Appendix C

FDS Inputs

GCUH Engineering JV
ABN 98 443 657 196
32 Turbot Street
(Locked Bag 331) Brisbane
Queensland 4001 Australia

Telephone: +61 7 3173 8000
Facsimile: +61 7 3173 8001

Fire Engineering Report
Gold Coast University Hospital
Queensland Health

Volume 2: Mental Health Unit

07 September 2015
Reference EJV-FE-MEH-REP-0001-PDF
Revision 23

Document Control

GCUH ENGINEERING

aurecon SKM S2F

Document ID: EJV-FE-MEH-REP-0001-PDF-Rev23.doc

Rev No	Date	Revision Details	Typist	Author	Verifier	Approver
0	15 April 2008	TN22 FEB – 50% Schematic design, Preliminary	T Enright	T Enright		
1	6 June 2008	TN22 FEB – 70% Schematic design, QFRS meeting	T Enright	T Enright	J Shelley	T Enright
2	28 July 2008	TN22 FEB – Schematic design, post QFRS meeting	T Enright	T Enright		
3	8 August 2008	TN22 FEB – 90% Schematic design	T Enright	T Enright	J Shelley	T Enright
4	19 December 2008	FEB (VOL2) Mental Health. Design Development.	T Enright	T Enright	J Shelley	T Enright
5	13 February 2009	FER (VOL2) Mental Health. Design Development.	T Enright	T Enright	J Shelley	T Enright
6	15 April 2009	FER (VOL2) Mental Health. Client Presentation.	T Enright	T Enright	J Shelley	T Enright
7	5 May 2009	FER (VOL2) Mental Health – QFRS Presentation	T Enright	T Enright	J Shelley	T Enright
8	17 June 2009	FER (VOL2) Mental Health – Design Development	J Shelley	J Shelley		
9	25 June 2010	FER (VOL2) Mental Health – BAN Issue	J Shelley	J Shelley		
10	23 August 2010	FER (VOL2) Mental Health – BAN Issue – incl APC comments	J Shelley	J Shelley		
11	8 March 2011	FER (VOL2) Mental Health – BAN Issue – incl PS comments	J Shelley	J Shelley	I Moore	M Hill
12	6 April 2011	FER (VOL2) Mental Health – BAN Issue – incl new Compliance Issues 11 and 12	J Shelley	J Shelley		
13	6 April 2011	FER (VOL2) Mental Health – BAN Issue – modifications to Compliance Issues 8 and 11	J Shelley	J Shelley		
14	6 June 2011	FER (VOL2) Mental Health – BAN Issue – modifications to Compliance Issues 11 & 12 and addition of compliance issue 13 and to address QFRS comments on Rev 13 dated 25 May 2011 (attached in Appendix H of this report)	J Shelley/ A Ting	J Shelley/ A Ting		
15 16	16 June 2011 30 January 2012	Changes made are highlighted throughout the document. Revision to Section 5.3 & 5.4 Addition of Section 14.4 & appendix I Addition of Section 17 – non compliance issue 14	J Shelley/ A Ting	J Shelley/ A Ting	I Moore	M Hill
17	09 March 2012	Revision in accordance with certifier's comments (refer appendix D)	A Ting	A Ting	I Moore	M Hill
18	16 April 2012	Addition of Section 18 - non compliance issue 15	A Ting	A Ting	I Moore	M Hill

19	28 September 2012	• Revision Section 2.1.3, smoking is permitted in specific areas identified by QH in MEH as smoking areas.				
20	12 November 2012	• Revision of Section 4 to include consideration of the timber 'fins' attachment to the walkway structure. • Revision of Section 3 to include updated EWIS evacuation zones • Revision of Section 3.2 to incorporate details and operation of AAF facility and clarify the activation of the evacuation signal in areas served by MASD system. • Revision of Section 3.4 to clarify the alarm sound levels proposed in MEH • Revision of Section 3.6 to differentiate between fire safety key for unlocking security doors and 003 key. • Revision of Section 8 to clarify the use of fire safety key for unlocking FHR, hydrant cabinets. • Addition of Section 18.2.2 to address the non-provision of sprinkler coverage to the underside of canopy in a courtyard.	A Ting	A Ting	I Moore	I Moore
21	3 April 2014	• Addition of section a new section 19 to include the alternative solution for the direction of swing of internal egress doors	W Quin	W Quin	I Moore	I Moore
22	16 July 2015	• Section 3 updated to include items from VO-262 • Section 19 amended for smoke doors rather than fire doors	J Shelley	J Shelley	J Partridge	P Glodic RPEQ 7840
23	07 September 2015	• Minor updates to incorporate BAS comments	J Shelley	J Shelley	J Partridge	P Glodic RPEQ 7840

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Contents

Executive Summary

This is the Fire Engineering Report (FER) for the Gold Coast University Hospital.

The purpose of this FER is to provide the background upon which the basis of the analysis was agreed (i.e. the preceding FEB), the subsequent evaluation and results, and the drawing of conclusions on Building Code compliance. This is consistent with the International Fire Engineering Guidelines process.

This Volume of the FER (Volume 2) covers the **Mental Health Building** (MEH). The other Volumes of the FER are:

- Volume 1: Clinical Services and IPU (CSB & IPU)
- Volume 3: Pathology and Education (PED)
- Volume 4: Central Energy Plant and Engineering Workshop (CEP & EWK)
- Volume 5: Service Tunnel and Pedestrian Links (TUN) and
- Volume 0: Appendices.

The MEH building comprises of three levels.

- A basement floor plant room / substation and tunnels at Level B1 (RL 15.16 m, at that location one level below grade)
- A health care floor at level LG (RL 19.58, at that location on grade)
- Administration offices and plant at Level 00 (RL ~24.0 m, at that location one storey above grade).

The building has pedestrian links to the main Clinical Services Building at Level B1, Level LG and Level 00.

The building is protected with a non-required automatic fire sprinkler system and an emergency warning system and intercom system for emergency purposes.

The Trial Design departs from the Deemed to Satisfy (DTS) fire provisions, of the Building Code of Australia (BCA), in the following instances.

- Fire compartments linked by covered walkways
- Non-provision of 30 minutes FRL to floor separating storeys in Class 9a building of Type C construction
- Exit travel distance in Level B1
- Four smoke compartments are greater than 500 m^2, 1,000 m^2 fire compartmentation not provided
- FHR and portable extinguisher cabinets secured in patient accessible areas
- Fire and smoke door automatic hold open devices only release on activation of smoke detectors within 1.5 m of doors
- Egress ladders provided as second means of escape from Level 00 plant areas do not comply with AS 1657
- Doorway thresholds incorporate a step (hob)
- Fire compartmentation does not extend fully to ‘edge’ of building line
- Doorway in a Class 9a health care building incorporates a sliding door
- Structural steel elements pass through fire walls
- Fire hose reels pass through doorways fitted with fire and smoke doors.
- MASD system in lieu of ionisation type detector on egress paths in Class 9a patient care areas
- Smoke proof wall construction does not comply with C2.5 or Specification C2.5 of BCA

- Deletion of requirement for sprinkler coverage in EDB cupboards and underside of a canopy in a courtyard

This FER concludes that the Trial Design satisfies the performance requirements of the BCA.

This revision of the Fire Engineering Report (Volume 2) is issued for Authority approval. It has previously been issued to the design team and assessing authority and incorporates their comments.

1. Introduction

This is the Fire Engineering Report (FER) for the Mental Health Building (MEH).

The GCUH project including the MEH is described in detail in the Project Definition Plan (PDP). The key features from the PDP are that:

- The MEH is a new 72-bed tertiary mental hospital
- It contains three levels with an approximate gross floor area of 250 m^2 on the basement floor, 5,000 m^2 on the ground floor and 1,100 m^2 on the first floor
- The location is shown in Figure 1 below.

Figure 1.1: Site plan

Each level of the MEH will contain the following:

- Basement Floor (BL)
  - Plant room
  - Main electrical switch room
  - Substation
  - Intermittently occupied areas*
- Ground Floor (L0)
  - Patient wards
  - Medical services rooms
  - Intermittently occupied areas*
- First Floor (L1)
  - Administration offices
  - Fan rooms and electrical rooms
  - Intermittently occupied areas*

* Intermittently occupied area = toilets, corridors, stairs / lifts, lunchroom / kitchen etc.

2. Fire Engineering Brief

The Fire Engineering Brief (Revision 4) was issued on 18 December 2008. The FEB was the subject of a stakeholder meeting on 20 January 2009, minutes of which are included in Appendix B (of Volume 0).

The FEB was superseded by the first issue of the FER (13 February 2009). The Revision numbering is continuous across the FEB and FER process, so the first issue of the FER is Revision 5. This was issued for Assessing Authority approval.

This document is the twenty third issue of the FEB/FER (Revision 23, 07 September 2015) and it incorporates the Assessing Authority's comments.

2.1 Scope of the project

2.1.1 Contractual context

This Fire Engineering Brief has been prepared by the GCUH Engineering Joint Venture (EJV).

The EJV was engaged by Queensland Health to progress the design in a traditional manner through the Project Definition Plan (PDP) and Schematic Design (SD) phases.

The further phase, Design Development (DD) and the current phase Contract Documentation (CD) are being undertaken for the managing contractor Lend Lease (formerly Bovis Lend Lease).

2.1.2 Regulatory framework agreement

Health care buildings are classified as State building work and as such this work is deemed to be self-assessable development. It must be carried out under the building assessment provisions as defined in Section 30 of the Building Act 1975.

The authority responsible for self-assessment is Building and Asset Services (formerly Project Services Building Surveying). Other relevant authorities include Queensland Health and the Queensland Fire and Emergency Services (formerly Queensland Fire and Rescue Service).

Self-assessable building work is carried out in accordance with applicable technical codes and standards.

The following codes have been identified by the Assessing Authority as being applicable for assessment of the proposed building work –
Building Act 1975
Building Regulation 2006
Queensland Development Code (QDC) including

- MP 4.3 Alternative water sources – commercial buildings
- MP 5.1 Workplaces

Building Code of Australia 2008 edition (BCA) and referenced standards.

This assessment process involves a review by Project Services Building Surveying of preliminary design documentation, assessment of contract documentation and inspection during construction to ensure compliance. Certification is provided at substantial completion of the building work confirming building code compliance and to permit lawful occupation.

2.1.3 Building Code of Australia

The Building Code of Australia, published by the Australian Building Codes Board (ABCB 2008), is a performance-based building code. It is hierarchal with 'Objectives'†, 'Functional Statements' and 'Performance Requirements' for each of its sections.

This is described in Figure 2.

Figure 2.1 Building Code hierarchy, reproduced from the BCA (ABCB 2008)

2.1.4 Project programme

The Project Definition phase is complete, having run from July 2007 through to January 2008. The Schematic Design phase is also complete having run from March 2008 through September 2008.

The Design Development phase is complete having run from October 2008 through to April 2009.

The Contract Documentation and construction phases are complete, having commenced in May 2009, with official opening of the GCUH occurring in December 2012.

The current revision of the FER (Revision 23) covers amendments made during the post construction phase following occupancy of the MEH building.

† The objectives of the BCA are discussed in more detail in Section 2.5 'General Objectives'.

2.2 Relevant Stakeholders

Table 2.1 lists the stakeholders in the context of the Fire Engineering Report.

Table 2.1 Relevant stakeholders and representatives

Role	Organisation	Contact
Client	Queensland Health	Don Glynn (Assistant Director)
Assessing Authority	Building and Asset Services (see NOTE 1 below)	John Wilson (Manager Building Surveying) Larry Porter (Senior Building Surveyor)
Emergency Services	Queensland Fire & Emergency Services (see NOTE 2 below)	Ken Clark (BAO) Lex Midren (BAO) Steven McKee (Fire engineer)
	Queensland Ambulance Service	TBC
Designers	Architect – GCUH Architecture	Ian Downing (Project Director) Peter Thomas (Project Planner) Dennis Esam (Coordinator, Bldg Services) Stephen Watson (MEH Architect)
	Fire Engineers – GCUH EJV (Revision 0 to Revision 21)	Jonathan Shelley (Author/Verifier) Arthur Ting (Author) Wayne Quin (Author) Tony Enright (Author/Verifier/Approver) Ian Moore (Verifier/Approver) Mike Hill (Approver)
	Fire Engineers – Omnii Pty Ltd (Revision 22 to Revision 23)	Jonathan Shelley (Author) Jack Partridge (Verifier) Peter Glodic (Approver)
	Structural Engineer – GCUH EJV	Ben Coxon
	Services Engineers – GCUH EJV	Mike Hill (EJV Team Leader) Bill Drake (Mechanical) John Harland (Electrical) Paul Jacobson (Hydraulic) Wayne Quin (Fire Protection)
	BCA Consultant – Stokes Perna	Tony Stokes Cameron McLean

Managing Contractor	Lend Lease (formerly Bovis Lend Lease)	James Wright Russell Dobson Melissa Chandler

For the purpose of the FEB and FER, the Building Certifier is the Assessing Authority and provides interface with the other Regulatory Authorities, particularly the Queensland Fire and Emergency Services (QFES)

NOTE 1: RE ASSESSING AUTHORITY
Up to 30 June 2013 the Assessing Authority was Project Services. This entity transitioned to Building and Asset Services from 01 July 2013. Both names are used in this report as appropriate.

NOTE 2: RE FIRE SERVICE
During the project the fire authority has transitioned from Queensland Fire and Rescue Service (QFRS) to the Queensland Fire and Emergency Services (QFES). Both names are used in this report as appropriate.

2.3 Principal Building Characteristics

2.3.1 Introduction

The proposed building is described in the following architectural drawings by GCUH Architecture.

Table 2.2 Documents reviewed

Drawing No.	Title	Date	Issue
PSH-AR-MEH-DWG-20B1100	Level B1 – Floor Plan	02.02.2010	C
PSH-AR-MEH-DWG-20LG100	Level LG – Floor Plan	16.11.2010	G
PSH-AR-MEH-DWG-2000100	Level 00 – Floor Plan	24.11.2010	F
PSH-AR-MEH-DWG-400000-1 to 9	Elevations	-	E/F/G/H
PSH-AR-MEH-DWG-500000-1 to 13	Sections	-	D/E/F
PSH-AR-MEH-DWG-26B1100	Level B1 – Fire Compartmentation	09.02.11	C
PSH-AR-MEH-DWG-26LG100	Level LG – Fire Compartmentation	09.02.11	F
PSH-AR-MEH-DWG-2600100	Level 00 – Fire Compartmentation	09.02.11	E

2.3.2 Basic Data

Following in Table 3 is a summary of basic data.

Table 2.3 Basic data

Level	Location	Classification
Level B1	Substations, electrical switch room, chiller plant	Class 8
Level LG	Patient care (accommodation, dining etc)	Class 9a
Level 00	Administration offices, Plant rooms	Class 5, 8

The building has a rise of storey of two with the occupants' classification of Class 5 and 8 on the top floor. Hence based on the BCA Table C1.1 and clause C1.3 the type of construction required is Type C. The building will include a non-required automatic fire sprinkler system.

2.3.3 Fire compartmentation

The main patient care building is divided into three 120 minute fire compartments, which in turn are sub-divided in to a number of smoke compartments. The two level section of the building is separated at the central stair into a lower level Class 9a fire compartment, and an upper level Class 5 fire compartment by 120 minute fire-resistant construction. Additional fire-resistant construction is also provided at the wings of the single level part closest to the two level part to enable the two parts to be considered separate fire compartments. Note that the two parts are joined by covered walkways, and this is the subject of an alternative solution covered in Section 3 of this FER. The MEH building is also separated from the Engineering Tunnel at Level B1 by 120 minute fire-resistant construction.

For a detailed description of the fire separation, refer to the fire compartment drawings provided in Appendix B of Volume 0 of the FER.

2.3.4 Smoke hazard management

There is no requirement for smoke exhaust or zone pressurisation in the MEH building, and therefore the smoke hazard management strategy shall be shutdown of all mechanical systems immediately upon activation of the fire alarm anywhere in the building.

Although a progressive evacuation strategy is proposed for the building, the fact that the patient care areas are at grade means that windows and doors can be opened or closed to control the inside environment, and therefore conditions are expected to remain tolerable for the duration of any fire incident which has resulted in internal evacuation.

2.3.5 Fire brigade access

Fire brigade access has been provided to the site-wide fire control room located at the PED, as well as to the main attendance point and SIP, booster points, and the main access points for the MEH building. A site plan showing approach roads, proposed appliance attendance points and available hardstanding and distances to building access points, booster cabinets etc is provided in Appendix A of Volume 0 of the FER.

Note that the SIP for the MEH building is located in a separate room adjacent to the sprinkler valve room by the ambulance bay, rather than in the main lobby of the building. This provision has been made to guard against the risk of malicious tampering with the SIP by patients, and has been discussed with QFRS (refer minutes of fire services meeting with QFRS in Appendix B of FER). A strobe light will be provided to indicate location of SIP room.

2.4 Dominant Occupant Characteristics

2.4.1 Occupant groups

The dominant occupant groups are patients, staff and visitors.

The characteristics of the patients are such that they are highly vulnerable to the effects of fire. In most areas they are unlikely to be restricted (detained) however they may or may not be ambulant and may have very limited awareness and response characteristics. They will be highly dependent on the care staff who will typically be alert, responsive and well trained in fire evacuation.

Patients the PICU units are described as likely to be heavily sedated and incapable of unassisted evacuation. Some patients may be consciously uncooperative requiring a high-level of assistance to evacuate.

Visitors will also be present in the MEH building. Whilst they will generally be unfamiliar with their surroundings they are likely to be present only in controlled circumstances.

2.5 General Objectives

The objectives are to provide a functional and economic building complying with the requirements of the Building Code of Australia (ABCB 2008). The client has also specified that the building should include an automatic fire sprinkler system regardless of whether required by the BCA or not. The primary objectives of the BCA as described in the Fire Engineering Guidelines‡ (FCRC 1996) are to protect: -

- Life safety of occupants – the occupants must be able to leave the building (or remain in a safe refuge) without being subjected to hazardous or untenable conditions
- Adjacent buildings – structures must not collapse onto adjacent property, and fire spread by radiation should not occur
- Life safety of fire fighters – fire fighters must be given a reasonable time to rescue any remaining occupants before hazardous conditions or building collapse occurs.

Compliance with the BCA is achieved by satisfying the Performance Requirements. This can be achieved by one of three methods:

a) Complying with Deemed to Satisfy (DTS) provisions of the BCA
b) Formulating an Alternative Solution which complies with the Performance Requirements
c) A combination of a) and b).

The BCA clause A0.9 provides the following assessment methods to determine that a building solution complies with the BCA performance requirements:

a) Evidence to support that the use of a material, form of construction or design meets a Performance Requirement or a Deemed-to-Satisfy Provision
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) Comparison with the Deemed-to-Satisfy Provisions
d) Expert Judgement.

The assessment methods adopted will be a combination of b) and c) above.

‡ The first revision of, and predecessor to the IFEG

2.6 Hazards and preventative and protective measures

2.6.1 Frequency

It is not proposed to undertake a probabilistic risk assessment. It is however, informative to consider fire frequency in health care facilities.

NSW

In 1992 there were 236 institutional fires of which 63 fires were in hospitals, which equates to about 1% of property fires (NSWFB 2003). In 2001/2002 there were 297 institutional building fires and similarly hospitals accounted for about 1% of overall property fires. The number on injuries over a 5 year period to 2002 indicates that 10 injuries occur per year and there were no fire fatalities over that period. Interestingly, approximately one-third of fires in institutional buildings are started within kitchens.

Victoria

CSIRO (1993) report data from Melbourne's Metropolitan Fire and Emergency Services Board (MFB). For the period 1989 to 1991 hospital fires accounted for 1.2% of property fires. This value is similar to the values obtained from NSW Fire Brigade statistics.

USA

The US National Fire Protection Association (NFPA 2003) reported fire incident data in healthcare facilities (excluding nursing homes). The data indicates that fires in healthcare facilities account for 0.6% of US property fires. The number of fires has dropped considerably since 1980, with a 74% reduction in the number of fires. This is due to various State and Federal requirements for fire protection, with over 90% of fire incidents now being detected by smoke alarms. The data also shows that in the period from 1994 to 1998 there were 7 deaths in 3,800 fires, equating to 1.8 fatalities per 1,000 fires.

UK

It is reported by the Home Office in the UK (2001) and the National Health Service (NHS 1994), that for the ten year period to 2001, hospital fires accounted for approximately 5% of property fires. The number of fatal fires averaged at approximately two fatal fires per year (1991 to 2001) and accounted for about 2% of fire deaths from all property fires. There are approximately 0.7 fatalities per 1,000 fires and 43 non-fatal casualties per 1,000 fires. The fire frequency in a hospital is estimated in BS7974-PD7 (BSI 2003) as 3.0×10^{-1} starts per year, or one every three years (just over).

New Zealand

For the period from 1998 to 2002, New Zealand data (NZFS 2003) on healthcare shows that the number of fires was approximately 1.5% of recorded property fires and there has been one recorded fire death within this time period.

2.6.2 Hazards

The following list of hazards has been adapted from the ISO Draft Technical Recommendation on Fire Risk Assessment, (health care facility example) (ISO 2008).

Fire hazards in hospitals / offices include:

- Laundry supplies, such as bedding and towels, and medical supplies, such as disposable aprons
- Toiletries, aerosols, wall and ceiling hangings and linings
- Plastics and rubber (e.g. soft play or restraint areas), video tapes, polyurethane foam-filled furniture, foam-filled mats and polystyrene-based display materials

- Wood or wood-based furniture, textiles and soft furnishings, such as spare clothes and hanging curtains
- Clothing and private belongings (such as toys), seasonal and religious occasion decorations, such as Christmas decorations
- Flammable products, such as cleaning and decorating products, petrol, white spirit, methylated spirit, cooking oils, disposable cigarette lighters and photocopier chemicals
- Flammable gases such as liquefied petroleum gas (LPG), including aerosol canisters
- Waste products, particularly finely divided items such as shredded paper and wood shavings, off cuts, and dust.
- Electronic devices such as computers, printers and kitchen wares
- Paper products such as books

Materials of construction that can cause fire hazard include:

- Hardboard, chipboard, block-board walls or ceilings
- Synthetic ceiling or wall coverings, such as polystyrene wall or ceiling tiles
- Flooring of polypropylene carpet or carpet tiles
- Particular fixtures and fittings.

Potential ignition sources in health care facilities are sources of heat which could get hot enough to ignite material found there. These sources include:

- Smoking materials such as cigarettes, matches and lighters
- Naked flames, such as matches, candles or gas or liquid-fuelled open-flame equipment
- Electrical, gas or oil-fired heaters (fixed or portable)
- Cooking equipment
- Faulty or misused electrical equipment
- Lighting equipment
- Hot surfaces and obstruction of equipment ventilation, such as photocopiers
- Hot processes, such as welding by contractors
- Arson, such as by patients who suffer from mental illness.

The main source of oxygen for combustion is in the air, but in healthcare and laboratory premises, additional sources of oxygen can sometimes be found in materials used or stored there, such as:

- Some chemicals (oxidising materials), which can provide a fire with additional oxygen and so help it burn, or
- Oxygen supplies from cylinder storage and piped systems, such as medical oxygen, oxygen used by contractors (in welding processes).

Rooms that are particularly prone to fires include:

- Cleaners' rooms
- Clothing storage
- Dayrooms
- Disposal rooms
- Lift motor rooms
- Linen stores
- Patient bedrooms
- Staff changing and locker rooms
- Store rooms
- Ward kitchens

2.6.3 Preventative and protective measures

- Automatic sprinkler system complying with Specification E1.5 and AS2118 throughout the building except within the EDB cupboards where sprinkler coverage is not provided
- Sound system and intercom systems for emergency purposes (formerly EWIS) to AS1670.4
- Smoke detection and occupant warning system complying with AS 1670
- Fire hydrant system installed in accordance with AS 2419.1
- Fire hose reels installed in accordance with AS 2441
- Portable fire extinguishers as required by Table E1.6 and in accordance with AS 2444
- Emergency lighting complying with AS 2293.1
- Exit signs and direction signs complying with AS 2293.1
- Fire resistance levels in accordance with Part C of the BCA (subject to fire engineering analysis)
- Emergency preparedness and regular training of Fire Wardens.
- Management in use must clearly stipulate no storage of any combustible items in the covered walkway areas shown in Figure 4.1 of Section 4 at anytime.

2.7 Trial designs for evaluation

The Trial Design for evaluation is documented on the architectural drawings referred to by Table 2 in Section 2.3 'Principal Building Characteristics' and reproduced below.

Table 2.4 Documents reviewed (reproduced from Table 2)

Drawing No.	Title	Date	Issue
PSH-AR-MEH-DWG-20B1100	Level B1 – Floor Plan	02.02.2010	C
PSH-AR-MEH-DWG-20LG100	Level LG – Floor Plan	16.11.2010	G
PSH-AR-MEH-DWG-2000100	Level 00 – Floor Plan	24.11.2010	F
PSH-AR-MEH-DWG-400000-1 to 9	Elevations	-	E/F/G/H
PSH-AR-MEH-DWG-500000-1 to 13	Sections	-	D/E/F
PSH-AR-MEH-DWG-26B1100	Level B1 – Fire Compartmentation	09.02.11	C
PSH-AR-MEH-DWG-26LG100	Level LG – Fire Compartmentation	09.02.11	F
PSH-AR-MEH-DWG-2600100	Level 00 – Fire Compartmentation	09.02.11	E

2.8 Compliance issues and specific objectives

A BCA audit identifying compliance issues was issued by the Building Code Consultant, Stokes Perna on 17 November 2008 (GCOM-000007). Comments were received by the Assessing Authority, Project Services on 12 March 2009 (PRS-GCOM-000877). Additional compliance issues have been identified by the design team during design development. Table 2.5 outlines the non-compliance issues identified to date and also lists the relevant Deemed-to-Satisfy (DTS) Provisions and Performance Requirements to be addressed.

Table 2.5 BCA compliance issues

Compliance Issue		DTS Clause	Primary Perf. Req.
1	The fire compartment area is greater than prescribed by C2.5, due to the covered ways between buildings.	C2.5, C3.3	CP3 (and to a lesser extent CP2)
2	Non-provision of 30 minutes FRL to floor separating storeys in Class 9a building of Type C construction.	C1.1, Spec C1.1 Clause 5.1(e)	CP1, CP2
3	The distance of travel exceeds the required 20m travel distance in the lower level plant area.	D1.4	DP4
4	1,000 m^2 compartment with 60/60/60 FRL not provided to ward areas. Smoke proof subdivision exceeds 500 m^2 limit.	C2.5	CP2, CP3
5	FHR cabinets will be key locked with no frangible panel.	E1.3	EP1.1
6	Fire door hold-open device only releases upon local smoke detector activation within 1.5 m of doors.	C3.5, Spec C3.4	CP3
7	Alternate egress ladders from Level 00 plant rooms do not comply fully with AS 1657.	D1.11	DP4
8	Doorway thresholds incorporate a step (hob)	D1.6, D2.15	DP2, DP4
9	Fire compartmentation does not extend fully to ‘edge’ of building line	C2.7	CP2, CP3
10	A doorway in a Class 9a health care building incorporates a sliding door	D2.19	DP2, DP4
11	Building elements pass through a fire rated wall	C2.7	CP1, CP2
12	Fire hose reels pass through doorways fitted with fire and smoke doors	E1.4	CP2, CP3, DP5 and EP1.1

Compliance Issue		DTS Clause	Primary Perf. Req.
13	MASD system in lieu of ionisation in egress paths to exits in Class 9a patient care areas	Specification E2.2a (d)(i)(A)	EP2.1
14	Smoke proof wall construction	C2.5, Specification C2.5	CP2, CP3
15	Sprinkler coverage	E1.5	EP1.4
16	Smoke doors swing against direction of egress*	C2.5, Specification C3.4 (via Spec C2.5)	DP2(b), CP3

* Compliance with Spec 3.4 is required under DTS Clause C2.5, by way of Spec C2.5

The relevant Performance Requirements from the BCA are:

CP1 *A building must have elements which will, to the degree necessary, maintain structural stability during a fire appropriate to –*

(a) the function or use of the building; and

(b) the fire load; and

(c) the potential fire intensity; and

(d) the fire hazard; and

(e) the height of the building; and

(f) its proximity to other property; and

(g) any active fire safety systems installed in the building; and

(h) the size of any fire compartment; and

(i) fire brigade intervention; and

(j) other elements they support; and

(k) the evacuation time.

CP2 *(a) A building must have elements which will, to the degree necessary, avoid the spread of fire-*

(i) to exits; and

(ii) to sole-occupancy units and public corridors; and

Application: CP2(a)(ii) only applies to a Class 2 or 3 building or Class 4 part.

(iii) between buildings; and

(iv) in a building,

(b) Avoidance of the spread of fire referred to in (a) must be appropriate to-

(i) the function or use of the building; and

(ii) the fire load; and

(iii) the potential fire intensity; and

(iv) the fire hazard; and

(v) the number of storeys in the building; and
(vi) its proximity to other property; and
(vii) any active fire safety systems installed in the building; and
(viii) the size of any fire compartment; and
(ix) fire brigade intervention; and
(x) other elements they support; and
(xi) the evacuation time.

CP3 *A building must be protected from the spread of fire and smoke to allow sufficient time for the orderly evacuation of the building in an emergency.*

Application:
CP3 only applies to-
(a) a patient care area of a Class 9a health-care building; and
(b) a Class 9c aged care building.

DP2 *So that people can move safely to and within a building, it must have –*
(a) Walking surfaces with safe gradients; and
(b) Any doors installed to avoid the risk of occupants –
(i) having their egress impeded; or
(ii) being trapped in the building; and
(c) Any stairways and ramps with –
(i) slip-resistant walking surfaces on –
A. ramps; and
B. stairway treads or near the edge of the nosing; and
(ii) suitable handrails where necessary to assist and provide stability to people using the stairway or ramp; and
(iii) suitable landings to avoid undue fatigue; and
(iv) landings where a door opens from or onto the stairway or ramp so that the door does not create an obstruction; and in the case of a stairway, suitable safe passage in relation to the nature, volume and frequency of likely usage.

DP4 *Exits must be provided from a building to allow occupants to evacuate safely, with their number, location and dimensions being appropriate to-*
(a) the travel distance; and
(b) the number, mobility and other characteristics of occupants; and
(c) the function or use of the building; and
(d) the height of the building; and
(e) whether the exit is from above or below ground level.

DP5

To protect evacuating occupants from a fire in the building exits must be fire isolated, to the degree necessary, appropriate to –

(a) the number of storeys connected by the exits; and

(b) the fire safety system installed in the building; and

(c) the function or use of the building; and

(d) the number of storeys passed through by the exits; and

(e) fire brigade intervention.

EP1.1 *A fire hose reel system must be installed to the degree necessary to allow occupants to safely undertake initial attack on a fire appropriate to –*

(a) the size of the fire compartment; and
(b) the function or use of the building; and
(c) any other fire safety systems installed in the building; and
(d) the fire hazard.

EP1.3 *A fire hydrant system must be provided to the degree necessary to facilitate the needs of the fire brigade appropriate to –*

(a) fire-fighting operations; and
(b) the floor area of the building; and
(c) the fire hazard.

EP2.2 *(a) In the event of a fire in a building the conditions in any evacuation route must be maintained for the period of time occupants take to evacuate the part of the building so that-*

(i) the temperature will not endanger human life; and
(ii) the level of visibility will enable the evacuation route to be determined; and
(iii) the level of toxicity will not endanger human life.

(b) The period of time occupants take to evacuate referred to in (a) must be appropriate to-

(i) the number, mobility and other characteristics of the occupants; and
(ii) the function or use of the building; and
(iii) the travel distance and other characteristics of the building; and
(iv) the fire load; and
(v) the potential fire intensity; and
(vi) the fire hazard; and
(vii) any active fire safety systems installed in the building; and
(viii) fire brigade intervention.

Limitation: EP2.2 does not apply to an open-deck car-park or open spectator stand.

2.9 Approaches and Methods of Analysis

Approaches can be:

- Qualitative or quantitative, and
- Comparative or absolute, and
- Deterministic or probabilistic.

Definitions of these approaches, abridged form the IFEG (ABCB 2005) are included below in Table 2.6. In justifying the compliance issues outlined in Table 2.5, the approach varies according to the specific compliance issue. The specific methods of analysis are described in Table 2.7.

Table 2.6 Summary of analysis approach

Approach	Definition (abridged from IFEG)
Qualitative	Qualitative analysis may be agreed during the FEB process to be sufficient for the consideration of minor stand-alone compliance issues. The basis (logic) on which this approach is used should be documented with appropriate references.
Quantitative	The complexity of the compliance issues will often require a quantitative approach. This entails the use of one or more of the many analysis methods available The quantitative methods will often be supported by additional qualitative arguments.
Comparative	A comparative approach aims to determine whether the alternative solution is equivalent to (or better than) the deemed-to-satisfy or prescriptive design. The comparative approach is often referred to as an “equivalence” approach.
Absolute	In an absolute approach, results of the analysis are matched directly against the performance requirements of the BCA, using agreed acceptance criteria
Deterministic	Deterministic analyses are based on physical relationships derived from scientific theories and empirical results. Characteristically, for a given set of initial boundary conditions, a deterministic methodology will always produce the same outcome. They do not, however, indicate the probability of that outcome being realized.
Probabilistic	Probabilistic approaches use a variety of risk based methodologies. These methods generally assign reliabilities to the performance of the various fire protection measures and assign frequencies of occurrence of events. They may analyse and combine several different scenarios as part of a complete fire engineering evaluation of a building design. This use of multiple scenarios and their combination through probabilistic techniques is the key feature of some of the methods.

Table 2.7 Approach and method of analysis

	Compliance Issue	Approach	Method of analysis
1	The fire compartment area is greater than prescribed by C2.5, due to the covered ways between buildings.	Quantitative, comparative, deterministic	The covered ways are open. The effects of fire and smoke spread will be calculated via received heat flux (radiative and convective) on the far barrier.
2	Non-provision of 30 minutes FRL to floor separating storeys in Class 9a building.	Quantitative, absolute, deterministic, and qualitative	Calculate the exposed gas temperature at steel beam height under a sprinkler controlled fire. Steel columns – to be covered within 13 mm gypsum plasterboard or Powerscape board.
3	The distance of travel exceeds the required 20m travel distance in the lower level plant area.	Quantitative, comparative, deterministic	Compare difference in detection time($\Delta t_{detection}$) with difference in travel time (Δt_{travel})
4	1,000 m^2 compartment with 60/60/60 FRL not provided to ward areas. Smoke proof subdivision exceeds 500 m^2 limit.	Quantitative, comparative, deterministic	Calculate the RSET of the trial design and compare to a representative DTS building. Additionally repeat for ASET. (Refer to Vol 1 EJV-FE-MEH-REP-0001-PDF-REV5).
5	FHR and hydrant cabinets will be key locked with no frangible panel.	Qualitative, absolute	Ward areas are under high level of supervision. Staff will all have keys.
6	Fire door hold open device only releasing upon local smoke detector activation within 1.5 m of doors.	Qualitative, absolute	Occupants particularly in Ward areas are easier to evacuate into adjacent fire/smoke compartments if a fire occurs away from the accessible fire/smoke doors.
7	Alternate egress ladders from Level 00 plant rooms do not comply fully with As 1657.	Qualitative, comparative	Compliance as near as is reasonably practicable, reduced risk due to non-required sprinkler system.
8	Doorway thresholds incorporate a step (hob).	Qualitative, absolute	Identification of hob and induction training of staff
9	Fire compartmentation does not extend fully to 'edge' of building line.	Qualitative, comparative	Design represents an equivalent risk to other DTS compliant building configuration

Compliance Issue		Approach	Method of analysis
10	A doorway in a Class 9a health care building incorporates a sliding door.	Qualitative	Low occupancy load with high staff/patient ratio (i.e. 3 staff with only 1 patient) Room has alternative designated exit with swing doors
11	Building elements pass through a fire rated wall	Qualitative (quantitative by 3rd party)	Fire spray elements back to first connection to provide insulation rating Statement by structural engineer attesting that design will satisfy structural adequacy and integrity requirements
12	Fire hose reels pass through doorways fitted with fire and smoke doors	Qualitative	Fully compliant hose reel coverage to be maintained to all parts of the building FHRs permitted to pass through fire and smoke doors to small plant and comms rooms providing the rooms are not more than 100 m^2 in area
13	MASD system in lieu of ionisation in egress paths to exits in Class 9a patient care areas	Quantitative	Comparison of the capability of proposed MASD system with an ionisation detector required by DTS provisions.
14	Smoke proof wall construction	Qualitative	Analysis of the relevant performance requirements
15	Sprinkler coverage	Qualitative	Assessment of risk of fire development in these areas without sprinkler coverage and impact on the sprinkler system installed throughout the rest of building space
16	Smoke doors swing against direction of egress	Qualitative	Assessment of risk associated with smoke door swing based on provision of hold open devices triggered by locally activated smoke detection only

2.10 Acceptance Criteria for Analysis

The acceptance criteria, outlined in Table 2.8 describe the means by which Alternative Solutions are assessed for compliance with the Performance Requirements of the BCA.

Table 2.8 Acceptance criteria

	Compliance Issue	Approach & method of analysis	Acceptance criteria
1	The fire compartment area is greater than prescribed by C2.5, due to the covered ways between buildings.	Approach: Quantitative, comparative, deterministic Method: Radiative and convection received heat flux calculations.	Received heat flux ≤ 20 kW/m².
2	Non-provision of 30 minutes FRL to floor separating storeys in Class 9a building.	Approach: Quantitative, qualitative, deterministic Method: convection received gas temperature calculations for beams; and to provide inherent fire resistance with gypsum plasterboard or Powerscape board for columns.	Received gas temperature at beam height < 460 °C.
3	The distance of travel exceeds the required 20m travel distance in the lower level plant area.	Approach: Quantitative, comparative, deterministic Method: Compare difference in detection time($\Delta t_{detection}$) with difference in travel time (Δt_{travel})	$\Delta t_{detection} \geq \Delta t_{travel}$
4	1,000 m² compartment with 60/60/60 FRL not provided to ward areas. Smoke proof subdivision exceeds 500 m² limit.	Approach: Quantitative, comparative, deterministic Method: Calculate the ASET of the Trial Design and compare to a representative DTS building. (EJV-FE-MEH-REP-0001-PDF-REV5).	Trial Design ASET ≥ DTS ASET (referring also to Vol 1 EJV-FE-MEH-REP-0001-PDF-REV5).
5	FHR, portable fire extinguisher and hydrant cabinets will be key locked with no frangible panel.	Approach: Qualitative, absolute Method: The Ward areas will have high level of supervision and staff will all have keys	Agreement by Building Certifier and QFES
6	Fire door hold open device only releasing upon local smoke detector activation within 1.5 m of doors.	Approach: Qualitative, absolute Method: Ease of travel to adjacent fire/smoke compartment particularly while moving patients in Ward areas	Agreement by Building Certifier and QFES

Compliance Issue		Approach & method of analysis	Acceptance criteria
7	Alternate egress ladders from Level 00 plant rooms do not comply fully with AS 1657.	Approach: Qualitative, comparative Method: Compliance as near as is reasonably practicable, reduced risk due to non-required sprinkler system	Agreement by Building Certifier and QFES
8	Doorway thresholds incorporate a step (hob).	Approach: Qualitative, absolute Method: Identification of hob and induction training of staff	Agreement by Building Certifier and QFES
9	Fire compartmentation does not extend fully to 'edge' of building line	Approach: Qualitative, comparative Method: Design represents an equivalent risk to other DTS compliant building configuration	Agreement by Building Certifier and QFES
10	A doorway in a Class 9a health care building incorporates a sliding door	Approach: Qualitative Method: High staff/patient ratio (i.e. 3 staff with only 1 patient) Room has alternative designated exit with swing doors	Agreement by Building Certifier and QFES
11	Building elements pass through a fire rated wall	Approach: Qualitative (quantitative by 3rd party) Method: Fire spray elements back to first connection to provide insulation rating Statement by structural engineer attesting that design will satisfy structural adequacy and integrity requirements	Agreement by Building Certifier and QFES
12	Fire hose reels pass	Approach: Qualitative	Agreement by Building Certifier

	Compliance Issue	Approach & method of analysis	Acceptance criteria
	through doorways fitted with fire and smoke doors	Method: Fully compliant hose reel coverage to be maintained to all parts of the building FHRs permitted to pass through fire and smoke doors to small plant and comms rooms providing the rooms are not more than 100 m^2 in area	and QFES
13	MASD system in lieu of ionisation in egress paths to exits in Class 9a patient care areas	Approach: Quantitative Method: comparison of capability of proposed MASD system and Ionisation detector required by DTS provisions of BCA.	Demonstration that the MASD system is expected to provide a level of fire warning not less than that by ionisation detectors.
14	Construction of smoke proof walls with plywood timber nogging on the inside.	Approach: Qualitative Method: Analysis of the relevant performance requirements.	Demonstration through analysis that the performance requirements of a smoke wall can still be achieved with the proposed system.
15	Proposed deletion of sprinkler coverage to the EDB cupboards and underside of a canopy in one of the courtyards.	Approach: Qualitative Method: Assessment of risk of fire development in these areas without sprinkler coverage and impact on the sprinkler system installed throughout the rest of building space.	The risk of a significant fire developing in the non-sprinkler protected EDB cupboards and overwhelm the sprinkler system in the rest of building areas is unlikely.
16	Smoke doors swing against the direction of egress	Approach: Qualitative Method: Provision of locally triggered hold open devices provided to relevant smoke doors	Agreement by Building Certifier and QFES

2.11 Fire Scenarios and Parameters for Design Fires

2.11.1 Design fire scenarios

Design fire scenarios will be used in the calculation of the received heat flux for Compliance issue 1.

There are two design fire scenarios:

- Health care design fire, and
- Office design fire

Details of design fires relating to these scenarios follow.

The following descriptions relate to free-burning items. They do not take account of manual or sprinkler control or suppression, which may be considered in the further analysis. If control or suppression is considered, it will be strictly to the methodology contained in Section 2.7.2 'Automatic suppression' of the IFEG (ABCB 2005).

2.11.2 Health care design fire

The fire load within a hospital varies from general combustible facilities rooms such as treatment rooms and patient wards, to high fuel-load spaces such as a linen storeroom or medical library.

The severity of the fire hazard mainly depends on the arrangement and chemical properties of the combustibles, the fire compartment geometries, and the provided fire protection systems.

A number of studies were carried out by O'Conner (2003) to investigate the likelihood of hospital fire causes and fatality locations, and these indicate that most fire fatalities or injuries are located at in-patient care locations.

The typical fuel load within an in-patient care area contains wooden wardrobes, mattresses and upholstered furniture, which are critical due to their fast growth rate (as shown in Figure 3) and extensive smoke production. The NIST experimental results of the heat release rates (HRR) for these typical furnishings are shown in Figure 4.

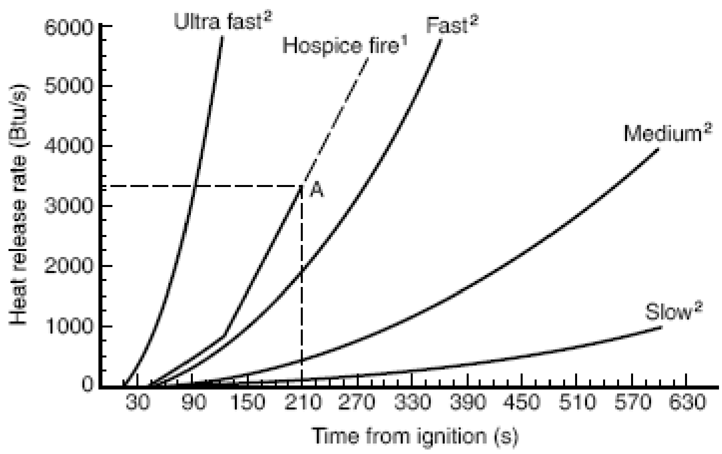


Figure 2.2 Comparison of the Hospice Fire to NFPA 72, (O'Connor 2003)

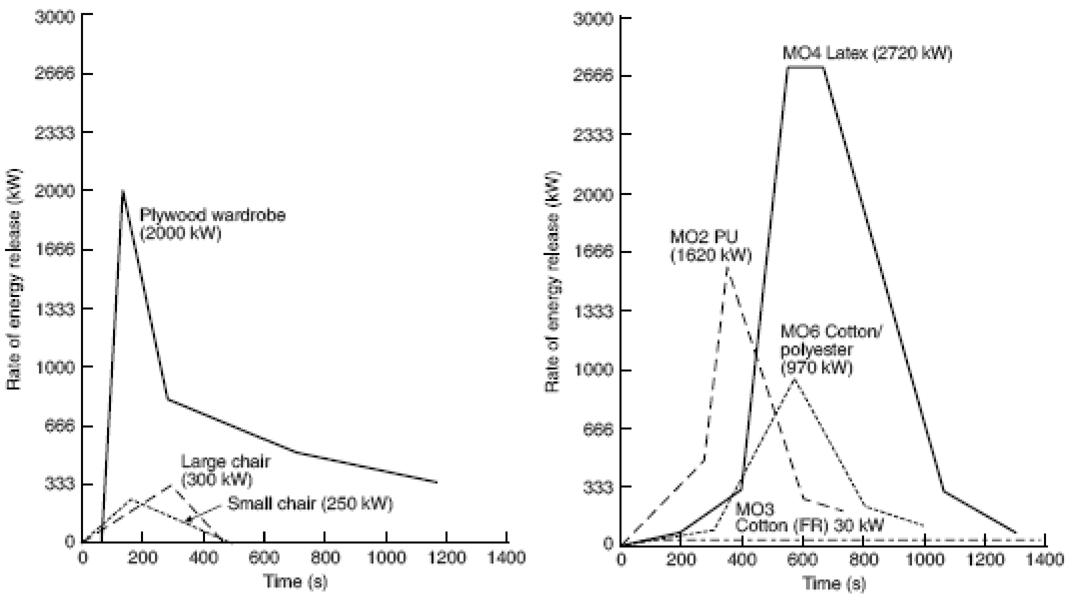


Figure 2.3 Convective HRR for the Miscellaneous Furniture and Beds (O'Connor 2003)

2.11.3 Office design fire

A study relating to office fires was conducted by the US National Institute of Standards and Technology (NIST). The experimental data is available as a web-based resource at www.fire.nist.gov with links to "Fire on the Web".

The study indicated that the worst case category of office furnishings in terms of heat release rate is work stations (plastics, vertical orientation), surrounded by partitions on three sides that re-radiate heat back towards the source.

Workstation configurations were tested, where each work station comprised a desk, office chair, partitions, book shelf, computer, keyboard, file boxes, paper, notebooks, file holders and newspaper. The HRR time history is shown in Figure 5. The NIST data is of a free-burning object, and the decline in HRR shown in Figure 5 is the decay phase rather than representing suppression.

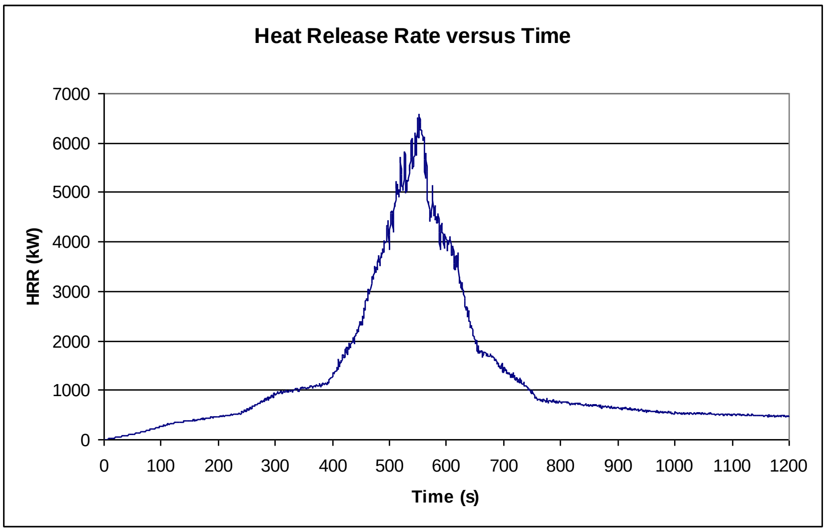


Figure 2.4 The NIST three sided workstation with decay.

2.12 Assumptions and clarifications

- Some of the egress stairs in MEH building are not fire-isolated exits.
- Staff carry keys to secured exit doors and doors on paths of travel to exit doors at all times, and are trained in procedures for providing for the immediate escape of occupants in the event of fire.
- Walls shown red in Figure 4.1 below are provided with a two-way 120 minute FRL.

2.13 Management in use

- House-keeping must be undertaken to maintain the egress paths and exits clear in order to allow unimpeded travel.
- Staff within the building must be appropriately trained and be familiar with emergency evacuation procedures.
- No smoking policy is to be implemented in all areas, except specific areas identified by QH in MEH as smoking areas
- Commissioning and integrated function testing of all fire safety systems including interfaces to ensure proper function
- There is the potential for penetrations in fire walls to compromise the fire separation’s integrity. Particularly over the life of the building. It is recommended that penetration zones are nominated within fire walls for ease of inspection and maintenance.
- All essential services are to be maintained and tested in accordance with the requirements of the Queensland Development Code (QDC) and AS1851-2005 and their system-specific Australian Standards.

Following is a schedule of essential fire safety measures and their system-specific standard.

Table 2.9 Essential fire safety measures

Item	Fire safety measure	Standards
1	Components for the protection of openings in fire-resistant walls • Fire resistant doors	AS 1905.1-2005 AS 1905.2-2005
2	Fire detection, warning, control and intercom systems – System design, installation and commissioning • Fire • Alarm monitoring • Sound systems and intercom systems for emergency purposes. MASD system in egress paths to exits in patient care areas in lieu of ionisation detectors required by Specification E2.2a Clause 4(d)(i)(A) as discussed in Section 16 of this report.	AS 1670.1-2004 AS 1670.3-2004 AS 1670.4-2004 (and AS 4428.4-2004)
3	Automatic fire sprinkler systems • General requirements • Combined sprinkler and hydrant	AS 2118.1-1999 AS 2118.6-1995
4	Emergency escape lighting and exit signs • System design, installation and operation	AS 2293.1-2005
5	Fire dampers	AS 1682.1-1990 and AS 1682.2-1990
6	Fire hydrant systems • System design, installation and commissioning	AS 2419.1-2005
7	Fire hose reel systems	AS 2441-2005
8	Mechanical air handling systems • Fire and smoke control between multi-compartments	AS/NZS 1668.1-1998
9	Access and Egress • Provision for escape • Construction of exits	BCA 2008 (D1) BCA 2008 (D2)
10	Perimeter vehicle access for emergency vehicles	BCA 2008
11	Portable fire extinguishers and fire blankets • Selection and location	AS 2444-2001
12	Required (automatic) exit doors	BCA 2008
13	Smoke dampers	AS/NZS 1668.1-1998
14	Smoke detectors and heat detectors	AS 1670.1-2004
15	Wall-wetting sprinkler and drencher systems	AS 2118.2-1995

3. Evacuation strategy

3.1 Overview

The evacuation strategy is determined by the patients' vulnerability. Patients are expected to have higher level of stress and anxiety particularly under emergency situation such as fire. As such, staff are expected to have completed specialist training for assisting patients to safe areas. "Protect-in-place" and "everybody-out" are the two extremes of evacuation strategies, in between is a 'staged' or 'progressive' evacuation strategy. The choice of strategies mainly depends on the fire hazard, occupant characteristics and building characteristics.

A staged evacuation strategy will be implemented for the MEH building with occupants of the fire compartment of origin being evacuated to the adjacent fire compartment and then if necessary to subsequent fire compartments further away from the fire. A non-required sprinkler system has been provided in this building and therefore the risk of a serious (i.e. uncontrolled) fire developing is considered very low, and consequently it is unlikely that occupants would need to be evacuated further than the closest adjacent fire compartment.

Although evacuation internally to another fire compartment is the preferred option, it is important to note that all patient care areas are located on ground level (Level LG) and therefore it is possible to evacuate directly to outside from all parts of the building. The patient care areas of the MEH have DTS compliant egress provisions, including travel distances and exit widths. Egress directly to outside provides an additional level of safety, and provides an alternative egress option for staff should conditions mean it is not possible to safely evacuate all occupants to an adjacent fire compartment within the building.

3.2 Evacuation Sequencing

The evacuation system for the MEH building allows for two different input types, which produce two different types of evacuation sequences. 'Input 1' is for a single smoke detector activation within a Class 9a fire compartment, and will trigger the evacuation sequence associated with the Alarm Acknowledgement Facility (AAF), which is discussed in further detail in Section 3.3. 'Input 2' is for any other type of detection device activation, including a second smoke detector or a manual call point. Input 2 will override Input 1. The evacuation sequence associated with each input is detailed below, and summarised in Figure 3.1.

3.2.1 Input 1

Upon activation of a single smoke detector (including a multi-criteria detector not in 'Heat only' mode) in a Class 9a fire compartment, the Alarm Acknowledgement Facility (AAF) system as detailed in Section 3.3 will be initiated. If the AAF is not 'acknowledged' or 'isolated' within the given timeframes, the Input 1 evacuation sequence will be initiated. Input 1 will place the Class 9a fire compartment of origin into 'Alert' for a period of 5 minutes, with no other Alert or Evacuate signal sounding in any other fire compartment. Following the 5 minute 'Alert' period the fire compartment of origin will go into 'Evacuate', all other Class 9a fire compartments on the floor of origin will go into 'Alert'. The evacuation sequence will then cascade in accordance with the EWIS Matrix as detailed in Appendix J.

Note that Input 1 is only relevant for Class 9a fire compartments where an AAF is provided. A single smoke detector activation in any non-Class 9a fire compartment will result in an Input 2 evacuation sequence (see Section 3.2.2). Variations to the Input 1 sequence for the MEH Building are discussed in Section 3.4.1.

3.2.2 Input 2

Upon activation of any device other than a single smoke detector (i.e. a heat detector, a fire sprinkler or a manual call point) in a Class 9a fire compartment, the fire compartment of origin is placed in 'Evacuate', all other Class 9a fire compartments on the floor of origin will go into 'Alert', and any non-Class 9a fire compartments on the floor of origin will go into 'Evacuate'. The evacuation sequence will then cascade in accordance with the EWIS Matrix as detailed in Appendix J.

Note that activation of a second smoke detector in the Class 9a fire compartment of origin will also initiate an Input 2 sequence, even if an Input 1 sequence is already underway (in other words, activation of a device initiating an Input 2 sequence will override an existing Input 1 sequence).

Activation of any device (including a single smoke detector) in a non-Class 9a fire compartment will also initiate an Input 2 sequence (Input 1 is only applicable to Class 9a fire compartments where an AAF is provided).

If an AAF has been placed in 'Isolate' following the activation of a single smoke detector, any subsequent activation of any device prior to the system being reset, including a single smoke detector either in the fire compartment of origin or any other fire compartment, will result in an Input 2 sequence being initiated.

Activation of a single smoke detector in another Class 9a fire compartment while an Input 1 sequence is underway will result in an Input 1 sequence in that second fire compartment (in other words, more than one simultaneous Input 1 sequence can be in operation at any time). Variations to the Input 1 sequence for the MEH Building are discussed in Section 3.4.1.

3.3 Staff pre-alarm investigation facility – Alarm Acknowledgement Facility (AAF)

As with the Ward and Treatment Areas within the CSB and IPU Building, the Ward Areas within the MEH Building are provided with an Alarm Acknowledgement Facility (AAF). The purpose of the AAF is to reduce the consequence of unwanted alarms to the operation of the MEH Building, and to minimise stress and anxiety to vulnerable patients, by providing staff with the opportunity to delay the operation of the audible fire alarm signal sounding, following activation of a single smoke detector.

The building's fire detection and alarm system is required to comply with AS 1670.1, and this would include the AAF. Alarm Acknowledgement Facilities are detailed in Section 3.2 of AS 1670.1, which requires the AAF to comply with the following:

- Each alarm acknowledgment facility shall control only one sole occupancy unit.
- The alarm acknowledgment facility control shall be located within the sole occupancy unit it serves.
- Each detector shall have a visual alarm indicator.

The requirements for AAFs under Section 3.2 of AS 1670.1 relate to Sole Occupancy Units, as AS 1670.1 envisions that AAFs will primarily be applied to residential buildings. However the commentary accompanying Section 3.2 (Commentary C3.2) clearly states that AAF may have other applications, which need to be assessed on a case by case basis. The term Sole Occupancy Unit (SOU) is defined in the BCA. The definition of a Sole Occupancy Unit includes a room or suite of associated rooms in a Class 5, 6, 7, 8 or 9 building for occupation by one or joint owner, lessee, tenant or other occupier. The definition also includes sleeping facilities and any area for the exclusive use of a resident in a Class 9c aged care building. On the basis of these definitions, the MEH Ward area smoke compartments provided with AAFs can be considered as SOUs for the purpose of compliance with Section 3.2 of AS 1670.1.

Commentary C3.2 of AS 1670.1 also recommends (commentaries are for information only and do not need to be followed for compliance with the Standard) that an acknowledgement period of 30 seconds and a maximum alarm clearance time of 90 seconds be used. In the case of the MEH AAF system, the acknowledgement period will be 60 seconds and the investigation period (equivalent to alarm clearance time) will be 180 seconds. While these periods exceed the recommendations in Commentary C3.2, they still comply with the time periods detailed in AS 4428.1 for AAF.
The AAF system installed to the Ward areas within the MEH is therefore considered to comply with the requirements of AS 1670.1.

Additional requirements for AAFs are contained in AS 4428.1, however compliance with this Standard is not specifically mandated for AAFs under AS 1670.1, and therefore is not considered necessary for BCA compliance. Nevertheless, Australian Standards are considered to represent industry practice, and therefore where possible the MEH AAF system is intended to comply with AS 4428.1 (e.g. maximum delay periods). Where compliance with AS 4428.1 is not achieved, the following brief discussion demonstrates that an equivalent level of performance is still achieved.

Three key areas where the MEH AAF departs from the requirements of AS 4428.1 are the provision of an 'Isolate' button (AS 4428.1 does not permit manual cancelling of the alarm), the sounder volume (AS 4428.1 requires at least one sounder to achieve a sound pressure level of at least 75dB), and the fact that the MEH fire alarm system is designed to handle only one AAF operation at a time (AS 4428.1 requires that the fire alarm system Control and Indicating Equipment (CIE) be able to operate at least two AAFs simultaneously). Each of these departures is discussed individually as follows:

Provision of 'Isolate' Button

The provision of an Isolate button on the AAF system is not considered to reduce the level of safety because:

- the AAF does not delay fire brigade callout (and in this respect it is more conservative than a standard AAF); and

- once the Isolate button is pushed, the AAF functionality is disabled and any further device activation (whether in the fire compartment of origin or elsewhere in the building) will activate the building's evacuation system in accordance with the staged evacuation strategy, without any additional delay (i.e. if a detection device is registering the presence of smoke above the alarm threshold when the Isolate button is pushed or any time subsequent, the fire alarm system will initiate the building's progressive evacuation process).

AAF Sound Pressure Level

While the MEH AAF may not achieve an audible warning level of 75dB (a sound pressure level of 75dB is a recommendation of the FER, but not a requirement), the additional alerting measures provided are considered to adequately compensate for this departure from AS 4428.1, including notifying staff via their personal comms devices, provision of an amber strobe light at the AAF Nurse Station, notification of EMT personnel by personal comms device, and notification to the Security Room. These measures are discussed in further detail below, however are considered to provide an equivalent level of notification to that achieved where a standard AAF is used in a hospital building. As a further safeguard, failure to acknowledge the AAF within the designated acknowledgement period will initiate the building's progressive evacuation process in the same way as a standard AAF would.

Operation of Only a Single AAF at One Time

The MEH fire alarm system will only handle one AAF operation at a time. Activation of a second AAF will automatically trigger operation of the fire alarm system proper for both the initial and subsequent activations. Again, the difference in system design is considered to make the MEH AAF system conservative in comparison to the Standard.

The measures described above are considered to provide the hospital's AAF with at least an equivalent level of safety to a fully AS 4428.1 compliant system, if not better due to there being no delayed fire brigade response. In addition, the maximum time delays for AAF are incorporated into any evacuation assessments contained in this FER, which demonstrate adequate time is available for safe evacuation.

While the proposed AAF system shares some characteristics with the Alarm Investigation Facility (AIF) detailed in AS 4428.10 (e.g. the provision of a 'reset' or 'cancel' facility), it is important to recognise that AIFs are specifically not permitted to be used in Healthcare buildings. For this reason the MEH AAF system does not delay the fire brigade response, and is not considered an AIF under AS 4428.10.

AAF units (also referred to as repeater panels) comprise an LCD visual display, a buzzer and amber strobe light, and a push button control panel. The amber strobe is to be located in a clearly visible position within, or adjacent to, the Nurse Base housing the AAF, preferably at high level, and located so as not to be obscured from outside the Nurse Base by any bulkhead around the Nurse Base. To avoid potential confusion in locating an AAF, amber strobes shall not be located at Nurse Bases that do not contain an AAF.

The AAF control panel will have an 'Acknowledge' button and an 'Isolate' button. Upon activation of a single smoke detector, the buzzer and the strobe light will operate at each AAF unit located within the smoke compartment of origin. AAF notification will not be provided in the non-affected smoke or fire compartments, however notification will immediately be sent to the Emergency Management Team (EMT) which will be comprised of trained QH personnel in positions of authority. Notification of the smoke detector activation will also be immediately sent to the EMT via the graphics facility and the FIP to the Fire Control & Security Room located in the PED.

It is to be noted that when plantrooms and/or comms rooms are located within the fire rated and smoke compartment, the detectors installed in these rooms (i.e., plantrooms or comm. rooms) will not report through the AAF in that smoke/fire compartment as they have restricted access and are subject to a different detection response (in other words, any detection in a plant room or coms room within a Class 9a fire compartment shall initiate an Input 2 sequence).

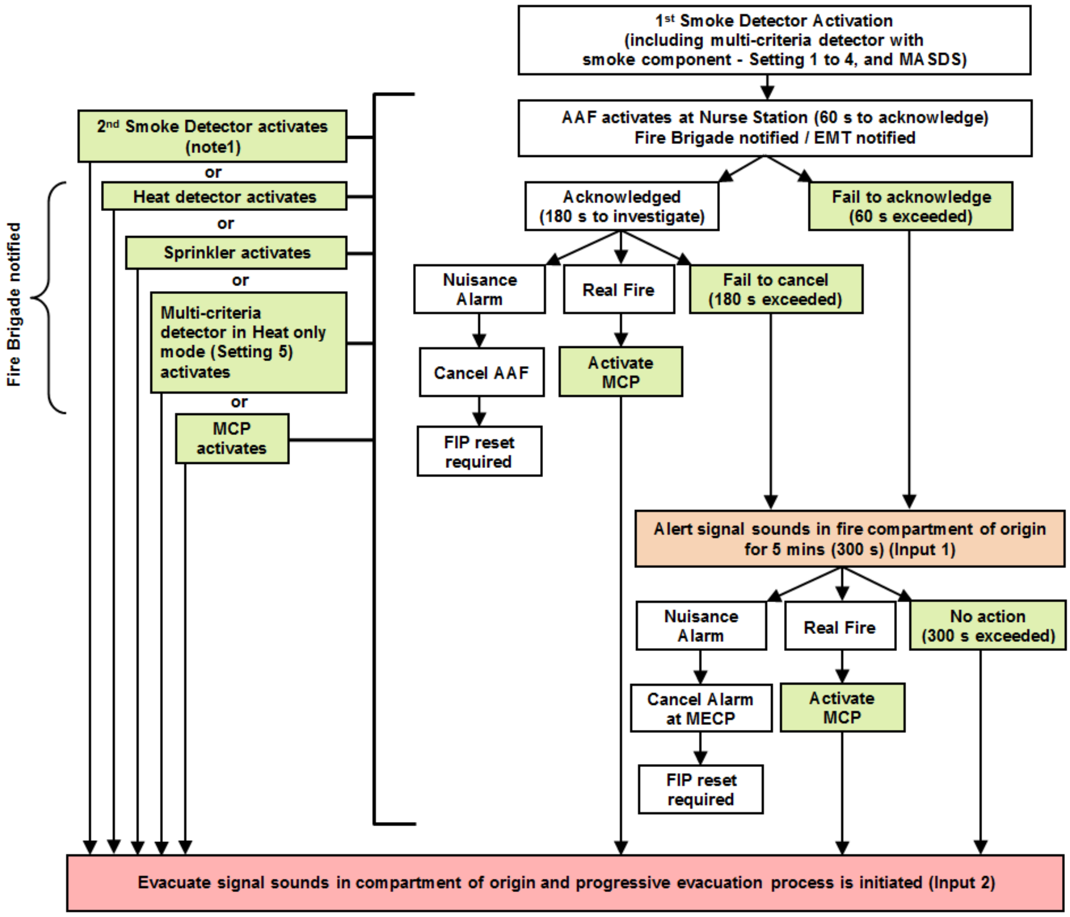
The AAF will be provided with the following two features, in the form of buttons located on the AAF panel, for staff to use in the event of a single smoke detector activation:

- **Acknowledgement** - Staff will have a pre-determined time of 60 seconds to acknowledge the smoke detector activation following notification

- **Isolate** - Having acknowledged the activation, staff will have a pre-determined time of 180 seconds to investigate the cause of the activation and, if no threat is detected, cancel the system

Note that the alarm acknowledgement facility equipment and delay periods described above comply with AS 4428.1:1998 (Clause 2.16 – *Alarm Acknowledgement Facility*, Amendment 1:2004), and are the maximum times permitted under that standard.

Note also that the fire brigade will be automatically called upon activation of any fire detection device, including a single smoke detector. Cancelling the AAF system will not cancel fire brigade response, and will not reset the fire alarm system. Cancelling the AAF within the pre-programmed Acknowledge and Investigation periods will however prevent the fire alarm system proper from activating and initiating the building's progressive evacuation process. The operating protocol for the staff response delay period AAF system in Class 9a fire compartments is summarised in the flow chart shown in Figure 3.1 below.



