; and
  - The following buildings shall be provided with a BOWS:
    - Multi-Purpose Pavilion; and
    - Music Building; and
    - Arrow Building; and
- Provide an Emergency Warning & Intercommunication System (EWIS) in accordance with BCA Specification E2.2a and AS1670.4:2018 which shall initiate on either sprinkler head or detector activation to the following locations:
  - Teaching & Learning; and

  - Quadrangle Building; and
  - Performing Arts; and
  - Founders Building; and
- Emergency lighting and exit signage shall be provided in accordance with AS2293.1:2018; and
- The main occupants are considered to be awake, coherent and aware of their surroundings; and
- Occupants are considered to be familiar with the floor plate as they will use these areas regularly for school attendance.

9.5 Methodology

The methodology to address the design issue relative to the extended travel distances has been based upon a combination of both a qualitative 'risk' and quantitative 'comparative' evaluation. The qualitative aspect of the evaluation has considered the school areas function & use (e.g. available ventilation and external nature of portions of the path of travel, areas were staff occupants only are expected in Plant and Kitchen areas), risk of fire ignition and the proposed fire safety measures (i.e. provision of smoke detection being an enhancement, strobe light/sounders to plant areas). Further consideration of the impact imposed onto attending fire-fighter personnel has also been undertaken.

The analysis has considered the three (3) main components: detection, pre-movement and movement (i.e. $t_d + t_{pm} + t_m$ = RSET) to demonstrate that the increased time associated with the identified travel distances shall be suitably compensated through enhanced occupant warnings and detection (i.e. smoke detection system, strobe light to plant areas) and distance of travel to a place of relative safety (i.e. external walkway environment). The overall occupant evacuation time shall be enhanced such that the egress strategy suitably compensates the additional travel distance and is at least equivalent to a DtS building solution.

The analysis has adopted quantitative aspects including the comparison of alarm times based on the requirement for the provision of sprinkler activation alarm requirements and the proposed AS1670.1:2018 detectors with spacings of 10m between detectors. The reduced activation time compensated for the additional distance of travel. The input parameters for detector activation times are provided in Table 9.2.

Table 9.2: Input parameters for Sprinkler/Detector activation calculations

Item	DtS Equivalent Design (Sprinklers)	Proposed Design (Smoke Detection)
Activation Temperature	68°C	13°C above ambient conditions (Heskestad, 1995 – Temperature Equivalence method)
Response Time Index (RTI)	$50m^{-0.5}s^{-0.5}$	$10m^{-0.5}s^{-0.5}$ (Evans, 1984)
Location of Sprinkler/Detector	2.75m Ceiling level (typical)	2.75m Ceiling level (typical)
Sprinkler/Detector Spacing	4.6m x 4.6m grid spacing based on Light Hazard (Radial Distance 3.25m)	**Typical**: 10m x 10m grid spacing based on AS1670.1:2018 (Radial Distance 7.1m) **T&L Level B1**: 8m x 8m grid reduced spacing (Radial Distance 5.66m)
Fire Growth Rate	Medium t^2 & Fast t^2	Medium t^2 & Fast t^2

9.6 Acceptance Criteria

The basic objective and intent of this analysis pertains to the life safety of the evacuating occupants. Thus, the primary acceptance criterion has been met by demonstrating that the early alarm notification provided by enhanced detection systems and strobe/horn sounders, and the reduced travel to a place of temporary safety afforded by the external walkway areas (i.e. "Arrow Building") will result in reduced evacuation times when compared to an equivalent DtS building solution. The Required Safe Egress Time (RSET) of the proposed Performance Solution shall be demonstrated to be is equal to or better than the Required Safe Egress Time of a DtS compliant design solution i.e.:

$$RSET_{\text{Performance Solution}} \leq RSET_{\text{DtS Building Solution}}$$

The secondary acceptance criterion has been met by demonstrating that attending fire-fighter personnel are not negatively impacted upon by the additional travel distances.

9.7 Qualitative Evaluation

9.7.1 Building Function and Use

As noted in Section 2.2, the proposed development is to be primarily utilised for everyday school uses. The Class 9b school will have two distinct groups of occupants, students and teachers. Referring to the dominant occupant characteristics provided in Section 2.2, teachers while few in number, will be familiar and will have a natural tendency to take charge and direct students to evacuate in the event of an emergency. Students will be the majority and have various degrees of ability and familiarity, however students would be expected to wait to be given instructions typical for the age and the teacher student relationship and generally begin to evacuate from the building as directed by the staff/teacher occupant group to a designated safe area.

Specific to the Basement Level 1 of the Teaching & Learning Precinct, it is noted that the area consists of multiple storage enclosures and a change room. Therefore, the Basement Level 1 of the Teaching & Learning Precinct is considered transient within minimal occupant loading.

The extended travel distance within the Level 1 portion relates to occupants being located within the Kitchen Servery adjacent to the Performance Hall portion. This area is expected to be occupied by staff members only (i.e. cooks, wait staff and the like) and is generally not expected to be occupied by students or visitors. Accordingly, occupants within this space are expected to be familiar with the floor layout and exit locations as this is their place of work.

With regards to the Level 4 plant areas within the Teaching & Learning Precinct and the Performing Arts Precinct, the aforementioned areas are generally accessed by maintenance personnel only. Therefore, it can be said that there will be minimal occupants within the plant areas at any given time. It shall also be noted that the maintenance personnel accessing the plant areas are generally familiar with the overall layout of the building(s).

9.7.2 Fire Hazard and Risk

9.7.2.1 General

As noted in Section 4, the hazard analysis undertaken for an education building are summarised below:

- Many education department officers cannot recall any deaths in school fires; hazard to life safety is low.
- On average, a school fire with losses exceeding one million dollars occurs every two weeks in Australia. However, this loss is less than 0.1% of school assets.
- Most fires are small; most of the loss is due to only a small proportion of all fires.
- Most of the losses appear to be due to arson. However, statistics on this matter are unclear. Arson is sometimes interpreted as burglary.
- Arson fires are consistently the single most significant source of fire starts (54% of school fires in NSW, 60% in UK, and 52% in USA)"
  - Arson in a school is a risk however it is considered to be more related to security of the building. Many security practices not only reduce burglary but also reduce arson.
  - Mitigating the risk of arson is a delicate balance between onerous security which may be problematic and management. As such minimising waste and good storage of combustibles whilst maintaining clear travel paths result in low accessible fuel loads.
- In view of the multi-use school building(s) it is anticipated that there will be some sources of ignition. The ignition sources that are primarily related to the proposed building(s) include:
  - Electrical switch assemblies;
  - Lighting;
  - Electronic audio/video (e.g. stage equipment);
  - Occasional special effects equipment for staged performances;
  - Arson.
- In view of the variable nature of activities associated with the subject building(s) it is anticipated that the likely fuel loads will consist of seating and some office furnishings within the multi-use spaces. The adjacent class rooms, store rooms, offices and kitchenette present a separate potential fuel load of which the combustible content of the proposed building(s) shall include:
  - Furniture (e.g. tables, chairs, cabinets & shelving arrangements)
  - Storage contents (e.g. boxed items, books, folders and the like)
  - Audio/Visual/computer equipment;
  - Electrical equipment;
  - Seating and/or table arrangements;
  - Ovens.

It can be summarised that the risk to occupants within school facilities is very low. This is outlined in both the national and international results collated and when compared to other types of building classifications. The buildings contained within the Trinity Grammar School are comparative for use, size and occupants with the data compiled for the above results obtained.

9.7.2.2 Ventilation Availability

It is noted that a number of egress paths pass via portions of the building which are provided with substantial levels of ventilation, whereby smoke would be expected to vent to atmosphere from these spaces mitigating the effect of smoke on occupant tenability within these spaces.

It is noted that a number of travel distances from the T&L building is measured to the open stair within the Arrow building, rather than the exit doors of the T&L building. Upon reaching the sprinkler-protected Arrow building, occupants shall be provided with an external walkway/circulation space which shall be open along at least one (1) perimeter. Due to the nature of the arrow building being primarily utilised for circulation/thoroughfare, it is further noted that fuel loads within this space are expected to be lower than the internal portions of the building.

Accordingly, upon reaching this arrow building, occupants are considered to have entered a place of relative safety from which access to one of multiple open stairways serving the arrow building would be available.

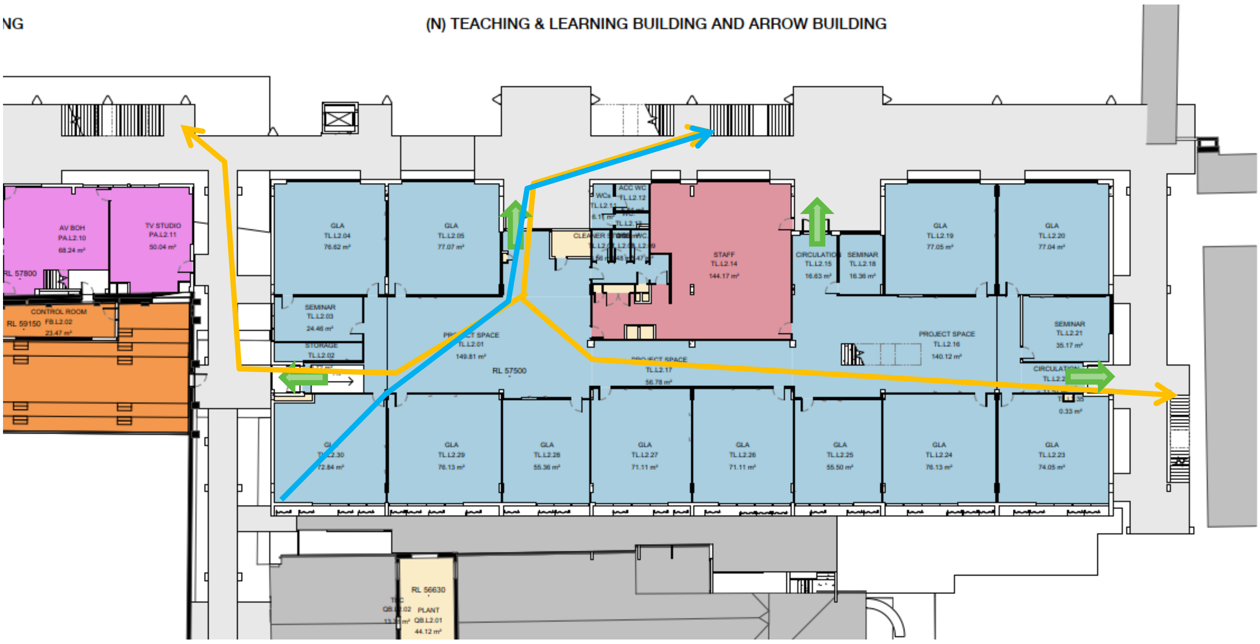


Figure 9.9: Egress to the arrow building from the T&L Precinct (Level L2 shown)

Egress from the Roof Plant areas are further noted to be provided with egress paths that are generally open to the sky. Smoke from a fire located within these areas are expected to vent directly to atmosphere mitigating the risk to occupants within these spaces.

9.7.3 Fire Safety Systems

9.7.3.1 Automatic Sprinkler System

It is noted that the aforementioned buildings shall be provided with an automatic sprinkler system designed and installed in accordance with Clause E1.5, Specification E1.5 of the BCA and AS2118.1:2017. Sprinkler protection is expected to provide a reliable and effective means of maintaining tenable conditions for occupants and fire-fighters, structural adequacy, and limiting fire spread within a building and to adjacent building(s). Effective sprinkler activation and operation is also likely to reduce the generation of smoke and maintain low compartment temperatures. Furthermore, studies have shown that fire sprinkler systems operate and control fires in 85% of fire occurrences (refer to Appendix D). The statistical data from the paper titled "US Experience with Sprinklers" indicate that sprinklers with appropriate maintenance are highly effective in reducing the loss of life and limiting fire spread.

It is considered that the automatic sprinkler system shall activate to either supress or control a potential fire event which shall considerably improve conditions along the paths of travel for evacuating occupants and fire brigade personnel. Given the presence of an automatic sprinkler system, fire spread beyond the area of origin has been shown to be unlikely to occur. Therefore, the sprinkler system is expected to prevent a severe fire from occurring and limit and possibly and potential risk of fire spread throughout the building.

9.7.3.2 Smoke Detection and Alarm System

It is also noted that the subject building shall be provided with a smoke detection and alarm system. In accordance with Table E2.2a of Volume One of the BCA, for a Class 9b building with an effective height of no more than 25m, the building must be provided with the following:

- In each required fire-isolated stairway, including any associated fire-isolated passageway or fire-isolated ramp, an automatic air pressurisation system for fire-isolated exits in accordance with AS 1668.1; OR
- A zone pressurisation system between vertically separated fire compartments in accordance with AS 1668.1, if the building has more than one fire compartment; OR
- An automatic smoke detection and alarm system complying with Specification E2.2a; OR
- A sprinkler system (other than a FPAA101D or FPAA101H system) complying with Specification E1.5.

As noted in Section 9.7.3.1, the subject buildings shall be provided with an automatic sprinkler system. Therefore, the provisions of a smoke detection and alarm system throughout the subject building is considered an enhancement in active fire safety measures. More specifically, automatic smoke detection and alarm system shall be provided throughout all buildings of the Stage 3-5 portion in accordance with AS1670.1:2018 and with the inclusion of the following:

- The main switch rooms within the Teaching & Learning and Performing Arts/Founders Buildings shall be provided with centrally located smoke detectors; and
- The Basement Level 1 of the Teaching & Learning building shall be provided with a detection system on a reduced spacing of 8m x 8m; and

In addition, additional smoke detectors shall be installed within the sports building within 1.5m of tilt glass panel at distances no greater than 10m along the width of the tilt panel.

In summary, the provision of smoke detection and alarm system can provide occupants with an early notification to egress and escape in the instance of a potential fire. A quantitative assessment was performed in the subsequent sections to compare the activation times between the sprinkler system and smoke detection system.

9.7.3.3 Strobe Lights and Sounders

To further improve on occupant evacuation times within the Teaching & Learning Precinct (Basement B1 and Level 4) and Performing Arts Precinct (Level 1 & Level 4), strobe lights & alarm horn sounders shall be provided (refer to Figure 9.10 to Figure 9.13). The strobe lights and sounders shall be interconnected into the Emergency Warning & Intercommunication System (EWIS) serving the T&L Building and Performing Arts Building such that they are set to initiate upon General Fire Alarm (GFA). In the case of a fire initiating remote from the identified areas, occupants shall still be provided with strong visual & audible cues to commence evacuation.

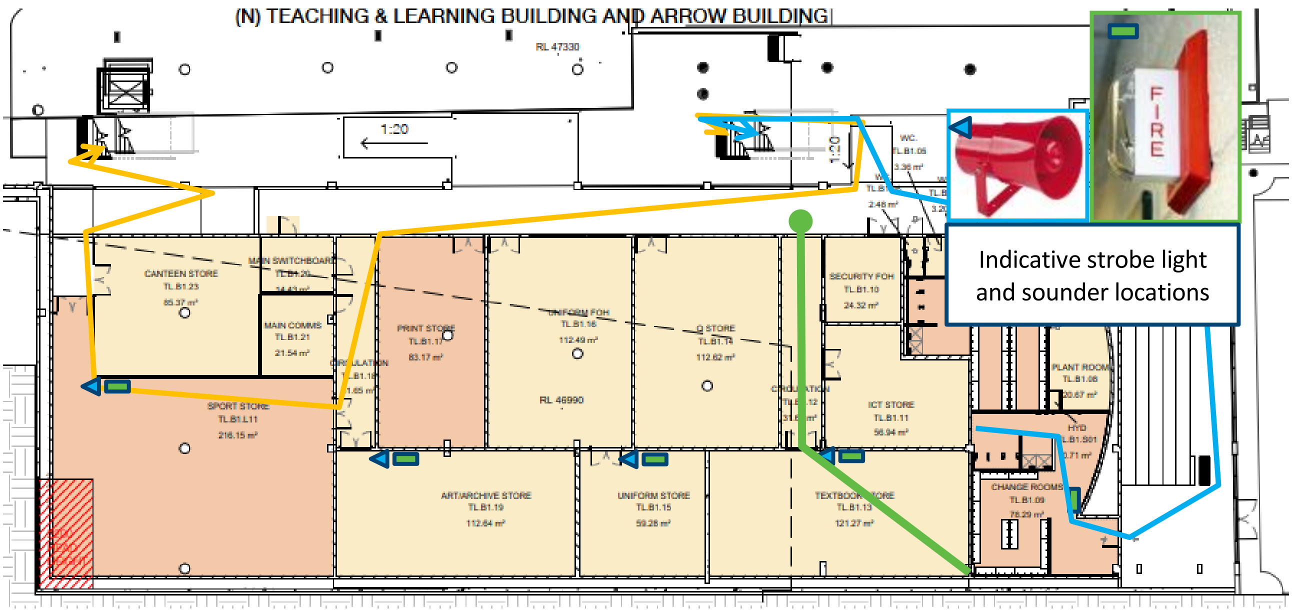


Figure 9.10: Extended Travel Distance within T&L Precinct (Level B1)

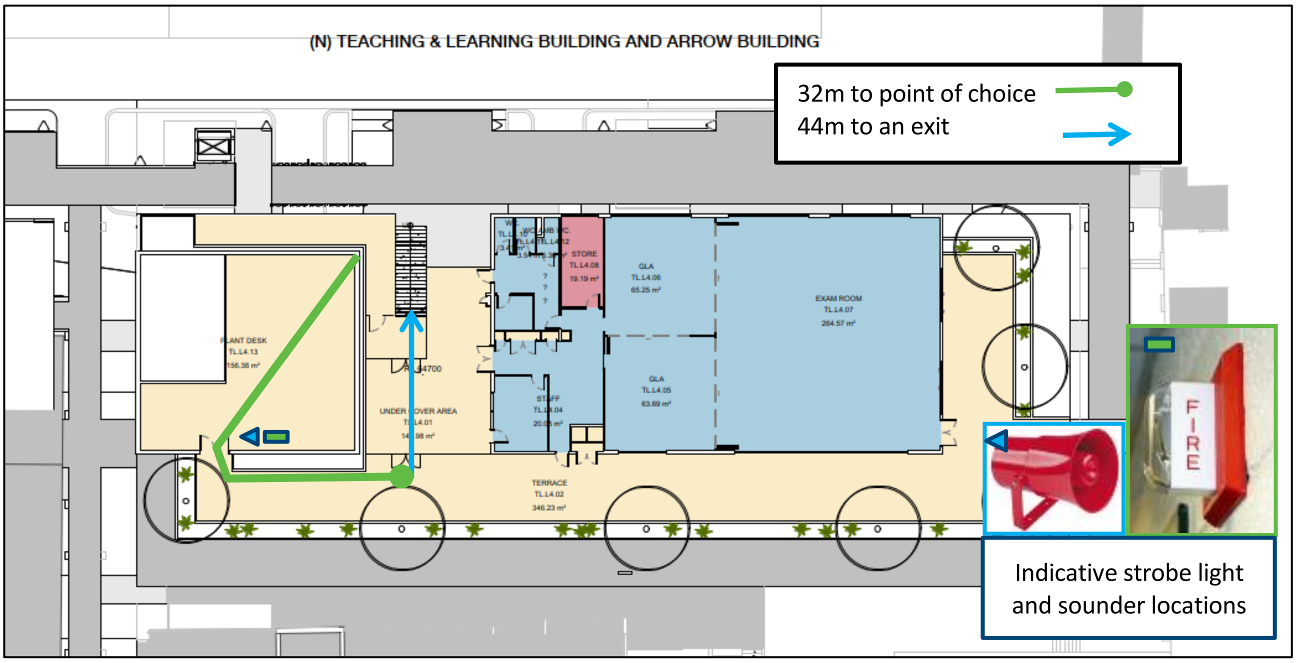


Figure 9.11: Extended Travel Distance within T&L Precinct (Level L4)

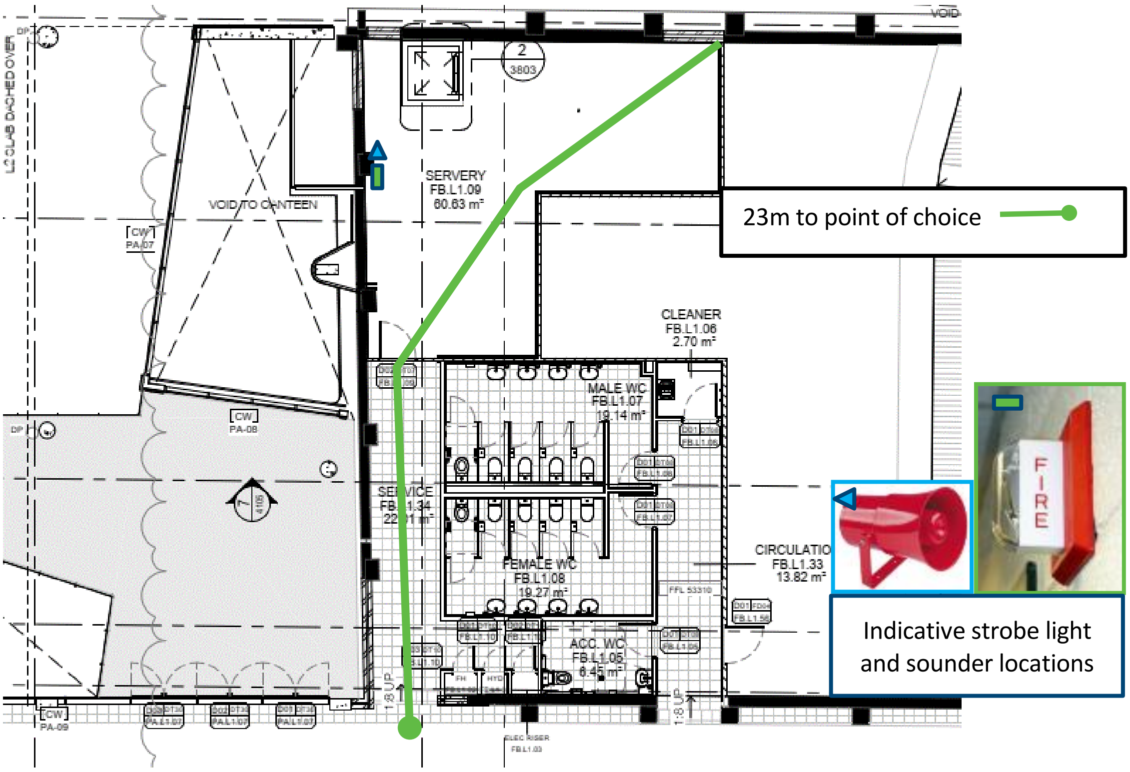


Figure 9.12: Extended Travel Distance within Performing Arts Precinct (Level 1)

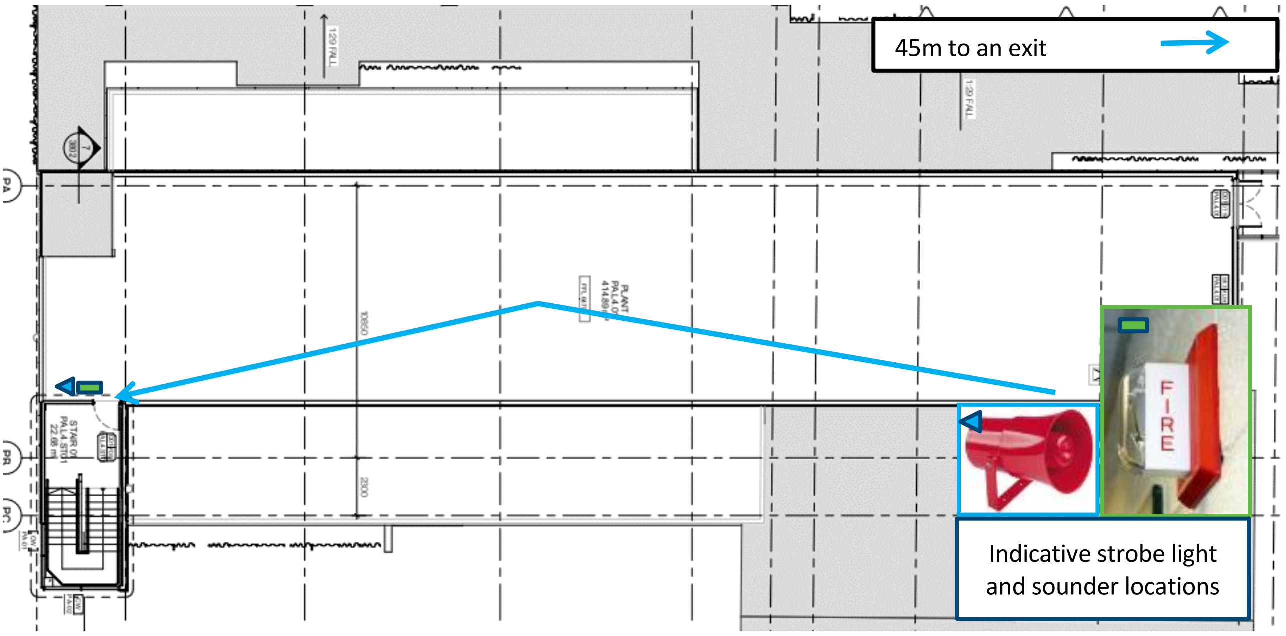


Figure 9.13: Extended Travel Distance within Performing Arts Precinct – Rooftop Plant (Level 4)

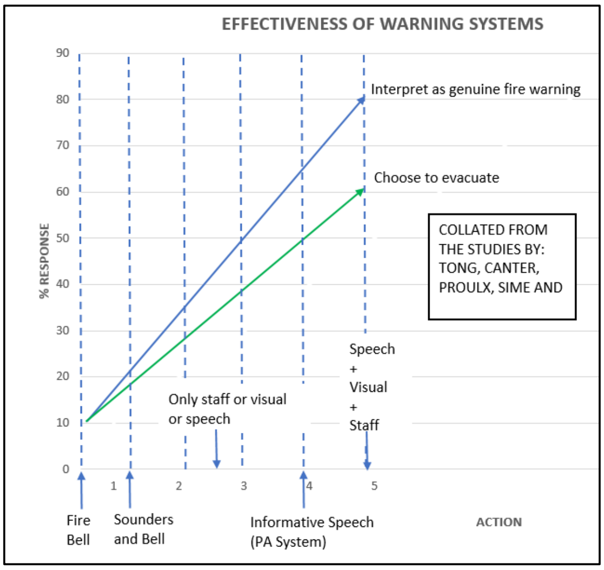


Figure 9.14: Effectiveness of warning systems

As shown in Figure 9.14, presence of a visual warning system (such as a strobe light) can increase the warning effectiveness by up to 30%. Research conducted by Nillson (2006) demonstrated that flashing lights encourage people to use an exit which can be a result of cognitive affordances introduced by the system. It is therefore expected that the impact of the strobe lights on reducing the detection and pre-movement times will be significant.

British Standard PD 7974-6:2019 suggests pre-movement times in occupancies where automatic detection is provided throughout a building activating an immediate general fire alarm to occupants of all affected parts of the building. A pre-movement time of 90 seconds (i.e. 1.5 minutes) has been adopted for the pre-movement time associated with the school facility. This value is attributed to occupants in this area of the building that are expected to be awake and alert when compared to occupants in the residential area that could be asleep. Therefore, the pre-movement time (i.e. 30% improvement, 90 seconds x 0.7 = 63 seconds or **+27 second** improvement) can assist in compensating for the increased travel times.

9.7.3.4 Way Finding and Visibility

Illuminated emergency lighting and exit signs shall be provided in accordance with AS2293.1.

Figure 9.15: Directional exit signs shall be provided as required in accordance with AS2293.1

To further aid occupants to evacuate efficiently, it is required to maintain the immediate entrance areas and public corridors clear of combustible materials. This is considered to minimise any obstructions that may impede occupant evacuation and furthermore, limit fuel loads contributing towards the development and growth of a potential fire.

9.8 Quantitative Evaluation

9.8.1 Occupant Evacuation Timeline Analysis

The evacuation process comprises three (3) main components: detection, pre-movement and movement. The concept of the evacuation is provided in the following equation:

$$t_{evac} = t_{detection} + t_{pre-movement} + t_{movement}$$

Of these three (3) components, the travel time of the occupants to reach a place of safety is generally the most predictable and typically is the smallest time involved. The alarm activation and cue recognition (i.e. detection) coupled with pre-movement phases can extend over several minutes of elapsed time.

9.8.2 Determining Detection Time

As part of the assessment, the time for building occupants to detect a fire has been based on either sprinkler activation (DtS Design) or automatic smoke detection (Proposed Design). Alpert's correlation has been conducted to calculate the difference in detection time associated with both an equivalent DtS compliant design and the proposed design. The input parameters are detailed in Table 9.3.

Table 9.3: Input parameters for smoke detection activation comparison

Item	DtS Equivalent Design (Sprinklers)	Proposed Design (Smoke Detection)
Activation Temperature	68°C	13°C above ambient conditions (Heskestad, 1995 – Temperature Equivalence method)
Response Time Index (RTI)	$50m^{-0.5}s^{-0.5}$	$10m^{-0.5}s^{-0.5}$ (Evans, 1984)
Location of Sprinkler/Detector	2.75m Ceiling level (typical)	2.75m Ceiling level (typical)
Sprinkler/Detector Spacing	4.6m x 4.6m grid spacing based on Light Hazard (Radial Distance 3.25m)	**Typical**: 10m x 10m grid spacing based on AS1670.1:2018 (Radial Distance 7.1m) **T&L Level B1**: 8m x 8m grid reduced spacing (Radial Distance 5.66m)
Fire Growth Rate	Medium t^2 & Fast t^2	Medium t^2 & Fast t^2

Table 9.4: Alpert's Correlation Outcomes for Sprinkler/Detector activation times

No.	Parameter	DtS Equivalent Design (Sprinklers)	Proposed Design (Smoke Detection 10m x 10m spacing)
Medium t^2	**Required Inputs**		
	Ambient Temperature, T =	20 (°C)	20 (°C)
	Fire Growth Rate =	Medium	Medium
	Time Step Interval =	20 (s)	20 (s)
	Radial Distance of the Detector from the Fire, r =	3.25 (m)	7.10 (m)
	The Height of the Ceiling above the fire, H =	2.75 (m)	2.75 (m)
	The Response Time Index of the Detector, RTI =	50 $(m^{1/2}s^{1/2})$	10 $(m^{1/2}s^{1/2})$
	Sprinkler Density of Discharge =	5 mm / min	5 mm / min
	Sprinkler Activation Temperature =	68 (°C)	33 (°C)
	Calculated Quantites at Detector Activation		
	The Gas Temperature at Sprinkler Activation, T =	85.12 (°C)	35.61 (°C)
	HRR at Sprinkler Activation =	624.10 (kW)	160.00 (kW)
	The Gas Velocity, U =	1.03 (m/s)	0.34 (m/s)
	Time at Sprinkler Activation =	238 (s)	121 (s)
	Time to Reach 10% of peak HRR =	924 (s)	807 (s)
	Ratio, r / H =	1.18	2.58
Fast t^2	**Required Inputs**		
	Ambient Temperature, T =	20 (°C)	20 (°C)
	Fire Growth Rate =	Fast	Fast
	Time Step Interval =	20 (s)	20 (s)
	Radial Distance of the Detector from the Fire, r =	3.25 (m)	7.10 (m)
	The Height of the Ceiling above the fire, H =	2.75 (m)	2.75 (m)
	The Response Time Index of the Detector, RTI =	50 $(m^{1/2}s^{1/2})$	10 $(m^{1/2}s^{1/2})$
	Sprinkler Density of Discharge =	5 mm / min	5 mm / min
	Sprinkler Activation Temperature =	68 (°C)	33 (°C)
	Calculated Quantites at Detector Activation		
	The Gas Temperature at Sprinkler Activation, T =	99.01 (°C)	38.08 (°C)
	HRR at Sprinkler Activation =	834.18 (kW)	199.51 (kW)
	The Gas Velocity, U =	1.14 (m/s)	0.37 (m/s)
	Time at Sprinkler Activation =	138 (s)	68 (s)
	Time to Reach 10% of peak HRR =	824 (s)	754 (s)
	Ratio, r / H =	1.18	2.58

Table 9.5: Alpert's Correlation Outcomes for Sprinkler/Detector activation times - Basement B1 only

No.	Parameter	DtS Equivalent Design (Sprinklers)	Proposed Design (Smoke Detection 8m x 8m spacing)
Medium t^2	**Required Inputs**		
	Ambient Temperature, T =	20 (°C)	20 (°C)
	Fire Growth Rate =	Medium	Medium
	Time Step Interval =	20 (s)	20 (s)
	Radial Distance of the Detector from the Fire, r =	3.25 (m)	5.66 (m)
	The Height of the Ceiling above the fire, H =	2.75 (m)	2.75 (m)
	The Response Time Index of the Detector, RTI =	50 $(m^{1/2}s^{1/2})$	10 $(m^{1/2}s^{1/2})$
	Sprinkler Density of Discharge =	5 mm / min	5 mm / min
	Sprinkler Activation Temperature =	68 (°C)	33 (°C)
	Calculated Quantites at Detector Activation		
	The Gas Temperature at Sprinkler Activation, T =	85.12 (°C)	35.78 (°C)
	HRR at Sprinkler Activation =	624.10 (kW)	129.60 (kW)
	The Gas Velocity, U =	1.03 (m/s)	0.39 (m/s)
	Time at Sprinkler Activation =	238 (s)	109 (s)
	Time to Reach 10% of peak HRR =	924 (s)	795 (s)
	Ratio, r / H =	1.18	2.06
Fast t^2	**Required Inputs**		
	Ambient Temperature, T =	20 (°C)	20 (°C)
	Fire Growth Rate =	Fast	Fast
	Time Step Interval =	20 (s)	20 (s)
	Radial Distance of the Detector from the Fire, r =	3.25 (m)	5.66 (m)
	The Height of the Ceiling above the fire, H =	2.75 (m)	2.75 (m)
	The Response Time Index of the Detector, RTI =	50 $(m^{1/2}s^{1/2})$	10 $(m^{1/2}s^{1/2})$
	Sprinkler Density of Discharge =	5 mm / min	5 mm / min
	Sprinkler Activation Temperature =	68 (°C)	33 (°C)
	Calculated Quantites at Detector Activation		
	The Gas Temperature at Sprinkler Activation, T =	99.01 (°C)	38.56 (°C)
	HRR at Sprinkler Activation =	834.18 (kW)	165.38 (kW)
	The Gas Velocity, U =	1.14 (m/s)	0.42 (m/s)
	Time at Sprinkler Activation =	138 (s)	62 (s)
	Time to Reach 10% of peak HRR =	824 (s)	748 (s)
	Ratio, r / H =	1.18	2.06

Alpert's correlation has been adopted to calculate the difference in detection times (refer to Table 9.4). The calculation shows that the detection time associated with an equivalent DtS compliant design (i.e. sprinkler activation) in comparison to the detection time associated with the proposed design (i.e. smoke detection) (refer to Table 9.6)

Table 9.6: detection time for Fast t^2 fire for DtS compliant design and proposed design

Smoke Detector Spacing	Fast t^2 fire
DtS compliant design (i.e. sprinkler activation)	138 seconds
Performance Solution design (i.e. smoke detection)	Typical: 68 seconds Basement B1: 62 seconds
Difference between the spacing times	Typical: +70 seconds Basement B1: +76 seconds

Thus, as noted from Table 9.6, the difference between DtS Compliant Design (i.e. sprinkler activation) and Proposed Building Design (i.e. smoke detection system) for a Fast t^2 fire is approximately **70 seconds** for the typical areas within the aforementioned buildings and approximately **76 seconds** for Basement B1 within the Teaching& Learning precinct. The improvement of up to 76 second difference in detection times have been adopted to calculate the overall evacuation time. This in turn improves the overall evacuation times by approximately 14 seconds.

- DtS Compliant Design Detection Time: **138 seconds**
- Proposed Building Design Detection Time (i.e. within the typical level): **68 seconds**
- Proposed Building Design Detection Time (i.e. within Basement B1): **62 seconds**

9.8.3 Determining Pre-Movement Time

The pre-movement component of the evacuation process often has the greatest variability. There is much evidence to demonstrate that the quality and nature of the alarm signal has a profound impact on the pre-movement times (BSI 1997). Where there is a distinctive, recognised building wide alarm signal, the pre-movement times of the occupants will be much reduced. This is further aided by clear emergency evacuation procedures applicable to the building with which the occupants are familiar.

With reference to the Fire Safety Science- Proceedings of the Tenth International Symposiums, studies have indicated that the pre-movement time for a building of this nature vary between 30 seconds to 15 minutes depending on the management level, alarm level and building complexity of the development. Table 9.7 provides a pre-movement times for the subject areas of the building.

Table 9.7: Suggested pre-movement times from PD7974-6:2019

Scenario Category	First Occupants (mins)	Occupant Distribution (mins)
Awake and unfamiliar (education building)		
M1 (B1) (A1 – A2)	0.5	2.5
M2 (B1) (A1 – A2)	**1.0**	**4.0**
M3 (B1) (A1 – A3)	>15	>30

Note:

For B2, add 0.5 for wayfinding

For B3, add 1.0 for wayfinding

Definitions:

Management Level

M1: Occupants (staff) should be trained to a high level of fire safety management.

M2: Similar to M1 but lower staff ratio and floor wardens not always present.

M3: Basic management with minimum fire safety management.

Alarm Level

A1: Automatic detection throughout the building activating an immediate general alarm to all occupants.

A2: Automatic detection throughout the building providing a pre-alarm to management with a manually activated general fire alarm.

A3: Local automatic detection and alarm only near location of the fire or no automatic detection with manually activated general alarm.

Building Complexity

B1: Simple rectangular single storey building with on or few enclosures and simple layout.

B2: Simple multi-enclosure (usually multi-storey) building and simple internal layout.

B3: Large complex building where occupants may have way finding difficulties.

The pre-movement time detailed in Table 9.7 provides a high degree of inherent conservatism as occupant in the near vicinity of fire origin would generally be expected to react with minimal delay. Occupant pre-movement within these areas are conservatively taken as **90 seconds** for the equivalent DtS building solution. This value is attributed to occupants who are located away from the area of fire origin but still located in the same floor. Pre-movement period is highly influenced by wayfinding activities. With reference to Section 9.7.3.3, the addition of strobe lights and sounders within Basement B1 and the Level 4 plant areas under the performance solution is expected to improve recognition delays by up to 30%. As such the pre-movement time associated with the performance solution is taken as **63 seconds** (or 90 sec x 0.7 = 42 sec). Therefore, the following pre-movement times have been adopted in calculating the overall evacuation time:

- DtS Building Solution Pre-Movement Time: **90 seconds**
- Performance Solution Pre-Movement Time: **63 seconds**

9.8.4 Determining Movement Time

The travel time during the evacuation process is governed by the movement speed of occupants or queuing at potential bottlenecks such as doorways. It is noted that due to the limited number of occupants expected to be present at any given time queuing will not occur hence, the actual travel distances are estimated to dictate the overall travel time.

Travel speeds recommended by the SFPE Handbook of Fire Protection Engineering (5th Edition, 2017) for a corridor or an aisle is 1.19 m/s. For persons with limited mobility, i.e. a person on crutches, travel speeds as high as 0.94m/s are recommended (Ramachandran & Charters, Quantitative Risk Assessment in Fire Safety, 2011). This correlates well with studies conducted by various researchers detailed in 'Egress Design Solutions' (Lord et al, 2005 & Fahy et al 2001) and Kuligowski (2005) which have established occupant walking speeds for different occupant groups and/or disability and the corresponding travel speeds are provided in Appendix G.

Based on the information presented, occupant movement speed has been based on the average weighted horizontal movement speed of **0.9ms^{-1}.** The following table tabulates the travel distances for both the proposed and DtS compliant building designs.

9.8.5 Determining the Overall Evacuation Time (RSET)

All elements of the evacuation process are combined into a timeline and calculated in the aforementioned sections. The evacuation times associated with both the proposed design and an equivalent DtS compliant building design are detailed in Table 9.8.

Table 9.8: RSET comparison

Scenario	Detection (s)	Pre-Movement (s)	Movement (s)	RSET (s)	Difference / Safety Margin	Acceptance Criteria Met
Teaching & Learning Precinct Basement Level 1						
DtS prescriptive distance to a point of choice (20m)	138	90	22.5	250.5	+96.5/1.62	Yes
Proposed distance to a point of choice (26m)	62	*63	29	154		
DtS prescriptive distance to an exit (40m)	138	90	44.5	272.5	+73/1.36	Yes
Proposed distance to an exit (67m)	62	*63	74.5	199.5		
DtS prescriptive distance between alternative exits (60m) [Distance to Exit + to Alternate Exit = 100m]	138	90	112	340	+51/1.17	Yes
Proposed distance between alternative exits (97m) [Distance to Exit + to Alternate Exit = 164m]	62	*63	164	289		
Teaching & Learning Precinct Level 2						
DtS prescriptive distance to an exit (40m)	138	90	44.5	272.5	+62/1.29	Yes
Proposed distance to an exit (47m)	68	90	52.5	210.5		
DtS prescriptive distance between alternative exits (60m) [Distance to Exit + to Alternate Exit = 100m]	138	90	112	340	+46/1.15	Yes
Proposed distance between alternative exits (75m) [Distance to Exit + to Alternate Exit = 122m]	68	90	136	294		

Scenario	Detection (s)	Pre-Movement (s)	Movement (s)	RSET (s)	Difference / Safety Margin	Acceptance Criteria Met
Teaching & Learning Precinct Level 3						
DtS prescriptive distance to a point of choice (20m)	138	90	22.5	250.5	+63.5/1.33	Yes
Proposed distance to a point of choice (26m)	68	90	29.0	187		
DtS prescriptive distance to an exit (40m)	138	90	44.5	272.5	+25.5/1.10	Yes
Proposed distance to an exit (42m)	68	90	89.0	247		
Teaching & Learning Precinct Level 4						
DtS prescriptive distance to a point of choice (20m)	138	90	22.5	250.5	+16/1.06	Yes
Proposed distance to a point of choice (30m)	138	*63	33.5	234.5		
Performing Arts Precinct Basement Level 2						
DtS prescriptive distance to a point of choice (20m)	138	90	22.5	250.5	+64.5/1.35	Yes
Proposed distance to a point of choice (25m)	68	90	28.0	186		
Performing Arts Precinct Level 1						
DtS prescriptive distance to a point of choice (20m)	138	90	22.5	250.5	+66.5/1.36	Yes
Proposed distance to a point of choice (23m)	68	90	26	184		
Performing Arts Precinct Level 3						
DtS prescriptive distance to a point of choice (20m)	138	90	22.5	250.5	+69/1.38	Yes
Proposed distance to a point of choice (21m)	68	90	23.5	181.5		
DtS prescriptive distance to an exit (40m)	138	90	44.5	272.5	+64.5/1.31	Yes
Proposed distance to an exit (45m)	68	90	50.0	208		
Performing Arts Precinct Level 4						
DtS prescriptive distance to an exit (40m)	138	90	44.5	272.5	+21.5/1.08	Yes
Proposed distance to an exit (45m)	138	*63	50	251		

**Note: the pre-movement time for the proposed design is based on the effectiveness of strobe lights and sounders provided to the Basement B1 and plant areas*

Based on the RSET times detailed in Table 9.8, the provision of smoke detectors throughout the subject building(s) have considered to improve the overall evacuation times when directly compared to an equivalent DtS compliant building design. Furthermore, the provisions of strobe lights and sounders to the basement B1 and Level 4 plant areas have shown to improve occupant pre-movement time and overall evacuation time. Therefore, it can be justified that the proposed design can compensate on the extended travel distances within the aforementioned areas.

9.8.6 Impact of Queuing

In an environment with a large number of occupants, evacuation would be controlled by queuing. The impact of the exit travel distances would be limited to the early stages of evacuation where the first group of occupants reach a point of choice or exit. Queuing controlled movement time can be calculated using the following equation:

$$t_q = \frac{N}{w_e F_r} \qquad (1)$$

where,

t_q = time associated with queuing (s)

N = number of occupants (based on Table D1.13 of Volume One of the BCA)

w_e = Effective width (m) (taken as the clear width minus boundary layer clearance) (SFPE, 2002)

F_r = Specific flow rate through the respect exit doorway or stairway

Table 9.9: Occupant Numbers

Building	Location	Function and Use	Floor Area	Area per person	Occupant Number (N)
Teaching & Learning Precinct	Basement 1	Storage	1000 m^2	30 m^2	33
	Level 2	General Classrooms	1400 m^2	2 m^2	700
	Level 3	General Classrooms	1600 m^2	2 m^2	800
	Level 4	General Classrooms and plant	General classrooms: 453m^2 Plant: 205 m^2	General classrooms: 2 m^2 Plant: 30 m^2	General classrooms: 227 Plant: 7
Performing Arts Precinct	Basement 2	Indoor Cricket	358 m^2	3 m^2 (Considered Gymnasium for the purposes of D1.13)	120
	Level 1	Performance Hall	*Based on number of chairs (JHA-AV-DWG-0ST-30051 Rev. A dated 16/09/2022))	N/A	411
	Level 3	General Classrooms	867 m^2	2 m^2	434
	Level 4	Plant	404 m^2	30 m^2	14

Table 9.10 details the time delay associated with occupant queuing through the stairways and exits.

Table 9.10: Occupant queuing within egress path

Building	Queuing Location	Occupant Number (N)	*Effective Width (w_e) (m)	**Flow Rate (F_r) (persons/s/m of w_e)	Queuing Time (t_q) (s)
Teaching & Learning Precinct	Basement 1	33	2 x [2.0m – (2 x 0.15)] = 3.4m	0.94	10
	Level 2	700	4 x (2.0m) = 8.0m	1.3	67
	Level 3	800	3 x (2.0m) = 6.0m	1.3	102
	Level 4	234	2.0m – (2 x 0.15) = 1.85m	0.94	135
Performing Arts Precinct	Basement 2	120	2 x [1.0m – (2 x 0.15)] = 1.4m	0.94	92
	Level 1	411	4 x [2.0 – (2 x 0.15)] = 6.8m	1.3	47
	Level 3	434	2 x [2.0 – (2 x 0.15)] + 2 x [1.0 – 0.15] = 5.1m	1.3	65.5
	Level 4	14	1 x [1.0 – 0.15] = 0.85m	0.94	17.5

***Note:** Calculation of effective width has maintained a boundary layer clearance from obstacles (e.g. walls/handrails) based on values presented in Table 3-14.1 of SFPE Handbook 3rd Edition (pp3-369) (2002).

****Note:** Flow rate based on values presented in Table 3-14.5 of SFPE Handbook 3rd Edition (pp3-371) (2002).

Table 9.11 compares the occupant queuing time and movement time within the identified areas.

Table 9.11: Comparison between queuing and movement times

Building	Queuing Location	Occupant Number (N)	Queuing Time (t_q) (s)	Maximum Movement time (t_m) (s)
Teaching & Learning Precinct	Basement Level 1	33	10	89.0
	Level 2	700	67	94.5
	Level 3	800	102	89.0
	Level 4	234	135	49.0
Performing Arts Precinct	Basement Level 2	120	92	28
	Level 1	411	47	25.5
	Level 3	434	65.5	28.0
	Level 4	14	17.5	44.5

In this regard, it can be said that in an area with high occupancy load, the occupant evacuation is governed by queuing time, whereas for areas with a low occupancy load (i.e. Basement B1 storage areas), occupant movement time is the governing factor.

Based on the rationale above it can be seen that the overall benefit afforded to the proposed design is that occupants would be provided with an earlier queuing environment due to the provisions of smoke detection and alarm system and strobe lights (and sounders located at basement B1 and Level 4 plant areas only). In the instance of a fire where queuing time is the governing factor, occupants will be provided with an early notification (i.e. early detection). This allows occupants to queue at an exit/stairway during the initial development phase of a fire. Therefore, it can be justified that the provisions of smoke detectors and strobe lights (and sounders located at basement B1 and Level 4 plant areas only) can improve the overall occupant evacuation time to compensate on the extended travel distance.

9.8.7 Fire Brigade Intervention

The intent towards quantifying Fire Brigade arrival time and intervention time in this instance has been to determine whether the performance solution is satisfactory (to the degree necessary) to ensure that the attending fire fighters are provided with a 'safe' entry point to undertake firefighting activities.

The activities performed by the attending fire crews, the time associated per activity and the cumulative time from fire initiation until the commencement of water application onto the fire is tabulated in Appendix F: Table F.8. The FBIM timeline indicates the following:

- From fire initiation the cumulative time taken for the closest and second closest fire appliances to reach the fire scene (kerb side) are as follows:
  - Closest (Ashfield Fire Station): **608 seconds** or approximately 10.1 minutes; and
  - Second Closest (Marrickville Fire Station): **1,028 seconds** or approximately 17.1 minutes;
- Having arrived at the fire scene (kerb side), the time taken for fire crews to gain entry, gather information, assess the situation and set-up water supplies ready for the commencement of water control/extinguishment activities is an additional **1,114 seconds** or approximately 18.6 minutes;
- From fire initiation to the commencement of water control/extinguishment activities the cumulative time take for the closest & second closest responding fire stations is as follows:
  - Closest (Ashfield Fire station): **1,722 seconds** or approximately 28.7 minutes; and
  - Second Closest (Marrickville Fire Station): **2,142 seconds** or approximately 35.7 minutes

In line with the AFAC FBIM Model Manuel (Version 3.0, dated 14/04/2020) the total time taken for fire brigade intervention is based upon the second closest fire station. In this regard, attending fire crews from Marrickville Fire Station are expected to conduct water control/extinguishment activities within **2,142 seconds** or approximately 35.7 minutes.

It is considered that the automatic sprinkler system shall activate to either supress or control a potential fire event which shall considerably improve conditions within the enclosure of fire origin for fire brigade personnel. Given the presence of an automatic sprinkler system, fire spread beyond the area of origin has been shown to be unlikely to occur. Therefore, the sprinkler system is expected to prevent a severe fire from occurring and limit and possibly and potential risk of fire spread throughout the building.

In addition, the provisions of smoke detection and alarm system provided throughout the buildings interconnected with system monitoring to a fire station or fire station despatch centre can provide the responding fire station with early notification, allowing fire brigade personnel to arrive earlier than the approximated fire brigade arrival time as noted in Appendix F: Table F.8. Therefore, it is unlikely that the identified travel distances will have an adverse impact towards firefighting operations.

9.9 Discussion of Assessment Outcomes

The qualitative aspect of the evaluation has demonstrated that the proposed risk associated with the extended travel distances within the risk to occupants within the school facilities is very low. The qualitative aspect also considered the function and use and fire hazard of the subject areas, including the benefits of sprinkler protection.

The quantitative aspect of the evaluation demonstrated that the proposed smoke detection and alarm system can provide occupants with an early notification in the instance of a fire, thus improving on occupant evacuation time. In addition, the provision of strobe lights and sounders to the Basement B1 and Level 4 plant areas can improve on occupant pre-movement times. In this regard, the adoption of fire safety systems were deemed to compensate the identified additional travel distances.

In the context of Fire Brigade intervention, the inclusion of smoke detectors was considered to improve Fire Brigade notification & kerb side arrival. In addition, the presence of sprinkler protection shall assist in maintaining low compartment temperatures for attending fire crews.

Based on the rationale presented above, the proposed performance design solution with regard to the additional travel distances is considered to satisfy the Performance Requirements of DP4 & EP2.2 of the BCA. This conclusion is contingent on the requirements detailed in Section 15.2 being implemented into the design.

10. Interconnection of Non-Fire Isolated Stairways

10.1 Background to the Issue

It has been identified that there are a number of non-fire isolated stairways (required & non-required) which facilitate egress and interconnect multiple storeys as follows:

- **<u>Performing Arts Precinct:</u>**
  - Open stairway interconnects four (4) storeys in lieu of three (3) within sprinkler protected building
- **<u>Arrow Building (i.e. external walkway):</u>**
  - A number of open stairways which interconnect up to five (5) storeys in lieu of three (3) within sprinkler protected building.

The proposed design forms a deviation from Clause D1.3(b) of the BCA which prescribes a stairway serving as a required exit to interconnect no more than two (2) storeys within a non-sprinkler protected building and no more than three (3) consecutive storeys within a sprinkler protected building. The design also deviates from Clause D1.7 of the BCA as the stairways are strictly required to be provided with fire-isolated shaft construction due to the number of levels interconnected. Finally, the design deviates from Clause D1.12 of the BCA which prescribes non-required non-fire isolated stairways to interconnect no more than three (3) storeys in a sprinkler protected building. Figure 10.1 to Figure 10.2 illustrate the non-fire isolated stairways and interconnection of levels.

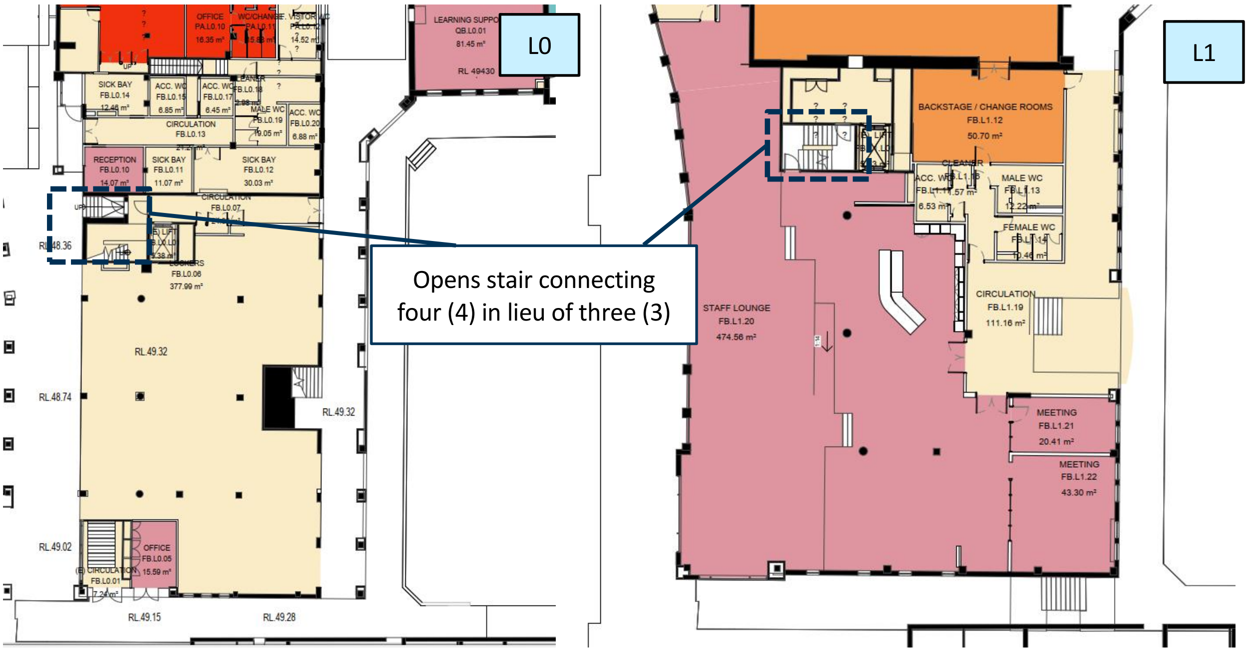


Figure 10.1: Open stairways (L0 & L1)

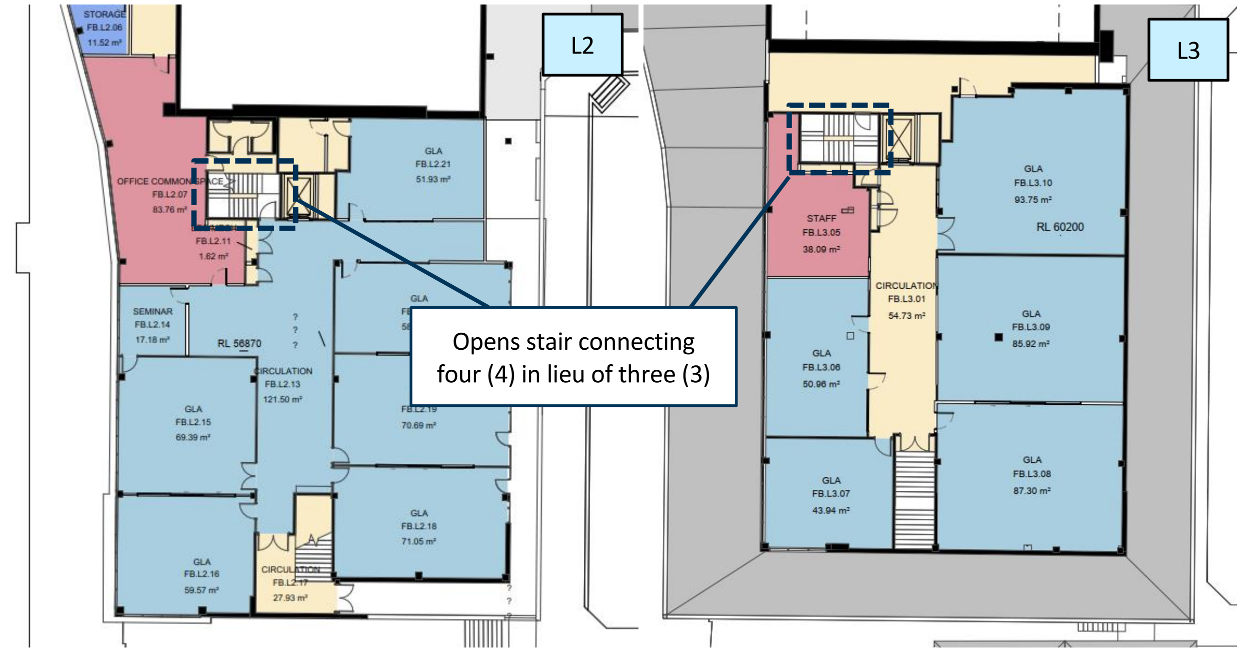


Figure 10.2: Open stairways (L2 & L3)

Figure 10.3: Open stairways (Arrow Building Stairs L3 shown)

10.2 Performance Solution

In accordance with the BCA Clause A2.2 *Performance Solution* the following assessment method has been adopted to demonstrate that the *Performance Solution* meets the relevant *Performance Requirements of CP1, CP2 & DP5.*

Table 10.1: Method of Analysis

Identified Design Issues	Performance Solution	AFEG Method of Analysis
It has been identified that the non-fire isolated stairways interconnect the following:	A2.2(2)(d) Comparison with the *Deemed-to-Satisfy Provisions.*	A qualitative 'comparative' approach demonstrating that the proposed design is

Identified Design Issues	Performance Solution	AFEG Method of Analysis
Performing Arts Precinct: • Open stairway interconnects four (4) storeys in lieu of three (3) within sprinkler protected building **Arrow Building (i.e. external walkway):** • A number of open stairways which interconnect up to five (5) storeys in lieu of three (3) within sprinkler protected building.		at least equivalent to a DtS building solution.

10.3 Hazards Specific to Interconnection of Non-Fire Isolated Stairways

The 'Guide to the BCA' (ABCB, 2019) states that the intent associated with prescribing a maximum number of storeys interconnected by a non-fire isolated stair as being *"To indicate when fire isolated stairways and ramps are required to enable safe egress in case of fire".* It is therefore considered that the main hazards specific to the design issue relates to:

- Fire and smoke spread impacting on the safe egress of occupants located on the upper levels in the event of a fire emergency; and
- The paths of travel and subsequent stair becoming inaccessible due to smoke and fire within the lower levels interconnected by the stair.

10.4 Hazard Mitigation

The 'Guide to the BCA' (ABCB, 2019) identifies the potential for occupants to become exposed to untenable conditions as they evacuate via the non-fire isolated stairway. In this regard, the following hazard mitigation systems, requirements and features of the design are noted:

- Full-height solid bounding construction extending to the underside of the slab above (i.e. between L0 to L1 slab) and achieving a minimum FRL of 120-minutes from both sides. The doors serving the stairway shall be self-closing and achieve an FRL of -/120/30 fitted with medium temperature smoke seals. Refer to Figure 10.4; and
- Sprinkler protection throughout the new building portions which shall suppress or control a fire event thereby reducing potential smoke generation & compartment temperatures; and
- Smoke detection system providing early warning & notification of a fire event; and
- Provide a Building Occupant Warning System (BOWS) in accordance with BCA Specification E2.2a, AS1670.1:2018 which shall initiate on either sprinkler head or detector activation and with the inclusion of the following:
  - The BOWS shall comprise a pre-recorded public address system; and
  - The following buildings shall be provided with a BOWS:
    - Multi-Purpose Pavilion; and
    - Music Building; and
    - Arrow Building; and
- Provide an Emergency Warning & Intercommunication System (EWIS) in accordance with BCA Specification E2.2a and AS1670.4:2018 which shall initiate on either sprinkler head or detector activation to the following locations:
  - Teaching & Learning; and
  - Quadrangle Building; and
  - Performing Arts; and
  - Founders Building; and

10.5 Methodology

The methodology adopted to address the design issue relative to the non-fire isolated stairways interconnecting up to three (3) to five (5) storeys has been based upon a combined qualitative and quantitative evaluation. The qualitative evaluation has considered the building function/use (incl. occupant characteristics), fire hazard and proposed separation measures (internal stairways) which shall alter the nature of these open stairway configurations similar to a DtS building solution.

The available ventilation for the external stairways (i.e. arrow building) has been considered in relation to smoke spread and smoke hazard to occupants of these external walkways. The evaluation has also considered the likely impact imposed onto attending fire-fighter personnel.

The quantitative aspect of the evaluation has adopted an ASET/RSET analysis to investigate the effectiveness of the ventilation provisions to the external walkway portion and the maintenance of tenability for occupants egressing via this external portion prior to these external areas being compromised. This evaluation has adopted an ASET/RSET analysis. An FDS model has been undertaken & analysed to determine the smoke layer height within the external "Arrow Building" portion in order to assess smoke spread into a portion of this external walkway from a fire scenario located within the adjacent internal portions of the building.

More specifically, a smoke spread scenario utilising the Fire Dynamic Simulation (FDS) program by NIST has been utilised to determine the extent of smoke/fire spread into the external walkway/arrow building and the venting performance once smoke has spread. CFD models are able to provide reasonable predictions of the ASET for uncomplicated building geometries. Refer to Section 10.8 for the further information about the FDS program and the output of the ASET quantitative analysis.

The evacuation modelling utilised to determine Required Safe Egress Time (RSET) has been determined based on computer modelling software Pathfinder. The RSET has been determined by the total time for the occupants on Level 2 being the level of fire origin and Level 3 and Level 4 to enter the external walkway "Arrow Building" and potentially pass the Level 2 fire location. As such the egress time has been calculated for all occupants on Level 2, Level 3 and Level 4 to either evacuate to a "safe place" being Ground Floor via the external walkway stairs adjacent to the T&L building or alternatively, egress away from the T&L building via the external walkway towards alternate stairs.

10.6 Acceptance Criteria

The basic objective and intent of the analysis pertains to the life safety of occupants as they evacuate via the non-fire isolated stairways. The qualitative acceptance criterion has been met by demonstrating that the introduction of additional separation alters the stair configuration such that no more than two (2) or three (3) levels are directly interconnected and no different to an equivalent DtS building solution.

The basic objective and intent of the analysis pertains to the life safety of evacuating occupants and attending firefighter personnel. Thus, the quantitative acceptance criterion has been met by demonstrating that the building performance solution is afforded with an egress strategy that is at least equivalent to a DtS building solution.

With respect to the ASET/RSET assessment, the acceptance criteria has been met by demonstrating the following:

- ASET is determined for the time at which the smoke layer height within Level 2 and/or Level 3 of the arrow building breaches a smoke layer height of 2.1m above the finished floor level reducing visibility within this location to be less than 10m. A secondary criterion of convective heat has also been adopted if the smoke layer height drops below 2.1m. According to the SFPE handbook an acceptable temperature threshold for heat to not irritate or burn humans is taken as 60°C. Refer to Section 10.8 for the output of the ASET quantitative analysis.
- The RSET has been determined by the total time for the occupants on the level of fire origin (i.e. Level 2), Level 3 and Level 4 to either exit the building or egress away from the T&L building via the external walkway. As such the egress time has been calculated for all occupants on Level 2 – Level 4 to either evacuate to Ground Floor or alternatively, a "safe place" remote from the fire location via the external walkway.

$$\textbf{ASET}_{\text{L3 smoke layer height 2.1m AFFL}} > \textbf{1.0 x RSET}_{\text{Level 3}}$$

$$\textbf{ASET}_{\text{L2 smoke layer height 2.1m AFFL}} > \textbf{1.0 x RSET}_{\text{Level 2}}$$

10.7 Qualitative Evaluation

10.7.1 Function and Use

As detailed above, the Performance Arts/Founders and Arrow Building shall be served by required and non-required non-fire isolated stairways to serve as egress stairways during an evacuation. The stairways would provide interconnection between the different school levels and between the different buildings on site. Overall the stairways shall function as a communication stair, facilitating the general circulation & movement of teachers and students between the various school levels.

The Arrow building shall primarily accommodate the following:

- The Arrow Building is an external walkway structure which connects both new precincts and existing buildings
- Allows for students to circulate around the campus without the need to enter the building(s)
- The external walkways shall be covered by undulating perforated metal screens

The Performing Arts/Founders shall primarily accommodate the following:

- New building proposed to interlink existing Music and Founders Buildings
- Five (5) storeys overall with basement link to carpark
- Black Box Theatre, B1 Founders Building
    - The Black Box Theatre shall replace the existing ones situated within the B1 level of the Founders Building

  - The Black Box shall be openable to an outdoor fixed tiered seating space which transitions from ground level
  - Staff to have the ability to close the Black Box from the outdoor space to transform it into a rehearsal studio
- Assembly Hall & Lobby
  - Multi-functional space situated on L1 proposed to operate under a number of modes including performance, concert & assembly
  - The assembly hall shall contain an upper-level mezzanine providing access to upper tiers and adjacent learning facilities in the precinct
  - Interconnection to Library & Founders Building via external walkway (Arrow Building)

The Class 9b school will have two distinct groups of occupants, students and teachers. Referring to the dominant occupant characteristics provided in Section 2.2, teachers while few in number, will be familiar and will have a natural tendency to take charge and direct students to evacuate in the event of an emergency. Students will be the majority and have various degrees of ability and familiarity, however students would be expected to wait to be given instructions typical for the age and the teacher student relationship and generally begin to evacuate from the building as directed by the staff/teacher occupant group to a designated safe area, and the students can be considered familiar with the school layout.

The Performance Arts/Founders portion may operate anywhere between 5 to 7 days per week with performances during after school hours. The type of occupants expected within the performing arts centre would be staff and students who can be regarded as permanent (i.e. regular) and therefore likely to be familiar to a significant degree with the overall layout of the building. The other group of occupants expected within the performing arts centre are the general public attending performances who may be considered as transient and therefore less familiar with the building.

10.7.2 Fire Hazard

The fire hazards associated with the Arrow Building & Founders/PA blocks is considered to be relatively low when compared to other building classifications. Based on the statistics outlined below and in Appendix B, it is evident that the main risk and hazards for schools relate to property protection and not to the life safety of occupants. The main salient points with regards to school fire hazards are as follows (Clancy et al 2004):

- Many education department officers cannot recall any deaths in school fires; hazard to life safety is low.
- On average, a school fire with losses exceeding one million dollars occurs every two weeks in Australia. However, this loss is less than 0.1% of school assets.
- Losses from burglaries in schools are seven times larger than fire losses.
- Most fires are small; most of the loss is due to only a small proportion of all fires.
- Most of the losses appear to be due to arson. However, statistics on this matter are unclear. Arson is sometimes interpreted as burglary.
- Arson fires are consistently the single most significant source of fire starts (54% of school fires in NSW, 60% in UK, and 52% in USA).
- The school fire problem is one of property protection the responsibility for which lies with the owner rather than the building code. It is a small but significant problem.
- The following depicts the typical equipment and fuel loads within Class 9b buildings. Although there are high levels of combustible materials (i.e. timber, plastic, paper etc.), the ignition sources are deemed extremely low due to the function and use of the classrooms.
- From the Victoria and NSW data collected, it was determined that the portion of fires in majority of cases was suspicious/ incendiary. The total number of fires for the Victorian results was noted as being 220 fires and 478 fires for the NSW sets of results.
- With respect to the Performance Arts the fire load of the stage area is expected to primarily consist of performance props/decorations, and audio/visual equipment. The fire load of the auditorium area is expected to primarily consist of seating. The ignition sources that are primarily related to the proposed building include:
  - electrical switch assemblies
  - lighting
  - electronic audio/video stage equipment
  - Occasional special effects equipment for staged performances

As the main cause of fires is arson, it can be assumed that the hours in which the fires are likely to occur is after school hours (between 3:00pm to 8:00am). The statistics have indicated that the main ignition sources in a school facility are caused by the incendiary/suspicious. In most cases, fires caused were either confined to the object of fire origin and within close proximity (i.e. area) of fire origin. The likelihood of fires extending beyond the structure of origin is considered to be extremely low. It is evident from the results obtained that the main cause of fires in a school facility is the incendiary/suspicious types of fires. The next highest is noted as being undetermined.

Therefore, it can be concluded that the likelihood of an accidental fire initiating within the subject building (i.e. being Class 9b) in particular, within the Arrow Building & Founders/PA blocks is likely to be consistent with a DtS compliant design.

10.7.3 Fire Safety Systems

10.7.3.1 Passive Fire Separation

The Performing Arts building is provided with an open stairway interconnects four (4) storeys in lieu of three (3) within sprinkler protected building. In this instance it is proposed to fire separate the ground level (i.e. L0) to provide an equivalent DtS building design. To ensure the performing arts open stairway does not interconnect more than three (3) consecutive storeys the fire-separation method shall consist of the following:

- Full-height solid bounding construction extending to the underside of the slab above (i.e. between L0 to L1 slab) and achieving a minimum FRL of 120-minutes from both sides. The doors serving the stairway shall be self-closing and achieve an FRL of -/120/30 fitted with medium temperature smoke seals. Refer to Figure 10.4; and

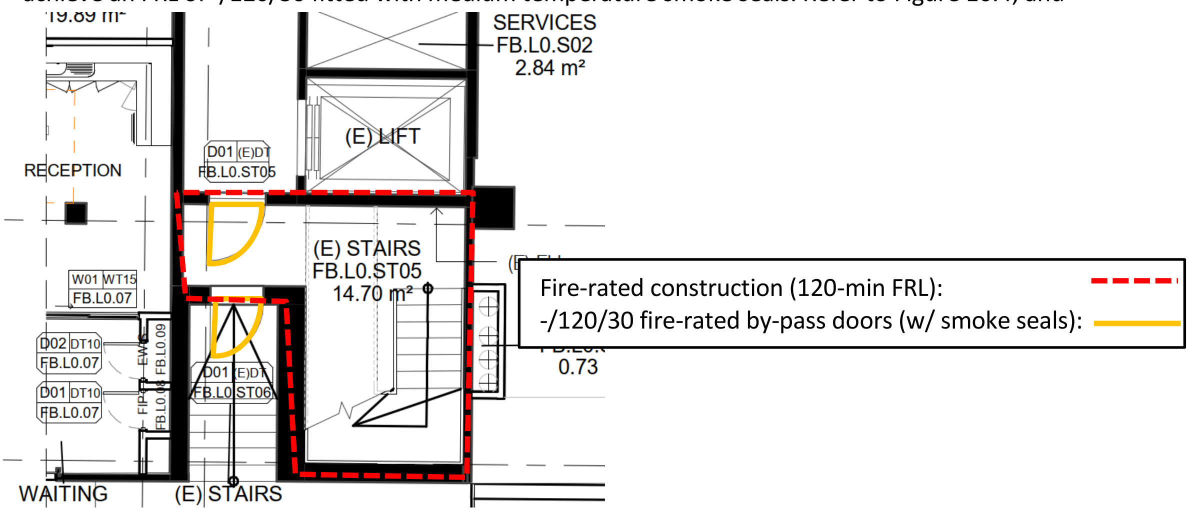


Figure 10.4: Fire separation at L0 stairway within Performance Arts/Founders

10.7.3.2 Automatic Sprinkler System

The Performance Arts/Founders and Arrow blocks shall be provided with automatic sprinkler protection and shall be designed and installed in accordance with AS 2118.1:2017. From the information presented in Appendix D in the majority of cases where a sprinkler system is present and activates accordingly, the fires are generally confined to the object or area of fire origin. Additionally, statistics presented by Hall (2010) have demonstrated that where sprinklers were present in the fire area, they operated in 93% of all reported fires large enough to activate sprinklers and furthermore were effective 97% of the time resulting in a combined operating performance of 91%.

Automatic sprinklers are capable of suppressing or controlling fires such that the temperature rise of fire product gases and radiant heat is significantly reduced. It is assumed that the hot layer gases remain at the same temperature, as they were when the sprinklers activate which is approximately 75-100°C. It is evident that the effect of sprinklers on a fire is to wet down potential fuel sources, control or suppress the burning process and to cool the resultant smoke layer. It has been cited that the resultant smoke temperatures in a sprinkler-controlled fire are reduced to 100°C -120°C within 60 seconds of sprinkler activation (CIBSE 1997, Sekizawa, 1996, Milke, 2001, Madrzykowski, 2008).

It is considered that the automatic sprinkler system shall activate to either supress or control a potential fire event which shall considerably improve conditions for occupant in an emergency situation. It is considered that with the presence of automatic sprinkler protection, tenable conditions shall be maintained along the egress routes such that occupants are able to safely travel to the exit on ground level (i.e. L0) should the need arise.

10.7.4 Egress Analysis

10.7.4.1 Founders/PA

The subject stairway which connects four (4) storeys provides egress for occupants within the Founders and Performance Arts building. As per Section 10.7.3.1 it is proposed to fire separate the ground level (i.e. L0) of this stairway to provide an equivalent DtS building design.

Clause D1.3(a)(ii) states that a non-fire isolated stairway is permitted for a Class 9b occupancy if it passes through two (2) consecutive storeys. Furthermore, one storey can be added if the building has a sprinkler system. In this instance the building is sprinklered and as such three (3) consecutive storeys is permitted. However, this stairway is connecting four (4) consecutive storeys.

However, to provide the non-fire isolated stairway to connect three (3) consecutive levels, it is proposed to provide fire rated construction around the stairway at ground level (i.e. L0) which shall eliminate the ground level (i.e. L0) being connected to the stairway. Refer to Figure 10.5 and Figure 10.6 for an illustration.

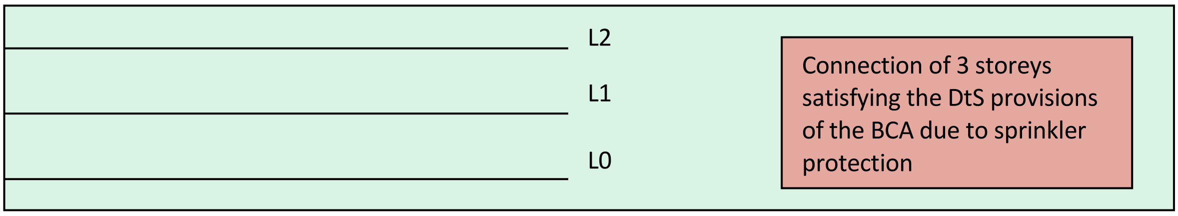


Figure 10.5: DtS Solution

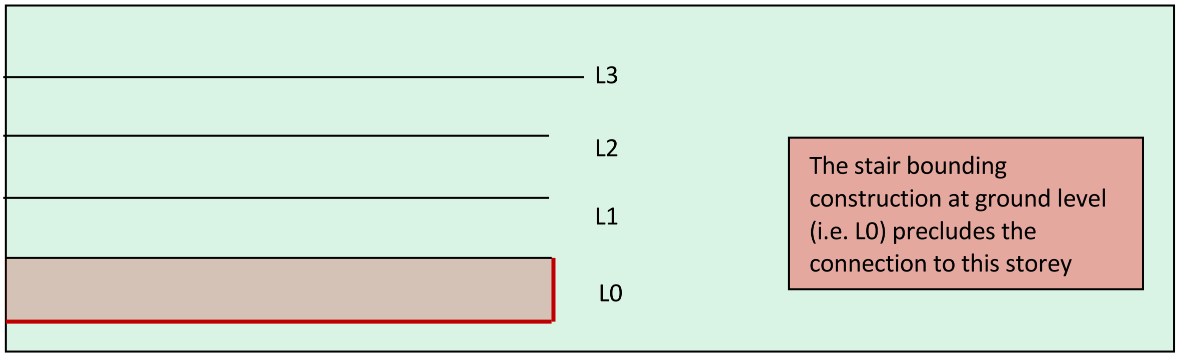


Figure 10.6: Performance Solution

This means occupants evacuating from either Level 1, 2 or 3 via the non-fire isolated stairway would have minimal effect from a potential fire at ground level (i.e. L0) due to the stairway being protected. It should be noted that on all levels above ground occupants are provided with another stairway for egress if the nominated open stairway is compromised.

Therefore, it can be stated that the proposal for the non-fire isolated stairway is comparably equivalent to a DtS solution since the non-fire isolated stairway is open for three (3) consecutive levels and protected on the ground floor.

10.7.4.2 Arrow Building

In this instance the Arrow Building is provided with three (3) open stairways which interconnect up to either four (4) or five (5) storeys in lieu of three (3) within sprinkler protected building. The intent is to permit the identified stairways to remain non-fire isolated without any further fire separating construction. This has been based on the function and use, egress provisions, semi-external in nature and fire safety systems located within the Arrow Building.

As described in previous section the Arrow Building is an external walkway structure which connects both new precincts and existing buildings and allows for students to circulate around the campus without the need to enter the building(s). The external walkways shall be covered by undulating perforated metal screens. The Arrow building extends from ground (i.e. L0) to level 4. Refer to Figure 10.7 and Figure 10.8 for plan and elevation view of the Arrow building based on the description provided above.

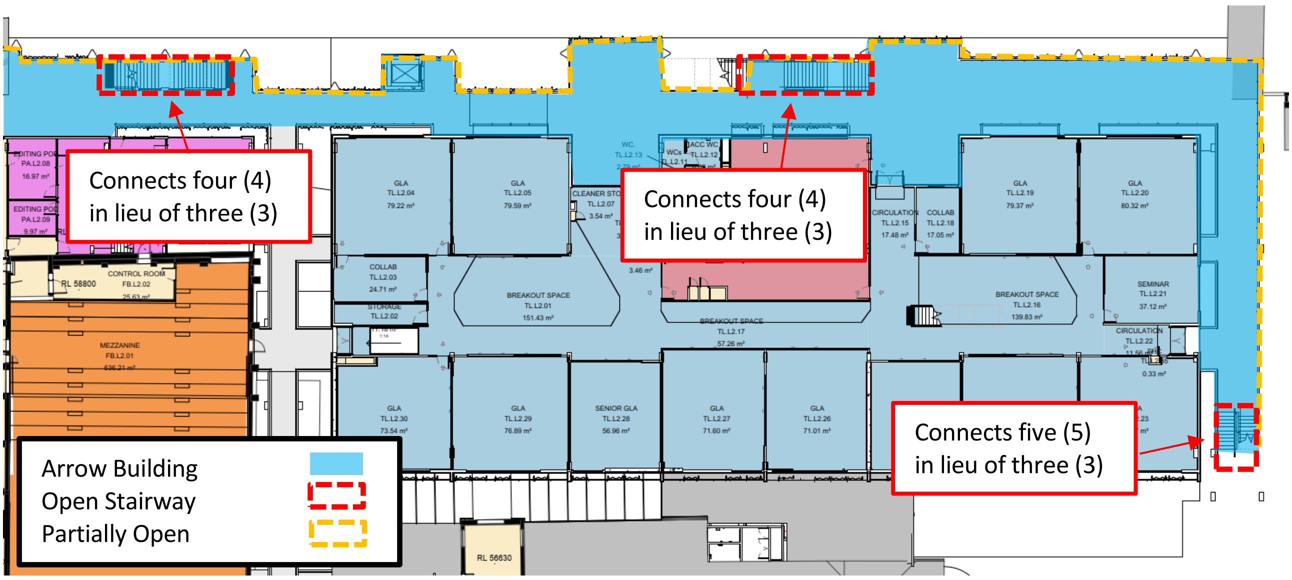


Figure 10.7: Typical Arrow Building Level (i.e. Level 2)

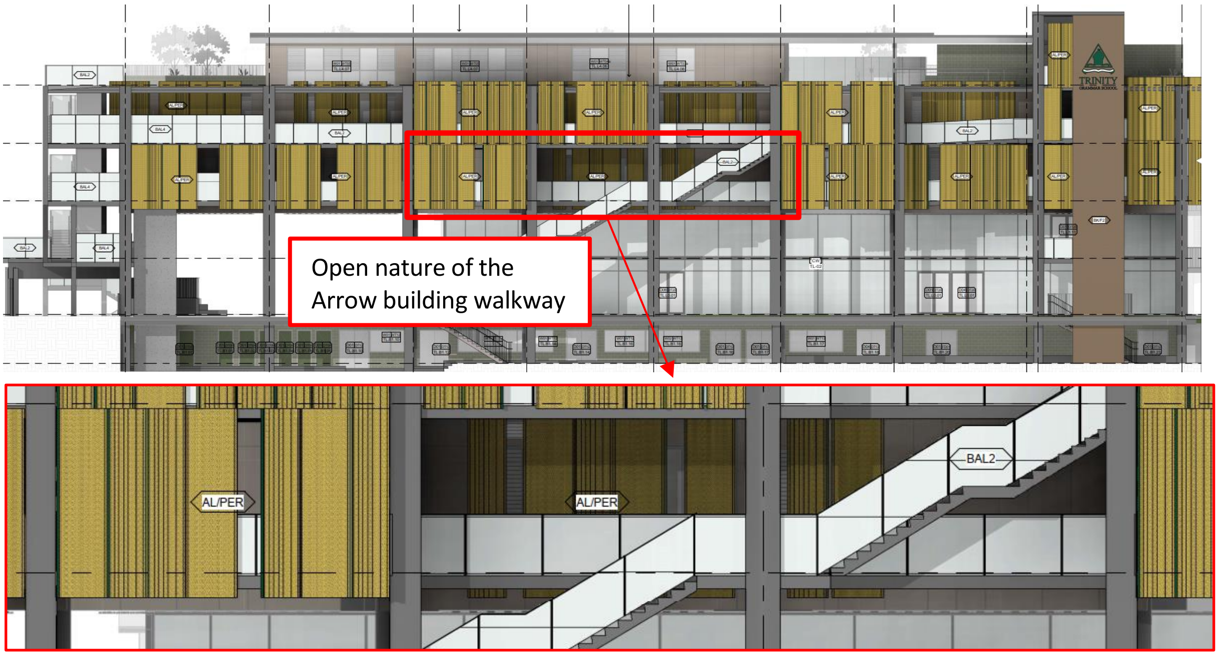


Figure 10.8: West Elevation of Arrow Building

Based on the function and use of the Arrow building there would be limited fuel loads and ignition sources present. The main fuel loads would consist of student lockers which would be connected to the external walls of the Teaching and Learning and some scattered seating for students. With respect to ignition sources this would also be limited to mainly electrical lighting and outdoor heating equipment. As such the likelihood of a fire initiating within this space is deemed to be highly unlikely. Since it's an external walkway structure the area is considered to be transient for students who are circulating around the campus between building and as a result the main throughfares will not be stored with fuel loads which would impact on the functionality of this space.

To further aid occupants to evacuate efficiently within this space, it is required to maintain the egress pathways free of obstructions and combustible materials. This is considered to minimise any obstructions that may impede occupant evacuation and furthermore, limit fuel loads contributing towards the development and growth of a potential fire.

In the highly unlikely event of a fire within the external walkways of the Arrow building, the western elevation has been provided with undulating perforated metal screens and open portions to assist in the ventilation of smoke and hot gases directly into the atmosphere. This has been illustrated in Figure 10.8. It should be further noted that the Arrow building is also provided with a suite of fire safety measures. The underside of external walkway covering shall be fitted with sprinklers and detectors.

Providing early detection shall ensure that the occupants investigate the fire during the early stages of fire development. This would allow for possible early intervention, if safe to do so, assist staff to direct students with early evacuation. The Arrow building shall be provided with emergency lighting and exit signage to assist in way-finding during an evacuation.

Further to the automatic detection the structure shall be protected by automatic sprinkler protection. From the information presented in Appendix D, in the majority of cases where a sprinkler system is present and activates accordingly, the fires are generally confined to the object or area of fire origin. The presence of sprinklers within this space shall ensure that the fire shall be contained within the external walkways of Arrow building and reduce the likelihood of fire spread back into the Teaching and Learning areas.

During an evacuation based on a fire within the Arrow building the location of the stairways assist in effective egress. As shown in Figure 10.7 the three (3) stairways are separated by a distance of 30m from one another. As such in the highly unlikely event that one (1) of the stairways is compromised occupants are provided with an alternative stairway to evacuate. Due to the distance between stairways, the non-fire isolation of the stairways which connect more than three (3) storeys within the Arrow building will not have a detrimental impact on occupants evacuating from this space.

Based on the assessment undertaken above the with three (3) open stairways which interconnect up to either four (4) or five (5) storeys in lieu of three (3) within sprinkler protected building shall be permitted to remain non-fire isolated without any further fire separating construction.

10.7.5 Fire Brigade Intervention

As detailed in Section 5, the approximate time associated with Fire Brigade notification, kerbside arrival and set-up activities to the point where fire-fighters are ready commence water application activities was determined to be in the order of **2,142 seconds** or approximately 36 minutes.

From an access perspective, attending fire crews shall be provided with multiple entry points from both internal & external locations along the L0 & L1. With respect to the Founders and Performance Arts building, fire brigade can utilise the non-fire isolated stairway or an external stairway to gain access into the building. Similarly, the Arrow building is served with three (3) non-required non-fire isolated external stairways but also internal stairways from the Teaching and Learning building which provides access to the Arrow building. As such the fire personnel shall be provided with perimeter entrances from ground level (i.e. L0) in conjunction with the external stairs. The multiple stairways throughout the building shall provide crews with multiple points to ascend the building internally and/or externally.

From an operational perspective, the building shall be provided with fully compliant fire hydrant system achieving the required pressures/flows and coverage requirements. Fire crews would likely set-up & stage operations externally prior to entering the building and ascending the stairs either externally or internally. In addition, correct activation of the automatic sprinkler system can be expected to present fire crews with favourable conditions from which to conduct intervention activities.

Based on the rationale presented above it is therefore considered that attending fire-fighter personnel shall be able to undertake intervention activities inclusive of the discontinuous stair arrangements without being negatively impacted upon.

10.8 Quantitative Assessment (as per FRNSW comment)

10.8.1 General

In line with FRNSW comment, the following quantitative assessment has investigated the effectiveness of the ventilation provisions to the external walkway portion and the maintenance of tenability for occupants egressing via this external portion prior to these external areas being compromised. This evaluation has adopted an ASET/RSET analysis. An FDS model has been undertaken & analysed to determine the smoke layer height within the external "Arrow Building" portion in order to assess smoke spread into a portion of this external walkway from a fire scenario located within the adjacent internal portions of the building.

In this instance, a fire scenario shall be located in the staff room of the T&L building at Level 2 in order to assess the potential impact on the adjacent stair (i.e. AB_ST11 & AB_ST10). This portion of the Arrow Building has been selected for quantitative analysis for the following reasons of conservatism:

- The area surrounding subject stairway contains a number of screens (typically 50% free area) which may result in reduced ventilation/venting capacity of this portion of the arrow building when compared to other portions; and
- Stair TL_ST08 from L4 leading to L3 is a stair involving discontinuous egress, whereby occupants are then expected to egress via the subject selected stairs AB_ST11 & AB_ST10. Furthermore, occupants egressing from the discontinuous stair TL_ST07 are likely to either take the subject stairs or alternatively stair AB_ST14. Accordingly, the quantitative analysis also considers the impact on occupants affected by discontinuous egress as outlined in Section 11.
- The subject stairways AB_ST11 & AB_ST10 also serve as exits with regard to a number of extended travel distances to an exit & between alternate exits. Accordingly, the quantitative analysis also considers the impact on occupants affected by this extended travel distances as outlined in Section 9, and indicated in Figure 9.2 & Figure 9.3.
- The Level 2 staff room located adjacent to this area was selected as the lowest proximate internal location adjacent to these stairs i.e. L1 and GF library portions shall be set-back from these stairs resulting in a likely lower impact of smoke on the subject egress path.

The intent of the proposed an ASET/RSET analysis was to investigate the effectiveness of the ventilation provisions to mitigate smoke/fire spread into the proposed stairway and ensure occupants are able to evacuate via the external walkway portion while tenability is maintained.

10.8.2 Fire Scenario

In this instance and as nominated above, the fire scenario shall be located within the Staff Room on Level 2 of the T&L building (TL.L2.14). The subject fire scenario has been selected to determine the impact on occupants who are utilising the adjacent stairs AB_ST11 & AB_ST10 in order to determine if they can still utilise the external stairways without untenable smoke conditions occurring within this external walkway space.

As illustrated in Figure 10.11 the fire scenario is as follows:

- **FS01: Sprinkler controlled scenario** (1st ring sprinkler activation) (core scenario).
  - The design fire assumes an electrical malfunction of a notebook computer igniting the computer then the adjacent furniture.
  - The sprinkler shall activate at 138 seconds and as designed shall control the fire (fast t^2 fire – refer to Table 9.4 & Table 9.5).
  - The fire will grow at a fast t^2 rate and maintain its heat release rate upon activation of the sprinkler heads, hence the fire is not extinguished.

10.8.3 FDS Program

For the assessment of the subject development, the fire and smoke spread model Fire Dynamics Simulator (FDS Version 6.7.5) has been used to model the fire scenario. The NIST field model FDS is a Computational Fluid Dynamics (CFD) model of fire-driven fluid flow. The FDS software is appropriate for low-speed, thermally driven flow with the emphasis on smoke and heat transport from fires (K B McGratten et-al 2002). The FDS model to be used is a deterministic 'fire model' which is used to predict the spread of heat and smoke in an enclosure or multiple enclosures. Visual presentations of the FDS simulation modelling results have been provided using the 'smokeview' program (K B McGratten et-al 2002).

CFD models, or as sometimes referred to, field models rely less on empirical correlations and are based on solving conservation equations for mass, momentum and energy. Fluid dynamics involves mathematical equations that describe the physical behaviour of fluids (gases and liquids) and are in the general form of three-dimensional, time-dependent, non-linear partial differential equations known as the 'Navier-Stokes' equations. Further details of the Computational Fluid Dynamics model are presented in Appendix H.

10.8.4 FDS Model Geometry

The modelled domain has adopted a simplified geometry based on the L2 & L3 arrow building floor plate located adjacent to the subject staff room portion, including the partially open elevations, and the staff room or fire origin. In this instance, smoke spread from the staff room to the external arrow building shall occur via an opening assumed to be an open window. As such this has been provided within the FDS model. The FDS model has adopted the following compartment geometries (refer to Figure 10.9 to Figure 10.12).

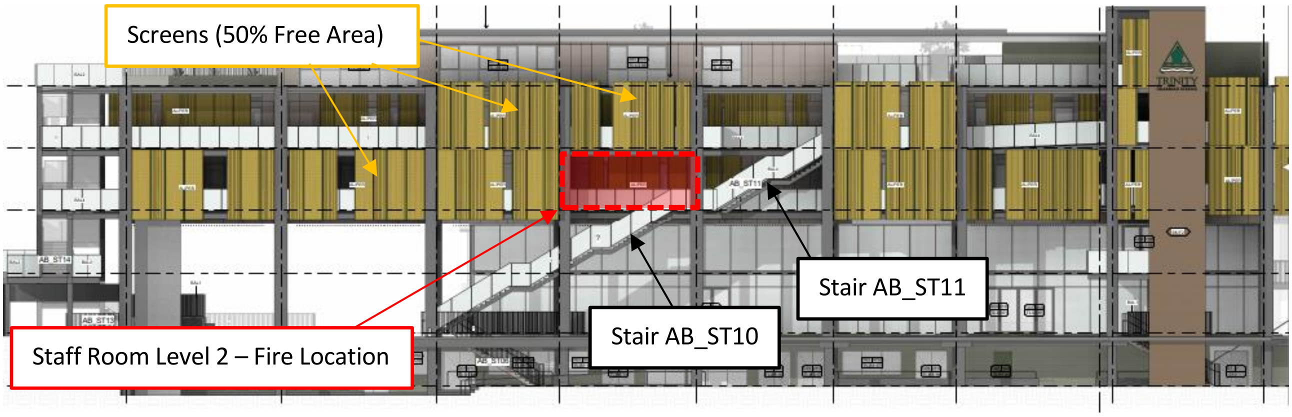


Figure 10.9: Elevations View (Arrow and T&L Building)

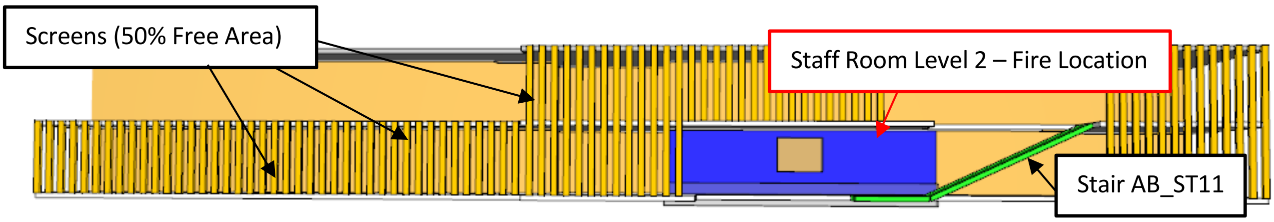


Figure 10.10: FDS Model – Side view illustrating opening from staff room and arrow building screens

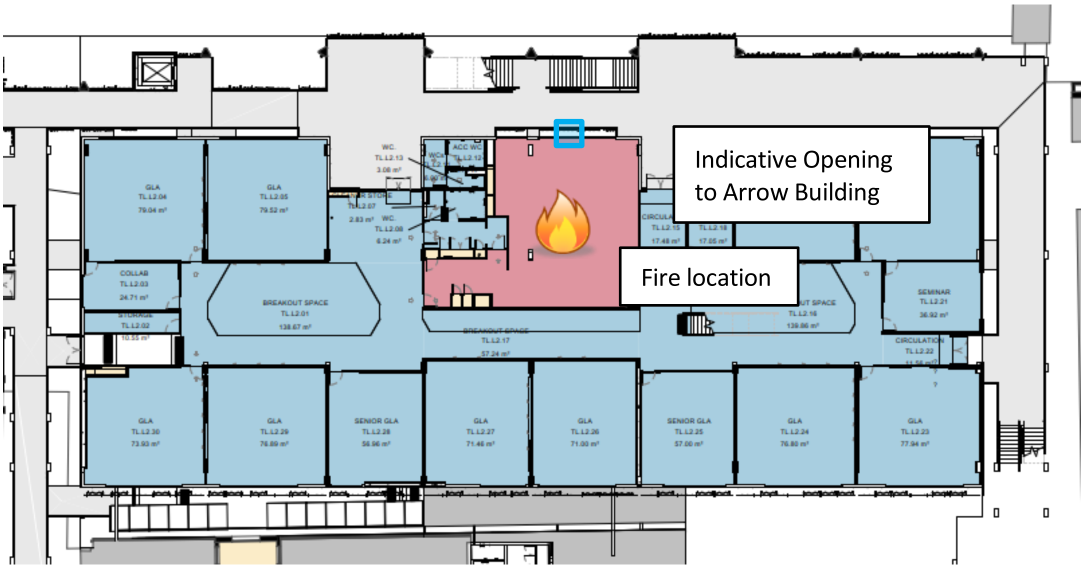


Figure 10.11: Level 2 Floor Plan (Fire Level)

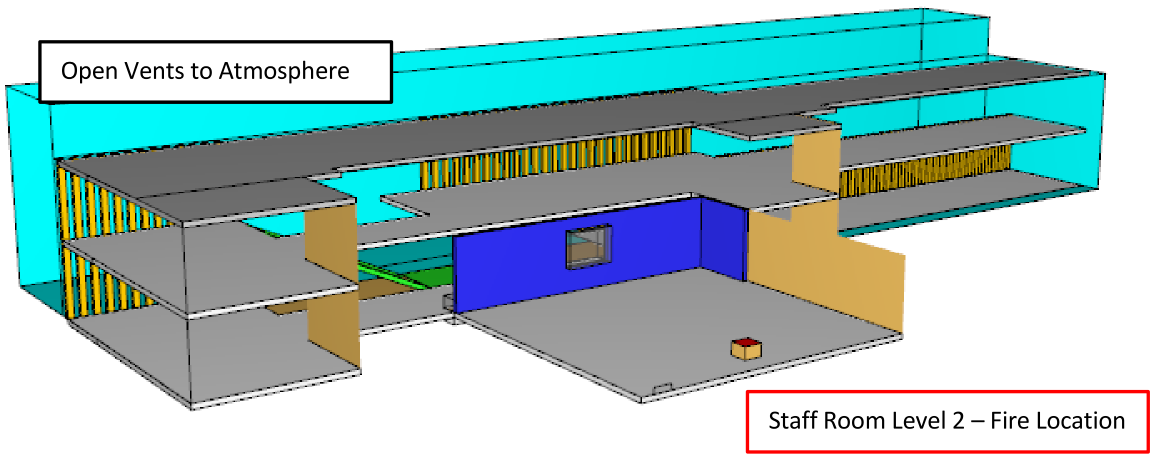


Figure 10.12: FDS Model – Isometric View

10.8.5 Design Fire Justification

In this instance the design fire has been based on the time for sprinkler activation to occur and control the heat release rate. Following sprinkler activation, it has been assumed that the fire maintains its peak heat release and hence the fire is not extinguished. Alpert's Correlation has been conducted utilising the input parameters detailed in Table 10.2 & Figure 10.13.

Table 10.2: Alpert's Correlation input parameters (TL.L2.14)

Parameter	Input
Fire location	TL.L2.14
Distance between fire and sprinkler	3.25m (based on 4.6m x 4.6m grid spacing, 12m^2 coverage to LH)
Sprinkler height	2.75m
Sprinkler activation temperature	68°C (FEG, 1996)
Sprinkler Response Time Index (RTI)	50m$^{-0.5}$s$^{-0.5}$ (FEG, 1996)
Fire growth rate	Fast t^2

Required Inputs	
Ambient Temperature, T =	20 (°C)
Fire Growth Rate =	Fast
Time Step Interval =	20 (s)
Radial Distance of the Detector from the Fire, r =	3.25 (m)
The Height of the Ceiling above the fire, H =	2.75 (m)
The Response Time Index of the Detector, RTI =	50 ($m^{1/2}s^{1/2}$)
Sprinkler Density of Discharge =	5 mm / min
Sprinkler Activation Temperature =	68 (°C)
Calculated Quantites at Detector Activation	
The Gas Temperature at Sprinkler Activation, T =	99.01 (°C)
HRR at Sprinkler Activation =	834.18 (kW)
The Gas Velocity, U =	1.14 (m/s)
Time at Sprinkler Activation =	138 (s)
Time to Reach 10% of peak HRR =	824 (s)
Ratio, r / H =	1.18

Figure 10.13: Alpert's Correlation program output

From the program output reproduced in Figure 10.13 the sprinkler system is calculated to activate at a time of **138 seconds** corresponding to a fire size of **850kW** or **0.85MW**.

The FDS model has adopted a soot yield (Y_s) value of **0.07 kg/kg.** This has been based on Verification Method: Framework for Fire Safety Design C/VM2 table 2.1 which stipulates a soot yield of 0.07 kg/kg for pre flash over fires in "All buildings including storage with a stack height of less than 3.0m". This is further supported by Table 10.3 which details soot yield values extracted from Table A.39 of SPFE (5th Edition, 2016) for well-ventilated free burning fires involving "sooty" fuels are in the range 0.008 –0.18 g/g with lesser values appropriate for clean burning fuels and wood products.

Table 10.3: Soot Yields appropriate to a variety of materials (values extracted from Table A.39 of SFPE 5th Edition, 2016)

Fuel	Soot Yield (kg/kg)	Fuel	Soot Yield (kg/kg)
Polyurethane Foam	0.131	PVC	0.172
Plastics (Nylon)	0.075	Synthetic material (PE)	0.007
Corrugated Paper Boxes	0.061	Synthetic material (Silicone)	0.006
Polystyrene Foam	0.180	Synthetic material (PMMA)	0.022
Wood	0.015	Synthetic material (PP)	0.059

The FDS model has adopted a soot yield (Y_s) value of **0.07 kg/kg**. This soot yield value is considered to be representative of a variety of fuel loads which may be situated within the school building.

10.8.5.1 FDS Modelling Outcomes (Visibility)

As noted in the previous section, ASET shall be determined for the time at which the smoke layer height within either Level 2 or Level 3 breaches a smoke layer height of 2.1m above the finished floor level such that visibility is reduced to be less than 10m. A secondary criterion of convective heat has also been adopted if the smoke layer height drops below 2.1m. According to the SFPE handbook an acceptable temperature threshold for heat to not irritate or burn humans is taken as 60°C.

Based upon the smoke modelling conducted, Table 10.4 provides an summary of the outcomes for the model. The table specifically details the major occurrences in relation to the acceptance criteria as detailed in Section 10.6. Graphic modelling outcomes are depicted in Appendix H.

Table 10.4: Design fire scenario discussion

Design Fire Scenario	Design Fire Scenario Summary	Layer Height and Temperature at the Conclusion of the Modelling
FS01: Sprinkler controlled scenario (1st ring sprinkler activation) **Core Scenario**	The design fire assumes an electrical malfunction of a notebook computer igniting the computer then the adjacent furniture. **Growth Rate:** Fast t^2 **Ceiling Height:** 3.25m **Fire Size:** 0.85MW **Location:** TL.L2.14	**System Activation:** The sprinkler shall activate at 138 seconds and as designed shall control the fire. **Occupant Tenability Criteria:** **Visibility:** The model demonstrated acceptable tenable conditions within the visibility acceptance criteria (i.e. visibility >10m) within the Arrow Building being maintained for a duration as follows: • Level 3 – Visibility criteria was not breached (<10m) for the duration of the model at 1000 seconds. This was due to the ventilation provisions applicable to the external walkway. • Level 2 – Visibility criteria was not breached (<10m) for the duration of the model at 1000 seconds. This was due to the ventilation provisions applicable to the external walkway. **Convective Heat:** The smoke layer temperature (below 2.1m above the finished floor level) did not exceed 60°C for durations greater than 1000 seconds due to the convection of cool air (i.e. open nature of walkway). **Conclusion:** The visibility and temperature tenability criteria was not breached at 1000 seconds and as such determined the ASET to be >1000 seconds.

The FDS model has adopted a simulation time of 1000 seconds. The modelling outcomes have demonstrated that the ventilation provisions provided to the Arrow Building (i.e. completely open or 50% free area sheeting) provide substantial venting availability for smoke spreading from the T&L building to the Arrow Building. Smoke build-up within the arrow building did not occur to breach the visibility or temperature occupant tenability criteria during the 1000 seconds of model duration. Refer to Appendix H for FDS results.

10.8.5.2 RSET

Core Scenario

In the event of a fire, occupants would be expected to be alerted to the presence of a fire through activation of the smoke detection or sprinkler system. In this instance, the fire initiating in the Level 2 TL.L2.14 shall provide occupant notification via the activation of the fire detection system. Based on Alpert's correlation has been conducted to calculate the smoke detector activation time (detection time) within a fire at Level 2 TL.L2.14. The resulted detailed in Section 9 calculated a detection time of 68 seconds, while the Pre-Movement Time (T_{pm}) has been taken as 90 seconds for the classroom areas as per Section 9.8.3.

The movement time was determined based on computer modelling software Pathfinder. It should be noted that the pre-movement time was incorporated into the movement time modelling as described above. In this instance, movement Time (T_m) including the pre-movement time was estimated as 90 seconds.

The overall RSET ($T_d + T_{pm} + T_m$) was 503 seconds (i.e. 68 sec + 435 sec).

10.8.5.3 ASET/RSET Comparison

It is therefore concluded that tenable conditions are maintained within the Arrow Building for periods greater than the required time to evacuate with a sufficient safety factor. Table 10.5 provides a summary of the ASET/RSET comparison and safety factor achieved.

Table 10.5: ASET/RSET comparison

Fire Scenario	Evacuation Scenario	RSET (s)	ASET (s)	ASET/RSET Safety Factor	Acceptance Criterion Satisfied
Fire within TL.L2.14	Full Occupant Loading with access to all exits. Occupant evacuation begins following detection and pre-movement times.	503	>1000	>1.98	YES

Based on the outcomes above, it is concluded that the externally open walkway (i.e. arrow building) and associated stairways are unlikely to compromise the ability for occupants to egress via the non-fire isolated stairways available around the Arrow Building. This is attributed to the performance of the automatic sprinkler protection and open nature of the Arrow Building afforded by open elevations.

In this instance, the acceptance criterion of 1.0 has been met as per Section 10.6. In this instance the analysis demonstrated a factor of safety of 1.98.

Fire within TL.L2.14: 503 seconds $_{(RSET)}$ < 1000 seconds $_{(ASET)}$

Redundancy Scenario

While the above ASET analysis has demonstrated ongoing tenability being achieved under steady-state conditions at the termination of the 1000 second model. The analysis has also conducted a Redundancy Evacuation Scenario to demonstrate the impact of the availability of egress routes from the Arrow Building/external walkway. In this instance, an additional evacuation model was conducted which had assumed that the subject stairway has been blocked and is no longer available to occupants. The impact of overall evacuation from the building has therefore been considered under this event. In this instance, the evacuation model without the use of the subject stair was found to involve only a slight increase in the evacuation time of occupants.

