25 Dunheved Circuit, St Marys, NSW 2760

Fire Engineering Report

Prepared for:

Dewcape Pty Ltd

Prepared By:

Austech International Pty Ltd
PO Box 1848,
Nth Sydney NSW 2060

Document Issue	B

October 2016

Project No: 160033

Document Status

Title	Waste Sorting Facility	
Location	25 Dunheved Circuit, St Marys, NSW 2760	
Description	Fire Engineering Report	
Primary Contact	Imran Shaikh	
Authors	SI	
Reviewed		
Revision and Date	B	October 2016
Issued to		

Copyright / Disclaimer

Without written permission from Austech Pty Ltd, no part of this report may be reproduced in any form or by any means. The report is based solely on client instructions, and therefore should not be used by any third party without prior knowledge of such instructions.

Contents

1 Introduction

This document relates to the purposed development comprising a Class 8 factory with ancillary Class 5 office space located at 25 Dunheved Circuit, St Marys. The building will house waste sorting and compacting machinery along with storage areas for the sorted waste.

Austech have been appointed by Dewcape to assess the proposed Performance Solutions identified in Section 3.0 of this report against the relevant National Construction Code (NCC) Building Code of Australia (BCA) 2016 Performance Requirements and prepare a Fire Engineering Report (FER).

The FER should be read in conjunction with the Fire Engineering Brief Questionnaire (FEBQ) ref: FEBQ-Bingo St Marys dated 24/08/2016 dated by Austech.

1.1 Proposed Fire Safety Strategy & Schedule of Works

The following scope of works, but not limited to, shall be implemented to support the fire safety strategy for the building in relation to the proposed Alternative Solution.

1.1.1 General

1) All fire safety aspects are to comply with BCA DtS Provisions with the exception of the proposed Alternative Solutions.

2) The use and storage of Dangerous Goods in the facility shall be in accordance with the relevant dangerous goods legislation including AS 1940-2005.

1.1.2 Fire Resistance & Compartmentation

1) The building shall comply with Type A Construction under Section C of the BCA with the exception of Performance Solution #1.

2) In line with Performance Solution #1, the volume of the main shed is permitted to be 30,545 m^3 in lieu of 30,000 m^3. The floor area is 3,437 m^2.

1.1.3 Egress Provisions

1) The building shall comply with egress provisions under Section D of the BCA with the exception of Performance Solution #2.

2) In line with Performance Solution #2, an extended travel distance of up to 28 m to an exit is permitted.

3) A dedicated 1 m wide egress pathway shall be provided from the sorting machine in the centre to respective exits. To assist in way-finding during evacuation, the egress paths are to be indicated by permanent floor markings in colour contrasting with the background, as shown in Figure 1-1 by the grey highlights.

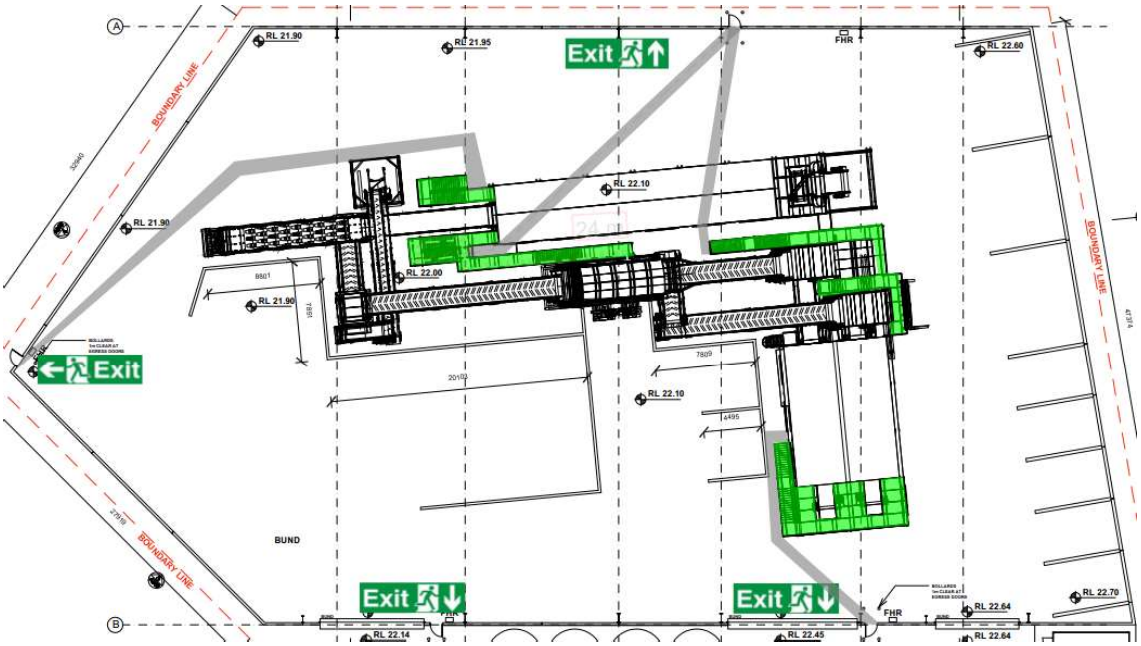


Figure 1-1 – Designated exits from the building with the 1 m dedicated egress pathways shown in grey

4) Occupant characteristics and floor population are to be in accordance with Section 6. Due to the nature of the facility, the Client has advised that all plant operators will be physically fit and without mobility impairments.

1.1.4 Fire Services

This section summarises the fire safety services that are proposed within the building critical to the proposed Alternative Solutions within this report. Further information on the fire services can be found in the relevant services engineer's specifications and drawings.

1.1.4.1 Fire Hydrants

1) Fire hydrant system shall be provided in accordance BCA E1.3 and AS 2419.1-2005 with the exception of Performance Solution #3.

2) In line with Performance Solution #3, the external hydrants are permitted to be located within 2.4 m of openings in the building façade without fire rated construction. The pillar hydrants shall have sheet metal backing as shown in Figure 1-2.

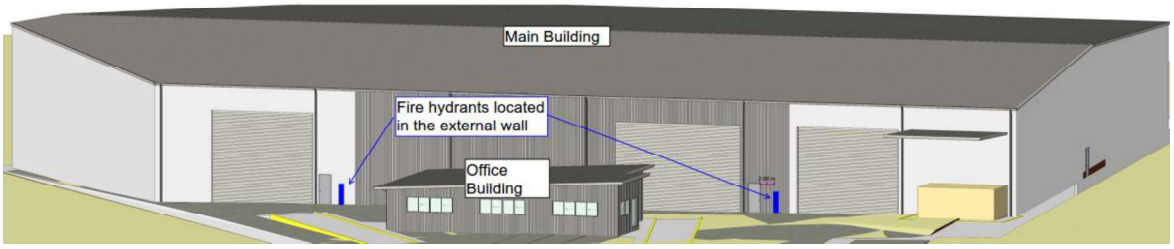


Figure 1-2 – 3D perspective of the building with the external hydrants marked up

3) All fire hydrant valves shall be fitted with Storz aluminium alloy delivery couplings manufactured and installed in accordance with Clauses 7.1 and 8.5.11.1 of AS 2419.1-2005. All hydrant valves shall have a forging symbol and manufacturers mark, and shall comply with Fire & Rescue NSW Guide Sheet No. 4.

1.1.4.2 Fire Hose Reels

1) Fire hose reels shall be provided in accordance with BCA E1.4 and AS 2441-2005 in throughout the building.

1.1.4.3 Automatic Sprinkler System

1) An automatic sprinkler system shall be installed throughout the building in accordance with BCA E1.5 and AS 2118.1-1999.

2) The sprinkler head properties shall be in accordance with the Table 1-1 below as advised by the Fire Services Designer.

Table 1-1 – Sprinkler head properties are to be verified by the Fire Services Designer and contractor prior to construction

Sprinkler Type	Hazard Category	RTI	Activation Temperature
Tyco TY323	OH3	36 $(m.s)^{1/2}$	68°C

1.1.4.4 Portable Fire Extinguishers

1) Portable fire extinguishers shall be provided in accordance with BCA E1.6 and AS 2444-2001 throughout the facility including the elevated platforms.

2) On-board manual fire suppression is to be provided on all maintenance vehicles (e.g. garbage trucks, loaders, scissor lifts) that will be used in the building in accordance with the relevant Australian Standards.

1.1.4.5 Building Occupant Warning System

1) A building occupant warning system shall be provided in accordance with BCA Specification E2.2a and AS 1670.1-2015.

2) The building occupant warning system shall be enhanced to incorporate a verbal directive, which instructs occupants to evacuate in the event of fire. The verbal directive shall be in clear and concise English that announces the following in the event of a fire alarm: 'Emergency' and 'Evacuate Now'.

3) Manual Call Points (MCP) in accordance with AS 1670.4-2015 are to be provided throughout the building to initiate the occupant warning system.

4) MCPs to be provided on the platform level, within the control room and besides all exits to the building.

5) MCPs are to be provided at 15 m intervals on the elevated platform and 30 m on the ground floor.

6) Strobe lights are to be provided in accordance with AS 1670.4-2015 at critical locations on the ground floor within the main building and the elevated platforms.

1.1.4.6 Two-way Radio

1) Two-way radio communication systems shall be provided to all staff within the facility to aid in emergency notification and evacuation.

2) The two-way radio communication system shall be designed as an essential service and listed on the annual fire safety statement. The two-way radio communication system is to be maintained as per AS 1851-2012 and the manufacturers specification.

1.1.4.7 Emergency Lighting and Exit Signage

1) With the exception of Performance Solution #4, emergency lighting and exit signs are to be installed throughout the subject development in accordance with BCA E4.4, E4.5, E4.6 and E4.8 and the relevant provisions of AS 2293.1-2005. All exit and directional exit signs are to be of the illuminated type.

2) In line with Performance Solution #4, jumbo exit signs shall be used in the subject development and are permitted to be mounted at a height of 3.5 m above ground.

3) The elevated walkways are to be provided with both of the following measures to aid in way-finding:

- Measures A: Self-illuminating photo-luminescent floor markings are to be provided on the elevated walkways to direct occupants to the exits. The photo-luminescent floor markings shall comply with ICBO – AC 169 and BCA Specification E4.8.
- Measures B: Low level emergency lighting on the elevated walkways to direct occupants to the exits.
- Mounting details for both photo-luminescent markings and low level emergency lighting on the elevated platforms is subject to input by the Electrical Engineer and plant operator.

1.1.4.8 Smoke Vents

1) A high level ridge vent shall be provided on the roof with a minimum aerodynamic free area of 38 m^2 as shown by the Figure 1-3. The roof vents are to be fixed permanently open.

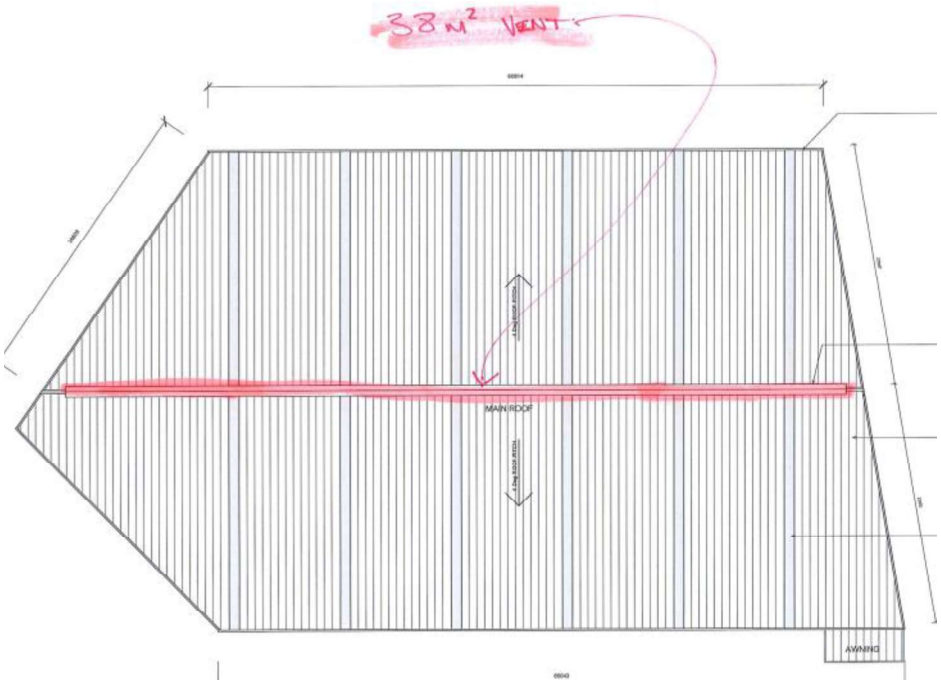


Figure 1-3 – High level ridge vent in the roof

2) The minimum aerodynamic free vent area of the smoke and heat vents in the are shown in Table 1-2. All the access openings need to be either permanently open or open on fire trip.

Table 1-2 – Aerodynamic vent area for openings utilised for natural smoke venting

Location	Type of Opening	Minimum Aerodynamic Free Vent Area
Roof	Roof Mounted ridge vent exhaust	38 m^2
Roller Shutter #1	Access opening	53.9379 m^2
Roller Shutter #2	Access opening	60.3677 m^2
Roller Shutter #3	Access opening	38.311 m^2

1.1.4.9 Process Control Points

1) Process control points (i.e. emergency stops or the like) shall be provided at regular intervals along the elevated pathways to allow occupants to stop the machine if necessary.

1.1.5 Minimum Commissioning and Maintenance Requirements

The following items are to be included in the Management-in-Use Plans for the facility:

1) The maintenance of fire and other safety systems is a mandatory requirement for building owners under the provisions of the NSW Environmental Planning and Assessment Act 1979 and the Environmental Planning and Assessment Regulation 2000. All systems provided should be designed, detailed, commissioned and maintained in accordance with the relevant legislation and standards including AS 1851-2012. As a minimum Table 1-3 nominates minimum requirements for the Occupation Certificate (OC) stage.

Table 1-3 – Minimum Commissioning Requirements for Essential Fire Safety Measures at Occupation Certification Stage

No.	Fire Safety Measures	Documentation required	Inspection / Testing
1)	Fire hydrant system	Installation and commissioning records	Flow test and Visual spot check
2)	Hose reel system	Installation and commissioning records	Flow test and Visual spot check
3)	Fire sprinkler system	Installation and commissioning records	Flow test and Visual spot check
4)	Fire extinguisher	Installation and commissioning records	Visual spot check
5)	Fire indicating panels (FIP) and associated control equipment	Installation and commissioning records	Visual spot check
6)	Emergency lighting and exit signage	Installation records	Visual spot check

No.	Fire Safety Measures	Documentation required	Inspection / Testing
7)	Fire doors	Installation record and manufacturers certification	Visual sport check
8)	Manual call points	Installation record and manufacturers certification	Visual sport check
9)	Two-way radios	Manufacturers specification	Visual sport check

2) All systems must be fully operational under all circumstances. An interim fire strategy shall be developed by a Fire Safety Engineer for any temporary disconnections. Should any building works extend over a number of days, the system should be re-instated as far as practical at the end of each day.

3) Maintenance contracts shall be in place and supplemented by building management on a regular basis.

4) Electrical and process equipment subject to any statutory requirements for inspection and maintenance is to be undertaken by a Qualified Electrician.

5) The Fire Engineering Report shall form part of the Fire Safety Schedule for the subject development and shall be certified annually as part of the Annual Fire Safety Statement.

1.1.6 Emergency Control Procedures

Emergency Control Organisation and Procedures in accordance with Clause 43 of the Work Health & Safety Regulation (2011) and AS 3745-2010 shall be developed and implemented incorporating the following:

1) Exit paths are to be kept clear of items that constitute a fire load or impede occupant egress.

2) Staff induction prior to undertaking work on the site.

3) Identify the procedures to be followed in the event of a fire including emergency evacuation drills.

4) The emergency evacuation drills are to be held at least every 3 months.

5) Training is to include initial attack on a fire when safe to do so using portable fire extinguishers and/or fire hose reels.

6) Training on the use of MCPs and two-way radio communication systems during emergencies.

7) Occupants who have not been trained to use fire extinguishers and/or fire hose reels should evacuate the building immediately and notify the Fire Brigades.

8) Emergency evacuation plans and fire orders are to be prepared and displayed adjacent to each exit comprising the location of fire protection equipment.

9) Hot works permits are to be provided including Insurance notification forms.

1.1.7 Management-in-Use Procedures

1) Management-use-plans and emergency response plans are to be developed to address the fire risk mitigation measures identified in Section 4.

2) Procedures are to be developed for overnight waste storage including minimisation of ignition sources, fire hazards and incident response during an emergency/alarm. This includes prohibiting overnight parking of fully-laden garbage trucks in the facility.

3) It is understood that Bingo has the above procedures in place for their existing operations, which are to be extended to this facility as well.

1.1.8 Fire Brigade Intervention

1) The following measures are to be provided to assist in fire brigade intervention:
2) Designated safe areas away from the building for appliance staging, breathing apparatus staging, rehabilitation, ambulance staging and evacuation assembly.
3) Emergency information box containing diagrams including a site map, building layout; diagrams, contact numbers and hazardous materials register adjoining the main Fire Indicator Panel and control room.
4) Emergency controls and stop switches for compactors and other automated processes;
5) Warning signs to alert fire brigade personnel of unfenced garbage pits with dangerous depths, maturation pads and other hazards.
6) Availability of heavy machinery such as front loaders that can be used by the fire brigade during an emergency.
7) Emergency procedures are to be developed in consultation with the local responding fire stations

1.2 Relevant Stakeholders

The relevant project stakeholders that have been nominated by the Client for purposes of participating in the fire engineering process are outlined Table 1-4. It is noted that other parties may have a vested interest in the outcome of the Fire Engineering assessment in some cases. Such parties can include local councils, local fire brigades, Insurers, various environmental protection agencies, project control groups, end users and community representatives. Although not always a legislative requirement, the design team should give due consideration to their inclusion in the Fire Engineering process. Where not required by legislation it is the Client's decision to involve such parties, especially local fire brigade, to ensure a transparent and adequate fire safety solution for all. Where Austech are not notified of the inclusion of such parties at the Fire Engineering Brief (FEB) stage it is considered that the Client / Client's representative has given due consideration to the above.

Table 1-4 – Project stakeholders

Name	Company	Role
Brendan Cadden	Dewcape	Client and Architect
Steve Watson	Steve Watson & Partners	Certifying Authority
Joshua Hawke	Steve Watson & Partners	BCA Consultant
Paul Smit	MGP Building and Infrastructure Services	Hydraulics Consultant
Allan Lam	Lam Consulting	Electrical Engineer
Imran Shaikh Azeem Shaikh	Austech International	Fire Safety Engineer

1.3 Definitions

The following definitions apply to terminology used in this report

- Architect – refers to Dewcape
- ASET – refers to Available Safe Egress Time

- BCA – refers to the Building Code of Australia 2016
- BCA DtS – refers to the Building Code of Australia 2016 (BCA) Deemed-to-Satisfy Provision (DtS)
- Certifying Authority – refers to Steve Watson & Partners
- Client – refers to Dewcape
- Fire Engineering Brief Questionnaire (FEBQ) – refers to the Fire Engineering Brief Questionnaire (ref: FEBQ-Bingo St Marys dated 24/08/2016)
- Fire Engineering Report (FER) – refers to the Fire Engineering Report (This document)
- Fire Safety Engineer – refers to Austech
- FRL – refers to Fire Resistance Level as defined in the BCA
- FRNSW – refers to Fire & Rescue NSW
- NCC – refers to National Construction Code
- RSET – refers to Required Safe Egress Time

2 Building Details

This document relates to the purposed development comprises a Class 8 factory with ancillary Class 5 office space located at 25 Dunheved Circuit, St Marys. The building will house waste sorting and compacting machinery along with storage areas for the sorted waste.

2.1 Description of Building

The building is located at 25 Dunheved Circuit, St Marys. An overview view of the site and the boundaries is shown in Figure 2-1.

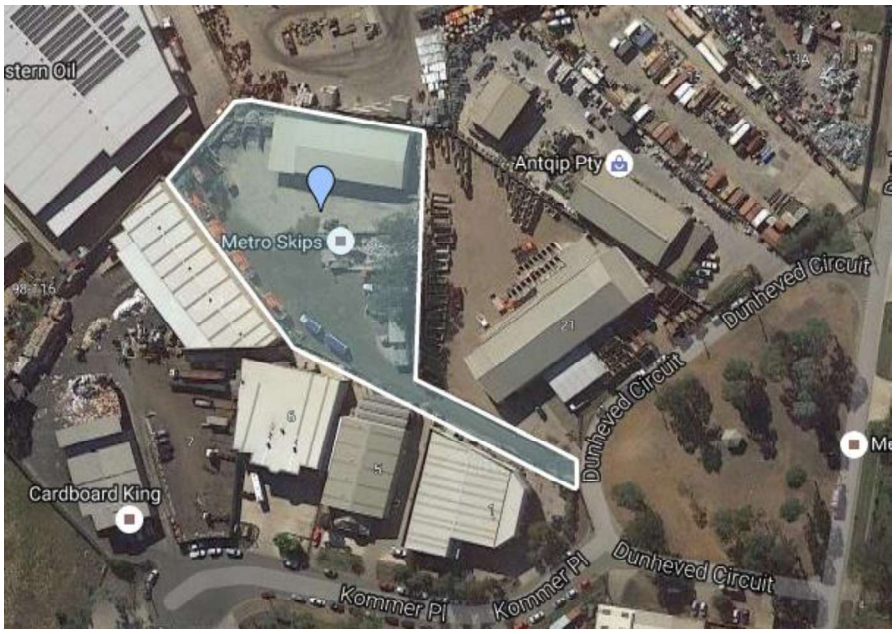


Figure 2-1 – Aerial view of 25 Dunheved Circuit, St Marys (Courtesy of Google Maps)

2.2 Egress

Egress from the main building is via the designated exits as depicted in Figure 2-2.