(Note 1: fire brigade will be called out on activation of 1st smoke detector as per right hand side of flow chart)

Figure 3.1 Staff pre-alarm investigation (AAF) and 5 Minute Alert Signal Strategy

If the AAF 'Isolate' button is pressed, the AAF will go into 'Isolate' mode, and an alarm servicing agent (fire alarm technician) will be required to reset the system. While in 'Isolate' mode, the fire alarm system will still be capable of initiating a fire alarm on activation of a fire detection device anywhere within the building. However while the fire alarm system is in 'Isolate' mode, no further use of the AAF system is possible i.e. activation of a single smoke detector while the fire alarm system is in 'Isolate' mode will trigger an Input 2 evacuation sequence.

If the Acknowledge button is not pressed within 60 seconds of AAF activation, an Input 1 sequence will automatically be initiated. If the Isolate button is not pressed within 180 seconds of the Acknowledge button being pressed, an Input 1 evacuation sequence will also be initiated. If during the Acknowledge or Investigation periods staff determine that a threat exists, the 'Evacuate' signal can activated (i.e. the Input 2 sequence initiated) via a Manual Call Point (MCP), which will be located at each Staff Base within Class 9a fire compartments and within 30m of any point on the floor as required by Specification E2.2 of BCA.

The purpose of the 5 minute Alert period provided under the Input 1 sequence within the fire compartment of origin is to provide staff with a further opportunity to investigate the source of a single smoke detector activation, before evacuation of the fire compartment is initiated. If staff can identify that the smoke detector activation occurred as a result of a spurious activation, the occupant warning can be cancelled from within the Fire Control Centre by an authorised member of the EMT. This provides an additional level of protection against disruption created by unwanted alarms, while still providing an elevated level of warning within the fire compartment of origin.

5 minutes is understood to provide sufficient time for staff in the fire compartment of origin to investigate and report back via the WIP phone at the Nurse Station, and for EMT personnel to respond to the Fire Control Centre. If during the 5 minute Input 1 Alert period, staff identify that the source of the activation is spurious, they can convey this information to the EMT personnel in the Fire Control Centre via the WIP phone located at the Nurse Station, and the decision to cancel the evacuation signal at the MECP can be made by an authorised member of the EMT.

At the end of the 5 minute Alert period, the fire compartment of origin goes into Evacuate, all other Class 9a fire compartments on the floor of origin go into Alert, and all other fire compartments on the floor of origin go into Evacuate in accordance with the Input 1 evacuation sequence. The evacuation system then cascades at not more than 10 minute intervals. Note that each Class 9a fire compartment is an individual EWIS zone, however non-Class 9a fire compartments may be grouped together to form a single EWIS zone.

The AAF will not be a stand-alone response to a single smoke detector activation, but will be part of a robust response strategy to ensure an appropriate level of safety is achieved. On activation of a single smoke detector, the following events will occur:

- Fire brigade called immediately on activation of any device, including a single smoke detector (i.e. the AAF does not delay fire brigade response)
- Nursing staff within the fire compartment of origin will be notified by personal comms device upon activation of any detection device (i.e. at commencement of the AAF phase)
- QH Emergency Management Team (EMT) will be notified by personal comms device upon activation of any detection device (i.e. at commencement of the AAF phase)
- A local buzzer will sound and an amber strobe light will flash at the Nurse Station where the AAF is located within the smoke compartment of origin, to provide additional warning that the AAF has activated (note that the buzzer will have a differentiated sound compared to fire alarm system proper Alert and Evacuate tones – recommend 75 dB at 1.0 m from speaker as per AS 4428.1)
- The location of the activated detection device will be displayed on the AAF mimic panel LCD screen
- Nursing staff will have 60 seconds to acknowledge the AAF at the mimic panel once activated, otherwise the 5 minute Alert phase will be initiated in the fire compartment of origin (note that remote cancelling from outside the fire compartment of origin is not permitted).
- Following acknowledgement of the AAF, staff will have a further 180 seconds to investigate the source of the activation and isolate the system at the mimic panel, otherwise the 5 minute Alert phase will be initiated in the fire compartment of origin (note that remote cancelling from outside the fire compartment of origin is not permitted).

- If a genuine incident is discovered at any time during the AAF acknowledge and investigate phases, or the subsequent 5 minute Alert phase, staff can activate the MCP located at the Nurse Station to override the AAF or Alert phases. This will place the fire compartment of origin into Evacuate with all other fire compartments following the cascading evacuation sequence associated with placing the fire compartment of origin in Evacuate

- Activation of a second smoke detector, or a single thermal detector, fire sprinkler head or MCP at any time within the fire compartment of origin will also override the AAF phase and the 5 minute Alert phase and place the fire compartment of origin in Evacuate, with all other fire compartments following the cascading evacuation sequence associated with placing the fire compartment of origin in Evacuate

- Note that Multi-Criteria Detectors (MCDs) located within Class 9a fire compartments that are specified with an active smoke component will be treated as smoke detectors (i.e. will trigger the AAF if first device activated), whereas MCDs that are specified with an active thermal component only will be treated as a heat detector (i.e. will place the fire compartment of origin into Evacuate)

It is important to note that the staff response delay period occurs only upon activation of a single smoke detector within a Class 9a fire compartment. Should a second smoke detector activate within the same fire compartment at any time during the staff response delay period, the Input 2 evacuation sequence will automatically be initiated. This is not a double-knock system, and does not require provision of multiple detectors in every space. Automatic upgrade (Input 2 initiation) on activation of a second detector is simply an additional level of safety built into the system. Similarly, activation of a heat detector (including a multi-sensor detector set only to heat mode), or the sprinkler system, or an MCP, at any time within the fire compartment of origin will also automatically initiate the Input 2 sequence.

As noted above, the Emergency Management Team (EMT) manning the Security Room in the PED will be automatically notified of any fire detection device activation, including a single smoke detector activation, via the graphics facility in the Security Room and via the FIP in the Fire Control Room. It is expected that the EMT will identify the area of activation and confirm to the EMT personnel in that area to investigate via personal communication devices (PCD). This additional level of response will complement the response of nursing staff in the fire compartment of origin.

3.4 Staged evacuation procedure

3.4.1 5 Minute Alert Phase Following AAF Phase – Class 9a Fire Compartments

When AAF time thresholds are exceeded, the fire compartment of origin is placed in Alert for 5 minutes.. During this time no other Alert or Evacuate signal occurs within any other fire compartment. Note that provision of an Alert signal preceding the Evacuation signal is permitted under AS 1670.4, providing it is specified in the Building Management Plan, and the cascade interval complies with AS 1670.4.

The procedure for managing the evacuation process during the Alert phase (including any investigation procedures) will be documented in the Building's Management Plan and Fire Safety Plan.

At the end of the 5 minute Alert period, the fire compartment of origin goes into Evacuate and all other fire compartments go into Alert (unlike the CSB/SSB/IPU evacuation strategy, non-Class 9a fire compartments do not immediately go in to Evacuate in MEH). The evacuation system then cascades in 10 minute maximum intervals. Note that each fire compartment is an individual EWIS zone, except for

Fire Compartment FC.MEH.LG.03, which incorporates EWIS Zone H (L00 administration offices) and part of EWIS Zone E (LG Entry Foyer).

If during the 5 minute Alert period staff identify that the source of the activation is spurious, they convey this information to the EMT personnel in the Fire Control Centre via the WIP phone located at the Nurse Station, and the decision to cancel the evacuation signal at the MECP is made by an authorised member of the EMT.

The purpose of creating a 5 minute Alert period within the fire compartment of origin is to provide staff with a further opportunity to investigate the source of a single smoke detector activation, before evacuation of the fire compartment is initiated. If staff can identify that the smoke detector activation occurred as a result of a spurious activation, the occupant warning can be cancelled from within the Fire Control Centre by an authorised member of the EMT. 5 minutes is understood to provide sufficient time for staff in the fire compartment of origin to investigate and report back via the WIP phone at the Nurse Station, and for EMT personnel to respond to the Fire Control Centre.

In addition to the audible and visual alarm system, the following measures are provided:

- Fire brigade called immediately on activation of any device, including a single smoke detector (i.e. the AAF does not delay fire brigade response)
- Selected nurses on-duty within the smoke compartment of origin are automatically notified via personnel comms devices upon activation of any detection device (i.e. at commencement of the AAF phase)
- QH Emergency Management Team (EMT) will be notified by personal comms device upon activation of any detection device (i.e. at commencement of the AAF phase)
- Visual notification (amber strobe light) occurs at the Staff Base in the smoke compartment of origin, to provide additional warning that the AAF has activated
- The location of the activated detection device will be displayed on the AAF mimic panel LCD screen
- Nursing staff will have 60 seconds to acknowledge the AAF at the mimic panel once activated, otherwise the 5 minute Alert phase will be initiated in the fire compartment of origin
- Following acknowledgement of the AAF, staff will have a further 180 seconds to investigate the source of the activation and isolate the system at the mimic panel, otherwise the 5 minute Alert phase will be initiated in the fire compartment of origin
- If a genuine incident is discovered at any time during the AAF acknowledge and investigate phases, or the subsequent 5 minute Alert phase, staff can activate the MCP located at the Nurse Station to override the AAF or Alert phases. This will place the fire compartment of origin into Evacuate with all other fire compartments following the cascading evacuation sequence associated with placing the fire compartment of origin in Evacuate
- Activation of a second smoke detector, or a single thermal detector or fire sprinkler head in the fire compartment of origin at any time will also override the AAF phase and the 5 minute Alert phase and place the fire compartment of origin in Evacuate, with all other fire compartments following the cascading evacuation sequence associated with placing the fire compartment of origin in Evacuate

- Note that Multi-Criteria Detectors (MCDs) located within Class 9a fire compartments that are specified with an active smoke component (Settings 1 to 4) will be treated as smoke detectors (i.e. will trigger the AAF if first device activated), whereas MCDs that are specified with an active thermal component only (Setting 5) will be treated as a heat detector (i.e. will place the fire compartment of origin into Evacuate)

The evacuation system configuration will result in the following minimum and maximum delays between activation of a single smoke detector and initiation of the Evacuate signal within the fire compartment of origin are shown in Table 3.1.

Table 3.1 – Delay Times for Initiation of Evacuate Signal (based on single smoke detector activation)

Delay	AAF Phase	Alert Phase	Total
Minimum	60s	300s (5 mins)	360s (6 mins)
Maximum	240s (60s + 180s)	300s (5 mins)	540s (9 mins)

The 5 minute (300 second) delay for initiation of the Evacuate signal is considered acceptable due to the high number of safeguards that are in place, summarised as follows:

- Fire brigade response is immediate (i.e. initiated on activation of any device)
- EMT response initiated by personnel comms device signal (i.e. initiated on activation of any detection device)
- Delay only occurs on activation of a single smoke detector - activation of any other device (including a second smoke detector) during either AAF or Alert period will place the fire compartment of origin into Evacuate and initiate the evacuation sequence
- Failure to acknowledge AAF within the required time (60s) automatically places fire compartment of origin into Alert
- Failure to isolate AAF within the required time (180s after acknowledgement) automatically places fire compartment of origin into Alert
- Staff can manually place the fire compartment of origin into Evacuate at any time during AAF or Alert period by activating an MCP
- Building is fire sprinkler protected
- Class 9a areas are staffed at all times when patients are present
- Analysis contained in Section 4 demonstrates that the inclusion of the 5 minute Alert phase preceding the Evacuate signal in Ward areas is not considered to unduly affect the level of safety in the building

The proposed evacuation system strategy for Class 9a fire compartments is summarised in the flow chart shown in Figure 3.1, in Section 3.3. A qualitative assessment on the impact of the 5 minute Alert period on the evacuation of the Class 9a fire compartments is contained in Section 3.4.6.

3.4.2 Level 00 Class 5 Administration Office Fire Compartment

The Class 5 Administration Office fire compartment FC.MEH.LG.03, located primarily on Level 00 of the southern block of MEH, forms part of the cascading evacuation sequence for the MEH building. In other words, unlike the CSB/SSB/IPU evacuation strategy, the Class 5 fire compartment does not immediately go into Evacuate as soon as any Class 9a fire compartment goes into Evacuate. However as the Class 5 fire compartment does not have an AAF, on activation of a fire detection device within the Class 5 fire compartment, the Class 5 fire compartment shall immediately go into Evacuate, with the Class 9a fire compartments then cascading through the Alert and Evacuate sequence detailed in Section 3.4.5.

It should be noted that an Alert signal will not be provided to the Class 5 fire compartment upon fire detection activation within that compartment, however occupant awareness of the audible evacuate cue will be enhanced by provision of automatic voice messaging as part of the audible Evacuate signal. It is expected that the voice message would contain the same wording as utilised in other GCUH buildings where voice messaging is employed, or the following wording in compliance with AS 1670.4:

“EMERGENCY - EVACUATE NOW”

The voice message would be interspersed with the T3 evacuate tones in accordance with the requirements of AS 1670.4. For consistency, the automatic voice message will be provided to the Evacuate signal in all fire compartments, including Class 9a fire compartments.

3.4.3 Level 00 Class 8 Plant Rooms

Class 8 plant rooms are located on Level 00, above the north block Level LG Class 9a ward fire compartments. As the building is of Type C construction, the Level 00 plant rooms are not fire separated at the floor slab from the Class 9a fire compartments below (although the fire walls separating the various fire compartments on Level LG are extended up through to Level 00), and therefore form part of the Level LG Class 9a fire compartment below. The three plant rooms do however form a separate evacuation zone (Zone G) from the Class 9a parts below. Each of the Level 00 plant rooms is given an individual sub-zone number, i.e. Zone G1, G2 and G3, although all three plant rooms behave as a single EWIS zone.

The plant rooms are not accessible by nursing staff, and consequently are not covered by the relevant AAF located in the Class 9a fire compartment below. Therefore a fire detector activation in a Level 00 plant room will place the fire compartment in which it is located (including the interconnected Class 9a part on Level LG below), into Evacuate, without a preceding 5 minute Alert period. Note that fire detector activation in a Level 00 plant room will also place the other two Level 00 plant rooms in Evacuate immediately (i.e. no preceding Alert signal), even though they are in separate fire compartments.

However if a Class 9a part of the fire compartment below a plant room goes into the 5 minute Alert period due to the activation of a single smoke detector, the Alert signal will sound simultaneously through all three Level 00 plant rooms.

The voice messaging provisions as discussed in Section 3.4.2 shall also be provided to the Level 00 plant room EWIS zones.

3.4.4 Evacuation Cascade between Floors

Level LG Entry Foyer (part of Evacuation Zone E) and the L00 Administration Offices (part of Evacuation Zone H) are located within the same fire compartment (FC.MEH.LG.03). Consequently the evacuation sequence is configured so that Zone H goes into Evacuate on activation of a device in Zone E, and vice versa.

Vertical evacuation has been aligned with the strategy adopted for CSB/IPU/SB, in that cascade to the next floor will not occur until all fire compartments on the floor of origin have gone in to Evacuate. In the case of the MEH Building, a 'virtual cascade' philosophy has been utilised as part of the strategy, in a similar manner to the CSB/IPU/SSB building. The virtual cascade philosophy allows the time to cascade to the floor above or below to be delayed for the time that would have been required for the fire floor cascade to progress through all adjacent fire compartments, regardless of the actual sequencing of fire compartments. The 'virtual cascade' philosophy is described in further detail as follows:

<u>Virtual Cascade</u>
Under AS 1670.4, each fire compartment can form a separate Evacuation Zone, however in the MEH evacuation sequence, a single evacuation zone is made up of a number of separate Class 5 fire compartments. While this single evacuation zone cannot be sub-divided into separate evacuation zones by fire compartment due to limitations on the EWIS system, the time interval until the system cascades to adjacent evacuation zones can be adjusted based on a 'virtual cascade' through the fire compartments that comprise the evacuation zone.

For example, if a single evacuation zone is made up of three (3) consecutive fire compartments, the amount of time until the EWIS system cascades to the next adjacent evacuation zone can be extended to up to 3 cascade steps, just as if the system had actually cascaded sequentially through each of the three fire compartments one at a time. In the case of the GCUH buildings, a 9 minute step has been used for each EWIS cascade interval. This means that by utilising the 'virtual cascade' philosophy described above, a time delay of 27 minutes could be provided to the next adjacent fire compartment.

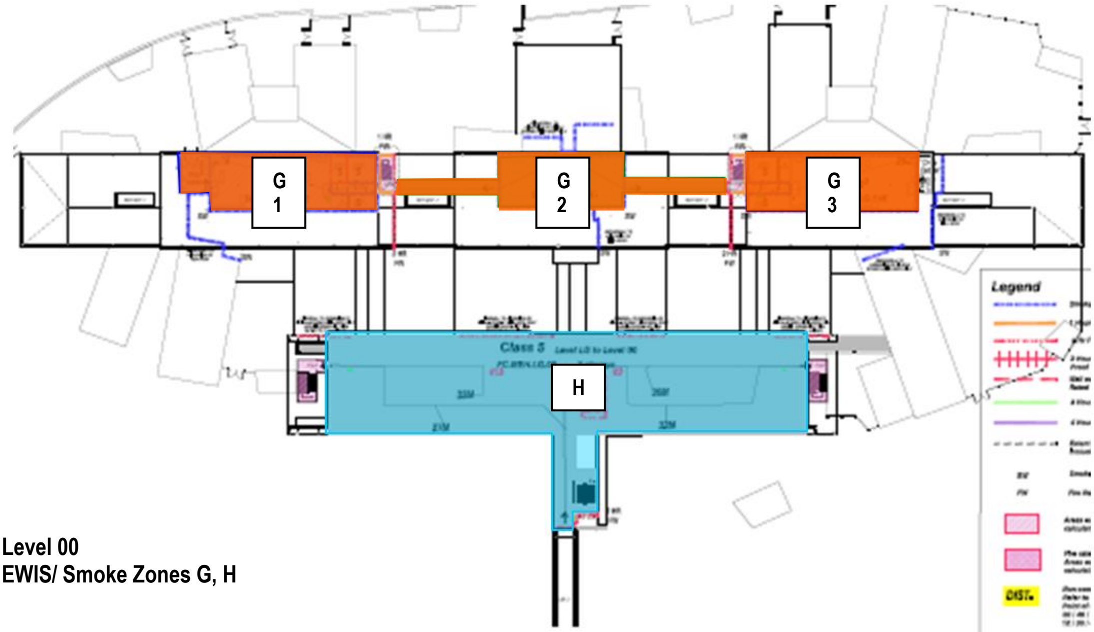
3.4.5 Summary of Evacuation Cascade Sequence

The following matrix in Table Figure 3.2 summarises the evacuation cascade sequence for the MEH, based on the strategies detailed in Section 3.4.1 to Section 3.4.4 .

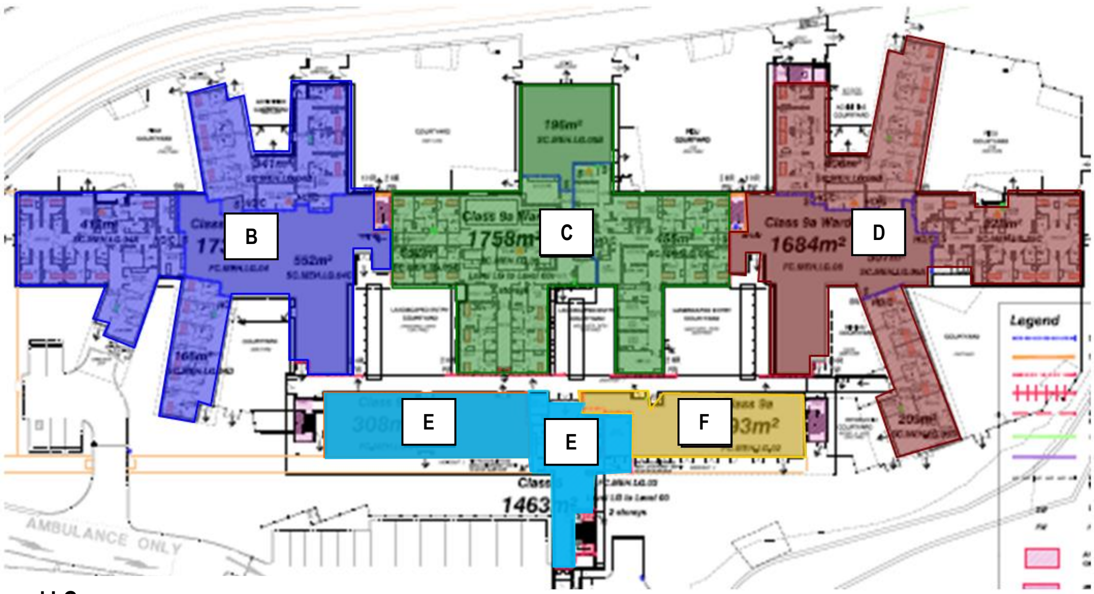
		Evacuation Sequence									
		A	B	C	D	E	F	G1	G2	G3	H
Compartment of Activation	A	FIRE	1	1	1	1	1	1	1	1	1
	B	3	FIRE	1	2	1	2	0	0	0	2
	C	2	1	FIRE	1	1	1	0	0	0	1
	D	3	2	1	FIRE	2	1	0	0	0	2
	E	3	1	1	2	FIRE	1	1	1	1	0
	F	3	2	1	1	1	FIRE	1	1	1	1
	G1	3	0	1	2	1	2	FIRE	0	0	1
	G2	2	1	0	1	1	1	0	FIRE	0	1
	G3	3	2	1	0	1	1	0	0	FIRE	1
	H	3	2	1	2	0	1	1	1	1	FIRE

Figure 3.2 MEH evacuation sequence for EWIS/ Smoke Zones (refer plans below)

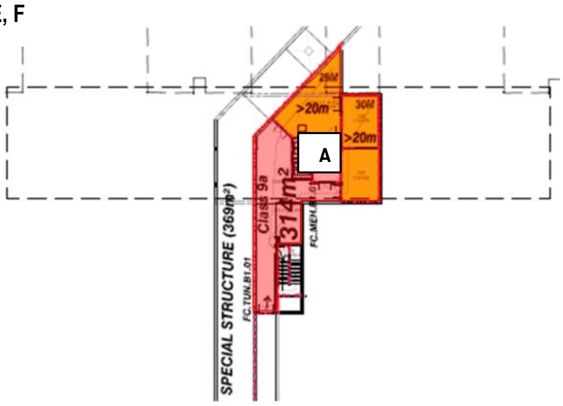
The matrix shows that a maximum of three evacuation steps are required to evacuate the entire building under the automatically cascading staged evacuation process, however it is expected that the fire brigade, in conjunction with hospital management, will take manual control of the evacuation process at an early stage in the incident.



Level 00
EWIS/ Smoke Zones G, H



Level LG
EWIS/ Smoke Zones B, C, D, E, F



Level B1
EWIS/ Smoke Zone A

Figure 3.3 Evacuation zones

As the building is sprinkler protected, it is unlikely that a manually controlled staged evacuation will progress more than two steps (i.e. it is unlikely that occupants would need to be moved more than two fire compartments away from the compartment of origin). In most situations it is expected that occupants would not need to be moved beyond the adjacent fire compartment or compartments.

3.4.6 Assessment of Impact on Evacuation of the 5 Minute Alert Phase

As discussed in Section 3.4.1, provision of an Alert signal preceding the Evacuation signal is permitted under AS 1670.4, providing it is specified in the Building Management Plan and the cascade interval complies with AS 1670.4.

Travel distances and occupancy loads within the MEH building are BCA DTS compliant for the Class 9a Fire Compartments and consequently evacuation time for Class 9a ward areas has not been specifically assessed in the Fire Engineering Report (FER). It is considered that the only compliance issue associated with the Class 9a fire compartments that could potentially be impacted by the 5 minute alert period is the increase in maximum smoke compartment size from 500m^2 to 652m^2, and non-provision of 60 minute fire separation.

The assessment methodology adopted in the FER to address oversized smoke and fire compartmentation is based on the following four (4) points:

- Building is provided with a non-required sprinkler system
- Compartment occupancy loads are significantly less than those permitted under the DTS Provisions
- Travel distances are DTS compliant
- Additional compartment volume acts as smoke reservoir and increases available safe egress time

The impact of the additional smoke reservoir volume generated by the increase in smoke compartment size (up to 750m^2) is assessed quantitatively in Section 7, by comparing the visibility in a BCA DTS compliant smoke compartment to that in an oversized smoke compartment. An additional level of conservatism was added to the assessment by assuming that a fire sprinkler system was also present in the BCA DTS compliant example, whereas in reality, this is a non-required system.

The results of the comparative visibility assessment carried out in Section 7 are summarised in Figure 3.4 below, and show that that increase in smoke reservoir volume improves visibility within the compartment. Therefore, as an Alert Signal is permitted as part of the BCA DTS complaint solution, and the analysis shows that conditions within the oversized smoke compartment will always be better than those in the BCA DTS compliant compartment, the provision of the 5 minute Alert signal preceding the Evacuation signal is not expected to adversely affect the level of safely within the Class 9a fire compartments. This is particularly so given the presence of a non-required fire sprinkler system in the building.

Considering the parameters identified in the International Fire Engineering Guidelines (ABCB, 3rd Edition, 2005), being the size of the compartment, the ceiling height, expected relatively low fire load (i.e. no high piled storage), absence of significant shielding risk and the expectation that the fire will be extinguished by one or a few sprinkler heads, it is likely that the a fire starting in a Class 9a fire compartment would be suppressed by the fire sprinkler system. The graph in Figure 3.4 clearly shows that visibility is maintained for an indefinite period of time under a sprinkler suppressed fire scenario (assuming an acceptance criterion of 10m). Therefore the provision of a non-required fire sprinkler system, in conjunction with the increased smoke reservoir size, further enhances the level of safety provided within the building and supports the provision of the proposed Alert signal.

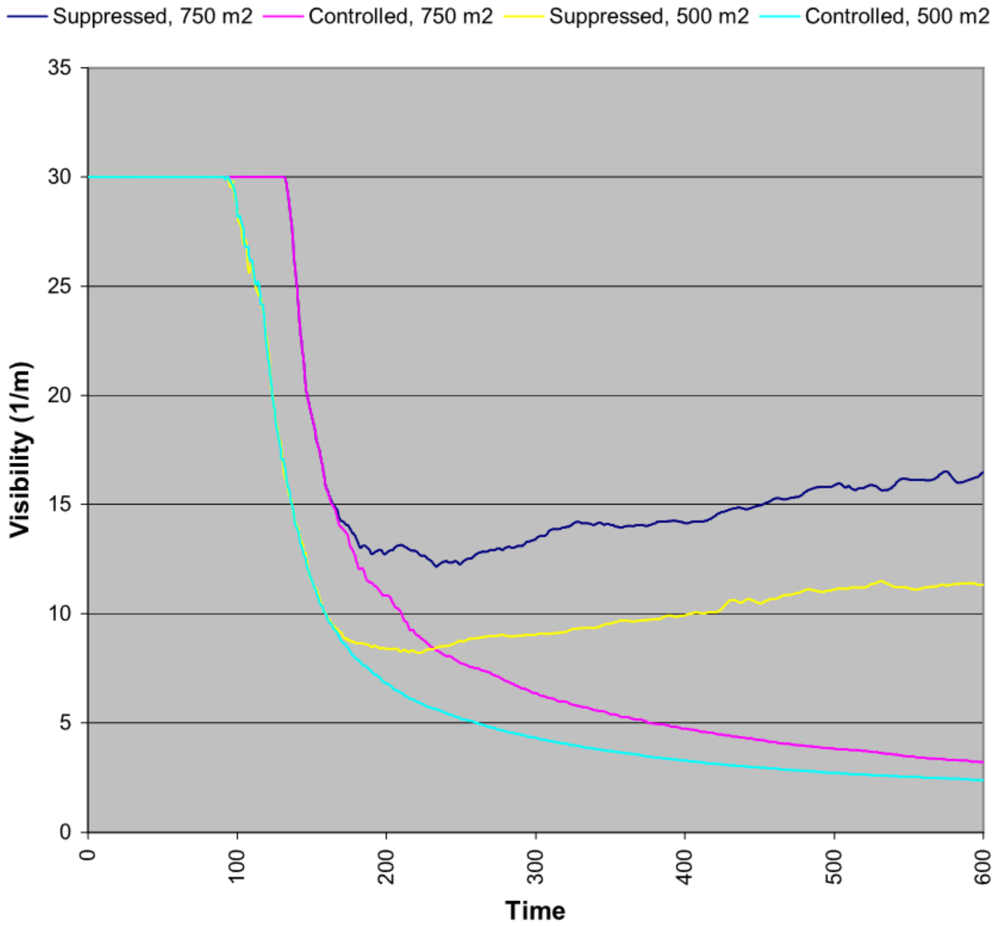


Figure 3.4 Comparison of Visibility Conditions (refer Section 7 for further details)

3.5 Fire alarm audible signal levels

In order to avoid undue distress to vulnerable MEH patients, the audible evacuate and alert signals will have a reduced decibel rating compared to that required under AS 1670.1 as permitted under BCA Specification E2.2a. It is proposed that the minimum acceptable sound level within all patient ensuites to be a minimum 50 dB and in the rest of the MEH, 75 dB.

Visual evacuate and alert signals will be provided in the accessible facilities in the MEH building to assist the disabled in identifying an emergency event, as well as the plant areas where the ambient noise level is such that the audible signal level under AS 1670.1 may not be heard. It is recommended that any visual annunciator panels provided in the MEH building be interfaced with the AAF system and the fire alarm system proper to display a visual fire mode signal.

3.6 Operation of security doors in fire mode

The majority of egress doors in the MEH building will be secured during normal operation, and for security reasons, will not release automatically on fire alarm activation. This is considered a DTS compliant solution under DTS Provision D2.21(a)(iii)(B) which allows exits doors in mental health facilities to remain secured, providing that the door *“can be immediately unlocked by hand by a person or persons specifically nominated by the owner, properly instructed as to the duties and responsibilities* *involved and available at all times when the building is lawfully occupied so that persons in the building or part may immediately escape if there is a fire".*

The staff on duty in the MEH building are considered suitable to carry out this role, and the Queensland Health operational procedures shall require all staff who are on duty in the MEH building to carry keys for all required exit doors and doors on the path of travel to a required exit. As further discussed in Section 8 of this report, this MEH master key will also be required to unlock the doors to fire hydrant, fire hose reel and portable fire extinguisher cupboards.

Queensland Health shall also produce operational procedures detailing staff actions with respect to providing for the immediate escape of the buildings occupants in the event of a fire, and the provision for ongoing training in these procedures, as supporting evidence that the requirements of D2.21 have been met. In developing their operational procedures to address evacuation through secure doors separating the various IPU and PICU ward areas, particular attention will also need to be made for the safe evacuation of occupants of locked Seclusion Rooms, as the Seclusion Room doors will not unlock automatically on fire alarm activation.

In addition to the above discussed security master key, each of the doors to the seclusion rooms, seclusion room ensuites and the external door from the seclusion room leading to the PICU courtyard, as shown in Figure 3.5, Figure 3.6 and Figure 3.7 below is also provided with an override release key system located within the in the PICU Staff Station. The key control for each door is located with one next to the other at the override system to allow the operator in the PICU Staff Station to release these doors when required in an emergency.

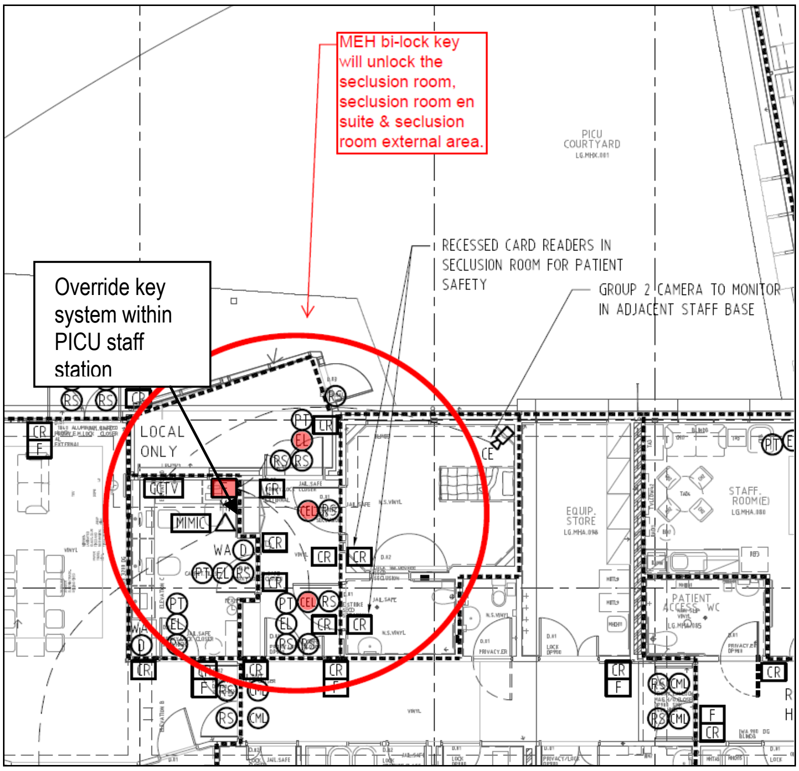


Figure 3.5 Override key system in PICU staff station and associated seclusion room doors (marked in red) on LG, between gridlines MC & MD

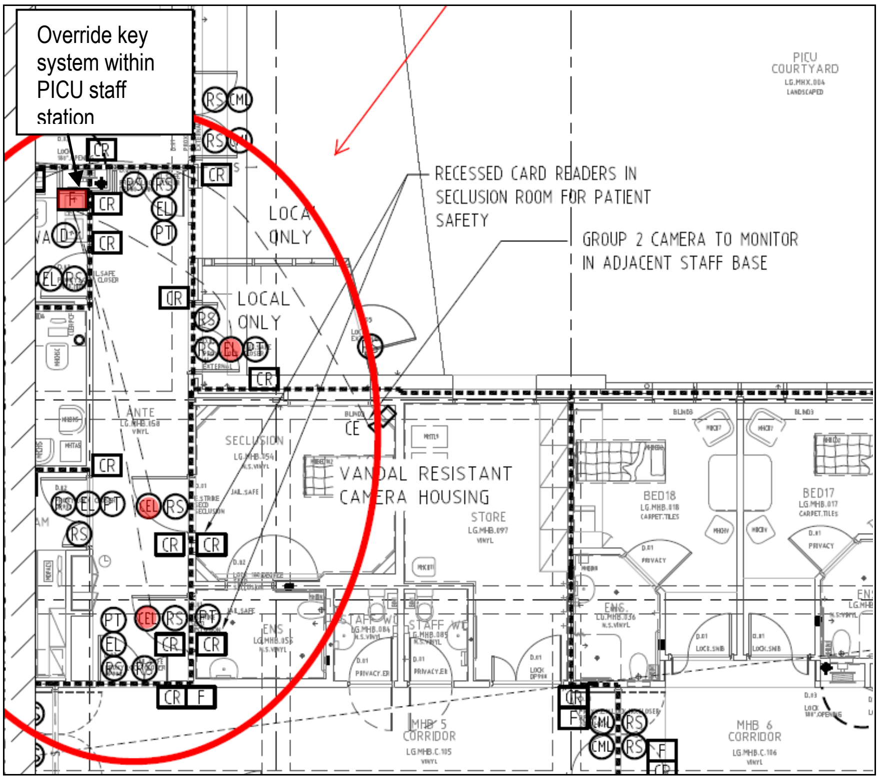


Figure 3.6 Override key system in PICU staff station and associated seclusion room doors (marked in red) on LG, between gridlines MS & MU

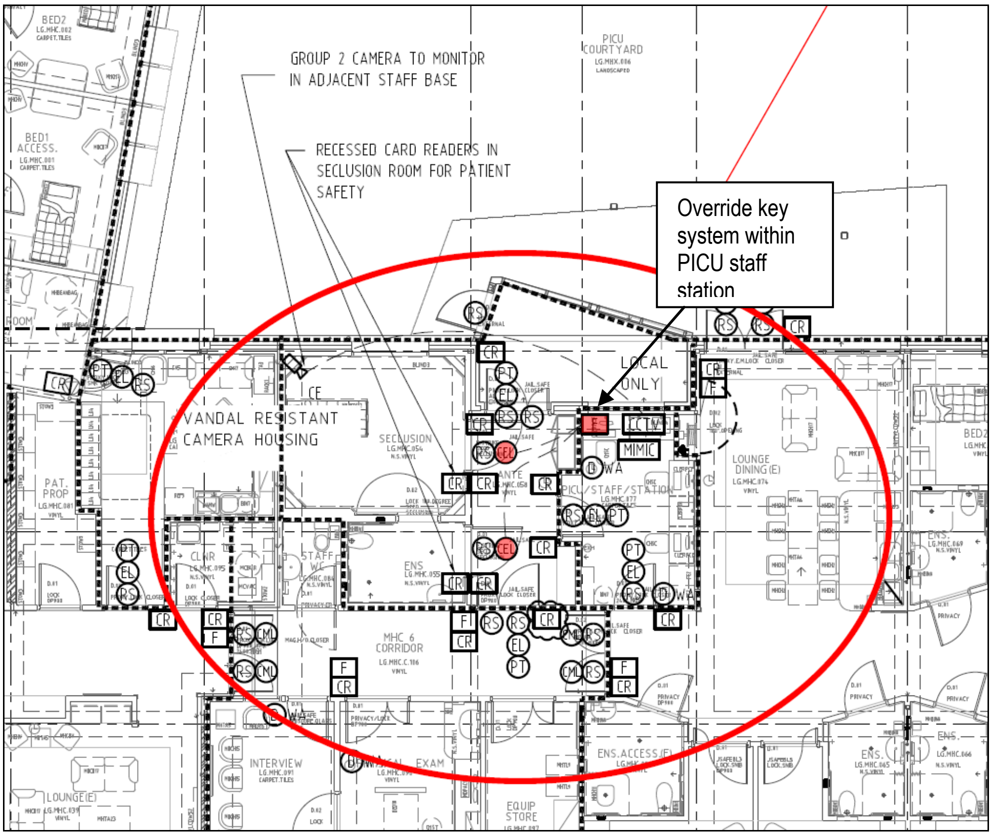


Figure 3.7 Override key system in PICU staff station and associated seclusion room doors (marked in red) on LG, between gridlines MAC & MAE

3.7 Operation of secure courtyard gates in fire mode

The gates to the secure courtyards surrounding the MEH building are locked, however they can be opened with a key that will be carried by all MEH staff. This will allow staff to move occupants further away from the compartment of fire origin, and ultimately to a road or other place of safety if necessary. The requirements for opening secure courtyard gates for evacuation purposes is covered under the DTS Provision D2.21(a)(iii)(B) as described in Section 3.6 above, and Queensland Health will need to produce operational procedures detailing staff actions with respect to providing for the immediate escape of the buildings occupants in the event of a fire, and the provision for ongoing training in these procedures, as supporting evidence that the requirements of D2.21 have been met. It is recommended that the gates be secured with a specific fire safety key supplied by Queensland Health to enable the fire brigade to also unlock the security gate if necessary.

4. Compliance Issue 1: Fire Compartments linked by Covered Paths

The compliance issue and the alternative solution's approach, method of analysis and acceptance criterion were developed during the FEB stage. These are summarised in Table 2.8 Section 2.10 'Acceptance Criteria for Analysis', repeated below and illustrated by the typical detail in Figure 4.1.

Table 4.1 Compliance issue 1

	Compliance issue	DTS clause & perf. requirement	Approach & method of analysis	Acceptance criteria
1	The fire compartment area is greater than prescribed by C2.5, due to the covered paths.	DTS clause C2.5, C3.3	Approach: Quantitative, comparative, deterministic.	Received heat flux ≤ 20 kW/m².
		Perf. requirement CP3 (and to a lesser extent CP2)	Method: Radiative and convection received heat flux calc's.	

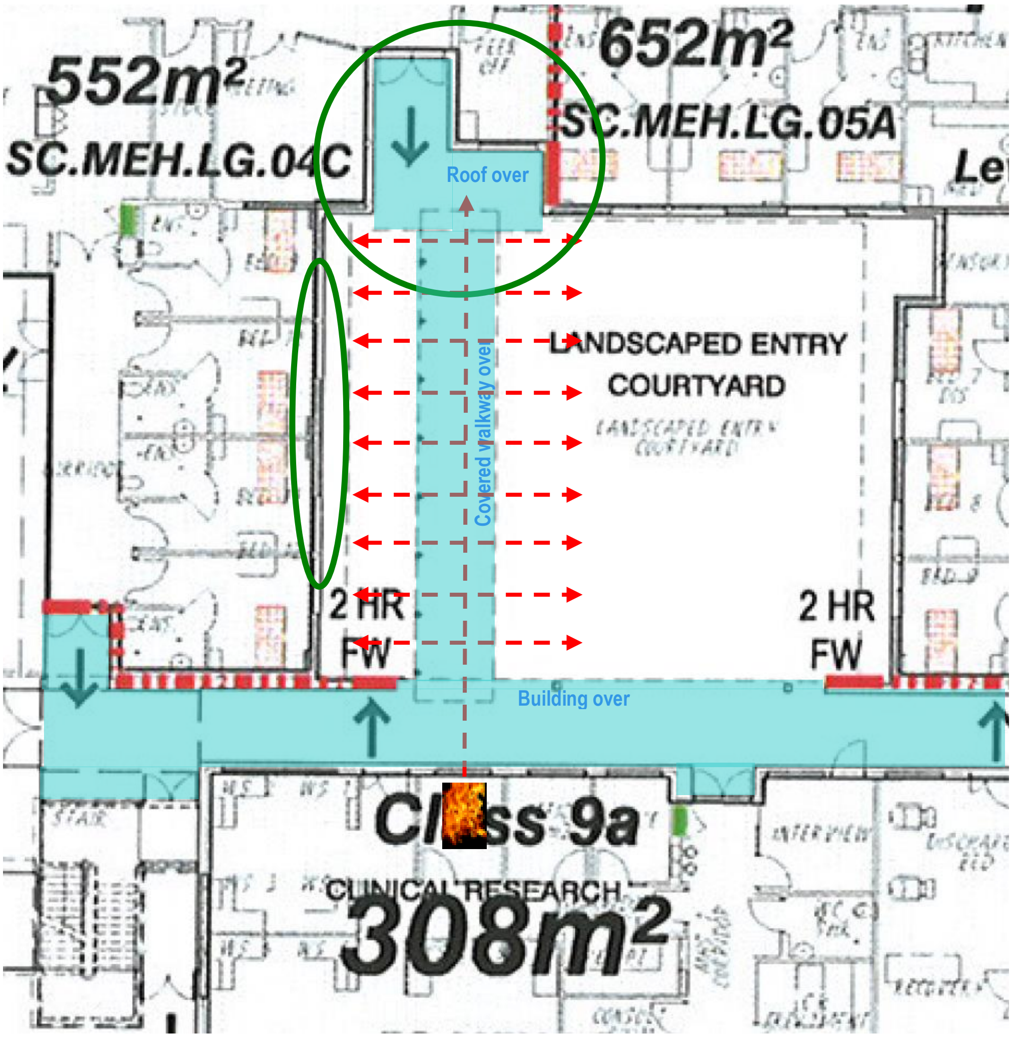


Figure 4.1 Illustration of Compliance Issue 1 (adapted from part drawing PSH-AR-MEH-DWG-26LG100)

The issue is that whilst the MEH building is divided into fire compartments of ≤ 2,000 m^2 for a Class 9a building, parts of the building are linked by covered walkways. Heat and smoke from a fire in one compartment would not directly vent to atmosphere but may travel to an adjacent fire compartment.

The covered areas are shown shaded light blue, and the dashed red lines are the locations of the fire separation. The areas circled are the two area of concern from a design fire scenario located in the Clinical Research office as they are:

(i) linked to another fire compartment, or
(ii) within 3 m of the walkway.

Note that the covered walkways themselves are primarily constructed of non-combustible material. In addition they form the primary circulation space between the different parts of the building and are exposed to the elements. As such there is not expected to be any significant fuel load under the walkways themselves, and the risk of a sizeable fire developing in this area is considered negligible.

It is noted that there are timber feature 'fins' attached to the columns of the walkway structure, as shown in below.

Timber 'fins' attached to the walkway columns

In view of the lack of obvious ignition source in the walkway and the MEH being a highly supervised environment, the risk of the timber fins being ignited is considered unlikely. In addition, a fire from the limited fuel load represented by these timber fins is not expected to be able to overwhelm the sprinkler system in the building.

Therefore the following analysis will concentrate on demonstrating that the walkways do not contribute to the spread of fire between the enclosed portions of the building (which form separate fire compartments). This argument is reinforced by the fact that the covered walkway running East/West that connects the Administration Block to the Ward Block will be provided with sprinkler protection.

Therefore the chance of a significant fire occurring in this area, or the chance of fire spread via this section of walkway, is considered very low.

On the basis that the presence of the covered walkways will be shown to not contribute to fire spread, the extent of fire rated construction provided between the different fire compartments (including wing walls as shown in Figure 4.1 above) is intended to comply with Clause C3.3 of the DTS Provisions when measured between the external walls of adjacent fire compartments. The presence of the intervening covered walkway has been ignored for this purpose (i.e. the separation requirements are measured between the external walls of each fire compartment, not between the external wall and the closest edge of the covered walkway).

4.1 Methods of analysis

The effects of fire and smoke spread are analysed by Computational Fluid Dynamics (CFD).

CFD analyses divide a control volume into a very large number of small three-dimensional cells. Relationships describing the conservation of mass, momentum and energy, in the form of the Navier-Stokes equations are solved numerically, across the faces of each of these cell at small time steps. This provides a powerful predictive tool enabling a more accurate calculation of the changing hazardous environmental conditions. The CFD model used in this analysis is Fire Dynamics Simulator (FDS) (McGrattan, 2007a, 2007b). There are two companion programs to FDS the graphical user interface (GUI) PyroSim (Thunderhead 2007) and the post-processor Smokeview (Forney 2007).

Fire Dynamics Simulator

The CFD computer model used is FDS (McGrattan, 2007a). FDS has been developed by the US National Institute of Standards and Technology (NIST). Version 1 of FDS was publicly released in February 2000, version 2 in December 2001, version 3 in November 2002 and version 4 in July 2004. Version 5, which was released in October 2007, has been used for the FDS calculations in this FER, and was the current version at the time the CFD modelling was carried out.

FDS has become the CFD model of choice among fire engineers, as among other reasons;

- It is specifically written for fire engineering applications
- The modelling approach to turbulence uses Large Eddy Simulation (LES) rather than a Reynolds Averaged Navier-Stokes (RANS) approach, meaning more accurate results (subject to grid resolution), and
- It is public-domain software.

PyroSim

PyroSim (Thunderhead 2008) is an interactive, graphical user interface (or front end) for FDS. The PyroSim interface provides immediate input feedback and ensures the correct format for the FDS input file. In addition, PyroSim offers high-level 2D and 3D geometry creation features, such as diagonal walls, background images for sketching, object grouping, flexible display options, as well as copying and replication of obstructions.

Smokeview

Smokeview (Forney 2007) is as an advanced scientific software tool designed to visualize numerical predictions generated by fire models such as FDS. Smokeview performs this visualization by displaying time dependent tracer particle flow, animated contour slices of computed gas variables and surface data. Smokeview also presents contours and vector plots of static data anywhere within a simulation scene at a fixed time. Smokeview can be used before, during and after model runs. Smokeview is used in a post-processing step to visualize FDS data after a calculation has been completed. Smokeview may also be used during a calculation to monitor a simulation's progress and before a calculation to setup FDS input files more quickly, as users can also use Smokeview to edit or create blockages by specifying the size, location and/or material properties.

Acceptance criteria

FDS and companion programmes are used to create and review a method of calculating the received heat flux (radiative and convective) and temperature on the boundary face, particularly windows, of the circled areas as shown on Figure 4.1.

It is assumed the worst case that the receiving windows will be open to allow for sparks to ignite the furniture within the bedrooms / offices. The Guide to the BCA (ABCB 2008) provides some typical examples of the amount of radiant heat necessary to ignite common materials used in buildings. The Guide provides the following values for timber (i.e. wooden furniture):

> Ignition in the absence of a spark 35 kW/m^2
> Ignition in the presence of a spark 20 kW/m^2

Given that wind could blow a burning ember or spark towards the target building, selecting a value of 20 kW/m^2 is considered appropriate. Temperature profiles are also measured to check that the glazing does not reach a breakage temperature (nominally 300 °C, Babrauskas V., 2005).

4.2 Model inputs

Fire Size

A steady state fire is assumed at or after sprinkler activation. This is a sprinkler controlled fire but not suppressed. The computer program FireWind (Shestopal 2003), developed by Fire Modelling and Computing Pty Ltd, NSW, is used for the initial assessment of sprinkler activation. FireWind contains a sub routine for calculating sprinkler activation time with defined sprinkler properties, fire size, and ceiling height. It is assumed the fire will be controlled by the sprinkler activation (i.e. constant HRR).

It is assumed that given the room is small the sprinkler would be located directly above the fire. An RTI of 150 $m^{1/2} s^{1/2}$ was assigned to the sprinkler, representing a conservative response time index for the assumed quick response sprinkler heads present in the MEH building. The activation temperature was assumed to be 68 ºC. The FireWind inputs for sprinkler actuation time are summarised in the figure below.

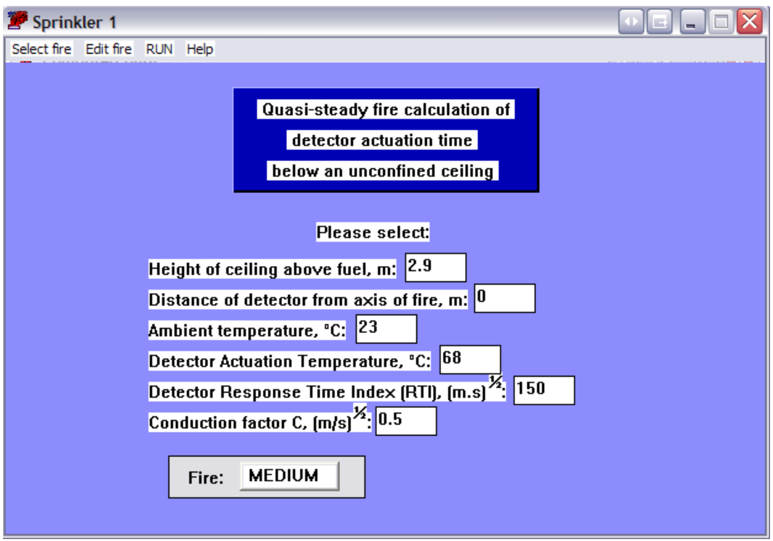


Figure 4.2 FireWind input data for sprinkler activation

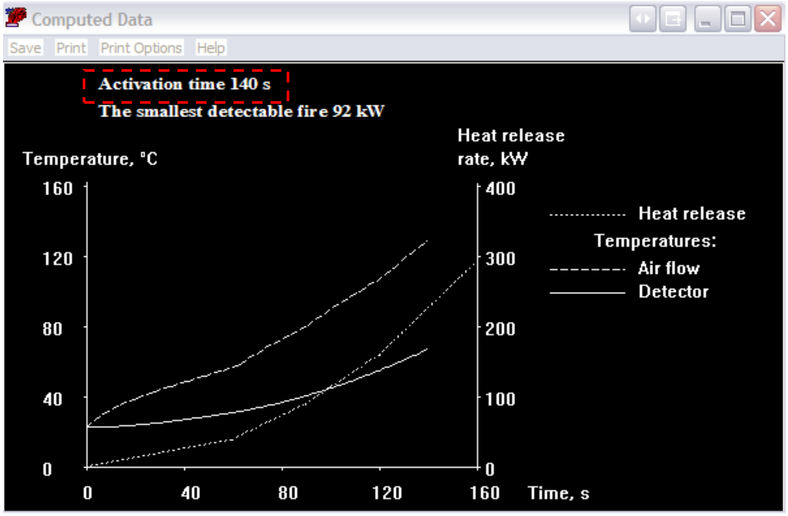


Figure 4.3 FireWind output results for sprinkler activation

Hence, based on a sprinkler activation time of 140 s with a medium growth rate (i.e. α = 0.012 kW/s^2), the sprinkler controlled constant heat release rate (HRR) is assumed to be approximately 235 kW.

However to be conservative, a steady state 2 MW fire is assumed for the analysis.

Reaction Properties

The reaction properties for the office fire are based on the assumption that the fuel load by mass will be 67% cellulose (i.e. wood-based) and 33% synthetic (i.e. plastics based). The parameters are summarised in Table 11.

Table 4.2 Combustion Parameters for Schematic Design Fires

	Polyurethane	Wood	Combined	Units
Fuel				
Molecular weight of fuel	130.300	87.000	**101.289**	g/mol
Number of N2 Molecules	0.500	0.000	**0.165**	
Mass fraction of fuel in burner	1.000	1.000	**1.000**	
Ambient O2 mass fraction	0.230	0.230	**0.230**	
Ideal Hydrocarbon Coefficients				
Fuel Coefficient	1.000	1.000	**1.000**	
O_2 coefficient	7.020	3.700	**4.796**	
H_2O coefficient	3.550	3.100	**3.249**	
CO_2 coefficient	6.300	3.400	**4.357**	
O	2.100	2.500	**2.370**	
H	7.100	6.200	**6.500**	
C	6.300	2.400	**4.360**	
N	1.000	0.000	**0.330**	
ΔH_C	18,808	14,676	**16,039**	kJ/kg
Fire				
Flame height multiplier	1.000	1.000	**1.000**	
Limiting oxygen index	0.150	0.150	**0.150**	
Critical flame temperature	1427.000	1427.000	**1427.000**	^oC
By Products				
CO yield	0.0378	0.0044	**0.0154**	
Radiative loss fraction	0.350	0.350	**0.350**	
Energy release per unit mass O2	13100.000	11020.000	**11706.400**	
Smoke				
Soot yield	0.070	0.0100	**0.0298**	
Mass extinction coefficient	7600.000	7600.000	**7600.000**	m^2/kg
Visibility factor	3.000	3.000	**3.000**	
Maximum visibility	30.000	30.000	**30.000**	m

Computational Domain

A representation of the concerned areas (the fire source, the covered walkway, and the receiving boundary faces) was constructed using the FDS model builder PyroSim. The computational domain measured 25.6 m by 8.0 m wide by 4.0 m high. The domain boundaries were modelled as open except the ground level, which was assumed to be inert. The characteristic cell size was 0.2 m throughout the domain.

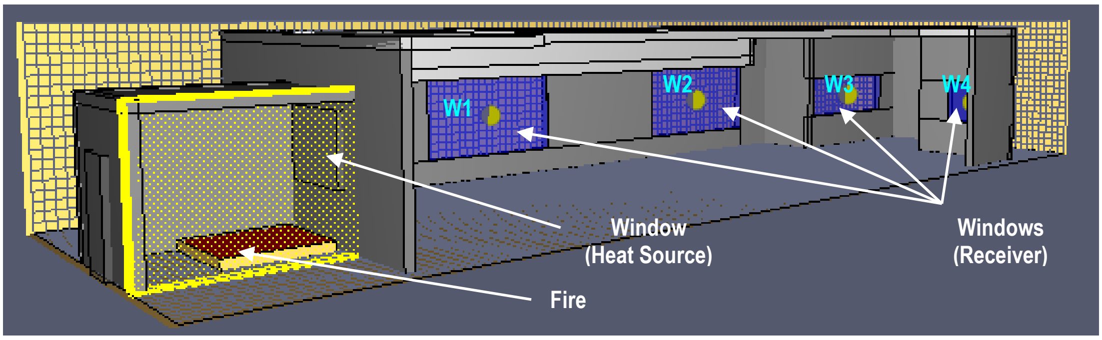


Figure 4.4 PyroSim Representation of the computational domain.

Material Properties

The external masonry walls are assumed to have thermal properties similar to concrete, ceilings are to have gypsum plaster properties representing plasterboard ceilings; and windows are to have the glass properties except the source window is assumed to be a hole (i.e. window broken open from fire).

The detailed inputs for these material properties are shown in the FDS input file included in Appendix B (of Volume 0).

4.3 Results

The radiant and convective heat flux on the windows, the weakest element, are displayed using two-dimensional contours after 30 minutes§ steady-state burning as per Figure 4.5. These are observed to be less than the 20 kW/m^2 criterion for heat flux. Similarly, the temperature contours are shown after 30 minutes on Figure 4.6.

The transient heat flux and temperature at a point source in each of the windows' centres is also measured and reported in Figure 4.7 below.

§ This is a 30 minute 'real' time – chosen to provide representative results yet limit excessive computational time. The required FRL is 120 minutes time equivalent. The two are not the same. The 30 minute duration was chosen as exceeding the lesser of; automatic suppression, brigade intervention or RSET.

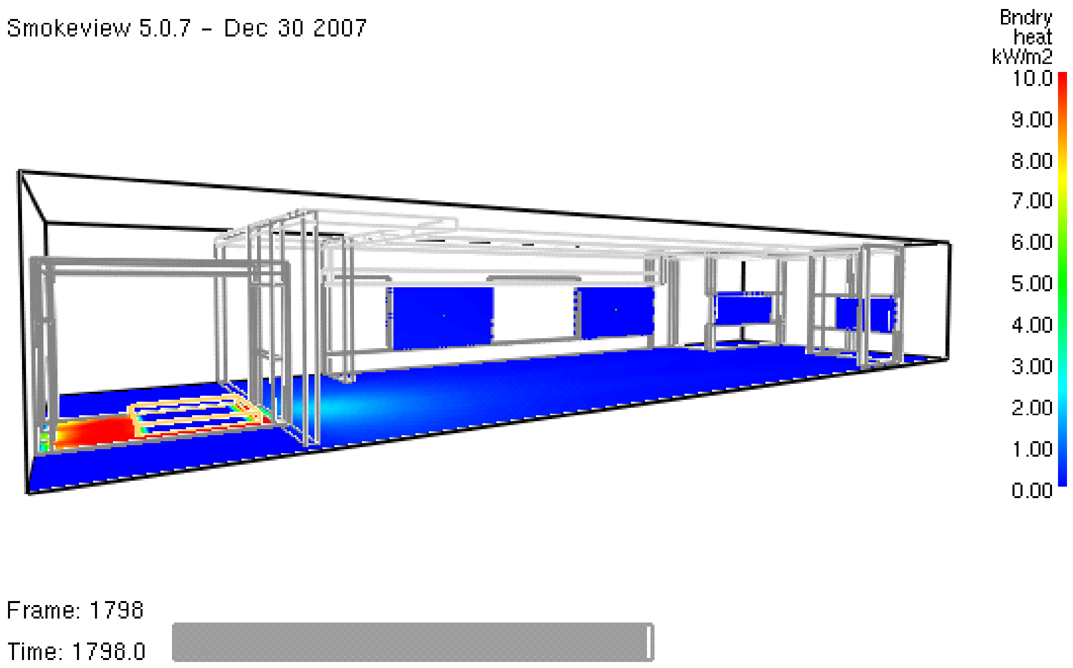


Figure 4.5 Heat flux 2D profiles at 1,800 s

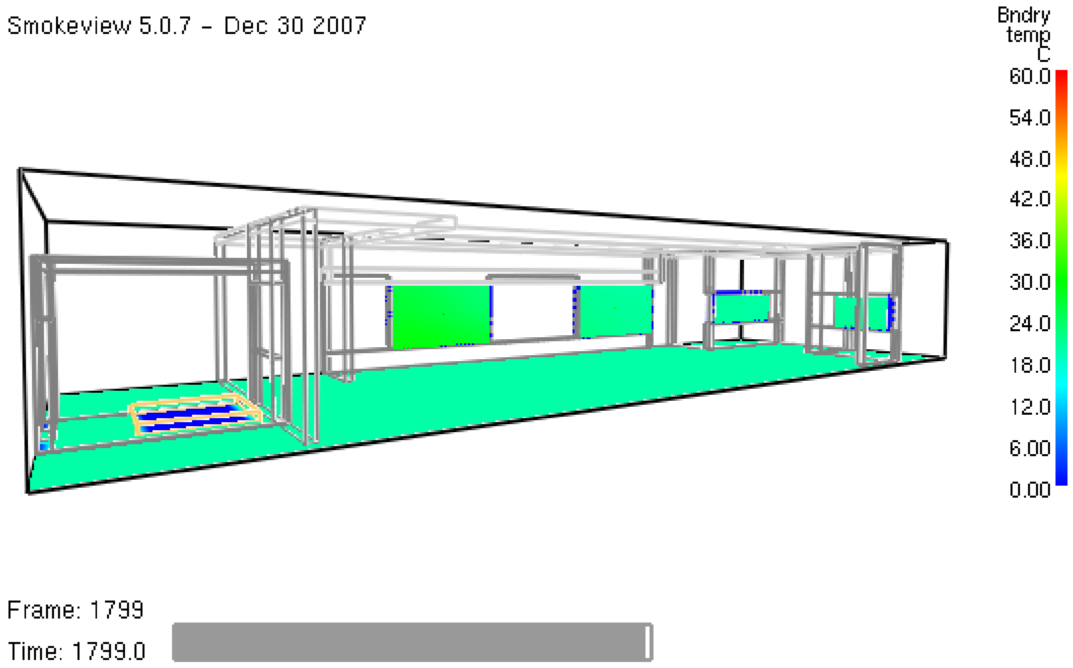


Figure 4.6 Surface temperature 2D profiles at 3,600 s

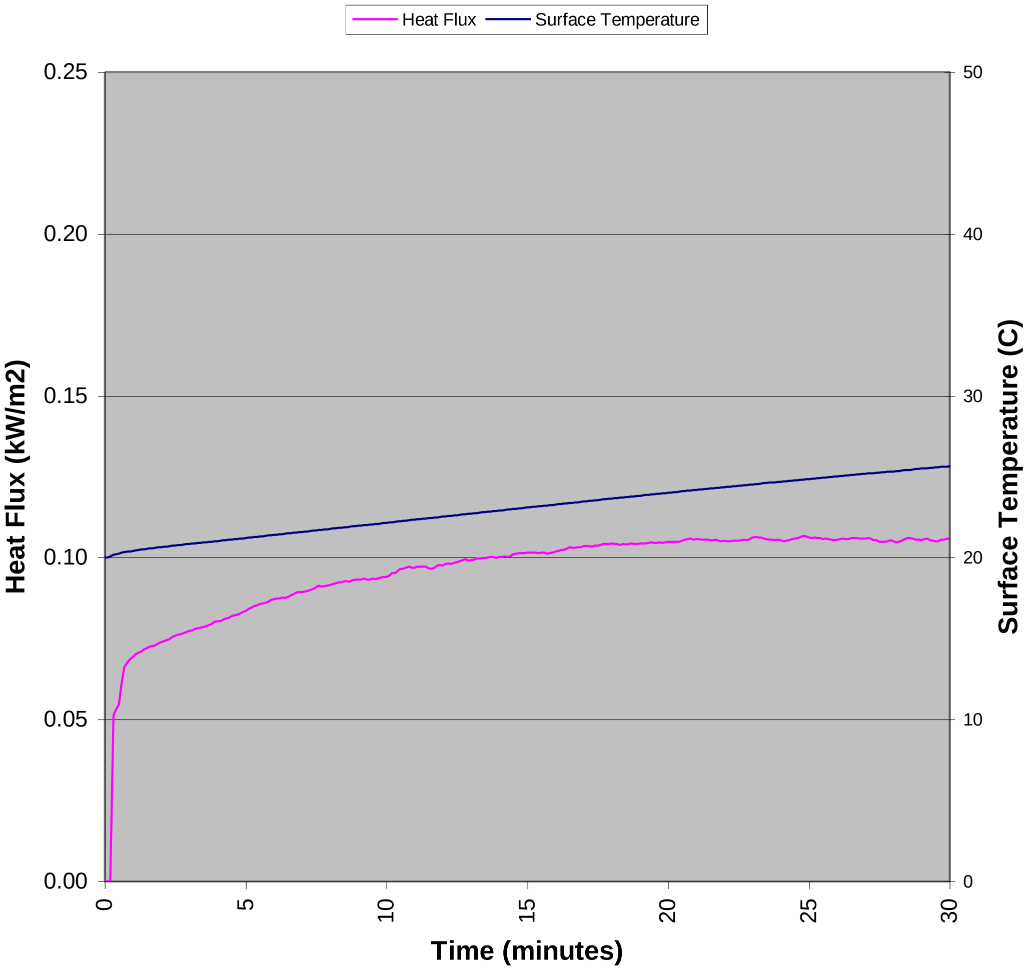


Figure 4.7 Heat flux and surface temperature time history for the 2 MW fire

4.4 Conservatism and redundancy

Conservatism and redundancy in the calculations include:

- The benefit of automatic fire suppression is conservatively ignored (i.e. fire sprinklers) noting that IFEG section 2.7.2.1 permits a sprinkler suppressed fire in the following circumstances (which apply in this case):
  - The enclosure height is low, and
  - The size of enclosure is small, and
  - The fire size is relatively low
- The benefit of manual fire suppression by occupants is conservatively ignored (i.e. fire hose reels and extinguishers)
- The benefit of fire brigade intervention is conservatively ignored
- The fire is assumed to be steady state, i.e. no growth phase
- The fire location is assumed to stay continuously in the worst location for exposure.

4.5 Sensitivity case

Notwithstanding the above conservatism, the calculations were re-run with a steady state 8 MW fire as a 'sensitivity' case assuming sprinkler failure. These 8 MW time-history results shown in Figure 4.8 below.