The overall RSET ($T_d + T_{pm} + T_m$) was 525 seconds (i.e. 68 sec + 457 sec).

Therefore it is noted that even in the very unlikely event where this non-fire isolated stair was compromised, occupants are provided with substantial alternate egress routes with only a minor increase in evacuation times.

Table 10.6: ASET/RSET comparison – Redundancy Scenario

Fire Scenario	Evacuation Scenario	RSET $_{Redundancy}$ (s)
Fire within TL.L2.14	Redundancy Scenario: Full Occupant Loading. Subject Stairway most proximate to fire scenario is blocked (i.e. Acceptance Criteria not met). Occupant evacuation begins following detection and pre-movement times.	525 i.e. + 22 Seconds (4.3% Increase)

10.9 Discussion of Assessment Outcomes

The qualitative evaluation undertaken above has considered the open stairways with respect to potential fire/smoke spread and impact on occupant life safety. The function/use of the stair was described and noted to facilitate both circulation & egress. With respect to the Performing Arts building stairway it was concluded that the separation measures at ground level (i.e. L0) effectively altered the stairway such that it connected three (3) consecutive levels in lieu of four (4) and comparable to an equivalent DtS building solution.

With respect the Arrow building the three (3) open stairways which interconnect up to either four (4) or five (5) storeys in lieu of three (3) within sprinkler protected building shall be permitted to remain non-fire isolated without any further fire separating construction due to the open nature of the external walkways, low fire hazards and fire safety systems (i.e. sprinklers and detection).

In the context of occupant egress, occupants are provided with multiple egress pathways within the Founders/ Performance Arts and Arrow buildings. The availability of alternative exits provides occupants with a level redundancy.

In line with FRNSW comment, an ASET/RSET analysis was conducted utilising FDS modelling. The modelling demonstrated the effectiveness of the open elevations and natural ventilation provisions to maintain tenability within this external walkway portion by venting the smoke directly to atmosphere without creating untenable conditions adjacent to the area of fire origin. The ASET/RSET comparison demonstrated that occupants are able to safely evacuate prior to untenable conditions occurring and are afforded with a safety factor in the order of 1.98. An additional redundancy study was undertaken to demonstrate that suitable levels of alternate egress are also providing such that in the event one exit did become inaccessible, the evacuation time would be expected to be only slightly impacted.

In this regard, it was concluded that the proposed design afforded a suitable level of protection to the subject external non-fire isolated stairs, to the degree necessary.

In the context of fire brigade intervention, attending fire crews were noted to be afforded with safe & reliable access to the Founders/ Performance Arts and Arrow buildings. Overall, it was concluded that fire crews would be able to conduct intervention activities in a manner that is no different to an equivalent DtS building solution.

Based on the rationale presented above it is therefore concluded that the proposed design meets the relevant Performance Requirements of CP1, CP2 & DP5 of the BCA. This conclusion is contingent on the requirements detailed in Section 15.2 being implemented into the design.

11. Travel via Non-Fire Isolated Stairway – Discontinuous Egress Paths

11.1 Background to the Issue

It has been identified that there are a number of non-fire isolated stairways serving the Teaching & Learning & Founders/PA blocks that do not provide a continuous means of egress by their own flights/landings. In this regard, occupants are required to descend via the open stairways and travel horizontally to an adjacent stairway prior to evacuating to road or open space. The proposed design forms a deviation from Clause D1.9(a) of the BCA which prescribes non-fire isolated stairways to provide a continuous means of egress by way of their own flights/landings directly to road or open space. Figure 11.1 to Figure 11.4 illustrate the discontinuous egress paths.

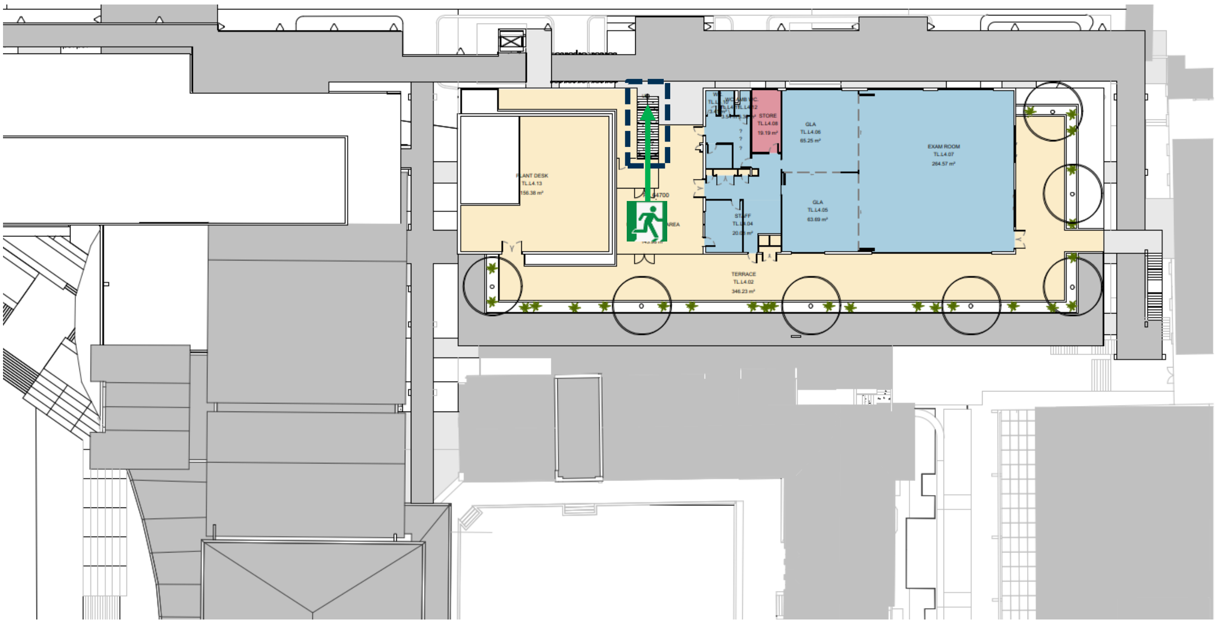


Figure 11.1: Discontinuous egress (L4)

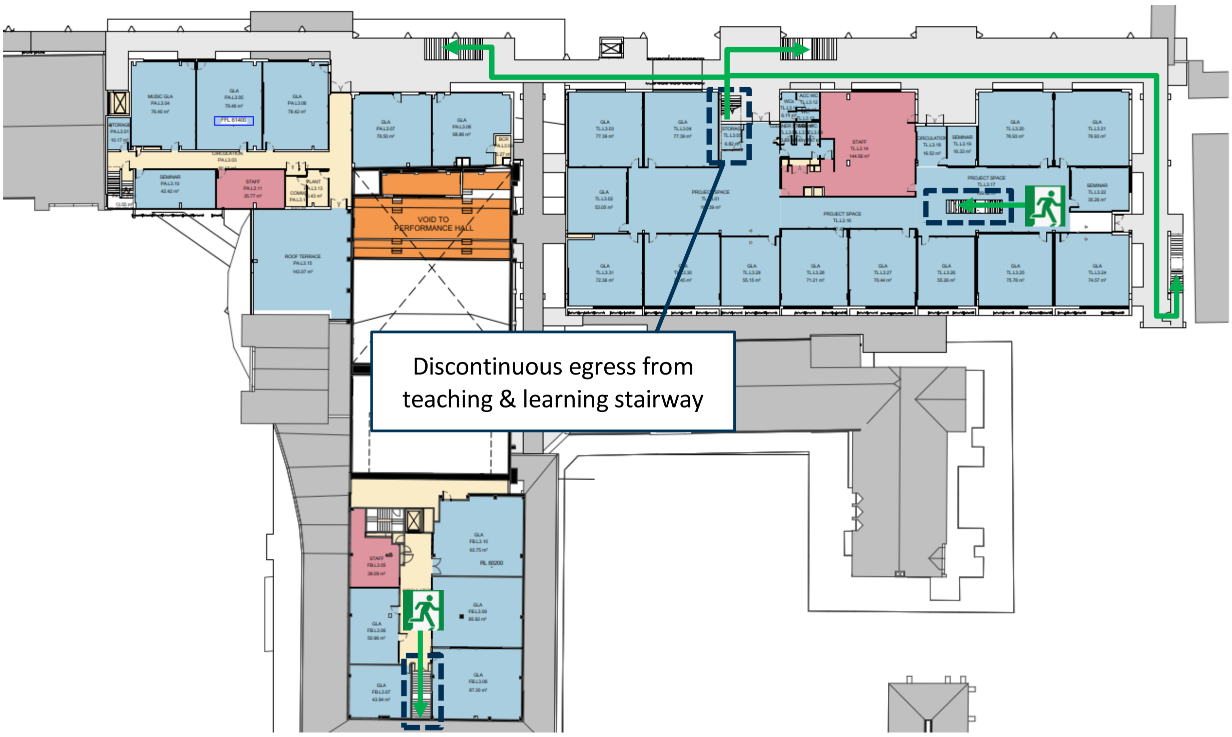


Figure 11.2: Discontinuous egress (L3)

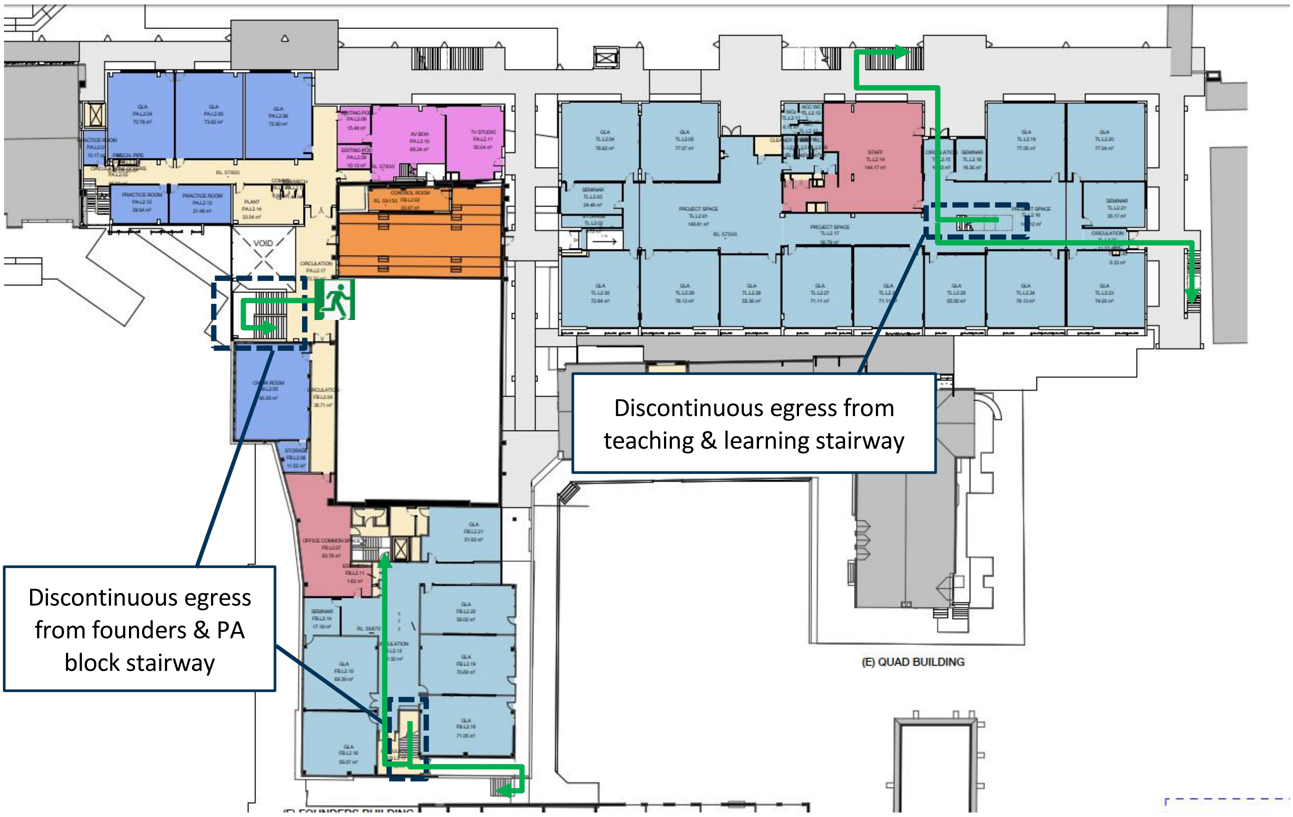


Figure 11.3: Discontinuous egress (L2)

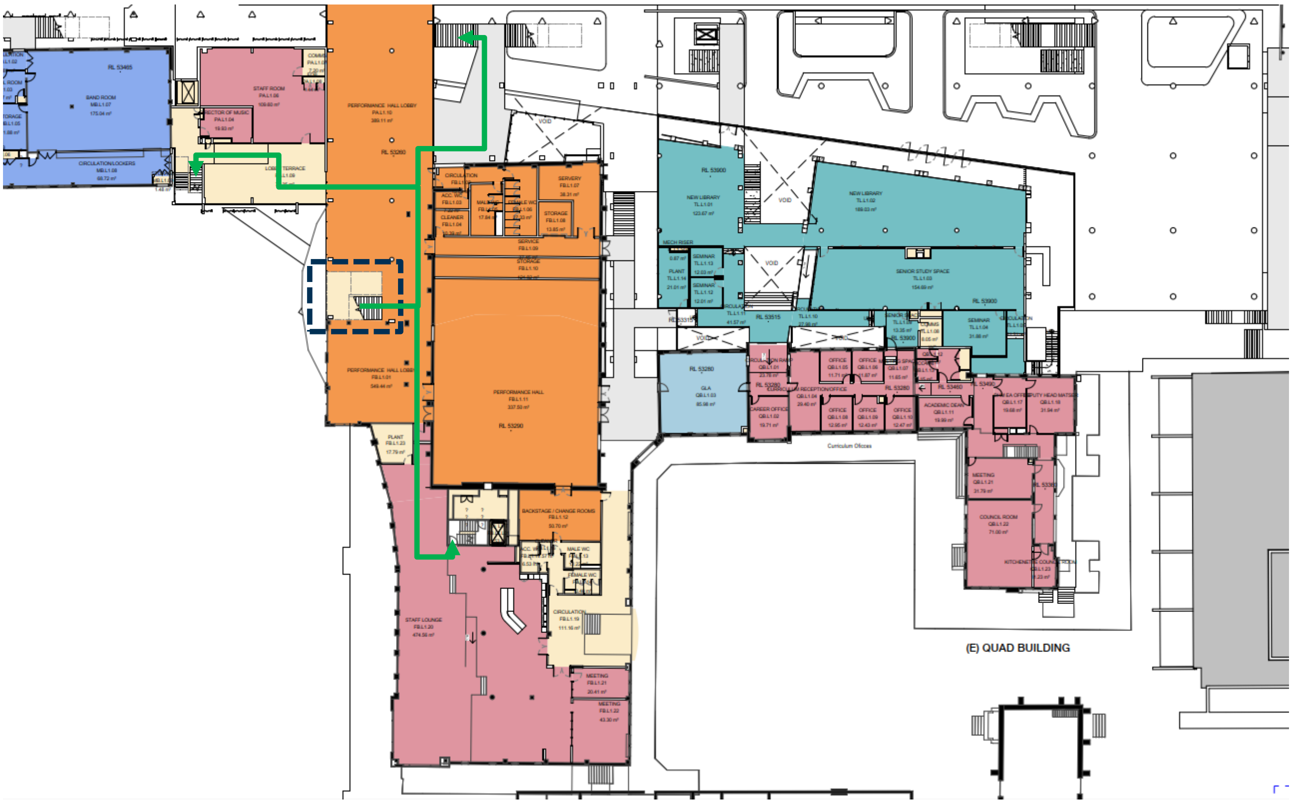


Figure 11.4: Discontinuous egress (L1)

11.2 Performance Solution

In accordance with the BCA Clause A2.2 *Performance Solution* the following assessment method has been adopted to demonstrate that the *Performance Solution* meets the relevant *Performance Requirements of DP4 & EP2.2.*

Table 11.1: Method of Analysis

Identified Design Issues	Performance Solution	AFEG Method of Analysis
It has been identified that a number of the non-fire isolated stairways serving the Teaching & Learning & Founders/PA blocks that do not afford a continuous means of egress by their own flights/landings.	A2.2(2)(b)(ii) Other *Verification Methods*, accepted by the *appropriate authority* that show compliance with the relevant *Performance Requirements.*	A qualitative 'deterministic' approach demonstrating that the proposed design satisfies the *Performance Requirements* of the BCA.

11.3 Hazards Specific to Travel via Non-Fire Isolated Stairway – Discontinuous Egress Paths

The 'Guide to the BCA' (ABCB, 2019) states that the intent associated with prescribing continuous means of egress via non-fire isolated stairs as being *"To require that a person using a non-fire-isolated stairway or ramp be provided with a safe evacuation path".* It is therefore, considered that the main hazards specific to the design issues requiring assessment are:

- The potential for fire by-products (smoke and toxic gasses) to restrict the path of occupant travel (i.e. potential for tenability limits to be exceeded within the path of travel); and
- Increase in potential obstructions within the path of travel; and
- The potential for smoke to obscure the view of the non-fire isolated stair arrangements providing egress during a potential fire situation.

11.4 Hazard Mitigation

The 'Guide to the BCA' (ABCB, 2019) identifies the potential for occupants to encounter unsafe conditions as they evacuate via discontinuous stair arrangements. In this regard the following hazard mitigation systems, requirements and features of the design are noted:

- Automatic sprinkler protection shall be provided throughout the building in accordance with BCA Clause E1.5, Specification E1.5 and AS2118.1:2017 with the inclusion of the following:
  - Automatic sprinkler protection shall be installed to the following building locations:
    - Teaching & Learning (incl. Quadrangle building); and
    - The underside of the Level 2 slab located above the Agora portion of the building shall be provided with sprinkler protection; and
    - Arrow Building (external walkways); and
    - Music Building; and
    - Performance Arts (incl. cafeteria & assembly hall); and
    - Founders Building; and
  - Sprinkler heads shall be fast response type heads having an actuation temperature of not greater than 68°C and RTI of not greater than $50m^{-0.5}s^{-0.5}$; and
  - Activation of the sprinkler system shall initiate a General Fire Alarm (GFA) throughout the Trinity Grammar School campus; and
  - Omit the requirement to provide automatic sprinkler protection within main switch rooms within the Teaching & Learning and Performing Arts/Founders Buildings; and
- Automatic smoke detection shall be provided throughout all buildings of the Stage 3-5 portion in accordance with AS1670.1:2018 and with the inclusion of the following:
  - The main switch rooms within the Teaching & Learning and Performing Arts/Founders Buildings shall be provided with centrally located smoke detectors; and
  - The Basement Level 1 of the Teaching & Learning building shall be provided with a detection system on a reduced spacing of 8m x 8m in lieu of 10m x 10m; and
  - Additional detectors shall be installed within the sports building within 1.5m of tilt glass panel at distances no greater than 10m along the width of the tilt panel. Activation of these detectors shall activate the EWIS within the T&L building; and
- Provide a Building Occupant Warning System (BOWS) in accordance with BCA Specification E2.2a, AS1670.1:2018 which shall initiate on either sprinkler head or detector activation and with the inclusion of the following:
  - The BOWS shall comprise a pre-recorded public address system; and
  - The following buildings shall be provided with a BOWS:
    - Multi-Purpose Pavilion; and

  - Music Building; and
  - Arrow Building; and
- Provide an Emergency Warning & Intercommunication System (EWIS) in accordance with BCA Specification E2.2a and AS1670.4:2018 which shall initiate on either sprinkler head or detector activation to the following locations:
  - Teaching & Learning; and
  - Quadrangle Building; and
  - Performing Arts; and
  - Founders Building; and
- Occupants utilising the non-fire isolated stairways are provided with a point of choice at each lower-level landing; and
- Mounted exit signage shall be provided along the paths of travel and shall assist occupants in resolving wayfinding; and
- Evacuation diagrams/mud-maps shall be provided to direct occupants to nearest alternative exit location(s).
- Occupants are considered to be awake, alert and ready to respond in the event of a fire emergency.

11.5 Methodology

The methodology adopted to address the design issue relative to the discontinuous egress has been based upon a qualitative evaluation. The evaluation has considered the discontinuous egress paths with respect to the occupant characteristics, availability of alternative paths upon discharge and the proposed measures which shall improve wayfinding for evacuating occupants. The evaluation has also considered the likely impact imposed onto attending fire crews.

11.6 Acceptance Criteria

The basic objective and intent of the analysis shall pertain to occupant life safety. Thus, the primary acceptance criterion has been met by demonstrating that occupants are able to safely evacuate via the discontinuous stair configurations without any increased ambiguity or confusion. The secondary acceptance criterion has been met by demonstrating that fire crews are able to traverse the stair configuration without being negatively impacted.

11.7 Qualitative Evaluation

11.7.1 Function and Use

As detailed above, the Teaching & Learning & Founders/PA blocks shall be served by non-fire isolated stairways whereby upon descending occupants are required to horizontally travel to an adjacent stair prior to descending again and reaching the level of egress. In this instance, as the stair arrangements do not provide a continuous evacuation path to the level of egress there is the potential for occupants to become negatively impacted upon as they evacuate the building.

The Teaching & Learning shall primarily accommodate the following:

- General learning areas (GLA's) & staff rooms
- Largest classroom to support capacity for up to 30 x students
- Staff rooms centrally located with direct access to the Arrow Building (external walkways).
- Faculty space to contain desk/workstations, storage & break out furniture for collaborative work between staff & interaction with students
- Main access via the Arrow Building (external walkways) with internal circulation also provided

The Performing Arts/Founders shall primarily accommodate the following:

- New building proposed to interlink existing Music and Founders Buildings
- Five (5) storeys overall with basement link to carpark
- Black Box Theatre, B1 Founders Building
  - The Black Box Theatre shall replace the existing ones situated within the B1 level of the Founders Building
  - The Black Box shall be openable to an outdoor fixed tiered seating space which transitions from ground level
  - Staff to have the ability to close the Black Box from the outdoor space to transform it into a rehearsal studio
- Assembly Hall & Lobby
  - Multi-functional space situated on L1 proposed to operate under a number of modes including performance, concert & assembly
  - The assembly hall shall contain an upper-level mezzanine providing access to upper tiers and adjacent learning facilities in the precinct
  - Interconnection to Library & Founders Building via external walkway (Arrow Building)

The Class 9b school will have two distinct groups of occupants, students and teachers. Referring to the dominant occupant characteristics provided in Section 2.2, teachers while few in number, will be familiar and will have a natural tendency to take charge and direct students to evacuate in the event of an emergency. Students will be the majority and have various degrees of ability and familiarity, however students would be expected to wait to be given instructions typical for the age and the teacher student relationship and generally begin to evacuate from the building as directed by the staff/teacher occupant group to a designated safe area, and the students can be considered familiar with the school layout.

The Performance Arts/Founders portion may operate anywhere between 5 to 7 days per week with performances during after school hours. The type of occupants expected within the performing arts centre would be staff and students who can be regarded as permanent (i.e. regular) and therefore likely to be familiar to a significant degree with the overall layout of the building. The other group of occupants expected within the performing arts centre are the general public attending performances who may be considered as transient and therefore less familiar with the building.

11.7.2 Fire Hazard

The fire hazards associated with the Teaching & Learning & Founders/PA blocks is considered to be relatively low when compared to other building classifications. Based on the statistics outlined below and in Appendix B, it is evident that the main risk and hazards for schools relate to property protection and not to the life safety of occupants. The main salient points with regards to school fire hazards are as follows (Clancy et al 2004):

- Many education department officers cannot recall any deaths in school fires; hazard to life safety is low.
- On average, a school fire with losses exceeding one million dollars occurs every two weeks in Australia. However, this loss is less than 0.1% of school assets.
- Losses from burglaries in schools are seven times larger than fire losses.
- Most fires are small; most of the loss is due to only a small proportion of all fires.
- Most of the losses appear to be due to arson. However, statistics on this matter are unclear. Arson is sometimes interpreted as burglary.
- Arson fires are consistently the single most significant source of fire starts (54% of school fires in NSW, 60% in UK, and 52% in USA).
- The school fire problem is one of property protection the responsibility for which lies with the owner rather than the building code. It is a small but significant problem.
- The following depicts the typical equipment and fuel loads within Class 9b buildings. Although there are high levels of combustible materials (i.e. timber, plastic, paper etc.), the ignition sources are deemed extremely low due to the function and use of the classrooms.
- From the Victoria and NSW data collected, it was determined that the portion of fires in majority of cases was suspicious/ incendiary. The total number of fires for the Victorian results was noted as being 220 fires and 478 fires for the NSW sets of results.
- With respect to the Performance Arts the fire load of the stage area is expected to primarily consist of performance props/decorations, and audio/visual equipment. The fire load of the auditorium area is expected to primarily consist of seating. The ignition sources that are primarily related to the proposed building include:
  - electrical switch assemblies
  - lighting
  - electronic audio/video stage equipment
  - Occasional special effects equipment for staged performances

As the main cause of fires is arson, it can be assumed that the hours in which the fires are likely to occur is after school hours (between 3:00pm to 8:00am). The statistics have indicated that the main ignition sources in a school facility are caused by the incendiary/suspicious. In most cases, fires caused were either confined to the object of fire origin and within close proximity (i.e. area) of fire origin. The likelihood of fires extending beyond the structure of origin is considered to be extremely low. It is evident from the results obtained that the main cause of fires in a school facility is the incendiary/suspicious types of fires. The next highest is noted as being undetermined.

Therefore, it can be concluded that the likelihood of an accidental fire initiating within the subject building (i.e. being Class 9b) in particular, within the Teaching & Learning & Founders/PA blocks is likely to be consistent with a DtS compliant design.

11.7.3 Fire Safety Systems

11.7.3.1 Automatic Sprinkler System

The Teaching & Learning & Founders/PA blocks shall be provided with automatic sprinkler protection and shall be designed and installed in accordance with AS 2118.1:2017. From the information presented in Appendix D, in the majority of cases where a sprinkler system is present and activates accordingly, the fires are generally confined to the object or area of fire origin. Additionally, statistics presented by Hall (2010) have demonstrated that where sprinklers were present in the fire area, they operated in 93% of all reported fires large enough to activate sprinklers and furthermore were effective 97% of the time resulting in a combined operating performance of 91%.

Automatic sprinklers are capable of suppressing or controlling fires such that the temperature rise of fire product gases and radiant heat is significantly reduced. It is assumed that the hot layer gases remain at the same temperature, as they were when the sprinklers activate which is approximately 75-100°C. It is evident that the effect of sprinklers on a fire is to wet down potential fuel sources, control or suppress the burning process and to cool the resultant smoke layer. It has been cited that the resultant smoke temperatures in a sprinkler-controlled fire are reduced to 100°C -120°C within 60 seconds of sprinkler activation (CIBSE 1997, Sekizawa, 1996, Milke, 2001, Madrzykowski, 2008).

It is considered that the automatic sprinkler system shall activate to either supress or control a potential fire event which shall considerably improve conditions for occupant in an emergency situation. It is considered that with the presence of automatic sprinkler protection, tenable conditions shall be maintained along the egress routes (i.e. discontinuous internal stairways) such that occupants are able to safely travel to the exit on ground level (i.e. L0) should the need arise.

11.7.3.2 Way Finding and Visibility

In buildings where artificial lighting is provided for normal use, the illumination of the means of egress is required to ensure that occupants can evacuate the building quickly.

Studies conducted demonstrate that the ambient illumination and the sign luminosity influence the effectiveness of the exit signage. Ambient illumination has been shown to reduce the visibility of the emergency exit signs in either clear conditions or smoky conditions (Boyce & Mulder, 1995; Quellette, 1988, 1993). Sign luminosity however has a beneficial effect on sign visibility both in clear and smoky conditions. In smoke-filled conditions, the higher the luminosity resulted in better visibility for the occupants (Collins et al., 1992, Quellette, 1993). Refer to Figure 11.5 which illustrates illuminate exit sign within smoky conditions in an office building (for example).

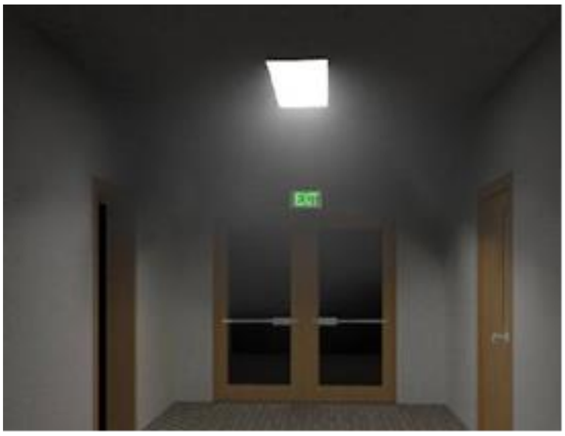


Figure 11.5: Illuminate exit sign within smoky conditions in an office building

Another variable impacting visibility for escape depends on the size of an enclosure and occupant familiarity with escape routes. Furthermore, people's response to obscuration of vision and its detrimental effects on movement speed and way finding efficiency is highly variable as familiarity, fire cues all become part of the evacuation process.

Referring to Section 11.7.1, the permanent staff (i.e. teachers) and students are considered to be generally familiar with the overall layout of the building and surroundings. It can be expected that they would be awake and alert. Generally, they would be able bodied but all would be considered to be familiar with the office layout and the exit locations to the extent that they would assist visitors in an evacuation. The visitors would be considered to be awake and alert yet not necessarily all familiar with the building layout or the emergency procedures.

However, as a result of the discontinuous nature of the stairway(s) serving the Teaching & Learning & Founders/PA blocks additional strategically located mounted exit signage shall be provided along the paths of travel and shall assist occupants in resolving wayfinding. The illuminated emergency lighting and exit signs throughout the building shall be provided in accordance with AS2293.1:2018.

As such any issues associated with wayfinding and familiarisation of the building are considered not to pose any significant life safety concerns for occupants given that there will be additional exit signs to assist staff/students and the presence of another stairway on the same level. This will be further supported by the presence of evacuation diagrams/mud-maps at the discharge location of the discontinuous stairways to direct occupants to nearest alternative exit location(s). Refer from Figure 11.6 to Figure 11.9 which illustrates the location of the additional directional exit signage and evacuation diagrams/mud-maps.

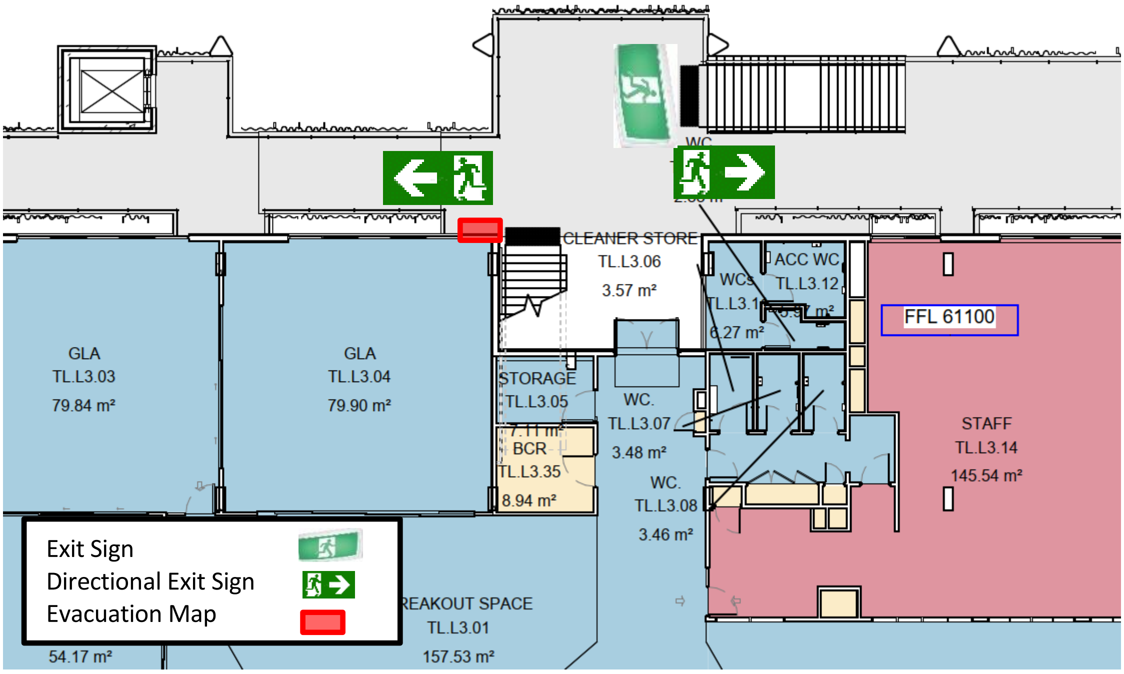


Figure 11.6: Identified additional direction exit signage and evacuation diagrams level 3 within Teaching & Learning

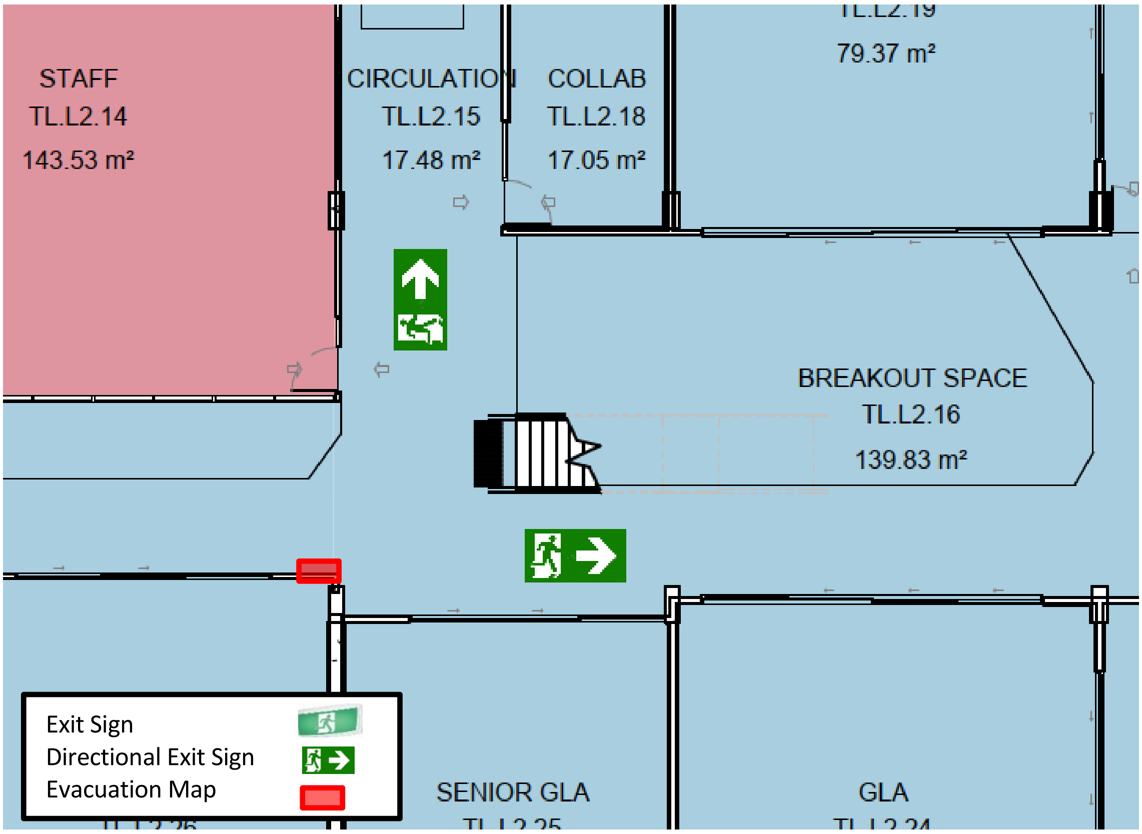


Figure 11.7: Identified additional direction exit signage and evacuation diagrams level 2 within Teaching & Learning

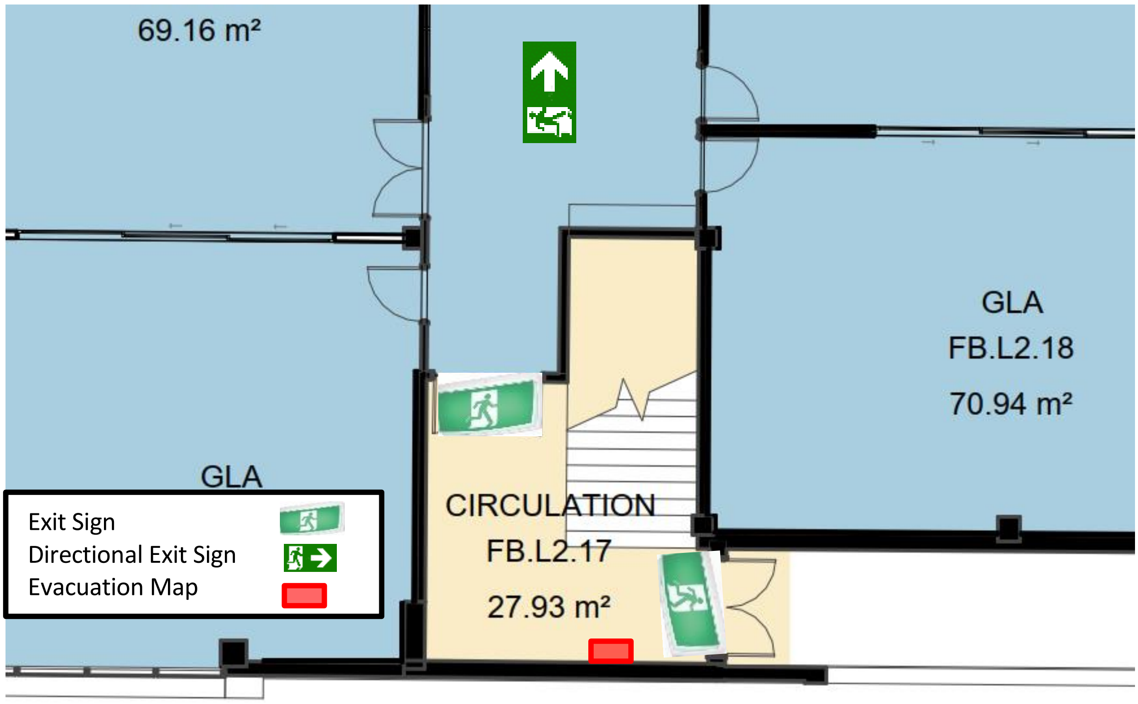


Figure 11.8: Identified additional direction exit signage and evacuation diagrams level 2 within Founders/PA

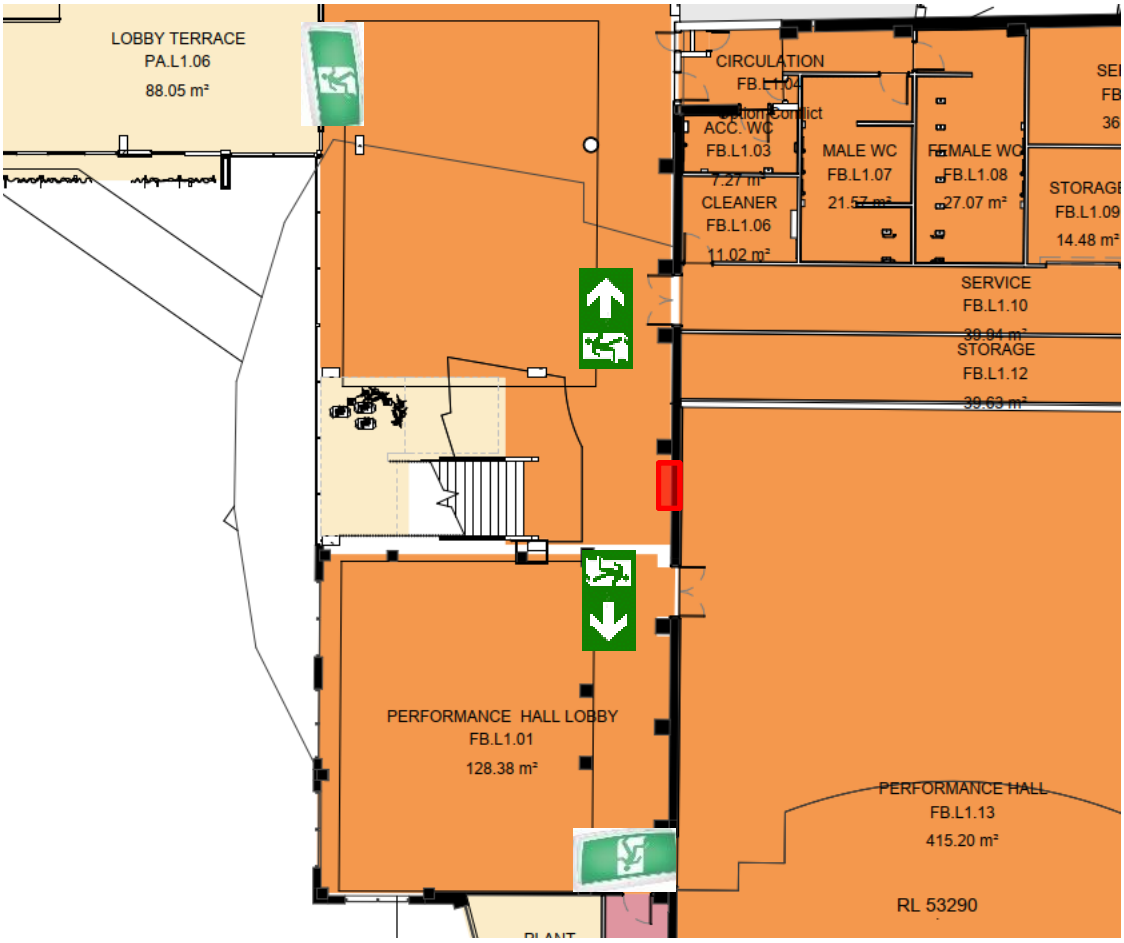


Figure 11.9: Identified additional direction exit signage and evacuation diagrams level 1

To further aid occupants to evacuate efficiently, it is required to maintain the immediate exit doorway and egress pathways free of obstructions and combustible materials. This is considered to minimise any obstructions that may impede occupant evacuation and furthermore, limit fuel loads contributing towards the development and growth of a potential fire.

11.7.4 Egress Analysis

In the event of a potential fire, the emergency evacuation process of building occupants in a fire emergency has been commonly recognised as comprising three major components. These are:

- Alarm activation and recognition phase
- Pre-movement phase
- Travel to safety phase

Of these three components, the travel time of the occupants to a place of safety is generally the most predictable and typically is the smallest time involved. The alarm activation and cue recognition coupled with the pre-movement phases can extend over several minutes of elapsed time. The travel time during an evacuation process is governed by the movement speed of occupants or queuing at potential bottlenecks such as doors. Given that the occupant numbers will be high due to the school environment and understanding the variability of individual response to alarms, the potential for any significant queuing to occur at any of the exits may occur. However, this can be managed by the multiple exits provided on a given floor plate to assist occupants during an evacuation.

As described above, egress from the building within Teaching & Learning & Founders/PA blocks on Level 1, 2, 3 and 4 is described below:

- External stair on Level 4 within Teaching & Learning as shown in Figure 11.1 shall discharge on Level 3 Arrow building before allowing occupants with three (3) paths of egress to an alternative stairway as shown in Figure 11.2; and
- Internal stair on Level 3 within Teaching & Learning as shown in Figure 11.2 shall discharge on Level 2 within Teaching & Learning before allowing occupants with two (2) paths of egress to an alternative stairway as shown in Figure 11.3; and
- Internal stair on Level 3 within Founders/PA as shown in Figure 11.2 shall discharge on Level 2 within Founders/PA before allowing occupants with two (2) paths of egress to an alternative stairway as shown in Figure 11.3; and
- Internal stair on Level 2 within Founders/PA as shown in Figure 11.3 shall discharge on Level 1 within Founders/PA before allowing occupants with three (3) paths of egress to an alternative stairway as shown in Figure 11.4; and

The main issue with the discontinuous nature of the stairway is occupants within the building not recognising the location of the secondary flight of stairs when they have discharged onto the level below. However, in this instance it is expected that the staff members and students are considered to be familiar with the layout would utilise the same path of travel to their respective areas to attend classes or the performance hall.

Taking the above into account way finding abilities by occupants to the exit is anticipated to be effective. This is further assisted with the presence additional exit signs and evacuation plans at Level 1, 2 and 3 to navigate the staff/students via to the alternative stairways as well as the presence of an automatic sprinkler which shall maintain the tenable conditions along the egress routes (i.e. discontinuous internal stairway) such that occupants are able to safely travel to the exits on ground level.

Given the magnitude and uncertainties associated with the times of the other phases such as detection and pre-movement, involved, this increase in travel time due to the discontinuous nature of the stairway at Level 1, 2, 3 and 4 within Teaching & Learning & Founders/PA blocks is considered to have minimal adverse impact on the life safety of occupants in the event of a fire. The assessment has outlined the nature of the building and occupants to establish the overall impact associated with the life safety of occupants during the evacuation process.

11.7.5 Fire Brigade Intervention

As detailed in Section 5, the approximate time associated with Fire Brigade notification, kerbside arrival and set-up activities to the point where fire-fighters are ready commence water application activities was determined to be in the order of **2,142 seconds** or approximately 36 minutes.

From an access perspective, attending fire crews shall be provided with multiple entry points from both internal & external locations along the L0 & L1. With respect to the Founders and Performance Arts building, fire brigade can utilise the non-fire isolated stairway or an external stairways to gain access into the building. Similarly the Teaching and Learning building & Arrow building is served with three (3) non-required non-fire isolated external stairways but also internal stairways from the Teaching and Learning building which provides access to the Arrow building. As such the fire personnel shall be provided with perimeter entrances from ground level (i.e. L0) in conjunction with the external stairs. The multiple stairways throughout the building shall provide crews with multiple points to ascend the building internally and/or externally.

From an operational perspective, the building shall be provided with fully compliant fire hydrant system achieving the required pressures/flows and coverage requirements. Fire crews would likely set-up & stage operations externally prior to entering the building and ascending the stairs either externally or internally. In addition, correct activation of the automatic sprinkler system can be expected to present fire crews with favourable conditions from which to conduct intervention activities.

Based on the rationale presented above it is therefore considered that attending fire-fighter personnel shall be able to undertake intervention activities inclusive of the discontinuous stair arrangements without being negatively impacted upon.

11.8 Discussion of Assessment Outcomes

Based on the qualitative assessment undertaken, it is therefore considered that occupants shall be able to effectively egress from the building irrespective of the discontinuous stair arrangement(s) serving the Teaching & Learning & Founders/PA blocks. It is considered that the proposed active and passive fire safety measures (i.e. additional exit signage, evacuation plans and sprinkler system) shall minimise the risk of occupant egress within the building. Based on the rationale presented, it is considered that the Performance Requirement DP4 & EP2.2 of the BCA is satisfied. This conclusion is contingent on the requirements detailed in Section 15.2 being implemented into the design.

12. Fire Hydrant System Design

12.1 Background to the Issue

As part of the fire services design and to achieve a level of consistency with the Stage 1 & 2 fire services infrastructure, the fire hydrant system is proposed to be designed & installed in accordance with the recent AS2419.1:2017 Australian Standard in lieu of the 2005 Australian Standard. The proposed design forms a deviation from Clause E1.3 of the BCA which prescribes the fire hydrant system to be designed & installed in accordance with the 2005 Australian Standard.

Note: This is consistent with the hydrant standard adopted for the design of Stage 1 and 2 prepared by Arup (Report No. 281228, V01, dated 17 March 2022).

12.2 Performance Solution

In accordance with the BCA Clause A2.2 *Performance Solution* the following assessment method has been adopted to demonstrate that the *Performance Solution* meets the relevant *Performance Requirements EP1.3.*

Table 12.1: Method of Analysis

Identified Design Issues	Performance Solution	AFEG Method of Analysis
The fire hydrant system is proposed to be designed & installed in accordance with the AS2419.1:2017 Australian Standard in lieu of AS2419.1:2005. *Note: This is consistent with the hydrant standard adopted for the design of Stage 1 and 2 prepared by Arup (Report No. 281228, V01, dated 17 March 2022).*	A2.2(2)(d) Comparison with the *Deemed-to-Satisfy Provisions.*	A qualitative 'comparative' approach has demonstrated that the design is at least equivalent to a *DtS Building Solution.*

12.3 Hazards Specific to Fire Hydrant System Design

The 'Guide to the BCA' (ABCB, 2019) states that the intent associated with prescribing the location of the fire hydrant booster assembly as being "*To require the installation of suitable fire hydrant systems to facilitate the fire brigades fire-fighting operations".* It is therefore considered that the main hazard specific to the identified design issue relates to:

- Increase in potential for attending Fire Brigade personnel to become unduly delayed/hindered whilst operating and utilising the fire hydrant system based on AS2419.1:2017 design.

12.4 Hazard Mitigation

The 'Guide to the BCA' (ABCB, 2019) identifies the potential for fire-fighting personnel to become unduly delayed or hindered whilst utilising the fire hydrant system. In this regard, the following hazard mitigation systems, requirements and features of the design are noted:

- Permit the fire hydrant system to be designed, installed & commissioned in accordance with AS2419.1:2017 in lieu of AS2419.1:2005 to be consistent with Stage 1 & 2; and
  - The Stage 3-5 portion will be served by the site-wide booster assembly which is located on Victoria Street. This location was included as a Performance Solution within the Arup FER; and
    - The booster shall be provided with a visual warning device (red strobe) in accordance with Clause 7.3.2 of AS2419.1:2017 and shall activate upon GFA; and
    - The block plans across the site (including at the booster assembly) shall be updated to reflect the Stage 3-5 works; and

12.5 Methodology

The methodology adopted to address the design issue relative to the fire hydrant design has been based upon a qualitative 'comparative' evaluation. The evaluation has conducted a gap analysis, in conjunction with direct input from the Fire Services Engineer, between the AS2419.1:2017 (proposed) and AS2419.1:2005 (required) Australian Standards to identify the key differences in hydrant design characteristics between the two (2) Standards. In this regard, the evaluation has compared both the proposed Performance Solution and an equivalent DtS building solution specific to fire brigade operations and use.

Note: *This is consistent with the hydrant standard adopted for the design of Stage 1 and 2 prepared by Arup (Report No. 281228, V01, dated 17 March 2022).*

12.6 Acceptance Criteria

The basic objective and intent of the analysis pertains to the life safety of evacuating occupants and attending fire-fighter personnel. Thus, the primary acceptance criterion has been met by demonstrating that the proposed fire hydrant system design maintains a level of functionality & efficacy that is at least equivalent to a DtS building solution.

12.7 Qualitative Evaluation

12.7.1 General

As detailed above, the fire hydrant system is to be designed in accordance with the most recent Australian Standard AS2419.1:2017 in lieu of AS2419.1:2005. The main reason is to ensure that the fire services design shall achieve a level of consistency with the Stage 1 & 2 fire services infrastructure which is proposed to be designed & installed in accordance with the recent AS2419.1:2017 Australian Standard in lieu of the 2005 Australian Standard.

The fire hydrant system shall form part of the buildings essential services and is provided solely for use by attending fire-fighter personnel. More specifically, the hydrant system is provided for fire crews to charge their hydrant hoses and enable commencement of water extinguishment activities. In this regard, the fire hydrant system is required to meet the operational demands of the attending fire brigade.

The following qualitative analysis has been conducted to demonstrate that the proposed system shall maintain a level of functionality & efficacy as an equivalent DtS building solution and furthermore shall facilitate deployment of Standard Operating Guideline's (SOG's).

12.7.2 Australian Standards Comparison

Table 12.2 provides a comparison of the fire hydrant system design considerations/parameters that prescribed within the two (2) Australian Standards.

Table 12.2: Comparison of fire hydrant standards – AS2419.1:2005 & AS2419.1:2017

Hydrant Design Parameter/ Characteristic	AS2419.1:2005 (DtS Building Solution)	AS2419.1:2017 (Performance Solution)	Comment
Minimum number of hydrants required to flow simultaneously	Equivalent design outcome	Equivalent design outcome	Equivalent design outcome
Minimum fire hydrant outlet pressure & flow rate	20 L/s @ 250 kPa unassisted or 700 kPa assisted	Equivalent design outcome	Equivalent design outcome
Hydrant pressure when fire pump is operating	700 kPa	700 kPa	Equivalent design outcome
Hydrant outlet location and protection requirements	Internally: situated within fire-isolated stairway or within 4m of required exit Externally: situated >10m from building façade, or, if <10m provided with radiant heat shield protection	Internally: situated within fire-isolated stairway or within 4m of required exit Externally: situated >10m from building façade, or, if <10m provided with radiant heat shield protection or sprinkler protection	Similar requirements whereby the 2017 Australian Standard allows concession for sprinkler protection buildings. Equivalent design outcome
Hydrant outlet coverage requirements	30m with additional 10m hose spray	30m with additional 10m hose spray	Equivalent design outcome
Hydrant system water supply requirements	Equivalent design outcome	Equivalent design outcome	Equivalent design outcome
Provision of water storage tank/s	Equivalent design outcome	Equivalent design outcome	Equivalent design outcome
Fire hydrant pump configuration & control	Diesel or electric pump to boost hydrant pressure	Diesel or electric pump to boost hydrant pressure	Equivalent design outcome
Fire brigade booster assembly arrangement, location and protection requirements	As per BCA 2019 Amendment 1 & AS2419.1:2005	As per BCA 2019 Amendment 1 & AS2419.1:2017	Similar requirements whereby the 2017 Australian Standard allows concession for sprinkler protection buildings. Equivalent design outcome

Hydrant Design Parameter/ Characteristic	AS2419.1:2005 (DtS Building Solution)	AS2419.1:2017 (Performance Solution)	Comment
Pipework, valves & fittings	Galvanised steel pipes suitable in accommodating pressure fluctuations of the boosted system. Valve connections compatible with fire brigade connections.	Galvanised steel pipes suitable in accommodating pressure fluctuations of the boosted system. Valve connections compatible with fire brigade connections.	Equivalent design outcome
Inspection, testing & commissioning	Equivalent design outcome	Equivalent design outcome	Equivalent design outcome
Other key differences specific to the design of the subject building.	Equivalent design outcome	Equivalent design outcome	Equivalent design outcome

Based on the comparison presented above the adoption of the AS2419.1:2017 hydrant standard is considered to provide an equivalent design outcome. Operationally, fire crews shall be afforded with identical hydrant provisions which achieve the required pressures/flows & coverage for hydrant outlets.

In this regard, the proposed design is considered to facilitate the operational requirements of the fire brigade. On this basis can be concluded that the proposed design shall maintain a level of functionality & efficacy that is at least equivalent to a DtS building solution.

12.8 Discussion of Assessment Outcomes

The qualitative evaluation undertaken above has considered the proposed fire hydrant design with respect to the impact on attending fire brigade operations. A gap analysis was conducted between the 2005 & 2017 Australian Standard and demonstrated that the key hydrant characteristics (i.e. pressure/flow, coverage, outlet locations etc.) did not vary significantly between either Standard. It was therefore concluded that the proposed design maintained a level of efficacy & functionality equivalent to a DtS building solution whilst also facilitating the Standard Operational Guideline's (SOG's) of the attending fire brigade.

Based on the rationale presented above, it is considered that the proposed design meets the Performance Requirement of EP1.3 of the BCA. This conclusion is contingent on the requirements detailed in Section 15.2 being implemented into the design.

13. Omission of Fire Hose Reels

13.1 Background to the Issue

It is proposed to omit the requirement to provide fire hose reels throughout the building (i.e. library, staff lounge, administration etc, noting that classrooms & associated corridors are not required to be provided with fire hose reels). In this instance, additional portable fire extinguishers shall be provided to facilitate an initial fire attack by building occupants. The proposed design forms a deviation from Clause E1.4 of the BCA & AS2441:2005 which prescribes fire hose reels to be provided within school buildings (excl. classrooms & associated corridors). Figure 13.1 to Figure 13.7 depict the general locations which are proposed to omit fire hose reels.

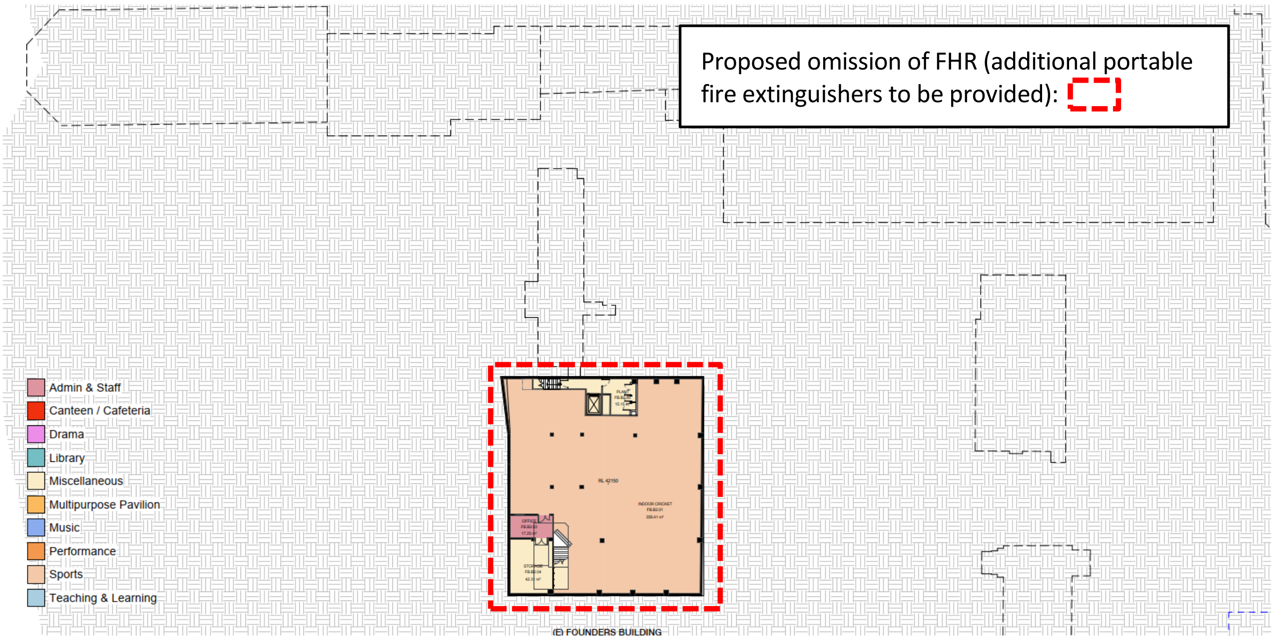


Figure 13.1: Areas proposed to omit FHR (B2)

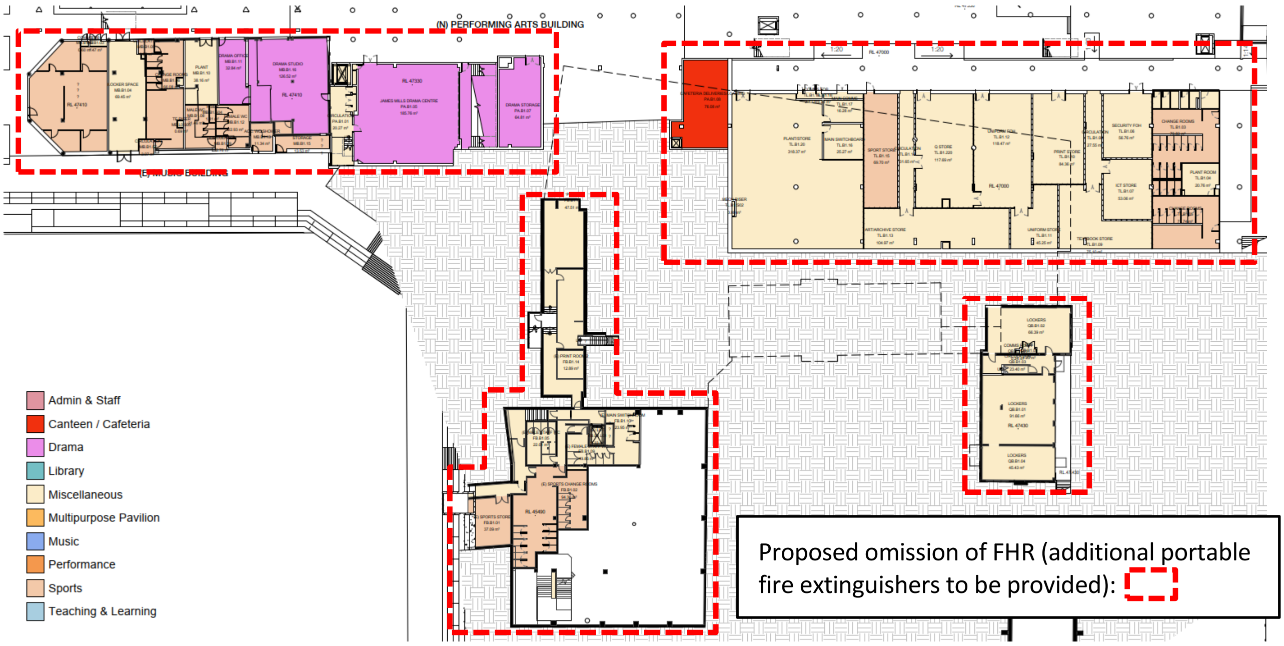


Figure 13.2: Areas proposed to omit FHR (B1)

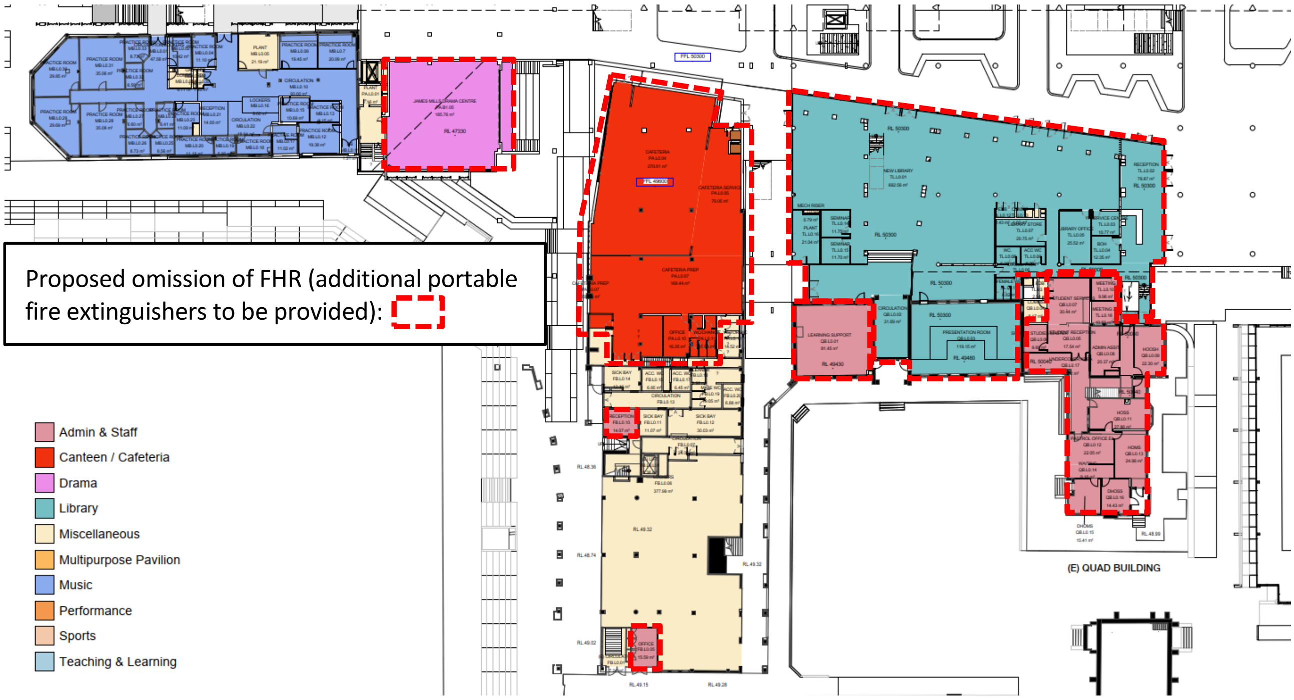


Figure 13.3: Areas proposed to omit FHR (L0)

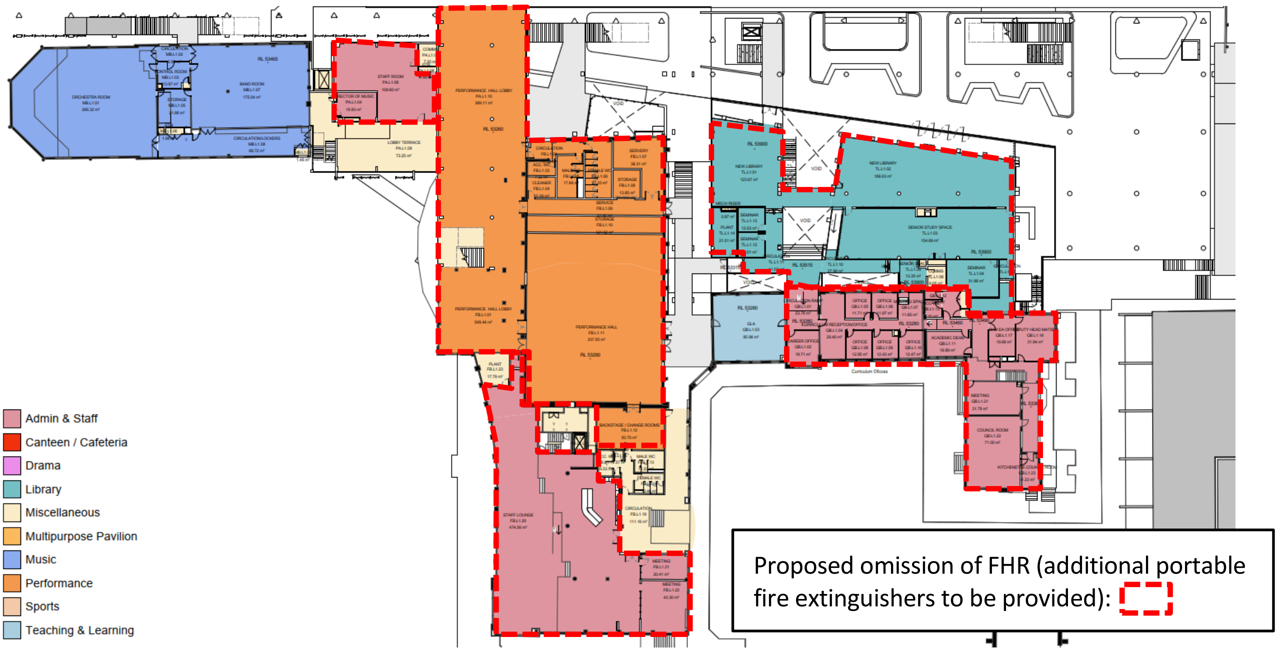


Figure 13.4: Areas proposed to omit FHR (L1)

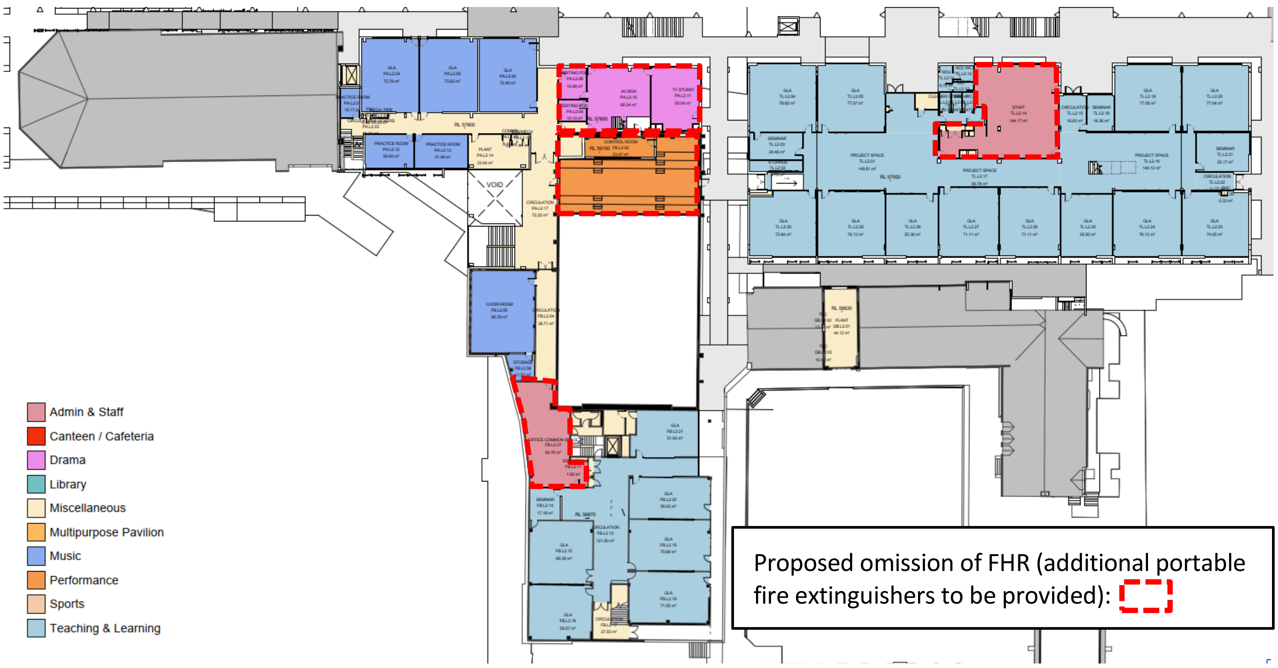


Figure 13.5: Areas proposed to omit FHR (L2)

Figure 13.6: Areas proposed to omit FHR (L3)

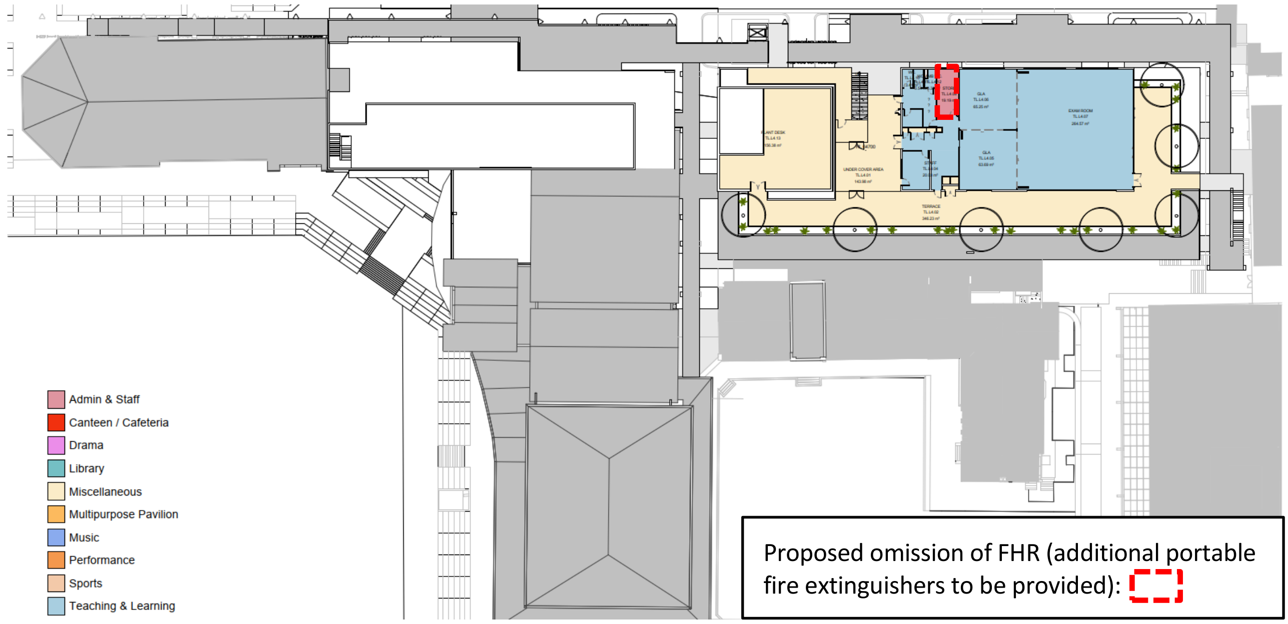


Figure 13.7: Areas proposed to omit FHR (L4)

13.2 Performance Solution

In accordance with the BCA Clause A2.2 *Performance Solution* the following assessment method has been adopted to demonstrate that the *Performance Solution* meets the relevant *Performance Requirements EP1.1.*

Table 13.1: Method of Analysis

Identified Design Issues	Performance Solution	AFEG Method of Analysis
It is proposed to omit the requirement to provide fire hose reels within the school building throughout (i.e. library, staff lounge etc, noting that classrooms & associated corridors are not required to be provided with fire hose reels).	A2.2(2)(d) Comparison with the *Deemed-to-Satisfy Provisions.*	A qualitative 'comparative' approach has demonstrated that the design is at least equivalent to a *DtS Building Solution.*

13.3 Hazards Specific to Omission of Fire Hose Reels

The 'Guide to the BCA' (ABCB, 2019) states that the intent associated with prescribing fire hose reels as being *"To require the installation of suitable hose reel systems to enable, where appropriate, a building's occupant to undertake an initial attack on a fire".* It is therefore considered that the main hazards specific to the issue are as follows:

- The potential for the fire to overwhelm the occupants undertaking an initial attack with the proposed fire extinguishers; and
- The potential for occupants to be blocked and unable to safely evacuate.

13.4 Hazard Mitigation

The 'Guide to the BCA' (ABCB, 2019) identifies the requirement for fire hose reels to allow for occupants to undertake an initial attack on a fire. In this regard, the following hazard mitigation system, requirements and features of the design are noted:

- Portable fire extinguishers in accordance with BCA Clause E1.6 and AS2444:2001 with the inclusion of the following:
  - Additional portable fire extinguishers shall be provided through school portions throughout as per the following:
    - In these locations, a 9-litre water type extinguisher shall be provided which would be suitable toward Class A fires. Where kitchens or the like are situated an additional 4.5kg 40B:E Type Dry Chemical or 4.5kg 2A:4F Wet Chemical or 4.5kg 2A:20B:E Dry Chemical (without deep fryer) portable fire extinguisher shall be provided adjacent the exit and between 2-20m from the cooking area. Where electrical switchboards are situated within the school portions an additional 4.5kg 2A:20B:E Dry chemical portable fire extinguisher shall be provided between 2-20m from the electrical switchboard; and

  - Portable fire extinguishers may be placed within a metal cabinet in an accessible location (i.e. not within a locked cabinet) Portable fire extinguishers may be placed within a metal cabinet mounted to a wall and fitted with a break glass to limit the likelihood of damage, vandalism or theft; and
- **Note**: The above fire extinguishers are to be considered ***in addition to*** the portable fire extinguishers otherwise required by BCA Clause E1.6 and AS2444:2001; and

- Emergency lighting & exit signage in accordance with AS2293.1:2018.

13.5 Methodology

The methodology adopted to address the design issue relative to the omission of fire hose reels has been a qualitative 'comparative' evaluation. The evaluation has considered the adoption of portable fire extinguishers with respect to the function/use of building, potential fire hazard, fire compartment size & fire safety systems installed. A comparison has been conducted to assess the ability for occupants to undertake an initial attack and subsequently move to a place of safety with respect to provisions of portable fire extinguishers.

13.6 Acceptance Criteria

The basic objective and intent of the analysis shall pertain to the life safety of occupants undertaking an initial attack on a fire by utilising portable fire extinguishers. Thus, the primary acceptance criterion has been met by demonstrating that provisions for portable fire extinguishers suitably facilitates the ability for occupants to conduct an initial fire attack.

13.7 Qualitative Evaluation

13.7.1 Building Function and Use

In this instance, it is proposed to omit the requirement to provide fire hose reels throughout the building (i.e. library, staff lounge, administration etc), noting that classrooms & associated corridors are not required to be provided with fire hose reels). The reason for fire hose reels within this building is due to the administration and office portions which are considered part of the Class 9b learning/teaching areas and not a separate Class 5 building which is exempt for fire hose reels as per the DtS provisions of the BCA.

It is noted that the entire building (i.e. including aforementioned areas) will be sprinkler protected in accordance with AS2118.1-2017 and first-attack fire-fighting is not intended as the main measure to contain the fire in these areas. It is also important to highlight that any potential fire initiating within the school buildings on this site is expected to activate the sprinkler system. Correct sprinkler activation shall suppress or control a potential fire event thus reducing the likelihood of an initial attack being warranted by occupants. The effectiveness of the sprinkler system has been discussed in detail in Appendix D.

The Class 9b school will have two distinct groups of occupants, students and teachers. Referring to the dominant occupant characteristics provided in Section 2.2, the dominant occupants would be staff/teachers, will be familiar and will have a natural tendency to take charge and direct students/visitors to evacuate in the event of an emergency. Students will be the majority as a typical school building and have various degrees of ability and familiarity, however students would be expected to wait to be given instructions typical for the age and the teacher student relationship and generally begin to evacuate from the building as directed by the staff/teacher occupant group to a designated safe area. Generally, the staff/teachers and students would be considered to be familiar with the building layout and the required emergency evacuation procedures to the extent that they would assist visitors in an evacuation.

The Guide to the BCA (ABCB 2019) acknowledges that installation of suitable fire hose reel systems is provided to enable, where appropriate, a building's occupants the ability to undertake an initial attack on a fire. Furthermore, the size of the fire compartment, the potential harm and the degree of exposure arising from the ignition to the spread of fire all need to be considered before undertaking an initial attack on fire.

In this instance, additional portable fire extinguishers are proposed to be installed in accordance with AS2444:2001 within the identified areas such that occupants are able to initiate early intervention. Fire extinguishers are provided for a 'first attack' firefighting measure generally undertaken by the occupants of the building before the fire service arrives.

13.7.2 Statistical Evaluation of Fire Hose Reels Usage

Generally, fire hose reels are provided to enable occupants to undertake initial attempts at fire control and extinguishment. As an alternative to fire hose reels, fire extinguishers are also installed in the built environment providing a means of manual fire suppression during the early stages of fires. Fire extinguishers are provided as a 'first attack' fire-fighting measure generally utilised by building occupants in an attempt to extinguish small fires (where safe to do so). However, most fires start as a small fire and may be extinguished if the correct type and amount of extinguishing agent is applied whilst the fire is in its infancy and controllable. This is an activity considered to be undertaken prior to fire brigade arrival. It is important that occupants are familiar with the use of either of the first aid fire-fighting equipment.

Australian data for the period between 2003 and 2004 shows that for a total of 813 recorded fires, fire hose reels did not appear as the means of suppression. From the statistical data provided, portable fire extinguishers were utilised for extinguishment purposes for a total of 96 fires (Brown, 2005). Refer to Figure 13.8for further details. While the study was limited to Commercial premises the trend is likely to be similar for other classifications.

Reported Major Method of Extinguishment for Fires in Commercial Premises from July 1, 2003, to June 30, 2004 (n = 813)

Major method of extinguishment	Reported fires
Hose line(s) deployed from fire apparatus tank	405
Self extinguished	73
Manual firefighting aid(s), for example fire blankets	64
Unknown portable fire extinguisher	50
Hose line(s) deployed from pump	49
Portable fire extinguisher(s) installed in premises	46
Hose line(s) deployed directly from hydrant	45
Portable fire extinguisher(s) carried on fire apparatus	32
Automatic extinguishing system(s)	29
Portable fire extinguisher(s) installed in neighboring premises	18
Monitor deployed by the fire service	2

Figure 13.8: Methods of Extinguishment in Commercial Buildings

13.7.3 Fire Hose Reel Use and Potential Impact on Occupants

Fire hose reels require a degree of manoeuvrability in order for the occupant to extend the fire hose to access a fire. Fire hose reels are normally 36m in length. Access to the area may require the occupant to manoeuvre the fire hose reel around a number of corners and bends which may include walls and other obstructions. Physically, some occupants may find this difficult and in many cases, may delay the time for water to be applied to a fire. Occupants may be required to pass the hose through doorways which may also swing against the direction to which an occupant is moving to access a fire; hence there is the potential for the fire hose to be jammed within the doorway whilst being extended towards the fire. As there are many obstructions located throughout these areas where a fire hose reel system may become awkward and cumbersome to use, a portable fire extinguisher in this instance would therefore be more practical for initial fire fighting around obstacles and corners.

13.7.4 Appropriateness of Portable Fire Extinguishment

As part of the performance solution, it shall be noted that portable fire extinguishers selected in accordance with BCA Clause E1.6 and AS 2444:2001 shall be provided to the identified areas depicted in Figure 13.1 to Figure 13.7 in lieu of fire hose reels. The proposed portable fire extinguishers shall be provided through school portions throughout as per the following:

- Provide additional portable fire extinguishers located adjacent the required exit locations (i.e. within 4m) in lieu of fire hose reels; and
- A 9-litre water type extinguisher shall be provided which would be suitable toward Class A fires. Where kitchens or the like are situated an additional 4.5kg 40B:E Type Dry Chemical or 4.5kg 2A:4F Wet Chemical or 4.5kg 2A:20B:E Dry Chemical (without deep fryer) portable fire extinguisher shall be provided adjacent the exit and between 2-20m from the cooking area. Where electrical switchboards are situated within the school portions an additional 4.5kg 2A:20B:E Dry chemical portable fire extinguisher shall be provided between 2-20m from the electrical switchboard; and
- Portable fire extinguishers may be placed within a metal cabinet in an accessible location (i.e. not within a locked cabinet) Portable fire extinguishers may be placed within a metal cabinet mounted to a wall and fitted with a break glass to limit the likelihood of damage, vandalism or theft; and

  Note: The above fire extinguishers are to be considered *in addition to* the portable fire extinguishers otherwise required by BCA Clause E1.6 and AS2444:2001.

The extinguishing agents of the proposed portable fire extinguishers noted above is considered appropriate for the function and use of the areas identified in Figure 13.1 to Figure 13.7. This is because the hazards associated with these areas are kitchen (i.e. cafeteria), school storage fuel load (i.e. lockers, change rooms, school storage), typical office fuwl loads and ignition sources (i.e. administration, staff rooms) and electrical (i.e. drama centre, music rooms, performance theatre and BOH areas, computers).

From the statistics discussed in Section 13.7.2 and 13.7.3 occupants are more likely to use portable fire extinguishers to supress a fire than a fire hose reel. The adoption of portable fire extinguishers is likely to see occupants use them in preference to fire hose reels. Therefore, the omission of the fire hose reel can be compensated by the placement of portable fire extinguishers where these omissions occur.

It may be argued that a portable fire extinguisher has limited extinguishing agent within the cylinder, however a limited capacity may be advantageous to the occupant such that when the water is exhausted, the occupant would have limited opportunity to continue to undertake first aid fire-fighting and hence, would most likely evacuate the area of fire origin. In such a circumstance, a small fire may have developed to a size beyond the ability for an untrained occupant to continue fire-fighting and the most appropriate action would be to move towards an exit or place of relative safety.

Further to the above, Ghosh et al as part of the research paper titled “Assessment of the benefits of Fire Extinguishers as fire safety precautions in New Zealand Buildings” reviewed the data collected by New Zealand Fire Service (NZFS) on the use of portable extinguisher. In summary, New Zealand Fire Service (NZFS) in 2004 collected data associated with the use of portable fire extinguisher by building occupants as part of developing Code of Practice for Hand Operated Extinguishers. The data was collected over a range of occupancies as shown in Figure 13.9 and Figure 13.10.

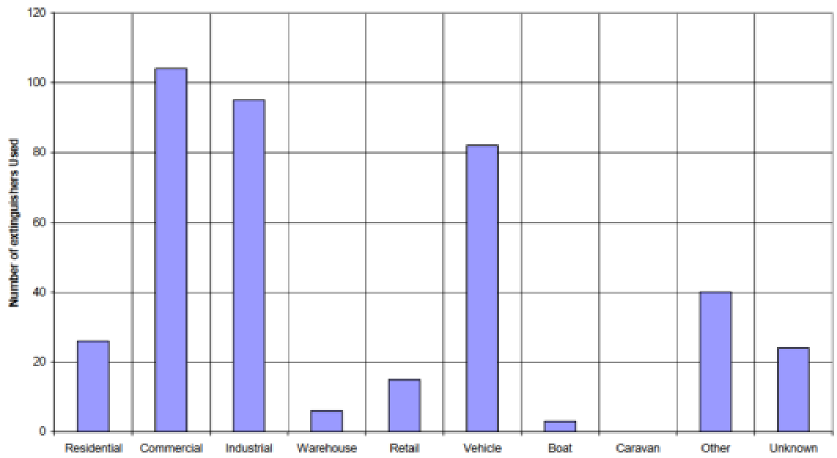


Figure 13.9: Occupancies associated with fire extinguishers data collected (Source Ghosh et al, 2008)

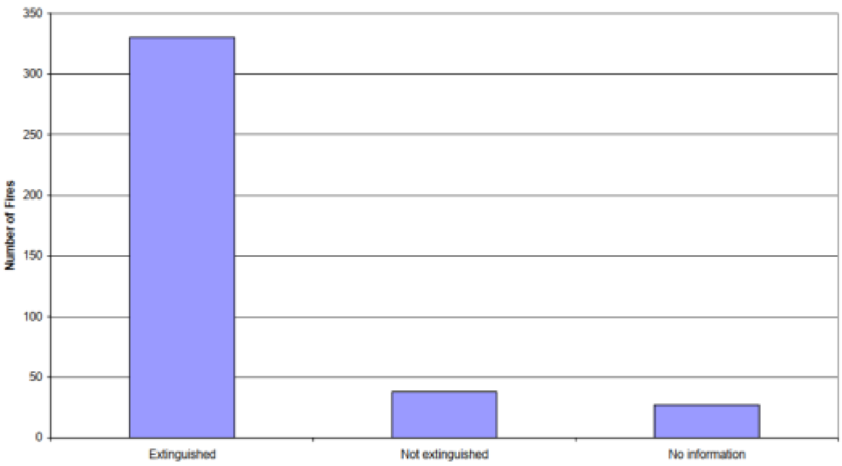


Figure 13.10: Fire Extinguisher Effectiveness (Source: Ghosh et al, 2008)

13.7.5 Benefit of Sprinkler Protection

From the information presented in Appendix Din the majority of cases where a sprinkler system is present and activates accordingly, the fires are generally confined to the object or area of fire origin. Additionally, statistics presented by Hall (2010) have demonstrated that where sprinklers were present in the fire area, they operated in 93% of all reported fires large enough to activate sprinklers and furthermore were effective 97% of the time resulting in a combined operating performance of 91%.

Automatic sprinklers are capable of suppressing or controlling fires such that the temperature rise of fire product gases and radiant heat is significantly reduced. It is assumed that the hot layer gases remain at the same temperature, as they were when the sprinklers activate which is approximately 75-100°C. It is evident that the effect of sprinklers on a fire is to wet down potential fuel sources, control or suppress the burning process and to cool the resultant smoke layer. It has been cited that the resultant smoke temperatures in a sprinkler-controlled fire are reduced to 100°C -120°C within 60 seconds of sprinkler activation (CIBSE 1997, Sekizawa, 1996, Milke, 2001, Madrzykowski, 2008).

It is considered that the automatic sprinkler system shall activate to either supress or control a potential fire event which shall considerably improve conditions for occupant in an emergency situation. Furthermore, the overall size and extent of a potential fire can be expected to be significantly reduced whilst occupants undertake an initial fire attack.

13.7.6 Fire Brigade Intervention

Other than being used for mopping activities, fire hose reels are not considered to be a firefighting tool for fire brigades. From the perspective of fire brigades at the time they commence water control and extinguishment activities the fire is expected to be either extinguished or controlled by means a portable fire extinguisher or the sprinkler system. Hence, from the fire brigade perspective the omission of fire hose reel to the nominated areas does not create any additional risks to the fire fighters.

13.8 Discussion of Assessment Outcomes

Based on the rationale presented above, it becomes evident that the proposed portable fire extinguishers enable the occupants to utilise an extinguisher at an accessible location to undertake initial fire attack.

Portable fire extinguishers facilitate a means to undertake firefighting whilst providing occupants with the ability to nominate the appropriate extinguishing agent before undertaking an initial attack on fire. Although portable fire extinguishers have limited agent capacity, once exhausted the occupant is likely to move towards an exit point. Practically, portable fire extinguishers are expected to be easier to use by an occupant without having to negotiate a heavy fire hose reel around fixed or movable obstructions. In this regard, occupants shall be afforded with suitable initial fire attack measures.

Based on the rationale presented above, the proposed design is considered to satisfy the Performance Requirement of EP1.1 of the BCA. This conclusion is contingent on the requirements detailed in Section 15.2 being implemented into the design.

14. Omission of Sprinklers from Main Switch Rooms

14.1 Background to the Issue

As part of the fire services design it is proposed to omit the requirement to provide automatic sprinkler protection within main switch rooms within the Teaching & Learning and Founders/PA blocks. The proposed design forms a deviation from Clause E1.5 of the BCA and AS2118.1:2017 which prescribes sprinkler protection to be provided throughout. Figure 14.1 depicts the main switch room locations.

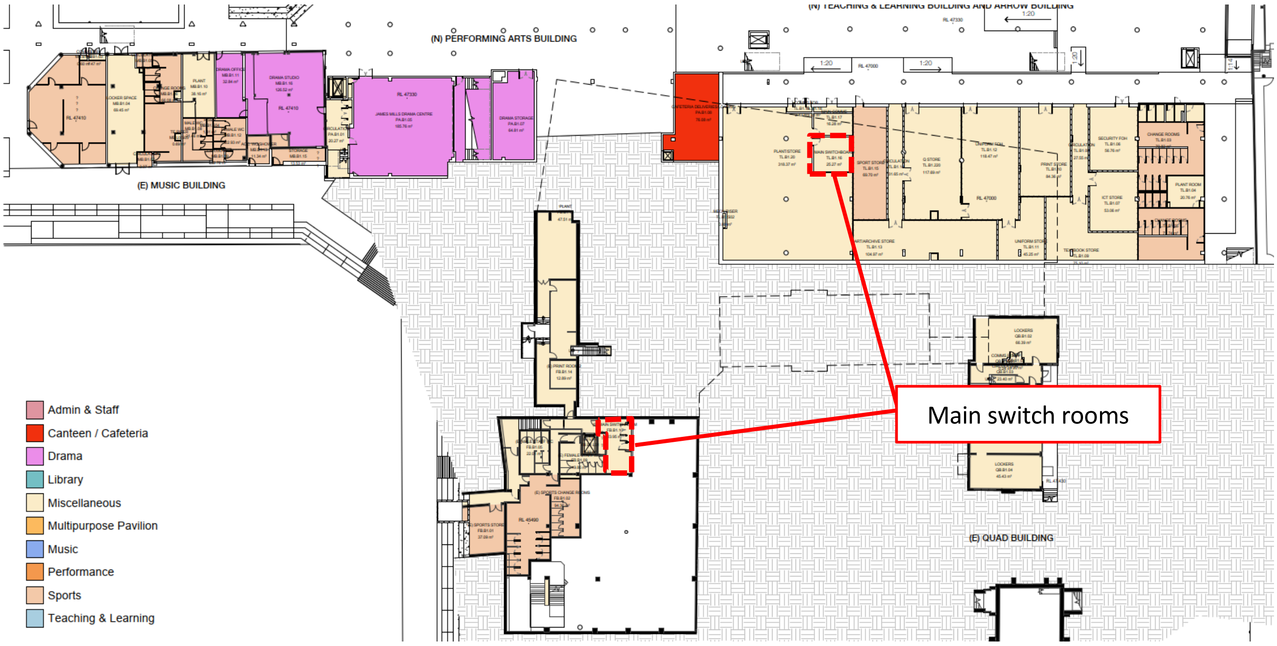


Figure 14.1: Main switch room locations (B1)

14.2 Performance Solution

In accordance with the BCA Clause A2.2 *Performance Solution* the following assessment method has been adopted to demonstrate that the *Performance Solution* meets the relevant *Performance Requirements of EP1.4.*

Table 14.1: Method of Analysis

Identified Design Issues	Performance Solution	AFEG Method of Analysis
It is proposed to omit the requirement to provide automatic sprinkler protection within the main switch rooms within the Teaching & Learning and Founders/PA blocks.	A2.2(2)(b)(ii) Other *Verification Methods*, accepted by the *appropriate authority* that show compliance with the relevant *Performance Requirements.*	A qualitative & quantitative 'deterministic' approach demonstrating that the proposed design satisfies the *Performance Requirements* of the BCA.

14.3 Hazards Specific to Omission of Sprinklers from Main Switch Rooms

The 'Guide to the BCA' (ABCB, 2019) states that the intent associated with prescribing a sprinkler system within a building is "*To require the installation of suitable fire sprinkler systems where necessary to address specific hazards".* It is therefore, considered that the main hazards specific to the issue to be considered in the assessment are:

- The potential for a fire to initiate within the main switch rooms and grow uncontrolled into a fully developed fire; and
- The potential for fire spread between the main switch rooms and adjacent parts of the building; and
- Increase in the potential impact / risk imposed onto attending fire-fighter personnel undertaking operations.

14.4 Hazard Mitigation

The 'Guide to the BCA' (ABCB, 2019) identifies the main function & use of a sprinkler system as being to contain a potential fire. In this regard, the following hazard mitigation system, requirements and features of the design are noted:

- The main switch rooms shall be bound by fire-rated construction (full-height 120-min FRL & self-closing -/120/30 fire doors) which shall limit/restrict potential fire spread to/from the main switch rooms; and
- The main switch rooms shall be provided with smoke detectors and provide early warning/notification; and

- The building areas adjacent the main switch rooms shall remain sprinkler protected and shall assist in limiting/ restricting fire spread should the compartment become breached.

14.5 Methodology

The methodology adopted to address the design issue relative to the omission of sprinkler protection from the main switch rooms has been based on a qualitative 'risk' evaluation. The evaluation has considered the main switch rooms with respect to their function/use, compartment size and the proposed fire safety measures shall enhance passive separation from the surrounding areas and provide early detection/notification.

14.6 Acceptance Criteria

The basic objective and intent of the analysis pertains to fire development and fire spread from the main switch rooms. Thus, the primary acceptance criterion has been met by demonstrating that the main switch rooms are provided with suitable passive & active fire safety measures to mitigate the development & spread of a fire. The secondary acceptance criterion has been met by demonstrating the proposed design maintains a suitable level of occupant/fire-fighter life safety.

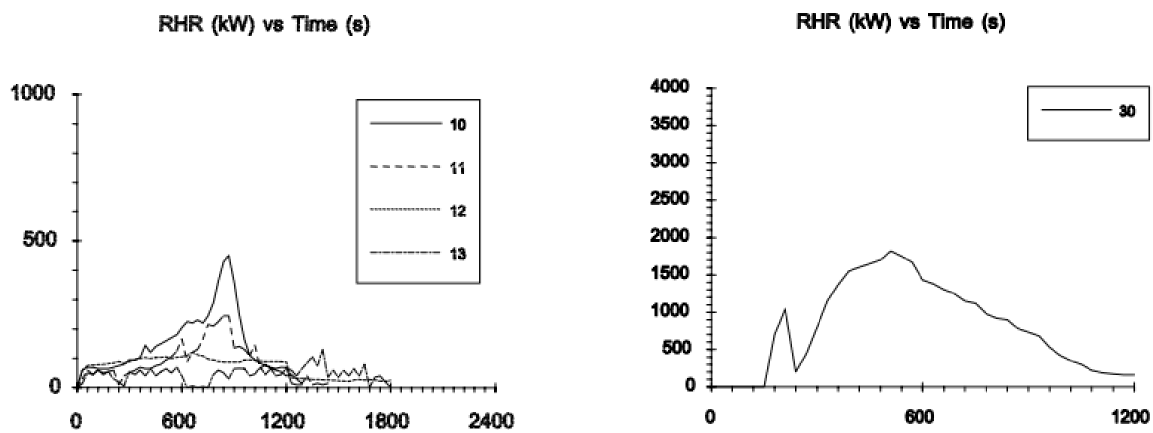
14.7 Qualitative Evaluation

As identified above, sprinkler protection is proposed to omit the requirement to provide automatic sprinkler protection within main switch rooms within the Teaching & Learning and Founders/PA blocks as shown in Figure 14.1. In the event of a fire initiating within these locations there is the potential for a fire to develop and spread uncontrolled within the building or to a point where it overwhelms the sprinkler system.

The main switch rooms themselves shall generally contain electrical distribution boards (EDB), equipment and the like. Based on the statistics presented in this report, the main switch rooms are considered to represent an ignition source given the nature of equipment contain (e.g. electrical, heat). The presence of an ongoing maintenance regime / equipment servicing schedule can be expected to mitigate the potential for an accidental fire to occur as a result of an operational deficiency (e.g. improper start-up/shut-down, overloaded, failure to clean, spontaneous heat etc.).

On the other hand, the main switch rooms shall not necessarily represent areas of high fuel load with combustible contents limited to the material contained therein such as plastics, rubber (e.g. cabling/components) & textiles (e.g. carpet). On this basis, the main switch rooms are considered to represent a relatively low fire risk with respect to development & spread beyond the enclosure of origin.

Lund University (Sardqvist, 1998) undertook fire testing of building materials which can be regarded as being representative of those contained within the main switch rooms. An electrical cabling fire involving 18kg of cables was analysed and it was noted that the maximum output recorded was 450 kW (refer to Figure 14.2), additionally it was noted that the mean burning duration was in the order of 20 minutes. Similarly, plastics and plastic laminates were tested. In a test involving 16.8kg of stacked polystyrene plastic boards a maximum output of 1,800 kW was recorded for duration of 20 minutes (refer to Figure 14.2).



(a) HRR for 18kg bundle of electrical cabling **(b) HRR for 16.8kg of stacked polystyrene plastic boards**

Figure 14.2: HRR of test materials (Sardqvist, 1998)

A factor which needs to be taken into consideration is that the amount of oxygen available will affect the rate of burning. A low concentration of oxygen will slow the burning right down. The fire tests mentioned above were conducted in well-ventilated chambers. With consideration of the subject main switch rooms, a limited amount of ventilation is considered to be provided via the access doorway. The access doorways shall be provided with a lockable latch which shall ensure they are in the closed position when not in use reducing the flow of oxygen into the main switch rooms. In the event of a fire impacting the main switch rooms, a realistic outcome would be a smouldering fire scenario producing limited amounts of burning and heat release due to the under-ventilated environment. With this in mind, the likely low temperatures generated under such a fire scenario would be unlikely to be sufficient in activating a sprinkler head.

It is important to highlight that the areas immediately adjacent / surrounding the main switch rooms shall remain fully sprinkler protected. Based on the information presented in Appendix D, correct sprinkler activation would be expected to control or suppress a potential fire event such that spread much beyond the immediate enclosure area would be effectively mitigated.

As part of the performance solution, the main switch rooms shall be bounded by fire-rated construction achieving a minimum FRL of 120 minutes. The bounding construction afforded to the main switch rooms shall provide a level of fire/smoke separation from the adjacent areas. In addition, main switch rooms shall be provided with smoke detection that is interconnected into the EWIS. In the unlikely event of a fire initiating within the main switch rooms, the production of smoke resulting from the early stage of ignition shall activate the smoke detector and provide occupants early warning to commence evacuation. Similarly, the passive separation afforded to the main switch rooms shall mitigate the potential for fire/smoke to spread beyond the enclosure of origin.

From an occupant egress perspective, occupants are provided with multiple evacuation points from Basement level 1 of the Teaching & Learning and Founders/PA blocks. In this regard, multiple egress paths shall allow occupants to safely evacuate without being required to pass the main switch rooms. Additionally, the introduction of smoke detection shall provide occupants with early/warning & notification. In a similar manner, attending fire crews would likely receive notification upon activation of the smoke detector. Passive separation in combination with automatic sprinkler protection to the surrounding areas would likely contain/restrict fire growth thus providing fire crews with favourable conditions upon arrival.

It is therefore concluded that the omission of sprinkler protection from the main switch rooms represents a relatively low fire risk. The provision of passive fire separation & smoke detection shall mitigate the potential for fire development & spread and shall furthermore maintain a suitable level of occupant/fire-fighter life safety.

14.8 Discussion of Assessment Outcomes

The qualitative evaluation undertaken above has considered the main switch rooms in relation to the proposed omission of sprinkler protection and potential for fire to develop/spread. The main switch rooms were noted to represent an ignition source however did not necessarily areas of high fuel load and hence were considered to represent a low fire risk. The main switch rooms were noted to comprise under-ventilated environments that would only likely sustain a smouldering fire scenario. Such a scenario was considered to be unlikely to generate sufficient heat to activate a sprinkler head. Overall, the presence of passive fire separation, introduction of smoke detection and presence of sprinkler protection to surrounding areas were considered to mitigate the potential for fire development & spread. Similarly, the aforementioned protective measures alongside multiple access/egress routes were deemed to provide and maintain a suitable level of life safety for occupants/fire-fighters.

Based on the rationale presented above it is therefore considered that the proposed design with the omission of sprinkler protection from main switch rooms satisfies the Performance Requirement of EP1.4 of the BCA. This conclusion is contingent on the requirements detailed in Section 15.2 being implemented into the design.

15. Conclusion

15.1 General

The Fire Safety Engineering assessment detailed in this report demonstrates that the proposed Performance Solution aspects of the Building solution have been shown to meet the corresponding identified Performance Requirements of the BCA as listed in Table 3.1.

The assessment and verification methodologies employed have been in accordance with the requirements of the BCA and conform to the principles of AFEG.

The building incorporates a range of fire safety measures in accordance with the relevant Australian Standards. In summary, the BCA defines the fire safety measures and their applicable standards required to be installed within buildings. Unless otherwise stated, the applicable standard of fire safety system installation (active and passive) must be compliant with the BCA and the relevant Australian Standards.

The Client is to ensure that the relevant stakeholders and services consultants that have been involved in the project are in agreement with the proposals made in this document. Furthermore it is the responsibility of the other designers and consultants (not SFS) to complete the detailed design of the various active and passive fire safety systems in accordance with the relevant design and installation Australian Standards and in accordance with the requirements listed in this report.

15.2 Fire Safety Measures

The building incorporates a range of fire safety measures in accordance with the relevant Australian Standards. In summary, the BCA defines the fire safety measures and their applicable standards required to be installed within the building. Unless otherwise stated, the applicable standard of fire safety system installation (active and passive) must be compliant with the BCA and the relevant Australian Standards.

The other fire safety system features which are specific to the alternative solution proposed for this building are:

15.2.1 Stage 1 & 2 Performance Solution

1. Stage 1 & 2 parts of Trinity Grammar School were subject to a Performance Solution prepared by Arup Australia Pty Ltd (Report No. 281228, V01, dated 17 March 2022). The requirements in the aforementioned report do not have any impact on the proposed analysis, its assumptions and recommendations with the exception of the following:
    a. Fire hydrant system throughout the building in accordance with BCA Clause E1.3 and AS2419.1:2017.

In order to achieve a level of consistency across the Stage 3-5 parts of the Trinity Grammar School, the design proposes to maintain the hydrant installation in accordance with AS2419.1:2017.