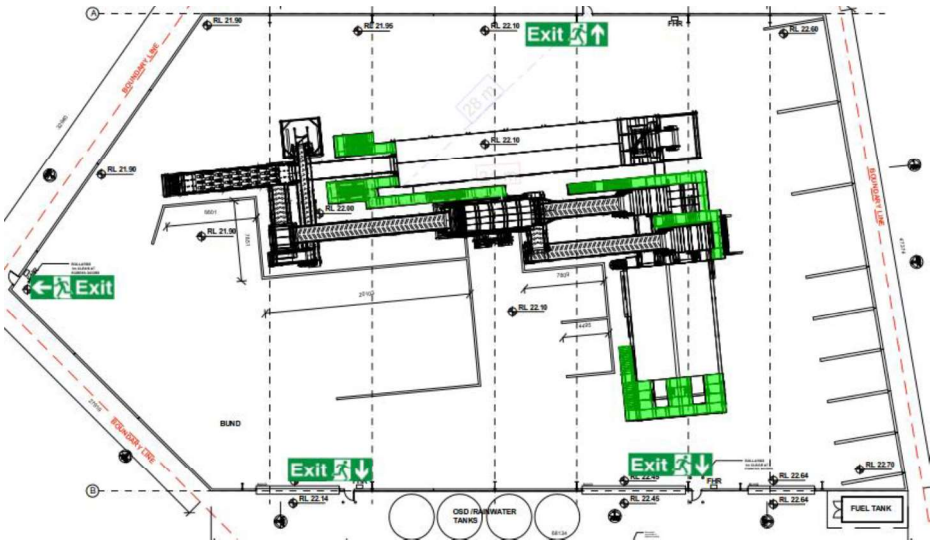


Figure 2-2 – Designated exits from the main building

2.3 Building Codes of Australia Description Summary

Key BCA DtS criteria as identified by the Certifying Authority for 25 Dunheved Circuit, St Marys is detailed below in Table 2-1.

Table 2-1 – BCA Deemed-to-Satisfy (DtS) criteria

	BCA Clause	Description or Requirement
A3.2	Classification	Class 8 (Factory) Class 5 (Office)
C1.2	Rise in Storeys	One (1)
C1.2	Effective Height	0 m
C1.3	Construction Type	Type A
C2.2	Floor Area Limitations	Class 8: 3,437 m^2 & 30,545 m^3 Class 5: 150 m^2
C2.3	Large-Isolated Building	N/A
D1.13	Floor population	Refer to Section 6

3 Proposed Performance Solutions

Steve Watson & Partners are the Certifying Authority (CA) for purposes of assessing an application for a Construction Certificate (CC) for this project. Table 3-1 summarises the BCA DtS Variations, Proposed Alternative Solutions, relevant BCA Performance Requirements and BCA Assessment Methods.

Table 3-1 – BCA DtS Variations, Proposed Performance Solutions, Relevant BCA Performance Requirements and Assessment Methods

BCA Clause	BCA DtS Provisions	Performance Solution	Relevant Performance Requirement	Assessment Method / Acceptance Criteria
C2.2	BCA Clause C2.2 states that for Type A Construction the maximum floor area permitted is 5,000 m^2 and the maximum volume is 30,000 m^3.	**Performance Solution #1** It is proposed to permit the process facility to have a floor area of ~3,409 m^2 and a volume of 30,545 m^3 which exceeds the maximum volume permitted under C2.2 for Type A Construction.	CP2	Qualitative and Quantitative Analysis based on A0.3(b)(i) and A0.5(b)(ii) 'Other verification method'.
D1.4	BCA Clause D1.4 states that no point on a floor must be more than 20 m from an exit or point in which travel in different directions is possible in which case the maximum distance to one of those exits must not exceed 40 m.	**Performance Solution #2** An extended travel distance of 64 m to an exit from the Northern façade of the building though the point of choice is proposed.	DP4 and EP2.2	Qualitative Analysis based on A0.3(b)(i) and A0.5(b)(ii) 'Other verification method'.
E1.3	BCA Clause E1.3 states that if the fire hydrant is in a position less than 10 m from the building façade, it requires radiant heat shields extending 3 m above the outlets and 2 m either side of the hydrant.	**Performance Solution #3** It is proposed to permit fire hydrants to be located within the external wall of the building without radiant heat shields as per AS 2419.	EP1.3	Qualitative Analysis based on A0.3(b)(i) and A0.5(b)(ii) 'Other verification method'.
E4.8	BCA Clause E4.8 states that exit signs must be compliant with AS 2293 and must be visible at all times. It goes on to state that the exit sign must be mounted at a	**Performance Solution #4** Due to the overall height of the building, exit signs are proposed to be located at a	EP4.2	Qualitative Analysis based on A0.3(b)(i) and A0.5(b)(ii) 'Other verification method'

BCA Clause	BCA DtS Provisions	Performance Solution	Relevant Performance Requirement	Assessment Method / Acceptance Criteria
	maximum height of 2.7 m above the floor.	height greater than 2.7 m.		

4 Hazard Identification

4.1 Ignition Sources

Table 4-1 tabulates potential ignition sources and fire hazards likely to be encountered in various locations in this building. The table is based on a literature review of similar occupancies (Rahikainen 1998), (Marryatt 1998) and (Thomas, et al. 1992).

Table 4-1 – Ignition Sources

Location	Ignition sources	Fire Hazards	Mitigation Measures
Waste Sorting Facility	Arson Unauthorised smoking Repairs and maintenance including hot works Electrical defects	Trucks and vehicles Front loaders and excavators Electrical and mechanical equipment Sorted waste storage	House keeping Water mist dust suppression Management-in-use procedures, safe work practices, e.g. hot work permit system Security measures Automatic sprinkler system Occupant intervention using manual suppression Fire Brigade intervention

5 Fire Scenarios

Based on the fire hazards identified above, the following fire scenarios are to be utilised to assess occupant life safety, structural adequacy and fire brigade intervention in relation to the proposed Alternative Solution on this project.

Although arson has been shown statistically to contribute to fires in buildings, however in this report it will only be considered from an occupant life safety perspective in accordance with the BCA DtS Provisions. In this case, the building is a private secured premises, hence an arson fire scenario was not considered in relation to the proposed Alternative Solutions.

5.1 Design Fire Scenario

Fire Scenario	Description
T-1 T-2 (Design Cases)	Fire scenario T-1 involves a sprinkler controlled fast t^2 fire in a loading truck centrally located. Fire scenario T-2 involves a sprinkler controlled fast t^2 fire in a loading truck located in a corner of the building. The fire size will be capped upon the activation of the 2nd sprinkler head. Upon activation of the sprinkler head, the heat release rate is levelled off and maintained constant. For example, the modelled fire is considered to be located between four sprinklers heads at a radial distance of 2.12 m. Fire Scenarios T-1 and T-2 were estimated to have a Peak Heat Release Rate (HRR) of ~2.7 MW based on an average ceiling height of 11 m, fast response sprinkler heads RTI = 38 $(m.s)^{1/2}$, radial distance of 2.12 m for the closest sprinkler head and activation temperature of 68°C.
T-3 (Sensitivity Case)	Fire scenario T-2 involves a 30 MW truck fire coincident with sprinkler failure. A peak heat release rate of 30 MW was used based large scale fire test data (National Fire Protection Association 2004), (The Highways Agency 1999) and (Permenant International Association of Road Congress 1999). It is further highlighted that this fire scenario will only be considered as the sensitivity case in the analysis.

6 Occupant Scenario

Based on information provided by the client, there are likely to be a maximum of 10 staff within the facility. This was further verified during the site inspection undertaken by Austech of the Auburn waste sorting facility that Bingo Recycling operates.

It is further highlighted that staff represent the majority of occupants within the facility with visitors representing a small minority (i.e. truck drivers dumping rubbish to be sorted) who are at the facility for a relatively short duration of time.

6.1 Primary Occupant Group – Staff

Characteristics	Description
Distribution – Age, Gender, Location	Staff are considered to be representative of the general population with no specific or unusual distributions applicable in gender, age and physical or mental attributes.
State of Awareness	Occupants are expected to be awake and conscious of their surroundings.
Familiarity - egress routes, group roles, training	This occupant group is generally expected to be highly familiar with egress routes, have particular group roles and have some emergency response training.
Mobility	This occupant group is considered to have a similar level of mobility as the general population and do not require special assistance for evacuation.

6.2 Secondary Occupant Group – Visitors

Characteristics	Description
Distribution – Age, Gender, Location	Visitor characteristics are considered to be representative of the general population with no specific or unusual distributions applicable in gender, age and physical or mental attributes.
State of Awareness	The occupants are expected to be awake and conscious of their surroundings.
Familiarity - egress routes, group roles, training	This occupant group is generally expected to be unfamiliar with egress routes, have no particular group roles except for immediate family/friends and have no emergency response training.
Mobility	This occupant group is considered to have a similar level of mobility as the general population and do not require special assistance for evacuation.

7 Design Objectives

7.1 BCA Compliance Objectives

In terms of BCA Compliance, the primary objective of this report is to address the BCA DtS variations identified in Section 3 via proposed Alternative Solutions. The Alternative Solutions will be assessed against relevant BCA Performance Requirements. With the exception of the identified BCA DtS variations all other new fire safety aspects of the subject building are to comply with BCA DtS Provisions.

7.2 Fire Safety Objectives

The design objectives for this fire engineering assessment are contained in the relevant BCA Performance Requirements in Sections C, D and E, which may be summarised as:

- Occupant Life Safety – to safeguard people from illness or injury due to a fire in a building and whilst evacuating a building during a fire.
- Protection of adjacent property – to avoid the spread of fire between buildings and protect other property from physical damage caused by structural failure of a building as a result of fire.
- Fire Brigade Intervention – to facilitate the activities of emergency services personnel.

The fire safety objectives are based on acceptable levels of occupant life safety as absolute fire safety within buildings is not attainable. Accordingly, the BCA is utilised as a benchmark for establishing an acceptable level of fire safety. The process used to define the acceptance criteria for this project will include community representation via the Regulatory Authorities such as Certifying Authority and Fire & Rescue NSW along with input from other relevant project stakeholders.

This assessment will be consistent with the objectives and limitations of the BCA and therefore specifically excludes arson (other than as a source of initial ignition), multiple ignition sources, acts of terrorism, protection of property (other than adjoining property), business interruption or losses, personal or moral obligations of the owner/occupier, reputation, environmental impacts, broader community issues etc. Specific building owner objectives relating to any of the above matters have not been identified by the relevant stakeholders and were therefore not considered in this report.

As an Alternative Solution is not identical to a BCA Deemed-to-Satisfy (DtS) Solution, the property losses resulting from a fire in the subject building may under some circumstances vary from a building complying fully with the BCA DtS Provisions.

7.3 Fire Brigade Objectives

Fire brigade objectives with respect to building design and fire brigade intervention are to be addressed in accordance with the relevant BCA Performance Requirements. It should be noted that the Fire & Rescue NSW (FRNSW) have their own charter for the protection of life, property and environment. However, Fire Brigades responsibilities that may be contained within their Statutory Act or other objectives are over and above the BCA and beyond the scope of this report.

8 Acceptance Criteria

The following acceptance criteria are nominated for the fire engineering analysis that will be undertaken to assess the proposed Performance Solution against the relevant BCA Performance Requirements.

8.1 Performance Solution Acceptance Criteria

The acceptance criteria for assessing each of the proposed Performance Solutions is described in Section 10, 11 and 12 of this report.

8.2 Design Tenability Criteria

Smoke modelling on this project will be undertaken using the CFD model – FDS (Fire Dynamics Simulator - Version 6.2.0). The adapted tenability criteria for the CFD modelling in relation to occupant life safety will be based on the following parameters (Fire Code Reform Centre 1996) and (Society of Fire Safety 2014) outlined in

Table 8-1 – Design tenability criteria for CFD modelling.

Tenability Criteria	Description
Air/smoke temperature	Air/smoke temperature reaches 183°C (approximately equal to 2.5 kW/m^2) consistently across the entire fire enclosure at any height; or Significant pockets of air/smoke reach 100°C in the vicinity of the egress path at a height of 6.8 m.
Visibility	Substantial accumulation of stagnant smoke is formed below 6.8 m in the vicinity of the egress path such that visibility is limited to less than 10 m (i.e. an optical density of 0.1 m^{-1}); or Substantial accumulation of stagnant smoke is formed below 6.8 m in the vicinity of the egress path such that visibility is limited to less than 5 m (i.e. an optical density of 0.2 m^{-1}), subject to CO and CO_2 concentration being maintained within tenable limits.
Carbon monoxide	In the event that visibility falls below 10 m, carbon monoxide (CO) concentration exceeds 2700 ppm in the vicinity of the egress path at a height of 6.8 m or below.
Carbon dioxide	In the event that visibility falls below 10 m, carbon dioxide (CO_2) concentration exceeds 7% in the vicinity of the egress path at a height of 6.8 m or below.

8.3 Fire Brigade Acceptance Criteria

8.3.1 Structural Adequacy

The building will have equivalent level of structural adequacy to that of a similar BCA DtS compliant building at the commencement of fire brigade intervention. It is noted that the subject building has Type A Construction applicable under BCA DtS Provisions and there are no explicit fire rating requirements for any construction elements in relation to fire brigade intervention.

8.3.2 Heat Radiation

Notwithstanding the structural adequacy discussed above, the limiting condition for radiant heat from the upper layer will be taken as 4.5 kW/m^2 at a height of 1.5 m above the floor level in accordance with the Fire Brigade

Intervention Model (Australasian Fire and Emergency Service Authorities Counci 2004). Typical fire brigade tenability criteria are outlined in Table 8-2.

Table 8-2 – Fire Brigade tenability criteria

Conditions	Description
Routine	Elevated temperatures, but not direct thermal radiation. Maximum time – 25 minutes Maximum air temperature – 100°C (in lower layer) Maximum radiation – 1kW/m^2
Hazardous	When fire fighters would be expected to operate for a short period of time in high temperatures in combination with direct thermal radiation. Maximum time – 10 minutes Maximum air temperature – 120°C (in lower layer) Maximum radiation – 3kW/m^2
Extreme	These conditions would be encountered in a snatch rescue situation or a retreat from a flashover. Maximum time – 1 minute Maximum air temperature – 160°C (in lower layer) Maximum air temperature – 280°C (in upper layer) Maximum radiation – 4kW/m^2

8.4 Environmental & Loss Control Acceptance Criteria

Environmental and loss control acceptance criteria are outside the scope of this report and are not addressed herein. As a general guidance the impact on environment and loss of property could be reduced by early detection and intervention by either staff or fire brigades.

9 Evaluation Methods

9.1 Assessment Methods

Compliance with the relevant BCA Performance Requirements will be achieved by using the respective BCA Assessment Methods, as documented in Table 3-1 under Section 3.

9.2 Fire and Smoke Modelling

FDS 6.2.0 is a field model based on the Large Eddy Simulation (LES) modelling technique involving equations describing the transport of mass, momentum and energy by fire induced fluid flow in the compartment/s under study. The equations are solved numerically for a network of rectangular cells representing the physical space. The results generated from FDS 6.2.0 are illustrated by coloured graphics showing levels of contamination and temperature via a three-dimensional viewing package, Smokeview 13.

Key CFD modelling input parameters for the fire scenarios relating used in the assessment are outlined in the CFD Modelling Report in Annexure B.

10 Performance Solutions #1: Oversized Compartment

The assessment of Performance Solution #1 is outlined below.

Consideration	Criterion
Applicable BCA DtS Provisions	BCA Clause C2.2 states that for Type A Construction the maximum floor area permitted is 5,000 m^2 and the maximum volume is 30,000 m^3.
Variation to the BCA DtS Provision	It is proposed to permit the process facility to have a floor area of ~3,409 m^2 and a volume of 30,545 m^3 which exceeds the maximum volume permitted under C2.2 for Type A Construction.
Acceptance Criteria	With reference to BCA Performance Requirement CP2, the acceptance criterion is a compartment volume that is satisfactory from occupant life safety and Fire Brigade Intervention perspective.
Methods of Analysis	Qualitative and Quantitative Analysis based on A0.3(b)(i) and A0.5(b)(ii) 'Other verification method'.
Relevant IFEG sub Systems	The relevant sub system from the International Fire Engineering Guidelines is considered to be: • Sub-system A: Fire Initiation and Development and Control • Sub-system C: Fire Spread and Impact and Control • Sub-system D: Fire Detection, Warning and Suppression • Sub-system E: Occupant Evacuation and Control • Sub-system F: Fire Services Intervention

10.1 Assessment

The Guide to the BCA (Australian Building Codes Board 2016) states the intent of BCA C2.2 as being:

"To limit the size of any fire in a building by limiting the size of the floor area and volume of a fire compartment"

With reference to Figure 10-1, the main building has a compartment size greater than that permitted for similar Class 8 factories comprising Type A construction. It is highlighted that although the compartment volume exceeds that permitted the floor area is under the maximum allowable for Type A Construction.

A Performance Solution is proposed to allows the compartment volume to exceed the Type A limitations based on a CFD analysis to determine the time taken for conditions in the compartment to become untenable.

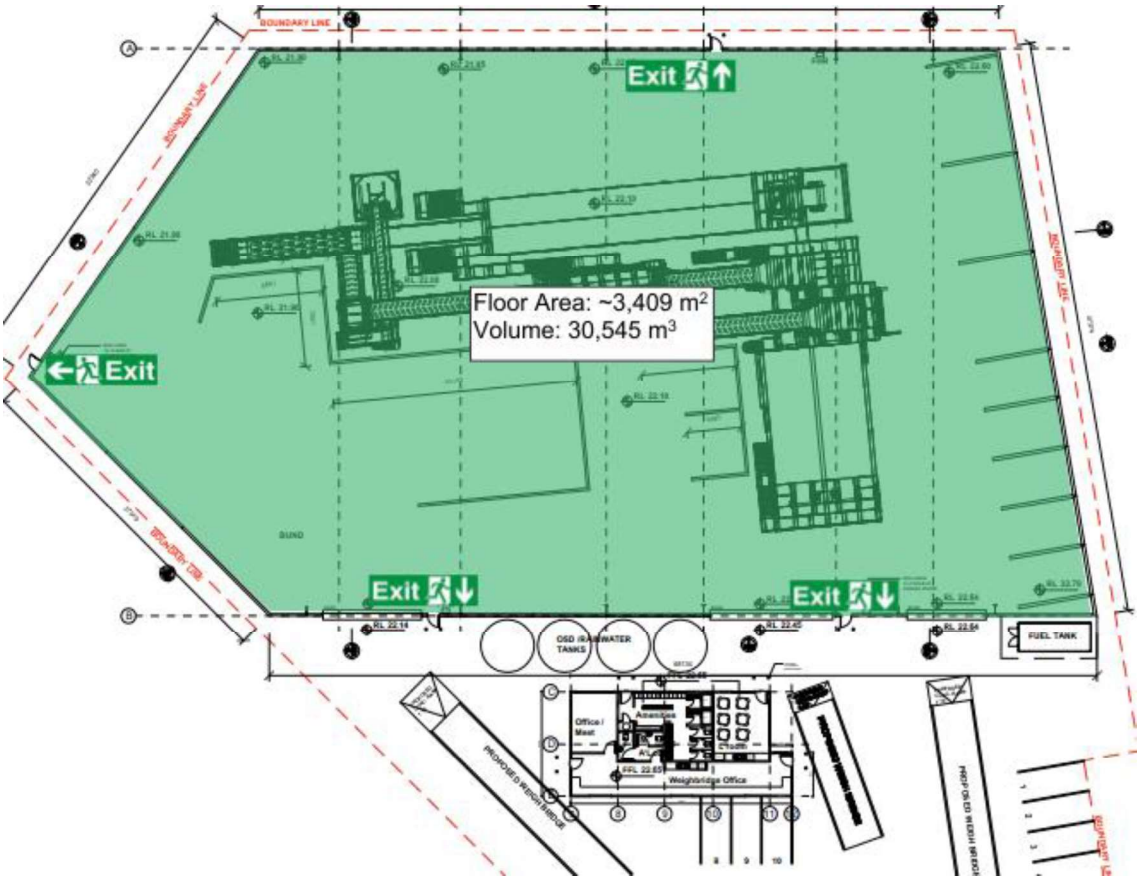


Figure 10-1 – Floor area and volume of the building

10.1.1 Intent of Fire Compartmentation

The primary goal of fire compartmentation is to limit the spread of fire and smoke and enable a passive means of fire protection for life safety, property protection, and continuity of operations.

The inclusion of sprinkler protection in buildings has been recognised in numerous instances for increasing occupant life safety and reducing area damage, the extent of fire spread, probability of flashover and financial loss (Rasbash, et al. 2004). Rasbash 2004 further noted that, concessions can be given to buildings which are fully equipped with a sprinkler system, including:

1) Reduction in FRL

2) Increase in building size

3) Increase in compartment size

4) Increase in design evacuation time

BRE Global have reviewed the correlations between sprinklers and compartment sizes (Lennon 2015). They note that in Approved Document B, Fire safety, B3 Table 12, guidance is provided which indicate the limitations on the maximum size of compartments. It is understood that these compartment size limitations are based on survey data from the 1940s. Recognition of the benefits of sprinklers within non-residential building in terms of compartment size has been highlighted by BRE Global. A review of existing fire database and compartment sizes information was undertaken by BRE Global and the following was concluded:

- There was a clear trend for average fire area to increase as the area of room of origin increases;

- There were no clear trends for life risk to increase as the area of the room of origin increases;
- Life risk was reduced with the installation of sprinkler in non-residential buildings;
- The primary benefits of the provision of a sprinkler system in non-residential buildings is property protection.

