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Huntingwood West NSW

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Fire Safety Strategy

Toll IPEC

Bungarribee Industrial Estate

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02	20/11/2012	Final Issue		<i>Grad Dip (Performance Based Building & Fire Codes)</i> <i>Accredited Fire Engineer</i> <i>BPB 0501</i> <i>MIEAust</i> <i>CPEng 2180287</i>

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1 INTRODUCTION

1.1 OVERVIEW

This Fire Safety Strategy has been undertaken to nominate proposed Alternative Solutions for assessing compliance with the nominated performance requirements of the BCA [1] in accordance with the methodologies defined in the IFEG [3].

In order to develop and assess the nominated non-compliances the following flowchart process is to be adopted.

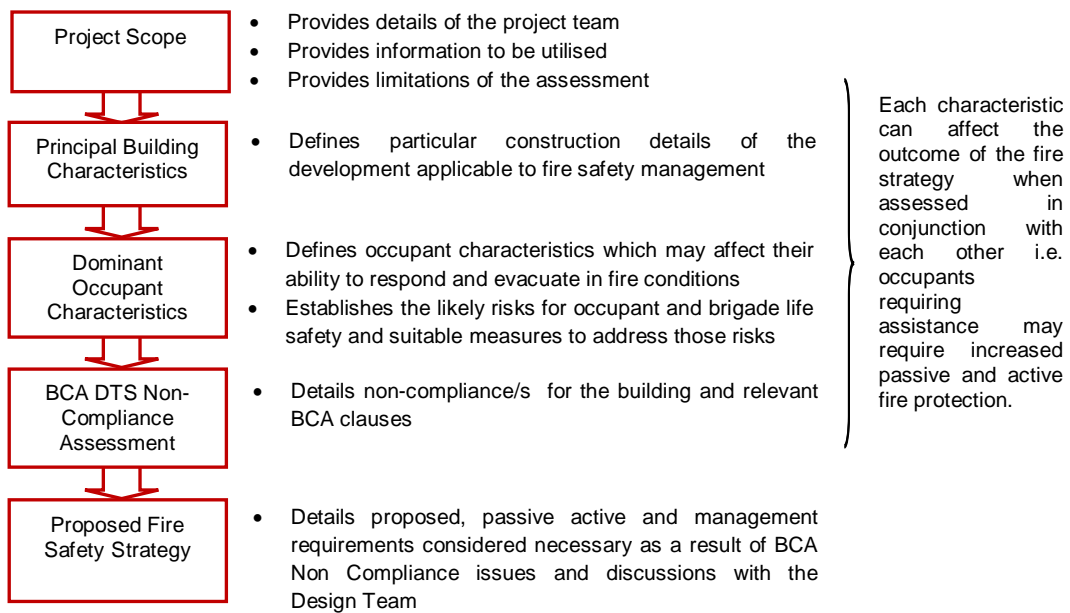


Figure 1-1: Fire Safety Strategy Process

The scope of the Fire Safety Strategy is to detail the nominated non-complying BCA DTS provisions with the performance requirements of the BCA and provide methodologies for establishing a workable and safe Fire Safety Strategy through a trial design.

1.2 FIRE SAFETY OBJECTIVES

The objective of a Fire Engineering Assessment is to develop a Fire Safety System, which satisfies the performance requirements of the BCA whilst maintaining an acceptable level of life safety, protection of adjacent property and adequate provisions for Fire Brigade intervention. At a community level, fire safety objectives are met if the relevant legislation and regulations are complied with. As stated in the BCA, "A Building Solution will comply with the BCA if it satisfies the Performance Requirements". In addition to this certain non-regulatory objectives exist as detailed below.

1.2.1 Building regulatory objectives

The following items are a summary of the fire and life safety objectives of the BCA:

- **Life safety of occupants** - the occupants must be able to leave the building (or remain in a safe refuge) without being subject to hazardous or untenable conditions. The objective of the Fire Engineering Assessment is to demonstrate that the proposed building design and fire safety systems would minimise the risk of exposing building occupants to hazardous or untenable conditions in an event of a fire.
- **Life safety of fire fighters** - fire fighters must be given a reasonable time to rescue any remaining occupants before hazardous conditions or building collapse occurs. The objective of



the Fire Engineering Assessment is to demonstrate that the proposed building design and fire safety systems would facilitate fire brigade intervention and minimise the risk of exposing fire fighters to hazardous or untenable conditions in an event of a fire.

- **Protection of adjoining buildings** - structures must not collapse onto adjacent property and fire spread by radiation should not occur. The objective of the Fire Engineering Assessment is to demonstrate that the proposed building design and fire safety systems would minimise the risk of fire spreading from one building to another.

1.2.2 Fire Brigade objectives

The overall philosophical Fire Brigade objectives throughout Australia are to protect life, property and the environment from fire according to the Fire Brigade Intervention Model (FBIM) [5] as per the Fire Services State and Territory Acts and Regulations.

Over and above the requirements of the BCA, the Fire Brigade has functions with regard to property and environmental protection and considerations regarding occupational health and safety for its employees.

1.2.3 Non-prescribed objectives

Fire Engineering has an overarching benefit to many facets of the built environment where non-prescribed objectives can have an influence on the Fire Safety Strategy adopted. Although not assessed within, the following can be considered if requested.

- **Business continuity** - will the loss of a particular facility due to fire / smoke damage result in excessive financial impact on the client? For example, is the facility critical to business continuity?
- **Public perception** - should a fire occur within the facility is there likely to be questionable public perception about the safety and operation of the facility?
- **Environmental protection** – fires of excessive sizes can have significant effects on the environment which may require a detailed risk assessment to minimise such outcomes.
- **Risk mitigation / insurance limitations** - are there specific limitations on insurance with respect to risk mitigation and fire safety design? i.e. Does the relevant insurer have concerns with respect to open atriums through the building?
- **Future proofing (isolation of systems)** - what flexibility is required in the overall design to allow for future development or changes in building layout?
- **OHS requirements** - buildings may have specific fire safety requirements pertaining to OHS requirements.

1.3 REGULATORY FRAMEWORK OF THE FIRE ENGINEERING ASSESSMENT

1.3.1 Building Code of Australia

One of the goals of the BCA is the achievement and maintenance of acceptable standards of safety from fire for the benefit of the community. This goal extends no further than is necessary in the public interest and is considered to be cost effective and not needlessly onerous in its application.

Section A0.5 of the BCA [1] outlines how compliance with the Performance Requirements can be achieved. These are as follows:

- (a) complying with the Deemed-to-Satisfy Provisions; or
- (b) formulating an Alternative Solution which –
 - (i) complies with the Performance Requirements; or
 - (ii) is shown to be at least equivalent to the Deemed-to-Satisfy Provisions or
- (c) a combination of (a) and (b).

Section A0.9 of the BCA provides several different methods for assessing that an Alternate Solution complies with the Performance Requirements. These methods are summarised as follows:



- (d) Evidence to support that the use of a material, form of construction or design meets a Performance Requirement or a Deemed-to-Satisfy Provision.
- (e) Verification Methods such as:
 - (i) the Verifications Methods in the BCA; or
 - (ii) such other Verification Methods as the appropriate authority accepts for determining compliance with the Performance Requirements.
- (f) Comparison with the Deemed-to-Satisfy Provisions.
- (g) Expert Judgment.

Section A0.10 of the BCA provides methods for complying with provisions A1.5 (to comply with Sections A to J of the BCA inclusive). The following method must be used to determine the Performance Requirements relevant to the Alternative Solution: These methods are summarised as follows:

- (i) Identify the relevant Deemed-to-Satisfy Provision of each Section or Part that is to be the subject of the Alternative Solution.
- (ii) Identify the Performance Requirements from the same Section or Part that are relevant to the identified Deemed-to-Satisfy Provisions.
- (iii) Identify Performance Requirements from the other Sections and Parts that are relevant to any aspects of the Alternative Solution proposed or that are affected by the application of the Deemed-to-Satisfy Provisions that are the subject of the Alternative Solution.

1.3.2 International Fire Engineering Guidelines

The IFEG [3] document has been developed for use in fire safety design and assessment of buildings and reflects world's best practice. The document is intended to provide guidance for fire engineers as they work to develop and access strategies that provide acceptable levels of safety.

The document is particularly useful in providing guidance in the design and assessment of Alternative Solutions against the Performance Requirements of the BCA. The prescribed methodology set out in the IFEG has been generally adopted in the Fire Safety Strategy.



2 PROJECT SCOPE

2.1 PROJECT SCOPE



RAWFire Safety Engineering has been engaged to undertake a fire safety review of the new Toll IPEC forwarding facility located in the Bungarribee Industrial Estate, Huntingwood in NSW.

The site contains a large storage and dispatch facility with an ancillary office. The total floor area of the building is 53,220m². The warehouse contains a 2-storey operations office as well as a mezzanine level with a maximum height of 7.5m above FFL. A conveyor system will be in operation in the facility transporting goods between docks and storage areas.

The purpose of this fire safety review is to outline the fire engineering principles that will be utilised in ensuring that the non-compliances with the DTS provisions of the BCA are resolved in order to conform to the building regulations. The complete fire engineered analysis will be completed in the Fire Engineering Report, and as such is not documented herein. This Fire Safety Strategy outlines the construction and management requirements considered necessary to achieve an acceptable level of life safety within the building and satisfy the Performance Requirements of the BCA.

2.2 RELEVANT STAKEHOLDERS

This Alternative Solution has been developed collaboratively with the relevant stakeholders as identified below:

Table 2-1: Relevant Stakeholders

ROLE	NAME	ORGANISATION
Development Manager	Richard Seddon	Goodman
Principal Certifying Authority	Steve Natilli	McKenzie Group
Fire Services Consultant	Stephen Trevor	Flame Safe
Mechanical Consultant	Michel Sarkis	Two MS
Architect	Greg Baird	SBA Architects
Fire Safety Consultant(s)	Graham Morris Thomas Newton	RAWFire Safety Engineering
Fire Safety Engineers	Sandro Razzi	

It should be noted that at times some parties may have a vested interest in the outcome of the Fire Engineering assessment. Such parties can include local fire brigades, insurers, 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 clients' decision to involve such parties, especially local fire brigade, to ensure a transparent and adequate fire safety solution for all. Where we are not notified of the inclusion of such parties it is assumed the client / representative has given due consideration to the above.

2.3 SOURCES OF INFORMATION

The following sources of information have been provided by the design team:

- Building BCA compliance assessment produced by McKenzie Group Consulting. Report No: 062706, dated 15th November 2012, Revision B.
- Architectural plans provided by Goodman, as indicated in Table 2-2.



Table 2-2: Drawings

DRAWING NO.	DESCRIPTION	ISSUE	DATE
DA-01	Location Plan	A	02-11-2012
DA-03	Site Plan	C	02-11-2012
DA-04	Warehouse Ground Floor Plan	C	02-11-2012
DA-05	Warehouse Mezzanine Plan	D	02-11-2012
DA-06	Warehouse Roof Plan	C	02-10-2012
DA-07	Warehouse Elevations	D	02-11-2012
DA-08	Warehouse Sections and Elevations	D	02-11-2012
M-GEN-000	Conveyor System Layout	0	07-11-2012

2.4 LIMITATIONS AND ASSUMPTIONS

In this instance the Fire Engineering Strategy is developed based on applicable limitations and assumptions for the development which are listed as follows:

- The report is specifically limited to the project described in Section 2.1.
- The report is based on the information provided by the team as listed above in Section 2.3.
- Building and occupant characteristics are as per Section 3 and 4 respectively of this report. Variations to these assumptions may affect the Fire Engineering Strategy and therefore they should be reviewed by a suitably qualified Fire Engineer should they differ.
- As per any building design, DTS or otherwise, the report is limited to the fire hazards and fuel loads as prescribed in Section 6.2. The report does not provide guidance in respect of areas, which are used for bulk storage, processing of flammable liquids, explosive materials, multiple fire ignitions or sabotage of fire safety systems.
- The development complies with the DTS provisions of the BCA [1] with all aspects unless otherwise specifically stated in this report. Where not specifically mentioned, the design is expected to meet the BCA DTS requirements of all relevant codes and legislation at the time of construction and / or at the time of issue of this report.
- The assessment is limited to the objectives of the BCA and does not consider property damage such as building and contents damage caused by fire, potential increased insurance liability and loss of business continuity.
- Malicious acts or arson with respect to fire ignition and safety systems are limited in nature and are outside the objectives of the BCA. Such acts can potentially overwhelm fire safety systems and therefore further strategies such as security, housekeeping and management procedures may better mitigate such risks.
- This report is prepared in good faith and with due care for information purposes only, and should not be relied upon as providing any warranty or guarantee that ignition or a fire will not occur.
- The Fire Engineering Strategy is only applicable to the completed building. This report is not suitable, unless approved otherwise, to the building in a staged handover.
- Where parties not nominated in Table 2-1 have not been consulted or legislatively are not required to be, this report does not take into account, nor warrant, that fire safety requirements specific to their needs have been complied with.



3 PRINCIPAL BUILDING CHARACTERISTICS

3.1 OVERVIEW



Building characteristics are assessed as part of the Fire Engineering Review due the following:

1. The location can affect the time for fire brigade intervention and potential external fire exposure issues.
2. The structure will impact on the ability to resist a developing fire and support condition to allow occupants to escape the building and the fire brigade to undertake fire fighting to the degree necessary.
3. The floor area determines the potential fire size and area required to be evacuated in the event of a fire.
4. BCA details such as Type of Construction, Class and Height will dictate passive and active fire safety systems.