15.2.2 Fire Resistance & Type of Construction – Stages 3-5

1. Building elements throughout shall be constructed in accordance with the minimum FRL's commensurate with Type A fire resisting prescribed in Part C from Volume One of the Building Code of Australia 2019 Amendment 1 unless otherwise identified herein; and
2. It is proposed to permit the Multipurpose Pavilion structure (excluding the Oval 3 basement level carpark) to be constructed in accordance with the minimum FRL's commensurate with Type C fire-resisting construction in lieu of Type A fire-resisting construction and inclusive of the following:
    a. The Multipurpose Pavilion structure shall consist of non-combustible construction. This performance solution relates to the applicable FRL's only; and
    b. The Multipurpose Pavilion shall be fire-separated from the basement level carpark via a fire-rated slab achieving a minimum FRL of 120-minutes in accordance with the DtS provisions of the BCA. Any services penetrations through the fire-rated floor slab shall be fire-stopped and must conform to a tested system in accordance with AS1530.4:2014; and
3. The non-fire isolated stairways interconnecting multiple storeys without the provision of a fire-isolated shaft shall be fire-separated at key levels as per the following:
    a. The performing arts open stairway shall be fire-separated such that it does not interconnect more than three (3) consecutive storeys; and
    b. Full-height solid bounding construction extending to the underside of the slab above (i.e. between L0 to L1 slab) and achieving a minimum FRL of 120-minutes from both sides. The doors serving the stairway shall be self-closing and achieve an FRL of -/120/30 fitted with medium temperature smoke seals. Refer to Figure 15.1; and

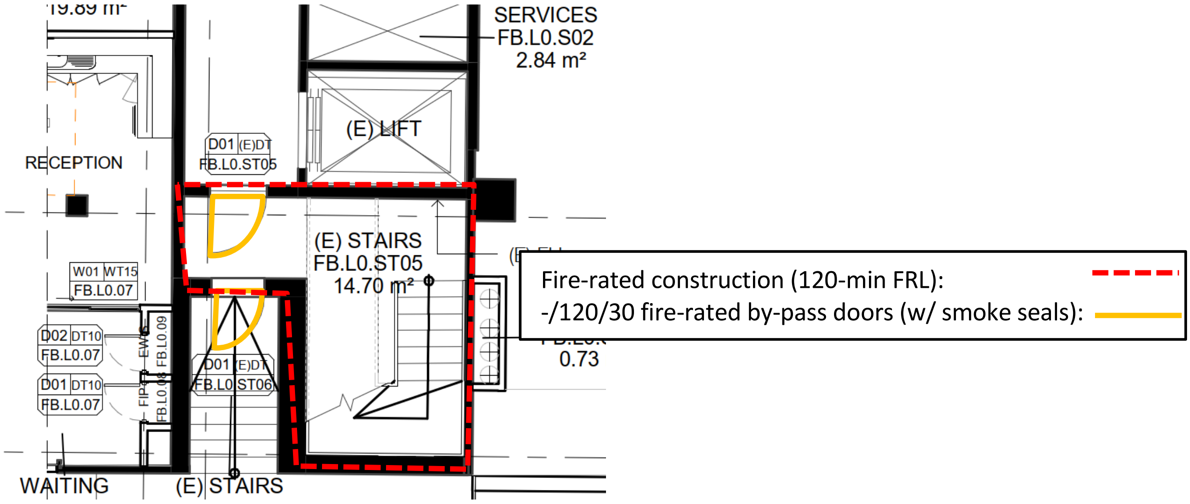


Figure 15.1: Fire separation at L0 stairway within Performance Arts/Founders

4. The stairway within the Performing Arts Building indicated in Figure 15.2 shall be located within a fire-isolated shaft and shall discharge directly to the outside at the lowest level; and
    a. Glazed elements within the external wall shall comply with Clause C3.8 of the BCA; and
    b. The northern wall of this stair shall consist of solid fire-rated construction achieving a minimum FRL consistent with the DtS provisions of the BCA; and

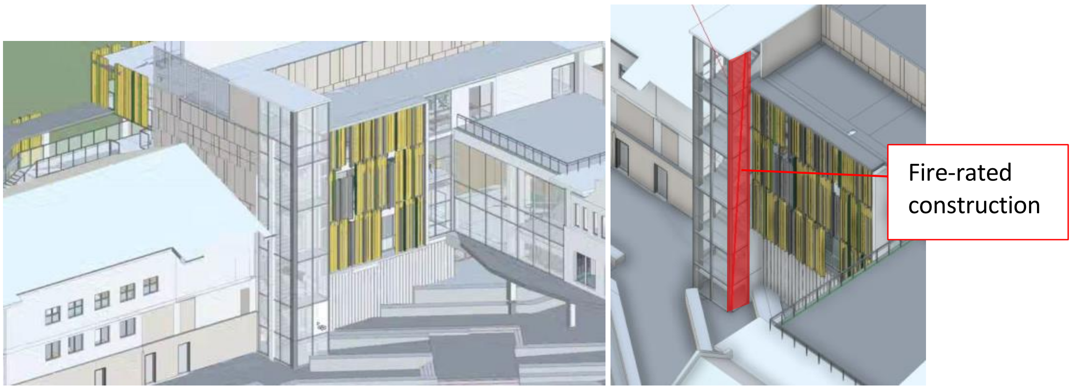


Figure 15.2: Stairway to generally be located within a fire-isolated shaft where glazed external construction shall comply with Clause C3.8

5. The main switch rooms situated within the Teaching & Learning and Performing Arts/Founders Buildings shall be bound by full-height, two-way fire-rated construction achieving a minimum FRL of 120-minutes and self-closing -/120/30 fire-rated doors; and
6. It has been identified that the southern wall & openings of the Teaching & Learning block at L0 to L3 are situated approximately 5.8m from the northern wall & openings of the Founders/PA block without being protected in accordance with Clause C3.4 (refer to Figure 7.1 & Figure 7.2); and
7. It has been identified that the Teaching & Learning block abuts the existing Sports/Science/Aquatic blocks without being provided with a full-height fire wall which complies with Clause C2.7 as a result of glazed openings within the dividing wall (refer to Figure 8.1 & Figure 8.2); and
    a. It has also been identified that there are unprotected glazed openings forming part of the Teaching & Learning block which are configured in a parallel orientation and within 6m of the subject dividing wall (refer to Figure 8.5); and
8. The tiered seating within the Agora area shall consist of non-combustible construction; and
9. The screens located along the elevations of the 'Arrow Building" walkway shall maintain a minimum open free-area of 50% with the exception of the following:
    a. The screens outlined in red as indicated in Figure 15.3 below only may maintain a minimum open free-area of 20%; and

Figure 15.3: Screens located along elevations of Arrow Building

10. All components forming part of the external wall system serving the buildings (with the exception of the Multipurpose Pavilion) shall be non-combustible in accordance with Clause C1.9(a)(i); and
11. All fire compartment sizes (i.e. fire compartment area and volume) throughout the Stage 3-5 works shall comply the Deemed-to-Satisfy provisions of the BCA.

15.2.3 Occupant Egress Provisions – Stages 3-5

1. Occupant egress provisions shall comply with the DtS Provisions in Part D from Volume One of the Building Code of Australia 2019 Amendment 1 unless otherwise identified herein; and
2. Permit travel distances to a point of choice, to an exit and between alternative exits to exceed the maximum distances prescribed by the prescriptive provisions of the BCA as per the following:

Teaching & Learning Precinct:

Basement Level 1

a. It is proposed to permit a travel distance to a point of choice of up to 26m in lieu of 20m; and
b. It is proposed to permit a travel distance to an exit where two exits are available of up to 67m in lieu of 40m; and
c. It is proposed to permit a distance of travel between alternative exits of up to 97m in lieu of 60m (where measured through the point of choice).

Level 2

a. It is proposed to permit a travel distance to an exit where two exits are available of up to 47m in lieu of 40m; and
b. It is proposed to permit a distance of travel between alternative exits of up to 75m in lieu of 60m.

Level 3

a. It is proposed to permit a travel distance to a point of choice of up to 26m in lieu of 20m; and
b. It is proposed to permit a travel distance to an exit where two exits are available of up to 42m in lieu of 40m.

Level 4

a. It is proposed to permit a travel distance to a point of choice of up to 30m in lieu of 20m.

Performing Arts Precinct:

Basement Level 2

a. It is proposed to permit a travel distance to a point of choice of up to 25m in lieu of 20m; and

Level 1

a. It is proposed to permit a travel distance to a point of choice of up to 23m in lieu of 20m; and

Level 3

a. It is proposed to permit a travel distance to a point of choice of up to 21m in lieu of 20m; and
b. It is proposed to permit a travel distance to an exit where two exits are available of up to 45m in lieu of 40m.

Level 4

a. It is proposed to permit a travel distance to a single exit of up to 45 m in lieu of 40m within the roof plant area.

3. Permit the non-fire isolated stairs serving the Teaching & Learning and Performing Arts/Founders Buildings to provide discontinuous egress paths in lieu of continuous egress by their own flights/landings to road/open space; and
4. Permit non-fire isolated stairways to interconnect multiple storeys without the provision of a fire-isolated shaft as per the following:
   a. Performing Arts Precinct:
      i. Open stairway interconnects four (4) storeys in lieu of three (3) within sprinkler protected building
   b. Arrow Building (i.e. external walkway):
      i. A number of open stairways which interconnect up to five (5) storeys in lieu of three (3) within sprinkler protected building.

15.2.4 Fire Services & Equipment – Stages 3-5

1. Fire services & equipment shall comply with the DtS Provisions in Part E from Volume One of the Building Code of Australia 2019 Amendment 1 unless otherwise identified herein; and
2. Automatic sprinkler protection shall be provided throughout the building in accordance with BCA Clause E1.5, Specification E1.5 and AS2118.1:2017 with the inclusion of the following:
   a. Automatic sprinkler protection shall be installed to the following building locations (refer Appendix L):
      i. Teaching & Learning (incl. the Quadrangle building); and
         The underside of the Level 2 slab located above the Agora portion of the building shall be provided with sprinkler protection; and
      ii. Arrow Building (external walkways); and
      iii. Music Building; and
      iv. Performance Arts (incl. cafeteria & assembly hall); and
      v. Founders Building; and
   b. Sprinkler heads shall be fast response type heads having an actuation temperature of not greater than 68°C and RTI of not greater than $50m^{-0.5}s^{-0.5}$; and
   c. Activation of the sprinkler system shall initiate a General Fire Alarm (GFA) throughout the Trinity Grammar School campus; and
   d. Omit the requirement to provide automatic sprinkler protection within main switch rooms within the Teaching & Learning and Performing Arts/Founders Buildings; and
3. Where nominated glazed construction shall be protected by wall-wetting sprinkler protection designed and installed with the following requirements:
   a. The wall-wetting sprinkler system shall be designed and installed in accordance with AS2118.2:2010; and
   b. The wall-wetting sprinkler protected glazing shall be 6.0mm toughened or heat strengthened glass and fixed in the closed position. Horizontal mullions, vertical transoms or any other fixed obstructions/fixings/frame elements with may impede or block full wall-wetting sprinkler spray coverage are not permitted to the glazing system; and
   c. The nominated wall-wetting sprinkler system, shall be capable of providing full coverage to the entire glass panel; and
   d. Where glazing connectors or other fixed obstructions may impede water spray coverage to glazing, additional wall-wetting sprinkler heads may be required as per the manufacturer's data sheet to ensure that the nominated system provides complete spray coverage to the entire glass panel; and
   e. The maximum distance between any two (2) wall-wetting sprinklers shall be in accordance with the manufacturer's data sheet in order to provide sufficient and unimpeded coverage to the entire glass panel. It

shall be noted that wall-wetting sprinkler protection is an acceptable method of protection commensurate with BCA Clause C3.4; and

f. The water is to be supplied by an independent isolation valve to the sprinklers in the same area (i.e. not valved from the same sprinkler zones where the glazing is located); and
g. The water supply for the wall-wetting sprinklers protecting the glazing may be fed from the fire hydrant system installation. A maximum of twelve (12) wall-wetting sprinkler heads shall be served by the fire hydrant service; and
h. Where glazing construction is above ceilings to the slab structure or false ceiling space, wall-wetting sprinklers shall also be provided within the ceiling space such that the glazing is provided with unobstructed water spray. Alternatively, the ceiling space above the wall-wetting sprinkler protected glazing shall be provided with fire-rated construction achieving a minimum FRL of 120-minutes such that a consistent fire barrier is provided between adjacent fire compartments; and

4. Any openable, glazed swing door sets provided forming part of the nominated fire separation shall be provided with the following:
   a. Minimum 6.0mm thickened toughened (tempered) or heat strengthened glass panels; and
   b. Glazed doors shall be fitted with self-closing device or magnetic hold-open devices which are set to close/release upon General Fire Alarm (GFA). Glazed doors shall not be sliding; and
   c. The door leaves shall be fitted with medium temperature smoke seals suitable for smoke up to 200°C; and
   d. The wall-wetting sprinkler protection shall be designed and installed in accordance with AS2118.2:2010 and the parameters in item 3 above; and
5. The glazed double-door set indicated in Figure 15.4 shall be provided with wall-wetting sprinkler protection; and

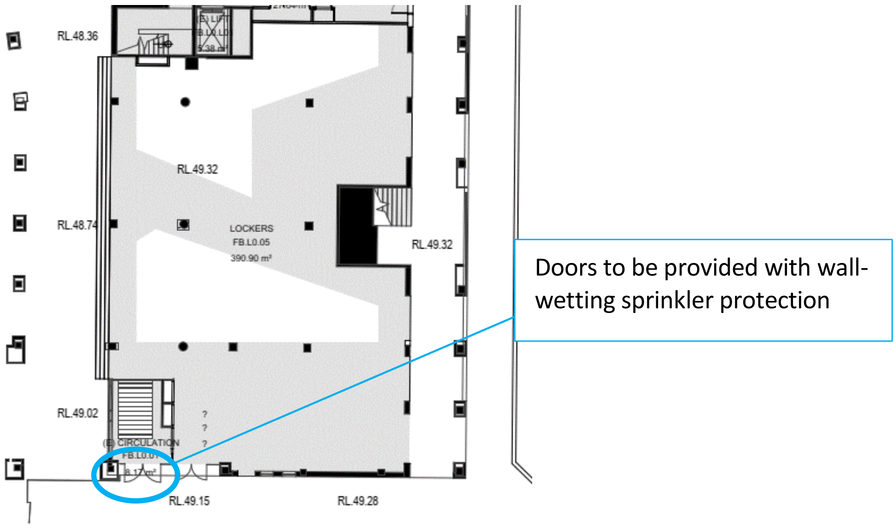


Figure 15.4: Doors to be provided with wall-wetting sprinkler protection

6. System monitoring to a fire station or fire station despatch centre shall be provided in accordance with AS1670.3:2018; and
7. Alarm Signalling Equipment (ASE) shall be provided with multiple outputs to designate the building of alarm origin; and
8. Automatic smoke detection shall be provided throughout all buildings of the Stage 3-5 portion in accordance with AS1670.1:2018 and with the inclusion of the following:
   a. The main switch rooms within the Teaching & Learning and Performing Arts/Founders Buildings shall be provided with centrally located smoke detectors; and
   b. The Basement Level 1 of the Teaching & Learning building shall be provided with a detection system on a reduced spacing of 8m x 8m in lieu of 10m x 10m; and
   c. Additional detectors shall be installed within the sports building within 1.5m of tilt glass panel at distances no greater than 10m along the width of the tilt panel. Activation of these detectors shall activate the EWIS within the T&L building; and
9. Provide a Building Occupant Warning System (BOWS) in accordance with BCA Specification E2.2a, AS1670.1:2018 which shall initiate on either sprinkler head or detector activation and with the inclusion of the following:
   a. The BOWS shall comprise a pre-recorded public address system; and
   b. The following buildings shall be provided with a BOWS:
      i. Multi-Purpose Pavilion; and

    ii. Music Building; and
    iii. Arrow Building; and

10. Provide an Emergency Warning & Intercommunication System (EWIS) in accordance with BCA Specification E2.2a and AS1670.4:2018 which shall initiate on either sprinkler head or detector activation to the following locations:
    a. Teaching & Learning; and
    b. Quadrangle Building; and
    c. Performing Arts; and
    d. Founders Building; and
11. As per Clause 5.2.1 of AS1668.1:2015, HVAC and air handling systems not designed to operate in fire mode shall shut down upon activation of GFA; and
12. The Trinity Grammar School campus shall be served by a number of Fire Indicator Panels (FIP's) generally configured and networked as follows (refer to Appendix K for details):
    a. The campus wide main FIP shall be situated at the entry of Oval 3 carpark (adjacent fire sprinkler/hydrant plant room and is closest to the booster assembly) and shall be connected to new FIP's on a high-level network which shall be located as follows:
        i. Multi-Purpose Pavilion FIP; and
        ii. Music Building FIP; and
        iii. Performance Arts Building FIP & EWIS Panel; and
        iv. Existing Hurlstone Building FIP (to be replaced with new FIP); and
        v. Teaching & Learning and Quadrangle Building FIP & EWIS Panel; and
        vi. Oval 2 Carpark FIP; and
        vii. Maintenance Building FIP; and
    b. Existing FIP's shall be connected to the main FIP at Oval 3 on a low-level simple interface and shall include the following locations:
        i. Existing pump room FIP; and
        ii. Existing Gym FIP; and
        iii. Existing Junior School FIP; and
        iv. Existing Science/IT FIP's & EWIS Panel; and
        v. Existing Delmar Gallery FIP; and
13. Provide strobe lights and alarm horn sounders at strategic locations where the most disadvantaged occupants shall be able to readily see the light(s) or hear the sounder(s). The strobe lights and sounders shall be set to activate upon General Fire Alarm (GFA). Strobes/sounders shall be provided as follows:
    a. Level B1 Store/Plant room. Refer to Figure 9.1 for indicative locations; and
    b. Level 4 Plant Deck. Refer to Figure 9.4 for indicative locations; and
14. Permit the fire hydrant system to be designed, installed & commissioned in accordance with AS2419.1:2017 in lieu of AS2419.1:2005 to be consistent with Stage 1 & 2; and
    a. The Stage 3-5 portion will be served by the site-wide booster assembly which is located on Victoria Street. This location was included as a Performance Solution within the Arup FER referenced in Section 0.5.1; and
        i. The booster shall be provided with a visual warning device (red strobe) in accordance with Clause 7.3.2 of AS2419.1:2017 and shall activate upon GFA; and
        ii. The block plans across the site (including at the booster assembly) shall be updated to reflect the Stage 3-5 works; and
    b. Hydrant outlet locations shall be located within 4.0m of an exit in accordance with the DtS provisions of the BCA throughout all buildings within the Stage 3-5 works; and
15. Couplings in the fire hydrant system (including fire hydrant booster assembly) shall be compatible with those of the fire appliances and equipment used by Fire and Rescue NSW. Fire hydrant booster assembly connections and all fire hydrant valves shall be fitted with Storz aluminium alloy delivery couplings manufactured and installed in accordance with the relevant Australian Standard; and
16. Block plans are to be provided at the Fire Indicator Panel (FIP), fire hydrant booster assembly & fire pump room in accordance with Section 7.11 of AS2419.1:2005, FRNSW Fire Safety Guideline – Emergency Services Information Package and Tactical Fire Plans (Version 02 dated 07/01/2019) and the inclusion of the following:
    a. The block plans should be orientated to reflect the aspect of the installation as it is presented to the reader; and

   b. The block plans across the site (including at the booster assembly) shall be updated to reflect the Stage 3-5 works; and

17. Omit the requirement to provide fire hose reel system school portions of the building with the inclusion of the following:
    a. Provide additional portable fire extinguishers located adjacent the required exit locations (i.e. within 4m) in lieu of fire hose reels; and
18. Portable fire extinguishers in accordance with BCA Clause E1.6 and AS2444:2001 with the inclusion of the following:
    a. Additional portable fire extinguishers shall be provided through school portions throughout as per the following:
        i. In these locations, a 9-litre water type extinguisher shall be provided which would be suitable toward Class A fires. Where kitchens or the like are situated an additional 4.5kg 40B:E Type Dry Chemical or 4.5kg 2A:4F Wet Chemical or 4.5kg 2A:20B:E Dry Chemical (without deep fryer) portable fire extinguisher shall be provided adjacent the exit and between 2-20m from the cooking area. Where electrical switchboards are situated within the school portions an additional 4.5kg 2A:20B:E Dry chemical portable fire extinguisher shall be provided between 2-20m from the electrical switchboard; and
        ii. Portable fire extinguishers may be placed within a metal cabinet in an accessible location (i.e. not within a locked cabinet) Portable fire extinguishers may be placed within a metal cabinet mounted to a wall and fitted with a break glass to limit the likelihood of damage, vandalism or theft; and
    b. In line with FRNSW comment, instructional signage shall be provided to staff rooms regarding fire extinguisher use. The signage shall include the following information as indicated in Figure 15.5; and

How to operate a fire extinguisher

There are a number of different types of portable fire extinguishers, each can be identified by the colour coding and labelling. Check that the extinguisher you intend to use is suitable for the type of fire encountered eg a water extinguisher must never be used on any fire involving electrical equipment.

There are four (4) basic steps for using modern portable fire extinguishers.

The acronym **PASS** is used to describe these four basic steps.

1. **Pull (Pin)**
   Pull pin at the top of the extinguisher, breaking the seal. When in place, the pin keeps the handle from being pressed and accidentally operating the extinguisher. Immediately test the extinguisher. (Aiming away from the operator) This is to ensure the extinguisher works and also shows the operator how far the stream travels
2. **Aim**
   Approach the fire standing at a safe distance. Aim the nozzle or outlet towards the base of the fire.
3. **Squeeze**
   Squeeze the handles together to discharge the extinguishing agent inside. To stop discharge, release the handles.
4. **Sweep**
   Sweep the nozzle from side to side as you approach the fire, directing the extinguishing agent at the base of the flames. After an A Class fire is extinguished, probe for smouldering hot spots that could reignite the fuel.

Figure 15.5: Fire Extinguisher Instructional Information to be incorporated in signage (Source: FRNSW website)

19. Emergency lighting and exit signage in accordance with AS2293.1:2018 with the inclusion of the following:
    a. External stair on Level 4 within Teaching & Learning shall discharge on Level 3 Arrow building before allowing occupants with three (3) paths of egress to an alternative stairway. Additional directional and static exit signage and evacuation map shall be provided on level 3 as per Figure 11.6; and
    b. Internal stair on Level 3 within Teaching & Learning shall discharge on Level 2 within Teaching & Learning before allowing occupants with two (2) paths of egress to an alternative stairway. Additional directional and static exit signage and evacuation map shall be provided on Level 2 as per Figure 11.7; and
    c. Internal stair on Level 3 within Founders/PA shall discharge on Level 2 within Founders/PA before allowing occupants with two (2) paths of egress to an alternative stairway. Additional directional and static exit signage and evacuation map shall be provided on Level 2 as per Figure 11.8; and
    d. Internal stair on Level 2 within Founders/PA shall discharge on Level 1 within Founders/PA before allowing occupants with three (3) paths of egress to an alternative stairway. Additional directional and static exit signage and evacuation map shall be provided on Level 1 as per Figure 11.9; and
20. All fire services and equipment for the Performance Hall must be in accordance with the DtS provisions of the BCA and/or to the satisfaction of the PCA.

15.2.5 Management in Use Requirements – Stages 3-5

1. Maintain paths of travel to an egress, stair entrances, vehicular access ramp, thoroughfares and lobby areas free of static storage and combustible materials at all times; and
    a. This Agora and Colonnade portions must also be kept clear of static storage and combustible materials at all times; and
2. Provide additional directional evacuation diagrams/mud-maps to the discharge landing of each non-fire isolated stairway affording discontinuous egress. The evacuation diagram shall depict the alternative egress paths available and be orientated to reflect the aspect as presented to the reader. The location of the additional directional evacuation diagrams/mud-maps shall be as per the following:
    a. External stair on Level 4 within Teaching & Learning shall discharge on Level 3 Arrow building before allowing occupants with three (3) paths of egress to an alternative stairway. Additional directional evacuation map shall be provided on level 3 as per Figure 11.6; and
    b. Internal stair on Level 3 within Teaching & Learning shall discharge on Level 2 within Teaching & Learning before allowing occupants with two (2) paths of egress to an alternative stairway. Additional directional evacuation map shall be provided on Level 2 as per Figure 11.7; and
    c. Internal stair on Level 3 within Founders/PA shall discharge on Level 2 within Founders/PA before allowing occupants with two (2) paths of egress to an alternative stairway. Additional evacuation map shall be provided on Level 2 as per Figure 11.8; and
    d. Internal stair on Level 2 within Founders/PA shall discharge on Level 1 within Founders/PA before allowing occupants with three (3) paths of egress to an alternative stairway. Additional evacuation map shall be provided on Level 1 as per Figure 11.9; and
3. Smoking shall not be permitted throughout the subject building; and
4. All fire safety measures and Management in Use requirements shall be incorporated into an Essential Services list. All fire safety measures shall be maintained in accordance with the requirements of AS1851 (or equivalent maintenance standard) as identified by Scientific Fire Services. Management in Use requirements shall be inspected and logged on an annual basis; and
5. An emergency management plan in accordance with AS3745:2010, including procedures for the safety of people in buildings, structures and workplaces during emergencies, the appointment of an Emergency Planning Committee and setting up an Emergency Control Organisation; and
6. Regular maintenance shall be undertaken of all fire safety systems as required by relevant Australian Standards; and
7. Fire training of staff and maintenance staff, including emergency evacuation procedures and use of firefighting equipment (where applicable) to be undertaken at regular intervals.

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Appendix A. Architectural Drawings

Table A.1: Architectural drawings relied upon (TKD Architects)

Drawing No.	Title	Date / Revision
TKD AR 2000	GA- B2 Floor Plan	H
TKD AR 2001	GA- B1 Floor Plan	H
TKD AR 2002	GA- L0 Floor Plan	H
TKD AR 2003	GA- L1 Floor Plan	H
TKD AR 2004	GA- L2 Floor Plan	H
TKD AR 2005	GA- L3 Floor Plan	H
TKD AR 2006	GA- L4 Floor Plan	H
TKD AR 2007	GA- Roof Plan	H
TKD AR 2140	GA- BLOCK 04 – FOUNDERS BUILDING B2 FLOOR PLAN	J
TKD AR 2141	GA - BLOCK 04 – FOUNDERS BUILDING B1 FLOOR PLAN – SHEET 01	J
TKD AR 2142	GA - BLOCK 04 - FOUNDERS AND PERFORMING ARTS BUILDING B1 FLOOR PLAN - SHEET 02	J
TKD AR 2143	GA - BLOCK 04 – FOUNDERS BUILDING L0 FLOOR PLAN – SHEET 01	J
TKD AR 2144	GA - BLOCK 04 - FOUNDERS AND PERFORMING ARTS BUILDING L0 FLOOR PLAN - SHEET 02	J
TKD AR 2145	GA - BLOCK 04 – FOUNDERS BUILDING L1 FLOOR PLAN – SHEET 01	J
TKD AR 2146	GA - BLOCK 04 - FOUNDERS AND PERFORMING ARTS BUILDING L1 FLOOR PLAN - SHEET 02	H
TKD AR 2147	GA - BLOCK 04 - FOUNDERS BUILDING L2 FLOOR PLAN – SHEET 01	H
TKD AR 2148	GA - BLOCK 04 - FOUNDERS AND PERFORMING ARTS BUILDING L2 FLOOR PLAN - SHEET 02	H
TKD AR 2150	GA - BLOCK 04 - FOUNDERS AND PERFORMING ARTS BUILDING L3 FLOOR PLAN - SHEET 02	H
TKD AR 2151	GA - BLOCK 04 – FOUNDERS BUILDING ROOF PLAN - SHEET 01	G
TKD AR 2152	GA - BLOCK 04 - FOUNDERS AND PERFORMING ARTS BUILDING ROOF PLAN - SHEET 02	G
TKD AR 2160	GA - BLOCK 06 - MULTI PURPOSE PAVILLION B2 FLOOR PLAN	G
TKD AR 2161	GA - BLOCK 06 - MULTI PURPOSE PAVILLION B1 FLOOR PLAN	G
TKD AR 2162	GA - BLOCK 06 - MULTI PURPOSE PAVILLION L0 (MEZZANINE) FLOOR PLAN	G
TKD AR 2163	GA - BLOCK 06 - MULTI PURPOSE PAVILLION ROOF PLAN	F
TKD AR 2155	GA - BLOCK 05 - MUSIC BUILDING B1 FLOOR PLAN	F
TKD AR 2156	GA - BLOCK 05 - MUSIC BUILDING L0 FLOOR PLAN	H
TKD AR 2157	GA - BLOCK 05 - MUSIC BUILDING L1 FLOOR PLAN	H
TKD AR 2158	GA - BLOCK 05 - MUSIC BUILDING ROOF PLAN	E
TKD AR 2130	GA - BLOCK 03 – QUADRANGLE BUILDING B1 FLOOR PLAN	G
TKD AR 2131	GA - BLOCK 03 – QUADRANGLE BUILDING L0 FLOOR PLAN	G
TKD AR 2132	GA - BLOCK 03 – QUADRANGLE BUILDING L1 FLOOR PLAN	G

Drawing No.	Title	Date / Revision
TKD AR 2133	GA - BLOCK 03 – QUADRANGLE BUILDING L2 FLOOR PLAN	G
TKD AR 2134	GA - BLOCK 03 – QUADRANGLE BUILDING ROOF PLAN	E
TKD AR 2120	GA - BLOCK 02 - TEACHING AND LEARNING B1 FLOOR PLAN	J
TKD AR 2121	GA - BLOCK 02 - TEACHING AND LEARNING L0 FLOOR PLAN	J
TKD AR 2122	GA - BLOCK 02 - TEACHING AND LEARNING L1 FLOOR PLAN	J
TKD AR 2123	GA - BLOCK 02 - TEACHING AND LEARNING L2 FLOOR PLAN	J
TKD AR 2124	GA - BLOCK 02 - TEACHING AND LEARNING L3 FLOOR PLAN	J
TKD AR 2125	GA - BLOCK 02 - TEACHING AND LEARNING L4 FLOOR PLAN	J
TKD AR 2126	GA - BLOCK 02 - TEACHING AND LEARNING ROOF PLAN	G
TKD AR 3170	ELEVATIONS - BLOCK 07 – ARROW BUILDING - SHEET 01	C
TKD AR 3171	ELEVATIONS - BLOCK 07 - ARROW BUILDING - SHEET 02	C
TKD AR 3172	ELEVATIONS - BLOCK 07 – ARROW BUILDING - SHEET 03	C

Table A.2: Fire Services Drawings

Drawing No.	Title	Date / Revision
DA331	Site Sections BB	B
JHA-HD-DWG-2TL-21B11	BLOCK 2 - T & L BUILDING, BASEMENT 1, WATER & GAS SERVICES LAYOUT	P1
JHA-HD-DWG-2TL-21L01	BLOCK 2 - T & L BUILDING, LEVEL 0, WATER & GAS SERVICES LAYOUT	P1
JHA-HD-DWG-2TL-21L11	BLOCK 2 - T & L BUILDING, LEVEL 1, WATER & GAS SERVICES LAYOUT	P1
JHA-HD-DWG-2TL-21L21	BLOCK 2 - T & L BUILDING, LEVEL 2, WATER & GAS SERVICES LAYOUT	P1
JHA-HD-DWG-2TL-21L31	BLOCK 2 - T & L BUILDING, LEVEL 3, WATER & GAS SERVICES LAYOUT	P1
JHA-HD-DWG-2TL-21L41	BLOCK 2 - T & L BUILDING, LEVEL 4 , WATER & GAS SERVICES LAYOUT	P1
JHA-HD-DWG-2TL-21L51	BLOCK 2 - T & L BUILDING, ROOF PLAN , WATER & GAS SERVICES LAYOUT	P1
JHA-HD-DWG-2TL-22B11	BLOCK 2 - T & L BUILDING, BASEMENT 1, SANITARY & ROOF DRAINAGE LAYOUT	P1
JHA-HD-DWG-2TL-22L01	BLOCK 2 - T & L BUILDING, LEVEL 0, SANITARY & ROOF DRAINAGE LAYOUT	P1
JHA-HD-DWG-2TL-22L11	BLOCK 2 - T & L BUILDING, LEVEL 1, SANITARY & ROOF DRAINAGE LAYOUT	P1
JHA-HD-DWG-2TL-22L21	BLOCK 2 - T & L BUILDING, LEVEL 2, SANITARY & ROOF DRAINAGE LAYOUT	P1
JHA-HD-DWG-2TL-22L31	BLOCK 2 - T & L BUILDING, LEVEL 3, SANITARY & ROOF DRAINAGE LAYOUT	P1
JHA-HD-DWG-2TL-22L41	BLOCK 2 - T & L BUILDING, LEVEL 4, SANITARY & ROOF DRAINAGE LAYOUT	P1
JHA-HYD-DWG-2TL-40001	BLOCK 2 - T & L BUILDING, SANITARY DRAINAGE SCHEMATIC	P1
JHA-HYD-DWG-2TL-40002	BLOCK 2 - T & L BUILDING, PRESSURE SERVICES SCHEMATIC	P1
JHA-HYD-DWG-2TL-40003	BLOCK 2 - T & L BUILDING, ROOF DRAINAGE SCHEMATIC	P1
JHA-HYD-DWG-2TL-40004	BLOCK 2 - T & L BUILDING, FIRE HYDRANT SCHEMATIC	P1

Appendix B. Detailed Hazard Analysis

B.1 Introduction

Fire hazard, as defined in the BCA, is the potential harm and degree of exposure of occupants to fire starts, and the spread of fire, smoke and gases generated.

Hazards are probabilistic – they cannot be eliminated, and they do not mean that adverse consequences will occur. Bennetts et al (2001) explain that the purpose of hazard analysis is to identify design fires of greatest risk (which is the product of probability and consequence) as well as characteristics of buildings and occupants that increase or decrease this risk – that is risk from harm and exposure to fire. All fire safety systems should be evaluated for the same fires. The hazard analysis is central to all issues to be evaluated.

Generally, there are not only characteristics of buildings and occupants that increase hazards but also characteristics that reduce hazards and help to ensure performance. Such characteristics are also identified in this section.

This section presents hazards and design fires that must be consistently addressed by all fire safety systems. It is inappropriate to have complementary subsystems designed for different fires. The subject building will contain fire hazards associated with the following occupancy types & building classifications:

Occupancy Use	BCA Building Classification
Administration & Offices	Class 5 (Admin & Office)
School	Class 9b (School)
Assembly Hall	Class 9b (Assembly Hall)

B.2 Class 5 – Office

B.2.1 General

A fire hazard analysis considers the influence of structure, contents and usage on the fire risk. The purpose is to identify those factors which pose risks relevant to the design. The intent of this analysis is to mitigate the risk elements through the design of fire safety features appropriate to the relevant factors of risk.

Offices are an occupancy where primarily administrative work is carried out – "white collar" work such as finance, administration, communication, design and coordination. The Guide to BCA 2016 Volume 1 (ABCB, 2016) clarifies that Class 5 "Office" occupancies includes professional chambers or suites, lawyers' offices, government offices, advertising agencies and accountants' offices. Offices are typically a work environment, and therefore usually occupied only during business working hours. Other entities' definitions vary slightly. For example, the USA's National Fire Protection Association defines office buildings as "A facility used for office, professional, or service-type transactions, including but not limited to storage of records and accounts."

Typically, contents of offices may include significant quantities of paper, electronic devices such as phones and computers, and furniture in the form of desks, tables and chairs, bookcases and filing systems.

While in the past large office buildings were almost universally constructed as multi-room affairs with one or two desks in each separate room, modern practice in larger commercial and government facilities has moved to "open-plan" offices, in which a single large room holds multiple desks separated by short partitions. This tends to allow fire and smoke to spread further, but also makes it easier for evacuating occupants to find the exits.

In all, Building Classification 5 includes a variety of different constructions. There are single stand-alone offices, offices associated with the administration of other facilities (usually as a Class 5 part of a building primarily containing another occupancy), and multistorey offices including some linked by atriums or open stairs. These last are relatively recent design innovations and therefore the influences of such linking of floor levels on fire statistics is not readily discernible.

B.2.2 Principal Sources of Data

Published fire related data is the most useful source of information on risks and hazards related to fire. By comparing the relative incidence and damage of fires in offices to those in other structures, one can obtain a broad appreciation of the hazards and risks in this occupancy.

Statistical data for this analysis has been drawn from a number of sources globally. This section outlines the sources of data consulted, the relevancy of that data to the Class 5 occupancy, and any assumptions or restrictions integral to the data.

Given the general lack of extensive and specific fire incident data for Australia, it is necessary to draw upon data from other sources. In this case, data has been drawn from sources in the United States of America, the United Kingdom, New

Zealand and Europe to enable more comprehensive analysis. These data sources are considered relevant because Australian regulations and construction practices are broadly similar to those in these countries. International analysis shows overall rates of fire starts and casualties similar to Australian rates (see Section B.2.5 of this appendix).

In addition, a report analysing Australasian Fire Authority Council data (Arup, 2008) (discussed below under Australian Data) compares Australian fire frequency data to UK data using methods proposed in British Standard BSI PD 7974 Part 7:2003. The result of one of these methods is displayed in Figure B.1. The report concludes based on these analyses that there is reasonable similarity between Australian and UK data.

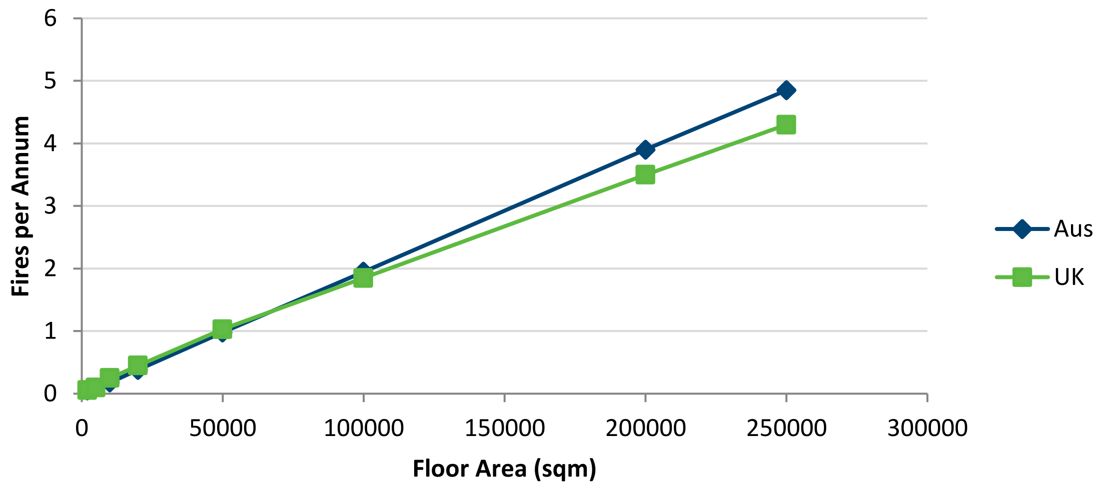


Figure B.1: Australian data compared to UK data for fire frequency in offices.

The principal sources of data used for this hazard analysis of office occupancies include:

B.2.2.1 Australian data:

Australian data is generally not made available by fire brigades, and when available is not divided by occupancy. Thus, data structured usefully for our purposes is infrequently available. Two useful reports are:

- Building Fire Scenarios – An analysis of fire incident statistics (CSIRO, 2000)

This report gives fire data for five years, 1989-1993, averaging 9,760 fires per year. This data was collected by the Australian Fire Incident Reporting Scheme, a nation-wide fire brigade system. It is estimated that only 81-85% of fires that occurred were reported in AFIRS, but the data has not been adjusted to counteract this because that would introduce additional uncertainty. This data corresponds very well to Class 5 buildings, as it is divided by Australian categorisation methods, which changed little over the intervening years. However, the CSIRO data is not displayed by occupancy apart from the statistics for fire frequency, so those are the only statistics useful for this analysis.

- AFAC National Incident Data Base Statistical Assessment – Preliminary Report (Arup, 2008)

In partnership with the Australasian Fire Authorities Council, Arup Fire prepared this report on data in the AFAC’s national incident database. The data investigated covers a period of six years between 1998 and 2004, including a total of 62,583 fire incidents. This data corresponds very well to Australian classifications, as it is drawn from Australian sources, however only 5 categories are analysed: Office, Retail, Institutional, Manufacturing and Storage. All other properties are grouped as “other”, hence comparison to educational, residential or other classifications is not possible.

B.2.2.2 New Zealand data:

New Zealand can be considered Australia’s closest neighbour in terms of culture and regulation. For example, Australia and New Zealand share a number of joint AS/NZ Standards. The New Zealand Fire Service’s annual reports do provide statistics divided by occupancy, and so are useful here:

- The New Zealand Fire Service Emergency Incident Statistics 2009-2010 (NZFS, 2010)

This report covers four years of fires, 2005/06-2009/10, totalling 22,572 fires per year on average. Note that the NZ classification system is different to the Australian one and the office class is a narrower group than Australia's Class 5 – the NZ subclass does not include, for example, dentists' offices or veterinary practices. In addition, the NZ data includes non-structure fires such as those on roads or recreational spaces, accounting for the much greater number of fires per year compared to the Australian statistics.

B.2.2.3 United States of America data:

Data sourced from the USA covers the years 2007-2011, but only includes fires reported to municipal fire departments. Data was collected via the U.S.A.’s National Fire Incident Reporting System (used by the fire brigades) and the annual

NFPA fire department experience survey, and so this data comes from a fire brigades' viewpoint. Three NFPA reports were referenced for this analysis:

- Structure Fires by Occupancy 2007-2011 (NFPA Fire Analysis and Research Division, 2013)

In this report the division of occupancies is different from the BCA. Occupancies considered valid in reference to Class 5 are: 'Business Office', 'Bank', 'Veterinary or research', and 'Post office or mailing firm'. These have been added together to create an approximation of Class 5 data.

- US Structure Fires in Office Properties (Campbell, Richard, 2013)

The sample size in this report is an average of 3,340 structure fires in office properties per year over the five-year period. This data relates to all of the different constructions of offices listed above except 'offices associated with other occupancies', but doesn't distinguish between them. Analysis of this data in Section B.2.4 of this appendix uses property damage as an indicator of fire size and therefore to some extent deadliness.

- High-rise Building Fires (Hall, 2009)

This is an older report which covers four years, 2003-2006, with an average of 13,400 high-rise building fires per year. As the title implies, it only deals with high-rise facilities.

B.2.2.4 United Kingdom data:

The United Kingdom's Home Office publishes fire data online in table form, as downloadable Microsoft Excel spreadsheets. The useful table for our purposes is:

- Fire Statistics Table 0301: Fires, fatalities and non-fatal casualties in other buildings by motive and building type, England (Gov.UK, 2016)

This table includes data for 2014/15, which is only 1 year of data. The United Kingdom Home Office has only made available data for England in 2014/15. Previous years' data is available for all of Great Britain, but does not separate Office tenancies from Retail. As a result, the usable data here has a small sample size, and may not be accurate to overall frequencies.

B.2.2.5 European data:

Data has also been drawn from the following studies in Finland:

- Utilisation of Statistics to Assess Fire Risks in Buildings (Tillander, 2004)
- The Ignition Frequency of Structural Fires in Finland 1996-99 (Tillander & Keski-Rahkonen, 2003)

This data was gathered using the Finnish national accident database PRONTO and data on floor areas was provided by Statistics Finland. It covers four years of fires, totalling 2376 fires per year on average. This is roughly one-fourth of the fires per year of the Australian data above, a difference which can be attributed to Finland's lower population, which is approximately one-fourth that of Australia. The frequencies of ignition have been divided by the floor area of each category to adjust for the much greater quantity of residential buildings.

So, while there is limited usable Australian fire statistics available, there are plenty of international sources of data, and these overseas sources are relevant to the Australian built environment, and can be used with care to inform fire engineering and design in Australia.

B.2.3 Fire Loads

The fire load of a space is the density of fuel there, usually expressed in megajoules per square metre. A greater fire load in a space will generally lead to larger, more dangerous fires. Unfortunately, there is no practical way to define or control fuel loads in an office space, and as a result there are no regulations on fuel load levels or furniture construction. Figure B.2 through Figure B.5 provide an illustration of the possible variety of office arrangements and associated fuel loads. There will be offices with much lesser fuel loads and potentially some with greater.

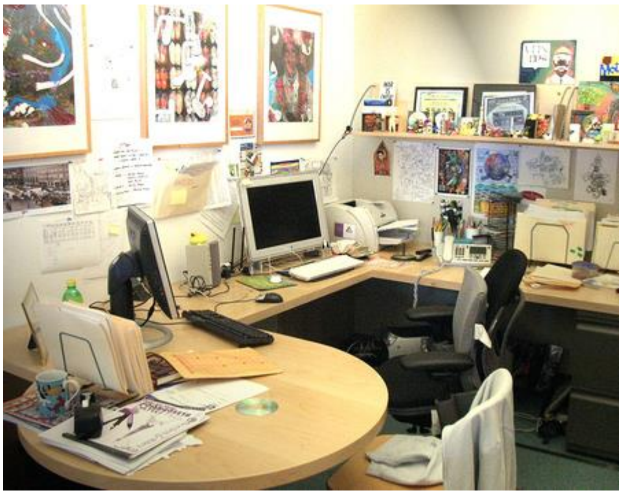


Figure B.2: A typical desk in an older closed-plan office.

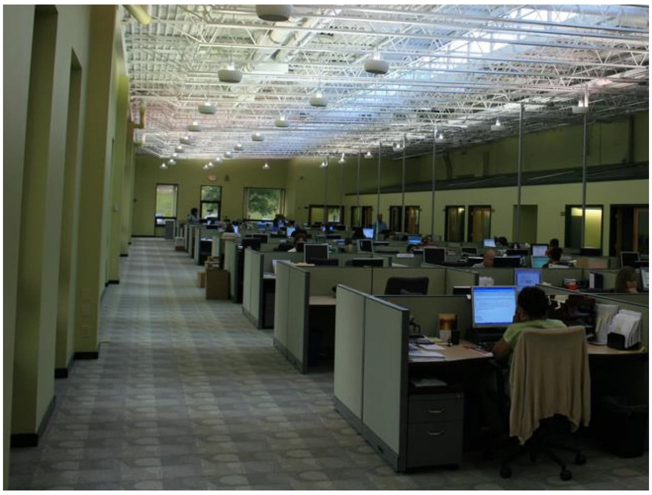


Figure B.3: Open-plan office in a large hall.

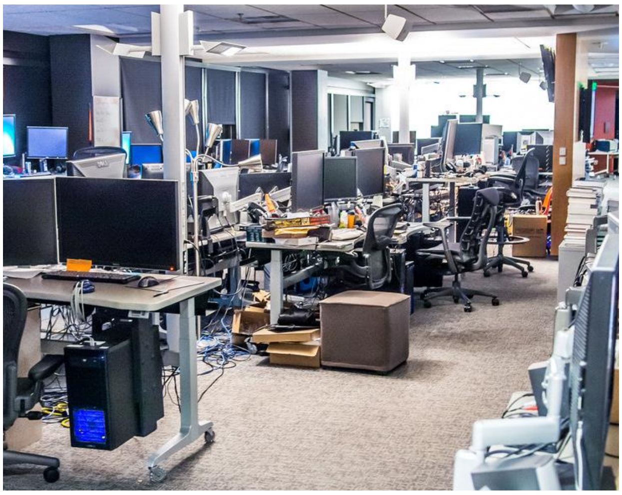


Figure B.4: Open-plan office with a fuel load of electronics.

Figure B.5: Open-plan office with significant paper storage.

To establish a representative quantity for an Office fire load, a number of sources have been examined:

Table B.1: Fire Loads from various sources

Category	Fire Load (MJ/m^2)	Standard Deviation	Source and Notes
Office	420	126	EN 1991-1-2 (2002) Referenced in SFPE Handbook (SFPE, 2016) No permanent load included – only contents
Office	827*	-	(Proe & Bennets, 1994) a fire test
Office	978-1269*	-	(Thomas, et al., 1992) A fire test, fire load noted as "in very high range"
Offices	1862	2361	(Claret & Andrade, 2007) Survey of Historic buildings, with minimal fire resisting construction and often primarily timber construction.
Authority or Bank Office	800		
Dentist or Doctor's Office	200		
High-rise Office Building	800		
Business Office	800		(England et al. 2000) 'Fire resistant barriers and structures', reproduced in the AFEG 2005
Engineering Office	600		
Machinery Manufacture Office	300		
Post Office	400		
Offices in Canada	557	286	(Khorasani, et al., 2014) review of a 2011 Canadian survey
Offices in India	348	262	(Khorasani, et al., 2014) review of a 1993 Indian survey

Category	Fire Load (MJ/m^2)	Standard Deviation	Source and Notes
Offices in Europe	300-900	-	(Khorasani, et al., 2014) review of a 2005 European survey
USA Government Offices	641	641	(Khorasani, et al., 2014)
USA Commercial Offices	720	562	
European data	330-420	330-400	(CIB, 1986)

** Value given in kg wood equivalent. Conversion to MJ/m^2 by multiplying by 18.8 MJ/kg, the average of all woods' net heats of combustion given in the SFPE Handbook (SFPE, 2016), Appendix 3, Table A.32, p3449.*

As can be seen in Table B.1, the overall fire load can vary significantly, depending in part on the storage and archival practices in place. For example, some offices would maintain only electronic archives, while others would store past files in hard copy.

It is also useful to consider the distribution of materials involved in fuel loads. Office fuel load distribution data used in Table B.2 breaks down Engineering and Clerical desk units (Kakegawa, 2003) and overall moveable fuel loads in offices (Caro & Milken, 1995).

Table B.2: Composition of Office Fuel Loads

Item	Mass	Given Materials
Engineering Desk Unit	**(kg)**	
desk	42.1	melamine resin, board, metal frame
desk wagon	23.9	polystyrene, ABS resin, metal frame
chair	11.1	polyurethane foam
telephone	0.7	
rubbish bin	0.6	polypropylene, paper
desktop computer	11	
desk partition	8	paper, wood, metal frame
paper files	125	paper
file box	30	paper
total	**240.7kg**	
Clerical Desk Unit	**(kg)**	
desk	35.4	melamine resin, board, metal frame
desk wagon	23.9	polystyrene, ABS resin, metal frame
chair	13.9	polyurethane foam, plastic
telephone	0.7	
rubbish bin	0.6	polypropylene, paper
laptop computer	3	
desk partition	7	paper, wood, metal frame
paper files	50	paper
file box	15	paper
total	**145.8kg**	
Average Total Movable Fuel Loads	**(lb)**	
Papers/Books	2742	paper
computer equipment	332	
furniture	136	
Partitions	854	
total	**3732lb**	

We can see that a significant majority of most office fuel loads will be in the form of paper or other cellulosic material (such as wood), but there are significant portions of plastics. Particular note should be paid to expanded plastic foams, as these ignite easily and burn very quickly. It should be noted that in the years since these studies, there may well have been a move toward more electronic (so-called "paperless") offices, which would reduce the quantity of cellulosic materials relative to plastics and electronics.

While it is largely impossible to control or regulate fire loads in office properties, most studies find a mean fuel load in the range of 300-700 MJ/m². Most of the fuel load in offices is in the form of paper or wood, but there are significant quantities of plastics and electronics present as well.

B.2.4 Ignition Sources

Fires have to start from something – they don't spontaneously appear. Potential sources of fire, which are therefore sources of risk, include items which produce heat or sparks, and are termed 'ignition sources'. Ignition sources must be considered because they determine where and how fires can start, thereby informing the location of design fires and providing direction to effective preventative measures. The most effective measure to reduce fire risk is to reduce the frequency of fires by controlling ignition sources.

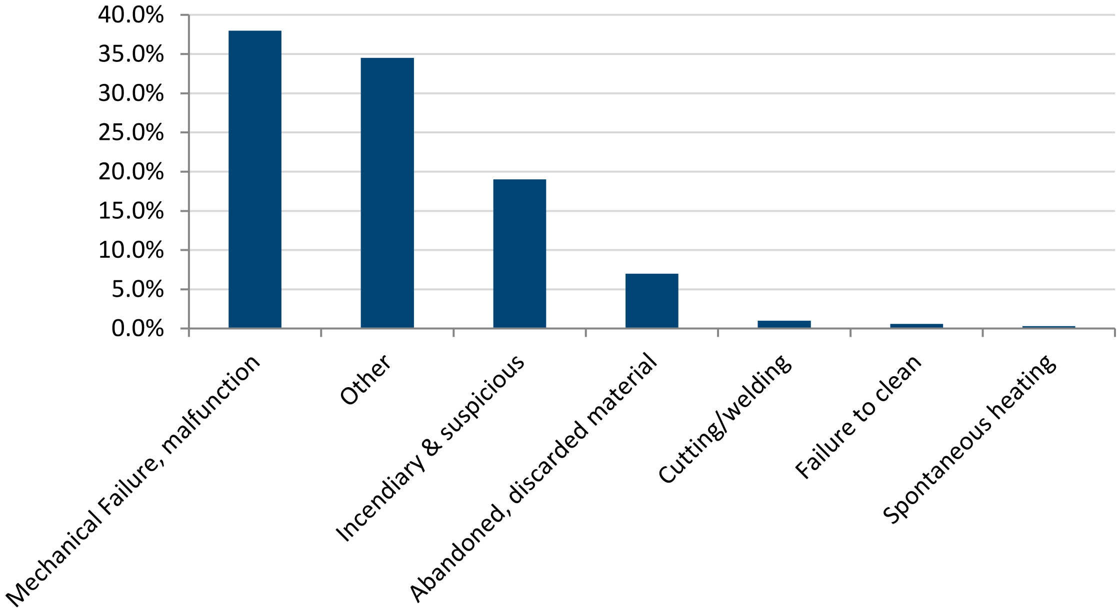


Figure B.6: Office fires in Australia by ignition sources 1998-2004 (Arup, 2008)

Australian data in Figure B.6 shows that malfunctions are the most common source of ignition. In addition, 62% of that category was related to short circuits and electrical malfunctions.

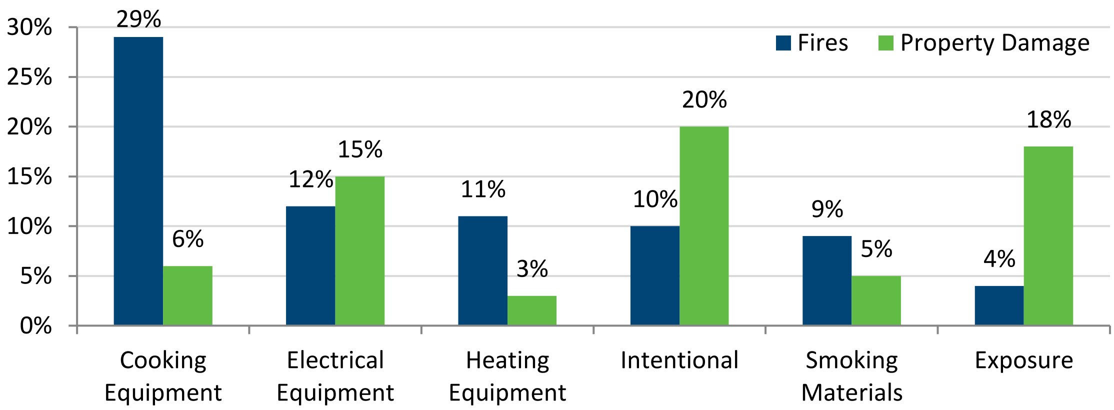


Figure B.7: Office fires and property damage in USA by 6 most common ignition sources 2007-2011 (Campbell, Richard, 2013)

NFPA data, as shown in Figure B.7, indicates:

- Cooking equipment fires are the most common, but not the most damaging.
- The most dangerous of these common fires (dangerousness determined by the ratio of their frequency to property damage) are the intentionally lit fires (i.e. arson), and exposure fires, which is the NFIRS term for when a fire spreads from an adjacent property or building.

Additionally, NFPA analysis of fire locations (Campbell, Richard, 2013) indicates that most office fires start in kitchen areas, while more damage is caused by fires starting in office areas proper.

In high-rise offices, cooking equipment and electrical distribution equipment have an even greater share of ignitions, causing 53% and 18% of fires respectively in the period 2003-2006 (compared to only 20% and 13% respectively in non-high-rise offices in the same period). This can be attributed to the reduction of many other ignition sources which simply don't occur with any frequency in high-rise properties, such as smoking materials (smoking being banned within almost all high-rise buildings) and heating equipment (if the high-rise has centralised heating).

The ignition sources that produce the most frequent fires in offices are cooking equipment and, to a lesser extent, electrical equipment. This is even more the case for high-rise offices. The sources that produce the most fire-related property damage are arson and fires in adjacent properties.

B.2.5 Fire Frequency

Available statistics can be used to give an overall indication of the frequency of fire starts in offices and are especially useful in comparing the relative hazard of offices to other occupancies. This section indicates the overall downward trend of office fires, the beneficial effects of sprinkler systems, modern design and materials, and the low risk of offices relative to other occupancies, as evidenced by data from Australia and other countries.

Figure B.8 shows that the frequency of fires in office properties has been steadily decreasing in recent years. While this is certainly a positive development, it is important to acknowledge that this trend is almost certainly caused by a range of factors. One of those factors is improving fire safety design, so this trend cannot be used to justify reduced fire safety systems.

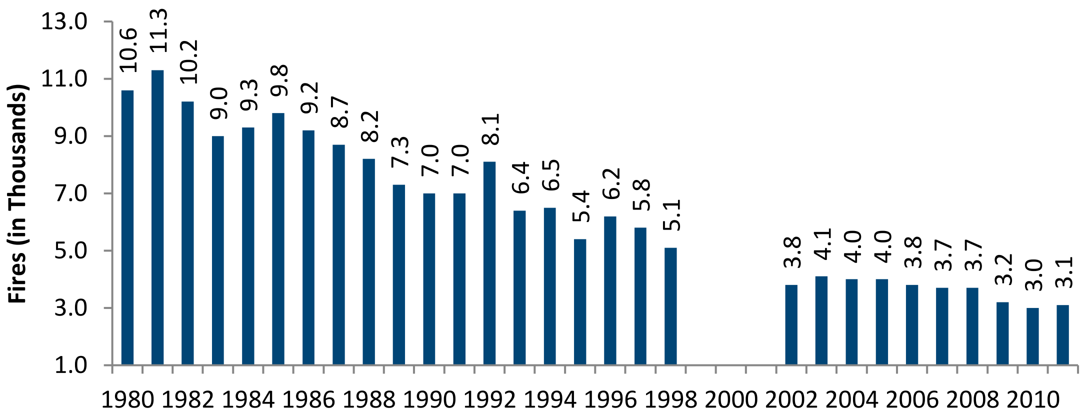


Figure B.8: Office Fires in USA by Year 1980-2011 (Campbell, Richard, 2013)

(1999-2001 was the transition period between versions of NFIRS, and the data from that period is unreliable)

The following figures compare office occupancies to other occupancies in terms of number of fires per year. In each figure, the occupancy containing office properties has been highlighted.

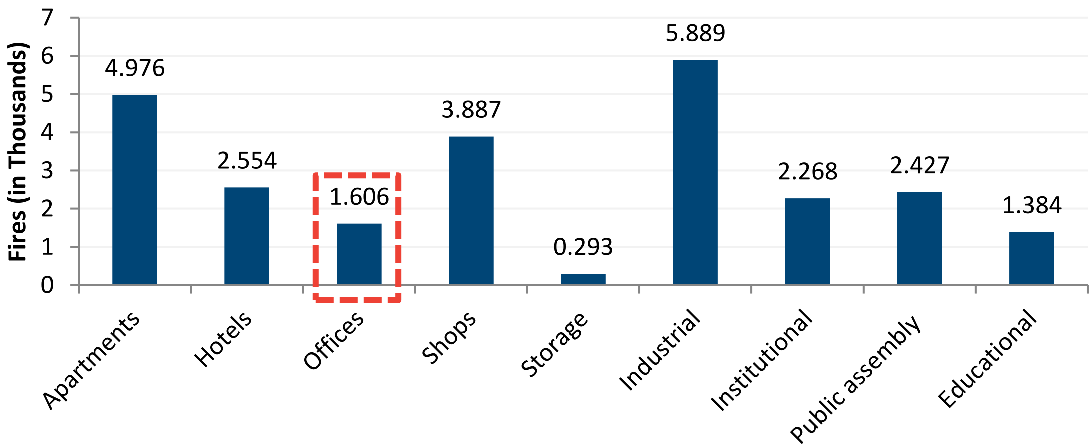


Figure B.9: Fires in Australia by Occupancy 1989-1993 (CSIRO, 2000)

Australian data in Figure B.9 shows that offices contained the third least number of fires from 1989-1993, after educational facilities. More recent data (Figure B.10) indicates a similar outcome.

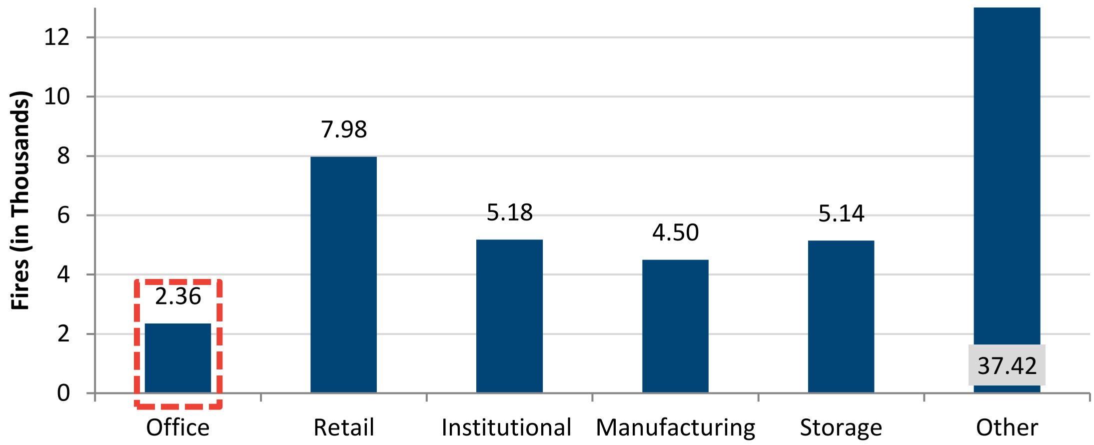


Figure B.10: Fires in Australia by Occupancy 1998-2004 (CSIRO, 2000)

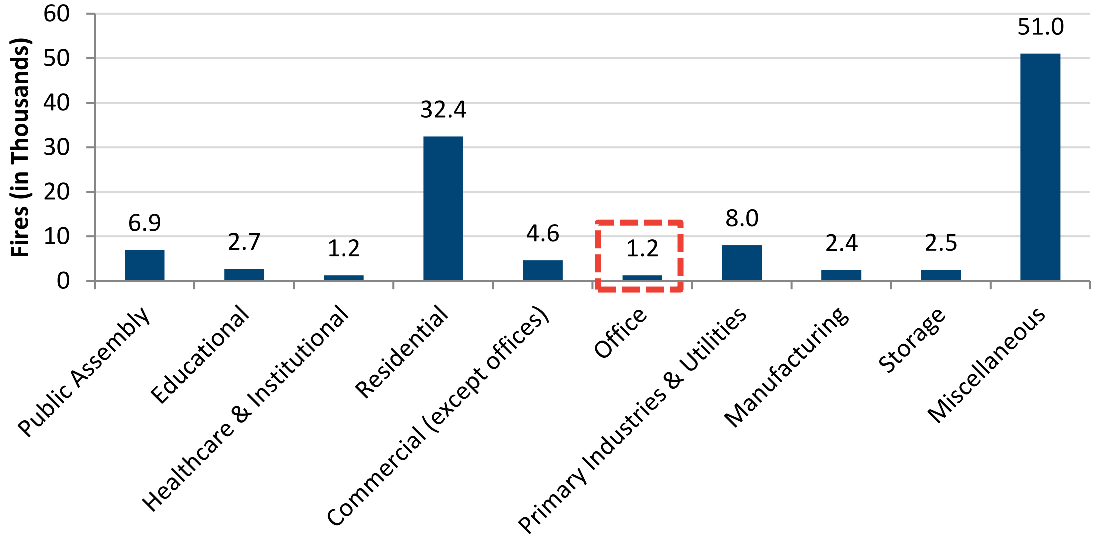


Figure B.11: Fires in New Zealand by Occupancy 2005/06-2009/10 (NZFS, 2010)

Figure B.11 shows that in New Zealand, offices are among the occupancies with the least frequent fires, along with healthcare properties. Note though that the New Zealand system groups offices with commercial properties, so this is a narrower group than Australia's Class 5 occupancy.

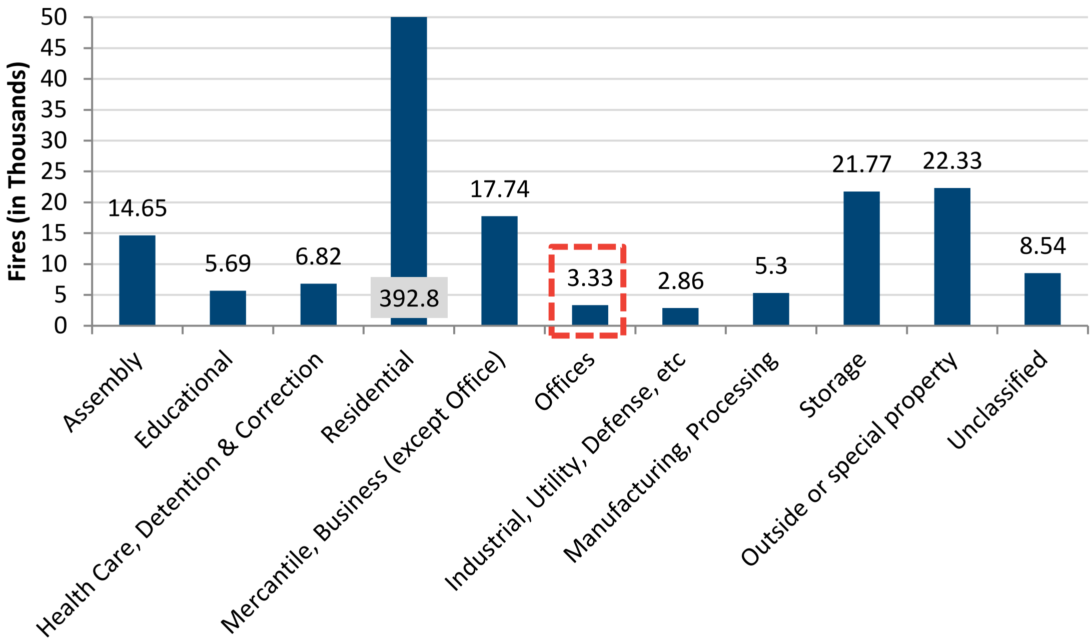


Figure B.12: Fires on Average per Year in USA by Occupancy 2007-2011 (NFPA Fire Analysis and Research Division, 2013)

Referring to Figure B.12, offices in the USA contribute fewer fires than any other classification except the one encompassing Industrial, Utility, Defence, Agriculture and Mining occupancies.

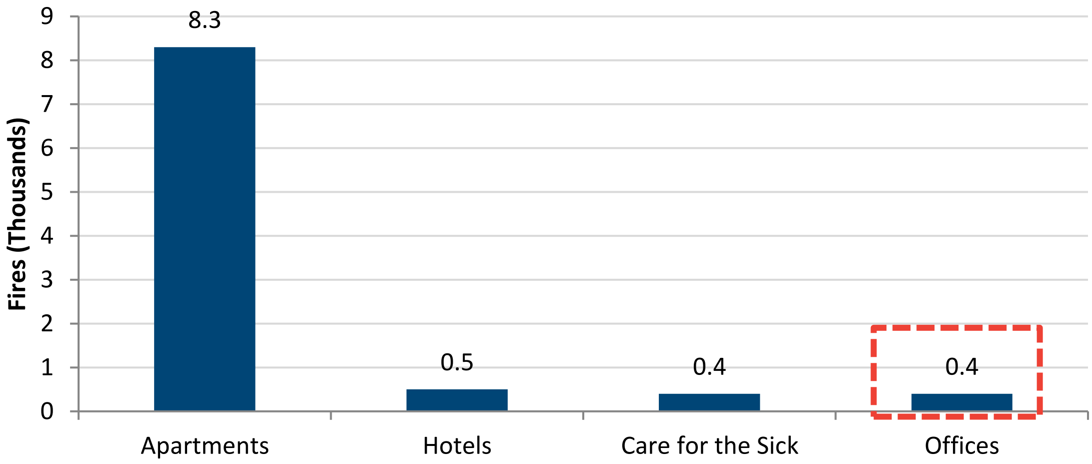


Figure B.13: High-rise Fires Average per Year in USA by Occupancy 2003-2006 (Hall, 2009)

Figure B.13 indicates that in USA High-rise buildings, offices have fewer fires by far than apartments.

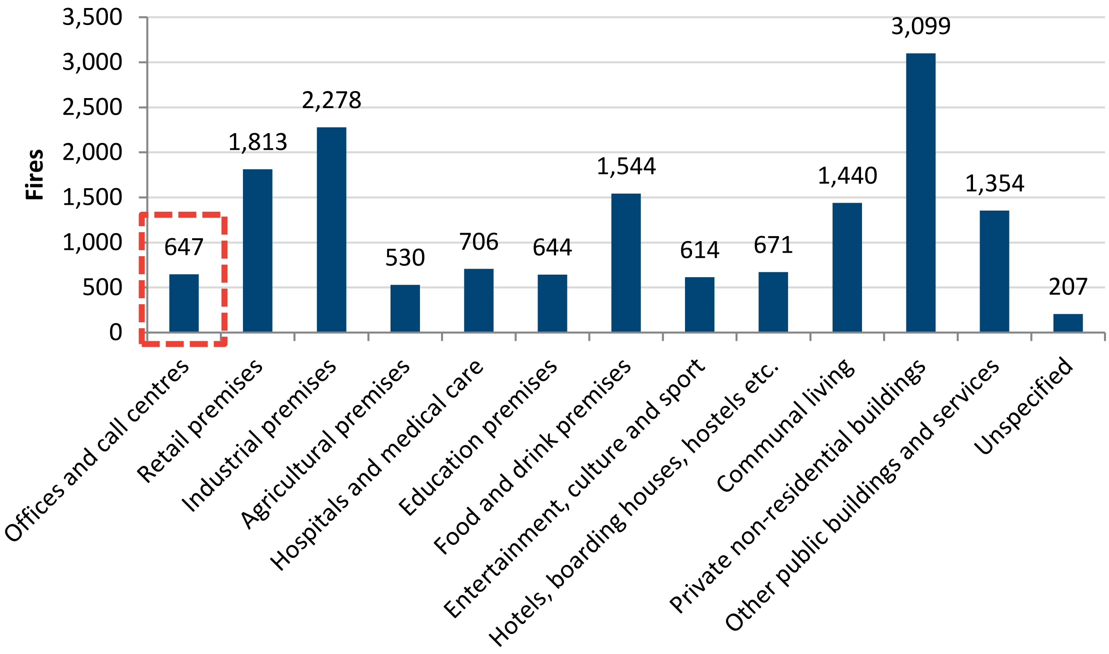


Figure B.14: Fires in England by Occupancy 2014/15

In Figure B.14 we see that offices were among the occupancies with the least frequent fires in England over this year. Offices contained a number of fires roughly equivalent to that found in controlled environments like hospitals or education premises. As mentioned above, the small sample size here reduces the applicability of the data somewhat, but overall comparisons are still useful.

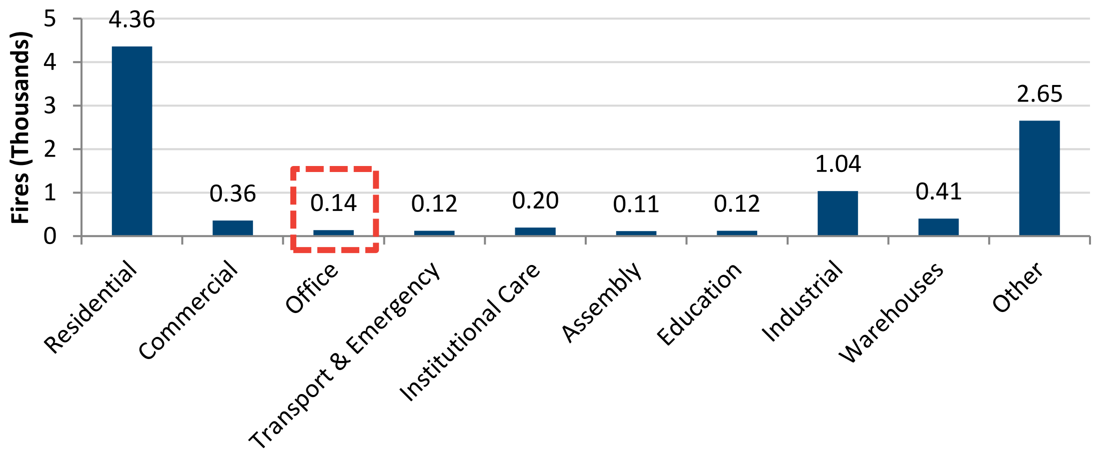


Figure B.15: Structure Fires in Finland by Occupancy 1996-99 (Tillander & Keski-Rahkonen, 2003)

Offices are among the occupancies with the least frequent fires in Finland. This is even clearer when the data is adjusted for floor area:

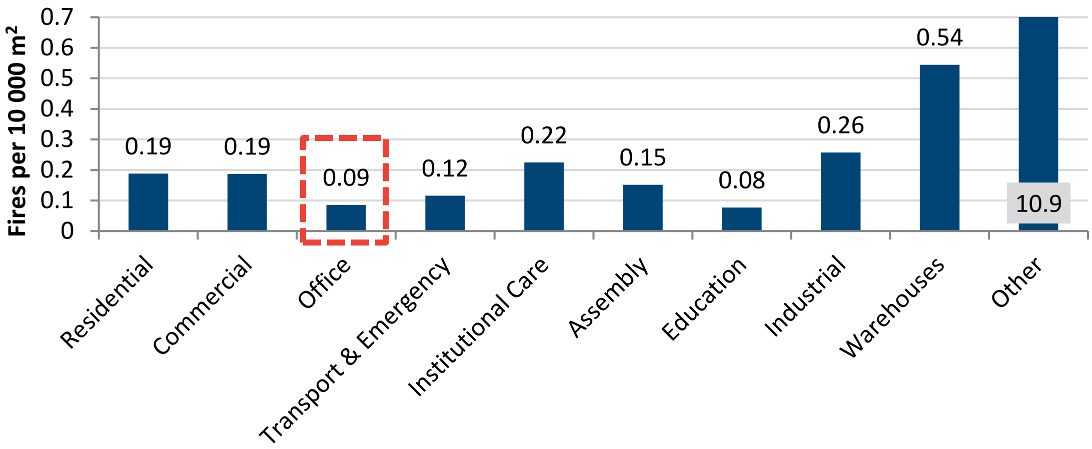


Figure B.16: Structure Fires per unit floor area in Finland by Occupancy 1996-99 (Tillander & Keski-Rahkonen, 2003)

Note that 'other' has a very low floor area, resulting in an ignition rate twenty times the next most frequent. This is largely irrelevant in this case because we are comparing Offices to other occupancies.

Other relevant statistics relating to frequency and spread include:

- While most fires in office properties occur in the middle of the day, most fire damage is caused at night (Campbell, Richard, 2013). This is consistent with the ignition sources above, as many ignition sources, such as cooking equipment, would only be used while the office is staffed (Arup, 2008). The greater damage caused at night can be attributed to the lack of detection and suppression by occupants.
- Average property damage per fire in offices is 46% reduced where wet pipe sprinklers were present (Campbell, Richard, 2013).
- Sprinklers, when they are present and operate, extinguish or prevent the spread of 94% of fires (Arup, 2008). Sprinklers are effective in controlling office fires even when fires are shielded by desks or other shelf-like arrangements (Lougheed, 1997).
- Fires in high-rise offices were half as likely as those in low-rise offices to spread beyond the room of origin, most likely due to the greater use of fire protection systems (including sprinklers) in high-rise buildings (Hall, 2009).

Thus, we see that the statistics worldwide indicate that an office building rates relatively low with respect to the risk of fire when compared to buildings of other occupancies. In addition, while (typically non-sprinkler-protected) mid- or low-rise offices are quite low risk, this is even more true of (typically sprinkler-protected) high-rise office properties.

B.2.6 Risk to Life

A pair of very useful statistics in comparing fire risks is the rates of injuries and of fatalities, as they give a good overall impression of the life safety risk of the occupancy, separate from the frequency or intensity of fires. It is important to note, however, that it is still affected by the relative quantities of the different occupancies – there are far more residential buildings than offices, for example, naturally resulting in greater numbers of fires, injuries and fatalities in residential buildings. It can be argued, however, that the smaller amount of time spent in offices as opposed to residential occupancies does make offices naturally safer.

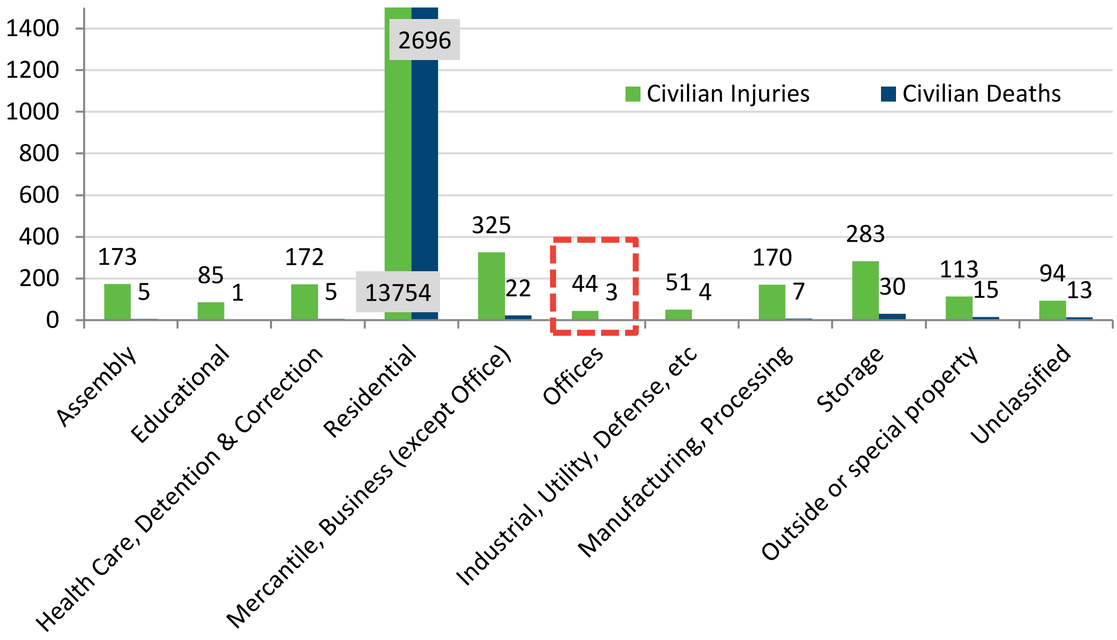


Figure B.17: Average Deaths and Injuries per Year in USA Fires by Occupancy 2007-2011 (NFPA Fire Analysis and Research Division, 2013)

The Office classification is not given as a major occupancy in (NFPA Fire Analysis and Research Division, 2013), however combining the data for occupancies which include the word “office” in their titles, we find that occupancies which in Australia would be Class 5 account for 0.83% of fires, 0.14% of civilian deaths, and 0.31% of civilian injuries.

Furthermore, deaths per thousand reported fires are 62% lower in stores and offices when wet pipe sprinklers are present (Campbell, Richard, 2013).

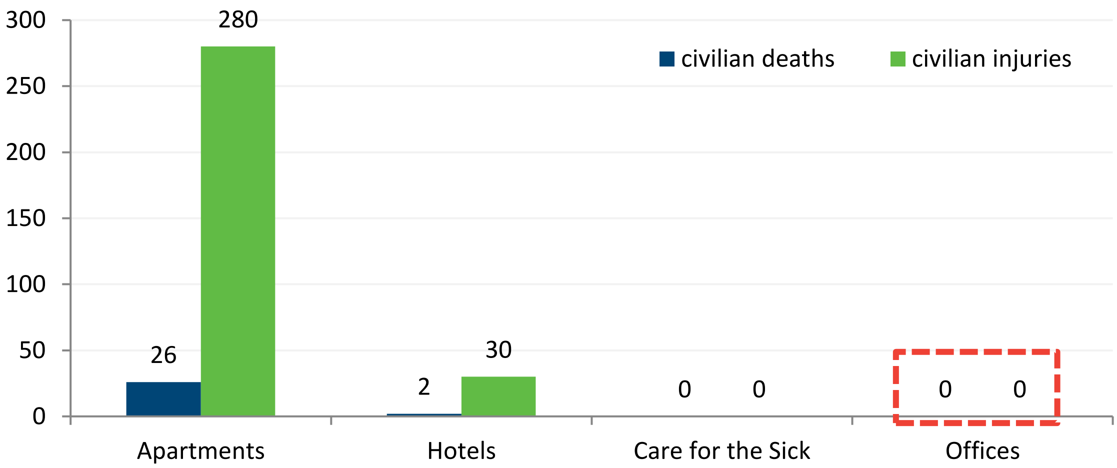


Figure B.18: Average Deaths and Injuries per Year in USA High-rise Fires by Occupancy 2003-2006 (Hall, 2009)

In high-rise buildings specifically, office fires cause far fewer injuries and fatalities than apartments and even hotels. This is likely because the increased fire safety systems installed in high-rise buildings mean that only unaware occupants (asleep or intoxicated or both) are at significant risk inside.

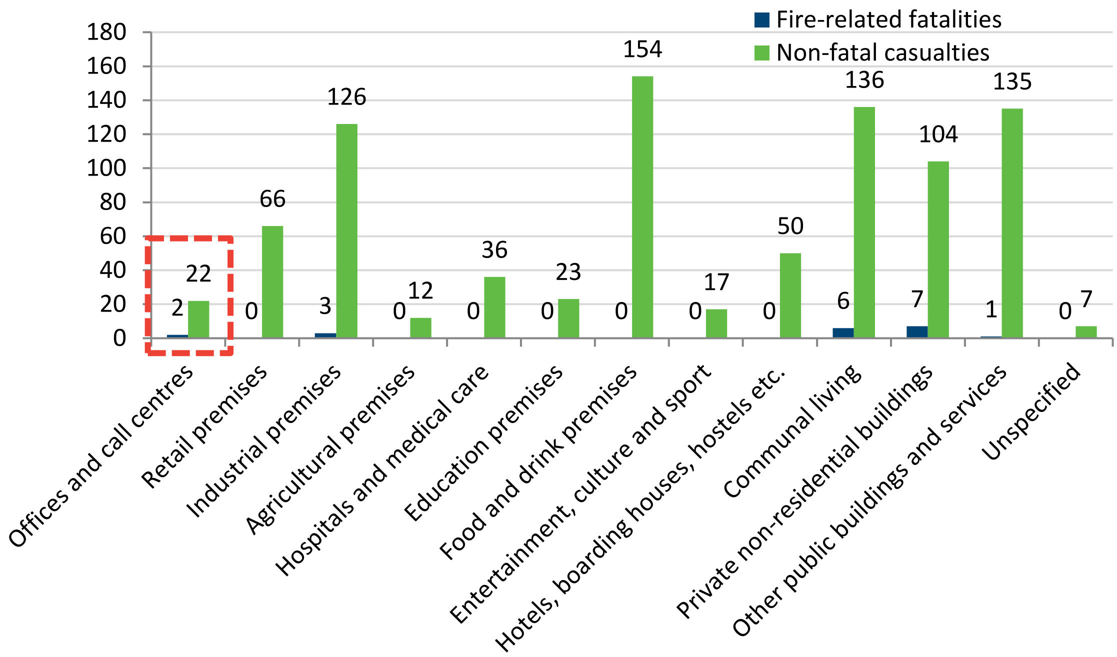


Figure B.19: Fatalities and Injuries in fire by Occupancy, England 2014/15

Offices are among the occupancies with the least frequent fire injuries in England. Unfortunately, the small sample size renders the fatality data here of questionable statistical use, as a single disastrous fire event in a given year can drastically change the number of fatalities in an occupancy for that year.

Thus, we can conclude that offices are an occupancy of low overall fire risk, and in particular have a significantly below-average risk to life from fire events.

B.2.7 Work Station Fires

There are various research publications discussing the likely heat release rates (HRR) for office work station fires. In order to establish the fire sizes for the building with no sprinkler suppression a number of studies has been reviewed and their findings have been adopted. These studies have been summarised in the VTT Technical Research Centre of Finland Working Paper 139, titled "Design Fire for Fire Safety Engineering" dated 2010. The subject document recommends and average HRR of 1156 kW/m^2 for office work station fires. This value is in line with studies conducted by Kakegawa (2002) which were based on typical office workstation fuel loads comprising papers, plastics, upholstery and alike (see Table B.3).

Table B.3: Office fuel loads (Kagewa, 2002)

Item	mass	given materials	representative material
Engineering Desk Unit	(kg)		
desk	42.1	melamine resin, board, metal frame	wood
desk wagon	23.9	polystyrene, ABS resin, metal frame	polystyrene
chair	11.1	polyurethane foam	flexible polyurethane foam
telephone	*0.7		
rubbish bin	0.6	polypropylene, paper	polypropylene
desktop computer	*11		
desk partition	8	paper, wood, metal frame	wood
paper files	125	paper	wood
file box	30	paper	wood
total	**240.7**		
Clerical Desk Unit	(kg)		
desk	35.4	melamine resin, board, metal frame	wood
desk wagon	23.9	polystyrene, ABS resin, metal frame	polystyrene
chair	13.9	polyurethane foam, plastic	flexible polyurethane foam
telephone	*0.7		
rubbish bin	0.6	polypropylene, paper	polypropylene
laptop computer	*3		
desk partition	7	paper, wood, metal frame	wood
paper files	50	paper	wood
file box	15	paper	wood
total	**145.8**		
Average Total Movable Fuel Loads	(lb)		
Papers/Books	2742	paper	wood
computer equipment	*332		
furniture	136		flexible polyurethane foam
Partitions	854		wood
total	**3732**		

*marks non-combustible items not counted toward total mass

Majority of studies conclude that the office fires are more likely to develop with a medium t^2 growth rate. As a matter of conservatism, a fast t^2 growth rate is considered for building design fires. ISO/CD 13388 Table 1 design fire growth rates are shown in Figure B.20

Table 1. Design fires as given in ISO/CD 13388

Design fire scenario	Category
Upholstered furniture and stacked furniture near combustible linings	*Ultra fast*
Light- weight furnishings	*Ultra fast*
Packing material in rubbish pile	*Ultra fast*
Non- fire retarded plastic foam storage	*Ultra fast*
Cardboard or plastic boxes in vertical storage arrangement	*Ultra fast*
Office furniture- horizontally distributed	*Medium*
Displays and padded work- station partitioning	*Fast*
Bedding	*Fast*
Floor coverings	*Slow*
Shop counters	*Medium*

Figure B.20: Design Fire Growth Rates

Based on *AS3590.2-1990 'Screen based workstations Part 2: Workstation furniture"* the area for a single workstation (desk and chair) has been established as 2 m^2.

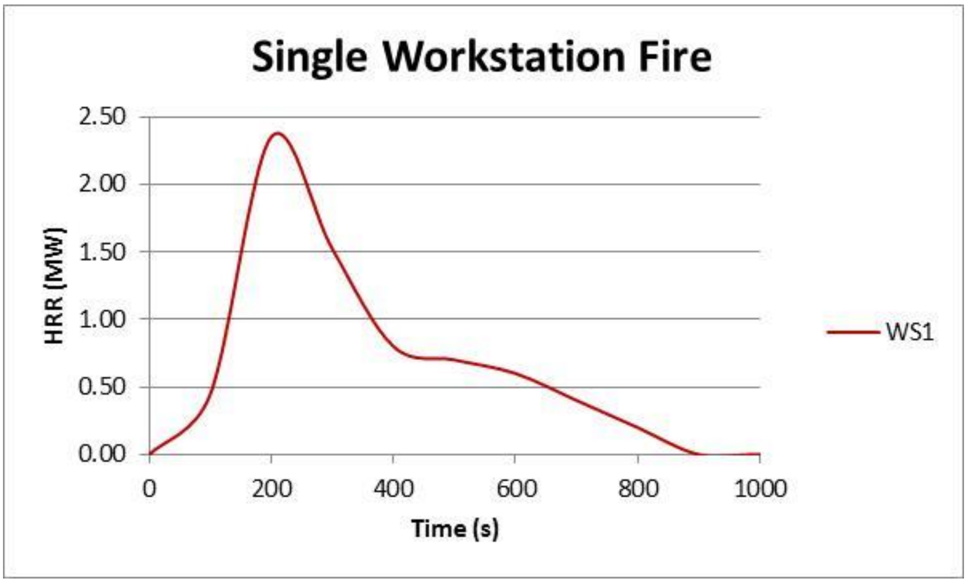


Figure B.21: Schematic representation of the single workstation fire (DF2)

The single workstation fire used as the basis for the design fire representing fire spreading gradually to multiple workstations and continuing to burn at the same rate as each ignited workstation fire eventually decays. Figure B.21 represent single work-station design fire.

With respect to typical office furniture fuel loads and fire sizes other studies also provide similar estimations. Sardqvist (1993) conducted a series of fire tests and identified the maximum HRR of a workstation comprising U shaped partitions, a workdesk and a filing cabinet as 2MW. His test finding for a computer workstation with a desk and bookcase was approximately 1.2 MW.

BSI (1994) recommends 250 kW/m^2 HRRPUA for offices which is significantly less than the value adopted for this study.

B.2.8 Multi-Work Station Fires

The single workstation fire used as the basis for the design fire representing fire spreading gradually to multiple workstations and continuing to burn at the same rate as each ignited workstation fire eventually decays. Figure B.22 represent a multi-workstation fire involving 4 work stations and gradually decaying.

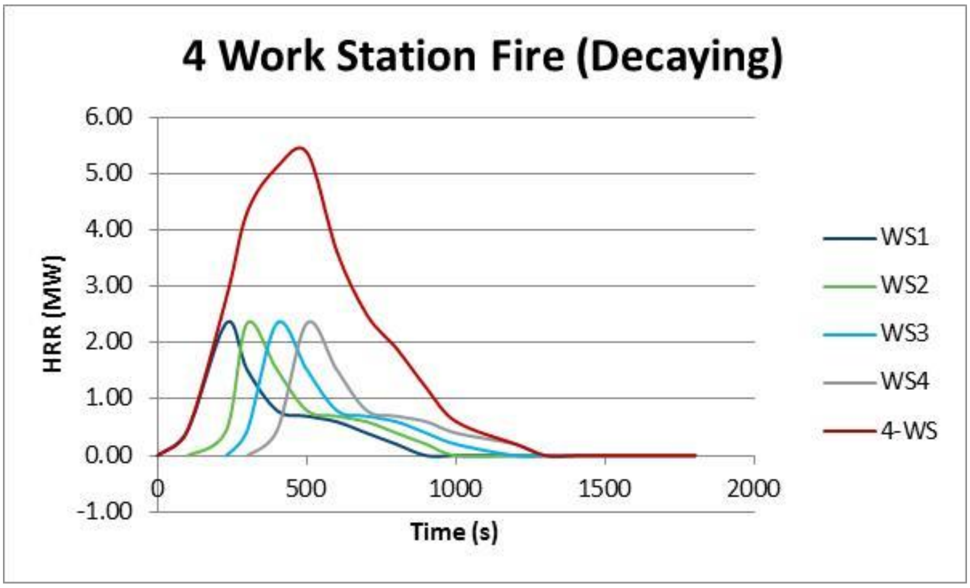


Figure B.22: Schematic representation of the multi- workstation fire (DF3)

B.2.9 Conclusion

While there is limited usable Australian fire statistics available, there are plenty of international sources of data (see Section B.2.2), and these overseas sources are relevant to the Australian built environment, so can be used with care to inform fire engineering and design in Australia. In office occupancies in particular, this data leads to a number of observations:

- While it is largely impossible to define or regulate fire loads in office properties, most studies find a mean fuel load in the range of 300-700 MJ/m^2 (see Table B.1). Most of the fuel load in offices is in the form of paper or wood, but there are significant quantities of plastics and electronics present as well (see Table B.2).
- The ignition sources that produce the most frequent fires in offices are cooking equipment and, to a lesser extent, electrical equipment (see Figure B.7). This is even more the case for high-rise offices. The sources that produce the most fire-related property damage are arson and fires in adjacent properties.
- Statistics worldwide indicate that an office building rates relatively low with respect to the risk of fire when compared to buildings of other occupancies (see Section B.2.5).
- While (typically non-sprinkler-protected) mid- or low-rise offices are quite low risk, this is even more true of (typically sprinkler-protected) high-rise office properties (see Figure B.13).
- Offices are one of the occupancies with the lowest fire fatality risk (see Section B.2.6).
- Automatic sprinkler systems are very effective at reducing the severity of fires in office properties (Lougheed, 1997).

In conclusion, offices are an occupancy of low overall fire risk, and in particular have a significantly below-average risk to life from fire events.

B.3 Class 9b – School

The hazards associated with schools are examined from data provided by FRNSW, Victoria fire brigades and overseas fire statistics on previous fire incidents. The data is to be utilised to determine the risk and hazards that are likely to be associated with Class 9b educational facilities.

The main salient points with regards to school fire hazards are as follows (Clancy et al 2004):

- Many education department officers cannot recall any deaths in school fires; hazard to life safety is low.
- On average, a school fire with losses exceeding one million dollars occurs every two weeks in Australia. However, this loss is less than 0.1% of school assets.
- Losses from burglaries in schools are seven times larger than fire losses.
- Most fires are small; most of the loss is due to only a small proportion of all fires.
- Most of the losses appear to be due to arson. However, statistics on this matter are unclear. Arson is sometimes interpreted as burglary.
- Arson fires are consistently the single most significant source of fire starts (54% of school fires in NSW, 60% in UK, and 52% in USA).
- The school fire problem is one of property protection the responsibility for which lies with the owner rather than the building code. It is a small but significant problem.

It is not appropriate to attempt to control specific arson fires or to attempt to eliminate it. Arson is a risk, and like all risks it can only be minimized, not eliminated. Minimization is best achieved with risk management that is naturally incorporated into the normal running of a school. It should not be seen as extra work. Fire is rare. An onerous risk management plan will eventually be ignored and not seen as effective due to the low frequency of fire. A good risk management plan will include the following features:

- Regular removal of rubbish
- Not storing rubbish under eaves or other places which facilitate ignition of the building following the burning of rubbish.
- Maintaining sterile egress paths and stairways by way of limiting any combustible items to required furnishings such as wall and floor coverings with no additional storage or combustible items permitted.
- Security not only trained to prevent burglary but also to minimize the risk of fire ignition. Many security practices not only reduce burglary but also reduce arson. Burglary is a driver for security which should be utilized to also reduce arson.

One of the main aims for fire protection should be to control fire spread. Based on the statistics outlined, it is evident that the main risk and hazards for schools relate to property protection and not to the life safety of occupants. As the main cause of fires is arson, it can be assumed that the hours in which the fires are likely to occur is after school hours (1500-0800).

B.3.1 Victoria and NSW Statistics (Fire Incidents):

Between the periods of 2000 to 2004 the Victoria fire services (MFB and CFA) attended a total of 429 fire incidents associated with school buildings. This was determined to equate to a total of 85.8 incidents per year (Refer to Figure B.23).

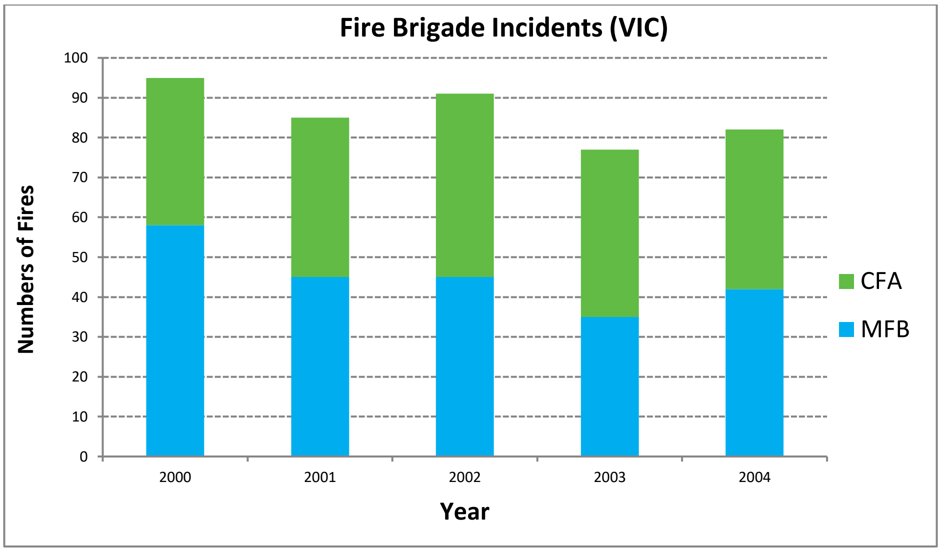


Figure B.23: School incidents attended by Victorian Fire Services (MFB & CFA)

Between this same periods, NSW fire services where identified to have attended a total of 905 fire incidents associated with school buildings. This is found to equate to approximately 181 incidents per year as depicted in Figure B.24.

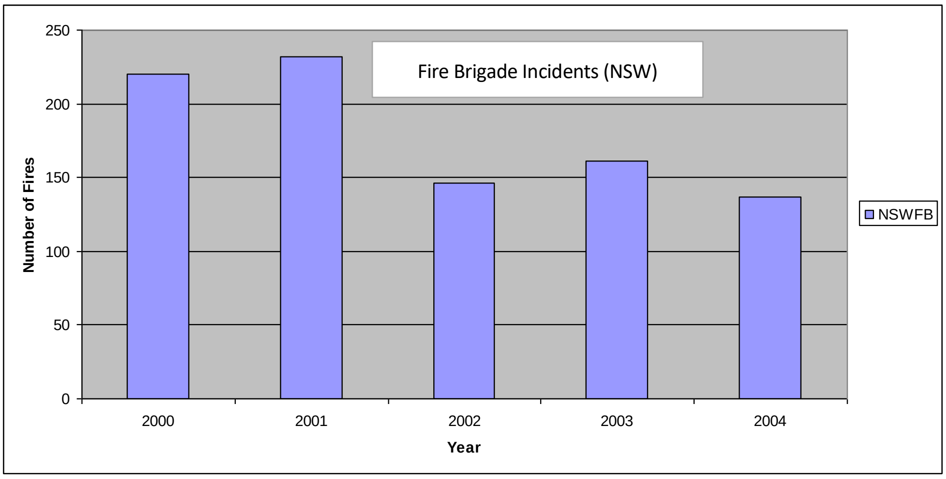


Figure B.24: School incidents attended by NSW Fire Services

A comparison of the different types of buildings (Office, Shops, and Residential) and the results obtained for schools in NSW within the period of 2000-2004 is outlined in the following Figure B.24.

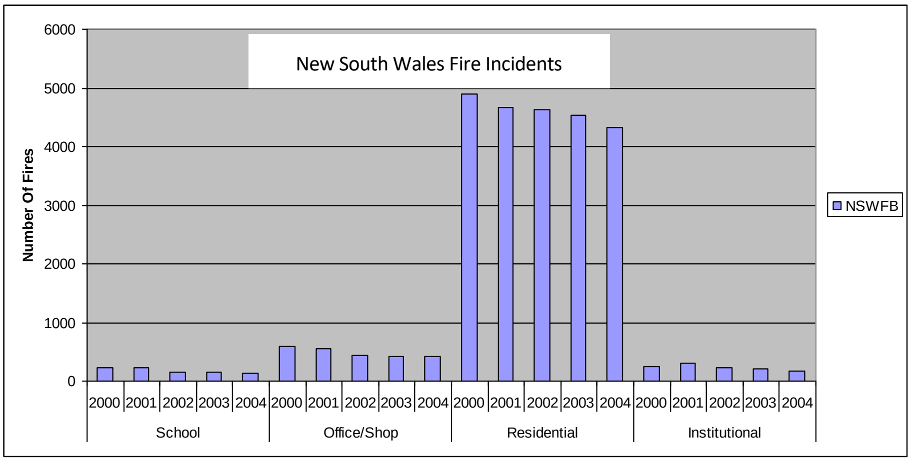


Figure B.25: Fire incidents (NSW)

As outlined in Figure B.25, it is identified that schools equate to a very small margin of fires that occur in comparison to the other types of buildings. Therefore, it is considered that the low hazards and risks previously outlined are further validated.

B.3.2 Victoria and NSW Statistics (Fire Starts):

For both sets of data collated, it was determined that the portion of fires in majority of cases was suspicious/ incendiary. The total number of fires for the Victorian results was noted as being 220 fires and 478 fires for the NSW sets of results as outlined in Figure B.26 and Figure B.27 respectively.

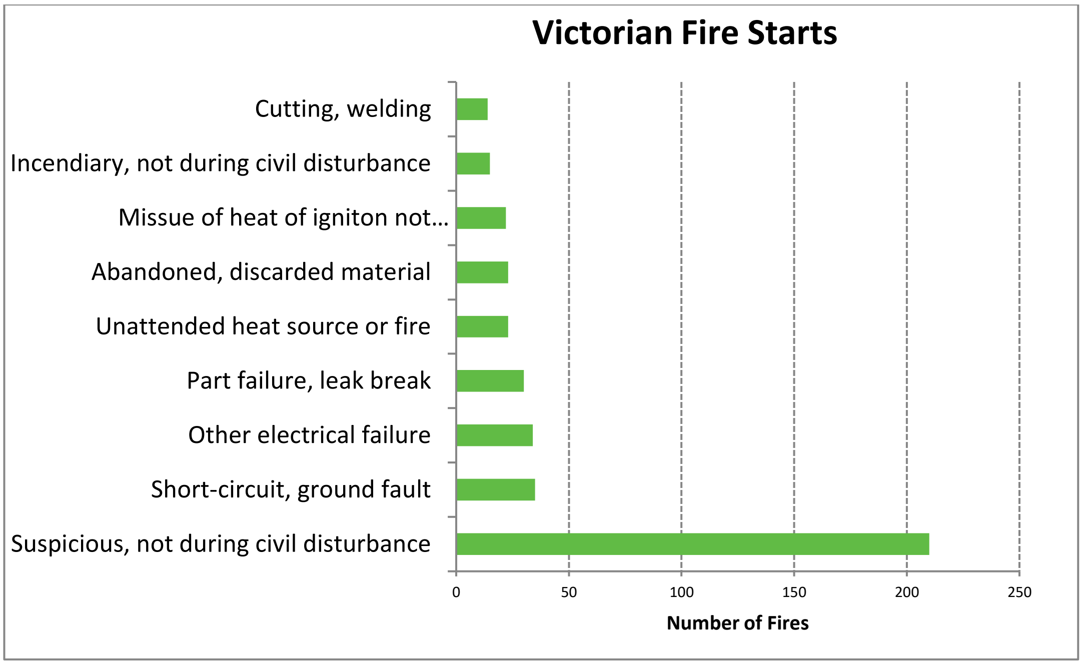


Figure B.26: Cause of fire starts (Victoria)

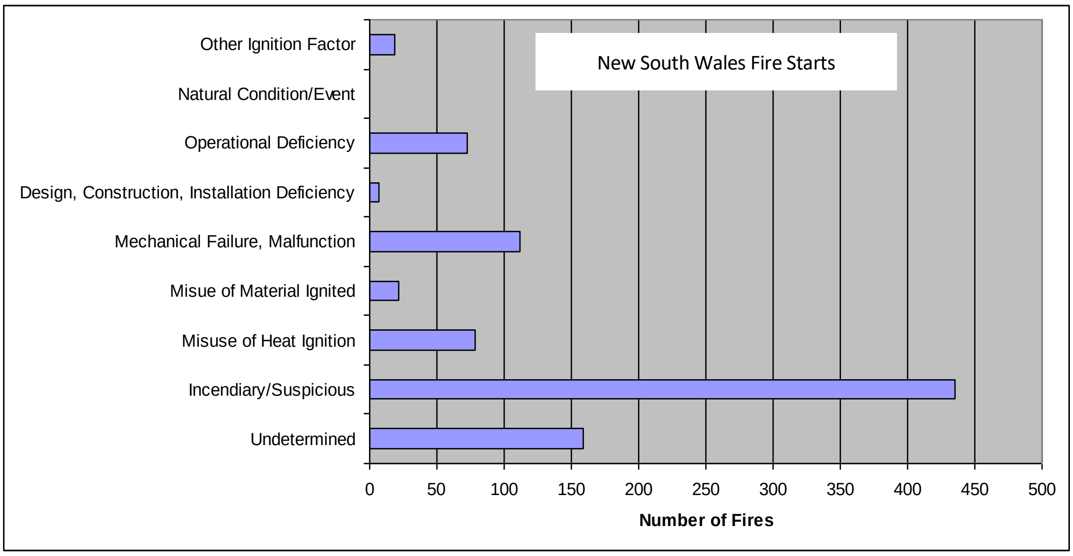


Figure B.27: Cause of fire starts (New South Wales)

It is evident from the results obtained that the main cause of fires in a school facility is the incendiary/suspicious types of fires. The next highest is noted as being undetermined.

B.3.3 Victoria and NSW Statistics (Extent of Damage):

As outlined in Figure B.28 and Figure B.29, historical data suggests that the most likely occurrence and extent of the damage caused by fires within schools is either confined to the room of fire origin or confined to the object of fire origin. Based on the results obtained, the significance and outcomes of these fires have been determined utilising the following equation:

Significant Fires = No of Fires/ No of Areas Considered to be Significant Fires x Percentage of Total Fires

The results analysed below for the state of Victoria (Refer to Figure B.28 below), indicates that 17% of school fire originated within the Metropolitan Fire and Emergency Services Board (MFB) jurisdiction whilst 58% of school fires occurred within the Country Fire Authority (CFA) jurisdictional area. Therefore, the total number of significant fires (as per the equation above) is calculated to be 26.7 school fires per year [(220/ 5 x 0.17) + (166/ 5 x 0.58)]. In most cases, fires caused were either confined to the object of fire origin and within close proximity (i.e. area) of fire origin. The likelihood of fires extending beyond the structure of origin is considered to be extremely low.

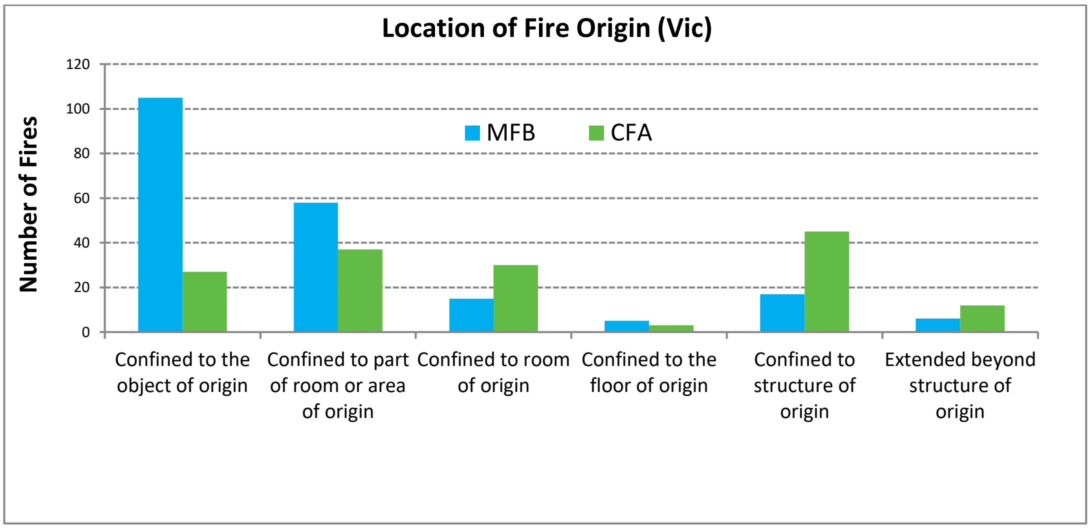


Figure B.28: Extent of fire damage (Victoria)

For the state of New South Wales (NSW) results depicted in Figure B.29 below, represents approximately 45% of school fires are deemed to be significant fires. Hence, the number of significant fires [(478 / 5 x 0.45)] equates to 38.3 school fires per year.