Various codes were compared in relation to permitted compartment sizes with and without sprinklers for single storey industrial and storage type facilities, shown in Figure 10-2. The percentage increases in compartment sizes for each of the countries in Figure 10-2 below has been summarised in Table 10-1.

Country	Code/Guidance/Regulation	Single-storey industrial				Single-storey storage			
		Unsprinklered		Sprinklered		Unsprinklered		Sprinklered	
		High risk	Low risk	High risk	Low risk	High risk	Low risk	High risk	Low risk
England	AD B	No limit	No limit	No limit	No limit	20000	20000	No limit	No limit
England	AD B (property protection)	7000	7000	14000	14000	2000	8000	2000	8000
Wales	AD B (Wales)	No limit	No limit	No limit	No limit	20000	20000	No limit	No limit
Scotland	NDTGD	33000	93000	66000	186000	1000	14000	2000	28000
ROI	TGDB	33000	93000	66000	186000	14000	No limit	28000	No limit
Australia	BCA	2000	2000	2000	2000	2000	2000	2000	2000
Hong Kong	HKCPSFB	10500	10500	10500	10500	10500	10500	10500	10500
South Africa	SANS 10400	5000	5000	No limit	No limit	No limit	No limit	No limit	No limit
Greece	Fire Building Regulation PD 71/88	5000	20000	12500	4000	3000	3000	3000	3000
China	GB 50016-2006	2500	2500	5000	5000	2500	2500	5000	5000
Holland	DBR	2500	2500	No limit	No limit	1000	1000	No limit	No limit
India	NBCI	1125	1125	No limit	No limit	1125	1125	No limit	No limit
Denmark	Information on fire safety sizing	2000	5000	10000	10000	2000	5000	10000	10000

Figure 10-2 – Permitted compartment sizes with and without sprinklers for industrial and storage type facilities from various regulatory codes around the world (Lennon 2015)

Table 10-1- Summary of permitted percentage increase in compartment size for industrial and storage facilities under various codes

Country	Code/Guidance/Regulation	Permitted % increase in Compartment Size	
		Single-storey Industrial	Single-storey Storage
England	AD B	None	No limit
England	AD B (property protection)	50% increase	75% increase
Wales	AD B (Wales)	None	No limit
Scotland	NDTGD	50% increase	50% increase
ROI	TGDB	50% increase	No limit
Australia	BCA	None	None

Country	Code/Guidance/Regulation	Permitted % increase in Compartment Size	
		Single-storey Industrial	Single-storey Storage
Hong Kong	HKCPSFB	None	None
South Africa	SANS 10400	No limit	None
Greece	Fire Building Regulations PD 71/88	60% increase	None
China	GB 50016-2006	50% increase	50% increase
Holland	DBR	No limit	No limit
India	NBCI	No limit	No limit
Denmark	Information on fire safety sizing	Up to 80% increase	Up to 80% increase

Based on the above discussion, it is considered that fire compartments can be increased based on the provisions of a sprinkler system. It is evident that the goals of fire compartmentation as a passive system can be achieved through the active sprinkler system. As such, fire protection for life safety, property protection, and continuity of operations is achieved through the implementation of the sprinkler system

10.1.2 Comparison to DtS Class 8 Building

The subject building on the other hand comprises a waste sorting facility with the excavators, trucks and the sorting machine representing the greatest hazards. With reference to Figure 10-3, the pre-sorted rubbish pile is mainly comprised

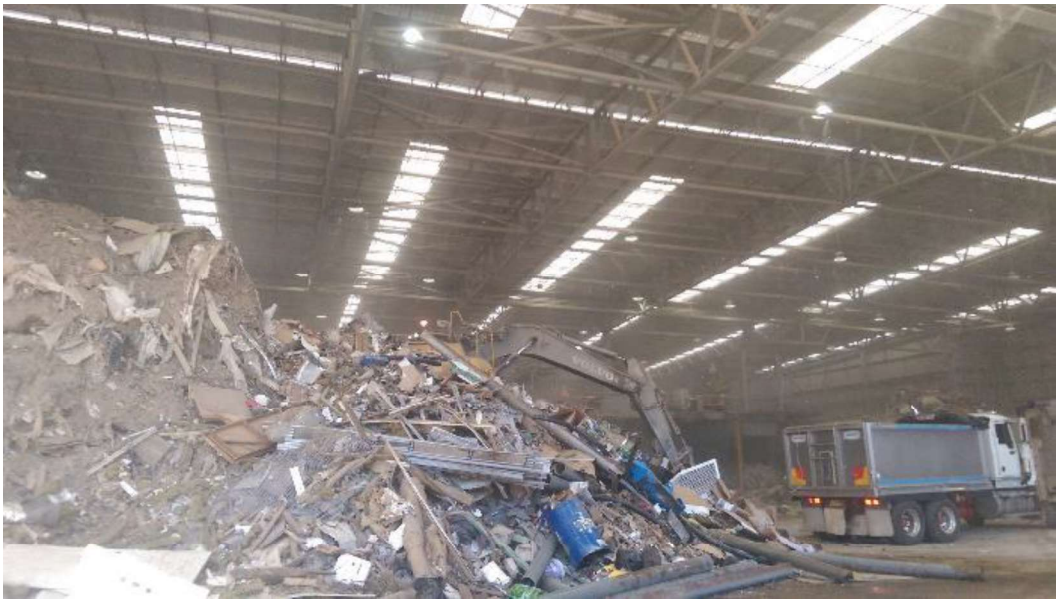


Figure 10-3 – Pre-sorted rubbish pile (Bingo Auburn facility)

As a comparison, the details of a Class 8 building compliant with BCA DtS provisions in terms of both floor area and volume and the proposed building are summarised in

Table 10-2 – Comparison between BCA DtS and Proposed Designs

Parameters	BCA DtS Provisions	Proposed Solution Provisions	Comment	Outcome
Floor Population	According to BCA Table D1.13, the number of persons accommodated by a Class 8 BCA DtS factory space is ~65 persons.	The Client has advised that there will be no more than 10 persons in the building.	In comparison to the BCA DtS Design, fewer occupants in the proposed Alternative Solution is expected to result in a shorter occupant evacuation time due to reduced queuing time and clogging at the required exits.	Proposed Solution is better than the BCA DtS Design.
Smoke Detection and Occupant Warning System	BCA DtS Provisions do not require smoke detection systems for a Class 8 building with an effective height of less than 25 m.	An AS 1670.1:2004 fire detection and occupant warning system with verbal messaging and AS 1670.3:2004 Manual Call Points (MCPs) will be provided within the building.	Provision of the fire detection and occupant warning systems will result in earlier occupant warning and fire brigade notification in comparison to a BCA DtS Design where fire detection depends on occupants receiving a sensory (visual, olfactory or auditory) cue.	Proposed Solution is better than the BCA DtS Design.
Occupant Evacuation Time & Fire Brigade Notification Time	Detection time of a fire incident will depend on occupants receiving a visual, olfactory or auditory cue of a developing fire. The fire brigade notification time depends on occupants manually alerting the fire brigade and hence is expected to be longer than that of the	The occupant detection time was determined to be 140 s based on visual detection of the smoke. It is highlighted that an automatic fire suppression system is will be provided in the building.	In comparison to the occupants in a BCA DtS Design, earlier detection and warning of a fire incident in the Alternative Solution Design will result in a much earlier and shorter occupant evacuation time.	Proposed Solution is better than the BCA DtS Design.

Parameters	BCA DtS Provisions	Proposed Solution Provisions	Comment	Outcome
	Alternative Solution Design.		Additionally, the provision of a fire detection and warning system with direct connection to the fire brigade results in significantly shorter fire brigade intervention time in the proposed solution.	
Natural Smoke Ventilation	The building will have no provisions for natural or automatic smoke venting, since these are not required for a Class 8 building having an effective height of less than 25 m.	The building will be provided with natural smoke ventilation facilitated through roof level smoke and heat vents and full height roller shutters on the Northern façade.	In comparison to the BCA DtS Design, tenability conditions (i.e. visibility, temperature and toxicity) in the Alternative Solution Design are significantly better as shown by the smoke modelling results.	Proposed Solution is <u>better</u> than the BCA DtS Design.

With reference to Table 10-2, the excessive compartment volume of the Class 8 waste sorting facility is not expected to have a significant impact on the occupant life safety and fire brigade intervention.

10.1.3 ASET / RSET Analysis

The International Fire Engineering Guidelines (Australian Building Codes Board 2005) states that an acceptable level of safety has been established in a fire safety system if:

$$ASET > RSET + Safety\ Margin$$

Where,

- *ASET is the available safe egress time (s) for occupants*
- *RSET is the required safe egress time (s) for occupants*

The Computational Fluid Dynamics (CFD) Program Fire Dynamics Simulator (FDS Version 6.2.0) was utilised to model the smoke movement within the main building as discussed in Annexure B. To this effect, smoke modelling was undertaken to determine the time for which tenable conditions (i.e. visibility, temperature and toxicity) are maintained. Figure 10-4 shows the 3D model used in the CFD assessment and the proposed location of openings considered in the analysis.

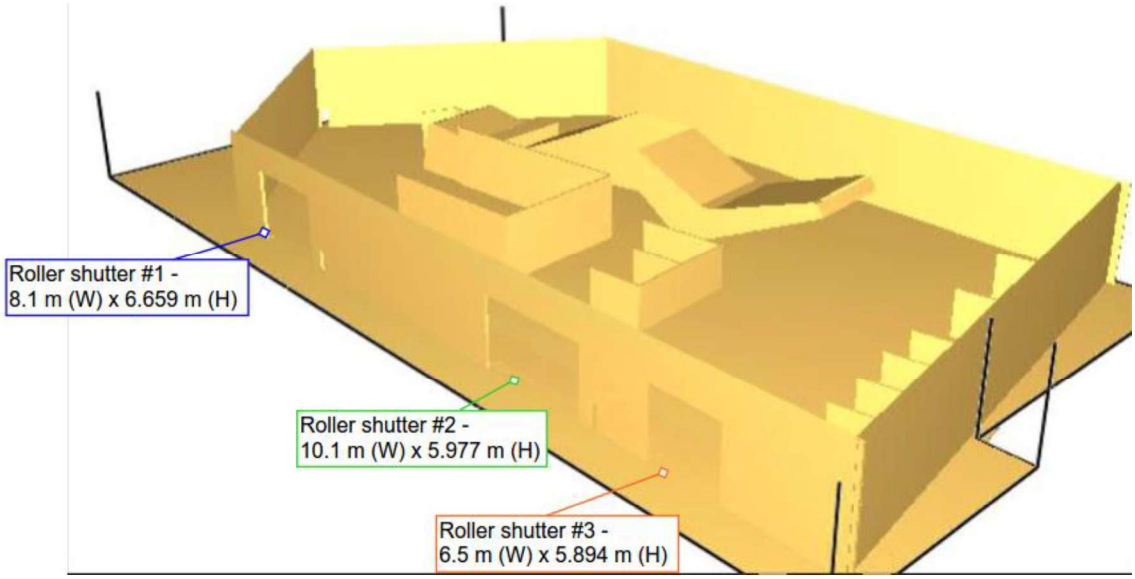
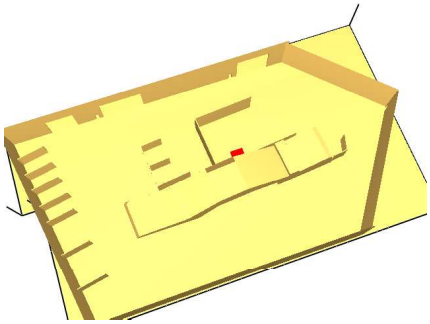
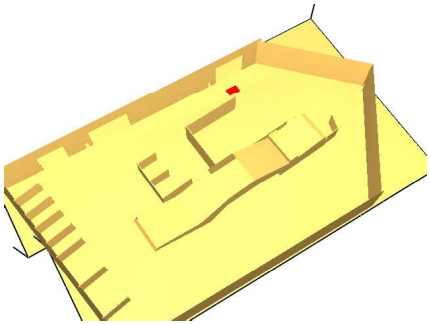


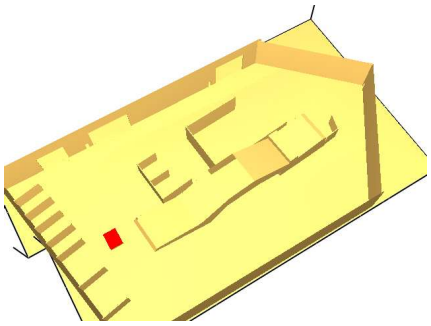
Figure 10-4 – 3D model used in the CFD analysis

10.1.3.1 Fire Scenarios

The following fire scenarios were considered and used in the CFD analysis of the building. Table 10-3 details the three (3) fire scenarios developed for use in the CFD analysis and the proposed location of the fire for each analysis undertaken.

Table 10-3 – Fire scenarios used for CFD modelling

Fire Scenario	Location of Fire	Diagram of Facility and Fire
Fire Scenario T-1	Fast fire capped at 2nd sprinkler head activation, located at the centre of the facility as shown by the red box beside the sorting machine in the centre	
Fire Scenario T-2	Fast fire capped at 2nd sprinkler head activation, located at the corner of the facility as shown by the red box beside the roller shutter	

Fire Scenario	Location of Fire	Diagram of Facility and Fire
Fire Scenario T-3	Truck fire coincident with sprinkler failure with a fire size based on experimental data (Permenant International Association of Road Congress 1999) located at the centre of the facility as shown by the red box the sorting machine in the centre	

10.1.3.2 Required Safe Egress Time (RSET)

The required safe egress time is the summation of the detection time, the pre-movement time and the movement time.

10.1.3.2.1 *Detection Time*

The detection time is the time interval between the ignition of the fire and the time when occupants become aware of a fire incident within the building. The detection time is generally given by the time at which the fire alarm is sounded by the automatic fire detection system, or the occupants receive a clear visual or olfactory cue, such as smoke. Due to the overall height of the building, occupants are likely to visually see the fire prior to the sprinkler system activating. In the subject facility for fire scenario T-1 and T-2 the detection time is the time taken for occupants to visually see smoke rising. With reference to Figure 10-5, the smoke occupies majority of the compartment, hence the time for visual detection was taken as 140 s.

Figure 10-5 – Smoke layer at 140 s

10.1.3.2.2 *Pre-movement Time*

The pre-movement time is the time from when people become aware of the fire until they begin to evacuate. One common reaction is to try to get more information about the fire and another is to try to extinguish the fire. Other factors that determine the pre-movement time include the occupant familiarity with the building, the reaction of the group that the occupants are in, the threat of the fire and the type of evacuation alarm. If the occupants have a clear visual cue, such as smoke, the pre movement time will be short. In the subject facility staff within the premises maintain radio contact with each other, furthermore the facility and the sorting machine is continually monitored by a staff member.

A study conducted in retail shops in the UK (Samochine, Boyce and Shields 2005) illustrates that the pre-movement time for staff is around 20 s. However, for sensitivity a pre-movement time of 60 s was considered.

10.1.3.2.3 *Movement Time*

Movement time is the time taken for occupants within the facility to reach a safe place outside of the facility. Due to the number of exits provided, the movement time for the subject facility is a consideration of the time taken to reach the closest exit as opposed to the time to reach a road or open space.

The SFPE Handbook, Section 3-14 (Nelson and Mowrer 2002) details that the maximum unimpeded movement speed along corridors was reported as 1.19 m/s and 1 m/s in stairways. Hence, a movement speed of 1 m/s was adopted for staff during evacuation.

With reference to Figure 10-6, majority of the occupants working within the facility are at a height of 4.5 m above the floor. Hence, the tenability criteria was split into two (2) portions, one at 6.6 m above floor level to account for persons using the central machine and the other at 2.1 m to account for persons at floor level.

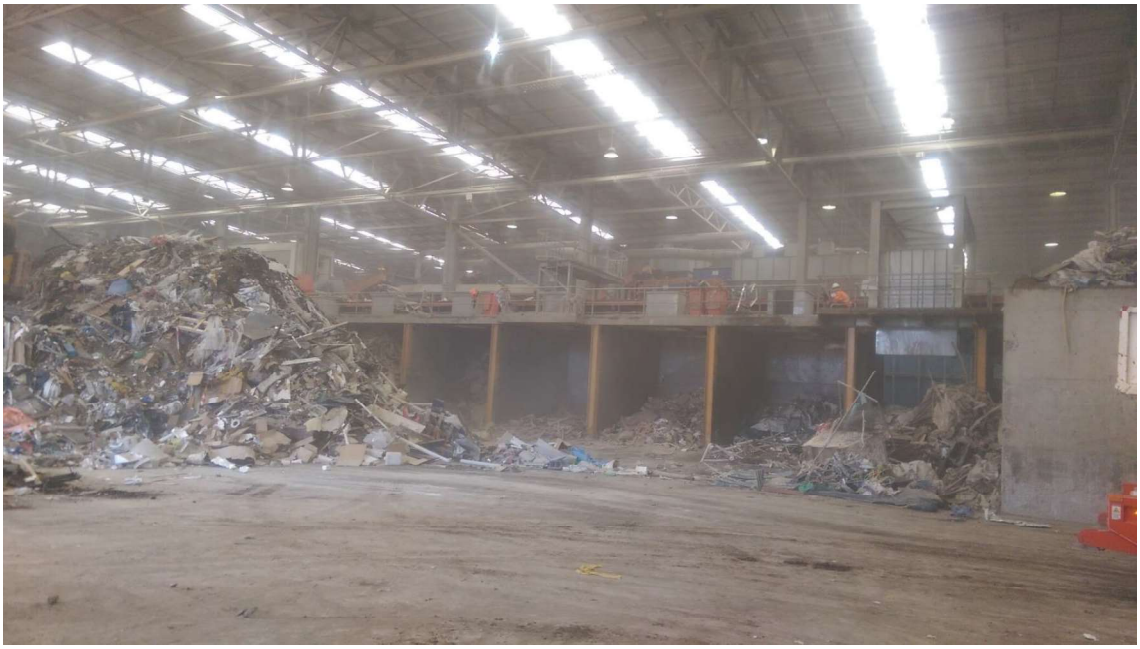


Figure 10-6 – Central sorting machine on which the occupants work on. Note that occupants are working approximately 4.5 m above the ground level

Based on the above, and with reference to Figure 10-7 in order to simplify the calculation of the RSET the areas highlighted in green are assumed to be located 4.5 m above floor level. Table 10-4 tabulates the RSET values for the three (3) aforementioned fire scenarios, a factor of safety of 1.5 was adopted for calculation of the final RSET values.

Figure 10-7 – Central sorting machine with the travel distance marked up

Table 10-4 – RSET values for the facility

Fire Scenario	RSET at 6.6 m	RSET for Occupants coming down from 6.6 m to reach the exit (2.1 m)	RSET at 2.1 m
Fire Scenario T-1	Visual Detection time: 140 s Pre-movement time: 60 s Movement time: 25 s RSET: 225 s RSET with factor of safety: 340 s	Detection time: 0 s Pre-movement time: 0 s Movement time: 27 s RSET: 27 s RSET with factor of safety: 41 s	Visual Detection time: 140 s Pre-movement time: 60 s Movement time: 25 s RSET: 295 s RSET with factor of safety: 340 s
Fire Scenario T-2	Visual Detection time: 140 s Pre-movement time: 60 s Movement time: 25 s RSET: 225 s RSET with factor of safety: 340 s	Detection time: 0 s Pre-movement time: 0 s Movement time: 27 s RSET: 27 s RSET with factor of safety: 41 s	Visual Detection time: 140 s Pre-movement time: 60 s Movement time: 25 s RSET: 225 s RSET with factor of safety: 340 s
Fire Scenario T-3	Visual Detection time: 140 s Pre-movement time: 60 s	Detection time: 0 s Pre-movement time: 0 s	Visual Detection time: 140 s Pre-movement time: 60 s

Fire Scenario	RSET at 6.6 m	RSET for Occupants coming down from 6.6 m to reach the exit (2.1 m)	RSET at 2.1 m
	Movement time: 25 s RSET: 225 s	Movement time: 27 s RSET: 27 s	Movement time: 25 s RSET: 225 s

10.1.3.3 Available Safe Egress Time (ASET)

With reference to Annexure B, Table 10-5 tabulates the ASET at 6.6 m whereas

Table 10-6 tabulates the ASET at 2.1 m above floor level.

Table 10-5 – ASET at 6.6 m above floor level

Fire Scenario	Temperature < 100°C at 6.6 m	Visibility > 10 m at 6.6 m	ASET
Fire Scenario T-1	Temperature mostly below 45°C until 700 s	Yes, until 500 s	500 s
Fire Scenario T-2	Temperature mostly below 45°C	Yes, until 300 s However, visibility drops to 5 m at 375 s	375 s
Fire Scenario T-3	Below 100°C	Yes, until 225 s	225 s

Table 10-6 – ASET at 2.1 m above floor level

Fire Scenario	Temperature < 100°C at 2.1 m	Visibility > 10 m at 2.1 m	ASET
Fire Scenario T-1	Temperature mostly below 45°C	Yes	700 s
Fire Scenario T-2	Temperature mostly below 40°C	Yes	1,100 s
Fire Scenario T-3	Temperature mostly below 40°C	Yes	680 s

10.1.3.4 ASET / RSET Comparison

With reference to Table 10-7, the respective ASET was compared to the calculated RSET from which a corresponding safety margin was determined.