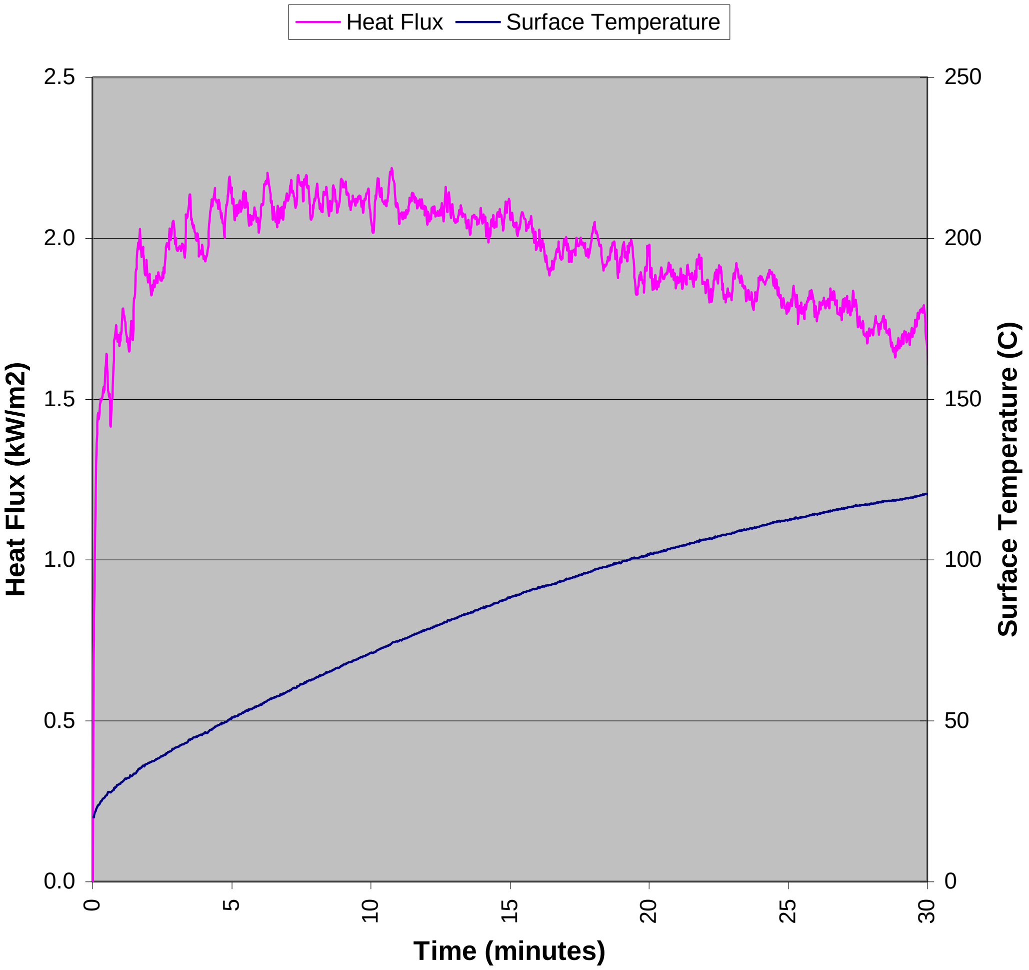


Figure 4.8 Heat flux and surface temperature time history 8 MW fire

The results of the analysis indicate that the presence of the covered paths, linking separate fire compartments do not create a hazard that would allow fire spread. The performance requirement of the BCA is satisfied for the Trial Design.

5. Compliance Issue 2: Unprotected Steel Columns & Beams

The compliance issue and the alternative solution's approach, method of analysis and acceptance criterion were developed during the FEB stage. These are summarised in Table 2.8 Section 2.10 'Acceptance Criteria for Analysis', repeated in part below.

Table 5.1 Compliance issue 2

	Compliance issue	DTS clause & perf. requirement	Approach & method of analysis	Acceptance criteria
2	Non-provision of 30 minutes FRL to floor separating storeys in Class 9a building.	DTS clause C1.1, Spec C1.1 Clause 5.1(e)	Approach: Quantitative, Qualitative, deterministic.	Gas temperature at height of floor slab beams less than limiting temperature of steel elements
		Perf. requirement CP1, CP2	Method: convective received gas temperature calculations for beams; and provide inherent fire resistance with gypsum plasterboard for columns.	

5.1 Introduction

The MEH building is comprised of two sections which are referred to in this report as Ward Block (to the North) and Administration Block (to the South). These blocks are inter-connected by open walkways on the lower ground level and are considered to be a single building under the BCA. The Ward Block contains in-patient care areas such as wards and dining facilities on Level LG, and plant areas on the upper level (L00). The Administration Block has Class 9a treatment areas on Lower Ground and offices on L00. The alternative solution covered by this section of the FER is only applicable to the structural elements supporting the Ward Block plant floor slabs on L00 as detailed in the figure below. The construction of the Administration Block to the South is considered to be wholly DTS compliant, and is required to achieve the fire resistance levels called up by the relevant DTS Provisions.

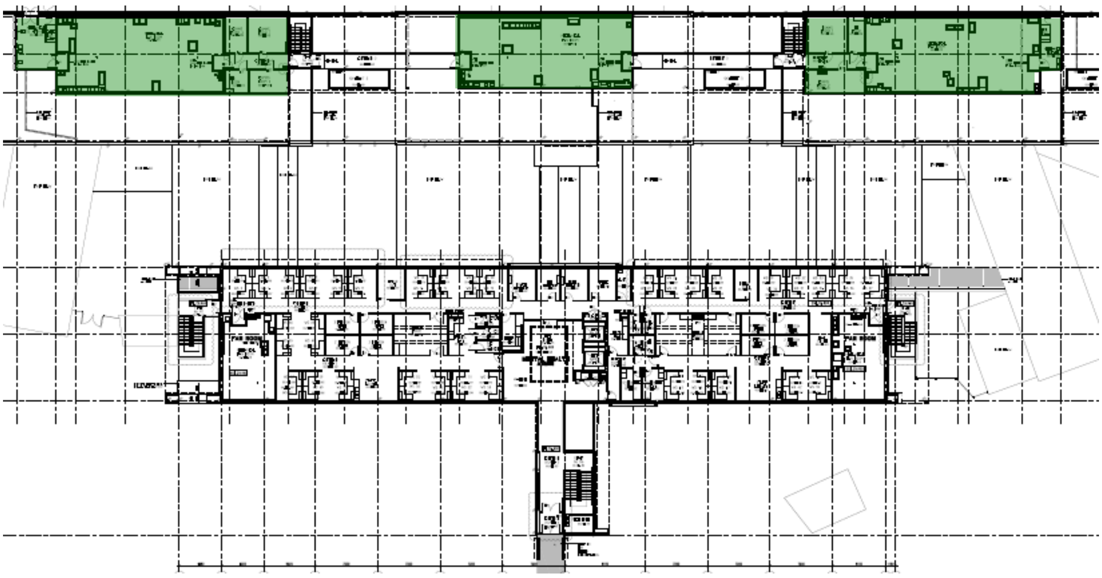


Figure 5.1 MEH L00 floor plan showing extent of floor slab covered in this alternative solution

In a Class 9a building, the DTS Provisions require fire protection to the floor separating storeys. In the case of the Ward Block L00 plant floor, it is not proposed to provide DTS compliant passive fire protection, on the basis that enhanced active fire protection is provided by the non-required sprinkler system. The relevant DTS clause is as follows:

Spec C1.1 Fire Resistance of Building Elements

(i) in a Class 2 or 3 building, except where within the one sole-occupancy unit, or a Class 9a health-care building or a Class 9b building, a floor separating storeys or above a space for the accommodation of motor vehicles or used for storage or any ancillary purpose, must —

(i) be constructed so that it is at least of the standard achieved by a floor/ceiling system incorporating a ceiling which has a resistance to the incipient spread of fire to the space above itself of not less than 60 minutes; or

(ii) have an FRL of at least 30/30/30; or

(iii) have a fire-protective covering on the underside of the floor, including beams incorporated in it, if the floor is combustible or of metal.

The Guide to the BCA states that the intent of the above clause is to focus on the highest degree of risk to such people who are very young, disabled, elderly, and asleep. It is considered that given the upper level of the Ward Block contains plant areas and will be occupied by maintenance staff only, the degree of risk presented by fire spread to the L00 plant area through the floor from the level below will be extremely low. Provision of a non-required sprinkler system is qualitatively considered to provide a level of safety at least as good as that provided by DTS compliant fire protection to the L00 plant room floor slabs for the following reasons:

- Under the criteria specified in Section 2.7.2.1 of the IFEG (ABCB 2005), a fire occurring in Level LG of the Ward Block would be considered sprinkler suppressed rather than sprinkler controlled because:
  - the enclosure height is low
  - the size of enclosure is small
  - the fire size is relatively low
  - significant shielding of the fire is not expected
  - the fire is likely to be extinguished with one or a few sprinkler heads;

  Consequently the fire would not reach a size or duration that could present a risk to the structural elements.
- Steel structures have been shown historically to fail under post flashover conditions (i.e. when exposed to sustained elevated temperatures). With the provision of a non-required sprinkler system in the building, the risk of a fire flashing over is considered very low.
- No patients will occupy L00 in the Ward Block and the structural members supporting each plant room floor slab are fire separated from the structural members supporting the other L00 floor slabs. In the very unlikely event that a fire on Level LG of the Ward Block did reach a size where the plant room floor slab was threatened, conditions within the LG fire compartment below would have become untenable and all occupants would need to have been evacuated before this point. Therefore any failure of the floor slab subsequent to this point would not impact on patients below as the fire compartment would have been evacuated.

To provide additional support for the alternative solution, a quantitative analysis has been carried out to assess the performance of the floor system under sprinkler controlled fire scenarios. Note that the above discussion has shown that in the Ward Block a sprinkler suppressed fire is expected, and therefore sprinkler controlled conditions are considered conservative.

5.2 Analysis

FireWind (Shestopal 2003) is also used in this analysis to predict sprinkler activation. It is assumed the fire will be controlled by the sprinkler activation (i.e. constant HRR).

The figure below shows the cross-section towards the West end of the Ward Block. The L00 plant room floors are constructed as concrete slabs supported by steel beams which in turn are supported by steel columns. The intent of this alternative solution is to demonstrate that the beams supporting the plant room floor slabs can be unprotected steel, and that encasing the steel columns supporting the plant room floor slabs in 13 mm Powerscape board will provide them with sufficient protection in the event of a sprinkler controlled fire that occurs in close proximity to a column.

The figure below shows that the typical ceiling height in Level LG of the Ward Block is 2.7 m. The ceiling is of 13 mm gypsum plaster board penetrated by fixtures such as lightings, aircon registers, etc. The steel columns supporting the floor will be encased within walls of 13 mm Powerscape board, which is expected to have equivalent fire performance characteristics to other gypsum plasterboard of the same dimensions.

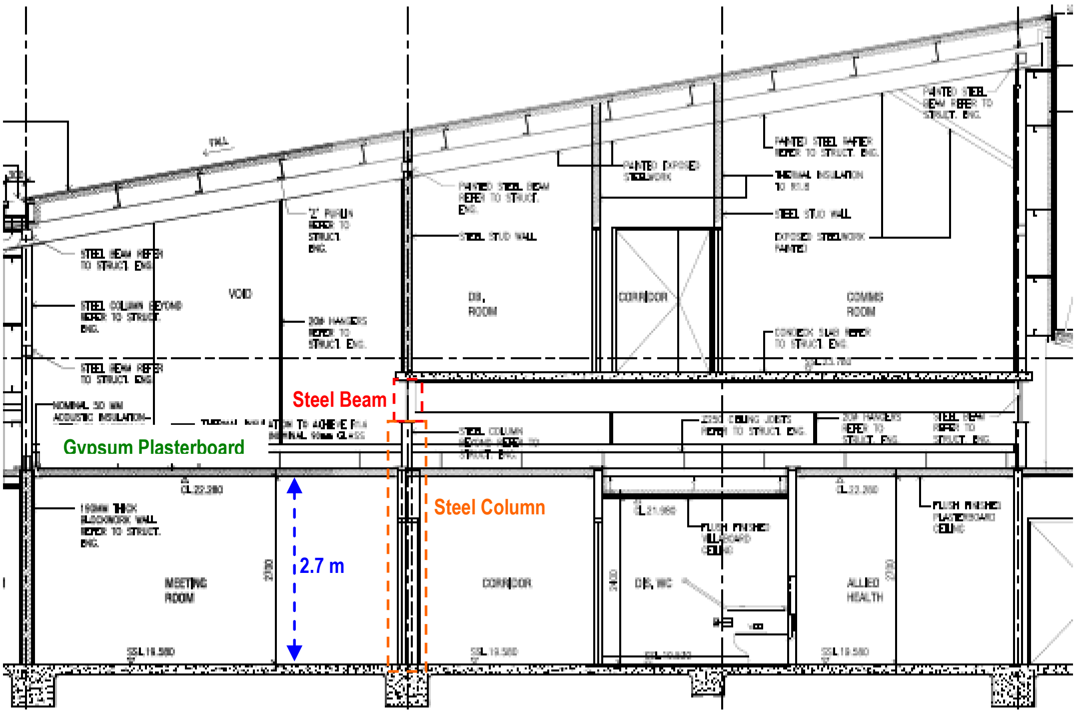


Figure 5.2 Cross-section of MEH building towards the West end of the North block

Eurocode 1 (2002) suggests a 'medium' fire growth rate for hospital and office type occupancies.

Max Rate of heat release *RHR*f			
Occupancy	Fire growth rate	t_α [s]	RHR_f [kW/m^2]
Dwelling	Medium	300	250
Hospital (room)	Medium	300	250
Hotel (room)	Medium	300	250
Library	Fast	150	500
Office	Medium	300	250
Classroom of a school	Medium	300	250
Shopping centre	Fast	150	250
Theatre (cinema)	Fast	150	500
Transport (public space)	Slow	600	250

Figure 5.3 Fire growth rate and RHR$_f$ for different occupancies (Eurocode 1, 2002)

It is assumed that the sprinklers were located on the ceiling above the fire, conservatively located at 3.25 m diagonally away as the furthest distance permitted for Light Hazard (i.e. 4.6 m spacing). An RTI of 150 m^{½} s^{½} was assigned to the sprinklers, representing a conservative response time index for the assumed quick response sprinkler heads present in the MEH building. The activation temperature was assumed to be 68 ºC. The FireWind inputs for sprinkler actuation time are summarised in the figure below.

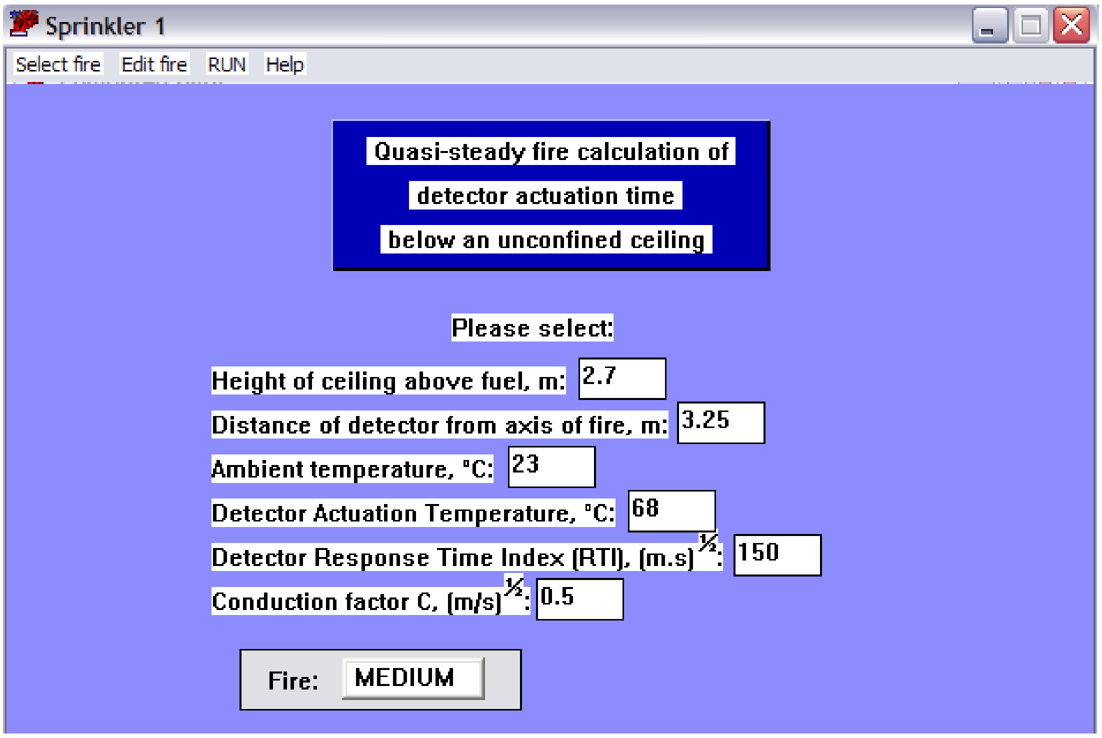


Figure 5.4 FireWind input data for sprinkler activation

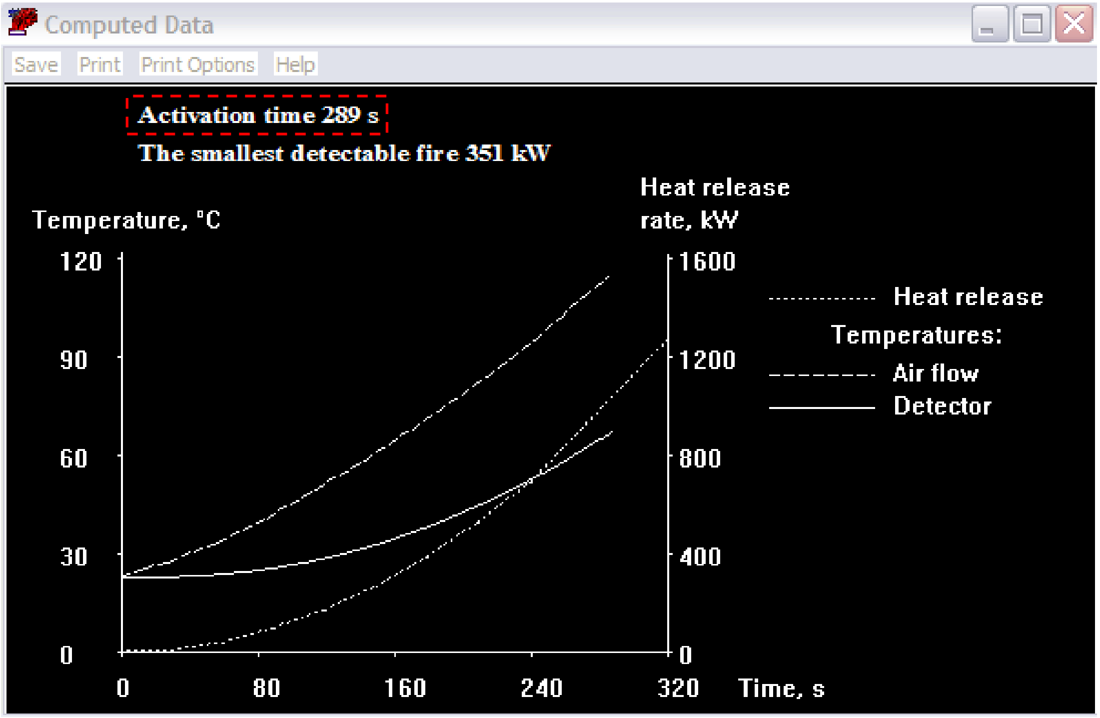


Figure 5.5 FireWind output results for sprinkler activation

Hence, based on a sprinkler activation time of 289 s with a medium growth rate (i.e. α = 0.012 kW/s^2), the sprinkler controlled constant heat release rate (HRR) is assumed to be approximately 1000 kW.

FireWind contains another sub routine to calculate the gas temperature at centreline of the plume given the fire size, flame temperature, and ceiling height. The assumptions and inputs for the plume calculations are summarised in the figure below.

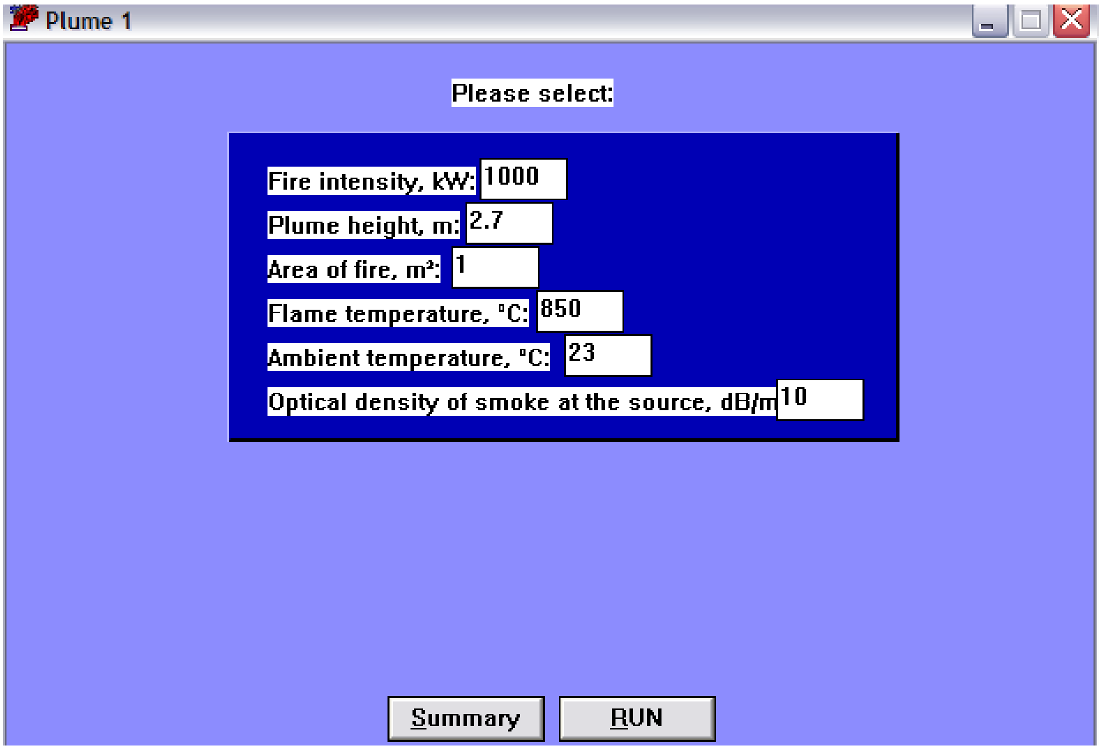


Figure 5.6 FireWind input data for plume centreline temperature

Computed Data

Save Print Print Options Help

Height	Average radius	Average temperature	Maximum temperature	Max. axial velocity	Flow
m	m	oC	oC	m/s	kg/s
1.12	0.56	347.7	849.5	4.61	2.59
1.22	0.57	329.5	796.0	4.61	2.73
1.33	0.58	312.2	745.4	4.60	2.89
1.44	0.59	296.3	699.6	4.58	3.05
1.54	0.60	281.5	657.7	4.56	3.21
1.65	0.61	267.7	618.9	4.53	3.39
1.75	0.62	254.4	581.9	4.50	3.58
1.86	0.63	242.2	548.4	4.47	3.77
1.97	0.64	230.4	516.4	4.43	3.99
2.07	0.66	219.6	487.5	4.39	4.20
2.17	0.67	209.5	460.6	4.35	4.43
2.28	0.68	199.9	435.5	4.31	4.66
2.38	0.70	190.9	412.0	4.26	4.91
2.49	0.71	182.5	390.2	4.22	5.17
2.60	0.73	174.6	370.0	4.18	5.44
2.70	0.75	167.2	351.3	4.14	5.71

Figure 5.7 FireWind output results for plume centreline temperature

5.3 Results

BS5950 Part 8 (2003) provides the following table for the limiting temperature of steel members in tension. It is considered conservative to use the lowest value of 460 °C to be the critical limiting temperature for this analysis.

Table 5.2 Limiting temperature of steel members in tension

Description of member	Limiting temperature (°C) at a load ratio of						
	0.7	**0.6**	**0.5**	**0.4**	**0.3**	**0.2**	**0.1**
Members in tension: all cases	**460**	510	545	590	635	690	770

Figure 5.7 indicates that at ceiling height the centreline temperature of the plume is approximately 351 °C maximum for a sprinkler controlled fire of 1 MW. This temperature is much less than the limiting temperature of the steel beams supporting the slab (i.e. 460 °C).

In addition, the unprotected steel beams will be above a layer of 13 mm Gypsum Plasterboard, which while not achieving an FRL, and containing some penetrations for fittings, is nonetheless expected to provide significant shielding from a sprinkler controlled fire below. Standard 13 mm plasterboard is expected to remain largely intact when exposed to temperatures of up to 400 °C, based on the following extract from the HERA FaST Users' Manual (HERA 2004)[†]:

"Expert advice[†] from Winstone Wallboards for their Gib® Board range of products are that the inside surface limiting temperatures for their products are:

† Hans Gerlich, Fire Engineer with Winstone Wallboards LTD, advice to Charles Clifton, HERA Senior Structural Engineer, Wellington, May 2004-08-13

- *400°C for Standard Gib ® Board*
- *600°C for Fyreline or Ultraline Gib ® Board*

Those temperatures are based on a large amount of testing and analysis and apply to the products installed in accordance with the appropriate fixing specification."

Note also that ablation (erosion due to heating) of gypsum plasterboard has not been considered as it occurs at high temperatures (> 800°C) (Gerlich 1995).

Due to the similar manufacturing processes shared by all plasterboards, the fire performance of Standard Gib ® Board is expected to be similar to 13 mm Powerscape board. Therefore with a maximum plume temperature of around 350 °C, the ceiling is expected to provide a reasonable degree of protection to the underside of the floor above.

Work by England et al (2000) indicates that upon successful performance of the sprinkler system, temperatures within the area of operation are generally below 200 °C except in the immediate vicinity of the flames. Therefore it is reasonable to expect that any steel columns within the area of sprinkler operation will not reach their limiting temperature of 460 °C. To provide protection against direct flame impingement, the steel columns will be encased in 13 mm Powerscape board; the column Powerscape encasement must extend at least to the junction with the top of the ceiling lining.

As the section of the columns above the ceiling is protected from exposure to a fire below by the 13mm gypsum plasterboard, with equivalent fire performance characteristics as the Powerscape board encasement, it is not required to have additional encasement. The extent of the proposed fire protection for the columns is illustrated in below:

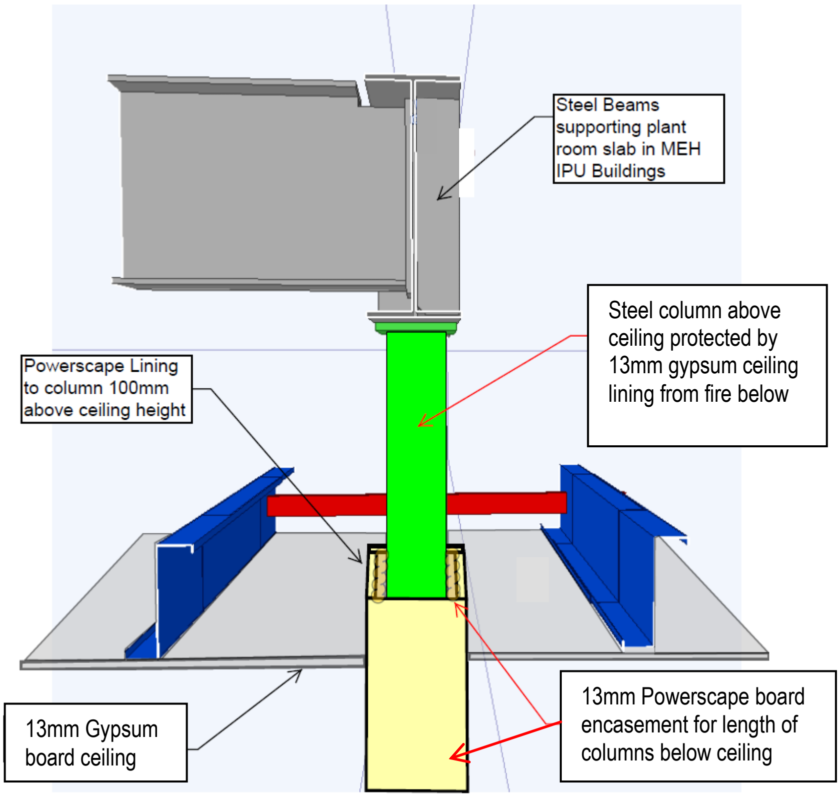


Figure 5.8 Proposed fire protection for steel columns

Note that this analysis is considered conservative because no account is taken of the significant cooling affect of sprinkler discharge on both the plume gas temperatures as it might affect the beams and the walls that are being wetted by sprinkler discharge spray.

5.4 Conclusion

Based on the above analysis, with provision of a non-required sprinkler system and encasement of the steel columns in 13 mm Powerscape board to the junction with the top of the ceiling lining, the design is considered to comply with the Performance Requirements CP1 and CP2.

6. Compliance Issue 3: Exit Travel Distances

Table 6.1 Compliance issue 3

Compliance issue		DTS clause & perf. requirement	Approach & method of analysis	Acceptance criteria
3	The distance of travel exceeds the required 20m travel distance in the lower level plant area.	DTS clause D1.4	Approach: Quantitative, comparative, deterministic	$\Delta t_{detection} \geq \Delta t_{travel}$
		Perf. requirement DP4	Method: Compare difference in detection time($\Delta t_{detection}$) with difference in travel time (Δt_{travel})	

6.1 Introduction

A single extended travel distance non-compliance has been identified for the MEH building, being the travel distance from the Level B1 plant rooms to the fire separated stair and/or tunnel. The distance of 31 m exceeds the DTS limit of 20 m to a point of choice.

According to the Guide to the BCA (ABCB 2008), the 20 m point of choice limitation is provided in case a fire blocks the path of travel. By allowing a certain distance where an alternative route is not possible, a degree of risk is inherent in the DTS compliant solution. This concept is reinforced by the Guide to the BCA which also states that the travel distances in the DTS Provisions are based on an assumption of what is considered “reasonable” distances to be travelled by occupants in reaching an exit.

Under the DTS Provisions, 20 m is considered a “reasonable” distance to travel to a point of choice, and by extension, the risk of a fire developing to the extent that it blocks the path of travel, in the time it takes to travel that distance, is considered acceptable.

Increasing the required travel distance to a point of choice can be considered to increase the risk compared to the DTS solution. However in the case of the MEH building, a non-required sprinkler system has been provided. According to Clause 4(d)(i)(B) of Specification E2.2a of BCA:

“in areas other than patient care areas and paths of travel to exits from patient care areas, rate of rise heat detectors may be installed in lieu of smoke detectors, except that the heat detectors need not be installed if the area is sprinklered.”

Therefore under the DTS Provisions, smoke detection does not need to be provided to the Level B1 plant rooms if sprinklers are installed. However in the trial design, smoke detection in the plant areas will be retained. Smoke detection will provide increased detection time compared to the detection time provided by the DTS compliant sprinkler system. This increase in detection time can be used to offset the increased travel time created by the extended travel distance, resulting in an overall RSET that is less than or equal to that provided under a DTS compliant solution.

6.2 Methodology

The following analysis compares the difference in detection time($\Delta t_{detection}$) for an AS 1670 compliant smoke detection system versus an AS2118 compliant sprinkler system, with the difference in travel time (Δt_{travel}) between the 31 m extended travel distance and the DTS complaint 20 m maxima. As this is a comparative analysis, the other elements that comprise RSET (e.g. factor of safety, response time and delay time) are considered the same for both scenarios and therefore do not have to be factored into the analysis.

The alternative solution is considered to be acceptable if $\Delta t_{detection} \geq \Delta t_{travel}$.

6.3 Analysis

6.3.1 Difference in travel time (Δt_{travel})

Travel time to an exit is calculated by the movement speed (m/s) multiplied by the distance (m). PD 7974:6-2004 (BS 2005a) cites various references that suggest individual travel speeds ranging from 0.8 ms^{-1} (for females) to 1.7 ms^{-1} (for males). PD 7974:6-2004 states that unimpeded walking speeds are typically quoted as being around 1.2 ms^{-1}. This is consistent with Nelson and Mowrer (SFPE Handbook, 3rd Ed. Ch 3-14), who provide a maximum unimpeded exit flow speed of 1.19 ms^{-1} for corridors, aisles, ramps and doorways.

This area will be occupied almost exclusively by maintenance personnel, who are expected to have a good level of mobility due to the nature of their activities. Nevertheless, to incorporate an element of conservatism, an unimpeded walking speed of 1.0 ms^{-1} will be used for the time required to walk the extended distance of travel (Δt_{travel}). The maximum travel distance to the single exit in the Level B1 plant area is 31 m (i.e. an increase of 11 m compared to that permitted by the DTS Provisions).

At a travel speed of 1.0 m/s, the travel time required to cover the 31 m is 31 seconds i.e. the difference in travel times between a DTS compliant solution and the worst case extended travel distance is 11 seconds. In other words:

$$\Delta t_{travel} = 11 \text{ seconds}$$

6.3.2 Difference in detection time ($\Delta t_{detection}$)

Smoke detector activation time

A generic floor space has been modelled in FDS using a 0.2 m square grid, with smoke detectors spaced in accordance with AS 1670 (i.e. 10.2 m apart). The ceiling height for the Level B1 plant area is assumed to be 2.4 m. A fast growing t^2 fire has been located in the centre of the space at the maximum permissible radial distance from the detectors, 0.4 m above floor level. A polyurethane combustion reaction has been specified and photoelectric detectors with an obscuration threshold of 3.28%/m have been used in the analysis.

Figure 6.1 shows a Smokeview image of the analysis setup. Figure 6.2 shows the FDS output of the two smoke detectors in graphical format. The time at which each smoke detector reaches the obscuration threshold is plotted on the graph, and from this, $t_{detection}$ for smoke detection is found.

In this case $t_{detection}$ = 34 seconds.

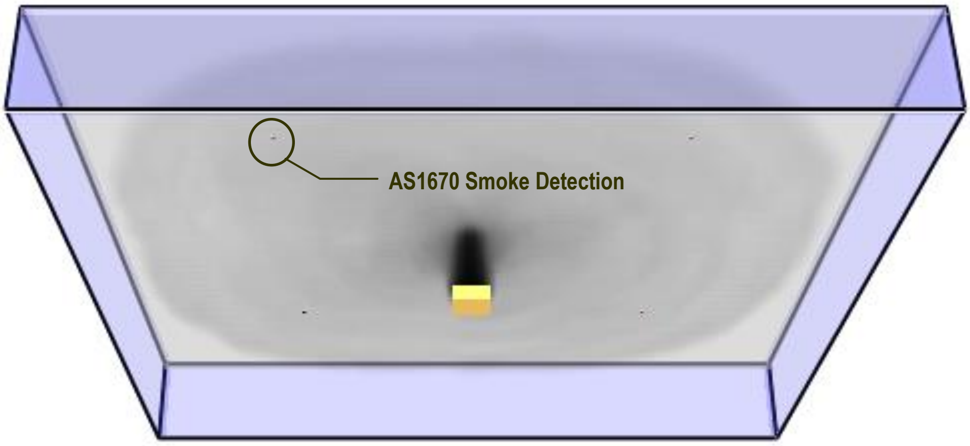


Figure 6.1 Smokeview visualisation of comparative detector activation time analysis

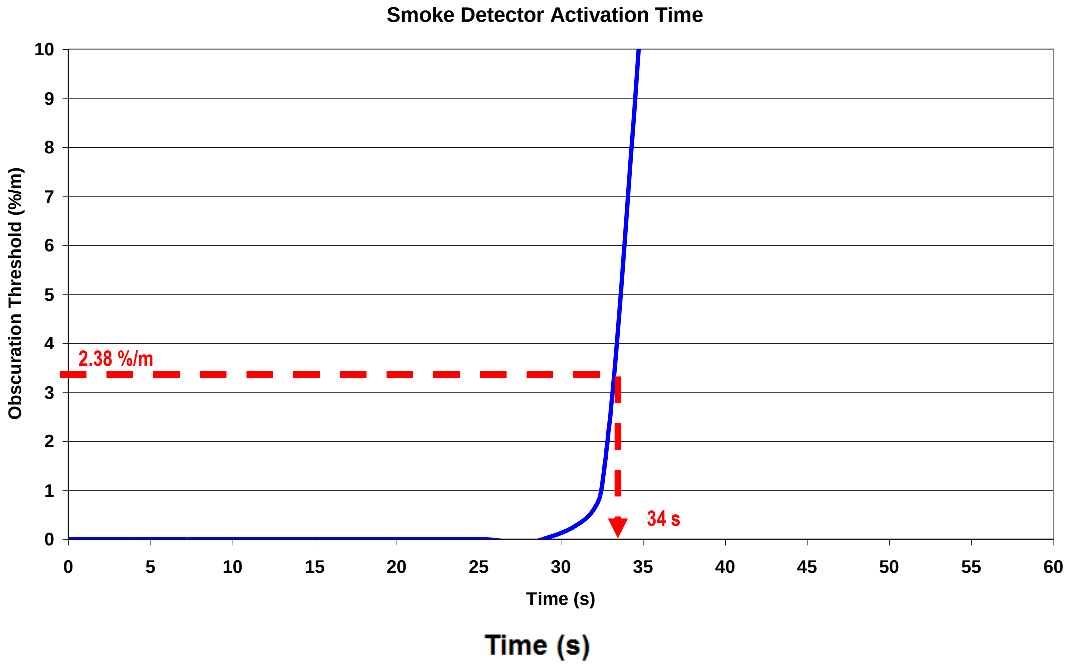


Figure 6.2 FDS output data showing activation time for AS 1670 smoke detector spacing

Sprinkler activation time

The subroutine 'Sprinkler' in the computer programme 'FireWind' (Shestopal 2003) has been used to calculate the sprinkler activation time. The same geometry and fire parameters as used to calculate the smoke detector activation time have been used in this calculation. The sprinkler is assumed to have an activation temperature of 68 °C, with an RTI of 50 $m^{½}s^{½}$ and a conduction factor (C) of 0 $m^{½}/s^{½}$ to minimise the difference in response compared to the smoke detector. A radial distance of 2.5 m for ordinary hazard has been conservatively assumed.

The input for the FireWind analysis is shown in Figure 6.3 while the results are plotted in Figure 6.4. The results show that the sprinkler head activated at 102 seconds. In other words $t_{detection}$ = 102 seconds.

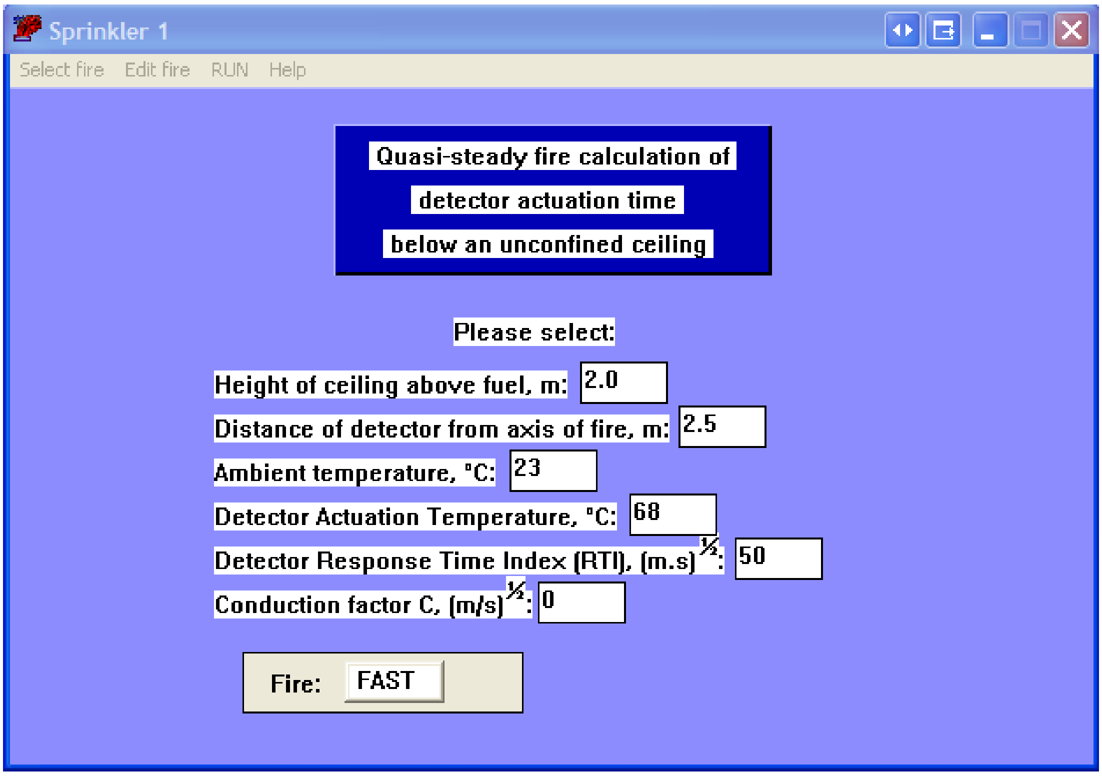


Figure 6.3 FireWind input parameters for sprinkler head activation calculation

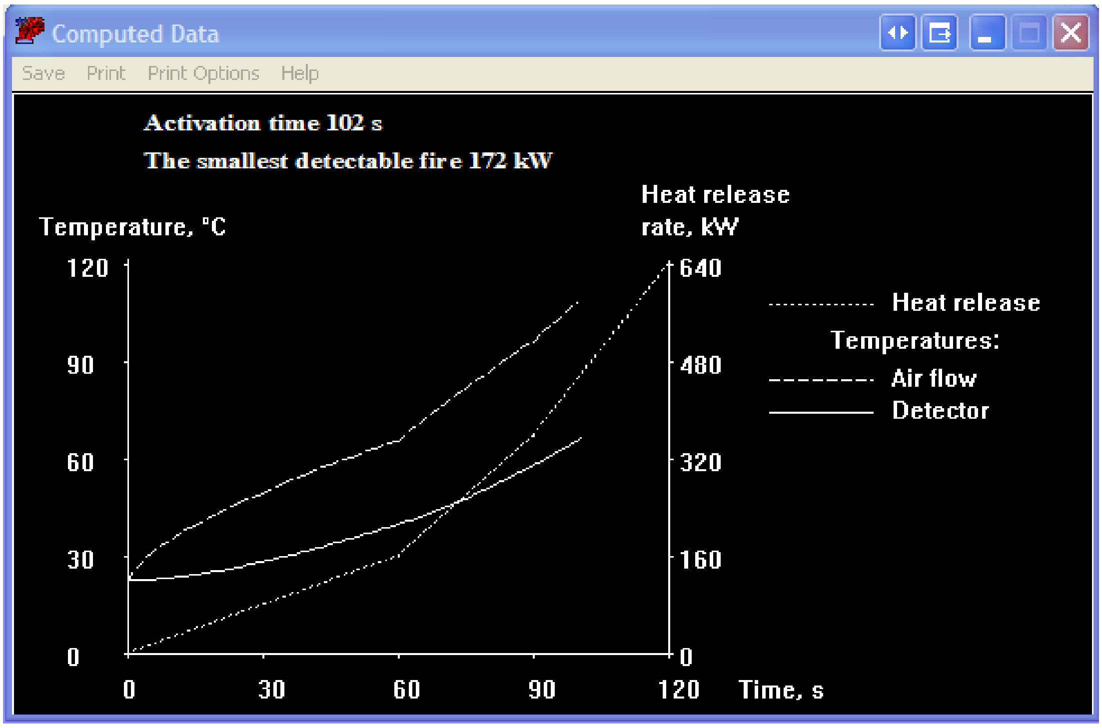


Figure 6.4 FireWind output data showing sprinkler head activation time

Difference in detection time

Smoke detector activation time = 34 seconds

Sprinkler activation time = 102 seconds

Therefore, $\Delta t_{detection}$ = 68 seconds

The risk to the life safety of occupants with a 31 m point of choice travel distance in a sprinkler protected building is considered lower than the risk with a 20 m point of choice travel distance in a non-sprinklered building. This is particularly so since the plant areas will have restricted access and be only intermittently occupied by maintenance staff, who are expected to have good mobility and levels of awareness.

As an additional measure, each plant room will be fire separated from the remainder of the path of travel to the exit, reducing the potential fire scenarios which could occur in this area. The Level B1 basement will also be covered by smoke detection as well as sprinklers to provide early warning, and the plant rooms will be provided with visual warning devices as well as speakers to provide enhanced warning to occupants.

The level of safety is provided by the sprinkler system is considered to be at least equivalent to that provided by DTS compliant travel distances in a non-sprinklered building, and therefore the design complies with the Performance Requirement DP4.

6.4 Results

$\Delta t_{detection}$ = 68 seconds

Δt_{travel} = 11 seconds

$\Delta t_{detection}$ exceeds Δt_{travel} by 57 seconds, and therefore the acceptance criterion of $\Delta t_{detection} \geq \Delta t_{travel}$ has been met.

6.5 Conclusion

The provision of automatic smoke detection to AS 1670.1 in the MEH Level B1 plant area has reduced the detection time by 58 seconds compared to the detection time provided by a DTS compliant sprinkler system. As the time required to travel the 11 m of extended travel distance is significantly less than this (i.e. 11 seconds), the overall RSET for the trial design is less than that for a DTS complaint design. Therefore the design is considered to comply with the Performance Requirement DP4.

7. Compliance Issue 4: Oversized Smoke Compartments

7.1 Introduction

Table 7.1 Compliance Issue 4

Compliance issue		DTS clause & perf. requirement	Approach & method of analysis	Acceptance criteria
4	1,000 m² compartment with 60/60/60 FRL not provided to ward areas. Smoke proof subdivision exceeds 500 m² limit.	DTS clause C2.5	Approach: Quantitative, comparative, deterministic	Trial Design ASET ≥ DTS ASET (referring also to Vol 1 EJV-FE-MEH-REP-0001-PDF-REV5).
		Perf. Requirement CP2, CP3	Method: Calculate the ASET of the Trial Design and compare to a representative DTS building. (referring also to Vol. 1 EJV-FE-MEH-REP-0001-PDF-REV5).	

The ward area of the MEH Building (level LG North) is divided into 3 separate fire compartments of FRL 120 fire rated construction, each less than the 2,000 m² DTS area limitation. However each fire compartment has not been sub-divided into 1,000 m² areas by FRL 60/60/60 construction, and the areas sub-divided by smoke proof walls (i.e. the 'smoke compartments') in some instances exceed the 500 m² DTS area limitation (three smoke compartments exceed the DTS limitation at 507 m², 552 m² and 650 m²).

7.2 Analysis

The departures from the DTS Provisions are justified on the basis of a number of advantages provided by the MEH design as follows:

- the building is provided with a non-required sprinkler system
- the compartment occupancy loads are significantly less than those permitted under the DTS Provisions
- travel distances are DTS compliant
- additional compartment volume acts as smoke reservoir and increases available safe egress time

Each of these contributing factors is examined in further detail in the following sections.

7.2.1 Provision of non-required sprinkler system

The Guide for the Design of Fire Resistant Barriers and Structures (England 2000), produced by the Australian Building Control Commission, provides the following commentary on the findings of experimental research into sprinkler controlled fire temperatures:

"the temperatures outside the immediate area of operation of the sprinkler system are below 100°C" and *"temperatures within the area of operation are generally below 200°C except in the immediate vicinity of the flames".*

Sprinkler systems, and Australian sprinkler systems in particular, have a very high historic level of reliability which is generally accepted by numerous references to be in excess of 95%[**]. Consequently the positive impact of a non-required sprinkler system on fire size and temperatures in the compartment of origin means that the risk of a fire developing to a size where fire rated construction is required to contain fire spread is considered very low. In this situation the benefits to the occupants of the compartment of origin in terms of reduction in exposure to hot, toxic gases produced by an uncontrolled fire compensates for the increase in fire compartment size, particularly since the occupancy load within the MEH ward fire compartments is significantly less than that which would be expected in a ward with DTS compliant fire compartment sizes, as discussed below.

7.2.2 Reduced occupancy load

Under the DTS occupancy density for patient care areas of 10 m^2 per person, each 500 m^2 smoke rated ward area could contain 50 persons. However to be conservative and in recognition of existing Queensland Health ward configurations, a comparative load of 20 persons per 500 m^2 smoke compartment has been adopted to demonstrate the significant advantage provided by the MEH building's reduced occupancy load compared to an exemplar DTS compliant design in Figure 7.1. Note that lounge/dining area loads have not been considered other than in the 2,000 m^2 fire compartment load as this scenario is equally applicable to either the DTS or alternative MEH situations.

<table>
<tr><th colspan="2">DTS compliant Class 9a compartmentation</th><th colspan="2">MEH Class 9a compartmentation</th></tr>
<tr><th>Compartment</th><th>Occupancy load</th><th>Compartment</th><th>Occupancy load</th></tr>
<tr><td>Smoke compartments
500 m²</td><td>20 patients</td><td>Smoke compartments
652 m² maximum</td><td>12 patients maximum</td></tr>
<tr><td>60 minute FRL fire walls
1,000 m²</td><td>40 patients</td><td rowspan="2">120 minute FRL fire compartments
1,758 m² maximum</td><td rowspan="2">25 patients
4 staff minimum</td></tr>
<tr><td>120 minute FRL fire compartments
2,000 m²</td><td>80 patients
4 staff minimum</td></tr>
</table>

Figure 7.1 Comparison of MEH and DTS ward fire compartment occupancy loads

Figure 7.1 shows quite clearly that the occupancy loads in the MEH for both the smoke compartment and 2,000 m^2 fire compartment are significantly less than the occupancy loads that would be permitted in a DTS compliant compartment size. Most importantly, the occupancy load for the 2,000 m^2 fire compartment in the MEH are much less than would be permitted in a 1,000 m^2 compartment bounded by walls with a 60 minute FRL. Given that the travel distances in all MEH patient care areas are DTS compliant, the additional volume available to act as a smoke reservoir in the MEH compartments will

[**] Marryatt (1998) provides one of the most widely referenced studies of sprinkler system reliability on a 100 year study of fires in automatic sprinkler protected buildings in Australia and New Zealand. The statistical data shows that for a total of 9,022 recorded fires in 231 occupancies types sprinklers controlled 99.46% of all fires. The Fire Engineering Guidelines (FCRC 1996) suggests the failure rate for new sprinkler heads to operate correctly has been estimated at 3.1% (reliability = 96.9%) and for old sprinklers at 5.1% (reliability = 94.9%). Powers (1979) estimates that the sprinkler reliability of success is 98.8% for highrise office buildings (New York City only), 98.4% for other office buildings, and 95.8% for low-rise buildings. For further information on the reliability of automatic sprinkler systems, Koffel (2003) has produced a paper regarding sprinkler reliability based on NFPA data. The paper analyses 273,400 actual fires occurred between 1989-1999 where sprinklers were present. In 83.6% of fires sprinklers operated, it is noted that in a number of the remaining cases the fire was too small to operate the sprinklers.

actually increase the available safe egress time. When this is combined with a lower occupancy load, and a smaller fire size due to the presence of non-required sprinklers, the level of safety provided in the MEH is considered to be at least equivalent to that of a DTS compliant design, despite non-provision of the 1,000 m^2 60 minute FRL bounding construction.

7.2.3 Improved available safe egress time due to increase in compartment volume

While the provision of sprinklers will reduce the fire risk within the MEH and hence enable a relaxation in the need for fire rated construction, the impact of smoke from a sprinkler controlled fire still needs to be considered in the context of the proposed oversized smoke compartments. The argument contained in Section 7.2.2 above has qualitatively shown that despite the increase in compartment size, the number of occupants exposed to the effects of a fire is less than would be found in a DTS compliant design. As travel distances are compliant in both cases, this provides a better overall level of safety for the MEH building.

However to provide further justification for this alternative solution, a quantitative analysis has been carried out to compare the available safe egress time (ASET) for both a DTS compliant smoke compartment, and the oversized smoke compartments found in the MEH building. It is important to note that this comparative analysis will be based on a sprinkler system being present in both cases, even though an exemplar DTS design would not require a sprinkler system. In this respect the analysis can be considered very conservative, as the recognised benefits to life safety provided by a sprinkler system have already been discussed above.

The analysis will demonstrate that conditions under a sprinkler controlled or suppressed fire within the MEH smoke compartments are at least equivalent to those found within a DTS compliant smoke compartment. This solution is based in part on the important fact that while the area of the smoke compartments is being extended, the occupancy load will remain no greater than that expected within a DTS compliant sized compartment.

The issue underlying the requirement to provide smoke and fire separation for Class 9a buildings relates to the time to evacuate patients, particularly those that may require assistance.

From the Guide to the BCA (ABCB 2008):

> ***Class 9a buildings – evacuation difficulties***
> *Residents or patients of Class 9a buildings are often unable to evacuate a building without assistance. They may be incapable of walking or bedridden. It is important to make sure that fire and smoke only affects small areas of the building*

All else being equal (i.e. occupancy loads are the same and travel distances are DTS compliant, the MEH design can be considered to comply with the building code if the available safe egress time is shown to be at least equivalent to that of a DTS complaint design.

Scenarios

Two scenarios are considered for this analysis:

- Sprinkler suppressed
- Sprinkler controlled

In each case a Fast-t^2 growth is assumed to sprinkler activation. The HRR time history in the suppressed (or extinguished) case begins to decay following sprinkler activation. The HRR time history plateaus in the controlled case.

The suppressed case is justified by the IFEG which allows that it can be assumed that suppression commences when activation occurs provided:

- the enclosure height is low
- the size of enclosure is small
- the fire size is relatively low
- significant shielding of the fire is not expected
- the fire is likely to be extinguished with one or a few sprinkler heads.

This is demonstrated figuratively in Figure 7.2 below.

Sprinkler activation is calculated using FDS. The key input assumptions are as follows:

- Height above fuel source: 2.7 m
- Radial distance from fuel centre: 3.2 m
- Ambient temperature: 20 °C
- Activation temperature: 68 °C
- Response time index (fast response): 50 $(m.s)^{1/2}$

The outputs for sprinkler activation are :

- Time of sprinkler activation: 148 s
- HRR at activation: 1,027 kW

The decay phase is described by the algorithm developed by Madrzykowski and Vittori, recommended in the IFEG (ABCB 2005).

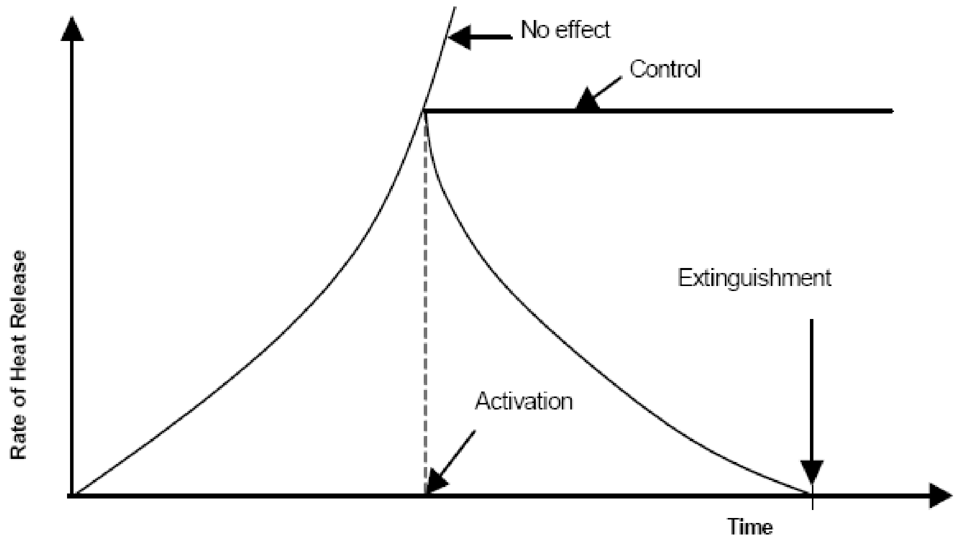


Figure 7.2 Possible effects of suppression on a design fire. Reproduced from the IFEG (ABCB 2005)

7.2.4 Results

The HRR time histories are shown below in Figure 7.3 for the suppressed and controlled scenarios. These are the same for the cases of 750 m^2 (from the CSB analysis) and 500 m^2.

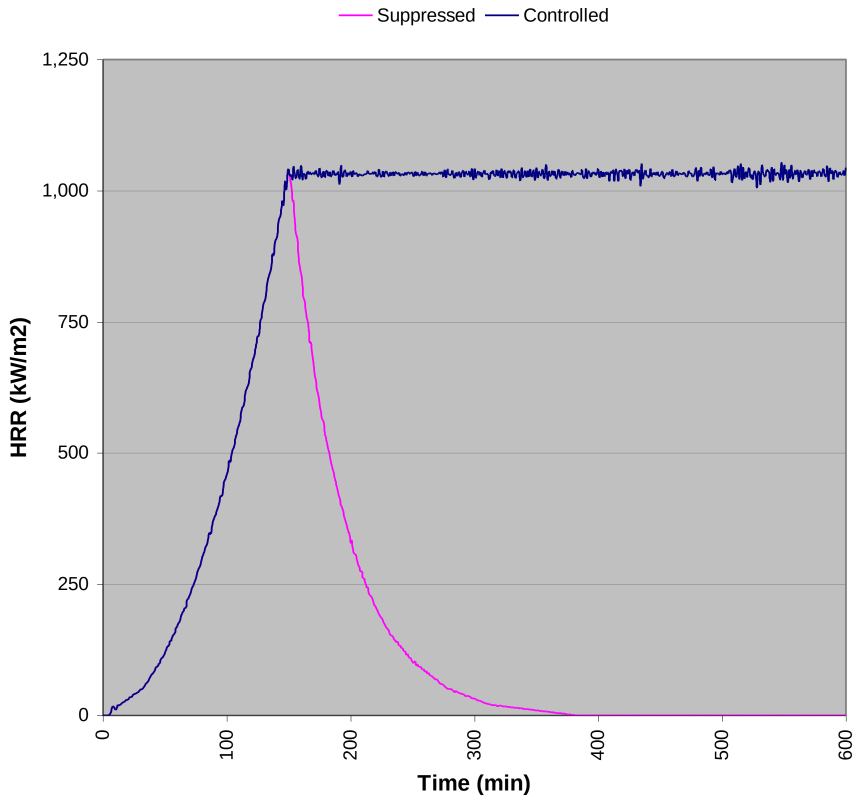


Figure 7.3: HRR time histories for the sprinkler-suppressed and sprinkler-controlled design fires

Figure 7.4 shows the visibility time history for the sprinkler-suppressed and sprinkler-controlled scenarios both in the 500 m^2 DTS case and the 750 m^2 TD case.

These histories are gained from averaging values from an array of point readings on an approximately 5 m grid. Individual point readings vary little from the average as the space is relatively small. Interestingly, tenability limits are reached first in those points on the array most remote from the fire source. This is due to the smoke layer rebounding from the walls and deepening and dropping. Also of interest, is that tenable conditions are maintained for case of a sprinkler-suppressed fire in the TD area of 750 m^2.

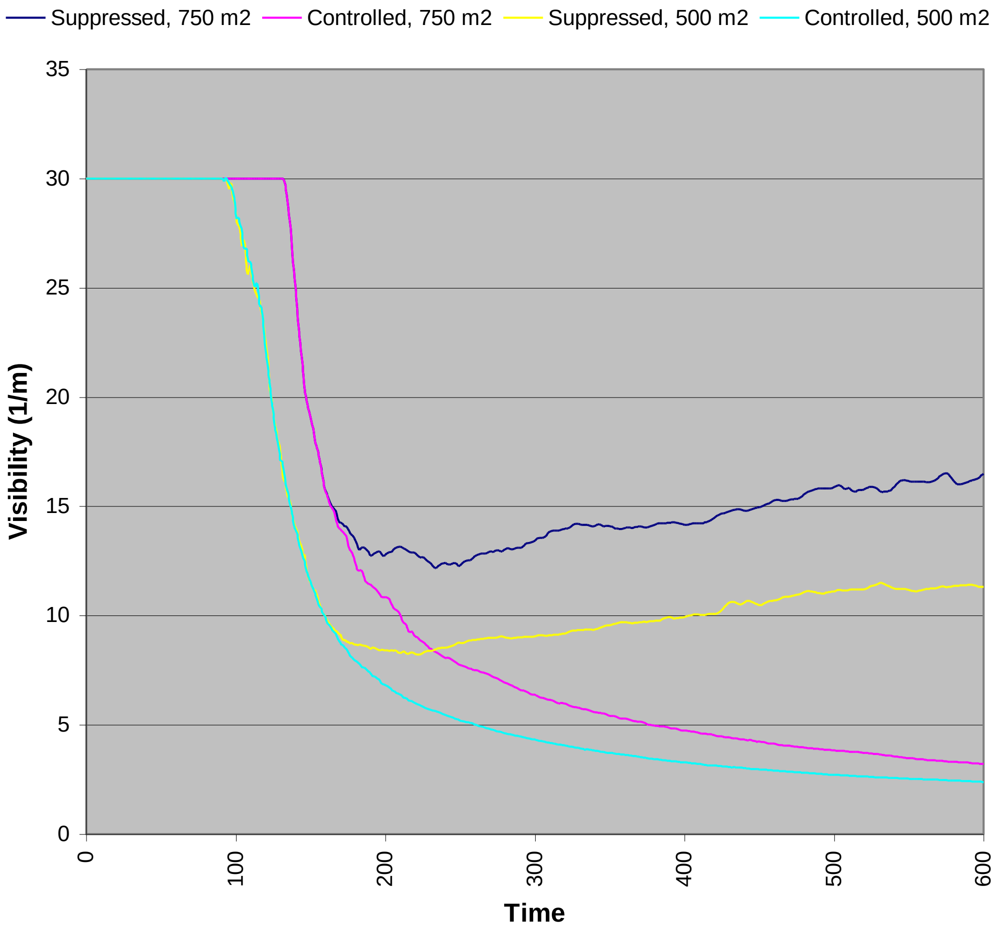


Figure 7.4 Visibility time histories

Results are presented in Table 7.2 below for visibility criteria of either 5 m^{-1} (small room) and 10 m^{-1} (large space). It can be seen that in each case the Trial design is better than the DTS. Indefinite ASET, which occurs in the suppressed cases, means that the tenability criterion is not reached.

Table 7.2 Summary of ASET Results (Visibility)

Sprinkler Effect	Controlled		Suppressed	
Visibility Criteria	10 m^{-1}	5 m^{-1}	10 m^{-1}	5 m^{-1}
Deemed To Satisfy	159 s	259 s	159 s	Indefinite
Trial Design	210 s	375 s	Indefinite	Indefinite
Result	DTS ≤ TD √	DTS ≤ TD √	DTS ≤ TD √	DTS ≤ TD √

Figure 7.5 shows the temperature time history for the sprinkler-suppressed and sprinkler-controlled scenarios, both in the 500 m² DTS case and the 750 m² TD case.

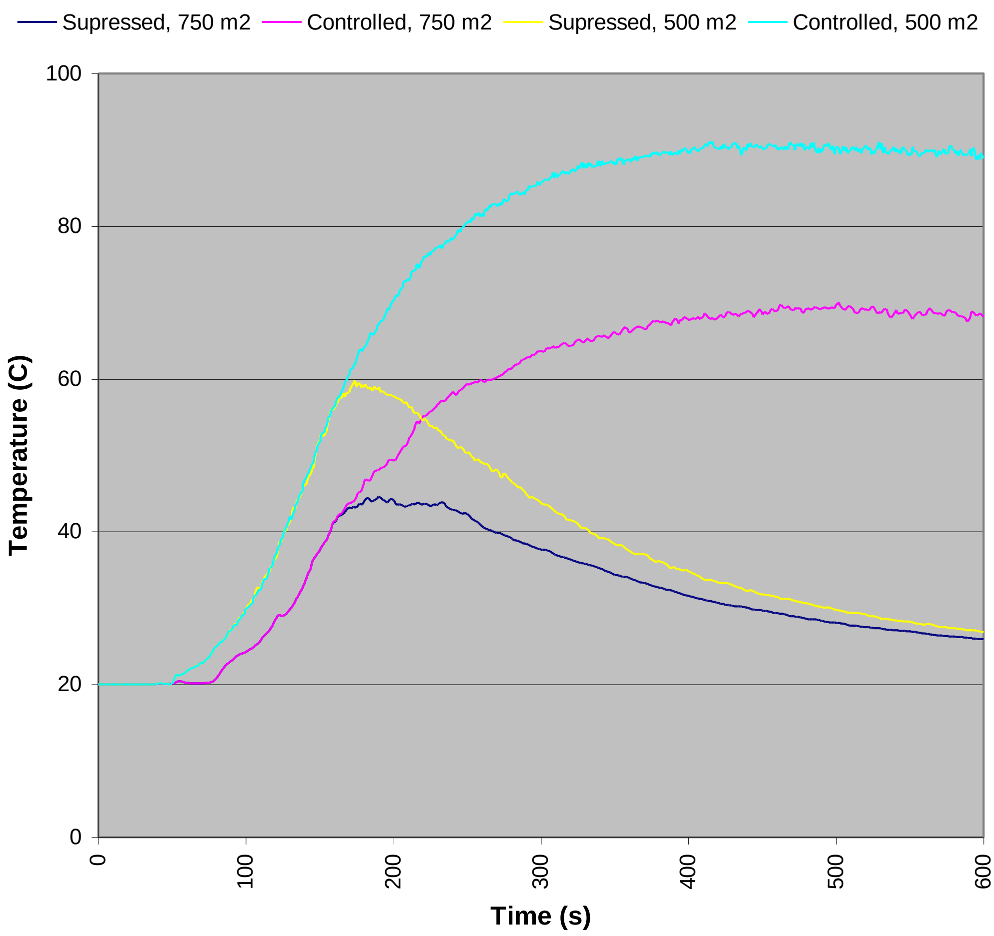


Figure 7.5 Temperature time histories

Results are presented in Table 7.3 below for the temperature criterion of 60 °C. It can be seen that in each case the Trial design is better than the DTS. Indefinite ASET, which occurs in the TD suppressed case, means that the tenability criterion is not reached.

Table 7.3 Summary of ASET Results (Temperature)

Sprinkler Effect	Controlled	Suppressed
Deemed To Satisfy	168 s	174 s[1]
Trial Design	268 s	Indefinite
Result	DTS ≤ TD √	DTS ≤ TD √

7.3 Conclusion

The above analysis has demonstrated that the level of safety provided in the MEH building is at least equivalent to that provided in a building with DTS compliant smoke and fire compartmentation, on the following basis:

- A non-required sprinkler system is provided such that the risk of a fire developing to a size that fire rated construction is required to contain it is considered very low
- The non-required sprinkler system will also provide a higher level of safety for the occupants within the compartment of fire origin by reducing the fire size and thereby reducing the amount of heat and toxic gases produced by the fire
- The occupancy loads with the MEH compartments are significantly less than those permitted in DTS compliant fire compartments, therefore the number of occupants exposed to a fire is no greater despite the increase in compartment sizes
- Travel distances are DTS compliant in the MEH patient care areas, therefore the required safe egress time (RSET) is at least equivalent to that in a DTS compliant design
- The ward area compartments are located on ground level (Level LG) and direct access to outside is available from every smoke and fire compartment
- Analysis has demonstrated that the available safe egress time (ASET) in the MEH patient care compartments is greater than that found in exemplar DTS compliant compartments due to the larger volume providing a bigger smoke reservoir

The provision of a non-required sprinkler system and the reduced occupancy load in conjunction with DTS compliant travel distances is considered to compensate for the non-provision of 1,000 m^2 60 minute fire walls. The reduced occupancy load and improved ASET is considered to compensate for the increase in the area of some smoke-proof compartments. Therefore on the basis of the above factors the MEH design is considered to comply with the Performance Requirements CP2 and CP3.