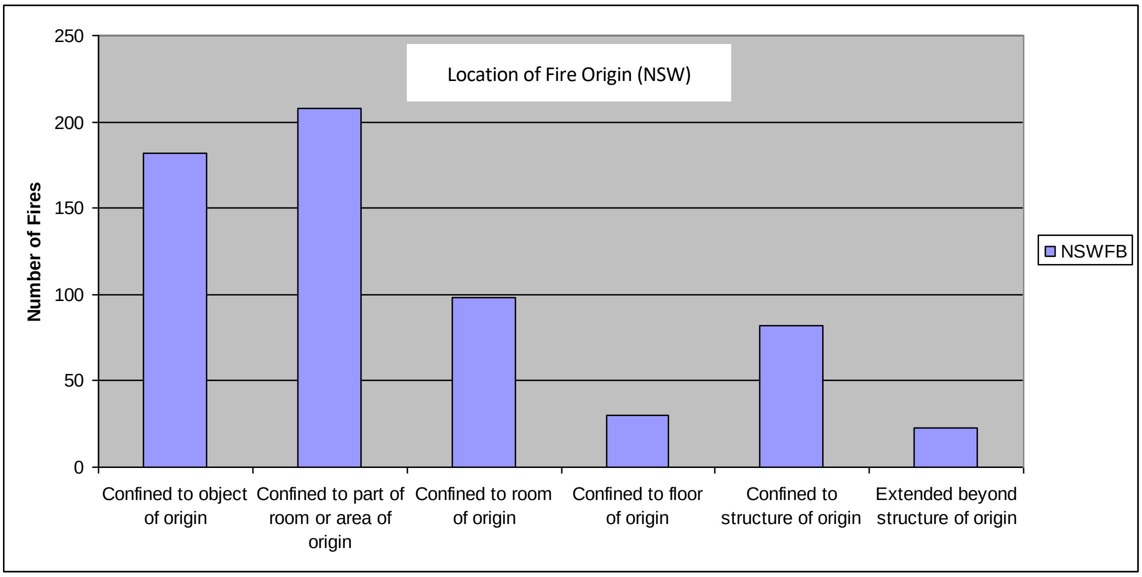


Figure B.29: Extent of fire damage (New South Walesa)

Similar to school fires in Victoria, those recorded for NSW also indicated that fires caused were either confined to the object of fire origin and within close proximity (i.e. area) of fire origin. The likelihood of fires extending beyond the structure of origin is considered to be extremely low.

In this instance and based on the location of the proposed building with respect to the fire source feature, the likelihood of fire spread (due to the unprotected openings) to a fire source feature (i.e. between buildings) or between levels is also considered to be minimised.

B.3.4 Fatalities and Injuries:

It has been identified that as a result of school fire incidents, injuries and fatalities and some key findings are summarised as follows:

- Majority of fires are found to be contained to either object of fire origin or the room of fire origin.
- Only one death has been reported in the past 20 years in NSW schools and was not attributed to the building structure.
- The average number of injuries that have been reported as a result of a fire on average is 5 people.

- There were no fatalities reported in the USA during 1996 to 1998 and in 2002. A longer term USA fatality rate is approximately 0.5 fatalities per 1000 fires in unprotected buildings (includes tertiary and pre-school).
- Injury rates in USA education properties are 22 per 1000 fires over the period of 1996 to 1998 and 29 per 1000 fires in 2001/02. A long-term rate for US Educational properties is approximately 25.9 per 1000 fires.

B.3.4.1 US Statistics (Fire Incidents):

US fire statistics indicate that the number of fatalities and/or injuries as a result of fires taking place in similar occupancies such as public assembly buildings and restaurants is very low. The statistics identify "Public Assembly" and "Eating Drinking" as specific occupancy types which would include all components of the subject building. Table B.4 shows 1996 statistics from US for non-residential occupancies.

Table B.4: US fire statistics

Relevant risk frequency	Number of non-residential:	Public Assembly % / no	Eating Drinking % / no	Total % / no
Fires	73,325	4.2/3080	7.5/5500	11.7/8580
Deaths	111	0.9/1	2.7/3	3.6/4
Injuries	1636	4.5/74	7.6/125	12.1/199

For public assemblies and eating-drinking places, the calculated rate of fire fatalities in US in 1996 was approximately 1.5 fatalities per 1000 fires. For the same period of time the calculated rate of fatalities in residential occupancies was 7.8 fatalities per 1000 fires. Thus the risk to occupants is considered to be relatively low.

Based on the nature of activities that are often associated with multipurpose halls and the data outlined in the US fire statistics, it is can be stated that the risk of a significant fire within these types of buildings are relatively low compared to other types of classifications.

B.3.4.2 Ignition Sources

In view of the likely use of the subject building(s) it is anticipated that there will be some sources of ignition. The ignition sources that are primarily related to the proposed building(s) include:

- electrical switch assemblies;
- lighting;
- electronic audio/video stage equipment;
- Occasional special effects equipment for staged performances.

B.3.4.3 Combustible Content

In view of the variable nature of activities associated with the subject building(s) it is anticipated that the likely fuel loads will consist of relatively sparse seating and some office furnishings at the entrance area of the main multi-use spaces. The adjacent class rooms, store rooms, office and kitchenette present a separate potential fuel load of which the combustible content of the proposed building(s) shall include:

- Furniture (e.g. tables, chairs, cabinets & shelving arrangements)
- Storage contents (e.g. boxed items, books, folders and the like)
- Audio/Visual/computer equipment;
- Electrical equipment;
- Seating and/or table arrangements;
- Ovens.

B.3.5 Hazard Summary

It can be summarised that the risk to occupants within school facilities is very low. This is outlined in both the national and international results collated and when compared to other types of building classifications. The building is considered to be comparative for use, size and occupants with the data compiled for the above results obtained.

B.4 Class 9b – Assembly Hall

The assembly hall portion of the building will undergo a wide variety of functions and use in the form of orchestral performances, plays, productions and various functions & social type events. Thus, the assembly hall is likely to present a wide range of hazards and possible fire scenarios.

B.4.1 Nature of Activities

The activities taking place in the main purpose hall would include:

- Lectures

- General assemblies
- Workshops
- Productions
- Music/Drama Performances

For this portion of the building the fire related hazards associated with the building arise from the usual mixture of ignition sources and fuel load content. The indoor non-smoking laws applying one of the major ignition sources have been removed. The other major potential source is the electrical wiring and equipment.

B.4.2 US Statistics (Fire Incidents)

US fire statistics indicate that the number of fatalities and/or injuries as a result of fires taking place in similar occupancies such as public assembly buildings and restaurants is very low. The statistics identify "Public Assembly" and "Eating Drinking" as specific occupancy types which would include all components of the subject building. Table B.5 shows 1996 statistics from US for non-residential occupancies.

Table B.5: US Fire Statistics

Design Issue	Number of non-residential:	Public Assembly % / no	Eating Drinking % / no	Total % / no
Fires	73,325	4.2/3080	7.5/5500	11.7/8580
Deaths	111	0.9/1	2.7/3	3.6/4
Injuries	1636	4.5/74	7.6/125	12.1/199

For public assemblies and eating-drinking places, the calculated rate of fire fatalities in US in 1996 was approximately 1.5 fatalities per 1000 fires. For the same period of time the calculated rate of fatalities in residential occupancies was 7.8 fatalities per 1000 fires. Thus the risk to occupants is considered to be relatively low.

Based on the nature of activities that are often associated with multipurpose halls and the data outlined in the US fire statistics, it can be stated that the risk of a significant fire within these types of buildings are relatively low compared to other types of classifications.

B.4.3 Ignition sources

In view of the likely use of the hall it is anticipated that there will be some sources of ignition. The ignition sources that are primarily related to the proposed building include:

- electrical switch assemblies
- lighting
- electronic audio/video stage equipment
- Occasional special effects equipment for staged performances

B.4.4 Combustible content

In view of the variable nature of activities associated with the assembly hall as an assembly building it is anticipated that the likely fuel loads will consist of the seating in the auditorium space, furnishings and lining materials. The stage area presents another potential fuel load of which the combustible content primarily related to the stage area of the proposed building include:

- Audio/Visual equipment
- Performance props and decorations

Appendix C. Regulatory Information – Relevant Extracts from BCA Report

26 September 2022

Our Ref: P219_288

Hansen Yuncken
Sent Via Email

Attention: Sasha Vuckovic

Trinity Grammar School – Renewal Project – Stages 3-5
BCA Report for Early Contractor Involvement Phase – July 2022

1. Introduction

This BCA Design Assessment Report has been prepared at the request of Hansen Yuncken and relates to the redevelopment of Trinity Grammar School, Summer Hill Campus.

The redevelopment of Trinity Grammar School proposes alterations and additions in construction stages as well as changes to staff and student numbers, comprising –

- Demolition of existing buildings including New School building, dwelling houses at 119 Prospect Road and 50 and 52 Seaview Street and part demolition of Music Building and Assembly Hall
- Construction of –
  - New building with a basement known as the T&L Building;
  - New Multi-purpose Pavilion; and
  - New maintenance building on Seaview Street
- Alterations and additions to existing buildings to create a Performing Arts Building;
- Refurbishment of the Music Building, New Founders Building, the Assembly Hall and North Quad Building;
- Extension and reconfiguration of the Jubilee carpark and staff carpark to increase carparking spaces from 312 to 324 and anew underground connection;
- Associated landscaping, removal of 29 trees, road and public domain works, ancillary signage
- Staged increase in student numbers from 1,500 to 2,100 and increase in FTE staff from 277 to 321.

Delivery of the project will be undertaken in sequential phases to maintain an operational school on the Park Road Campus and will involve enabling works separate to this application followed by separate construction phases for the new buildings and external works.

The purpose of this report is to provide an assessment of the proposal as described above and detailed within the finalise architectural submission which is reflective of the completion of the early contracted engagement phase.

2. Background

Design Confidence has been engaged to provide building regulatory advice regarding the compliance status of the proposed educational development when assessed against the relevant prescriptive requirements as contained within the Building Code of Australia (BCA) 2019 – Volume 1.

DESIGN CONFIDENCE

This statement has been provided to accompany the finalised design package prepared as part of the Early Contractor Involvement (ECI) delivery phase undertaken in conjunction with Hansen Yuncken Detailed assessments have been undertaken of the proposed design (as detailed within the documentation listed in Table 2.1 below).

Design Confidence has been involved on the project since the development of the architectural concept, the advice being provided to date has been in the context of the Building Code of Australia (BCA) 2019 – Volume 1, inclusive of the performance provisions contained therein.

The subject development will be of significance and has been designed to function as multi-level school. The development will also be provided multi-purpose halls and sporting spaces which will serve multiple purposes, at the time this correspondence was prepared the assembly hall within the building was not considered an entertainment venue.

3. BCA Compliance Strategy

Table 3.1 below summaries the proposed development in the context of the BCA

Table 3.1 – BCA Summary

DESCRIPTION OR REQUREMENT	
Building Classification	Basement Level B2 – Class 9b Basement Level B1 – Class 7a + 9b Ground Floor (level 0) – Class 5 & 9b Level 1 – Class 9b Level 2 – Class 9b Level 3 – Class 9b Level 4 – Class 9b
Rise in Storeys	Six (6)
Storeys Contained	Seven (7) (6 above ground and 1 basement level)
Construction Type	Type A
Effective Height	17.700 (RL47.000 – RL64.700)
Entertainment Venue	Building not considered an entertainment venue

4. Assessment

4.1 BCA Summary

The following table summarises the compliance status of the architectural design in terms of each applicable prescriptive provision of the BCA and indicates a capability for compliance with the BCA.

4.1.1 Section B – Structure

BCA CLAUSE		COMPLIES (Y/N)	ADDITIONAL COMMENTARY
B1.1	Resistance to actions	**Y**	Compliance is predicated on the structural engineer confirming compliance.
B1.2	Determination of individual actions	**Y**	Compliance is predicated on the structural engineer confirming compliance.

DESIGN CONFIDENCE

BCA CLAUSE		COMPLIES (Y/N)	ADDITIONAL COMMENTARY
B1.4	Materials and form of construction	Y	Compliance is predicated on the structural engineer confirming compliance and the information contained within the architectural specification/s and schedules.

4.1.2 Section C – Fire Resistance

BCA CLAUSE		COMPLIES (Y/N)	ADDITIONAL COMMENTARY
C1.1	Fire resisting construction	Y	Compliance is predicated on the structural engineer confirming their design complies with this clause. The fire safety engineer has proposed a reduction in FRLs to the multi-purpose building, hence co-ordination between fire safety engineer, structural engineer and architect needed to affirm all recommendations and assumptions required by the fire safety engineer has occurred.
C1.8	Structural tests for lightweight construction	Y	Compliance is predicated on information contained within the architectural specification/s and schedules.
C1.9	Non-combustible building elements	N	**External walls are required to be non-combustible. This includes all barriers and insulation used in the external wall. Please detail in schedule that these products are to be non-combustible.** It is requested that prior to the procurement of any materials that the test reports be provided to this office for review / approval.
C1.10	Fire hazard properties	Y	Compliance is predicated on information contained within the architectural specification/s and schedules. It is requested that prior to the procurement of any materials that the test reports be

DESIGN CONFIDENCE

BCA CLAUSE		COMPLIES (Y/N)	ADDITIONAL COMMENTARY
			provided to this office for review / approval.
C1.14	Ancillary elements	Y	Compliance is predicated on information contained within the architectural specification/s and schedules. It is requested that prior to the procurement of any materials that the test reports be provided to this office for review / approval.
C2.2	General floor area and volume limitations	Y	Compliance is predicated on information contained within the architectural documentation. The compartmentation strategy being adopted is based upon a performance-based approach hence co-ordination between all design consultants needs to occur to affirm all recommendations and assumptions required by the fire safety engineer has been implemented into their designs.
C2.6	Vertical separation	Y	Building will be provided with a sprinkler system compliant with AS2118.1, hence vertical separation need not be provided.
C2.7	Separation by fire walls	Y	Compliance is predicated on information contained within the Wall Type Plans
C2.10	Separation of lift shafts	N	**Further information / review is required to ensure wall detail and FRL's comply**
C2.11	Stairways and lifts in one shaft	Y	Stairways and lifts have not been located in the same shaft.
C2.12	Separation of equipment	Y	Compliance is predicated on information contained within the Wall Type Plans
C2.13	Electricity supply system	Y	Compliance is predicated on information contained within the Wall Type Plans
C3.3	Separation of external walls and associated openings in different fire compartments	Y	Compliance is predicated on information contained within

BCA CLAUSE		COMPLIES (Y/N)	ADDITIONAL COMMENTARY
			the architectural documentation. The compartmentation strategy being adopted is based upon a performance-based approach hence co-ordination between all design consultants needs to occur to affirm all recommendations and assumptions required by the fire safety engineer has been implemented into their designs.
C3.5	Doorways in fire walls	Y	Compliance is predicated on information contained within the architectural specification/s and schedules.
C3.8	Openings in fire-isolated exits	N	**Doors opening to Fire Stair 1 to be fire doors achieving an FRL of -/60/30.**
C3.9	Service penetrations in fire-isolated exits	N	**Building Services team are to confirm that the fire-isolated exits are not to be penetrated by any service other than electrical wiring associated with fire services or surveillance equipment or water supply pipes for fire services.**
C3.10	Openings in fire-isolated lift shafts	Y	Compliance is predicated on information contained within the VT performance specification prepared by JHA.
C3.12	Openings in floors and ceilings for services	N	Building Services team are to confirm any service penetrations through fire rated construction.
C3.13	Openings in shafts	Y	Compliance is predicated on information contained within the architectural specification/s and schedules. It is requested that prior to the procurement of any materials that the test reports be provided to this office for review / approval.
C3.15	Openings for service installations	N	Building Services team are to confirm any service

DESIGN CONFIDENCE

BCA CLAUSE		COMPLIES (Y/N)	ADDITIONAL COMMENTARY
			penetrations through fire rated construction.
C3.16	Construction joints	Y	Compliance is predicated on information contained within the architectural specification/s and schedules. It is requested that prior to the procurement of any materials that the test reports be provided to this office for review / approval.
C3.17	Columns protected with lightweight construction to achieve an FRL	Y	Compliance is predicated on information contained within the architectural specification/s and schedules. It is requested that prior to the procurement of any materials that the test reports be provided to this office for review / approval.

4.1.3 Section D – Access & Egress

BCA CLAUSE		COMPLIES (Y/N)	ADDITIONAL COMMENTARY
D1.2	Number exits required	Y	A compliant number of exits have been provided.
D1.3	When fire-isolated stairways and ramps are required	N	**Fire Stair 1 should be separated from the building with construction of at least 120/120/120 (or -/120-/120 if non-loadbearing). IWP2 wall is noted as 60/60/60 only** The egress design for the building is the subject of performance-based approach. Reference needs to be made to the recommendations and assumptions outlined in the fire safety engineering report and ensure they have been appropriately implemented into the design.
D1.4	Exit travel distances	N	**The FEBQ prepared by Scientific Fire Services indicates specific travel distances, however due to design changes some of these**

DESIGN CONFIDENCE

BCA CLAUSE		COMPLIES (Y/N)	ADDITIONAL COMMENTARY
			distances have changed, specifically – **Teaching & Learning Precinct** Basement Level 1 - Up to 26m to a point of choice - Up to 67m to the nearest exit - Up to 97m between alternative exits Level 2 - Up to 47m to the nearest exit - Up to 75m between alternative exits Level 3 - Up to 26m to a point of choice - Up to 42m to the nearest exit Level 4 - Up to 30m to a point of choice **Performing Arts Precinct/Founders** ▪ Basement Level 2 - Up to 25m to a point of choice ▪ Level 1 - Up to 23m to a point of choice. ▪ Level 3 - Up to 21m to a point of choice and up to 45m to the nearest exit ▪ Level 4 - Up to 45m to an exit (to allow for plant) **Music Building** - DTS **Multi-Purpose Hall** - DTS
D1.5	Distance between alternative exits	**Y**	See above
D1.6	Dimensions of exits and paths of travel to exits	**N**	**The following areas appear to have paths of travel less than 1m:** ▪ **Bottom of Stair 2 in multi-purpose building.**

DESIGN CONFIDENCE

BCA CLAUSE		COMPLIES (Y/N)	ADDITIONAL COMMENTARY
			▪ **Between cubicles and wall of Male WC on B1 of Music Building (MB.B1.14)**
D1.7	Travel via fire-isolated exits	**N**	**Plant room opens directly on to Fire Stair ST01 on Level 0. It is advised that airlock is provided between the stair and the plant room.**
D1.8	External stairways in lieu of fire-isolated exits	**Y**	The egress design for the building is the subject of performance-based approach. Reference needs to be made to the recommendations and assumptions outlined in the fire safety engineering report and ensure they have been appropriately implemented into the design.
D1.9	Travel by non-fire-isolated stairways or ramps	**Y**	The egress design for the building is the subject of performance-based approach. Reference needs to be made to the recommendations and assumptions outlined in the fire safety engineering report and ensure they have been appropriately implemented into the design.
D1.10	Discharge from exits	**Y**	Compliance is predicated on information contained within the architectural specification/s and schedules.
D1.17	Access to lift pits	**Y**	Compliance is predicated on information contained within the VT performance specification prepared by JHA.
D2.2	Fire-isolated stairways and ramps	**Y**	Compliance is predicated on the structural engineer confirming compliance and the information contained within the architectural specification/s and schedules.
D2.3	Non-fire-isolated stairways and ramps	**Y**	Compliance is predicated on the structural engineer confirming compliance and the information contained within the architectural specification/s and schedules.

DESIGN CONFIDENCE

BCA CLAUSE		COMPLIES (Y/N)	ADDITIONAL COMMENTARY
D2.4	Separation of rising and descending stair flights	Y	All stairways are appropriately separated.
D2.7	Installations in exits and paths of travel	Y	Compliance is predicated on information contained within the architectural specification/s and schedules
D2.8	Enclosure of space under stairs and ramps	Y	Compliance is predicated on information contained within the architectural specification/s and schedules.
D2.12	Roof as open space	Y	In part the roof to Oval 2 & 3 has been used as open space. Compliance is predicated on the structural engineer confirming compliance that roof to Oval 2 & 3 achieves an FRL of 120/120/120.
D2.13	Goings and risers	N	**Reference should be made to the comments overlaid on the architectural drawings contained in Appendix B1**
D2.14	Landings	Y	Compliance is predicated on information contained within the architectural documentation.
D2.15	Thresholds	N	**Stair 2 on Level 1 of the Quadrangle building is with the swing of the doorway. Landing should be increased to at least 850mm**
D2.16	Balustrades	Y	Compliance is predicated on information contained within the architectural documentation.
D2.17	Handrails	N	**Reference should be made to the comments overlaid on the architectural drawings contained in Appendix B1**
D2.19	Doorways and doors	Y	Compliance is predicated on information contained within the architectural documentation.
D2.20	Swinging doors	N	**The following exits do not swing in the direction of egress:** ▪ **Exits to open space on Level 0 of Music building**
D2.21	Operation of latch	Y	Compliance is predicated on information contained within the architectural specification/s and schedules

DESIGN CONFIDENCE

BCA CLAUSE		COMPLIES (Y/N)	ADDITIONAL COMMENTARY
D2.23	Signs on doors	N	Further information / review is required to ensure signage package complies. Reference is to also be made to the fire engineering report as it requires signage to be provided

4.1.4 Section E – Access & Egress

BCA CLAUSE		COMPLIES (Y/N)	ADDITIONAL COMMENTARY
E1.3	Fire hydrants	Y	Compliance is predicated on wet fire drawings and specification as prepared by JHA. The fire engineering report also make reference to the use of AS2419.1-2017 in lieu of 2005.
E1.4	Fire hose reels	Y	Fire hose reels in their entirety have been omitted from Stages 3-5. Reference needs to be made to the recommendations and assumptions outlined in the fire safety engineering report and ensure they have been appropriately implemented into the design.
E1.5	Sprinklers	Y	Compliance is predicated on wet fire drawings and specification as prepared by JHA. The fire engineering report also places reliance upon the installation of a sprinkler system throughout the buildings, hence reference needs to be made to the recommendations and assumptions outlined in the fire safety engineering report and ensure they have been appropriately implemented into the design.
E1.6	Portable Fire Extinguishers	Y	Compliance is predicated on wet fire drawings and specification as prepared by JHA.

DESIGN CONFIDENCE

BCA CLAUSE		COMPLIES (Y/N)	ADDITIONAL COMMENTARY
			The fire engineering report also places reliance upon the installation of additional PFE's throughout the buildings to offset the removal of fire hose reels, hence reference needs to be made to the recommendations and assumptions outlined in the fire safety engineering report and ensure they have been appropriately implemented into the design.
E2.2	Smoke Hazard Management – Smoke Detection	Y	Compliance is predicated on dry fire drawings and specification as prepared by JHA. The fire engineering report also places reliance upon the installation of additional PFE's throughout the buildings to offset the removal of fire hose reels, hence reference needs to be made to the recommendations and assumptions outlined in the fire safety engineering report and ensure they have been appropriately implemented into the design.
E2.2	Smoke Hazard Management – Performance Hall	N	**Confirmation required that smoke and heat vents have been provided above the stage.**
E3.1	Lift Installations	Y	Compliance is predicated on information contained within the VT performance specification prepared by JHA.
E3.2	Stretcher facility in lifts in fire	Y	Compliance is predicated on information contained within the VT performance specification prepared by JHA.
E3.3	Warning against use of lifts in fires	N	Further information / review is required to ensure signage package complies.
E3.4	Landings	Y	Compliance is predicated on information contained within the VT performance specification prepared by JHA.

BCA CLAUSE		COMPLIES (Y/N)	ADDITIONAL COMMENTARY
E3.6	Passenger Lifts	Y	Compliance is predicated on information contained within the VT performance specification prepared by JHA.
E3.7	Fire Service Controls	Y	Compliance is predicated on information contained within the VT performance specification prepared by JHA.
E3.9	Fire Service recall control switch	Y	Compliance is predicated on information contained within the VT performance specification prepared by JHA.
E3.10	Lift car fire service drive control switch	Y	Compliance is predicated on information contained within the VT performance specification prepared by JHA.
E4.2	Emergency Lighting	Y	Compliance is predicated on electrical drawings and specification as prepared by JHA. The fire engineering report also places reliance upon the installation of a emergency lighting throughout the buildings, hence reference needs to be made to the recommendations and assumptions outlined in the fire safety engineering report and ensure they have been appropriately implemented into the design.
E4.4	Design and operation of emergency lighting	Y	Compliance is predicated on electrical drawings and specification as prepared by JHA.
E4.5	Exit signs	Y	Compliance is predicated on electrical drawings and specification as prepared by JHA.
E4.6	Direction signs	Y	Compliance is predicated on electrical drawings and specification as prepared by JHA.
E4.8	Design and operation of exit signs	Y	Compliance is predicated on electrical drawings and specification as prepared by JHA.

DESIGN CONFIDENCE

BCA CLAUSE		COMPLIES (Y/N)	ADDITIONAL COMMENTARY
E4.9	Emergency warning and intercom system	Y	Compliance is predicated on electrical drawings and specification as prepared by JHA.

4.1.5 Section F – Health and Amenity

BCA CLAUSE		COMPLIES (Y/N)	ADDITIONAL COMMENTARY
F1.1	Stormwater Drainage	Y	Compliance is predicated on hydraulic drawings and specification as prepared by JHA.
F1.4	External above ground membranes	Y	Compliance is predicated on information contained within the architectural specification/s and schedules
F1.5	Roof coverings	Y	Compliance is predicated on information contained within the architectural specification/s and schedules
F1.6	Sarking	Y	Compliance is predicated on information contained within the architectural specification/s and schedules. It is requested that prior to the procurement of any materials that the test reports be provided to this office for review / approval.
F1.7	Waterproofing of wet areas in buildings	Y	Compliance is predicated on information contained within the architectural specification/s and schedules. It is requested that prior to the procurement of any materials that the test reports be provided to this office for review / approval.
F1.10	Damp-proofing of floors on the ground	Y	Compliance is predicated on the structural engineer confirming compliance.
F.13	Glazed assemblies	Y	Compliance is predicated on information contained within the architectural specification/s and schedules.
F2.3	Facilities in Class 3 to 9 buildings	Y	Compliance is predicated on information contained within

DESIGN CONFIDENCE

BCA CLAUSE		COMPLIES (Y/N)	ADDITIONAL COMMENTARY
			the architectural documentation.
F2.4	Construction of sanitary facilities	Y	Compliance is predicated on information contained within the architectural documentation.
F3.1	Height of rooms and other spaces	N	**A classroom or corridor accommodating more than 100 persons is required to be at least 2.7m in height.** **It appears that numerous corridors that will accommodate more than 100 persons have a ceiling height of 2.4m such as in the Music Building and upper levels of the Founders and Performing Arts Building. A full review of ceiling heights is to be undertaken by DC and a list of areas of concern will be provided for potential Performance Solution.**
F4.1	Provision of natural light	Y	Compliance is predicated on information contained within the architectural documentation.
F4.4	Artificial lighting	Y	Compliance is predicated on electrical drawings and specification as prepared by JHA.
F4.5	Ventilation of rooms	Y	Compliance is predicated on mechanical drawings and specification as prepared by JHA.
F4.6	Natural Lighting	Y	Compliance is predicated on information contained within the architectural documentation.
F4.8	Restriction of position of water closets and urinals	Y	Compliance is predicated on information contained within the architectural documentation.
F4.9	Airlocks	Y	Compliance is predicated on information contained within the architectural documentation.
F6.2	Pliable building membrane	Y	Compliance is predicated on information contained within the architectural specification/s and schedules

BCA CLAUSE		COMPLIES (Y/N)	ADDITIONAL COMMENTARY
F6.3	Flow rate of discharge or exhaust systems	Y	Compliance is predicated on mechanical drawings and specification as prepared by JHA.
F6.4	Ventilation of roof spaces	Y	Compliance is predicated on mechanical drawings and specification as prepared by JHA.
H1.1	Application of Part	N	**Please confirm if the stage will have an associated rigging loft.** **Please confirm the proposed population (number of seats) of the performance hall.**
H1.4	Seating area	N	**Please provide details of seating area to confirm heights of risers etc.**
H1.7	Aisle lights	Y	Compliance is predicated on electrical drawings and specification as prepared by JHA.

4.2 Fire Safety Engineering

As discussed in Section 4.1 above the development will comply with both the BCA deemed to satisfy provisions as well as complying with the performance-based requirements, specifcally in relation to fire safety.

The below table outlines a list of current performance solutions that have been discussed with the fire safety engineer engaged on this project, however the below are required to be modified based upon the most recent review undertaken.

Table 4.2 – BCA DtS Variations

NO.	BCA DTS VARIATIONS	DTS CLAUSE	PERFORMANCE REQUIREMENT
STAGES 3-5			
1.	It is proposed to permit FRL's commensurate with Type C fire resisting construction (non-combustible) in lieu of Type A fire resisting construction for the Multipurpose Pavilion structure only (excluding the Basement Carpark).	C1.1 & Spec C1.1	CP1 & CP2
2.	It has been identified that the southern wall & openings of the Teaching & Learning block at L0 to L3 are situated approximately 5.8m from the northern wall & openings of the Founders/PA block without being protected in accordance with Clause C3.4.	C2.7	CP2
3.	It has been identified that the Teaching & Learning block abuts the existing Sports/Science/Aquatic blocks without being provided with a full-height fire wall which complies with Clause C2.7 as a result of glazed openings within the dividing wall. It is further noted that this dividing wall separates the sprinkler protected T&L building/Carpark from the existing non-sprinkler protected Sports/Science/Aquatic block. It has also been identified that there are unprotected glazed openings forming part of the T&L block which are configured in a parallel orientation and within 6m of the subject dividing wall. ***Separation of the carpark and the Agora is the be reviewed at Basement 1 by Scientific Fire Services and the separation strategy updated to reflect how it will be addressed.***	C2.7 & C3.3	CP2
4.	It is proposed to permit extended travel distances within various portions of the building as follows: **Teaching & Learning Precinct:** Basement Level 1 • It is proposed to permit a travel distance to a point of choice of up to 36m in lieu of 20m; and • It is proposed to permit a travel distance to an exit where two exits are available of up to 64m in lieu of 40m; and • It is proposed to permit a distance of travel between alternative exits of up to 65m in lieu of 60m.	D1.4 & D1.5	DP4, DP5 & EP2.2

DESIGN CONFIDENCE

NO.	BCA DTS VARIATIONS	DTS CLAUSE	PERFORMANCE REQUIREMENT
	Level 2 • It is proposed to permit a travel distance to an exit where two exits are available of up to 47m in lieu of 40m; and • It is proposed to permit a distance of travel between alternative exits of up to 75m in lieu of 60m. Level 3 • It is proposed to permit a travel distance to a point of choice of up to 26m in lieu of 20m; and • It is proposed to permit a travel distance to an exit where two exits are available of up to 42m in lieu of 40m. Level 4 • It is proposed to permit a travel distance to a point of choice of up to 32m in lieu of 20m; and • It is proposed to permit a travel distance to an exit where two exits are available of up to 44m in lieu of 40m. **Performing Arts Precinct:** Level 3 • It is proposed to permit a travel distance to a point of choice of up to 21m in lieu of 20m; and • It is proposed to permit a travel distance to an exit where two exits are available of up to 45m in lieu of 40m. Level 4 • It is proposed to permit a travel distance to a single exit of up to 40 m in lieu of 20m within the roof plant area. ***Refer to D1.4 in Section 4 of this report for updated travel distances to be integrated into Fire Engineering Strategy***		
5.	It has been identified that the non-fire isolated stairways interconnect the following: Performing Arts Precinct: • Open stairway interconnects four (4) storeys in lieu of three (3) within sprinkler protected building Arrow Building (i.e. external walkway): • A number of open stairways which interconnect up to five (5) storeys in lieu of three (3) within sprinkler protected building	D1.3, D1.7 & D1.12	CP1, CP2 & DP5
6.	It has been identified that a number of the non-fire isolated stairways serving the Teaching & Learning & Founders/PA blocks that do not afford a continuous means of egress by their own flights/landings.	D1.9	DP4 & EP2.2
7.	The fire hydrant system is proposed to be designed & installed in accordance with the AS2419.1:2017 Australian Standard in lieu of AS2419.1:2005. Note: This is consistent with the hydrant standard adopted for the design of Stage 1 and 2 prepared by Arup (Report No. 281228, V01, dated 17 March 2022)	E1.3	EP1.3

NO.	BCA DTS VARIATIONS	DTS CLAUSE	PERFORMANCE REQUIREMENT
8.	It is proposed to omit the requirement to provide fire hose reels within the school building throughout (i.e. library, staff lounge etc, noting that classrooms & associated corridors are not required to be provided with fire hose reels).	E1.4	EP1.1
9.	It is proposed to omit the requirement to provide automatic sprinkler protection within the main switch rooms within the Teaching & Learning and Founders/PA blocks.	E1.5	EP1.4

4.3 BCA Performance Solutions

The below table outlines a list of potential performance solutions not relating to fire safety that may be required from other consultants engaged on this project such as access consultant.

Table 4.3 – BCA DtS Variations

NO.	BCA DTS VARIATIONS	DTS CLAUSE	PERFORMANCE REQUIREMENT
STAGES 3-5			
1.	Please refer to access report which nominated performance solutions relating to access items.	Part D, F2.4	DP1, DP2, FP2.1 & DP9
2.	Performance Requirement FP1.4 for the prevention of the penetration of water through external walls, must be complied with. Note: There is no DTS provisions in respect to external walls. A performance solution addressing FP1.4 is usually provided by façade engineer.	F1.1	FP1.4
3.	Various areas (TBC) are proposed to be provided with ceiling height less than permitted by Clause F3.1 of the BCA.	F3.1	FP3.1
4.	Section J / JV3 Report may be required from a Section J Consultant.	Section J	JP1

DESIGN CONFIDENCE

5. Fire Safety Measures

Table 4.1 below outlines the relevant statutory fire safety measures that will provided as part of the development such that compliance with the BCA is achieved.

Table 4.1 – Fire Safety Measures

STATUTORY FIRE SAFETY MEASURES	PROPOSED STANDARD OF PERFORMANCE
Access panels and hoppers to fire-resisting shafts	BCA Cl. C3.13 & AS1905.1-2005 & AS1530.4-2005
Alarm signalling equipment	BCA Spec 1.5 & AS1670.3-2018
Automatic fail-safe devices	BCA Cl. D2.21
Automatic fire detection and alarm systems	BCA Cl. E2.2, Spec E2.2a & AS1670.1-2018
Automatic fire suppression systems	BCA E1.5, Spec E1.5& AS2118.1-2017
Emergency warning and intercommunication systems	BCA Cl. E2.2, Spec E2.2a & AS1670.4-2018
Emergency lighting	BCA Cl. E4.2, E4.4 & AS/NZS2293.1-2018
Exit signs	BCA Cl. E4.5, E4.6, E4.8 & AS/NZS2293.1-2018
Fire dampers	BCA Cl. C3.15, Spec. C3.15, AS1530.4-2005 & AS4072.1-2005 with tested prototype and manufactures specifications
Fire doors	BCA C3.2, C3.4, D1.8 & AS1905.1-2005
Fire hydrant systems	BCA Cl. E1.3 & AS2419.1-2017
Fire seals protecting openings in fire-resisting components of the building	BCA Cl. C3.15, Spec. C3.15, AS1530.4-2005 & AS4072.1-2005 with tested prototype and manufactures specifications
Lightweight construction	BCA Cl. C1.8, D1.8, Spec C1.1 & AS1530.4-2005 with tested prototype and manufactures specifications
Mechanical air-handling systems (automatic shutdown)	BCA Cl. E2.2 (NSW), Spec E2.2a (clause 5) & AS1668.1-2015
Mechanical air-handling systems (smoke and heat vents)	BCA Cl. E2.2 (NSW), Spec E2.2c & AS1668.1-2015
Portable Fire Extinguishers	BCA Cl. E1.6 & AS2444-2001
Wall wetting sprinkler and drencher systems	BCA Cl. C3.4 & D1.8 with tested prototype and manufactures specifications
Warning and operational signs	BCA D2.23 & E3.3
Fire Engineering Performance Solutions	Scientific Fire Services

DESIGN CONFIDENCE

6. Summary

Our strategy for ensuring compliance will be refined and documented over the coming months in conjunction with the continual development of the architectural documentation, if required.

In order to achieve compliance with the BCA, whilst preserving the functional and aesthetic requirements of the project, the use of performance-based designs may be required. It is our belief that performance-based design can deliver a building that meets the Performance Requirements of the BCA.

We are of the opinion that compliance can be achieved, be it via either complying with the DtS provisions or Performance requirements of the BCA.

This statement should not be construed as relieving any other parties of their legislative obligations.

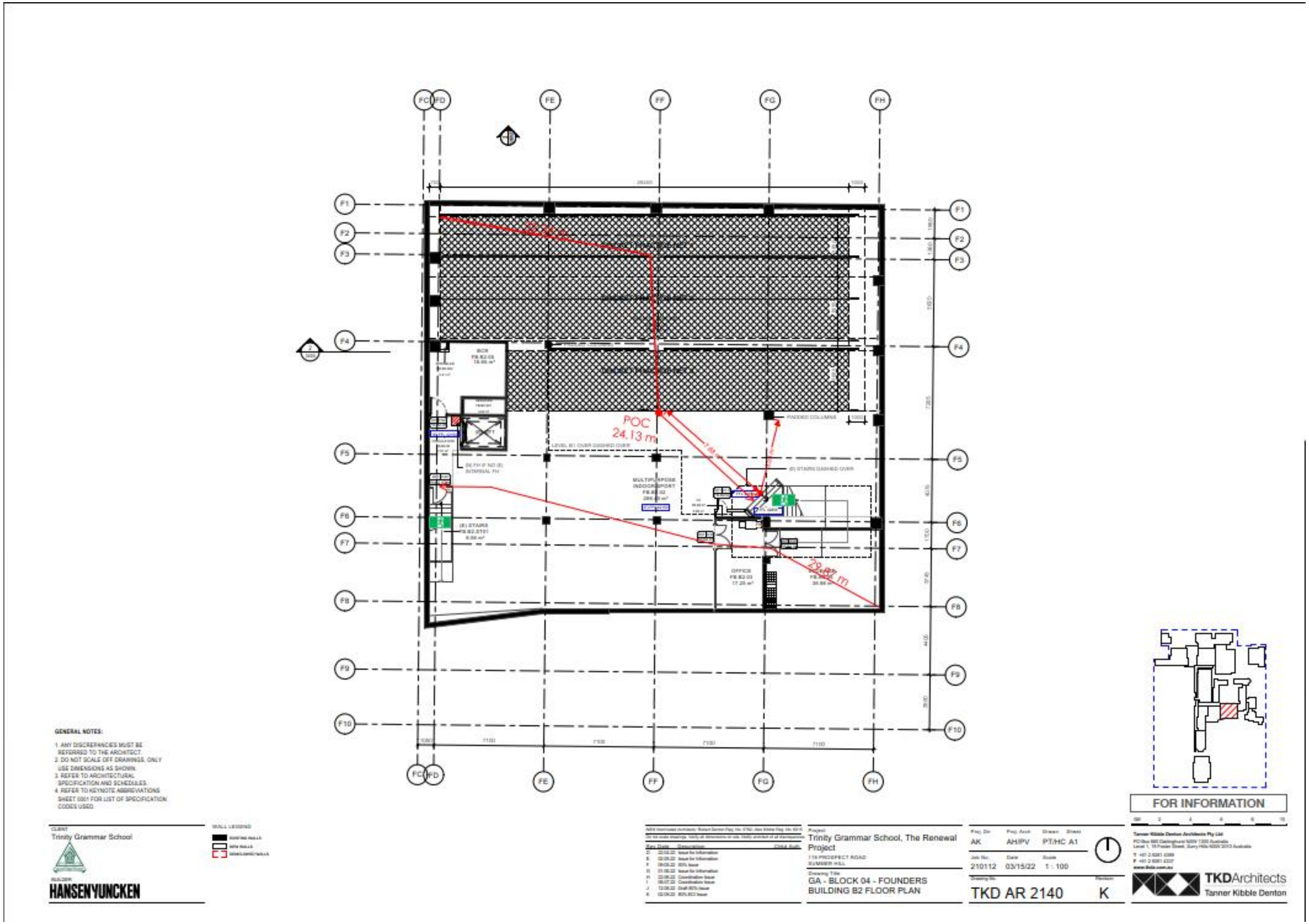
I possess Indemnity Insurance to the satisfaction of the building owner or my principal.

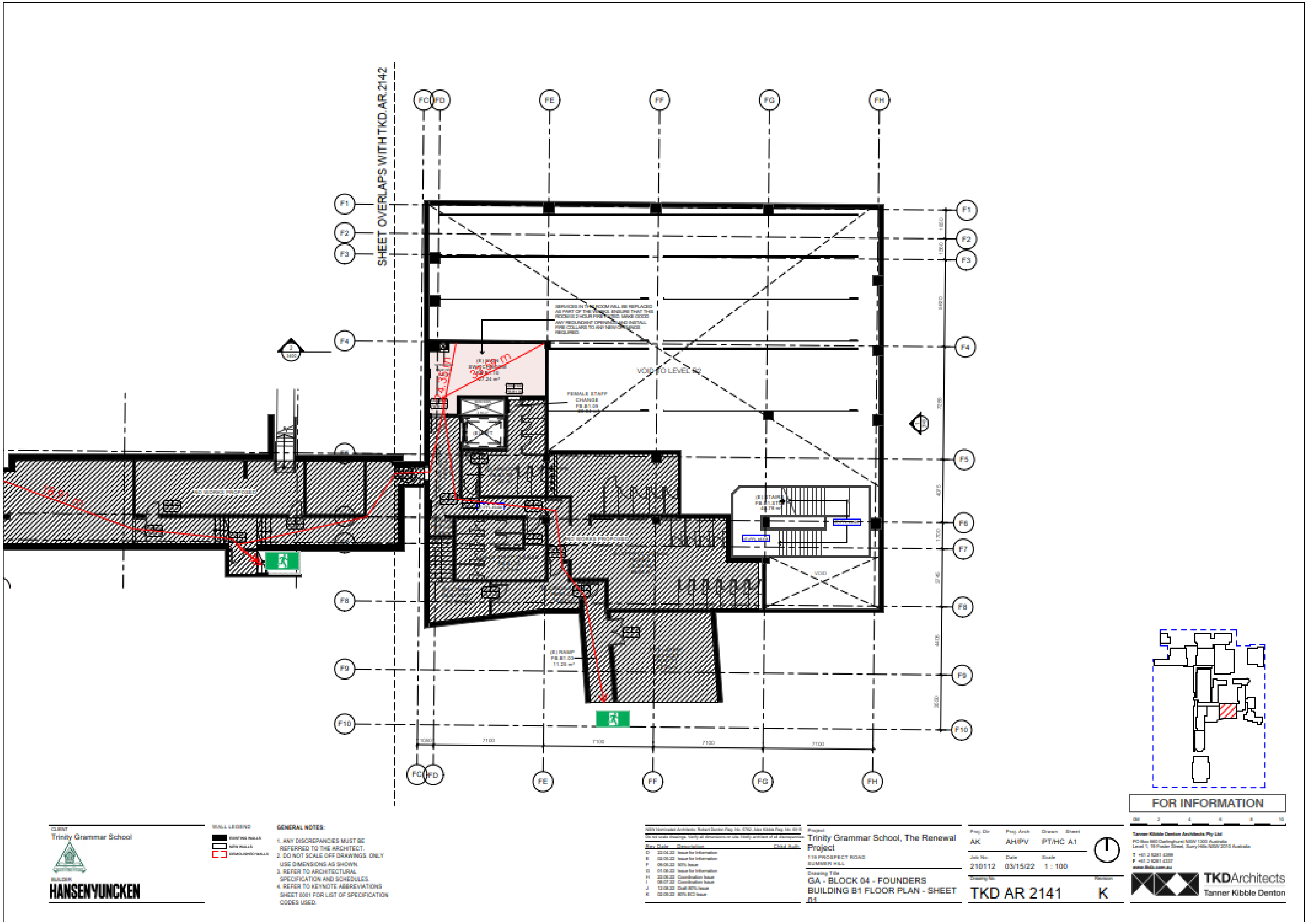
Report By

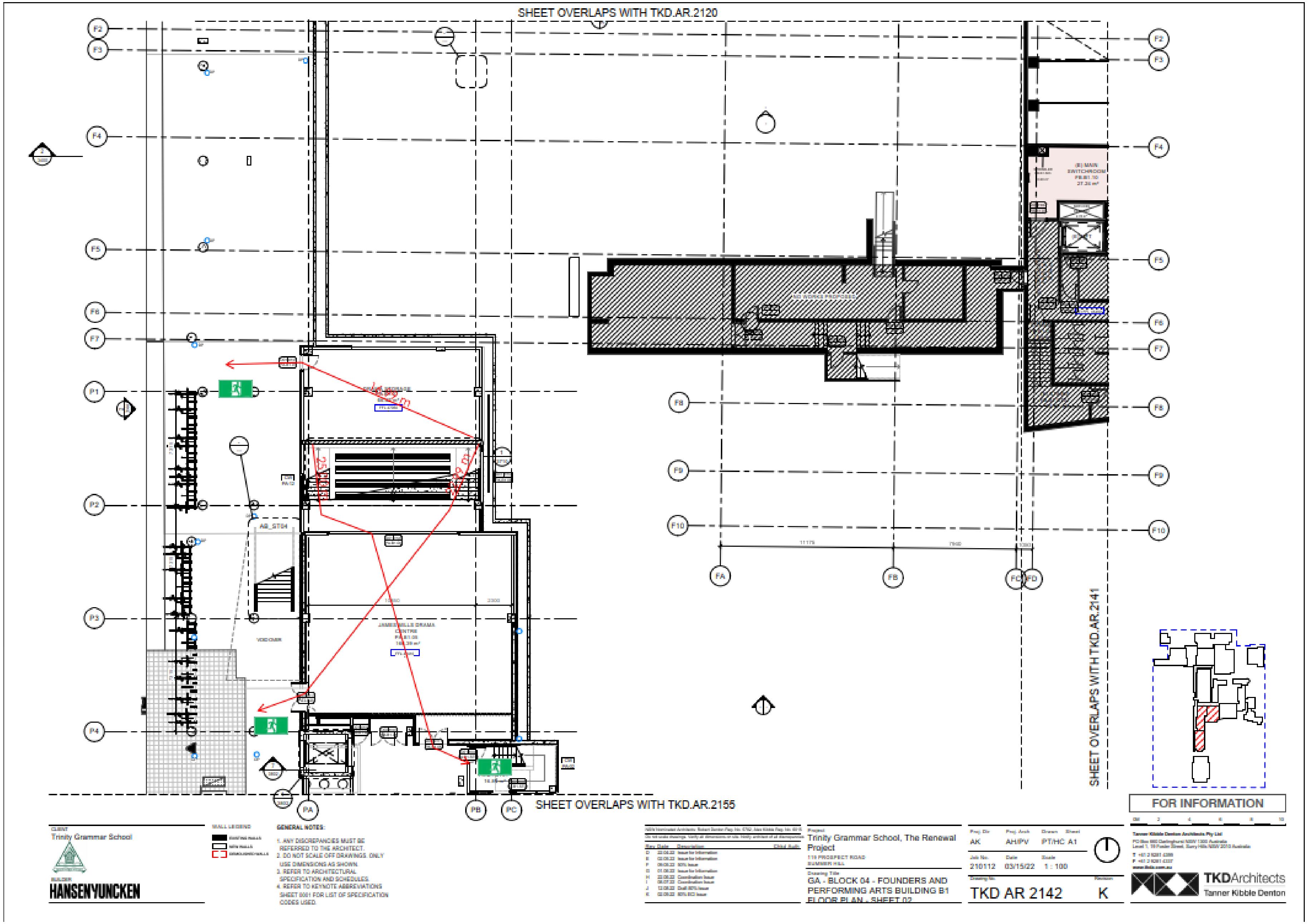
Ryan Dillon
Senior Building Regulations Consultant
For Design Confidence (Sydney) Pty Ltd

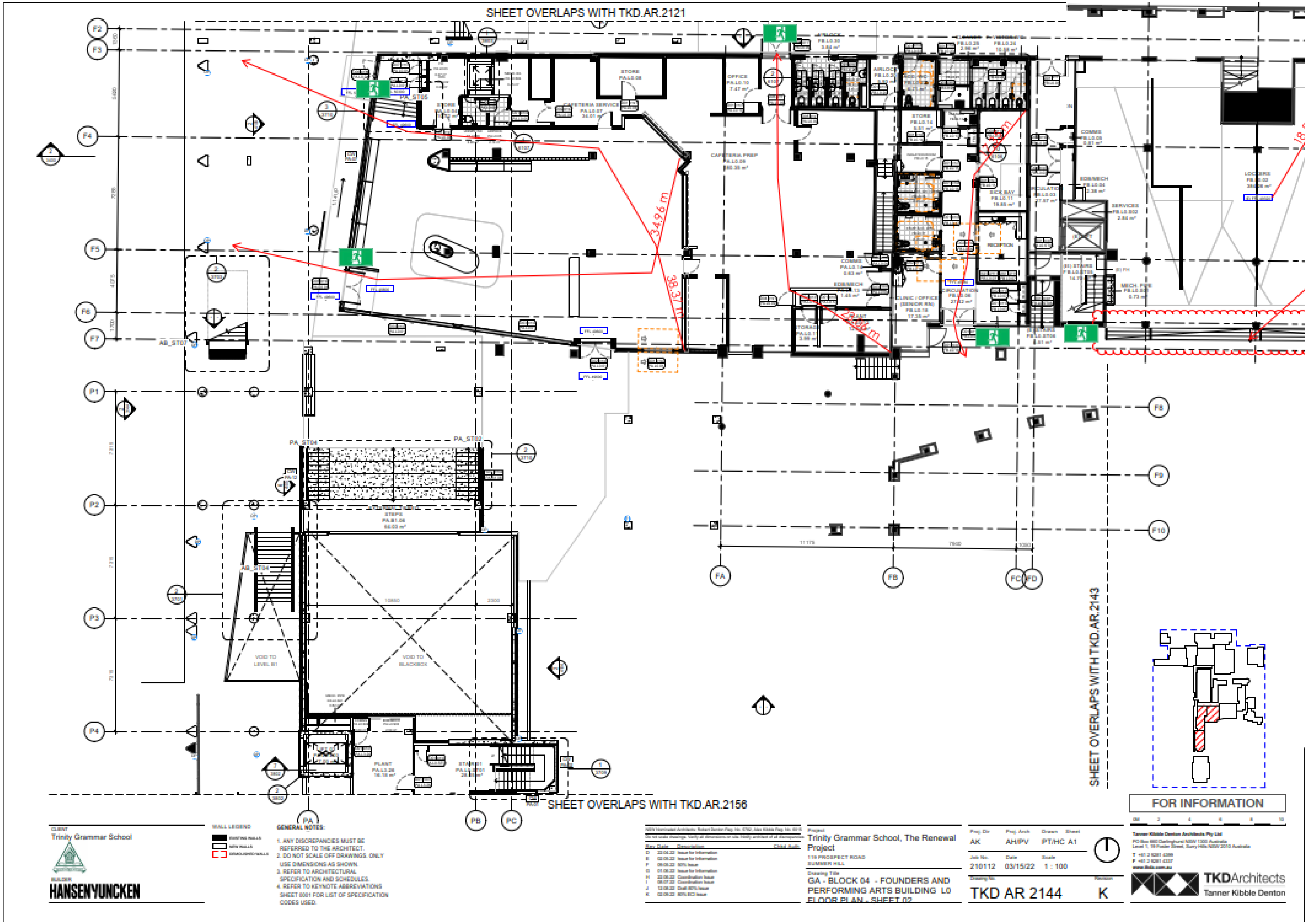
Verified By

Luke Sheehy
Principal
For Design Confidence (Sydney) Pty Ltd


POC
24.13 m
GENERAL NOTES:
1. ANY DISCREPANCIES MUST BE REFERRED TO THE ARCHITECT.
2. DO NOT SCALE OFF DRAWINGS. ONLY USE DIMENSIONS AS SHOWN.
3. REFER TO ARCHITECTURAL SPECIFICATION AND SCHEDULES.
4. REFER TO KEYNOTE ABBREVIATIONS SHEET 0001 FOR LIST OF SPECIFICATION CODES USED.
CLIENT
Trinity Grammar School
BUILDER
HANSENYUNCKEN
FOR INFORMATION
Trinity Grammar School, The Renewal Project
GA - BLOCK 04 - FOUNDERS BUILDING B2 FLOOR PLAN
AK
AH/PV
PT/HC A1
210112
03/15/22
1 : 100
TKD AR 2140
K
TKDArchitects
Tanner Kibble Denton


SHEET OVERLAPS WITH TKD AR 2142
VOID TO LEVEL 00
FEMALE STAFF CHANGE
NO WORKS PROPOSED
FOR INFORMATION
Trinity Grammar School
HANSENYUNCKEN
GENERAL NOTES:
Trinity Grammar School, The Renewal Project
GA - BLOCK 04 - FOUNDERS BUILDING B1 FLOOR PLAN - SHEET 01
TKD AR 2141
K
TKDArchitects
Tanner Kibble Denton


SHEET OVERLAPS WITH TKD.AR.2120
SHEET OVERLAPS WITH TKD.AR.2155
SHEET OVERLAPS WITH TKD.AR.2141
FOR INFORMATION
Trinity Grammar School
HANSENYUNCKEN
Trinity Grammar School, The Renewal Project
GA - BLOCK 04 - FOUNDERS AND PERFORMING ARTS BUILDING B1 FLOOR PLAN - SHEET 02
AK
AH/PV
PT/HC
A1
210112
03/15/22
1 : 100
TKD AR 2142
K
TKDArchitects
Tanner Kibble Denton


SHEET OVERLAPS WITH TKD.AR.2121
SHEET OVERLAPS WITH TKD.AR.2143
SHEET OVERLAPS WITH TKD.AR.2156
34.96 m
38.37 m
FOR INFORMATION
Trinity Grammar School
HANSENYUNCKEN
GENERAL NOTES:
1. ANY DISCREPANCIES MUST BE REFERRED TO THE ARCHITECT.
2. DO NOT SCALE OFF DRAWINGS. ONLY USE DIMENSIONS AS SHOWN.
3. REFER TO ARCHITECTURAL SPECIFICATION AND SCHEDULES.
4. REFER TO KEYNOTE ABBREVIATIONS SHEET 0001 FOR LIST OF SPECIFICATION CODES USED.
Trinity Grammar School, The Renewal Project
GA - BLOCK 04 - FOUNDERS AND PERFORMING ARTS BUILDING L0 FLOOR PLAN - SHEET 02
AK
AH/PV
PT/HC
A1
210112
03/15/22
1 : 100
TKD AR 2144
K
TKDArchitects
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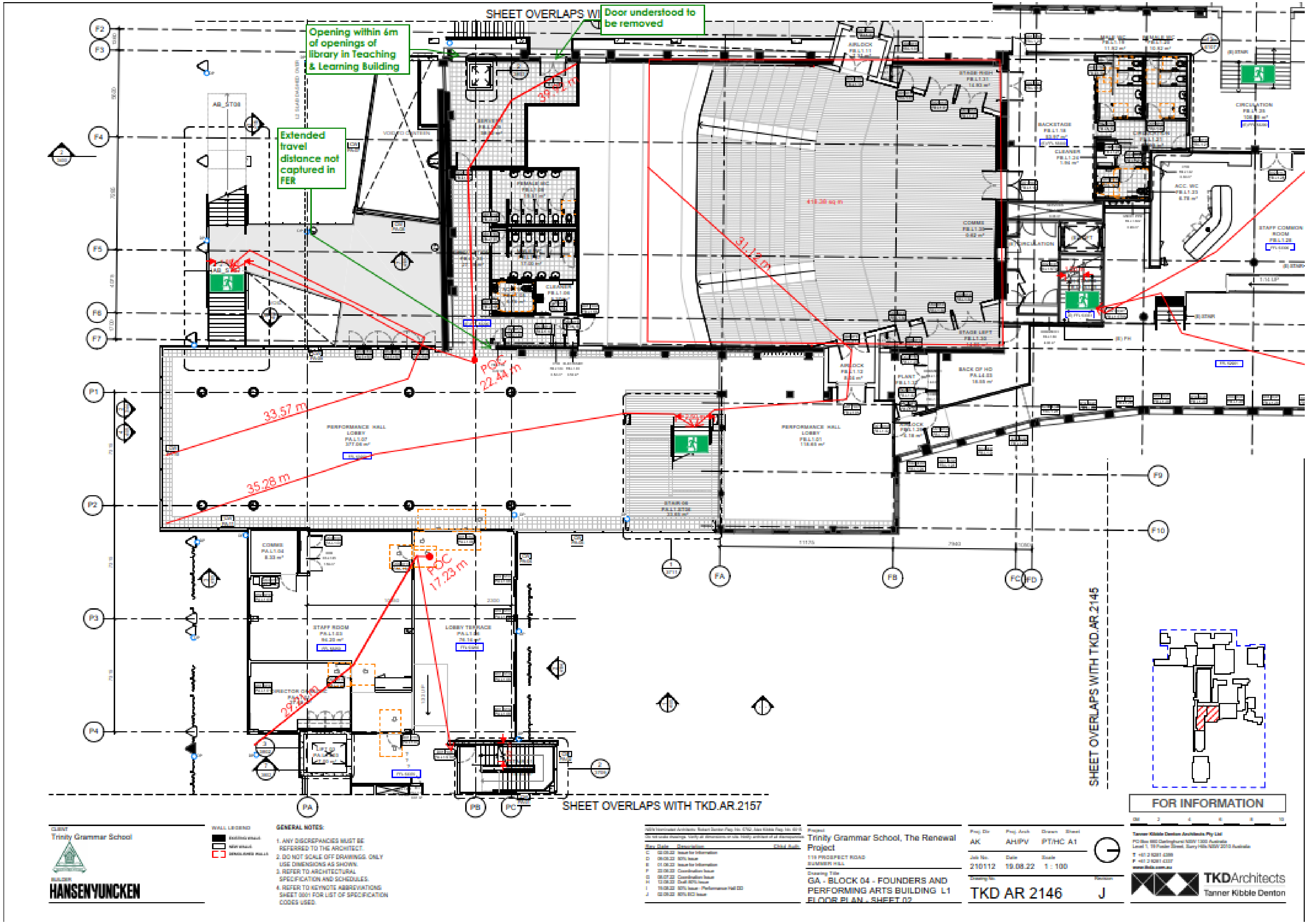
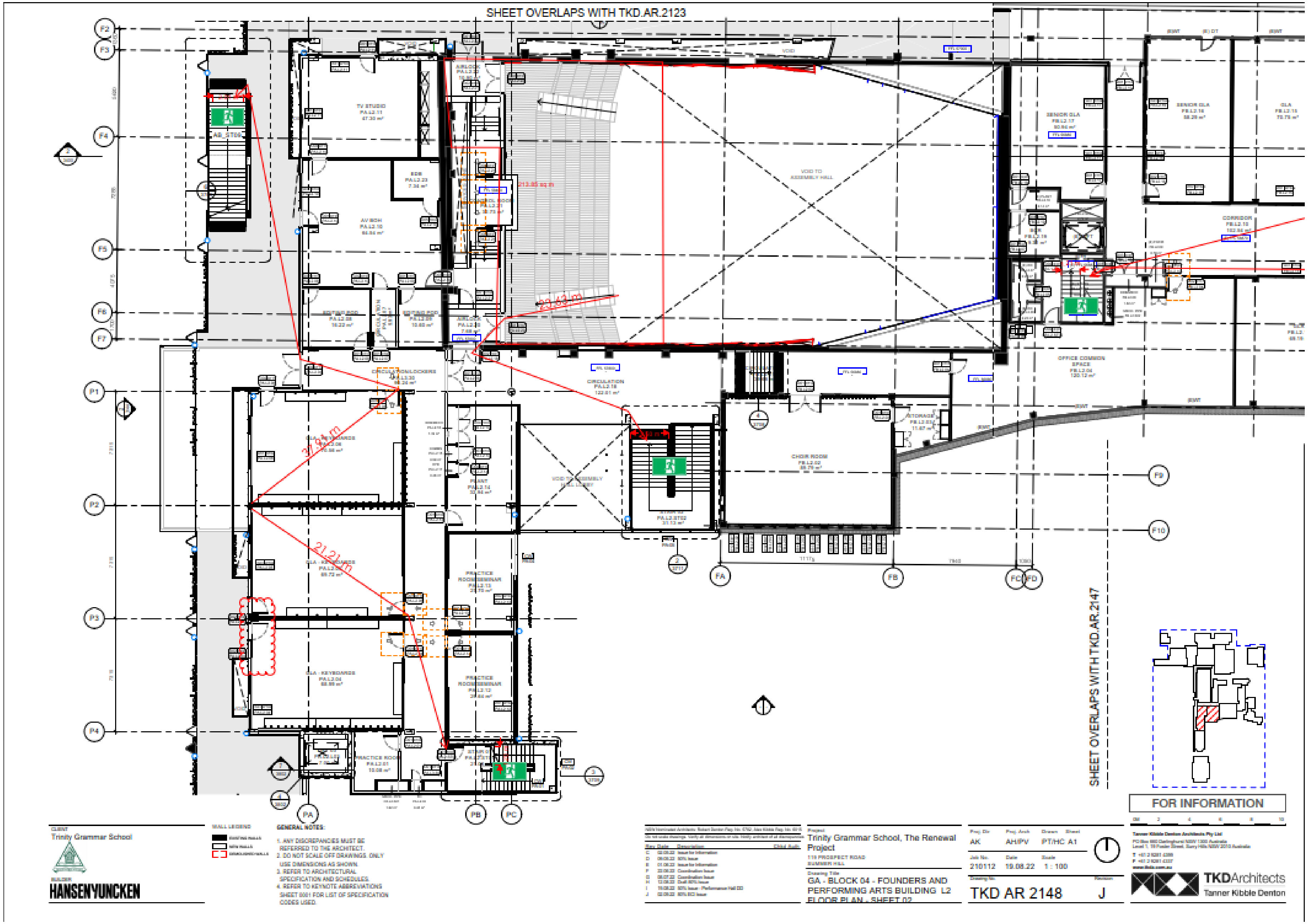
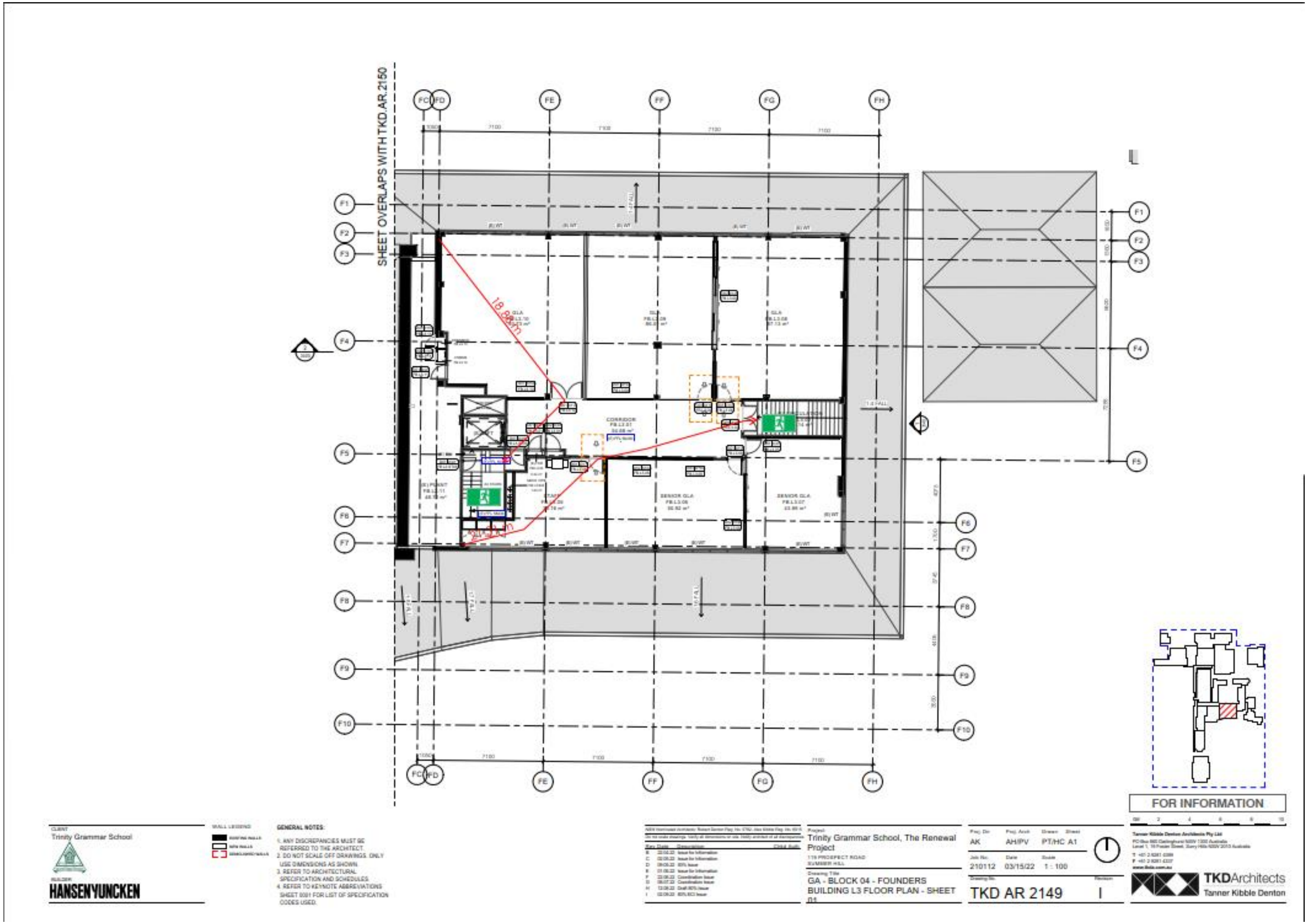

Opening within 6m of openings of library in Teaching & Learning Building
Door understood to be removed
Extended travel distance not captured in FER
SHEET OVERLAPS WITH TKD.AR.2157
SHEET OVERLAPS WITH TKD.AR.2145
39.12 m
31.12 m
33.57 m
35.28 m
POC 22.44 m
POC 17.23 m
PERFORMANCE HALL LOBBY
STAFF ROOM
LOBBY TERRACE
COMMS
FOR INFORMATION
Trinity Grammar School
HANSENYUNCKEN
Trinity Grammar School, The Renewal Project
GA - BLOCK 04 - FOUNDERS AND PERFORMING ARTS BUILDING L1 FLOOR PLAN - SHEET 02
TKD AR 2146
J
210112
19.08.22
1 : 100
TKDArchitects
Tanner Kibble Denton


SHEET OVERLAPS WITH TKD.AR.2123
SHEET OVERLAPS WITH TKD.AR.2147
TV STUDIO
AV BOH
VOID TO ASSEMBLY HALL
CHOIR ROOM
OFFICE COMMON SPACE
SENIOR GLA
CORRIDOR
CIRCULATION
GLA - KEYBOARDS
PRACTICE ROOM/SEMINAR
FOR INFORMATION
Trinity Grammar School
HANSENYUNCKEN
GENERAL NOTES:
1. ANY DISCREPANCIES MUST BE REFERRED TO THE ARCHITECT.
2. DO NOT SCALE OFF DRAWINGS. ONLY USE DIMENSIONS AS SHOWN.
3. REFER TO ARCHITECTURAL SPECIFICATION AND SCHEDULES.
4. REFER TO KEYNOTE ABBREVIATIONS SHEET 0001 FOR LIST OF SPECIFICATION CODES USED.
Trinity Grammar School, The Renewal Project
GA - BLOCK 04 - FOUNDERS AND PERFORMING ARTS BUILDING L2 FLOOR PLAN - SHEET 02
AK
AH/PV
PT/HC
A1
210112
19.08.22
1 : 100
TKD AR 2148
J
TKDArchitects
Tanner Kibble Denton


SHEET OVERLAPS WITH TKD.AR.2150
FC
FD
FE
FF
FG
FH
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10
CORRIDOR
SENIOR GLA
FOR INFORMATION
Trinity Grammar School
HANSENYUNCKEN
GENERAL NOTES:
1. ANY DISCREPANCIES MUST BE REFERRED TO THE ARCHITECT.
2. DO NOT SCALE OFF DRAWINGS. ONLY USE DIMENSIONS AS SHOWN.
3. REFER TO ARCHITECTURAL SPECIFICATION AND SCHEDULES.
4. REFER TO KEYNOTE ABBREVIATIONS SHEET 0001 FOR LIST OF SPECIFICATION CODES USED.
Trinity Grammar School, The Renewal Project
GA - BLOCK 04 - FOUNDERS BUILDING L3 FLOOR PLAN - SHEET 01
AK
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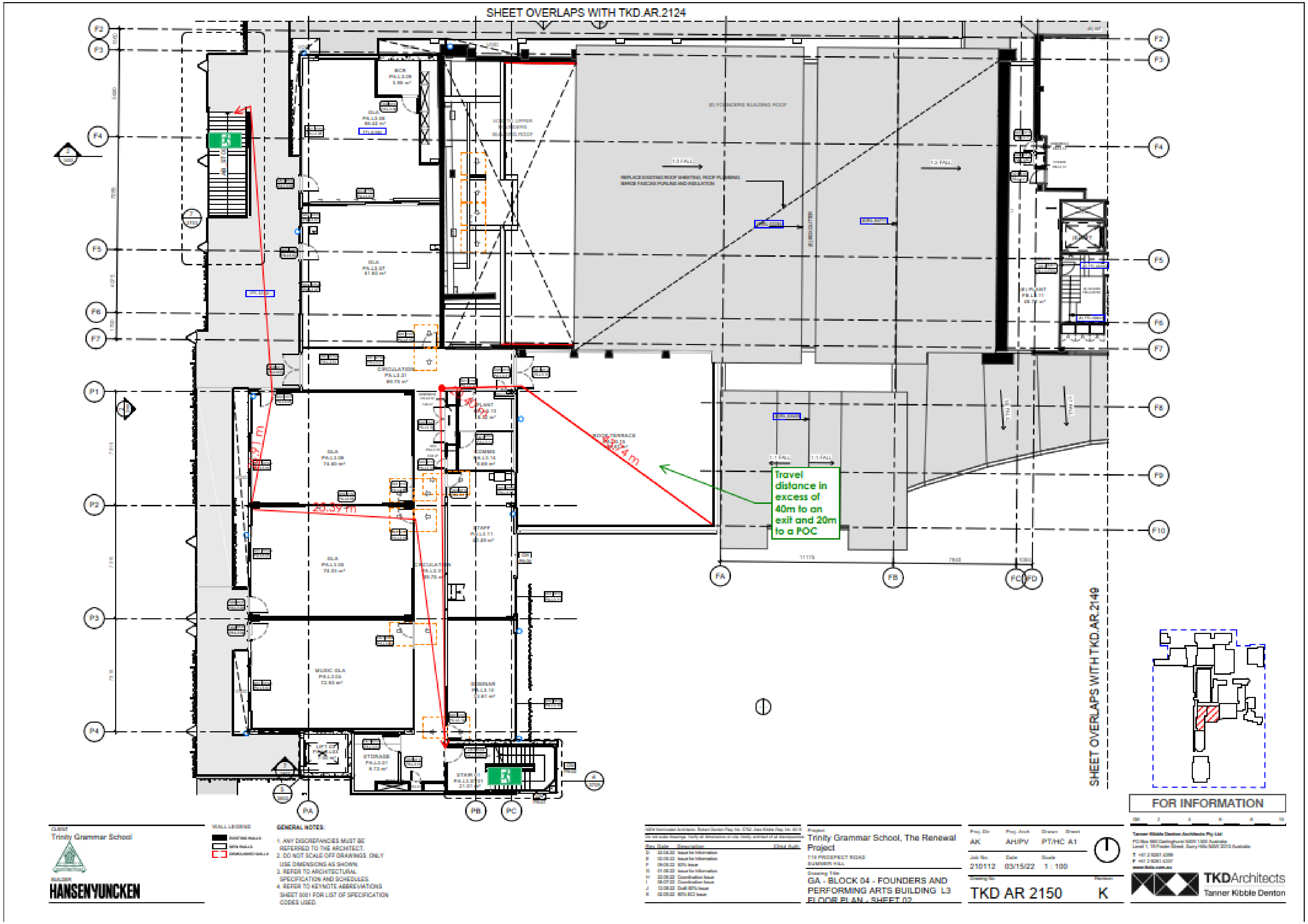
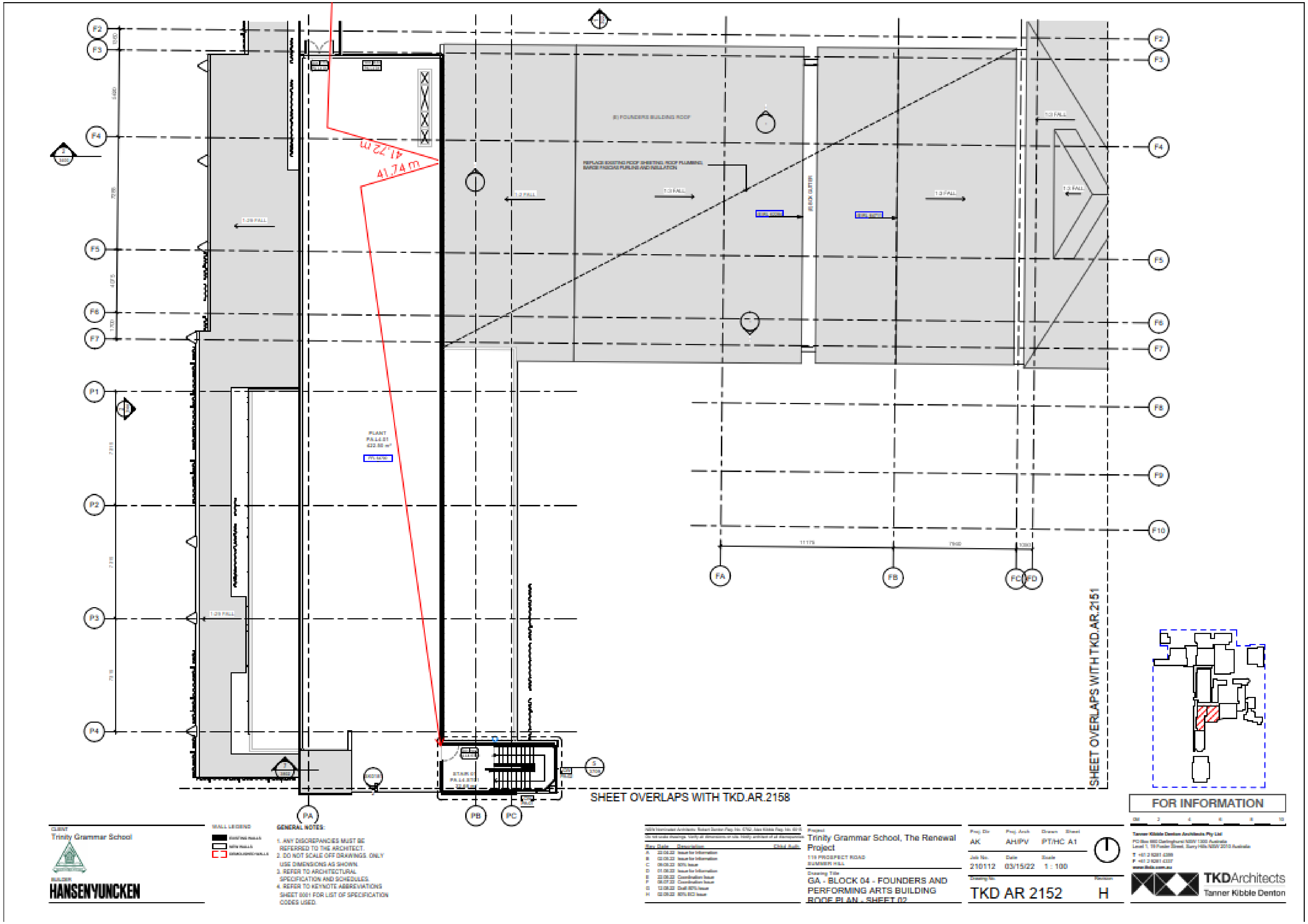
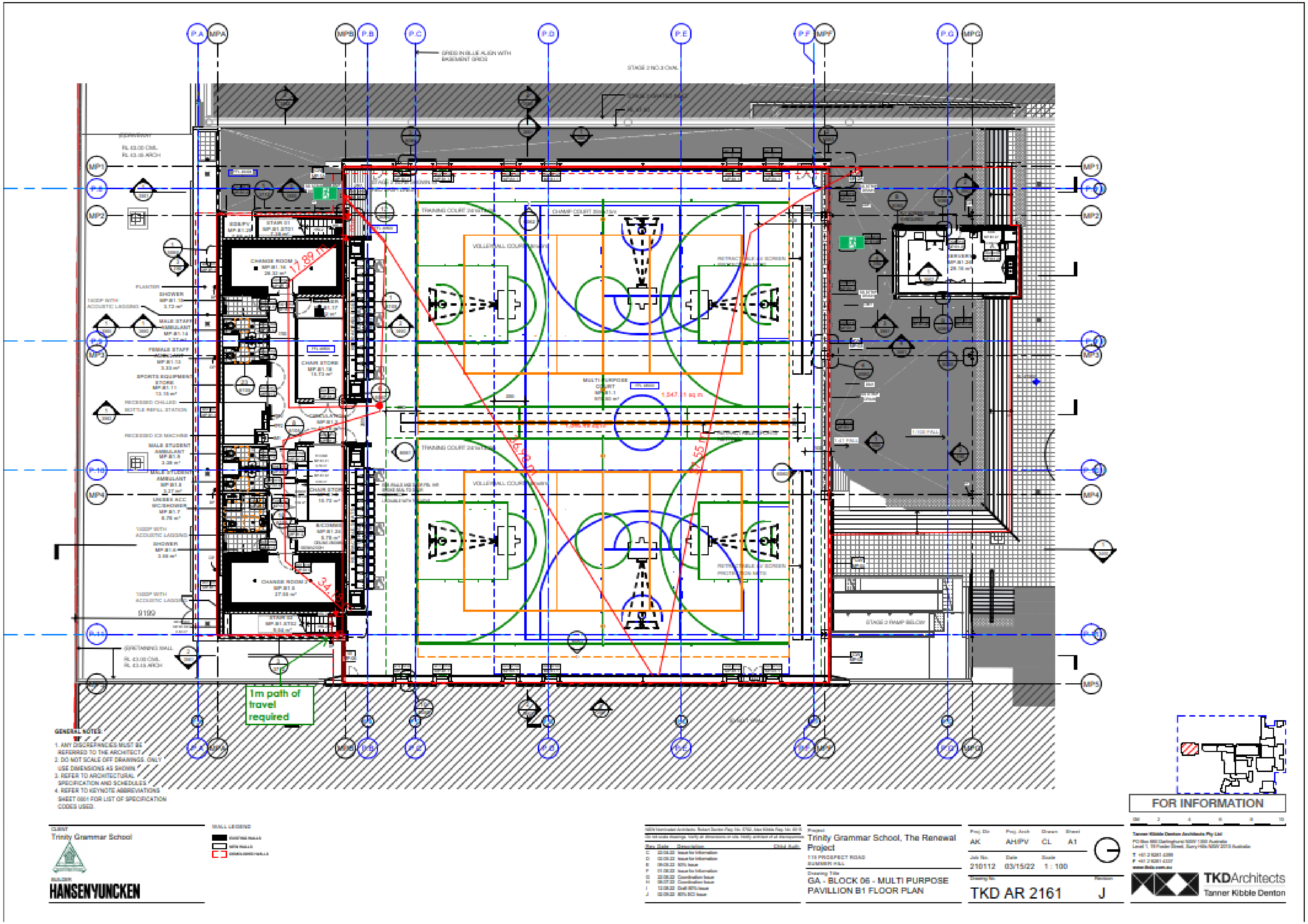
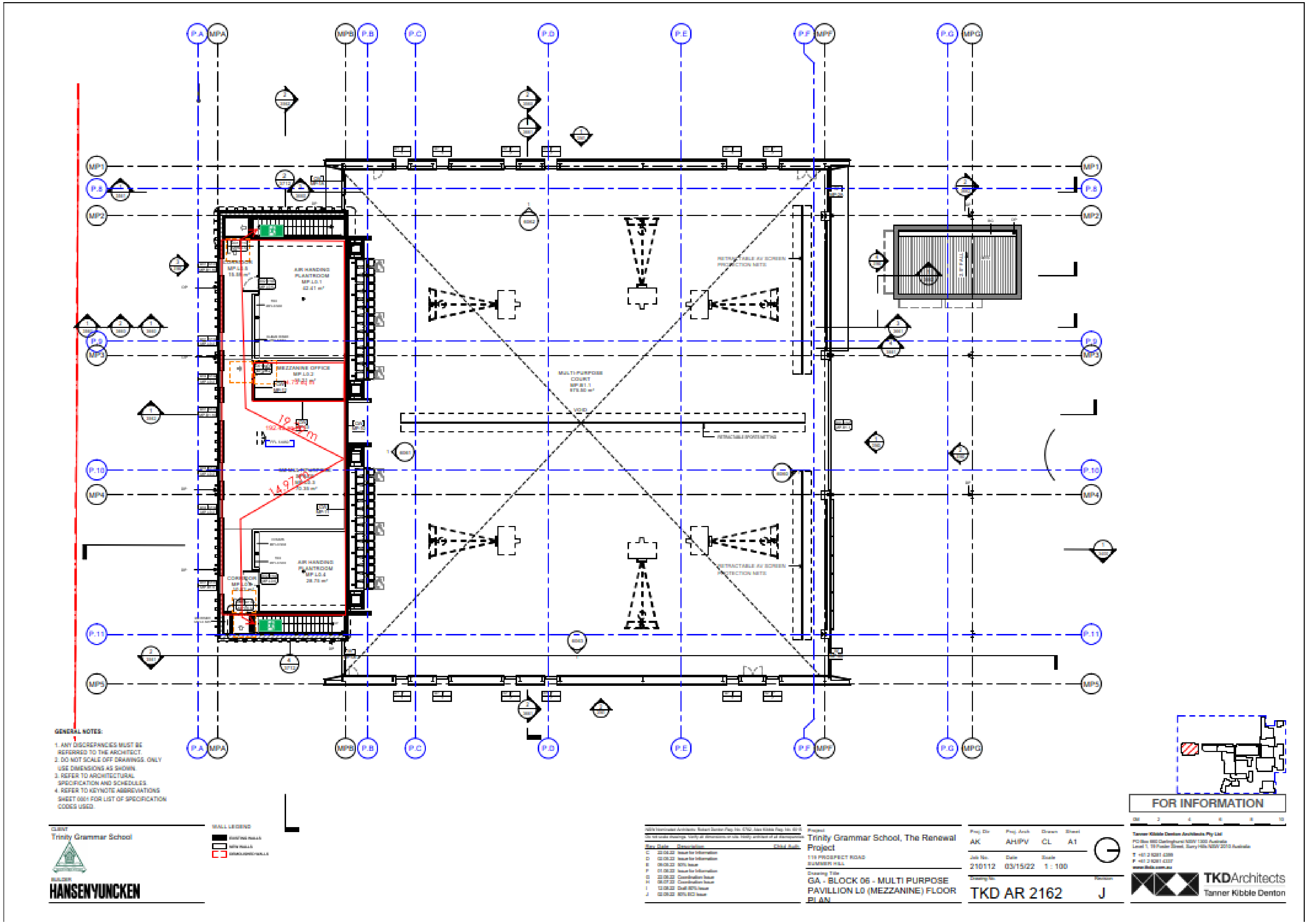
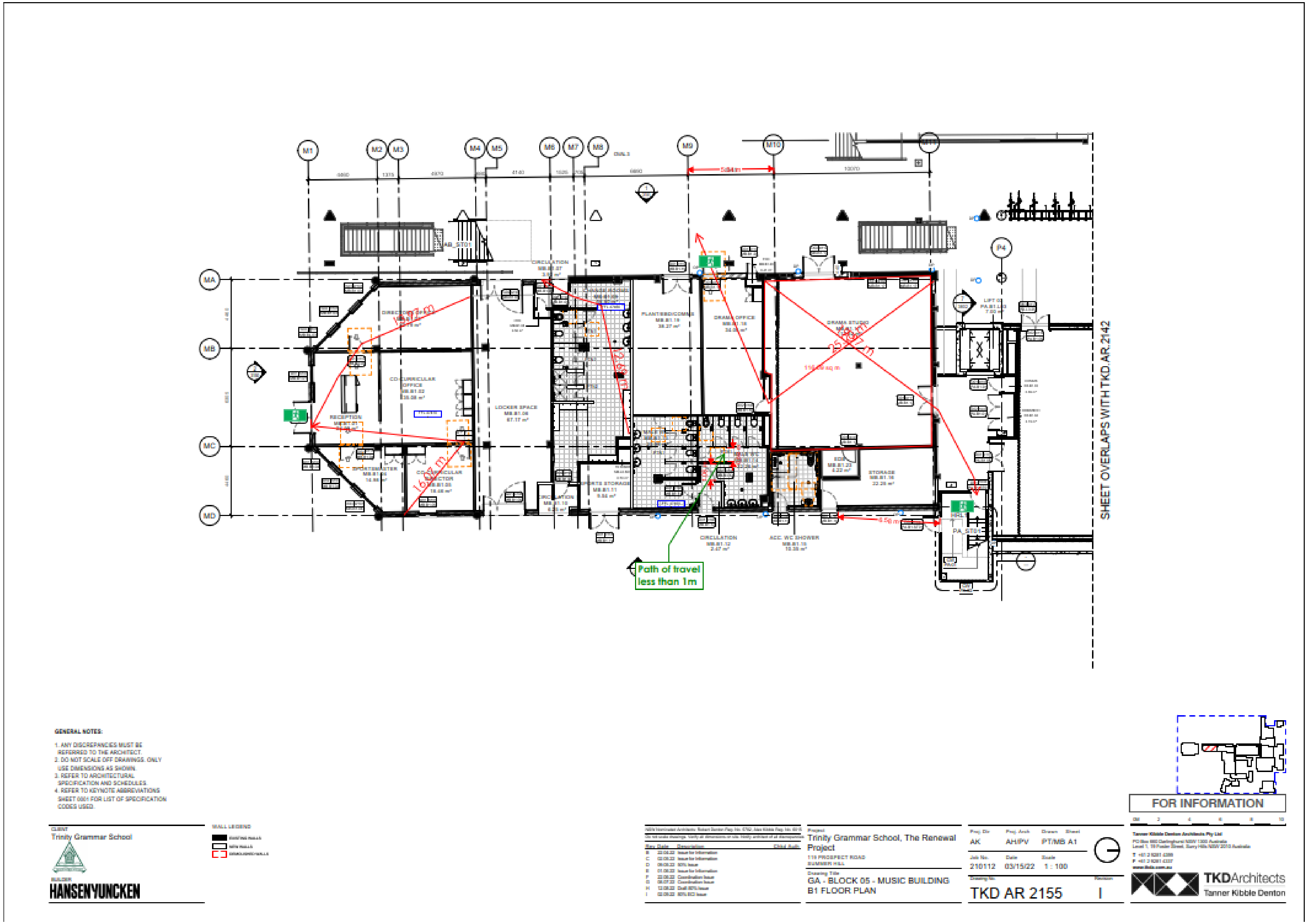
PT/HC
A1
210112
03/15/22
1 : 100
TKD AR 2149
I
TKDArchitects
Tanner Kibble Denton

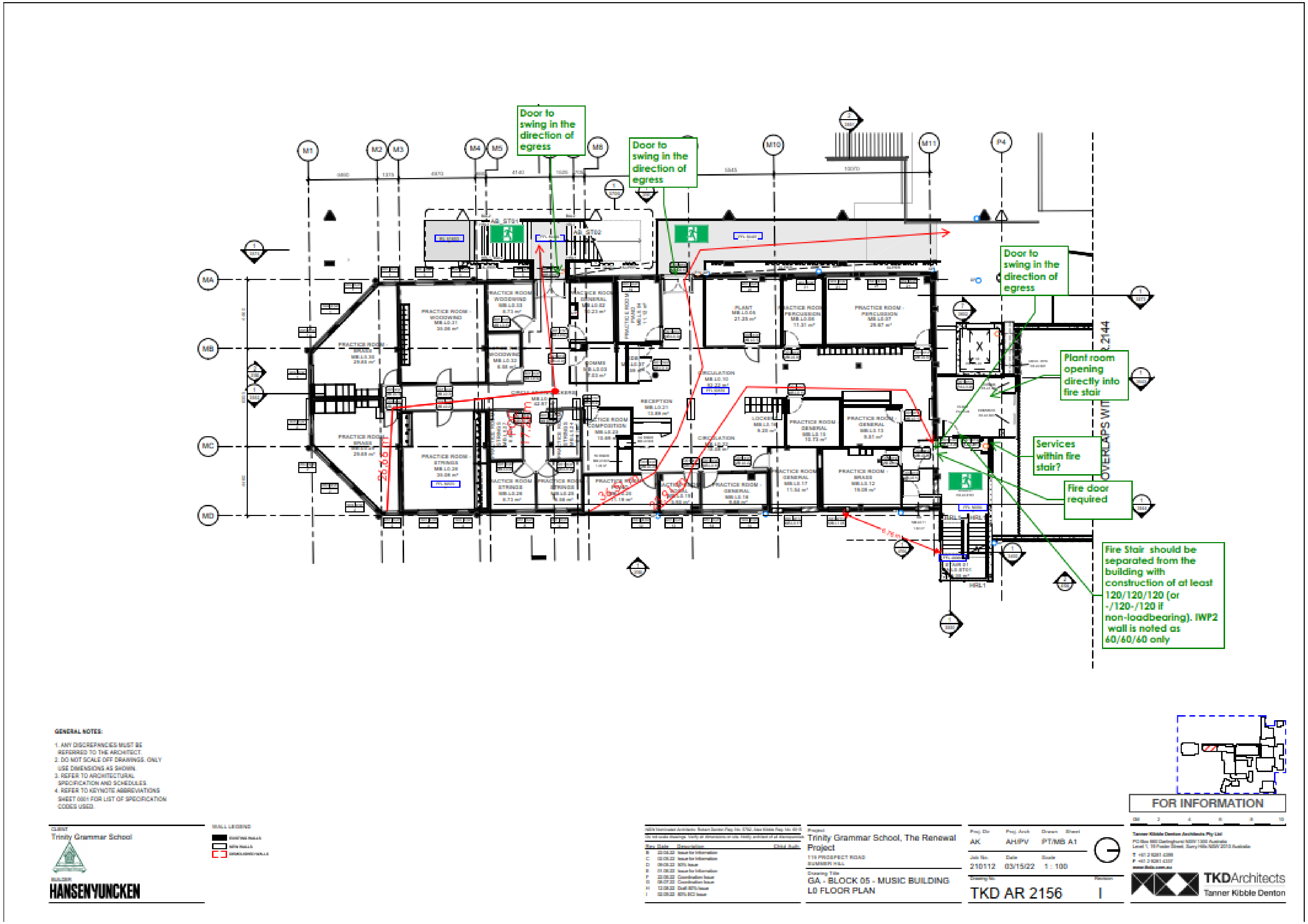

SHEET OVERLAPS WITH TKD.AR.2124
SHEET OVERLAPS WITH TKD.AR.2149
Travel distance in excess of 40m to an exit and 20m to a POC
23.39 m
FOR INFORMATION
Trinity Grammar School
HANSENYUNCKEN
GENERAL NOTES:
1. ANY DISCREPANCIES MUST BE REFERRED TO THE ARCHITECT.
2. DO NOT SCALE OFF DRAWINGS. ONLY USE DIMENSIONS AS SHOWN.
3. REFER TO ARCHITECTURAL SPECIFICATION AND SCHEDULES.
4. REFER TO KEYNOTE ABBREVIATIONS SHEET 0001 FOR LIST OF SPECIFICATION CODES USED.
Trinity Grammar School, The Renewal Project
GA - BLOCK 04 - FOUNDERS AND PERFORMING ARTS BUILDING L3 FLOOR PLAN - SHEET 02
AK
AH/PV
PT/HC
A1
210112
03/15/22
1 : 100
TKD AR 2150
K
TKDArchitects
Tanner Kibble Denton

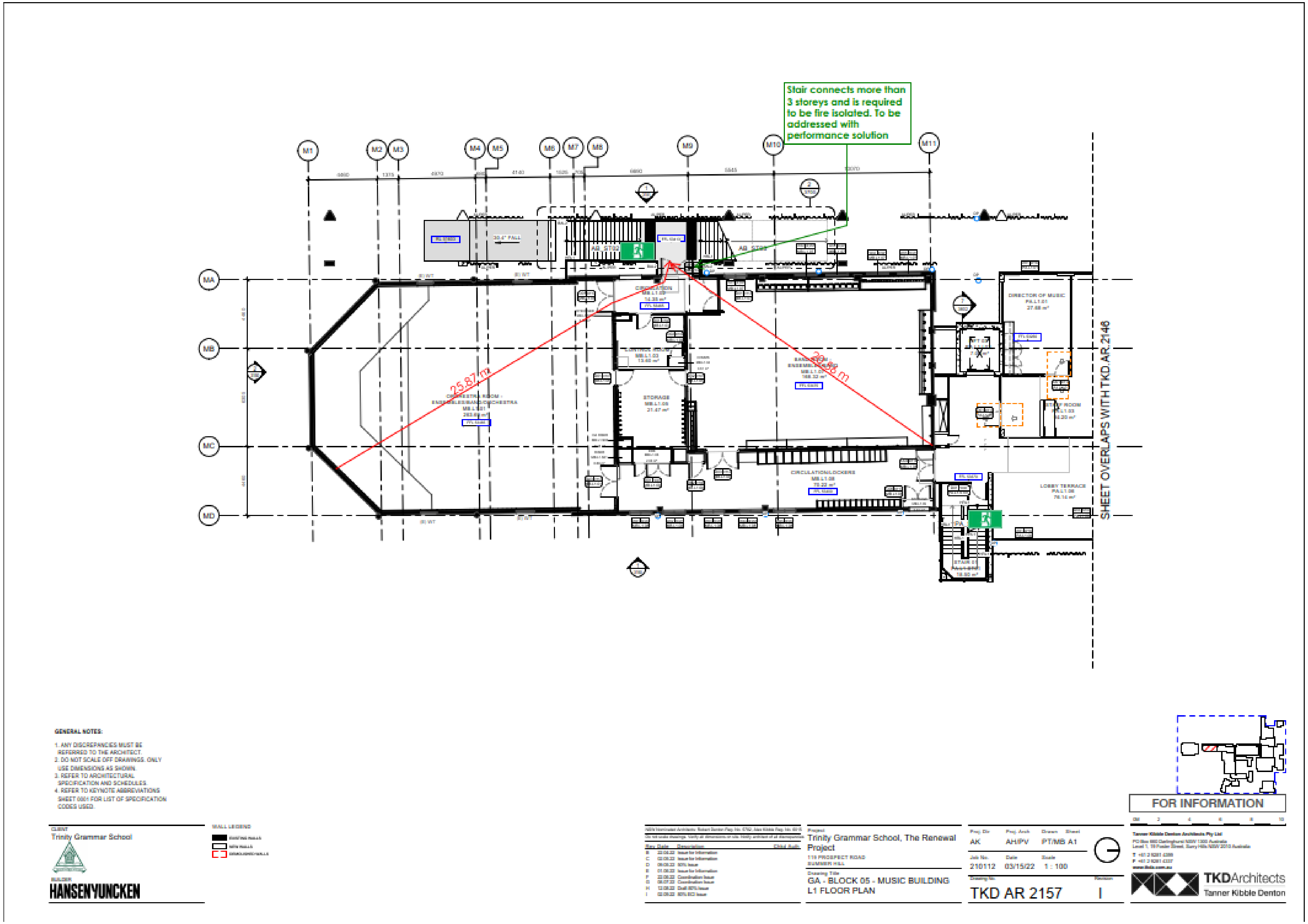

41.72 m
41.74 m
SHEET OVERLAPS WITH TKD.AR.2151
SHEET OVERLAPS WITH TKD.AR.2158
FOR INFORMATION
Trinity Grammar School
HANSENYUNCKEN
GENERAL NOTES:
Trinity Grammar School, The Renewal Project
GA - BLOCK 04 - FOUNDERS AND PERFORMING ARTS BUILDING ROOF PLAN - SHEET 02
AK
AH/PV
PT/HC A1
210112
03/15/22
1 : 100
TKD AR 2152
H
TKDArchitects
Tanner Kibble Denton

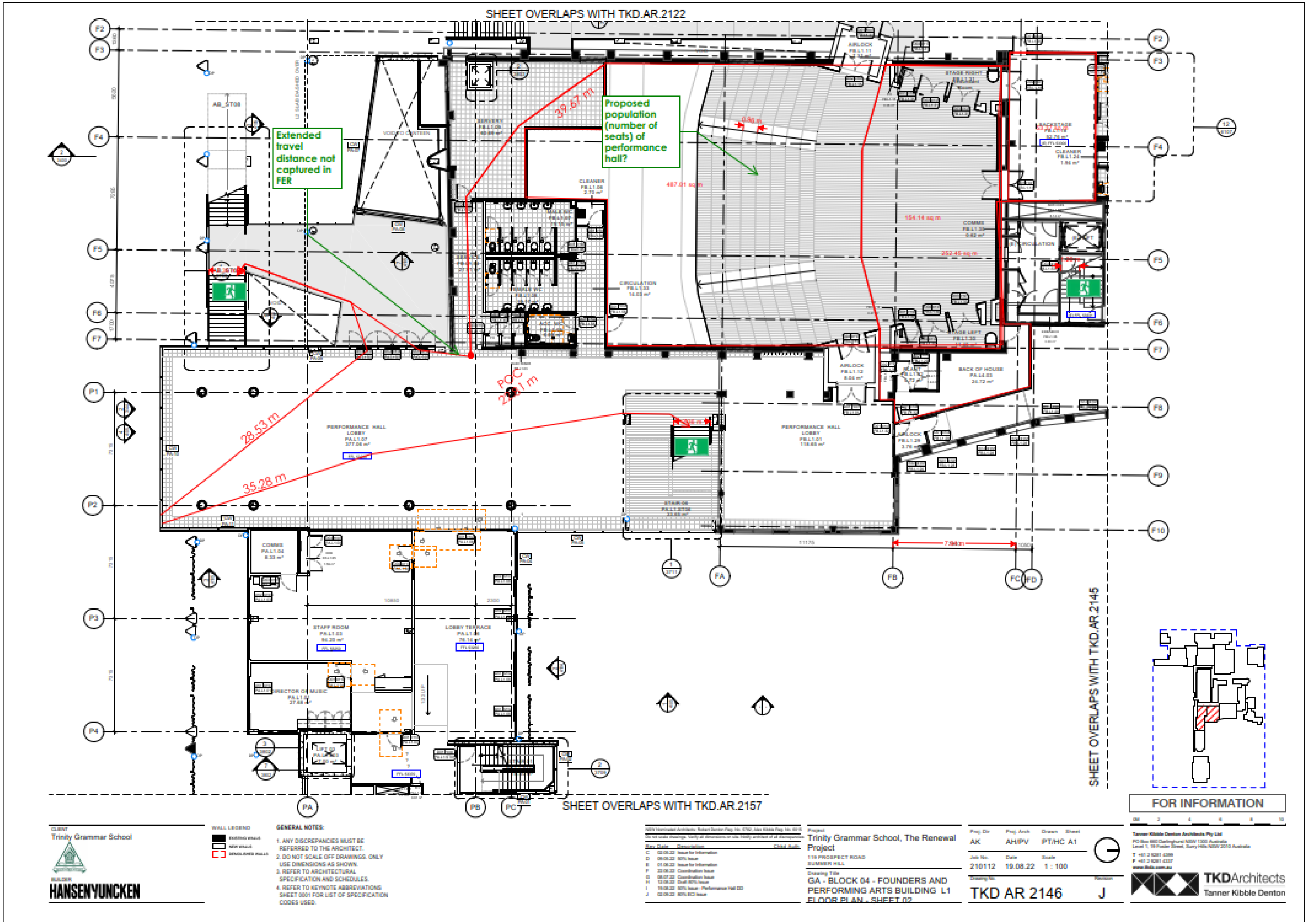

1m path of travel required
FOR INFORMATION
Trinity Grammar School
HANSENYUNCKEN
Trinity Grammar School, The Renewal Project
GA - BLOCK 06 - MULTI PURPOSE PAVILION B1 FLOOR PLAN
AK
AH/PV
CL
A1
210112
03/15/22
1 : 100
TKD AR 2161
J
TKDArchitects
Tanner Kibble Denton

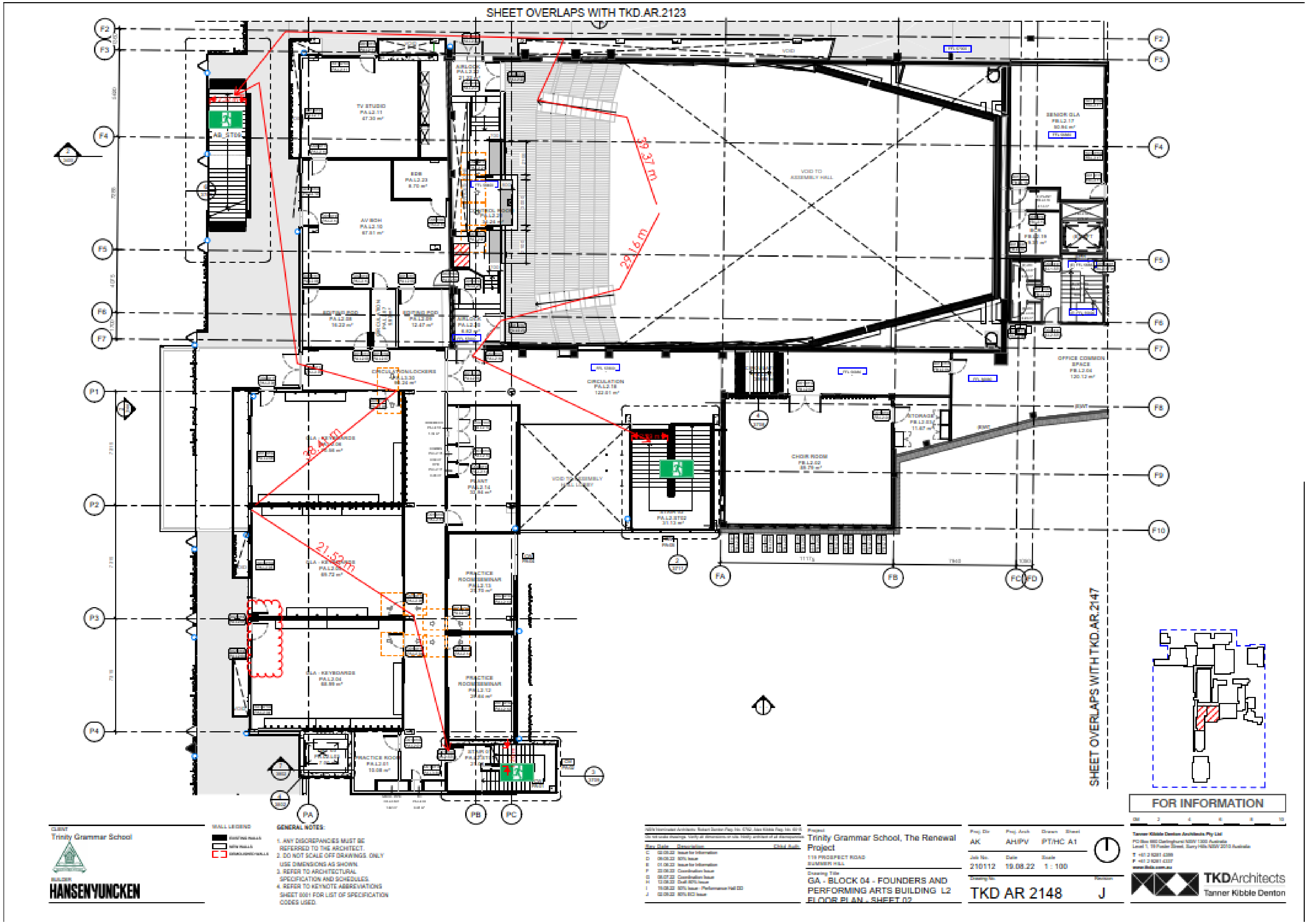

MULTI-PURPOSE COURT
AIR HANDLING PLANTROOM
MEZZANINE OFFICE
CORRIDOR
RETRACTABLE AV SCREEN PROJECTION NETS
GENERAL NOTES:
1. ANY DISCREPANCIES MUST BE REFERRED TO THE ARCHITECT.
2. DO NOT SCALE OFF DRAWINGS. ONLY USE DIMENSIONS AS SHOWN.
3. REFER TO ARCHITECTURAL SPECIFICATION AND SCHEDULES.
4. REFER TO KEYNOTE ABBREVIATIONS SHEET 0001 FOR LIST OF SPECIFICATION CODES USED.
CLIENT
Trinity Grammar School
BUILDER
HANSENYUNCKEN
WALL LEGEND
FOR INFORMATION
Trinity Grammar School, The Renewal Project
GA - BLOCK 06 - MULTI PURPOSE PAVILION L0 (MEZZANINE) FLOOR PLAN
AK
AH/PV
CL
A1
210112
03/15/22
1 : 100
TKD AR 2162
J
TKDArchitects
Tanner Kibble Denton