Table 10-7 – ASET / RSET comparison

Fire Scenario	RSET (s)		ASET (s)		Safety Margin (s)	
	At 6.6 m	At 2.1 m	At 6.6 m	At 2.1 m	At 6.6 m	At 2.1 m
Fire Scenario T-1	340 s	340 s	500 s	700 s	55 s	360 s
Fire Scenario T-2	340 s	340 s	375 s	1100 s	35 s	760 s
Fire Scenario T-3	225 s	225 s	225 s	680 s	0 s	455 s

As seen in the above table, the ASET for the proposed design in Fire Scenario T-1 was substantially greater than the RSET at both 6.6 m and 2.1 m. However, for Fire Scenario T-2 the results at 6.6 m become marginally better. This is primarily attributed to the pre-movement time that was based on staff evacuation utilising a factor of safety of 2.

Furthermore, it is highlighted that staff members have radios that are interlinked to notify others of potential hazards and dangers. Therefore, this is expected to reduce the detection time as a staff member would be able to notify others of potential fire scenario rather than relying on the sprinkler system in the building. However, the quantification of such data is much more susceptible to errors as this relies on human factors to be taken into consideration along with personal hazard perception.

Therefore, in summary despite having a volume greater than the BCA DtS provisions Class 8 buildings of Type A Construction, occupants can safely evacuate the building prior to the onset of untenable conditions.

10.1.4 Fire Brigade Intervention

The Fire Brigade Intervention Model (FBIM) (Australasian Fire and Emergency Service Authorities Counci 2004) was used to predict the intervention time. The results from the FBIM show that the Dunheved Fire Crew are expected to arrive at 1094 s (~18.3 min) and apply water within 1605 s (~27 min).

With reference to

Table 10-6 above, the temperature in the compartment at 2.1 m above the floor was much lower than 100°C and visibility was greater than 10 m. Therefore, the increased volume of the compartment is expected to have minimal impact on intervention activities.

10.2 Performance Requirements

The proposed Performance Solution for Oversized Compartment was assessed against BCA Performance Requirement CP2, as shown by the table below.

Table 10-8 – BCA Performance Requirement CP2

Parameter for Consideration	Discussion	Parameter Addressed
CP2 (a) A building must have elements which will, to the degree necessary, avoid the spread of fire (I) to exits (ii) to SOU and public corridors (iii) between buildings (iv) in a building.		
CP2 (b) Avoidance of the spread of fire referred to in (a) must be appropriate to-		

Parameter for Consideration	Discussion	Parameter Addressed
(i) the function or use of the building; and	The function or use of the building as a Class 8 building was considered in relation to the proposed Alternative Solution and considered equivalent to a similar BCA DtS compliant building.	Yes
(ii) the fire load; and	The fuel load in the building was considered in relation to the proposed Performance Solution and considered equivalent to a similar BCA DtS compliant building.	Yes
(iii) the potential fire intensity; and	The potential fire intensity in the building was considered in relation to the proposed Performance Solution and considered equivalent to a similar BCA DtS compliant building.	Yes
(iv) the fire hazard; and	The potential fire hazard in the building was considered in relation to the proposed Performance Solution and considered equivalent to a similar BCA DtS compliant building.	Yes
(v) the number of storeys in the building; and	The number of storeys in the building was considered in relation to the proposed Performance Solution and considered equivalent to a similar BCA DtS compliant building.	Yes
(vi) its proximity to other property; and	The proximity of the subject building to other property was considered in relation to the proposed Performance Solution and considered equivalent to a similar BCA DtS compliant building.	Yes
(vii) any active fire safety systems installed in the building	The provision of a fast response sprinkler system with RTI of 38 was considered.	Yes
(viii) the size of any fire compartment; and	The size of the fire compartment was addressed in this Performance Solution.	Yes
(ix) fire brigade intervention; and	Fire Brigade intervention was considered in relation to the proposed Performance Solution and considered equivalent to a similar BCA DtS compliant building.	Yes
(x) other elements they support; and	Not considered	N/A

Parameter for Consideration	Discussion	Parameter Addressed
(xi) The evacuation time.	The evacuation time was considered in relation to the proposed Performance Solution and considered equivalent to a similar BCA DtS compliant building.	Yes

10.3 Schedule of Works Arising from Performance Solution

3) In line with Performance Solution #1, the volume of the main shed is permitted to be 30,545 m^3 in lieu of 30,000 m^3.

4) As part of Performance Solution #1, automatic sprinkler system shall be provided throughout the building in accordance with BCA E1.5 and AS 2118.1-1999.

5) Building Occupant Warning System shall be provided in the facility and shall automatically activate upon operation of the automatic fire sprinkler system.

6) The Building Occupant Warning System (BOWS) shall incorporate a verbal directive (e.g. “Warning” and Evacuate Now”.

7) Two-way radio communication systems to be provided to all staff within the facility.

8) Strobe lights are to be provided in accordance with AS 1670.4-2015 at critical locations on the Ground floor within the main building and the elevated platforms.

9) Manual Call Points (MCP) in accordance with AS 1670.4-2015 are to be provided throughout the building. The MCPs are to initiate the occupant warning system.

10) Floor population in the shed shall be in accordance with the limit set out in Section 10.1.2.

10.4 Conclusion

It is considered the opinion of Austech that the proposed Performance Solution for oversized compartment meets BCA Performance Requirement CP2, subject to the above scope of works being implemented.

11 Performance Solution #2: Travel Distances

The assessment of Performance Solution #2 is outlined below.

Consideration	Criterion
Applicable BCA DtS Provisions	BCA Clause D1.4 states that no point on a floor must be more than 20 m from an exit or point in which travel in different directions is possible in which case the maximum distance to one of those exits must not exceed 40 m.
Variation to the BCA DtS Provision	An extended travel distance of 28 m to an exit in the Northern façade is proposed.
Acceptance Criteria	With reference to BCA Performance Requirements DP4 and EP2.2, the acceptance criterion is a comparison between the required egress time for occupants to evacuate the building and available egress time for the smoke layer to descend to head height.
Methods of Analysis	Qualitative Analysis based on A0.3(b)(i) and A0.5(b)(ii) 'Other verification method'.
Relevant IFEG sub Systems	The relevant sub system from the International Fire Engineering Guidelines is considered to be: • Sub-system A: Fire Initiation and Development and Control • Sub-system C: Fire Spread and Impact and Control • Sub-system F: Fire Services Intervention

11.1 Assessment

BCA Clause D1.4 in the BCA states that:

"Class 5, 6, 7, 8 or 9 buildings -

(i) no point on a floor must be more than 20 m from an exit, or a point from which travel in different directions to 2 exits is available, in which case the maximum distance to one of those exits must not exceed 40 m"

The Guide to the BCA states that the intent of D1.4 is;

"To maximise the safety of occupants by enabling them to be close enough to an exit to safely evacuate."

As stipulated by BCA clause D1.4, the maximum travel distances allowed by DtS provisions are based occupants reaching a "safe" place, such as an exit stairway or a final exit doorway that discharges into open space. The BCA attempts to limit the exposure of occupants to a fire by controlling the maximum travel distances to an exit.

The potential for occupants within the floor of fire origin being exposed to a fire is based on three primary factors:

- The risk of occupants being trapped by the seat of the fire along the single exit path or before reaching a point of choice. The BCA specifies a maximum of 20 m for such egress condition.
- There is a risk of occupants being trapped from the point of choice to the nearest exit. The BCA specifies multiple exits to allow occupants an alternative in the case that one exit is not accessible for egress.

- In the event that one exit is blocked, there is a risk of occupants being exposed to the combustion of fire whilst travelling to the alternative exit

With reference to Figure 11-1, an extended travel distance of 28 m to an exit is proposed from one of the platforms providing access to the sorting machine in the center.

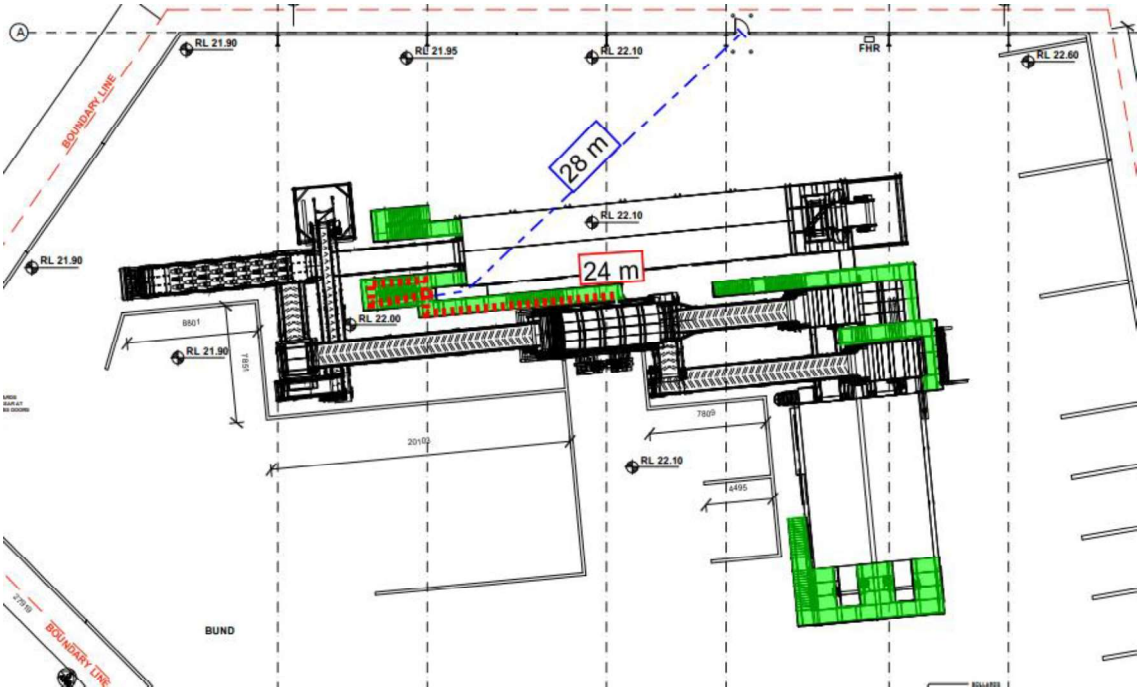


Figure 11-1 – Extended travel distance from the raised platforms to the exit

11.1.1 Evacuation Assessment

In line with the analysis undertaken as part of Performance Solution #1, the RSET was determined to be 340 s.

With reference to Annexure B and Section 10.1.3, the ASET was calculated and summarised in Table 11-1 below.

Table 11-1 – ASET at 2.1 m above floor level

Fire Scenario	Temperature < 100°C at 2.1 m	Visibility > 10 m at 2.1 m	ASET
Fire Scenario T-1	Temperature mostly below 45°C	Yes	700 s
Fire Scenario T-2	Temperature mostly below 40°C	Yes	1,100 s
Fire Scenario T-3	Temperature mostly below 40°C	Yes	680 s

With reference to Table 11-4, the results of the ASET / RSET comparison are summarised.

Table 11-2 – ASET / RSET comparison

Fire Scenario	RSET (s)	ASET (s)	Safety Margin (s)
	At 2.1 m	At 2.1 m	At 2.1 m
Fire Scenario T-1	340 s	700 s	360 s
Fire Scenario T-2	340 s	1100 s	760 s
Fire Scenario T-3	225 s	680 s	455 s

Therefore, despite occupants having to travel an extended distance of 28 m to the exit the compartment conditions remain tenable during the period of evacuation.

11.1.2 Fire Brigade Intervention

The Fire Brigade Intervention Model (FBIM) (Australasian Fire and Emergency Service Authorities Counci 2004) was used to predict the intervention time. The results from the FBIM show that the Dunheved Fire Crew are expected to arrive at 1094 s (~18.3 min) and apply water within 1605 s (~27 min).

With reference to

Table 10-6 above, the temperature in the compartment at 2.1 m above the floor was much lower than 100°C and visibility was greater than 10 m. Therefore, the increased volume of the compartment is expected to have minimal impact on intervention activities.

11.2 Performance Requirements

The proposed Alternative Solution for extended travel distances were assessed against BCA Performance Requirements DP4 and EP2.2, as shown by the tables below.

Table 11-3 – BCA Performance Requirement DP4

Parameter for Consideration	Discussion	Parameter Addressed
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	The travel distances to the exit were considered in relation to the proposed Performance Solution as discussed above.	Yes
(b) the number, mobility and other characteristics of occupants; and	The number, mobility and other characteristics of occupants were considered in relation to the proposed Performance Solution and found to be equivalent to a similar BCA DtS building.	Yes, discussed as part of Performance Solution #1
(c) the function or use of the building; and	The function or use of the building consisting of Class 5 and Class 8 was considered in relation to the proposed	Yes

Parameter for Consideration	Discussion	Parameter Addressed
	Performance Solution and considered equivalent to a similar BCA DtS building.	
(d) the height of the building; and	The effective building height is less than 25 m and was considered in relation to the proposed Performance Solution.	Yes
(e) whether the exit is from above or below ground level.	The location of exits which are above ground were considered in relation to the proposed Performance Solution.	Yes

Table 11-4 – BCA Performance Requirement EP2.2

Parameter for Consideration	Discussion	Parameter Addressed
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	The temperature was considered as detailed in Annexure B.	Yes
(ii) the level of visibility will enable the evacuation route to be determined; and	The level of visibility was considered as detailed in Annexure B.	Yes
(iii) the level of toxicity will not endanger human life.	The toxicity was not directly determined but is considered to be equivalent to a similar BCA DtS compliant solution.	Yes
(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	The number, mobility and other characteristics of occupants was considered in relation to the proposed Performance Solution and considered equivalent to DtS building.	Yes, discussed as part of Performance Solution #1
(ii) the function or use of the building; and	The function or use of the building consisting of Class 5 and Class 8 was considered in relation to the proposed Performance Solution and considered equivalent to a similar BCA DtS building.	Yes

Parameter for Consideration	Discussion	Parameter Addressed
(iii) the travel distance and other characteristics of the building; and	The travel distance and other characteristics of the building was considered in relation to the proposed Performance Solution.	Yes
(iv) the fire load; and	The fire load associated was considered in relation to the proposed Performance Solution.	Yes
(v) the potential fire intensity; and	The potential fire intensity was considered in relation to the proposed Performance Solution.	Yes
(vi) the fire hazard; and	The fire hazard associated was considered in relation to the proposed Performance Solution.	Yes
(vii) any active fire safety systems installed in the building; and	An automatic fast response sprinkler system shall be provided throughout the building.	Yes
(viii) fire brigade intervention.	Fire brigade intervention was considered in relation to the proposed Performance Solution.	Yes

11.3 Schedule of Works Arising from Performance Solution

1) In line with Performance Solution #2, an extended travel distance of up to 28 m to an exit is permitted.

2) As part of Performance Solution #2, automatic sprinkler system shall be provided throughout the building in accordance with BCA E1.5 and AS 2118.1-1999.

3) Building Occupant Warning System shall be provided in the facility and shall automatically activate upon operation of the automatic fire sprinkler system.

4) The Building Occupant Warning System (BOWS) shall incorporate a verbal directive (e.g. “Warning” and Evacuate Now”.

5) Manual Call Points (MCP) in accordance with AS 1670.1-2004 are to be provided throughout the building. The MCPs are to initiate the occupant warning system.

6) Floor population in the shed shall be in accordance with the limit set of in Section 10.1.2.

7) A dedicated 1 m wide egress pathway shall be provided from the sorting machine in the centre to the respective exits. To assist in way-finding during evacuation, the egress paths are to be indicated by permanent floor markings in colour contrasting with the background.

11.4 Conclusion

It is considered the opinion of Austech that the proposed Performance Solution for travel distance meets BCA Performance Requirements DP4 and EP2.2, subject to the above scope of works being implemented.

12 Performance Solution #3: External Fire Hydrants

The assessment of Performance Solution #3 is outlined below.

Consideration	Criterion
Applicable BCA DtS Provisions	BCA Clause E1.3 states that if a fire hydrant is in a position less than 10 m from the building façade, it requires radiant heat shields extending 3 m above the outlets and 2 m either side of the hydrant.
Variation to the BCA DtS Provision	It is proposed to permit fire hydrants to be located within the external wall of the building without radiant heat shields as per AS 2419.
Acceptance Criteria	With reference to BCA Performance Requirement EP1.3, the acceptance criterion is a booster assembly that provides adequate radiant heat exposure shielding to allow fire-fighter access and also meets FRNSW operational requirements.
Methods of Analysis	Qualitative Analysis based on A0.3(b)(i) and A0.5(b)(ii) 'Other verification method'.
Relevant IFEG sub Systems	The relevant sub system from the International Fire Engineering Guidelines is considered to be: • Sub-system F: Fire Services Intervention

12.1 Assessment

The Guide to the BCA (Australian Building Codes Board 2016) states that the intent of E1.3 as;

"Fire hydrants are needed to prevent the spread of fire between buildings and fire compartments. They are basically needed for fire brigade use and are not intended for use by occupants. Properly trained people and special equipment are needed for effective firefighting using a fire hydrant system. AS 2419.1 provides the details for determining the number of fire hydrants required and where they should be located."

12.1.1 Fire Brigade Intervention

The importance of the location of the fire brigade booster assembly location is to provide maximum accessibility and protection for fire brigades use. If the booster assembly is located within the external wall of the building, the booster assembly is required to have fire resisting construction to minimise exposure to fire, smoke or radiation. Otherwise, the booster assembly is to be located at least 10 m away to avoid the need for any booster protection.

As outlined in the Fire Brigade Intervention Model (Australasian Fire and Emergency Service Authorities Counci 2004), the critical factors that may affect the operation of a fire fighter include:

1) Air temperature

2) Visibility

3) Humidity

4) Incident thermal radiation

5) Air flow past the fire fighter

6) Time for which they are exposed

The above tenability conditions generally relate to conditions expected inside the building enclosure.

12.1.2 External Fire Hydrants

It is noted that fire fighters are unlikely to be exposed to the same fire hazards in an open space environment. With reference to Figure 12-1, attack hydrants highlighted in red are proposed to be located within the building façade.

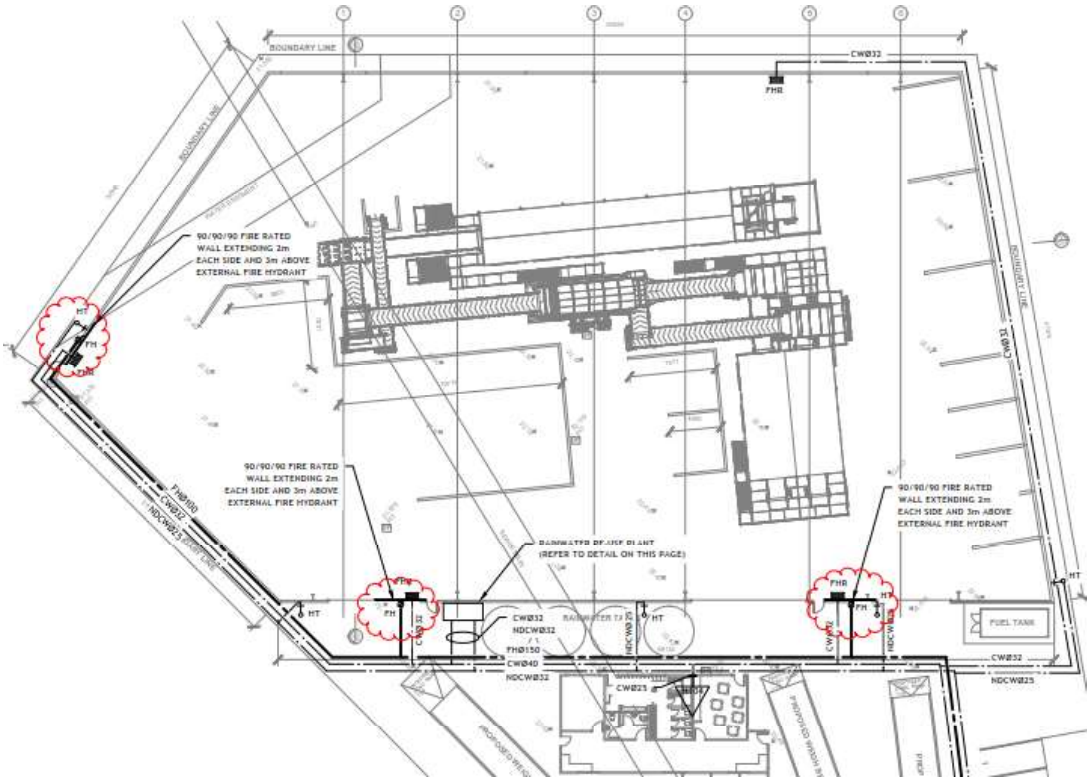


Figure 12-1 – External attack hydrants located within 10 m of the building

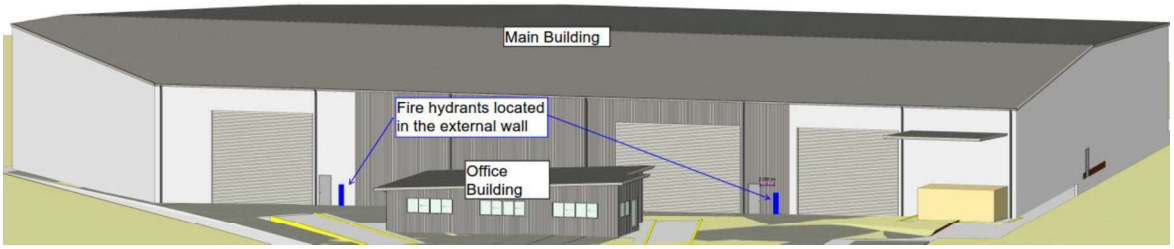


Figure 12-2 – 3D perspective of the building with the external hydrants marked up

A radiant heat assessment of openings located within 10 m of the hydrant was conducted to determine the heat flux emitted at the hydrant booster. Approved Document B – Fire Safety (Her Majestys Government 2010) provides a methodology for calculating an appropriate set back from openings in external walls from unprotected areas. It is further highlighted that the entire building is required to be sprinkler protected in

accordance with BCA E1.5. For a sprinkler controlled fire scenario the compartment temperature is not expected to exceed 100°C (The Charted Institute of Building Services Engineers 1995).