3.2 SITE & DEVELOPMENT DESCRIPTION

The development site is located in Huntingwood West, approximately 40km west of Sydney City. The site is accessed by Huntingwood Drive and the newly created William Dean Street. The existing Metcash Facility is to the east between the site and Brabham Drive with the Great Western Highway to the north. To the south is a public reserve between the allotment and the M4 Western Motorway, while the western side of the allotment is bound by the Western Sydney Parklands.



Figure 3-1: Existing site location

Source: www.nearmap.com.au (08/09/12)

The two nearest fire brigade stations that are provided with permanent staff are located in Huntingwood and Seven Hills approximately 1km and 9km from the site respectively.



The main development on the site is a 47,000m² storage and distribution warehouse with a design that includes 6 wings from the central area with two 2-storey offices. To the south and west of the warehouse are 700 staff/visitor car parking spaces. To the north-west is a 1,200m² Fleet Workshop and a 400m² Driver's Rest Area is located to the south-east. Access to the site is via two gatehouses with (pick-up/delivery vehicle) PUD entry from the north east and trailer entry from the north-west. Travel around the site is one-way with the single exit located at the north-west gatehouse. The site layout is illustrated in Figure 3-2.

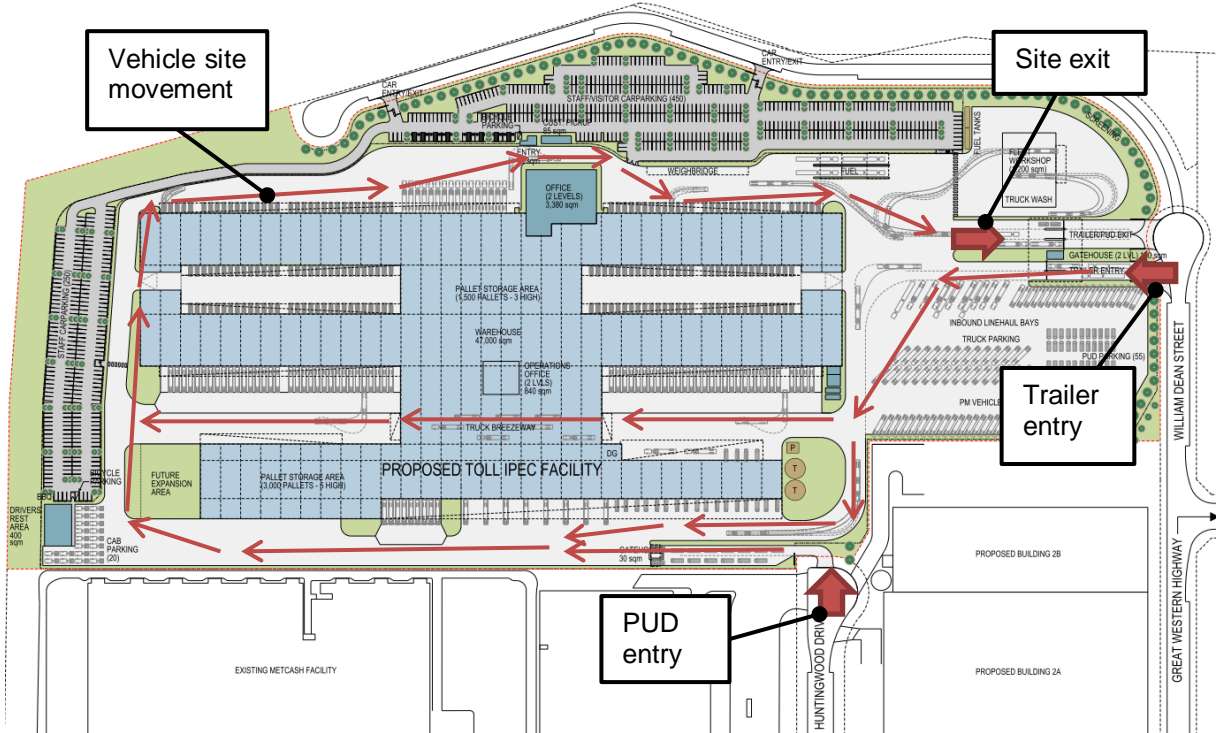


Figure 3-2: Site Plan

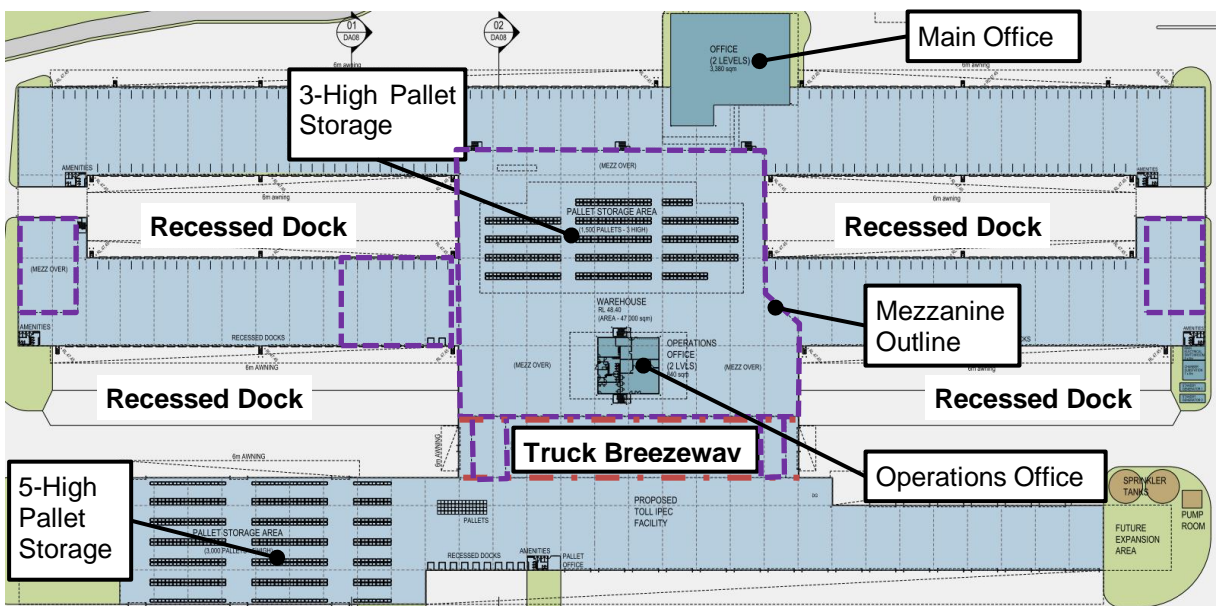


Figure 3-3: Warehouse Layout

The layout of the main warehouse is shown in Figure 3-3 with sections annotated in Figure 3-4 and Figure 3-5. The main occupant entry to the facility is via the 2-storey office to the west of the building,



accessed by a walkway over the vehicle route. A secondary 2-storey operations office is located centrally within the warehouse around which there is a mezzanine structure totalling 8,600m². The majority of the central mezzanine is situated at a height of 3.2m above FFL which rises to approximately 5.8m at the small sections above the truck breezeway. This mezzanine is mainly for maintenance purposes with additional maintenance mezzanines also located in the central north and south wings, at 5m above FFL.

An additional fashion mezzanine is located in the central south wing, adjacent to the central mezzanine and is situated approximately 7m above FFL. As the mezzanine is in excess of 6m and is not the only storey above ground level, it must be regarded as 2 storeys in accordance with BCA DTS Clause C1.2. Subsequently, for certification purposes the building has a rise in storeys of three, triggering the requirement for Type B construction.

The eastern section of the warehouse is separated from the rest of the warehouse by a truck breezeway which allows trucks to pass directly through the building and load / unload in the building. The north-eastern portion of the warehouse is primarily a bulk set-down area. There are two locations for high bay storage, the south eastern wing with pallets stored 5 high and the central mezzanine area with pallets stored 3 high.

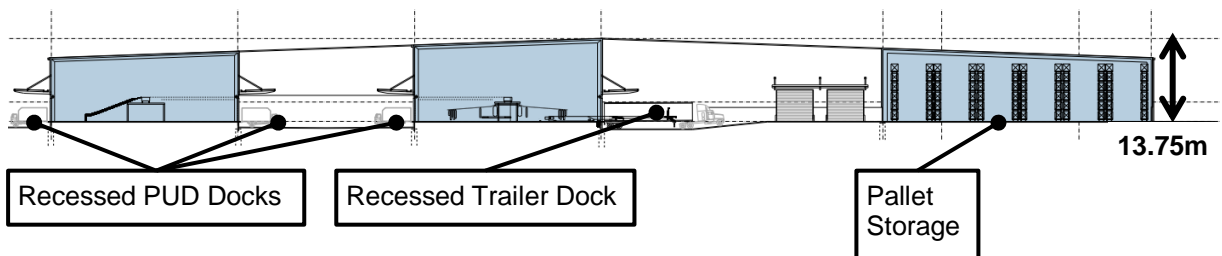


Figure 3-4: Section through Southern Wings

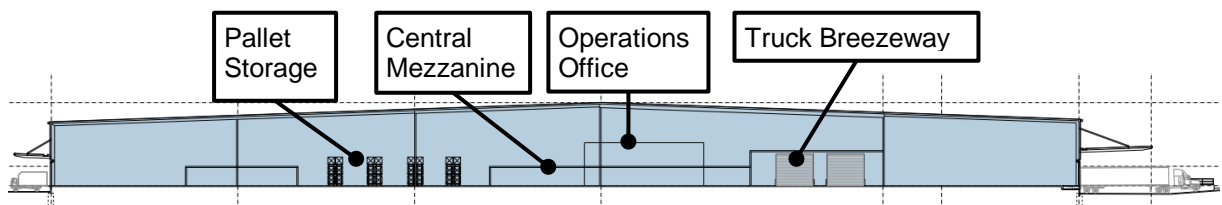


Figure 3-5: Section through Central Area

A conveyor system transports goods for delivery and pick-up through the four main distribution wings of the warehouse via the mezzanine areas. The four distribution wings are accessed via open air recessed docks to which entry is under a roof connecting the end of the wings. The conveyor layout is shown in Figure 3-6 along with sections showing the height of the belts at different locations.

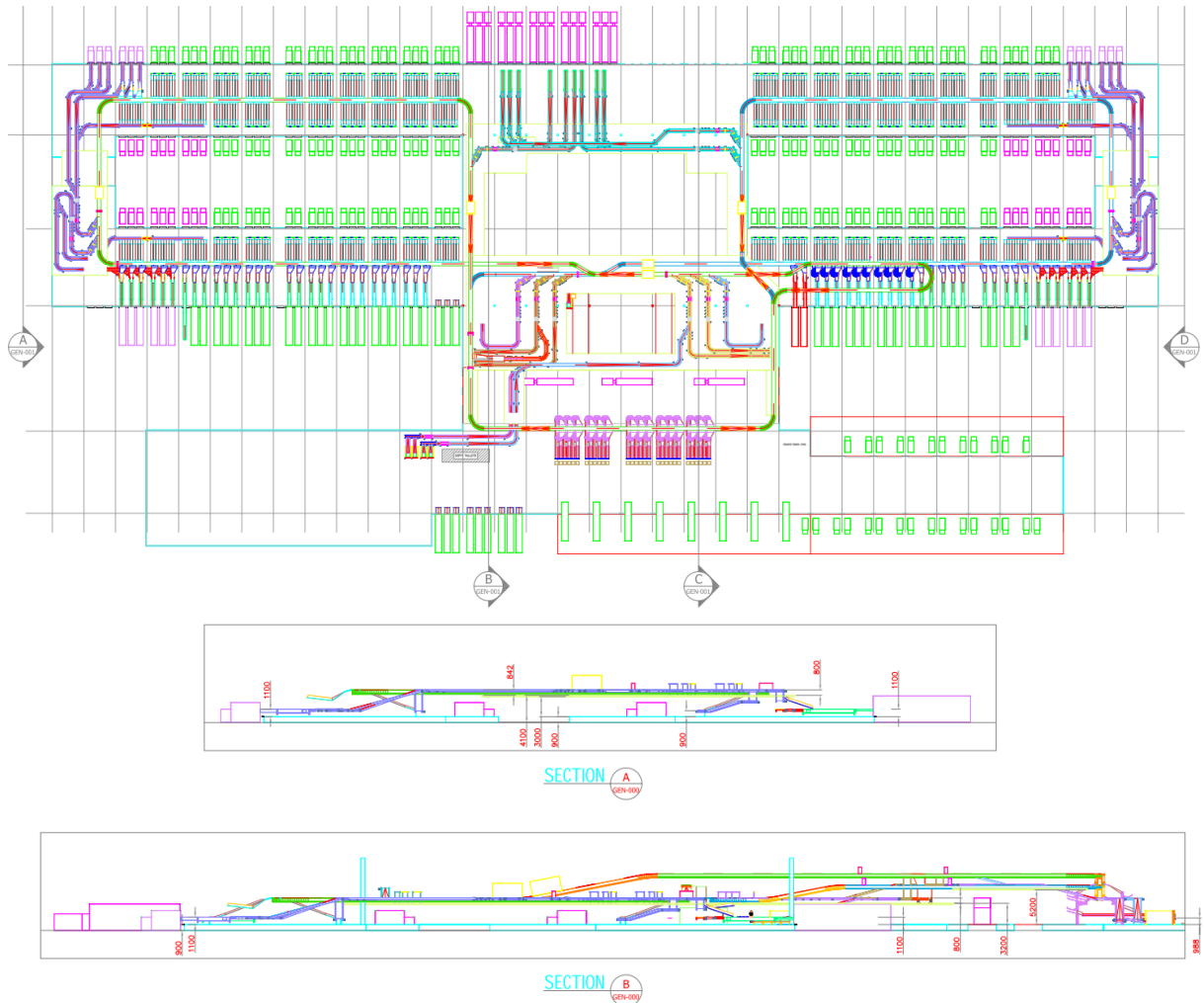


Figure 3-6: Conveyor System Layout and Sections

3.3 BUILDING CHARACTERISTIC ASSESSMENT

Table 3-1: Building Characteristics

CHARACTERISTIC	DESCRIPTION
Location	<p>The site is located within the Bungarrabee Industrial Estate in Huntingwood West, NSW. The two nearest fire brigade stations are located within 9km of the site.</p> <p>The building site influences the likely fire brigade intervention times, and given the close proximity to the nearest fire station is expected to facilitate a relatively convenient and expedient fire brigade response.</p> <p>Furthermore being located within a major city outer suburb, the development is provided with the services and facilities expected in an urban setting.</p>
Layout	<p>The main warehouse building consists of six distribution wings attached to a central area. The western wings are served by a conveyor system and the eastern section includes a lay down area and a 5-high pallet storage area.</p> <p>The central area contains a mezzanine over surrounding a 2-storey operations office, a truck breezeway through the building and a 3-high pallet storage area.</p>