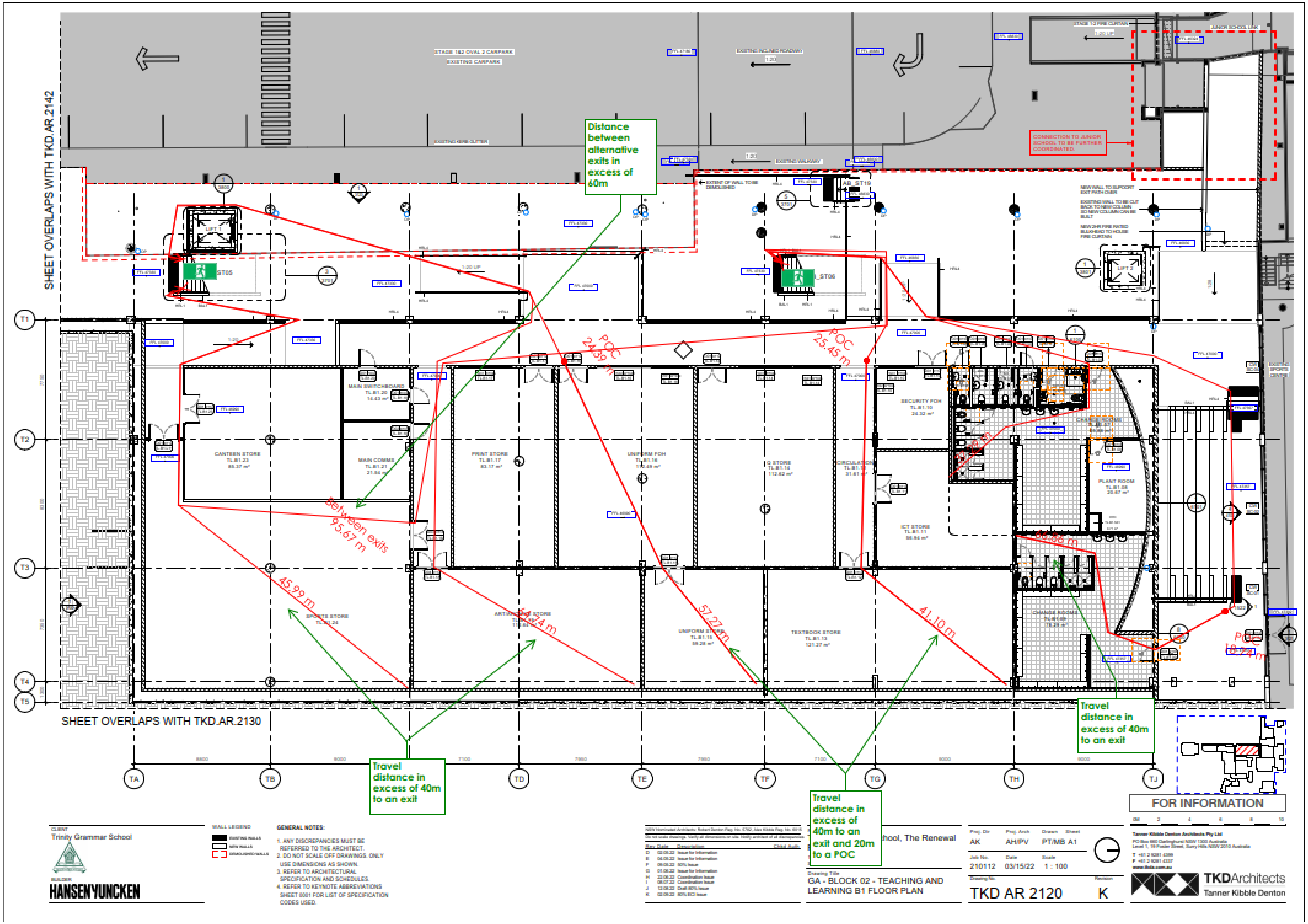

SHEET OVERLAPS WITH TKD AR 2142
Path of travel less than 1m
GENERAL NOTES:
1. ANY DISCREPANCIES MUST BE REFERRED TO THE ARCHITECT.
2. DO NOT SCALE OFF DRAWINGS. ONLY USE DIMENSIONS AS SHOWN.
3. REFER TO ARCHITECTURAL SPECIFICATION AND SCHEDULES.
4. REFER TO KEYNOTE ABBREVIATIONS SHEET 0001 FOR LIST OF SPECIFICATION CODES USED.
CLIENT
Trinity Grammar School
BUILDER
HANSENYUNCKEN
FOR INFORMATION
Project
Trinity Grammar School, The Renewal Project
119 PROSPECT ROAD
SUMMER HILL
Drawing Title
GA - BLOCK 05 - MUSIC BUILDING
B1 FLOOR PLAN
Proj. Dir
AK
Proj. Arch
AH/PV
Drawn
PT/MB
Sheet
A1
Job No.
210112
Date
03/15/22
Scale
1 : 100
Drawing No.
TKD AR 2155
Revision
I
TKDArchitects
Tanner Kibble Denton

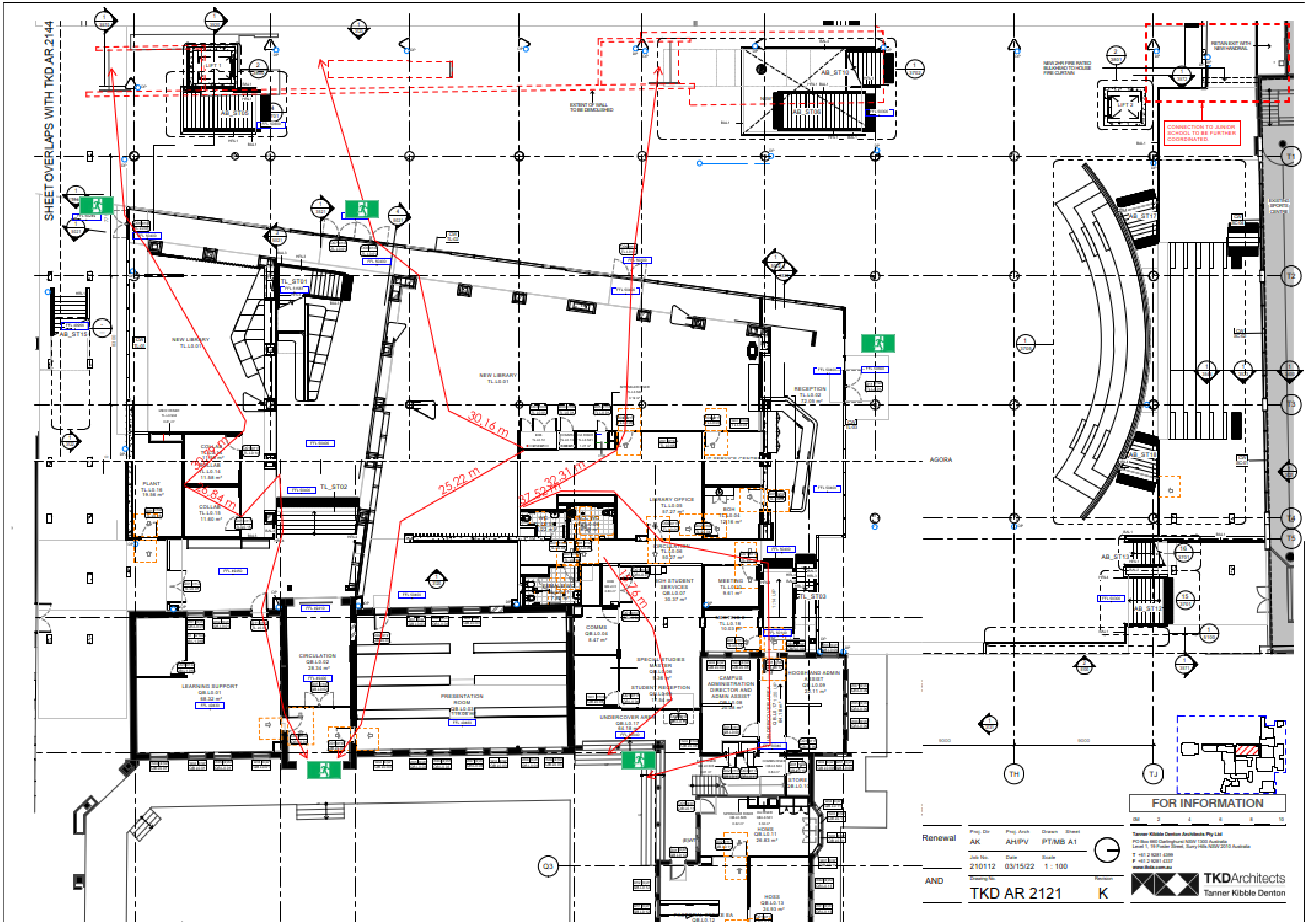

Door to swing in the direction of egress
Door to swing in the direction of egress
Door to swing in the direction of egress
Plant room opening directly into fire stair
Services within fire stair?
Fire door required
Fire Stair should be separated from the building with construction of at least 120/120/120 (or -/120-/120 if non-loadbearing). IWP2 wall is noted as 60/60/60 only
GENERAL NOTES:
1. ANY DISCREPANCIES MUST BE REFERRED TO THE ARCHITECT.
2. DO NOT SCALE OFF DRAWINGS. ONLY USE DIMENSIONS AS SHOWN.
3. REFER TO ARCHITECTURAL SPECIFICATION AND SCHEDULES.
4. REFER TO KEYNOTE ABBREVIATIONS SHEET 0001 FOR LIST OF SPECIFICATION CODES USED.
Trinity Grammar School
HANSENYUNCKEN
FOR INFORMATION
Trinity Grammar School, The Renewal Project
GA - BLOCK 05 - MUSIC BUILDING L0 FLOOR PLAN
TKD AR 2156
TKDArchitects
Tanner Kibble Denton

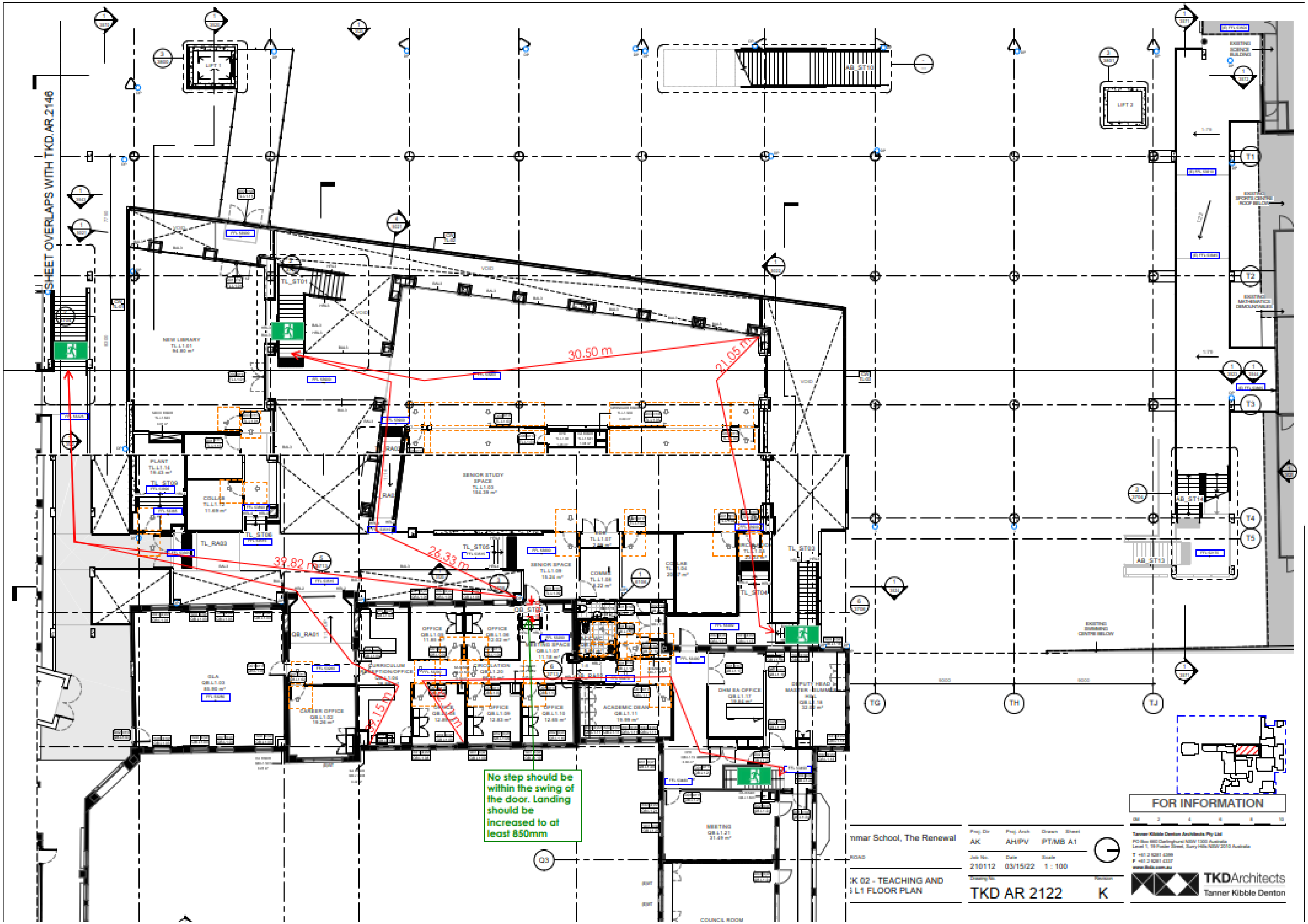

Stair connects more than 3 storeys and is required to be fire isolated. To be addressed with performance solution
25.87 m
SHEET OVERLAPS WITH TKD AR 2148
GENERAL NOTES:
1. ANY DISCREPANCIES MUST BE REFERRED TO THE ARCHITECT.
2. DO NOT SCALE OFF DRAWINGS. ONLY USE DIMENSIONS AS SHOWN.
3. REFER TO ARCHITECTURAL SPECIFICATION AND SCHEDULES.
4. REFER TO KEYNOTE ABBREVIATIONS SHEET 0001 FOR LIST OF SPECIFICATION CODES USED.
Trinity Grammar School
HANSENYUNCKEN
FOR INFORMATION
Trinity Grammar School, The Renewal Project
GA - BLOCK 05 - MUSIC BUILDING L1 FLOOR PLAN
AK
AH/PV
PT/MB A1
210112
03/15/22
1 : 100
TKD AR 2157
I
TKDArchitects
Tanner Kibble Denton

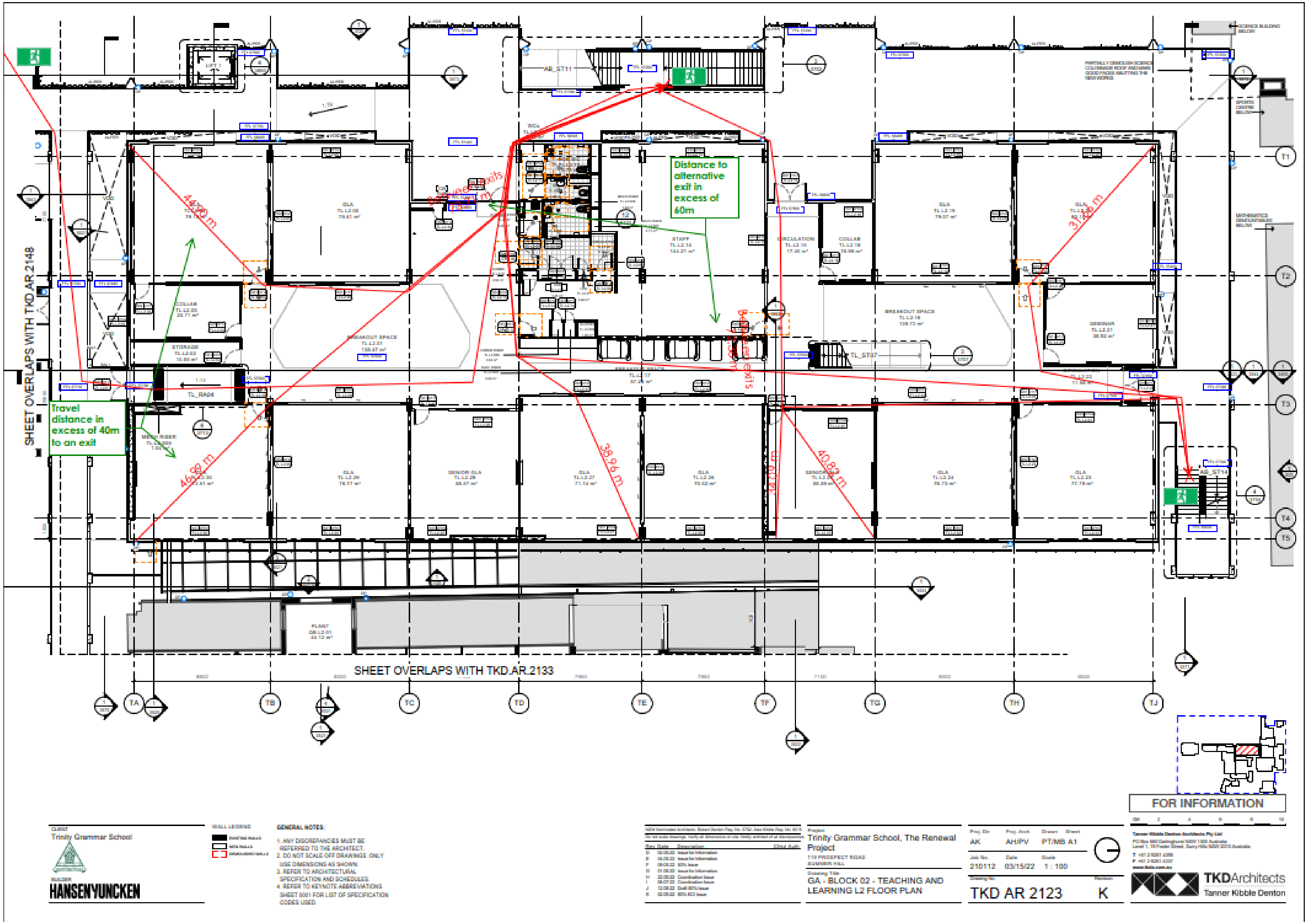

SHEET OVERLAPS WITH TKD.AR.2122
Extended travel distance not captured in FER
Proposed population (number of seats) of performance hall?
39.67 m
28.53 m
35.28 m
POC 29.61 m
7.94 m
PERFORMANCE HALL LOBBY
CIRCULATION
STAFF ROOM
LOBBY TERRACE
BACK OF HOUSE
SHEET OVERLAPS WITH TKD.AR.2157
SHEET OVERLAPS WITH TKD.AR.2145
FOR INFORMATION
Trinity Grammar School
HANSENYUNCKEN
GENERAL NOTES:
Trinity Grammar School, The Renewal Project
GA - BLOCK 04 - FOUNDERS AND PERFORMING ARTS BUILDING L1 FLOOR PLAN - SHEET 02
TKD AR 2146
J
TKDArchitects
Tanner Kibble Denton

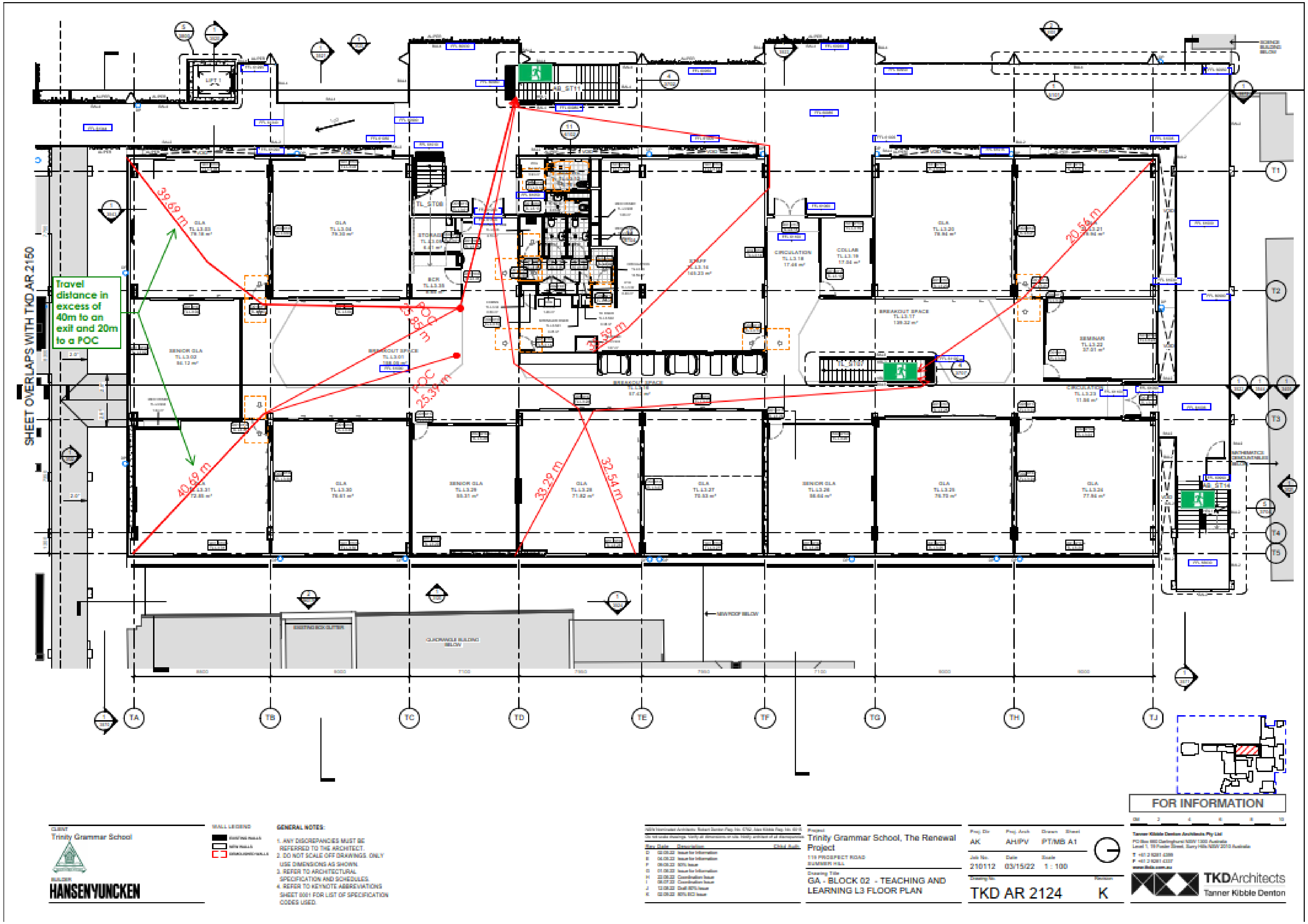

SHEET OVERLAPS WITH TKD.AR.2123
SHEET OVERLAPS WITH TKD.AR.2147
29.37 m
29.16 m
21.52 m
CHOIR ROOM
FOR INFORMATION
Trinity Grammar School
HANSENYUNCKEN
GENERAL NOTES:
Trinity Grammar School, The Renewal Project
GA - BLOCK 04 - FOUNDERS AND PERFORMING ARTS BUILDING L2 FLOOR PLAN - SHEET 02
TKD AR 2148
J
TKDArchitects
Tanner Kibble Denton

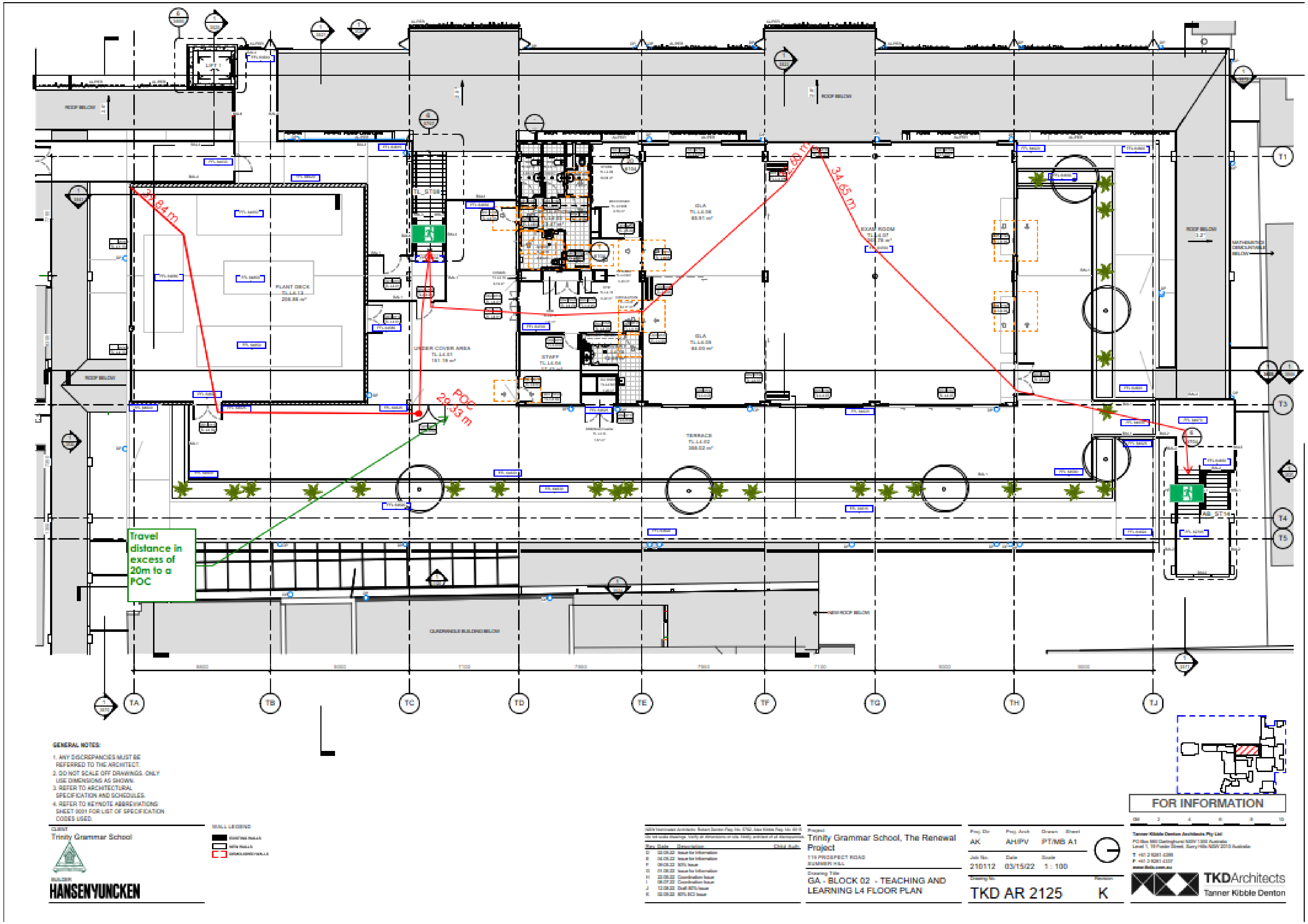

Distance between alternative exits in excess of 60m
between exits 95.67 m
POC 24.39 m
POC 25.45 m
45.99 m
57.27 m
41.10 m
Travel distance in excess of 40m to an exit
Travel distance in excess of 40m to an exit
Travel distance in excess of 40m to an exit and 20m to a POC
SHEET OVERLAPS WITH TKD.AR.2142
SHEET OVERLAPS WITH TKD.AR.2130
FOR INFORMATION
Trinity Grammar School
HANSENYUNCKEN
GA - BLOCK 02 - TEACHING AND LEARNING B1 FLOOR PLAN
TKD AR 2120
K
TKDArchitects
Tanner Kibble Denton


SHEET OVERLAPS WITH TKD AR 2144
NEW LIBRARY
AGORA
30.16 m
25.22 m
FOR INFORMATION
TKD AR 2121
K
TKDArchitects
Tanner Kibble Denton


SHEET OVERLAPS WITH TKD.AR.2146
30.50 m
21.05 m
39.82 m
26.33 m
No step should be within the swing of the door. Landing should be increased to at least 850mm
FOR INFORMATION
TKD AR 2122
K
TKDArchitects
Tanner Kibble Denton


Distance to alternative exit in excess of 60m
Travel distance in excess of 40m to an exit
SHEET OVERLAPS WITH TKD.AR.2148
SHEET OVERLAPS WITH TKD.AR.2133
FOR INFORMATION
Trinity Grammar School
HANSENYUNCKEN
GENERAL NOTES:
Trinity Grammar School, The Renewal Project
GA - BLOCK 02 - TEACHING AND LEARNING L2 FLOOR PLAN
TKD AR 2123
K
TKDArchitects
Tanner Kibble Denton


Travel distance in excess of 40m to an exit and 20m to a POC
39.69 m
POC 18.8 m
POC 25.39 m
35.59 m
20.56 m
40.69 m
33.29 m
32.54 m
SHEET OVERLAPS WITH TKD AR 2150
AB_ST11
AB_ST14
TL_ST08
BREAKOUT SPACE
FOR INFORMATION
Trinity Grammar School
HANSENYUNCKEN
GENERAL NOTES:
Trinity Grammar School, The Renewal Project
GA - BLOCK 02 - TEACHING AND LEARNING L3 FLOOR PLAN
TKD AR 2124
K
TKDArchitects
Tanner Kibble Denton


Travel distance in excess of 20m to a POC
POC
29.33 m
34.65 m
PLANT DECK
UNDER COVER AREA
GLA
EXAM ROOM
STAFF
TERRACE
ROOF BELOW
QUADRANGLE BUILDING BELOW
TA
TB
TC
TD
TE
TF
TG
TH
TJ
T1
T3
T4
T5
GENERAL NOTES:
1. ANY DISCREPANCIES MUST BE REFERRED TO THE ARCHITECT.
2. DO NOT SCALE OFF DRAWINGS. ONLY USE DIMENSIONS AS SHOWN.
3. REFER TO ARCHITECTURAL SPECIFICATION AND SCHEDULES.
4. REFER TO KEYNOTE ABBREVIATIONS SHEET 0001 FOR LIST OF SPECIFICATION CODES USED.
CLIENT
Trinity Grammar School
BUILDER
HANSENYUNCKEN
WALL LEGEND
FOR INFORMATION
Project
Trinity Grammar School, The Renewal Project
Drawing Title
GA - BLOCK 02 - TEACHING AND LEARNING L4 FLOOR PLAN
AK
AH/PV
PT/MB
A1
210112
03/15/22
1 : 100
TKD AR 2125
K
TKDArchitects
Tanner Kibble Denton

Appendix D. Sprinkler System Reliability and Effectiveness

D.1 Reliability and Effectiveness

Automatic sprinklers are highly effective elements of total system designs for fire protection in buildings. They save lives and property, producing large reductions in the number of deaths per thousand fires, in average direct property damage per fire, and especially in the likelihood of a fire with large loss of life or large property loss. When sprinklers are present in the fire area, they operate in 93% of all reported structure fires large enough to activate sprinklers, excluding buildings under construction. When they operate, they are effective 97% of the time, resulting in a combined performance of operating effectively in 91% of reported fires where sprinklers were present in the fire area and fire was large enough to activate sprinklers. In homes (including apartments), wet-pipe sprinklers operated effectively 96% of the time (Hall, 2010).

Whether with a performance design or with a prescriptive code, the reliability of fire protection systems and features must be considered. Reliability includes both operational reliability and performance reliability. The operational reliability is a measure of the probability that a system or component will operate as intended when needed. The performance reliability is a measure of the adequacy of the system once it has operated (Koffell, 2005). For a sprinkler system, operational reliability accounts for the “readiness” of the system components, while performance reliability addresses the “capability” of the system to perform satisfactorily under specific fire exposures.

Table D.1: Historical data on operational reliability (Koffell, 2005)

Reference	Reliability of Success	Comments
Marryat[1]	99.5	Inspection, testing, and maintenance exceeded normal expectations and higher pressures
Maybee[2]	99.4	Inspection, testing, and maintenance exceeded normal expectations.
Powers[3]	98.8	Office buildings only in NewYork City
Powers[4]	98.4	Other than office buildings in New York City
Finucane et al[5]	96.9 – 97.9	
Milne[6]	96.6/97.6/89.2	
NFPA[7]	88.2 – 98.2	Data provided for individual occupancies – total for all occupancies was 96.2%.
Linder[8]	96	
Richardson[9]	96	
Miller[10]	95.8	
Powers[11]	95.8	Low rise buildings in New York City
US Navy[12]	95.7	1964 – 1977
Smith[13]	95	UK data
Miller[14]	94.8	
Budnick[15]	92.2/94.6/97.1	Values are lower in commercial uses (excludes institutional and residential)
Kook[16]	87.6	Limited data base
Ramachandran[17]	87	Increases to 94 percent if estimate number of fires not reported is included and based upon 33% of fires not reported to fire brigade
Factory Mutual[18]	86.1	1970 – 1977
Miller[19]	86	Commercial uses (excludes institutional and residential)
Oregon State Fire Marshal[20]	85.8	1970 – 1978
Taylor[21]	81.3	Limited data base

Marryat, H. W., Fire: A Century of Automatic Sprinkler Protection in Australia and New Zealand 1886 – 1986, Australia Fire Protection Association, Melbourne, Australia.

Maybee, W. W. "Summary of Fire Protection Programs in the U.S. Department of Energy—Calendar Year 1987," U.S. Department of Energy, Frederick, MD, August 1988.

Powers, R. W. "Sprinkler Experience in High-Rise Buildings (1969-1979)," *SFPE Technology Report 79-1*, Society of Fire Protection Engineers, Boston, MA, 1979.

Powers, R. W., ibid

Finucane, M, and Pickney, D. "Reliability of Fire Protection and Detection Systems," United Kingdom Atomic Energy Authority, University of Edinburgh, Scotland.

Milne, W. D., "Automatic Sprinkler Protection Record, "*Factors in Special Fire Risk Analysis*, Chapter 9 pp. 73-89.

NFPA. "Automatic Sprinkler Performance Tables, 1970 Edition," *Fire Journal*, July 1970, pp. 35-39.

Linder, K. W. "Field Probability of Fire Detection Systems," Balanced Design Concepts Workshop, NISTIR 5264, R.W. Bukowski (ed.), Building and Fire Research Laboratory, National Institute of Standards and Technology, September 1993.

Richardson, J. K. "The Reliability of Automatic Sprinkler Systems," *Canadian Building Digest*, Vol. 238, July 1985.

Miller, M. J. "Reliability of Fire Protection Systems," *Loss Prevention ACEP Technical Manual 8*, 1974.

Power, R. W., ibid.

Kelly, Kevin J. "Trade Ups", *Sprinkler Quarterly*, Summer 2003

Smith, Frank. "How Successful are Sprinklers," *SFPE Bulletin*, Vol. 83-2, April 1983, pp 23-25.

Miller, M. J., ibid.

Budnick, Edward J., ibid.

Kook, K. W. "Exterior Fire Propagation in a High-Rise Building," Master's Thesis, Worcester Polytechnic Institute, Worcester, MA, November 1990.

Ramachandran, Ganapathy. "The Economics of Fire Protection," New York: E & FN Spon, 1998.

Kelly, Kevin J., ibid.

Miller, M. J., ibid.

Kelly, Kevin J., ibid.

Taylor, K. T. "Office Building Fires...A Case for Automatic Fire Protection," *Fire Journal*, 84(1),January/February 1990, pp. 52-54.

Most automatic sprinkler systems are designed to control a fire but not necessarily to completely extinguish the fire. The NFPA fire data supports the concept that sprinkler systems can control fires but do not necessarily result in complete extinguishment. Table 2 indicates the percentage of fires where sprinklers are present and that are reported as being extinguished by a sprinkler system.

Table D.2: Sprinkler reliability and efficacy – US data (Hall, 2010)

Property	Percent where sprinklers operated (A)	Percent effective of those operated (B)	Percent where equipment operated effectively (AxB)
Residential homes and apartments	96%	100%	96%
Office / commercial	96%	99%	96%
Educational	75%	100%	75%
Heath care including Nursing home, hospital, clinic, doctor's office, or development disability facility	90%	99%	89%
Large Retail / Department Store	95%	99%	94%
Warehouse and cold storage	85%	97%	93%
Hotel / Motel	88%	99%	87%
All public assembly	97%	97%	94%

For all occupancy classifications, when they operate, the effectiveness of the sprinkler systems is significantly high (97% to 100%). Operational probabilities vary in US data but for majority of classifications remain above 90%. The efficacy values show a similar trend.

D.1.1 Sprinkler Performance in Other Occupancy Classifications

Carparks

All carparks accommodating more than 40 vehicles are required to be provided with sprinkler systems in Australia. Studies show that sprinklers are significantly effective in carparks

Based on UK fire data the sprinkler effectiveness in carparks assumed to be as high as 99%. Between 1994 and 2005 there were 3095 report fires in car parks in the UK. Of these, only 162 fires occurred where a fixed fire suppression system was present. Automatic fire sprinklers extinguished or contained 100 of these fires. In only 1% of cases, fire sprinklers operated but did not extinguish or contain the fire. It is assumed that the remainder were too small to actuate the sprinklers and either simply burned out or was extinguished quickly by persons using fire extinguishers etc. (UK Fire Statistics, 2010).

The most modern car designs, with increased flammability, are adequately protected by the latest sprinkler system designs because rapid rises in temperature cause earlier operation of the system which prevents faster fire spread, thus causing much less smoke and heat. Although sensitive to rapid heat increases caused by fire, inadvertent operation of a sprinkler system is virtually unknown due to “built in” integrity (Eurofeu Technical Report, 2009).

D.1.2 Failures that may be Attributed to the Sprinkler Systems

Several of the causes of failure are attributable to the human factor. This leads to a discussion about which causes of failure that really should be attributed to the sprinkler system. Component failure, although it can be deduced to man, is assessed to be a failure that should be attributed to the sprinkler system. Besides that can just about any cause of failure be attributed to human handling of the sprinkler systems, and therefore it is primarily this that needs to be taken care of in order to increase the reliability.

D.2 Impact of Sprinkler Systems on Fire Temperatures and Heat Release Rates

With the presence of sprinklers, the likelihood of a fire growing to the extent where it will spread beyond the object of fire origin is considered unlikely. Sprinkler protection is expected to provide a reliable and effective means of maintaining tenable conditions for occupants and fire-fighters, structural adequacy, and limiting fire spread within the subject building as well as to adjacent building(s). Effective sprinkler activation and operation is also likely to reduce the generation of smoke and maintain low compartment temperatures thus mitigating smoke spread between adjacent compartments.

Experimental evidence and numerical studies have demonstrated that sprinklers are very effective in controlling and suppressing fires. Sprinkler systems are designed to contain a fire. However UK data shows that in 40% of the fires the fire is extinguished (UK Incident Statistics from London, 2008). Swedish data estimates 60% extinguishment (Swedish Incident Statistics, 2008).

Automatic sprinklers are capable of suppressing or controlling fires such that the temperature rise of fire product gases and radiant heat is significantly reduced. It is assumed that the hot layer gases remain at the same temperature, as they were when the sprinklers activate which is approximately 75-100°C. It is evident that the effect of sprinklers on a fire is to wet down potential fuel sources, control or suppress the burning process and to cool the resultant smoke layer. It has been cited that the resultant smoke temperatures in a sprinkler controlled fire are reduced to 100°C -120°C (CIBSE 1997; Sekizawa, 1996, Milke, 2001, Madrzykowski, 2008) within 60 seconds of sprinkler activation. (Refer to Figures Figure D.1 to Figure D.4).

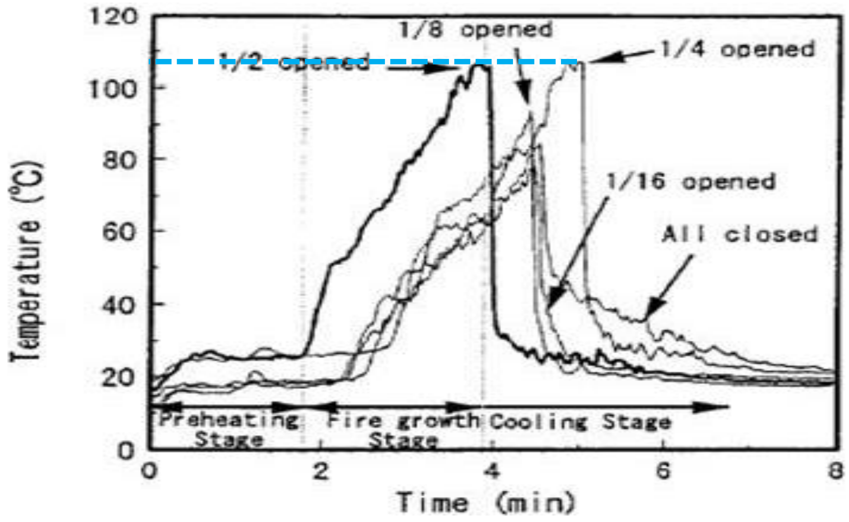


Figure D.1: Sprinkler controlled room temperatures (Sekizawa, 1996)

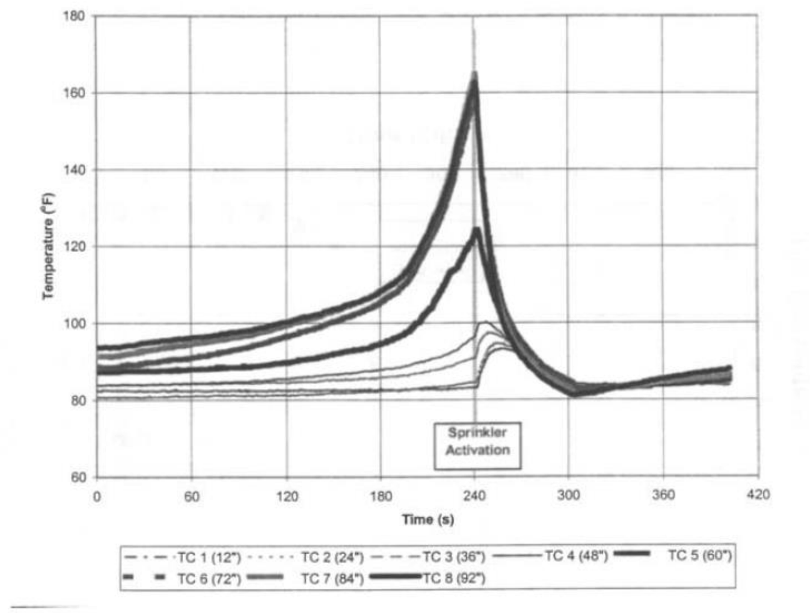


Figure D.2: Sprinkler controlled room temperatures (Milke, 2001)

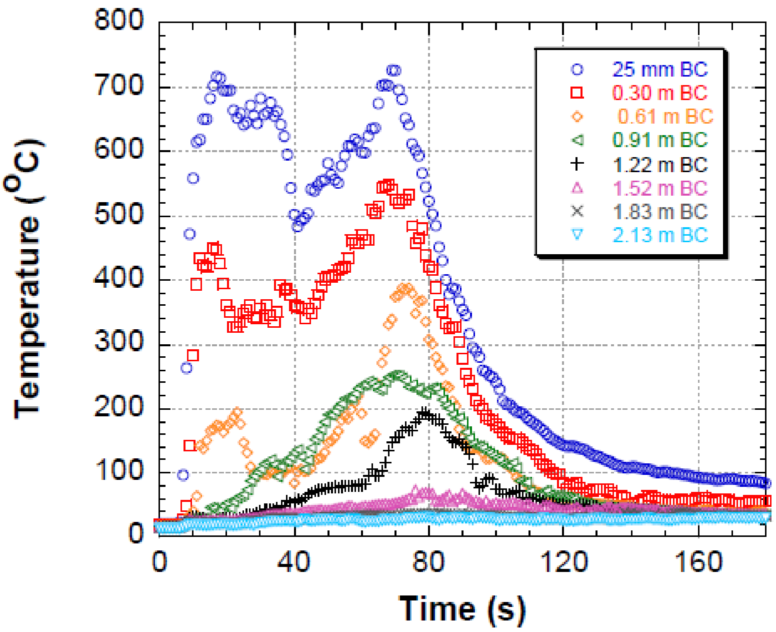


Figure D.3: Sprinkler controlled room temperatures (Madrzykowski, 2008)

With the presence of the sprinkler systems the risk of distress to building elements, barriers and the like is minimal. When a sprinkler system is activated in a room fire the heat release rate of the burning fuel is reduced or controlled to a relatively small level. Similarly the smoke and hot gas temperatures inside the room of fire origin are reduced or maintained due to the cooling effect of water spray.

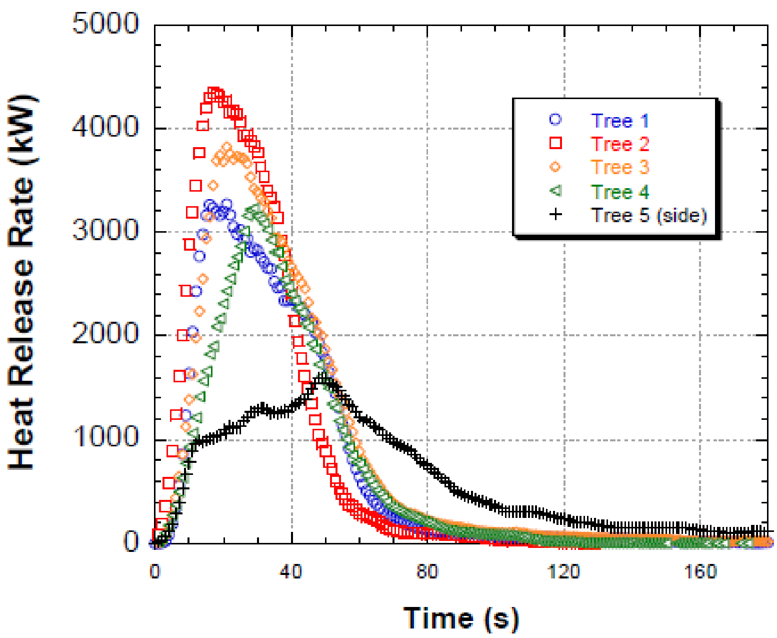


Figure D.4: Reduction in heat release rates with sprinkler activation (Madrzykowski, 2008)

D.3 Conclusion

Global data demonstrates that sprinkler systems are highly reliable especially in buildings where regular inspections and maintenance is conducted. The operational probability can be as high as 0.97, the effectiveness 100% and the efficacy 96% based on the classification of a building.

Once sprinklers activate the temperatures are expected to be reduced to less than 150°C within 60 seconds of the activation. The Heat Release Rate profiles also follow a similar trend.

Appendix E. Radiant Heat Transfer Methodology

E.1 Radiant Heat Flux Equation

The radiant heat flux, Q (W/m^2) from a single opening of a burning building (see Figure E.1) to a point some distance away is determined by the black body emission equation as shown in the following equation. (ABCB, FSEG, 2001).

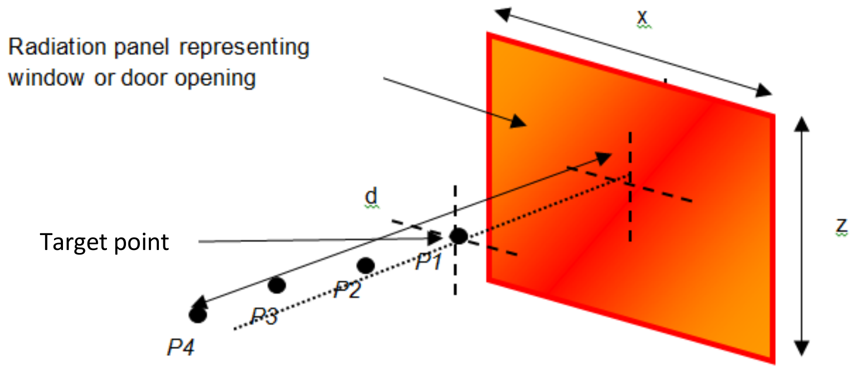


Figure E.1: Radiant heat transfer for calculating incident heat flux

$$Q = \varepsilon \sigma F T^4$$

where,

ε = emissivity = 0.9

σ = Stephan-Boltzmann constant = 5.67x10^{-8} W/m^{2}K^4

T = temperature of emitting surface = 1173 K (900°C) - angle of 90° and 0° for non-sprinkler protected building and/or sprinkler failure scenario

F = configuration (view) factor

Each variable in the equation is explained in the following sections.

E.1.1 Estimation of Emissivity (ε)

Based on Drysdale (1999), the emissivity levels for different materials are tabulated in Table E.1. It is noted that for reflective surfaces such as polished steel, the emissivity levels are low due to radiant heat being reflected away. For the purpose of the assessment, it is proposed to adopt the worst-case scenario whereby the emissivity of sheet steel with rough oxide layer is **0.9** (i.e. absorbing 90% of the radiant heat).

Table E.1: Emissivity levels based on Drysdale (1999)

Surface	Emissivity
Steel (polished)	0.066
Mild Steel	0.2-0.3
Sheet steel with rough oxide layer	0.8-0.9
Fire brick	0.75
Concrete tiles	0.63

E.1.2 The Stefan–Boltzmann Constant (σ)

The Stefan–Boltzmann constant is the constant of proportionality in the Stefan–Boltzmann law: "the total intensity (physics) radiated over all wavelengths increases as the temperature increases". The Stefan-Boltzmann constant can be used to measure the amount of heat that is emitted by a blackbody, which absorbs all of the radiant energy that hits it, and will emit all the radiant energy. The value of the Stefan–Boltzmann constant is given in SI units by:

σ = 5.67x10^{-8} W/m^{2}K^4

E.1.3 Estimation of Flame Temperatures (T)

Alam and Beever (1996) states that an average surface temperature of 800°C is considered to exist as a result of flames from a fire emerging from open windows and/or doors.

However, as the windows are perpendicular to the building the glass must be broken and hence the flames must be external from the subject buildings. Therefore, the temperature of the radiating notional panel is significantly reduced as a result of the hot turbulent gases of the fire mixing with the cooler external air. As the flame projects from the window, 70% of the heat is convective and 30% is radiant (Klote and Milke 2003). The convection involves the rapid rise and turbulence of hot gases as they come into contact and mix with cool air. The turbulence cools the flame from some 900°C to 600°C as advised by Buchanan (2001). Similarly, studies and fire tests undertaken by Welch et al (2007) have demonstrated that external flame temperatures vary between 800°C to 400°C due to the direction and intensity of air movement passing though the external wall of the building.

A section through a flame showing that most of the flame has temperatures in the vicinity of 600°C is given in Figure E.2 and Figure E.3. As a conservative approach a temperature of **900°C** has been adopted for the calculations for openings located within close proximity to the title boundary.

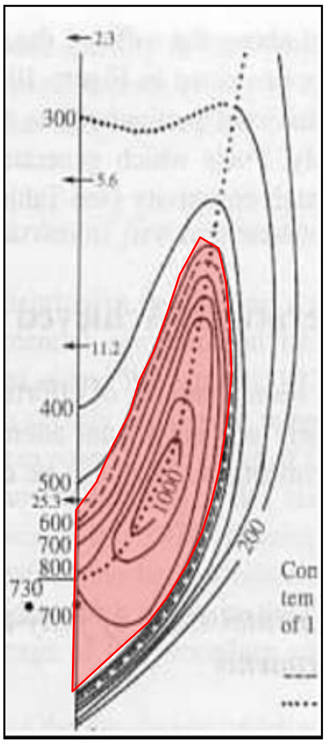


Figure E.2: Isotherms in flame projecting from a window (Drysdale, 1999)

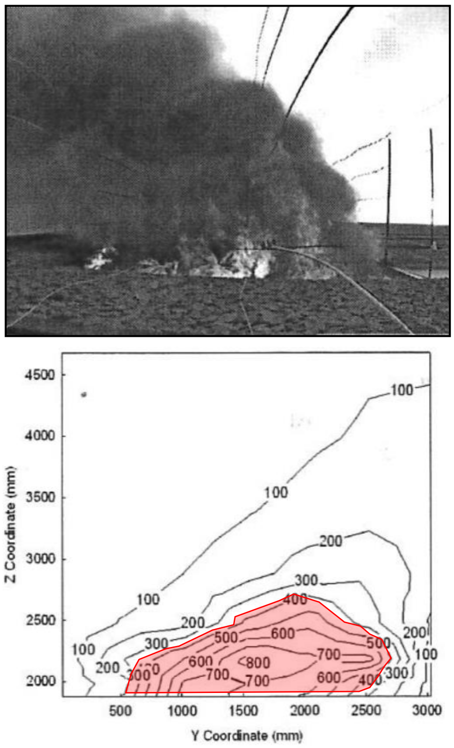


Figure E.3: External temperature contours (Welch et al., 2007)

E.1.4 Configuration / View Factor (F or Φ)

In radiative heat transfer, a view factor, F is the proportion of the radiation which leaves surface A that strikes surface B. View factors are also sometimes known as configuration factors, form factors or shape factors. To determine the intensity of radiation received by a surface remote from an emitter, a configuration factor is needed to take into account the geometrical relationship between the emitting surface and the receiver.

An approximate value of the configuration factor for radiation at a distance R from a rectangular radiator is given by the following equation:

$\Phi = A_v / \pi R^2$

Where $A_v = W_r H_r$ is the area of the radiating surface and R is the radiation distance between the emitting and receiving surfaces (m). The exact value of configuration factor is given by:

$$\Phi = \frac{1}{90}\left(\frac{x}{\sqrt{1+x^2}}\tan^{-1}\left(\frac{y}{\sqrt{1+x^2}}\right) + \frac{y}{\sqrt{1+y^2}}\tan^{-1}\left(\frac{x}{\sqrt{1+y^2}}\right)\right)$$

where $x = H_r/2R$

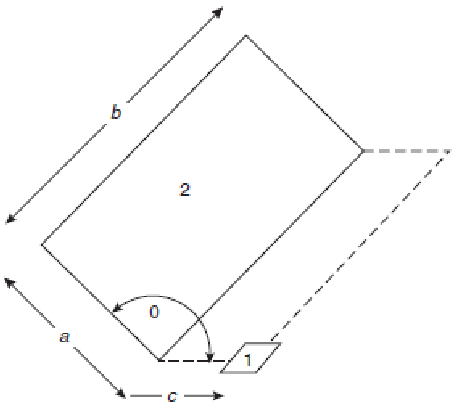
$y = W_r/2R$

H_r is the height of enclosing rectangle (m)

W_r is the width of enclosing rectangle (m)

$\tan^{-1}$ is the inverse tangent (in degrees).

For surfaces at an angle the following equation is adopted (Note $F_{12} = \Phi$):



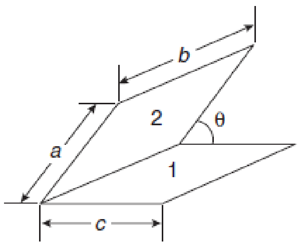
$$F_{12} = \frac{1}{2\pi}\left\{\tan^{-1}\left(\frac{1}{L}\right) + V(N\cos\phi - \phi L)\tan^{-1}V + \frac{\cos\phi}{W}\left[\tan^{-1}\left(\frac{N - L\cos\phi}{W}\right) + \tan^{-1}\left(\frac{L\cos\phi}{W}\right)\right]\right\}$$

$$V = \frac{1}{\sqrt{N^2 + L^2 - 2NL\cos\phi}}$$

$$W = \sqrt{1 + L^2\sin^2\phi}$$

$$N = \frac{a}{b}$$

$$L = \frac{c}{b}$$



$N = a/b$
$L = c/b$

Figure E.4: Equation for determining surface at an angle

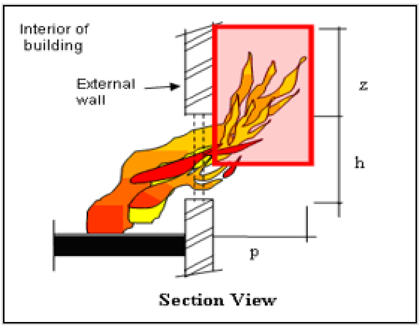
E.1.5 Determination of Flame Projection

Flame projection calculations have been undertaken based on the opening size of **8.0m (w) x 2.8m (h)**. The following spreadsheet calculation demonstrates the flame projection size with respect to the projected flame width & height.

Flame Projection From Window

(Ref. NZ Fire Engineering Design Guide - Based on Wood Equivalent)

Opening Dimensions Input		
Width (w) =	8.00	m
Height (h) =	2.80	m



Formula Calculations

Horizontal Flame Projection (P) = $0.314h^{1.53}w^{-0.53}$ = 0.50 m

Height above the Soffit (z) = $12.8(\dot{m}/w)^{2/3}$ -h = 4.49 m

where

Average burning rate ($\dot{m}$) = $5.5\,A_v\sqrt{h}$ = 3.44 kg/s

and

Area of opening (A_v) = h x w = 22.40 m^2

Determined Flame Projection Size		
Flame Projection Width =	0.50	m
Flame Projection Height =	5.89	m

Figure E.5: Flame projection based on opening (8.0m (w) x 2.8m (h))

From the calculations undertaken above, the flame projection width associated with the adopted notional panel is 0.50m. In instances where openings are configured to be situated more than 0.50m from the adjacent title boundary and hence direct flame impingement is not expected to occur. Therefore, the acceptance criterion of **20kW/m²** (i.e. non-piloted ignition) has been adopted for the analysis.

E.1.6 Radiant Heat Flux Calculation Results

Radiant Heat Transfer for Parallel Openings

Input Parameters				
w (b)	-	*Width of Opening*	use table >	
h (a)	-	*Height of Opening*	use table >	
d (c)	-	*Distance to receiving surface*	use table >	
T_B	-	*Temperature of radiator (Opening)*	900	°C
T_S	-	*Temperature of receiving surface*	20	°C
T_B	-	*Calculated Radiator Temperature (K)*	1173	K
T_S	-	*Calculated Receiving Temperature (K)*	293	K
σ	-	*Stefan Boltzman Constant*	5.67E-11	kW/m^2K
ε_r	-	*Emissivity of the Surface*	0.9	
		Input parameters		
		Calculated values/Constants		

Opening ID	w	h	c	Maximum Radiation Received
	(m)	(m)	(m)	(KW/m^2)
L0 T&L library glazed window	8.00	2.80	5.80	15.31

Formula Calculations
$q_r = k_1 \times F_{d1\text{-}2} \times \varepsilon_r \times \sigma \times (T_B^4 - T_S^4)$

Illustration

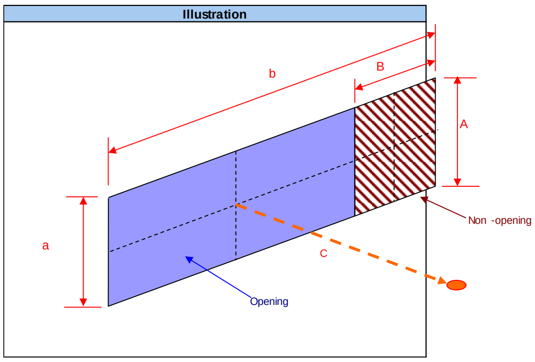


Figure E.6: Quantitative heat transfer calculation between T&L and Founders/PA block

Appendix F. Fire Brigade Intervention Model

F.1 Responding Stations

For the purpose of determining a time at which the local fire brigade would attend a potential fire located at the subject building, a Fire Brigade Intervention Model (AFAC, 2020) has been undertaken. The Fire Brigade Intervention Model (FBIM) is an event-based methodology which quantifies Fire Brigade activities from the point from Fire Brigade notification through to search, rescue, fire control and extinguishment and overhaul activities.

The Fire Brigade arrival time and commencement of intervention activities has been estimated and assessed whereby Fire Brigade intervention is listed as sub-requirements of the relevant Performance Requirements of the BCA.

The nominated responding fire stations to the subject site via road travel have been illustrated in Figure F.1. The subject site is within the FRNSW response area with the nominated fire stations as follows:

Table F.1: Responding Stations and Brigades

Fire Station	Address	Distance
Ashfield Fire Station	16 Victoria St, Ashfield NSW 2131	1.1km
Marrickville Fire Station	309 Marrickville Rd, Marrickville NSW 2204	3.4km

Figure F.1: Responding Fire Stations (Ashfield & Marrickville) to Trinity Grammar School

F.2 Assumptions and Parameters

In this instance, a FBIM was undertaken from notification to commencement of water application at the designated fire scenario. The following assumptions and parameters were also adopted to determine Fire Brigade Intervention:

- Based on information provided by FRNSW, the nominated fire stations are manned as follows:
  - Ashfield Fire Station: Permanent firefighter staff.
  - Marrickville Fire Station: Permanent firefighter staff.
- The FBIM timeline has been adjusted to accommodate the staffing circumstances of the nominated fire stations
  - As the fire stations are fully manned, the FBIM timeline has adopted an additional 90 seconds to account for “time to dress, assimilate information and depart”;

- Google Maps TM has been used to identify the appropriate travel time from the nominated stations to the subject site.
- Firefighters including the Officer in Charge (OIC) would require time to don BA gear and gather necessary information.
- The attending crew would be expected to receive information about the location of the fire via the main Fire Indicator Panel (FIP) if it was visible upon arrival.
- Occupants are expected to be evacuated and/or in the process of evacuation from the building so forced entry is not expected to be required.
- Fire crews shall be equipped with BA and equipment suitable to allow entry to fire affected area.
- Firefighter tenability is to be maintained and fire crews are unlikely to be exposed to extra ordinary hazards.
- Firefighters travel to the subject site and set up in the most practical area for the fire brigade appliances.
- Multiple fire appliances are expected to attend a fire event at the subject site and communications between attending crews are expected to facilitate the coordination and positioning of fire crews and appliances.
  - One appliance is expected to be located on Victoria Street to connect to the hydrant booster, another appliance is expected to be positioned along Prospect Road to allow easier access to the subject building.
- The time to reposition fire appliances shall be based on a speed of 8km/hr for travel on internal roads within the subject site and the designated speed limit on any public road (i.e 40km/hr in this instance).

F.2.1 Time for Detection & Brigade Notification

The subject building contains an automatic fire sprinkler system in accordance with AS2118.1:2017, and an automatic smoke detection system in accordance with AS1670.1:2018. In this instance, detection time has been based on the sprinkler activation time:

- The sprinkler activation times were determined using Alpert's Correlation (refer to Figure A.2.1). The spreadsheet model has computed the thermal response of a sprinkler head located on the ceiling. The formulas utilised to calculate the sprinkler response time are with reference to R.L. Alpert Fire Technology 1972 pp181-195.
- Certain input parameters were incorporated for the estimated activation time as detailed in Table F.2

Table F.2: Detector Activation Parameters

Parameter	Input
Fire location:	GLA TL.L3.27
Distance between fire and detector/sprinkler:	3.25m (based on a 4.6m x 4.6m grid spacing)
Sprinkler height:	2.75m (ceiling height)
Sprinkler activation temperature:	68°C
Sprinkler Response Time Index (RTI)	$50m^{0.5}s^{0.5}$ (sprinklers)
Fire growth rate:	Fast t^2 fire

Alpert's correlation has been conducted to calculate the sprinkler activation time. The result detailed below calculates a detection time of **138 seconds**. An additional 180 seconds will be required for depressurisation of the sprinkler system.

Required Inputs		
Ambient Temperature, T =	20	(°C)
Fire Growth Rate =	Fast	
Time Step Interval =	20	(s)
Radial Distance of the Detector from the Fire, r =	3.25	(m)
The Height of the Ceiling above the fire, H =	2.75	(m)
The Response Time Index of the Detector, RTI =	50	($m^{1/2}s^{1/2}$)
Sprinkler Density of Discharge =	5	mm / min
Sprinkler Activation Temperature =	68	(°C)
Calculated Quantites at Detector Activation		
The Gas Temperature at Sprinkler Activation, T =	99.01	(°C)
HRR at Sprinkler Activation =	834.18	(kW)
The Gas Velocity, U =	1.14	(m/s)
Time at Sprinkler Activation =	138	(s)
Time to Reach 10% of peak HRR =	824	(s)
Ratio, r / H =	1.18	

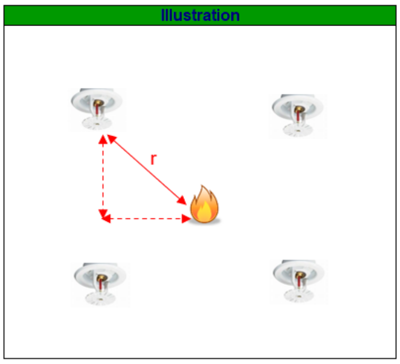


Figure F.2: Alpert's correlation results

In line with Clause 8(d) of Specification E2.2a of the BCA, the building shall be monitored by a fire station or fire station dispatch centre in line with AS1670.3:2018. As such fire brigade are called out upon activation of the detection system with the nearest fire stations sent to respond.

F.2.2 Time to Reach Fire Scene

The responding fire stations to the subject site are Ashfield & Marrickville Fire Stations. The anticipated primary response is detailed in Table F.3.

Table F.3: Responding Stations and Brigades

Fire Station	Address	Distance
Ashfield Fire Station	16 Victoria St, Ashfield NSW 2131	1.1km
Marrickville Fire Station	309 Marrickville Rd, Marrickville NSW 2204	3.4km

The time taken for fire crews to reach the scene has been based upon a number of digital mapping scenarios utilising Google Maps TM. In order to achieve the most appropriate approach and in line with the AFAC FBIM Model Manual (Version 3.0, dated 14/04/2020) the analysis has adopted the following:

- Times have been collected from both the closest and second closest fire stations. The time adopted has been based on the second closest station to allow the possibility that the appliance(s) closest may already be in use.
- Sample times have been considered for different days of the week and at different times.
- The travel time adopted is representative of the median taken from the slowest time sample.

Table F.4 & Table F.5 provide a summary of the digital mapping scenario outcomes from the responding fire stations to the subject building.

Table F.4: Closest appliance travel times using digital mapping (Ashfield Fire station)

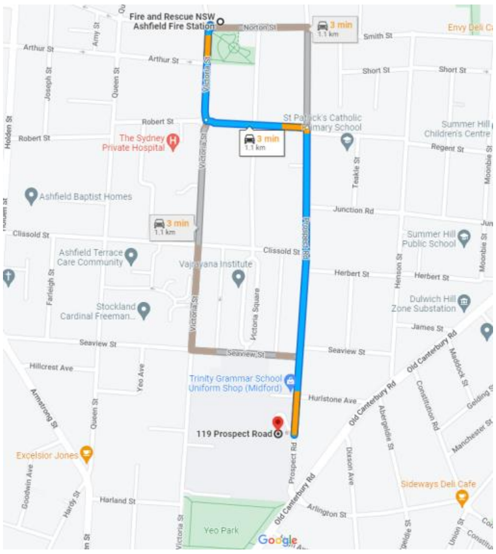
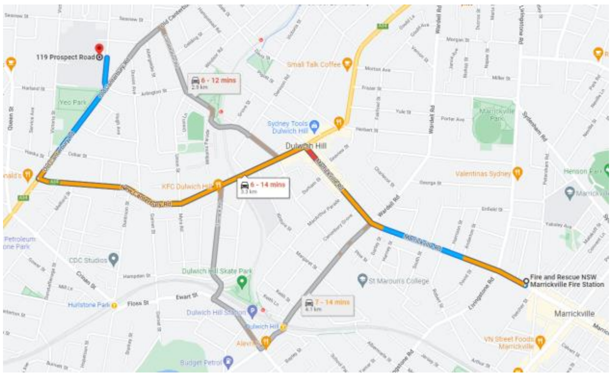
Responding Fire Station	Mapping Snapshot	Distance	Day of the Week	Time of Day	Time Range
Ashfield Fire Station		1.1km	Tuesday	08:30	~3 min
				12:00	~3 min
				17:00	~3 min
				23:00	~3 min
			Friday	08:30	~3 min
				12:00	~3 min
				17:00	~3 min
				23:00	~3 min
			Saturday	08:30	~3 min
				12:00	~3 min
				17:00	~3 min
				23:00	~3 min

Table F.5: Second closest appliance travel times using digital mapping (Marrickville Fire station)

Responding Fire Station	Mapping Snapshot	Distance	Day of the Week	Time of Day	Time Range
Marrickville Fire Station		3.3km	Tuesday	08:30	6-12 min
				12:00	6-12 min
				17:00	6-14 min
				23:00	5-8 min
			Friday	08:30	6-12
				12:00	6-12 min
				17:00	6-14 min
				23:00	5-9 min
			Saturday	08:30	5-9 min
				12:00	6-14 min
				17:00	6-12 min
				23:00	5-9 min

**Red indicates the longest estimated arrival time*

From the mapping scenarios collected the longest of the median arrival times are as follows:

- Ashfield Fire Station: 3 minutes or 180 seconds (closest)
- Marrickville Fire Station: 10 minutes or 600 seconds (second closest)

F.2.3 Firefighter Travel Speeds

F.2.3.1 Firefighter Horizontal Travel

Upon fire incident call-out, fire brigades will arrive kerbside along Victoria Street. The attending fire crews will be required to travel (on foot) to the Fire Indicator Panel which shall be located near the entrance to the oval 3 carpark. The following steps portray the assumed indicative path of travel nominated for the FBIM scenario for fire-fighting operational procedures with a fire origin occurring within the development:

- Firefighters arrive onsite whereby the Office in Charge (OIC) proceed to the Sub-FIP to confirm the fire location.
  - The OIC will then assess the situation by investigating the area to determine appropriate actions and allocation of resources.
- If accessible and required, fire brigades will move the appliance to be positioned closer to the setup area;
  - All appliance travel speeds will be taken as 8km/hr (AFAC FBIM Model Manual, 2020) or the designated speed limit on public road around the subject site; and
- Fire crews will don BA equipment, gather necessary tools and proceed to the nearest available fire hydrant outlet from where they connect and charge their hydrant hose lines; and
- Firefighters proceed to the area of fire origin with a charged hose line ready to perform fire extinguishment operations.

Table F.6: Firefighter horizontal travel speed (Table Q, AFAC 2020)

Graph	Travel Conditions	Speed (m/s)	
		μ	σ
Q1	Dressed in turnout uniform	2.3	1.4
Q2	Dressed in turnout uniform with equipment	1.9	1.3
Q3	Dressed in turnout uniform in BA with or without equipment	1.4	0.6
Q4	Dressed in full hazardous incident suit in BA	0.8	0.5

Horizontal foot travel time is based upon the data provided in the AFAC dataset (Version 2020.05, dated May 2020). In this instance fire crews are considered to be dressed in turnout uniform with BA & equipment.

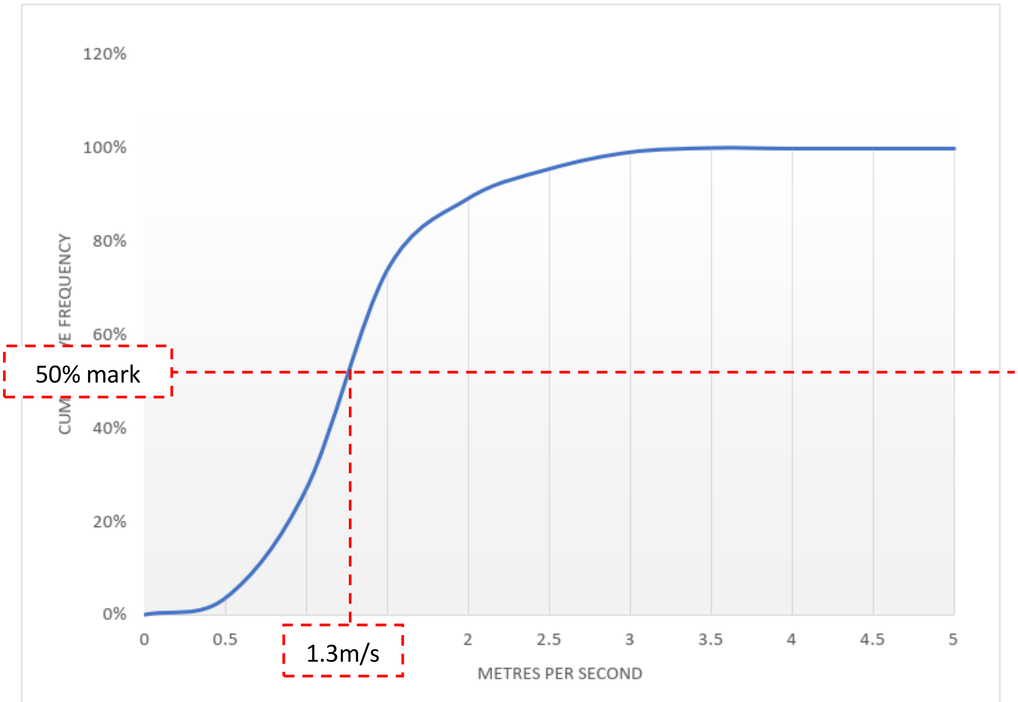


Figure F.3: Cumulative Frequency for Horizontal travel in turnout uniform in BA (AFAC dataset, Version 2020.05)

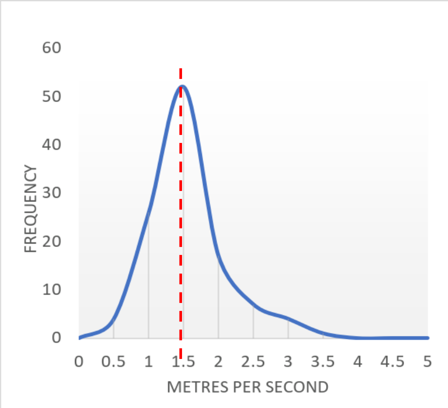


Figure F.4: Distribution for Horizontal travel speeds in turnout uniform in BA (AFAC dataset, Version 2020.05)

The approximate median speed was found from the cumulative frequency percentage shown in Figure F.3 which was approximately 1.3m/s. The speed distribution shown in Figure F.4 indicates the most frequent speed (mode) is approximately 1.5m/s. As the data relates to speed, the distributions are all skewed to an extent since they necessarily start from zero. The mean, median and mode are approximately equal (between values of 1.3-1.5m/s) which is a feature of normal distributions.

On the other hand, in the research study presented in the paper "Speed Distribution Curves for Pedestrians during Walking and Crossing" (Chandra et. al, 2013), pedestrian walking speed was normalised based on data collected throughout 2008 to 2009 (refer to Figure F.5). The research was conducted in seven (7) sites which were selected for the study, four for walking and three for crossing conditions. The paper concluded that "Pedestrian walking speeds follow the normal distribution for all types of facilities and at all site locations."

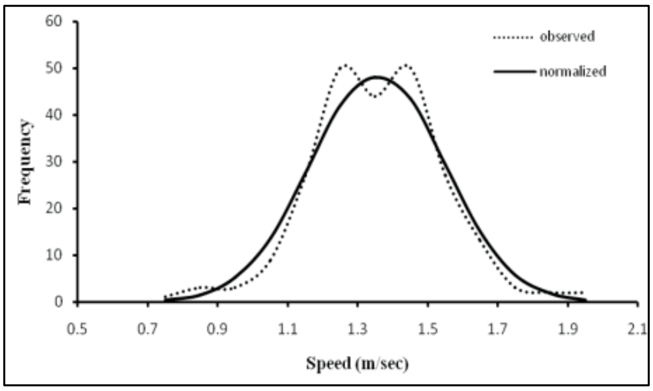


Figure F.5: Normalised distribution of pedestrian walking speed (Chandra et. al, 2013)

Given the features and findings discussed above, a normal distribution can also be considered to justify the walking speed of firefighters adopted in the FBIM.

Applying a 75th %-ile k-factor of 0.67 (Table 4.3 of FBIM V2.2 October 2004- Section 4), mean (µ) of 1.4m/s and a standard deviation (σ) of 0.6m/s (refer to Table F.6), the horizontal travel speed is calculated as follows to introduce a reasonable level of conservatism into the movement speed calculation:

$s = \mu - (k \times \sigma)$ (AFAC FBIM Model Manual, 2020)

$s = 1.4 - (0.67 \times 0.6)$

$s = 1.0$ m/s

It should be noted that the adopted travel speed is compatible with the recommendations of the AFAC FBIM Manual Version 2020.05.

F.2.3.2 Firefighter Stair Travel Speed

Firefighter vertical travel time is based upon the data provided in the AFAC dataset (Version 2020.05, dated May 2020). In this instance, upon identifying the fire location on the upper levels of the subject building, fire crews are considered to ascend the stairs in BA with equipment. Assuming a normal distribution, a 75th %-ile k-factor of 0.67 is applied to a mean (μ) of 0.9steps/s and a standard deviation (σ) of 0.4steps/s (refer to Table F.7). The vertical stair travel speed is calculated as follows:

$s = \mu - (k \times \sigma)$ (AFAC FBIM Model Manual, 2020)

$s = 0.9 - (0.67 \times 0.4)$

$s = 0.63$ steps/s

Table F.7: Firefighter Stair Travel

Graph	Travel Conditions	Speed (steps/second)	
		μ	σ
T1	Ascend stairs in BA with equipment	0.9	0.4
T2	Ascend stairs with high pressure hose	0.5	0.3
T3	Ascend stairs with 65mm diameter hose	0.7	0.3
T4	Ascend stairs with 38mm diameter hose	0.8	0.3
T5	Descend stairs in BA	1.0	0.5
T6	Rest breaks (valid after 6 stair flights)	1.9	0.8

For the purposes of the calculations undertaken, a stair travel speed of 0.63 steps/second, based on stair ascension in BA with equipment, has been adopted. For each flight of stairs there are approximately 18 steps and the attending crews are expected to take 18 / 0.63 = 29 seconds per flight of stairs.

F.2.4 Indicative Brigade Travel paths

The following figures depict an indicative travel path taken by attending fire crews upon arrival kerb side.

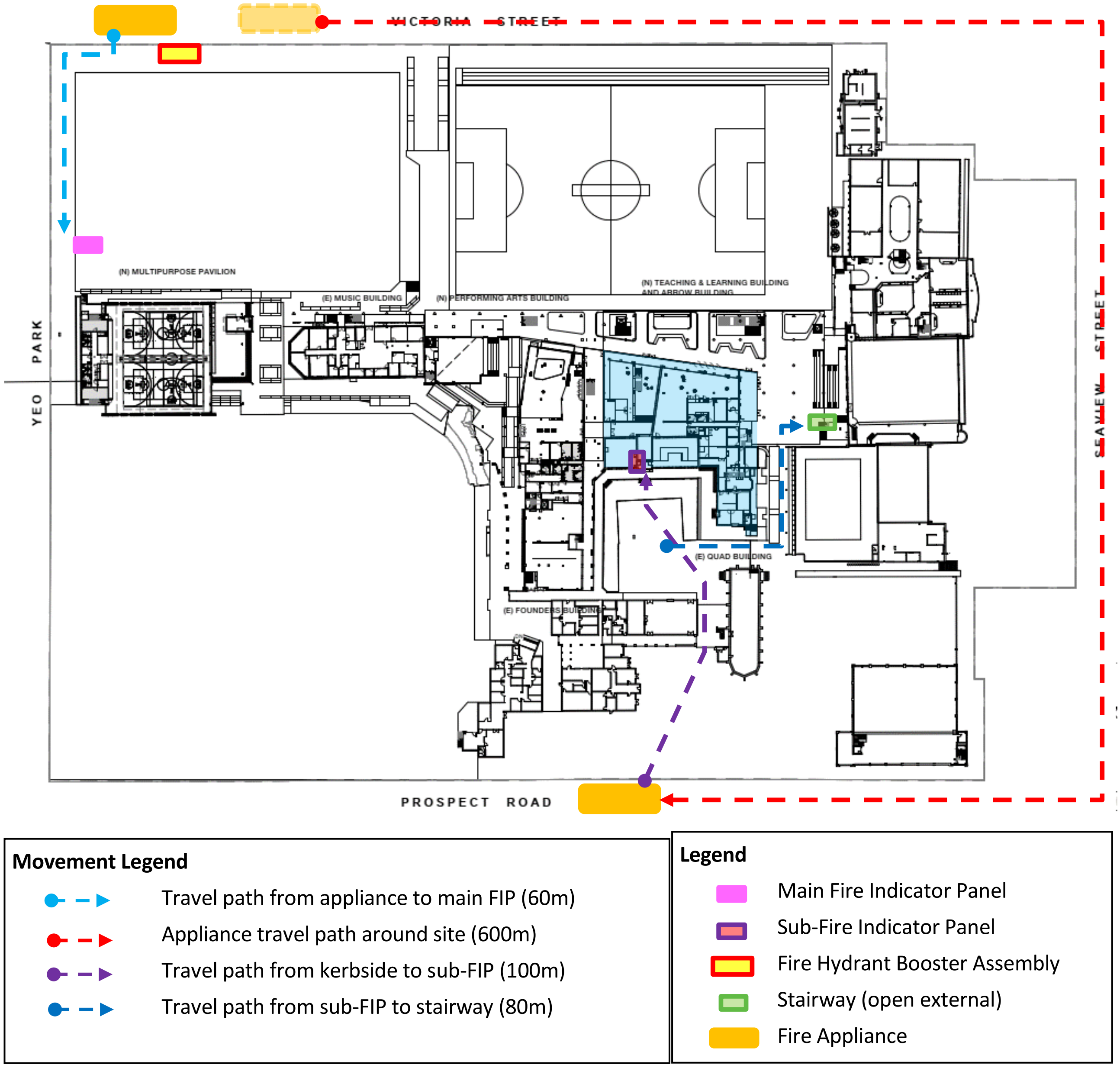


Figure F.6: Firefighter travel paths (Example Only)

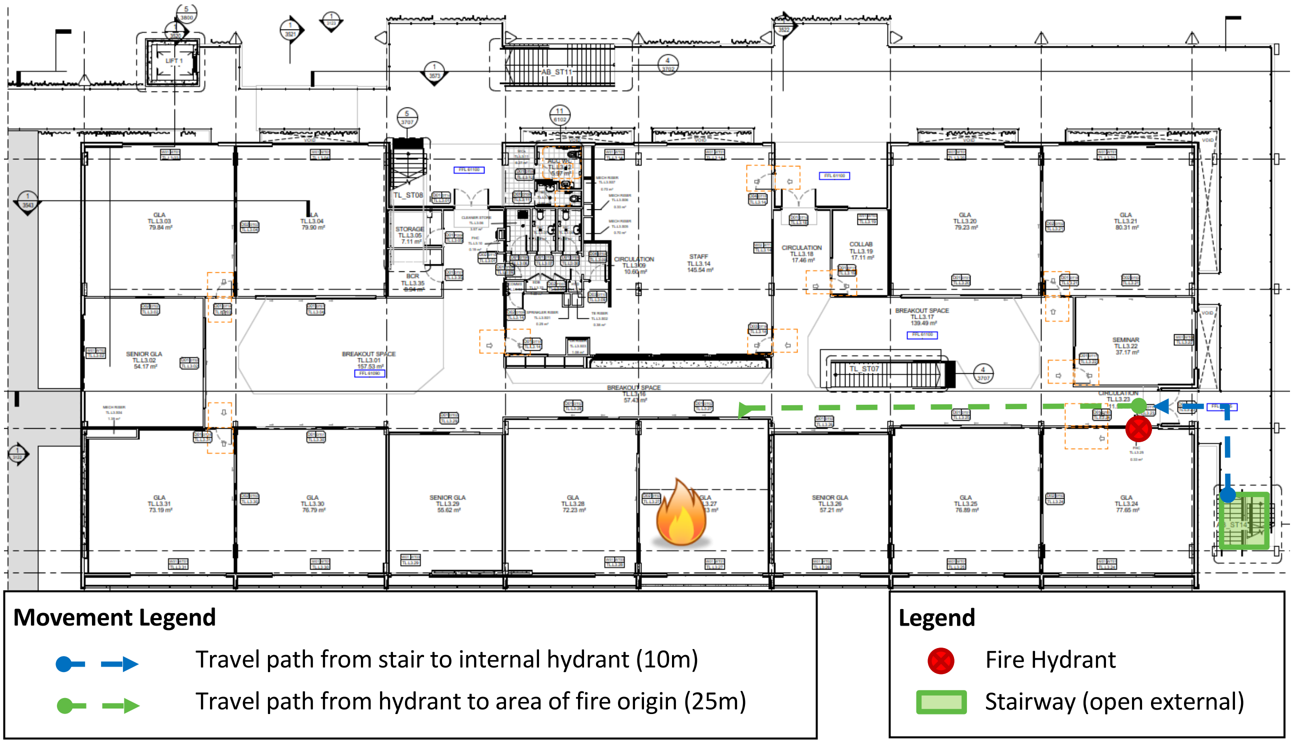


Figure F.7: Firefighter travel paths L3 (Indicative Only)

F.3 Fire Brigade Intervention Model (FBIM) Timeline

The activities performed by the attending fire crews, the time associated per activity and the cumulative time from fire initiation until the commencement of water application onto the fire is tabulated below. For analysis purposes, the timeline has assumed intervention activities being conducted in a linear manner

No specific distribution was assumed for the individual Fire Brigade Intervention activities, thus applying a k-factor of 2.0 which corresponds to the 75th %-ile is deemed appropriate.

Table F.8: Fire Brigade Intervention Model Timeline

Activity	Time Per Activity (seconds)	Cumulative Time (seconds)	FBIM Details
Time for fire detection	138	138	Time for sprinkler activation, Refer to Figure F.2.
Time to depressurise system and activate alarm	180	318	Table A, Chart 1
Time delay for alarms/fire verification	20	338	Table B, Chart 1
Time for firefighter response	90	428	Table E, Chart 3 Time to dress, assimilate information and depart
Time to reach fire scene (kerb side)	180	608	Travel time for closest fire appliance (Ashfield Fire Station), refer to Table F.4 for digital mapping analysis outcomes, Chart 4
	600	1028	Travel time for second closest fire appliance (Marrickville Fire Station), refer to Table F.5 for digital mapping analysis outcomes, Chart 4
Time to dismount fire appliance and don BA	158	1186	Table M, Chart 6 Dismount appliance and don BA. 75th %ile k=2, μ = 88.1 & σ = 34.9; s = 88.1+(2x34.9) = 158 seconds;
Time for firefighter travel to main FIP	60	1246	Table Q, Charts 5 & 9 Time for OIC to walk to main FIP.

			s = 60 m/1.0 ms^{-1} = 60 seconds;
Time for fire location confirmation at FIP	90	1336	Table L, Chart 5 Time for fire location confirmation at FIP, building floor area; >10,000m^2.
Time to remove & connect hose from appliance to booster connections	80	1416	Table V, Chart 11 Time to remove & connect hose from appliance to booster connections. 75^{th} %ile k=2, μ = 45.3 & σ = 17.1, s = 45.3+(2x17.1) = 80 seconds
Time to position additional appliances closer to subject building	54	1470	Time to move fire appliance (600m at 8km/hr), Table F, Chart 8
Time to remove necessary tools from appliance	69	1539	Table P, Chart 6 Hydrant Equipment. 75^{th} %ile k=2, μ = 32.5 & σ = 18.1; s = 32.5+(2x18.1) = 69 seconds;
Time for horizontal travel from appliance to Sub-FIP	100	1639	Table Q, Charts 5 & 9 Time to walk to Sub-FIP within subject building from appliance located on Prospect Road. s = 100 m/1.0 ms^{-1} = 100 seconds;
Time to assess fire	150	1789	Table Q, R, T Chart 7 Time for OIC to investigate extent of fire, walk around the perimeter of building s = 150 m/1.0 ms^{-1} = 150 seconds;
Time for horizontal travel from Sub-FIP to stairs	80	1869	Table Q, Charts 5 & 9 Time to walk to stairs. s = 100 m/1.0 ms^{-1} = 80 seconds;
Time for vertical travel via stairs	87	1956	Table T, Graph T4 Chart 9 Time for Stair travel in BA with equipment (3 flights of stairs at 29 seconds/flight);
Time to gain entry	10	1966	Table J, Chart 5 Time to gain entry, Side hung door
Time to conduct safety procedures	74	2040	Table O, Chart 6 Time to flush hydrant. 75^{th} %ile k=2, μ = 32.8 & σ = 20.6; s = 32.8+(2x20.6) = 74 seconds;
Time to connect and charge hoses to boosted hydrant	77	2117	Table V, Chart 10 Time to lay, connect and charge hose Connect 1 length of 38mm hose 75^{th} %ile k=2, μ = 40.9 & σ = 17.8 s = 40.9 + (2x17.8) = 77 seconds
Time for horizontal firefighter travel from set-up area to fire area	25	2142	Table Q, Charts 9 & 10 Time for fire crews to travel to fire zone, s=25/1.0ms^{-1} = 25 seconds
Total FBIM time from fire initiation to commence water control and/or extinguishment activities	-	1722	Travel time for closest fire appliance (Ainslie Fire Station)
	-	2142	Travel time for second closest fire appliance (Fyshwick Fire Station)

Referring to Table F.8 above the approximate times for the closest and second closest fire stations, Ashfield and Marrickville Fire Stations has been provided. The FBIM timeline indicates the following:

- From fire initiation the cumulative time taken for the closest and second closest fire appliances to reach the fire scene (kerb side) are as follows:
  - Closest (Ashfield Fire Station): **608 seconds** or approximately 10.1 minutes; and
  - Second Closest (Marrickville Fire Station): **1,028 seconds** or approximately 17.1 minutes;
- Having arrived at the fire scene (kerb side), the time taken for fire crews to gain entry, gather information, assess the situation and set-up water supplies ready for the commencement of water control/extinguishment activities is an additional **1,114 seconds** or approximately 18.6 minutes;
- From fire initiation to the commencement of water control/extinguishment activities the cumulative time take for the closest & second closest responding fire stations is as follows:
  - Closest (Ashfield Fire station): **1,722 seconds** or approximately 28.7 minutes; and
  - Second Closest (Marrickville Fire Station): **2,142 seconds** or approximately 35.7 minutes

In line with the AFAC FBIM Model Manuel (Version 3.0, dated 14/04/2020) the total time taken for fire brigade intervention is based upon the second closest fire station. In this regard, attending fire crews from Marrickville Fire Station are expected to conduct water control/extinguishment activities within **2,142 seconds** or approximately 35.7 minutes.

Appendix G. Movement Speed

The travel time during an evacuation process is governed by the movement speed of occupants or queuing at potential bottlenecks such as at a fire-isolated stair. As a conservative approach travel distance is considered to govern the movement speed which would not necessarily be the case where maximum occupant loading is present within an enclosure.

Travel time of an occupant to a place of safety is generally the most predictable and typically is the smallest time involved. Travel speeds recommended by the SFPE Handbook of Fire Protection Engineering (5th Edition, 2017) for a corridor or an aisle is 1.19 m/s. For persons with limited mobility, i.e. a person on crutches, travel speeds as high as 0.94m/s are recommended (Ramachandran & Charters, Quantitative Risk Assessment in Fire Safety, 2011). This correlates well with studies conducted by various researchers detailed in 'Egress Design Solutions' (Lord et al, 2005 & Fahy et al 2001) and Kuligowski (2005) which have established occupant walking speeds for different occupant groups and/or disability and the corresponding travel speeds are provided in Table G.1.

Table G.1: Horizontal walking speeds for varying occupant groups (Egress Design Solutions, 2007 and Kuligowski, 2005).

Occupant Group	Walking Speed
Children (0-6 years old)	0.4 m/s
Children (7-12 years old)	0.8m/s
Male (13-69 years old)	1.2 m/s
Female (13-69 years old)	1.0 m/s
70+ years old	0.8 m/s
Mobility impaired	0.5 m/s

For a particular building it is difficult to determine the exact distribution /percentage of occupant groups. However, the following percentage distribution of occupant groups have been based on the Australian Census Data (2017) with respect to occupant age and gender.

- Children (0-6 years old) = 9%
- Children (7-12 years old) = 8%
- Male (13-69 years old) = 36%
- Female (13-69 years old) = 37%
- Adults (70+ years old) = 10%

Furthermore, the percentage of population having some level of mobility impairment, based on the data provided by the Australian Network on Disability, is estimated to be 20%. It should be noted that this is a conservative assumption as it includes all forms of disabilities including some which may not have any impact on movement capability of a person such as a hearing impairment. Based on the above percentages of occupant groups and occupant movement speeds detailed in Table G.1., the weighted average occupant horizontal travel speeds have been calculated and tabulated in Table G.2.

Table G.2: Weighted average of horizontal walking speeds for varying occupant groups

Occupant Group	% Base Population	% Mobility Impairment Adjusted Population (A)	Avg. Walking Speed (B)	Weighted Average Occupant Travel Speed (A x B)
Children (0-6 years old)	9 %	8 %	0.4 m/s	0.032
Children (7-12 years old)	8 %	7 %	0.8m/s	0.056
Male (13-69 years old)	36 %	30%	1.2 m/s	0.36
Female (13-69 years old)	37%	30 %	1.0 m/s	0.30
70+	10%	5 %	0.8 m/s	0.04
Mobility impaired	-	20 %	0.5 m/s	0.1
Average weighted horizontal movement speed for the whole spectrum of occupants based on age, gender and physical ability.				***0.9m/s***

Based on the likely characteristics of the occupants, the geometry of the building and the proposed egress provisions, the occupants would be expected to traverse at their normal walking speed to the subject exit locations. According to the above literature, the movement speed of 0.9m/s is considered conservative when considering the average movement speeds. Also, the breakdown may be reflective of a generic occupancy with the typical occupancy distribution with respect to age and disability, but, for occupancy classifications such as commercial or industrial, majority of the occupants are likely to be from the occupant groups with the fastest average walking speeds.

Travel speed is a function of occupant movement density. A speed of 0.9 m/s reflects a density of 1.5 persons per square meter (or 3 persons per 2-meter squares) which is a realistic assumption for residential, office and retail occupancies (refer to Figure G.1). For different occupancies such as sports venues higher densities and slower travel speeds may be adopted. On the other hand, for occupancies such as carparks lower densities and higher speeds may be adopted as per Figure G.1.

The software adopted for the purposes of modelling (i.e. Pathfinder, or Wayout) adjusts the travel speeds for stairway ascends and descents. Where manual input is required, an average constant ascend/descent speed of 0.6 may be adopted or the speed may be based on Figure G.1.

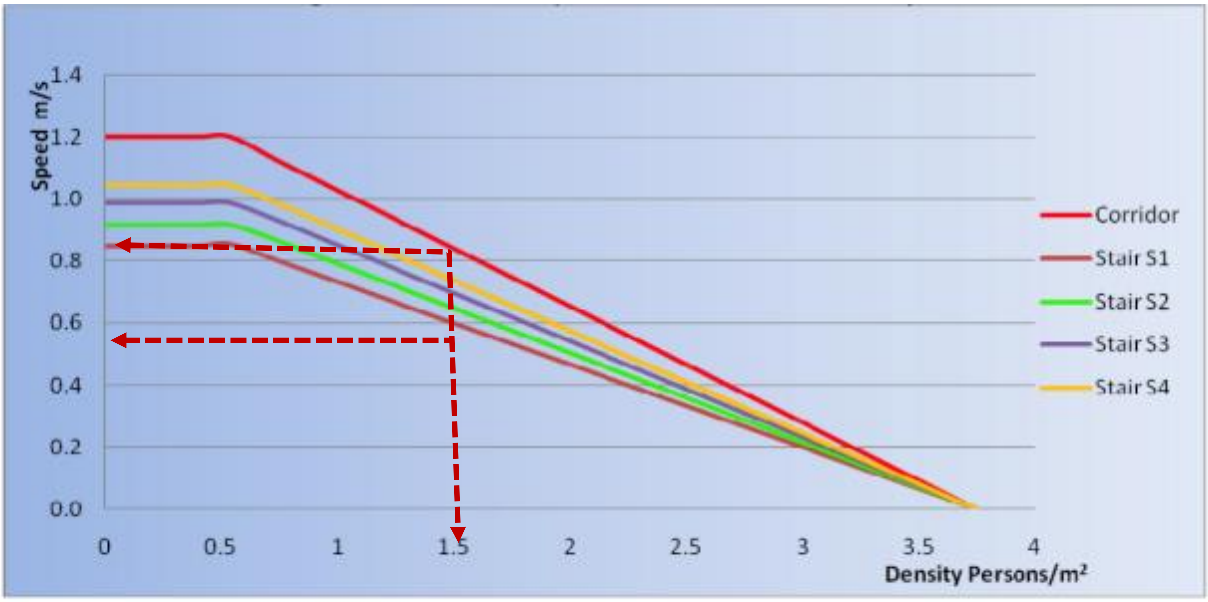


Figure G.1: Travel speeds based on occupant travel densities (Ref: "Fire safety engineering concerning evacuation from buildings"; CFPA-E Guideline No 19:2009 F; The Confederation of Fire Protection Associations in Europe)

Research studies have taken into consideration groups of grown-up people without any physical disabilities (not real situation). Specific estimations have been done considering disabled people. They have confirmed individual walking speed variability. Literature may give experimental examples on walking speed estimations. For occupants with mobility limitations SFPE Handbook recommends varying travel speeds as shown in Figure G.2 and Figure G.3. Based on the type of disability expected, travel speeds can be adopted from these sources.

Speed on horizontal surface				
Subject Group	Mean	Standard deviation	Range	Interquartile range
All disabled	1,00	0,42	0,10-1,77	0,71-1,28
With locomotion disabilities	0,80	0,32	0,24-1,68	0,57-1,02
No aid	0,95	0,32	0,24-0,1,68	0,70-1,02
Crutches	0,94	0,30	0,63-1,35	0,67-1,24
Walking sticks	0,81	0,38	0,26-1,60	0,49-1,08
Rollator	0,57	0,29	0,10-1,02	0,34-0,83
No locomotion disability	1,25	0,32	0,82-1,77	1.05-1,34
Electric wheelchair	0,89	-	0,85-1,77	-
Manual wheelchair	0,69	0,35	0,13-1,35	0,38-0,94
Manual wheelchair	0,36	0,14	0,11-0,70	0,20-0,47
Assisted manual wheelchair	1,30	0,94	0,84-1,98	1,02-1,59
Assisted ambulant	0,78	0,34	0,21-1,40	0,58-0,92

Source: Table 3-13.2 from Section 3, Chapter 13: "Movement Of People: The Evacuation Timing", The SFPE Handbook of Fire Protection Engineering, 3rd Edition, NFPA Inc., Quincy, Massachusetts, 2002

Figure G.2: Travel speeds for occupants with disabilities on horizontal surfaces.

Speed on stairs				
Subject Group	Mean	Standard deviation	Range	Interquartile range
Ascent				
With locomotion disabilities	0,38	0,14	0,13-0,62	0,26-0,52
No aid	0,43	0,13	0,14-0,62	0,35-0,55
Crutches	0,22	-	0,19-0,31	0,26-0,45
Walking stick	0,35	0,11	0,18-0,49	-
Rollator	0,14			
Without disabilities	0,70	0,24	0,55-0,82	0,55-0,78
Descendent				
With locomotion disabilities	0,33	0,16	0,11-0,70	0,22-0,45
No aid	0,36	0,14	0,11-0,70	0,20-0,47
Crutches	0,22	-	-	-
Walking stick	0,32	0,12	0,11-0,49	0,24-0,46
Rollator	0,16	-	-	-
Without disabilities	0,70	0,26	0,45-1,10	0,53-0,90

Source: Table 3-13.3 from Section 3, Chapter 13: "Movement Of People: The Evacuation Timing", The SFPE Handbook of Fire Protection Engineering, 3rd Edition, NFPA Inc., Quincy, Massachusetts, 2002

Figure G.3: Travel speeds for occupants with disabilities on stairs

Appendix H. Fire Dynamics Simulator

H.1 General

The fire and smoke spread model Fire Dynamics Simulator (FDS) has been used to model the fire scenario. The NIST field model FDS is a Computational Fluid Dynamics (CFD) model of fire-driven fluid flow. The FDS software is appropriate for low-speed, thermally driven flow with the emphasis on smoke and heat transport from fires (K B McGratten et-al 2002). The FDS model to be used is a deterministic 'fire model' which is used to predict the spread of heat and smoke in an enclosure or multiple enclosures. Visual presentations of the FDS simulation modelling results has been provided using the 'smokeview' program (K B McGratten et-al 2002).

The NIST FDS is a CFD model, or sometimes referred as a field model. Field models rely less on empirical correlations and are based on solving conservation equations for mass, momentum and energy. Fluid dynamics involves mathematical equations that describe the physical behaviour of fluids (gases and liquids) and are in the general form of three-dimensional, time-dependent, non-linear partial differential equations known as the 'Navier-Stokes' equations**.**

H.2 Basic CFD Input Information

H.2.1 CFD Fire Surface Area Justification

The area of the fire surface used for the fire needs to be justified such that it represents a credible fire scenario. The Fire Dynamics Simulator Technical Reference Guide Volume 3: Validation (i.e. page 57). To calculate the most appropriate area of the fire surface the Fire Froude Number $\dot{Q}^*$ has to be calculated. The fire Froude Number is a non-dimensional quantity for plume correlations and flame height estimates. It is essentially the ratio of the fuel gas exit velocity and the buoyancy-induced plume velocity.

It should be noted that jet fires are characterized by large Froude numbers. Typical accidental fires have a Froude number near unity (i.e. 1). Typical accidental fires are the common fire scenario used in ASET/RSET analysis. Furthermore, An Introduction to Fire Dynamics (Drysdale page 130) states that turbulent jet fires occur when Q* > 5 and pool fires occur when Q* < 1. The Fire Froude Number $\dot{Q}^*$ is shown below:

$$\dot{Q}^* = \frac{\dot{Q}}{\rho_\infty c_p T_\infty \sqrt{gD} D^2}$$

Eq.1

where:

- D: characteristic fire diameter
- Q : total heat release rate, kW;
- $\rho\infty$: density at ambient temperature, kg/m^3 = 1.2;
- Cp : specific heat of gas, kJ/kg.K = 1.0;
- $T\infty$: ambient temperature, K = 298;
- g : acceleration of gravity, m/s^2 = 9.81.

Table H.1: Calculated Froude number

Fire Scenario	Total HRR (kW)	Fire Dimension	Calculated Fire Diameter	Calculated Q*
FS01	850	0.75m x 0.75m	0.846	1.190

Based on the calculations in Table H.1, it was concluded that the diameter size adopted for the above fire scenarios was appropriate to simulate an accidental fire, 1< $(\dot{Q}^*)$ <5, would was the basis for the fire scenario.

H.2.2 Visibility C Factor

In FDS analysis where visibility is used as tenability criteria the C factor if the signage (if there is any) is a key parameter. In the context of the current project a C factor 3 has been adopted based on the presence of reflective signage.

H.2.3 Boundary Conditions

The boundary conditions for the smoke modelling were as follows:

- Air Temperature inside computational domain = 20°C.
- External Air Temperature = 25°C.

- Outside walls are adiabatic.
- The compartment floor and roof modelled as concrete, using the standard materials database provided with FDS.
- The model is surrounded by free, neutral pressure boundaries.

H.2.4 Adopted Fuel

The adopted Fuel input is as per the following:

- SOOT_YIELD = (refer to justification below)
- NU_O2 = 3.7
- NU_CO2 = 3.4
- NU_H2O = 3.1
- MW_FUEL = 87.
- EPUMO2 = 11020.

H.2.5 Adopted Soot Yield

The FDS model has adopted a soot yield (Y_S) value of **0.07 kg/kg.** This has been based on Verification Method: Framework for Fire Safety Design C/VM2 table 2.1 which stipulates a soot yield of 0.07 kg/kg for pre flash over fires in “All buildings including storage with a stack height of less than 3.0 m”. This is further supported by Table R.2 which details soot yield values extracted from Table A.39 of SPFE (5th Edition, 2016) for well-ventilated free burning fires involving “sooty” fuels are in the range 0.008 –0.18 g/g with lesser values appropriate for clean burning fuels and wood products.

Table H.2: Soot Yields appropriate to a variety of materials (values extracted from Table A.39 of SFPE 5th Edition, 2016)

Fuel	Soot Yield (kg/kg)	Fuel	Soot Yield (kg/kg)
Polyurethane Foam	0.131	PVC	0.172
Plastics (Nylon)	0.075	Synthetic material (PE)	0.007
Corrugated Paper Boxes	0.061	Synthetic material (Silicone)	0.006
Polystyrene Foam	0.180	Synthetic material (PMMA)	0.022
Wood	0.015	Synthetic material (PP)	0.059

The FDS model has adopted a soot yield (Y_S) value of **0.07 kg/kg**. This soot yield value is considered to be representative of a variety of fuel loads which may be situated within the school building.