In line with FRNSW guidelines the radiant heat flux threshold value for prolonged exposure was established as 3 kW/m^2. The receiver is taken as being fire brigade personnel standing in close proximity to the booster during intervention operations.

Table 12-1 – Radiation emitted from openings perpendicular to external hydrants

Description of Opening			Distance to Fire Hydrant (m)	Height of Emitter (m)	Width of Emitter (m)	Distance to Receiver (m)	Radiation received at Receiver (kW/m^2)
Façade	Level	Window No.					
North	Ground	Roller Shutter #1	2.65	5.894	6.5	1	0.09
North	Ground	Roller Shutter #3	2.4	6.659	8.1	1	0.11

With reference to Table 12-1, the radiant heat flux emitted from openings on the Ground floor is less than the threshold value of 3 kW/m^2. Hence, external hydrants are permitted to be located within the building façade approximately 2.4 m away from openings on the Ground floor.

12.2 Performance Requirements

The proposed Performance Solution for External hydrants were assessed against BCA Performance Requirement EP1.3, as shown by the table below.

Table 12-2 – BCA Performance Requirement EP1.3

Parameter for Consideration	Discussion	Parameter Addressed
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	Fire-fighting operations were considered in relation to the proposed Performance Solution and found to be equivalent to a BCA DtS compliant building.	Yes
(b) the floor area of the building; and	The floor area of the building was considered in relation to the proposed Performance Solution and found to be equivalent to a similar BCA DtS compliant building.	Yes
(c) the fire hazard.	The potential fire hazard in the building was considered in relation to the proposed Performance Solution and found to be equivalent to a similar BCA DtS compliant building.	Yes

12.3 Schedule of Works Arising from Performance Solution

1) In line with Performance Solution #3, the external hydrants are permitted to be located within 2.4 m of openings in the building façade without protection.

2) The location of hydrant booster assembly and external hydrants shall be shown on the block plan at the booster and the Fire Indicator Panel (FIP). All fire hydrant valves shall be fitted with Storz aluminium alloy delivery couplings manufactured and installed in accordance with Clauses 7.1 and 8.5.11.1 of AS 2419.1-2005. All hydrant valves shall have a forging symbol and manufacturers mark, and shall comply with Fire & Rescue NSW Guide Sheet No. 4.

12.4 Conclusion

It is considered the opinion of Austech that the proposed Performance Solution for external hydrants meets BCA Performance Requirement EP1.3, subject to the above scope of works being implemented.

13 Performance Solution #4: Exit Signage

The assessment of Performance Solution #4 is outlined below.

Consideration	Criterion
Applicable BCA DtS Provisions	BCA Clause E4.8 states that exit signs must be compliant with AS 2293 and must be visible at all times. It goes on to state that the exit sign must be mounted at a maximum height of 2.7 m above the floor.
Variation to the BCA DtS Provision	Due to the overall height of the building, exit signs are proposed to be located at a height greater than 2.7 m.
Acceptance Criteria	With reference to BCA Performance Requirement EP4.2, the acceptance criteria is a design in which the exit sign remains visible for the duration of occupant evacuation.
Methods of Analysis	Qualitative Analysis based on A0.3(b)(i) and A0.5(b)(ii) 'Other verification method'.
Relevant IFEG sub Systems	The relevant sub system from the International Fire Engineering Guidelines is considered to be: • Sub-system A: Fire Initiation and Development and Control • Sub-system B: Smoke Development and Spread and Control • Sub-system C: Fire Spread and Impact and Control • Sub-system D: Fire Detection, Warning and Suppression • Sub-system E: Occupant Evacuation and Control

13.1 Assessment

The intent of BCA Clause E4.8 is:

"To specify how exit signs must be designed and operate, to minimise the risk of death or injury to occupants during an emergency because of an inability to find an exit."

Due to the overall height of the building "jumbo" exit signs are proposed to be provided around the perimeter of the building at a height greater than 2.7 m allowing a greater viewing distance of up to 32 m. With reference to Figure 13-1, exit signs are located at points either hanging from the ceiling or on the perimeter walls. Due in part to the size of the building certain signs may become difficult to see.

Figure 13-1 – Typical exit sign hanging from the ceiling to direct occupants to the exit (picture from Bingo Auburn facility)

13.1.1 Smoke Layer Height

In line with the analysis undertaken as part of Performance Solution #1, the visibility was determined from the CFD model as reported in Annexure B and Section 10.1.3.

With reference to Table 13-1, the ASET values for visibility at both 2.1 m and 6.6 m above floor level are summarised and tabulated.

Table 13-1 – ASET for visibility

Fire Scenario	Visibility > 10 m at 2.1 m	ASET @ 2.1 m	Visibility > 10 m at 6.6 m	ASET @ 6.6 m
Fire Scenario T-1	Yes	700 s	Yes, until 500 s	500 s
Fire Scenario T-2	Yes	1,100 s	Yes, until 300 s However, visibility drops to 5 m at 375 s	375 s
Fire Scenario T-3	Yes	680 s	Yes, until 225 s	225 s

With reference to Table 13-2, the results of the ASET and RSET analysis are summarised.

Table 13-2 – ASET / RSET comparison

Fire Scenario	RSET (s)		ASET (s)		Safety Margin (s)	
	At 6.6 m	At 2.1 m	At 6.6 m	At 2.1 m	At 6.6 m	At 2.1 m
Fire Scenario T-1	340 s	340 s	500 s	700 s	55 s	360 s
Fire Scenario T-2	340 s	340 s	375 s	1100 s	35 s	760 s
Fire Scenario T-3	225 s	225 s	225 s	680 s	0 s	455 s

Based on the analysis, the visibility within the compartment drops below 10 m after occupants have egressed from the elevated platforms to the ground level. Upon which conditions remain tenable and visibility is much greater than 10 m.

To further aid in occupant wayfinding on the elevated platforms, the elevated walkways will be provided with both of the following measures to aid in way-finding:

- Measures A: Self-illuminating photo-luminescent floor markings are to be provided on the elevated walkways to direct occupants to the exits. The photo-luminescent floor markings shall comply with ICBO – AC 169, Acceptance Criteria for Photo-Luminescent Egress System Illumination, Sept 2000.
- Measures B: Low level emergency lighting on the elevated walkways to direct occupants to the exits.

The use of jumbo exit signs is therefore permitted in the building to assist in occupant wayfinding. Further to this, the signs will not be mounted higher than 3.5 m of the floor level.

13.2 Performance Requirement

The proposed Performance Solution for exit signage was assessed against BCA Performance Requirement EP1.3, as shown by the table below.

Table 13-3 – BCA Performance Requirement EP4.2

Parameter for Consideration	Discussion	Parameter Addressed
EP4.2 – To facilitate evacuation, suitable signs or other means of identification must, to the degree necessary —		
(a) be provided to identify the location of exits; and	The provision of exit signs to identify the location of exits has been considered in relation to the proposed Performance Solution	Yes
(b) guide occupants to exits; and	The provision of suitable exit signs to guide occupants in the building has been considered in relation to the proposed Performance Solution	Yes
(c) be clearly visible to occupants; and	The visibility exit signs to guide occupants in the building has been considered in relation to the proposed Performance Solution	Yes

Parameter for Consideration	Discussion	Parameter Addressed
(d) operate in the event of a power failure of the main lighting system for sufficient time for occupants to safely evacuate.	The provision of back power supply for the exit signs in the building has been considered in relation to the proposed Performance Solution	Yes

13.3 Schedule of Works Arising from Performance Solution

1) In line with Performance Solution #4, exit signs are permitted to be mounted at a height 3.5 m above the floor level.

2) "Jumbo" exit signs shall be used throughout the building. Exit signs shall be provided on both the elevated platform levels and ground levels to assist in occupant way-finding.

3) To further aid in occupant wayfinding on the elevated platforms shall be provided with both of the following measures to aid in way-finding:

- Measures A: Self-illuminating photo-luminescent floor markings are to be provided on the elevated platforms to direct occupants to the exits. The photo-luminescent floor markings shall comply with ICBO – AC 169 and BCA Specification E4.8.
- Measures B: Low level emergency lighting on the elevated platforms to direct occupants to the exits.
- Details of mounting both photo-luminescent markings and low level emergency lighting on the elevated platforms is subject to input by the Electrical Engineer and plant operator.

13.4 Conclusion

It is considered the opinion of Austech that the proposed Performance Solution for exit signage meets BCA Performance Requirement EP4.2, subject to the above scope of works being implemented.

14 Report Basis Information

14.1 Reference Legislation

This assessment is based on the following reference legislation:

1) NSW Environmental Planning and Assessment Act, 1979.

2) NSW Environmental Planning and Assessment Regulation, 2000.

3) National Construction Code Building Code of Australia 2016, Australian Building Codes Board, 2015.

14.2 Reference Codes & Guidelines

This assessment is based on the following reference codes and guidelines:

1) International Fire Engineering Guidelines, Australian Building Code Board, 2005.

2) Guide to the BCA, Australian Building Codes Board, 2016.

3) Engineers Australia, Society of Fire Safety, Role of Registered Practitioners in Fire Safety Engineering, 2011.

14.3 Documents Considered

This assessment is based on the following documentation:

1) Fire Engineering Brief Questionnaire (FEBQ) – refers to the Fire Engineering Brief Questionnaire (ref: FEBQ-Bingo St Marys dated 24/08/2016)

2) BCA Report by Steve Watson and Partners dated 28/01/2016 (ref: 16/010 BCA Assessment Report).

3) Architectural Drawings by Dewcape as listed in Table 14-1.

Table 14-1 – Architectural drawings

Drawing No.	Title	Date/Issue
A001	Site Plan	24/08/2016 Rev 04
A100	Ground Floor Plan	09/08/2016 Rev 2
A200	Sections	09/08/2016 Rev 2
A201	Sections 3	09/08/2016 Rev 1

15 Conclusion

In line with the analysis conducted in Section 10, Section 11, Section 12 and Section 13, the proposed Performance Solutions meets the BCA Performance Requirements CP2, DP4, EP1.3, EP2.2 and EP4.2 subject to the implementation of the schedule of works arising as detailed in Section 1.1.

16 References

Alpert, R. L. “Calculation of response time of ceiling mounted fire detectors.” *Fire Technology*, 1972: 181-195.

Australasian Fire and Emergency Service Authorities Counci. *Fire Brigade Intervention Model Version 2.2.* 2004.

Australian Building Codes Board. “Building Access Outcomes Report.” 1998.

—. *Guide to the BCA 2016.* Australia, 2016.

—. *International Fire Engineering Guidelines.* Canberra, 2005.

England, J.P, S.A Young, M.C Hui, and N Kurban. *Guide for the Design of Fire Resistant Barriers and Structures.* Melbourne: Building Control Commission, 2000.

European Commission. “Development of design rules for steel structures sunjecuted to natural fires in large compartments.” Luxembourg, 1999.

Fire Code Reform Centre. “Fire Engineering Guidelines.” Sydney, March 1996.

Her Majestys Government. “Approved Document B (fire safety): Volume 2 - Buildings Other than Dwellinghouses.” *The Building Regulations 2010.* England, 2010.

Law, Margret. “Heat radiation from fires and building separation.” *Fire Research Technical Paper No. 5*, 1963.

Lennon, T. “Compartment Sizes - are they still fit for purpose?” *BRE Fire Conference.* 2015.

Marryatt, H.W. “Fire - A Century of Automatic Fire Protection in Australia and New Zealand 1886 - 1996.” *FPAA*, 1998.

National Fire Protection Association. “NFPA 502.” *Standards for road tunnels, bridges and other limited access highways.* Quincy, Massachusetts, 2004.

Nelson, Harold.E, and Frederick W. Mowrer. “Emergency Movement.” In *SFPE Handbook of Fire Protection Engineering*. 2002.

NFPA 204. “Standard for Smoke and Heat Venting.” Quincy, MA, 2002.

NFPA 92B. “Guide for Smoke Management Systems in Malls, Atria and Large Areas.” Quincy, 2009.

NSWFB. “Annual Statistical Report 2006/07.” New South Wales Fire Brigade, 2007.

Permenant International Association of Road Congress. “Fire and smoke control in road tunnels.” 1999.

Poh, Weng. “Tenability Criteria for Design of Smoke Hazard Mangement Systems.” *Ecolibrium*, 2011: 32-37.

Proulx, Guylene. “Movement of People: The Evacuation Timing.” In *SFPE Handbook of Fire Protection Engineering*, 876-900. Massachusetts: National Fire Protection Association, 2002.

Proulx, Guylène, and Rita. F Fahy. “The Time Delay to Start Evacuation: Review of Five Case Studies.” *Fire Safety Science - Proceedings from the Fifth International Symposium.* 1997. 783-794.

Rahikainen, J. and Keski-Rahkonen, O. “Determinition of Ignition Frequency of Fires in Diffferent Premises in Finland.” *Fire Engineers Journal*, 1998.

Rasbash, D, G Ramachandran, B Kandola, and J & Law, M Watts. *Evaluation of Fire Safety.* John Wiley & Sons, 2004.

Reid, E. “Understanding Buildings: A Multidisiplinary Approach.” England: Construction Press, 1984.

Samochine, Dimitry A., Karen Boyce, and Jim Shields. “An Investigation into Staff Behaviour in Unannounced Evacuations of Retail Stores – Implications for Training and Fire Safety Engineering.” *Fire Safety Science Proceedings of the Eighth International Symposium.* International Association for Fire Safety Science, 2005. 519 - 530.

Sardqvist, S. “Initial Fires, RHR, Smoke production and CO Generation from Single items and Room Fire Tests.” 1993.

Society of Fire Safety. “Practice note for tenability in buildings.” Engineers Australia, 2014.

The Charted Institute of Building Services Engineers. “TM19.” *Relationships for Smoke Control Calculations.* London, 1995.

The Highways Agency. “BD 78/99.” *Design manual for roads and bridges.* 1999.

Thomas, I.R., I.D. Bennetts, P.H. Dayawansa, D.J Proe, and R.R. Lewins. *Fire Tests of the 140 William Street Office Building.* BHP Melbourne Research Laboratories, 1992.

17 Assumptions & Limitations

The reader's attention is drawn to the following limitations with respect to the fire engineering assessment undertaken in this report:

1) The report is limited to the assessment of BCA DtS variations identified in Section 1.2 of this report for compliance with relevant BCA Performance Requirements. With the exception of these Alternative Solutions, all other fire safety aspects of the building are to comply with the BCA DtS Provisions.
2) This assessment deals with the fire safety provisions of the BCA only and does not consider amenity or non-fire related matters in the building such as health, amenity, security, energy efficiency, occupational health & safety, compliance with Disability Discrimination Act (DDA) etc., which are to be addressed by others. Consequently, the outcomes of this assessment have not been checked or verified for their fitness for purpose of any non-fire safety related matters including the ones outlined above.
3) This assessment is not a full compliance or conformance audit for any fire safety system. Therefore, operational checks of fire safety equipment, verification of construction techniques, fire resistance levels or the witnessing of fire drills or exercises are specifically excluded from the scope of this assessment. The operational status of systems, items of equipment and staff training should be addressed as part of the inspection, commissioning, enforcement, maintenance, testing, training and management procedures for the building.
4) This assessment will be consistent with the objectives and limitations of the BCA and therefore specifically excludes arson (other than as a source of initial ignition), multiple ignition sources, acts of terrorism, protection of property (other than adjoining property), business interruption or losses, personal or moral obligations of the owner/occupier, reputation, environmental impacts, broader community issues etc.
5) Arson has been shown statistically to contribute to fire. This report has addressed the incidence of minor forms of arson as a single ignition source. However major arson involving accelerants and/or multiple ignition sources are beyond the scope of this assessment and have been excluded.
6) Egress and fire safety provisions for persons with disabilities have only been considered to the same degree as the BCA DtS Provisions.
7) The design concepts outlined in this report are for a complete and operational building and do not address protection of the building during construction, renovation or demolition.
8) Any change in building, occupant or fuel conditions from those considered in this report, or any deviation from the implementation of the fire safety strategy outlined in this brief, may result in outcomes not anticipated by the proposed strategy and should be reviewed.
9) Evaluation of the expected level of fire induced property damage with respect to the contents and building structure is specifically excluded.
10) The recommendations in this assessment are based on information provided by others. The fire safety engineer has not verified the accuracy and/or completeness of this information and accepts no responsibility or liability for any errors or omissions which may be incorporated into this assessment as a result.
11) It is considered that the scope of works arising from this report and limitations of this report are read, understood and implemented. The fire safety engineer shall be contacted in relation to any queries on the report content and takes no responsibility for misinterpretation of the report content by others.
12) The recommendations, data and methodology documented in this assessment are based on the documentation in Section 11 and specifically apply to the subject building / project and must not be utilised for any other purpose. Any modifications or changes to the building, fire safety management system, or building usage from that described may invalidate the findings of this assessment necessitating a re-assessment. No warranty is intended or implied for use by any other third party and no responsibility is undertaken to any other third party for material contained herein.

Annexure A: Fire Brigade Intervention Model

With reference to Figure A.1 – Building site with responding fire stations, the building at 25 Dunheved Circuit, St Marys and is marked by the blue icon. The two (2) responding fire stations are shown by the red fire icons. FRNSW have advised that in case of a fire the responding fire stations would be the Dunheved and St Marys Fire Stations.

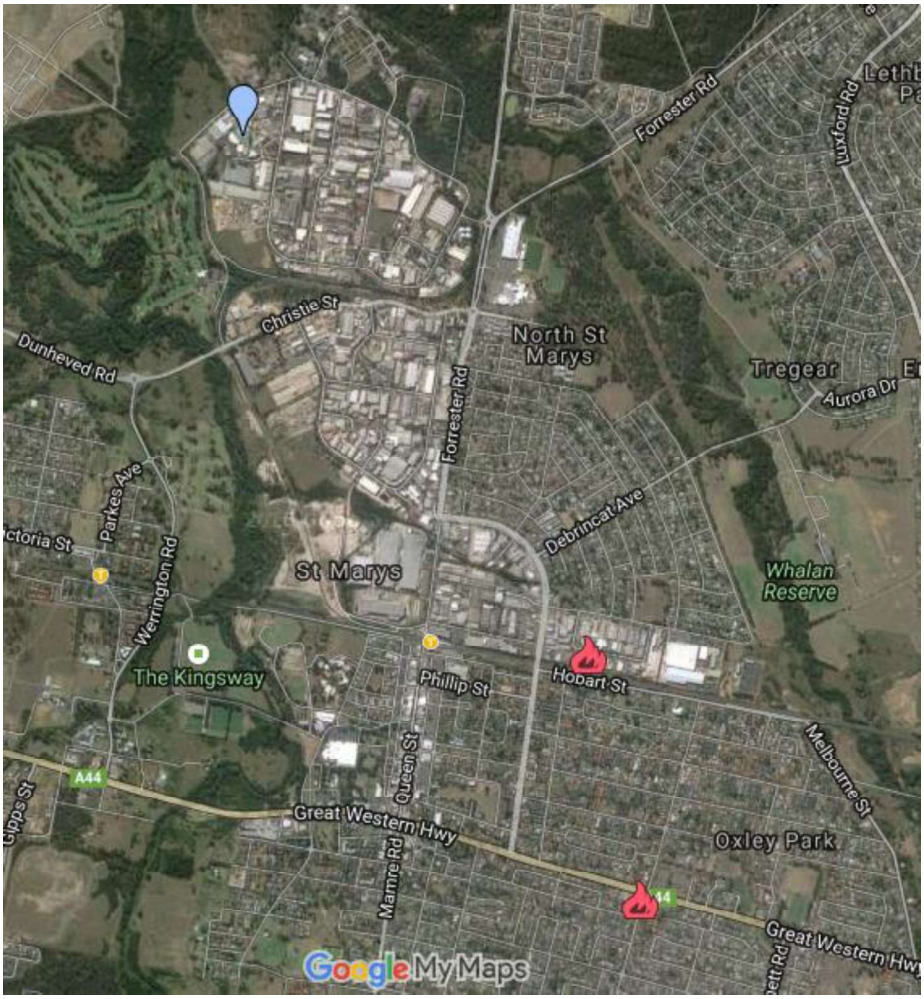


Figure A.1 – Building site with responding fire stations (courtesy of Google Maps)

The Fire Brigade Intervention Model (FBIM) (Australasian Fire and Emergency Service Authorities Counci 2004) was used to predict the intervention time. The results from the FBIM show that the Dunheved Fire Crew are expected to arrive at 1094 s (~18.3 min) and apply water within 1605 s (~27 min) as detailed in Table A.1.