CHARACTERISTIC	DESCRIPTION	
Structure	<p>Materials and finishes shall be in accordance with the DTS requirements for Type B construction. Construction materials will include concrete and steel with external steel sheeting.</p> <p>Materials used in construction will conform with the testing methodology outlined in the DTS provisions so as to avoid the spread of smoke and fire and minimise the risk to occupants and fire fighters.</p>	
Total Floor area	<p>The floor areas of structures located on this site are as follows:</p> <ul style="list-style-type: none"> ■ Warehouse: 47,000m² ■ Offices: 4,220m² ■ Fleet workshop: 1,200m² ■ Truck wash: 225m² ■ Drivers rest area: 400m² ■ Gatehouses: 130m² ■ Customer pick-up: 85m² ■ Staff / visitor entry: 45m² <p>The PCA has advised that the main building can be Classified as 7b as office parts constitute less than 10% of the total floor area which is 51,220m².</p>	
BCA Assessment	Classification	Class 7b (warehouse including offices), Class 5 (rest area, entry, pick-up area), Class 8 (fleet workshop, truck wash)
	Construction Type	Type B Construction (<i>Large Isolated Building</i>)
	Rise in Storeys	<p>The office and mezzanine areas have 1 storey above ground floor. However as the fashion mezzanine area has a height of greater than 6m. Subsequently, for certification purposes the building has a rise in storeys of three, triggering the requirement for Type B construction.</p> <p>NB: Increasing the number of floors in a building increases the building population, placing more occupants at risk in the event of a fire, and allowing for overcrowding in stairways and other pinch points in the path of egress to a final exit.</p>
	Effective Height	The main warehouse compartment has an effective height of less than 12m.



4 DOMINANT OCCUPANT CHARACTERISTICS

4.1 OVERVIEW



The occupant characteristics are assessed within the Fire Safety Strategy due to the following:

1. Population numbers can dictate the time required to evacuate the building and the required life safety systems to be provided due to evacuation times.
2. Physical and mental attributes affects the occupants capacity to respond to various fire cues and react accordingly.
3. Familiarity of occupants can affect the time taken to evacuate the building and subsequent active / passive requirements.

4.2 OCCUPANT CHARACTERISTIC ASSESSMENT

Table 4-1: Occupant Characteristics

CHARACTERISTIC	DESCRIPTION
Population numbers	<p>The BCA assumes the following occupant densities per an area's function and use:</p> <ul style="list-style-type: none"> ■ Warehouse: 30m² per person ■ Office: 10m² per person ■ Workshop: 30m² per person ■ Rest area: 10m² per person <p>Therefore the maximum population expected on the site in accordance with the BCA densities is 1,473 people.</p> <p>However as indicated by the tenant the expected population of the main warehouse building is to be 550 with the following distribution:</p> <ul style="list-style-type: none"> ■ 150 office staff ■ 400 warehouse staff / drivers
Population location	<p>The office areas will 'on average' be more densely populated than the loading and receiving docks and the storage areas. The tenant has indicated that the warehouse staff / drivers will be approximately distributed as follows:</p> <ul style="list-style-type: none"> ■ 50 dockstaff / drivers at each of the 6 PUD docks ■ 40 dockstaff on the trailer docks ■ 60 dockstaff / drivers in the bulk area
Physical and mental attributes	<p>Occupants in the building may be of mixed age, although the elderly and children are generally not expected to be present. The population is therefore expected to be that of the general working public and be adults between the ages of 16 to 70. Due to the nature of the work conducted the majority of occupants are assumed to be able bodied people with a small number of less mobile occupants requiring assistance during an evacuation.</p> <p>All occupants are expected to be awake and alert adults or in the direct company of an adult, capable of entering the leaving the building under their own volition. Occupants in all of these areas are not expected to be adversely impaired by drugs, alcohol, fatigue or other adverse conditions to degrees</p>



CHARACTERISTIC	DESCRIPTION
	<p>greater than in other warehouse and office buildings.</p> <ul style="list-style-type: none"> ■ Staff and Security – are expected to be mobile with normal hearing and visual abilities, and occupants in this group are considered to take and implement decisions independently, and require minimal assistance during evacuation in a fire emergency. This occupant group is expected to be awake and fully conscious at all times when inside the building; and ■ Clients / Visitors – are expected to be mobile with normal hearing and visual abilities, this occupant group are expected to be capable of making and implementing decisions independently however may require assistance in locating the nearest and safest egress path in an emergency; and ■ External Maintenance Contractors – are expected to be mobile with normal hearing and visual abilities and occupants in this group are considered to take and implement decisions independently and require minimal assistance during evacuation in a fire emergency. The contractors are expected to be awake and aware of their surroundings at all times when inside the building; and ■ Fire & Rescue NSW – are expected to be equipped with safety equipment and will be educated in fire fighting activities and the dangers associated with fire incidents. This occupant group would be expected to be in a position to assist other occupants requiring assistance to evacuate. It is not expected that this occupant group would be present in the building at the time of fire ignition; however, they are expected to enter the building at a later stage to assist with the evacuation of occupants, if required, and to undertake fire suppression activities.
Familiarity with the building	<ul style="list-style-type: none"> ■ Staff, Maintenance and Security – can be expected to have a good familiarity with the building and the fire safety systems provided and may be trained in emergency procedures; and ■ Clients and /or Visitors – may or may not be familiar with the layout of the building and may require assistance in locating the exits; and ■ External Maintenance Contractors – this occupant group is expected to have a reasonable familiarity with the building as they would have to undergo site specific induction prior to commencement of work on site; and ■ Fire & Rescue NSW – are not expected to have any familiarity of the building layout, however are assumed to obtain the required information from the site block plans and tactical fire plans available prior to entering the building. Notwithstanding this they will be equipped with breathing apparatus and specialist equipment to prevent them from being adversely affected by fire hazards.



5 FIRE BRIGADE CHARACTERISTICS

5.1 OVERVIEW



The fire brigade characteristics are assessed within the Fire Safety Strategy due to the following:

1. Fire Brigade characteristics can dictate the time required for fire brigade intervention including search and rescue and fire attack.

5.2 FIRE BRIGADE ASSESSMENT

In order to assess the likely fire brigade response times and possible requirements additional to those normally presented within a DTS design an indicative assessment of fire brigade intervention has been undertaken based on the methods defined in the Fire Brigade Intervention Model (FBIM) [5].

Figure 5-1 illustrates the building layout with the site entry points and fire brigade access around the allotment.

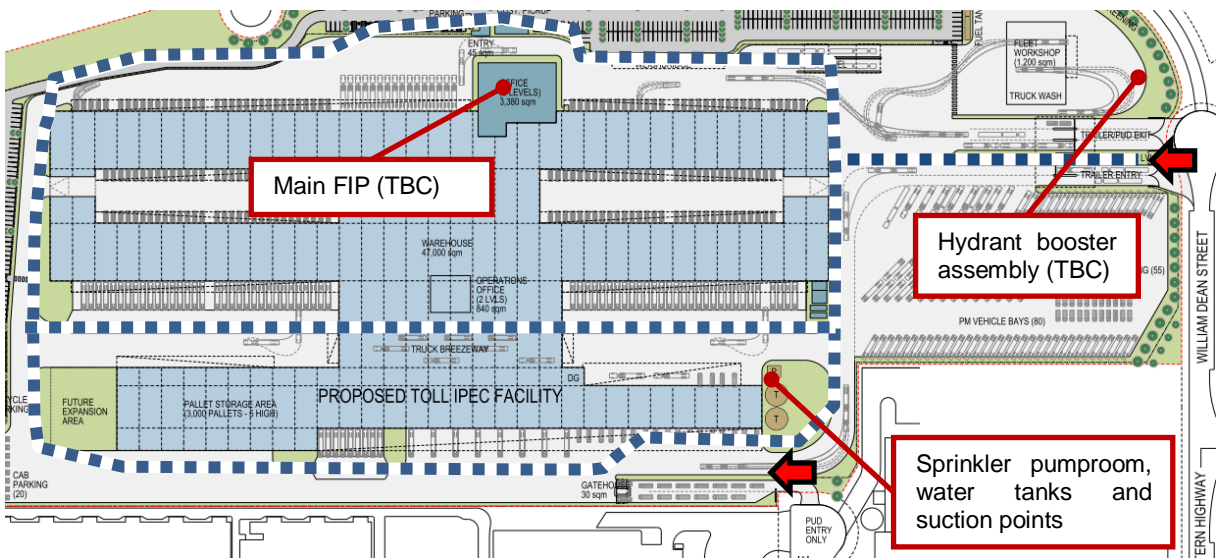


Figure 5-1: Fire Brigade Access and Site Facilities

The two nearest fire brigade stations that are provided with permanent staff are located in Huntingwood and Seven Hills approximately 1km and 9km from the site respectively. Figure 5-2 illustrates the expected route to be taken in the event of a fire.

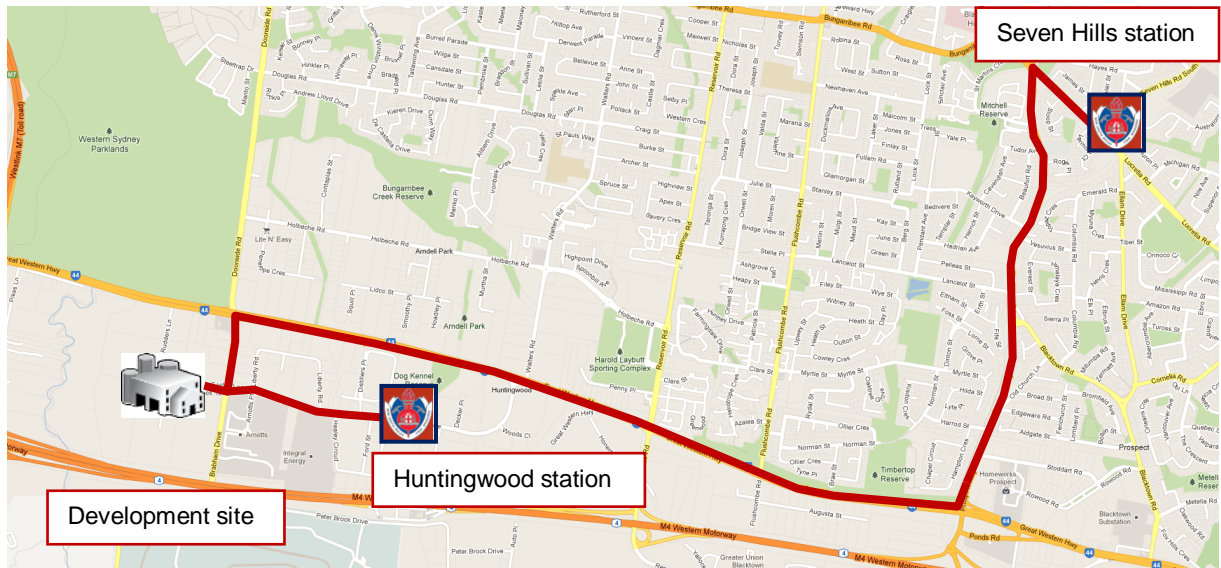


Figure 5-2: Route from the two Nearest Fire Stations

Due to the nature of the FBIM, it is necessary to justify the results through the inclusion of assumptions. The accuracy of results weighs heavily upon the measure of which assumptions are made and the sources from which they are derived.