Note that the following provisions apply to this alternative solution:

- The staged evacuation strategy must require horizontal evacuation through fire compartment lines. Staged evacuation only through smoke-proof walls shall not form part of the strategy (refer Section 3 for more details on the evacuation strategy)
- If the occupancy load within the MEH patient care areas changes, the fire engineering analysis will need to be revisited to confirm that this alternative solution remains compliant with the relevant Performance Requirements of the BCA

8. Compliance Issue 5: Security of FHR cabinets, portable fire extinguishers and manual call points

Table 8.1 Compliance issue 5

Compliance Issue		DTS clause & Perf. Requirement	Approach & method of analysis	Acceptance criteria
5	FHR, hydrants and portable fire extinguisher cabinets will be key locked with no frangible panel.	DTS clause E1.4, E1.6	Approach: Qualitative, absolute	Agreement by Building Certifier and QFES
		Perf. requirement EP1.1, EP1.2	Method: The patient accessible areas will have high level of supervision and staff will all have keys.	

To avoid the risk of malicious tampering with life safety equipment by patients, fire hose reels (FHRs), portable fire extinguishers and manual call points (MCPs) will be positioned in secure locations. MCPs will be located within the secure areas of Staff Bases, and wherever possible portable fire extinguishers will also be located within the secure areas of Staff Bases. FHRs, as well as hydrants in some instances, located in patient accessible areas will be in key locked cabinets. Where portable fire extinguishers are required to be located in patient accessible areas, they shall be co-located with FHRs in the locked cabinets.

AS 2441 and AS 2444 permit FHR and portable fire extinguisher cabinets respectively to be locked, however the Standards require a frangible panel to provide access to the latching mechanism. This frangible panel will not be provided in the MEH building patient accessible areas.

The location of Staff Bases is such that compliance with spacing of MCPs is still achieved (i.e. maximum travel distance of 30 m). Similarly FHR and portable fire extinguisher coverage is achieved. All facets of the building's operation are heavily managed by staff for the safety and well-being of patients, and fire safety equipment should be no different. Given the level of staff supervision in the building, there is no expectation that patients would be utilising either the MCPs or FHRs for their intended purposes. Staff are required to carry keys at all times to provide for immediate escape through locked doors in the event of fire, and it will be an additional part of their operational procedures to carry the key to the FHR and portable extinguisher cabinets as well.

In some instances FHRs and portable fire extinguishers will be co-located with fire hydrants in locked cabinets. Fire hydrants need to be accessible to the fire brigade, and therefore the door to the fire hydrant cabinets can only be unlocked with the specific MEH master key mentioned previously in Section 3.6 of this report. In order to provide access to co-located FHRs and portable fire extinguishers, MEH staff will need to carry the specific MEH master key.

In addition, a key safe containing multiple copies of the fire safety keys must be provided within the FIP cupboard of MEH for use by the fire fighters if required.

It is considered that the proposed locations and methods of securing the FHRs, portable fire extinguishers and MCPs will comply with the Performance Requirements EP1.1 and EP1.2.

9. Compliance Issue 6: Fire Door Hold Open Device Activation Mechanism

Table 9.1 Compliance issue 6

Compliance Issue		DTS clause & Perf. Requirement	Approach & method of analysis	Acceptance criteria
6	Fire door hold open device only releasing upon local smoke detector activation within 1.5 m of doors.	DTS clause C3.5, Spec C3.4	Approach: Qualitative, absolute	Agreement by Building Certifier and QFES
		Perf. requirement CP3	Method: Ease of travel to adjacent fire/smoke compartment particularly while moving patients in Ward areas	

In a fire event, the ability to rapidly evacuate occupants who are immediately threatened by the fire is critical. Many mental health patients are expected to be either consciously or unconsciously difficult to evacuate, and many will need to be physically assisted, if not carried from one fire compartment to another. Two hour rated fire doors are very heavy, and regardless of the direction of swing, having to contend with closed fire doors in addition to the physical demands placed on staff carrying out evacuation by the patients themselves is likely to significantly delay evacuation, potentially increasing the risk to occupants in the event of a fire.

As an alternative solution it is therefore proposed to release the automatic hold open devices on fire and smoke doors only upon activation of a smoke detector located within 1.5 m of either side of the door itself, and not on smoke detector activation in the associated fire compartment(s).

This strategy will enable doorways through fire and smoke compartments to remain unobstructed for as long as possible to facilitate evacuation and to only close when smoke directly threatened by the presence of smoke.

The smoke detectors used to release the hold open devices will be monitored, and in the event of a fault signal, the doors will release. Similarly the doors will release on power failure.

In addition, there will be a manual release button provided on one side of each door, to provide an additional level of redundancy.

It is therefore considered that the proposed strategy for release of automatic hold open devices on fire and smoke doors will comply with the Performance Requirement CP3.

10. Compliance Issue 7: Alternative Egress from Level 00 Plant Rooms

Table 10.1 Compliance issue 7

Compliance Issue		DTS clause & Perf. Requirement	Approach & method of analysis	Acceptance criteria
7	Alternate egress ladders from Level 00 plant rooms do not comply fully with AS 1657.	<u>DTS clause</u> D1.16	Approach: Qualitative, comparative	Agreement by Building Certifier and QFES
		<u>Perf. requirement</u> DP4	Method: Implementation of measures to ensure ladder is available and can operate freely in an emergency situation	

The egress ladders provided at the ends of each plant room on Level 00 are retractable, and as such do not comply with AS 1657.

It is important to note that the Level 00 plant spaces will only be intermittently occupied by a limited number of trained maintenance personnel, and that the retractable ladder is only the alternative egress means from the plant rooms. Each plant room has a fully compliant primary egress route via stairs to Level LG. In a building with a full automatic smoke detection and alarm system, and a non-required sprinkler system, the likelihood of the plant rooms being occupied during a fire incident, and the occupants needing to use the alternative egress route, is considered very low. Nevertheless, the provision of retractable alternate egress ladders is addressed in more detail in this section.

The critical issue associated with the use of a retractable ladder for emergency egress is to ensure that the ladder is able to extend fully when required. This means ensuring that the running mechanism is in good order, which can be addressed through an inspection and maintenance regime, and ensuring that the ladder drop zone is free from obstructions. This can be achieved through a combination of regular inspections and through the use of signage and demarcation.

The following provisions are to be implemented to ensure the retractable ladders will provide a suitable alternate egress method from the Level 00 plant rooms in the event of an emergency:

- Yellow floor markings are to be used to clearly demark the ladder drop zone on Level LG
- Signage is to be provided on the wall in the immediate vicinity of each drop zone requiring the demarcated area to be kept free from obstructions at all times – the signage should clearly identify the purpose of the demarcation zone and state that keeping the area free from obstructions is a fire safety requirement
- A weekly inspection regime by a responsible person to ensure the demarcated area is kept free from obstructions shall be incorporated into the MEH Management-in-Use Fire Safety Plan
- A monthly inspection regime for the testing of the ladder running assembly shall be implemented, and incorporated into the MEH Management-in-Use Fire Safety Plan
- Warning shall be provided in the immediate vicinity of the ladder drop zone on Level LG to warn occupants on Level LG that the ladder is about to drop – this warning should be both audible and visual (i.e. a strobe light) so as to be noticed when the fire alarm is sounding
- In order to provide sufficient warning that the ladder is about to drop, the audible and visual alarms should be activated by the opening of the door into the ladder enclosure on Level 00

Provision of the measures detailed above will mitigate the risks associated with the use of retractable egress ladders from plant areas, and therefore the design is considered to satisfy the Performance Requirement DP4.

11. Compliance Issue 8: Doorway thresholds incorporate a step

Table 11.1 Compliance issue 8

Compliance Issue		DTS clause & Perf. Requirement	Approach & method of analysis	Acceptance criteria
8	Doorway thresholds incorporate a step (hob).	DTS clause D1.6, D2.15	Approach: Qualitative, absolute	Agreement by Building Certifier and QFES
		Perf. requirement DP2, DP4	Method: Identification of hob and induction training of staff	

A hob, or raised perimeter protection (bunding), is commonly applied to plant areas to restrict the movement of water or other liquid spills. DTS Provision D2.15 states that the threshold of a doorway must not incorporate a step or ramp at any point closer to the doorway than the width of the door leaf.

Due to design constraints, there may be situations in MEH plant rooms where there is insufficient space to locate the hob the required distance away from the doorway. In these situations, the hob will be incorporated into the wall, directly below the bottom of the door, i.e. the sill of the door is raised above floor level, as with bulkhead doors in ships. DTS Provision D1.6 requires that the unobstructed height of any doorway on a path of travel to an exit must be not less than 1980 mm. The MEH plant room doors have a standard head height, however provision of a hob below the door sill may reduce the overall unobstructed doorway height to less than the 1980 mm permitted under the DTS Provisions.

The presence of a hob within the doorway presents a trip hazard and may impact on the ability of occupants to safely evacuate the plant room in the event of an emergency. In order to minimise this risk, the following provisions are to be implemented:

- Plant room hobs are to be located a suitable distance away from door thresholds wherever possible to comply with DTS Provision D2.15

Where this is not possible:

- Hobs are to be a maximum of 190 mm and a minimum of 115 mm high in compliance with DTS Provision D2.13
- The vertical face of the hob on both sides of the doorway is to be painted or affixed with yellow and black diagonal striping to provide visual warning of the trip hazard for the full depth of the hob, and the full width of the doorway.
- Signage is to be provided on both faces of the door, clearly indicating the presence of a trip hazard in bold writing of suitable size and contrast to the surrounding colour, to be easily read by an occupant approaching the door in ambient lighting conditions.
- Induction training for maintenance staff working in the MEH building will identify the trip hazard associated with the doorway hobs, and this shall be incorporated into the MIU Fire Safety Plan as a required part of induction training

Some of the above requirements relate to compliance with DP2 as well as DP4. In this particular instance full compliance with DP2 is not strictly relevant in terms of fire safety (e.g. from a fire safety perspective, only the side of the door facing the direction of egress needs to be addressed). Nevertheless, from a work place safety perspective, Project Services Building Surveying have required that signage and hazard identification be applied to both sides of the door. Project Services Building

Surveying also require documentation of Queensland Health's acceptance of the proposed solution in terms of work place safety be provided.

It is important to recognise that the MEH plant rooms will be highly restricted spaces, accessible only to trained maintenance staff, and therefore members of the public will not be exposed to the trip hazard. Maintenance staff using the building will have been made aware of the hob as part of their induction training, and are expected to have noted their presence when entering the space. Maintenance staff are familiar with negotiating hobs and other trip hazards in plant rooms, and therefore the risk of tripping is expected to be less than in a publicly accessible space.

With regard to the unobstructed height of the doorway, it is important to note that the hob is intended to be 'stepped-over' and not 'stepped-on'. This means that the occupants using the door for egress will not place their foot on any surface that is above floor level while passing through the doorway, and therefore a door with a standard head height of 2040 mm above floor level would not impede their ability to exit the plant room. Once again it should be noted that the occupants will be maintenance personnel who are familiar with working in restricted environments where they are required to step over or duck under obstructions. The hob is clearly identified as an obstruction that needs to be stepped over, and as per above, staff will not need to 'duck under' the door lintel to exit. Consequently the intent of DTS Provision D1.6 has been met in this case.

It is therefore considered that with the implementation of the safety provisions detailed above, the presence of a hob at the doorway threshold will not prevent the occupants from safely evacuating the plant room in the event of a fire incident, and consequently the design is considered to comply with the Performance Requirements DP2 and DP4.

An example of the type of signage and hazard markings that may be considered appropriate are shown in Figure 11.1. Note that this alternative solution is intended to address the egress requirements of the BCA as they relate to fire safety, and is not intended to address other access requirements that may relate to the presence of hobs at doorway thresholds.

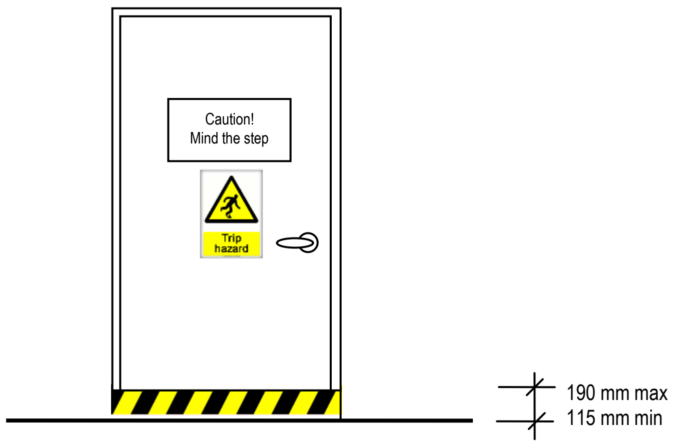


Figure 11.1 Indicative signage and hazard indication markings on the plant room side of doors with hobs incorporated into the thresholds

12. Compliance Issue 9: Horizontal fire compartmentation does not extend through undercroft space

Table 12.1 Compliance issue 9

Compliance Issue		DTS clause & Perf. Requirement	Approach & method of analysis	Acceptance criteria
9	Fire compartmentation does not extend fully to 'edge' of building line	DTS clause C2.7	Approach: Qualitative, comparative	Design equivalent to a DTS compliant solution
		Perf. requirement CP2, CP3	Method: Design represents an equivalent risk to other DTS compliant building configuration	

The BCA requires the fire separation wall between fire compartments be extended to the edge of building line. Level LG of the proposed MEH building has a couple of areas where a covered walkway outside the external wall forms an undercroft. In this situation, the line of the floor slab above is considered the outside edge of the building at Level 00, and consequently the fire compartmentation does not technically extend all the way to the outside of the building (as shown in the figure below).

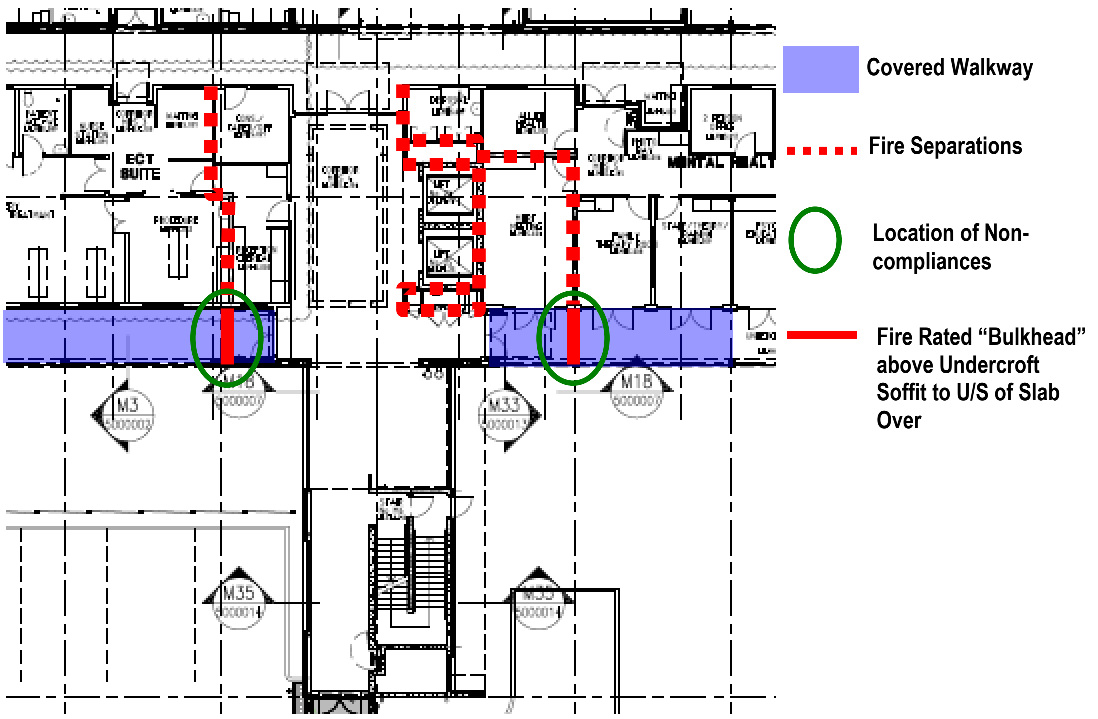


Figure 12.1 Level LG floor plan showing areas where extended fire separation is required (adapted from part drawing PSH-AR-MEH-DWG-20LG100)

There are two areas of risk associated with the design shown in Figure 12.1 in terms of horizontal fire spread between adjacent fire compartments. The first is the risk of fire spread through the undercroft bulkhead that runs along the walkway below the Level 00 floor slab. To address this risk, the bulkhead space between the walkway ceiling and the slab over will be provided with a 2-hour FRL partition in the line of the fire compartment to minimise the risk of fire spreading from one fire compartment, into the bulkhead void, and from there into the adjacent fire compartment.

The second area of risk is that of fire spread via flame extension out the window openings from one fire compartment into the walkway, and from there into the adjacent fire compartment via window openings between that fire compartment and the walkway. The primary risk here is that flames are trapped under the walkway ceiling, which increases the chance of horizontal fire spread to the adjacent fire compartment. The risk associated with this mechanism of fire spread can be assessed through comparison with a DTS compliant solution.

The MEH building has a non-required sprinkler system. Under the BCA Section 2.7, a non-sprinklered building of Type A construction requires either aprons or spandrels to prevent vertical fire spread. The use of apron construction is considered similar to the proposed MEH design in terms of the slab over the walkway. The risk of flame spreading horizontally from one compartment to another under the undercroft soffit is therefore considered equivalent to the risk of fire spreading from one compartment to another under an apron in a DTS compliant design. This principle is illustrated graphically in Figure 12.2 below. Note that the fact that the Staff Area above extends to the outer edge of the undercroft is irrelevant as vertical fire spread is not being assessed in this analysis.

The fact that the MEH building will be provided with sprinkler protection greatly minimises the risk of fire growth and spread compared to the comparative DTS compliant solution. Therefore, the level of safety provided by the proposed MEH design is considered to be at least equivalent, and most likely significantly better than, that provided by the DTS compliant design for a non-sprinklered building, and therefore the design complies with the Performance Requirement CP2 and CP3.

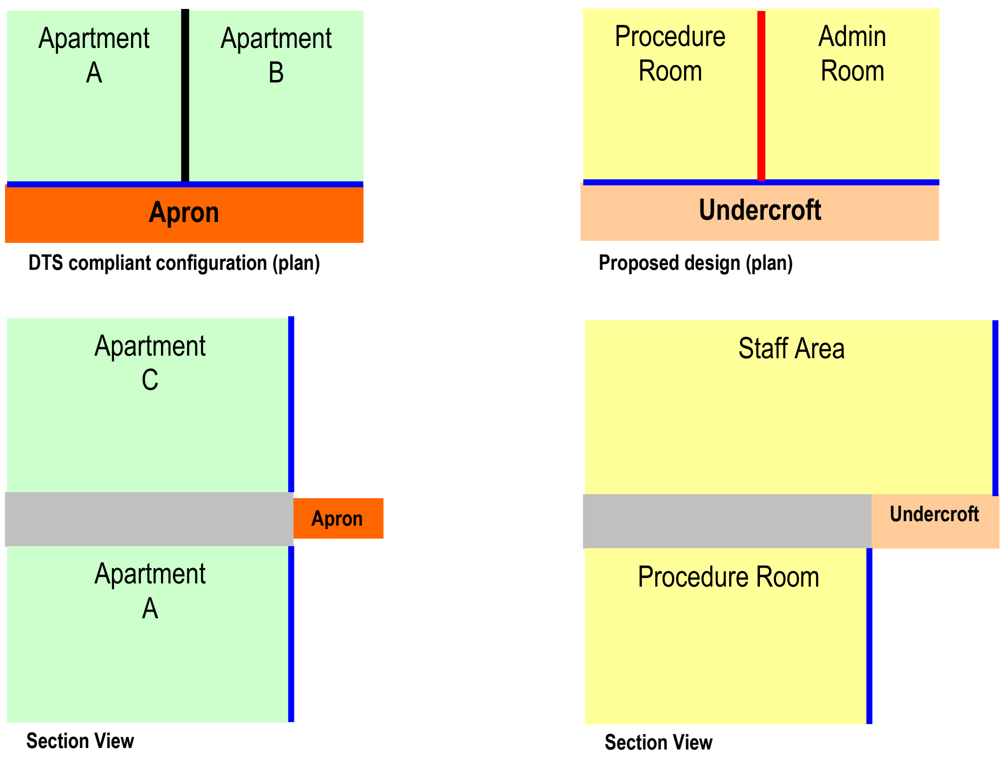


Figure 12.2 Comparison of a DTS compliant building configuration to the proposed MEH building design

13. Compliance Issue 10: Use of sliding doors in a Class 9a health care building

Table 13.1 Compliance issue 10

	Compliance Issue	DTS clause & Perf. Requirement	Approach & method of analysis	Acceptance criteria
10	A doorway in a Class 9a health care building incorporates a sliding door	DTS clause D2.19	Approach: Qualitative	Agreement with Building Certifier and QFES
		Perf. requirement DP2, DP4	Method: Low occupancy load with high staff/patient ratio (i.e. 3 staff with only 1 patient) Room has alternative designated exit with swing doors	

13.1 Introduction

DTS Clause D2.19(b)(iii) requires that a doorway in a patient care area of a Class 9a health-care building must not be fitted with a sliding door unless –

(A) it leads directly to a road or open space; and
(B) the door is able to be opened manually under a force of not more than 110N.

The Guide to BCA (ABCB 2008) states the intent of this requirement is to minimise the risk that a door may obstruct a person evacuating. The key risk is considered to be a number of occupants pushing against the door, jamming the door against its housing and thereby preventing the rollers from sliding within their tracks. The alternative solution covered in this section of the FER will demonstrate that this risk is not present due to very low occupancy loads within the space served by the sliding doors, and by the fact that an additional egress route is available from this space via compliant side hung doors.

13.2 Analysis

The area of non-compliance is shown in Figure 13.1 below. The double sliding doors provide access into the ECT suite procedure room. The detail shows that the procedure room is very small, approximately 6 m x 4 m in dimension. The occupancy load for this room is expected to be 1 patient and up to 3 staff. With this low occupancy load, safe and timely egress is not expected to be affected by the presence of a set of sliding doors, particularly as the majority of the occupants will be staff members who will be familiar with the layout of the building, the operation of the sliding doors and the emergency evacuation procedures within the MEH. These staff members will also be able to assist the patient with evacuation.

In addition, the detail shows that a set of side hung doors that open in the direction of egress is also available from the procedure room which provides a second safe and DTS compliant egress path from this room. The double side hung doors are sufficiently wide to accommodate a bed bound patient if required.

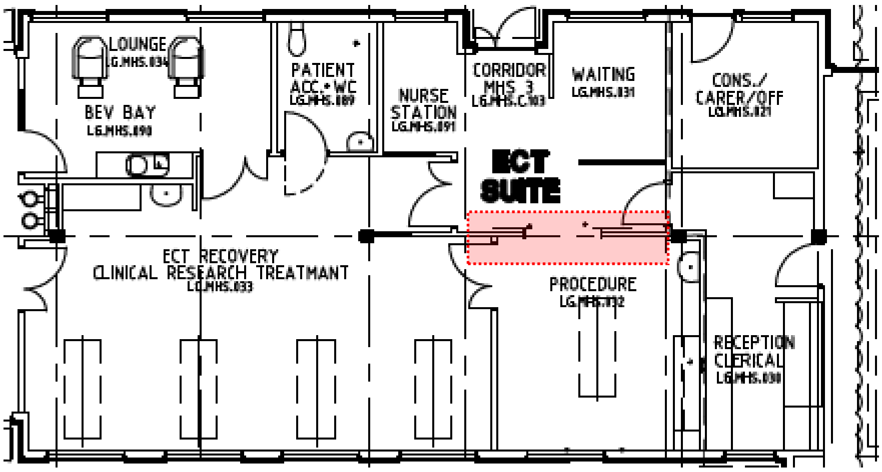


Figure 13.1 Level LG floor plan showing area of sliding door in patient care areas (adapted from part drawing PSH-AR-MEH-DWG-20LG100)

13.3 Conclusion

Given the limited size of the procedure room served by the sliding doors and the low occupancy load (4 persons), combined with the high staff to patient ratio in this room (up to 3 staff to 1 patient). It is considered that the presence of sliding doors would not unduly impede the ability of occupants to egress from the procedure room in the event of an emergency. In addition, a fully compliant set of side hung doors swinging in the direction of egress is also provided in this room and it is expected that this set of swing doors would serve as the primary egress path from the procedure room.

To provide additional direction, an Exit sign shall be mounted above the side hung doors in the procedure room.

The above analysis, with the provision of the exit signage as described, is considered to have demonstrated that the design complies with the Performance Requirements DP2 and DP4 for egress from the Level 00 procedure area.

14. Compliance Issue 11: Building elements pass through fire rated walls

Table 14.1 Compliance issue 11

Compliance Issue		DTS clause & Perf. Requirement	Approach & method of analysis	Acceptance criteria
11	Building elements pass through a fire rated wall	DTS clause C2.7	Approach: Qualitative (quantitative by 3rd party)	Agreement with Building Certifier and QFES
		Perf. requirement CP1, CP2	Method: Fire spray elements back to first connection to provide insulation rating Statement by structural engineer attesting that design will satisfy structural adequacy and integrity requirements	

14.1 Introduction

The MEH Ward Block is divided into three separate fire compartments by two fire walls running North – South beside each of the fire-isolated stairways. A number of structural steel members pass through these two fire walls, in particular steel z-purlins supporting the roof, cleats supporting Level LG ceiling plane bracing elements and ceiling purlins, and other specific horizontal structural framing members.

Under the DTS Provision C2.7(a)(iii) building elements, other than roof battens with dimensions of 75 mm x 50 mm or less or sarking-type material, must not pass through or cross a fire wall unless the required fire resisting performance of the fire wall is maintained. Fire resistance is broken into three separate but interconnected elements; structural adequacy (ability of designated load-bearing elements to carry the required load under fire conditions), integrity (ability to prevent the passage of flames and hot gases) and insulation (ability to prevent the transfer of heat from one side of the wall to the other). The following sections details the methodology employed to demonstrate that the required fire resisting performance of the fire walls is maintained.

14.2 Structural adequacy and integrity

The key issue in terms of structural adequacy and integrity is to ensure failure of members crossing, or connected to, the fire wall as a result of fire exposure does not adversely affect the ability of the fire wall to carry its required load or prevent the passage of flames and hot gases. For example collapse of the roof on one side of the fire wall should not pull down or otherwise damage the fire wall. The Structural Engineer has designed the structural frame inside the fire wall, the structural elements that cross, or connect to, the fire walls, and the members that support these structural members in such a way that the structural adequacy and integrity of the fire walls will be maintained in the event of a fire in one of the adjacent fire compartments. Part of the structural solution relies on fire-rating the relevant structural members to the extent detailed in Section 14.3 below.

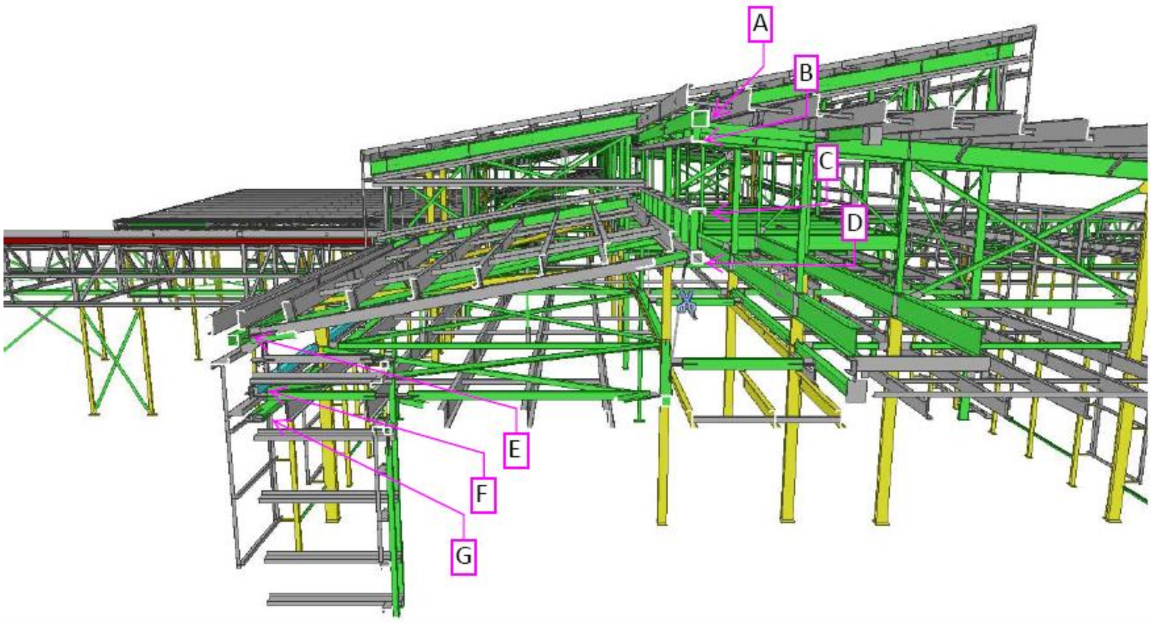
The horizontal members that are specifically required to be fire-rated as part of the structural solution (in addition to the roof z-purlins and the cleats holding the L00 ceiling bracing and purlins) are identified in the structural sketches contained in Appendix E.

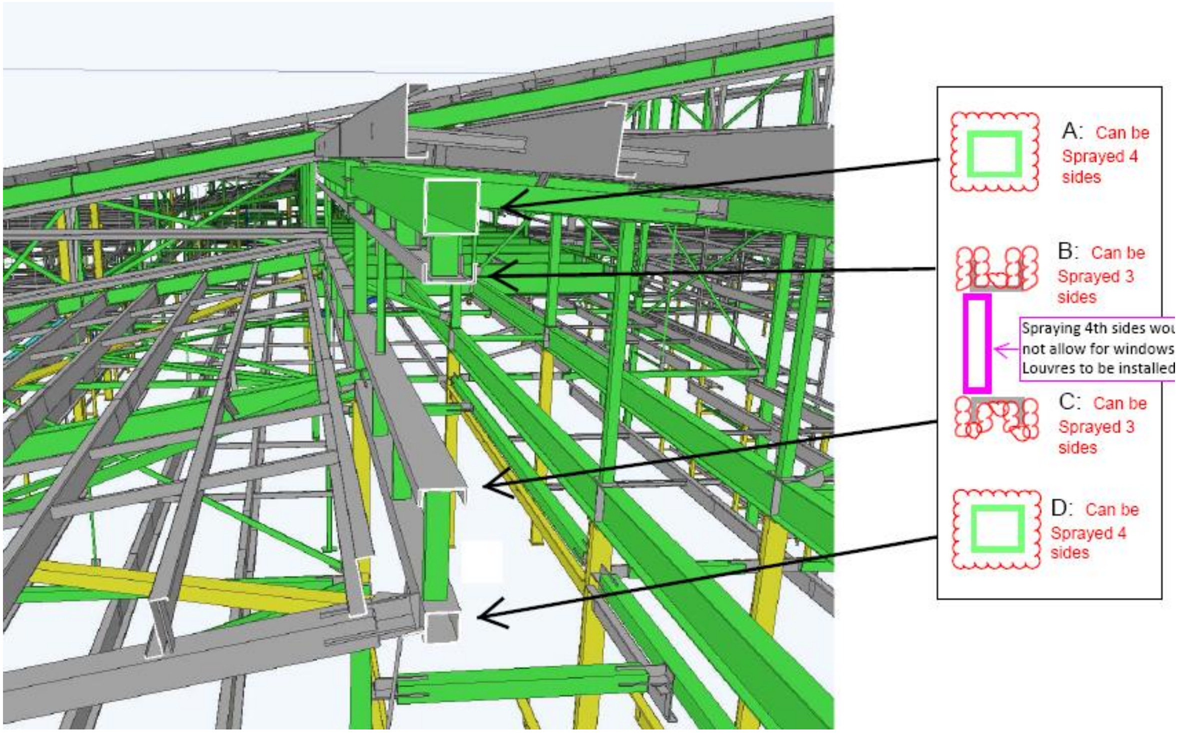
Generally, the members identified are required to be protected on all sides, however, as per the notes in Appendix E, it is proposed to provide three sides protection to the following members:

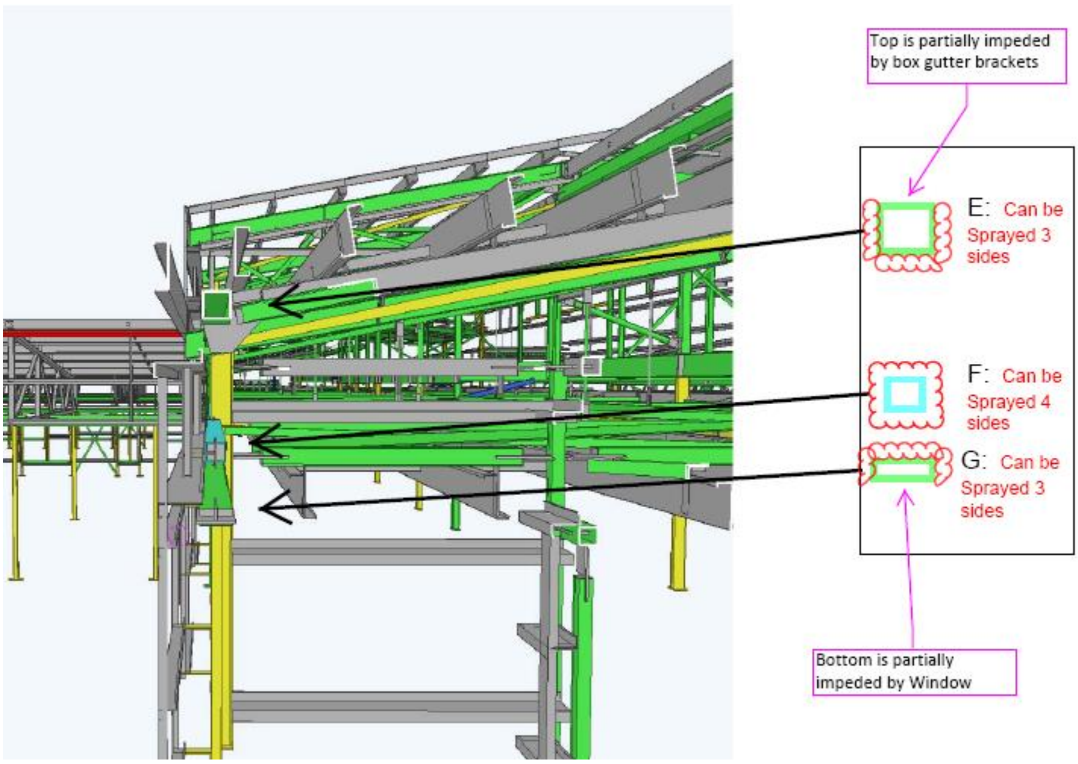
Table 14.2 Members provided with partial protection

member	location	side not protected	comments
B	double height ceiling level window	bottom	Due to the location of members B & C at over 4m above the floor of a common walkway the risk of a fire developing and affecting these members is remote; any fire in the walkway below is expected to be of limited size and will not impinge on these members. In addition, the window glazing installed between the two members is expected to fail and vent out the heat in the event of hot smoke accumulating at the ceiling level.
C	double height ceiling level window	top	
E	Roof level	top (gutter above)	as the top is adjoining the roof and not directly exposed to a fire risk, it is considered acceptable not to provide protection to this side.

The locations of the subject members above are illustrated in the following diagrams:







Note: member G does not extend to other fire compartment therefore protection is not required, confirmed by structural engineer it is not critical for stability of adjacent fire wall

The following is a statement from the Structural Engineer regarding the performance of the fire walls in the event of a fire:

"The structural design of the MEH building at the fire wall is such that should fire occur to one side of the fire wall it will not adversely effect to the point of failure the structural adequacy or integrity of the other side of the fire wall. This will be achieved provided all structural members passing through the fire wall are fire-rated to the level required of the fire wall, and members inside the fire wall are adequately protected against fire to give the frame stability under normal working loads."

14.3 Insulation

The key issue in terms of insulation is to ensure that conductive heat transfer from one side of the fire wall to the other via the steel elements passing through the fire wall does not result in ignition occurring on the opposite side of the fire wall. The risk of conductive heat transfer has been addressed by providing sprayed-on fire protection to each steel member that passes through the fire wall. The following requirements for applied fire protection must be met in order to achieve the necessary performance in terms of structural adequacy, integrity and insulation:

- The applied fire protection must be a listed product (e.g. vermiculite spray), applied by a licensed installer, and must achieve the 2 hour fire-rating required of the fire wall.
- Each member passing through the fire wall must be protected back to the point where they are connected to another supporting element, such as a column or load bearing wall, or rafter in the case of the roof purlins. The supporting members generally lie on the grid lines either side of the two fire walls, being grids MV and MW for the western fire wall, and grids ML and MN for the eastern fire wall. The distance to the nearest supporting members varies, but is generally between 3.2 m and 3.6 m back from the fire wall.
- In addition to the roof z-purlins and the cleats holding the L00 ceiling bracing and purlins, specific horizontal members that require protecting are identified in the structural sketches contained in Appendix E.
- Roof z-purlins do not require protection for structural purposes, and therefore are only required to be protected for insulation purposes. Roof z-purlins must be protected on a minimum of 3 faces (being the bottom edge and the two sides). The top edge will either be protected by the insulated roofing material, or in the event of failure of the roofing material, be exposed directly to open air, and therefore not subject to the full extent of fire exposure.
- Where a structural element is connected to a cleat that passes through the fire wall, only the cleat requires protection. The surface area of connection between the cleat and the structural element is considered insufficient to allow significant heat transfer into the cleat and subsequently through to elements on the opposite side of the wall. The connecting surface between the cleat and the attached element does not require treatment.
- The sprayed-on protection must be applied to the relevant members on both sides of the fire wall.

14.4 Steel member penetrations in other areas

Apart from the steel member penetrations through the fire compartment walls discussed above, Figure 14.1 below shows the other areas of MEH where steel penetrations through fire walls occur:

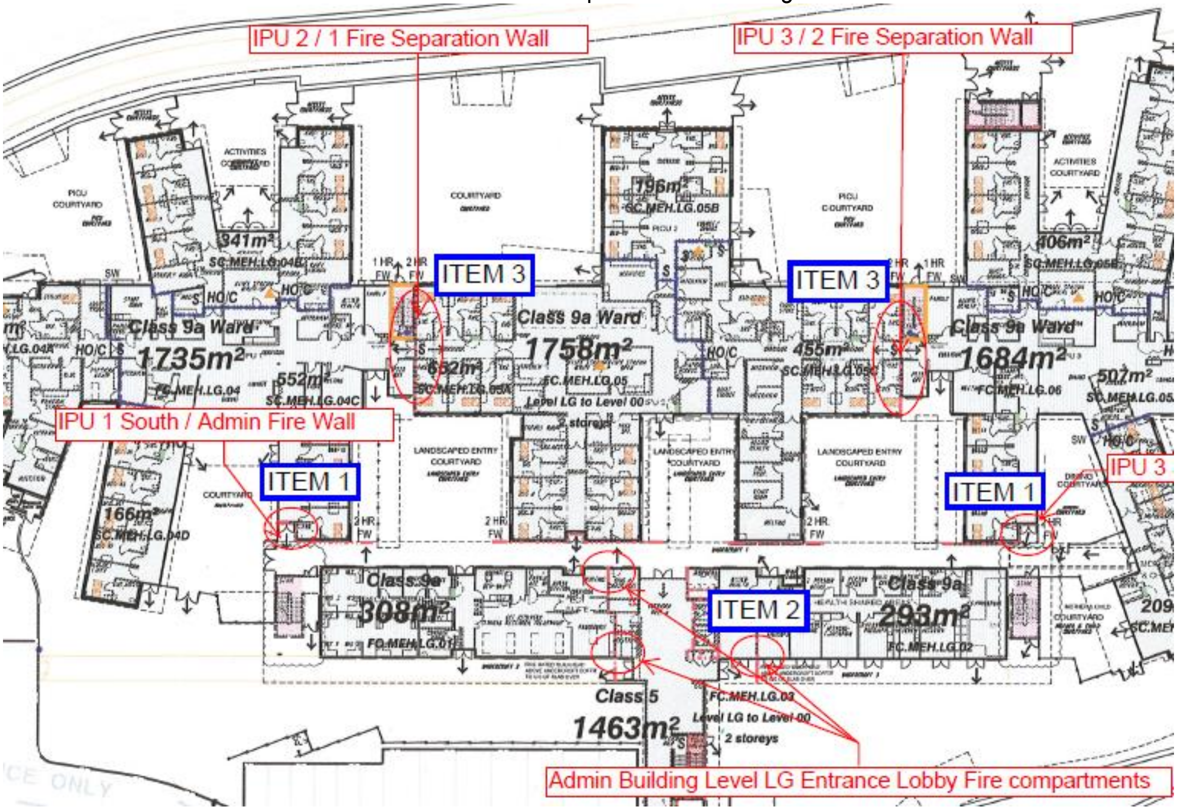


Figure 14.1 Overview of areas with steel penetration through fire compartment walls – items 1 to 3

The details of the above penetration issue and associated fire protection strategy are discussed below:

a) Item 1 IPU 1 & 3 south/ admin fire wall penetrations

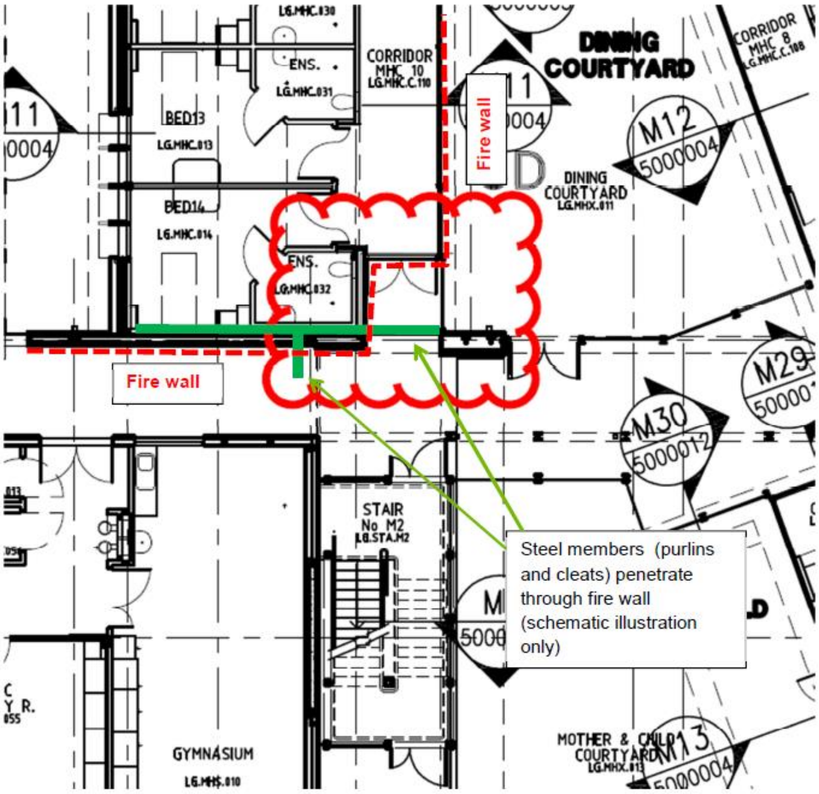


Figure 14.2 Item 1 – Plan view of IPU 3 (similar for IPU 1)

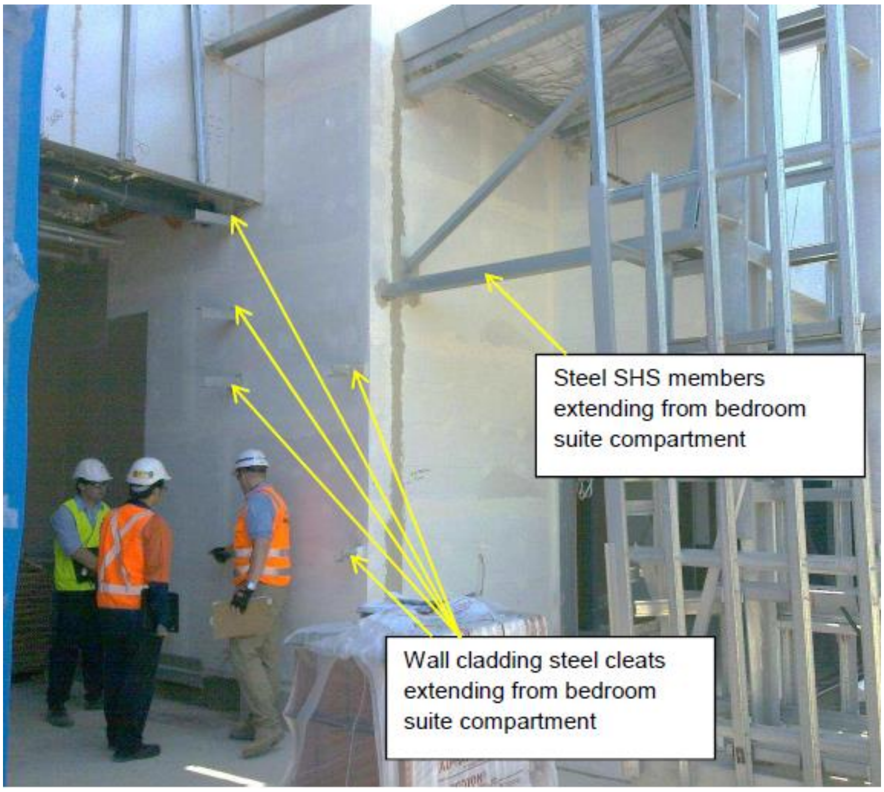


Figure 14.3 Item 1 photo steel member penetration through fire walls in IPU 3 (similar for IPU 3)

As per the above diagram and photo, a steel support for the roof structure outside a bedroom suite of IPU 1 & 3 extend from within the suite through the associated fire walls. As per the advice of the structural engineer, the stability of the steel support structure in the event of a fire in the bedroom is critical for the stability of the fire walls. Therefore the steel structure must be protected to the same 120-minute FRL within the bedroom suite.

Protection to the part of the roof truss and wall cladding cleats exposed to the external open air is not considered necessary as limited fire load and ignition source are expected in the external open space. The risk of fire spread to adjacent buildings by heat conduction through these members is considered remote in view of the limited area of the steel members exposed to the outside and expected heat dissipation to the atmosphere.

Therefore it is not considered necessary to provide additional fire protection for the parts of the roof truss as well as the facade support cleats exposed to the external space.
The proposed members to be fire protected using Vermiculite spray are as shown below:

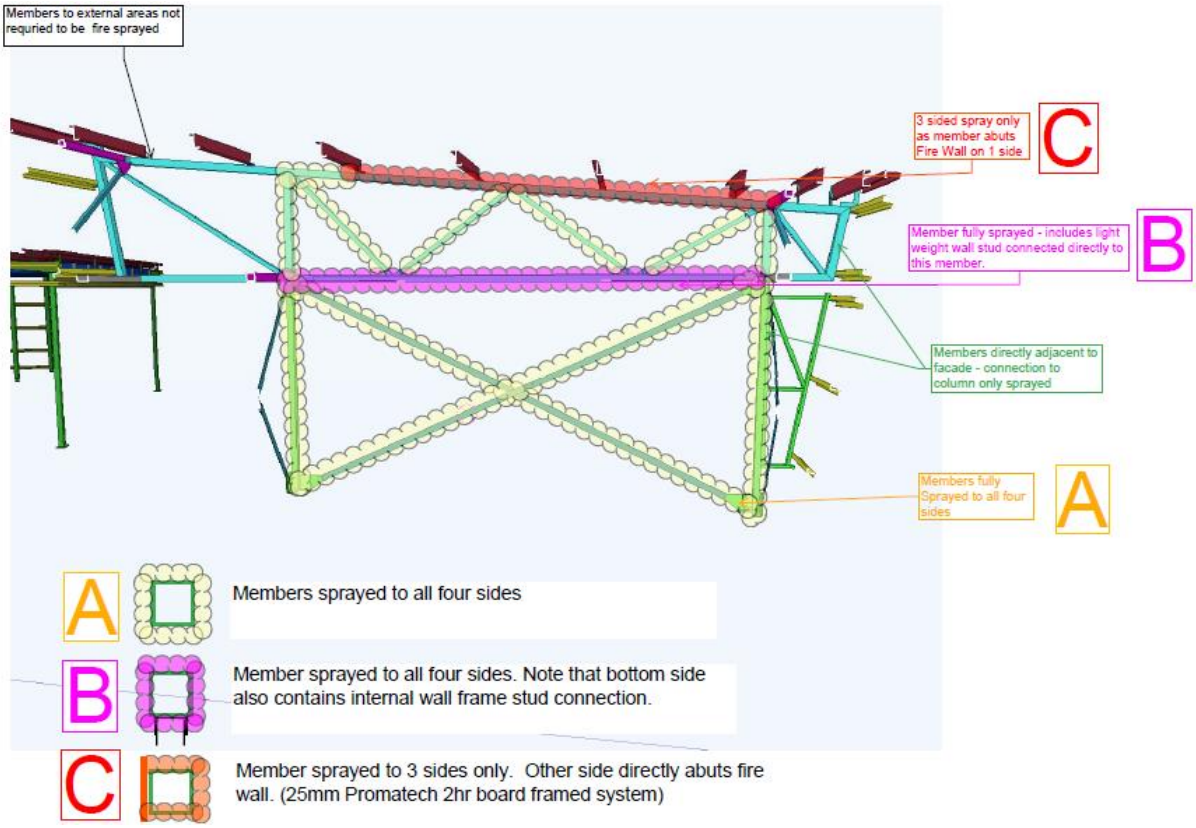


Figure 14.4 Proposed fire spray protection for IPU 1 & 3 steel members penetrating through fire walls

As per the above figure, type C protection is only required to the three sides exposed to the interior of the bedroom as the side abutting the fire wall is shielded from fire exposure; however, any gap between this member and the fire wall must be blocked off.

b) Item 2 admin building LG entrance lobby fire walls

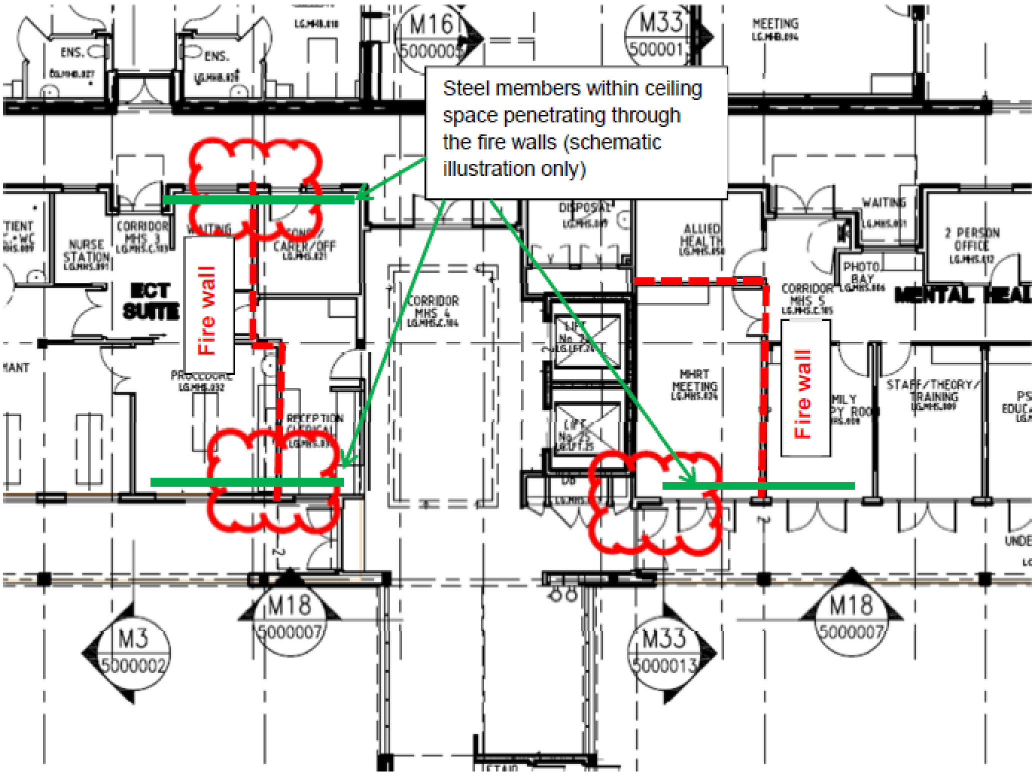


Figure 14.5 Item 2 - plan view of admin building Level LG entrance lobby

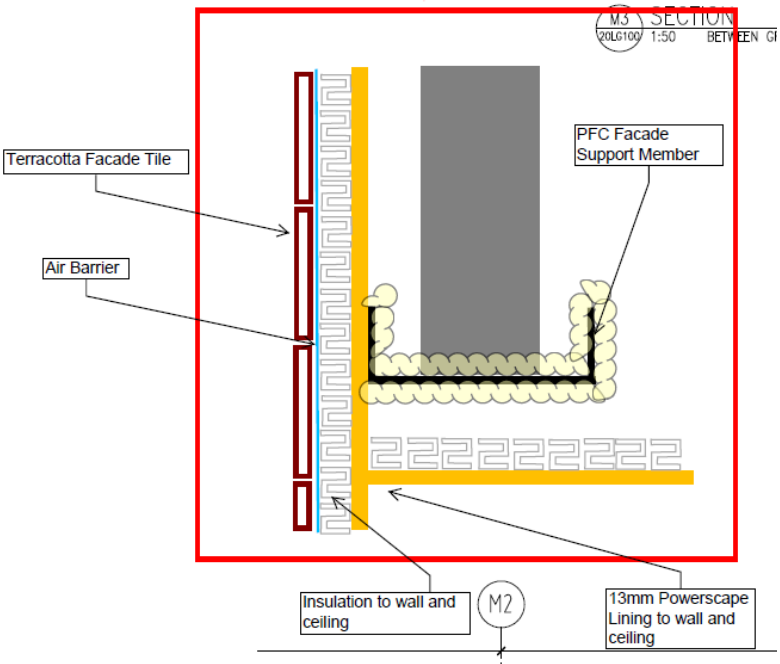


Figure 14.6 Item 2 - Proposed fire protection by Vermiculite spray on three sides of PFC members penetrating through the fire walls

Fire-rated sprayed-on protection must be provided to each of the secondary steel PFC members supporting the LG façade and penetrate through the fire walls indicated in Figure 14.5 above. The protection must be provided to the full length of these members, back to the closest connection to another supporting member, on both sides of the fire wall. The sprayed-on protection must achieve the 2 hour FRL required.

As per Figure 14.6 above, the fire protection is only required on the three sides exposed to the interior space and not the side that abuts the external wall as it is considered shielded from potential fire exposure.

c) Item 3 IPU 2/1 & IPU 3/2 fire walls

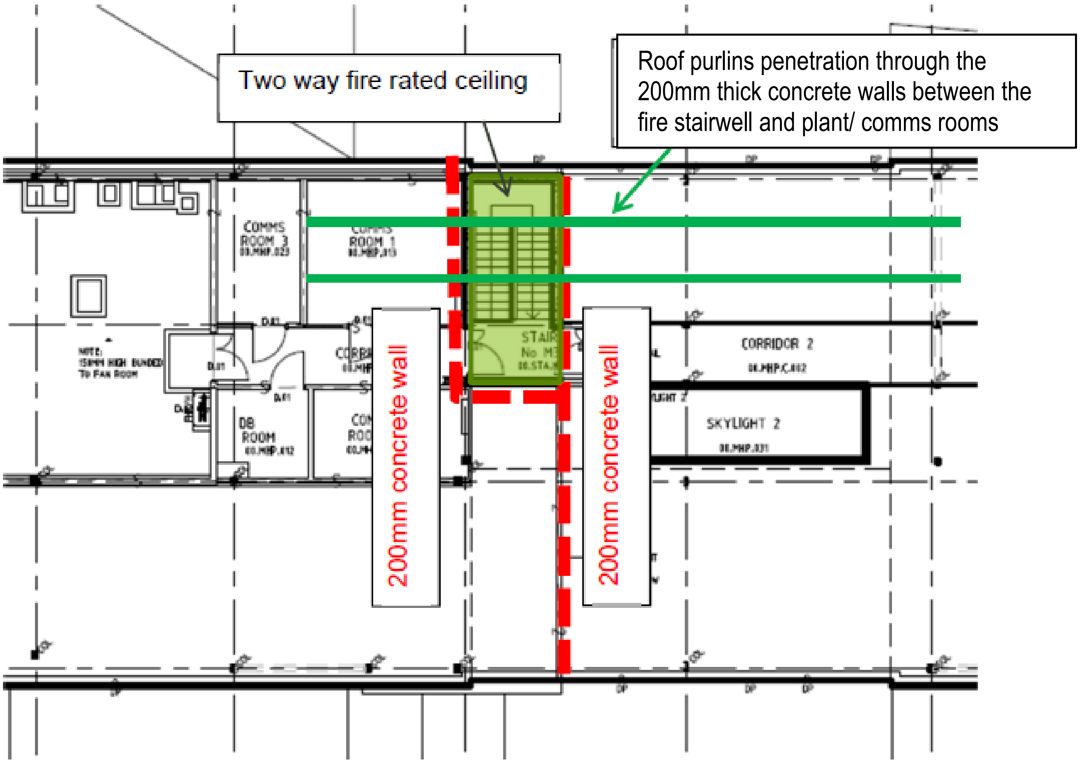


Figure 14.7 Item 3 - plan view of IPU 2/1 and IPU 3/2 fire wall penetrations

As shown in the above figure, the non-fire rated roof purlins penetrate through 200mm thick concrete fire compartment walls between the fire isolated stairwell and the comms and plant rooms on either side.

As per the Onesteel Fire Design Note # 2 attached in Appendix I of this report, steel members penetrating through a concrete wall with a minimum thickness of 200mm is tested to be acceptable as heat conduction through the steel members will be attenuated by the concrete wall such that the temperature rise of the side of the steel member not exposed to the fire source is not more than 185^{o}C.

Therefore no additional fire protection is required for these purlins. Any gap between the steel purlins and concrete wall must be filled up with concrete-base infill.

d) Link bridge fire wall

As part of the overall fire compartmentation for MEH, the link bridge is fire separated from the MEH by a 2-hour fire rated wall as shown in Figure 14.8 below. As shown in Figure 14.9, one of the structural support members for the fire wall being a steel member fixed to the top of the wall and welded to the link bridge structure at roof level. While this steel member is protected within the fire wall from a fire in the MEH, it is exposed to the link bridge without any additional fire protection.

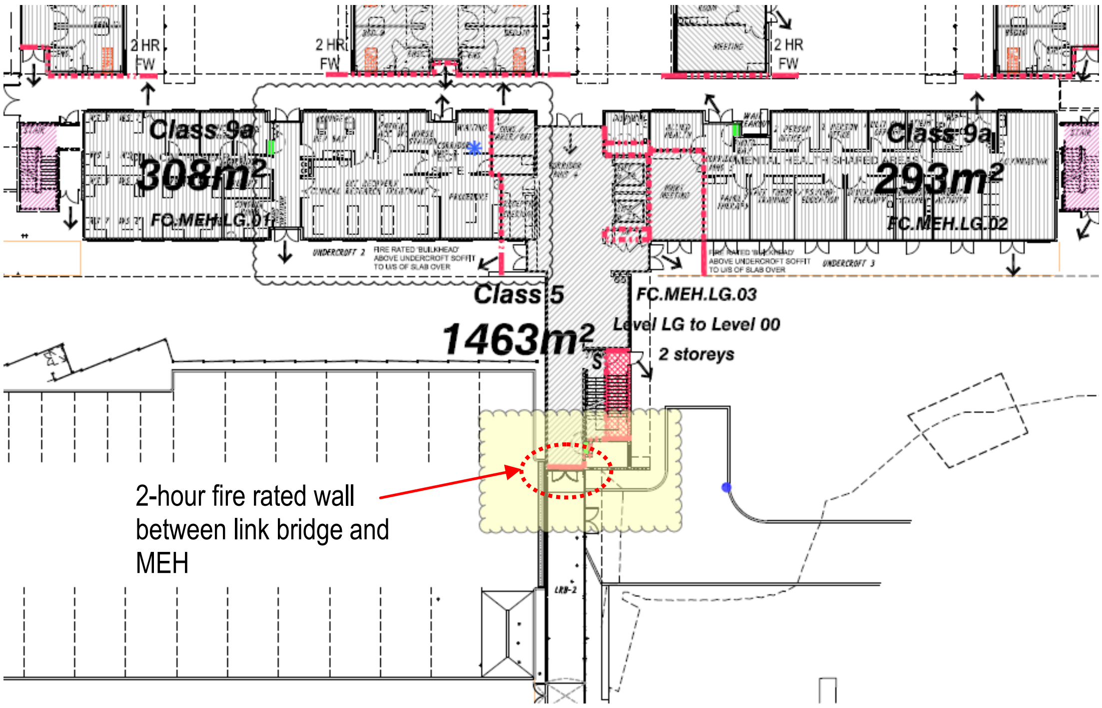


Figure 14.8 Fire rated link bridge wall

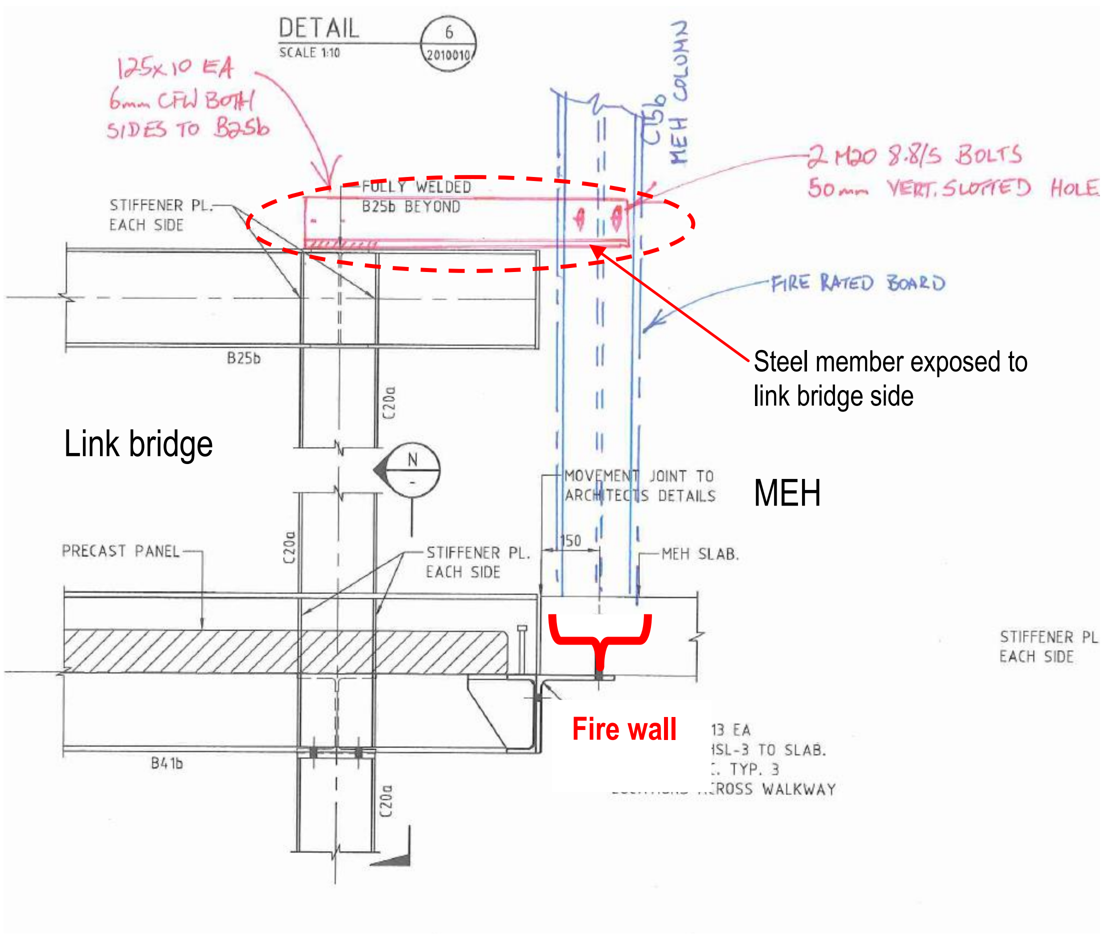


Figure 14.9 Fire wall section view

However, considering the lack of fire load or ignition source in the link bridge, used for access between buildings, the risk of a fire developing and affecting the exposed steel member from the fire wall is considered unlikely. Therefore it is considered acceptable for the steel support member to be exposed to the link bridge without requiring any additional fire rating.

14.5 Conclusion

The statement provided by the Structural Engineer demonstrates that the fire wall and the elements that pass through, or connect to, the fire wall have been specifically designed to ensure that partial or complete collapse of structure as a result of fire on one side of the fire wall will not adversely affect the structural adequacy or integrity of the wall.

Apart from the members specifically discussed in Sections 14.2 & 14.4 above, fire-rated sprayed-on protection will be provided to each structural element that passes through the fire wall, back to the closest connection to another supporting member, on both sides of the fire wall. The sprayed-on protection will achieve the 2 hour FRL required of the fire wall as part of the structural solution, and to reduce the risk of fire spread occurring via conductive heat transfer through the steel members that pass through the fire wall. Consequently the structural adequacy, integrity and insulation requirements for the wall are considered to be maintained.

With the above measures in place, the design of the fire wall is considered to achieve the requirements of DTS Provision C2.7(a)(iii), and therefore complies with the Performance Requirement s CP1 and CP2.