Table A.1 – Summary of FBIM results

Fire Station	Distance to Site	Time to Arrive	Time to Apply Water
Dunheved	5 km	18.3 min	27 min
St Marys	6 km	20.6 min	29.1 min

Table A.2 – FBIM Model for 25 Dunheved Circuit, St Marys

FBIM

Responding Station #1	Dunheved
Responding Station #2	St Marys

	Reference	Time (s)	Time (min)
Detection		210	
Chart 1-Time taken for initial Brigade notification			
(2) Automatic detection	Yes	210	
(5) Suppression system	No		
(6) Depressurise system and activate	Table A		
(7) Alarm verification delay	Table B	20	
(9) Automatic connection to FB	Yes		
(15) Time to transmit information to fire brigade		230	
Chart 2-Time taken to dispatch resources			
(4) Call electric	Yes		
(6) Call taken at central communications	Yes		
(10) Time to relay dispatch information by phone or radio	Table D	0	
(11) Time for fire fighters to respond to call and leave station	Chart 3	90	
(12) Time to respond		90	
Chart 3-Time taken for firefighters to respond to dispatch call			
(2) Station manned full time	Yes		
(4) Fire fighters in the fire station	Yes		
(5) Time to dress, assimilate information and leave station	Table E	90	
(7) Time to respond & depart fire station		90	
Chart 4-Time taken to reach fire scene (kerb side)			
(2) Percentile response time to be used	No		
(4) Turnout from fire station	Yes		
(7) Distance from fire station (Dunheved)	km	5	
(7) Distance from fire station (St Marys)	km	6	
(9) Design Speed	km/hr	26.3	
(11) Travel Time (Dunheved)	s	684	
(11) Travel Time (St Marys)	s	821	
Chart 5-Time taken for initial determination of fire location			
(2) Road travel within site necessary	Yes		
(4) Fire visible on arrival	No		
(5) Premises occupied	No		
(11) Forced entry	No		
(14) Time to don safety equipment	Chart 6	301	
(15) Time to gain entry	Table J	60	
(18) Time resolve way finding	Table K	10	
(17) Time for internal travel to primary target	Chart 9	50	
(19) Time for information gathering	Table L	90	
(20) Time taken to determine fire location		511	

Chart 6-Time taken to don safety equipment and gather necessary tools			
(2) Time to dismount fire appliance and don BA	Table M	158	
(3) Other safety equipment necessary	No		
(5) Time to conduct safety procedures	Table O	74	
(6) Tools necessary for initial access and set up (hoses etc)	Yes		
(7) Time to remove necessary tools from appliance	Table P	69	
(8) Time taken to don safety equipment and gather necessary tools		301	
Chart 7-Time taken to assess fire			
(2) Fire location and extent obvious without recon	Yes		
(10) Time for fire assessment		0	
Chart 8-Time taken to travel to set-up area			
(2) Road travel within site necessary	Yes		
(5) Safety equipment donned	Yes		
(7) Set up area inside the building	No		
(12) Time taken to travel to set-up area		0	
Chart 9-Time taken for firefighter travel			
(2) Doors to be negotiated	No		
(6) Horizontal travel	Yes		
(7) Horizontal travel time	Table Q	50	
(8) Vertical travel	No		
(15) Travel time		50	
Chart 10-Time taken to set up water for initial fire fighter protection			
(2) Fire attack from appliance	No		
(9) Time to set up water requirements	Chart 11	135	
(10) Time taken to set up water for initial fire fighter protection		135	
Chart 11-Time taken to set up water supply requirements			
(2) Appropriate hydrant system flow and pressure	Yes		
(12) Time taken to connect and charge hoses	Table V	135	
(15) Time taken to set up water requirements		135	
Dunheved (Charts 1-4)		1094	18.3 min
St Marys (Charts 1-4)		1231	20.6 min
Dunheved (Time to apply water)		1605	27 min
St Marys (Time to apply water)		1742	29.1 min

Annexure B: CFD Assessment

Introduction

The purposed development comprises a Class 8 factory with ancillary Class 5 office space located at 25 Dunheved Circuit, St Marys. The building will house waste sorting and compacting machinery along with storage areas for the sorted waste.

With reference to Performance Solutions #1, #2 and #4 a quantitative analysis employing CFD Modelling Package Fire Dynamics Simulator (FDS) Version 6.2.0 was undertaken to determine:

- The Available Safe Egress Time (ASET) to maintain tenable conditions (i.e. visibility, temperature and toxicity) within the main building during occupant evacuation.

The CFD Modelling analysis the compartment conditions within the shed and determine if any additional fire safety measures are required to maintain tenability for the course of occupant evacuation.

Fire Dynamics Simulator

Computational Fluid Dynamics (CFD) smoke modelling simulations were undertaken using Fire Dynamics Simulator [1] (FDS Version 6.2.0) which examines the flow of heat and smoke caused by a fire as described in the Design Fire Scenario Section.

The FDS program is a field model, based on the approach of Large Eddy Simulation technique, where low Mach number combustion equations (representing a simplified form of equations describing the transport of mass, momentum and energy by the fire induced flows) are solved numerically in a large number of rectangular cells representing the physical space. This approach is considered suitable to simulate the flow of heat and smoke through a large area.

The modelling parameters were defined in the form of a text file using a software called Pyrosim, which is used as the 'input' to the FDS program. The results generated from FDS program are illustrated by colour graphics showing levels of contamination and temperature by Smokeview[2], a module of the computer program where 3-dimensional graphical representations of the results are developed.

Modelling Objectives

The objective of the smoke modelling is to:

1) Model smoke movement within the shed facility area; and

2) Determine Available Safe Egress Time (ASET s) to maintain tenable conditions (i.e. visibility, temperature and toxicity).

1 McGrattan KB, Forney GP, Floyd JE, Hostikka S and Prasad K, Fire Dynamics Simulator Version 3, NISTIR 6784, 2007 Ed, NIST BFRL, US, Nov 2007.
2 Forney GP and McGrattan KB, Smokeview Version 3.1, NISTIR 6980, NIST BFRL, US, April 2003.

Results

Table B.1 – Visibility and temperature slices at 6.6 m above ground

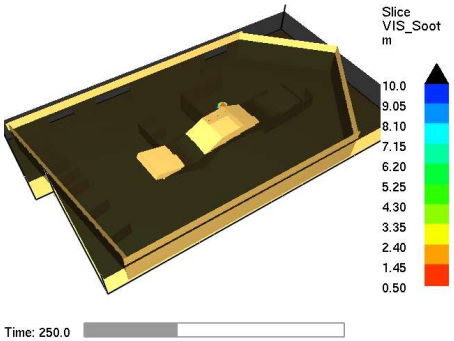
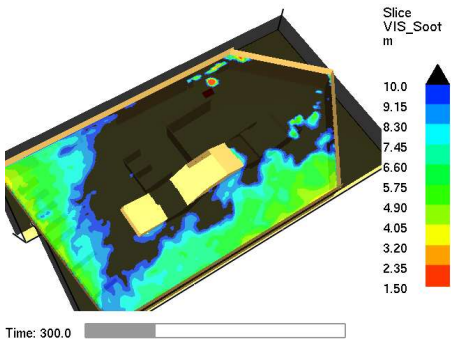
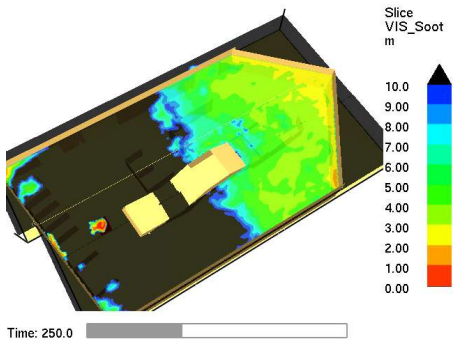
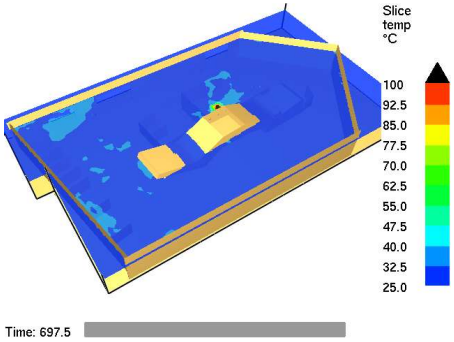
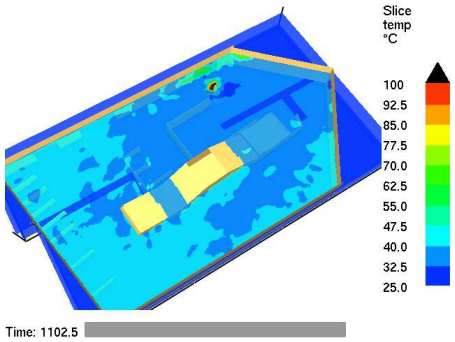
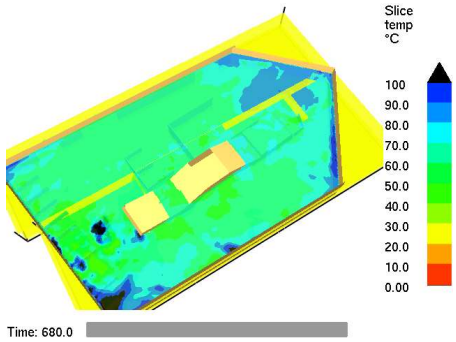
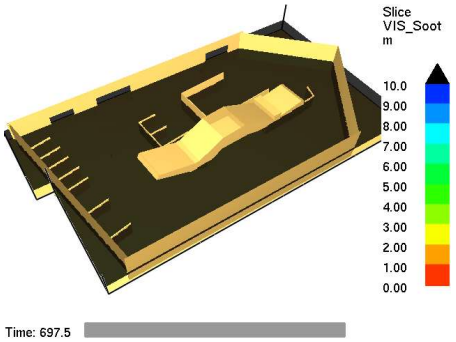
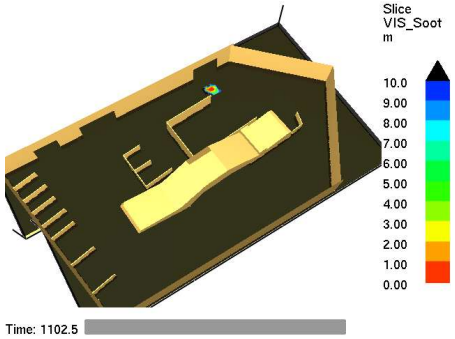
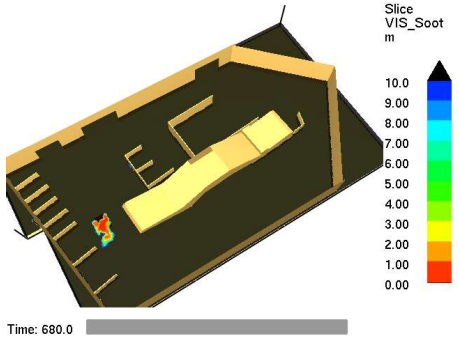
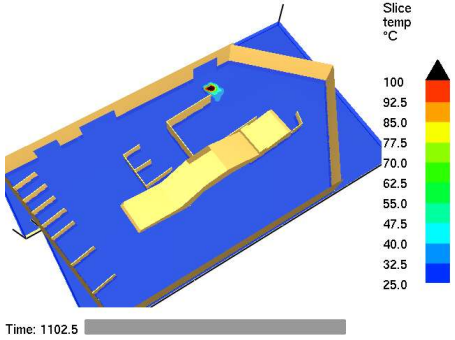
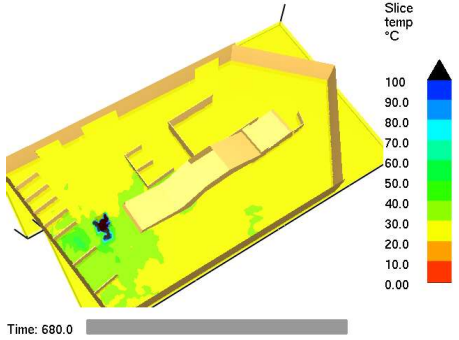
	Fire Scenario 1	Fire Scenario 2	Fire Scenario 3
Visibility at 250 s			
Temperature at end of simulation			

Table B.2 – Visibility and temperature slices at 2.1 m above ground

	Fire Scenario 1	Fire Scenario 2	Fire Scenario 3
Visibility at end of simulation			
Temperature at end of simulation			

AUTOMATIC FIRE SUPPRESSION SYSTEMS - INSTALLATION CERTIFICATE

Project Name	*Bingo Group Waste Management Facility*
Address	*25 Dunheved Circuit St Marys NSW 2760*
Part of Building to be certified	*Whole Building (Office & Warehouse)*

Pursuant to the provisions of **Clause A2.2 of the Building Code of Australia,** I hereby certify that the installation of the services has been undertaken in accordance with normal engineering practice and meets the requirements of the Building Code of Australia, any relevant fire safety engineering report, relevant Australian Standards and relevant conditions of the Development Consent. In particular, the installation is in accordance with the following:

Measure and/or system	**Standards of Performance**
Automatic fire suppression systems *(Sprinklers)*	BCA2016 Specification E1.5 and AS 2118.1 – 1999

I am an appropriately qualified and competent person in this area being listed in the NPER, or other appropriate body and as such can certify that the system and performance of the systems comply with the above and have been detailed within the Engineered set of drawings.

Relevant qualifications and accreditations: DOFT 2525180

The information contained in this statement is true and accurate to the best of my knowledge and I as a professional engineer possess Indemnity Insurance to the satisfaction of the building owner or my principal.

Name: SCOTT THOMPSON

Company: ENGIE SERVICES

Address: B/255 RAWSON ST, AUBURN 2144

Phone No. 02 9714 4700 *Fax No.* 02 9714 4799

Signature

26-04-2017

Date

BUILDING OCCUPANT WARNING SYSTEM - INSTALLATION CERTIFICATE

Project Name	*Bingo Group Waste Management Facility*
Address	*25 Dunheved Circuit St Marys NSW 2760*
Part of Building to be certified	*Whole Building (Office & Warehouse)*

Pursuant to the provisions of **Clause A2.2 of the Building Code of Australia,** I hereby certify that the installation of the services has been undertaken in accordance with normal engineering practice and meets the requirements of the Building Code of Australia, any relevant fire safety engineering report, relevant Australian Standards and relevant conditions of the Development Consent. In particular, the installation is in accordance with the following:

Measure and/or system	Standards of Performance
Building Occupant Warning System; including – • Enhanced to incorporate a verbal directive, to instruct occupant to evacuate in the event of a fire. The verbal directive shall be in clear and concise English that announces the following in the event of a fire alarm: **'Emergency' and 'Evacuate Now'** BREAK GLASS ALARMS • Provided on the platform levels at intervals of 15m, within the control room and besides all exits of the building located at 30m intervals on the ground floor; and • Strobe lights are to be provided at critical locations on the ground floor within the main building and the elevated platforms.	BCA2016 Clause 5 of Specification E2.2a, AS1670.1-2015, AS1670.4-2015 and Fire Engineering Report 160033 Revision C dated October 2016 from Austech Pty Ltd

I am an appropriately qualified and competent person in this area being listed in the NPER, or other appropriate body and as such can certify that the system and performance of the systems comply with the above and have been detailed within the Engineered set of drawings.

Relevant qualifications and accreditations: DOFT 2525186

The information contained in this statement is true and accurate to the best of my knowledge and I as a professional engineer possess Indemnity Insurance to the satisfaction of the building owner or my principal.

Name: SCOTT THOMPSON

Company: ENGIE SERVICES

Address: B/255 RAWSON ST, AUBURN 2144

Phone No. 02 9714 4700 *Fax No.* 02 9714 4799

Signature **Date** 26.04.2017

PORTABLE FIRE EXTINGUISHERS - INSTALLATION CERTIFICATE

Project Name	*Bingo Group Waste Management Facility*
Address	*25 Dunheved Circuit St Marys NSW 2760*
Part of Building to be certified	*Whole Building (Office & Warehouse)*

I hereby certify that:

a) The works have been inspected during construction and have been completed in accordance with the nominated Standards of Performance.

Measure and/or system	Standards of Performance
Portable fire extinguishers- including: • On-board manual fire supression is to be provided to all maintenance vehicles (garbage trucks, loaders & scissor lifts) that will be utilised within the building → BY OTHERS.	BCA2016 Clause E1.6, AS 2444 – 2001 and Fire Engineering Report 160033 Revision C dated October 2016 from Austech Pty Ltd

b) I am a properly qualified person and have a good working knowledge of the relevant codes and standards referenced above. (My qualifications and accreditations are listed below)

Relevant qualifications and accreditations: DOFT 2525186

c) The information contained in this statement is true and accurate to the best of my knowledge.

Name: SCOTT THOMPSON

Company: ENGIE SERVICES

Address: B/235 ROWSON ST, AUBURN 2144

Phone No. 02 9714 4700 *Fax No.* 02 9714 4799

Signature _____ **Date** 26/04/2017

WALL WETTING SPRINKLER AND DRENCHER SYSTEMS - INSTALLATION CERTIFICATE

Project Name	*Bingo Group Waste Management Facility*
Address	*25 Dunheved Circuit St Marys NSW 2760*
Part of Building to be certified	*Whole Building (Office & Warehouse)*

Pursuant to the provisions of **Clause A2.2 of the Building Code of Australia,** I hereby certify that the installation of the services has been undertaken in accordance with normal engineering practice and meets the requirements of the Building Code of Australia, any relevant fire safety engineering report, relevant Australian Standards and relevant conditions of the Development Consent. In particular, the installation is in accordance with the following:

Measure and/or system	Standards of Performance
Wall wetting sprinkler and drencher systems	BCA2016 Clause C3.4

I am an appropriately qualified and competent person in this area being listed in the NPER, or other appropriate body and as such can certify that the system and performance of the systems comply with the above and have been detailed within the Engineered set of drawings.

Relevant qualifications and accreditations: DOFT 2525182

The information contained in this statement is true and accurate to the best of my knowledge and I as a professional engineer possess Indemnity Insurance to the satisfaction of the building owner or my principal.

Name: SCOTT THOMPSON

Company: ENGIS SERVICES

Address: 8/255 RANSON ST, AUBURN 2144

Phone No. 02 9714 4700 *Fax No.* 02 9714 4799

Signature 

26.04.2017

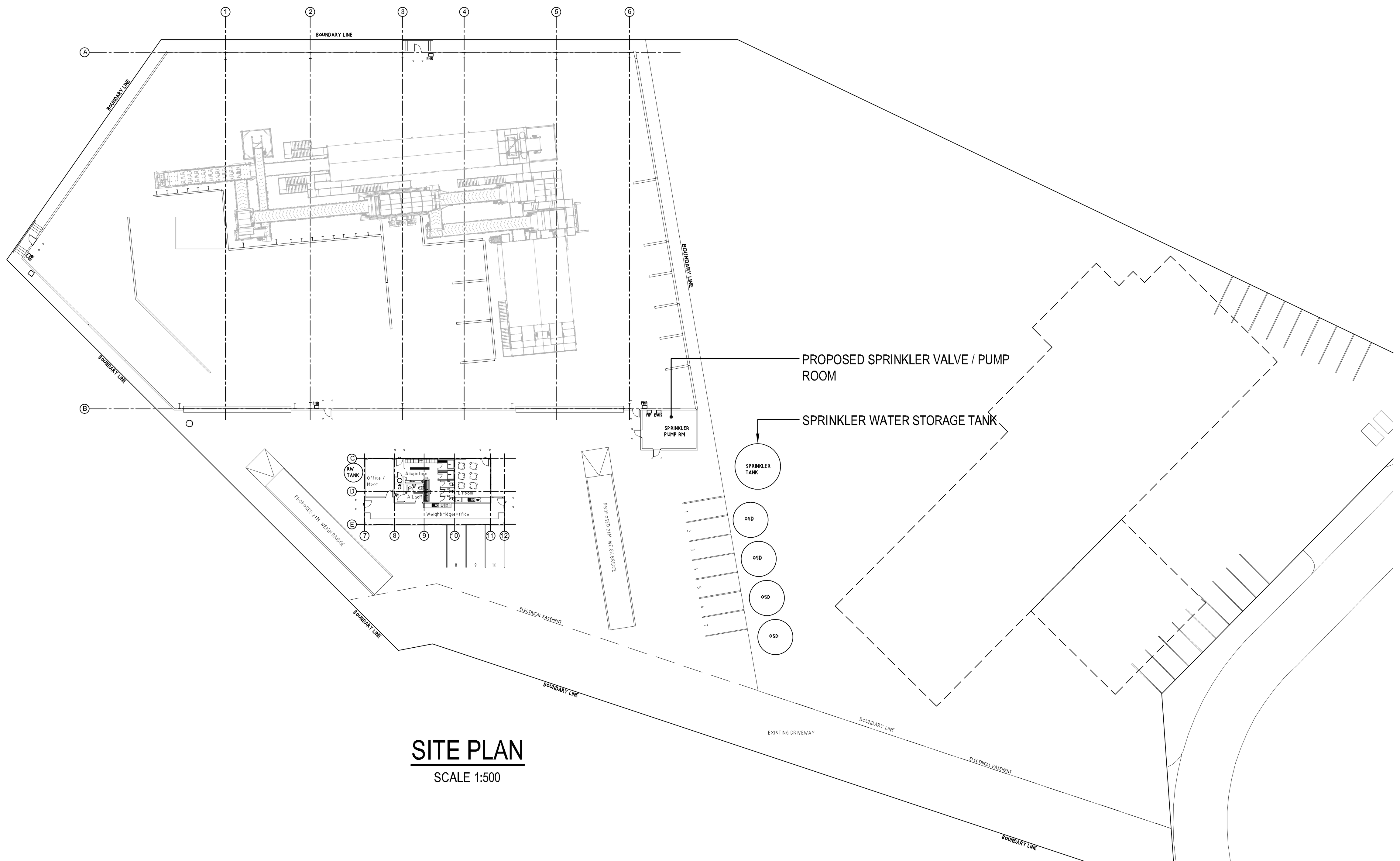
Date

BINGO INDUSTRIES

25 DUNHEVED CIRCUIT ST MARY'S NSW
FIRE SERVICES

FIRE LEGEND

- SPRINKLER PIPE.
- SPRINKLER PIPE UNDER STAIRS & OR DUCT.
- HYDRANT PIPE.
- DRAIN PIPE.
- PIPE RISER.
- PIPE DROP.
- FH FIRE HYDRANT.
- FHR FIRE HOSE REEL.
- BELOW CEILING SPRINKLER HEAD.
- EXPOSED PENDENT SPRINKLER HEAD.
- EXPOSED PENDENT SPRINKLER HEAD WITH GUARD.
- CEILING SPACE PENDENT SPRINKLER HEAD.
- WALL WETTING DRENCHER SPRINKLER
- SIDEWALL SPRINKLER HEAD.
- EC SIDEWALL EXTENDED COVERAGE SPRINKLER HEAD.
- WALL WETTING SPRINKLER.
- SPRINKLER ALARM VALVE (PLAN).
- SPRINKLER ALARM VALVE (SCHEMATIC).
- FS FLOW SWITCH.
- PS PRESSURE SWITCH.
- JACKING PUMP.
- ISOLATING VALVE (NORMALLY OPEN).
- ISOLATING VALVE (NORMALLY CLOSED).
- M ISOLATING VALVE (MONITORED).
- P PRESSURE GAUGE.
- DRAIN VALVE WITH PLUG.
- CAPPED END TO PIPE.
- PRESSURE REDUCING VALVE
- NON RETURN VALVE
- MAGNETIC DOOR HOLDER.
- SMOKE DETECTOR WITH DUCT SAMPLING UNIT.
- HEAT DETECTOR.
- H HEAT DETECTOR WITH HIGH TEMPERATURE RATING
- REMOTE INDICATOR.
- STROBE LIGHT.
- CEILING RECESSED SPEAKER.
- SURFACE MOUNTED SPEAKER.
- HS HORN SPEAKER.
- EMERGENCY CALL POINT (BREAK GLASS ALARM).
- WIP WARDEN INTERCOM PHONE.
- MM MONITORED MODULE (INPUT DEVICE).
- CM CONTROL MODULE (OUTPUT DEVICE).
- MECP MASTER EMERGENCY CONTROL PANEL.
- FIP FIRE INDICATOR PANEL
- MIMIC LCD MIMIC REPEATER
- MSSB MECHANICAL SERVICES SWITCH BOARD (BY OTHERS)
- SECURITY SECURITY SYSTEM PANEL (BY OTHERS)
- FFCP FIRE FAN CONTROL PANEL (BY OTHERS)
- DCP DRY CHEMICAL POWDER EXTINGUISHER
- CO2 CARBON DIOXIDE (CO_2) PORTABLE EXTINGUISHER
- AAM ALARM ACKNOWLEDGEMENT MODULE
- DUAL HEADED SUCTION CONNECTION
- DUAL HEADED BOOSTER CONNECTION
- FB FIRE BLANKET