The model produced details the time it will take for brigade personnel within the aforementioned location to receive notification of a fire, time to respond and dispatch resources, time for resources to reach the fire scene, time for the initial determination of the fire location, time to assess the fire, time for fire fighter travel to location of fire, and time for water setup such that suppression of the fire can commence. The following are details of the assumptions utilised in this FBIM:

Location of Fire

- This FBIM will only be an indicative model of one fire scenario within the building. For conservative purposes, the FBIM considers a fire in the location from the main entry point, i.e. the south eastern part of the extension.

Time between Ignition and Detection

- Based on calculations using the Alpert's Correlations (Figure 5-3) the initial brigade notification is via the activation of the warehouse sprinkler system conservatively assuming the operation of the roof level sprinklers at the highest point.

The alarm time calculated has considered a fire with a Fast t-squared fire growth rate, which is expected to be indicative of the type of fire in the pallet storage area. The alarm time following fire ignition was calculated to occur at 537 seconds.



Input data required		Fire Type: $\alpha =$
The ambient temperature of the room, $T_{\infty} =$	20 (°C)	Ultrafast 0.178
Fire Category =	Fast	Fast 0.044
Output time step =	10 (s)	Medium 0.011
The distance of the detector from the fire, $r =$	5 (m)	Slow 0.003
The height of the ceiling above the fire, $H =$	13 (m)	Custom <input type="text" value="0.02"/>
The Response Time Index of the detector, $RTI =$	50 ($m^{1/2}s^{1/2}$)	
Sprinkler density of discharge =	5 mm / min	
Detector activation temperature =	93 (°C)	
Calculated quantities at detector activation		
The gas temperature at sprinkler activation, $T =$	97.32 (°C)	
HRR at sprinkler activation =	12768.71 (kW)	
The gas velocity, $U =$	4.30 (m/s)	
Time at detector activation =	<input type="text" value="537"/> (s)	
Time to reach 10% of peak HRR =	0 (s)	
Ratio, $r / H =$	0.38	

Figure 5-3: Sprinkler Activation

Time for Initial Brigade Notification

- Fire brigade notification is expected to occur via a direct monitored alarm.
- A time for alarms/fire verification and any notification delay is 20 seconds based on Table B of the Fire Brigade Intervention Model. Therefore the time after ignition at which the fire brigade receive the alarm is $(537+20) = 557$ seconds.

Time to Dispatch Resources

- The two fire stations are assumed to be manned at the time of the fire as they are permanently staffed stations.

Time for fire fighters to respond to dispatch call and leave fire station is included in the travel time for fire brigade in NSW (Fire Brigade Intervention Model [5]).

Time to Travel to Scene

Table 5-1: FBIM data for the FRNSW (Table F2 FBIM)

GRAPH	REGION CLASSIFICATION	SPEED (KM/H)	
		μ	σ
F2.1	Major city central business district	26.6	11.3
F2.2	Major city inner suburb	26.3	11.9
F2.3	Major city outer suburb	29.5	12.2
F2.4	Rural town centre	21.6	11.0
F2.5	Rural country	40.5	15.6

Based on speed data provided by the Fire Brigade Intervention Model (FBIM) [5], this travel speed assumes the brigade is travelling at a mean speed of 29.5km/h (major city outer suburb) with a standard deviation of 12.2km/h. Since the mean speed would result in this particular travel speed occurring 50% of the time, there is an equal likelihood that the travel speed would take longer. Hence, it is desirable to introduce a margin of safety of using a greater percentile of 90%.

In order for the speed to be within the 90% percentile value, a safety factor of 1.28 is applied to the standard deviation as noted in Table 4.3 of Fire Brigade Intervention Model V2.2 [5].



Hence, a mean travel speed will be taken at a much slower travel speed at $29.5 - (12.2 \times 1.28) = 13.9\text{km/h}$ which is conservative.

- Appliance travel speeds of 13.9km/h have been adopted for the purposes of modelling, and as such the following travel times are expected:-

Table 5-2: Fire Brigade Arrival Times

STATION	TRAVEL SPEED (km/h)	DISTANCE (km)	TRAVEL TIME (sec)
Huntingwood	13.9 km/h	1 km	259
Seven Hills		9 km	2331

Time for Initial Determination of Fire Location

- On arrival, the fire location is not visible to the approaching brigade personnel, thus requiring information to be obtained from the Fire Indicator Panel (FIP) and evacuating occupants.
- Fire brigade personnel assemble at the FIP in the office building's main entry.
- Fire brigade tactical fire plans will be provided.
- Security procedures are expected to be minimal as brigade personnel will be issued with a key for the site. As such, forced entry into the building is not required.

Time for Water Setup

- The first appliance would be expected to commence the initial attack on the fire.
- Time taken to connect and charge hoses from on-site hydrants to the fire area is based on Table V of the Fire Brigade Intervention Model Guidelines, which indicates an average time of 45.3 seconds, and a standard deviation of 17.1 seconds. Using a 90th percentile approach as documented in the FBIM [5], the standard deviation is multiplied by a constant *k*, in this case being equal to 1.28. Therefore, the time utilised in this FBIM is $45.3 + (1.28 \times 17.1) = 68$ seconds.

Time for Fire Fighters to Travel to Fire Location

- Time for fire fighters to travel from the FIP to the fire affected area; in this case conservatively assumed to be the furthest point from the main FIP (i.e. the south eastern pallet storage area).

Table 5-3: FBIM Data for Horizontal Travel Speeds

GRAPH	TRAVEL CONDITIONS	SPEED (KM/H)	
		μ	σ
Q1	Dressed in turnout uniform	2.3	1.4
Q2	Dressed in turnout uniform with equipment	1.9	1.3
Q3	Dressed in turnout uniform in BA with or without equipment	1.4	0.6
Q4	Dressed in full hazardous incident suit in BA	0.8	0.5

Horizontal egress speeds have been based on fire brigade personnel dressed in turnout uniform in BA. An average travel speed of 1.4m/s with a standard deviation of 0.6m/s are utilised. As such, for the purposes of the calculations, a horizontal travel speed of $1.40 - (1.28 \times 0.6) = 0.63\text{m/s}$ is utilised.

- Horizontal travel distances (not including travel via lifts or stairs) will include the following:
 - Travel from the kerb to the Main FIP in the office foyer and finally to the southern corner of the warehouse is approximately 400m.
 - Based on the above travel distance of 400m coupled with an egress speed of 0.63m/s the horizontal travel time expected is approximately 635 seconds.

Search and Rescue

- Search and rescue will consist of a perimeter search of the warehouse; due to the size of the warehouse in comparison to the office it is assumed that a second team will conduct a search of



the office in the time required to cover the warehouse. Thus, this will provide fire fighting personnel with an additional 2,000m of travel. At a speed of 0.63m/s, this will take fire fighting personnel approximately 3175 seconds.

Table 5-4 Summary of the Fire Brigade Intervention Model (FBIM)

FIRE STATION	TIME OF ALARM	TRAVEL TIME TO SCENE	ASSUMED SET UP TIME	TIME TO REACH THE FIRE BASE	TIME OF ATTACK	PERIMETER SEARCH & RESCUE
Huntingwood	557	259	68	635	1519 (25 min)	3175 sec
Seven Hills		2331			3591 (60 min)	

The FBIM indicates that the arrival time of the brigade from the nearest two fire stations is approximately 13 and 48 minutes respectively after fire ignition. It is estimated that it takes another 12 minutes for the fire brigade to carry out activities including determination of fire location, preparation of fire fighting equipment and travel on foot to the fire base. As such, fire fighting activities are expected to commence between approximately 25 and 60 minutes.



6 FIRE HAZARDS AND PROTECTIVE MEASURES

6.1 OVERVIEW



The fire hazard analysis forms the basis for the review of non-compliances within the building. In assessing expected and statistically validated hazards, preventative and protective measures are developed commensurate with those expected risks. The following section reviews applicable hazards and recommends possible measures to address those risks. Furthermore, hazards identified can form a justified basis for selected scenarios.

6.2 FIRE STATISTICS

In order to assess the most likely fire hazards within the building, and subsequently the risk presented by these hazards it is necessary to develop an understanding of the factors that have an influence on the fire safety of building occupants. The best method in doing so is to review existing statistical data.

Existing data is an invaluable tool in providing an overview of the situations in which occupant deaths have, and are likely to occur, and factors that contribute to more severe fires. This aids in understanding, and helps evaluate the effectiveness of, and the need for various fire safety systems. Reference is made to the American database as it is significantly larger than Australian data sets, but is generally considered to be representative of the Australian situation.

Table 6-1: Fire Statistics in all Building Types

STRUCTURE USE	FIRES PER YEAR	CIVILIAN FATALITIES PER YEAR	CIVILIAN FATALITIES PER 1000 FIRES
Public assembly	15,050	5	0.33
Health Care, Detention and Correction	7,090	6	0.85
Manufacturing	5,670	5	0.88
Business offices	3,020	4	1.32
Parking garage	4,760	8	1.68
Warehouse	1,290	4	3.10
Hotels or motels	3,700	12	3.24
Apartments	108,530	422	3.89
Homes	263,150	2163	8.22

Source: NFPA 'Structure Fires by Occupancy 2006-2010' Report [6]

The civilian fatality rates from 2006 to 2010 highlighted in Table 6-1 show that storage warehouses have a medium risk to life compared to other property types with 4 civilian deaths per 1000 fires on average annually.

From the National Fire Protection Association (NFPA) report on 'Warehouses Fires Excluding Cold Storage' [7] statistics specific to building types relevant to this development can be analysed.

Note that the statistics below have been compiled from U.S. fires reported to U.S. municipal fire departments between 2003 and 2006, and do not include fires where private or government fire brigades responded or fires that were not reported. Further, it should be noted that cold storage, residential storage and self-storage are excluded.



These statistics represent a much greater number of events than Australian statistics and therefore have a greater statistical reliability. Building construction types and fire hazards are estimated to be sufficiently similar between Australia and the U.S. for the following results to be applicable.

Warehouse (excluding cold storage) Fire Statistics

A total of 1,350 structure fires occurred in warehouses. The fires recorded resulted in 5 occupant fatalities, and 21 occupant injuries and \$124 million in direct property damage per year. The leading cause of fires in warehouses (excluding cold storage) is from electrical distribution or lighting resulting in 17% civilian injuries. The leading area of fire origin in warehouses comes from an unclassified storage area resulting in 21% civilian injuries.

The potential fire hazards (inclusive of the leading causes, as well as area of origin of a fire) identified throughout the development are illustrated in the graphs below. The statistics as illustrated in the figures below have been obtained from the NFPA website (www.nfpa.com).