15. Compliance Issue 12: Fire hose reels pass through doorways fitted with fire and smoke doors

Table 15.1 Compliance issue 12

Compliance Issue		DTS clause & Perf. Requirement	Approach & method of analysis	Acceptance criteria
12	Fire hose reels pass through doorways fitted with fire and smoke doors	DTS clause E1.4	Approach: Qualitative	Agreement with Building Certifier and QFES
		Perf. requirement CP2, CP3, DP5 and EP1.1	Method: Fully compliant hose reel coverage to be maintained to all parts of the building FHRs do not pass through or into required fire compartmentation or fire-isolated stairways	

15.1 Introduction

Under the DTS Provision E1.4(c)(iv), fire hose reels are not permitted to pass through doorways fitted with fire and smoke doors. A number of smaller smoke and fire compartments have been formed on L00 to provide separation to comms rooms and minor plant rooms, as well as an interview and a dirty utility room on LG. These rooms are less than 100 m^2 in area (generally single rooms around 20 m^2), and it is not considered practical to install fire hose reels in each of these rooms. In addition, the catwalks providing access to the central plant room from either fire-isolated stairway are smoke separated from the plant room, are not provided with fire hose reels. Therefore fire hose reel coverage to L00 of the Ward Block is not fully compliant with DTS Provision E1.4. The relevant areas are shown in Figure 15.1 to Figure 15.4 below.

15.2 Analysis

The Guide to the BCA provides additional commentary on the basis for the requirements of E1.4:

"Fire hose reels are not permitted to be installed within a fire-isolated exit, thereby avoiding having the hose pass through the door to access the fire. Such an arrangement would require the exit to be open, and thereby cause a significant risk of smoke entering.

The same concerns do not apply to the other Deemed-to-Satisfy Provisions listed at the end of ***E1.4(c)(iv)****."*

The commentary in the Guide makes it clear that this requirement is intended to safeguard required fire-isolated exits. In the case of the MEH plant and comms rooms on L00, the majority of the compartmentation lines that would be crossed by fire hose reels are not required under the DTS Provisions, but are rather a user requirement intended to separate parts of the building for asset protection purposes. Other areas such as the catwalks are only separated from the plant room they serve for convenience, as it is not practical to provide smoke separation to open catwalks. The travel distances on Level 00 of the ward Block to the nearest fire-isolated stairway are DTS compliant, and therefore fire-isolated passages or horizontal exits are not a requirement in terms of means of escape under the DTS Provisions.

Both access catwalks can be served by the fire hose reel located within the central plant room, and therefore hose reels do not need to cross the required fire walls separating the three fire compartments in the Ward Block. In addition, fire hose reels do not need to pass into, or through, the two fire-isolated stairways serving L00. Consequently, as the travel distances are DTS compliant and the integrity of the required fire walls and fire-isolated exits is not compromised, the intent of DTS Provision E1.4 is considered to have been achieved, and therefore the proposed location of fire hose reels on L00 and LG of the MEH Ward Block is considered acceptable.

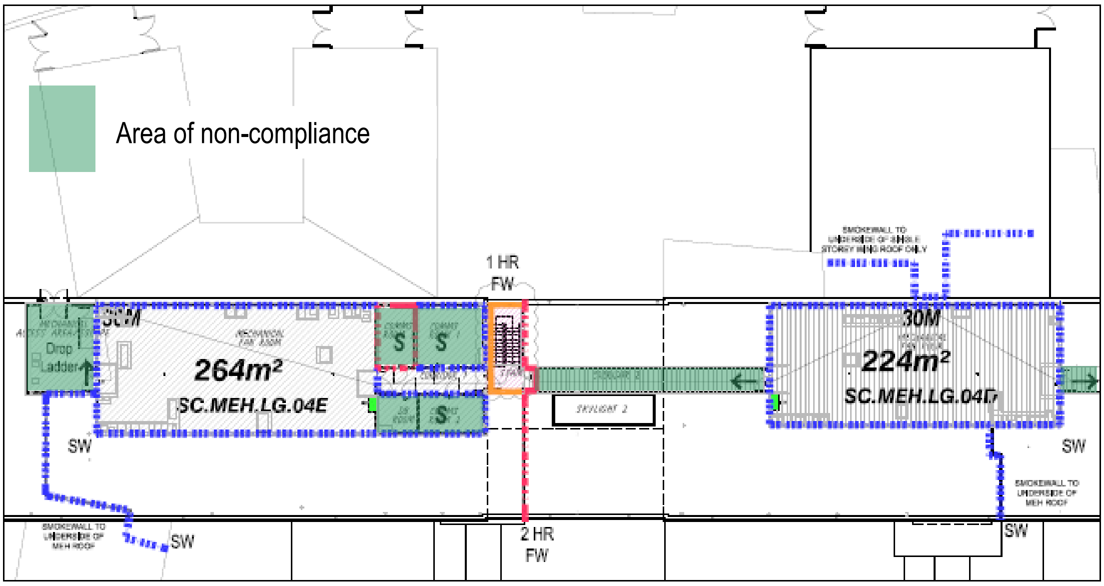


Figure 15.1 Level 00 floor plan of Ward Block (West) showing extent of non-compliance with fire hose reel requirements (adapted from part drawing PSH-AR-MEH-DWG-2600100)

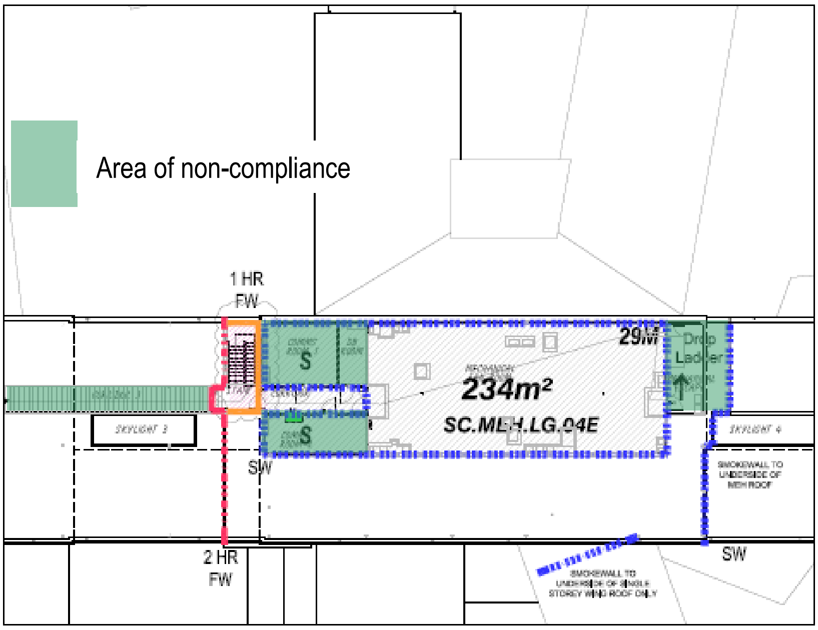


Figure 15.2 Level 00 floor plan of Ward Block (East) showing extent of non-compliance with fire hose reel requirements (adapted from part drawing PSH-AR-MEH-DWG-2600100)

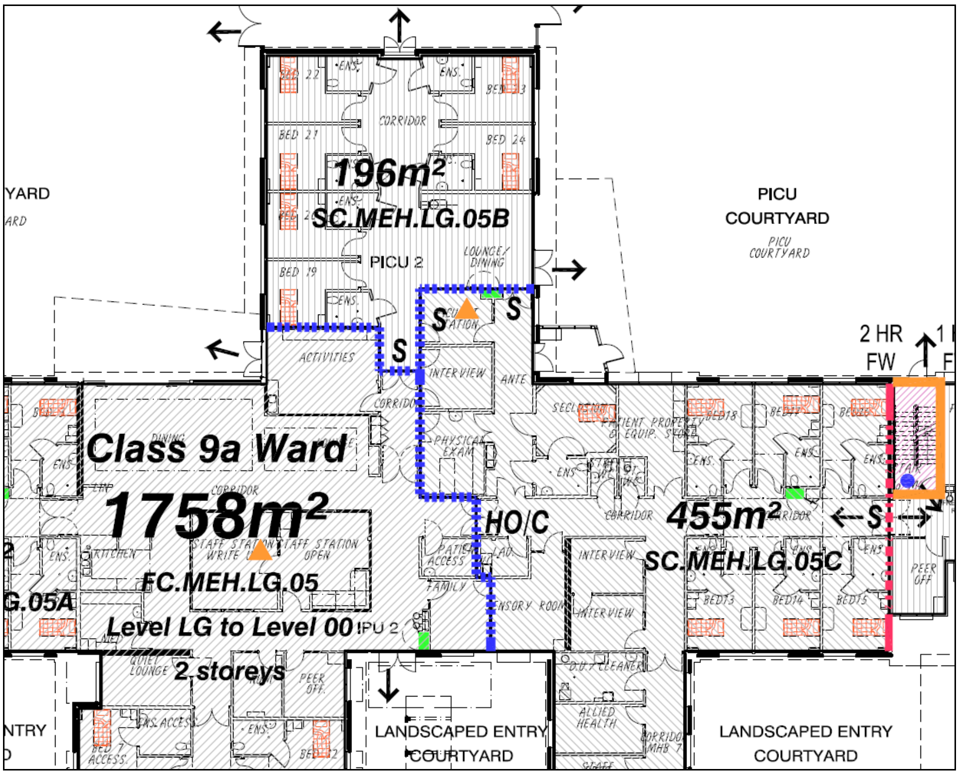


Figure 15.3 Lower Ground floor plan (centre) showing extent of non-compliance with fire hose reel requirement (to interview room) (adapted from part drawing PSH-AR-MEH-DWG-26LG100)

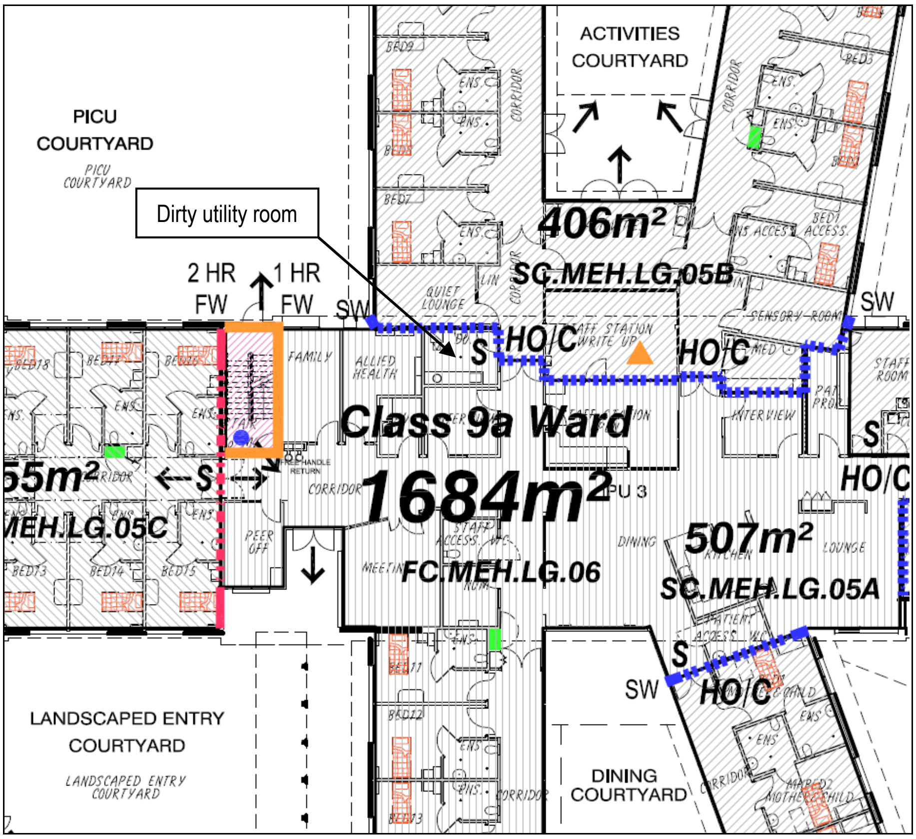


Figure 15.4 Lower Ground floor plan (east) showing extent of non-compliance with fire hose reel requirement (to dirty utility room) (adapted from part drawing PSH-AR-MEH-DWG-26LG100)

The following key points are noted in relation to this alternative solution:

- The building is provided with a non-required sprinkler system which will reduce the risk of fire growth, and consequently the need for occupants to utilise fire hose reels for first aid fire fighting purposes
- The building is provided with a fully compliant fire hydrant system to enable fire brigade intervention
- Fire hose reels do not cross required fire compartment walls or into or through fire-isolated stairways
- Travel distances and compartment sizes are DTS compliant and therefore the fire and smoke separation through which fire hose reels need to pass is not required under the DTS Provisions for occupant egress purposes
- L00 of the Ward Block is not publically accessible and will only be intermittently occupied by a small number of trained maintenance personnel – the risk of smoke logging exit routes and compromising occupant egress due to the use of fire hose reels is therefore considered to be low; the interview room and dirty utility room on LG, both being a small single room with limited fire load, are considered a minimal risk, especially with the provision of sprinkler system
- Fire hose reel coverage is fully compliant with AS 2441
- The spaces not provided with compliant fire hose reel coverage discussed above are very small (generally single rooms around $20m^2$ in area each)
- The DTS Provisions specifically allow for fire hose reels to pass through doorways fitted with fire and smoke doors in similar situations (i.e. electricity substations, sole-occupancy units in Class 2 and 3 buildings and openings in shafts.

15.3 Performance requirements CP2, CP3, DP5, EP1.1

In accordance with the Performance requirements CP2, CP3, DP5, EP1.1 detailed in Section 2.8 of this report, buildings must have elements which will avoid the spread of fire and smoke to fire exits and egress paths to allow building occupants to safely evacuate without being affected by spread of fire or smoke.

As the subject rooms are protected by sprinkler system and either fire or smoke separated from the rest of the building space the smoke from a fire within these rooms is expected to be contained within the room if the fire is not successfully suppressed by the sprinkler system.

Therefore the potential risk of smoke or fire spread from these rooms to the other areas of building during evacuation process can only occur if the fire or smoke door to the room of fire origin is obstructed by fire hose reel abandoned by its user after an unsuccessful attempt to suppress the fire using the hose reel.

However, in view of the small size of the rooms identified above, the severity of fire is expected to be apparent to the building occupants and any significant fire or smoke spread within the rooms is expected to deter the building occupants from entering. Therefore the risk of the smoke or fire door to the subject room being obstructed by hose reel in the event of a major fire in these rooms is considered remote. It should be noted that the provision of fire hose reels, in accordance with Section E1.4 of the BCA Guide, is, *" to enable, where appropriate, a building's occupants to undertake initial attack on a fire."*. Therefore it is not mandatory for building occupants to use fire hose reels in the event of a fire, especially when the fire is deemed by the building occupants to be too great to fight.

Even in the unlikely event of the fire or smoke doors to one of the subject rooms being obstructed by a hose reel abandoned by its user in an unsuccessful attempt to suppress the fire, the spread of smoke will be limited to the smoke compartment outside as shown in Figure 15.1 to Figure 15.4 above and not affect the rest of the building spaces. It is expected that with the warning from the smoke detection alarm system and various visual and audio cues, the occupants in the same smoke compartment as the fire origin would have been aware of a fire during the initial fire fighting by other occupants using hose reel occurs and therefore expected to evacuate at early stage.

As per Table 15.2 below, only in an extreme event of failure of both sprinkler system and hose reel to suppress a fire in addition to obstruction of the door by hose reel can smoke spread beyond the room of fire origin; in which event the smoke is still expected to be contained within the smoke compartment outside the room and not impact on the rest of the building spaces.

Table 15.2 Matrix of various fire events

fire suppression by sprinkler	manual fire fighting using hose reel	manual fire suppression by hose reel	smoke/ fire door to room close remain close during fire	smoke spread beyond room	smoke spread beyond next smoke compartment
yes	not required	n/a	not relevant	nil	nil
no	yes	yes(small fire)	not relevant	nil	nil
no	no (fire size deemed big to fight using hose reel)	no	yes	nil	nil
no	yes	no (unsuccessful attempt)	yes (user left room with hose reel)	nil	nil
no		no (unsuccessful attempt)	no (obstructed by hose reel abandoned by user)	yes	nil (contained by smoke separation)

15.4 Conclusion

The mitigating features discussed above are considered to demonstrate that the intent of E1.4 as expressed in the Guide to the BCA (in terms of fire hose reels passing through fire and smoke doors) has been met. That is to say, the non-provision of fire hose reels in minor plant, comms rooms and the central plant room catwalks, as well as the singles rooms on LG is not considered to present a risk of smoke spread to required fire-isolated exits.

The design is therefore considered to comply with the Performance Requirements CP2, CP3, DP5 and EP1.1.

16. Compliance Issue 13: Fire detection and alarm system

Table 16.1 Compliance issue 13

Compliance Issue		DTS clause & Perf. Requirement	Approach & method of analysis	Acceptance criteria
13	The proposed MASD system on the egress paths to exits in some of the Class 9a patients care area in lieu of the ionisation type detector does not meet the requirements of Specification E2.2a of the BCA 2008	DTS clause Specification E2.2a, clause 4(d)(i)(A)	Approach: Qualitative	Demonstration of equivalency of the proposed MASD system with the BCA compliant system
		Perf. requirement EP2.1	Method: comparison of the performance of the MASD system with ionisation type detector.	

16.1 Introduction

In accordance with Clause 4(d)(i)(A) of Specification E2.2a of BCA, alternate photoelectric and ionisation type detectors must be installed in the path of travel to exits from Class 9a patient care areas.

It is proposed to provide MASD system in several patient care areas within the MEH building in lieu of alternating photoelectric and ionisation type detectors.

16.2 Analysis

The MASD system is an aspirated type detector which detection is based on the level of product of combustion in the air sample actively drawn through tubes to the system analyser and is considered a variant of the photoelectric type detector.

However, as per the information attached in Appendix (G) of this report, provided by Xtralis Australia, the sensitivity of MASD system can be adjusted to exceed the range achievable with the standard ionisation or photoelectric detectors.

Therefore the proposed alternative solution is considered to be at least equivalent to the Deemed-to-Satisfy provision of the BCA.

16.3 Conclusion

The design is therefore considered to comply with the Performance Requirements EP 2.1.

17. Compliance Issue 14: Smoke proof wall construction

Table 17.1 Compliance issue 14

Compliance Issue		DTS clause & Perf. Requirement	Approach & method of analysis	Acceptance criteria
14	Construction of smoke proof walls with plywood timber nogging on the inside.	<u>DTS clause</u> C2.5, Specification C2.5	<u>Approach:</u> Absolute Qualitative Deterministic	Demonstration through analysis that the performance requirements of a smoke wall can still be achieved with the proposed system.
		<u>Perf. requirement</u> CP 2, CP 3	<u>Method:</u> Analysis of the relevant performance requirements.	

17.1 Introduction

It is proposed to use a plywood timber nogging on the inside of the smoke proof walls proposed for the smoke compartmentation of the patient care areas in MEH. This is not compliant with Specification C2.5 of BCA, which specifies that smoke proof walls must be constructed of non-combustible material.

As shown below the sketches below, the smoke walls are constructed of powerscape board with steel stud system in between; however plywood sheet nogging has been incorporated in the wall as strengthening for the wall.

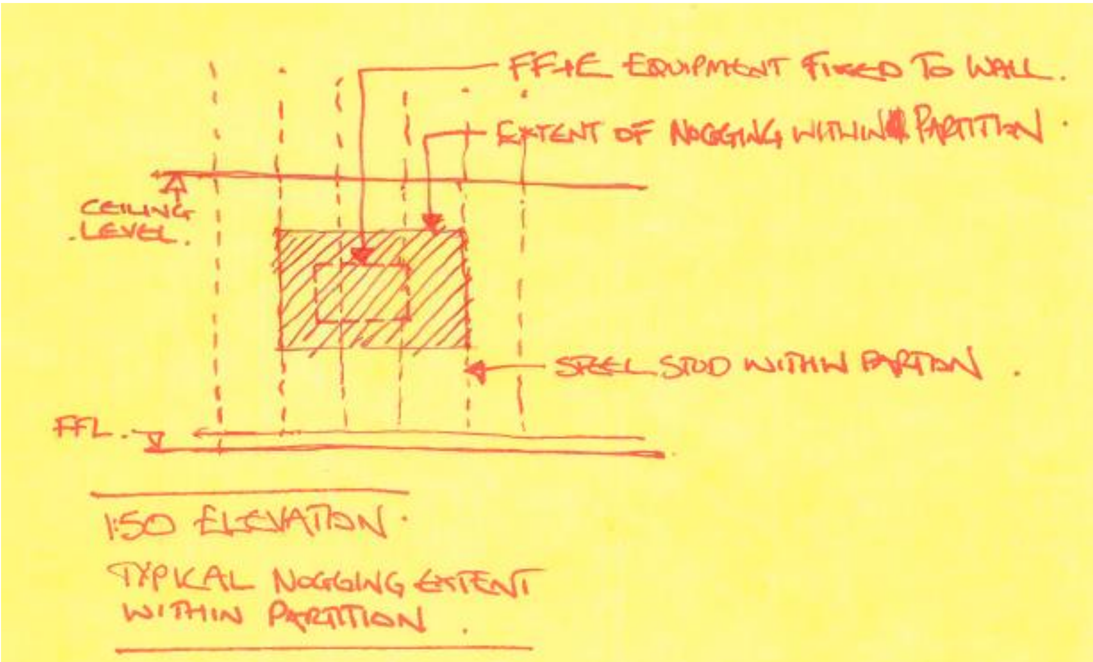


Figure 17.1 Elevation view of smoke wall (plywood timber nogging within wall shown as hatched area)

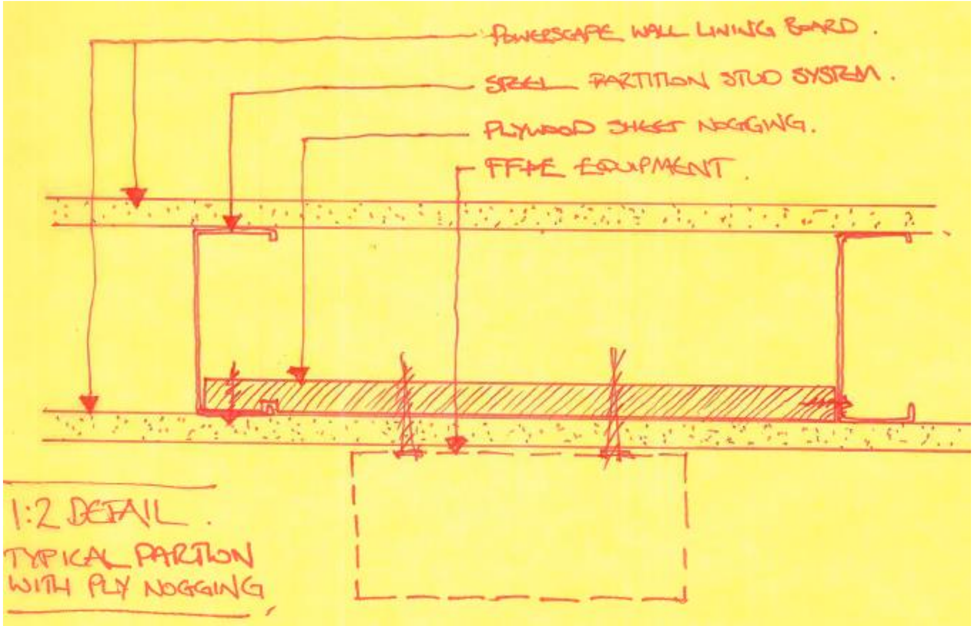


Figure 17.2 Section view of smoke wall from top (plywood timber nogging within wall shown as hatched area)

As the plywood is protected by compliant, non-combustible powerscape board, the smoke proof wall is considered to still meet the requirement of Specification C2.5 of being not combustible. In the event of a fire adjacent to the smoke walls, it is unlikely that the plywood nogging would ignite as it is shielded from direct contact with flame from the powerscape board. A number of fire testing on fire systems involving the use of Powerscape as the wall material, such as Fire Rating Test Report CSIRO 1458FSV and FSP1464A appear to indicate that Powerscape board has up to 2 hours of fire rating, which is expected to provide sufficient protection to the timber noggin within.

It should be noted that a smoke proof wall is not a fire rated system and therefore not required to withstand a well-developed fire; a smoke proof wall is only provided to assist patient evacuation by mitigating smoke spread to the patient areas and egress paths at the early stage of fire event at which the external powescape board lining is expected to remain intact.

17.2 Conclusion

The design is therefore considered to comply with the Performance Requirements CP 2 & 3.

18. Compliance Issue 15: Sprinkler Coverage

18.1 Introduction

Table 18.1 Summary of compliance Issue 15

Compliance Issue		DTS clause & Perf. Requirement	Approach & method of analysis	Acceptance criteria
15	Proposed deletion of sprinkler coverage to: • EDB cupboards, and • a canopy in courtyard LG.MHX.022 adjacent o Stair M1 on the Lower Ground of MEH	<u>DTS clause</u> E1.5	<u>Approach</u>: Absolute Qualitative Deterministic.	The risk of a significant fire developing in the non-sprinkler protected EDB cupboards and overwhelm the sprinkler system in the rest of building areas is unlikely.
		<u>Perf. requirement</u> EP1.4	<u>Method</u>: Assessment of risk of fire development in these areas without sprinkler coverage.	

18.2 Fire Engineering Analysis

18.2.1 EDB cupboards

It is proposed not to provide sprinklers within the EDB cupboards (Electrical Distribution Board); this is a variation from BCA and AS 2118.1- 1999 across all GCUH buildings. The provision of sprinklers in electrical areas represents a safety hazard to the occupants and fire fighters and therefore should be avoided.

A typical EDB cupboard in GCUH buildings is shown in the following photos:

Figure 18.1 Typical EDB cupboard – photo 1

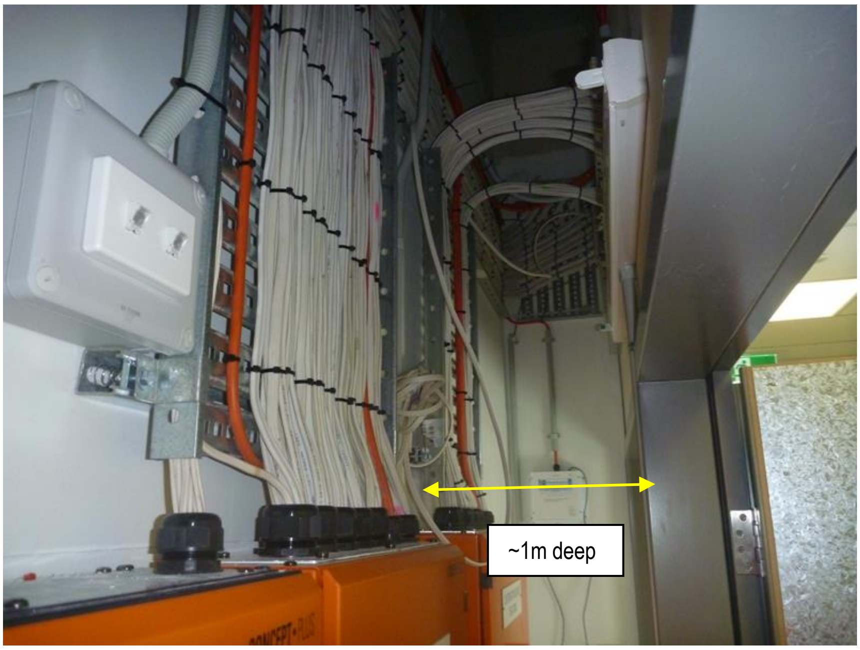


Figure 18.2 Typical EDB cupboard – photo 2 (Interior)

Figure 18.3 Typical EDB cupboard – photo 3 (top)

The plan and section views of a typical EDB cupboard are shown in Figure 18.6 below.

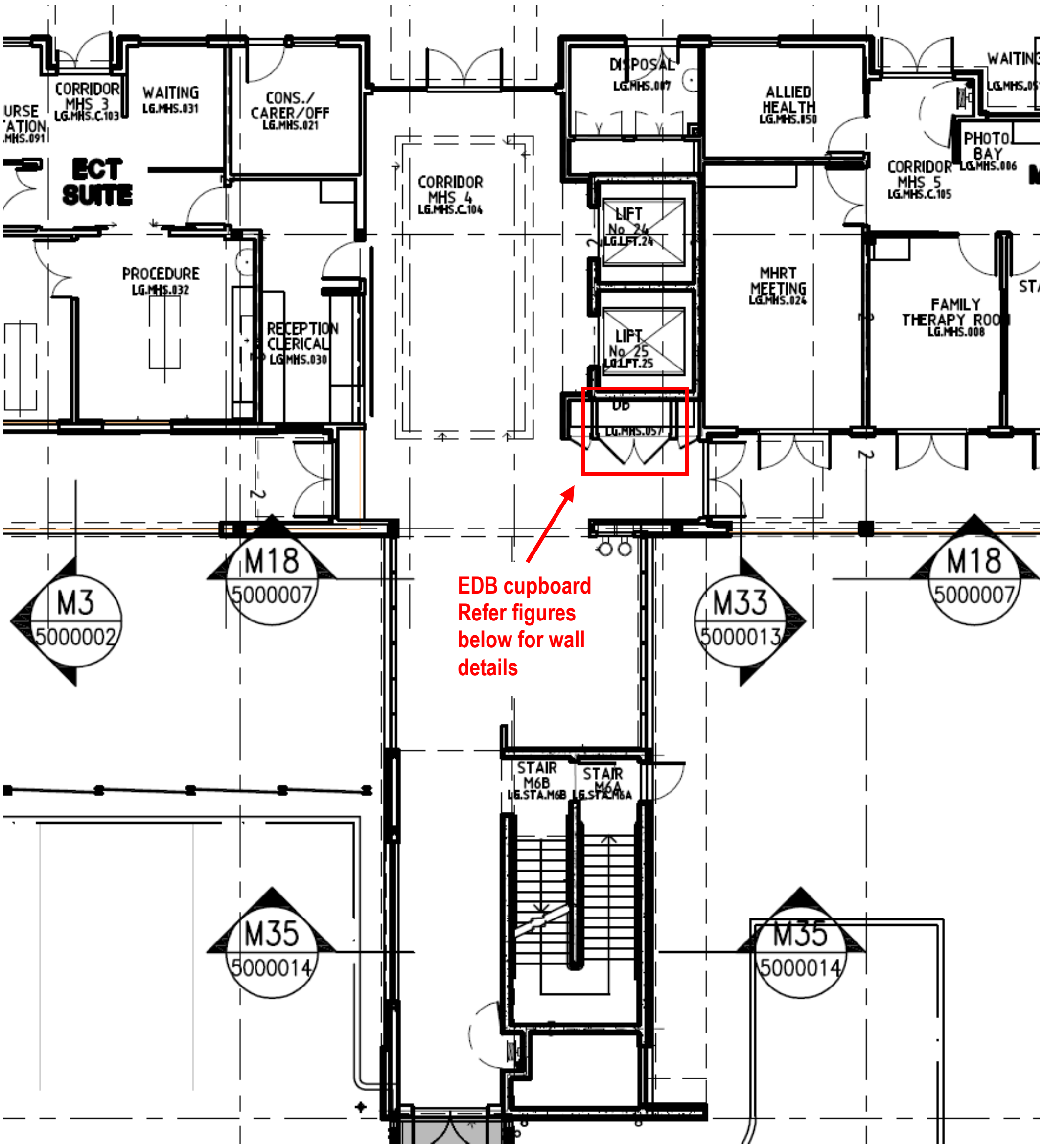


Figure 18.4 Typical EDB cupboard location (MEH Level LG)

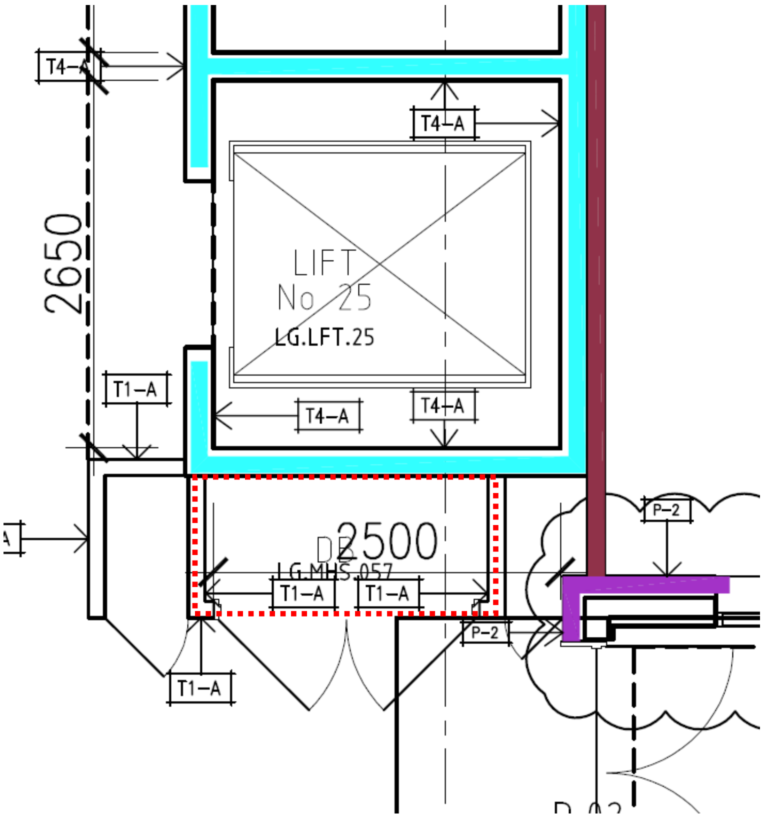


Figure 18.5 EBD cupboard construction wall types

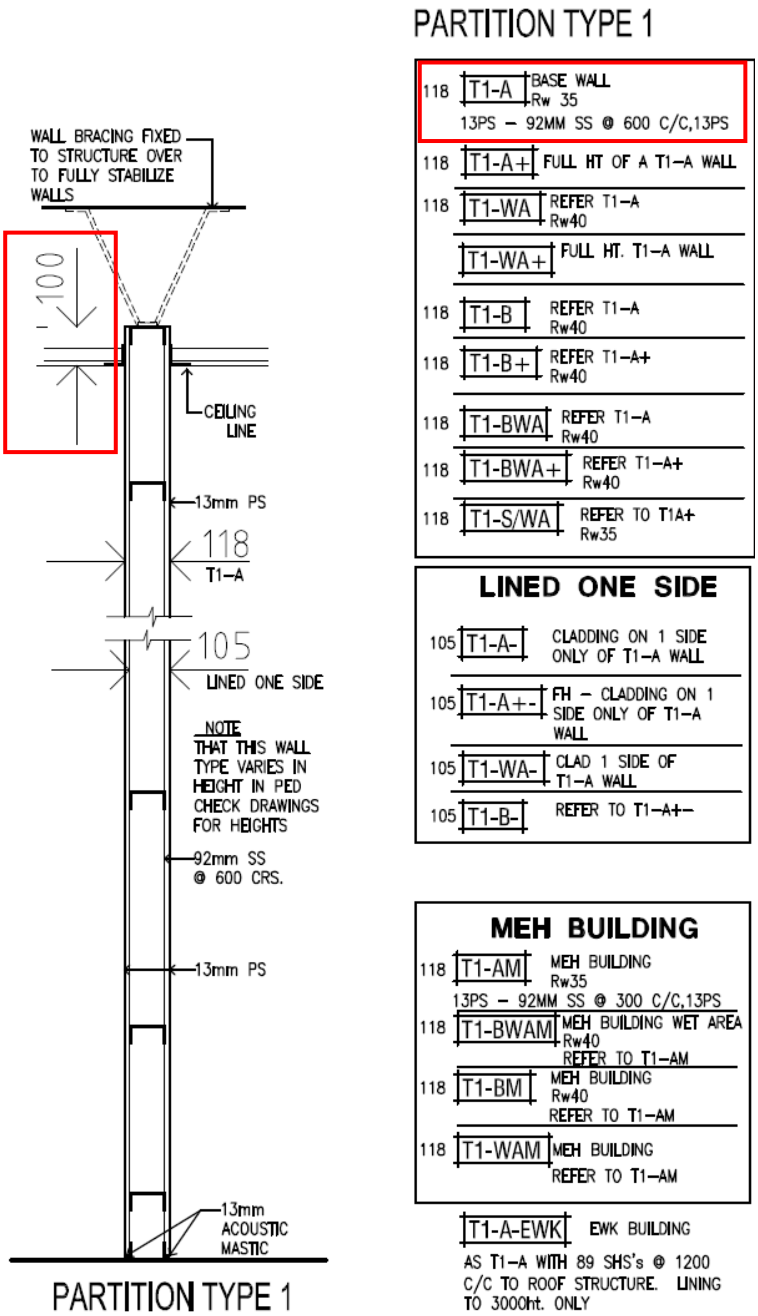


Figure 18.6 Section details of smoke wall T1-A

As shown above, a typical EDB cupboard is approximately 2.5m wide by 1m deep and contains mainly an electrical distribution board and cables.

In view of the limited size and fire load present within the EDB cupboard, a fire occurring within the cupboard is expected to be of low or mild intensity and the damage restricted within the cupboard. The heat release rates of typical cable fires obtained from a calorimeter test at University of Lund are shown in Figure 18.7 below:

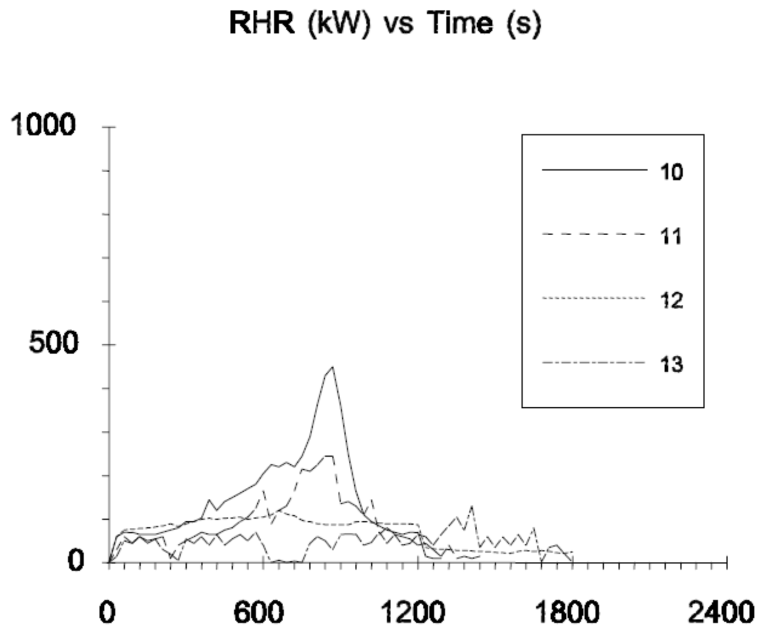


Figure 18.7 Typical heat release rates of cable fire (sample 10 comprises 35 cables in single layer arrangement), extracted from Initial Fires[††]

As shown in the above fire test data, cable fires have very slow fire growth rate (slower than a 'Slow' t^2 fire which reaches 1MW in 600 seconds) and the heat release is limited; the peak heat release rate achieved by a sample of 35 cable is less than 0.5MW over a period of 900 seconds. Therefore, the spread of fire beyond the cupboard to the rest of the floor is expected to be mitigated by the sprinklers installed throughout the rest of the floor and unlikely to overwhelm the AS2118.1 sprinkler system. As cables are not highly combustible, the risk of a fire start is low, especially within the EDB cupboard where ignition source is limited.

In addition, to mitigate the impact of from a fire within the EDB cupboard to the rest of the building, it is to be constructed of smoke proof walls extending at least 100 mm above the ceiling line and smoke stop doors, as shown in Figure 18.6 above. The building smoke detection system is to extend into the EDB cupboards to provide warning to the building occupants at the early stage of a fire in the cupboard for evacuation.

Any penetrations through the floor slabs are fire stopped to the same FRL requirement for the floors to maintain the fire compartmentation between floors.

18.2.2 Courtyard canopy

It is proposed not to provide sprinkler coverage to a canopy in courtyard LG.MHX.022 adjacent o Stair M1 on the Lower Ground of MEH, as shown in Figure 18.8 below:

[††] Initial Fires, Stefan Sardqvist, University of Lund, April 1993

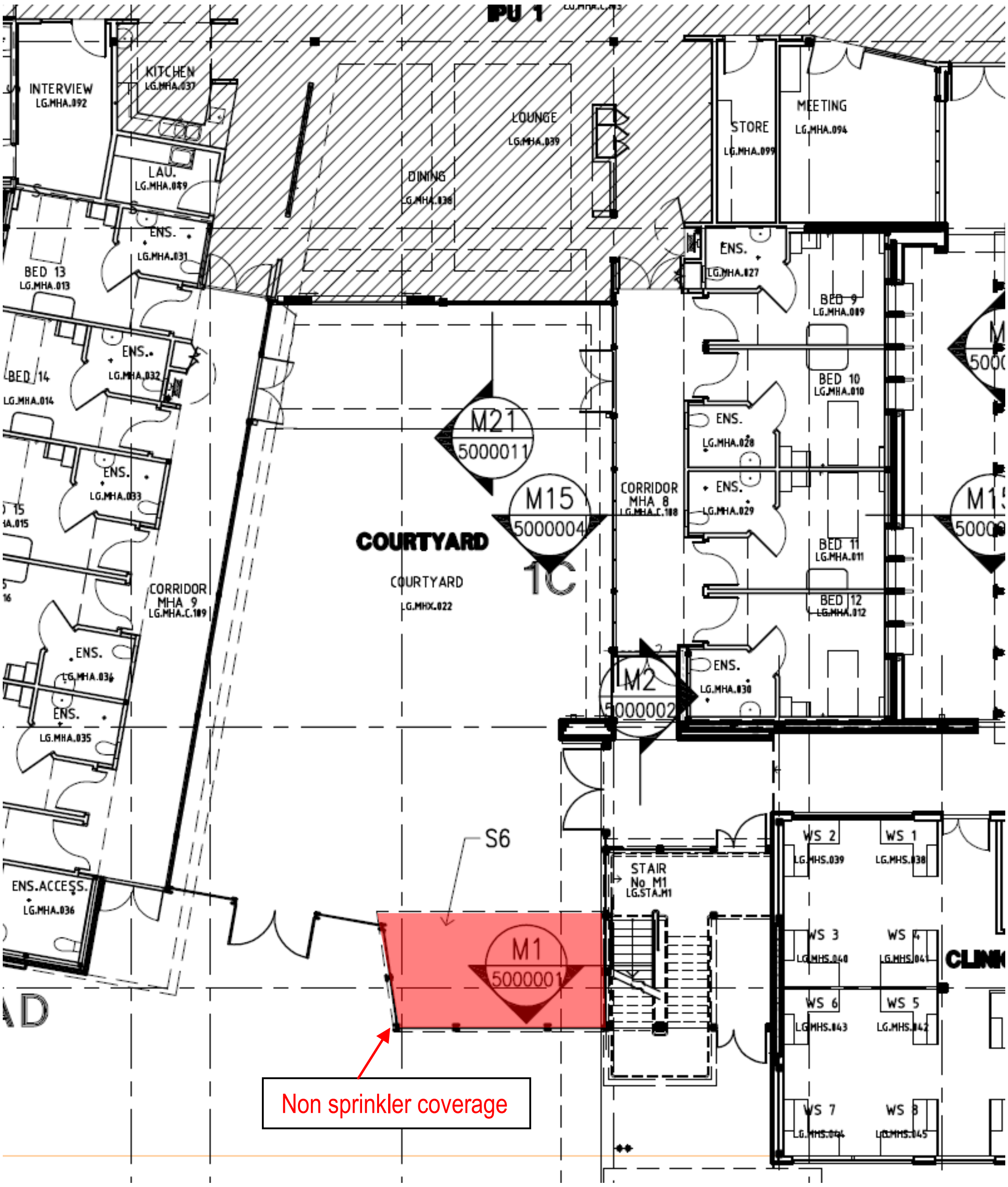


Figure 18.8 Non sprinkler protected canopy in courtyard

Figure 18.9 Non-sprinkler protected canopy in courtyard (proposed wording for signage)

Sprinkler coverage is required by AS211.8.1 to underside of any canopy with a width of more than 2.5m in width as the area underneath large canopy of roof overhand could be used for storage of combustible items.

As the area underneath the canopy is not intended to be used for storage and therefore not expected to contain any significant fire load. Therefore even in an unlikely event of a fire occurring in this area, the fire is not expected to be able to overwhelm the sprinkler system provided in the building. The courtyard is open at the top, therefore any fire in this area will be vented directly to the atmosphere.

The MEH building is a highly supervised environment with staff present in the premises full time; therefore the risk of arson is considered low; in addition, the building is provided with portable fire fighting equipment such as fire hose reels and extinguishers, which are available for use by the staff for fire fighting at the early stage of a fire.

It must be included in the management-in-use for the building to prohibit the use of the area under this canopy for storage at any times. A signage must be provided in this area to inform the staff of this restriction.

18.3 Conclusion

As per the above analysis, the proposed alternative solution is considered to comply with the performance requirements EP1.4 of the BCA.

19. Compliance Issue 16: Smoke doors to swing in the opposite direction to egress

Table 19-19.1 Summary of compliance Issue 16

Compliance issue		DTS clause & perf. requirement	Approach & method of analysis	Acceptance criteria
16	With progressive horizontal evacuation strategy, smoke doors separating smoke compartments in Class 9a Ward Areas doors may not swing in the direction of travel	DTS clause C2.5, Spec C3.4 Cl. 3.2(a)	Approach: Qualitative, comparative	Agreement by Building Certifier and QFES
		Perf. requirement DP2(b), CP3	Method: Provision of locally triggered hold open devices provided to relevant smoke doors	

19.1 Analysis

The overarching strategy for evacuation of patient care areas in the MEH is to minimise the movement of patients wherever possible. A key component of this strategy is the use of horizontal evacuation, where occupants are moved through a smoke or fire compartment wall in the first instance and the decision to move occupants further made on a risk basis.

The adoption of a horizontal evacuation strategy offers significant advantages for the management of patients who may not be capable of self evacuation, or for whom it would be undesirable to evacuate to the outside. A horizontal progressive evacuation strategy is used in one form or other in the majority of large hospitals within Australia and around the world. However, one implication of a horizontal evacuation strategy is that the direction of travel in an emergency will change depending on the location of the incident. This in turn can generate a non-compliance with BCA DTS Provision C2.5 and the associated Specification C3.4, which require that a smoke door must swing in the direction of travel.

As an alternative solution it is proposed that the majority of required smoke doors on the path of travel between smoke compartments in Class 9a Ward Areas in the MEH Building will be on magnetic hold open devices and will be closed only by activation of a smoke detector located within 1.5 m of the door. This means that smoke doors are provided with the opportunity to remain open for as long as is safely possible, allowing for efficient evacuation from either direction. Having the smoke doors on hold open devices triggered only by local smoke detection is in itself an alternative solution that is covered in Section 9 of this FER.

The provision of locally triggered hold open devices on the majority of required smoke doors will provide the best opportunity for unimpeded egress from one smoke compartment to another irrespective of direction of door swing, and therefore the design is considered to comply with the Performance Requirement DP2.

In two (2) instances, smoke doors that swing against the identified direction of egress are also secure doors – both these doors are located in smoke compartment SC.MEH.LG.05B, as shown in Figure 19.1.

SC.MEH.LG.05B is a PICU (Paediatric Intensive Care Unit), and as such it is unlikely that during the execution of a horizontal evacuation, staff would elect to move adult patients into a PICU. At least two alternative egress routes into a separate fire compartment (FC.MEH.LG.06) and a separate smoke compartment (SC.MEH.LG.05A) are available from the smoke compartment (SC.MEH.LG.05C) from where the smoke doors in question will swing in the wrong direction. The smoke doors leading into SC.MEH.LG.05A are fitted with a hold open device, and therefore comply with the Alternative Solution detailed above.

Therefore given the potential risk of evacuating into a PICU, and the provision of alternative egress routes into different fire or smoke compartments, it is considered that the two smoke doors in question are unlikely to form part of a horizontal evacuation strategy from SC.MEH.LG.05C. Consequently it is not considered necessary for these smoke doors to swing in the direction of egress from SC.MEH.LG.05C.

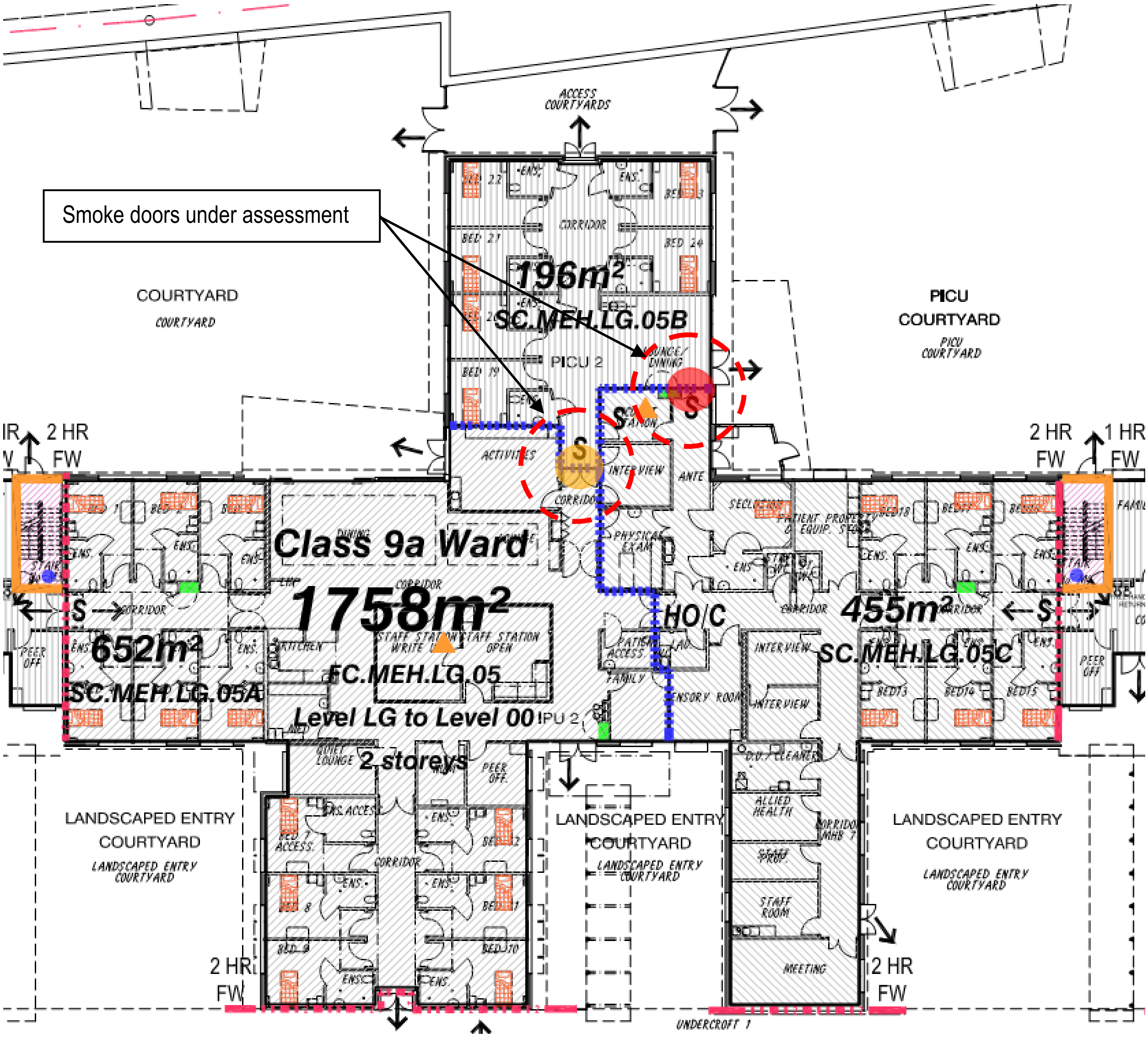


Figure 19.1 Smoke Doors that Swing in the Opposite Direction from Egress (incl. for two-way Horizontal Evacuation)

19.2 Additional signage

As per request of QFES, a "Push" or "Pull" signage must be provided on both sides of all doors on egress paths designed to swing both ways to assist the building occupants identify the direction of egress during a fire emergency (this includes the two secure smoke doors in SC.MEH.LG.05B that are not on hold open devices) .

19.3 Conclusion

As per the above analysis, the proposed alternative solution will facilitate the evacuation of patients in an emergency and it is considered to meet the Performance Requirements DP2(b) and CP3 of the BCA.

20. Conclusions

20.1 This is the Fire Engineering Report (FER) for the Gold Coast University Hospital. This Volume of the FER (Volume 2) covers the Mental Health Building (MEH).

20.2 The purpose of this FER is to provide the background upon which the basis of the analysis was agreed (i.e. the FEB), the subsequent evaluation and results, and the drawing of conclusions on Building Code compliance. Ten compliance issues have been considered:

20.3 Compliance Issue 1: Fire Compartment Size

- The first compliance issue relates to the concern covered walkways connecting different fire compartments constitute oversized compartments.
- This basis of justification includes details of:
  a. The compliance issue (fire spread between compartments)
  b. The DTS clause of the BCA from which it departs, C2.5
  c. The BCA performance parameters relating to the DTS clause, CP3 (and to a lesser extent CP2)
  d. The proposed alternative solution and its:
     i. Approach (quantitative, absolute, deterministic)
     ii. Method of analysis (CFD analysis)
     iii. Acceptance criteria (heat flux does not exceed 20 kW/m^2)
- It is concluded that fire spread does not occur with the presence of covered walkways and the Performance Requirements CP2 and CP3 are therefore satisfied.

20.4 Compliance Issue 2: Non-provision of 30 minutes FRL to floor separating storeys in Class 9a building.

- The second compliance issue relates to the use of unprotected steel columns and beams supporting the Level 00 fan and electrical room floors which are required to have a 30 minute FRL.
- This basis of justification includes details of:
  a. The compliance issue (non-provision of a fire separation between storeys)
  b. The DTS clause of the BCA from which it departs, C1.1 Spec C1.1 Clause 4.1(i)
  c. The BCA performance parameter relating to the DTS clause, CP2
  d. The proposed alternative solution and its:
     i. Approach (quantitative, absolute, deterministic, and qualitative)
     ii. Method of analysis (Plume temperature analysis)
     iii. Acceptance criteria (Steel temperature does not exceed 460 °C)
- It is concluded that with the provision of a non-required sprinkler system and encasing the columns with 13 mm Powerscape board, the design will comply with the Performance Requirement CP2.

20.5 Compliance Issue 3: Exit Travel Distance Level B1

- The third compliance issue relates to a single exit travel distance of 31 m at Level B1 from the Substation to Stair 6
- This basis of justification includes details of:
  a. The compliance issue (extended exit distance 31 m > 20 m)
  b. The DTS clause of the BCA from which it departs, D1.4
  c. The BCA performance parameter relating to the DTS clause, DP4
  d. The proposed alternative solution and its:
     i. Approach (quantitative, comparative, deterministic)
     ii. Method of analysis (Compare difference in detection time($\Delta t_{detection}$) with difference in travel time (Δt_{travel}))

iii. Acceptance criteria ($\Delta t_{detection} \geq \Delta t_{travel}$)

- It is concluded that provision of automatic smoke detection provides an overall RSET that is less than that provided by a DTS complaint solution, and therefore the design complies with the Performance Requirement DP4.

20.6 Compliance Issue 4: Oversized Smoke compartment

- The fourth compliance issue relates to smoke compartment size
- This basis of justification includes details of:
  a. The compliance issue (smoke compartment area > 500 m^2)
  b. The DTS clause of the BCA from which it departs, C2.5
  c. The BCA performance parameters relating to the DTS clause, CP2 and CP3
  d. The proposed alternative solution and its:
     i. Approach (quantitative, comparative, deterministic)
     ii. Method of analysis (Calculate the ASET of the Trial Design and compare to a representative DTS building)
     iii. Acceptance criteria (Trial Design ASET ≥ DTS ASET)
- It is concluded that with the oversized smoke compartments satisfy the Performance Requirements CP2 and CP3.

20.7 Compliance Issue 5: Security of FHR cabinets

- The fifth compliance issue relates to the security of FHR cabinets in patient areas
- This basis of justification includes details of:
  a. The compliance issue (FHR cabinets to be key locked with no frangible panel)
  b. The DTS clause of the BCA from which it departs, E1.3
  c. The BCA performance parameters relating to the DTS clause, EP1.3
  d. The proposed alternative solution and its:
     i. Approach (qualitative, absolute)
     ii. Method of analysis (the patient accessible areas will have high level of supervision and staff will all have keys)
     iii. Acceptance criteria (agreement by Building Certifier and QFES)
- It is concluded that the proposed locations and methods of securing the MCPs and FHRs will comply with the Performance Requirements EP1.3.

20.8 Compliance Issue 6: Fire door automatic hold open device release mechanism

- The sixth compliance issue relates to the operation of the exit fire door while evacuate mental health patients under emergency events
- This basis of justification includes details of:
  a. The compliance issue (fire door hold open device only releasing upon local smoke detector activation within 1.5 m of doors)
  b. The DTS clause of the BCA from which it departs, E2.2a
  c. The BCA performance parameters relating to the DTS clause, EP2.2
  d. The proposed alternative solution and its:
     i. Approach (qualitative, absolute)
     ii. Method of analysis (ease of travel to adjacent fire/smoke compartment particularly while moving patients in Ward areas)
     iii. Acceptance criteria (agreement by Building Certifier and QFRS)
- It is concluded that the proposed strategy for release of automatic hold open devices on fire and smoke doors will comply with the Performance Requirement EP2.2

20.9 Compliance Issue 7: Alternate egress ladders from Level 00 plant rooms do not comply fully with AS 1657.

- The seventh compliance issue relates to the construction of egress ladders on Level 00

- This basis of justification includes details of:
  a. The compliance issue (the egress ladders provided at the ends of each plant room on Level 00 are retractable)
  b. The DTS clause of the BCA from which it departs, D1.16
  c. The BCA performance parameters relating to the DTS clause, DP4
  d. The proposed alternative solution and its:
     i. Approach (qualitative, comparative)
     ii. Method of analysis (implementation of measures to ensure ladder is available and can operate freely in an emergency situation)
     iii. Acceptance criteria (agreement by Building Certifier and QFES)
- It is concluded that the provision of retractable ladders will satisfy the Performance Requirement DP4.

20.10 Compliance Issue 8: Doorway thresholds incorporate a step (hob).

- The eight compliance issue relates to the provision of steps (hobs) at the threshold of doors into plant rooms
- This basis of justification includes details of:
  a. The compliance issue (plant rooms may have a hob located at the threshold of the doorway)
  b. The DTS clause of the BCA from which it departs, D2.15
  c. The BCA performance parameter relating to the DTS clause, DP4
  d. The proposed alternative solution and its:
     i. Approach (qualitative, absolute)
     ii. Method of analysis (the proposed solution involves provision of hazard identification markings to hob, warning signage on doors, and induction training for maintenance staff)
     iii. Acceptance criteria (agreement by Building Certifier and QFES)
- It is concluded that the Performance Requirement of the BCA is satisfied

20.11 Compliance Issue 9: Fire compartmentation does not extend fully to 'edge' of building line

- The ninth compliance issue relates to the level of fire separation between fire compartments.
- This basis of justification includes details of:
  a. The compliance issue (fire spread between compartments)
  b. The DTS clause of the BCA from which it departs, C2.7
  c. The BCA performance parameters relating to the DTS clause, CP2
  d. The proposed alternative solution and its:
     i. Approach (qualitative, comparative)
     ii. Method of analysis (design represents an equivalent risk to other DTS compliant building configuration)
     iii. Acceptance criteria (agreement by Building Certifier and QFES)
- It is concluded that given the MEH building has a non-required sprinkler system, the risk of fire spread to adjacent fire compartment is at least equivalent to a fire in a non-sprinklered DTS compliant building fitted with aprons over openings.

20.12 Compliance Issue 10: A doorway in a Class 9a health care building incorporates a sliding door

- The tenth compliance issue relates to the use of sliding doors in a Class 9a health care building.
- This basis of justification includes details of:
  a. The compliance issue (sliding doors in a health care building)
  b. The DTS clause of the BCA from which it departs, D2.19
  c. The BCA performance parameters relating to the DTS clause, DP2 & DP4

d. The proposed alternative solution and its:
   i. Approach (qualitative)
   ii. Method of analysis (low occupancy load with high staff/patient ratio; room has an alternative designated exit with swing doors)
   iii. Acceptance criteria (agreement by Building Certifier and QFES)

- It is concluded that the Performance Requirement of the BCA is satisfied.

20.13 Compliance Issue 11: Building elements pass through a fire rated wall

- The eleventh compliance issue relates to certain structural steel members passing through fire rated construction.
- This basis of justification includes details of:
  a. The compliance issue (structural steel members pass through the fire walls in the Ward Block)
  b. The DTS clause of the BCA from which it departs, C2.7
  c. The BCA performance parameters relating to the DTS clause, CP1 & CP2
  d. The proposed alternative solution and its:
     i. Approach (qualitative and quantitative)
     ii. Method of analysis (Fire spray elements back to first connection to provide insulation rating. Statement by structural engineer attesting that design will satisfy structural adequacy and integrity requirements)
     iii. Acceptance criteria (agreement by Building Certifier and QFES)
- It is concluded that the Performance Requirement of the BCA is satisfied.

20.14 Compliance Issue 12: Fire hose reels pass through doorways fitted with fire and smoke doors

- The twelfth compliance issue relates to the non-provision of fire hose reels in minor smoke and fire compartments
- This basis of justification includes details of:
  a. The compliance issue (FHRs passing through fire and smoke doors)
  b. The DTS clause of the BCA from which it departs, E1.4
  c. The BCA performance parameters relating to the DTS clause, CP2, CP3, DP5 & EP1.1
  d. The proposed alternative solution and its:
     i. Approach (qualitative)
     ii. Method of analysis (Fully compliant hose reel coverage to be maintained to all parts of the building. FHRs do not pass through or into required fire compartmentation or fire-isolated stairways)
     iii. Acceptance criteria (agreement by Building Certifier and QFES)
- It is concluded that the Performance Requirement of the BCA is satisfied.

20.15 Compliance Issue 13: Fire detection and alarm system

- The thirteenth compliance issue relates to the use of MASD system as fire detection system in the egress paths of some patient care areas in lieu of alternating photoelectric and ionisation type detectors
- This basis of justification includes details of:
  e. The compliance issue
  f. The DTS clause of the BCA from which it departs, Specification E2.2a, clause 4(d)(i)(A)
  g. The BCA performance parameters relating to the DTS clause, EP 2.1
  h. The proposed alternative solution and its:
     iv. Approach (quantitative)
     v. Method of analysis (comparison of performance of MASD to ionisation detectors)

vi. Acceptance criteria (demonstration that the performance of MASD system is at least equivalent to that of ionisation detectors)

- It is concluded that the Performance Requirement of the BCA is satisfied.

20.16 Compliance Issue 14: Smoke proof wall construction

- The fourteenth compliance issue relates to the use of plywood timber nogging within the construction of smoke proof walls required in the patient care area for the mounting of fire fighting equipment.
- This basis of justification includes details of:
  - i. The compliance issue
  - j. The DTS clause of the BCA from which it departs, clause C 2.5 and Specification C 2.5,
  - k. The BCA performance parameters relating to the DTS clause, CP2 & 3
  - l. The proposed alternative solution and its:
    - vii. Approach (qualitative)
    - viii. Method of analysis (analysis of relevant functional requirements of BCA)
    - ix. Acceptance criteria (demonstration that the performance the proposed smoke proof walls will meet the objective of BCA)
- It is concluded that the Performance Requirement of the BCA is satisfied.

20.17 Compliance Issue 15: Sprinkler coverage

- The fifteenth compliance issue relates to the deletion of sprinkler coverage from the EDB cupboards and area under a canopy in the courtyard
- This basis of justification includes details of:
  - m. The compliance issue
  - n. The DTS clause of the BCA from which it departs, clause E1.5 and AS 2118.1,
  - o. The BCA performance parameters relating to the DTS clause, EP1.4
  - p. The proposed alternative solution and its:
    - x. Approach (qualitative)
    - xi. Method of analysis (analysis of relevant functional requirements of BCA)
    - xii. Acceptance criteria (demonstration that the risk and impact from a EDB cupboard fire is minimal)

It is concluded that the Performance Requirement of the BCA is satisfied

20.18 Compliance Issue 14: Exit doors swing against direction of travel

- This basis of justification includes details of:
  - a. The compliance issue, being that exit doors from fire compartments may not swing in the direction of travel due to horizontal evacuation strategy
  - b. The DTS clause is D2.20
  - c. The BCA performance parameter relating to the DTS clause is DP4
  - d. The proposed solution involves use of locally triggered hold open devices to ensure exit doors remain open for as long as is safely possible regardless of egress direction and “pull” and “push” signage be provided on these doors where necessary to clearly indicate the direction of door swing.

It is concluded that the performance requirements of the BCA are satisfied

20.19 This concludes the Fire Engineering Report for the Mental Health Building. This revision of the FER is issued for Authority approval.

21. Standards of construction, commissioning, management, use of maintenance

21.1 Fire safety systems

All fire safety systems provided in this building should be installed in accordance to the relevant standards and the manufacturer's technical information. Industry practice should be followed at all times.

Commissioning should be carried out in accordance with the relevant standards. Commissioning and integrated function testing of all fire safety systems including interfaces should be carried out to ensure proper function.

The 'Management-in-Use (MIU) Fire Safety Plan' which incorporates the ongoing fire safety of the building shall include the following items:

- Operational procedures detailing staff actions with respect to providing for the immediate escape of the buildings occupants in the event of a fire, and the provision for ongoing training in these procedures, as supporting evidence that the requirements of D2.21 have been met.
- General house-keeping must be undertaken to maintain the egress paths and exits clear in order to allow unimpeded travel.
- It must be included in the management-in-use for the building to prohibit the use of the area under the canopy in courtyard LG.MHX.022, discussed in Section 18.2.2, for storage at any times. A signage must be provided in this area to inform the staff of this restriction.
- Emergency control organisation and procedures in accordance with AS 3745:2002 shall be developed and implemented.
- Development of emergency procedures shall be accompanied by regular staff training and induction, to direct occupants to the nearest exit in the event of a fire alarm as well as keeping the paths of travel to exits clear of items that constitute a fire load or impede occupant egress.
- No smoking policy is to be implemented in all areas, except specific areas identified by QH in MEH as smoking areas
- Commissioning and integrated function testing of all fire safety systems including interfaces to ensure proper function.