H.3 CFD Input Parameters

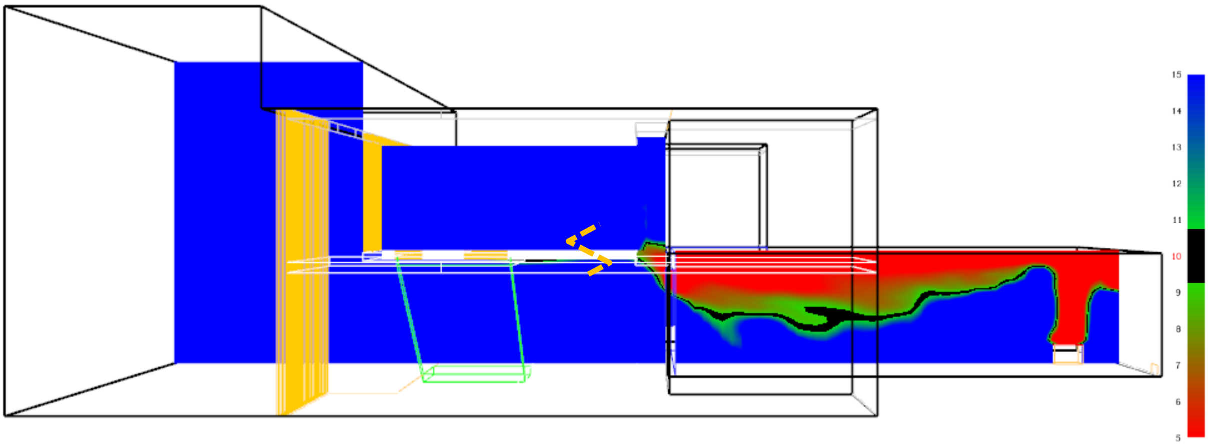
H.3.1 Summary of CFD Input Parameters

Project Details	
Name	Fire Dynamic Simulator (FDS)
Version	6.7.5
Other relevant details	N/A
General / Domain Parameters	
Number of meshes	Approximately 25
Type of mesh (e.g. Cartesian)	Cartesian Grid (FDS Default)
Mesh Size	0.25 x 0.25 x 0.125
Material Properties	The floor and ceiling to be modelled as Inert. These have been calculated using the standard materials database provided within FDS.
Boundary Conditions	Outside walls are adiabatic surface to determine modelled boundary profiles. The model is surrounded by free, neutral pressure boundaries
Major geometrical or other simplifications or assumptions	None
Steady-State or Transient	Steady state environment has been adopted.
Simulation Time	1000 seconds
Fire Parameters	

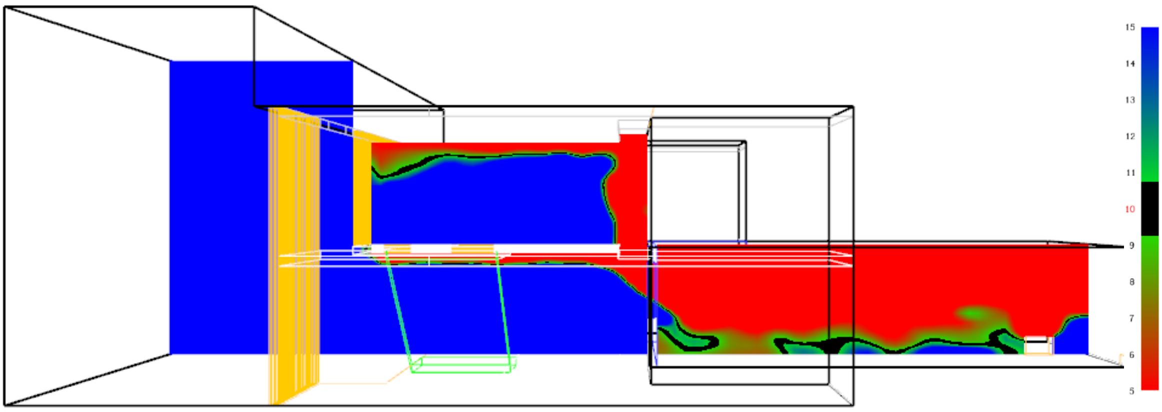
Project Details	
Radiative Fraction	N/A
Reaction Properties	Reaction properties based on the composition of materials such as plastics, wood, etc. NU_O2 = 3.7 NU_CO2 = 3.4 NU_H2O = 3.1 MW_FUEL = 87. EPUMO2 = 11020.
Soot Yield (value and means of including in model)	0.07kg/kg has been adopted for the fire scenarios based on the average and a range of combustible commodities.
Visibility Factor (or other parameters used to obtain Visibility output)	The visibility factor of 3 has been adopted representative of an reflective signage at visibility distance of 10m.
Heat Release Rate Per Unit Area (HRRPUA)	Refer to Section 10.8.5 of this report.
Means of achieving fire growth rate (e.g. ramp, multiple fire objects, etc.)	Fast t^2 growth rate
Details of materials where fire spread to objects is being assessed (e.g. ignition temperature, heat of combustion, etc.)	N/A.
Fire locations (including height above floor)	Refer to Section 10.8.5 of this report for fire location
Scenario Parameters	
Ambient Temperature	Air temperature inside the computational domain: 20°C External Air Temperature: 20°C
Wind	N/A
Others	N/A
Fire Safety System / Device Parameters	
Mechanical smoke exhaust	N/A
Mechanical supply air	N/A
Jet fans	N/A
Natural vents	Open Balustrade along arrow building elevation, open area above the roof of the Arrow Building. (Note, the Arrow Building roof was modelled as an obstruction)
Natural make-up air	Leakage based on number of openings through external walls.
Fire Safety System / Device Parameters	
Assumed building leakage	Leakage based on number of openings through external walls.
Sprinklers (RTI, spacing, location, distance to fire, temperature rating, etc.)	Refer to Section 10.8.5 of this report.
Detectors (RTI, spacing, location, distance to fire, temperature rating, activation obscuration, etc.)	N/A
Other systems / devices	N/A

H.4 FDS Results

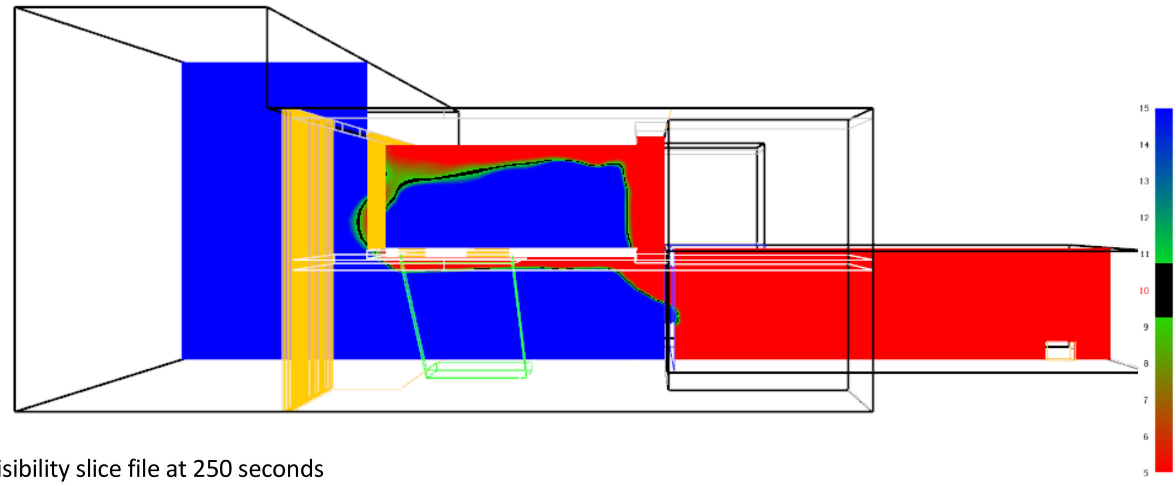
H.4.1 FS01



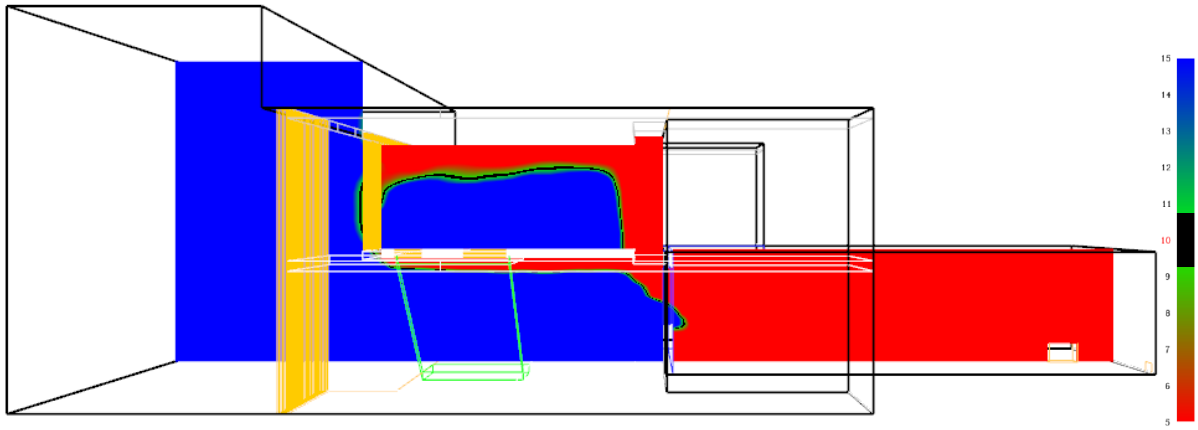
Visibility slice file at 80 seconds



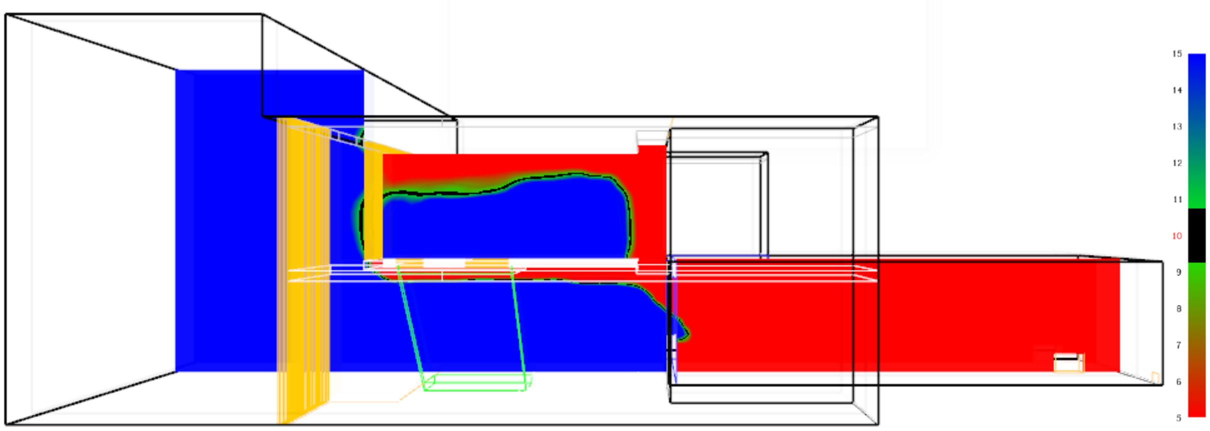
Visibility slice file at 150 seconds



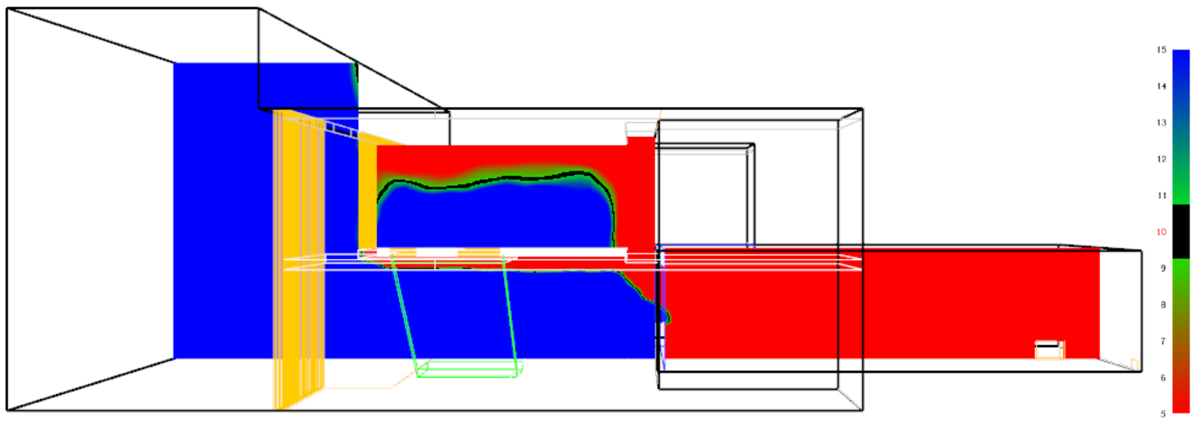
Visibility slice file at 250 seconds



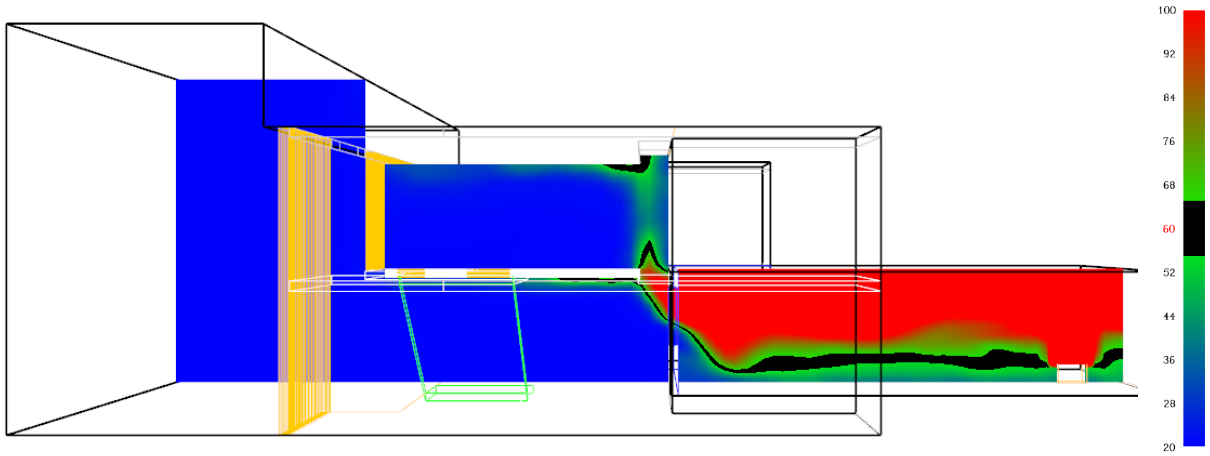
Visibility slice file at 350 seconds



Visibility slice file at 503 seconds (RSET)



100 seconds (End of Model – Steady State Achieved)



Temperature slice file at 1000 seconds (End of Model – Steady State Achieved)

Appendix I. Evacuation Modelling “Pathfinder”

I.1 General Overview

The movement (or the floor clearing times) is to be calculated using computer program Pathfinder. Pathfinder human movement simulation program is a validated and tested evacuation program. Pathfinder uses two primary options for occupant motion called SFPE mode and a steering mode. The SFPE mode implements the concepts in the SFPE Handbook of Fire Protection Engineering [Nelson and Mowrer, 2002]. This is a flow model, where walking speeds are determined by occupant density within each room and flow through doors is controlled by door width. The pathfinder computer program adopts the methodologies and principles outlined and based on actual research that has been conducted (IMO-Evacuation Analyses for New and Existing Passenger Ships). Pathfinder uses an occupant profile system to manage distributions of parameters across groups of occupants. This system helps you control the occupant speed, size, and visual distributions.

The alternate method in Pathfinder is the steering mode which is based on the idea of inverse steering behaviours. Steering behaviours were first pr’sented “n Craig Reynolds' paper "Steering Behaviours ”or Autonomous Characters" [Reynolds, 1999] and later refined into inverse steering behaviours in a paper by Heni Ben Amor [Amor e’. al., 2006]. Pathfinder's steering mode allows more complex behaviour to naturally emerge as a by-product of–the movement algorithms - eliminating the need for explicit door queues and density calculations. It is noted that in this instance the SFPE mode was incorporated in the Pathfinder simulation.

Pathfinder is an agent-based egress simulator that uses steering behaviours to model occupant motion throughout evacuation. It consists of three modules:

- The graphical user interface: and
- The simulator; and
- The 3D results viewer.

In the Pathfinder evacuation modelling the occupants may be allocated profiles and behaviours. The profile defines characteristics of the occupants, such as speed, radius, avatar, and colour. The behaviour defines a sequence of actions the occupant will take throughout the simulation, such as moving to a refuge area, waiting or queuing at the exit, and then exiting.

Behaviours in Pathfinder represent a sequence of actions the occupant will take throughout the simulation. For each occupant behaviour in an evacuation model dedicated to agents there is an implicit action to move the occupant to an exit. This implicit action will always happen last. Additional intermediate actions may also be added in Pathfinder evacuation modelling can make the occupant wait or travel to a non-exit destination, such as a room or particular location on the floor plate. By default in the Pathfinder model the occupant behaviour is called “Go to Any Exit.” This behaviour type simply makes the occupant move from their starting position to any exit present in the model by the fastest route.

The SFPE mode uses the set of assumptions presented in the SFPE Handbook of Fire Protection Engineering and generally gives answers similar to hand calculations, depending on or if selected assumptions have been applied in the model. In SFPE simulations, the mechanism that controls simulation movement is the door queue, as queuing generally governs occupant evacuation. The Steering mode is more dependent on collision avoidance and occupant interaction for the final answer and often gives answers more similar to experimental data than the SFPE mode.

All occupants in Pathfinder use individual (or agent based) decision making algorithms. The model is a PC-based computer program capable of simulating the evacuation of large numbers of people through geometrically complex buildings.

Verification and Validation of the Pathfinder program have been documented by Thunderhead Engineering and Rolf Jensen & Associates Fire Protection Consultants (Document no: Pathfinder 2009.1.0417, Document Title: Verification and Validation). The aforementioned document has conducted the following:

- *Verification tests: Synthetic test cases designed to ensure that the simulator is performing as specified by the Pathfinder Technical Reference. Usually these tests attempt to isolate specific simulated quantities or behaviours and may include only a small number of occupants. This type of test often has very specific pass/fail criteria. Verification tests ensure that the software is implements a particular model correctly –they are not designed to measure how accurately that model reflects reality.*
    - The document has documented eleven (11) IMO (International Maritime Organization) Tests which have demonstrated satisfactory results. These tests are listed below:
        - Movement speed, and
        - Stairway speed (Up), and

- Stairway speed (Down), and
- Door flow rates, and
- Initial delay times, and
- Concave geometry (Boundaries), and
- Multiple movement speeds, and
- Counter flow, and
- Sensitivity to available doors, and
- Exit assignments, and
- Congestions.

- Validation tests – Designed to measure how well Pathfinder's implementation of simulation models captures real behaviour. Usually these tests will explore the interaction between multiple simulations elements and may have less specific pass/fail criteria. Validation tests are usually based on experimental data or experience.
- Comparisons – Pathfinder results alongside the results of other simulators. These tests are design to give the reader a sense of where Pathfinder "fits in" relative to other simulation software.

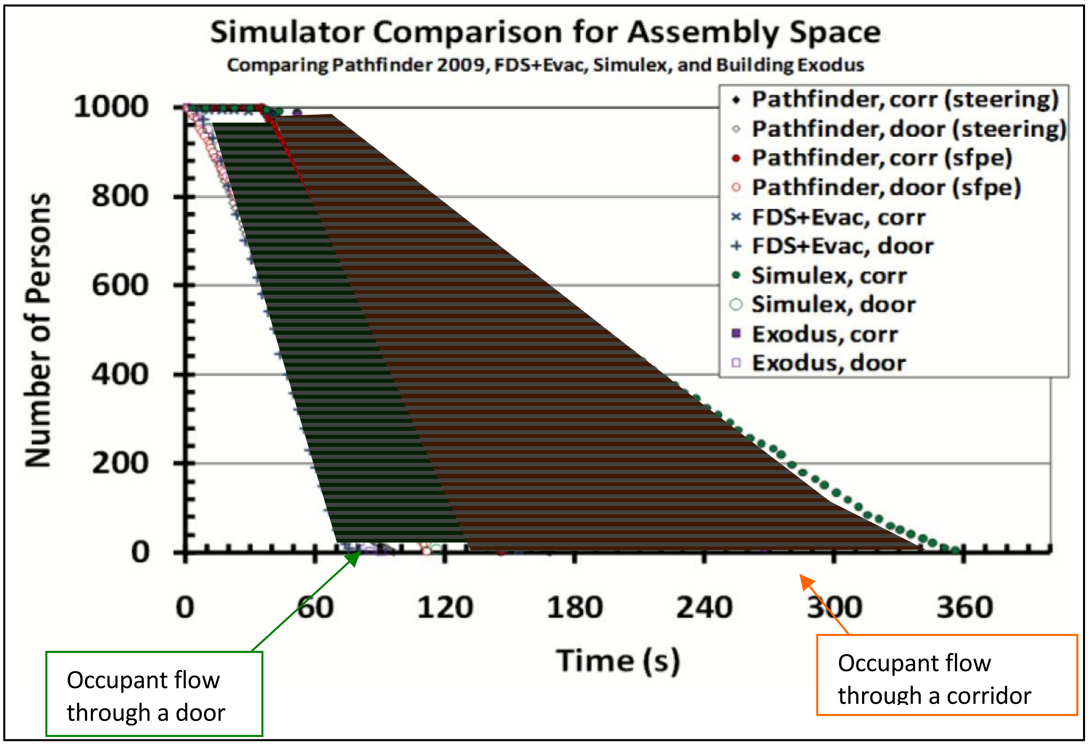


Figure I.1: Occupant movement simulator comparisons between different software.

I.2 Summary of Pathfinder Input Parameters

Project Details	
Model / Program Details	
Name	Pathfinder
Version	2016.1.0229 x64
Simulation Parameters	
Behaviour mode	Steering
Collision handling	Yes
Inertia	Yes
Geometry Parameters	
Floor layout	As per architectural drawings
Exit locations	As per architectural drawings
Number of storeys	4

Stairs	Yes
Occupant distribution	Evenly distributed throughout.
Number of occupants	In accordance with Table 9.9 of this report.
Occupant Parameters	
Occupant movement speed	0.9m/s
Occupant shoulder width	45-55 cm
Occupant height	1.8m
Alarm Delay time	Included in each evacuation scenario.
Pre-movement time	Included in each evacuation scenario.

I.3 Occupant Shoulder Width Justification

The studies conducted by Fruin et al (2007) have determined that an average male person’s shoulder width is approximately 500-600 mm. This is further supported by the NFPA 101B Annex A which presents selected anthropometric data for adults. The information provided in Annex A states that for an average person the static width is in the order of 508mm (20inch) which is similar to the results obtained by Fruin. Therefore, an occupant width of 500mm 600mm has been implemented into the Pathfinder software.

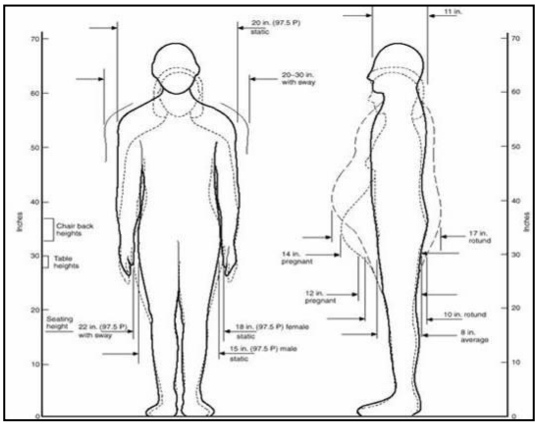


Figure I.2: Average shoulder widths of adults

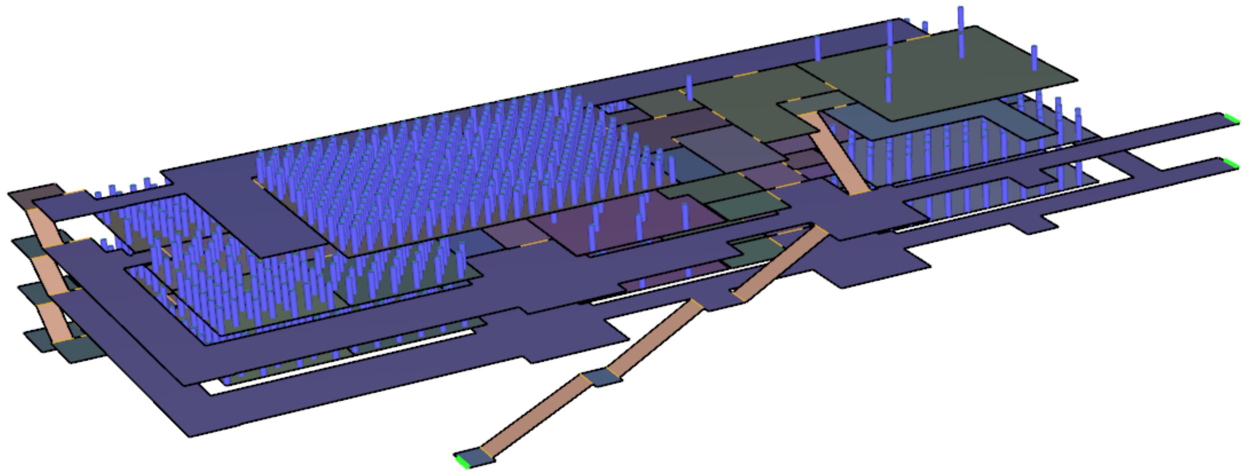
I.4 Occupant Risk Contour Approach

The risk contour approach is the concept methodology (Horasan, Kilmartin 2009) which has been adopted in this instance for the evacuation modelling. This concept has also been adopted and reflected by the New Zealand Department of Building and Housing as part of the Building Codes in the document titled “C/VM2 Verification Method: Framework for Fire Safety Design For New Zealand Building Code Clauses C1-C6 Protection from Fire”.

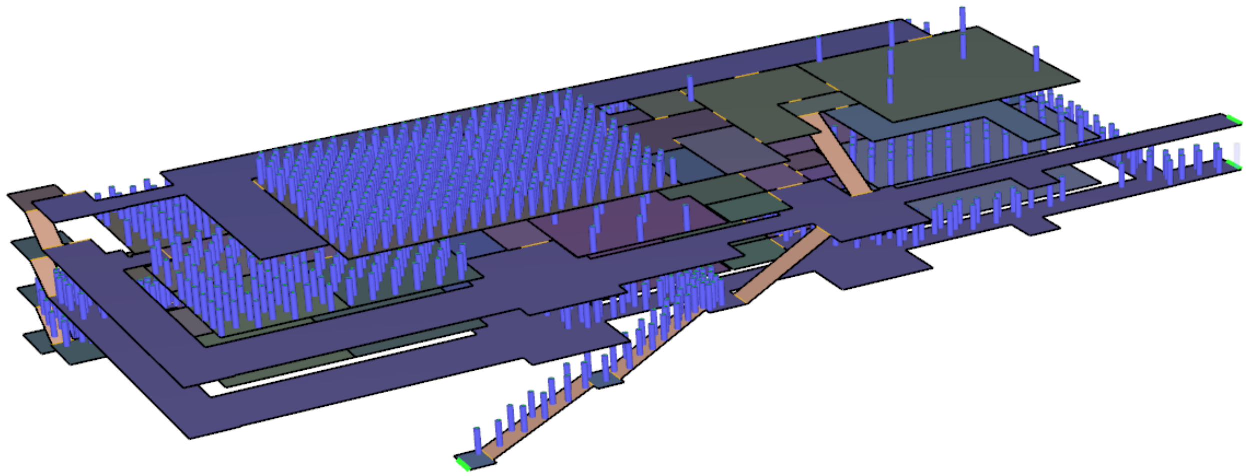
It is important to highlight that the evacuation modelling forming part of the overall Life Safety Analysis was performed utilising the ‘Pathfinder’ computer software program. The ‘Pathfinder’ computer software program was used to compute the cumulative time for both **pre-movement and movement times**. Verification and Validation of the Pathfinder program has been documented by Thunderhead Engineering and Rolf Jensen & Associates Fire Protection Consultants.

I.5 Pathfinder Results

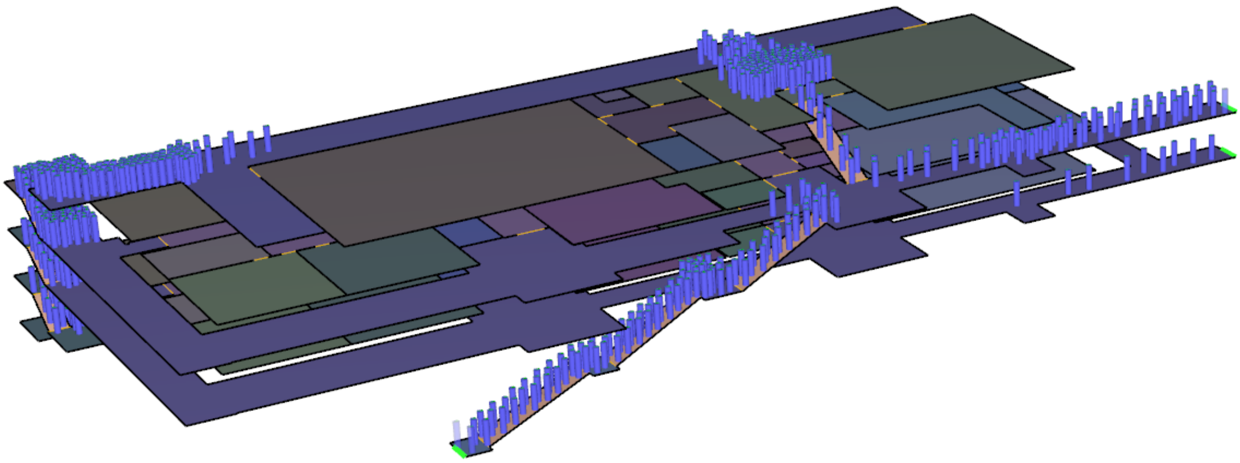
I.5.1 Core Scenario



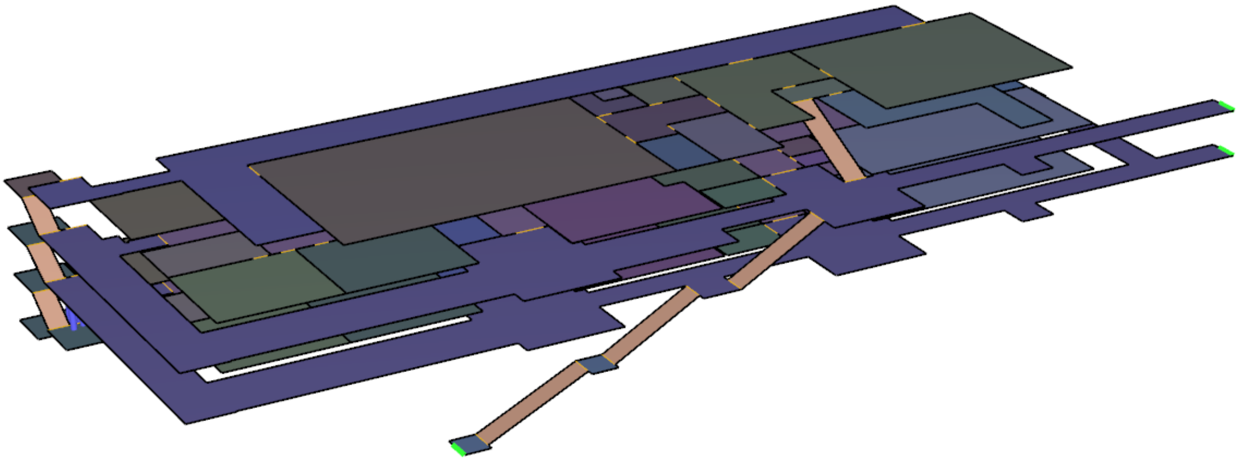
Pathfinder Model at 0 seconds



Pathfinder Model at 100 seconds

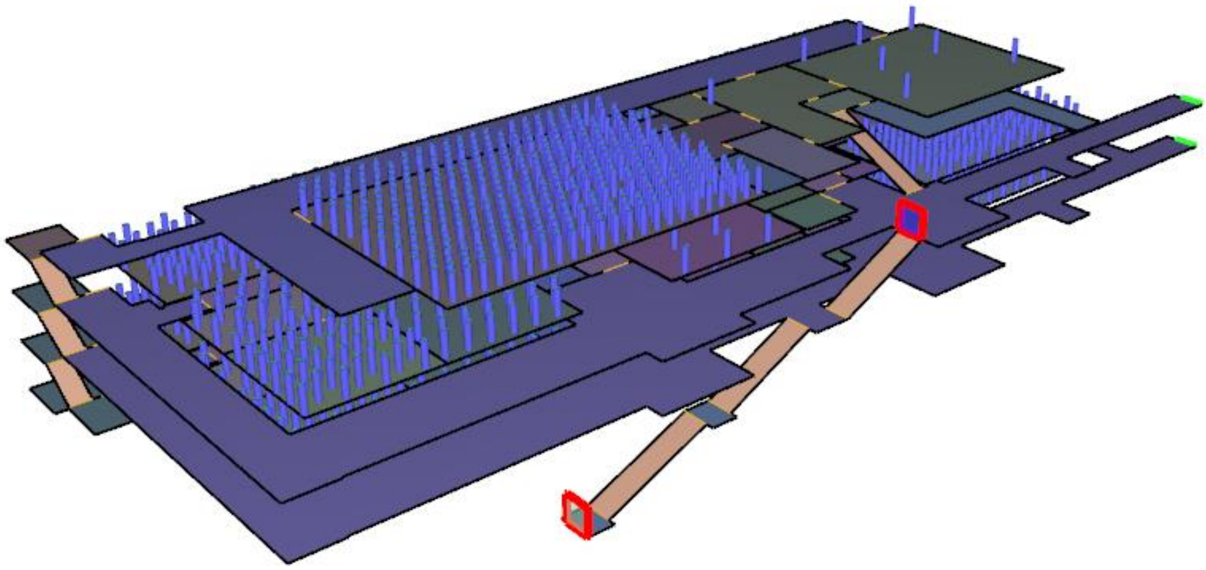


Pathfinder Model at 250 seconds

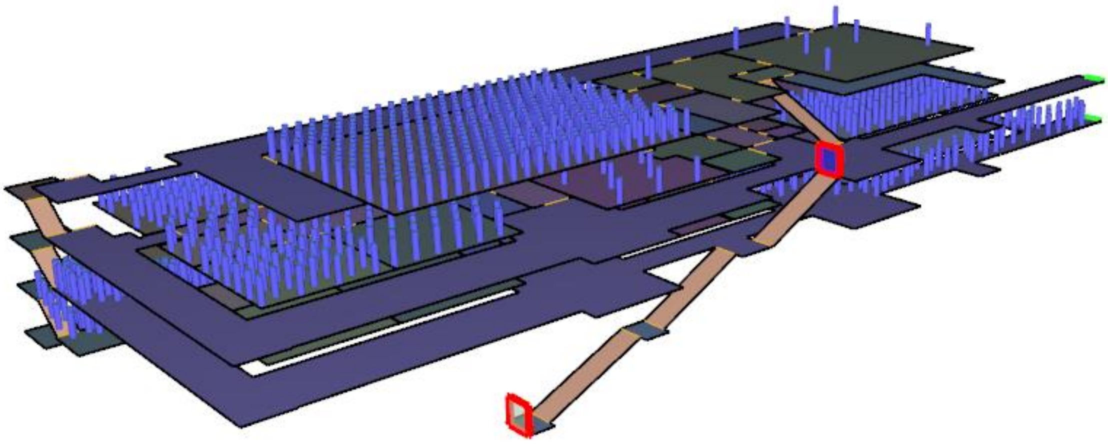


Pathfinder Model at 435 seconds (RSET reached, occupants on alternate stair having reached L1)

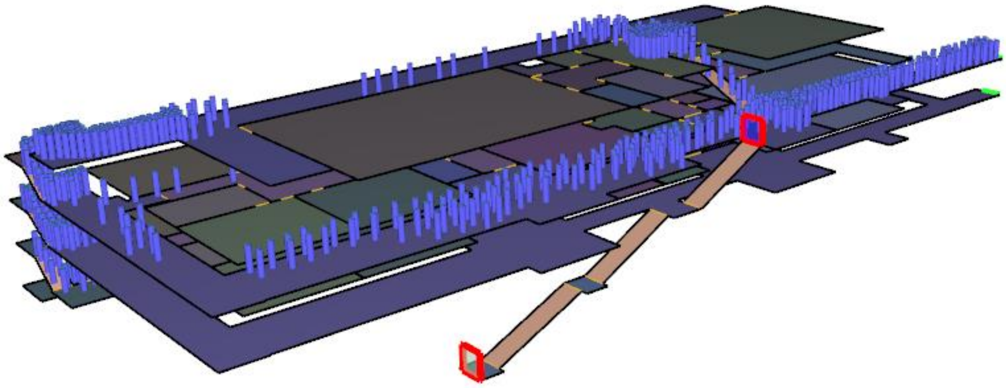
I.5.2 Redundancy Scenario



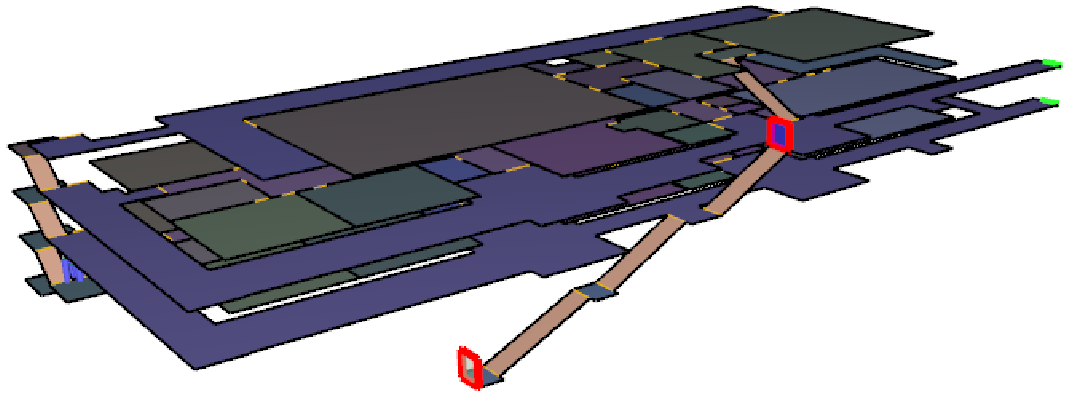
Pathfinder Model at 0 seconds



Pathfinder Model at 100 seconds

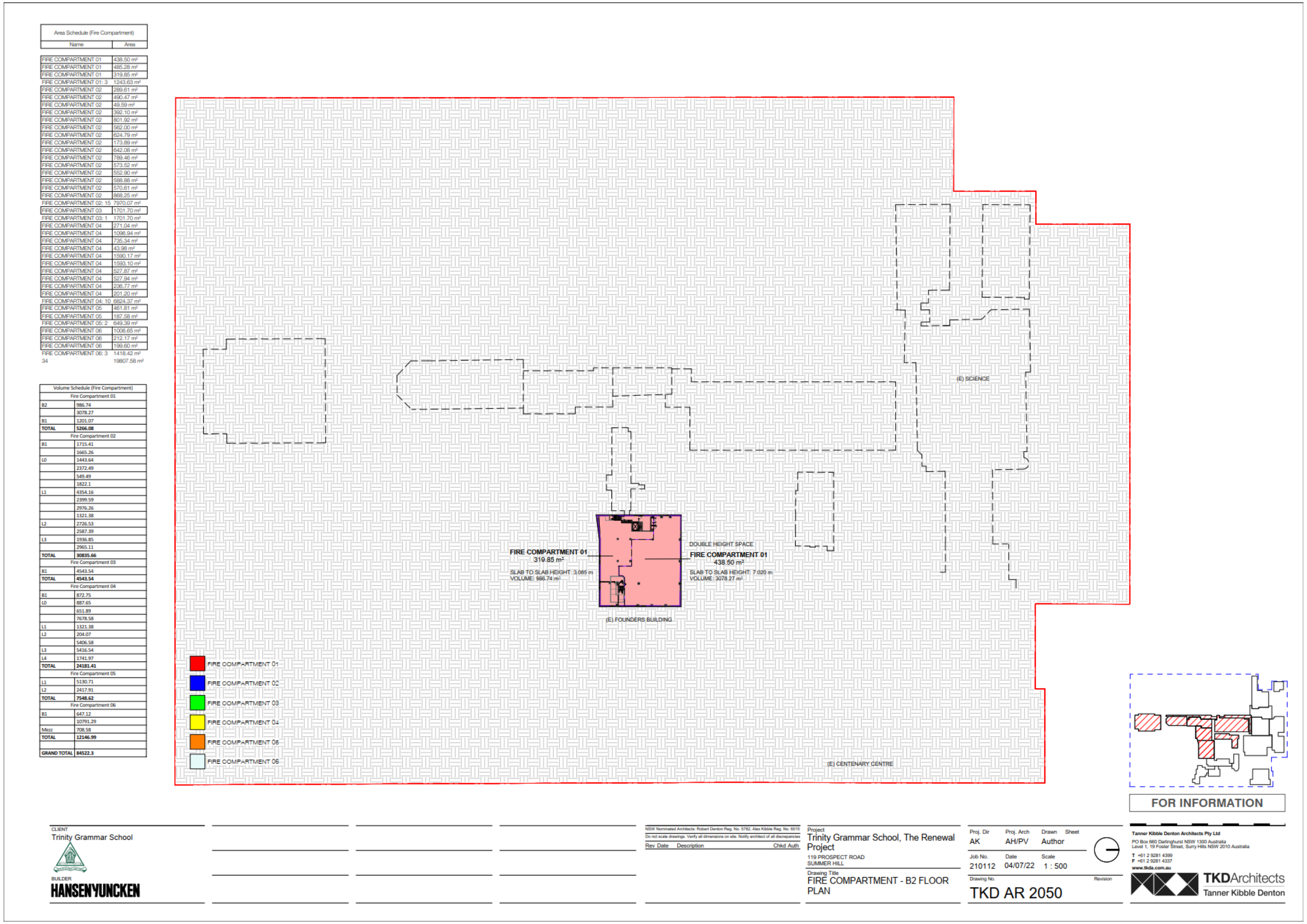


Pathfinder Model at 250 seconds



Pathfinder Model at 457 seconds (RSET reached, occupants on alternate stair having reached L1)

Appendix J. Fire Compartmentation Drawings

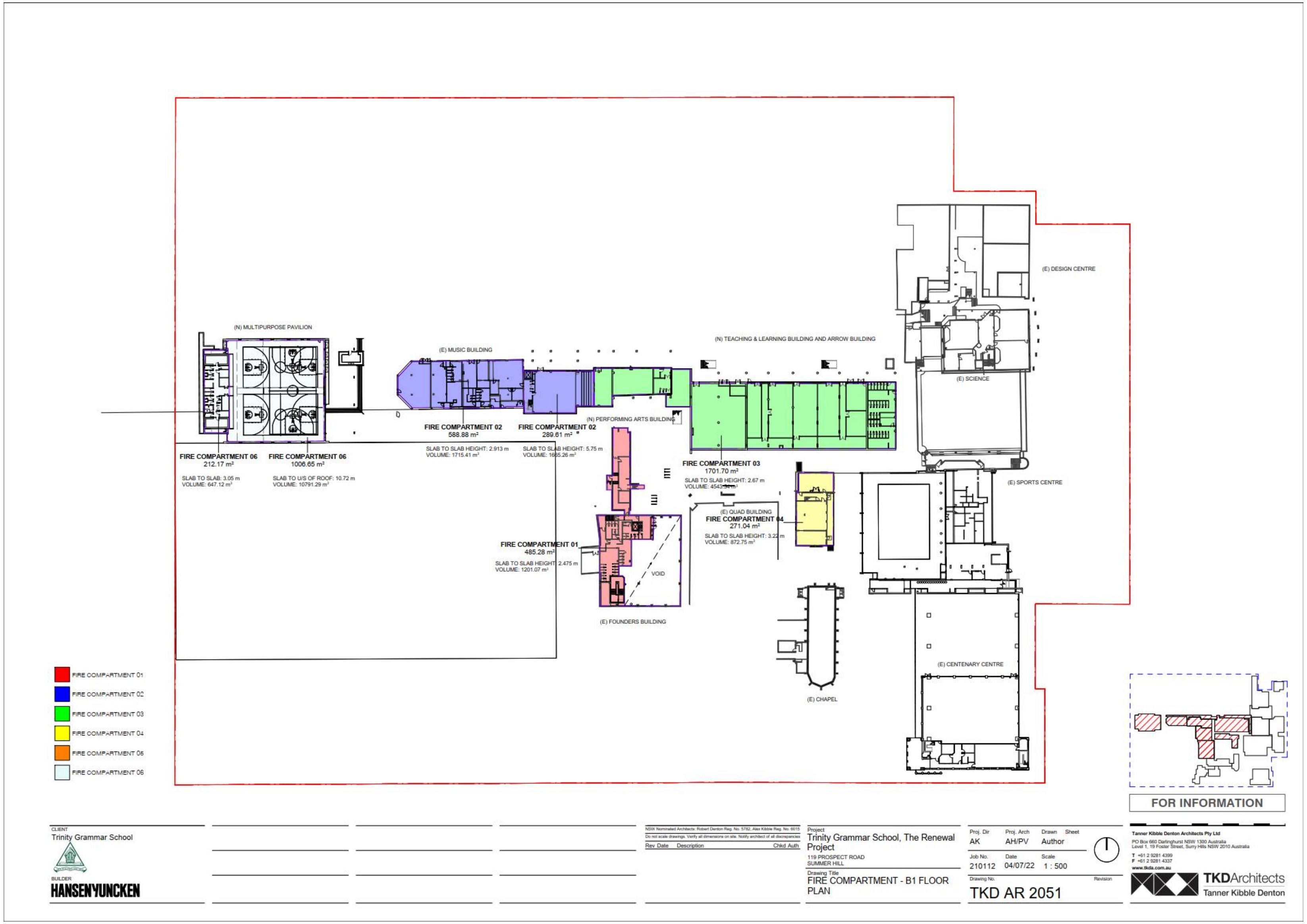


Area Schedule (Fire Compartment)

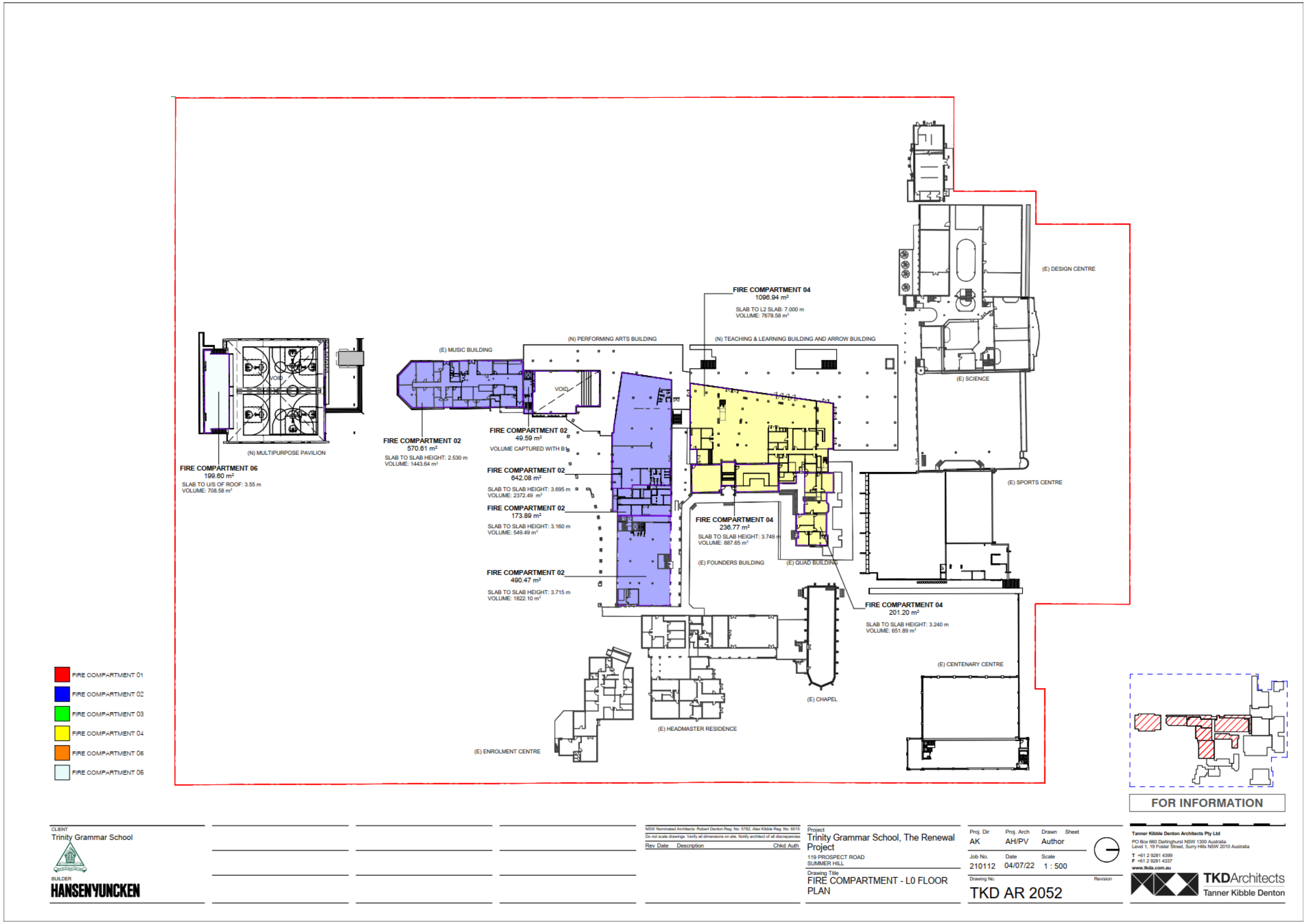
Name	Area
FIRE COMPARTMENT 01	438.50 m²
FIRE COMPARTMENT 01	485.28 m²
FIRE COMPARTMENT 01	319.85 m²
FIRE COMPARTMENT 01: 3	1243.63 m²
FIRE COMPARTMENT 02	289.61 m²
FIRE COMPARTMENT 02	490.47 m²
FIRE COMPARTMENT 02	49.59 m²
FIRE COMPARTMENT 02	392.10 m²
FIRE COMPARTMENT 02	801.92 m²
FIRE COMPARTMENT 02	562.00 m²
FIRE COMPARTMENT 02	624.79 m²
FIRE COMPARTMENT 02	173.89 m²
FIRE COMPARTMENT 02	642.08 m²
FIRE COMPARTMENT 02	789.46 m²
FIRE COMPARTMENT 02	573.52 m²
FIRE COMPARTMENT 02	552.90 m²
FIRE COMPARTMENT 02	588.88 m²
FIRE COMPARTMENT 02	570.61 m²
FIRE COMPARTMENT 02	868.25 m²
FIRE COMPARTMENT 02: 15	7970.07 m²
FIRE COMPARTMENT 03	1701.70 m²
FIRE COMPARTMENT 03: 1	1701.70 m²
FIRE COMPARTMENT 04	271.04 m²
FIRE COMPARTMENT 04	1096.94 m²
FIRE COMPARTMENT 04	735.34 m²
FIRE COMPARTMENT 04	43.98 m²
FIRE COMPARTMENT 04	1590.17 m²
FIRE COMPARTMENT 04	1593.10 m²
FIRE COMPARTMENT 04	527.87 m²
FIRE COMPARTMENT 04	527.94 m²
FIRE COMPARTMENT 04	236.77 m²
FIRE COMPARTMENT 04	201.20 m²
FIRE COMPARTMENT 04: 10	6824.37 m²
FIRE COMPARTMENT 05	461.81 m²
FIRE COMPARTMENT 05	187.58 m²
FIRE COMPARTMENT 05: 2	649.39 m²
FIRE COMPARTMENT 06	1006.65 m²
FIRE COMPARTMENT 06	212.17 m²
FIRE COMPARTMENT 06	199.60 m²
FIRE COMPARTMENT 06: 3	1418.42 m²
34	19807.58 m²

Volume Schedule (Fire Compartment)

Fire Compartment 01	
B2	986.74
	3078.27
B1	1201.07
TOTAL	5266.08
Fire Compartment 02	
B1	1715.41
	1665.26
L0	1443.64
	2372.49
	549.49
	1822.1
L1	4354.16
	2399.59
	2976.26
	1321.38
L2	2726.53
	2587.39
L3	1936.85
	2965.11
TOTAL	30835.66
Fire Compartment 03	
B1	4543.54
TOTAL	4543.54
Fire Compartment 04	
B1	872.75
L0	887.65
	651.89
	7678.58
L1	1321.38
L2	204.07
	5406.58
L3	5416.54
L4	1741.97
TOTAL	24181.41
Fire Compartment 05	
L1	5130.71
L2	2417.91
TOTAL	7548.62
Fire Compartment 06	
B1	647.12
	10791.29
Mezz	708.58
TOTAL	12146.99
GRAND TOTAL	84522.3



(N) MULTIPURPOSE PAVILION
(E) MUSIC BUILDING
(N) TEACHING & LEARNING BUILDING AND ARROW BUILDING
(E) DESIGN CENTRE
(E) SCIENCE
(E) SPORTS CENTRE
(N) PERFORMING ARTS BUILDING
FIRE COMPARTMENT 02
588.88 m²
SLAB TO SLAB HEIGHT: 2.913 m
VOLUME: 1715.41 m³
FIRE COMPARTMENT 02
289.61 m²
SLAB TO SLAB HEIGHT: 5.75 m
FIRE COMPARTMENT 06
212.17 m²
SLAB TO SLAB: 3.05 m
VOLUME: 647.12 m³
FIRE COMPARTMENT 06
1006.65 m²
SLAB TO U/S OF ROOF: 10.72 m
VOLUME: 10791.29 m³
FIRE COMPARTMENT 03
1701.70 m²
SLAB TO SLAB HEIGHT: 2.67 m
(E) QUAD BUILDING
FIRE COMPARTMENT 04
271.04 m²
VOLUME: 872.75 m³
FIRE COMPARTMENT 01
485.28 m²
VOLUME: 1201.07 m³
VOID
(E) FOUNDERS BUILDING
(E) CHAPEL
(E) CENTENARY CENTRE
FIRE COMPARTMENT 01
FIRE COMPARTMENT 02
FIRE COMPARTMENT 03
FIRE COMPARTMENT 04
FIRE COMPARTMENT 06
FIRE COMPARTMENT 06
FOR INFORMATION
CLIENT
Trinity Grammar School
BUILDER
HANSENYUNCKEN
Rev Date Description Chkd Auth
Project
Trinity Grammar School, The Renewal Project
119 PROSPECT ROAD
SUMMER HILL
Drawing Title
FIRE COMPARTMENT - B1 FLOOR PLAN
Proj. Dir AK
Proj. Arch AH/PV
Drawn Author
Sheet
Job No. 210112
Date 04/07/22
Scale 1 : 500
Drawing No.
TKD AR 2051
Revision
Tanner Kibble Denton Architects Pty Ltd
TKDArchitects
Tanner Kibble Denton


(N) MULTIPURPOSE PAVILION
VOID
FIRE COMPARTMENT 06
199.60 m²
SLAB TO U/S OF ROOF: 3.55 m
VOLUME: 708.58 m³
(E) MUSIC BUILDING
FIRE COMPARTMENT 02
570.61 m²
SLAB TO SLAB HEIGHT: 2.530 m
VOLUME: 1443.64 m³
(N) PERFORMING ARTS BUILDING
FIRE COMPARTMENT 02
49.59 m²
VOLUME CAPTURED WITH B1
FIRE COMPARTMENT 02
642.08 m²
SLAB TO SLAB HEIGHT: 3.695 m
VOLUME: 2372.49 m³
FIRE COMPARTMENT 02
173.89 m²
SLAB TO SLAB HEIGHT: 3.160 m
VOLUME: 549.49 m³
FIRE COMPARTMENT 02
490.47 m²
SLAB TO SLAB HEIGHT: 3.715 m
VOLUME: 1822.10 m³
FIRE COMPARTMENT 04
1096.94 m²
SLAB TO L2 SLAB: 7.000 m
VOLUME: 7678.58 m³
(N) TEACHING & LEARNING BUILDING AND ARROW BUILDING
FIRE COMPARTMENT 04
236.77 m²
SLAB TO SLAB HEIGHT: 3.749 m
VOLUME: 887.65 m³
(E) FOUNDERS BUILDING
(E) QUAD BUILDING
FIRE COMPARTMENT 04
201.20 m²
SLAB TO SLAB HEIGHT: 3.240 m
VOLUME: 651.89 m³
(E) DESIGN CENTRE
(E) SCIENCE
(E) SPORTS CENTRE
(E) CENTENARY CENTRE
(E) CHAPEL
(E) HEADMASTER RESIDENCE
(E) ENROLMENT CENTRE
FIRE COMPARTMENT 01
FIRE COMPARTMENT 02
FIRE COMPARTMENT 03
FIRE COMPARTMENT 04
FIRE COMPARTMENT 05
FIRE COMPARTMENT 06
FOR INFORMATION
CLIENT
Trinity Grammar School
BUILDER
HANSENYUNCKEN
NSW Nominated Architects: Robert Denton Reg. No. 5782, Alex Kibble Reg. No. 6015
Do not scale drawings. Verify all dimensions on site. Notify architect of all discrepancies
Rev Date Description Chkd Auth
Project
Trinity Grammar School, The Renewal Project
119 PROSPECT ROAD
SUMMER HILL
Drawing Title
FIRE COMPARTMENT - L0 FLOOR PLAN
Proj. Dir
AK
Proj. Arch
AH/PV
Drawn
Author
Sheet
Job No.
210112
Date
04/07/22
Scale
1 : 500
Drawing No.
TKD AR 2052
Revision
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F +61 2 9281 4337
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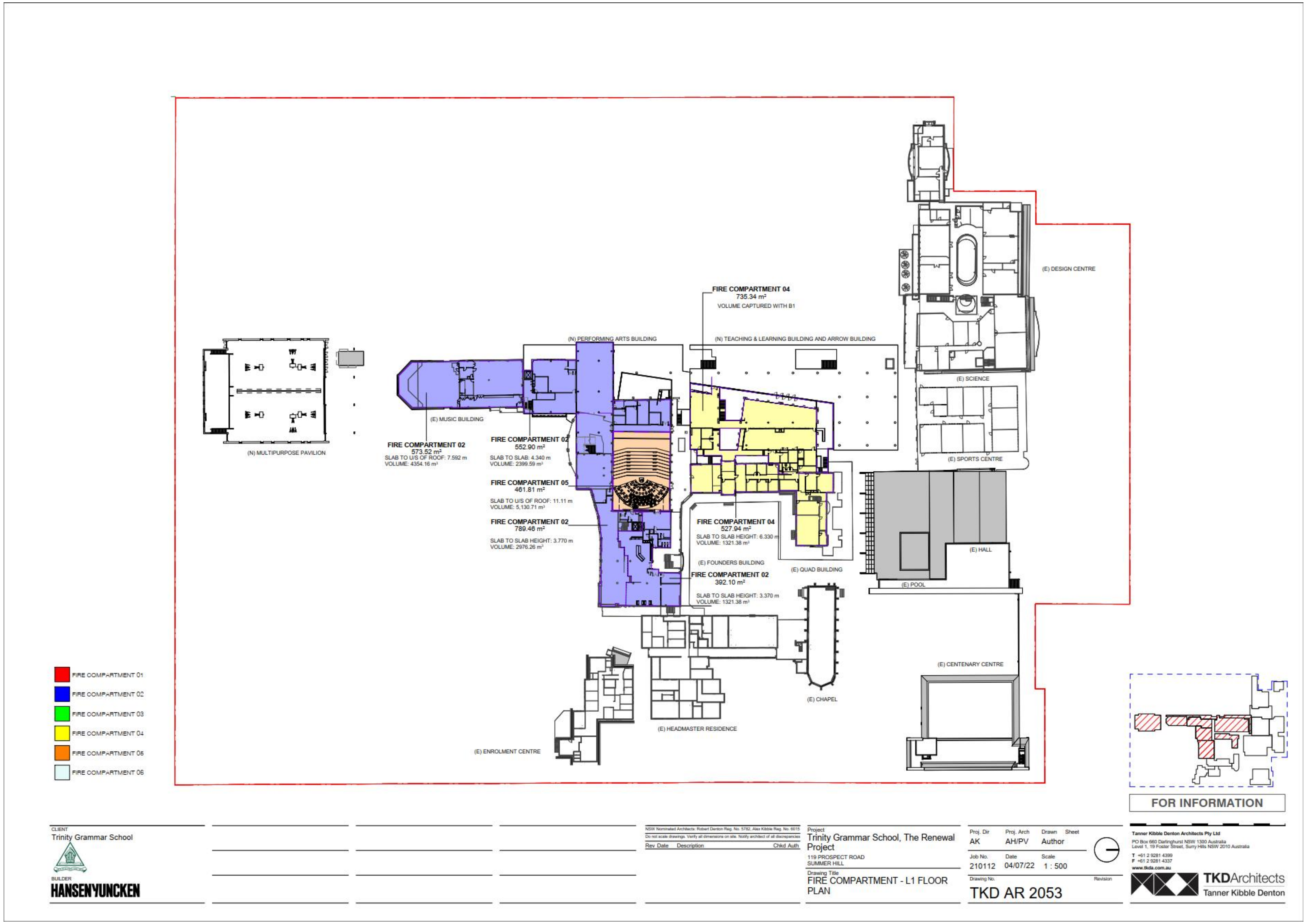
TKDArchitects
Tanner Kibble Denton


FIRE COMPARTMENT 04
735.34 m²
VOLUME CAPTURED WITH B1
(N) PERFORMING ARTS BUILDING
(N) TEACHING & LEARNING BUILDING AND ARROW BUILDING
(E) DESIGN CENTRE
(E) SCIENCE
(E) SPORTS CENTRE
(E) MUSIC BUILDING
(N) MULTIPURPOSE PAVILION
FIRE COMPARTMENT 02
573.52 m²
SLAB TO U/S OF ROOF: 7.592 m
VOLUME: 4354.16 m³
FIRE COMPARTMENT 02
552.90 m²
SLAB TO SLAB: 4.340 m
VOLUME: 2399.59 m³
FIRE COMPARTMENT 05
461.81 m²
SLAB TO U/S OF ROOF: 11.11 m
VOLUME: 5,130.71 m³
FIRE COMPARTMENT 02
789.46 m²
SLAB TO SLAB HEIGHT: 3.770 m
VOLUME: 2976.26 m³
FIRE COMPARTMENT 04
527.94 m²
SLAB TO SLAB HEIGHT: 6.330 m
VOLUME: 1321.38 m³
(E) FOUNDERS BUILDING
FIRE COMPARTMENT 02
392.10 m²
SLAB TO SLAB HEIGHT: 3.370 m
VOLUME: 1321.38 m³
(E) QUAD BUILDING
(E) HALL
(E) POOL
(E) CHAPEL
(E) CENTENARY CENTRE
(E) HEADMASTER RESIDENCE
(E) ENROLMENT CENTRE
FIRE COMPARTMENT 01
FIRE COMPARTMENT 02
FIRE COMPARTMENT 03
FIRE COMPARTMENT 04
FIRE COMPARTMENT 05
FIRE COMPARTMENT 06
FOR INFORMATION
CLIENT
Trinity Grammar School
BUILDER
HANSENYUNCKEN
Rev Date Description Chkd Auth
Project
Trinity Grammar School, The Renewal Project
119 PROSPECT ROAD
SUMMER HILL
Drawing Title
FIRE COMPARTMENT - L1 FLOOR PLAN
Proj. Dir AK
Proj. Arch AH/PV
Drawn Author
Sheet
Job No. 210112
Date 04/07/22
Scale 1 : 500
Drawing No.
TKD AR 2053
Revision
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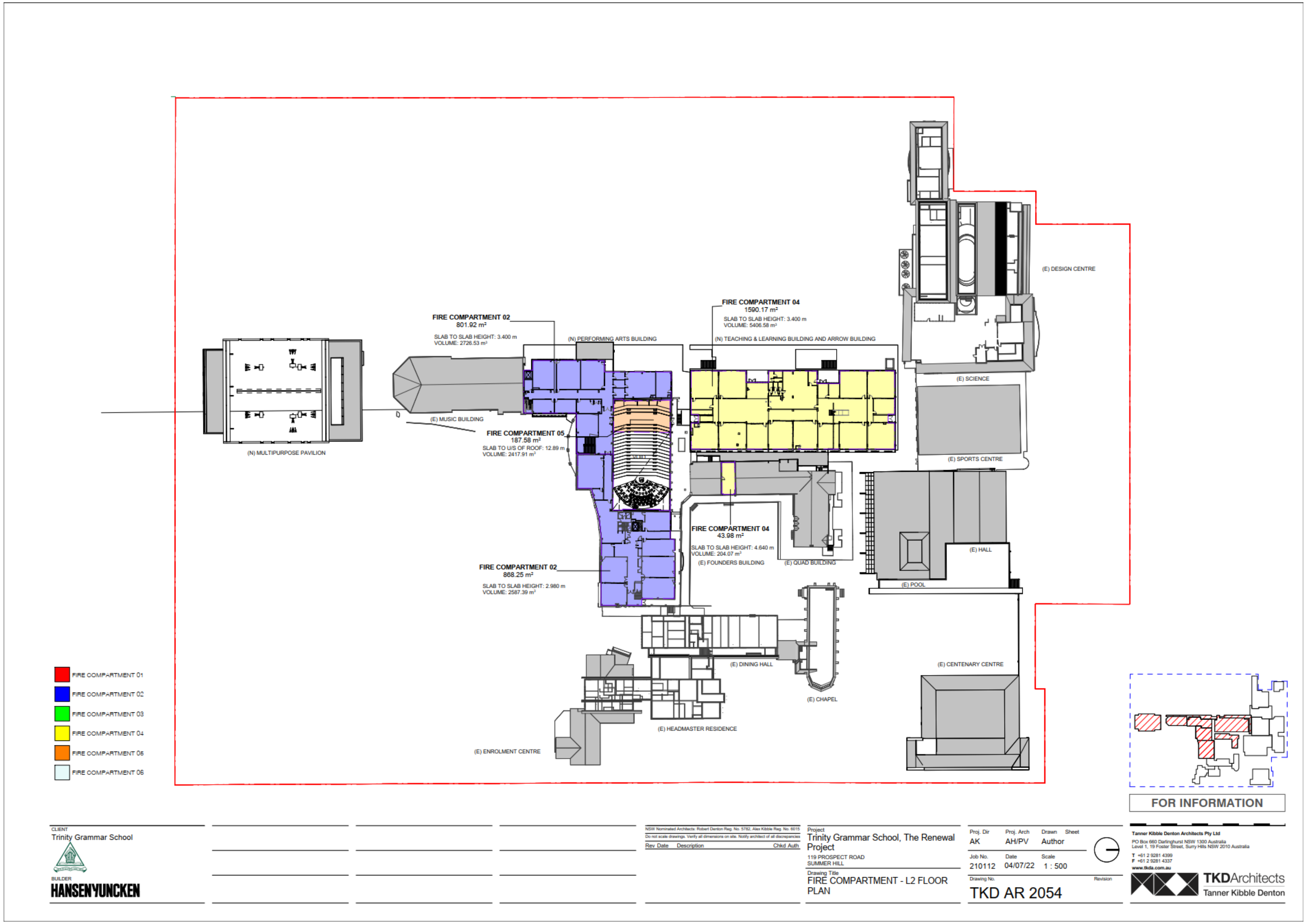
FIRE COMPARTMENT 02
801.92 m²
SLAB TO SLAB HEIGHT: 3.400 m
VOLUME: 2726.53 m³
(N) PERFORMING ARTS BUILDING
FIRE COMPARTMENT 04
1590.17 m²
SLAB TO SLAB HEIGHT: 3.400 m
VOLUME: 5406.58 m³
(N) TEACHING & LEARNING BUILDING AND ARROW BUILDING
(E) DESIGN CENTRE
(E) SCIENCE
(E) SPORTS CENTRE
(E) MUSIC BUILDING
(N) MULTIPURPOSE PAVILION
FIRE COMPARTMENT 05
187.58 m²
SLAB TO U/S OF ROOF: 12.89 m
VOLUME: 2417.91 m³
FIRE COMPARTMENT 04
43.98 m²
SLAB TO SLAB HEIGHT: 4.640 m
VOLUME: 204.07 m³
(E) FOUNDERS BUILDING
(E) QUAD BUILDING
(E) HALL
(E) POOL
FIRE COMPARTMENT 02
868.25 m²
SLAB TO SLAB HEIGHT: 2.980 m
VOLUME: 2587.39 m³
(E) DINING HALL
(E) CENTENARY CENTRE
(E) CHAPEL
(E) HEADMASTER RESIDENCE
(E) ENROLMENT CENTRE
FIRE COMPARTMENT 01
FIRE COMPARTMENT 02
FIRE COMPARTMENT 03
FIRE COMPARTMENT 04
FIRE COMPARTMENT 05
FIRE COMPARTMENT 06
FOR INFORMATION
CLIENT
Trinity Grammar School
BUILDER
HANSENYUNCKEN
NSW Nominated Architects: Robert Denton Reg. No. 5782, Alex Kibble Reg. No. 6015
Do not scale drawings. Verify all dimensions on site. Notify architect of all discrepancies
Rev Date Description Chkd Auth
Project
Trinity Grammar School, The Renewal Project
119 PROSPECT ROAD
SUMMER HILL
Drawing Title
FIRE COMPARTMENT - L2 FLOOR PLAN
Proj. Dir
AK
Proj. Arch
AH/PV
Drawn
Author
Sheet
Job No.
210112
Date
04/07/22
Scale
1 : 500
Drawing No.
TKD AR 2054
Revision
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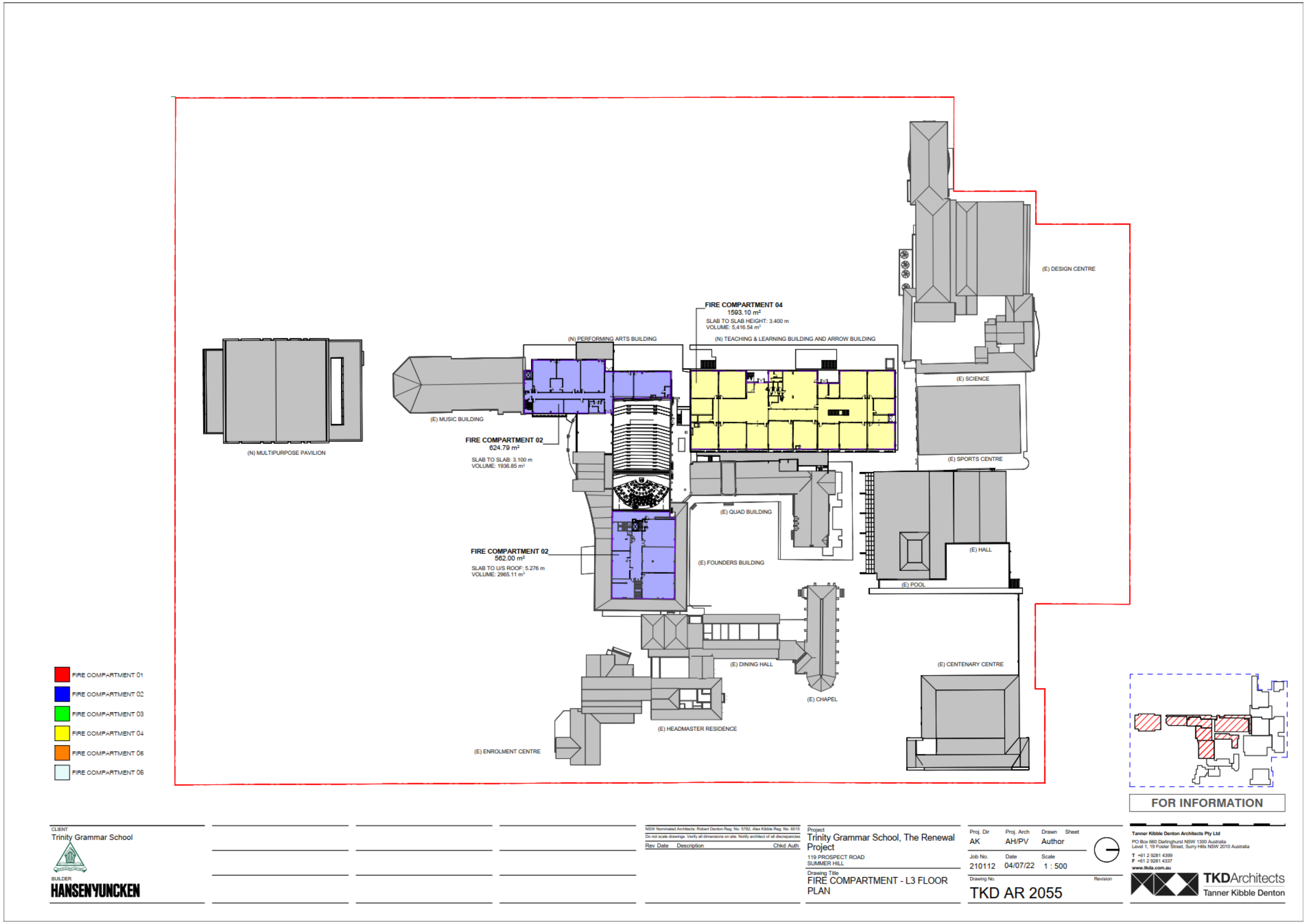
FIRE COMPARTMENT 04
1593.10 m²
SLAB TO SLAB HEIGHT: 3.400 m
VOLUME: 5,416.54 m³
(N) PERFORMING ARTS BUILDING
(N) TEACHING & LEARNING BUILDING AND ARROW BUILDING
(E) DESIGN CENTRE
(E) SCIENCE
(E) SPORTS CENTRE
(E) MUSIC BUILDING
(N) MULTIPURPOSE PAVILION
FIRE COMPARTMENT 02
624.79 m²
SLAB TO SLAB: 3.100 m
VOLUME: 1936.85 m³
(E) QUAD BUILDING
(E) HALL
FIRE COMPARTMENT 02
562.00 m²
SLAB TO U/S ROOF: 5.276 m
VOLUME: 2965.11 m³
(E) FOUNDERS BUILDING
(E) POOL
(E) DINING HALL
(E) CENTENARY CENTRE
(E) CHAPEL
(E) HEADMASTER RESIDENCE
(E) ENROLMENT CENTRE
FIRE COMPARTMENT 01
FIRE COMPARTMENT 02
FIRE COMPARTMENT 03
FIRE COMPARTMENT 04
FIRE COMPARTMENT 05
FIRE COMPARTMENT 06
FOR INFORMATION
CLIENT
Trinity Grammar School
BUILDER
HANSENYUNCKEN
NSW Nominated Architects: Robert Denton Reg. No. 5782, Alex Kibble Reg. No. 6015
Do not scale drawings. Verify all dimensions on site. Notify architect of all discrepancies
Rev Date Description Chkd Auth
Project
Trinity Grammar School, The Renewal Project
119 PROSPECT ROAD
SUMMER HILL
Drawing Title
FIRE COMPARTMENT - L3 FLOOR PLAN
Proj. Dir AK
Proj. Arch AH/PV
Drawn Author
Sheet
Job No. 210112
Date 04/07/22
Scale 1 : 500
Drawing No.
TKD AR 2055
Revision
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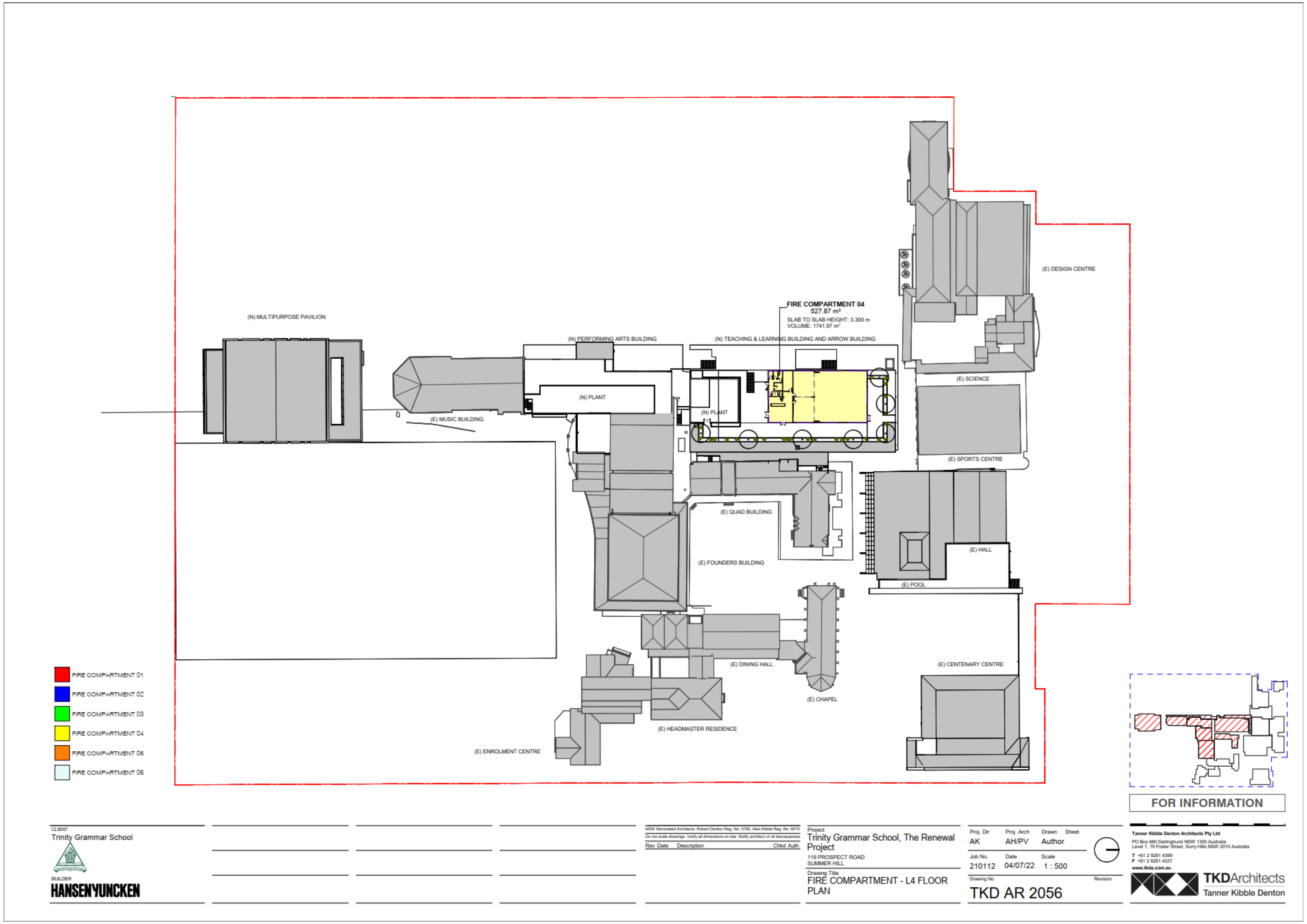
FIRE COMPARTMENT 04
527.87 m²
SLAB TO SLAB HEIGHT: 3.300 m
VOLUME: 1741.97 m³
(N) MULTIPURPOSE PAVILION
(N) PERFORMING ARTS BUILDING
(N) TEACHING & LEARNING BUILDING AND ARROW BUILDING
(N) PLANT
(N) PLANT
(E) MUSIC BUILDING
(E) DESIGN CENTRE
(E) SCIENCE
(E) SPORTS CENTRE
(E) QUAD BUILDING
(E) FOUNDERS BUILDING
(E) HALL
(E) POOL
(E) DINING HALL
(E) CHAPEL
(E) CENTENARY CENTRE
(E) HEADMASTER RESIDENCE
(E) ENROLMENT CENTRE
FIRE COMPARTMENT 01
FIRE COMPARTMENT 02
FIRE COMPARTMENT 03
FIRE COMPARTMENT 04
FIRE COMPARTMENT 05
FIRE COMPARTMENT 06
FOR INFORMATION
CLIENT
Trinity Grammar School
BUILDER
HANSENYUNCKEN
Rev Date Description Chkd Auth
Project
Trinity Grammar School, The Renewal Project
119 PROSPECT ROAD
SUMMER HILL
Drawing Title
FIRE COMPARTMENT - L4 FLOOR PLAN
Proj. Dir AK
Proj. Arch AH/PV
Drawn Author
Sheet
Job No. 210112
Date 04/07/22
Scale 1 : 500
Drawing No.
TKD AR 2056
Revision
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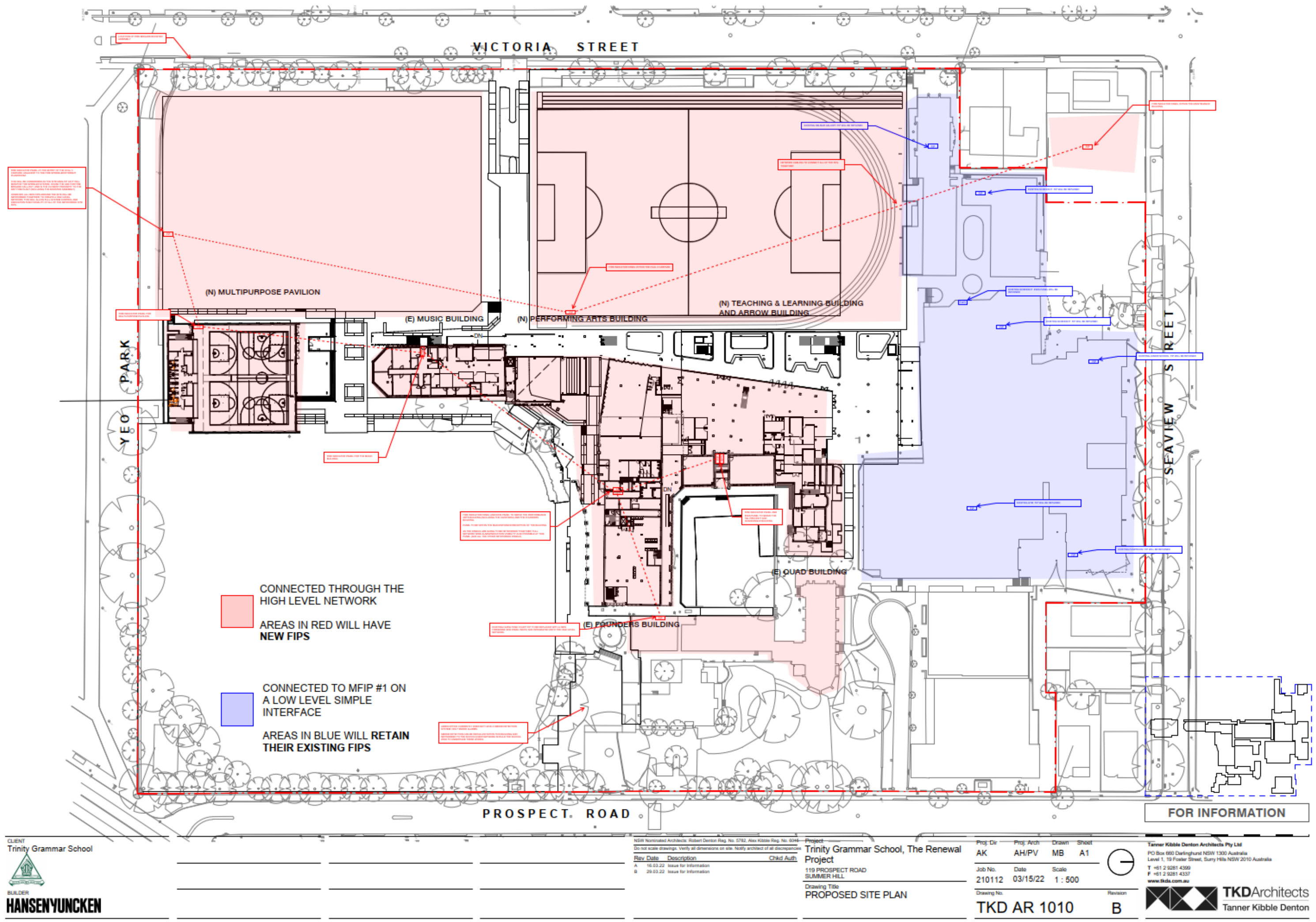
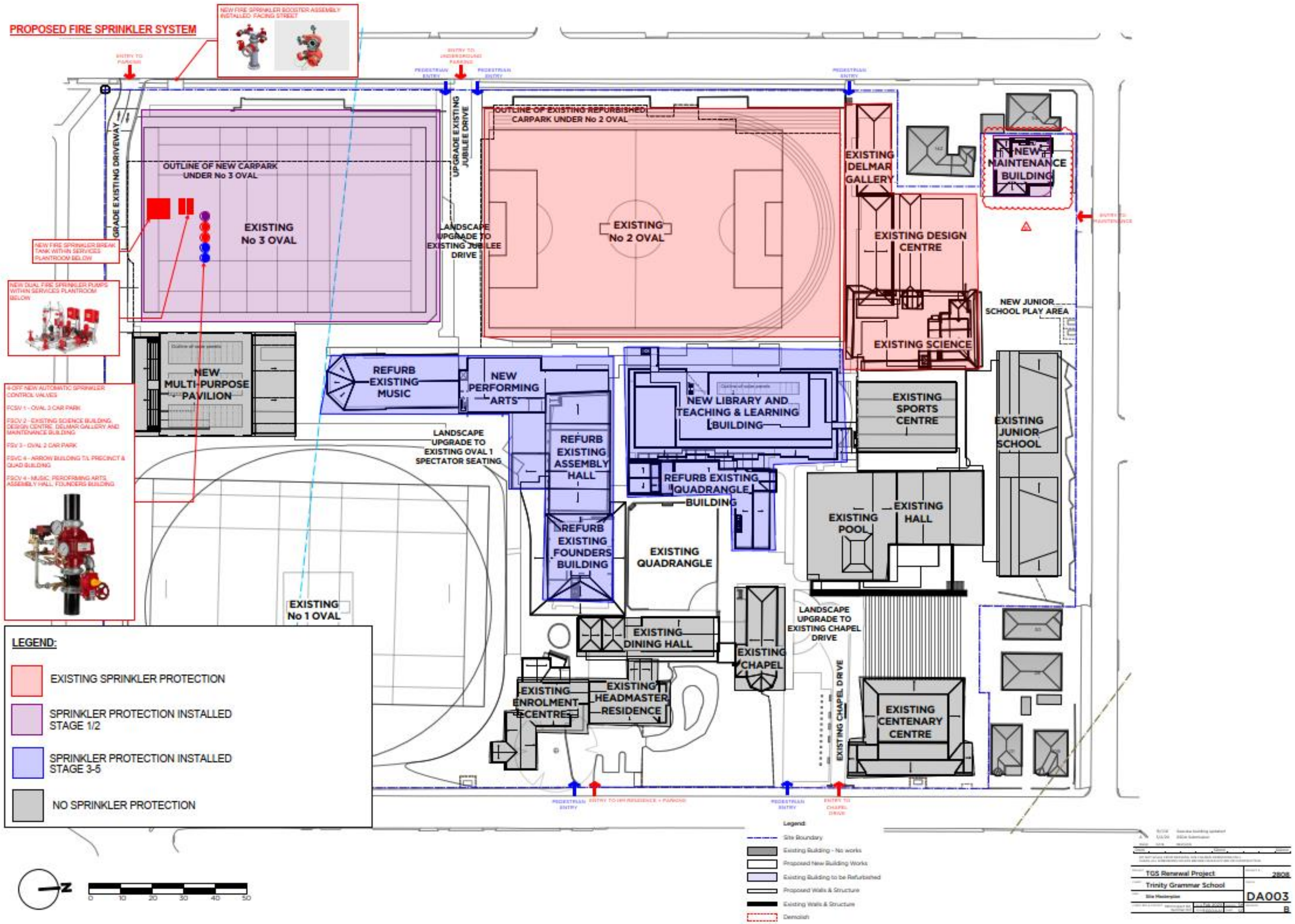
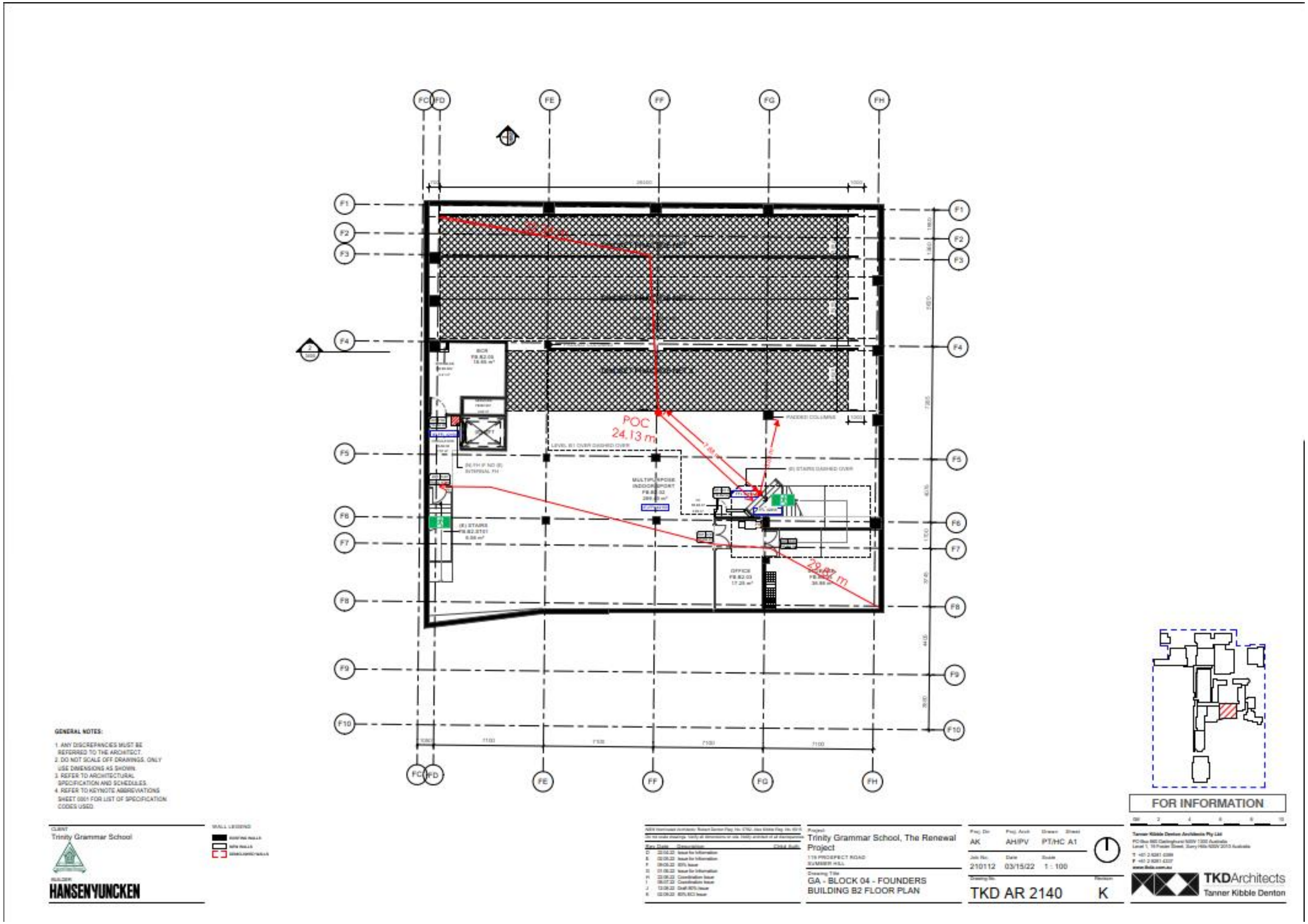
Appendix K. FIP Network Strategy

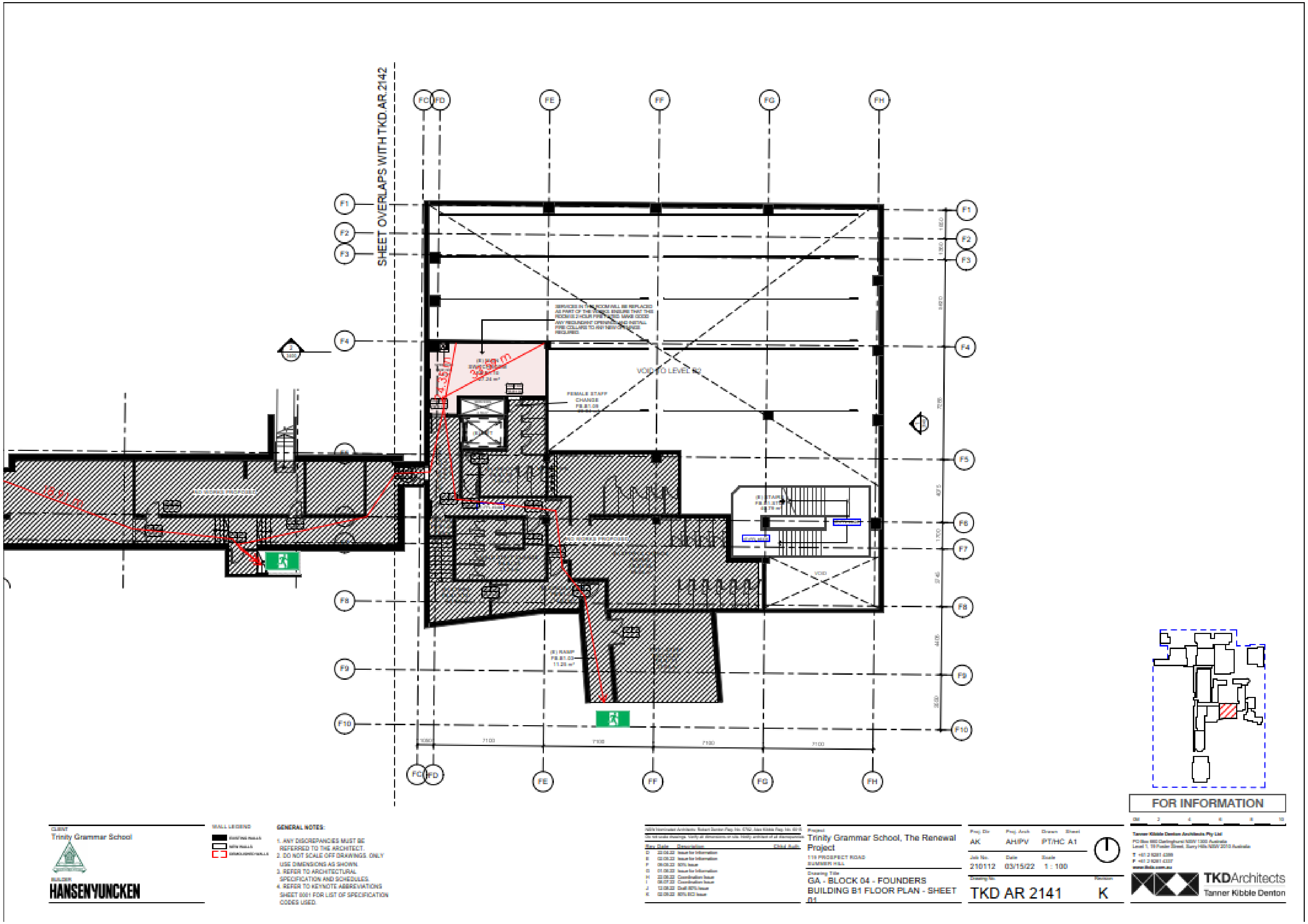


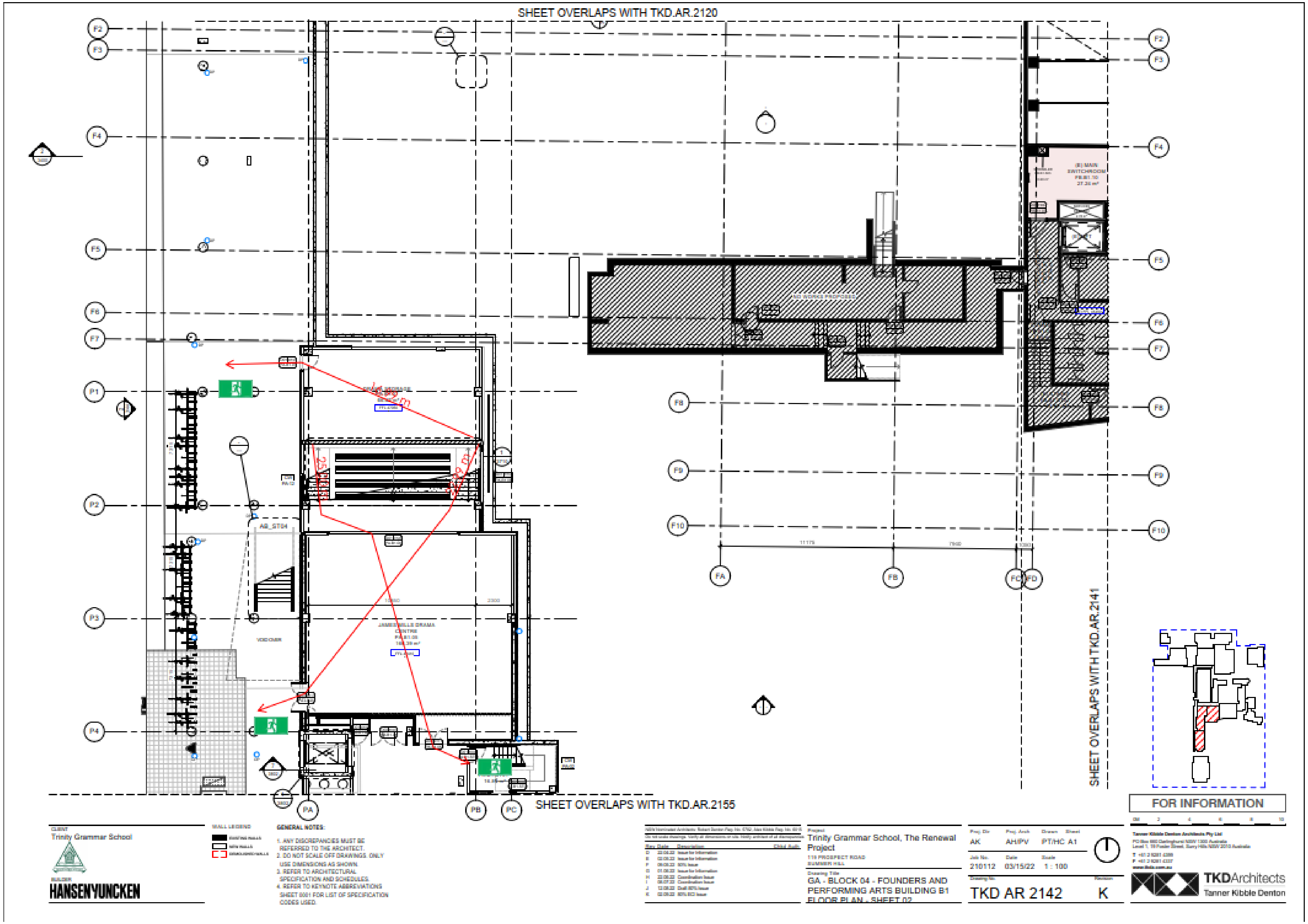
Appendix L. Proposed Extent of Sprinkler Protection



Appendix M. Hydrant and Egress Mark-up


POC
24.13 m
29.8? m
MULTIPURPOSE INDOOR SPORT
OFFICE
(E) STAIRS
FOR INFORMATION
Trinity Grammar School
HANSENYUNCKEN
Trinity Grammar School, The Renewal Project
GA - BLOCK 04 - FOUNDERS BUILDING B2 FLOOR PLAN
TKD AR 2140
K
AK
AH/PV
PT/HC A1
210112
03/15/22
1 : 100
TKDArchitects
Tanner Kibble Denton


SHEET OVERLAPS WITH TKD AR 2142
VOID TO LEVEL 00
FOR INFORMATION
Trinity Grammar School
HANSENYUNCKEN
GENERAL NOTES:
Trinity Grammar School, The Renewal Project
GA - BLOCK 04 - FOUNDERS BUILDING B1 FLOOR PLAN - SHEET 01
TKD AR 2141
K
TKDArchitects
Tanner Kibble Denton


SHEET OVERLAPS WITH TKD.AR.2120
SHEET OVERLAPS WITH TKD.AR.2155
SHEET OVERLAPS WITH TKD.AR.2141
AB_ST04
JAMES MILLS DRAMA CENTRE
VOID OVER
(E) MAIN SWITCHROOM
NO WORKS PROPOSED
FOR INFORMATION
CLIENT
Trinity Grammar School
BUILDER
HANSENYUNCKEN
WALL LEGEND
GENERAL NOTES:
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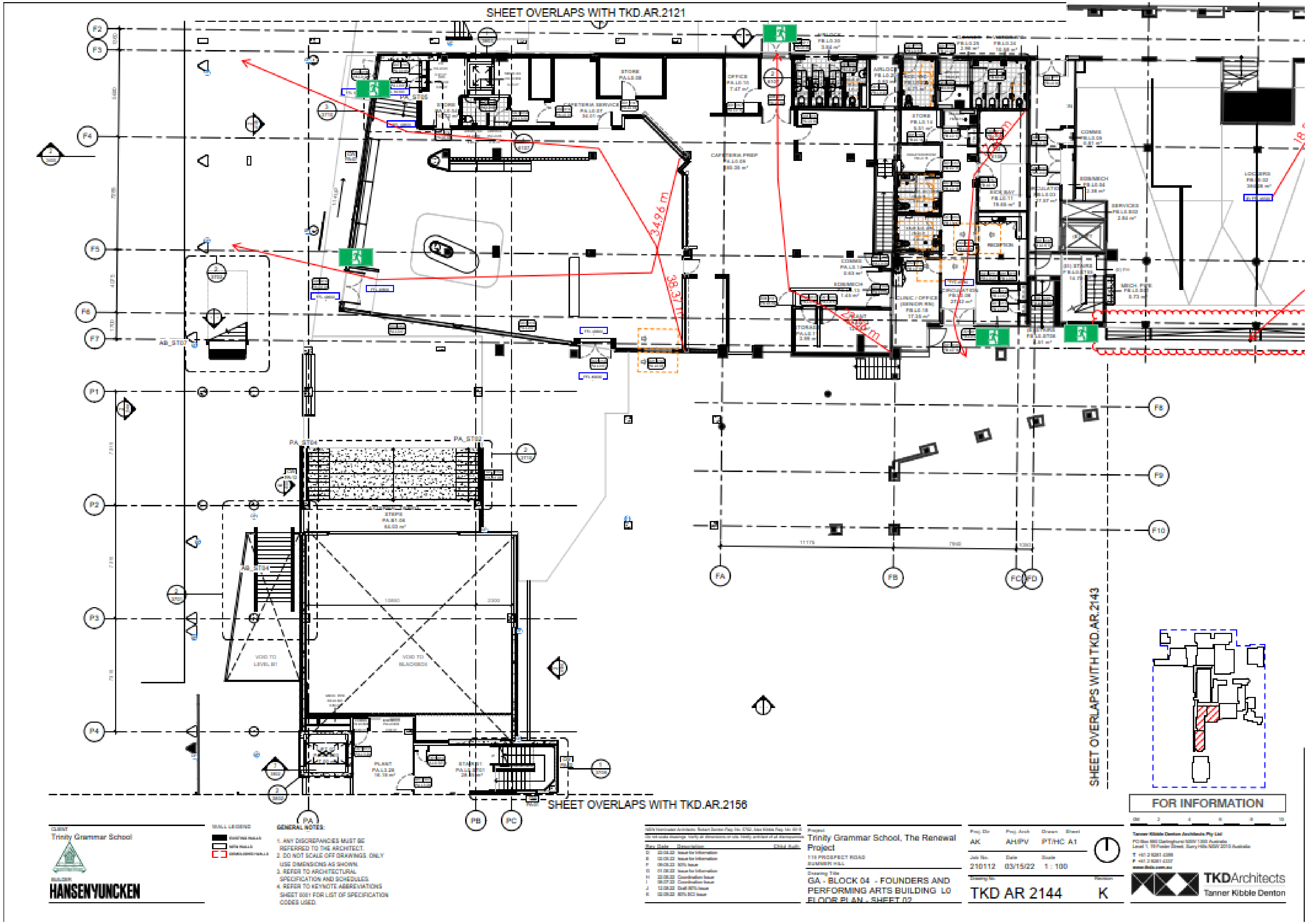
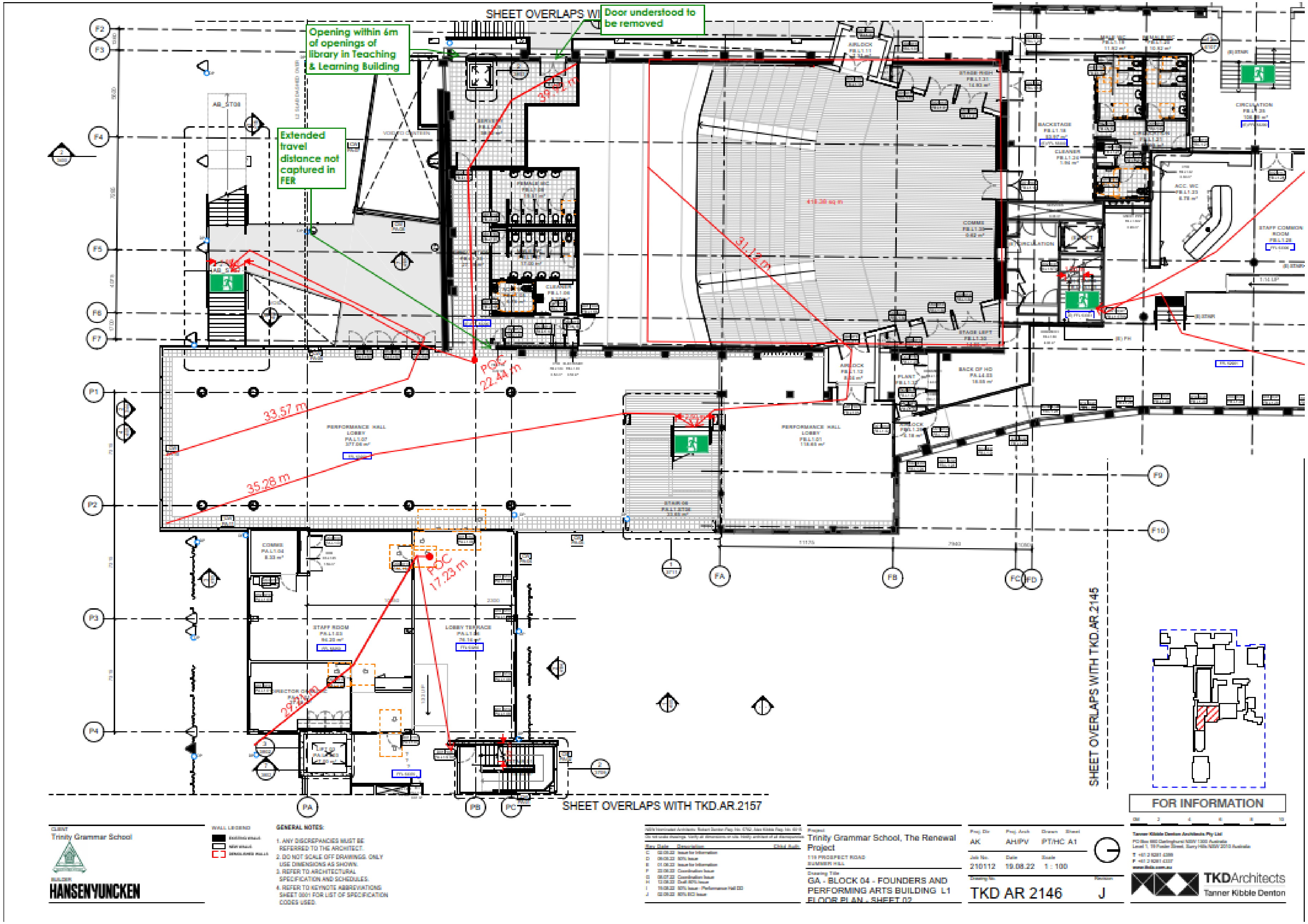
4. REFER TO KEYNOTE ABBREVIATIONS SHEET 0001 FOR LIST OF SPECIFICATION CODES USED.
Project
Trinity Grammar School, The Renewal Project
119 PROSPECT ROAD SUMMER HILL
Drawing Title
GA - BLOCK 04 - FOUNDERS AND PERFORMING ARTS BUILDING B1 FLOOR PLAN - SHEET 02
Proj. Dir AK
Proj. Arch AH/PV
Drawn PT/HC
Sheet A1
Job No. 210112
Date 03/15/22
Scale 1 : 100
Drawing No. TKD AR 2142
Revision K
TKDArchitects
Tanner Kibble Denton