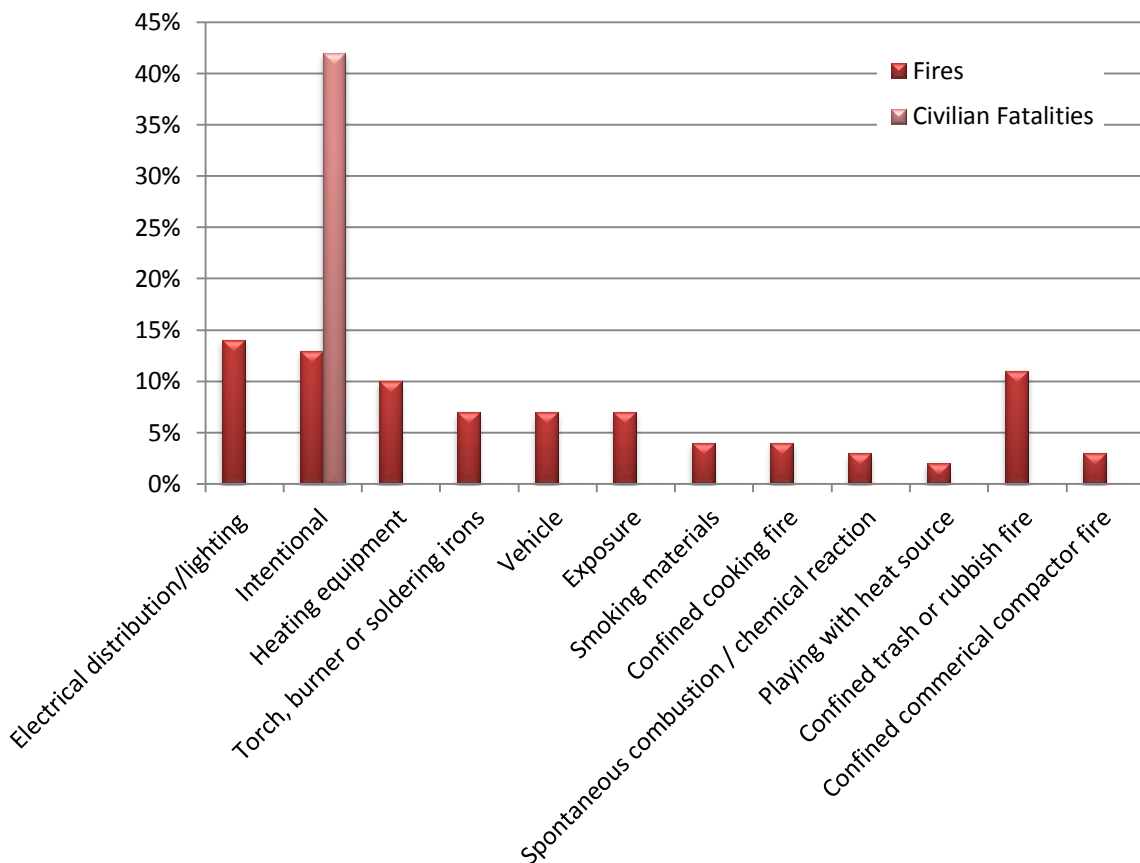


Figure 6-1 Leading Causes of Fires in Warehouse Structures

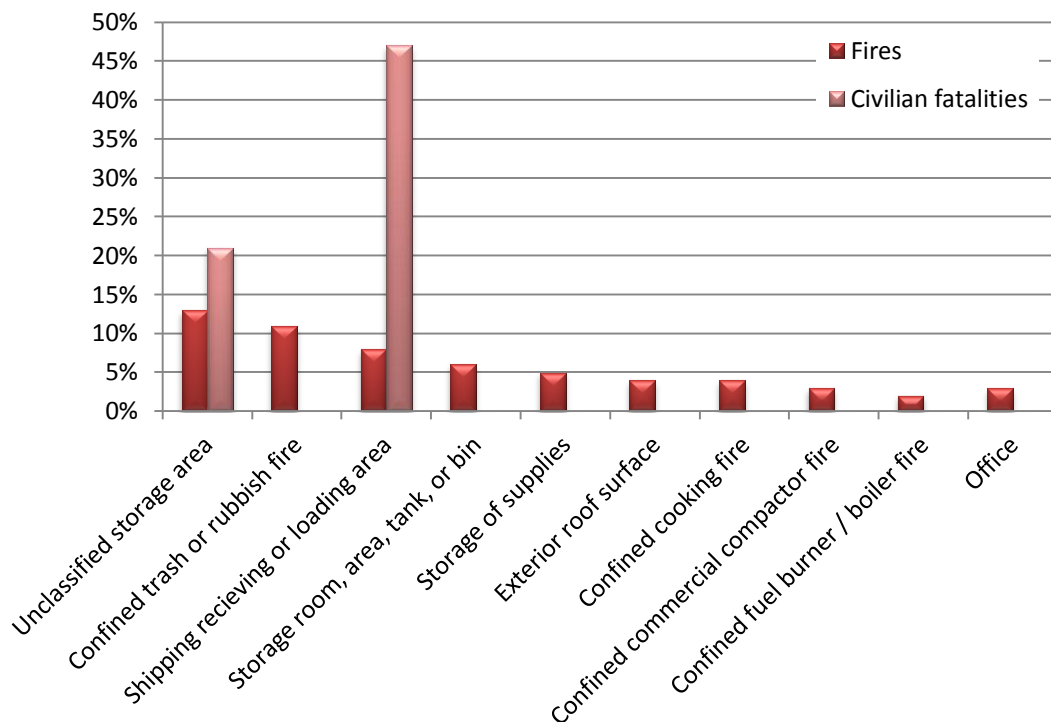


Figure 6-2 Structure Fires in Warehouse Structures by Area of Origin

6.3 SPRINKLER EFFECTIVENESS & RELIABILITY

The effectiveness of automatic fire sprinklers in general in limiting fire spread and growth is supported by statistics and studies undertaken into the effects of automatic fire sprinklers within buildings. These studies show that fire sprinkler systems operate and control fires in 81% to 99.5% of fire occurrences [3]. The lower reliability estimates of 81.3% [10] as well as some of the higher values of 87.6% [12] appear to reflect significant bias in data in terms of the small number of fire incidents and the lack of differentiation between fire sprinklers and other fire suppression systems. A number of the lower figures are results of dated studies.

It must be noted that the higher reliability of fire sprinklers reported by Marryatt [14] of 99.5% reflect fire sprinkler systems where inspections, testing and maintenance exceeded normal expectations and applies to installations specifically in Australia and New Zealand. The statistical data indicate that sprinklers with appropriate maintenance are highly effective in reducing the loss of life and limiting fire spread and in particular the Storage Mode system has an exemplary record.

With reference to FM Global data sheet (2-2) as of 2002 [5] there had been six known fires involving suppression mode sprinkler protection. In all of these incidents, the sprinkler system was successful in suppressing the fire and no more than four sprinkler heads operated. Therefore for the purposes of this assessment, on the activation of the Storage Mode fire sprinkler system, the fire growth is considered to be suppressed within the area of activation.

FM Global Data Sheet 2-0 states that, FM Global loss history over the past twenty years indicates that approximately 25% of the time, the operation of a single sprinkler will control or suppress a fire if the sprinkler system has been properly designed and installed. This percentage increases to approximately 50% of the time with the operation of 3 or fewer sprinklers, and 75% of the time with the operation of nine or fewer sprinklers.

In addition analysis of the likelihood of sprinkler failure shows that most sprinkler system failures are due to impaired water supplies such as closed valves, blocked pipes, impaired sources, etc., which tend to affect sections of or the entire system [12]. As such, system reliability can be increased by active monitoring of water supplies and controls. The general consensus within the fire protection



industry is that problems with individual sprinkler heads are rare. This information combined with sprinkler reliability data is favourable when compared with the reliability of fire compartmentation [3].

Moinuddin and Thomas [12] have found that masonry fire rated construction had a reliability of 81-95%, and gypsum 69-95%, with the upper level in both instances having been reported within the IFEG [3]. Both reported ranges are considered to be less than that offered by automatic sprinkler systems. Table 6-2 lists the effectiveness of sprinkler systems in the event of a fire growing to a size that facilitates sprinkler head activation [12].

Table 6-2: Effectiveness of Sprinkler systems

PROPERTY TYPE	EFFECTIVENESS OF SPRINKLERS IN EVENTS WHERE SPRINKLERS OPERATE
Public Assembly	90%
Educational	93%
Health care / Correctional Centre	95%
Residential (average)	97%
Office / Retail	91%
Manufacturing	93%
Storage	86%
Cold Storage	89%
All properties	7%

Statistics for general sprinkler effectiveness in storage properties is provided in the table below which is drawn from the research of Rohr [15]. The data indicates over 77% of storage fires and 84% of manufacturing facility fires are confined to the area of fire origin where sprinklers are fitted.

Table 6-3: The Effectiveness of Sprinkler in Storage Facilities

EXTENT OF FLAME DAMAGE	FIRES WITH SPRINKLER PROTECTION	FIRES WITHOUT SPRINKLER PROTECTION
Confined to object of origin	50.0%	19.9%
Confined to area of origin	27.8%	14.1%
Confined to room of origin	6.7%	4.9%
Confined to fire-rated compartment of origin	1.1%	0.6%
Confined to floor of origin	2.4%	1.1%
Confined to structure of origin	10.0%	45.0%
Extended beyond structure of fire origin	2.2%	14.3%
Total:	900 fires	29,330 fires

According to the tests undertaken by FM Global Property Loss Prevention Data Sheets [5], automatic smoke exhaust systems would operate prior to an installed storage mode sprinkler system. This would result in the removal of hot smoke from the ceiling causing a critical delay in sprinkler operation. As such, FM Global recommends that a sprinkler system should not be installed in conjunction with automatic smoke exhaust systems.

It is considered likely that the BCA DTS smoke management would hinder and prevent the activation of the sprinkler system as discussed in the FM Global Property Loss Prevention Data Sheets. The failure of the sprinkler system would allow fire development and cause uncontrolled spread throughout the building leading to a more rapid onset of untenable conditions, significant property loss, and restriction of fire fighter access into the building.

Furthermore, rapid fire development and spread could eventually overrun the sprinkler system by resulting in the activation of several fast response sprinkler heads, over and above the system design requirement, potentially depleting the water supply. In this instance, the system may be rendered ineffective and unable to hydraulically perform as intended. As such, it is recommended that the removal of the BCA DTS smoke management system would allow hot smoke to build up in the ceiling leading to the activation of the sprinkler system as intended by design parameters which are based on tested systems and therefore improving the likelihood of fire control and/or suppression.



6.4 FIRE LOAD

The fire load within a room or compartment will influence the duration and severity of a fire and resultant hazard to occupants. The effective fire load for the building has been estimated by consideration of the typical spaces within the building.

The following fire loads have been extracted from Chapter 3.4 of the International Fire Engineering Guidelines [3] and are listed in Table 6-4. This data is derived from Switzerland, however is also deemed applicable to buildings in Australia of similar use.

The warehouses are considered to generally contain mixed types of commodities, where in some cases cellulosic materials are mixed with plastics and non-combustible materials on the same racks. There is a large amount of data concerning the burning rates of items and materials; however, this information is not often presented such that it is sufficiently generic to be universally adopted.

Also, while the current occupants within the buildings may be known during the design stages of the development the length of their occupancy cannot be definitively identified. Therefore while what can be representative of the current fuel loadings for the enclosure, these may not be the case in the future use of the building. Therefore, it would be a rare assessment in which the specific items forming the fuel load had been tested to provide the fire heat release data. As such it is considered that the application of generic burning rates, translated through simplified mathematical expression (time squared growth rates) is a suitable means of estimating fire development.

Table 6-4: Fire Load Densities

TYPE OF OCCUPANCY	AVERAGE FIRE LOAD
Forwarding facility dealing in; beverages, food, furniture, glassware, plastic product, printed goods, textiles, varnish/polish.	Range from; 200 MJ/m ² - 1700 MJ/m ²
Storage of rubber products	5000 MJ/m ² /m
Storage of paper	1000 MJ/m ² /m

6.5 FIRE GROWTH RATE AND INTENSITY

As the fire increases in size, the rate of fire growth accelerates. The growth rate of a fire can result in various hazards for occupants due to the following:

- Protective and preventative measures may not be adequate.
- Occupants may have insufficient time to evacuate.
- Occupants may perceive a reduced threat from slow growing fires.

The rate of fire growth is generally expressed in terms of an energy release rate. The most commonly used relationship is what is commonly referred to as a quadratic time-squared fire. The basis of the time squared fire arises from the fact that the growth during the flaming stage can be approximated by a smooth curve that can be expressed mathematically. The rate of heat release is given by the expression:

$$Q = \left(\frac{t}{k} \right)^2$$

Where: t = time from after ignition of the fire (seconds)
 k = the growth time (seconds)
 Q = a heat release output of 1.055 MW.

Studies of actual fires have led to the adoption of five (5) standard fire growth rates covering a wide range of potential fire scenarios and fuel loads. It should be noted, the times of fire incubation are not included in the time-squared growth fire models. National Fire Protection Association Standard NFPA 92B [12] provides information on the relevance of time-squared approximation to real fire as depicted in the figure below.

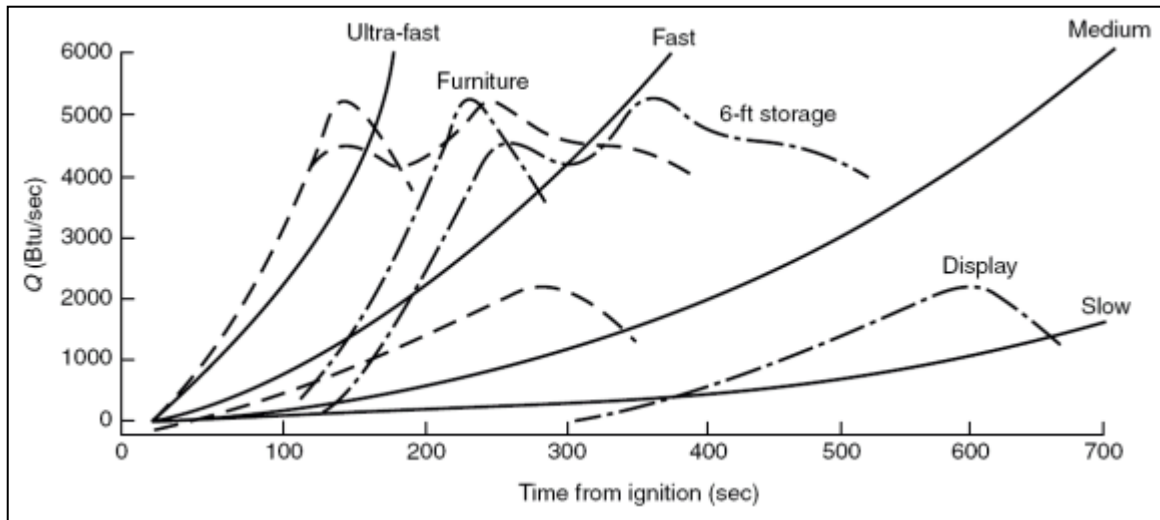


Figure 6-3: NFA 92B: t-squared fire, rates of energy release

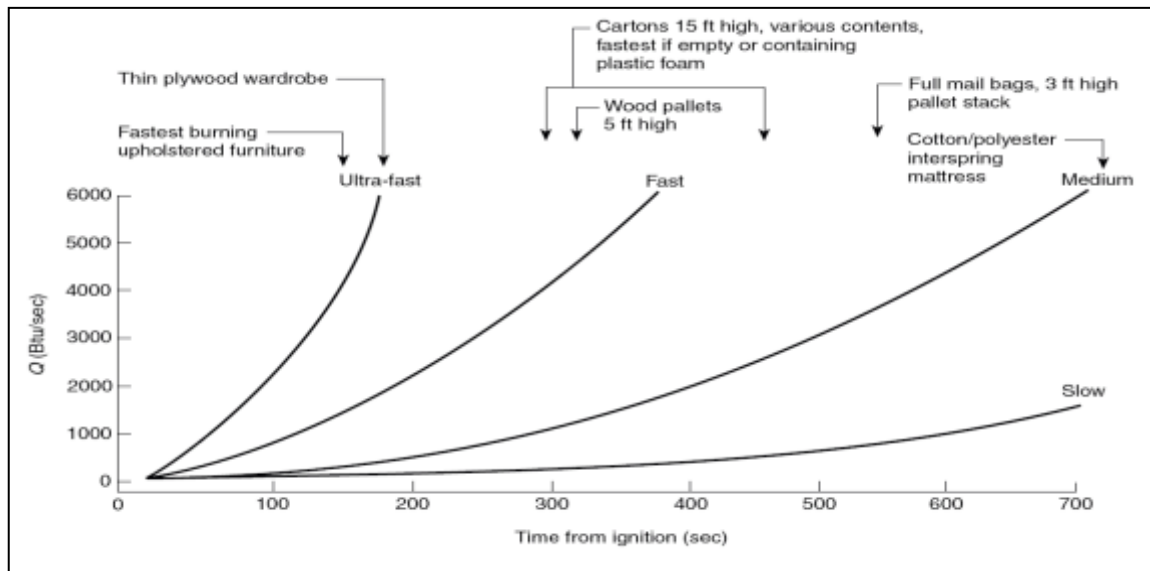


Figure 6-4: NFA 92B: Relation of t-squared Fires to some Fire Tests

The rate of fire growth can also be estimated from data published in British Standard (BS) 9999:2008 [5] as shown below in Table 6-5, and Table 6-6.