There is the potential for penetrations in fire walls to compromise the fire separation's integrity, particularly over the life of the building. It is recommended that penetration zones are nominated within fire walls for ease of inspection and maintenance.

Maintenance works of the fire safety measures are the responsibly of the Building Owner or appointed Manager. An annual maintenance statement is to be displayed within the main entrance. Notice of the Alternative Solutions shall also be prominently displayed at the Fire Indicator Panel (FIP).

All essential services are to be maintained and tested in accordance with the requirements of the Queensland Development Code (QDC) and AS1851-2005 and their system-specific Australian Standards. Table 21.1 below is a schedule of essential fire safety measures and their system-specific Standard. In particular, the following fire safety measures must be properly maintained and tested annually with the latest of the applicable standards including AS 1851.

Table 21.1 Essential fire safety measures

Item	Fire safety measure	Standards
1	Components for the protection of openings in fire-resistant walls • Fire resistant doors	 AS 1905.1-2005
2	Fire detection, warning systems – System design, installation and commissioning • Smoke detection and alarm system • Sound systems and intercom systems for emergency purposes MASD system in egress paths to exits in patient care areas in lieu of ionisation detectors required by Specification E2.2a Clause 4(d)(i)(A) as discussed in Section 16 of this report.	 AS 1670.1-2004 AS 1670.4
3	Automatic fire sprinkler systems • General requirements • Coverage to be provided throughout the building except within the EDB cupboards	 AS 2118.1-1999
4	Emergency escape lighting and exit signs • System design, installation and operation	 AS 2293.1-2005
5	Fire hydrant systems • System design, installation and commissioning	 AS 2419.1-2005
6	Fire hose reel systems	AS 2441-2005
7	Access and Egress • Provision for escape • Construction of exits • Access for people with disabilities	 BCA 2008 (D1) BCA 2008 (D2) BCA 2008 (D3)
8	Perimeter vehicle access for emergency vehicles	BCA 2008 (C2)
9	Portable fire extinguishers and fire blankets • Selection and location	 AS 2444-2001

21.2 Design verification

Verification as to the validity of the design in meeting the Performance Requirements of the BCA should be performed at various stages of the project, via:

- At the design and documentation stage verification and confirmation that all assumptions and limitations upon which the design is based have been transferred to the detailed design specifications and drawings by the relevant building surveyor, fire engineer, the architect or suitably experienced fire services and structural engineers.
- At the construction stage and as part of the on going maintenance, verification will need to involve review and confirmation that the assumptions and limitations on which the design is based remain valid and that the level of performance assumed is being achieved. The level of performance can be verified by:
  1. Ensuring all active and passive systems, interlocks and controls operate in the manner assumed in the design
  2. Ensuring system reliability is maintained
  3. Where the design involves management of fuel loads or hazards, ensure such management is being performed
  4. During normal operation of the facility, verification that layouts, occupancies accommodated in the building and physical features have not been changed in a manner, which causes the design to no longer, be valid

22. References

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Appendix A

Minutes of FEB Meetings

GCUH Engineering JV
ABN 98 443 657 196
153 Leichhardt Street
(Locked Bag 1800) Spring Hill
Queensland 4004 Australia

Telephone: +61 7 3135 8000
Facsimile: +61 7 3135 8001

Meeting Record

Project:	Gold Coast University Hospital	Reference:	EJV-FE-MEH-MIN-0001-PDF
Location:	Mental Health Executive Office, Gold Coast Hospital	Meeting Date:	22 September 2008

Present:	Apology:	Copy:	Circulate:	Name:	Company:	Email:
√				Stephen Watson (SW)	GCUH Architecture	Aconex contact
√				Ron Bridgefoot (RB)	GCUH Architecture	Aconex contact
√				Ian Bynon (IB)	Project Services	Ian_bynon@health.qld.gov.au
√				Paul Glover (PG)	GCH Mental Health	paul_glover@health.qld.gov.au
√				Angel Carrasco (AC)	GCH Mental Health	angel_carrasco@health.qld.gov.au
√				Jonathan Shelley (JS)	GCUH Engineering	Aconex contact
		√		Katie Eckersley	GCH Mental Health	katie_eckersley@health.qld.gov.au
		√		Bob McGlade	BLL	Aconex contact
		√		Dennis Esam	GCUH Architecture	Aconex contact
		√		Tony Enright	GCUH Engineering	Aconex contact
		√		Wayne Quin	GCUH Engineering	Aconex contact

Recorded By:	Jonathan Shelley	Total Pages:	3
Subject:	Mental Health Design Fire Safety Meeting #1		

Details:	Action By/Date:
Meeting opened at 2:30 pm	
1. Evacuation procedures	
1.1 IB stated that staged evacuation was the preferred strategy for the Mental Health building. Occupants from the fire compartment of origin would be moved into the adjacent fire compartment in the first instance, and then into the next fire compartment if possible. Evacuation to the outside was considered a last resort. JS stated that the Fire Engineering Report (FER) would be updated to reflect the proposed strategy.	JS
1.2 IB recommended that each bedroom in the PICU be a separate smoke compartment. JS stated that providing full smoke separation would be difficult because bedroom doors in patient care areas are not normally provided with hold open devices or self closers. A management-in-use strategy can be adopted where staff close the door on the room of fire origin, effectively creating a smoke separation.	Noted
1.3 IB recommended that electronic strikes be provided to all bedroom doors, which would fail safe open on fire alarm activation, as opposed to mechanical locks which may require staff to manually unlock from the outside in the event of an emergency. APC to investigate.	RB/SW

Project:	Gold Coast University Hospital	Reference:	EJV-FE-MEH-MIN-0001-PDF
Location:	Mental Health Executive Office, Gold Coast Hospital	Meeting Date:	22 September 2008

Details:		Action By/Date:
1.4	JS queried the ability of patients to self evacuate in the event of an emergency. PG responded that many patients would be medicated, and would need to be dragged from their rooms as the beds did not have castors and would not fit through the doorways. This would be a staff intensive exercise.	Noted
1.5	It was suggested that a site visit to the existing Walston Park facility would be beneficial to view systems currently in place. APC to arrange visit with CGH MH.	RB/SW
1.6	IB agreed to provide the EJV with a copy of current GCH Mental Health emergency evacuation procedures.	IB
2.	**Fire protection systems**	
2.1	Protection of fire services from malicious tampering or self harm was discussed. Aspirating Smoke Detection System (ASDS) was considered an option to address this issue, however this type of system made exact location of source difficult or expensive. Point type detection allowed more accurate source location, but would need to be behind a grill - either boxed in, or recessed into the ceiling. EJV agreed to investigate the standards compliance issues associated with placing a grill around point type detectors.	JS
2.2	It was agreed that the Level 1 staff area would be sufficiently secure from patients that unprotected point type detectors and pendant or semi-recessed sprinkler heads would be acceptable in this area.	Noted
2.3	JS stated that institutional sprinkler heads were proposed for the PICU, and it was agreed that institutional heads should be provided throughout patient accessible areas in the MH Building.	Noted
2.4	GCH advised that standard alert and evacuation audible warning tones were acceptable in the MH Building, including the PICU, at standard sound pressure levels.	Noted
2.5	JS queried the proposed extent of CCTV coverage in the MH Building. IB replied that CCTV coverage was only expected at the front entrance and in seclusion rooms, and would not extend throughout patient accessible areas.	Noted
2.6	GCH stated that to the best of their knowledge, there was no additional legislation requiring the installation of sprinkler systems in Mental Health facilities in Queensland.	Noted
3.	**Staffing numbers**	
3.1	The staff/patient ratio in the MH building was thought to be at a minimum 1 nurse per 8 patients. It was noted that additional staff such as doctors and counsellors would be present during business hours, potentially bringing the ratio down to 1:4, however these additional staff were not expected to be present at night. It was also noted that while the staff/patient ratio in the PICU needed to be 1:2, this could be made up from staff elsewhere in the building. GCH MH agreed to confirm minimum staff numbers.	AC

Meeting Record

Project:	Gold Coast University Hospital	Reference:	EJV-FE-MEH-MIN-0001-PDF
Location:	Mental Health Executive Office, Gold Coast Hospital	Meeting Date:	22 September 2008

Details: Action By/Date:

Meeting closed at 3:45 pm

Meeting record

Number	Date	Description
1	22/09/2008	Mental Health Design Fire Safety Meeting

GCUH Engineering JV
ABN 98 443 657 196
153 Leichhardt Street
(Locked Bag 1800) Spring Hill
Queensland 4004 Australia

Telephone: +61 7 3135 8000
Facsimile: +61 7 3135 8001

Meeting Record

Project:	Gold Coast University Hospital	Reference:	EJV-FE-MEH-MIN-0002-PDF
Location:	GCUH Architecture, Brisbane	Meeting Date:	23 October 2008

Present:	Apology:	Copy:	Circulate:	Name:	Company:	Email:
√				Stephen Watson (SW)	GCUH Architecture	Aconex contact
√				Ron Bridgefoot (RB)	GCUH Architecture	Aconex contact
√				Tony Stokes (TS)	Stokes Perna	Aconex contact
√				Jonathan Shelley (JS)	GCUH Engineering	Aconex contact
		√		Bob McGlade	BLL	Aconex contact
		√		Dennis Esam	GCUH Architecture	Aconex contact
		√		Tony Enright	GCUH Engineering	Aconex contact
		√		Wayne Quin	GCUH Engineering	Aconex contact

Recorded By:	Jonathan Shelley	Total Pages:	2
Subject:	Mental Health Design Fire Safety Meeting #2		

Details:		Action By/Date:
Meeting opened at 2:00 pm		
1.	**Fire fighting equipment**	
1.1	Fire hose reels to be located within 4 m of exits, and secured within a locked cabinet. APC will seek written confirmation from GCH MH that staff in the MH Building will carry keys for the cabinet at all times.	SW
1.2	A fire hose reel would also be provided adjacent to the open stair on the L1 walkway.	Noted
1.3	APC to show fire hose reel locations on architectural drawings, and provide copy to WQ for inclusion in fire services design.	SW
1.4	Portable fire extinguishers to be provided at nurses' stations only. *EJV post-meeting clarification:-* *Table E1.6 of the BCA permits Class E extinguishers to be located at nurses' stations. Confirmation required from TS that Class A coverage to AS 2444 is not required over and above provision of extinguishers at nurses' stations.*	TS
2.	**Fire compartmentation**	
2.1	A review of GL fire/smoke compartmentation was undertaken. RB agreed to provide smoke and fire walls to closely approximate the DTS Provisions for patient care areas. APC would provide fire and smoke compartment plans to TS as soon as possible for review.	RB/TS

Project:	Gold Coast University Hospital	Reference:	EJV-FE-MEH-MIN-0002-PDF
Location:	GCUH Architecture, Brisbane	Meeting Date:	23 October 2008

Details:		Action By/Date:
2.2	It was agreed that a review of the south west part of the MH Building was required to ensure the separation of external walls and associated openings in different fire compartments complied with the DTS Provisions. APC to address on fire compartmentation plans and provide to TS as soon as possible for review.	RB/TS
2.3	RB stated that the fan rooms on L1 of the MH Building contained no other equipment except hot water. TS agreed that in this situation there was no requirement to provide fire separation to these spaces under the DTS Provisions.	Noted
3.	**Egress provisions**	
3.1	The travel distance to the single exit from each of the two peripheral fan rooms exceeded the 20 m maximum permitted under the DTS Provisions. TS recommended provision of ladders complying with AS 1657 be provided in each of the peripheral fan rooms. It was noted that this would still be an alternative building solution.	Noted
3.2	TS confirmed that providing the walkway stair from B1 up to GL was fire separated, the walkway stair from L1 down to GL could be open.	Noted
3.3	The travel distance between the CSB L1 fire doors leading onto the walkway and the fire stairs at the MH Building end of the walkway is approximately 40 m. The walkway forms the path of travel from the horizontal exit to the single required exit and therefore the DTS travel distance is 20 m (walkway is part of L1 of MH Building, and therefore considered Class 5). It is considered that a 100% increase in travel distance presents a significant approvals risk, even for an external walkway that is mostly open.	Noted
3.4	It was agreed that APC would provide a set of fire doors halfway along the walkway to provide two 20 m travel distances. It was noted that this will still not be a fully DTS compliant solution as use of two consecutive horizontal exits on the same path of travel is not permitted (i.e. a non-horizontal exit must also be provided in the intermediate fire compartment, being the first section of walkway).	RB

Meeting closed at 3:10 pm

Meeting record

Number	Date	Description
1	22/09/2008	Mental Health Design Fire Safety Meeting #1
2	23/10/2008	Mental Health Design Fire Safety Meeting #2

GCUH Engineering JV
ABN 98 443 657 196
153 Leichhardt Street
(Locked Bag 1800) Spring Hill
Queensland 4004 Australia

Telephone: +61 7 3135 8000
Facsimile: +61 7 3135 8001

Meeting Record

Project:	Gold Coast University Hospital	Reference:	EJV-FE-MEH-MIN-03-PDF
Location:	GCUH Architecture Offices, Bowen Street, Spring Hill	Meeting Date:	20 January 2009

Present:	Apology:	Copy:	Circulate:	Name:	Company:	Email:
√				Andrew Kerr	Bovis Lend Lease	Aconex
√				James Wright	Bovis Lend Lease	Aconex
√				Tony Enright	EJV	Aconex
√				Calvin Tsang	GCUH Architecture	Aconex
√				Dennis Esam	GCUH Architecture	Aconex
√				John Wilson	Project Services	Aconex
√				Larry Porter	Project Services	Aconex
√				Tony Stokes	Stokes Perna	Aconex
			√	Faith Hutchinson	GCUH Architecture	Aconex
			√	Lisa Collins	EJV	Aconex

Recorded By:	Jonathan Shelley	Total Pages:	2
Subject:	**Fire Engineering Brief – Mental Health**		

Details: Action By/Date:

Meeting opened 1:30 PM

- TE introduced the FEB for MEH (issued 18 December 2008)
- TE raised the non-compliances,
  - Firstly, the issue of increased compartment size created by connected covered walkways
  - Secondly, non-compliance of fire construction to prevent fire spread to and from two storey part, and
  - Thirdly, exit travel distance from the lower plant level
- TE outlined the proposed approach, method of analysis and acceptance criteria (all contained in the FEB)

The FEB was accepted 'in principle' and the FER to be issued by the EJV — **EJV – 13 February 2009**

The meeting considered miscellaneous fire design issues related to MEH

- It is noted that the stairs are <u>required</u>, but non-fire isolated, because this is a two storey sprinklered building
- Classification of plant room – JW is of the opinion that plant rooms can be classified as per the rest of the building (Class 9a) and that non-patient care areas of a Class 9a building (ie plant rooms) can have the 20 – 40 m travel distance applied. The

Meeting Record

Project:	Gold Coast University Hospital	Reference:	EJV-FE-MEH-MIN-03-PDF
Location:	GCUH Architecture Offices, Bowen Street, Spring Hill	Meeting Date:	20 January 2009

Details:	Action By/Date:
affects the FRL by meaning a uniform FRL 120 instead of FRL 240 (stability) where Plant Rooms classified as Class 9.	
• JW noted that evacuation strategy for MEH will need to be explained in detail	
• JW noted that evacuation strategy of moving from patient care into non-patient care (ie from 9a into 5), will need to watch travel distances – must all then comply with patient care requirements	
• JW concerned about roof framing running into rather than over masonry fire walls	
• It is noted that the ladder descent point from plant levels needs to have client approval to ensure the discharge point will be acceptable to staff users	**APC to action**
• TS noted that all fire extinguishers will be locked up within the nurse care stations	
• Note Engineering Tunnel stair exits into MEH secure courtyard without further egress to the road	**APC to action**
• Meeting Closed 2:15 PM	
• Next fire engineering meeting 3 February 2009 – although not necessarily for MEH	

Meeting record

Number	Date	Description
EJV-FE-MEH-MIN-01-PDF	22 September 2008	Fire engineering meeting No. 1
EJV-FE-MEH-MIN-02-PDF	23 October 2008	Fire engineering meeting No. 2
EJV-FE-MEH-MIN-03-PDF	**20 January 2009**	**FEB Meeting**

GCUH Engineering JV
ABN 98 443 657 196
153 Leichhardt Street
(Locked Bag 1800) Spring Hill
Queensland 4004 Australia

Telephone: +61 7 3135 8000
Facsimile: +61 7 3135 8001

GCUH ENGINEERING
Connell Wagner SKM S2F

Meeting Record

Project:	Gold Coast University Hospital	Reference:	EJV-FE-MEH-MIN-0002-PDF
Location:	GCUH Architecture, Brisbane	Meeting Date:	23 October 2008

Present:	Apology:	Copy:	Circulate:	Name:	Company:	Email:
√				Stephen Watson (SW)	GCUH Architecture	Aconex contact
√				Ron Bridgefoot (RB)	GCUH Architecture	Aconex contact
√				Tony Stokes (TS)	Stokes Perna	Aconex contact
√				Jonathan Shelley (JS)	GCUH Engineering	Aconex contact
		√		Bob McGlade	BLL	Aconex contact
		√		Dennis Esam	GCUH Architecture	Aconex contact
		√		Tony Enright	GCUH Engineering	Aconex contact
		√		Wayne Quin	GCUH Engineering	Aconex contact

Recorded By:	Jonathan Shelley	Total Pages:	2
Subject:	Mental Health Design Fire Safety Meeting #2		

Details:		Action By/Date:
Meeting opened at 2:00 pm		
1.	**Fire fighting equipment**	
1.1	Fire hose reels to be located within 4 m of exits, and secured within a locked cabinet. APC will seek written confirmation from GCH MH that staff in the MH Building will carry keys for the cabinet at all times.	SW
1.2	A fire hose reel would also be provided adjacent to the open stair on the L1 walkway.	Noted
1.3	APC to show fire hose reel locations on architectural drawings, and provide copy to WQ for inclusion in fire services design.	SW
1.4	Portable fire extinguishers to be provided at nurses' stations only. *EJV post-meeting clarification:-* *Table E1.6 of the BCA permits Class E extinguishers to be located at nurses' stations. Confirmation required from TS that Class A coverage to AS 2444 is not required over and above provision of extinguishers at nurses' stations.*	TS
2.	**Fire compartmentation**	
2.1	A review of GL fire/smoke compartmentation was undertaken. RB agreed to provide smoke and fire walls to closely approximate the DTS Provisions for patient care areas. APC would provide fire and smoke compartment plans to TS as soon as possible for review.	RB/TS

GCUH ENGINEERING

Connell Wagner SKM S2F

Meeting Record

Project:	Gold Coast University Hospital	Reference:	EJV-FE-MEH-MIN-0002-PDF
Location:	GCUH Architecture, Brisbane	Meeting Date:	23 October 2008

Details:		Action By/Date:
2.2	It was agreed that a review of the south west part of the MH Building was required to ensure the separation of external walls and associated openings in different fire compartments complied with the DTS Provisions. APC to address on fire compartmentation plans and provide to TS as soon as possible for review.	RB/TS
2.3	RB stated that the fan rooms on L1 of the MH Building contained no other equipment except hot water. TS agreed that in this situation there was no requirement to provide fire separation to these spaces under the DTS Provisions.	Noted
3.	**Egress provisions**	
3.1	The travel distance to the single exit from each of the two peripheral fan rooms exceeded the 20 m maximum permitted under the DTS Provisions. TS recommended provision of ladders complying with AS 1657 be provided in each of the peripheral fan rooms. It was noted that this would still be an alternative building solution.	Noted
3.2	TS confirmed that providing the walkway stair from B1 up to GL was fire separated, the walkway stair from L1 down to GL could be open.	Noted
3.3	The travel distance between the CSB L1 fire doors leading onto the walkway and the fire stairs at the MH Building end of the walkway is approximately 40 m. The walkway forms the path of travel from the horizontal exit to the single required exit and therefore the DTS travel distance is 20 m (walkway is part of L1 of MH Building, and therefore considered Class 5). It is considered that a 100% increase in travel distance presents a significant approvals risk, even for an external walkway that is mostly open.	Noted
3.4	It was agreed that APC would provide a set of fire doors halfway along the walkway to provide two 20 m travel distances. It was noted that this will still not be a fully DTS compliant solution as use of two consecutive horizontal exits on the same path of travel is not permitted (i.e. a non-horizontal exit must also be provided in the intermediate fire compartment, being the first section of walkway).	RB

Meeting closed at 3:10 pm

Meeting record

Number	Date	Description
1	22/09/2008	Mental Health Design Fire Safety Meeting #1
2	23/10/2008	Mental Health Design Fire Safety Meeting #2

GCUH Engineering JV
ABN 98 443 657 196
153 Leichhardt Street
(Locked Bag 1800) Spring Hill
Queensland 4004 Australia

Telephone: +61 7 3135 8000
Facsimile: +61 7 3135 8001

Meeting Record

Project:	Gold Coast University Hospital	Reference:	EJV-FE-MEH-MIN-03-PDF
Location:	GCUH Architecture Offices, Bowen Street, Spring Hill	Meeting Date:	20 January 2009

Present:	Apology:	Copy:	Circulate:	Name:	Company:	Email:
√				Andrew Kerr	Bovis Lend Lease	Aconex
√				James Wright	Bovis Lend Lease	Aconex
√				Tony Enright	EJV	Aconex
√				Calvin Tsang	GCUH Architecture	Aconex
√				Dennis Esam	GCUH Architecture	Aconex
√				John Wilson	Project Services	Aconex
√				Larry Porter	Project Services	Aconex
√				Tony Stokes	Stokes Perna	Aconex
			√	Faith Hutchinson	GCUH Architecture	Aconex
			√	Lisa Collins	EJV	Aconex

Recorded By:	Jonathan Shelley	Total Pages:	2
Subject:	**Fire Engineering Brief – Mental Health**		

Details: Action By/Date:

Meeting opened 1:30 PM

- TE introduced the FEB for MEH (issued 18 December 2008)
- TE raised the non-compliances,
  - Firstly, the issue of increased compartment size created by connected covered walkways
  - Secondly, non-compliance of fire construction to prevent fire spread to and from two storey part, and
  - Thirdly, exit travel distance from the lower plant level
- TE outlined the proposed approach, method of analysis and acceptance criteria (all contained in the FEB)

The FEB was accepted 'in principle' and the FER to be issued by the EJV **EJV – 13 February 2009**

The meeting considered miscellaneous fire design issues related to MEH

- It is noted that the stairs are required, but non-fire isolated, because this is a two storey sprinklered building
- Classification of plant room – JW is of the opinion that plant rooms can be classified as per the rest of the building (Class 9a) and that non-patient care areas of a Class 9a building (ie plant rooms) can have the 20 – 40 m travel distance applied. The

Meeting Record

Project:	Gold Coast University Hospital	Reference:	EJV-FE-MEH-MIN-03-PDF
Location:	GCUH Architecture Offices, Bowen Street, Spring Hill	Meeting Date:	20 January 2009

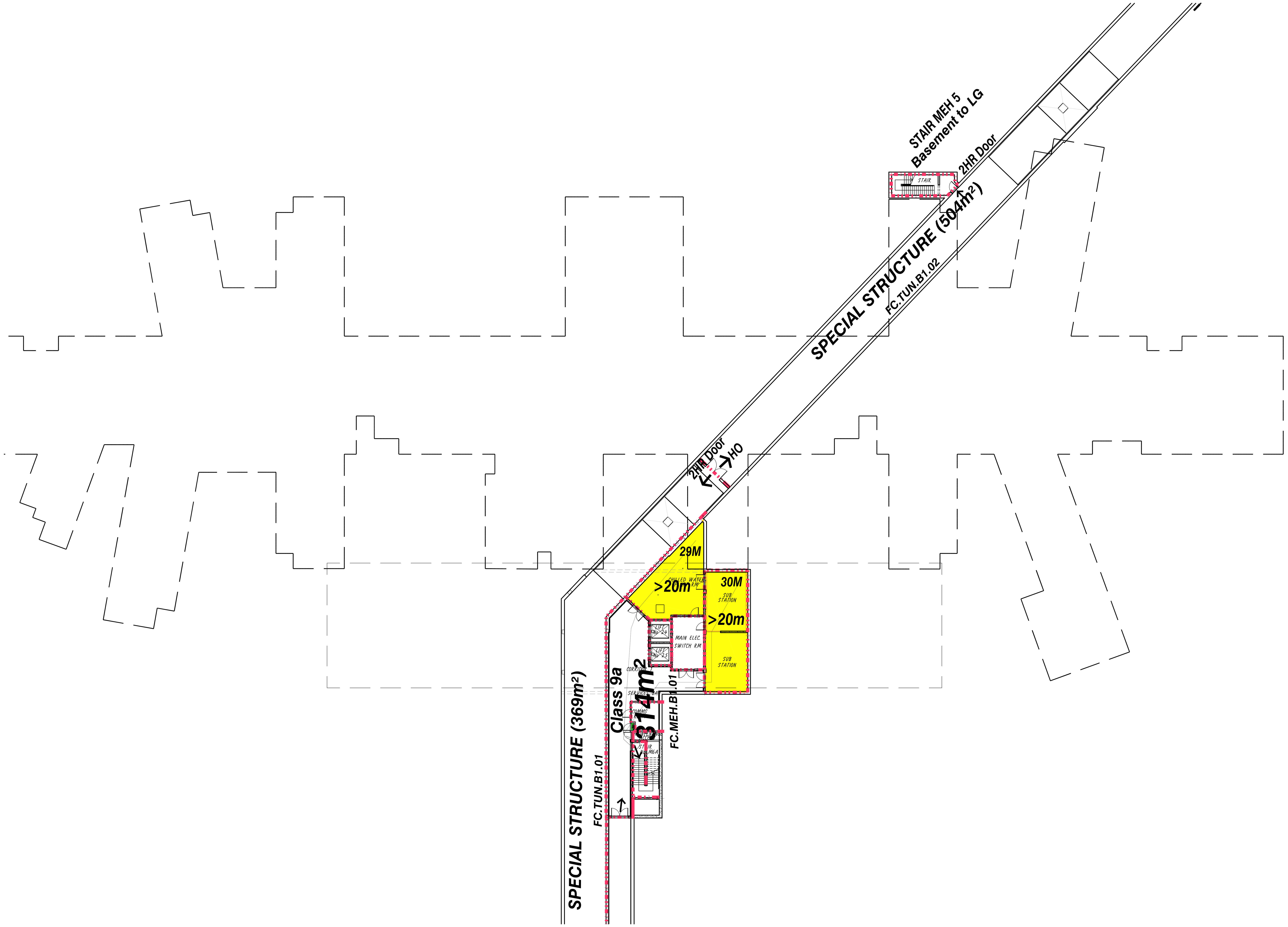
Details:	Action By/Date:
affects the FRL by meaning a uniform FRL 120 instead of FRL 240 (stability) where Plant Rooms classified as Class 9.	
• JW noted that evacuation strategy for MEH will need to be explained in detail	
• JW noted that evacuation strategy of moving from patient care into non-patient care (ie from 9a into 5), will need to watch travel distances – must <u>all</u> then comply with patient care requirements	
• JW concerned about roof framing running <u>into</u> rather than <u>over</u> masonry fire walls	
• It is noted that the ladder descent point from plant levels needs to have client approval to ensure the discharge point will be acceptable to staff users	**APC to action**
• TS noted that all fire extinguishers will be locked up within the nurse care stations	
• Note Engineering Tunnel stair exits into MEH secure courtyard without further egress to the road	**APC to action**
• Meeting Closed 2:15 PM	
• Next fire engineering meeting 3 February 2009 – although not necessarily for MEH	

Meeting record

Number	Date	Description
EJV-FE-MEH-MIN-01-PDF	22 September 2008	Fire engineering meeting No. 1
EJV-FE-MEH-MIN-02-PDF	23 October 2008	Fire engineering meeting No. 2
EJV-FE-MEH-MIN-03-PDF	**20 January 2009**	**FEB Meeting**

Appendix B

Fire Compartment Drawings



Legend

	Smoke Proof Wall
	1 Hour Fire Rated Wall
	2 Hr Fire Rated Compartment Wall
	2 Hour Fire Rated & Smoke Proof Wall
	Wall equivelant to 2 Hour Fire Rated Wall
	3 Hour Fire Rated Wall
	4 Hour Fire Rated Wall
	Extent of Fire Compartment included above
SW	Smoke Proof Wall
FW	Fire Rated Wall as noted
	Areas excluded from area calculations
	Fire rated ceiling & Areas excluded from area calculations
DIST.	Non-complying (DTS) escape distances. Refer to Fire Engineering Report Point of Choice/ Dist. to Exit/ Dist. between Exits 20 / 40 / 60m - Class 5 & 8 12 / 30 / 45m - Class 9a
	BRIDGE SPECIAL STRUCTURE
	Areas included in fire compartment above/below (as noted)
	Wall wetting sprinklers
	Required Fire Exit
	Fire Hose Reel (F.H.R) & Fire Extinguisher (F.E)
	Fire Hydrant (F.H)
	Combined F.H.R & F.H & F.E
	Fire Extinguisher (F.E)
HO	HOLD OPEN
HO(C)	ELECTROMAGNETIC HOLD OPEN/ CLOSER
S	SECURITY
M	MOTORISED

Note:
These are indicative only - Please refer to partition details drawing for construction type PSH-AR-PRW-DWG-61 series of Architectural drawings.
Refer to EJV drawings for all services.
Refer to Door Schedule and Security drawings

AS-BUILT

0 5 10 15 20 30 40
1:200 Scale bar

DIMENSIONS
Use figured dimensions, DO NOT SCALE.
Check all dimensions on site before fabrication or set out.

ORIGINAL SHEET SIZE: A0 - 841 x 1189

CHECKED
TEAM LEADER -
CAD MANAGER -
DATE - 17-Jan-13

AMENDMENTS

DATE	ISSUE	ACTIVITY	AUTH	CHK
16.01.13	AA	AS BUILT DRAWINGS	SW	ID

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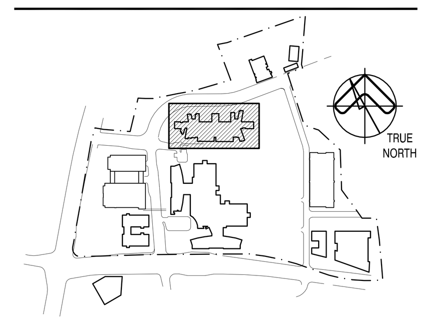
DRAWINGS ARE TO BE READ IN CONJUNCTION WITH ADDITIONAL NOTES, SPECIFICATIONS AND WHERE APPLICABLE, CALCULATIONS AND SPECIALISTS CONSULTANTS DETAILS.

Lend Lease 'AS-BUILT' APPROVED



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PDT + STH + HASSELL
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GCUH ENGINEERING
aurecon SKM S2F
ABN: 54 005 139 873 t 07 3135 8000

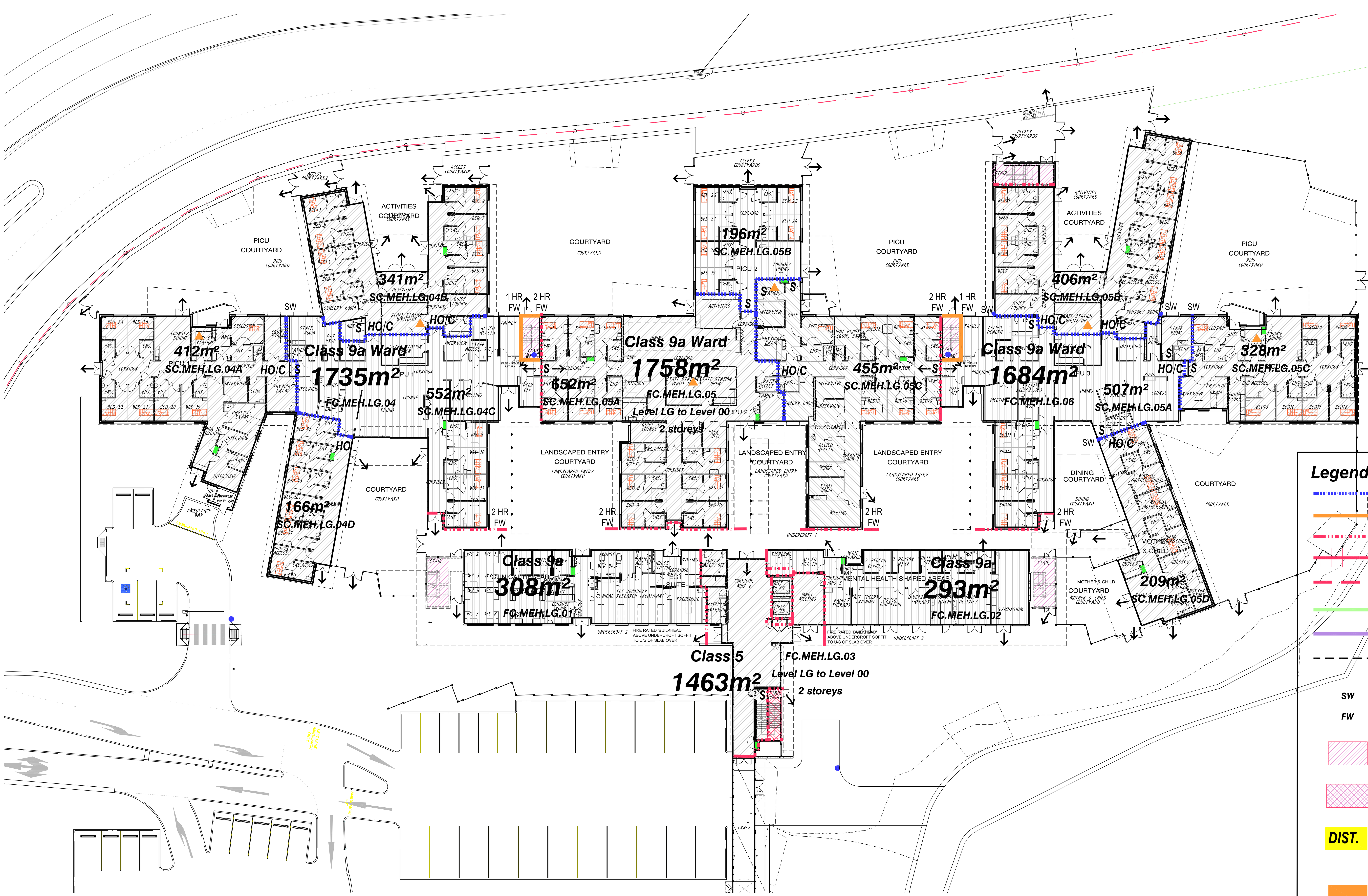
Lend Lease
ABN: 97 000 098 162 t 07 3225 7100

PROJECT DETAILS:
GOLD COAST UNIVERSITY HOSPITAL

SHEET TITLE:
FIRE COMPARTMENTATION
MENTAL HEALTH
LEVEL B1

JOB No.	STAGE	SCALES	ISSUE
5177	AB	1:200 @ A0	AA

DRAWING No.
PSH-AR-MEH-DWG-26B1100



Legend

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	1 Hour Fire Rated Wall
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	BRIDGE SPECIAL STRUCTURE
	Areas included in fire compartment above/below (as noted)
✳	Wall wetting sprinklers
→	Required Fire Exit
	Fire Hose Reel (F.H.R) & Fire Extinguisher (F.E)
	Fire Hydrant (F.H)
	Combined F.H.R & F.H & F.E
	Fire Extinguisher (F.E)
HO	HOLD OPEN
HO(C)	ELECTROMAGNETIC HOLD OPEN/ CLOSER
S	SECURITY
M	MOTORISED

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Refer to Door Schedule and Security drawings

0 5 10 15 20 30 40
1:200 Scale bar

DIMENSIONS
Use figured dimensions. DO NOT SCALE.
Check all dimensions on site before fabrication or set out.

CHECKED
TEAM LEADER -
CAD MANAGER -
DATE - 11-Feb-13

AMENDMENTS

DATE	ISSUE	ACTIVITY	AUTH	CHK
16.01.13	AA	AS BUILT DRAWINGS	SW	ID
11.02.13	AB	AS BUILT DRAWINGS	SW	ID

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aurecon SKM
ABN: 54 005 139 873 t 07 3135 8000

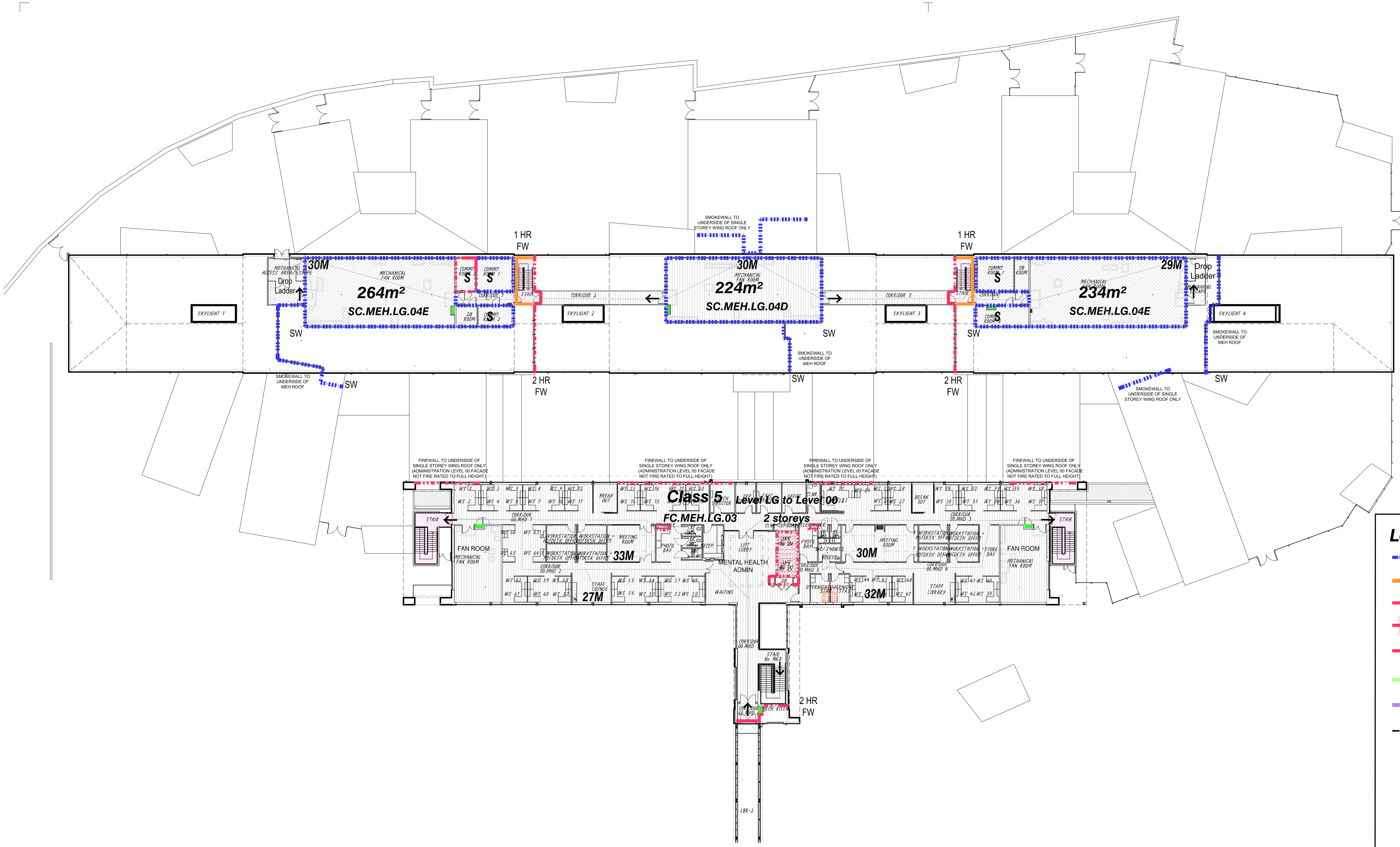
Lend Lease
ABN: 97 000 098 162 t 07 3225 7100

PROJECT DETAILS
GOLD COAST UNIVERSITY HOSPITAL

SHEET TITLE
FIRE COMPARTMENTATION
MENTAL HEALTH
LEVEL LG

JOB No.	STAGE	SCALES	ISSUE
5177	AB	1:200 @ A0	AB

DRAWING No.
PSH-AR-MEH-DWG-26LG100



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- BRIDGE SPECIAL STRUCTURE
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- Wall wetting sprinklers
- Required Fire Exit
- Fire Hose Reel (F.H.R) & Fire Extinguisher (F.E)
- Fire Hydrant (F.H)
- Combined F.H.R & F.H & F.E
- Fire Extinguisher (F.E)
- HO — HOLD OPEN
- HO(C) — ELECTROMAGNETIC HOLD OPEN/ CLOSER
- S — SECURITY
- M — MOTORISED

AS-BUILT

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0 5 10 15 20 30 40
1:200 Scale bar

DIMENSIONS
Use figured dimensions, DO NOT SCALE.
Check all dimensions on site before fabrication or set out.

ORIGINAL SHEET SIZE: A0 - 841 x 1189

CHECKED
TEAM LEADER -
CAD MANAGER -
DATE - 17-Jan-13

AMENDMENTS

DATE	ISSUE	ACTIVITY	AUTH	CHK
16.01.13	AA	AS BUILT DRAWINGS	SW	ID

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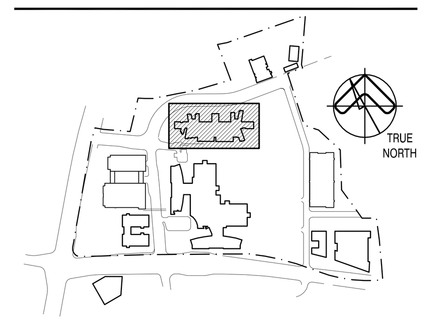
Lend Lease 'AS-BUILT' APPROVED



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PDT + STH + HASSELL
ACN: 127 046 566 t 07 3039 0400

GCUH ENGINEERING
aurecon SKM
ABN: 54 005 139 873 t 07 3135 8000

Lend Lease
ABN: 97 000 098 162 t 07 3225 7100

PROJECT DETAILS:
GOLD COAST UNIVERSITY HOSPITAL

SHEET TITLE:
FIRE COMPARTMENTATION
MENTAL HEALTH
LEVEL 00

JOB No.	STAGE	SCALES	ISSUE
5177	AB	1:200 @ A0	AA

DRAWING No.
PSH-AR-MEH-DWG-2600100

Appendix C

FDS Inputs

C.1 Compliance Issue 1: Fire Compartment linked by Covered Paths (FDS Modelling Input Data File)

```
=======
HISTORY
=======

00      11 FEB 2009
        ORIGINAL CREATED BY WEI-LI TSAI

01      11 FEB 2009
        TWEAKED BY TONY ENRIGHT
        WEI-LI RUNNING 2 MW FIRE

02      12 FEB
        MORE TIDY UPS,
        PAE RUNNING 8 MW FIRE

======
HEADER
======

&HEAD    CHID             ='27570-MEH-02'/

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         WALL_INCREMENT   =1/

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         NFRAMES          =3600
         DT_BNDF          =1/

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         RESTART          =.TRUE./


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XBAR0
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=============
FIRE SCENARIO (8 MW)
=============

----
REAC
----

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          H      =6.50
          O      =2.37
          N      =0.3300
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          CO_YIELD    =0.0154
          SOOT_YIELD=0.0397
          MASS_EXTINCTION_COEFFICIENT=7600/

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          HRRPUA      =2000./

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--------
CONCRETE
--------

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          DENSITY           =2000/

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          THICKNESS(1)       =0.1000/


--------------
GYPSUM PLASTER
--------------

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          CONDUCTIVITY       =0.4800
          DENSITY            =1440/

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-----
GLASS
-----

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          DENSITY            =2.7000000E003/

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          THICKNESS(1)       =0.0130/


====
OBST
====

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------
OFFICE
------

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-------
WALKWAY
-------

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```
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&OBST XB=6.00,19.20,0.40,0.60,3.60,3.70, SURF_ID='GYPSUM_PLASTER'/ ceiling



-------
GLAZING
-------

&OBST XB=1.00,4.60,1.80,2.00,1.00,2.20, SURF_ID='GLASS', BNDF_OBST=.TRUE./ Window
&OBST XB=2.4,2.6,5.6,7.4,1.00,2.20, SURF_ID='GLASS', BNDF_OBST=.TRUE./ Window
&OBST XB=6.00,9.80,0.0,0.20,0.60,2.60, SURF_ID='GLASS', BNDF_OBST=.TRUE./ Window
&OBST XB=13.60,17.20,0.00,0.20,0.60,2.60, SURF_ID='GLASS', BNDF_OBST=.TRUE./ Window


=================
OUTPUTS AND DEVCS
=================

&BNDF QUANTITY='HEAT_FLUX'/
&BNDF QUANTITY='WALL_TEMPERATURE'/

&SLCF QUANTITY='TEMPERATURE', PBY=4.50/
&SLCF QUANTITY='TEMPERATURE', PBX=12.60/
&SLCF QUANTITY='TEMPERATURE', PBY=3.40/


----------------
SURF TEMPERATURE
----------------

&DEVC XYZ=0.2,3.8,1.6,    QUANTITY='WALL_TEMPERATURE', IOR=1 /
&DEVC XYZ=2.8,2.0,1.6,    QUANTITY='WALL_TEMPERATURE', IOR=2 /
&DEVC XYZ=2.6,6.4,1.6,    QUANTITY='WALL_TEMPERATURE', IOR=1 /
&DEVC XYZ=8.0,0.2,1.6,    QUANTITY='WALL_TEMPERATURE', IOR=2 /
&DEVC XYZ=15.4,0.2,1.6,   QUANTITY='WALL_TEMPERATURE', IOR=2 /


'&DEVC , XYZ=18.00,0.2000,1.60, IOR=2/
'&DEVC QUANTITY='WALL_TEMPERATURE', XYZ=16.00,0.2000,1.60, IOR=2/
'&DEVC QUANTITY='WALL_TEMPERATURE', XYZ=14.00,0.2000,1.60, IOR=2/
'&DEVC QUANTITY='WALL_TEMPERATURE', XYZ=12.00,0.2000,1.60, IOR=2/
'&DEVC QUANTITY='WALL_TEMPERATURE', XYZ=10.00,0.2000,1.60, IOR=2/
'&DEVC QUANTITY='WALL_TEMPERATURE', XYZ=8.00,0.2000,1.60, IOR=2/
'&DEVC QUANTITY='WALL_TEMPERATURE', XYZ=6.00,0.2000,1.60, IOR=2/

'&DEVC QUANTITY='WALL_TEMPERATURE', XYZ=4.80,1.00,1.60, IOR=1/
'&DEVC QUANTITY='WALL_TEMPERATURE', XYZ=2.60,6.50,1.60, IOR=1/
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'&DEVC QUANTITY='WALL_TEMPERATURE', XYZ=2.00,2.00,1.60, IOR=2/
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```

```
'&DEVC QUANTITY='WALL_TEMPERATURE', XYZ=1.20,4.60,1.60, IOR=-2/




---------
HEAT FLUX
---------

&DEVC XYZ=0.2,3.8,1.6,    QUANTITY='HEAT_FLUX', IOR=1 /
&DEVC XYZ=2.8,2.0,1.6,    QUANTITY='HEAT_FLUX', IOR=2 /
&DEVC XYZ=2.6,6.4,1.6,    QUANTITY='HEAT_FLUX', IOR=1 /
&DEVC XYZ=8.0,0.2,1.6,    QUANTITY='HEAT_FLUX', IOR=2 /
&DEVC XYZ=15.4,0.2,1.6,   QUANTITY='HEAT_FLUX', IOR=2 /

'&DEVC QUANTITY='HEAT_FLUX', XYZ=18.00,0.2000,1.60, IOR=2/
'&DEVC QUANTITY='HEAT_FLUX', XYZ=16.00,0.2000,1.60, IOR=2/
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'&DEVC QUANTITY='HEAT_FLUX', XYZ=10.00,0.2000,1.60, IOR=2/
'&DEVC QUANTITY='HEAT_FLUX', XYZ=8.00,0.2000,1.60, IOR=2/
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'&DEVC QUANTITY='HEAT_FLUX', XYZ=4.80,1.00,1.60, IOR=1/
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&TAIL /
```

C.2 Compliance Issue 3: Exit Travel Distances (FDS Modelling Input Data File)

```
SmokeDetectorActivation.fds
Generated by PyroSim - Version 2010.1.0928

&HEAD CHID      ='SmokeDetectorActivation', TITLE='MEH Unprotected Steel'/

&TIME T_END     =100/

&DUMP RENDER_FILE     ='SmokeDetectorActivation.ge1'/

&MESH ID='MESH', IJK     =100,100,13, XB=0.00,20.00,0.00,20.00,0.00,2.60/

&REAC ID='POLYURETHANE',
  C=6.30,
  H=7.10,
  O=2.11,
  N=1.00,
  IDEAL=.TRUE.,
  CO_YIELD=0.0378,
  SOOT_YIELD=0.0700,
  MASS_EXTINCTION_COEFFICIENT=7.6000000E003/

&SURF ID='Fire',
  RGB=204,0,0,
  HRRPUA=1.0000000E003,
  RAMP_Q='Fire_RAMP_Q'/
&RAMP ID='Fire_RAMP_Q', T=0.00, F=0.00/
&RAMP ID='Fire_RAMP_Q', T=10.00, F=0.0100/
&RAMP ID='Fire_RAMP_Q', T=20.00, F=0.0400/
&RAMP ID='Fire_RAMP_Q', T=30.00, F=0.0900/
&RAMP ID='Fire_RAMP_Q', T=40.00, F=0.1600/
&RAMP ID='Fire_RAMP_Q', T=50.00, F=0.2500/
&RAMP ID='Fire_RAMP_Q', T=60.00, F=0.3600/
&RAMP ID='Fire_RAMP_Q', T=70.00, F=0.4900/
&RAMP ID='Fire_RAMP_Q', T=80.00, F=0.64/
&RAMP ID='Fire_RAMP_Q', T=90.00, F=0.81/
&RAMP ID='Fire_RAMP_Q', T=100.00, F=1.00/