SHEET OVERLAPS WITH TKD.AR.2121
SHEET OVERLAPS WITH TKD.AR.2156
SHEET OVERLAPS WITH TKD.AR.2143
34.96 m
38.37 m
FOR INFORMATION
Trinity Grammar School
HANSENYUNCKEN
Trinity Grammar School, The Renewal Project
GA - BLOCK 04 - FOUNDERS AND PERFORMING ARTS BUILDING L0 FLOOR PLAN - SHEET 02
TKD AR 2144
K
TKDArchitects
Tanner Kibble Denton


Opening within 6m of openings of library in Teaching & Learning Building
Door understood to be removed
Extended travel distance not captured in FER
39.12 m
31.12 m
33.57 m
35.28 m
POC 22.44 m
POC 17.23 m
PERFORMANCE HALL LOBBY
STAFF ROOM
LOBBY TERRACE
BACK OF HO
STAFF COMMON ROOM
SHEET OVERLAPS WITH TKD.AR.2157
SHEET OVERLAPS WITH TKD.AR.2145
FOR INFORMATION
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HANSENYUNCKEN
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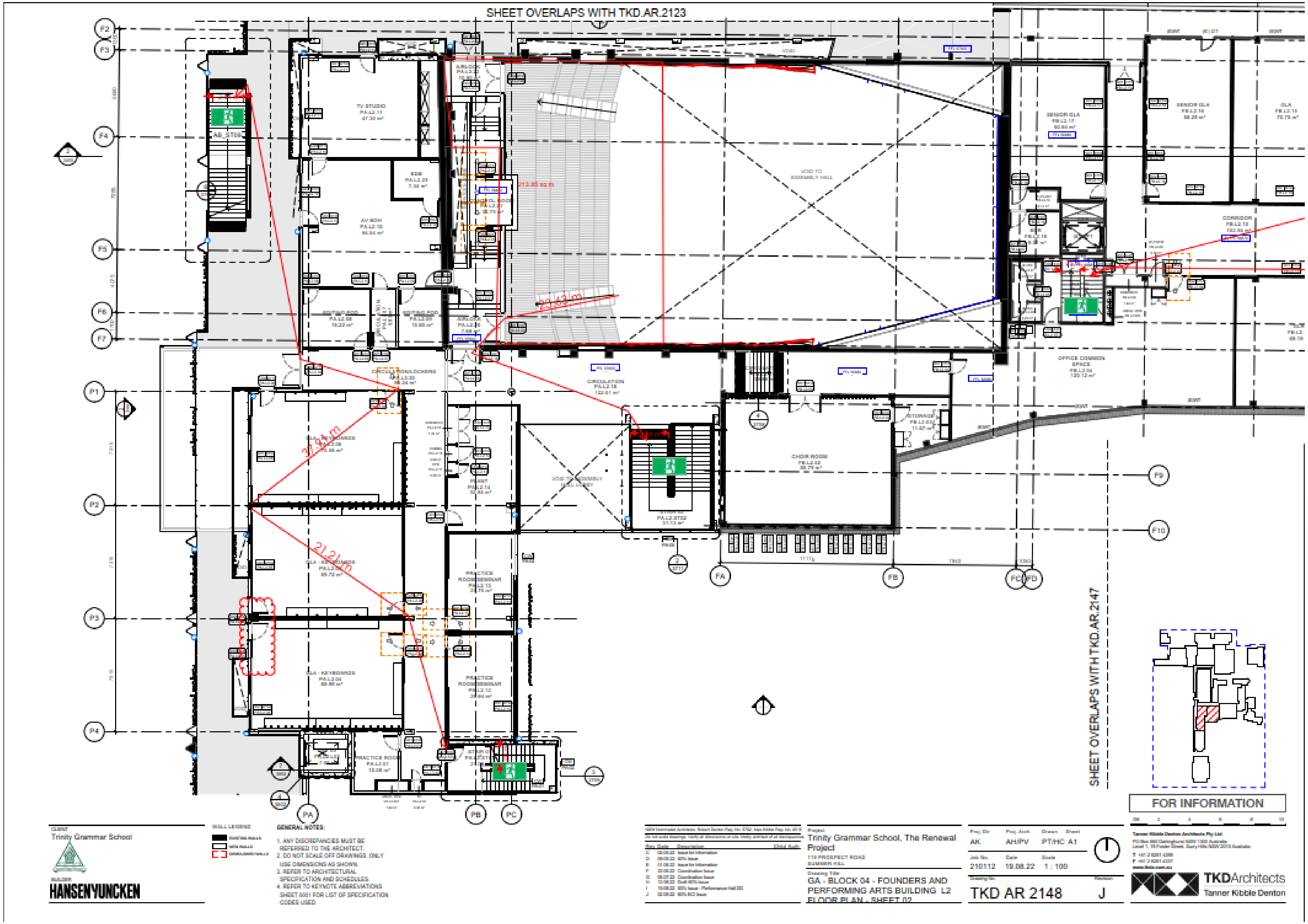
4. REFER TO KEYNOTE ABBREVIATIONS SHEET 0001 FOR LIST OF SPECIFICATION CODES USED.
Trinity Grammar School, The Renewal Project
GA - BLOCK 04 - FOUNDERS AND PERFORMING ARTS BUILDING L1 FLOOR PLAN - SHEET 02
AK
AH/PV
PT/HC A1
210112
19.08.22
1 : 100
TKD AR 2146
J
TKDArchitects
Tanner Kibble Denton


SHEET OVERLAPS WITH TKD.AR.2123
SHEET OVERLAPS WITH TKD.AR.2147
FOR INFORMATION
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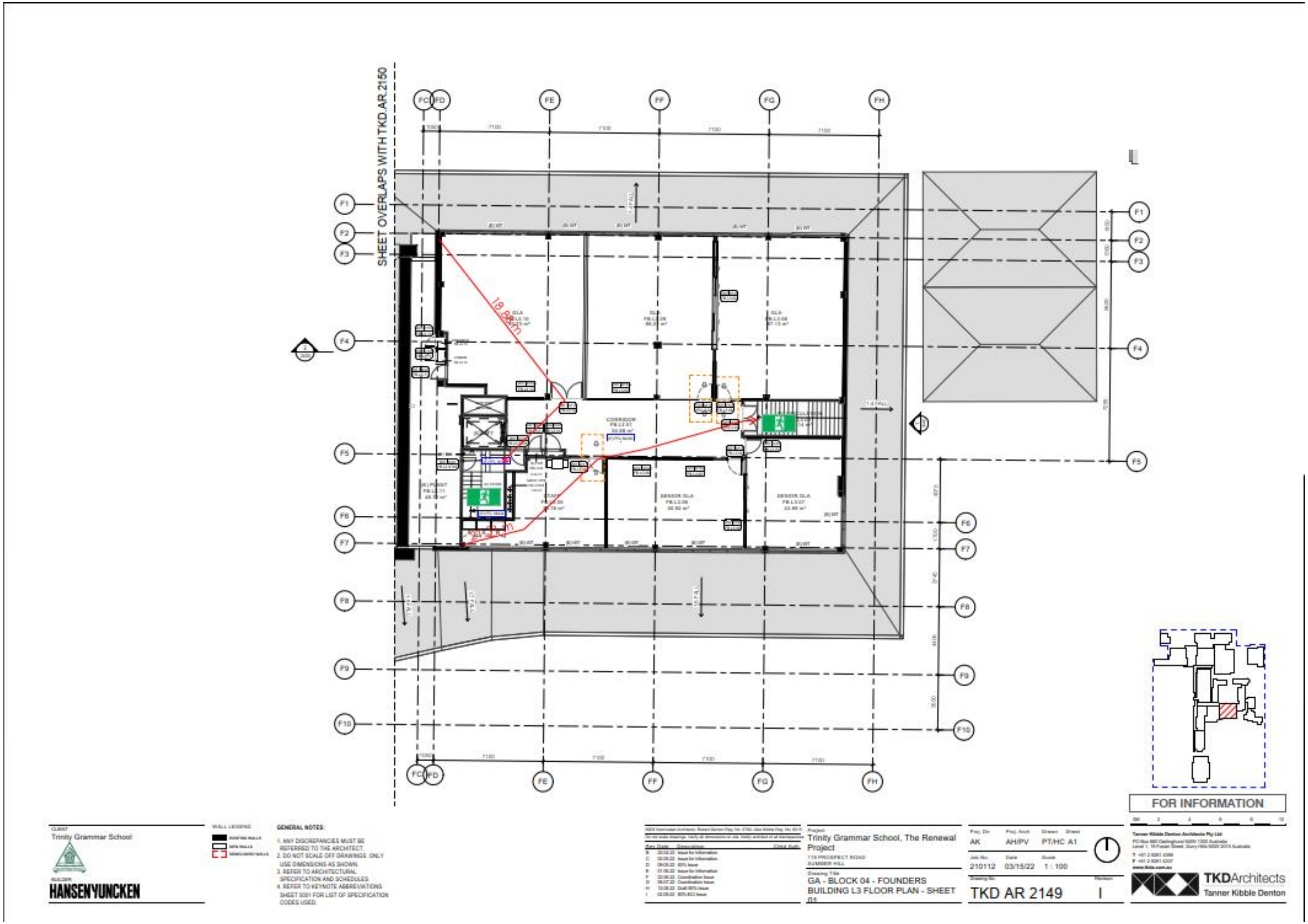
3. REFER TO ARCHITECTURAL SPECIFICATION AND SCHEDULES.
4. REFER TO KEYNOTE ABBREVIATIONS SHEET 0001 FOR LIST OF SPECIFICATION CODES USED.
Trinity Grammar School, The Renewal Project
GA - BLOCK 04 - FOUNDERS AND PERFORMING ARTS BUILDING L2 FLOOR PLAN - SHEET 02
AK
AH/PV
PT/HC
A1
210112
19.08.22
1 : 100
TKD AR 2148
J
TKDArchitects
Tanner Kibble Denton


SHEET OVERLAPS WITH TKD.AR.2150
FC
FD
FE
FF
FG
FH
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10
FOR INFORMATION
Trinity Grammar School
HANSENYUNCKEN
GENERAL NOTES:
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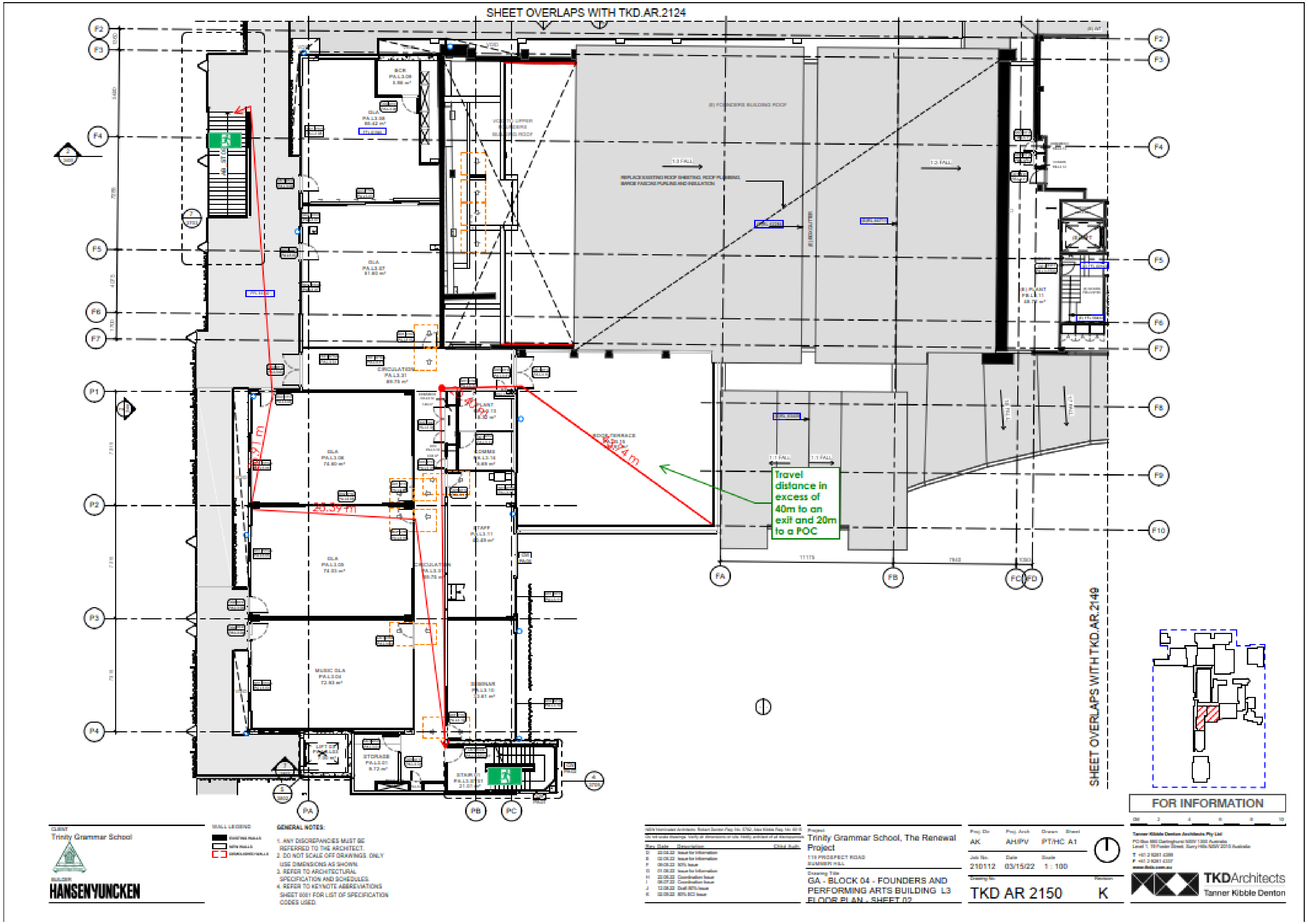
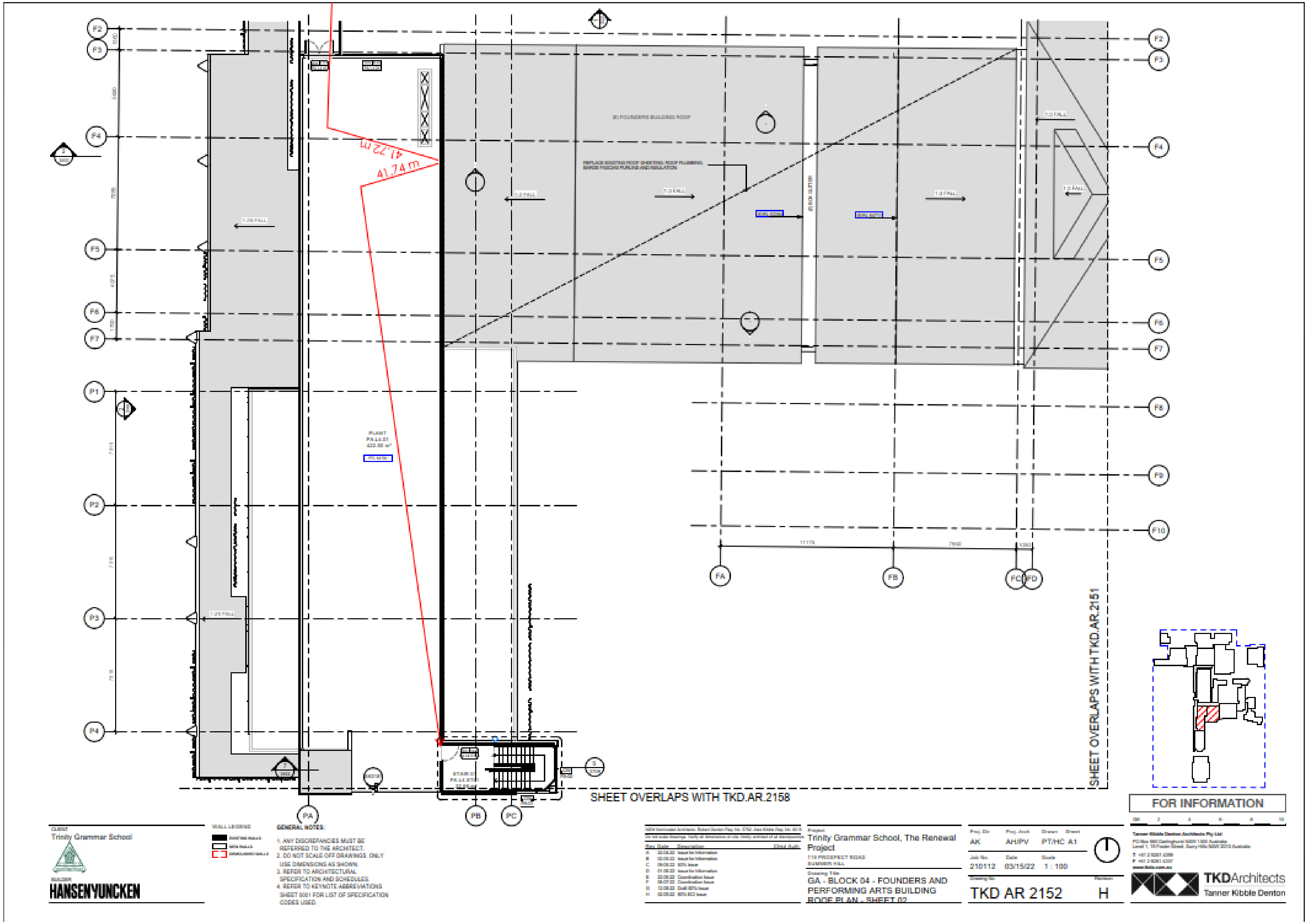
3. REFER TO ARCHITECTURAL SPECIFICATION AND SCHEDULES.
4. REFER TO KEYNOTE ABBREVIATIONS SHEET 0001 FOR LIST OF SPECIFICATION CODES USED.
Trinity Grammar School, The Renewal Project
GA - BLOCK 04 - FOUNDERS BUILDING L3 FLOOR PLAN - SHEET 01
AK
AH/PV
PT/HC
A1
210112
03/15/22
1 : 100
TKD AR 2149
I
TKDArchitects
Tanner Kibble Denton


SHEET OVERLAPS WITH TKD.AR.2124
SHEET OVERLAPS WITH TKD.AR.2149
Travel distance in excess of 40m to an exit and 20m to a POC
23.3y m
CIRCULATION
GLA
MUSIC GLA
STAFF
SEMINAR
STORAGE
PLANT
COMMS
ROOF TERRACE
FOR INFORMATION
Trinity Grammar School
HANSENYUNCKEN
GENERAL NOTES:
Trinity Grammar School, The Renewal Project
GA - BLOCK 04 - FOUNDERS AND PERFORMING ARTS BUILDING L3 FLOOR PLAN - SHEET 02
TKD AR 2150
K
TKDArchitects
Tanner Kibble Denton


41.72 m
41.74 m
SHEET OVERLAPS WITH TKD.AR.2158
SHEET OVERLAPS WITH TKD.AR.2151
FOR INFORMATION
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HANSENYUNCKEN
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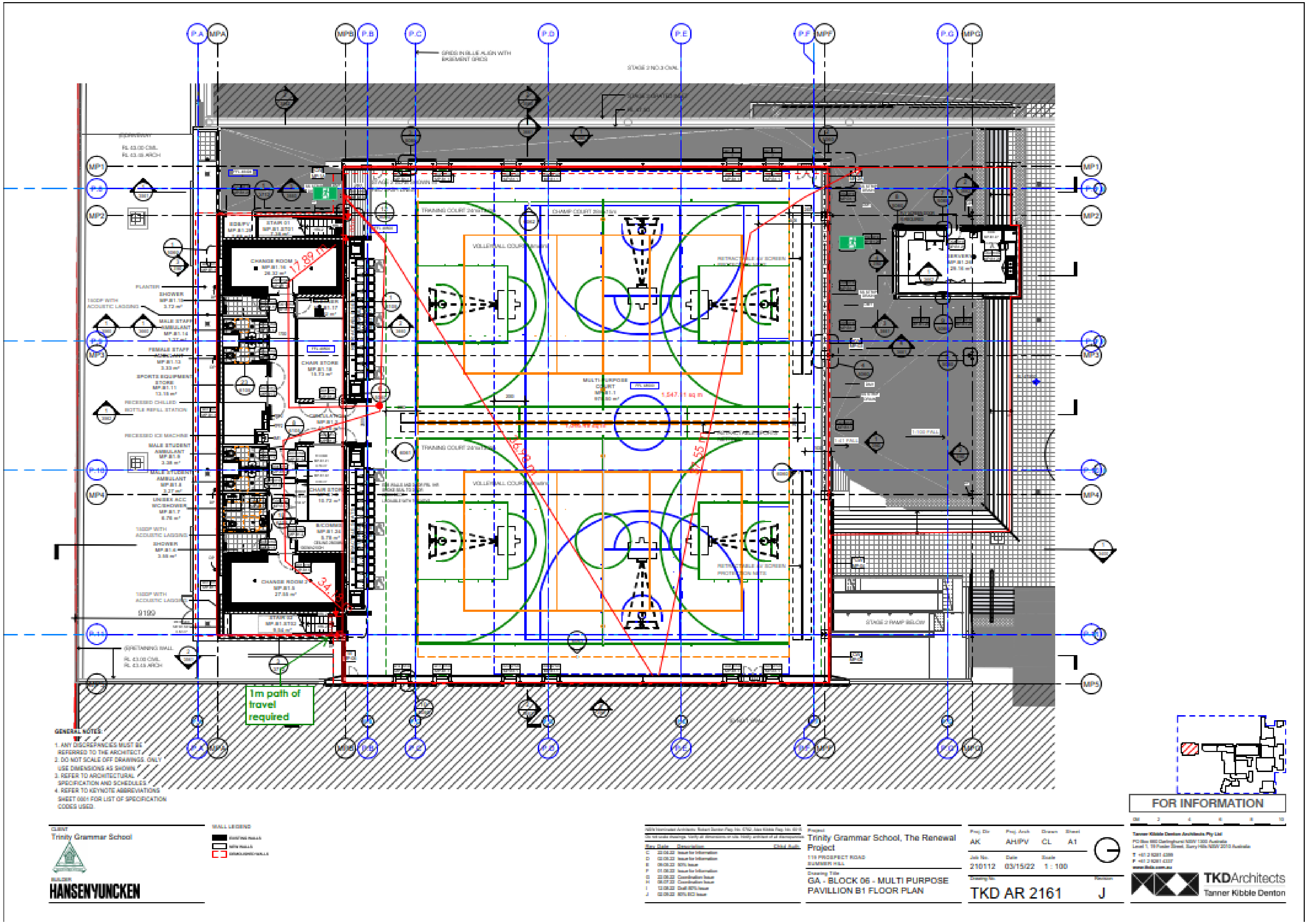
3. REFER TO ARCHITECTURAL SPECIFICATION AND SCHEDULES.
4. REFER TO KEYNOTE ABBREVIATIONS SHEET 0001 FOR LIST OF SPECIFICATION CODES USED.
Trinity Grammar School, The Renewal Project
GA - BLOCK 04 - FOUNDERS AND PERFORMING ARTS BUILDING ROOF PLAN - SHEET 02
AK
AH/PV
PT/HC
A1
210112
03/15/22
1 : 100
TKD AR 2152
H
TKDArchitects
Tanner Kibble Denton


1m path of travel required
17.89 m
34.6 m
26.78 m
27.55 m
1,547.1 sq m
CHANGE ROOM 1
CHANGE ROOM 2
STAIR 01
STAIR 02
CHAIR STORE
MULTI PURPOSE COURT
TRAINING COURT 24x14m
CHAMP COURT 28x15m
VOLLEYBALL COURT
GENERAL NOTES:
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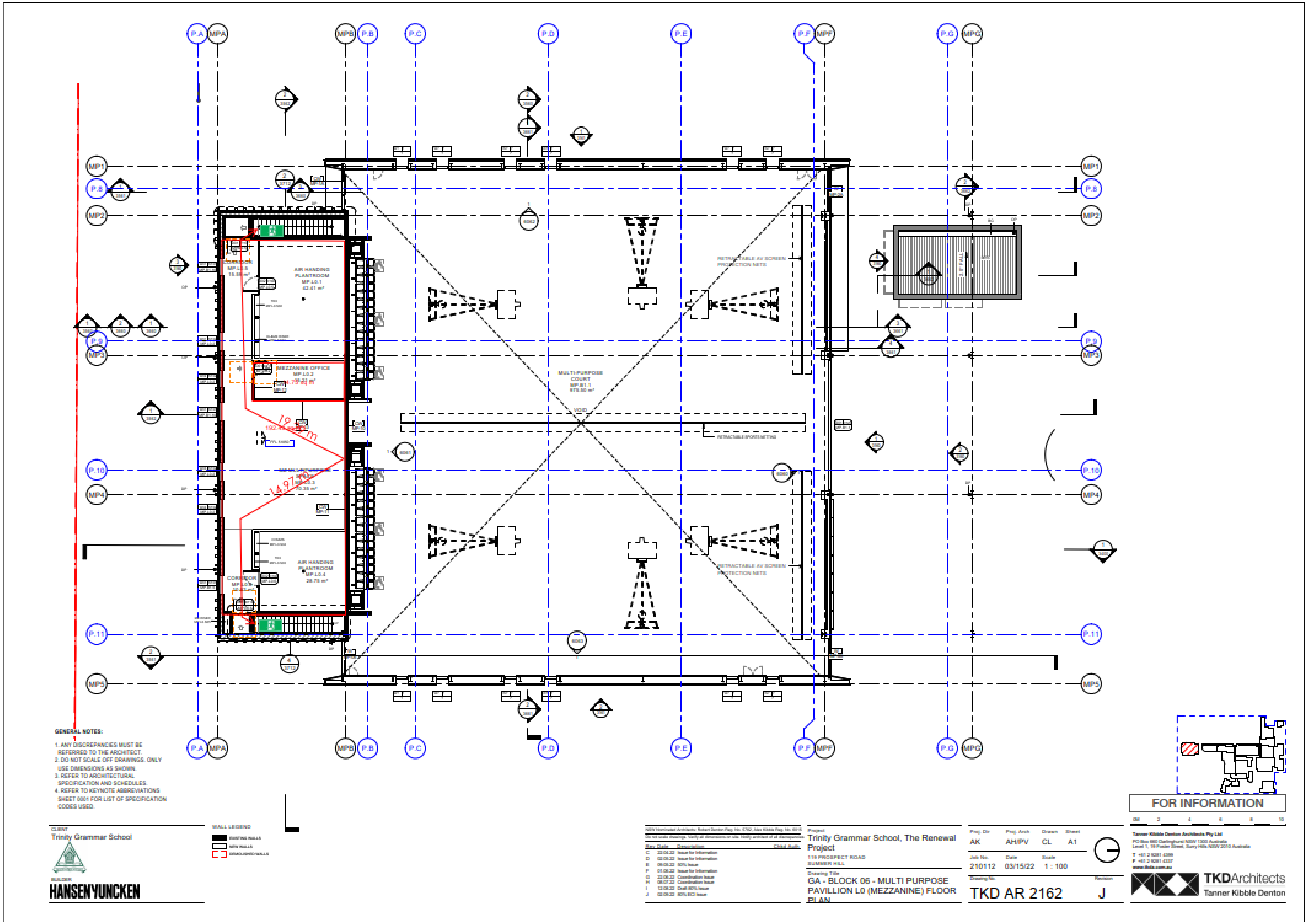
2. DO NOT SCALE OFF DRAWINGS. ONLY USE DIMENSIONS AS SHOWN
3. REFER TO ARCHITECTURAL SPECIFICATION AND SCHEDULES
4. REFER TO KEYNOTE ABBREVIATIONS SHEET 0001 FOR LIST OF SPECIFICATION CODES USED.
Client
Trinity Grammar School
Builder
HANSENYUNCKEN
FOR INFORMATION
Trinity Grammar School, The Renewal Project
119 PROSPECT ROAD SUMMER HILL
GA - BLOCK 06 - MULTI PURPOSE PAVILLION B1 FLOOR PLAN
AK
AH/PV
CL
A1
210112
03/15/22
1 : 100
TKD AR 2161
J
TKDArchitects
Tanner Kibble Denton


GENERAL NOTES:
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2. DO NOT SCALE OFF DRAWINGS. ONLY USE DIMENSIONS AS SHOWN.
3. REFER TO ARCHITECTURAL SPECIFICATION AND SCHEDULES.
4. REFER TO KEYNOTE ABBREVIATIONS SHEET 0001 FOR LIST OF SPECIFICATION CODES USED.
CLIENT
Trinity Grammar School
HANSENYUNCKEN
MULTI-PURPOSE COURT
AIR HANDLING PLANTROOM
MEZZANINE OFFICE
FOR INFORMATION
Project
Trinity Grammar School, The Renewal Project
119 PROSPECT ROAD
SUMMER HILL
Drawing Title
GA - BLOCK 06 - MULTI PURPOSE PAVILLION L0 (MEZZANINE) FLOOR PLAN
AK
AH/PV
CL
A1
210112
03/15/22
1 : 100
TKD AR 2162
J
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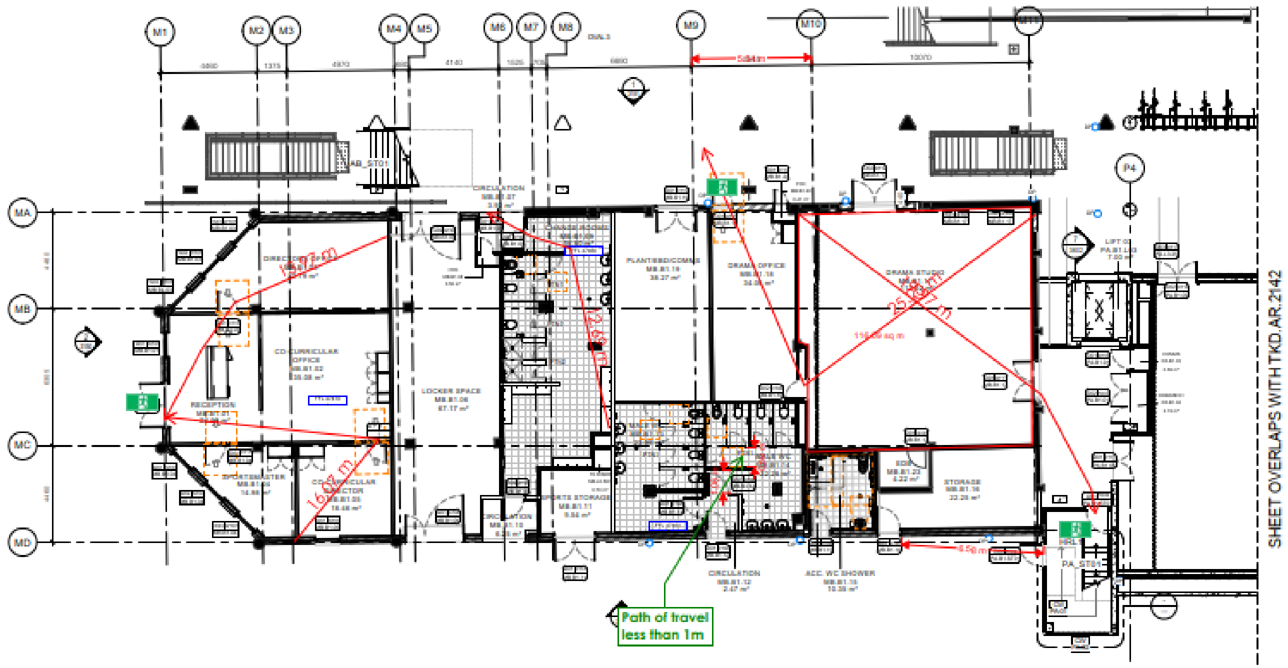
Tanner Kibble Denton



GENERAL NOTES:

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2. DO NOT SCALE OFF DRAWINGS. ONLY USE DIMENSIONS AS SHOWN.
3. REFER TO ARCHITECTURAL SPECIFICATION AND SCHEDULES.
4. REFER TO KEYNOTE ABBREVIATIONS SHEET 0001 FOR LIST OF SPECIFICATION CODES USED.

CLIENT
Trinity Grammar School

BUILDER
HANSENYUNCKEN

Rev	Date	Description
B	22.03.22	Issue for Information
C	02.05.22	Issue for Information
D	09.05.22	50% Issue
E	01.06.22	Issue for Information
F	22.06.22	Coordination Issue
G	08.07.22	Coordination Issue
H	12.08.22	Draft 80% Issue
I	02.09.22	80% ECI Issue

Project: Trinity Grammar School, The Renewal Project
116 PROSPECT ROAD
SUMMER HILL

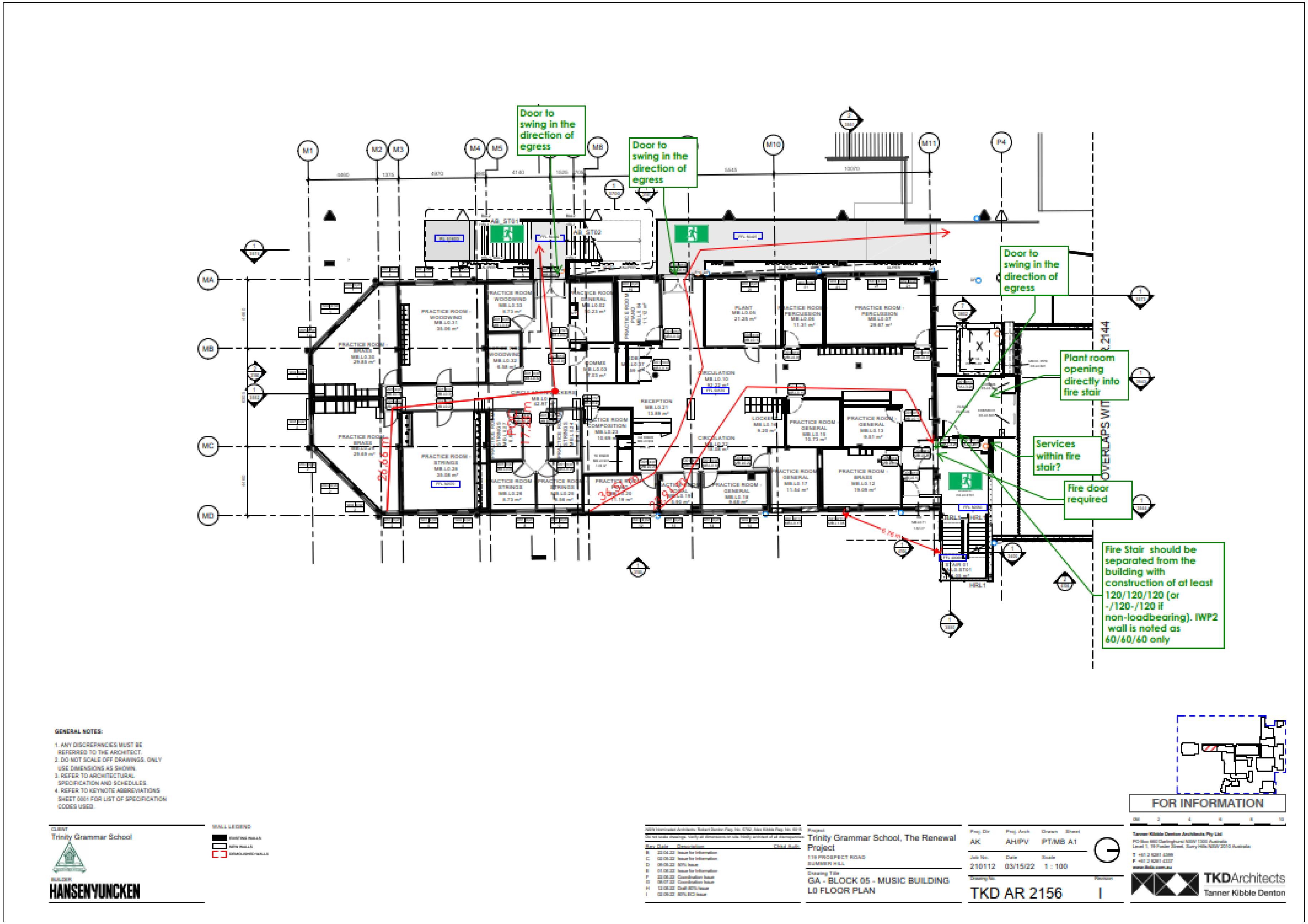
Drawing Title: GA - BLOCK 05 - MUSIC BUILDING B1 FLOOR PLAN

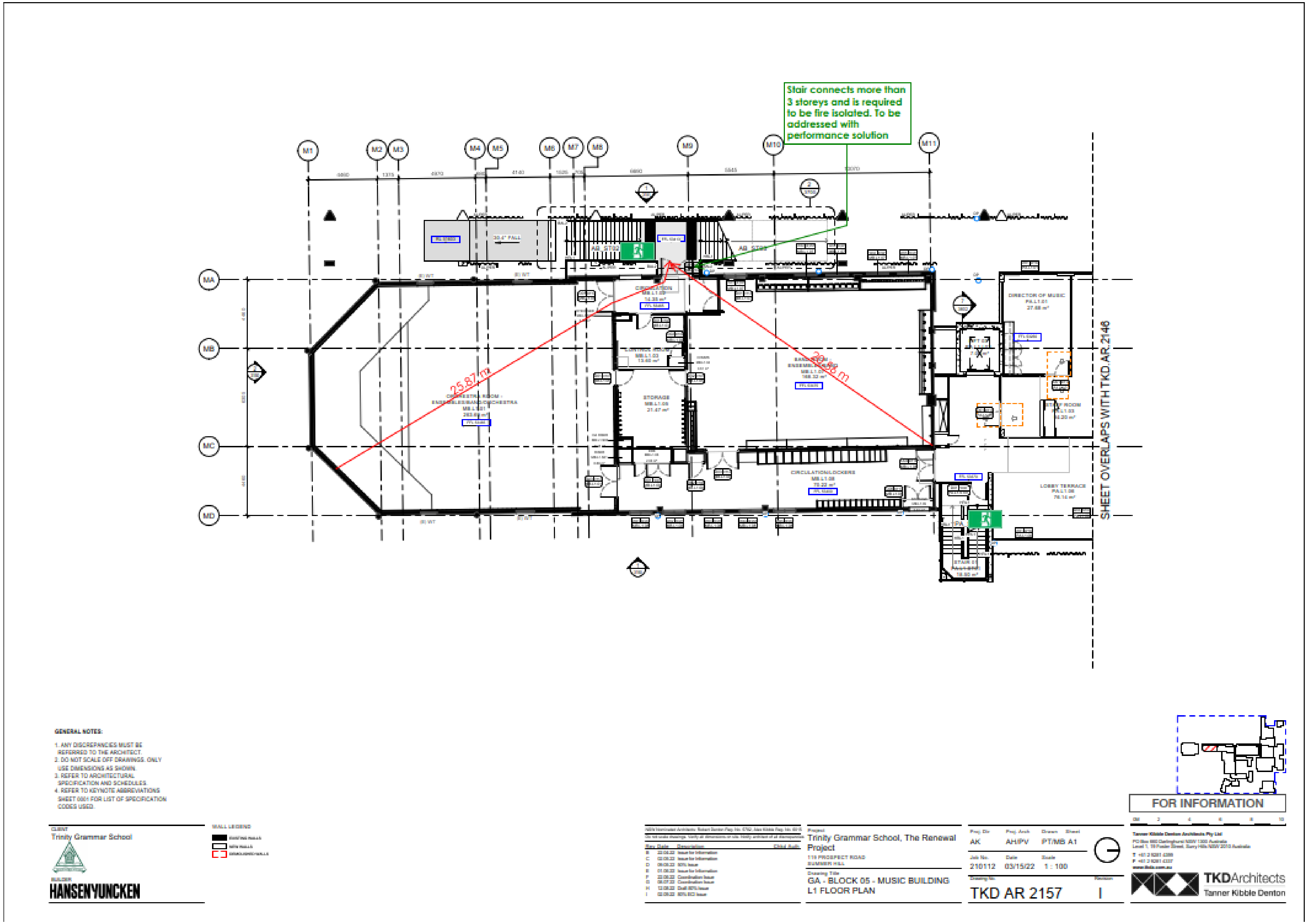
Proj. Dir	Proj. Arch	Drawn	Sheet
AK	AH/PV	PT/MB	A1

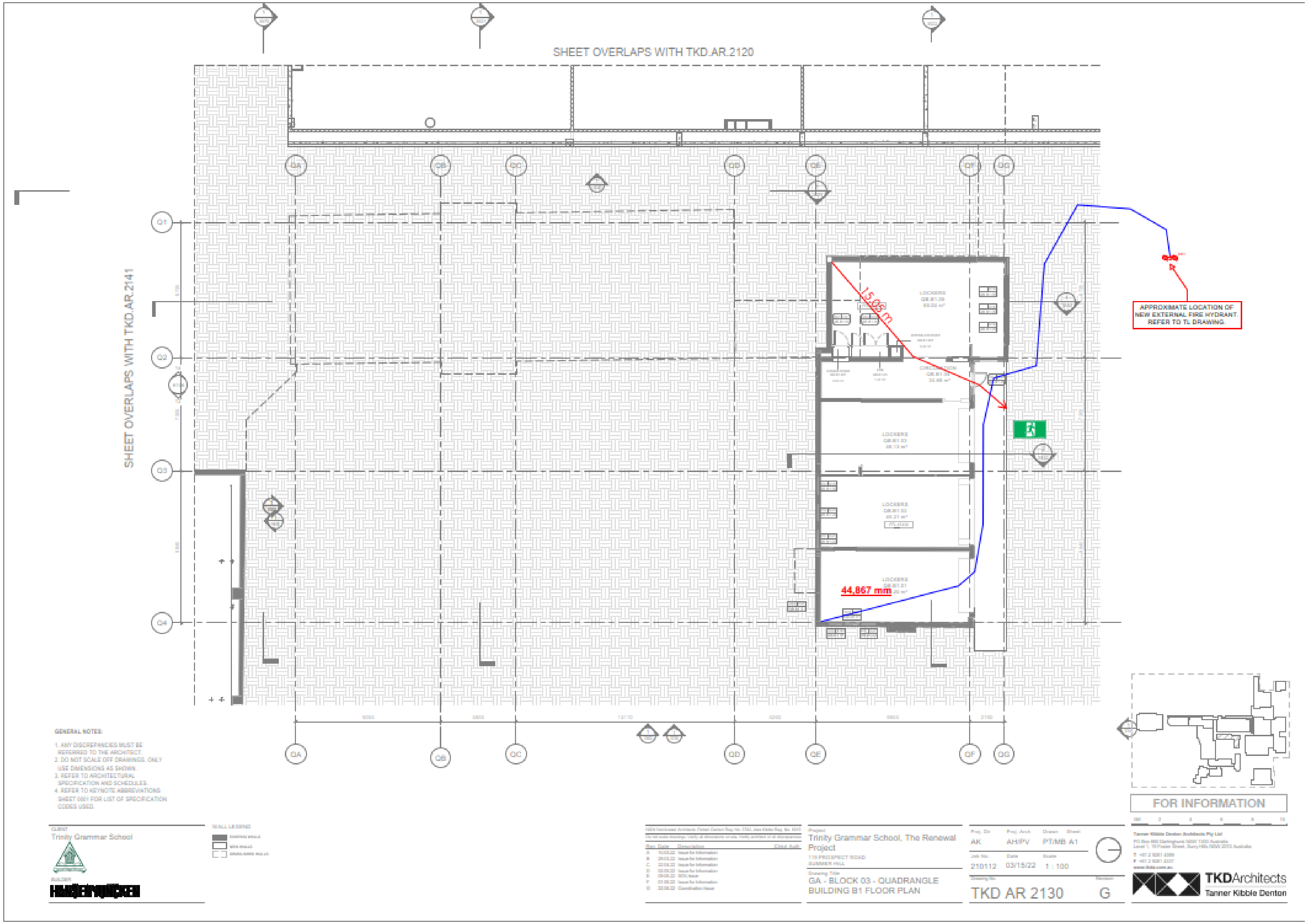
Job No.	Date	Scale
210112	03/15/22	1 : 100

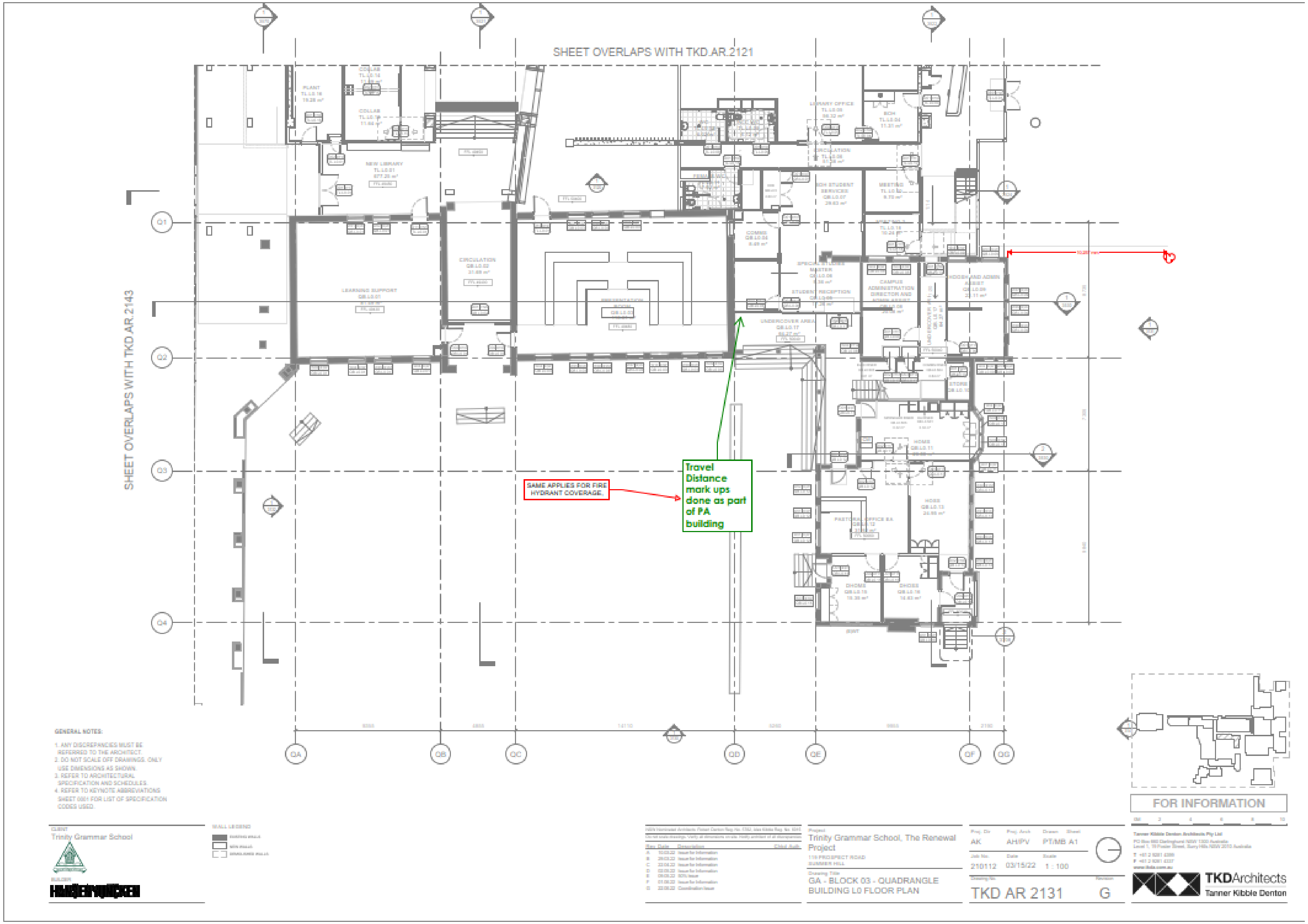
Drawing No.: TKD AR 2155 — Revision: I

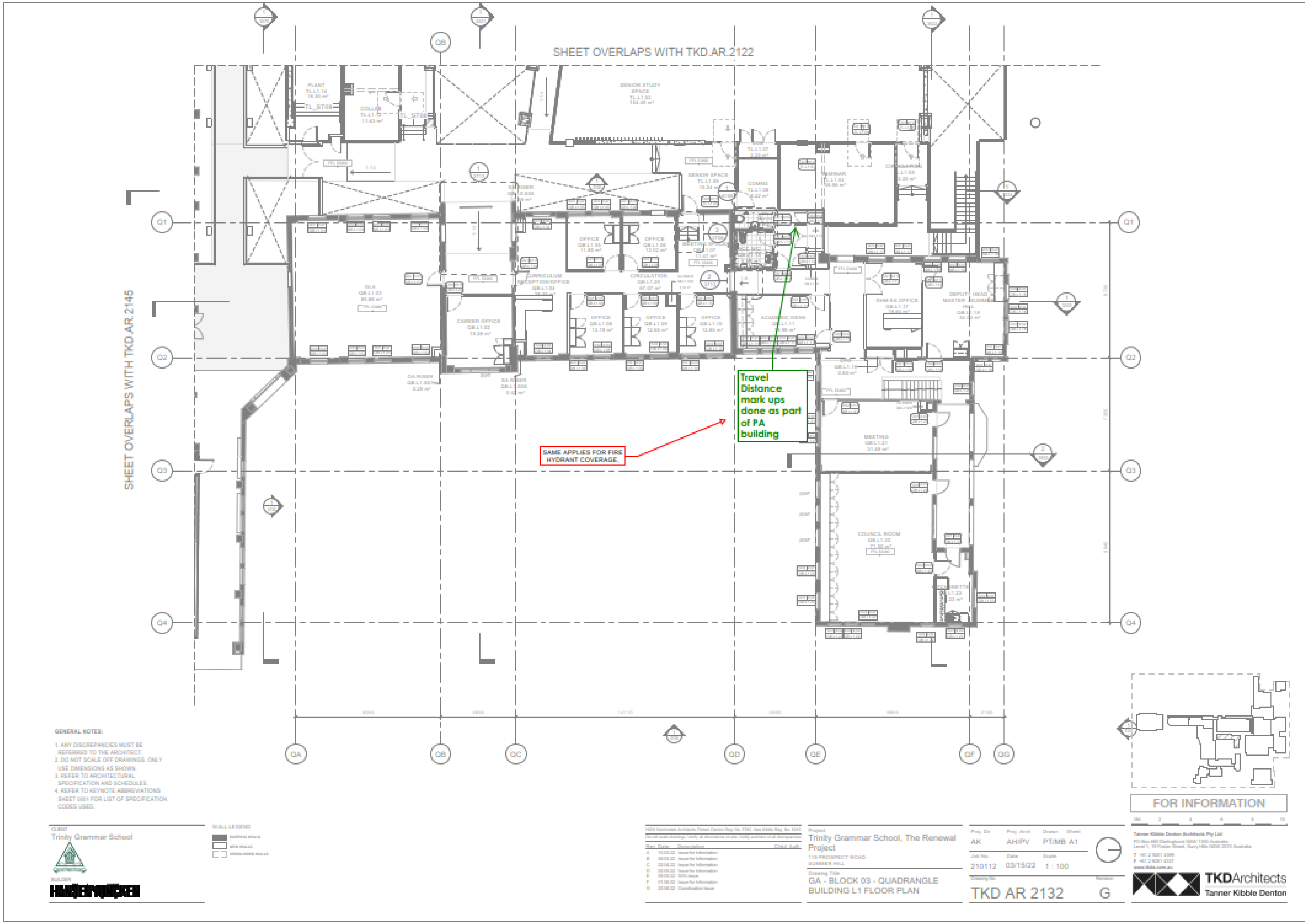
TKDArchitects
Tanner Kibble Denton

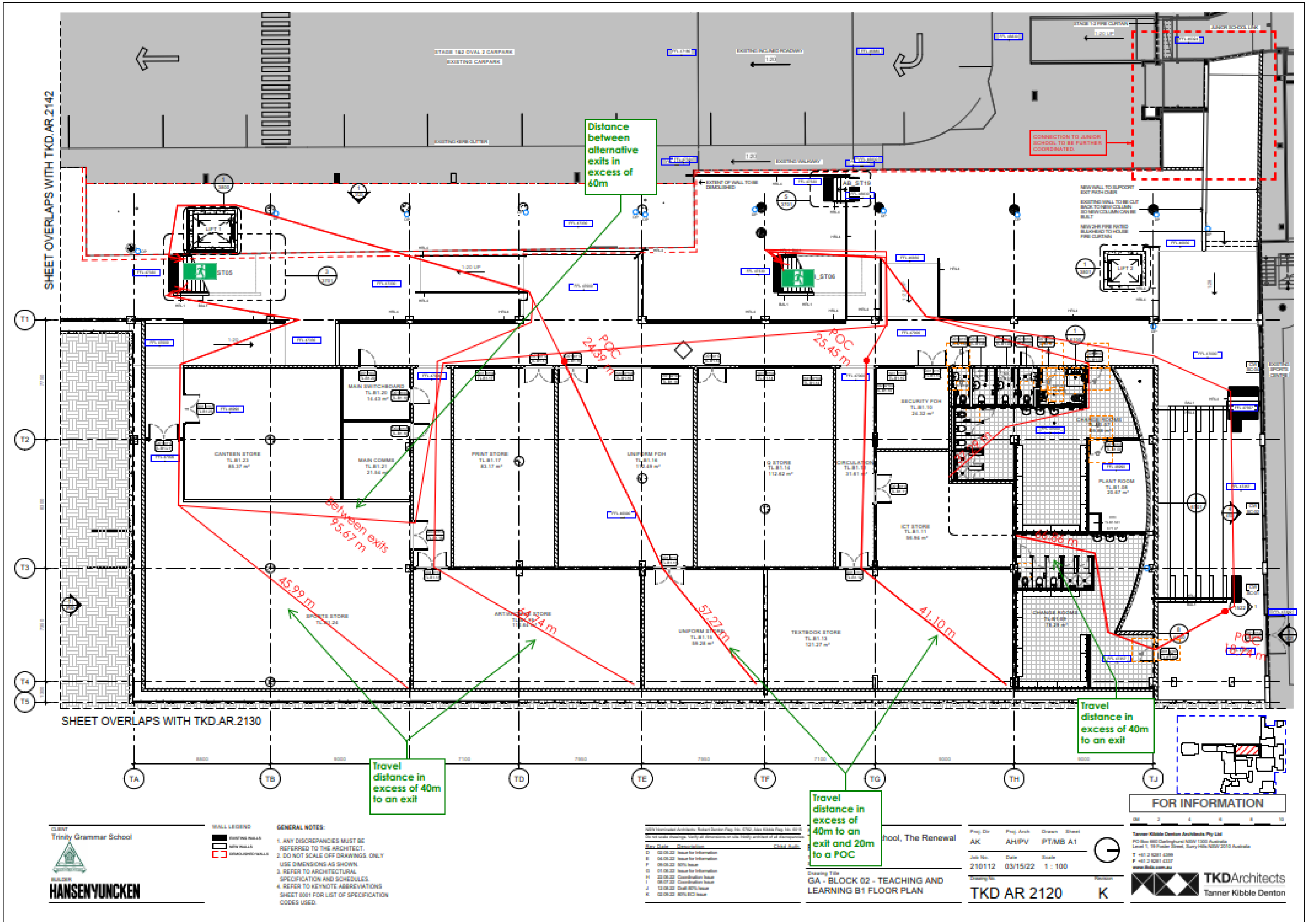

Door to swing in the direction of egress
Door to swing in the direction of egress
Door to swing in the direction of egress
Plant room opening directly into fire stair
Services within fire stair?
Fire door required
Fire Stair should be separated from the building with construction of at least 120/120/120 (or -/120-/120 if non-loadbearing). IWP2 wall is noted as 60/60/60 only
FOR INFORMATION
Trinity Grammar School
HANSENYUNCKEN
Trinity Grammar School, The Renewal Project
GA - BLOCK 05 - MUSIC BUILDING L0 FLOOR PLAN
TKD AR 2156
TKDArchitects
Tanner Kibble Denton

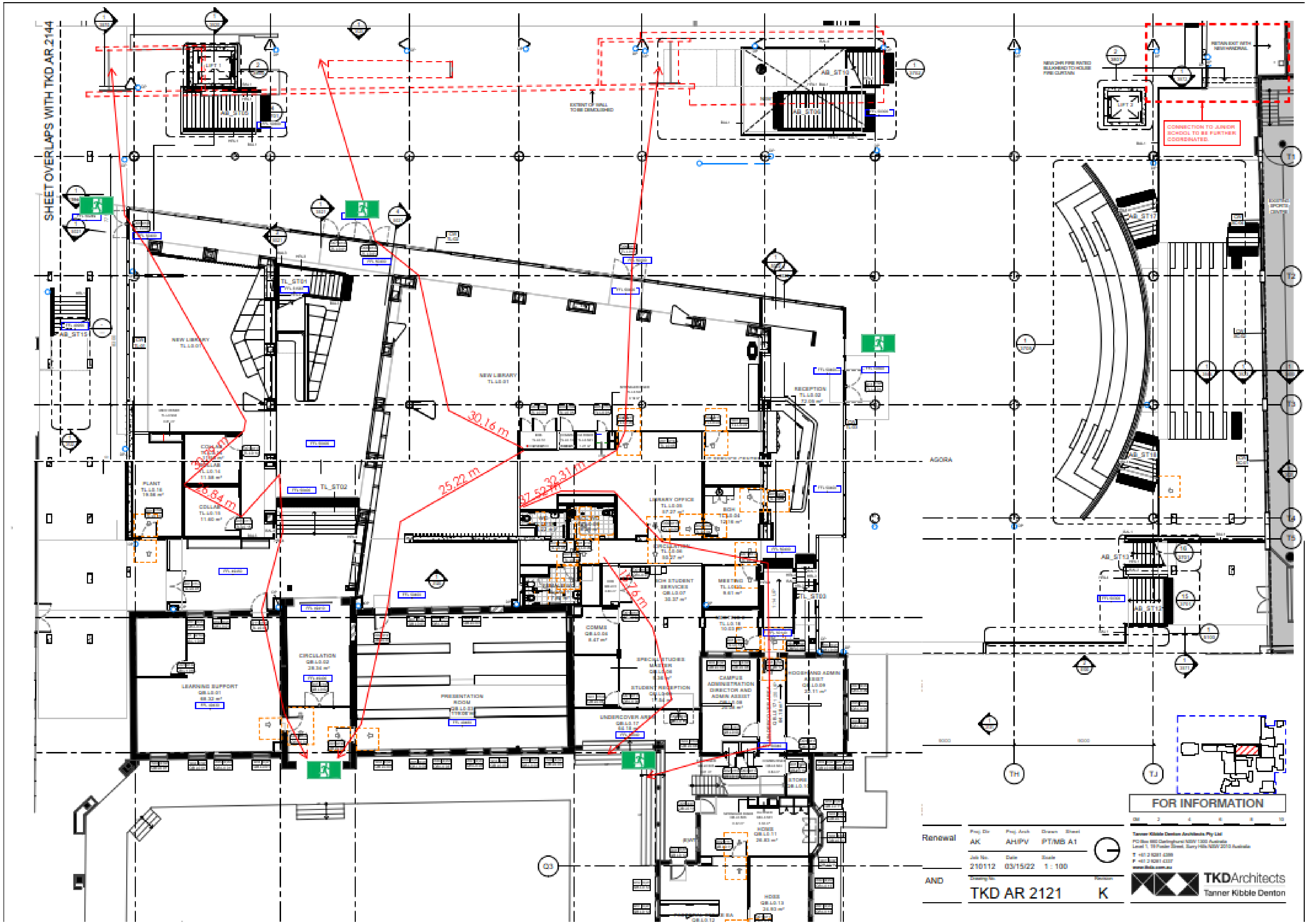

Stair connects more than 3 storeys and is required to be fire isolated. To be addressed with performance solution
25.87 m
SHEET OVERLAPS WITH TKD AR 2148
GENERAL NOTES:
1. ANY DISCREPANCIES MUST BE REFERRED TO THE ARCHITECT.
2. DO NOT SCALE OFF DRAWINGS. ONLY USE DIMENSIONS AS SHOWN.
3. REFER TO ARCHITECTURAL SPECIFICATION AND SCHEDULES.
4. REFER TO KEYNOTE ABBREVIATIONS SHEET 0001 FOR LIST OF SPECIFICATION CODES USED.
CLIENT
Trinity Grammar School
BUILDER
HANSENYUNCKEN
FOR INFORMATION
Project
Trinity Grammar School, The Renewal Project
119 PROSPECT ROAD
SUMMER HILL
Drawing Title
GA - BLOCK 05 - MUSIC BUILDING
L1 FLOOR PLAN
Proj. Dir
AK
Proj. Arch
AH/PV
Drawn
PT/MB
Sheet
A1
Job No.
210112
Date
03/15/22
Scale
1 : 100
Drawing No.
TKD AR 2157
Revision
I
TKDArchitects
Tanner Kibble Denton

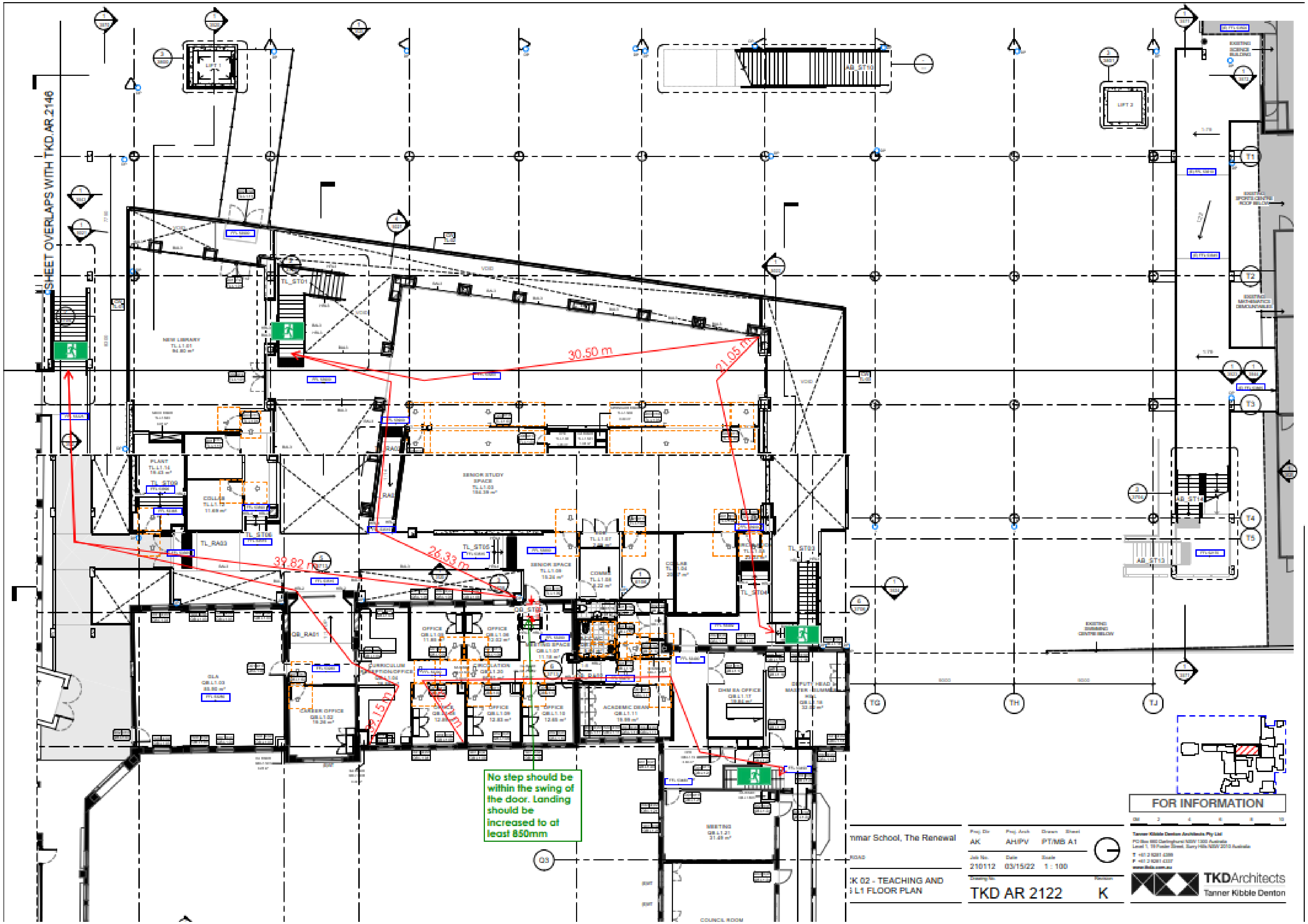

SHEET OVERLAPS WITH TKD.AR.2120
SHEET OVERLAPS WITH TKD.AR.2141
15.05 m
44,867 mm
APPROXIMATE LOCATION OF NEW EXTERNAL FIRE HYDRANT. REFER TO TL DRAWING.
LOCKERS
CIRCULATION
FOR INFORMATION
Trinity Grammar School
Trinity Grammar School, The Renewal Project
GA - BLOCK 03 - QUADRANGLE BUILDING B1 FLOOR PLAN
TKD AR 2130
G
TKDArchitects
Tanner Kibble Denton

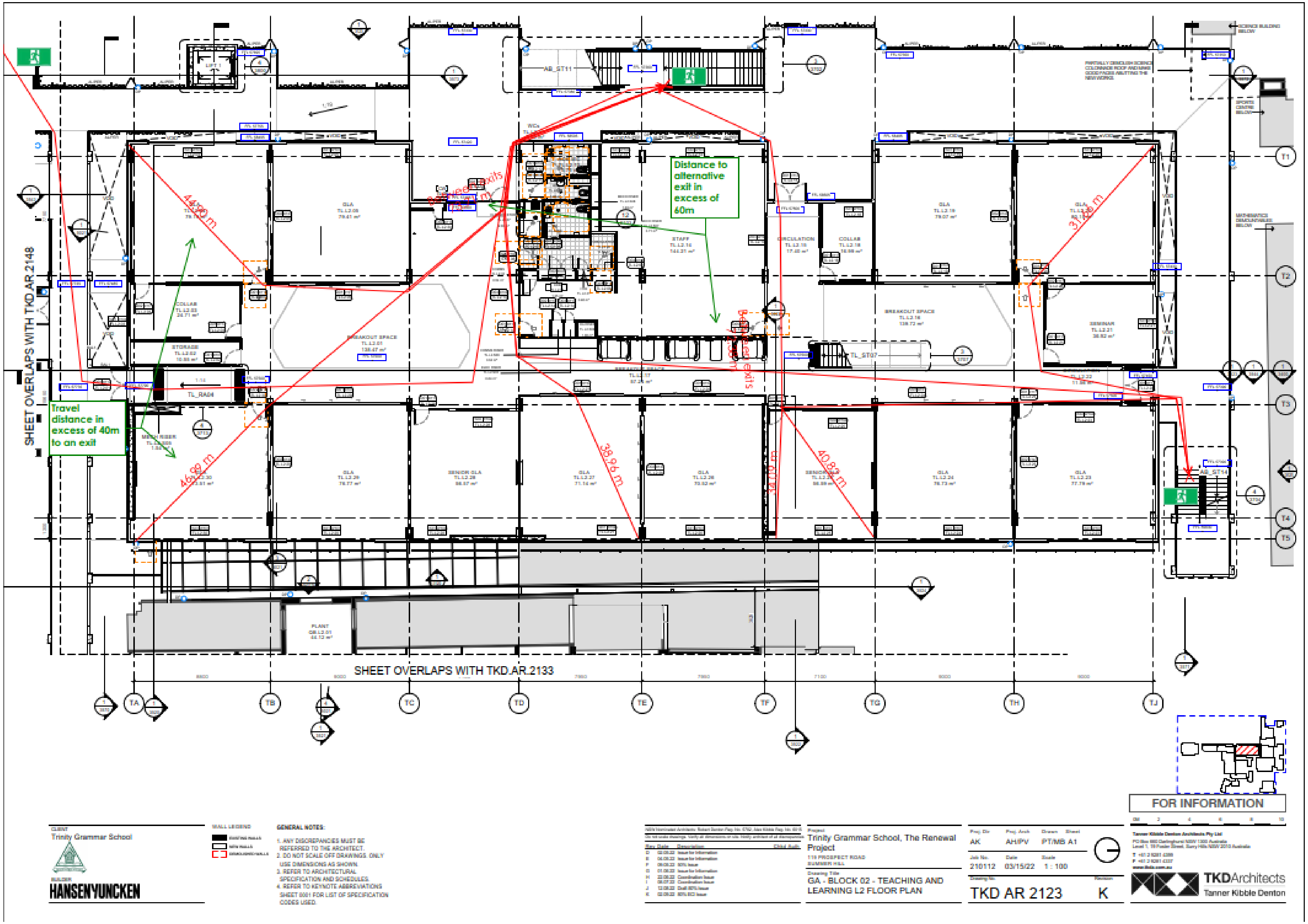

SHEET OVERLAPS WITH TKD.AR.2121
SHEET OVERLAPS WITH TKD.AR.2143
SAME APPLIES FOR FIRE HYDRANT COVERAGE.
Travel Distance mark ups done as part of PA building
FOR INFORMATION
Trinity Grammar School, The Renewal Project
GA - BLOCK 03 - QUADRANGLE BUILDING L0 FLOOR PLAN
TKD AR 2131
G
TKDArchitects
Tanner Kibble Denton

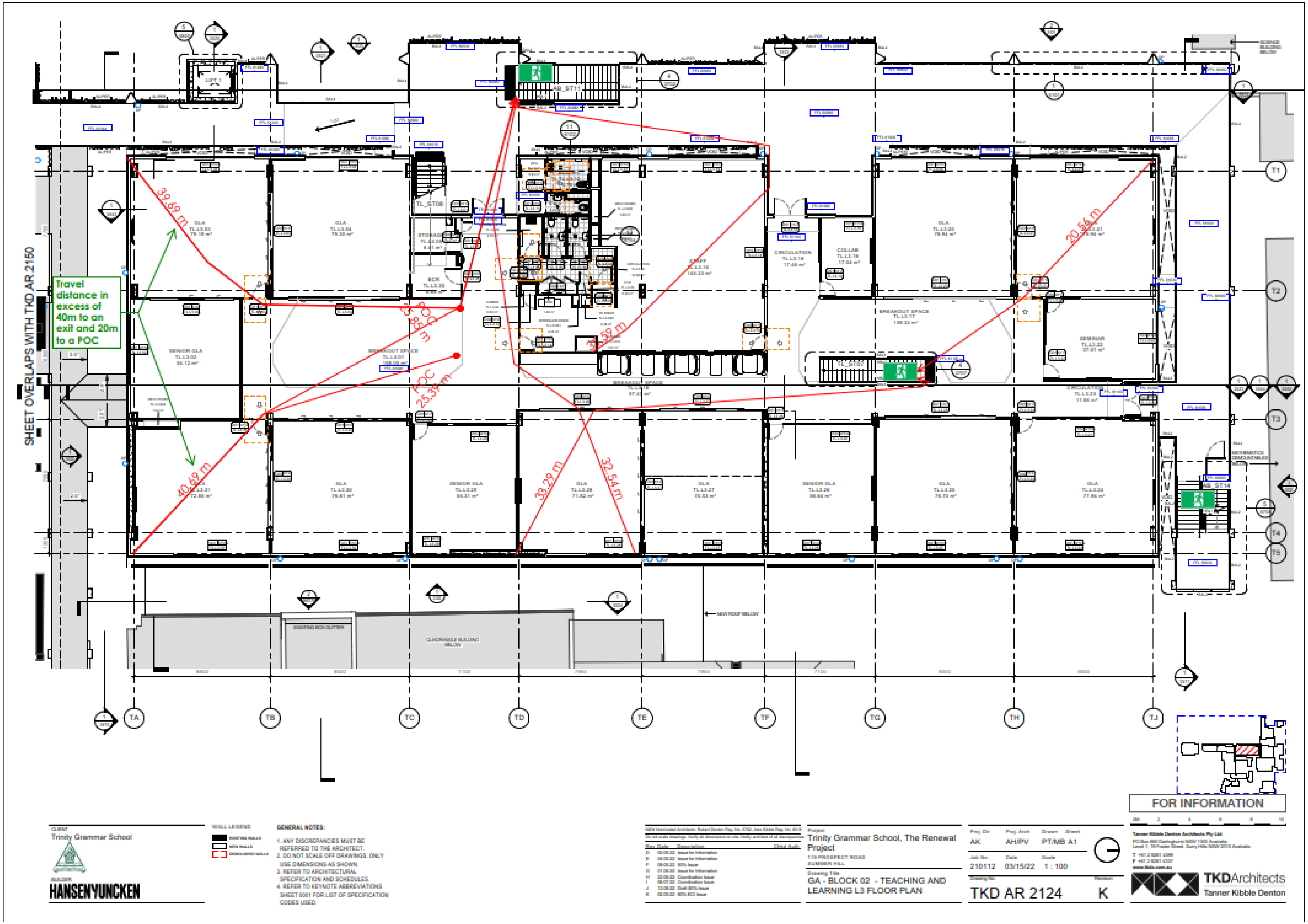

SHEET OVERLAPS WITH TKD.AR.2122
SHEET OVERLAPS WITH TKD.AR.2145
Travel Distance mark ups done as part of PA building
SAME APPLIES FOR FIRE HYDRANT COVERAGE.
GENERAL NOTES:
Trinity Grammar School
Trinity Grammar School, The Renewal Project
GA - BLOCK 03 - QUADRANGLE BUILDING L1 FLOOR PLAN
TKD AR 2132
G
FOR INFORMATION
TKDArchitects
Tanner Kibble Denton

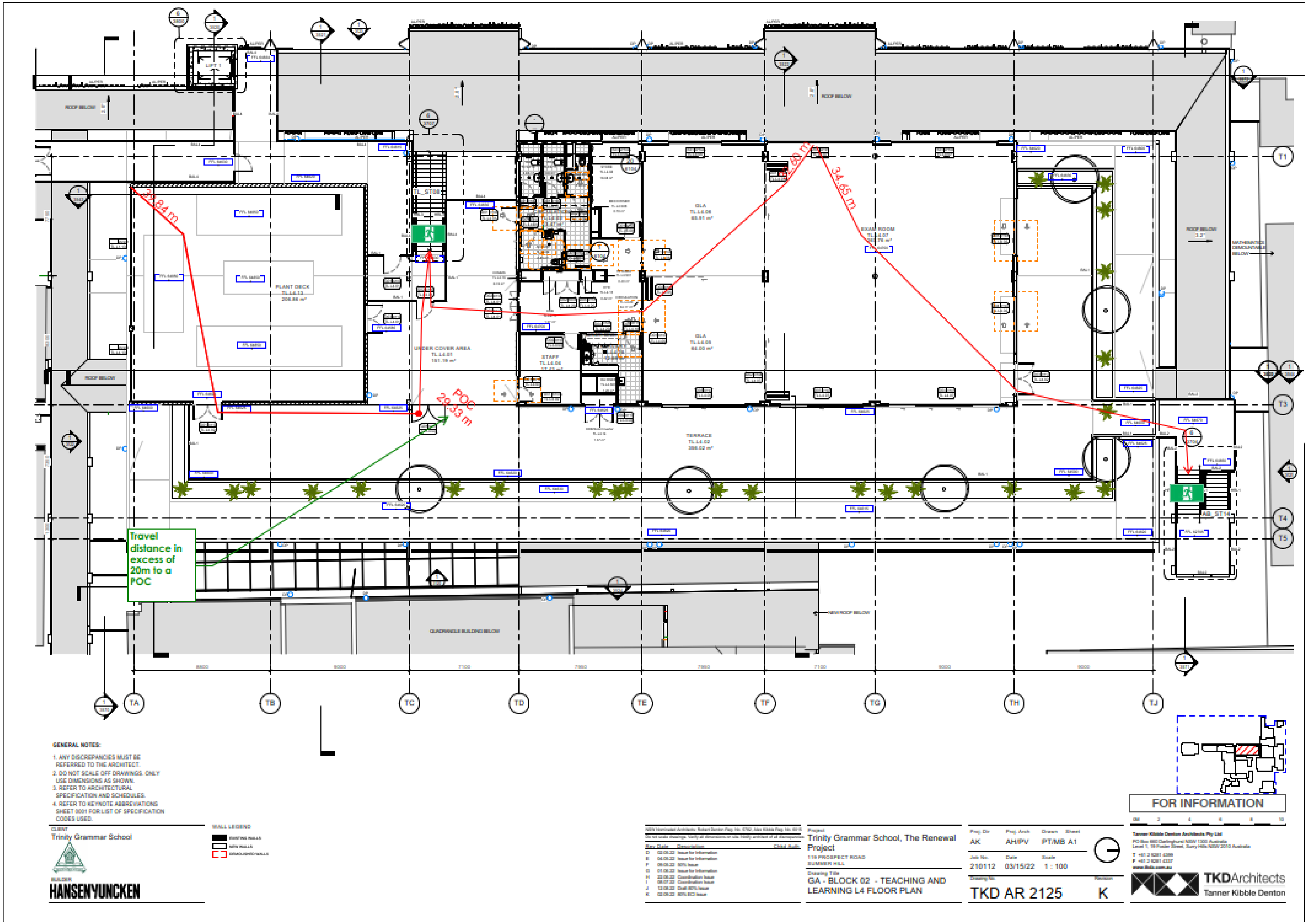

SHEET OVERLAPS WITH TKD.AR.2142
SHEET OVERLAPS WITH TKD.AR.2130
Distance between alternative exits in excess of 60m
POC 24.59 m
POC 25.45 m
between exits 95.67 m
45.99 m
57.27 m
41.10 m
Travel distance in excess of 40m to an exit
Travel distance in excess of 40m to an exit
Travel distance in excess of 40m to an exit and 20m to a POC
FOR INFORMATION
Trinity Grammar School
HANSENYUNCKEN
GA - BLOCK 02 - TEACHING AND LEARNING B1 FLOOR PLAN
AK
AH/PV
PT/MB A1
210112
03/15/22
1 : 100
TKD AR 2120
K
TKDArchitects
Tanner Kibble Denton


SHEET OVERLAPS WITH TKD AR 2144
30.16 m
25.22 m
32.31 m
FOR INFORMATION
TKD AR 2121
K
TKDArchitects
Tanner Kibble Denton


SHEET OVERLAPS WITH TKD.AR.2146
LIFT 1
LIFT 2
AB_ST10
TL_ST01
30.50 m
21.05 m
TL_RA03
TL_ST06
TL_ST05
39.82 m
26.33 m
TL_ST03
TL_ST04
GB_RA01
AB_ST14
AB_ST13
T1
T2
T3
T4
T5
TG
TH
TJ
No step should be within the swing of the door. Landing should be increased to at least 850mm
FOR INFORMATION
nmar School, The Renewal
K 02 - TEACHING AND
L1 FLOOR PLAN
AK
AH/PV
PT/MB A1
210112
03/15/22
1 : 100
TKD AR 2122
K
TKDArchitects
Tanner Kibble Denton


Distance to alternative exit in excess of 60m
Travel distance in excess of 40m to an exit
SHEET OVERLAPS WITH TKD.AR.2148
SHEET OVERLAPS WITH TKD.AR.2133
38.96 m
40.82 m
FOR INFORMATION
Trinity Grammar School
HANSENYUNCKEN
Trinity Grammar School, The Renewal Project
GA - BLOCK 02 - TEACHING AND LEARNING L2 FLOOR PLAN
TKD AR 2123
K
TKDArchitects
Tanner Kibble Denton


Travel distance in excess of 40m to an exit and 20m to a POC
39.69 m
POC 18.49 m
POC 25.39 m
40.69 m
35.59 m
20.56 m
33.29 m
32.54 m
SHEET OVERLAPS WITH TKD AR 2150
FOR INFORMATION
Trinity Grammar School, The Renewal Project
GA - BLOCK 02 - TEACHING AND LEARNING L3 FLOOR PLAN
TKD AR 2124
K
TKDArchitects
Tanner Kibble Denton
HANSENYUNCKEN


Travel distance in excess of 20m to a POC
POC
29.33 m
29.84 m
34.65 m
PLANT DECK
UNDER COVER AREA
STAFF
GLA
EXAM ROOM
TERRACE
ROOF BELOW
QUADRANGLE BUILDING BELOW
TA
TB
TC
TD
TE
TF
TG
TH
TJ
T1
T3
T4
T5
GENERAL NOTES:
1. ANY DISCREPANCIES MUST BE REFERRED TO THE ARCHITECT.
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CLIENT
Trinity Grammar School
BUILDER
HANSENYUNCKEN
WALL LEGEND
FOR INFORMATION
Trinity Grammar School, The Renewal Project
119 PROSPECT ROAD SUMMER HILL
GA - BLOCK 02 - TEACHING AND LEARNING L4 FLOOR PLAN
AK
AH/PV
PT/MB A1
210112
03/15/22
1 : 100
TKD AR 2125
K
TKDArchitects
Tanner Kibble Denton

Appendix N. FRNSW FEBQ Response

NSW GOVERNMENT FIRE + RESCUE

Fire Engineering Brief Questionnaire (FEBQ)

Cheat Sheet!

1 Document control

Applicant reference number Enter ref. no. **FRNSW reference number** FRN22/1947

Ver.	Author	Organisation	Status	Date
01	Parkan Behayeddin	Scientific Fire Services Pty Ltd	Initial submission	10/06/2022
02	Fabio Perri	FRNSW (BFS22/2770 #21797)	Response to V01	14/09/2022

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 performance solution:

☑ Copy of proposed building plans and specifications (e.g. relevant floor plans, elevations, site plan, section views, hydrant plan and schematic)
☐ BCA report or letter from an accredited certifier that identifies all non-compliances (if available)
☐ CFD/zone modelling inputs form (if applicable)
☑ Report extract of the trial design requirements/proposed fire safety measures (optional).

Name of fire engineer	Parkan Behayeddin	BPB number	0756
Company name	Scientific Fire Services		
Fire engineer's phone no.	+61 3 9686 4730		
Fire engineer's email	parkan.behayeddin@scifire.com.au		

2.2 Remittance advice information

Invoices will be issued based on the information provided below:

ASIC company name	Hansen Yuncken Pty Ltd		
Australian business number	38 063 384 056	Trading name	Hansen Yuncken Pty Ltd.
Remittance contact name	Fran Erkersky		
Remittance street address	Sydney Corporate Park, Building 1, L3, 75-85 O'Riordan, Street Alexandria NSW 2015		
Remittance email address	ferkersly@hansenyuncken.com.au		
Remittance phone number	02 9770 7600	Remittance fax number	Remitter's fax no.
Purchase order ref. no.	If applicable	Project code ref. no.	SC150
Project leader contact name	Michael Coelho		

Project leader contact email	mcoelho@hansenyucken.com.au

3 Consultation

3.1 Stakeholders

Role	Name and BPB number	Organisation and phone	Email address
BCA consultant	Luke Sheehy BDC0830	Design Confidence (Sydney) Pty Ltd 0283993707	lsheehy@designconfidence.com
Certifier	Brett Clabburn BDC0064	GROUP DLA 0409043136	bclabburn@groupdla.com.au
FRNSW reviewers	SO John Marzol Engineer Fabio Perri	Fire and Rescue NSW 02 9742 7434	firesafety@fire.nsw.gov.au

3.2 Meeting details

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

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

4 Project details

4.1 Premises

Premises name	Trinity Grammar School Stages 3-5: The Renewal Project
Primary street address	119 Prospect Road
Secondary street address	Secondary street address (if applicable)
Premises suburb	Summer Hills
Lot and DP numbers	E.g. Lots A and B of DP 12345, Lot 10 of DP 111213

4.2 Proposed works

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

Applicable NCC: NCC 2019

For existing buildings:
Approximate year of construction: Year
Building code when constructed: Select

How many performance solution issues are proposed in this FEBQ? 8

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

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

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

Identify if any previous performance solution applies to the building:

N/A

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

N/A

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

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

N/A

Will the premises be subject to a fire safety study, risk assessment or dangerous goods study? **Select**

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

4.3 Description of building occupancy

Main occupancy class	9b	Largest fire compartment (within the building)	Area (m²)	7970
Other occupancy classes	Class 9b (Assembly Hall – School-use only) & Class 5 (Administration & Office)		Volume (m³)	30836
Type of construction	A		Height (m)	**Height**
Effective height (m)	Less than 25m	Ground floor area (m²)		Approx. 3500
Rise in storeys	Five (5)	Total floor area (m²)		19807
Levels contained	Seven (7)	Total volume (m³)		84522

Outline any additional building characteristics:

Site Overall

The subject site is the Trinity Grammar School (TGS) and is located at 119 Prospect Road, Summer Hill NSW. The TGS campus is approximately 65,550m² and consists of Junior School, Secondary School, Specialist & shared facilities. The site is bound by Seaview Street to the north, Prospect Road to the east, Victoria Street to the west and Yeo Park to the south. The principal campus entrance is situated along Prospect Road. Figure 2.1 depicts a site plan of the campus.

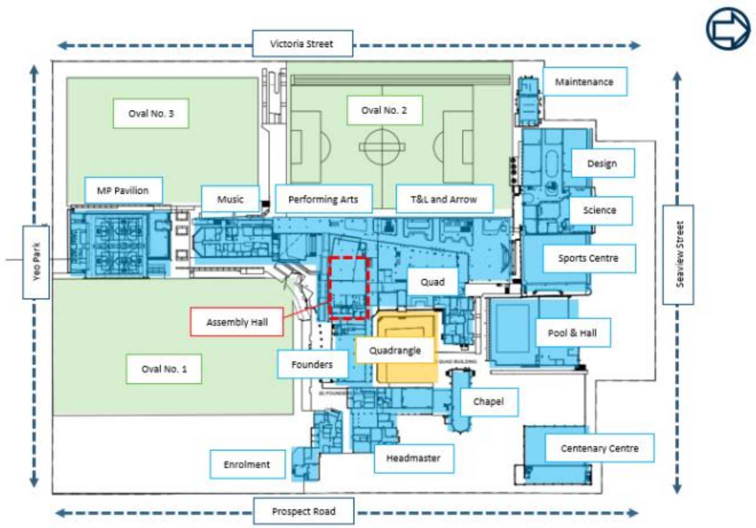


Figure 2.1: Site plan

Masterplan

The masterplan works have been developed in 5 stages to allow for the staged construction works, whilst maintaining the campus as operational. Stages 1-5 are broadly described as follows:

- Stage 1: Maintenance Building
  - New stand along maintenance building (2 storeys)
  - Demolition of Seaview Street properties No. 45-52 and Chapel Drive Ceremonial Axis landscaping upgrades
- Stage 2: Oval Carpark & Junior School Linkway
  - New Oval no. 3 carpark & sports field, ground area, back of house (BOH) and associated works to Yeo Park side driveway
  - Upgrade Junior School enclosed access path to connect to Oval 2 carpark
  - External tiered seating, paths and associated landscape works around Oval 1, external roadwork upgrade, intersection and footpath works.
- Stages 3-5: The Renewal Project
  - New five (5) storey teaching & learning facility
  - New performing arts precinct
  - New maintenance quarter
  - New multipurpose pavilion
  - Major improvement to on-site traffic
  - Refurbishment works to existing facilities incl. Founders Building, Music Building & Quadrangle Building

It is highlighted that the scope of fire safety engineering works under Stages 1-2 is documented within the Fire Engineering Report (FER) prepared by Arup Australia Pty Ltd (Report No. 281228, V01, dated 17 March 2022). The scope of fire safety engineering works under Stages 3-5 is documented herein. The staged works are indicative illustrated in Figure 2.2 & Figure 2.3.

Figure 2.2: Stage 1 & 2 works (extracted from Figure 2 of Arup FER, Report No. Report No. 281228, V01, dated 17 March 2022)

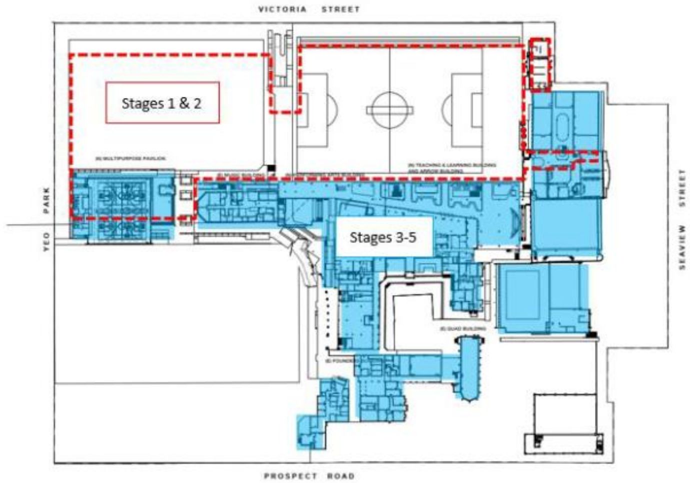


Figure 2.3: Indicative Stage 1 & 2 and Stage 3-5 works

Stage 3-5 Description

The Renewal Project shall generally involve alterations, additions and integration of new & existing building structures within the TGS campus. The emphasis is focused on providing contemporary learning spaces/facilities, improving circulation/connection within the campus and facilitate growth of the core student population to 2,100 (currently 1,680 secondary students). The key building characteristics associated with the Stages 3-5 works are detailed in Table 2.1 and depicted in Figure 2.4 to Figure 2.10.

Table 2.1: Building characteristics (Stages 3-5)

Precinct	Occupancy Use	Key Characteristics
Teaching & Learning	Teaching & Learning	• General learning areas (GLA's) & staff rooms • GLA's to be configured across the precinct to break out, seminar spaces to open onto a project space • Largest classroom to support capacity for up to 30 x students • Staff rooms centrally located with direct access to the Arrow Building (external walkways). Faculty space to contain desk/workstations, storage & break out furniture for collaborative work between staff & interaction with students • Main access via the Arrow Building (external walkways) with internal circulation also provided • Classrooms to be interconnected via operable walls • Amenities
	Library	• Situated within new civic space adjacent Agora • Two (2) levels comprising: – Ground floor: service counter, library staff space, learning areas, break away & reading nooks, central open stair, low bookshelves to demarcate functional zones – First floor: senior study space designed to accommodate groups of 20 in 2 or 3 acoustically separate spaces which can be merged
Performing Arts	Performing Arts	• New building proposed to interlink existing Music and Founders Buildings • Five (5) storeys overall with basement link to carpark
	Black Box Theatre, B1 Founders Building	• The Black Box Theatre shall replace the existing ones situated within the B1 level of the Founders Building • The Black Box shall be openable to an outdoor fixed tiered seating space which transitions from ground level • Staff to have the ability to close the Black Box from the outdoor space to transform it into a rehearsal studio
	Assembly Hall & Lobby	• Multi-functional space situated on L1 proposed to operate under a number of modes including performance, concert & assembly • The assembly hall shall contain an upper-level mezzanine providing access to upper tiers and adjacent learning facilities in the precinct • Interconnection to Library & Founders Building via external walkway (Arrow Building) • Maximum occupant loading of 600
	Cafeteria & Canteen	• New cafeteria to be extended to occupy larger footprint • Commercial kitchen to cater for school functions and events
	Music building	• Existing Music Building to be refurbished and upgraded (incl. demolition of internal fire stairs) • Access to be provided externally via Arrow Building (external walkways)
Arrow Building	General	• The Arrow Building is an external walkway structure which connects both new precincts and existing buildings • Allows for students to circulate around the campus without the need to enter the building(s) • The external walkways shall be covered by undulating perforated metal screens
Sports Precinct	Multipurpose Pavilion	• Indoor sporting facility with spectator seating & amenities • The MP pavilion shall primarily accommodate the following: – 1/no. x full size championship basketball court with retractable tiered seating – 2/no. x training basketball courts for training only • Amenities & support facilities generally consisting of: – Retractable seating, mezzanine area, 2 x change rooms, 4 x WC's (students), 2 x WC's (staff/patrons), 2 x showers (students), 1 x accessible WC & shower, 1 x office/first-aid, chair store, cleaners & comms • Other functions to include school assemblies, speeches, primary school movie nights • Maximum occupant loading of 1,200

Precinct	Occupancy Use	Key Characteristics
	Forecourt servery	• Simple servery for food and drinks with accommodation for BBQ area • Kitchen to allow heating and serving of preprepared food and drinks (not used for cooking) • Primarily used during weekend sport, but could also be used for special events
	Founders Building, B2 – Indoor Cricket	• B2 of Founders Building to be refurbished into new indoor sports, primarily for indoor cricket • Retractable netting allowing for double height space to be divided into practice areas
	Music Building, B1 – Sports Facilities	• B1 level of Music Building to be refurbished into new sports offices and amenities related to the school's outdoor ovals. • B1 level of the Music Building is to include: – Sports staff offices, sports storage, change room amenities, male WC, female WC, accessible WC & shower
Support Facilities	Reception & Administration	• The Agora will be the new arrival point for visitors coming from the carpark • Reception to be linked to senior leadership and administration offices situated in the refurbished Quadrangle Building.
	Staff Common Room	• Centrally located within Founders Building • Contemporary open plan environment facilitating staff socialisation & collaboration between staff members
	IT Support	• IT front of house to be situated within ground level of Library with additional ICT storage situated on B1.
	Miscellaneous Storage	• Miscellaneous storage areas situated within B1 of Teaching & Learning. Storage contents shall generally be associated with the following: – Unform shop, Q store (cadet uniform), security office, ICT store, print room, textbook store, archives & art collection store and sports store

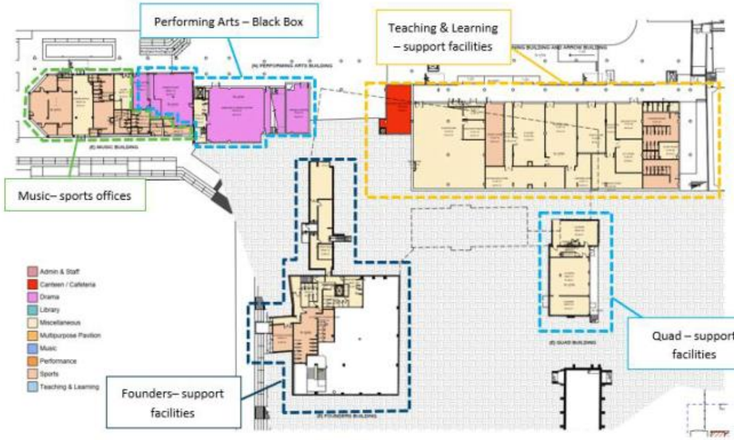


Figure 2.5: B1 Floor Plan (B1)

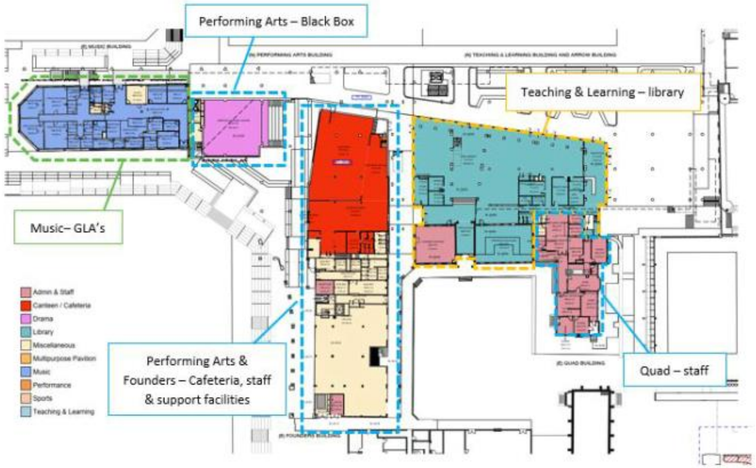


Figure 2.6: L0 Floor Plan (L0)

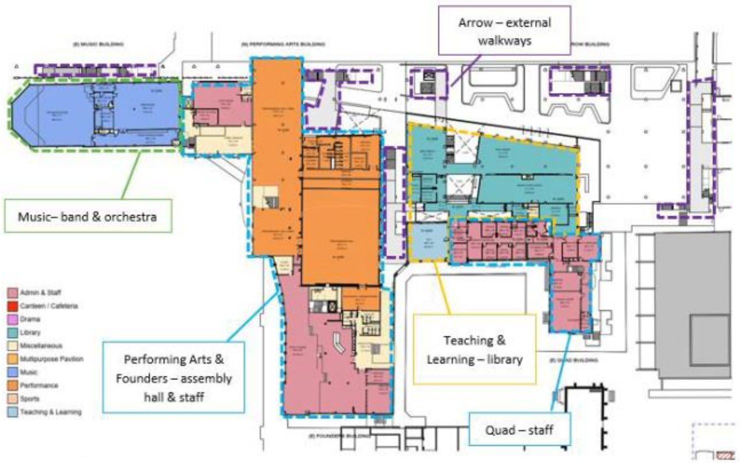


Figure 2.7: L1 Floor Plan (L1)

Figure 2.8: L2 Floor Plan (L2)

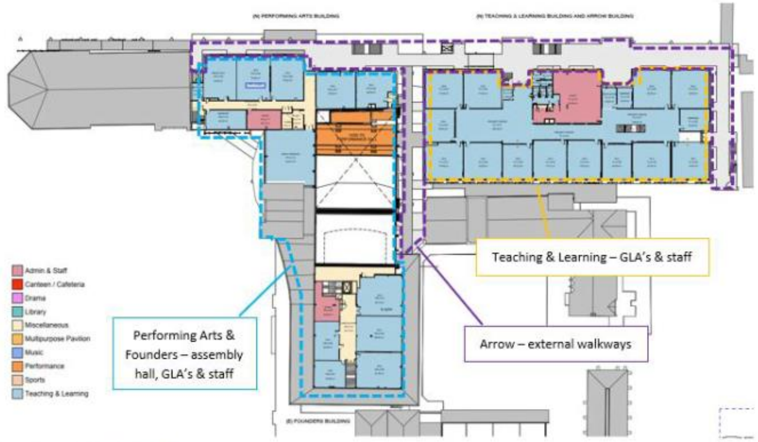


Figure 2.9: L3 Floor Plan (L3)

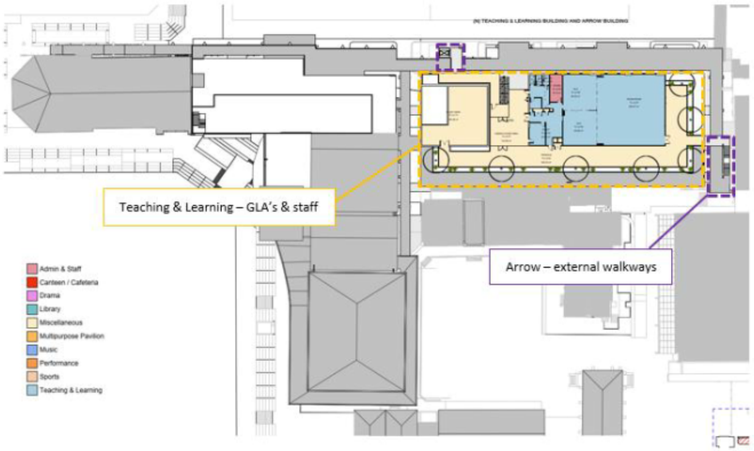


Figure 2.10: L4 Floor Plan (L4)

The building description based on the BCA classification system is provided in Table 2.2.

Table 2.2: BCA Description of building

Summary of Building/Tenancy	
Building Classification(s):	Class 9b (School), Class 9b (Assembly Hall) & Class 5 (Administration & Office)
Number of Storeys Contained:	Seven (7)
Rise in Storeys:	Five (5)
Effective Height:	Less than 25m
Required Type of Construction:	Type A fire-resisting construction – All buildings excluding Multi-purpose Pavilion

List key occupant characteristics for the building:

Occupant Characteristics

Understanding the likely behaviour of the building's occupants is an important element of the analyses of life safety in a building fire. Where there are a number of occupants involved, there are many characteristics relating to these occupants and their probable behaviour in a fire emergency that can be identified. Hence, making complete characterisation of individual occupants is a complex and difficult task.

However, for the purposes of analysis only a limited number of 'dominant occupant groups' may be considered, as these have been shown to have the greatest impact on the outcome of evacuation modelling. Characteristics therefore need only be developed for these dominant occupant groups

Guidance provided by IFEG (2005), the Engineering Guide: Human Behaviour in Fire (SFPE 2003) and Proulx (2003) has been considered in the determination of dominant occupant characteristics for this fire safety engineering evaluation.

Class 5 (Administration & Offices)

Within the subject administration & office portions there will be two major occupant groups. One group, the staff can be regarded as permanent and therefore likely to be familiar to a significant degree with the overall layout of the subject building. The other group, the clientele and/or visitors can be considered as transient and therefore less familiar with the buildings. There is no proposed usage of the buildings that would indicate that the gender mix and

proportion of persons with disabilities would be significantly different from the general national population norms. The characteristics (response capability, coping capability, and evacuation/avoidance capability) of the occupants are taken as those which are typical to office occupancy where the occupants are familiar with their surrounds.

The occupant characteristics of offices and workspaces are to be taken as typical of those found in this class of building. There are no other identified activities associated with this development other than those normally associated with an office. The characteristics (response capability, coping capability, and evacuation/avoidance capability) of the occupants within the office building can be assumed to be any member of the general public and therefore, have characteristics similar to the general population. The essential occupant characteristics are assumed to be:

- Occupants would be familiar with building layout and evacuation procedures,
- Occupants are considered to be awake and coherent due to the nature of the building.

Class 9b (School)

Students will be in the majority and have various degrees of familiarity. Teachers, while few in number will be familiar having the natural tendency to take charge in an event such as a fire emergency directing students to safely evacuate. Students would be expected to wait to be given instructions typical for the age and the teacher student relationship and generally begin to evacuate from the building as directed by the staff/teacher occupant group to a designated safe area.

There is no proposed usage of the building that would indicate that the proportion of persons with disabilities would be significantly different from the general national population norms. However, it should be noted, that in the event of an emergency evacuation able-bodied occupants are likely to be altruistic and assist the small proportion of disabled occupants, if any (Proulx 2002). The characteristics (response capability, coping capability, and evacuation/avoidance capability) of the occupants are taken as those which are considered to be typical for educational type occupancy, where the occupant is familiar with their surrounds and understands the cues of a fire alarm.

The proposed building(s) will not accommodate sleeping quarters for occupants therefore, the occupants would be considered to be alert, awake and coherent.

The evaluation shall consider the occupant characteristics identified and the usage of the building(s) as noted. Any changes in the building usage(s) and consequent potential change to the occupant characteristics will require a re-evaluation of the fire safety systems.