Table 6-5: Summary of Fire Growth Rates per Building Type

BUILDING AREA PROVIDING FUEL	GROWTH RATE	BUILDING AREA PROVIDING FUEL	GROWTH RATE
Reception area	Slow	Restaurant/Canteen	Medium
Office	Medium	Teaching Laboratories	Fast
Shop	Fast	Meeting Room	Medium
Warehouse	Medium/Fast/Ultra-Fast	Waiting Room	Slow

The variation in warehouse growth rates can be understood from the following table illustrating the types of stored items.



Table 6-6: Fire Growth Rates as described in BS 9999:2008

FIRE GROWTH RATE	STORED MATERIALS
Slow t^2	Banking hall, limited combustible materials.
Medium t^2	Stacked cardboard boxes, wooden pallets.
Fast t^2	<i>Baled thermoplastic chips, stacked plastic products, and baled clothing.</i>
Ultra-Fast t^2	Flammable liquids, expanded cellular plastics and foam.

From the above tables (and figures) it is concluded that the likely fire scenarios in the block pallet storage may be approximated by a Fast standard time-squared fire growth rate curve, while the office areas can be approximated with a Medium time-squared fire growth rate.

Note: where the pallets are stored in racking structures, an ultra-fast growth rate can be expected.

6.6 FIRE SOOT YIELD

The materials that make up the fuel load will determine the soot yield of a fire. The fire soot yield should be assessed with respect to hazard due to the following:

- Soot yield can affect visibility for occupants trying to escape a fire.
- Soot yield can be directly related to other products of combustion which may cause untenable conditions.

The fire load within the warehouse is likely to contain a variety of plastics and cellulosic materials. Generally cellulosic materials have far lower smoke yields than plastics. A common plastic is polyurethane which has a soot yield of 0.1 kg/kg as referenced from Babrauskas in the NFPA Handbook. As a conservative input into the computer fire/smoke modelling all material involved in the fire has therefore assumed to be plastic.

6.7 FIRE HAZARD SUMMARY

Subsequent to a review of the relevant fire statistics and hazards presented in Section 1 the fire hazards for the building are listed in the following table. Hazards due to functions or characteristics are reviewed based on the building in question and relevant statistics; and

1. A description is provided on the nominated hazards; and
2. Relevant preventative / protective measures are provided to address the nominated hazards.

Table 6-7: Building Hazard Assessment

POTENTIAL HAZARDS DUE TO:	DESCRIPTION / DETAILS		PREVENTATIVE & PROTECTIVE MEASURES TO ADDRESS HAZARDS
Building layout	Egress provisions	Exits are provided around the building perimeter to allow for multiple alternative egress opportunities. Areas within the warehouse have limited dead end travel routes to exits. However due to the size of the building, extended travel distances to the nearest of the alternative exits and between alternative exits exist. Within the subject building it is not expected that there will be any greater exposure to fire as a result of the alternative solution. No hazards to adjoining buildings have been identified, hazards generally relate to any internal exposures. Occupants in the area of fire origin are expected to be aware of fire and commence evacuation.	Type B construction, BCA Spec C1.1 (Table 5) except for Alternative Solution Fire Hydrants, BCA Clause E1.3, AS2419.1: 2005 Fire Hose Reels, BCA Clause E1.4, AS2441:2005



POTENTIAL HAZARDS DUE TO:	DESCRIPTION / DETAILS	PREVENTATIVE & PROTECTIVE MEASURES TO ADDRESS HAZARDS						
Activities	<p>With regard to activities it is not expected that regular hot work processes, manufacturing processes or operation of high friction or high temperature machinery will be performed within the building. The development is principally a forwarding facility with two dedicated storage areas in which pallets can reach 5 high. As it is a forwarding facility there is not expected to be any degradation of old stock.</p> <p>Notwithstanding the assumed turnover, the storage is assumed to be constantly filled to capacity due to the constant rolling stock.</p> <ul style="list-style-type: none"> ■ Corridors, stairs and lobbies will generally be used only for transient purposes, occupants travelling to and from the various parts of the building. 	<p>Fire Extinguishers, BCA Clause E1.6, AS2444:2001</p> <p>Automatic Suppression Systems, FM Global & AS 2118.1:1999</p>						
Ignition sources	<p>Based on the statistical review contained above the ignition sources relevant to this site;</p> <ul style="list-style-type: none"> ■ Mechanical equipment (applicable to the picking machinery) ■ Lighting equipment ■ Intentional fire starts ■ Stored waste or rubbish ■ Heating equipment 	<p>Occupant Warning System, AS1670.1:2004 Clause 3.22.</p> <p>Smoke Management System, Alternative Solution in lieu of BCA Spec E2.2b.</p>						
Fuel sources	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 15%; text-align: center;">Quantity of materials</td> <td>Dangerous goods will not be stored in the warehouse however there will be dangerous goods in transit. These goods are to be handled in accordance with the Australian Code for transport of Dangerous goods by Road and Rail.</td> </tr> <tr> <td style="text-align: center;">Location of materials</td> <td>The highest concentrations of fuel will be located in the pallet storage areas which can reach 5-high in the south-east wing and 3-high in the central section. Throughout other areas, goods will likely be in transit. The lobbies, stairways and corridors are to be maintained clear of furniture, stored items and the like and constructed with materials and assemblies in accordance with C1.10 to reduce fire spread and smoke production in the event of fire in common areas.</td> </tr> <tr> <td style="text-align: center;">Fire behaviour</td> <td>Fire growth rates will vary with fuel type and conditions of ventilation and compartmentation. The most likely outcome of any fire outbreak within the building is expected to be sprinkler controlled fire. Prior to suppression / control, a fire would be expected to grow at a Fast time squared fire growth rate.</td> </tr> </table>	Quantity of materials	Dangerous goods will not be stored in the warehouse however there will be dangerous goods in transit. These goods are to be handled in accordance with the Australian Code for transport of Dangerous goods by Road and Rail.	Location of materials	The highest concentrations of fuel will be located in the pallet storage areas which can reach 5-high in the south-east wing and 3-high in the central section. Throughout other areas, goods will likely be in transit. The lobbies, stairways and corridors are to be maintained clear of furniture, stored items and the like and constructed with materials and assemblies in accordance with C1.10 to reduce fire spread and smoke production in the event of fire in common areas.	Fire behaviour	Fire growth rates will vary with fuel type and conditions of ventilation and compartmentation. The most likely outcome of any fire outbreak within the building is expected to be sprinkler controlled fire. Prior to suppression / control, a fire would be expected to grow at a Fast time squared fire growth rate.	<p>Automatic Link to Fire Brigade, BCA Spec E1.5.</p> <p>Emergency Lighting, BCA Clause E4.2/E4.4, and AS2293.1:2005.</p> <p>Exit Signage, BCA Clause E4.5, NSW E4.6, NSW E4.8, AS2293.1:2005.</p>
Quantity of materials	Dangerous goods will not be stored in the warehouse however there will be dangerous goods in transit. These goods are to be handled in accordance with the Australian Code for transport of Dangerous goods by Road and Rail.							
Location of materials	The highest concentrations of fuel will be located in the pallet storage areas which can reach 5-high in the south-east wing and 3-high in the central section. Throughout other areas, goods will likely be in transit. The lobbies, stairways and corridors are to be maintained clear of furniture, stored items and the like and constructed with materials and assemblies in accordance with C1.10 to reduce fire spread and smoke production in the event of fire in common areas.							
Fire behaviour	Fire growth rates will vary with fuel type and conditions of ventilation and compartmentation. The most likely outcome of any fire outbreak within the building is expected to be sprinkler controlled fire. Prior to suppression / control, a fire would be expected to grow at a Fast time squared fire growth rate.							
Fire origins	<p>Refer to previous charts whereby fires are likely to occur in the following origins:</p> <ul style="list-style-type: none"> ■ Pallet storage areas ■ Waste and rubbish containers ■ Receiving or loading area 							



7 BCA DTS NON-COMPLIANCE ASSESSMENT

7.1 OVERVIEW



In this instance the BCA DTS non-compliances have been formulated based on the regulatory review as provided by the project building surveyor and / or design team. Where not listed herein the building is required to achieve compliance with relevant DTS clauses or if existing, comply with relevant codes, reports and / or Standards approved at the time of consideration.

The following table lists the departures from the DTS provisions of the BCA for the proposed building and the analysis methodology proposed for the Fire Engineering assessment, which is to be generally in accordance with the IFEG [3].

Table 7-1: Summary of Alternative Solutions

BCA DTS PROVISIONS & PERFORMANCE REQUIREMENT	PERFORMANCE BASED SOLUTION
<p>BCA DTS Provisions</p> <p>C1.1 – Fire resisting construction</p> <p>Performance Requirement</p> <p>CP1</p>	<p>BCA DTS Provision</p> <p><u>Specification C1.1</u> states that internal columns (other than those immediately below the roof) need prescriptively achieve a Fire Resistance Level (FRL) of 240/-/-- for a building of Type B construction.</p> <p>Non Compliance</p> <p>Internal load bearing columns supporting the mezzanine structures may not achieve an FRL of 240/-/-- and the building is required to be of Type B construction for certification purposes due to the fashion mezzanine having a height greater than 6m.</p> <p>Alternative Solution</p> <p>The reduced FRL of the columns supporting the mezzanine structures will be demonstrated to be sufficient through assessment of:-</p> <ul style="list-style-type: none"> ■ The effect of the sprinkler system on enclosure temperatures; ■ The consequence of failure of the mezzanine structures is low given that they are single storey constructions, therefore only localised failure is expected having minimal effect on the global structural behaviour; and ■ Occupant numbers, characteristics and evacuation times. <p>Assessment Methodology</p> <p>The assessment methodology will adhere to BCA Clauses A0.5b(i), A0.9(b)(ii) and A0.9(c) in an absolute assessment demonstrating compliance with the relevant Performance Requirement.</p>
<p>BCA DTS Provisions</p> <p>C2.4 – Vehicular access</p> <p>Performance Requirement</p> <p>CP9</p>	<p>BCA DTS Provision</p> <p><u>Clause C2.4</u> requires vehicular access as a continuous means of passage for emergency vehicles in a forward direction around the entire building. Further to this, the roadway is required to have a width of no less than 6m and be located within 18m of the building.</p> <p>Non Compliance</p> <p>Whilst vehicular access is provided around the whole of the building, access around the landscaped north-eastern and south-eastern areas marked for potential future expansion leaves a distance of greater than 18m to the proposed building.</p>