&PROP ID='Cleary Photoelectric P1',
  QUANTITY='CHAMBER OBSCURATION',
  ALPHA_E=1.80,
  BETA_E=-1.00,
  ALPHA_C=1.00,
  BETA_C=-0.80/
&DEVC ID='SD1', PROP_ID='Cleary Photoelectric P1', XYZ=5.00,5.00,2.30/
&DEVC ID='SD2', PROP_ID='Cleary Photoelectric P1', XYZ=15.20,5.00,2.30/
&DEVC ID='SD3', PROP_ID='Cleary Photoelectric P1', XYZ=15.20,15.20,2.30/
&DEVC ID='SD4', PROP_ID='Cleary Photoelectric P1', XYZ=5.00,15.20,2.30/
```

&OBST XB=0.00,20.00,0.00,20.00,2.40,2.60, RGB=204,204,204, TRANSPARENCY=0.50, SURF_ID='INERT',

TEXTURE_ORIGIN=0.00,6.20,2.80/ Ceiling
&OBST XB=9.40,10.40,9.40,10.40,0.00,0.4000, SURF_ID='INERT'/ Fire
&OBST XB=0.00,0.2000,0.00,20.00,0.00,2.60, RGB=51,51,255, TRANSPARENCY=0.2000, SURF_ID='INERT',

TEXTURE_ORIGIN=0.00,6.20,2.80/ Wall
&OBST XB=0.00,20.00,0.00,0.2000,0.00,2.60, RGB=51,51,255, TRANSPARENCY=0.2000, SURF_ID='INERT',

TEXTURE_ORIGIN=0.00,6.20,2.80/ Wall
&OBST XB=0.00,20.00,19.80,20.00,0.00,2.60, RGB=51,51,255, TRANSPARENCY=0.2000, SURF_ID='INERT',

TEXTURE_ORIGIN=0.00,6.20,2.80/ Wall
&OBST XB=19.80,20.00,0.00,20.00,0.00,2.60, RGB=51,51,255, TRANSPARENCY=0.2000, SURF_ID='INERT',

TEXTURE_ORIGIN=0.00,6.20,2.80/ Wall

&VENT SURF_ID='OPEN', XB=0.00,0.00,0.00,20.00,0.00,2.60, COLOR='INVISIBLE'/ Vent for Mesh XBAR0
&VENT SURF_ID='OPEN', XB=20.00,20.00,0.00,20.00,0.00,2.60, COLOR='INVISIBLE'/ Vent for Mesh XBAR
&VENT SURF_ID='OPEN', XB=0.00,20.00,0.00,0.00,0.00,2.60, COLOR='INVISIBLE'/ Vent for Mesh YBAR0
&VENT SURF_ID='OPEN', XB=0.00,20.00,20.00,20.00,0.00,2.60, COLOR='INVISIBLE'/ Vent for Mesh YBAR
&VENT SURF_ID='INERT', XB=0.00,20.00,0.00,20.00,0.00,0.00, COLOR='INVISIBLE'/ Vent for Mesh ZBAR0
&VENT SURF_ID='OPEN', XB=0.00,20.00,0.00,20.00,2.60,2.60, COLOR='INVISIBLE'/ Vent for Mesh ZBAR
&VENT SURF_ID='Fire', XB=9.40,10.40,9.40,10.40,0.4000,0.4000, COLOR='RED'/ Fire

&BNDF QUANTITY='RADIATIVE HEAT FLUX'/

&TAIL /

Appendix D

PS Comments

Building Surveying
Queensland Government
Department of Public Works

GOLD COAST UNIVERSITY HOSPITAL

Building Application No: 28419
PS Project No: 50631

COMMENTS ON FIRE ENGINEERING REPORT MEH Rev16

SPECIFIC COMMENTS CONCERNING THE REPORT

1.) **Pg 2, Executive Summary, item 15.3,**
Performance requirements should include EP1.1.

2.) **Pg 24, Table 2-8 Item 5, Compliance issue**
The description should include that there are hydrants located within the cabinets also.

3.) **Pg 36, Clause 3.1.6**
I believe that discussion with QFRS at a meeting was that a specific QH key was to be used instead of the 003 key. This needs to be finalised for this revision.

4.) **Pg 37, Clause 3.1.7**
I believe that discussion with QFRS at a meeting was that a specific QH key was to be used instead of the 003 key. This needs to be finalised for this revision.

5.) **Pg 68, Compliance issue 5**
The description needs to include hydrants as there are some that are located within cabinets.

6.) **Pg 91, 15.3**
Heading is to include EP 1.1

7.) **Pg 94, 17.1, second paragraph**
The description of the wall is that “the walls are constructed of powerscape plasterboard ……..” These are two dissimilar products, the description needs to be specific. Also the last statement is “for the mounting of fire fighting equipment” is not correct as the noggins are also used for other fixtures and equipment.

8.) **Pg 95, clause 17.1 the last two paragraphs**
There are instances where the term powerscape plasterboard has been used.
There are some fire tests that have been conducted by LL with plywood noggin in the wall with no adverse effect. These should be referenced for supportive documentation.

9.) **General**
The item for the removal of sprinkler heads to EDB cupboards that is being proposed for CSB & project wide does not appear to be included in this revision. Is this still the case for MEH?

FILENAME: MEH FER R16 Comments

FOR FURTHER INFORMATION PLEASE CONTACT:

Building Surveying
Project Services
Level 4b / 80 George Street
BRISBANE Q 4000
GPO Box 2906
BRISBANE Q 4001

Larry Porter
SENIOR BUILDING SURVEYOR

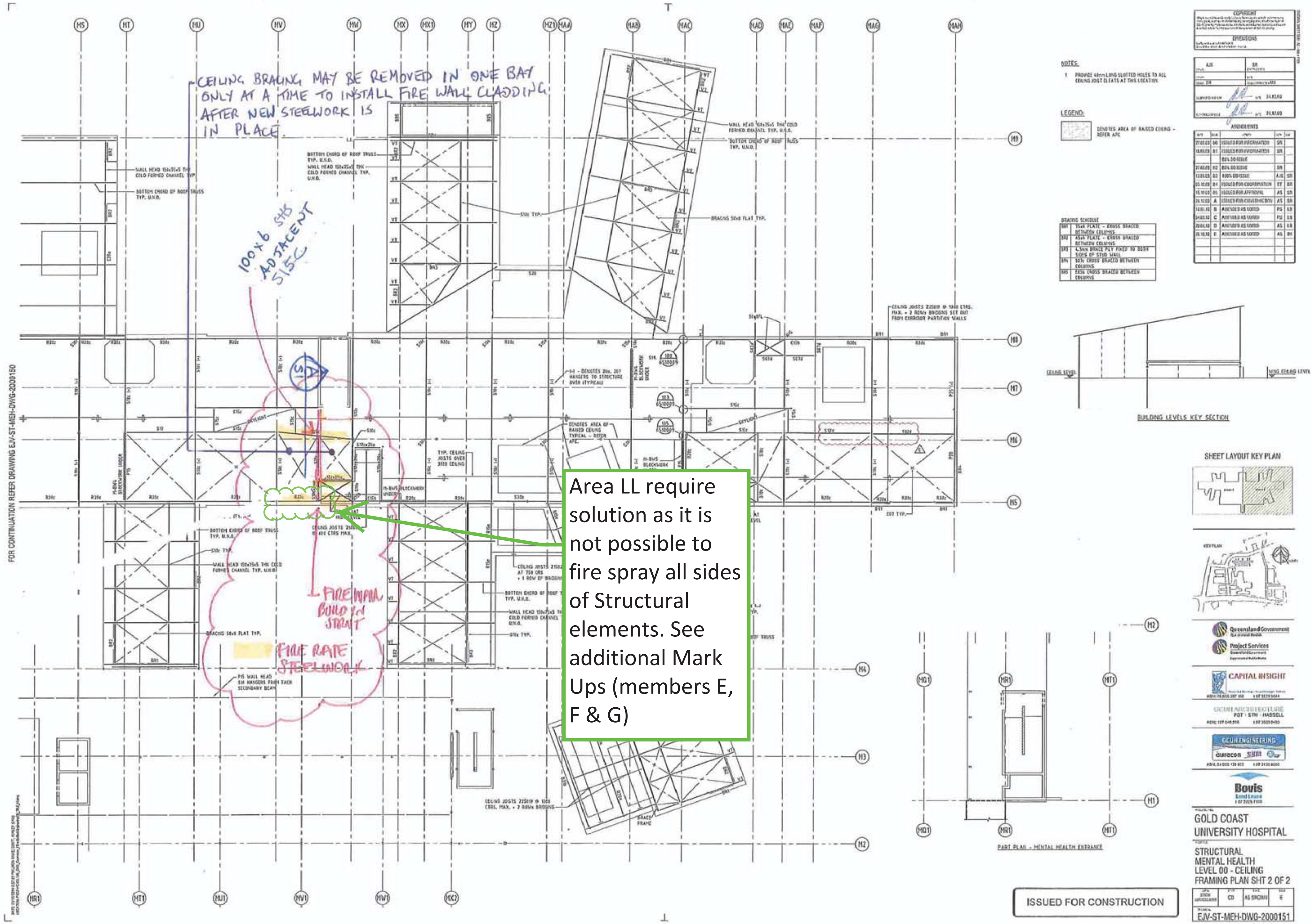
☎ 5514 5208

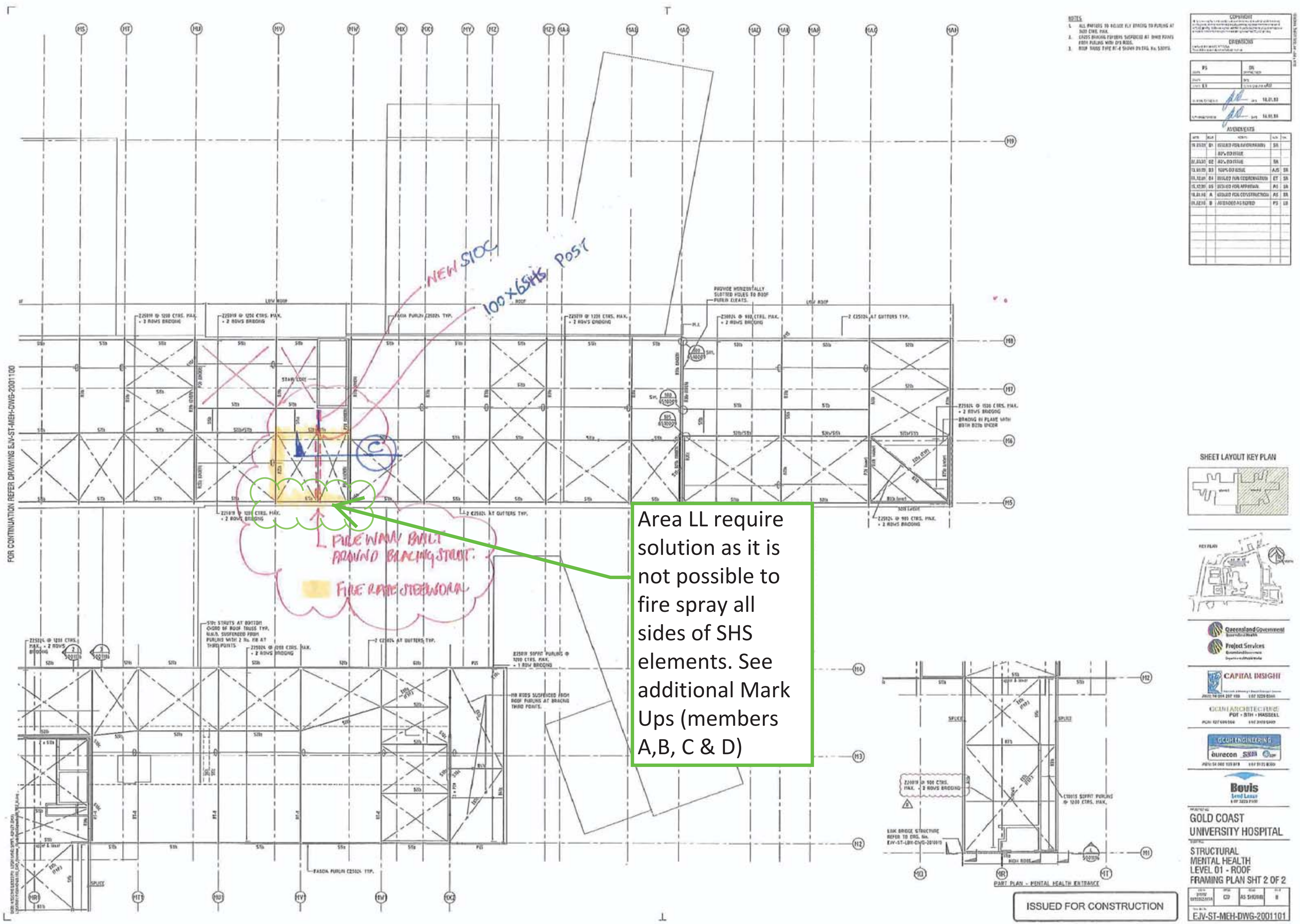
0409 877 570

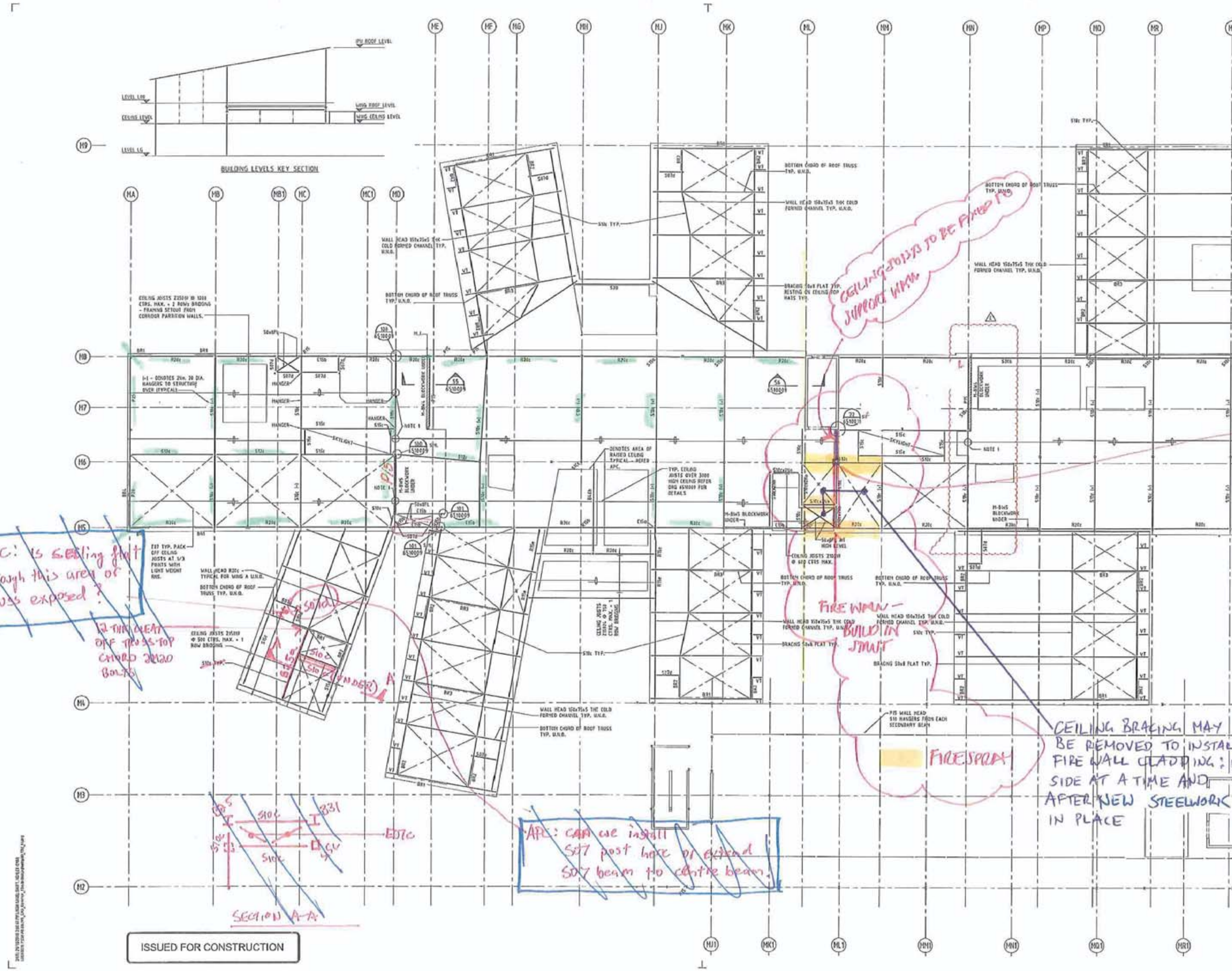
larry.porter@projectservices.qld.gov.au

Appendix E

Structural sketches of fire walls


CEILING BRACING MAY BE REMOVED IN ONE BAY ONLY AT A TIME TO INSTALL FIRE WALL CLADDING AFTER NEW STEELWORK IS IN PLACE
100x6 SHS ADJACENT 515C
FIREWALL BUILD IN STRUT
FIRE RATE STEELWORK
Area LL require solution as it is not possible to fire spray all sides of Structural elements. See additional Mark Ups (members E, F & G)
FOR CONTINUATION REFER DRAWING EJV-ST-MEH-DWG-2000150
BUILDING LEVELS KEY SECTION
SHEET LAYOUT KEY PLAN
PART PLAN - MENTAL HEALTH ENTRANCE
ISSUED FOR CONSTRUCTION
GOLD COAST UNIVERSITY HOSPITAL
STRUCTURAL
MENTAL HEALTH
LEVEL 00 - CEILING
FRAMING PLAN SHT 2 OF 2
EJV-ST-MEH-DWG-2000151


NEW SIOC
100x6SHS POST
FIRE WALL BUILT AROUND BRACING STRUT.
FIRE RATE STEELWORK
Area LL require solution as it is not possible to fire spray all sides of SHS elements. See additional Mark Ups (members A,B, C & D)
C
FOR CONTINUATION REFER DRAWING EJV-ST-MEH-DWG-2001100
SHEET LAYOUT KEY PLAN
KEY PLAN
PART PLAN - MENTAL HEALTH ENTRANCE
ISSUED FOR CONSTRUCTION
GOLD COAST UNIVERSITY HOSPITAL
STRUCTURAL MENTAL HEALTH LEVEL 01 - ROOF FRAMING PLAN SHT 2 OF 2
EJV-ST-MEH-DWG-2001101



FOR CONTINUATION REFER DRAWING EJV-ST-MEH-DWG-2000151

COPYRIGHT

DIMENSIONS

AMENDMENTS

REV	DATE	DESCRIPTION		
C0	27.02.09	ISSUED FOR INFORMATION	SR	
C1	16.03.09	ISSUED FOR INFORMATION	SR	
		80% DD ISSUE		
02	27.03.09	90% DD ISSUE	SR	
03	13.05.09	100% DD ISSUE		SR
C4	03.12.09	ISSUED FOR COORDINATION		SR
C5	15.12.09	ISSUED FOR APPROVAL	AS	SR
A	24.12.09	ISSUED FOR CONSTRUCTION	AS	SR
B		AMENDED AS NOTED	PS	SR
C		AMENDED AS NOTED	PS	SR
D		AMENDED AS NOTED	AS	SR
E		AMENDED AS NOTED	AS	SR

GENERAL NOTES:

1. REFER DWG. No. EJV-ST-MEH-DWG-2000101 FOR BRACING SCHEDULE.

LEGEND:

DENOTES AREA OF RAISED CEILING - REFER APC

SHEET LAYOUT KEY PLAN

KEY PLAN

Queensland Government

Project Services

CAPITAL INSIGHT

GCUH ARCHITECTURE
PDT · STH · HASSELL

GCUH ENGINEERING
aurecon SKM

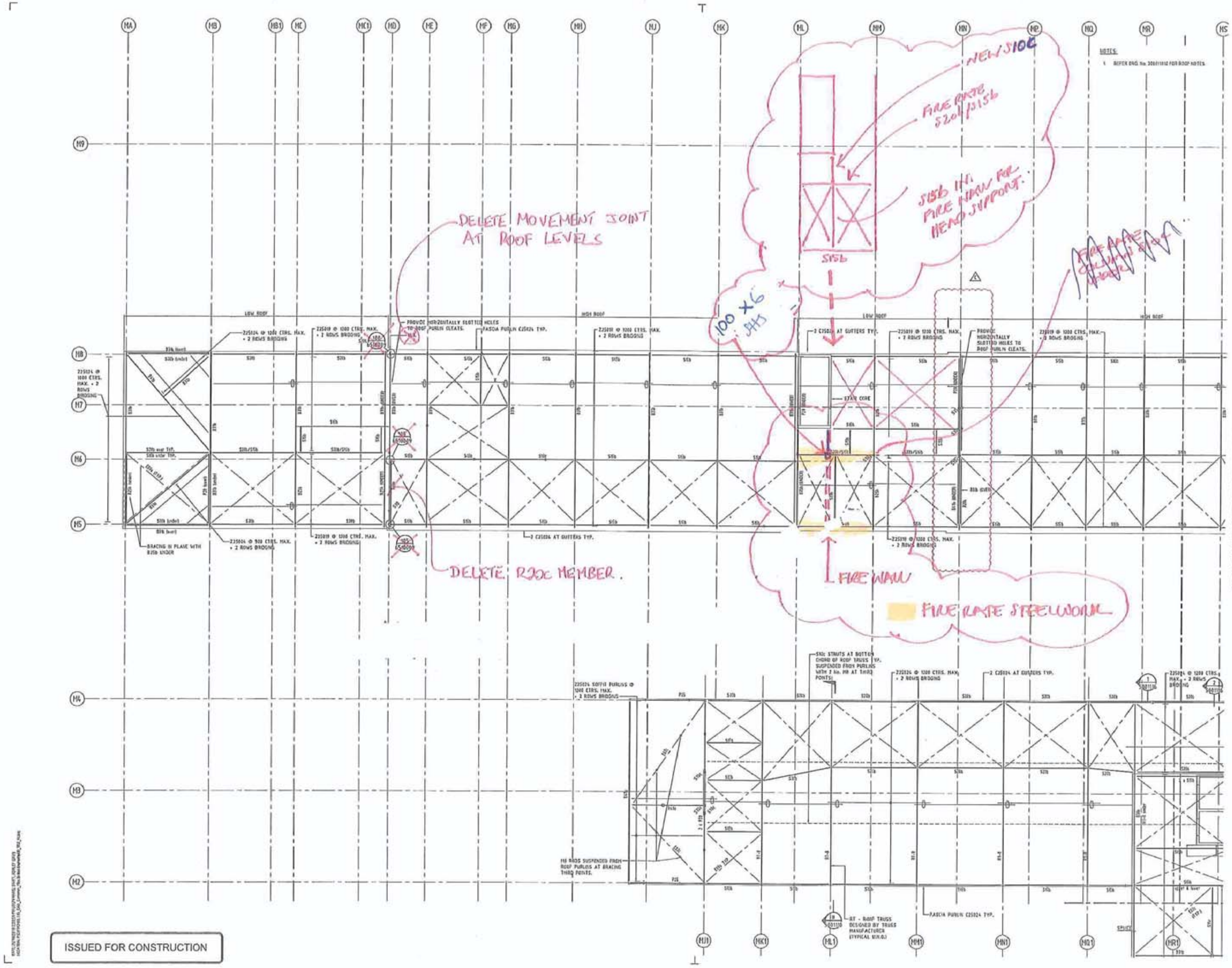
Bovis Lend Lease

GOLD COAST
UNIVERSITY HOSPITAL

STRUCTURAL
MENTAL HEALTH
LEVEL 00 - CEILING
FRAMING PLAN SHT 1 OF 2

	CD	AS SHOWN	E

EJV-ST-MEH-DWG-2000150



SHEET LAYOUT KEY PLAN

KEYPLAN

Queensland Government

Project Services

CAPITAL INSIGHT

GCUH ARCHITECTURE
PDT - ESH - HASSELL

GCUH ENGINEERING
aurecon

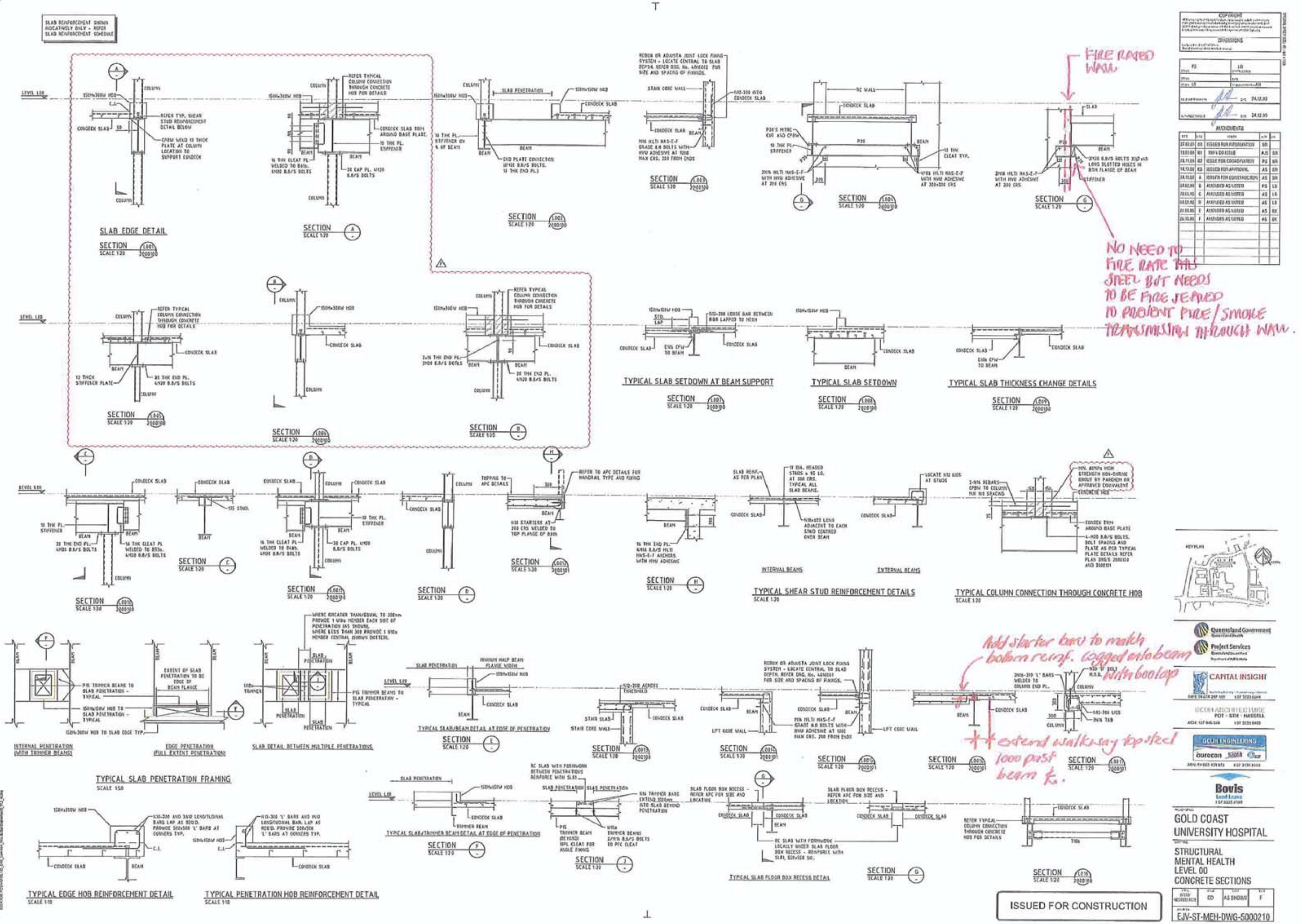
Bovis
Lend Lease

GOLD COAST
UNIVERSITY HOSPITAL

STRUCTURAL
MENTAL HEALTH
LEVEL 01 - ROOF
FRAMING PLAN SHT 1 OF 2

	CD	AS SHOWN	C

EJV-ST-MEH-DWG-2001100



KEYPLAN

Queensland Government

Project Services

CAPITAL INSIGHT

GCUH ARCHITECTURE

GCUH ENGINEERING

aurecon

Bovis Lend Lease

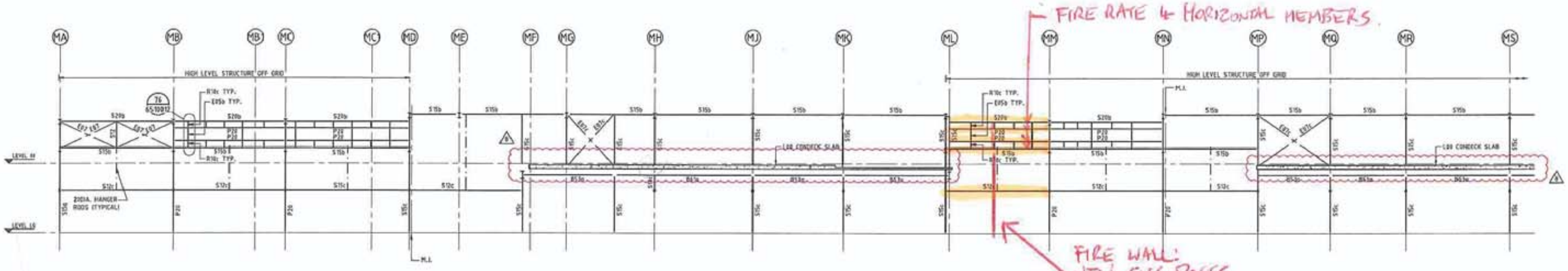
GOLD COAST UNIVERSITY HOSPITAL

STRUCTURAL
MENTAL HEALTH
LEVEL 00
CONCRETE SECTIONS

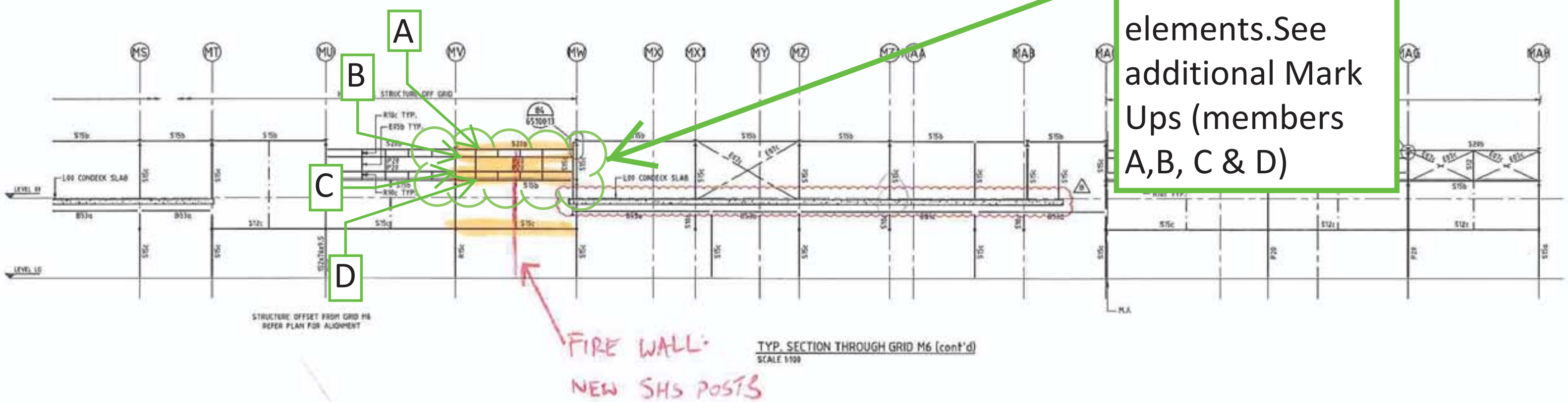
CD | AS SHOWN | F

EJV-ST-MEH-DWG-5000210

ISSUED FOR CONSTRUCTION



TYP. SECTION THROUGH GRID M6
SCALE 1:100



TYP. SECTION THROUGH GRID M6 (cont'd)
SCALE 1:100

AMENDMENTS

Date	Rev	Amendment		
27.03.09	01	50% DD ISSUE		SR
13.05.09	02	100% DD ISSUE	AJG	SR
03.12.09	03	ISSUED FOR COORDINATION	EY	SR
15.12.09	04	ISSUED FOR APPROVAL	AS	SR
18.01.10	A	ISSUED FOR CONSTRUCTION	AS	SR
04.02.10	B	AMENDED AS NOTED	PS	LB

Queensland Government
Project Services
CAPITAL INSIGHT
GCUH ARCHITECTURE
PDT • STH • HASSELL
GCUH ENGINEERING
aurecon SKM
Bovis Lend Lease

GOLD COAST UNIVERSITY HOSPITAL

STRUCTURAL
MENTAL HEALTH
STEEL FRAMING SECTIONS
SHEET 6

CD | AS SHOWN | B

EJV-ST-MEH-DWG-5001115

ISSUED FOR CONSTRUCTION

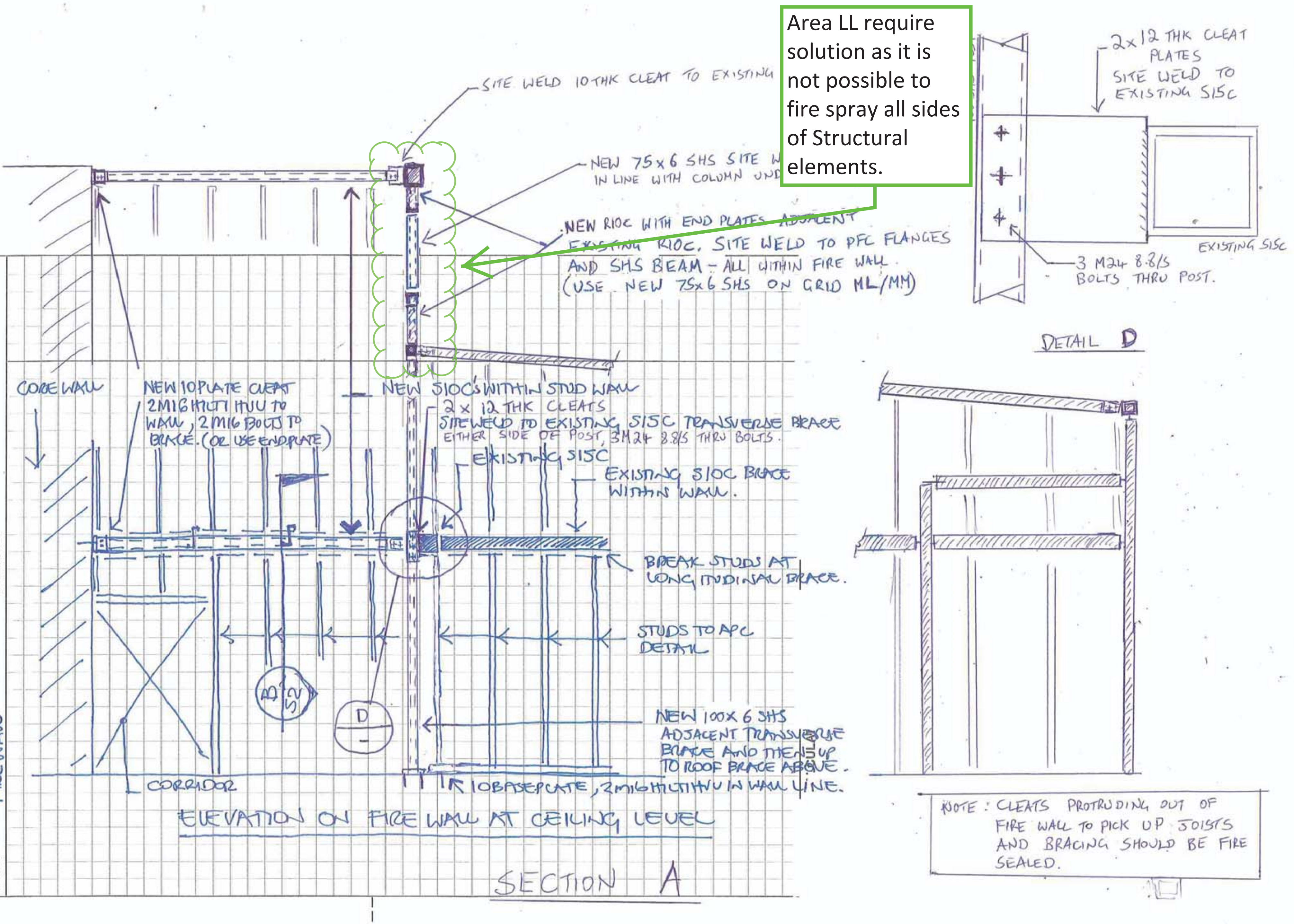
SKM SINCLAIR KNIGHT MERZ

Calculation Record

Form ET2 August 96

Project No. QB50332
File
SHEET No. OF
PREPARED BY JP DATE
CHECKED BY DATE

PROJECT	GCUH
TASK	FIRE WALL
WORK PACKAGE	S1.
ELEMENT	



SINCLAIR KNIGHT MERZ

Calculation Record

Form ET2 August 96

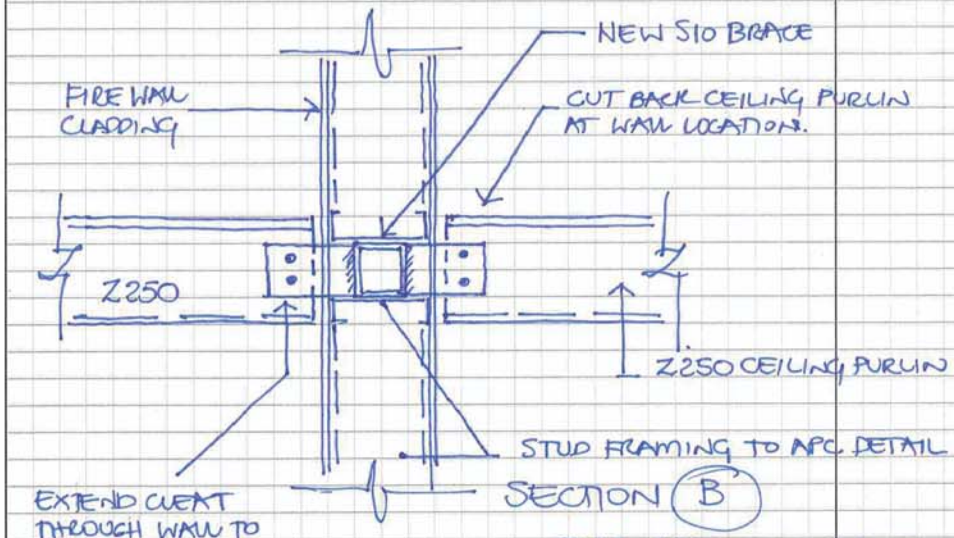
Project No. ΦBS0332 File

SHEET No. OF

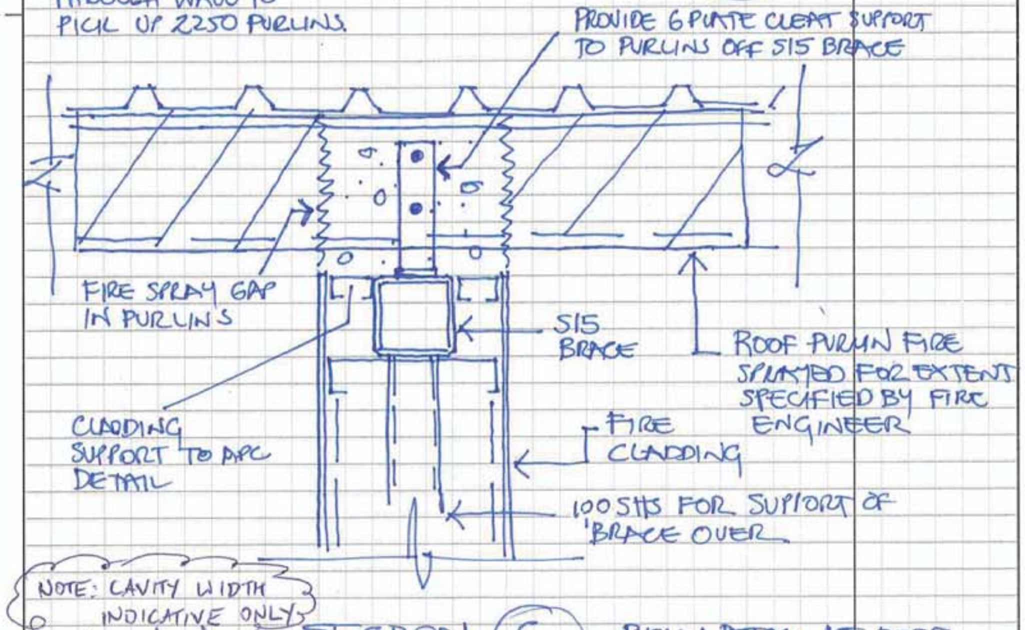
PREPARED BY DATE

CHECKED BY DATE

PROJECT	GCUH	**WORK PACKAGE**	FIRE WALL
TASK	FIREWALL DETAILING	**ELEMENT**	S2.



SECTION B

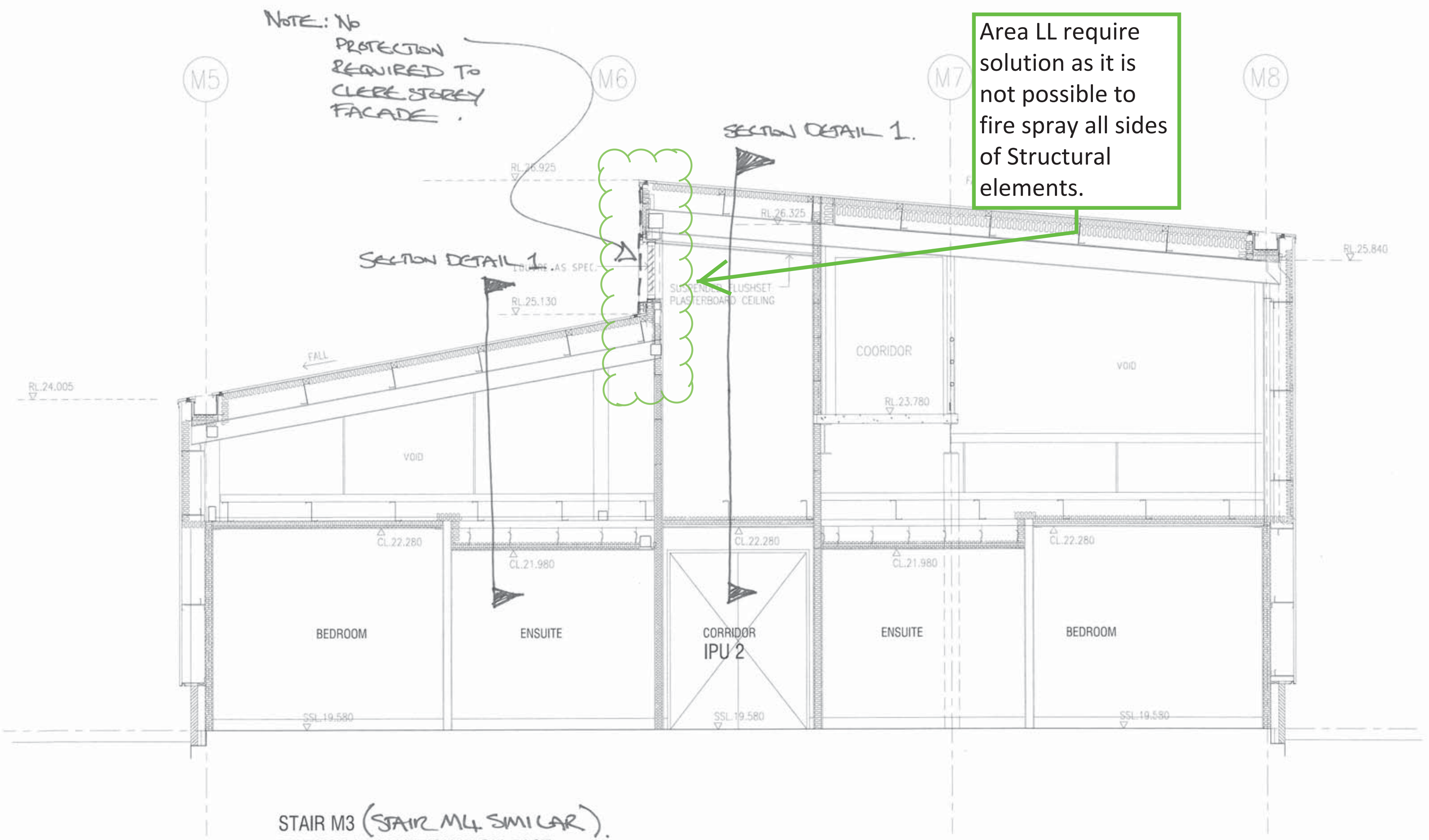


SECTION C

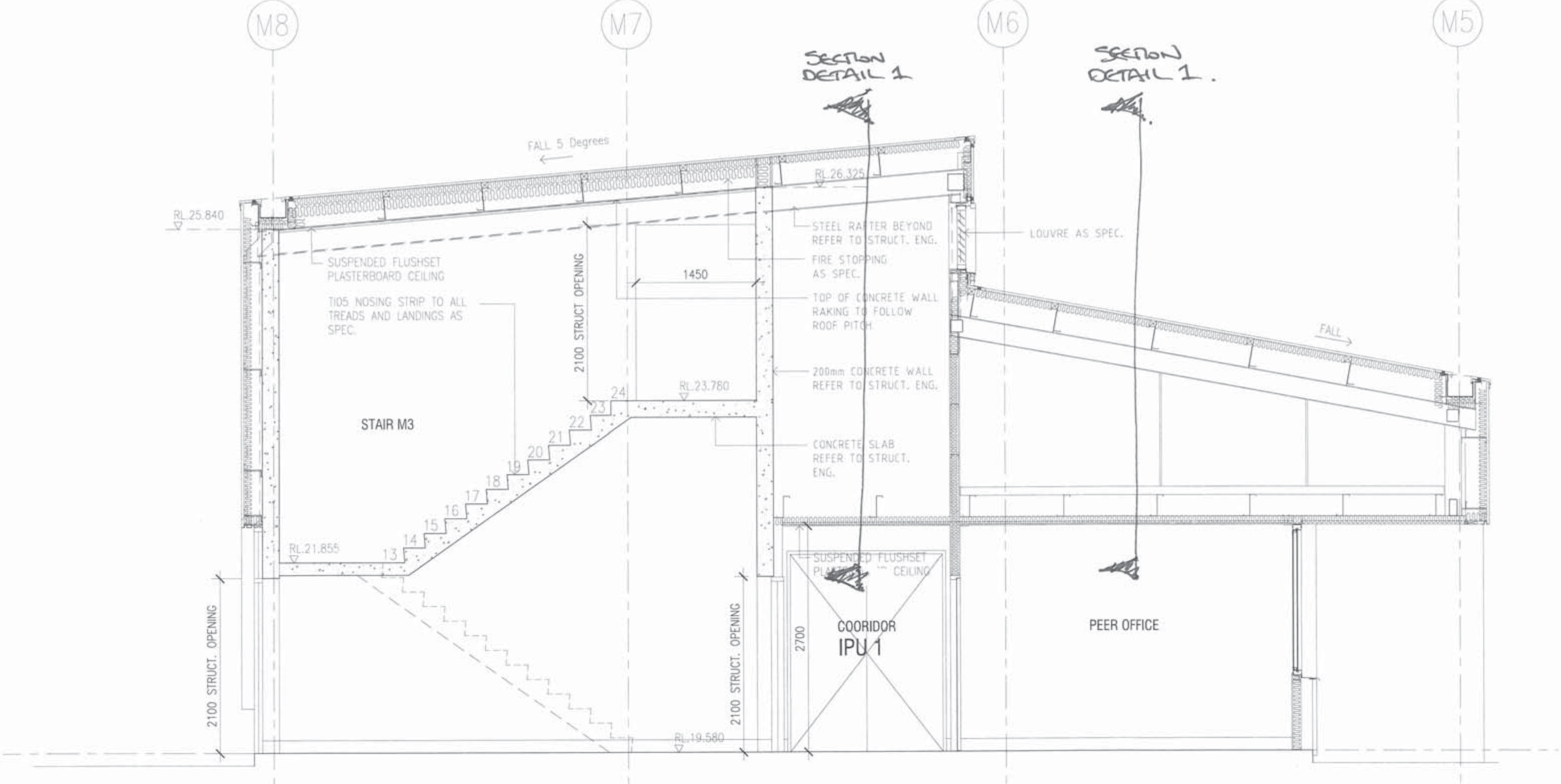
PURLIN DETAIL AT ROOF LEVEL

COMMENTS ON CALCULATION RECORD:

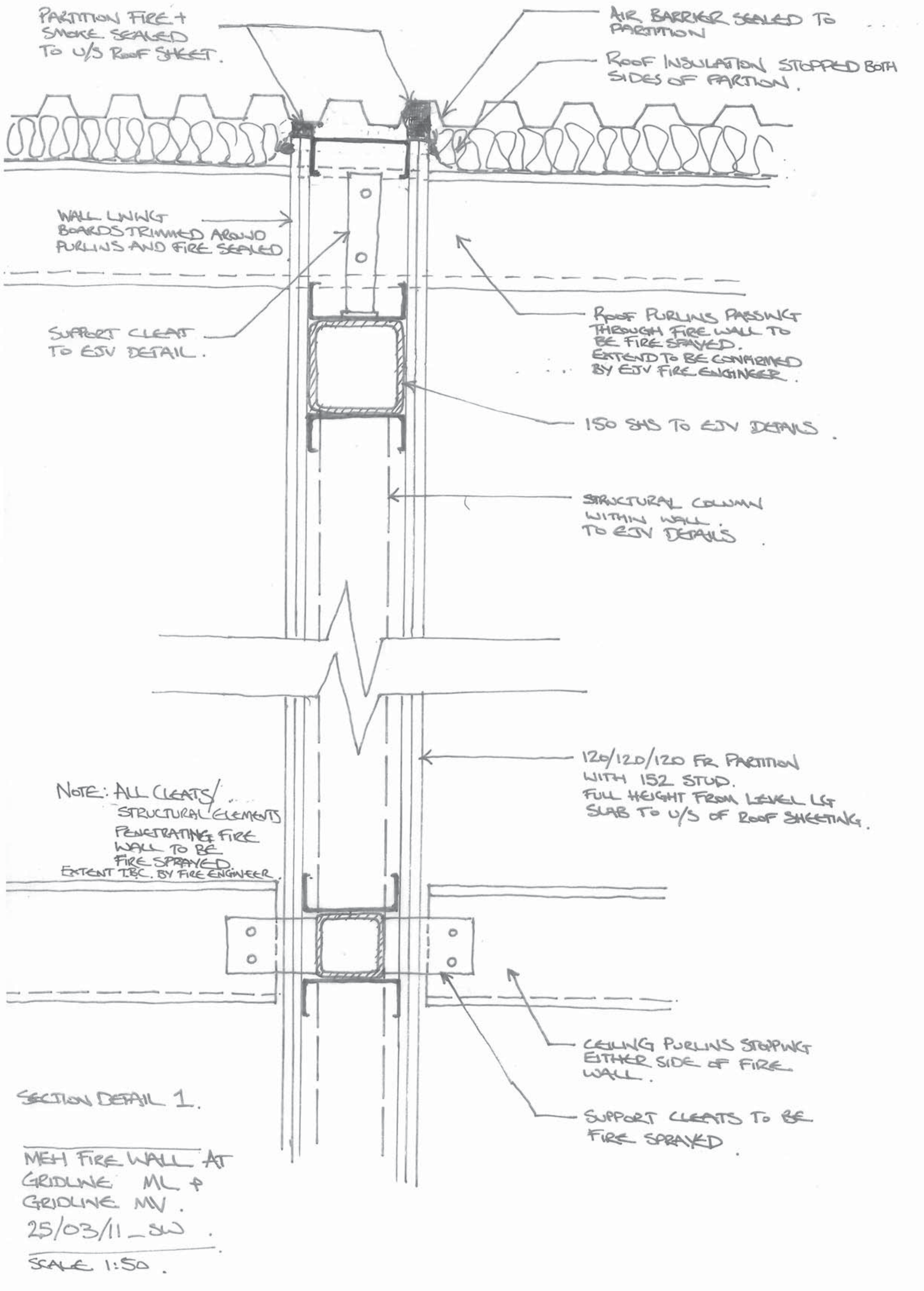
Comments by: Date:



STAIR M3 (STAIR M4 SIMILAR).
FIRE WALL ELEVATION FROM EAST
SKETCH 1:50 AT A3



STAIR M3 (STAIR M4 SIMILAR).
FIRE WALL ELEVATION FROM WEST
SKETCH 1:50 AT A3


PARTITION FIRE + SMOKE SEALED TO U/S ROOF SHEET.
AIR BARRIER SEALED TO PARTITION
ROOF INSULATION STOPPED BOTH SIDES OF PARTION.
WALL LINING BOARDS TRIMMED AROUND PURLINS AND FIRE SEALED
SUPPORT CLEAT TO EJV DETAIL.
ROOF PURLINS PASSING THROUGH FIRE WALL TO BE FIRE SPRAYED. EXTEND TO BE CONFIRMED BY EJV FIRE ENGINEER.
150 SHS TO EJV DETAILS.
STRUCTURAL COLUMN WITHIN WALL TO EJV DETAILS.
120/120/120 FR PARTITION WITH 152 STUD. FULL HEIGHT FROM LEVEL LG SLAB TO U/S OF ROOF SHEETING.
NOTE: ALL CLEATS/ STRUCTURAL ELEMENTS PENETRATING FIRE WALL TO BE FIRE SPRAYED. EXTENT T.B.C. BY FIRE ENGINEER.
CEILING PURLINS STOPPING EITHER SIDE OF FIRE WALL.
SUPPORT CLEATS TO BE FIRE SPRAYED
SECTION DETAIL 1.
MEH FIRE WALL AT GRIDLINE ML + GRIDLINE MV.
25/03/11_SW.
SCALE 1:50.

Appendix F

Curriculum Vitae of Author and Verifier

Arthur Ting

Ting is a senior fire engineer in our Brisbane office. Ting has over 9 years experience in the fire safety engineering consultancy for residential, commercial, industrial and institutional buildings. Ting's qualifications include a Master's Degree in Fire Engineering from the University of Canterbury and a Bachelor Degree in Civil Engineering; Ting is experienced in the formulation of alternative fire engineering design solutions and carrying out analysis computer programs such as fire simulation and evacuation models.

Position
Senior Fire Engineer

Qualifications and memberships
Master of Engineering in Fire Engineering, University of Canterbury, 1999

Bachelor of Engineer in Civil Engineering (Hons), University of Canterbury, 1997

Member of Engineers Australia (MIEAust)

Professional Registration
FSE Singapore, registration no.074

Specialisation
Fire safety engineering design and consultancy

Years in industry
9

Expertise

Specialises in the development of performance based fire engineering approaches for the design and specification of fire safety systems for buildings.

Advanced fire engineering assessments to suit client needs using a variety of computer software such as Computation Fluid Dynamics (CFD), BranzFire, Pyrosim, CFAST.

Preparation of fire safety engineering reports for Building Approval.

Employment History

Year	Employer	Position
September 2010 - present	Aurecon (Brisbane)	Senior Fire Safety Engineer
July 2007 – September 2010	Exova (formerly Bodycote Warringtonfire)	Fire Safety Consultant
Oct 2006 – July 2007	Norman Disney and Young	Fire engineer
Oct 2005 – Sep 2006	Sinclair Knight Merz (Auckland, New Zealand)	Senior fire engineer
Jan 2005 – Oct 2005	AC Consulting (Christchurch, New Zealand)	Intermediate level fire engineer
Mar 2003 – Jan 2005	Minsar consult (Sarawak, Malaysia)	Civil site engineer
Mar 2002 – Mar 2003	Duffil Watts and Kings (Dunedin, New Zealand)	Graduate structural/ fire engineer
Feb 2000 – Dec 2001	Fraser Thomas Consulting Engineers (Auckland, New Zealand)	Graduate fire engineer

Arthur Ting

Key project experience

Ting is the senior fire safety engineer of Aurecon's Fire Engineering Group in Brisbane, which, as part of the larger Buildings Group has both fire safety and fire services engineering design capability to deliver an integrated, practical, and fully realised fire engineering solution that proves both functional and cost effective.

EDUCATION PROJECTS

- QUT Creative Industries Precinct
- QUT Science and Technology Precinct
- Translational Research Institute, Princess Alexandra Hospital, Brisbane
- Bio-Pharmaceutical Australia, Princess Alexandra Hospital, Brisbane
- G39 building of Griffith University, Gold Coast Campus
- National Art Gallery, Singapore (initial design stage)

HEALTHCARE PROJECTS

- Gold Coast University Hospital
- University of Queensland Oral Health Clinic

COMMERCIAL & RETAIL PROJECTS

- Latitude Mackay
- Sunshine Coast Mazda
- Energex office building, Breakfast Creek Road, Brisbane
- Hamilton Harbour mixed use development, Brisbane
- High Street Plaza, Toowoomba
- Rockhampton Shopping Centre, Rockhampton

INDUSTRIAL PROJECTS

- G James warehouse, Brisbane
- Patrick Terminal 10, Brisbane
- Luv-a-Duck, Brisbane
- Valvoline warehouse, Brisbane

CIVIC PROJECTS

- Gabba Stadium, Brisbane
- National Art Gallery, Singapore

Ian Moore, Peer Reviewer

Ian has had over 22 years experience as a fire and risk specialist. He has developed fire safety strategies and performed risk assessments for a number of occupancy types including apartments, offices, warehouses, shopping centres and communications facilities. Fire safety assessments of buildings are evaluated using both quantitative and qualitative techniques. Risk management studies have involved communications facilities, hospitals, traffic tunnels, Fire Brigade services and computer facilities. Ian has pioneered the use of risk assessment and risk management in commercial fire engineering projects such as Westin Hotel, Federation Square, Gold Coast Stadium, and Canberra Deep Space Tracking Centre.

Qualifications and Memberships:
- Grad. Dip. Building Fire Safety and Risk Eng, (Hons), 1995
- Bachelor Applied Science in Metallurgy, (Hons), 1985
- Registered Professional Engineer Queensland (RPEQ No. 9861)
- Member, NPER3, Institution of Engineers, Australia
- Registered Building Practitioner RBP EF-1007
- Tasmanian Compliance Corpration CC4491 V, Fire Safety Engineer Unrestricted
- Member Society of Fire Protection Engineers
- Member Society Fire Safety
- Member Society Risk Engineers

Employment History:
- 2007 to present: Aurecon Group, Melbourne - Leader Fire Engineering
- 2006 to 2007: Sinclair Knight Merz - Global Fire Engineering Leader
- 2004 to 2006: Pitt & Sherry - Senior Fire and Risk Specialist
- 1997 to 2004: Ove Arup and Partners -Senior Associate, Leader Arup Fire Southern Region
- 1995 to 1997: Scientific Services Laboratory. Senior Fire Engineer
- 1994 to1995: Centre Environmental Safety and Risk Engineering -Project Manager

Representative projects participated in include:
- RMIT Building 5, Level 01, Melbourne
- RMIT, Basement Service Area, Bundoora
- Edith Cowan University . Building Fire Risk Assessment, Perth
- Fire Safety Audit Project Review, ITC City Campus, RMIT
- Overnewton Anglican Community College
- Ballarat Grammar, Victoria
- Scotch College, Melbourne
- Doug McConnel Building, Melbourne University
- Melbourne Cricket Ground North Stand
- Gold Coast Stadium
- Carisbrook Stadium
- State Hockey Centre, NSW
- State Library of Victoria
- Dandenong Performing Arts Centre
- National Gallery Redevelopment, Victoria
- Federation Square - Museum of Australian Art
- Central City Studios
- Federation Concert Hall, Tasmania
- Hordern Pavilion and Royal Hall of Industries, NSW

Dr Tony Enright

Tony is a Chartered Professional Engineer in our Melbourne office with 16 years professional engineering experience including international experience in Belgium, England, Hong Kong and NZ. He is widely experienced on a variety of major building, industrial, transportation and advisory projects and is highly proficient in fire dynamics, quantitative risk assessment (fire and non-fire applications), CFD modelling and computerised evacuation modelling. Tony has won several academic and project-based awards, including being the inaugural winner of the prestigious NFPA International Scholar in Fire Science. He has authored numerous peer-reviewed publications and presentations internationally.

Connell Wagner Position
Associate - Mechanical

Specialisation
Fire Engineering

Years in industry:
16

Qualifications and Memberships

PhD (Fire Engineering)
ME (Fire Engineering)
BE (Civil Engineering)
CPEng

Expertise

Doctorate in fire dynamics. Widely experienced in a variety of major projects. Proficient in fire risk assessment, CFD fire modelling and egress modelling.

Awards
2004 ACENZ Award of Merit for the NZFS Risk Analysis Project
2003 John Connell Innovation Award, Discipline Winner (Mechanical)
1999 Royal Society (NZ): Science and Technology Award
1997 NFPA (USA): International Scholar in Fire Science (Inaugural winner)

Key Project Experience

June 2001 – Current
Connell Wagner

Melbourne, Australia (2006 - Current)
Christchurch, New Zealand (2001 - 2005)

Sample Projects:

Aviation
- North Satellite Concourse, Hong Kong International Airport
- Hangar 2, Hong Kong Business Aviation Centre
- Cairns ITB redevelopment

Commercial
- 567 Collins Street, Melbourne
- World Trade Centre Redevelopment, Melbourne
- 139 Carlton Gore Road, Auckland

Education
- University of Auckland Population Health Complex
- Botany Downs Secondary College (Greenfields), Auckland
- Aquinas College, Tauranga

Entertainment
- West Kowloon Cultural District Development, Hong Kong
- Cinema 3, Blenheim

Health
- Alfred Hospital ICU redevelopment, Melbourne
- Canterbury Charity Hospital, Christchurch

Government
- Department of Building and Housing, expert advisor, Wellington
- Building Industry Authority ECC project, Wellington

Infrastructure
- West Gate Bridge Risk Review, Melbourne
- Eastern Busway Tunnels CDIMP, Brisbane
- Melbourne Underground Rail Loop MURL Tunnels fire safety review, Melbourne
- Melbourne Water ETP tunnel fire safety upgrade, Melbourne

Justice
- Maori Land Court, Christchurch
- Forensic Longstay, Christchurch

Laboratory
- Manaaki Whenua Landcare Research, Auckland

Public
- Waitakere City Civic Centre
- Henderson Library and Unitec Facility, Waitakere

Residential
- Scott Street Apartments, Brisbane
- Victoria Square Apartments, Christchurch, NZL

Retail
- Triangle Centre Redevelopment, Christchurch
- Sylvia Park, Auckland

Sporting Facility
- Multipurpose Indoor Entertainment Sports Stadium, Perth

Other
- Lecturer (full course), University of Canterbury NZL 1996, 2003, 2004
- Standards Development, ISO TC92 SC4, 2000 (BIN) , 2002-2004 (SNZ)

Jonathan Shelley

Jonathan is a Senior Associate in Omnii's Brisbane office and has over 10 years experience in the fire engineering sector. Jonathan specialises in the development of performance based fire engineering solutions for buildings, structures and infrastructure projects.

Jonathan is very experienced in the latest fire engineering processes including fire and evacuation computer modelling and risk modelling. Jonathan is also an experienced regulatory reviewer and is one of the preferred peer reviewers for the QFRS. Jonathan has worked on numerous large, multi-disciplinary buildings and infrastructure projects. Consequently, he has an in-depth understanding of the relationship between fire engineering and the related building services and structural disciplines and also of the various project delivery methods from traditional, D+C to Managing Contractor arrangements.

In addition to consultancy experience, Jonathan has an extensive background with the New Zealand Fire Service (NZFS), covering both fire engineering and operational firefighting. This background provides Jonathan with valuable knowledge and insight of the roles and requirements of both the building Certifier and the local Fire Authority, which is unique to the industry.

His project experience is wide and varied and includes, among many other projects, the following representative list:

- Nadi Airport Terminal Modernisation Project, Nadi Fiji
- Brisbane Supreme Court and District Court, Queensland
- Gold Coast University Hospital, Queensland
- QUT Science & Technology Precinct, Queensland
- Cairns Airport International Terminal Building Redevelopment, Queensland
- UQ Oral Health Centre, Queensland
- King George Square Redevelopment Stage 2, Queensland
- Acacia Ridge SkillsTech Stage 1C, Queensland
- Bay Grand Apartments, Queensland
- Qatar National Bank Tower, Qatar, Fire Engineering Review
- Airport Link and Northern Busway Tunnels, Queensland – Engineering Design Requirements and Performance Specification
- Northern Link Tunnel, Queensland – Reference Design and Performance Specification
- Gold Coast Rapid Transit Project, Queensland – Reference Design Fire Engineering

NFPA MEMBER 2014-15

FPA AUSTRALIA
Corporate Silver Member

Qualifications:
Master of Engineering in Fire Engineering (Distinction), University of Canterbury, NZ

Bachelor of Architecture, University of Auckland, NZ

Registrations:
Graduate Member Institution of Professional Engineers New Zealand

Members Examination, Institution of Fire Engineers

Omnii Pty Ltd ABN 26 590 358 533
National Fax 1300 765 109
Vic L2, 51 Queen Street Melbourne Victoria 3000 t 61 3 9620 4025
Qld L1, 8/56 Logan Road Woolloongabba Queensland 4102 t 61 7 3223 7370
WA L1, 982 Wellington Street West Perth Western Australia 6005 t 61 8 6160 2300

Jack Partridge

Jack is a Senior Fire Engineer with Omnii's Brisbane office and has responsibility for delivering Fire Safety and Fire Protection Services Designs. Jack also holds an Electrical Engineering degree and is RPEQ registered in this field.

Having worked in the Building Industry since 2007, Jack has experience providing Alternative Solutions for developments in a wide range of buildings. Jack possesses sound modelling skills using both Zone Models and Field Models and on-site practical experience garnered over the years, both in consulting and prior.

His experience extends to Hospitals, Aged Care, Office and Retail Buildings, Storage Facilities, Industrial Buildings and Educational/Public Buildings.

Prior to Jack's involvement in the Building Industry, Jack had had extensive Defence Force experience, working in the Maintenance Engineering, Project Engineering and Logistics fields.

His project experience includes, among many other projects, the following representative list:

- Redlands City Marina, Qld
- Novotel Airport Hotel, Brisbane, Qld
- New Port Office, Port of Brisbane, Qld
- St Vincent's Hospital, Toowoomba, Qld
- Pine Rivers Private Hospital, Qld
- Mackay Hospital, Qld
- Queensland Children's Hospital, Qld
- Steel Storage, Tingalpa, Qld
- Steel Storage, Yatala, Qld
- Steel Storage, Salisbury, Qld
- Visy Beverage Can Factory, Yatala, Qld
- Primo Smallgoods Stage 2, Wacol, Qld
- Yukana Aged Care Centre, Toowoomba, Qld
- St Mary's College, Ipswich, Qld
- 14 – 20 Constance Street, Fortitude Valley, Qld
- 135 Pring Street, Hendra, Qld
- Garden Central Towers, Mt Gravatt, Qld

Qualifications:

Bachelor of Engineering – Electrical
University of New South Wales

Post Graduate Certificate - Aerospace Engineering
Royal Melbourne Institute of Technology

Master of Engineering Management
Queensland University of Technology

Master of Engineering in Fire Engineering
University of Canterbury, NZ

Registrations:

Chartered Professional Engineer, Engineers Australia, CPEng

National Professional Engineers Register, NPER

Registered Professional Engineer Queensland, Electrical Engineering and Fire Safety Engineering, RPEQ

Member Engineers Australia, MIEAust (Electrical College)

Member Society of Fire Safety, SFS

Affiliate Member of Society of Fire Protection Engineers

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Peter Glodic

Peter is Managing Director of Omnii. He has responsibility for the core business direction of the company and oversees key aspects of project quality, management and marketing.

Peter's technical expertise is significant, ranging from an intimate knowledge of all facets of fire services including design, procurement and construction to fire engineering including alternate building solutions, computer modelling, auditing and risk assessments.

Peter has also worked in Fire Sprinkler Contracting which enables Peter to provide unique skills and advice to Omnii's clients as Consulting Engineers – experience that is extremely rare in the consulting engineering fraternity these days.

Peter has played key roles in master planning of projects as well as maintaining a hands on approach in key projects – paramount to a project's success.

Peter, via his prior experience in large multi-disciplinary and international engineering consultancies, has significant exposure to many project delivery methods ranging from Traditional to D+C to Novation to Managing Contractor approaches.

Testimony to Peter's standing in the Building and Construction Industry is his exposure to the range of market sectors including: Aviation, Educational/Public Buildings, Health and Aged Care, Industrial, Office/Commercial, Refurbishments, Residential, Retail and Defence.

Peter is an industry leader in Performance Based Design (Alternate Solutions). He is often the fire engineer of first choice – attributed to his client and outcome focussed project delivery and dedication to the fire industry.

His project experience is wide and varied and includes, among many other projects, the following representative list:

- Asia Pacific Fire Engineer for Iron Mountain
- Tower Parkway, Jumeirah Village South, Dubai, UAE
- Virgin Atlantic A380 Aircraft Hangar, Heathrow, UK
- Albury Wodonga Military Area, Fire Master Plan, Vic
- Wesley and Mater, Qld, Box Hill, Frankston, Maroondah and Northern Hospitals, Vic
- Melbourne University Private (UMEE), Hawthorn, Vic
- Various Warehouses – ALDI, Australia Post, Iron Mountain Nike, P+O, Qantas, Siemens
- Various Shopping Centres – Dalby Qld, Colonnades SA, Mt Gravatt Qld, The Glen Vic, Lynbrook Village Vic, Rhodes NSW, Woolworths (various)
- Various Residential Developments – MAB Docklands, Hallmark, Marquise, Royal Domain, Franklin Lofts, Espy, Edgewater Towers
- Commercial Fitouts – Various Rialto tenancies, St John's Ambulance, Right Management

ENGINEERS AUSTRALIA
Chartered Professional Engineer
FELLOW

NFPA
MEMBER
2014-15

FPA AUSTRALIA
Corporate Silver Member

Qualifications:

BE Mechanical & Computing (Honours), Monash University

Graduate Certificate in Performance Based Building and Fire Codes, VUT

Graduate Diploma in Building Fire Safety and Risk Engineering, VUT

DLIQ Internal Quality Assurance Auditor

Registrations:

Fellow, Engineers Australia, FIEAust

Chartered Professional Engineer, Engineers Australia, CPEng

Engineers Australia, National Professional Engineers Register, NPER

Registered Professional Engineer of Queensland, RPEQ 7840

Registered Building Practitioner, VIC EF-1022 & EM-18807

Accredited Certifier – Fire Safety Engineering Compliance BP Act and Scheme, NSW

Accredited Building Practitioner, Tasmania

Accredited Building Practitioner, Northern Territory

Member, Australian Institute of Company Directors, MAICD

Affiliate Member, Chartered Institution of Building Services Engineers (CIBSE), UK

Member, Society of Fire Safety, SFS

Member, Risk Engineering Society, RES

Member, Fire Protection Association of Australia, FPAA

Member, PRISM International

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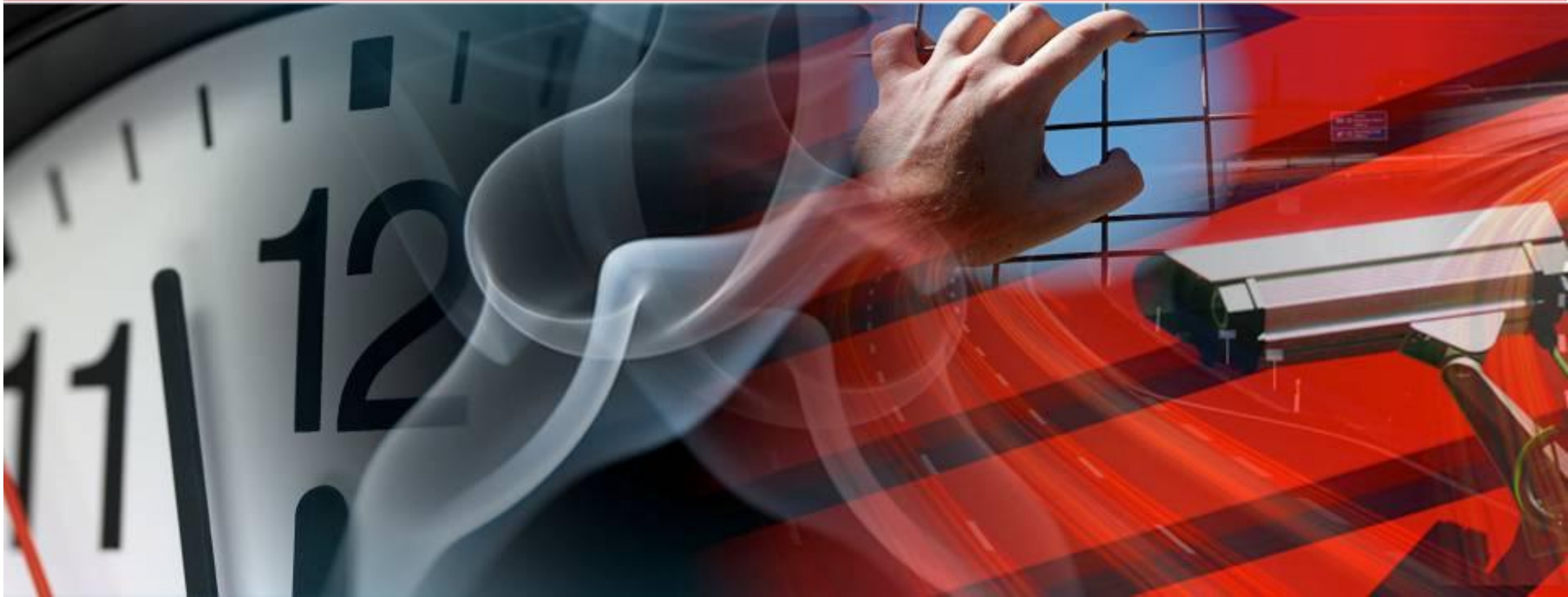
Appendix G

VESDA System vs Ionisation Detector

Xtralis / Aurecon

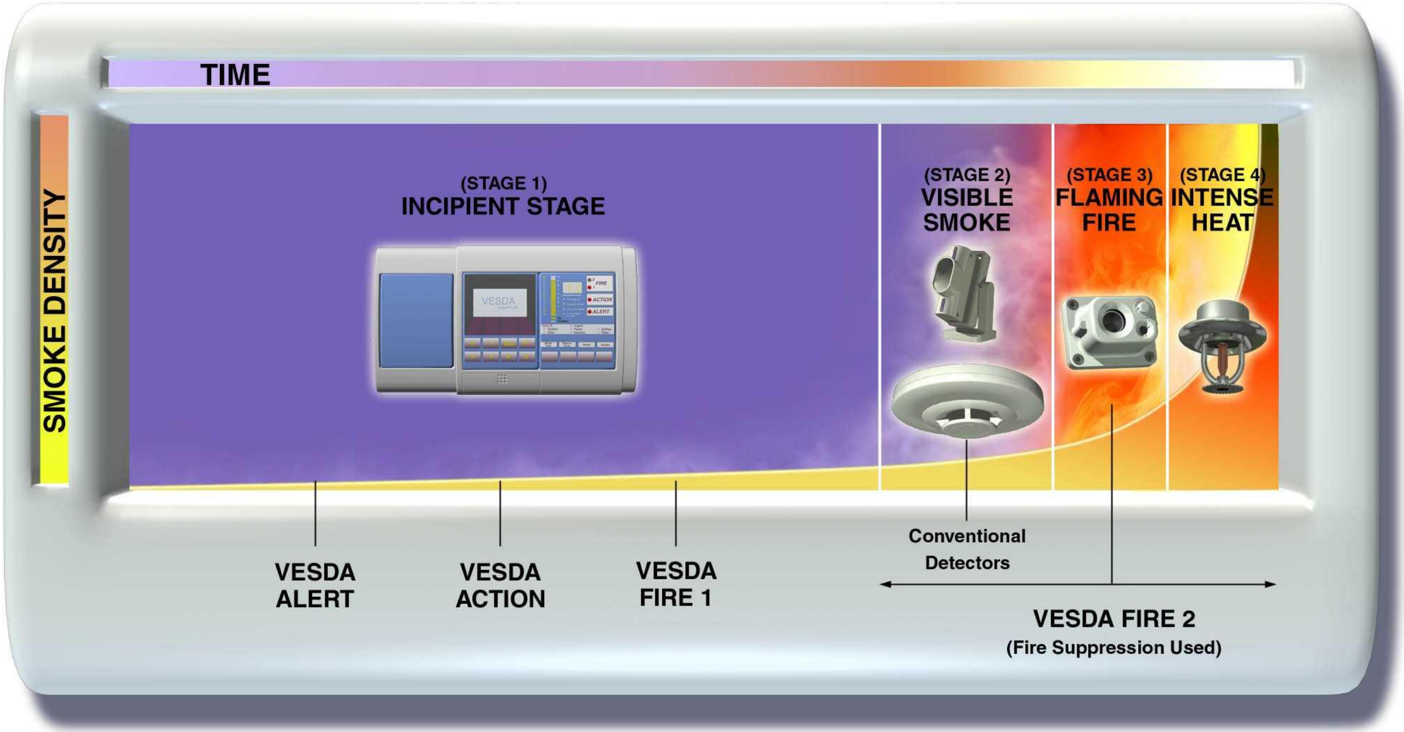
VESDA vs. Point Type Detectors

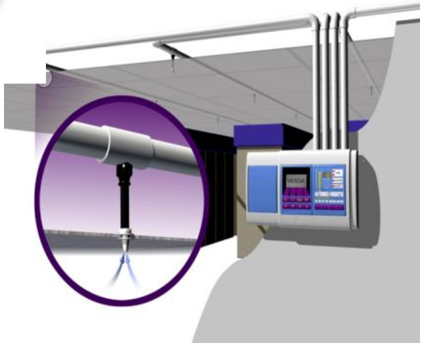


VESDA vs. Point Detection

	Point Detection (Photo / Ionisation)	VESDA (Aspirated)
Detector type	Passive detector with no adjustable sensitivity	Aspirated (Active draw) detector with fully adjustable sensitivity
Detector Sensitivity	1% - 5% Obs/m	0.005% - 20% obs/m
Alarm Levels	1 (Non adjustable)	4 (Fully adjustable)
Alarm Delays	No	Yes
Absolute Detection Capabilities	No	Yes
Subject To False Alarms	Yes	No
Airflow Restrictions	Yes	No
Detection Technology	Photo / Ionisation	Laser
Event Log Memory	No	Yes
Ceiling Height Restriction	Yes	No, documented successful installation for up to 64m
Periodically Re-Calibration	Yes	No
Pre - Filters	No	Yes
Auto Learn Function	No	Yes
Performance Software To Estimate Detection Time	No	Yes

VESDA vs. Point Detection





VESDA provides:

- Early detection
- Less False alarms
- Active system
- 4 alarm levels
- Wider detection range

Appendix H

QFRS comments on FER rev 13 and FER rev 22 (DRAFT)

RURAL FIRE SERVICE

Queensland Government

RECEIVED
25 MAY 2011
BY:

Assessment of Special Fire Services

Assessment Non Compliant

23 May 2011

Job #: 19686/3
File Ref: 19686
Certifier's Copy

Justin Porter
Project Services
GPO Box 2906
BRISBANE QLD 4001

Dear Sir/Madam

The Queensland Fire and Rescue Service (QFRS) have now assessed the proposed project for the premise address below:

Mental Health Unit
Gold Coast University Hospital
Parklands Drive
SOUTHPORT QLD 4215

The assessment has been carried out against information obtained from the documents and drawings shown in the attached assessment report.

The payer of the prescribed fees will receive an invoice shortly and is payable within 14 days.

Yours sincerely

Kenneth Clark
Building Approvals Officer
Queensland Fire and Rescue Service
South Eastern Region

South Eastern Region
Southport Office
Cnr Prince and Nerang Sts
SOUTHPORT QLD 4215
PO BOX 25
ASHMORE QLD 4214
Phone: +61 7 5583 7578
Fax: +61 7 5583 7570
Website: www.fire.qld.gov.au
ABN 93 035 163 778

Assessment of Special Fire Services

Assessment Non Compliant

Applicant

James Wright
Bovis Lend Lease
Level 18, 1 Eagle Street
BRISBANE QLD 4000

QFRS Assessed Floor Area: 8535m² **Discrepency:** 490m²

Applicant Assessed Floor Area: 8045m²

Documents

QFRS Application Form, IDAS Form Part A & B

Drawings and Other Documents

Fire Engineering Report
Gold Coast University Hospital
Queensland Health
Volume 2: Mental Health Unit,
6 April 2011
Reference EJV-FE-MEH-REP-000001-PDF
Revision 13

Drawings;
(PSH-AR-MEH-DWG-) 2000100/F, 2000101/F, 2000102/F, 2001100/F, 2001101/E, 2001102/E, 20B1100/C, 20B1101/C, 20LG100/G, 20LG101/F, 20LG102/G, 2600100/E, 26B1100/C, 26LG100/G, 4000000/H, 4000001/G, 4000002/G, 4000003/G, 4000004/G, 4000005/G, 4000006/H, 4000007/H, 4000008/H, 4000009/E, 5000001/E, 5000002/F, 5000003/E, 5000004/E, 5000005/F, 5000006/E, 5000007/D, 5000008/E, 5000009/D, 5000010/D, 5000011/D, 5000012/D, 5000013/E.
(EJV-FD-MEH-DWG-) 2000001/G, 2000002/G, 2000100/A, 2001001/2, 2001002/2, 20B1001/B, 20B1100/A, 20LG001/H, 20LG002/H, 20LG100/A, 5001000/B, 7001000/C.
(EJV-FW-MEH-DWG-) 2000001/F, 2000002/F, 2001001/02, 2001002/02, 20B1001/B, 20LG001/H, 20LG002/E, 7001000/C, SK00001/01, SK00002/01, 1010200/1, 1010207/1, 1010208/1, 6010002/1.

General Comments

The building does not comply with the Special Fire Services assessed by QFRS.

In accordance with the Sustainable Planning Act 2009 Part 3, Division 4, Subdivision 3, Clause 292(2) (b), QFRS recommends the building application be refused

This assessment is based on the building being type 'C' construction

Block plans, location diagrams and the like including all signage must be durable water & fade resistant on a single piece of rigid material as approved by QFRS. In addition they must be correctly oriented and permanently fixed in place using screws or rivets.

Any locking device required on a fire safety installation, must be a 003 type to Lockwood specifications.

This assessment has been assessed as per the drawings submitted should any changes take place that effect Special Fire Services the QFRS are to be advised so that a reassessment can be done.

This assessment is subject to the acceptance of the Fire Engineering report to vary the deemed to satisfy provisions of the BCA.

ADVICE

Alternative Building Solution for Fire Safety System

Documents Assessed:

ALTERNATIVE SOLUTION SIGNAGE

Permanent signage, e.g. engraved acrylic and screwed, should be provided adjacent to the Fire Indicator Panel advising that this building is the subject of an Alternative Building Solution. The signage should be a minimum A4 size. An example of the text is as follows;

FIRE ENGINEERED ALTERNATIVE DESIGN

This building is the subject of an Alternative Building Solution to meet the Performance Requirements of the Building Code of Australia.

- ***Fire compartment area is greater than prescribed by C2.5***
- ***Non-provision of 30 minutes FRL to floor separating storeys in a Class 9a building***
- ***Extended travel distance from in lower level plant area***
- ***1000m^2 compartment with 60/60/60 not provided to ward areas. Smoke proof subdivision exceeds 500m^2 limit***
- ***FHR cabinets will be key locked with no frangible panel***
- ***Fire door hold open device only releasing upon local smoke detector activation within 1.5m of doors***
- ***Alternate egress ladders from Level 00 plant rooms do not comply fully with AS1657***
- ***Doorway thresholds incorporate a step (hob)***
- ***Fire compartmentation does not extend fully to 'edge' of building line.***
- ***A doorway in a Class 9a health care building incorporates a sliding door***
- ***Building elements pass through a fire rated wall***
- ***Fire hose reels pass through doorways fitted with fire and smoke doors***

Any alterations to the building or the installed fire safety systems must be approved by a building certifier and should be reviewed by a fire safety engineer.

Issue 1. ***Fire Safety System:*** **"Restrict the Spread of Fire"- Open covered walkways link buildings -** ***Fire compartment area is greater than prescribed by C2.5***

QFRS Comments: **Management in use documentation is to clearly indicate that, no material or furnishing which could constitute a fire load can be stored in the walkway areas at anytime.. QFRS accept the alternative solution as detailed in the report.**

Issue 2. ***Fire Safety System:*** **"Restrict the Spread of Fire"-** ***Fire separation between storeys not provided -*** **Non-provision of 30 minutes FRL to floor separating storeys in a Class 9a building**

QFRS Comments: **QFRS accept the alternative solution as detailed in the report.**

Issue 3. ***Fire Safety System:*** **"Provide for Safe Evacuation"** ***Travel distance exceeds 20m in lower plant level area -*** **extended travel distance in lower level plant area**

QFRS Comments: QFRS accept the alternative solution as detailed in the report.

Issue 4. *Fire Safety System:* "Restrict the Spread of Fire" and "Provide for Safe Evacuation" - oversized fire and smoke compartments - *1000m² compartment with 60/60/60 not provided to ward areas. Smoke proof subdivision exceeds 500m² limits*

QFRS Comments: QFRS accept the alternative solution as detailed in the report.

Issue 5. *Fire Safety System:* "Extinguish Fire" - FHR to be readily accessible at all times - *FHR cabinets will be key locked with no frangible panel.*

QFRS Comments: QFRS accept the alternative solution as detailed in the report.

Issue 6. *Fire Safety System:* "Provide for Safe Evacuation" and "Restrict the Spread of Fire" - Fire doors are required to close on activation of any detection device installed - *Fire door hold open device only releasing upon local smoke detector activation within 1.5m of doors*

QFRS Comments: QFRS do not accept the alternative solution as detailed in the report.

Fire safety systems are installed to protect all building occupants. Given the horizontal evacuation strategy proposed for this building and increased fire and smoke compartment sizes. QFRS believe a robust evacuation strategy must be implemented to safeguard all building occupants. Any successful evacuation of the building will be dependent on effective compartmentation. Fire/smoke doors provide a vital link between adjoining compartments while, simultaneously maintaining a level of fire/smoke separation. Early activation/release of magnetic hold open devices restraining these fire safety doors is essential to confine a developing fire and contain any toxic by-products to the area of origin.

Dispensation to increase both fire and smoke compartments sizes has already been established, which could potentially see a larger fire or greater volume of smoke develop. As such, the risk of fire and/or smoke spread would also be increased. This in turn could see additional building occupants, staff and patients, unnecessarily exposed to a fire and its toxic by-products.

QFRS have been advised that only a limited numbers of patients will be occupying each of the fire/smoke compartments in this building, with only a small number of critical patients residing in each compartment? We are also told that a sufficient number of staff members will be on duty at all times to cater for these patients needs/safety? This in mind, QFRS suggest it would be more beneficial to contain a fire to the smallest area possible at an early stage, rather than risk it spreading to adjacent areas. By utilising supplementary on-duty staff from the other building areas, critical patients could be rapidly evacuated from a fire effected area, to a safe adjacent compartment, with the fire and smoke contained to the area of origin. This strategy would reduce the potential for smoke spread to other building areas. If smoke were to spread, increased patient numbers would require assistance, possibly in several compartments, and a reduced number of staff members would be available to supervise them. Also, additional sets of magnetic hold open devices would be activated which would cause further delays to the evacuation process.

Should a fire situation arise, all building occupants must be provided with sufficient time to evacuate? Any delay in activating the fire/smoke doors could allow the products of combustion to spread into adjoining areas. Which in turn, would result in greater numbers of occupants being exposed to fire? Closing fire doors in a fire compartment at the earliest detection of fire is considered essential to restrict the spread of fire into other building areas. To enhance this ABS proposal, QFRS request that in addition to the smoke detector located within 1.5m of the doorway, the automatic hold open devices should also activate on any sprinkler activation in a compartment. This would cater for any potential detector failure and subsequent fire growth, a senario which would see the sprinkler system activate a short time later.

Issue 7. ***Fire Safety System:*** **"Provide for Safe Evacuation" - Ladder used to provide egress from a plant room** - ***Alternate egress ladders from Level 00 plant rooms do not comply fully with AS1657***

QFRS Comments: **QFRS accept the alternative solution as detailed in the report.**

Issue 8. ***Fire Safety System:*** **"Provide for Safe Evacuation" - Exits must be provided to a building to allow occupants to evacuate safely** - ***Doorway thresholds incorporate a step (hob)***

QFRS Comments: **QFRS accept the alternative solution as detailed in the report.**

Issue 9. **Fire Safety System:** **"Restrict the Spread of Fire" - Horizontal fire spread between adjacent compartments** - ***Fire compartmentation does not extend fully to 'edge' of building line.***

QFRS Comments: **QFRS accept the alternative solution as detailed in the report.**

Issue 10. ***Fire Safety System:*** **"Provide for Safe Evacuation" - Exits must be provided to a building to allow occupants to evacuate safely** - ***A doorway in a Class 9a health care building incorporates a sliding door***

QFRS Comments: **Table 23 incorrectly identifies the relevant DTS clause associated with this issue as being *C2.19*. For accuracy, this should be amended to indicate *D2.19* as being the relevant clause associated with this issue. QFRS accept the alternative solution as detailed in the report.**

Issue 11. ***Fire Safety System:*** **"Restrict the Spread of Fire" - Building elements must not pass through or cross a fire wall** - ***Building elements pass through a fire rated wall.***

QFRS Comments: **QFRS accept the alternative solution as detailed in the report.**

Issue 12. ***Fire Safety System:*** **"Restrict the Spread of Fire" - Fire hose reels to be located to avoid hose passing through doorways fitted with fire or smoke doors** - ***Fire hose reels pass through doorways fitted with fire and smoke doors.***

QFRS Comments:**The only performance requirement associated with this BCA non-compliance is identified as being EP1.4. As such, QFRS believe that all BCA performance requirements associated with this non-compliance have not yet been addressed in the current FER, more specifically, CP2 , CP3 and DP5. This in mind, QFRS request additional information be provided clearly indicating how this solution satisfies BCA performance requirements CP2 , CP3 and DP5? QFRS do not accept the alternative solution as detailed in the report.**

General:

- Section 3.1.6 of the FER 'Operation of security doors in fire mode' suggests that 003 type keys should be used for unlocking secure doors serving the MEH building. QFRS wish to advise that 003 type keys are not an item exclusively used by QFRS. 003 type keys are in fact quite common and are used by many other companies and individual contractors. This in mind, utilising 003 type keys in this building could potentially compromise the security of the facility? Building keys will be supplied to QFRS at practical completion of the building. To maintain security of the MEH building at a high level, QFRS request an appropriate secure facility key be provided. In addition, QFRS suggest that additional copies of this key could be held on site in a secure location (i.e. in a 003 keyed box adjacent to FIP) which QFRS could access on arrival, if required?

Type of Special Fire Service	**Solution**	**Compliant**	**Certification**
Fire Fighting Equipment: Includes Booster Connection Fixed Pump Set	Deemed to Satisfy	Yes	Required

Comments

GENERAL:

- Fire hydrant system must comply with AS2419.1
- Certification indicating compliance of system installation and system performance with AS2419 will be required upon completion of the project
- The hardstand for fire appliance needs to be provided with demarcation lines/barriers prohibiting vehicles from parking in front of hydrants/booster assembly

Although hydrant coverage provided to the MEH building appears to be satisfactory, QFRS advise that an excessive number of hydrants appear to have been utilized to provide coverage. From the drawings supplied for assessment approximately 20 hydrants are currently indicated as providing coverage to the ground level (LG) of the building, the majority of these being internal type. QFRS are of the opinion more efficient coverage could have been afforded to the ground level (LG), utilizing 8 strategically positioned external hydrants. Internal hydrants are generally more difficult to locate in a fire situation. While, external hydrants are more readily identified and provide firefighters with a safer position to connect fire hose, prior to entering a dangerous environment.

HYDRANT BOOSTER ASSEMBLY

- The booster connection and enclosure must comply with Section 7 of AS2419.1-2005.
- The enclosure may be of masonry or other construction in lieu of a red cabinet provided the lettering on the door is of a contrasting colour to that of the background
- Lettering to be in compliance with AS2419.1-2005(7.10.2)
- The enclosure must be parallel with and face Hospital Boulevard
- A hard pavement work surface must be located in front of the booster cabinet
- Hydrant booster must be located so that it is not obstructed or obscured by obstacles, stored goods, vehicles, vegetation etc and have clear access at all times
- A 'Block Plan' to AS2419.1-2005(7.11) must be provided. The 'Block Plan' must be correctly oriented to the site and mechanically fixed to the cabinet door. In addition, should be either engraved or made of a durable water and fade resistant material as approved by QFRS.
- Test and boost (working) pressure signs to AS2419.1 - 2005(7.10.1) should be either engraved or made of a durable water and fade resistant material as approved by QFRS and mechanically fixed to the cabinet
- All isolating valves to be wheel or handle operated and secured in the open position. Locking devices must be operated by 003 key and the 003 lock must be to

Lockwood specifications suitable for fire brigade operations. Signage must be affixed to the main control valves in accordance with AS2419.1-2005(7.10)

- A minimum of 100mm clearance is required around the fully open valve wheel
- Stays should to be provided on cabinet doors to secure doors in the fully open position while in use.
- Locking devices on cabinet doors must be operated by 003 key. The 003 locks must be to Lockwood specifications suitable for fire brigade operations
- The minimum residual pressure at the booster assembly must be no less than 200kPa whilst system is operating at working pressure.
- **Please note**: The fire hydrant system will be tested by QFRS to confirm achievement of specified performance. The applicant is strongly advised to confirm performance of the system prior to QFRS attendance.

INTERNAL HYDRANTS

- Signage for cabinet doors must have the words "FIRE HYDRANT" in lettering not less than 50mm and of a contrasting colour to that of the background
- Fire hydrant test drains must be installed in accordance with AS2419. QFRS require the test facility to incorporate a 64mm female coupling on gal pipe at the most disadvantaged hydrant and discharging into a tank for re-use
- A minimum of 100mm clearance is required around the fully open valve wheel
- Hydrant valve outlets to face floor/appliance hardstand to which they serve in a downward position of 35 degrees from horizontal
- Hydrant valve outlets to be located, be accessible and have clearances in compliance with AS2419.1(3.5) and figure 3.5.1

EXTERNAL HYDRANTS

- Pillar Hydrants to be protected by bollards where they are likely to be subject to physical damage such as vehicle impact or workmen
- Hydrants to be painted red
- Cabinets for hydrant must have the words "FIRE HYDRANT" on the door in letters not less the 75mm high and of a contrasting colour to that of the background