SITE PLAN
SCALE 1:500

DRAWING SCHEDULE

No.	DRAWING TITLE	SCALE
F01	LEGEND, GENERAL NOTES AND DRAWING SCHEDULE	N.T.S
F02	FIRE SERVICES GROUND FLOOR PLAN - PART 1	1:100
F03	FIRE SERVICES GROUND FLOOR PLAN - PART 2	1:100
F04	FIRE SERVICES OFFICE BUILDING GROUND FLOOR	1:100

FIRE PROTECTION SERVICES STANDARD NOTES

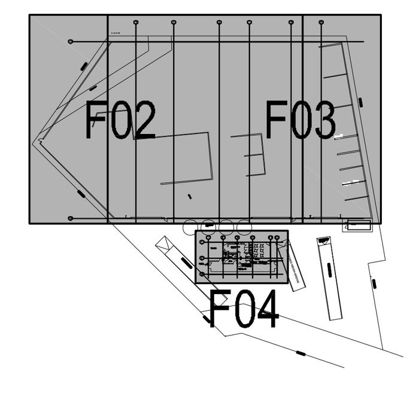
1. SCOPE OF WORKS:
   - INSPECT THE SITE, PRIOR TO TENDERING, TO QUANTIFY THE EXTENT OF EQUIPMENT REMOVAL.
   - CO-ORDINATE THE WORKS WITH ALL SERVICES AND TRADES
   - CO-ORDINATE WORKS WITH THE BUILDER'S CONSTRUCTION PROGRAM.
   - PROVIDE WALL, CEILING AND SLAB PENETRATIONS AND MAKE GOOD.
   - MAINTAIN FIRE AND ACOUSTIC AND FIRE RATING WHEN PENETRATING ANY WALL, CEILING OR SLAB.
   - TESTING AND COMMISSIONING OF THE FIRE PROTECTION SYSTEMS.
   - PROVIDE (3 OFF) OPERATION AND MAINTENANCE MANUAL
   - PROVIDE (3 OFF) SETS OF "AS INSTALLED" DRAWINGS.
   - PROVIDE CERTIFICATION FOR ALL FIRE PROTECTION SERVICES IN THIS SCOPE OF WORKS.
2. THE DRAWINGS PROVIDED ARE DIAGRAMMATIC ONLY SHOWING DESIGN INTENT AND THE - DESIGN, INSTALLATION AND MAINTENANCE OF THE FIRE PROTECTION SYSTEMS SHALL COMPLY WITH THE FOLLOWING CODES, AUTHORITIES AND AUSTRALIAN STANDARDS:
   - BUILDING CODE OF AUSTRALIA
   - FIRE AND RESCUE NSW.
   - AUTHORITIES HAVING JURISDICTION OVER THE WORKS.
   - AUSTRALIAN STANDARD AS 2444-2001 PORTABLE FIRE EXTINGUISHERS AND FIRE BLANKETS
   - AUSTRALIAN STANDARD AS 2118.1 1999 SPRINKLER SYSTEM (HIGH HAZZARD) SYSTEMS DESIGN, INSTALLATION AND COMMISSIONING.
   - AUSTRALIAN STANDARD AS 1851 MAINTANCE
   - AUSTRALIAN STANDARD AS 2220 EWIS
   - AUSTRALIAN STANDARDS AS 3000 WIRING RULES
   - AUSTRALIAN STANDARDS AS2241 FIRE HOSE REELS
3. ALL FIRE PROTECTION COMPONENTS SHALL BE CSIRO, FM OR UL LISTED
4. THE FIRE PROTECTION SERVICES DRAWINGS ARE DIAGRAMMATIC ONLY. THE DRAWINGS DO NOT SHOW DETAIL WIRING, PIPE FITTINGS, DROPPERS OR RISERS.
5. THE FIRE PROTECTION SERVICES FACILITIES EXISTING ON SITE SHALL BE MAINTAINED TO SUIT THE CONVENIENCE OF THE PRINCIPAL. NO INTERRUPTION SHALL BE MADE TO THE FIRE PROTECTION SERVICES WITHOUT THE PRIOR WRITTEN APPROVAL OF PRINCIPAL AND FIRE & RESCUE NSW APPROVAL. THE COST OF SUPPLYING TEMPORARY FACILITIES NECESSARY TO MAINTAIN THE FIRE PROTECTION SERVICES SHALL BE INCLUDED IN THE TENDER PRICE.
6. PROVIDE CERTIFICATION THAT THE FIRE PROTECTION SYSTEMS WERE INSTALLED IN COMPLIANCE WITH ALL THE CODES, AUTHORITIES AND AUSTRALIAN STANDARDS, NOMINATED ABOVE.
7. THE CONTRACTOR SHALL PROVIDE TWELVE MONTHS DEFECTS LIABILITY PERIOD. MAINTAIN THE FIRE PROTECTION SYSTEMS IN ACCORDANCE WITH THE AUSTRALIAN STANDARD AS 1851.
8. ALLOW FOR CO-ORDINATION WITH THE FIRE ENGINEERING REPORT AND ADITIONAL EQUIPMENT WHERE REQUIRED.
9. ALLOW FOR 200 SPRINKLER HEADS AND PIPEWORK FOR MACHINERY, CONVEYORS AND RIDGE VENT AND CREDIT IF NOT UTILISED. (CO-ORDINATE WITH BUILDER OF UNDERGROUND PIPEWORK TO MACHINERY AND CONVEYORS).
10. SEPARATE VALVE SHALL BE ALLOCATED FOR SPRINKLERS TO THE MACHINERY / CONVEYORS ETC.
11. ALLOW SPRINKLER TO RIDGE VENT.
12. SPRINKLER PIPEWORK IS INDICATIVE ONLY AND SUBJECT TO DETAILED CO-ORDINATION ON AS INSTALLED DRAWINGS WITH STRUCTURAL AND OTHER SERVICES.
13. FIRE SERVICES TRADE CONTRACTOR SHALL ALLOW TO PREPARE AS INSTALLED DRAWING SHOWING SPRINKLER HEADS AND REITCULATION PIPEWORK TO ALL AREAS INCLUDING RIDGE VENT / MACHINERY AND CONVEYORS.
14. BUILDER / FIRE TRADE CONTRACTOR SHALL ALLOW FOR UNDERGROUND 553,000L SPRINKLER WATER STORAGE TANK, TURBINE PUMPS (2 x DIESEL) 6,000 L/min @ 1100kPa SPRINKLER VALVE SETS AND ASSOCIATED ACCESSORIES.
15. FIRE INDICATOR PANEL INCLUDING MONITORING WITH NSWFB.
16. EWIS SHALL BE INCLUDED BY THE FIRE SERVICES TRADE CONTRACTOR.
17. FHR RETICULATION PIPEWORK SHALL BE CONNECTED TO THE DOMESTIC WATER SUPPLY (SHALL BE ALLOWED BY FIRE BY FIRE TRADE CONTRACTOR)

SYSTEM DESIGN - SPRINKLER SYSTEM

1. OH3 CATEGORY 3 HIGH HAZARD (17.5mm / MIN OVER 260m2 AS 2118.1, 1999 & E1.5
2. EMERGENCY WARNING AND INTERCOMMUNICATION SYSTEM TO AS 2220 & 2
   - WIP & BGA AT EACH EXIT DOOR
   - HORN SPEAKERS THROUGHOUTV SHED.

Copyright

Rev	Date	Amendment
A	26.08.16	PRELIMINARY ISSUE
B	05.09.16	TENDER ISSUE
C	29.09.16	SPRINKLER TANK & VALVE ROOM LOCATION UPDATED
D	27.10.16	CONSTRUCTION CERTIFICATE



KEY PLAN

Drawing Status
CONSTRUCTION CERTIFICATE

Project North Point

Client
DEWCAPE PTY LTD

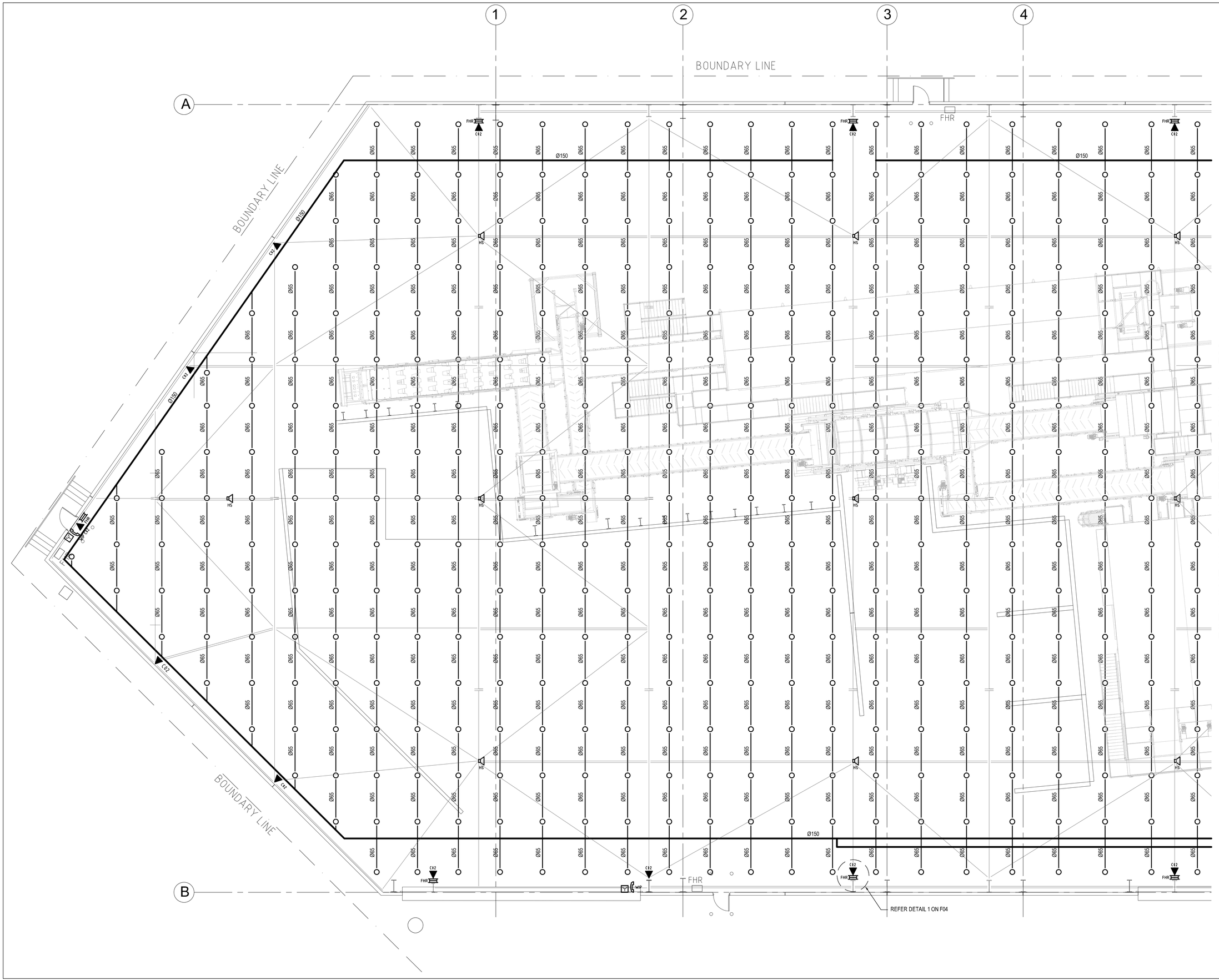
Project
BINGO INDUSTRIES
25 DUNHEVED CIRCUIT
ST MARY'S NSW

Consulting Engineer
AUSTECH
CONSULTING ENGINEER'S
www.austechintl.com

Drawing Title
FIRE SERVICES
LEGEND, GENERAL NOTES
AND DRAWING SCHEDULE

Scale	Designed	Drawn	Date
N.T.S.	IS	CLO	AUG '16

Project No.	Drawing No.	Rev No.
160033	F01	D



Copyright

Rev	Date	Amendment
A	26.08.16	PRELIMINARY ISSUE
B	05.09.16	TENDER ISSUE
C	27.10.16	CONSTRUCTION CERTIFICATE

Drawing Status
CONSTRUCTION CERTIFICATE

Project North Point

Client
DEWCAPE PTY LTD

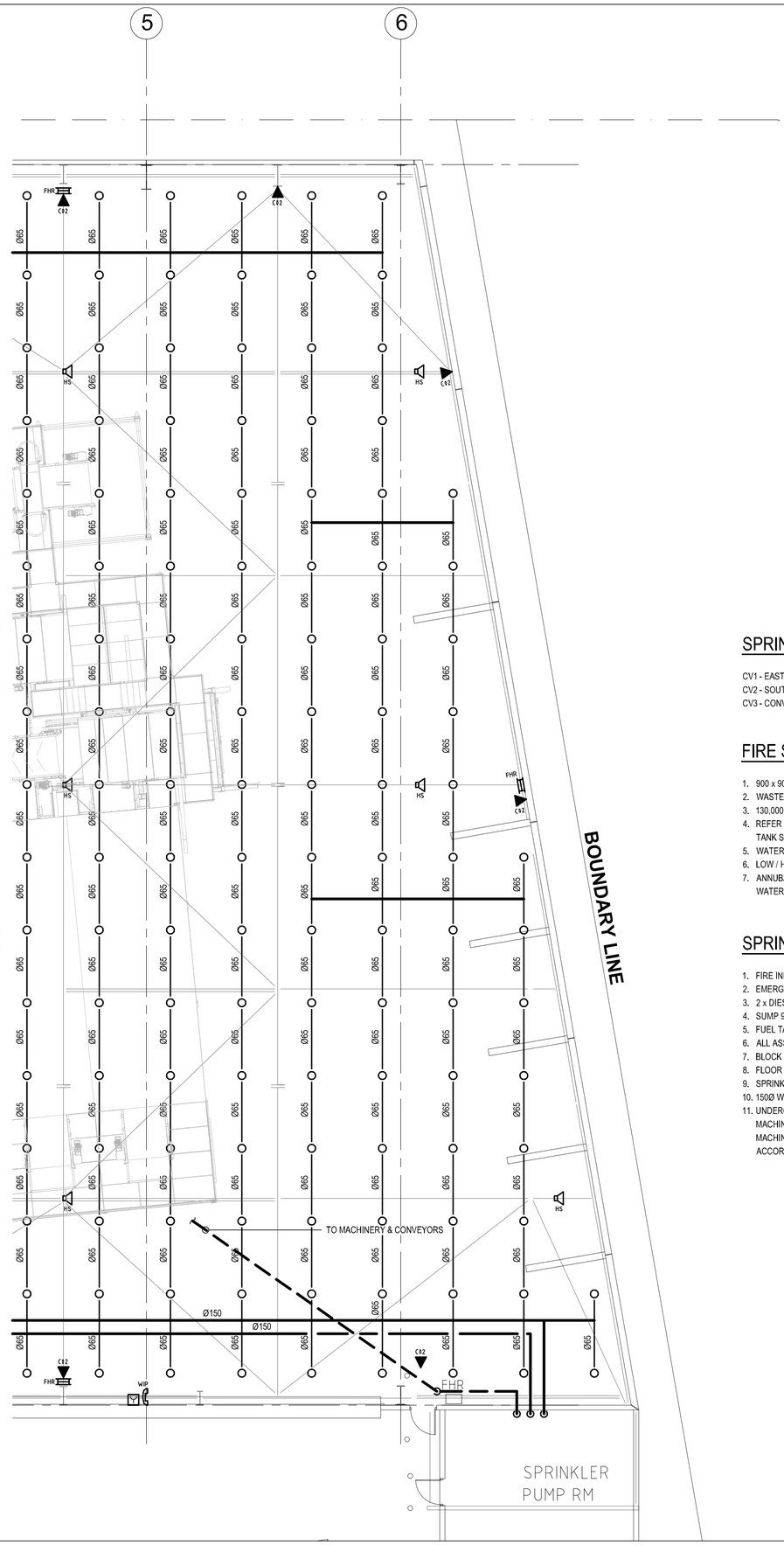
Project
BINGO INDUSTRIES
25 DUNHEVED CIRCUIT
ST MARY'S NSW

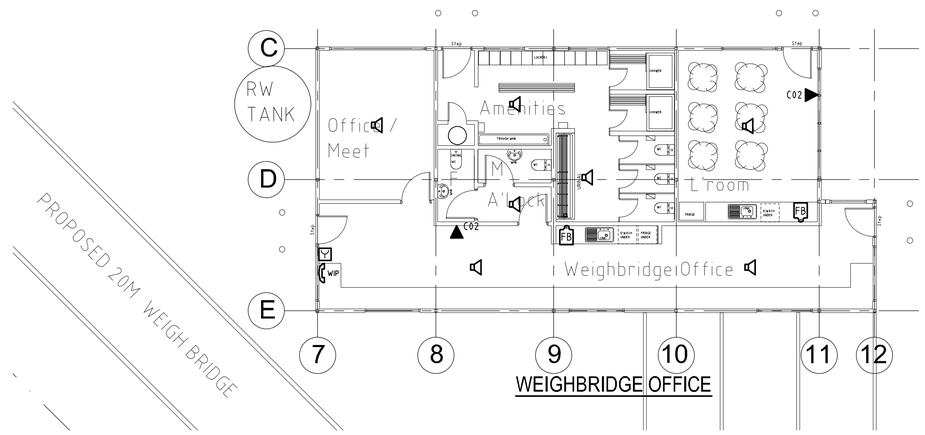
Consulting Engineer
AUSTECH
CONSULTING ENGINEER'S
www.austechintl.com

Drawing Title
FIRE SERVICES
GROUND FLOOR LEVEL
PART 1 OF 2

Scale	Designed	Drawn	Date
1:100	IS	CLO	AUG '16

Project No.	Drawing No.	Rev No.
160033	F02	C





SPRINKLER ZONES

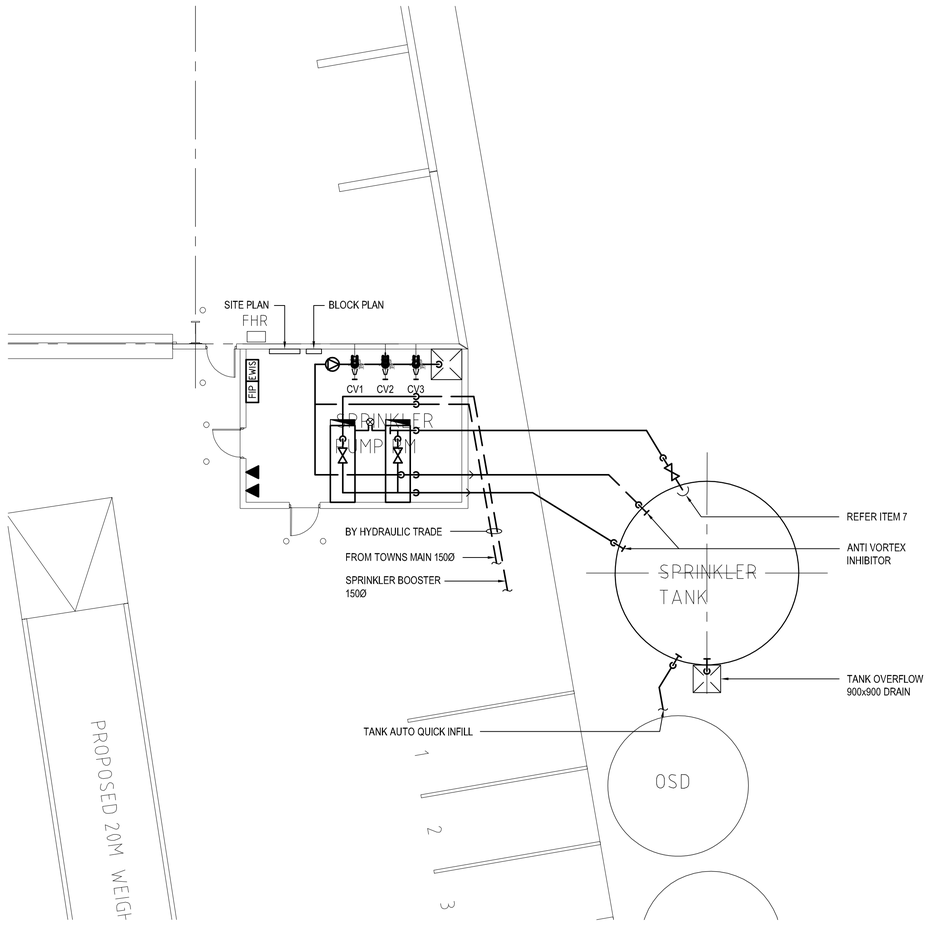
CV1 - EAST ROOF
CV2 - SOUTH ROOF
CV3 - CONVEYERS AND MACHINES

FIRE SPRINKLER TANK

1. 900 x 900mm GRATED DRAIN.
2. WASTE AND TEST PIPE AND ALARM GONG FOR WASTE ONLY.
3. 130,000L SPRINKLER WATER STORAGE TANK.
4. REFER STRUCTURAL ENGINEER'S DRAWINGS AND SPECIFICATION FOR TANK SLAB FOUNDATION.
5. WATER LEVEL INDICATOR AND LOW LEVEL ALARM AT FIP.
6. LOW / HIGH LEVEL TANK FLOAT.
7. ANNUBAR AND PRESSURE RELIEF LINES TO BE RECYCLED BACK INTO WATER STORAGE TANK.