BCA DTS PROVISIONS & PERFORMANCE REQUIREMENT	PERFORMANCE BASED SOLUTION
	<p>Alternative Solution</p> <p>The Alternative Solution will, in consultation with Fire & Rescue NSW demonstrate that the configuration of perimeter access combined with the fire safety systems installed within the building ensure that fire fighting capabilities are not adversely disadvantaged.</p> <p>Assessment Methodology</p> <p>The assessment methodology follows Clauses A0.5(b)(i), A0.9(b)(ii), A0.9(c) and A0.10 of the BCA. An absolute and qualitative approach fire safety engineering assessment shall be completed to establish that the design matches the relevant Performance Requirement in facilitating direct adequate access and entry into the building to undertake fire and emergency intervention activities.</p>
<p>BCA DTS Provisions</p> <p>Clause D1.4: Distance to the nearest exit.</p> <p>Clause D1.5: Distance between exits.</p> <p>Clause D1.6: Dimensions of exits and paths of travel to exits</p> <p>Clause D1.9: Travel by non-fire-isolated stairways</p> <p>Clause D1.10: Discharge from exits</p> <p>Clause E2.2: Smoke hazard management</p> <p>Performance Requirements DP4, DP6 & EP2.2</p>	<p>BCA DTS Provisions</p> <p><u>Clause D1.4</u> states that the travel distance to the nearest exit must not exceed 40m where more than one exit is available.</p> <p><u>Clause D1.5</u> states that the travel distance between alternative exits must not exceed 60m.</p> <p><u>Clause D1.6</u> states that the unobstructed height within required paths of travel must not be less than 2m and the unobstructed width not be less than 1m.</p> <p><u>Clause D1.9</u> states that the travel distance via a required non-fire-isolated must not exceed 80m and that discharge from a non-fire-isolated exit must not be more than 20m from an exit or 40m from the nearest of 2 required exits in opposite directions.</p> <p><u>Clause D1.10</u> requires that the path of travel from any discharge point from the building be in open space for the length of the path.</p> <p><u>Clause E2.2</u> (inter alia Table E2.2a) requires large isolated buildings with a ceiling height above 12m and a having floor area or volume more than 18,000m² or 108,000m³ respectively to be equipped with an automatic smoke exhaust system in compliance with the requirements of <u>Specification E2.2b</u>.</p> <p>Non-Compliances</p> <p>The following DTS non-compliances have been identified in the warehouse:</p> <ul style="list-style-type: none"> ■ Travel distances to a point of choice of up to 30m in lieu of 20m; ■ Travel distances to the nearest exit of up to 90m in lieu of 40m; ■ Travel distances of up to 110m between alternative exits in lieu of 60m; ■ Unobstructed height of exit paths is likely to be reduced to 1.8m in lieu of 2m in locations with the conveyor belt overhead; ■ Widths of exit path anticipated to be less than 1m in proximity to the conveyor belt; ■ Travel distances via non-fire-isolated stairways are likely to exceed 80m with discharge from these stairs exceeding 20m from a single exit and 40m from the nearest of 2 opposite exits; ■ Discharge into the recessed docks which requires occupants to pass under an awning and hence the path of travel does not do not consist of open space. ■ Smoke levels resulting from a fire will be managed by using either natural venting or an exhaust system throughout the warehouse with rationalised exhaust rates and reservoir sizes in lieu of the DTS requirements <p>Alternative Solution</p> <p>The Alternative Solution will rely upon the volume of the warehouse enclosure to act as a smoke reservoir for hot combustion products and the implemented smoke management system in order to provide the population with adequate time to safely evacuate the building prior to the onset of untenable conditions.</p>



BCA DTS PROVISIONS & PERFORMANCE REQUIREMENT	PERFORMANCE BASED SOLUTION
	<p>Egress below the roof leading from the from the recessed docks relies on the height of any openings, the width of the path and the free venting of smoke to the atmosphere to ensure occupants will not encounter hazardous conditions before reaching the nearest road.</p> <p>Assessment Methodology</p> <p>The assessment methodology will adhere to Clauses A0.5(b)(i), A0.9(b)(ii), and A0.10 of the BCA. The analysis will be absolute and quantitative with a supporting qualitative argument. The results of the deterministic assessment are measured directly against the agreed acceptance criteria.</p> <p>Computational Fluid Dynamics (CFD) will be used to simulate the fire development and smoke spread in the warehouse with these results utilised in an ASET/RSET time-line analysis to demonstrate occupant and fire brigade life safety.</p>



8 PROPOSED FIRE SAFETY STRATEGY

The fire safety strategy outlined below has been proposed to satisfy the fire and life safety objectives specified for this project by the relevant stakeholders. In addition, the fire safety strategy is required to adequately address the specific fire and life safety hazards identified for the proposed development, and as such have been generally derived from the preventative and protective measures outlined within the BCA, and fire engineering literature and research. Where items of non-compliance have not been identified by the design team in the concept design it is considered that those items are expected to be Deemed-to-Satisfy (DTS) solutions.

The specified Fire Safety Strategy will undergo analysis as part of the Fire Engineering Report to ascertain whether the relevant Performance Requirements of the BCA are satisfied. The fire safety strategy will incorporate the following elements:-

8.1 FIRE RESISTANCE PROVISIONS

8.1.1 Fire Resisting Construction

The requirements of Type B construction as listed in Specification C1.1 of the BCA 2012 are as follows:

- External walls >18m from fire-source feature: --/--/--
- External columns >3m from fire-source feature: --/--/--
- Loadbearing internal columns: 240/--/--
- Internal columns in the storey immediately below the roof: --/--/--
- Roof: --/--/--

The main warehouse structure shall be in accordance with the requirements of Type B construction with the exception of the internal load-bearing columns supporting the mezzanine structures. These columns will be assessed as part of an Alternative Solution with the FRL of these columns defined in the Fire Engineering Report through a fire severity analysis.

8.1.2 Early Fire Hazard Properties

Floor, wall and ceiling linings shall comply with the requirements of BCA Clause C1.10 and Specification C1.10 to reduce the spread of fire and the generation of toxic smoke products.

8.2 ACCESS AND EGRESS PROVISIONS

8.2.1 Evacuation Strategy

Activation of any sprinkler head or detector shall initiate the evacuation of all areas of the building. Dedicated fire wardens from the warehouse and office areas shall ensure that all clients, visitors, and staff are promptly evacuated.

8.2.2 Egress Provisions

The travel distances to a point of choice, to the nearest exit, and between alternative exits must comply with the BCA DTS requirements with the following exceptions which shall be assessed as part of an Alternative Solution;

- Travel distances to a point of choice of up to 30m
- Travel distances of up to 90m to the nearest exit;
- Travel distances of up to 110m between alternative exits.

Travel via non-fire-isolated exits may also exceed the DTS provisions with:

- Travel distances via non-fire-isolated stairways likely to exceed 80m; and
- Discharge from these stairs likely to exceed 20m to a single exit or 40m from the nearest of 2 exits in opposite directions.



Note: The above travel distances are based on the preliminary drawings provided and are to be confirmed by the Authority Having Jurisdiction.

Exit locations shall be located around the building perimeter with dedicated internal egress pathways made available to facilitate the above travel distances.

A clear height of no less than 2.0m above finished floor level shall be provided in all required egress paths with the exception of the clear height under the conveyor system which may be reduced to no less than 1.8m and will be assessed as part of an Alternative Solution. Further, egress widths through the operational area of the conveyor system may temporarily be reduced to 0.8m at pinch points.

Note: the quantity and location of the egress width and height non-compliances shall be reviewed upon receipt of a final conveyor layout design.

8.2.3 Door Hardware, Operation and Mechanisms

All exit doors and doors in a path of travel to an exit are required to be DTS compliant throughout. This includes the swing of doors, the applied latching and locking mechanisms and the force required mechanism used to open sliding doors.

8.2.4 Signage and Lighting

Emergency lighting is to be provided throughout in accordance with DTS Provisions E4.2 and E4.4 of the BCA 2012 and AS2293.1:2005.

Exit signage is to be provided throughout in accordance with the DTS Provisions E4.5, E4.6, E4.8 of the BCA 2012 and AS2293.1:2005; however the heights of some exit signs may exceed the maximum height of 2.7m above FFL.

8.3 SERVICES AND EQUIPMENT PROVISIONS

8.3.1 Fire Indicator Panels

Services to be connected to the Fire Indicator Panel (FIP) located in the main office entry area include; automatic sprinkler systems; smoke detection system; occupant warning and smoke hazard management systems.

The FIP must:

- Be capable of isolating, resetting, and determining the fire location within the development;
- Be connected to a direct brigade notification alarm and building occupant warning systems that shall both initiate upon fire detection by the sprinkler and/or smoke detection systems; and
- Have smoke hazard management system controls including clear signalling of the operational status of the fans.

8.3.2 Building Occupant Warning System

A building occupant warning system is to be installed such that an audible alarm is provided throughout all parts of the building. The system shall be in accordance with the prescriptive requirements of AS1670.1:2004, Specification E1.5 and Clause 6 of Specification E2.2a of the BCA 2012.

The occupant warning system shall be connected to the FIP such that the alarm tone is sounded throughout all areas upon fire detection by the smoke detection system or the sprinkler systems installed throughout the building.

8.3.3 Fire Sprinkler System

Automatic fire sprinklers shall be provided throughout the building:

- Storage Mode sprinklers will be installed above the pallet storage areas in the south-east wing and also in the central sections. They are to be installed in accordance with AS 2118.1:1999 with sprinkler heads located and spaced in accordance with FM Global Data Sheets 8-9 and 2-0.
- Ordinary hazard sprinklers throughout the rest of the warehouse installed in accordance with AS 2118.1:1999.



- Light hazard sprinklers in the office areas in accordance with AS 2118.1:1999.
- Different sprinkler hazard types are to be separated by a draught curtain as required by the relevant Australian Standard and manufacturer's specification. An indicative sprinkler layout and separation is shown in Figure 8-1.

The systems shall be connected to the reserve water supply, sprinkler pumpsets and fire indicator panel. The systems shall be programmed to initiate the building occupant warning system and direct brigade alarm upon activation of any sprinkler head in the system.

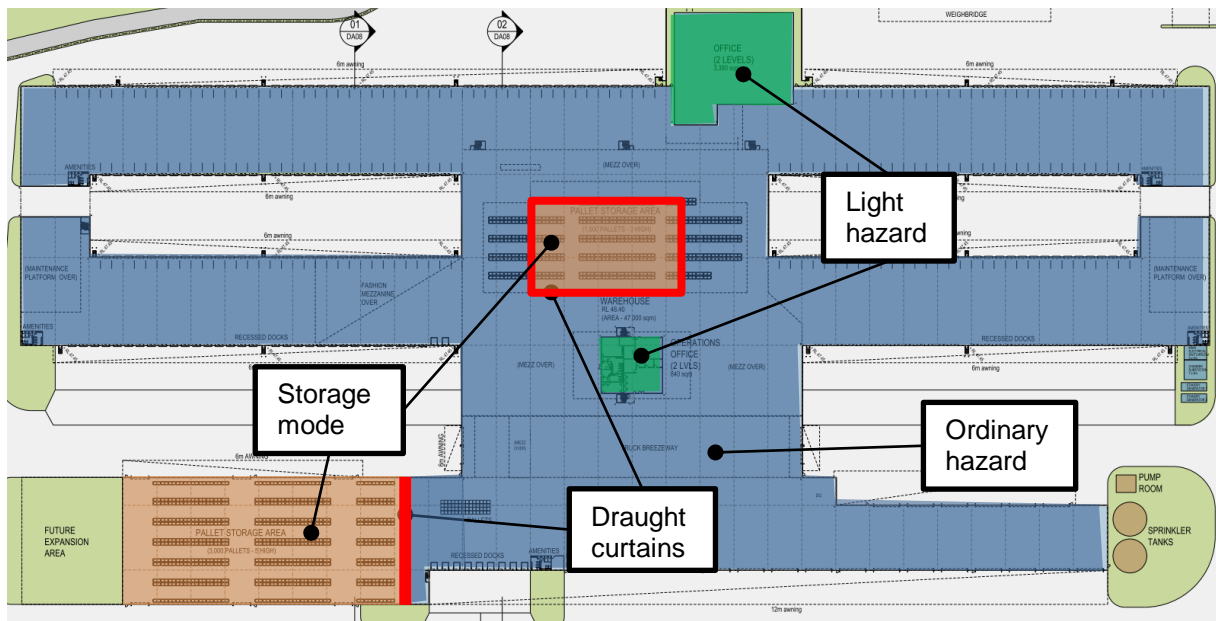


Figure 8-1: Indicative Sprinkler System Locations

To reduce the probability of fire spread, the conveyor belt and other automated machinery shall stop upon detection of a fire in the building.

8.3.4 Smoke Detection System

A smoke detection system shall be installed throughout the warehouse building in accordance with AS 1670.1:2004 with extended spacing in accordance with 1668.1:1998 (i.e. 20m by 20m grid). It shall be connected to the occupants warning alarm such that if a fire is detected in the building, the alarm is initiated throughout all areas.

8.3.5 Fire Hose Reels

Fire hose reels shall be provided throughout the building in accordance with the prescriptive requirements of Clause E1.4 of the BCA 2012 and AS2441:2005.

Locations should be signposted and readily accessible to occupants. Use of facilities should be monitored for abuse, mistreatment and servicing. The fire hose reels shall be located within 4m of an exit and provide coverage to all areas of the building based on a 36m hose length with a 4m water stream (i.e. maximum 40m coverage from the hose location).

8.3.6 Portable Fire Fighting Equipment

Portable fire extinguishers are to be provided throughout the building in accordance with the prescriptive requirements of Table E1.6 of the BCA 2012 with the extinguisher type selected, located, and distributed in accordance with AS2444:2001.