Class 9b (Assembly Hall)

As the building is to contain an assembly hall, the occupants are expected to comprise a combination of students, teachers and members of the general public who are there to attend a performance, production or social function. Therefore, we can essentially classify the occupants into two (2) major groups: transient (i.e. the public, students) and permanent (i.e. staff). Therefore, the occupants would comprise persons from all gender and of age groups. It is considered that the occupant characteristics of the public are consistent with the general population.

The transient occupant sub-group would have a varying degree of familiarity of the public access areas. However, it is expected only a minority will be unfamiliar given the simple floor plan and open nature of the building as the exits are visible. Given the nature of public access areas, it is expected from time to time that there may be large crowds and also people focused on tasks. So, it would be expected that the permanent staff members are likely to be knowledgeable of the specific evacuation process and aid other occupants so effective evacuation from the building can be undertaken.

Occupant Numbers

The subject building shall operate on a daily non-continuous basis consistent with typical school/business hours. Maximum occupant numbers are based on the information provided by the client who has identified a total of 2,100 occupants within the TGS campus overall.

Therefore, the adopted occupant numbers for the evacuation analysis shall be conservatively taken as **2,100 occupants** evenly distributed throughout the building. The adopted occupant loading shall provide a level of safety and conservatism for the purpose of the analysis.

5 Hazards

Outline any hazards unique to the building:

The IFEG (2005) states that a systematic review should be conducted to establish potential fire hazards (both normal and special) of the facility under evaluation. A hazard is the outcome of a particular set of circumstances that has the potential to give rise to unwanted consequences. In regard to a building fire, a fire hazard means the danger in terms of potential harm and degree of exposure arising from the start and spread of fire and the smoke and gases that are thereby generated.

The fire related hazards in a facility can arise from the layout of the building including its location with respect to adjoining properties, the construction materials, the activities undertaken in the facility, the possible ignition sources and the fuel sources.

One of the first stages in reviewing potential fire hazards for a project is to examine available fire incident data for facilities having the same or very similar form and usage. This data may be international in origin and therefore must be used with care in order to establish possible hazards and a realistic measure of the possible unwanted consequences of fire.

Every hazard has a risk associated with it. The risk arising from a hazard is the frequency of an event involving that hazard, times, the expected consequences. A hazard may be eliminated, but there will always be an event frequency of occurrence and therefore always a positive value of risk associated with the hazard.

Fire safety engineering is essentially a risk management process wherein the outcome is to minimize the overall fire risk associated with a facility by mitigating or eliminating serious hazards, or by reducing the frequency of hazardous events.

The risk assessment process, of which hazard analysis forms part, is the means by which those hazardous events with the most serious consequences are identified. This then enables the most appropriate fire scenarios related to these events to be defined. This process then allows the analyses to be carried out to ensure that the fire safety systems and strategies employed are sufficient to satisfy the Performance Requirements.

Whilst the frequency of hazardous events (probability) is considered during the hazard analysis, the consequent analyses for the evaluation of the resultant fire scenarios are deterministic.

The following sections provide data specific to the occupancies involved in this assessment.

Summary of Project Specific Hazards

A thorough and comprehensive analysis of the fire hazards associated with the subject building has been provided in Appendix B of this PBDB. A summary of the fire hazard analysis is provided in the following sub-sections presented below.

Summary of Hazards Specific to Class 5 (Administration & Office)

In relation to the Class 5 (Administration & Office) portions of the building, the hazard analysis undertaken illustrates a number of consistent observations. These observations are summarised below:

- While there is very little usable Australian fire statistics available, there are plenty of international sources of data (see Section B.2.2), and these overseas sources are relevant to the Australian built environment, so can be used with care to inform fire engineering and design in Australia.
- While it is largely impossible to define or regulate fire loads in office properties, most studies find a mean fuel load in the range of 300-700 MJ/m2 (see Table B.1). Most of the fuel load in offices is in the form of paper or wood, but there are significant quantities of plastics and electronics present as well (see Table B.2).
- The ignition sources that produce the most frequent fires in offices are cooking equipment and, to a lesser extent, electrical equipment (see Figure B.7). This is even more the case for high-rise offices. The sources that produce the most fire-related property damage are arson and fires in adjacent properties.
- Statistics worldwide indicate that an office building rates relatively low with respect to the risk of fire when compared to buildings of other occupancies (see Section B.2.5).
- While (typically non-sprinkler-protected) mid- or low-rise offices are quite low risk, this is even more true of (typically sprinkler-protected) high-rise office properties (see Figure B.13).
- Offices are one of the occupancies with the lowest fire fatality risk (see Section B.2.6).
- Automatic sprinkler systems are very effective at reducing the severity of fires in office properties (Lougheed, 1997).
- Offices are an occupancy of low overall risk, and in particular have a significantly below-average risk to life.

Summary of Hazards Specific to Class 9b (School)

In relation to the Class 9b (School) portions of the building, the hazard analysis undertaken illustrates a number of consistent observations. These observations are summarised below:

- Many education department officers cannot recall any deaths in school fires; hazard to life safety is low.
- On average, a school fire with losses exceeding one million dollars occurs every two weeks in Australia. However, this loss is less than 0.1% of school assets.
- Most fires are small; most of the loss is due to only a small proportion of all fires.

- Most of the losses appear to be due to arson. However, statistics on this matter are unclear. Arson is sometimes interpreted as burglary.
- Arson fires are consistently the single most significant source of fire starts (54% of school fires in NSW, 60% in UK, and 52% in USA)"
  - Arson in a school is a risk however it is considered to be more related to security of the building. Many security practices not only reduce burglary but also reduce arson.
  - Mitigating the risk of arson is a delicate balance between onerous security which may be problematic and management. As such minimising waste and good storage of combustibles whilst maintaining clear travel paths result in low accessible fuel loads.

- In view of the multi-use school building(s) it is anticipated that there will be some sources of ignition. The ignition sources that are primarily related to the proposed building(s) include:
  - Electrical switch assemblies;
  - Lighting
  - Electronic audio/video (e.g. stage equipment)
  - Occasional special effects equipment for staged performances
  - Arson.

- In view of the variable nature of activities associated with the subject building(s) it is anticipated that the likely fuel loads will consist of seating and some office furnishings within the multi-use spaces. The adjacent classrooms, store rooms, offices and kitchenette present a separate potential fuel load of which the combustible content of the proposed building(s) shall include:
  - Furniture (e.g. tables, chairs, cabinets & shelving arrangements)
  - Storage contents (e.g. boxed items, books, folders and the like)
  - Audio/Visual/computer equipment
  - Electrical equipment
  - Seating and/or table arrangements
  - Ovens

- It can be summarised that the risk to occupants within school facilities is very low. This is outlined in both the national and international results collated and when compared to other types of building classifications. The subject building is considered to be comparative for use, size and occupants with the data compiled for the above results obtained.

Summary of Hazards Specific to Class 9b (Assembly Hall – School use only)

In relation to the Class 9b (Assembly Hall) portions of the building, the hazard analysis undertaken illustrates a number of consistent observations. These observations are summarised below:

- The fire load of the stage area is expected to primarily consist of performance props/decorations, and audio/visual equipment. The fire load of the auditorium area is expected to primarily consist of seating.
- The ignition sources that are primarily related to the proposed building include:
  - electrical switch assemblies
  - lighting
  - electronic audio/video stage equipment
  - Occasional special effects equipment for staged performances

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

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

6 Preventative and protective measures

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

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

Additional information:

The performance solution for the subject building consists in part of some features which are included within the prescriptive provisions of the BCA and additional features which are specific to this building alone. The combination of these 'DtS' and additional fire safety system features comprises the 'Performance Solution' which form the basis of the trial design.

Unless otherwise stated the required fire safety systems for the subject building are to be designed and installed in accordance with the DtS provisions of the BCA and relevant referenced Australian Standards. Note the following list is considered to be a summary of the project specific fire safety features that form part of the proposed 'Performance Solution'. It should be noted however that given the status of the PBDB in the fire engineering process, the following list is not exhaustive and may be subject to amendment pending resolution of the final fire safety engineering assessment process.

The proposed 'Trial Design' applicable to the subject building, which is to be the subject matter of this assessment, may be summarised as follows:

Stage 1 & 2 Performance Solution

1. Stage 1 & 2 parts of Trinity Grammar School were subject to a Performance Solution prepared by Arup Australia Pty Ltd (Report No. 281228, V01, dated 17 March 2022). The requirements in the aforementioned report do not have any impact on the proposed analysis, its assumptions and recommendations with the exception of the following:
   a. Fire hydrant system throughout the building in accordance with BCA Clause E1.3 and AS2419.1:2017.

In order to achieve a level of consistency across the Stage 3-5 parts of the Trinity Grammar School, the design proposes to maintain the hydrant installation in accordance with AS2419.1:2017.

Fire Resistance & Type of Construction

1. Building elements throughout shall be constructed in accordance with the minimum FRL's commensurate with Type A fire resisting prescribed in Part C from Volume One of the Building Code of Australia 2019 Amendment 1 unless otherwise identified herein; and
2. It is proposed to permit the Multipurpose Pavilion structure (excluding the Oval 3 basement level carpark) to be constructed in accordance with the minimum FRL's commensurate with Type C fire-resisting construction in lieu of Type B fire-resisting construction and inclusive of the following:
   a. The Multipurpose Pavilion structure shall consist of non-combustible construction. This performance solution relates to the applicable FRL's only; and
   b. The Multipurpose Pavilion shall be fire-separated from the basement level carpark via a fire-rated slab achieving a minimum FRL of 120-minutes in accordance with the DtS provisions of the BCA. Any services penetrations through the fire-rated floor slab shall be fire-stopped and must conform to a tested system in accordance with AS1530.4:2014; and
3. The non-fire isolated stairways interconnecting multiple storeys without the provision of a fire-isolated shaft shall be fire-separated at key levels as per the following:
   a. The performing arts open stairway shall be fire-separated such that it does not interconnect more than three (3) consecutive storeys; and
   b. Fire-separating construction shall be one (1) or a combination of the following:
      i. Full-height solid bounding construction extending to the underside of the slab above and achieving a minimum FRL of 120-minutes; and
      ii. Wall-wetting sprinkler protection (both sides) installed over glazed wall/door construction. The wall-wetting sprinkler protection & glazed wall/door shall adopt the design parameters detailed in Fire Services and Equipment Items 3 & 4; and
4. The stairway within the Performing Arts Building indicated in Figure 0.4 shall be located within a fire-isolated shaft and shall discharge directly to the outside at the lowest level; and
   a. Glazed elements within the external wall shall comply with Clause C3.8 of the BCA; and
   b. The northern wall of this stair shall consist of either solid fire-rated construction achieving a minimum FRL of 60 minutes, or alternatively, shall be protected with wall-wetting sprinklers in accordance with Clause C3.4; and
      i. Any glazed elements within this external wall shall also be fixed-closed where protected by wall-wetting sprinklers in accordance with C3.4; and

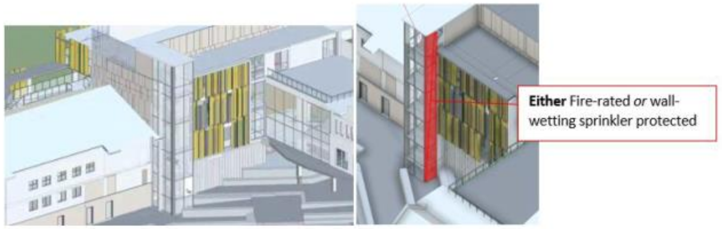


Figure 0.4: Stairway to generally be located within a fire-isolated shaft where glazed external construction shall comply with Clause C3.8

5. The main switch rooms situated within the Teaching & Learning and Performing Arts/Founders Buildings shall be bound by full-height by two-way fire-rated construction achieving a minimum FRL of 120-minutes and self-closing -/120/30 fire-rated doors; and
6. It has been identified that there are a number of openings associated with different fire compartments that are situated within minimum setback distances without the required protective measures; and
   a. Where external walls associated with different fire compartments are situated within minimum setback distance, one (1) of the external walls shall be provided with a two-way fire-rating achieving a minimum FRL of 120-minutes; and
   b. Where required openings shall be protected with one (1) or a combination of the following:
      i. Wall-wetting sprinkler protection (both sides) over fixed-closed or auto-closing glazing; and
      ii. Fire-rated curtain/shutter achieving minimum FRL of -/60/-; and
      iii. Fire-rated glazed construction achieving a minimum FRL of -/60/-.
   c. It is proposed to omit the protection specified in Part (b) above to the 'tilt-up' glazed door within the wall separating the Agora space and the sports centre building. It is proposed that this door remain unprotected (refer Figure 14.2); and
   d. It is proposed to omit the separation of fire compartments between the external agora area and the external colonnade area (refer Figure 14.2); and

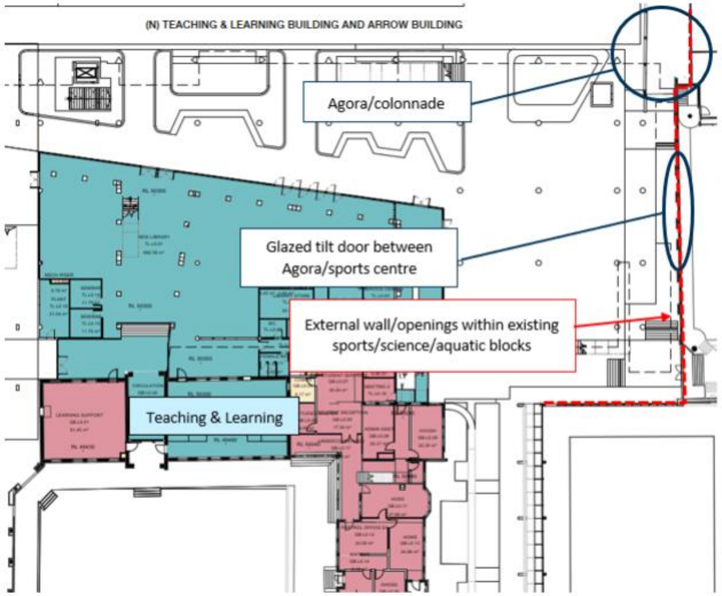


Figure 14.2: T&L and existing fire compartments (L0)

7. All components forming part of the external wall system serving the building shall be non-combustible in accordance with Clause C1.9(a)(i) and/or Verification Method CV3 from Volume One of the BCA; and
8. All fire compartment sizes throughout the Stage 3-5 works shall comply the Deemed-to-Satisfy provisions of the BCA.

Occupant Egress Provisions

1. Occupant egress provisions shall comply with the DtS Provisions in Part D from Volume One of the Building Code of Australia 2019 Amendment 1 unless otherwise identified herein; and
2. A bypass door shall be installed at Basement Level 1 within the T&L Precinct between the Plant/Store and the Art/Archive store as indicated in Figure 0.6; and

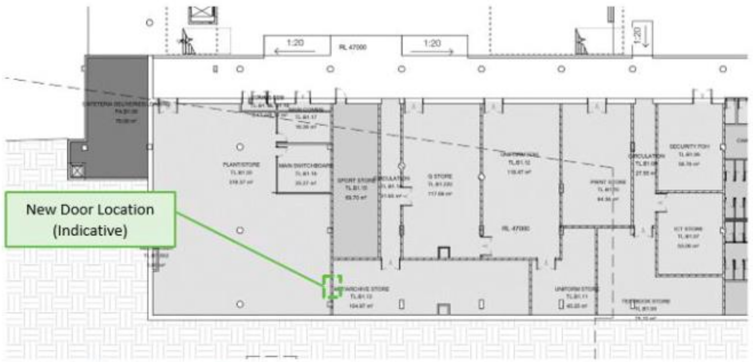


Figure 0.6: Indicative location of new door

3. Permit travel distances to a point of choice, to an exit and between alternative exits to exceed the maximum distances prescribed by the prescriptive provisions of the BCA as per the following:

Teaching & Learning Precinct:

Basement Level 1

a. It is proposed to permit a travel distance to an exit where two exits are available of up to 67m in lieu of 40m; and
b. It is proposed to permit a distance of travel between alternative exits of up to 80m in lieu of 60m.

Level 2

c. It is proposed to permit a travel distance to an exit where two exits are available of up to 47m in lieu of 40m; and
d. It is proposed to permit a distance of travel between alternative exits of up to 85m in lieu of 60m.

Level 3

e. It is proposed to permit a travel distance to a point of choice of up to 25m in lieu of 20m; and
f. It is proposed to permit a distance of travel between alternative exits of up to 80m in lieu of 60m.

Level 4

g. It is proposed to permit a travel distance to a point of choice of up to 32m in lieu of 20m; and
h. It is proposed to permit a travel distance to an exit where two exits are available of up to 44m in lieu of 40m.

Performing Arts Precinct:

Level 1

i. It is proposed to permit a travel distance to a point of choice of up to 30m in lieu of 20m; and

Level 3

j. It is proposed to permit a travel distance to a point of choice of up to 25m in lieu of 20m; and

Level 4

k. It is proposed to permit a travel distance to a single exit of up to 40 m in lieu of 20m within the roof plant area.

Music Building:

Level 0

l. It is proposed to permit a travel distance to a point of choice of up to 22m in lieu of 20m.

Multi-Purpose Hall:

Level 0

It is proposed to permit a travel distance to a point of choice of up to 30m in lieu of 20m.

4. Permit the non-fire isolated stairs serving the Teaching & Learning and Performing Arts/Founders Buildings to provide discontinuous egress paths in lieu of continuous egress by their own flights/landings to road/open space with the inclusion of the following:
   a. Provide directional evacuation diagrams/mud-maps to the discharge landing of each non-fire isolated stairway affording discontinuous egress. The evacuation diagram shall depict the alternative egress paths available and be orientated to reflect the aspect as presented to the reader; and
   b. Provide additional mounted illuminated exit signage (as required) to denote discontinuous egress paths from the non-fire isolated stairs serving the Teaching & Learning and Performing Arts/Founders Buildings.
5. Permit non-fire isolated stairways to interconnect multiple storeys without the provision of a fire-isolated shaft as per the following:
   a. Performing Arts Precinct:
      i. Open stairway interconnects four (4) storeys in lieu of three (3) within sprinkler protected building
   b. Arrow Building (i.e. external walkway):
      i. A number of open stairways which interconnect up to five (5) storeys in lieu of three (3) within sprinkler protected building.

Fire Services & Equipment

1. Fire services & equipment shall comply with the DtS Provisions in Part E from Volume One of the Building Code of Australia 2019 Amendment 1 unless otherwise identified herein; and
2. Automatic sprinkler protection shall be provided throughout the building in accordance with BCA Clause E1.5, Specification E1.5 and AS2118.1:2017 with the inclusion of the following:
   a. Automatic sprinkler protection shall be installed to the following building locations:
      i. Teaching & Learning (incl. Quadrangle building); and
         The underside of the Level 2 slab located above the Agora portion of the building shall be provided with sprinkler protection; and
      ii. Arrow Building (external walkways); and
      iii. Music Building; and
      iv. Performance Arts (incl. cafeteria & assembly hall); and
      v. Founders Building; and
   b. Sprinkler heads shall be fast response type heads having an actuation temperature of not greater than 68°C and RTI of not greater than $50m^{-0.5}s^{-0.5}$; and
   c. Activation of the sprinkler system shall initiate a General Fire Alarm (GFA) throughout the Trinity Grammar School campus; and
   d. Omit the requirement to provide automatic sprinkler protection within main switch rooms within the Teaching & Learning and Performing Arts/Founders Buildings; and
3. Where nominated glazed construction shall be protected by wall-wetting sprinkler protection designed and installed with the following requirements:
   a. The wall-wetting sprinkler system shall be designed and installed in accordance with AS2118.2:2010; and
   b. The wall-wetting sprinkler protected glazing shall be 6.0mm toughened or heat strengthened glass and fixed in the closed position. Horizontal mullions, vertical transoms or any other fixed obstructions/fixings/frame elements with may impede or block full wall-wetting sprinkler spray coverage are not permitted to the glazing system; and
   c. The nominated wall-wetting sprinkler system, shall be capable of providing full coverage to the entire glass panel; and
   d. Where glazing connectors or other fixed obstructions may impede water spray coverage to glazing, additional wall-wetting sprinkler heads may be required as per the manufacturer's data sheet to ensure that the nominated system provides complete spray coverage to the entire glass panel; and

   e. The maximum distance between any two (2) wall-wetting sprinklers shall be in accordance with the manufacturer's data sheet in order to provide sufficient and unimpeded coverage to the entire glass panel. It shall be noted that wall-wetting sprinkler protection is an acceptable method of protection commensurate with BCA Clause C3.4; and
   f. The water is to be supplied by an independent isolation valve to the sprinklers in the same area (i.e. not valved from the same sprinkler zones where the glazing is located); and
   g. The water supply for the wall-wetting sprinklers protecting the glazing may be fed from the fire hydrant system installation. A maximum of twelve (12) wall-wetting sprinkler heads shall be served by the fire hydrant service; and
   h. Where glazing construction is above ceilings to the slab structure or false ceiling space, wall-wetting sprinklers shall also be provided within the ceiling space such that the glazing is provided with unobstructed water spray. Alternatively, the ceiling space above the wall-wetting sprinkler protected glazing shall be provided with fire-rated construction achieving a minimum FRL of 120-minutes such that a consistent fire barrier is provided between adjacent fire compartments; and
4. Any openable, glazed swing door sets provided forming part of the nominated fire separation shall be provided with the following:
   a. Minimum 6.0mm thickened toughened (tempered) or heat strengthened glass panels; and
   b. Glazed doors shall be fitted with self-closing device or magnetic hold-open devices which are set to close/release upon General Fire Alarm (GFA). Glazed doors shall not be sliding; and
   c. The door leaves shall be fitted with medium temperature smoke seals suitable for smoke up to 200°C; and
   d. The wall-wetting sprinkler protection shall be designed and installed in accordance with AS2118.2:2010 and the parameters in item **Error! Reference source not found.** above; and
5. The glazed double-door set indicated in Figure 0.7 shall be provided with wall-wetting sprinkler protection; and

Figure 0.7: Doors to be provided with wall-wetting sprinkle protection

6. System monitoring to a fire station or fire station despatch centre shall be provided in accordance with AS1670.3:2018; and
7. Alarm Signalling Equipment (ASE) shall be provided with multiple outputs to designate the building of alarm origin; and
8. Automatic smoke detection shall be provided throughout all buildings of the Stage 3-5 portion in accordance with AS1670.1:2018 and with the inclusion of the following:
   a. The main switch rooms within the Teaching & Learning and Performing Arts/Founders Buildings shall be provided with centrally located smoke detectors; and
   b. The Basement Level 1 of the Teaching & Learning building shall be provided with a detection system on a reduced spacing of 8m x 8m in lieu of 10m x 10m; and
   c. Additional detectors shall be installed within the sports building within 1.5m of tilt glass panel at distances no greater than 10m along the width of the tilt panel. Activation of these detectors shall activate the EWIS within the T&L building; and
9. Provide a Building Occupant Warning System (BOWS) in accordance with BCA Specification E2.2a, AS1670.1:2018 which shall initiate on either sprinkler head or detector activation and with the inclusion of the following:
   a. The BOWS shall comprise a pre-recorded public address system; and

b. The following buildings shall be provided with a BOWS:
   i. Multi-Purpose Pavilion; and
   ii. Music Building; and
   iii. Arrow Building; and

10. Provide an Emergency Warning & Intercommunication System (EWIS) in accordance with BCA Specification E2.2a and AS1670.4:2018 which shall initiate on either sprinkler head or detector activation to the following locations:
    a. Teaching & Learning; and
    b. Quadrangle Building; and
    c. Performing Arts; and
    d. Founders Building; and
11. As per Clause 5.2.1 of AS1668.1:2015, air handling systems not designed to operate in fire mode shall shut down upon activation of GFA; and
12. The Trinity Grammar School campus shall be served by a number of Fire Indicator Panels (FIP's) generally configured and networked as follows (refer to 11 of this PBDB for details):
    a. The campus wide main FIP shall be situated at the entry of Oval 3 carpark (adjacent fire sprinkler/hydrant plant room and is closest to the booster assembly) and shall be connected to new FIP's on a high-level network which shall be located as follows:
       i. Multi-Purpose Pavilion FIP; and
       ii. Music Building FIP; and
       iii. Performance Arts Building FIP & EWIS Panel; and
       iv. Existing Hurlstone Building FIP (to be replaced with new FIP); and
       v. Teaching & Learning and Quadrangle Building FIP & EWIS Panel; and
       vi. Oval 2 Carpark FIP; and
       vii. Maintenance Building FIP; and
    b. Existing FIP's shall be connected to the main FIP at Oval 3 on a low-level simple interface and shall include the following locations:
       i. Existing pump room FIP; and
       ii. Existing Gym FIP; and
       iii. Existing Junior School FIP; and
       iv. Existing Science/IT FIP's & EWIS Panel; and
       v. Existing Delmar Gallery FIP; and
13. Provide strobe lights and alarm horn sounders at strategic locations where the most disadvantaged occupants shall be able to readily see the light(s) or hear the sounder(s). The strobe lights and sounders shall be set to activate upon General Fire Alarm (GFA). Strobes/sounders shall be provided as follows:
    a. Level B1 Store/Plant room. Refer to Figure 8.1 for indicative locations; and
    b. Level 4 Plant Deck. Refer to **Error! Reference source not found.** for indicative locations; and
14. Permit the fire hydrant system to be designed, installed & commissioned in accordance with AS2419.1:2017 in lieu of AS2419.1:2005 to be consistent with Stage 1 & 2; and
    a. The Stage 3-5 portion will be served by the site-wide booster assembly which is located on Victoria Street. This location was included as a Performance Solution within the Arup FER referenced in Section 0.5.1; and
       i. The booster shall be provided with a visual warning device (red strobe) in accordance with Clause 7.3.2 of AS2419.1:2017 and shall activate upon GFA; and
       ii. The block plans across the site (including at the booster assembly) shall be updated to reflect the Stage 3-5 works; and
15. Couplings in the fire hydrant system (including fire hydrant booster assembly) shall be compatible with those of the fire appliances and equipment used by Fire and Rescue NSW. Fire hydrant booster assembly connections and all fire hydrant valves shall be fitted with Storz aluminium alloy delivery couplings manufactured and installed in accordance with the relevant Australian Standard; and
16. Block plans are to be provided at the Fire Indicator Panel (FIP), fire hydrant booster assembly & fire pump room in accordance with Section 7.11 of AS2419.1:2005, FRNSW Fire Safety Guideline – Emergency Services Information Package and Tactical Fire Plans (Version 02 dated 07/01/2019) and the inclusion of the following:

    a. The block plans should be orientated to reflect the aspect of the installation as it is presented to the reader; and
    b. The block plans across the site (including at the booster assembly) shall be updated to reflect the Stage 3-5 works; and
17. Omit the requirement to provide fire hose reel system school portions of the building with the inclusion of the following:
    a. Provide additional portable fire extinguishers located adjacent the required exit locations (i.e. within 4m) in lieu of fire hose reels; and
18. Portable fire extinguishers in accordance with BCA Clause E1.6 and AS2444:2001 with the inclusion of the following:
    a. Additional portable fire extinguishers shall be provided through school portions throughout as per the following:
       i. In these locations, a 9-litre water type extinguisher shall be provided which would be suitable toward Class A fires. Where kitchens or the like are situated an additional 4.5kg 40B:E Type Dry Chemical or 4.5kg 2A:4F Wet Chemical or 4.5kg 2A:20B:E Dry Chemical (without deep fryer) portable fire extinguisher shall be provided adjacent the exit and between 2-20m from the cooking area. Where electrical switchboards are situated within the school portions an additional 4.5kg 2A:20B:E Dry chemical portable fire extinguisher shall be provided between 2-20m from the electrical switchboard; and
       ii. Portable fire extinguishers may be placed within a metal cabinet in an accessible location (i.e. not within a locked cabinet) Portable fire extinguishers may be placed within a metal cabinet mounted to a wall and fitted with a break glass to limit the likelihood of damage, vandalism or theft; and
19. Emergency lighting and exit signage in accordance with AS2293.1:2018 with the inclusion of the following:
    a. Provide additional mounted exit signage (as required) to denote discontinuous egress paths from the non-fire isolated stairs serving the Teaching & Learning and Performing Arts/Founders Buildings.

Management in Use Requirements

1. Maintain paths of travel to an egress, stair entrances, vehicular access ramp, thoroughfares and lobby areas free of static storage and combustible materials at all times; and
2. Smoking shall not be permitted throughout all public areas of the subject building in accordance with the Smoke-Free Environment Act 2000; and
3. All fire safety measures and Management in Use requirements shall be incorporated into an Essential Services list. All fire safety measures shall be maintained in accordance with the requirements of AS1851 (or equivalent maintenance standard) as identified by Scientific Fire Services. Management in Use requirements shall be inspected and logged on an annual basis; and
4. An emergency management plan in accordance with AS3745:2010, including procedures for the safety of people in buildings, structures and workplaces during emergencies, the appointment of an Emergency Planning Committee and setting up an Emergency Control Organisation; and
5. Regular maintenance shall be undertaken of all fire safety systems as required by relevant Australian Standards; and
6. Fire training of staff and maintenance staff, including emergency evacuation procedures and use of firefighting equipment (where applicable) to be undertaken at regular intervals.

7 Departures from the Deemed-to-Satisfy provisions

Issue number: 1 **Title:** Type of Construction Required within Multi-Purpose Hall

Details of departures from DtS provisions:

Clause C1.1 from Volume One of the NCC provides the Type of Construction Required for buildings based upon the rise in storeys and the associated building classification as defined under the BCA. Referring to Table C1.1 from Volume One of the NCC, the subject building is required to be constructed from Type B, fire resisting construction due to the rise-in-storeys of two (2) based on the configuration of the building including the location of the carpark below the building.

As part of the design and based on the existing nature of the subject building, it is proposed to permit and rationalize the Type of Construction to the Pavilion portion of the building (i.e. excluding the carpark underneath) of this structure which is a deviation from Clause C1.1 and Specification C1.1. The identified area has been illustrated in Figure 6.1.

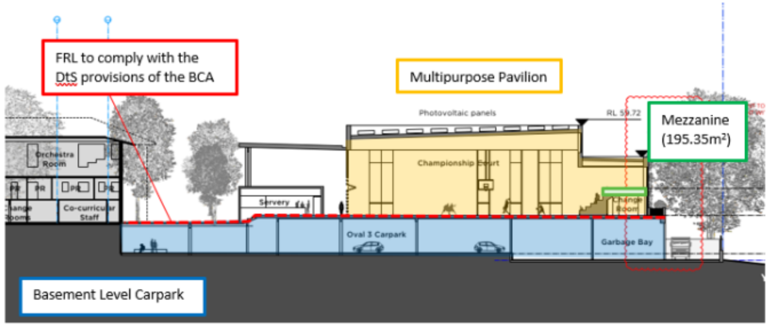


Figure 6.1: Section depicting Type of Construction of the Multipurpose Pavilion

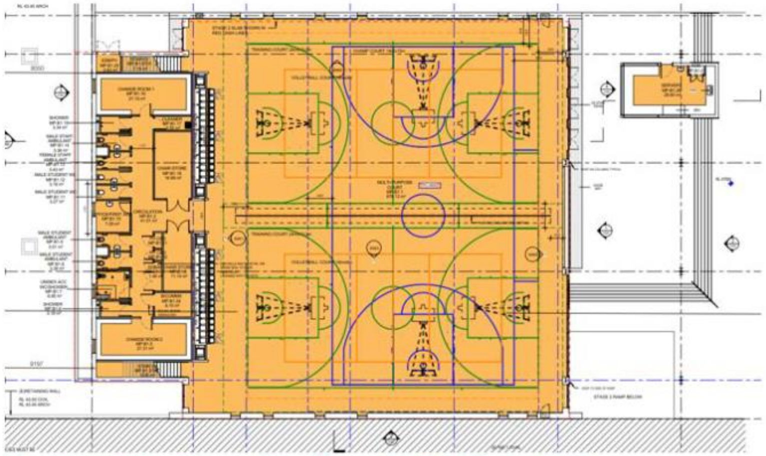


Figure 6.2: Extended Travel Distance within Multipurpose Pavilion Building (Level 0 - GF)

Applicable DtS provisions:	Clause C1.1 & Specification C1.1	Performance requirements:	CP1 & CP2

List key fire safety measures:

The Guide to the NCC (ABCB, 2019) identifies the potential for occupants to encounter unsafe conditions as fire may spread or the structural stability of the structure may be impacted upon. Therefore, by providing a suitable FRL, occupant life safety is still maintained to the degree necessary. In this regard the following hazard mitigation systems, requirements and features of the design are noted:

- It is proposed to permit the Multipurpose Pavilion structure (excluding the basement level carpark) to be constructed in accordance with the minimum FRL's commensurate with Type C fire-resisting construction in lieu of Type B fire-resisting construction and inclusive of the following:
  - The Multipurpose Pavilion structure shall consist of non-combustible construction. This performance solution relates to the applicable FRL's only; and
  - The Multipurpose Pavilion shall be fire-separated from the basement level Oval 3 carpark via a fire-rated slab achieving a minimum FRL of 120-minutes in accordance with the DtS provisions of the BCA. Any services penetrations through the fire-rated floor slab shall be fire-stopped and must conform to a tested system in accordance with AS1530.4:2014; and
- Aside from being located atop the carpark separating floor slab, the subject multi-purposes pavilion building is a separate building from any other building on the site; and
- The Oval 3 carpark below the multi-purpose pavilion structure shall be protected by automatic sprinkler protection; and
- Egress provisions from the pavilion floor shall be provided on-grade to an open space, and are independent from the carpark egress provisions. It is not proposed to have any interconnecting stairways between the carpark portion and the pavilion portion; and
- A fire detection and alarm system shall be provided throughout for all buildings within Stage 3-5 in accordance with Specification E2.2a and AS1670.1:2018; and
- Permanent occupants are expected to be familiar with the building layout and paths of egress.

Proposed performance solution:

The methodology to be adopted to address the proposed adoption of FRL's commensurate with Type C fire-resisting construction in lieu of Type B fire-resisting construction for the building shall be a qualitative comparative assessment. The Multipurpose Pavilion structure shall be compared to a standalone structure with consideration of the function and use of the building, the proposed fire separation of the carpark and the independent access/egress provisions afforded to both occupants and attending fire brigade personnel. Specifically, the risk of fire-spread throughout the Multipurpose Pavilion building and the ability for occupants to discharge directly to a road/open space and similarly the ability for attending fire brigade personnel when undertaking their operations shall be compared to a comparable deemed-to-satisfy design.

It should be noted that under the deemed-to-satisfy provisions (where considered independently) the Multipurpose Pavilion as a standalone building with a rise in storeys of one (1) based on its classification and use would only be required to be constructed in accordance with Type C construction requirements including the permissibility of combustible construction (noting that the proposed design shall be non-combustible).

The qualitative aspect of the evaluation shall also consider the proposed fire safety measures (i.e. provision of smoke detection being an enhancement).

Performance solution:

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

Assessment methods:

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

Assessment approach:

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

IFEG sub-systems used in the analysis:

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

Acceptance criteria and factor of safety:

The acceptance criterion shall be met by demonstrating that the fire separation and access/egress provisions for this building is comparable building with a rise-in-storeys of one (1), thus comparable to a building that would otherwise be required to achieve Type C construction as prescribed for a DtS compliant design. The benefit of the provision of smoke detection to this building (not required by the DTS provisions) shall also be considered.

Fire scenarios and design fire parameters:

N/A

Describe how fire brigade intervention will be addressed or considered:

Fire Brigade Intervention to be assessed in subsequent Fire Safety Engineering Report (FSER)

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

N/A

Provide details on proposed modelling/assessment tools:

N/A

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: 2 **Title:** Separation of External Walls & Associated Openings in Different Fire Compartments

Details of departures from DtS provisions:

It has been identified that there are a number of external walls and openings and that are associated with different fire compartments and are situated within close proximity to each other as follows:

- The southern wall & openings of the Teaching & Learning block at L0 & L3 is situated approximately 5.8m from the northern wall & openings of the Founders/PA block. It is proposed to provide two-way FRL protection from one (1) fire compartment side only in lieu of both fire compartments; and
- The new agora space of the Teaching & Learning block abuts the existing sports/science/aquatic blocks and contain non-protected openings as follows:
  - L0: glazed connection between agora and existing sports centre
  - L0-L4: glazed openings configured in a parallel orientation and situated within 6m of each other

The proposed design forms a deviation from Clause C2.7 of the BCA which prescribes the external wall construction of the different fire compartments to be fire-rated. The design also deviates from Clause C3.3 & Table C3.3 of the BCA which prescribes openings within different fire compartments to be suitably protected. Figure 7.1 to Figure 7.5 depict the different fire compartment proximities.

Figure 7.1: T&L and Founders/PA fire compartments (L0)

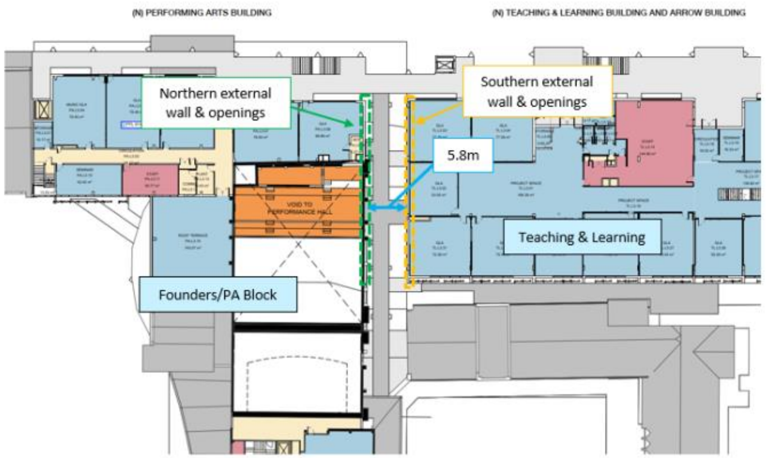


Figure 7.2: T&L and Founders/PA fire compartments (L3)

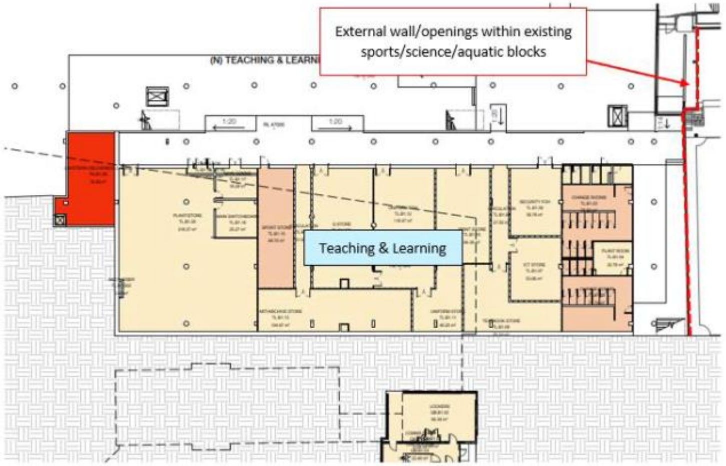


Figure 7.3: T&L and existing fire compartments (B1)

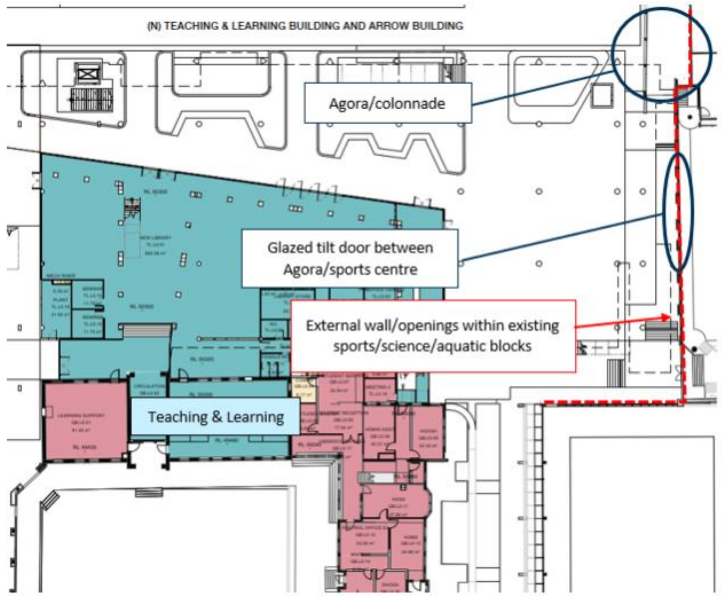


Figure 7.4: T&L and existing fire compartments (L0)

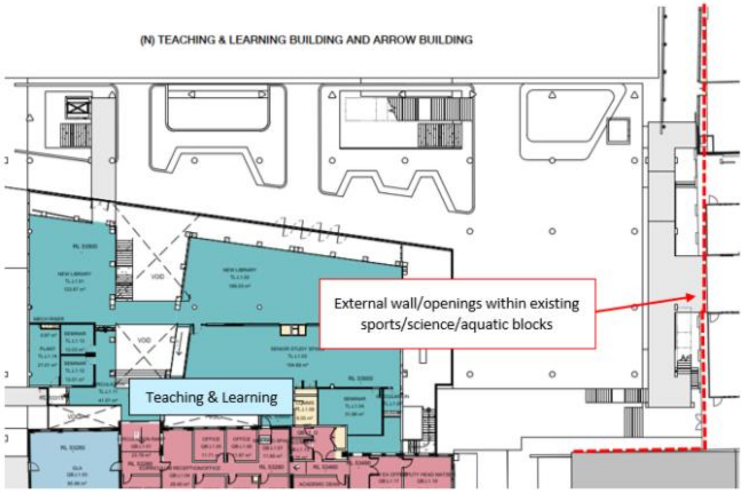


Figure 7.5: T&L and existing fire compartments (L1)

Applicable DtS provisions:	Clause C2.7, Clause C3.3 & Table C3.3	Performance requirements:	CP2

List key fire safety measures:

The 'Guide to the BCA' (ABCB, 2019) identifies the potential for fire to spread as a result of unprotected openings/walls associated with different fire compartments being situated within minimum setback distances. In this regard, the following hazard mitigation systems, requirements and features of the design are noted:

- Where external walls associated with different fire compartments are situated within minimum setback distance, one (1) of the external walls shall be provided with a two-way fire-rating achieving a minimum FRL of 120-minutes; and
- Where required openings shall be protected with one (1) or a combination of the following:
  - Wall-wetting sprinkler protection (both sides) over fixed-closed or auto-closing glazing; and
  - Fire-rated curtain/shutter achieving minimum FRL of -/60/-; and
  - Fire-rated glazed construction achieving a minimum FRL of -/60/-.

FRNSW Comment: FRNSW recommend the proposed separation be clearly marked up to permit a considered review.

- Automatic smoke detection shall be provided throughout all buildings of the Stage 3-5 portion in accordance with AS1670.1:2018 and with the inclusion of the following:
  - Additional detectors shall be installed within the sports building within 1.5m of tilt glass panel at distances no greater than 10m along the width of the tilt panel. Activation of these detectors shall activate the EWIS within the T&L building; and
- It is proposed to omit the protection specified in above to the 'tilt-up' glazed door within the wall separating the Agora space and the sports centre building. It is proposed that this door remain unprotected; and
- It is proposed to omit the separation of fire compartments between the external agora area and the external colonnade area.

Proposed performance solution:

The methodology to be adopted to address the design issue relative to openings in adjacent fire compartments shall be based upon a qualitative & quantitative 'deterministic' evaluation. The qualitative aspect shall consider the different compartments with respect to the function/use, fire hazard and proposed protection strategy (two-way protection from one side only). The evaluation shall also consider the impact imposed onto evacuating occupants and attending fire crews.

Quantitative Analysis

The quantitative aspect of the evaluation shall conduct a radiant heat exposure analysis based on the size & location of glazed openings to determine the potential for fire spread between adjacent fire compartments. The potential for fire spread shall be calculated utilising a radiant heat transfer calculation (Drysdale, 1999) (refer to Appendix E of this PBDB for further details of the radiant heat transfer methodology):

Radiant Heat Transfer: $q_r = \emptyset \sigma \varepsilon T_f^4$ [1]

where,

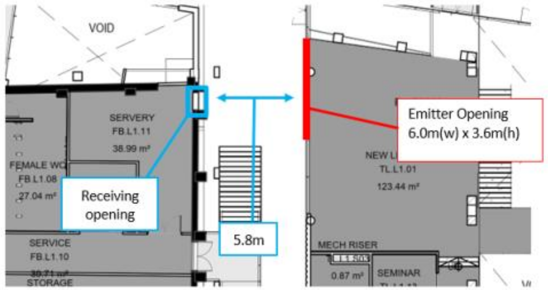
q_r = radiant heat flux level (kW/m²)

$\emptyset$ = configuration factor

σ = Stefan-Boltzman constant (5.68 x 10^{-8} W/m²/K⁴)

ε = emissivity of the fire source (0.9, Drysdale 1999)

T = Temperature (900°C, non-sprinklered building or sprinkler failure fire scenario)



Radiant Heat Transfer for Parallel Openings

Input Parameters				
w (b)	-	Width of Opening	use table >	
h (a)	-	Height of Opening	use table >	
d (c)	-	Distance to receiving surface	use table >	
T_B	-	Temperature of radiator (Opening)	900	°C
T_S	-	Temperature of receiving surface	20	°C
T_B	-	Calculated Radiator Temperature (K)	1173	K
T_S	-	Calculated Receiving Temperature (K)	293	K
σ	-	Stefan Boltzman Constant	5.67E-11	kW/m²K
ε_r	-	Emissivity of the Surface	0.9	
		Input parameters		
		Calculated values/Constants		

Opening ID	w	h	c	Maximum Radiation Received
	(m)	(m)	(m)	(KW/m^2)
Library	6.00	3.60	5.80	15.90

Figure 7.6: Indicative quantitative heat transfer calculation between fire compartments

FRNSW Comment: Clarification of the emitter dimensions is required noting it appears the glazed façade extends beyond that marked up.

Separation of Agora from Colonnade & Sports Building

With regard to the unprotected openings within the separation of the external Agora portion from the external colonnade and the proposed tilt-up glazed door within the sports centre wall, the analysis shall consider the external nature of the Agora and the associated availability of ventilation. The analysis shall also consider the expected fuel loads within the Agora/Colonnade in the area adjacent to the subject tilt-door. The analysis shall demonstrate that the external nature of this agora area and the low fuel loads of the subject areas shall mitigate the risk of fire spread between technically separate fire compartments.

FRNSW Comment: FRNSW recommend a management in use procedure be implemented to ensure these areas are maintained as required, this should be listed as an essential measure on the fire safety schedule.

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 basic objective and intent of the analysis pertains to fire spread between adjacent fire compartments. Thus, the primary acceptance criterion shall be met by demonstrating that two-way protection provided from one fire compartment side is sufficient in mitigating the potential for fire spread between adjacent fire compartments. The secondary acceptance criterion shall be met by demonstrating that occupants are able to safely evacuate, and fire-fighter personnel are able to undertake intervention activities without being negatively impacted upon.

The quantitative acceptance criterion shall be met by demonstrating that the radiant heat flux levels emitted/received by the adjacent fire compartments are less than $20kW/m^2$ which is the minimum radiant heat flux required to ignite curtain material in the absence of a spark (i.e. non-piloted ignition).

FRNSW Comment: Clarification is required whether any of the unprotected openings contain operable elements. If so, FRNSW consider that piloted ignition may be possible. The Guide to the BCA under Verification Method CV1 states that a value of $10\ kW/m^2$ is appropriate for curtain materials. AS1530.4 Table A3 details $13kW/m^2$ as appropriate for piloted ignition of cotton material.

Fire scenarios and design fire parameters:

N/A

Describe how fire brigade intervention will be addressed or considered:

Fire Brigade Intervention to be assessed in subsequent Fire Safety Engineering Report (FSER)

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

N/A

Provide details on proposed modelling/assessment tools:

N/A

FRNSW Comment: FRNSW comments above should be adequately addressed.

Issue number: 3 **Title:** Exit Travel Distance

Details of departures from DtS provisions:

Based on the existing and proposed floor plate configuration, it has been identified that the distance of travel to a point of choice, to an exit and between alternative exits from the most disadvantaged locations within the identified buildings do not comply with the DtS provisions of the BCA.

As part of the assessment, it is proposed to permit travel distances as per the following:

Teaching & Learning Precinct:

Basement Level 1

- It is proposed to permit a travel distance to a point of choice of up to 45m in lieu of 20m; and
- It is proposed to permit a travel distance to an exit where two exits are available of up to 67m in lieu of 40m; and
- It is proposed to permit a distance of travel between alternative exits of up to 80m in lieu of 60m.

Level 2

- It is proposed to permit a travel distance to an exit where two exits are available of up to 47m in lieu of 40m; and
- It is proposed to permit a distance of travel between alternative exits of up to 85m in lieu of 60m.

Level 3

- It is proposed to permit a travel distance to a point of choice of up to 25m in lieu of 20m; and
- It is proposed to permit a distance of travel between alternative exits of up to 80m in lieu of 60m.

Level 4

- It is proposed to permit a travel distance to a point of choice of up to 32m in lieu of 20m; and
- It is proposed to permit a travel distance to an exit where two exits are available of up to 44m in lieu of 40m.

Performing Arts Precinct:

Level 1

- It is proposed to permit a travel distance to a point of choice of up to 30m in lieu of 20m; and

Level 3

- It is proposed to permit a travel distance to a point of choice of up to 25m in lieu of 20m; and

Level 4

- It is proposed to permit a travel distance to a single exit of up to 40 m in lieu of 20m within the roof plant area.

Music Building:

Level 0

- It is proposed to permit a travel distance to a point of choice of up to 22m in lieu of 20m.

Multi-Purpose Hall:

Level 0

- It is proposed to permit a travel distance to a point of choice of up to 30m in lieu of 20m.

This is noted to form a deviation from Clause D1.4 & Clause D1.5 of the BCA which prescribes a maximum travel distance of travel to a point of choice to be no more than 20m, to an exit where two exits are available no more than 40m, and between alternative exits of no more than 60m. Figure 8.1 to Figure 8.9 illustrates the indicative locations where the egress provisions do not meet the DtS provisions of the BCA.

Figure 8.1: Extended Travel Distance within T&L Precinct (Level B1)

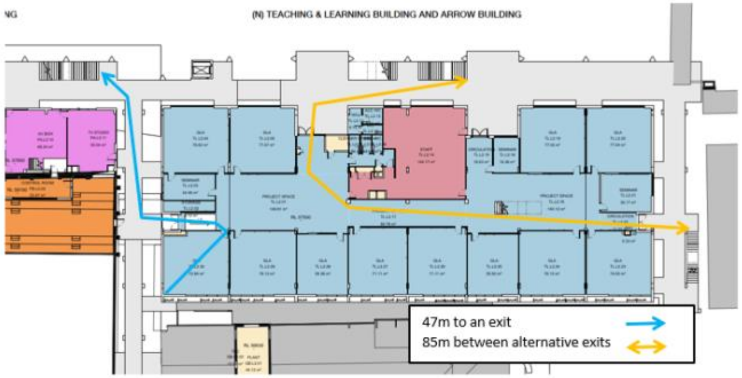


Figure 8.2: Extended Travel Distance within T&L Precinct (Level L2)

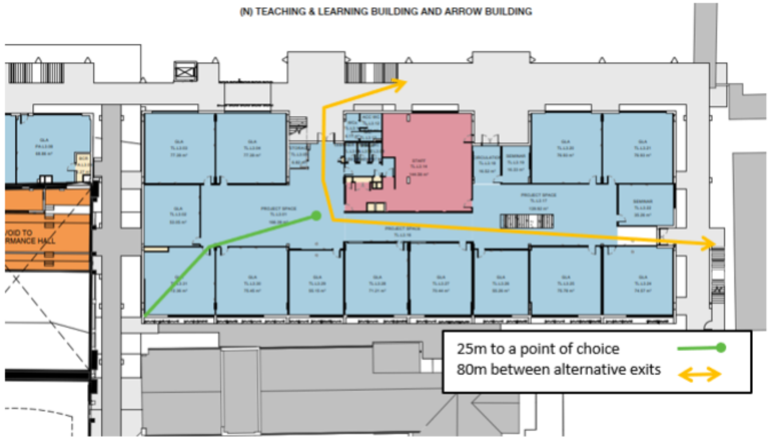


Figure 8.3: Extended Travel Distance within T&L Precinct (Level L3)

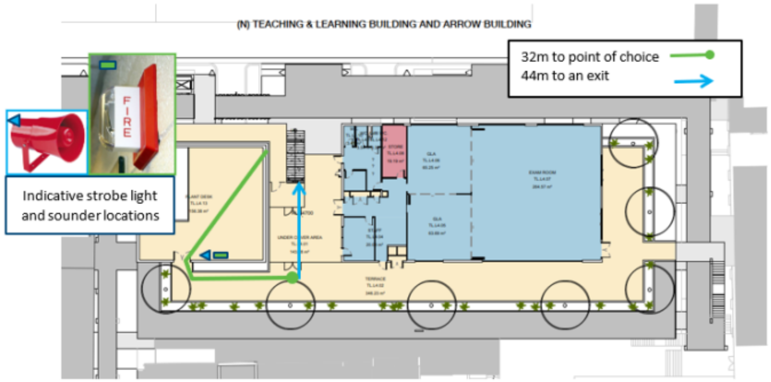


Figure 8.4: Extended Travel Distance within T&L Precinct (Level L4)

Figure 8.5: Extended Travel Distance within Performing Arts Precinct (Level 1)

Figure 8.6: Extended Travel Distance within Performing Arts Precinct (Level 3)

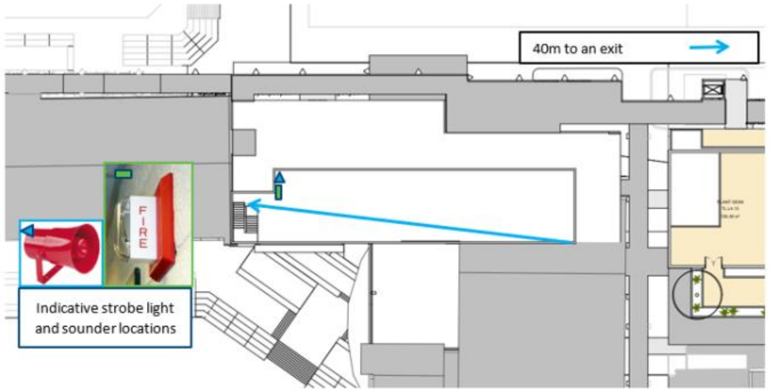


Figure 8.7: Extended Travel Distance within Performing Arts Precinct – Rooftop Plant (Level 4)

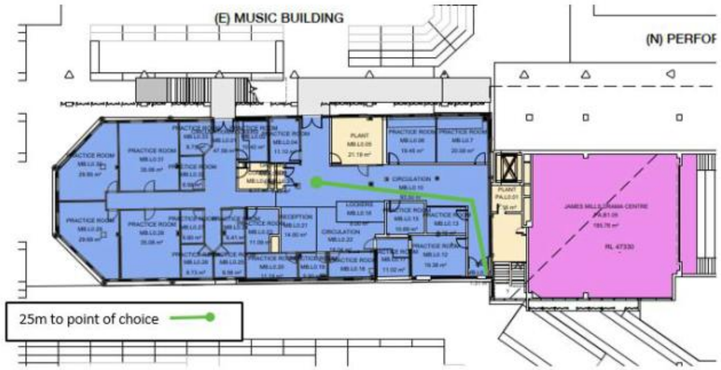


Figure 8.8: Extended Travel Distance within Music Building (Level 0 - GF)

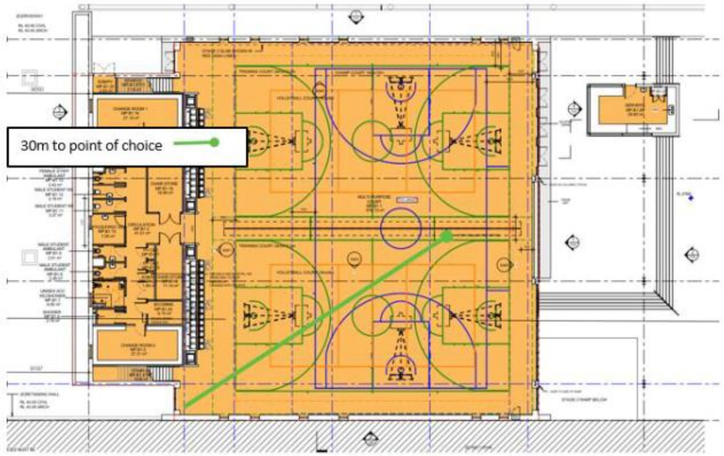


Figure 8.9: Extended Travel Distance within Multipurpose Pavilion Building (Level 0 - GF)

Applicable DtS provisions:	Clause D1.4 & Clause D1.5	Performance requirements:	DP4, DP5 & EP2.2

List key fire safety measures:

The 'Guide to the BCA' (ABCB, 2019) identifies the potential for occupants to encounter unsafe conditions whilst they evacuate from the building and hence prescribes *"what is a reasonable distance for occupants to travel to an exit"*. In this regard the following hazard mitigation systems, requirements and features of the design are noted:

- Automatic sprinkler protection shall be provided throughout the building in accordance with BCA Clause E1.5, Specification E1.5 and AS2118.1:2017 with the inclusion of the following:

- Automatic sprinkler protection shall be installed to the following building locations:
  - Teaching & Learning (incl. Quadrangle building); and
  - The underside of the Level 2 slab located above the Agora portion of the building shall be provided with sprinkler protection; and
  - Arrow Building (external walkways); and
  - Music Building; and
  - Performance Arts (incl. cafeteria & assembly hall); and
  - Founders Building; and
- Sprinkler heads shall be fast response type heads having an actuation temperature of not greater than 68°C and RTI of not greater than $50m^{-0.5}s^{-0.5}$; and
- Activation of the sprinkler system shall initiate a General Fire Alarm (GFA) throughout the Trinity Grammar School campus; and
- Omit the requirement to provide automatic sprinkler protection within main switch rooms within the Teaching & Learning and Performing Arts/Founders Buildings; and

- Automatic smoke detection shall be provided throughout all buildings of the Stage 3-5 portion in accordance with AS1670.1:2018 and with the inclusion of the following:
  - The main switch rooms within the Teaching & Learning and Performing Arts/Founders Buildings shall be provided with centrally located smoke detectors; and
  - The Basement Level 1 of the Teaching & Learning building shall be provided with a detection system on a reduced spacing of 8m x 8m in lieu of 10m x 10m; and
  - Additional detectors shall be installed within the sports building within 1.5m of tilt glass panel at distances no greater than 10m along the width of the tilt panel. Activation of these detectors shall activate the EWIS within the T&L building; and
- Travel distances include travel through the external covered walkway (i.e. Arrow Building) portions which shall contain low fuel loads, be provided with sprinkler protection and have substantial ventilation along the perimeter of the walkways such that smoke in this area would be expected to vent to atmosphere; and
- Provide strobe lights and alarm horn sounders at strategic locations where the most disadvantaged occupants shall be able to readily see the light(s) or hear the sounder(s). The strobe lights and sounders shall be set to activate upon General Fire Alarm (GFA). Strobes/sounders shall be provided as follows:
  - Level B1 Store/Plant room. Refer to Figure 8.1 for indicative locations; and
  - Level 4 Plant Deck. Refer to Figure 8.4 for indicative locations; and
- Provide a Building Occupant Warning System (BOWS) in accordance with BCA Specification E2.2a, AS1670.1:2018 which shall initiate on either sprinkler head or detector activation and with the inclusion of the following:
  - The BOWS shall comprise a pre-recorded public address system; and
  - The following buildings shall be provided with a BOWS:
    - Multi-Purpose Pavilion; and
    - Music Building; and
    - Arrow Building; and
- Provide an Emergency Warning & Intercommunication System (EWIS) in accordance with BCA Specification E2.2a and AS1670.4:2018 which shall initiate on either sprinkler head or detector activation to the following locations:
  - Teaching & Learning; and
  - Quadrangle Building; and
  - Performing Arts; and
  - Founders Building; and
- Emergency lighting and exit signage shall be provided in accordance with AS2293.1:2018; and
- The main occupants are considered to be awake, coherent and aware of their surroundings; and
- Occupants are considered to be familiar with the floor plate as they will use these areas regularly for school attendance.

Proposed performance solution:

The methodology to address the design issue relative to the extended travel distances shall be based upon a combination of both a qualitative 'risk' and quantitative 'comparative' evaluation. The qualitative aspect of the evaluation shall consider the school areas function & use (e.g. available ventilation and external nature of portions of the path of travel), risk of fire ignition and the proposed fire safety measures (i.e. provision of smoke detection

being an enhancement, strobe light/sounders to plant areas). Further consideration of the impact imposed onto attending fire-fighter personnel shall also be undertaken

The analysis shall consider the three (3) main components: detection, pre-movement and movement (i.e. $t_d + t_{pm} + t_m$ = RSET) to demonstrate that the increased time associated with the identified travel distances shall be suitably compensated through enhanced occupant warnings and detection (i.e. smoke detection system, strobe light to plant areas) and distance of travel to a place of relative safety (i.e. external walkway environment). The overall occupant evacuation time shall be enhanced such that the egress strategy suitably compensates the additional travel distance and is at least equivalent to a DtS building solution.

The analysis shall adopt quantitative aspects including the comparison of alarm times based on the requirement for the provision of sprinkler activation alarm requirements and the proposed AS1670.1:2018 detectors with spacings of 10m between detectors. The reduced activation time compensated for the additional distance of travel. The input parameters for detector activation times are provided in Table 8.2.

Table 8.2: Input parameters for Sprinkler/Detector activation calculations

Item	DtS Equivalent Design (Sprinklers Only)	Proposed Design (Smoke Detection & Sprinklers)
Sprinkler/Detector Activation Temperature	68°C	13°C above ambient conditions (Heskestad, 1995 – Temperature Equivalence method)
Response Time Index (RTI)	$50m^{0.5}s^{0.5}$	$10m^{0.5}s^{0.5}$ (Evans, 1984)
Location of Sprinkler/Detector	2.75m Ceiling level (typical)	2.75m Ceiling level (typical)
Sprinkler/Detector Spacing	4.6m x 4.6m grid spacing based on Light Hazard (Radial Distance 3.25m)	**Typical:** 10m x 10m grid spacing based on AS1670.1:2018 (Radial Distance 7.1m) **T&L Level B1:** 8m x 8m grid reduced spacing (Radial Distance 5.66m)
Fire Growth Rate	Medium t^2 & Fast t^2	Medium t^2 & Fast t^2

Table 8.3: Alpert's Correlation Outcomes for Sprinkler/Detector activation times

No.	DtS Equivalent Design (Sprinklers Only)	Proposed Design (Smoke Detection & Sprinklers)
Medium t^2	**Required Inputs** Ambient Temperature, T = 20 (°C) Fire Growth Rate = Medium Time Step Interval = 20 (s) Radial Distance of the Detector from the Fire, r = 3.25 (m) The Height of the Ceiling above the fire, H = 2.75 (m) The Response Time Index of the Detector, RTI = 50 ($m^{1/2}s^{1/2}$) Sprinkler Density of Discharge = 5 mm / min Sprinkler Activation Temperature = 68 (°C) **Calculated Quantites at Detector Activation** The Gas Temperature at Sprinkler Activation, T = 85.12 (°C) HRR at Sprinkler Activation = 624.10 (kW) The Gas Velocity, U = 1.03 (m/s) Time at Sprinkler Activation = 238 (s) Time to Reach 10% of peak HRR = 924 (s) Ratio, r / H = 1.18	**Required Inputs** Ambient Temperature, T = 20 (°C) Fire Growth Rate = Medium Time Step Interval = 20 (s) Radial Distance of the Detector from the Fire, r 7.10 (m) The Height of the Ceiling above the fire, H = 3.25 (m) The Response Time Index of the Detector, RTI = 10 ($m^{1/2}s^{1/2}$) Smoke/Sprinkler Density of Discharge = 5 mm / min Detector Activation Temperature = 33 (°C) **Calculated Quantites at Detector Activation** The Gas Temperature at Detector Activation, T = 35.15 (°C) HRR at Detector Activation = 196.54 (kW) The Gas Velocity, U = 0.40 (m/s) Time at Detector Activation = 134 (s) Time to Reach 10% of peak HRR = 820 (s) Ratio, r / H = 2.18
Fast t^2	**Required Inputs** Ambient Temperature, T = 20 (°C) Fire Growth Rate = Fast Time Step Interval = 20 (s) Radial Distance of the Detector from the Fire, r = 3.25 (m) The Height of the Ceiling above the fire, H = 2.75 (m) The Response Time Index of the Detector, RTI = 50 ($m^{1/2}s^{1/2}$) Sprinkler Density of Discharge = 5 mm / min Sprinkler Activation Temperature = 68 (°C) **Calculated Quantites at Detector Activation** The Gas Temperature at Sprinkler Activation, T = 99.01 (°C) HRR at Sprinkler Activation = 834.18 (kW) The Gas Velocity, U = 1.14 (m/s) Time at Sprinkler Activation = 138 (s) Time to Reach 10% of peak HRR = 824 (s) Ratio, r / H = 1.18	**Required Inputs** Ambient Temperature, T = 20 (°C) Fire Growth Rate = Fast Time Step Interval = 20 (s) Radial Distance of the Detector from the Fire, r 7.10 (m) The Height of the Ceiling above the fire, H = 3.25 (m) The Response Time Index of the Detector, RTI = 10 ($m^{1/2}s^{1/2}$) Smoke/Sprinkler Density of Discharge = 5 mm / min Detector Activation Temperature = 33 (°C) **Calculated Quantites at Detector Activation** The Gas Temperature at Detector Activation, T = 37.15 (°C) HRR at Detector Activation = 236.84 (kW) The Gas Velocity, U = 0.42 (m/s) Time at Detector Activation = 74 (s) Time to Reach 10% of peak HRR = 760 (s) Ratio, r / H = 2.18

No.	Proposed Design: T&L Level B1 (Smoke Detection 8m x 8m & Sprinklers)	
Medium t^2	**Required Inputs**	
	Ambient Temperature, T =	20 (°C)
	Fire Growth Rate =	Medium
	Time Step Interval =	20 (s)
	Radial Distance of the Detector from the Fire, r	5.66 (m)
	The Height of the Ceiling above the fire, H =	3.25 (m)
	The Response Time Index of the Detector, RTI =	10 ($m^{1/2}s^{1/2}$)
	Smoke/Sprinkler Density of Discharge =	5 mm / min
	Detector Activation Temperature =	33 (°C)
	Calculated Quantites at Detector Activation	
	The Gas Temperature at Detector Activation, T =	35.36 (°C)
	HRR at Detector Activation =	160.00 (kW)
	The Gas Velocity, U =	0.45 (m/s)
	Time at Detector Activation =	121 (s)
	Time to Reach 10% of peak HRR =	807 (s)
	Ratio, r / H =	1.74
Fast t^2	**Required Inputs**	
	Ambient Temperature, T =	20 (°C)
	Fire Growth Rate =	Fast
	Time Step Interval =	20 (s)
	Radial Distance of the Detector from the Fire, r	5.66 (m)
	The Height of the Ceiling above the fire, H =	3.25 (m)
	The Response Time Index of the Detector, RTI =	10 ($m^{1/2}s^{1/2}$)
	Smoke/Sprinkler Density of Discharge =	5 mm / min
	Detector Activation Temperature =	33 (°C)
	Calculated Quantites at Detector Activation	
	The Gas Temperature at Detector Activation, T =	37.44 (°C)
	HRR at Detector Activation =	193.60 (kW)
	The Gas Velocity, U =	0.48 (m/s)
	Time at Detector Activation =	67 (s)
	Time to Reach 10% of peak HRR =	753 (s)
	Ratio, r / H =	1.74

FRNSW Comment: Whilst the inputs to determine detection time are noted, premovement times and travel times assumptions have not been discussed. FRNSW recommend these inputs and assumptions be provided to permit a complete review.

Further, FRNSW recommends the assessment consider the extended travel to nearest exit and between exits holistically where the occur for the same path of travel. The comparative assessment should demonstrate that the provision of detection offsets the total travel distance compared to the DtS distance of 100m (40m + 60m).

Performance solution:

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

Assessment methods:

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

Assessment approach:

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

IFEG sub-systems used in the analysis:

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

Acceptance criteria and factor of safety:

The basic objective and intent of this analysis pertains to the life safety of the evacuating occupants. Thus, the primary acceptance criterion shall be met by demonstrating that the early alarm notification provided by enhanced detection systems and strobe/horn sounders, and the reduced travel to a place of temporary safety afforded by the external walkway areas (i.e. "Arrow Building") will result in reduced evacuation times when compared to an equivalent DtS building solution. The Required Safe Egress Time (RSET) of the proposed Performance Solution shall be demonstrated to be is equal to or better than the Required Safe Egress Time of a DtS compliant design solution i.e.:

$$RSET_{\text{Performance Solution}} \leq RSET_{\text{DtS Building Solution}}$$

The secondary acceptance criterion shall be met by demonstrating that attending fire-fighter personnel are not negatively impacted upon by the additional travel distances.

Fire scenarios and design fire parameters:

N/A

Describe how fire brigade intervention will be addressed or considered:

Fire Brigade Intervention to be assessed in subsequent Fire Safety Engineering Report (FSER)

Verification/validation analyses:

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

N/A

Provide details on proposed modelling/assessment tools:

N/A

FRNSW comment: Whilst there is merit in this assessment, FRNSW comments above and in issue 4 should be adequately addressed.

Issue number: 4 **Title:** Interconnection of Non-Fire Isolated Stairways

Details of departures from DtS provisions:

It has been identified that there are a number of non-fire isolated stairways (required & non-required) which facilitate egress and interconnect multiple storeys as follows:

- Performing Arts Precinct:
  - Open stairway interconnects four (4) storeys in lieu of three (3) within sprinkler protected building
- Arrow Building (i.e. external walkway):
  - A number of open stairways which interconnect up to five (5) storeys in lieu of three (3) within sprinkler protected building.

The proposed design forms a deviation from Clause D1.3(b) of the BCA which prescribes a stairway serving as a required exit to interconnect no more than two (2) storeys within a non-sprinkler protected building and no more than three (3) consecutive storeys within a sprinkler protected building. The design also deviates from Clause D1.7 of the BCA as the stairways are strictly required to be provided with fire-isolated shaft construction due to the number of levels interconnected. Finally, the design deviates from Clause D1.12 of the BCA which prescribes non-required non-fire isolated stairways to interconnect no more than three (3) storeys in a sprinkler protected building. Figure 9.1 to Figure 9.3 illustrate the non-fire isolated stairways and interconnection of levels.

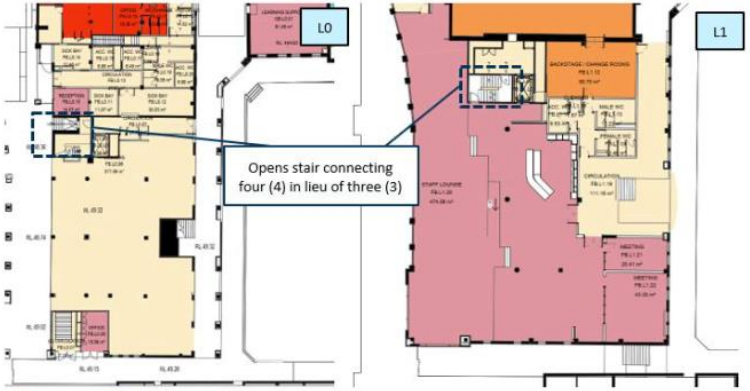


Figure 9.1: Open stairways (L0 & L1)

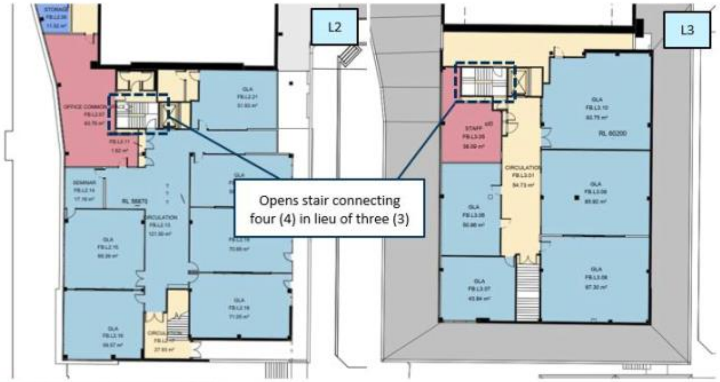


Figure 9.2: Open stairways (L2 & L3)

Figure 9.3: Open stairways (Arrow Building Stairs L3 shown)

Applicable DtS provisions:	Clause D1.3, Clause D1.7 & Clause D1.12	Performance requirements:	CP1, CP2 & DP5

List key fire safety measures:

The 'Guide to the BCA' (ABCB, 2019) identifies the potential for occupants to become exposed to untenable conditions as they evacuate via the non-fire isolated stairway. In this regard, the following hazard mitigation systems, requirements and features of the design are noted:

- The open stairways shall be afforded with fire-rated separating construction at one (1) or two (2) levels using one (1) or a combination of the following:

- Full-height fire-rated construction extending to the underside of the concrete slab above; and/or
- Wall-wetting sprinkler protected glazing (both sides); and

- Sprinkler protection throughout the new building portions which shall suppress or control a fire event thereby reducing potential smoke generation & compartment temperatures; and
- Smoke detection system providing early warning & notification of a fire event; and
- Provide a Building Occupant Warning System (BOWS) in accordance with BCA Specification E2.2a, AS1670.1:2018 which shall initiate on either sprinkler head or detector activation and with the inclusion of the following:
  - The BOWS shall comprise a pre-recorded public address system; and
  - The following buildings shall be provided with a BOWS:
    - Multi-Purpose Pavilion; and
    - Music Building; and
    - Arrow Building; and

- Provide an Emergency Warning & Intercommunication System (EWIS) in accordance with BCA Specification E2.2a and AS1670.4:2018 which shall initiate on either sprinkler head or detector activation to the following locations:
  - Teaching & Learning; and
  - Quadrangle Building; and
  - Performing Arts; and
  - Founders Building; and

Proposed performance solution:

The methodology adopted to address the design issue relative to the non-fire isolated stairways interconnecting up to three (3) to five (5) storeys shall be based upon a qualitative evaluation. The evaluation shall consider the building function/use (incl. occupant characteristics), fire hazard and proposed separation measures (internal stairways) which shall alter the nature of these open stairway configurations similar to a DtS building solution. The available ventilation for the external stairways (i.e. arrow building) shall also be considered in relation to smoke spread and smoke hazard to occupants of these external walkways. The evaluation shall also consider the likely impact imposed onto attending fire-fighter personnel.

The methodology adopted to address the design issue relative to the glazed construction of the stair wall shall qualitatively consider risk of fire spread to the stair and the potential radiant heat flux imposed upon occupants and firefighting personnel utilising the stair in relation to the spatial distance and 180o arrangement of the adjacent fire compartments to the glazed component. Table C3.3 of the BCA shall also be referenced in relation to the expected risk of fire spread to this stair via these glazed openings.

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 basic objective and intent of the analysis pertains to the life safety of occupants as they evacuate via the non-fire isolated stairways. The primary acceptance criterion shall be met by demonstrating that the introduction of additional separation alters the stair configuration such that no more than two (2) or three (3) levels are directly interconnected and no different to an equivalent DtS building solution.

Fire scenarios and design fire parameters:

N/A

Describe how fire brigade intervention will be addressed or considered:

Fire Brigade Intervention to be assessed in subsequent Fire Safety Engineering Report (FSER)

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

N/A

Provide details on proposed modelling/assessment tools:

N/A

FRNSW comment: In consideration of the non-compliance also presented in issue 5, FRNSW do not support the above assessment. FRNSW recommend it be quantitatively demonstrated that occupants egressing via these stairs will not be exposed to untenable conditions prior to evacuation.

FRNSW recommend issues 3, 4 and 5 be considered holistically.

Issue number: 5 **Title:** Travel via Non-Fire Isolated Stairway - Discontinuous Egress Paths

Details of departures from DtS provisions:

It has been identified that there are a number of non-fire isolated stairways serving the Teaching & Learning & Founders/PA blocks that do not provide a continuous means of egress by their own flights/landings. In this regard, occupants are required to descend via the open stairways and travel horizontally to an adjacent stairway prior to evacuating to road or open space. The proposed design forms a deviation from Clause D1.9(a) of the BCA which prescribes non-fire isolated stairways to provide a continuous means of egress by way of their own flights/landings directly to road or open space. Figure 10.1 to Figure 10.3 illustrate the discontinuous egress paths.

Figure 10.1: Discontinuous egress (L4)

Figure 10.2: Discontinuous egress (L3)

Figure 10.3: Discontinuous egress (L2)

Figure 10.4: Discontinuous egress (L1)

Applicable DtS provisions:	Clause D1.9	Performance requirements:	DP4 & EP2.2

List key fire safety measures:

The 'Guide to the BCA' (ABCB, 2019) identifies the potential for occupants to encounter unsafe conditions as they evacuate via discontinuous stair arrangements. In this regard the following hazard mitigation systems, requirements and features of the design are noted:

- Automatic sprinkler protection shall be provided throughout the building in accordance with BCA Clause E1.5, Specification E1.5 and AS2118.1:2017 with the inclusion of the following:
  - Automatic sprinkler protection shall be installed to the following building locations:
    - Teaching & Learning (incl. Quadrangle building); and
    - The underside of the Level 2 slab located above the Agora portion of the building shall be provided with sprinkler protection; and
    - Arrow Building (external walkways); and
    - Music Building; and
    - Performance Arts (incl. cafeteria & assembly hall); and
    - Founders Building; and
  - Sprinkler heads shall be fast response type heads having an actuation temperature of not greater than 68°C and RTI of not greater than 50m-0.5s-0.5; and
  - Activation of the sprinkler system shall initiate a General Fire Alarm (GFA) throughout the Trinity Grammar School campus; and
  - Omit the requirement to provide automatic sprinkler protection within main switch rooms within the Teaching & Learning and Performing Arts/Founders Buildings; and

- Automatic smoke detection shall be provided throughout all buildings of the Stage 3-5 portion in accordance with AS1670.1:2018 and with the inclusion of the following:
  - The main switch rooms within the Teaching & Learning and Performing Arts/Founders Buildings shall be provided with centrally located smoke detectors; and
  - Additional detectors shall be installed within the sports building within 1.5m of tilt glass panel at distances no greater than 10m along the width of the tilt panel. Activation of these detectors shall activate the EWIS within the T&L building; and

- Provide a Building Occupant Warning System (BOWS) in accordance with BCA Specification E2.2a, AS1670.1:2018 which shall initiate on either sprinkler head or detector activation and with the inclusion of the following:
  - The BOWS shall comprise a pre-recorded public address system; and
  - The following buildings shall be provided with a BOWS:
    - Multi-Purpose Pavilion; and
    - Music Building; and
    - Arrow Building; and

- Provide an Emergency Warning & Intercommunication System (EWIS) in accordance with BCA Specification E2.2a and AS1670.4:2018 which shall initiate on either sprinkler head or detector activation to the following locations:
  - Teaching & Learning; and
  - Quadrangle Building; and
  - Performing Arts; and
  - Founders Building; and

- Occupants utilising the non-fire isolated stairways are provided with a point of choice at each lower-level landing; and
- Mounted exit signage shall be provided along the paths of travel and shall assist occupants in resolving wayfinding; and
- Evacuation diagrams/mud-maps shall be provided to direct occupants to nearest alternative exit location(s).
- Occupants are considered to be awake, alert and ready to respond in the event of a fire emergency.

Proposed performance solution:

The methodology to be adopted to address the design issue relative to the discontinuous egress shall be based upon a qualitative evaluation. The evaluation shall consider the discontinuous egress paths with respect to the occupant characteristics, availability of alternative paths upon discharge and the proposed measures which shall improve wayfinding for evacuating occupants. The evaluation shall also consider the likely impact imposed onto attending fire crews.

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 basic objective and intent of the analysis shall pertain to occupant life safety. Thus, the primary acceptance criterion shall be met by demonstrating that occupants are able to safely evacuate via the discontinuous stair configurations without any increased ambiguity or confusion. The secondary acceptance criterion shall be met by demonstrating that fire crews are able to traverse the stair configuration without being negatively impacted.

Fire scenarios and design fire parameters:

N/A

Describe how fire brigade intervention will be addressed or considered:

Fire Brigade Intervention to be assessed in subsequent Fire Safety Engineering Report (FSER)

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

N/A

Provide details on proposed modelling/assessment tools:

N/A

FRNSW comment: Please refer FRNSW comments in issue 4.

Issue number: 6 **Title:** Fire Hydrant System Design

Details of departures from DtS provisions:

As part of the fire services design and to achieve a level of consistency with the Stage 1 & 2 fire services infrastructure, the fire hydrant system is proposed to be designed & installed in accordance with the recent AS2419.1:2017 Australian Standard in lieu of the 2005 Australian Standard. The proposed design forms a deviation from Clause E1.3 of the BCA which prescribes the fire hydrant system to be designed & installed in accordance with the 2005 Australian Standard.

Note: This is consistent with the hydrant standard adopted for the design of Stage 1 and 2 prepared by Arup (Report No. 281228, V01, dated 17 March 2022).

Applicable DtS provisions:	Clause E1.3 & AS2419.1:2005	Performance requirements:	EP1.3

List key fire safety measures:

The 'Guide to the BCA' (ABCB, 2019) identifies the potential for fire-fighting personnel to become unduly delayed or hindered whilst utilising the fire hydrant system. In this regard, the following hazard mitigation systems, requirements and features of the design are noted:

- Permit the fire hydrant system to be designed, installed & commissioned in accordance with AS2419.1:2017 in lieu of AS2419.1:2005 to be consistent with Stage 1 & 2; and
  - The Stage 3-5 portion will be served by the site-wide booster assembly which is located on Victoria Street. This location was included as a Performance Solution within the Arup FER referenced in Section 0.5.1, and
    - The booster shall be provided with a visual warning device (red strobe) in accordance with Clause 7.3.2 of AS2419.1:2017 and shall activate upon GFA; and
    - The block plans across the site (including at the booster assembly) shall be updated to reflect the Stage 3-5 works; and

Proposed performance solution:

The methodology to be adopted to address the design issue relative to the fire hydrant design shall be based upon a qualitative 'comparative' evaluation. The evaluation shall conduct a gap analysis, in conjunction with direct input from the Fire Services Engineer, between the AS2419.1:2017 (proposed) and AS2419.1:2005 (required) Australian Standards to identify the key differences in hydrant design characteristics between the two (2) Standards. In this regard, the evaluation shall compare both the proposed Performance Solution and an equivalent DtS building solution specific to fire brigade operations and use.

Note: *This is consistent with the hydrant standard adopted for the design of Stage 1 and 2 prepared by Arup (Report No. 281228, V01, dated 17 March 2022).*

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 basic objective and intent of the analysis pertains to the life safety of evacuating occupants and attending fire-fighter personnel. Thus, the primary acceptance criterion has been met by demonstrating that the proposed fire hydrant system design maintains a level of functionality & efficacy that is at least equivalent to a DtS building solution.

Fire scenarios and design fire parameters:

N/A

Describe how fire brigade intervention will be addressed or considered:

Fire Brigade Intervention to be assessed in subsequent Fire Safety Engineering Report (FSER)

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

N/A

Provide details on proposed modelling/assessment tools:

N/A

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: 7 **Title:** Omission of Fire Hose Reels

Details of departures from DtS provisions:

It is proposed to omit the requirement to provide fire hose reels throughout the building (i.e. library, staff lounge, administration etc, noting that classrooms & associated corridors are not required to be provided with fire hose reels). In this instance, additional portable fire extinguishers shall be provided to facilitate an initial fire attack by building occupants. The proposed design forms a deviation from Clause E1.4 of the BCA & AS2444:2001 which prescribes fire hose reels to be provided within school buildings (excl. classrooms & associated corridors). Figure 12.1 to Figure 12.7 depict the general locations which are proposed to omit fire hose reels.

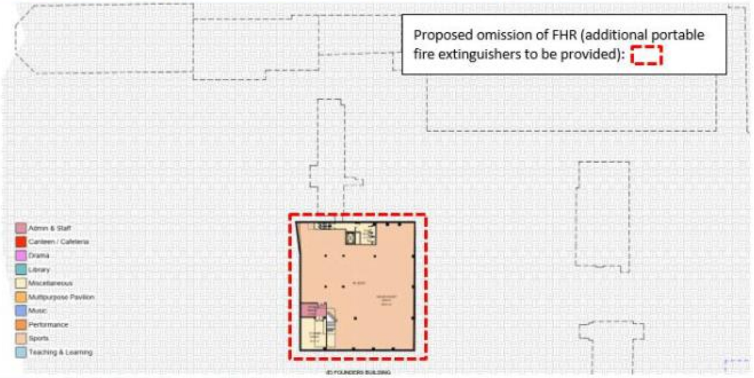


Figure 12.1: Areas proposed to omit FHR (B2)

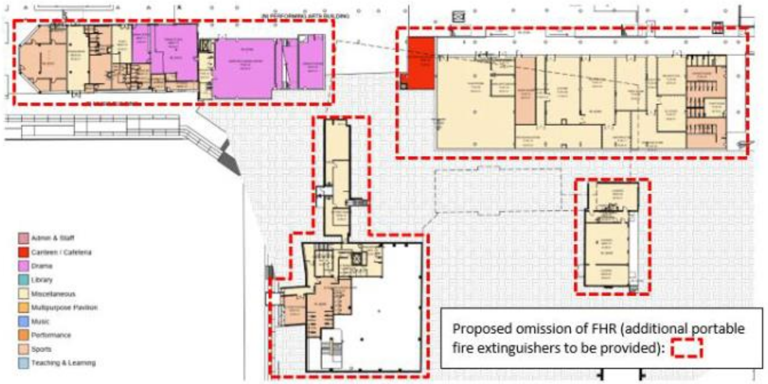


Figure 12.2: Areas proposed to omit FHR (B1)

Figure 12.3: Areas proposed to omit FHR (L0)

Figure 12.4: Areas proposed to omit FHR (L1)

Figure 12.5: Areas proposed to omit FHR (L2)

Figure 12.6: Areas proposed to omit FHR (L3)

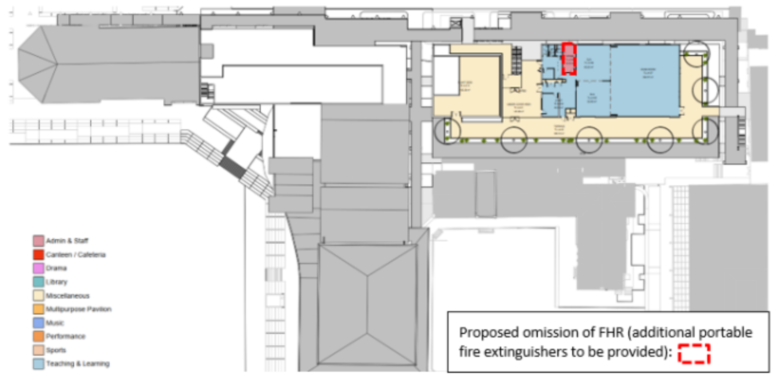


Figure 12.7: Areas proposed to omit FHR (L4)

Applicable DtS provisions:	Clause E1.4 & AS2441:2005	Performance requirements:	EP1.1

List key fire safety measures:

The 'Guide to the BCA' (ABCB, 2019) identifies the requirement for fire hose reels to allow for occupants to undertake an initial attack on a fire. In this regard, the following hazard mitigation system, requirements and features of the design are noted:

- Portable fire extinguishers in accordance with BCA Clause E1.6 and AS2444:2001 with the inclusion of the following:
  - Additional portable fire extinguishers shall be provided through school portions throughout as per the following:
    - In these locations, a 9-litre water type extinguisher shall be provided which would be suitable toward Class A fires. Where kitchens or the like are situated an additional 4.5kg 40B:E Type Dry Chemical or 4.5kg 2A:4F Wet Chemical or 4.5kg 2A:20B:E Dry Chemical (without deep fryer) portable fire extinguisher shall be provided adjacent the exit and between 2-20m from the cooking area. Where electrical switchboards are situated within the school portions an additional 4.5kg 2A:20B:E Dry chemical portable fire extinguisher shall be provided between 2-20m from the electrical switchboard; and
    - Portable fire extinguishers may be placed within a metal cabinet in an accessible location (i.e. not within a locked cabinet) Portable fire extinguishers may be placed within a metal cabinet mounted to a wall and fitted with a break glass to limit the likelihood of damage, vandalism or theft; and
  - **Note:** The above fire extinguishers are to be considered in addition to the portable fire extinguishers otherwise required by BCA Clause E1.6 and AS2444:2001; and
- Emergency lighting & exit signage in accordance with AS2293.1:2018.

FRNSW Comment: FRNSW recommend appropriate training also be provided such that staff are aware of the locations and how to use the extinguishers effectively.

Proposed performance solution:

The methodology adopted to address the design issue relative to the omission of fire hose reels shall be upon a qualitative 'comparative' evaluation. The evaluation shall consider the adoption of portable fire extinguishers with respect to the function/use of building, potential fire hazard, fire compartment size & fire safety systems installed. A comparison shall be conducted to assess the ability for occupants to undertake an initial attack and subsequently move to a place of safety with respect to provisions of portable fire extinguishers.

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 basic objective and intent of the analysis shall pertain to the life safety of occupants undertaking an initial attack on a fire by utilising portable fire extinguishers. Thus, the primary acceptance criterion shall be met be demonstrating that provisions for portable fire extinguishers suitably facilitates the ability for occupants to conduct an initial fire attack.

Fire scenarios and design fire parameters:

N/A

Describe how fire brigade intervention will be addressed or considered:

Fire Brigade Intervention to be assessed in subsequent Fire Safety Engineering Report (FSER)

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

N/A

Provide details on proposed modelling/assessment tools:

N/A

FRNSW Comment: In principle support is provided subject to:

- the analysis in the FER demonstrating compliance with the performance requirements of the NCC.
- FRNSW Comments being adequately addressed

Issue number: 8 **Title:** Omission of Sprinklers from Main Switch Rooms

Details of departures from DtS provisions:

As part of the fire services design it is proposed to omit the requirement to provide automatic sprinkler protection within main switch rooms within the Teaching & Learning and Founders/PA blocks. The proposed design forms a deviation from Clause E1.5 of the BCA and AS2118.1:2017 which prescribes sprinkler protection to be provided throughout. Figure 13.1 depicts the main switch room locations.

Figure 13.1: Main switch room locations (B1)

Applicable DtS provisions:	Clause E1.5. Table E1.5, Specification E1.5 & AS2118.1:2017	Performance requirements:	EP1.4

List key fire safety measures:

The 'Guide to the BCA' (ABCB, 2019) identifies the main function & use of a sprinkler system as being to contain a potential fire. In this regard, the following hazard mitigation system, requirements and features of the design are noted:

- The main switch rooms shall be bound by fire-rated construction (full-height 120-min FRL & self-closing -/120/30 fire doors) which shall limit/restrict potential fire spread to/from the main switch rooms; and
- The main switch rooms shall be provided with smoke detectors and provide early warning/notification; and
- The building areas adjacent the main switch rooms shall remain sprinkler protected and shall assist in limiting/ restricting fire spread should the compartment become breached.

Proposed performance solution:

The methodology to be adopted to address the design issue relative to the omission of sprinkler protection from the main switch rooms shall be based on a qualitative 'risk' evaluation. The evaluation shall consider the main switch rooms with respect to their function/use, compartment size and the proposed fire safety measures shall enhance passive separation from the surrounding areas and provide early detection/notification.

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 basic objective and intent of the analysis pertains to fire development and fire spread from the main switch rooms. Thus, the primary acceptance criterion shall be met by demonstrating that the main switch rooms are provided with suitable passive & active fire safety measures to mitigate the development & spread of a fire. The secondary acceptance criterion shall be met by demonstrating the proposed design maintains a suitable level of occupant/fire-fighter life safety.

Fire scenarios and design fire parameters:

N/A

Describe how fire brigade intervention will be addressed or considered:

Fire Brigade Intervention to be assessed in subsequent Fire Safety Engineering Report (FSER)

Verification/validation analyses:

☐ Sensitivity studies ☐ Redundancy studies ☐ Uncertainty studies ☑ None

N/A

Provide details on proposed modelling/assessment tools:

N/A

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

8 Construction, commissioning, management, use and maintenance

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

Listed in the Essential Services Lists All fire safety systems to be installed and commissioned in accordance with their relevant standards.

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

Listed in the Essential Services Lists. All fire safety systems to be installed and commissioned in accordance with their relevant standards

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

To be documented in Final Fire Safety Engineering Report (FSER).All fire safety measures and Management in Use requirements shall be incorporated into an Essential Safety Measures list. All fire safety measures shall be maintained in accordance with the requirements of AS1851 (or equivalent maintenance standard) as identified by Scientific Fire Services. Management in Use requirements shall be inspected and logged on an annual basis.

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

To be documented in Final Fire Safety Engineering Report (FSER).

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

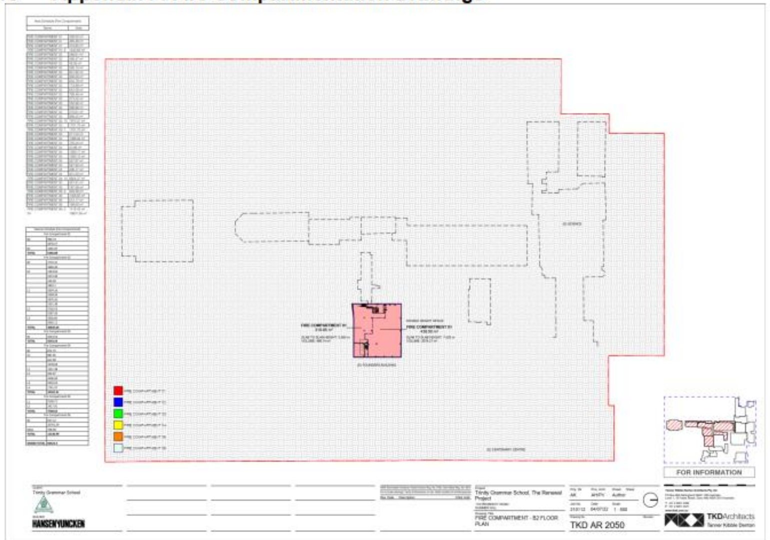
Final Fire Safety Engineering Report (FSER) to be kept on site and on the Annual Fire Safety Statement (AFSS).The recommendations forming part of the Performance Solution shall be identified as part of the Fire Safety Schedule (FSS) for the subject premise and is to form part of the building/s Essential Safety/Services List.

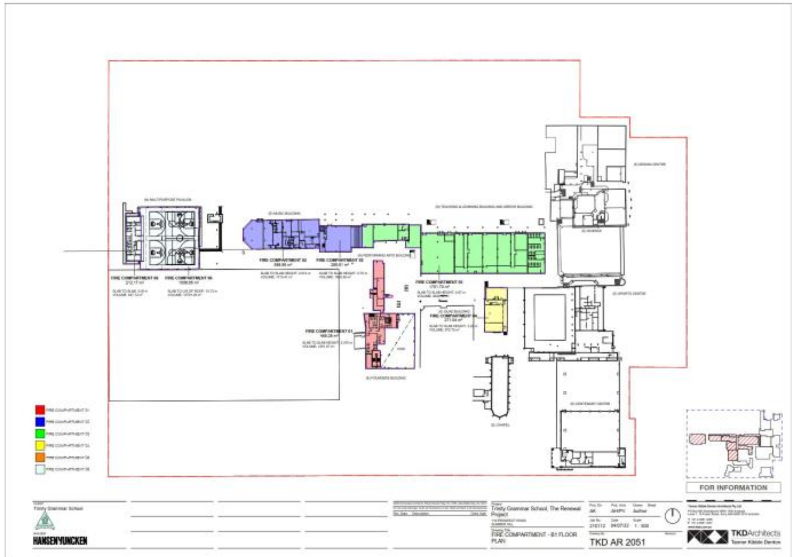
9 Additional comments

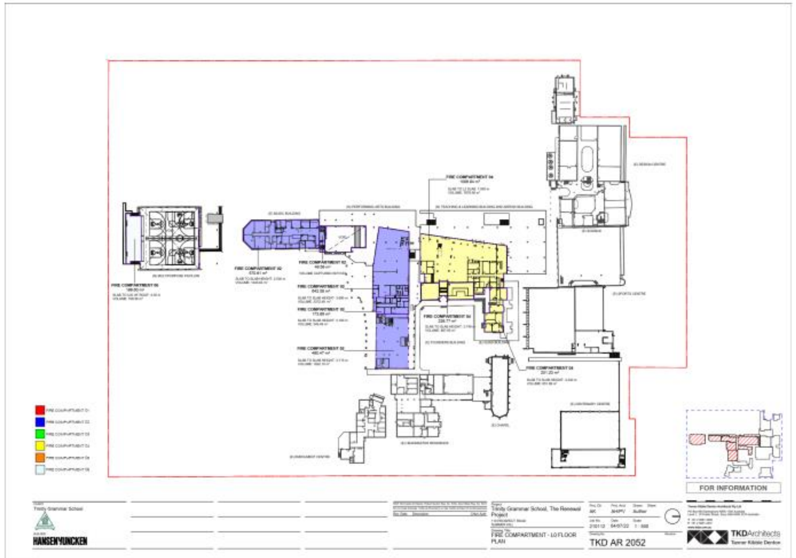
Provide any additional comment relevant to the FEBQ

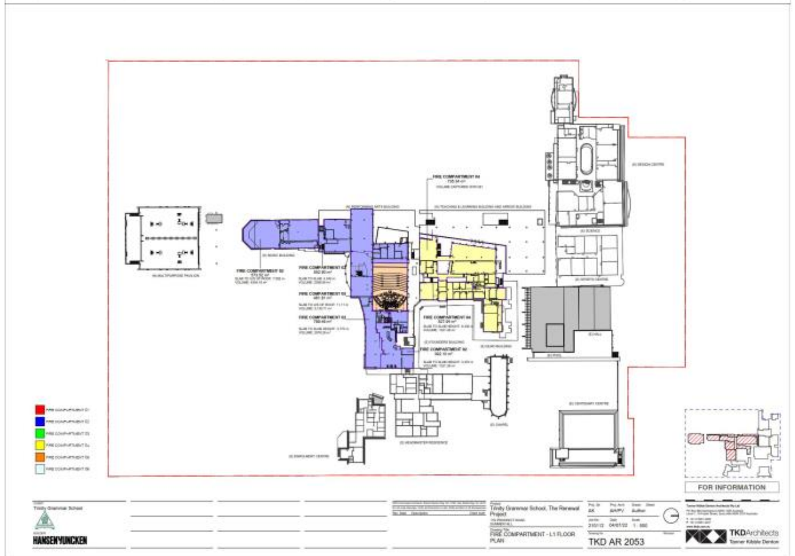
Note: Any in principle support extended for performance solution issues through consultation is contingent upon all assumptions, analyses and conclusions in the fire engineering report being fully justified, and referenced as appropriate, to demonstrate how the relevant performance requirements have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

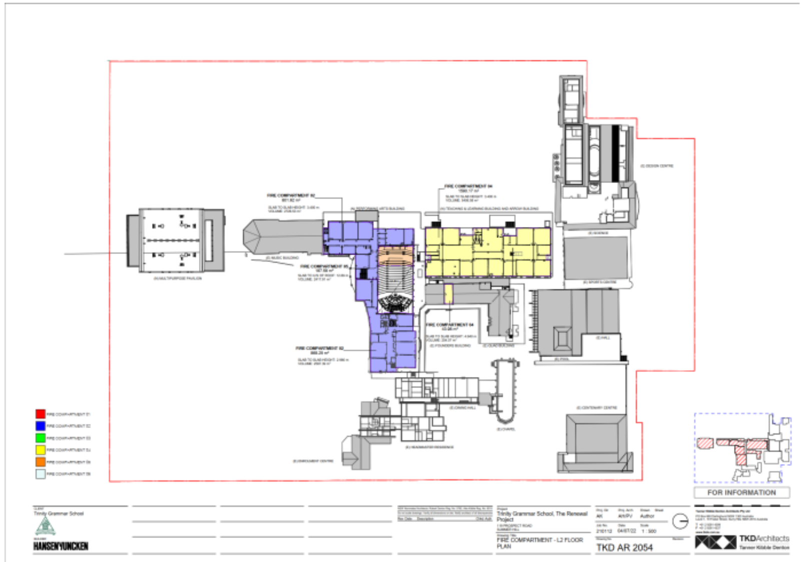
10 Appendix F. Fire Compartmentation Drawings

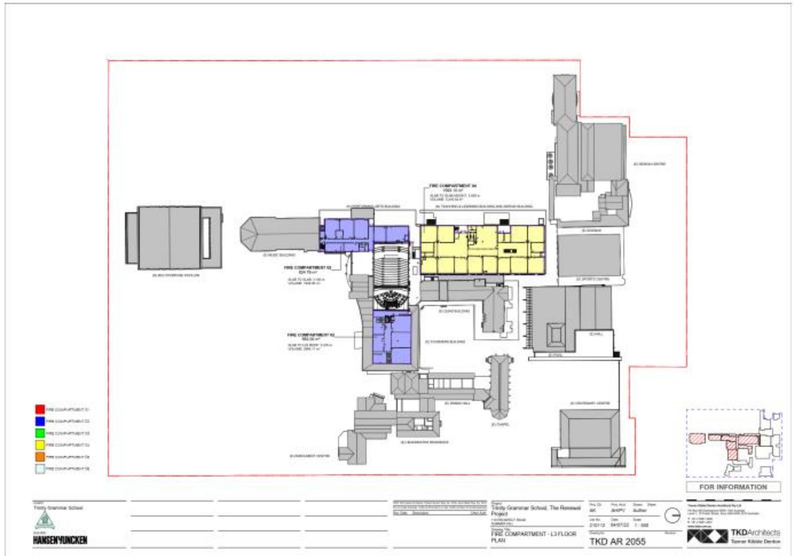


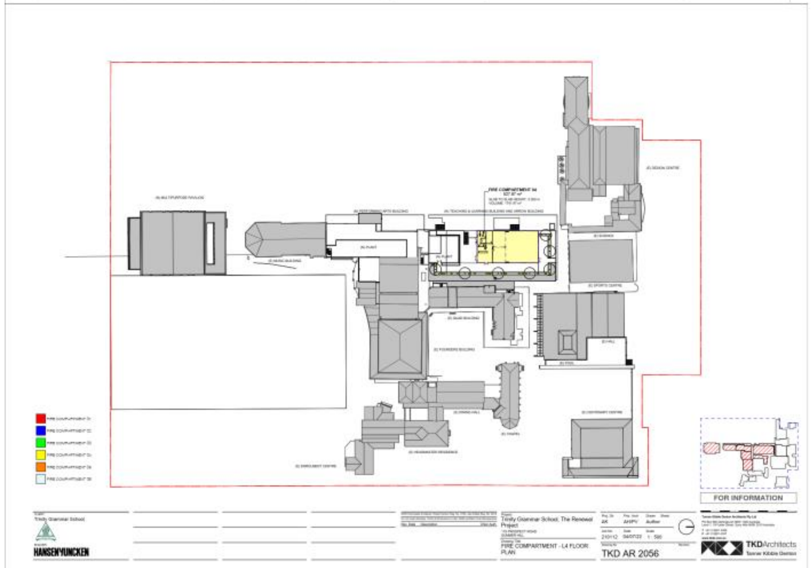




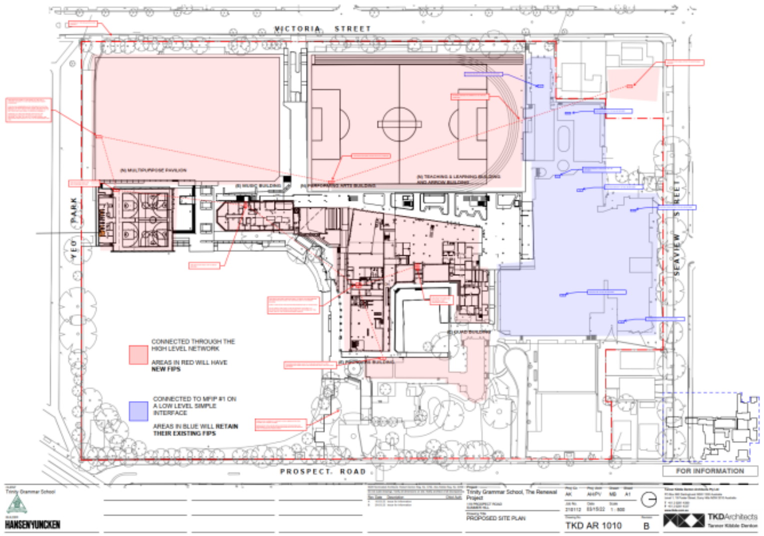



FOR INFORMATION
Trinity Grammar School, The Renewal Project
FIRE COMPARTMENT - L2 FLOOR PLAN
TKD AR 2054
HANSEN YUNCKEN
TKDArchitects


FOR INFORMATION
Trinity Grammar School, The Renewal Project
FIRE COMPARTMENT - L3 FLOOR PLAN
TKD AR 2055
HANSEN YUNCKEN
TKDArchitects


FOR INFORMATION
Trinity Grammar School, The Renewal Project
FIRE COMPARTMENT - L4 FLOOR PLAN
TKD AR 2056
HANSEN YUNCKEN
TKDArchitects

11 Appendix G.FIP Network Strategy



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.