SPRINKLER PUMP AND VALVE ROOM

1. FIRE INDICATOR PANEL.
2. EMERGENCY WARNING AND INTERCOMMUNICATION SYSTEM (EWIS).
3. 2 x DIESEL SPRINKLER PUMP SETS.
4. SUMP 900 x 900mm WITH GRATED DRAIN.
5. FUEL TANK.
6. ALL ASSOCIATED RETICULATION PIPEWORK.
7. BLOCK PLAN.
8. FLOOR WASTE BY HYDRAULIC TRADE.
9. SPRINKLER BOOSTER FROM VALVE ROOM.
10. 150Ø WTER SUPPLY TO VALVE ROOM.
11. UNDERGROUND SPRINKLER RETICULATION PIPEWORK TO THE MACHINERY AND CONVEYORS SHALL BE CO-ORDINATED WITH ALL MACHINERY AND UNDERGROUND SERVICES TRADE AND INSTALLED IN ACCORDANCE WITH THE RESPECTIVE AUSTRALIAN STANDARDS.



SPRINKLER PUMP, VALVE ROOM AND TANK

(NOTE: DRAWINGS ARE DIAGRAMMATIC ONLY)

Copyright

Rev	Date	Amendment
A	26.08.16	PRELIMINARY ISSUE
B	05.09.16	TENDER ISSUE
C	29.09.16	SPRINKLER TANK & VALVE ROOM LOCATION UPDATED
D	27.10.16	CONSTRUCTION CERTIFICATE

Drawing Status
CONSTRUCTION CERTIFICATE

Project North Point

Client
DEWCAPE PTY LTD

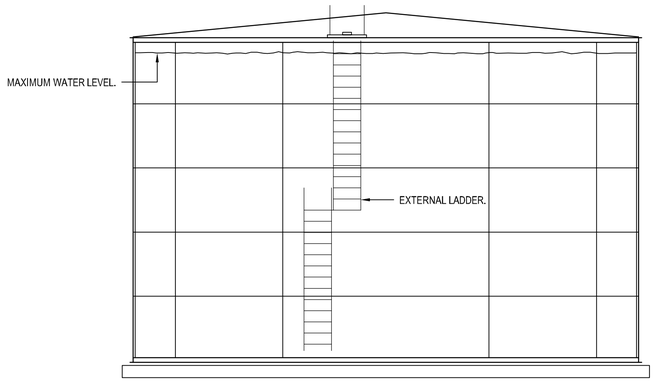
Project
BINGO INDUSTRIES
25 DUNHEVED CIRCUIT
ST MARY'S NSW

Consulting Engineer
AUSTECH
CONSULTING ENGINEER'S
www.austechintl.com

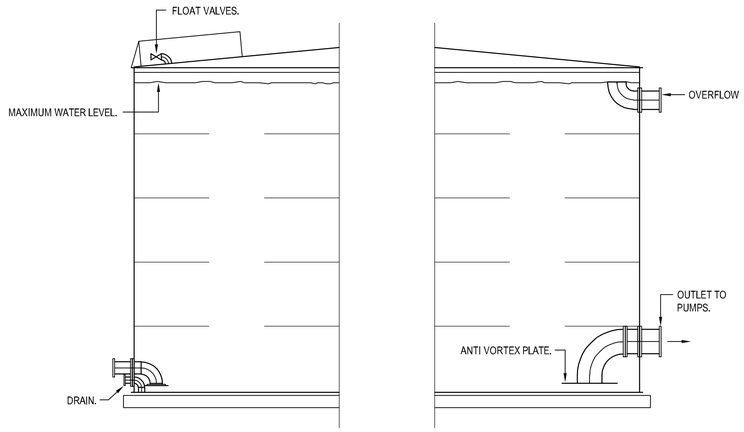
Drawing Title
FIRE SERVICES
GROUND FLOOR LEVEL
PART 2 OF 2

Scale	Designed	Drawn	Date
1:100	IS	CLO	AUG '16

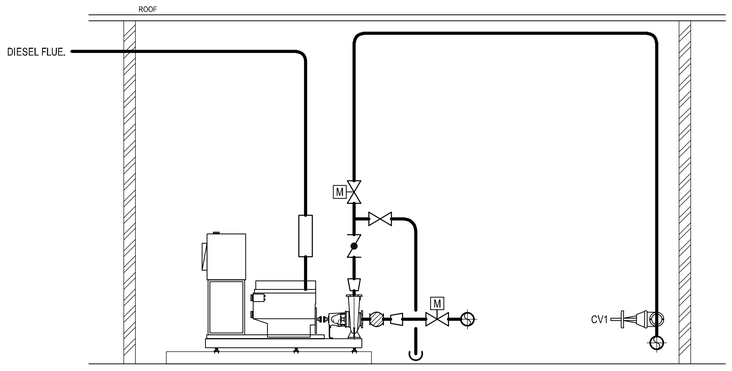
Project No.	Drawing No.	Rev No.
160033	F03	D



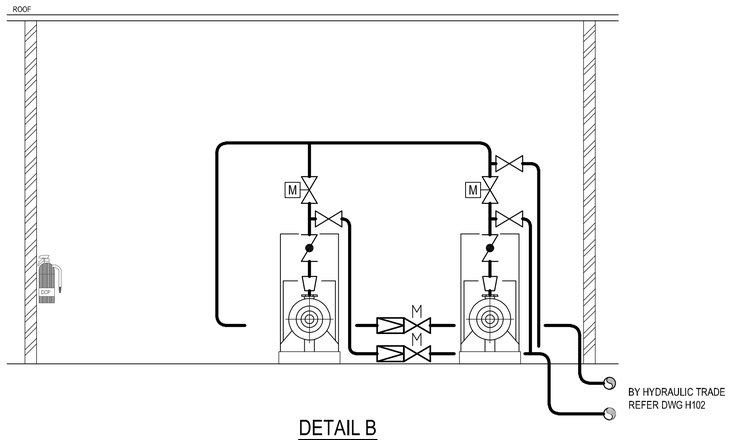
SPRINKLER TANK ELEVATION
(N.T.S.)



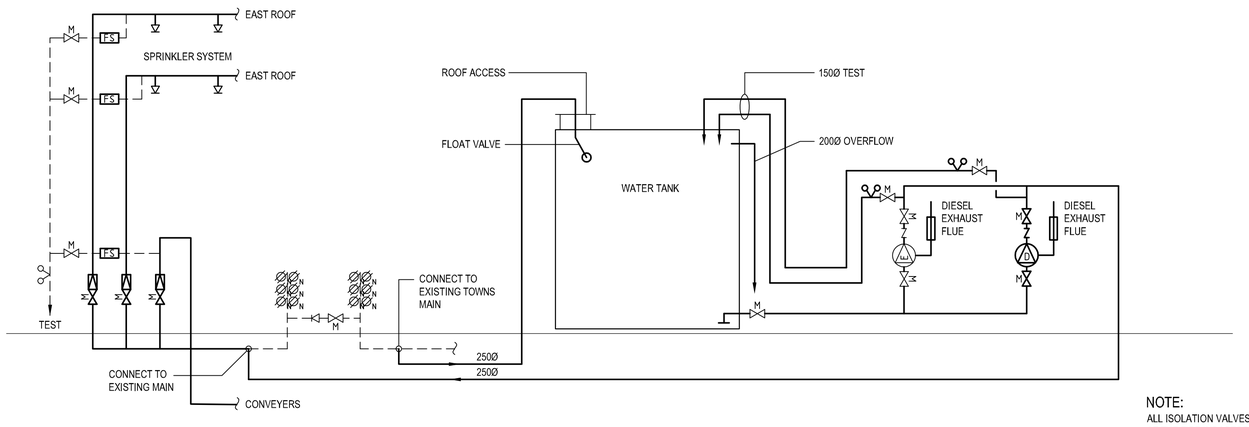
SPRINKLER TANK SECTION
(N.T.S.)



DETAIL A
(N.T.S.)

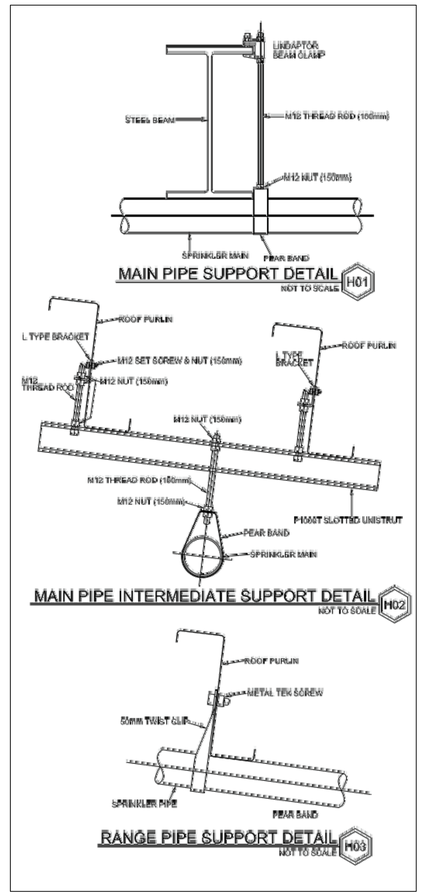


DETAIL B
(N.T.S.)



NOTE:
ALL ISOLATION VALVES TO BE MONITORED AT THE FIRE INDACTOR PANEL.

SPRINKLER SCHEMATIC DIAGRAM



PIPE SUPPORT DETAILS
N.T.S.

NOTE:

1. ALL DIAGRAMS ARE INDICATIVE AND FINAL RETICULATION PIPEWORK SHALL BE SUBJECT TO FINAL HYDRAULIC CALCULATIONS AND CO-ORDINATION ON WORKSHOP DRAWINGS.

Copyright

Rev	Date	Amendment
A	26.08.16	PRELIMINARY ISSUE
B	05.09.16	TENDER ISSUE
C	29.09.16	SPRINKLER TANK & VALVE ROOM LOCATION UPDATED
D	27.10.16	CONSTRUCTION CERTIFICATE

Drawing Status
CONSTRUCTION CERTIFICATE

Project North Point

Client
DEWCAPE PTY LTD

Project
BINGO INDUSTRIES
25 DUNHEVED CIRCUIT
ST MARY'S NSW

Consulting Engineer
AUSTECH
CONSULTING ENGINEER'S
www.austechintl.com

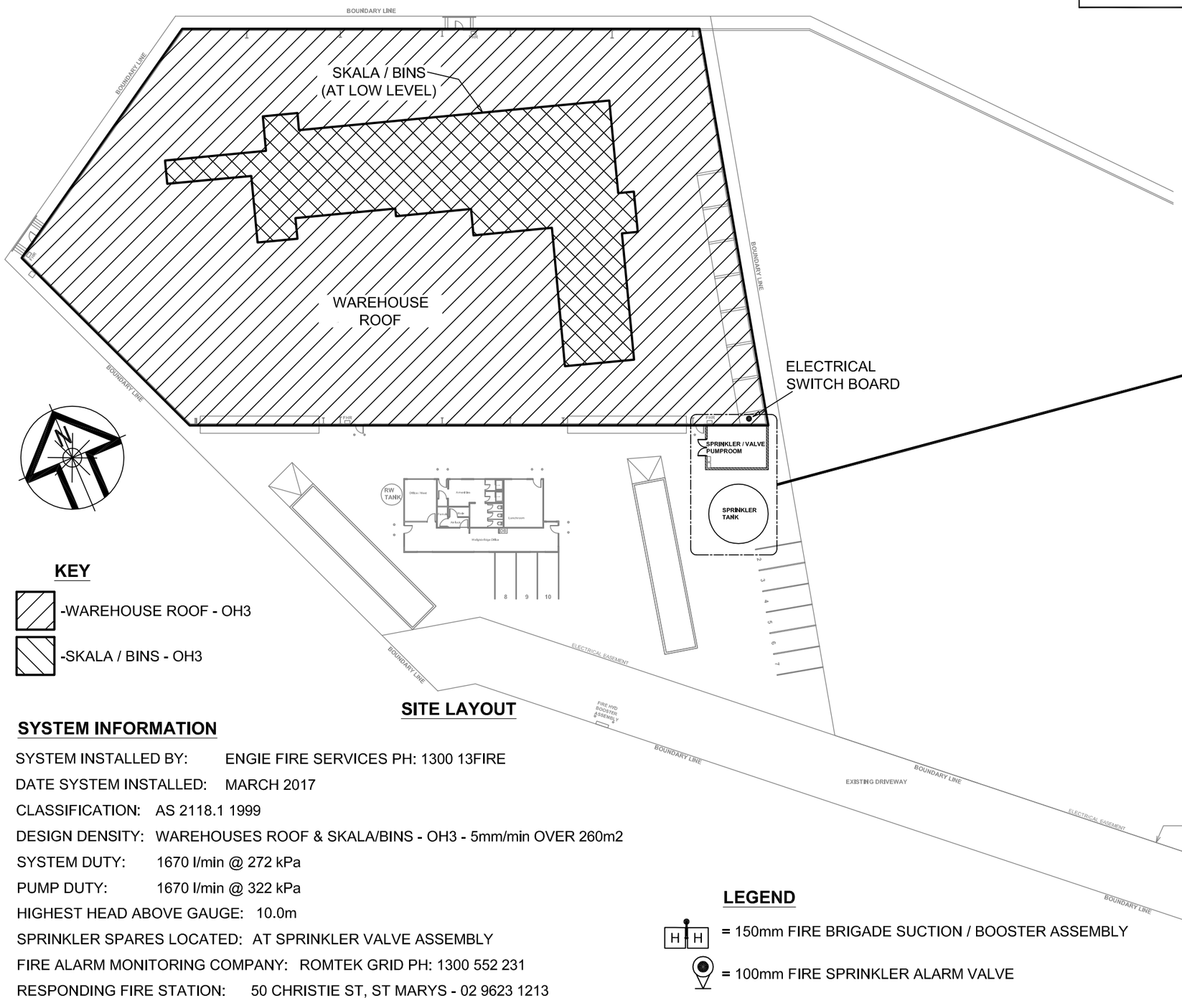
Drawing Title
FIRE SERVICES
OFFICE BUILDING
GROUND FLOOR

Scale	Designed	Drawn	Date
1:100	IS	CLO	AUG '16

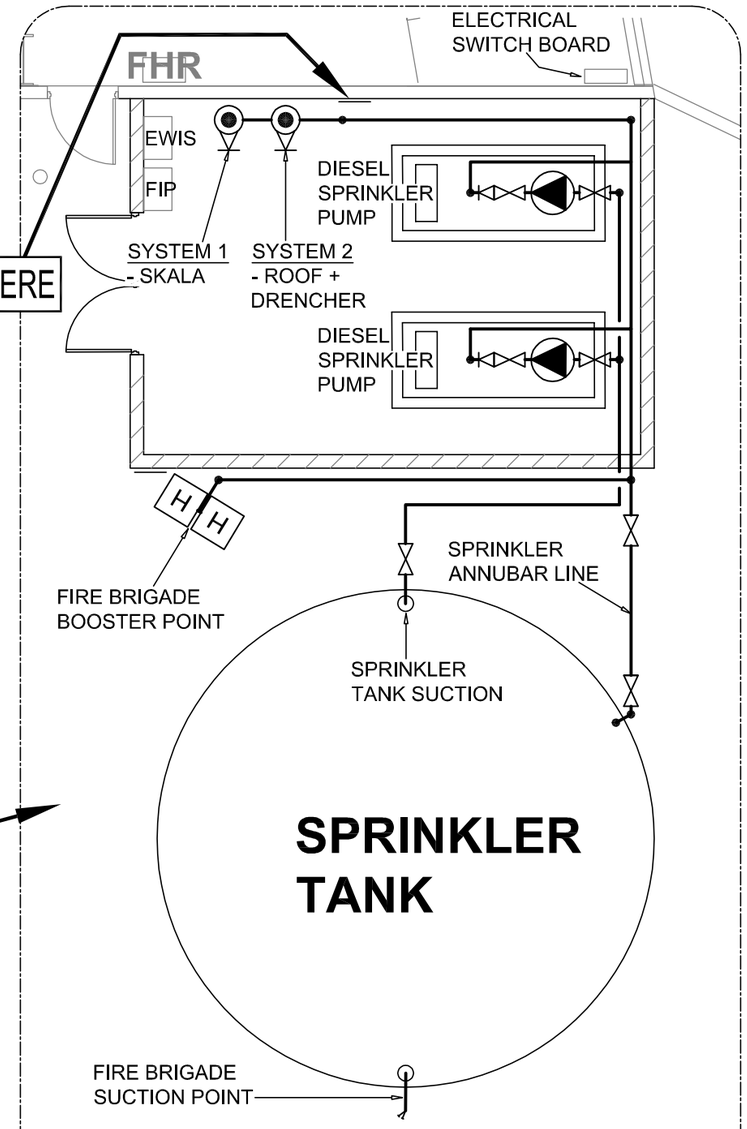
Project No.	Drawing No.	Rev No.
160033	F04	D

FIRE SPRINKLER BLOCK PLAN

BINGO RECYCLING - 25 DUNHEVED CIRCUIT, ST MARYS, NSW



SITE LAYOUT



FIRE SPRINKLER PUMPROOM & TANK LAYOUT

DUNHEVED CIRCUIT

KEY

-WAREHOUSE ROOF - OH3

-SKALA / BINS - OH3

SYSTEM INFORMATION

SYSTEM INSTALLED BY: ENGIE FIRE SERVICES PH: 1300 13FIRE

DATE SYSTEM INSTALLED: MARCH 2017

CLASSIFICATION: AS 2118.1 1999

DESIGN DENSITY: WAREHOUSES ROOF & SKALA/BINS - OH3 - 5mm/min OVER 260m2

SYSTEM DUTY: 1670 l/min @ 272 kPa

PUMP DUTY: 1670 l/min @ 322 kPa

HIGHEST HEAD ABOVE GAUGE: 10.0m

SPRINKLER SPARES LOCATED: AT SPRINKLER VALVE ASSEMBLY

FIRE ALARM MONITORING COMPANY: ROMTEK GRID PH: 1300 552 231

RESPONDING FIRE STATION: 50 CHRISTIE ST, ST MARYS - 02 9623 1213

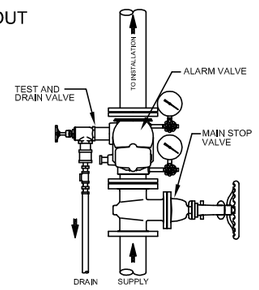
LEGEND

H H = 150mm FIRE BRIGADE SUCTION / BOOSTER ASSEMBLY

= 100mm FIRE SPRINKLER ALARM VALVE

EMERGENCY INSTRUCTIONS

1. MAKE SURE THAT FIRE IS OUT
2. CLOSE MAIN STOP VALVE
   (SHUTTING OFF WATER SUPPLY)
3. OPEN WASTE VALVE
   (DRAINING INSTALLATION)
4. REMAIN AT VALVES
   IF FIRE RE-OCCURS :-
   (a) CLOSE WASTE VALVE, and
   (b) RE-OPEN MAIN STOP VALVE



NOTE:- ABOVE INSTRUCTIONS MAY BE USED IN CASE OF LEAKAGE IN CASE THE SYSTEM IS CAUSING DAMAGE