- | | | |
|--|------------------|--------|
| ■ Plant rooms | Dry Powder (ABE) | 2.5 Kg |
| ■ Designated exits | Dry Powder (ABE) | 4.5 Kg |
| ■ Adjacent each fire hose reel cabinet | Dry Powder (ABE) | 4.5 Kg |
| ■ Electrical switch board | Dry Powder (ABE) | 5.0 Kg |



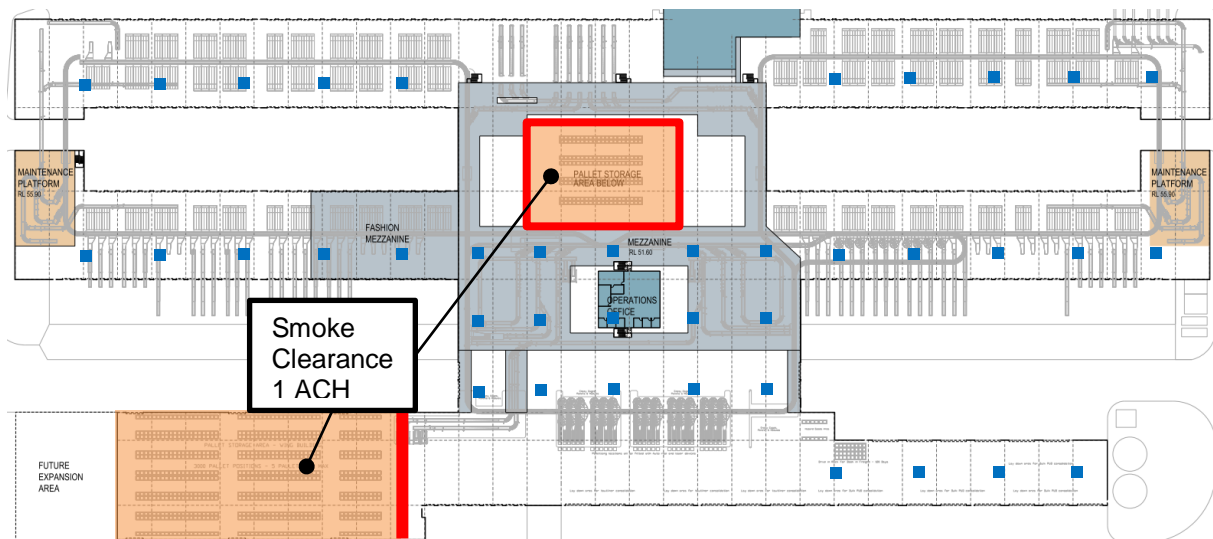
8.3.7 Smoke Hazard Management System

A method of managing smoke produced from a potential fire is required in order to ensure the safe egress of occupants from the building. Two systems shall be used, based on the sprinkler systems operational within the warehouse as outlined in Section 8.3.3. These are:

- Automatic smoke extraction; and
- Manual smoke clearance.

Manual smoke clearance systems will be installed in the locations where a storage mode sprinkler system is operational, specifically above the pallet storage areas in the central area and in the south-eastern wing.

Throughout the rest of the warehouse automatic smoke exhaust shall be installed to delay the onset of untenable conditions for egressing occupants. The number of fans and the exhaust rates required will be investigated fully in an Alternative Solution however through preliminary CFD modelling, it is suggested that the layout shown in Figure 8-2 be adopted, with exhausts capable of extracting 5000 L/s.



- Denotes location of 5000 L/s automatic smoke exhaust

Figure 8-2: Smoke Management Scheme

The mechanical smoke exhaust system must automatically activate upon smoke detector activation and as such, must be linked to the installed detection system. Smoke exhausts will be zoned with each wing and the central area comprising different zones and each zone operating independently upon detector activation within that zone.

The inlet area required in order to supply a sufficient volume of make-up air shall be calculated with perforations in roller shutters being used to achieve this.

8.4 FIRE BRIGADE INTERVENTION

8.4.1 Fire Brigade Rendezvous

The fire brigade rendezvous point shall be at the main FIP. The Main FIP shall be provided with tactical fire plans such that it shall form the fire control centre.

8.4.2 Fire Hydrants

The fire hydrant system must be capable of providing coverage to all parts of the building based on a 30m (internal hydrant connections) and a 60m (external hydrant connections) hose length with an additional 10m water stream. Where internal hydrants are located, blockplans no smaller than A4 in size shall be provided externally; adjacent to the nearest exit door for fire brigade reference.



All works shall be in accordance with the prescriptive requirements of the BCA 2012 Clause E1.3 and Part E1 and AS2419.1:2005.

- Flows and pressures are required to be achieved as per the current regulatory requirements.
- A ring main shall be installed to serve all hydrant points. It shall be provided with isolation valves, as required by AS2419.1:2005, that are external to the building and numbered with the corresponding numbers indicated on the blockplan at the booster assembly.
- External hydrant connections shall be provided with the heat shields per the requirements of AS2419.1 (i.e. FRL 90/90/90 2m either side, and 3m above the hydrant connection point) or be setback more than 10m from the building.
- All connection points must be fitted with Storz hose couplings which comply with Clause 7.1 and 8.5.11 AS2419.1:2005. Further information is available from the FRNSW Guide Sheet No.4 'Hydrant system connectors' available at www.fire.nsw.gov.au.

8.4.3 Vehicular Perimeter Access

Vehicular perimeter access around the building is required for the fire brigade to have adequate access to this large isolated building. The pathway shall be designed and constructed in all-weather surface capable of supporting all FRNSW appliances in accordance with BCA Clause C2.4 and NSW Fire Brigade Policy No. 4 'Guidelines for emergency vehicle access', available at http://www.fire.nsw.gov.au/gallery/files/pdf/guidelines/vehicle_access.pdf.

The pathway shall form a continuous access in a forward direction with a minimum unobstructed width of 6m, and no part of its furthest boundary more than 18m from the building with the following exceptions to be addressed by an Alternative Solution;

The vehicular access pathway around the landscaped areas at the south-eastern and north-eastern corners of the building which are marked for future expansion is permitted to be in excess of 18m from the structure. The details of this location are illustrated below in Figure 8-3.

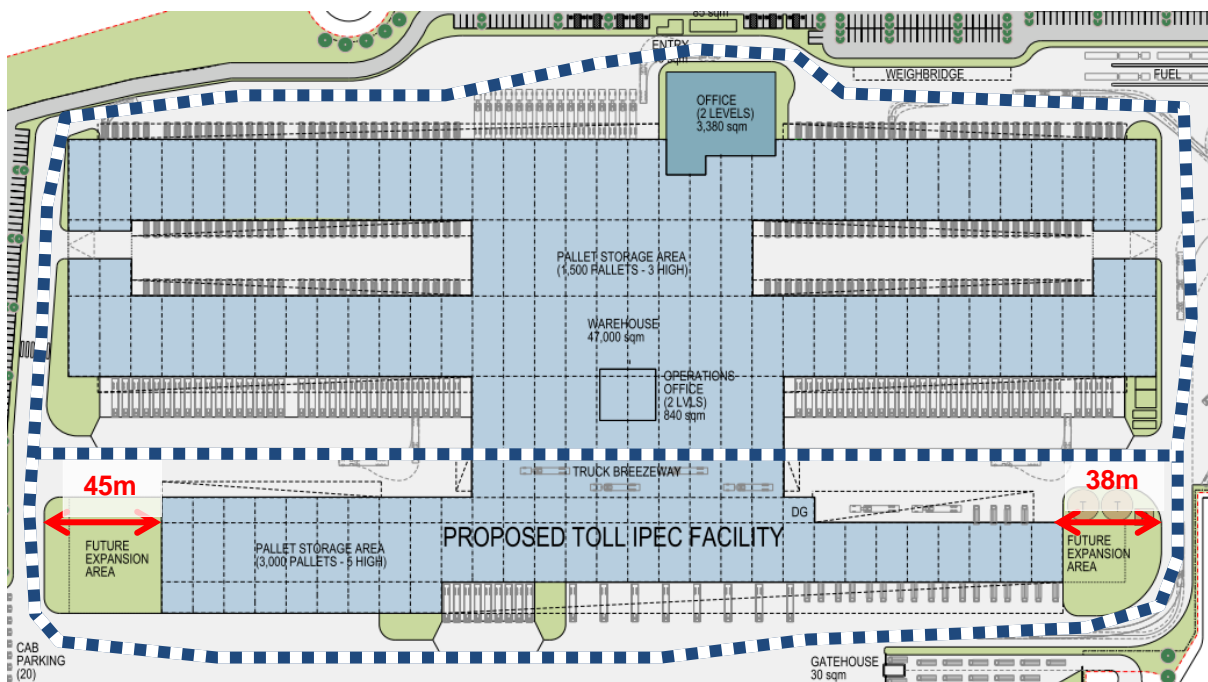


Figure 8-3: Non-Compliant Vehicular Perimeter Access

Note: where the pathway temporarily passes under awnings and/or the pedestrian walkover, a clear height of no less than 4.5m must be provided to allow free access for the fire brigade.

8.5 BUILDING MANAGEMENT PROCEDURES

The ongoing management of the building is as important in maintaining a high level of life safety as the provisions recommended during the design phase of the building.



8.5.1 Distribution of Commodities and Storage of DG / HS

The storage commodities to pass through the forwarding facility shall be classified and monitored to ensure that the quantities of any dangerous goods, i.e. hazardous, flammable or corrosive goods do not exceed the limitations defined in AS3833:2007 for 'Minor Storage'.

Dangerous goods will not be stored on site; however goods may pass through the site in transit. Where this is the case, dangerous goods must be handled in accordance with the Australian Code for Transport of Dangerous Goods by Road and Rail.

8.5.2 Maintenance of Fire Safety Equipment

The fire sprinkler system, emergency warning, fire hydrants, hose reels, portable fire extinguishers, emergency lighting and any other fire safety equipment shall be tested and maintained in accordance with Australian Standard AS 1851 or other relevant testing regulatory.

8.5.3 No Smoking Policy

A no-smoking policy shall be implemented and enforced through all internal areas of the building, with designated smoking areas provided externally away from building openings and areas used for external yard storage.

8.5.4 Housekeeping

A Fire Risk Assessment (FRA) or similar method should be adopted upon occupation to determine high risk areas, processes and fuel loads and instigate appropriate control measures. The FRA should be undertaken periodically or upon major alterations to the building layout or to the occupancy demographic or distribution.

8.5.5 Fire Drills and General Fire Safety Training

All fire wardens are to be trained in first-aid fire fighting and emergency response. All staff shall be inducted with a fire safety brief including the actions necessary on the activation of the building emergency warning system and the location of all emergency egress paths and fire exits.

In addition periodic fire drills should be undertaken and any lessons learned included in future fire safety procedures.

8.5.6 Evacuation Planning and Risk Management

An evacuation plan should be developed in accordance with AS3745:2010, with standard fire orders displayed throughout the building. Further to this AS4360:2204 should be consulted regarding risk management in the site.

8.5.7 Assembly Area

An assembly area is to be designated in a suitably safe and open location.

8.5.8 Fire Safety Manual

A fire safety manual shall be developed to provide an overview of all fire safety procedures and systems within the building. The manual will also record false alarms, outcomes from fire drills and provide details of the ongoing maintenance and inspection procedures. The manual should be reviewed annually and a lessons learned exercise undertaken. Any conclusions drawn from this exercise should be implemented into the fire safety procedures.

8.5.9 Premises Security

Arson is a major cause of industrial fires and malicious arson attacks may be well planned to overcome specific fire safety systems. The provision of adequate levels of security is a key parameter in reducing the number or effects of malicious arson attacks in any premises.

8.5.10 Hot Works Policy

A hot works policy should be put in place and rigorously enforced to ensure that all hot works, including grinding and welding, are managed to avoid the accidental ignition of fires.



9 REFERENCES

1. ABCB, "Building Code of Australia, Volume One", CanPrint Communications, Canberra 2012.
2. ABCB, "Guide to the BCA 2012", CanPrint Communications, Canberra 2012.
3. ABCB, "International Fire Engineering Guidelines", ABCB, Canberra, 2005.
4. The Chartered Institute of Building Services Engineers, 'CIBSE Guide E, "Fire engineering', 3rd Edition, May 2010.
5. Australasian Fire Authorities Council "Fire Brigade Intervention Model V2.2", Australasian Fire Authorities Council, October 2004.
6. Fire Analysis Research Division, (2012), 'Structure Fires by Occupancy' 2006-2010 – Annual Averages', National Fire Protection Association, Quincy, MA
7. Ahrens, M., (2009), Warehouse Fires Excluding Cold Storage, National Fire Protection Association, Quincy, MA
8. FM Global Data Sheet 2-0, Installation Guidelines for Automatic Sprinklers, March 2010.
9. FM Global Data Sheet 8-9, Storage of Class 1, 2, 3, 4 and Plastic Commodities, September 2010.
10. McGrattan, Kevin. "Sprinkler, Smoke & Heat Vent, Draft Curtain Interaction – Large Scale Experiments and Model Development" NISTIR 6196-1, National Institute of Standards and Technology, United States Department of Commerce, Gaithersburg Maryland, September 1998.
11. BS 9999: Code of practice for fire safety in the design, management and use of buildings, October 2008.
12. Technical Standard, "NFPA 92B: Standard for Smoke Management Systems in Malls, Atria and Large Spaces", National Fire Protection Association (NFPA), 2009.
13. Technical Report FCRC-TR 96-02: Building Fire Scenarios – An analysis of Fire Incident Statistics, Fire Code Reform Research Program, March 1996
14. Marryatt, H.W., "Fire: A Century of Automatic Sprinkler Protection in Australia and New Zealand 1886-1986", Australian Fire Protection Association, Melbourne, Australia, 1988.
15. Rohr, KD 2003, "US Experience with Sprinklers", National Fire Protection Association, Quincy, MA.
16. Technical Report FCRC-TR 96-02: Building Fire Scenarios – An analysis of Fire Incident Statistics, Fire Code Reform Research Program, March 1996
17. Flynn, Jennifer, "U.S. Structure Fires in Eating and Drinking Properties", National Fire Protection Association, Quincy Massachusetts, February 2007.
18. Marty Ahrens, (2001) "U.S. Fire Problem Overview Report", NFPA, Quincy, MA.