- Hydrant valve outlets to face floor / appliance hardstand to which they serve in a downward position of 35 degrees from horizontal
- A minimum of 100mm clearance is required around the fully open valve wheel
- Hydrants must not be obstructed or obscured by obstacles, stored goods, vehicles or vegetation etc
- Hydrants adjacent to the building they serve must be at least 10m from the building unless protected in compliance with AS2419 clause 3.2.2.2(e). Certification confirming protecting wall has an FRL of 90/90/90 is required
- Fire hydrant test drains must be installed in accordance with AS2419. QFRS require the test facility to incorporate a 64mm female coupling on gal pipe at the most

disadvantaged hydrant.

- **QFRS wish to advise that unless a suitable test facility is provided; testing of this special fire service may not take place.**

Type of Special Fire Service	Solution	Compliant	Certification
Sprinklers	Deemed to Satisfy	Yes	Required

Comments

- Sprinkler installation must comply with all BCA requirements, AS2118 and AS4428.4.
- Certification indicating installation complies with all BCA requirements, AS2118 and AS4428.4 is required at completion of project.
- Alarm Signalling Equipment (ASE) must be in place prior to final inspection to enable functional testing of connection.
- Occupant warning system sounders to be audible throughout the building
- All locking devices must be Lockwood specification 003 type.
- Block plans, location diagrams and the like including all signage must be durable water & fade resistant on a single piece of rigid material as approved by QFRS. In addition they must be correctly oriented and permanently fixed in place using screws or rivets. Approval may be obtained from QFRS prior to being permanently etched
- Block plan to include the location of all control valves
- Tagging plates to identify the control valves
- Stop valves controlling water supplies strapped and/or pad locked (003)
- A sign shall be provided at the Booster Connection stating **"MAXIUM ALLOWABLE INLET PRESSURE ________ kPa"**
- Note: If the sprinkler alarm bell is not mounted directly on the outside of the building, a sign is to be installed on the wall located above the stairs leading to the sprinkler valve room. This sign is to state the words: **"SPRINKLER VALVE ROOM"** in block letters 50mm high in a contrast in colour to the background

The current Australian Standard referenced by the BCA is AS2118.1 (1999). In this version of the standard, areas where 'high voltage' equipment is located is not specifically identified in Clause 3.1.3 'Permitted exceptions' as being exempted from having sprinkler protection installed. However, in contrast, the current 2006 version of AS2118.1 - clause 3.1.2 clearly indicates that sprinklers may be omitted from specific areas, for reasons of safety or incompatibility. This in mind, QFRS advise against the use of sprinkler protection in areas where High Voltage electrical equipment may present a danger to QFRS personnel engaged in firefighting activities. In addition, QFRS request that the information detailed in AS2118.1 (2006) clause 3.1.2 be taken in to consideration and, sprinkler protection be removed from areas of the building that are in conflict with this clause.

Sprinkler Booster Assembly:

- Signage as per AS2118.1
- QFRS recommend that the Sprinkler Booster assembly be located adjacent to Hydrant Booster assembly and facing Hospital Boulevard. Supply hydrants should be installed to facilitate the use of both installations.

Sprinkler Pump Sets:

- Pump status (LED's) to be provided on the FIP
- Arrange emergency lighting so that the Controllers & Indicators are afforded illumination.

Sprinkler Pump room:

- To be signed as to its use
- Installations in sprinkler valve room to be identified

Type of Special Fire Service	**Solution**	**Compliant**	**Certification**
Fire Detection and Alarm Systems	Alternate Solution	No	Required

Comments

- Fire detection system is to be compliant with BCA 2008 and AS1670.1.
- **The proposed Fire Detection and Alarm System, and location of detectors, does not appear to satisfy the requirements of the BCA Specification E2.2a Clause 4(d). From the drawings supplied for assessment a Vesda smoke detection system is indicated as providing coverage, to some areas within the building which are identified as being, paths of travel to exits from patient care areas. BCA Specification E2.2a clause 4(d)(i)(A) states that photoelectric and ionisation detectors must be installed in paths of travel to exits from patient care areas. This in mind, QFRS has been advised that a Vesda system is not compatible with ionisation type detectors? This being the case, the current detection system proposed for the MEH building does not currently meet the requirements of BCA 2008.**
- **To avoid unwanted alarm activations, the type of detection installed must suit the environmental conditions of the occupancy. QFRS advise that smoke detectors are currently indicated as being installed in in areas that may be subject to unwanted alarm activations i.e; Laundry, Kitchen area and Cleaners rooms. Sounders must be audible throughout the building.**
- **The current drawings supplied for assessment appear to indicate that the detector spacing is not consistent with the requirements of AS1670.1.**
- **Magnetic hold open devices are indicated as being installed on doors serving LG East Ward 3A and 3B. No detection devices are indicated within 1.5m of these doors to activate them?**
- **BCA Specification E2.2a clause 4(d)(ii) requires that, (Manual Call Points (MCP's) are required to be installed in evacuation routes so that no point on a floor is more than 30m from a MCP. Adequate coverage does not appear to to have been provided to the LG level at this point. An additional MCP appars to be required in the (M6, M7 - MT, MU) grid region ?**
- A 'Block Plan' to AS1670.1-2004(3.10) must be provided. The 'Block Plan' must be correctly oriented to the site and mechanically fixed to the cabinet door. In addition, should be either engraved or made of a durable water and fade resistant material as approved by QFRS.
- Certification of system installation compliance to AS1670, AS1603, AS4428.4 and

E2.2a of BCA required at completion of project

- Emergency lighting must be provided within two meters of the FIP
- Remote indicators must be fitted where detectors are installed within concealed spaces in accordance with AS1670 3.25.4 & 3.17
- As it is intended the fire alarm be monitored by QFRS, connection must be arranged with ASE in place prior to final inspection. Approval for QFRS monitoring will be confirmed upon completion of the QFRS complying inspection report
- AHU system must shut down upon activation of alarm system
- Zone block Plan to be permanently engraved and mechanically fixed adjacent to the FIP. The plan shall include

    1. the layout of the building and area covered by each zone
    2. the FIP location
    3. the year installation or the date of the latest revision
    4. location of any other CIE, including intercom systems for emergency purposes
    5. a notice advising, "In the event of fire ring "000" to ensure fire brigade response
    6. the block plan shall be displayed in the correct orientation of the building

Type of Special Fire Service	**Solution**	**Compliant**	**Certification**
EWIS	Alternate Solution	Yes	Required

Comments

- An EWIS must comply with all BCA requirements, AS 1670 and AS 4428.4
- Certification of system installation compliance with AS4428.4 is required at completion of project
- WIP phones to be identified on cupboard doors
- Tones to be audible throughout all tenancies/entire building
- In ward areas alarm may be adjusted in volume and content to minimise trauma consistent with the type and condition of patients.

Kenneth Clark
Building Approvals Officer
Queensland Fire and Rescue Service
South Eastern Region

23 May 2011

Queensland Government

Queensland Fire and
Emergency Services

Lex Mildren
Ph: 07 5583 7578
Our Ref: 19686/3
Your Ref: BA # 28419

7 June 2015

John Wilson
Building and Asset Services
GPO Box 2937
BRISBANE QLD 4001

Dear Sir/Madam

The Queensland Fire and Emergency Services (QFES) has assessed the application as being "**Compliant**" in consideration of QFES jurisdiction as identified in the *Sustainable Planning Regulation 2009,* Schedule 7, Table 1.

The attached report provides details of the assessment for:

Block F (MEH)
Gold Coast University Hospital
Parklands Drive
SOUTHPORT QLD 4215

The QFES is to be notified to inspect and test all referral agency aspects under the *Building Regulation 2006.*

An invoice for the fees applicable for this assessment will be forwarded to the person nominated as the billing customer at the time of application.

The invoice is payable within 14 days from the date of the invoice.

South Eastern Region - Community Safety Operations
PO Box 25, Ashmore City Queensland 4214
Telephone +61 7 5583 7578
Facsimile +61 7 5583 7570
Website www.qfes.qld.gov.au
ABN 19 823 962 345

If you have any questions regarding this report please contact the Building Approval Officer nominated below.

Yours sincerely

Lex Mildren
Building Approval Officer

Enc.

South Eastern Region - Community Safety Operations
PO Box 25, Ashmore City Queensland 4214
Telephone +61 7 5583 7578
Facsimile +61 7 5583 7570
Website www.qfes.qld.gov.au
ABN 19 823 962 345

Alternative Solution/Reassessment/Building Approval

Job Details

Address: Parklands Drive, SOUTHPORT QLD 4215

Building Details

Class:	5, 8, 9a	Floor Area:	8045m²	Effective Height:	8.8m
Size of Largest Fire Compartment:		1758m²		Rise in Storeys:	2
Legislation:	01-05-08 (BCA2008)				

Assessment Details

Fire Engineering Report: Gold Coast University Hospital - Mental Health Unit, Fire Engineering Report (EJV), Rev 22, 17 March 2015

Drawings

(EJV-FD-MEH-DWG-) 2000001/G	(EJV-FW-MEH-DWG-) 2000001/F	(PSH-AR-MEH-DWG-) 2000100/F
1010200/1	1010207/1	1010208/1
2000002/F	2000002/G	2000100/A
2000101/F	2000102/F	2001001/02
2001001/2	2001002/02	2001002/2
2001100/F	2001101/E	2001102/E
20B1001/B	20B1100/A	20B1100/C
20B1101/C	20LG001/H	20LG002/E
20LG002/H	20LG100/A	20LG100/G
20LG101/F	20LG102/G	2600100/E
26B1100/C	26LG100/G	4000000/H
4000001/G	4000002/G	4000003/G
4000004/G	4000005/G	4000006/H
4000007/H	4000008/H	4000009/E
5000001/E	5000002/F	5000003/E
5000004/E	5000005/F	5000006/E
5000007/D	5000008/E	5000009/D
5000010/D	5000011/D	5000012/D
5000013/E.	5001000/B	6 April 2011
6010002/1.	7001000/C	7001000/C.
Drawings	Fire Engineering Report	Gold Coast University Hospital
MEH Tech Note Rev 5	Queensland Health	Reference EJV-FE-MEH-REP-000001-PDF
Revision 18	SK00001/01	SK00002/01
Volume 2: Mental Health Unit		

General Comments

The following comments by QFES are in relation to the Gold Coast University Hospital Mental Health building Fire Engineering Report (EJV), Revision 22. The Fire Brigade's comments should be reviewed and actioned, where appropriate, prior to the final FER being issued.

1. I acknowledge the Fire Engineers responsible for the MEH building FER have changed as the document has evolved. Previous ‘author’, ‘verifier’ and ‘approver’ included Ian Moore, Arthur Ting, Jonathan Shelley, Wayne Quin and M Hill. Revision 20 included the CV of Ian Moore and Arthur

Ting. The final document issued should include CV's of the relevant parties who have been responsible for the FER. Jonathan has confirmed the persons responsible for this current revision are himself and Peter Glodic.

2. John Wilson has confirmed the version of Rev 22 that has been provided to QFES for review doesn't include most of the documentation that would normally be in the Appendices. I don't have a problem with this, however the final document issued should include relevant documentation in the Appendices

3. Rev 22 states the project fire engineer is Jonathan Shelly and Ian Moore is the verifier, in section 2.2. The document control table indicates Jonathan as the typist and author, but no one as the verifier and approver. The document is titled GCUH Engineering – Aurecon SKM etc'. Jonathan's email on 3 June confirms the RPEQ fire engineer is Peter Glodic and Omnii are in a sub-consultancy role. The document, as it exists, is quite confusing regarding these issues. Where appropriate, the document titles, relevant Stakeholders, document control table etc should be clarified to reflect who has been and who is currently responsible for this document.

4. In the document control table, rev 19/20, dot point 3, states 'revision of section 1.1 to include….'. The link goes to section 3.2.2, Input 2, not section 1.1. It is assumed that both 1.1 and 3.2.2 are incorrect, and if a link is to be provided, it should go to section 3.2, Evacuation Sequencing.

5. Table 2.5 lists the BCA compliance issues; however it doesn't appear to be accurate. The smoke door swinging against the direction of egress issue that is detailed in Table 19-19.1, states the DTS clauses are C2.5(a)(ii)(B) and Spec C3.4, section 3.2(a), and the Performance Requirement is DP2(b). Firstly, this DTS Clause relates to 'fire compartments' and I'm not sure if it's the intended clause. Secondly, Table 2.5 doesn't appear to include an issue with this DTS Clause and Performance Requirement, or smoke doors swinging against the direction of egress.

It also doesn't appear to include any issue that relates to the Evacuation Strategy detailed in section 3. QFES request confirmation the operation of devices and the evacuation strategy, as detailed in the FER, are DTS in regard to E2.2a and E4.9. The Table should be reviewed to ensure all non-compliance issues have been included.

6. Section 3.2, Evacuation Sequencing, final sentence, states 'the evacuation sequence associated….. and summarised in' appears to have missed the reference.

7. Section 3.2.2, Input 2, second paragraph, states 'note that activation of a second smoke detector in a Class 9a fire compartment…..'. Is this intended to be a second activation within the same 9a compartment or any 9a compartment. At the moment, it appears to be able to be interpreted either way. Subsequent paragraphs appear to clarify the issue somewhat; however for clarity, this paragraph may need to be revised.

8. The first paragraph below Figure 3.1, states 'if the AAF isolate button….. and an authorised alarm agent will be required to reset…..'. I'm not familiar with the term 'authorised alarm agent'. Is this term described somewhere else? If not, it may lead to varying interpretations.

9. Two paragraphs prior to section 3.4, Staged Evacuation Procedure, there is a reference to a 'second smoke detector activating within the same smoke compartment at any time…..'. Prior to this section, the reference to the second device appears to be in relation to fire compartments. This whole section should be reviewed to ensure the correct terminology is being stated in regard to whether the intent is for these activations to relate to fire or smoke compartments.

10. In section 3.4, Staged Evacuation Procedure, the fourth paragraph states, ‘at the end of the 5 minute alert period….. all other compartments go into Alert…..’. If the non-Class 9a compartments go in to Evacuate, which I think has been previously stated, it probably should state it here, to prevent confusion.

11. In dot point 4, just prior to Table 3.1, it states ‘visual notification (amber strobe light) occurs at the Staff Base in the fire compartment of origin…..’. This appears to be in conflict with section 3.3, where the third paragraph makes reference to ‘….. the buzzer and strobe light will operate at each AAF unit located within the smoke compartment of origin’. In section 3.3 there is both visual and audible cues and a reference to smoke compartments, not fire compartments. Also, in dot point 9, it mentions second smoke detector, single thermal detector or sprinkler head…..’. Presumably it isn’t only a sprinkler head. It would be any sprinkler alarm, and also MCP. I acknowledge it states it in other sections, but it gets confusing when it’s being stated differently in different parts.

12. Dot point 1, following Table 3.1, states ‘….. (ie initiated on activation of any detection device)’. Because it includes MCP’s, it should state ‘device’, not detection. This would be consistent with dot point 1 in the previous section. Dot point 3 also states ‘…. other detection device….’, but doesn’t include MCP.

13. Section 3.4.2, states ‘the class 5 administration…. does not immediately go into Evacuate…..’. Section 3.2.1, states ‘…..and any non-Class 9a fire compartment on the floor of origin will go into Evacuate’. Is there an inconsistency with these two sections. Also, where do the Class 8 areas fit in with all these statements about evacuation sequencing in non-Class 9 areas. Section 3.4.3 makes reference to these Class 8 areas and the fact they are the same fire compartment as the Class 9a areas below. These statements may all be correct, but it’s been so long since I’ve been involved with the GCUH project that I’m not clear where the Class 9, 5, 8 etc areas are and if what is being stated throughout this whole section is correct. Are there also plant rooms at a level below the Class 9a areas of MEH. If so, where do they fit in with what is being stated?

14. In section 3.4.6, dot point 1 states, ‘building is provided with a non-required sprinkler system’. There are other statements like this in the FER. Is the statement correct? If MEH is connected to CSB, is the separation in accordance with the BCA for it to be deemed a separate building, and not captured by the building >25m provisions that are on CSB. I acknowledge the FER for CSB covers the issue of its technical Effective Height being in excess of 25m, but it is > 25m, and I’m unsure if these statements regarding sprinklers in MEH are correct.

Alternative Solution Components

Type of Special Fire Service	**Assessment**
Fire Mains (including booster and/or pumps)	Compliant

- achievement of specified performance
- location and suitability of booster connections and enclosures
- location and suitability of internal and roof hydrants and external hydrants including fire separation from adjacent buildings
- operation of fixed pump-set controls and status indication
- provision of additional hydrant services as mentioned in AS 2419
- provisions for hard standing for fire appliances
- In accordance with Fire Engineering Report

Comments:

Required flow and pressure is 10 L/s @ 700 kPa (building pump) and 20 L/s @ 700 kPa (boosted).

Sprinklers (General System, Combined Sprinkler & Hydrant System) — Compliant

- operation of direct fire service alarm and location of directional signs
- operation of pump-set controls and status indications
- the location of valve room, pump-sets, water alarm and booster point
- In accordance with Fire Engineering Report

Fire Detection and Alarm Systems (Detection System) — Compliant

- achievement of specified performance of detection and alarm systems
- location and operation of main fire indicator panel, sub-indicator panels, mimic panels, local alarm bells and directional signs
- operation of direct fire service alarm
- suitability of nominated types of detection in all areas, and the location of manual call points
- suitability of weather protection, accessibility and lighting of equipment
- In accordance with Fire Engineering Report

Type of Fire Safety Installations	**Assessment**
Fire Shutters and Fire Doors	Compliant
• In accordance with Fire Engineering Report	
Penetrations Through Fire-rated Construction	Compliant
• In accordance with Fire Engineering Report	
Structural Fire Protection	Compliant
• In accordance with Fire Engineering Report	
Systems Required to have a Fire-resistance Level	Compliant
• In accordance with Fire Engineering Report	

In addition to the Alternative Solution components identified above, this building also has the following Deemed to Satisfy components.

Deemed To Satisfy Components

Type of Special Fire Service	**Assessment**
Wall-wetting Sprinklers	Compliant
• location of isolating valves	
• provision of suitable signs	
Fire Control Centres	Compliant
• location of control centre	
• suitability of contents, ventilation, signage, lighting and sound levels of control centre	
Emergency Warning and Intercommunication Systems	Compliant
• operation of interface of warning system with detection and alarm systems	
• location of main emergency control panel and warden intercom points	

Certification may be required for each Special Fire Service/ Fire Safety Installation. This Certification is to be provided prior to or at the time of inspection.

Appendix I

OneSteel Fire Design Note # 2

firedesignnote No. 2, July 2001

onesteel

STEEL ROOF MEMBERS

PENETRATION OF CONCRETE FIRE WALLS

by **C. C. Goh and I. D. Bennetts**
Centre for Environmental Safety and Risk Engineering
Victoria University of Technology

The Issue

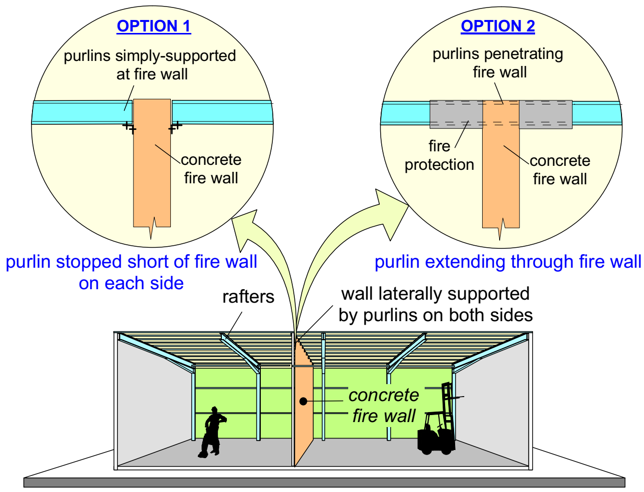
There are many situations where concrete fire walls are used to divide a building into separate fire compartments. The purpose of providing such walls within a building is to prevent the spread of fire from one compartment to another. The ability of the wall to prevent fire spread depends not only on the wall details but also on the presence of penetrating members which have the ability to conduct heat from one space to another.

In many of these situations, it may be practical for structural steel roof members to pass through the concrete wall rather than being curtailed at the wall. However, since steel is a good conductor, it has been traditionally assumed that fire may spread due to excessive temperature rise of the penetrating steel member. In the past such practices have been generally discouraged with steel members being stopped and supported on either side of the wall in order to minimise the flow of heat through the steel member and reduce the likelihood of ignition of combustibles on the non-fire side in the adjacent compartment.

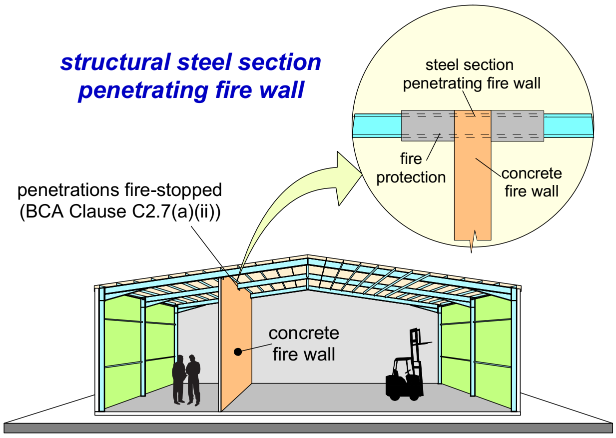
By means of its objectives and performance requirements, the Building Code of Australia (BCA) [1] makes it clear that the role of a wall separating two fire compartments is to prevent the spread of fire from one compartment to another. This is seen as being achieved provided the wall has the required performance with respect to insulation (preventing excessive temperatures on the unexposed face), integrity (preventing the flow of hot gases and flames) and structural adequacy (remaining in place for the required duration. According to AS1530.4 [2] which is referenced by the BCA, failure with respect to insulation occurs when the temperature *rise* of the unexposed face exceeds an average of 140°C or 180°C maximum at any of the measured locations.

The presence of a penetrating member through the wall does provide a potential path for heat to be transferred from one side of the wall to the other, and as noted above, this has provided a justification for the practice of stopping the member on each side of the wall.

purlins penetrating fire wall



In other situations where this has not been possible, the steel member has been covered with fire protection material to minimise the flow of heat from one side to the other. This can be costly.

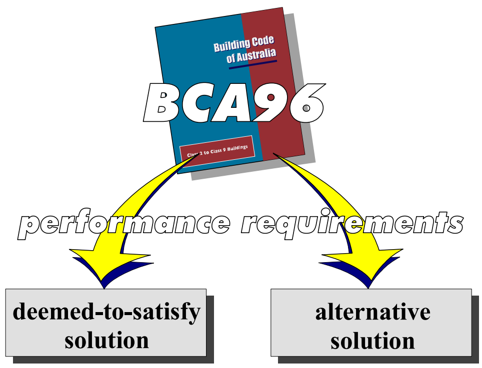


The question must be asked: *is it necessary for a steel member to be curtailed at a fire wall, and if it penetrates the wall, is it necessary for it to be fire protected ?*

The purpose of this fire design note is to answer this question.

Deemed-To-Satisfy vs Alternative Solution

The performance requirements of the BCA can be achieved by satisfying the deemed-to-satisfy (DTS) provisions or by demonstrating that an alternative solution satisfies these requirements.



The penetration of concrete fire walls by bare steel roof members may not strictly comply with the deemed-to-satisfy provisions due to excessive temperature rise.

What temperatures will be reached by steel members on the unexposed side of the wall? Will such temperatures result in fire spread to the other compartment? This design note answers these questions and provides a justification and basis for an alternative solution involving the penetration of concrete fire walls by bare steel roof members.

What Performance is Required?

An alternative solution must satisfy both the BCA objectives and performance requirements. In the context of the issue being considered, the relevant performance requirement is:

CP2 - A building must have elements which will, to the degree necessary, avoid the spread of fire -
- (a) to exits; and.
- (b) to sole-occupancy units and public corridors; and
- (c) between buildings; and
- (d) in a building,

appropriate to -
- (i) the function or use of the building; and.
- (ii) the fire load; and
- (iii) the potential fire intensity; and
- (iv) the fire hazard; and
- (v) the height of the building; and
- (vi) its proximity to other property; and
- (vii) any active fire safety systems installed in the building; and
- (viii) the size of any fire compartment; and
- (ix) fire brigade intervention; and
- (x) other elements they support
- (xi) the evacuation time

In summary, the wall construction and any penetrating members between compartments must be designed and detailed so as to prevent the spread of fire.

How can Adequate Performance be Achieved?

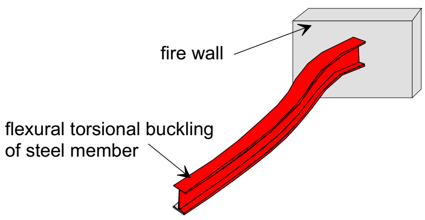
The thermal and structural behaviour of both the wall and the penetrating steel roof member must be sufficient to prevent spread.

Concrete Wall

(a) General

In the case of the wall itself, it will be assumed that it is designed in accordance with AS3600 [3]. The provisions of this standard dictate the wall thickness, height-to-thickness ratio and the level of applied load, to ensure that the wall can achieve the required performance with respect to insulation and structural adequacy. AS3600 presumes that integrity will be achieved provided the thickness requirements of the wall are met. However, since the wall is penetrated it is necessary to ensure that the gaps around the member are sealed with concrete or grout or other fire-stopping material.

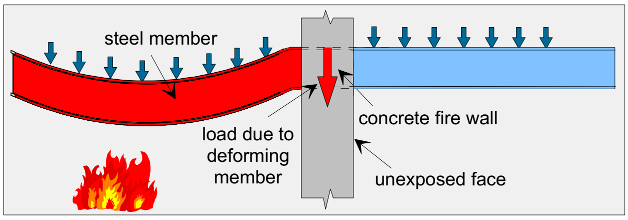
The heating of a steel roof member may result in flexural-torsional buckling of the member as well as vertical deformation, particularly if it is restrained by cooler parts of the roof.



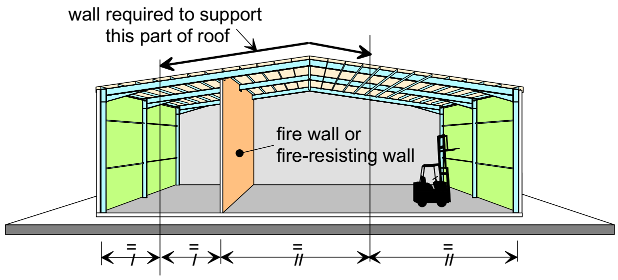
At first sight this might suggest that the integrity of the wall at the penetration may be reduced due to such movements. However this will not be the case due to the fact that the steel temperatures are lowest closest to the wall (due to heat conduction to the cooler side) so that most inelastic deformation will occur away from the penetration. Thus the integrity of the wall will not be affected.

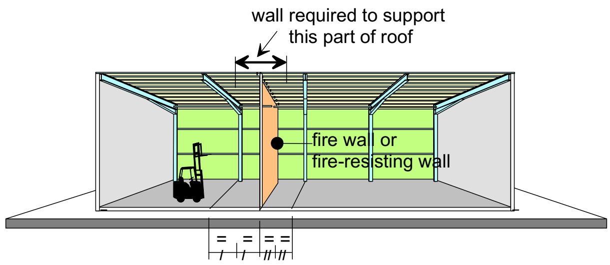
(b) Structural Adequacy

Deformation of a penetrating roof member may impose additional vertical forces at the top of the wall and these need to be considered when designing the wall for structural adequacy in accordance with AS 3600.



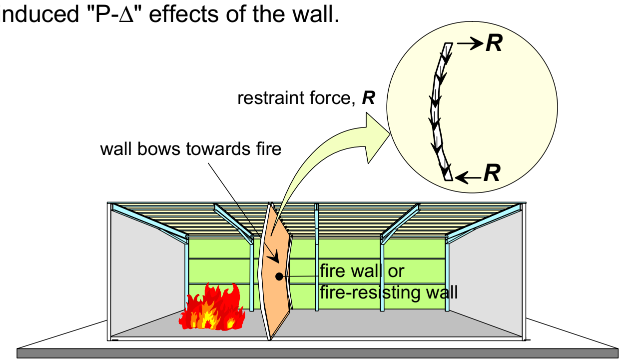
The area of roof that must be supported by a wall is given below for two situations.





The vertical load to be resisted by the wall can be taken as 1.1 times the weight of the area of roof to be supported [4].

The penetrating members may have been designed to provide lateral support to the top of the wall. It is important that such restraint is maintained under fire conditions. In the fire situation the lateral restraining force may be greater than under normal temperarture conditions due to the thermally induced "P-Δ" effects of the wall.



A conservative estimate of this restraining force can be obtained by assuming that the maximum lateral displacement of the wall at midheight will not exceed $H/10$, where H is the height of the wall. The required restraining force can be calculated from

$$R = 1.67Ht \text{ kN per metre width of wall}$$

where H and t are the height (m) and thickness (m), respectively.

These forces are not large. The ability of the roof member on the non-fire side to provide such restraint is a function of the temperature reached by the end of the member and connection. This matter is now considered.

Steel Roof Member

The temperature reached by a steel roof member on the non-fire side of the wall will influence the likelihood of spread of fire and the ability of the member to restrain the wall. Accordingly, the following questions are raised:

> ***What temperature will be achieved by a penetrating member on the non-fire side?***
>
> ***Will such temperatures reduce significantly the ability of the member to act as an effective restraint?***
>
> ***Will such temperatures lead to spread of fire?***

To address these questions, a test program [5,6] was carried out at the Centre for Environmental Safety and Risk Engineering of Victorian University of Technology.

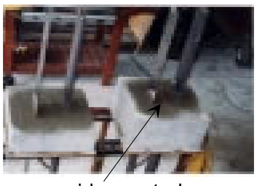
Test Program

A total of eight specimens were tested in a series of four tests. Each test specimen contained two steel plates, one with dimensions of 2 mm thick x 100 mm wide x 1200 mm long and the other having dimensions of 20 mm thick x 100 mm wide x 1200 mm long. A concrete block of dimensions 365 mm x 385 mm x 120 mm (or 200 mm) thick was cast around the middle section of the length of the steel plates. The concrete block was considered to simulate the presence of a concrete wall, and the plates chosen to simulate the web or flange of a rolled section (in the case of the 20 mm plate) and a purlin penetrating the wall (in the case of the 2 mm plate).

Specimen Construction

Four specimens were cast in the horizontal position (i.e. with the steel plate vertical) so good compaction of the concrete was obtained. The concrete blocks for the other four specimens were cast with holes to allow grouting of the steel plates once they were located. For two of these specimens, the voids were grouted when the blocks were in the vertical position to simulate a situation that may occur on site. The other two specimens were grouted with the blocks in the horizontal position.

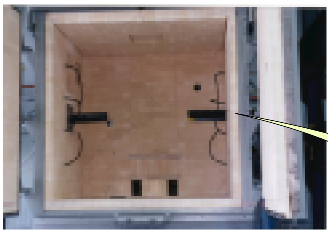
voids around steel plates



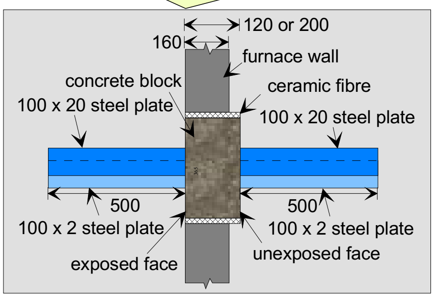
voids grouted

Test Set-up

The tests were conducted in a fire test furnace which internally measures 2.1 m width x 1.8 m depth x 2.1 m height. The specimens were subjected to standard fire test durations of up to 180 minutes.



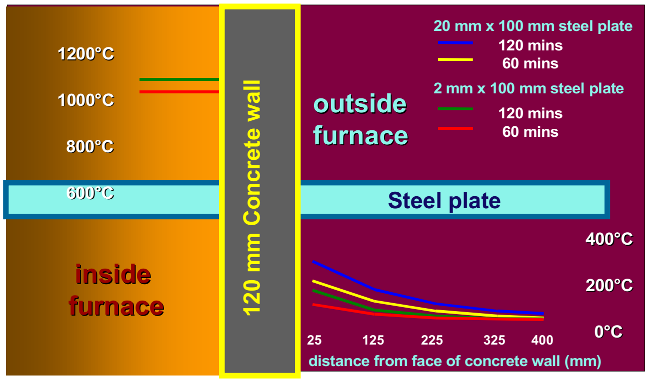
Overall view of test set-up

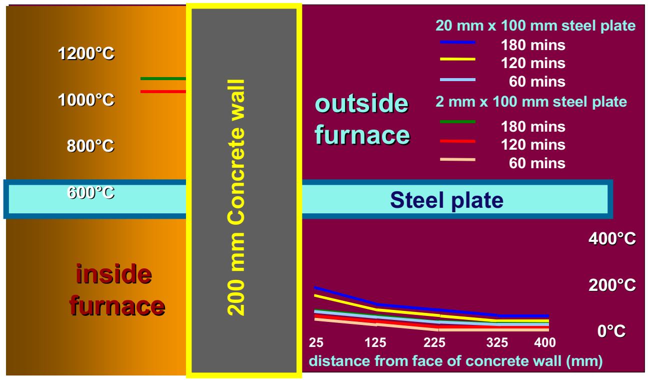


Layout of test set-up

Test Results

Plotted below are the steel temperatures on each side of the wall for wall thicknesses of 120 mm and 200 mm. The plotted temperatures correspond to times of 60 minutes, 120 minutes and 180 minutes (only for 200 mm wall) of standard fire test duration.





The maximum steel temperatures measured at 25 mm from the unexposed face of the walls were:

Maximum steel temperatures (°C)

Exposure duration	120 mm wall	200 mm wall
20 mm steel plate		
180 mins	-	185
120 mins	280	140
60 mins	195	80
2 mm steel plate		
180 mins	-	85
120 mins	155	65
60 mins	95	45

A length of non fire-retarded PVC cable and cardboard were attached to the hottest steel plate directly adjacent to the unexposed face of the wall. The corresponding measured steel temperature 25 mm from the wall was, at this stage, 265°C. After about 12-13 minutes of exposure, no ignition occurred except that the cable melted and the cardboard was lightly scorched.

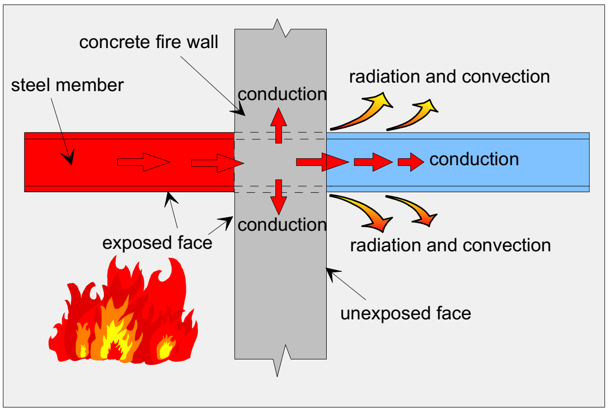
PVC cable

Cardboard

Conditions of PVC and cardboard after 12-13 minutes of exposure

Summary and Discussion

The test results show a dramatic difference in steel temperature from the fire to the non-fire side. This reduction in temperature is due to the mechanisms illustrated below.



At the roof level it is most unlikely that goods and combustibles will be located in close contact with a penetrating member such that the heat loss mechanisms illustrated above will be significantly impaired. It is therefore considered that the test results are directly applicable to the roof situation being addressed in this note.

In all tests, the maximum steel temperatures recorded at the unexposed side of the steel plate were less than 280°C for concrete walls of 120 mm thick (after 120 minutes of fire exposure), and less than 185°C for walls of 200 mm thick (after 180 minutes of fire exposure). The tests also showed that regardless of the voids cast vertically, horizontally or in-situ, the maximum temperatures reached were similar.

On the non-fire side of the wall, the steel members will only be affected locally by the elevated temperature conditions. Furthermore, the temperatures are such that the stiffness of the member will be hardly affected whilst the local strength will be reduced by no more than 15%. The adequacy of the roof members to provide lateral support to the top of wall should be checked given this reduction in strength.

The temperatures at the unexposed side of the steel plates were not sufficient to cause ignition of non-fire-retarded PVC cabling or cardboard. This is not surprising as testing conducted by Lie [7] has demonstrated that the temperatures required for ignition are considerably higher than the insulation failure criteria stated previously and given in AS1530.4. It can therefore be concluded that spread of fire will not occur.

Conclusions

The test results presented in this design note illustrate the dramatic reduction in temperature from the fire to non-fire sides of steel members penetrating concrete walls. The resulting temperatures of the non-fire side of the member are sufficiently low that fire spread will not occur, and in situations where the steel roof member has been designed to resist the lateral forces required to restrain the top of the wall, lateral restraint to the wall will be maintained provided its strength exceeds the applied forces by more than 15%.

The above conclusions are applicable to roof members penetrating concrete walls provided that the walls are designed for the appropriate fire duration in accordance with AS3600, and any additional loads imposed on the top of the wall by deforming roof members, are taken into account. Under these circumstances it is not necessary for the roof members to be fire protected.

REFERENCES

[1] "Building Code of Australia 1996", Volume 1—Class 2 to 9, Australian Building Codes Board, 1996.

[2] Standard Australia, AS 1530.4, "Methods for Fire Tests on Building Materials, Components and Structures, Part 4: Fire-resistance Tests of Building Construction", 1997.

[3] Standard Australia, AS 3600, "Concrete Structures", 1994.

[4] Standard Australia, AS1170.1, "SAA Loading Code - Part 1: Dead and Live Loads and Load Combinations", 1989.

[5] Bennetts, I.D., Culton, M., and Goh, C.C., "Behaviour of Steel Members When Penetrating Fire Walls", VUT-CESARE Report No. VUT/CESARE/BHP/2000/002, March 2000.

[6] Bennetts, I.D., and Goh, C.C., "Fire Behaviour of Steel Members Penetrating Concrete Walls", Electronic Journal of Structural Engineering (EJSE), First Issue: Volume 1 - 2001, pp. 38-51.

[7] Schwatz, K. J. and Lie, T. T., "Investigating the Unexposed Surface Temperature Criteria of Standard ASTM E119", Fire Technology, 21, February 1985, pp. 169-180.

STRUCTURAL STEEL

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Steel Roof Members: Penetration of Concrete Fire Walls

Written by: C.C. Goh and I.D. Bennetts
Published by: OneSteel Manufacturing Pty Limited
ABN 42 004 651 325

July 2001

Appendix J

Evacuation Matrix

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MEH EWIS MATRIX

Level Basement EWIS Matrix

	Fire Compartment (Amplifier Number)	0-9mins	9-18 mins	18-27 mins	27-36 mins	36-45 mins	45-54mins	54-63mins	63-72mins	72-81mins	81-90mins	90-99mins	99-108mins	108-117mins	117-126mins
ITC 1 Zone 12 Tested	Alarm Zone A	ANY ALARM INPUT	230	230											
	A (amp 2)	EVAC	EVAC	EVAC											
	B (amp ,3,4,5,6)	Alert	EVAC	EVAC											
	C (amp 1)	Alert	EVAC	EVAC											
	D (amp 7, 8, 9, 10)	Alert	EVAC	EVAC											
	E (amp11)	Alert	EVAC	EVAC											
	F (amp 12)	Alert	EVAC	EVAC											
	G1 (amp 13)	Alert	EVAC	EVAC											
	G2 (amp 13)	Alert	EVAC	EVAC											
	G3 (amp 13)	Alert	EVAC	EVAC											
	H(amp 14)	Alert	EVAC	EVAC											

Level LG EWIS Matrix ZONE B

		5 mins Only	5mins to 14 mins	14mins to 23 mins	23mins to 32 mins	32mns to 41 mins	41mins to 50 mins	50mins to 59 mins	59mins to 68 mins	68 mins to 77 mins	77mins to 86 mins	86mins to 95mins	95mins to 104mins	104mins to 113mins	113mins to 122mins
ITC 2 and 3 Zone 13 Tested	Alarm Zone B	INPUT 1 Zone alarm or Fail to respond to AAF or AAF time out 60 sec time out or 180 secs investigation period. Following the activation of a single smoke detector or VESDA 231	231	232	233	234									
INPUT 1	A (amp 2)		Alert	Alert	Alert	EVAC									
	B (amp ,3,4,5,6)	Alert	EVAC	EVAC	EVAC	EVAC									
	C (amp 1)		Alert	EVAC	EVAC	EVAC									
	D (amp 7, 8, 9, 10)		Alert	Alert	EVAC	EVAC									
	E (amp11)		Alert	EVAC	EVAC	EVAC									
	F (amp 12)		Alert	Alert	EVAC	EVAC									
	G1 (amp 13)	Alert	EVAC	EVAC	EVAC	EVAC									
	G2 (amp 13)	Alert	EVAC	EVAC	EVAC	EVAC									
	G3 (amp 13)	Alert	EVAC	EVAC	EVAC	EVAC									
	H(amp 14)		Alert	Alert	EVAC	EVAC									

		0-9mins	9-18 mins	18-27 mins	27-36 mins	36-45 mins	45-54mins	54-63mins	63-72mins	72-81mins	81-90mins	90-99mins	99-108mins	108-117mins	117-126mins
ITC 4 and 5 Zone 136 Tested	Alarm Zone B	INPUT 2 First Activation of a Sprinkler, MCP, Heat detector or a 2nd Smoke Detector activation 231	232	233	234										
INPUT 2 Shall overide input 1	A (amp 2)	Alert	Alert	Alert	EVAC										
	B (amp ,3,4,5,6)	EVAC	EVAC	EVAC	EVAC										
	C (amp 1)	Alert	EVAC	EVAC	EVAC										
	D (amp 7, 8, 9, 10)	Alert	Alert	EVAC	EVAC										
	E (amp11)	Alert	EVAC	EVAC	EVAC										
	F (amp 12)	Alert	Alert	EVAC	EVAC										
	G1 (amp 13)	EVAC	EVAC	EVAC	EVAC										
	G2 (amp 13)	EVAC	EVAC	EVAC	EVAC										
	G3 (amp 13)	EVAC	EVAC	EVAC	EVAC										
	H(amp 14)	Alert	Alert	EVAC	EVAC										

Level LG EWIS Matrix ZONE C

		5 mins Only	5mins to 14 mins	14mins to 23 mins	23mins to 32 mins	32mns to 41 mins	41mins to 50 mins	50mins to 59 mins	59mins to 68 mins	68 mins to 77 mins	77mins to 86 mins	86mins to 95mins	95mins to 104mins	104mins to 113mins	113mins to 122mins
ITC 6 and 7 Zone 14 Tested	Alarm Zone B	INPUT 1 Zone alarm or Fail to respond to AAF or AAF time out 60 sec time out or 180 secs investigation period. Following the activation of a single smoke detector or VESDA 235	235	236	237										
INPUT 1	A (amp 2)		Alert	Alert	EVAC										
	B (amp ,3,4,5,6)		Alert	EVAC	EVAC										
	C (amp 1)	Alert	EVAC	EVAC	EVAC										
	D (amp 7, 8, 9, 10)		Alert	EVAC	EVAC										
	E (amp11)		Alert	EVAC	EVAC										
	F (amp 12)		Alert	EVAC	EVAC										
	G1 (amp 13)	Alert	EVAC	EVAC	EVAC										
	G2 (amp 13)	Alert	EVAC	EVAC	EVAC										
	G3 (amp 13)	Alert	EVAC	EVAC	EVAC										
	H(amp 14)		Alert	EVAC	EVAC										
		0-9mins	9-18 mins	18-27 mins	27-36 mins	36-45 mins	45-54mins	54-63mins	63-72mins	72-81mins	81-90mins	90-99mins	99-108mins	108-117mins	117-126mins
ITC 8 and 9 Zone 137 Tested	Alarm Zone B	INPUT 2 First Activation of a Sprinkler, MCP, Heat detector or a 2nd Smoke Detector activation 235	236	237											
INPUT 2 Shall overide input 1	A (amp 2)	Alert	Alert	EVAC											
	B (amp ,3,4,5,6)	Alert	EVAC	EVAC											
	C (amp 1)	EVAC	EVAC	EVAC											
	D (amp 7, 8, 9, 10)	Alert	EVAC	EVAC											
	E (amp11)	Alert	EVAC	EVAC											
	F (amp 12)	Alert	EVAC	EVAC											
	G1 (amp 13)	EVAC	EVAC	EVAC											
	G2 (amp 13)	EVAC	EVAC	EVAC											
	G3 (amp 13)	EVAC	EVAC	EVAC											
	H(amp 14)	Alert	EVAC	EVAC											

Level LG EWIS Matrix ZONE D

		5 mins Only	5mins to 14 mins	14mins to 23 mins	23mins to 32 mins	32mns to 41 mins	41mins to 50 mins	50mins to 59 mins	59mins to 68 mins	68 mins to 77 mins	77mins to 86 mins	86mins to 95mins	95mins to 104mins	104mins to 113mins	113mins to 122mins
ITC 10 and 11 Zone 15 Tested	Alarm Zone B	INPUT 1 Zone alarm or Fail to respond to AAF or AAF time out 60 sec time out or 180 secs investigation period. Following the activation of a single smoke detector or VESDA 238	238	239	240	241									
INPUT 1	A (amp 2)		Alert	Alert	Alert	EVAC									
	B (amp ,3,4,5,6)		Alert	Alert	EVAC	EVAC									
	C (amp 1)		Alert	EVAC	EVAC	EVAC									
	D (amp 7, 8, 9, 10)	Alert	EVAC	EVAC	EVAC	EVAC									
	E (amp11)		Alert	Alert	EVAC	EVAC									
	F (amp 12)		Alert	EVAC	EVAC	EVAC									
	G1 (amp 13)	Alert	EVAC	EVAC	EVAC	EVAC									
	G2 (amp 13)	Alert	EVAC	EVAC	EVAC	EVAC									
	G3 (amp 13)	Alert	EVAC	EVAC	EVAC	EVAC									
	H(amp 14)		Alert	Alert	EVAC	EVAC									
		0-9mins	9-18 mins	18-27 mins	27-36 mins	36-45 mins	45-54mins	54-63mins	63-72mins	72-81mins	81-90mins	90-99mins	99-108mins	108-117mins	117-126mins
ITC 12 and 13 Zone 138 Tested	Alarm Zone B	INPUT 2 First Activation of a Sprinkler, MCP, Heat detector or a 2nd Smoke Detector activation 238	239	240	241										
INPUT 2 Shall overide input 1	A (amp 2)	Alert	Alert	Alert	EVAC										
	B (amp ,3,4,5,6)	Alert	Alert	EVAC	EVAC										
	C (amp 1)	Alert	EVAC	EVAC	EVAC										
	D (amp 7, 8, 9, 10)	EVAC	EVAC	EVAC	EVAC										
	E (amp11)	Alert	Alert	EVAC	EVAC										
	F (amp 12)	Alert	EVAC	EVAC	EVAC										
	G1 (amp 13)	EVAC	EVAC	EVAC	EVAC										
	G2 (amp 13)	EVAC	EVAC	EVAC	EVAC										
	G3 (amp 13)	EVAC	EVAC	EVAC	EVAC										
	H(amp 14)	Alert	Alert	EVAC	EVAC										

Level LG EWIS Matrix ZONE E

ITC 14
Zone 16
Tested

Fire Compartment (Amplifier Number)	0-9mins	9-18 mins	18-27 mins	27-36 mins	36-45 mins	45-54mins	54-63mins	63-72mins	72-81mins	81-90mins	90-99mins	99-108mins	108-117mins	117-126mins
Alarm Zone A	ANY ALARM INPUT 242	243	244	245										
A (amp 2)	Alert	Alert	Alert	EVAC										
B (amp ,3,4,5,6)	Alert	EVAC	EVAC	EVAC										
C (amp 1)	Alert	EVAC	EVAC	EVAC										
D (amp 7, 8, 9, 10)	Alert	Alert	EVAC	EVAC										
E (amp11)	EVAC	EVAC	EVAC	EVAC										
F (amp 12)	Alert	EVAC	EVAC	EVAC										
G1 (amp 13)	Alert	EVAC	EVAC	EVAC										
G2 (amp 13)	Alert	EVAC	EVAC	EVAC										
G3 (amp 13)	Alert	EVAC	EVAC	EVAC										
H(amp 14)	EVAC	EVAC	EVAC	EVAC										

Level LG EWIS Matrix ZONE F

ITC 15
Zone 17
Tested

Fire Compartment (Amplifier Number)	0-9mins	9-18 mins	18-27 mins	27-36 mins	36-45 mins	45-54mins	54-63mins	63-72mins	72-81mins	81-90mins	90-99mins	99-108mins	108-117mins	117-126mins
Alarm Zone A	ANY ALARM INPUT	246	247	248										
A (amp 2)	Alert	Alert	Alert	EVAC										
B (amp ,3,4,5,6)	Alert	Alert	EVAC	EVAC										
C (amp 1)	Alert	EVAC	EVAC	EVAC										
D (amp 7, 8, 9, 10)	Alert	EVAC	EVAC	EVAC										
E (amp11)	Alert	EVAC	EVAC	EVAC										
F (amp 12)	EVAC	EVAC	EVAC	EVAC										
G1 (amp 13)	Alert	EVAC	EVAC	EVAC										
G2 (amp 13)	Alert	EVAC	EVAC	EVAC										
G3 (amp 13)	Alert	EVAC	EVAC	EVAC										
H(amp 14)	Alert	EVAC	EVAC	EVAC										

Level 00 EWIS Matrix ZONE G1

ITC 16
Zone 18
Tested

Fire Compartment (Amplifier Number)	0-9mins	9-18 mins	18-27 mins	27-36 mins	36-45 mins	45-54mins	54-63mins	63-72mins	72-81mins	81-90mins	90-99mins	99-108mins	108-117mins	117-126mins
Alarm Zone A	ANY ALARM INPUT 427	428	429	430										
A (amp 2)	Alert	Alert	Alert	EVAC										
B (amp ,3,4,5,6)	EVAC	EVAC	EVAC	EVAC										
C (amp 1)	Alert	EVAC	EVAC	EVAC										
D (amp 7, 8, 9, 10)	Alert	Alert	EVAC	EVAC										
E (amp11)	Alert	EVAC	EVAC	EVAC										
F (amp 12)	Alert	Alert	EVAC	EVAC										
G1 (amp 13)	EVAC	EVAC	EVAC	EVAC										
G2 (amp 13)	EVAC	EVAC	EVAC	EVAC										
G3 (amp 13)	EVAC	EVAC	EVAC	EVAC										
H(amp 14)	Alert	EVAC	EVAC	EVAC										

Level 00 EWIS Matrix ZONE G2

ITC 1
Zone 19
Tested

Fire Compartment (Amplifier Number)	0-9mins	9-18 mins	18-27 mins	27-36 mins	36-45 mins	45-54mins	54-63mins	63-72mins	72-81mins	81-90mins	90-99mins	99-108mins	108-117mins	117-126mins
Alarm Zone A	ANY ALARM INPUT 431	432	433	433										
A (amp 2)	Alert	Alert	EVAC	EVAC										
B (amp ,3,4,5,6)	Alert	EVAC	EVAC	EVAC										
C (amp 1)	EVAC	EVAC	EVAC	EVAC										
D (amp 7, 8, 9, 10)	Alert	EVAC	EVAC	EVAC										
E (amp11)	Alert	EVAC	EVAC	EVAC										
F (amp 12)	Alert	EVAC	EVAC	EVAC										
G1 (amp 13)	EVAC	EVAC	EVAC	EVAC										
G2 (amp 13)	EVAC	EVAC	EVAC	EVAC										
G3 (amp 13)	EVAC	EVAC	EVAC	EVAC										
H(amp 14)	Alert	EVAC	EVAC	EVAC										

Level 00 EWIS Matrix ZONE G3

ITC 1
Zone 139
Tested

Fire Compartment (Amplifier Number)	0-9mins	9-18 mins	18-27 mins	27-36 mins	36-45 mins	45-54mins	54-63mins	63-72mins	72-81mins	81-90mins	90-99mins	99-108mins	108-117mins	117-126mins
Alarm Zone A	ANY ALARM INPUT 434	435	436	437										
A (amp 2)	Alert	Alert	Alert	EVAC										
B (amp ,3,4,5,6)	Alert	Alert	EVAC	EVAC										
C (amp 1)	Alert	EVAC	EVAC	EVAC										
D (amp 7, 8, 9, 10)	EVAC	EVAC	EVAC	EVAC										
E (amp11)	Alert	EVAC	EVAC	EVAC										
F (amp 12)	Alert	EVAC	EVAC	EVAC										
G1 (amp 13)	EVAC	EVAC	EVAC	EVAC										
G2 (amp 13)	EVAC	EVAC	EVAC	EVAC										
G3 (amp 13)	EVAC	EVAC	EVAC	EVAC										
H(amp 14)	Alert	EVAC	EVAC	EVAC										

Level 00 EWIS Matrix ZONE H

ITC 1
Zone 140
Tested

Fire Compartment (Amplifier Number)	0-9mins	9-18 mins	18-27 mins	27-36 mins	36-45 mins	45-54mins	54-63mins	63-72mins	72-81mins	81-90mins	90-99mins	99-108mins	108-117mins	117-126mins
Alarm Zone A	ANY ALARM INPUT 438	439	440	441										
A (amp 2)	Alert	Alert	Alert	EVAC										
B (amp ,3,4,5,6)	Alert	Alert	EVAC	EVAC										
C (amp 1)	Alert	EVAC	EVAC	EVAC										
D (amp 7, 8, 9, 10)	Alert	Alert	EVAC	EVAC										
E (amp11)	EVAC	EVAC	EVAC	EVAC										
F (amp 12)	Alert	EVAC	EVAC	EVAC										
G1 (amp 13)	Alert	EVAC	EVAC	EVAC										
G2 (amp 13)	Alert	EVAC	EVAC	EVAC										
G3 (amp 13)	Alert	EVAC	EVAC	EVAC										
H(amp 14)	EVAC	EVAC	EVAC	EVAC										