Coles CDC Expansion
M7 Business Hub, Wallgrove Road
Eastern Creek NSW 2766

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Fire Safety Strategy
Coles CDC Expansion
M7 Business Hub, Eastern Creek

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Report Details

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Document: Fire Safety Strategy

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Report Revision History

REV	DATE ISSUED	COMMENT	PREPARED BY	REVIEWED BY
01	17/01/13	Draft Issue for Comment	**Graham Morris** *MEng (Structural and Fire Safety Engineering)*	**Trent De Maria** *Grad. Cert. (Performance Based Building and Fire Codes)* *Grad Dip (Bdg Fire Safety & Risk Eng)* *B.App Sc, G.C PM, GC Bdg & Planning, Adv Dip OH&S, M.Env & Bus. Mgt*
02	11/02/13	Final Issue		

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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.

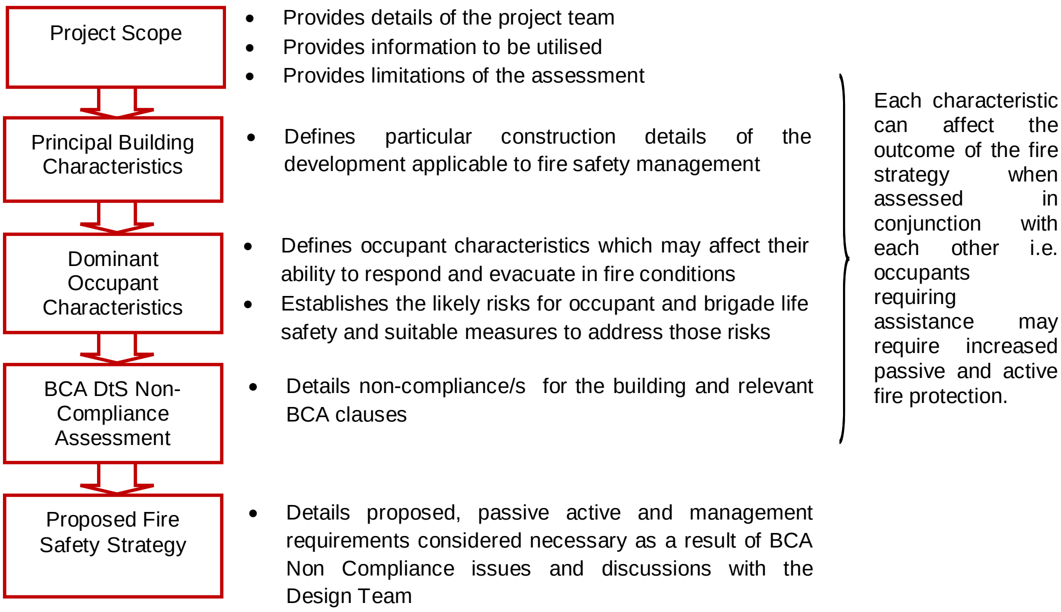


Figure 1-1: Fire Safety Strategy Process

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 assess 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

Project Scope

RAWFire Safety Engineering has been engaged to prepare a fire safety strategy for the warehouse expansion of the Coles Chilled Distribution Centre (CDC) in the M7 Business Hub, Eastern Creek, NSW.

The purpose of this fire safety strategy 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.

RAWFire's scope of works having regard to the expansion is proposed to address the following departures from the BCA DtS Provisions:-

- Permitting extended travel to the nearest and between alternative exits; and
- Rationalised smoke hazard management systems.

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	Will Dwyer	Goodman
Planner	Renee Coull	McKenzie Group
Principal Certifying Authority	Dean Goldsmith	Blackett Maguire + Goldsmith
Fire Safety Consultant(s)	Trent De Maria Graham Morris	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:

- BCA compliance assessment provided by Dean Goldsmith of BM+G dated 07/02/13, rev: 1.
- Architectural plans provided by Goodman, as indicated in Table 2.2.

Table 2-2: Drawings

DRAWING NO.	DESCRIPTION	ISSUE	DATE
DA-02	Site Plan	F	08/02/2013
DA-03	Ground Floor Plan	I	08/02/2013
DA-06	Sections	E	08/02/2013
DA-07	Elevations	D	08/02/2013

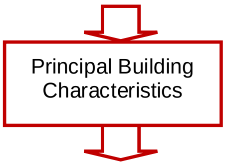
2.4 LIMITATIONS AND ASSUMPTIONS

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 Eastern Creek, approximately 40km west of Sydney CBD. The site is accessed from Roberts Road to the west, with the site bounded by Capicure Drive to the south and Old Wallgrove Road to the north. There are adjacent tenancies to the east but on all sides the distance to a fire source feature is greater than 6m.

The two nearest fire brigade stations that are provided with permanent staff are located in Huntingwood and Mount Druitt approximately 6km and 9km from the site respectively.

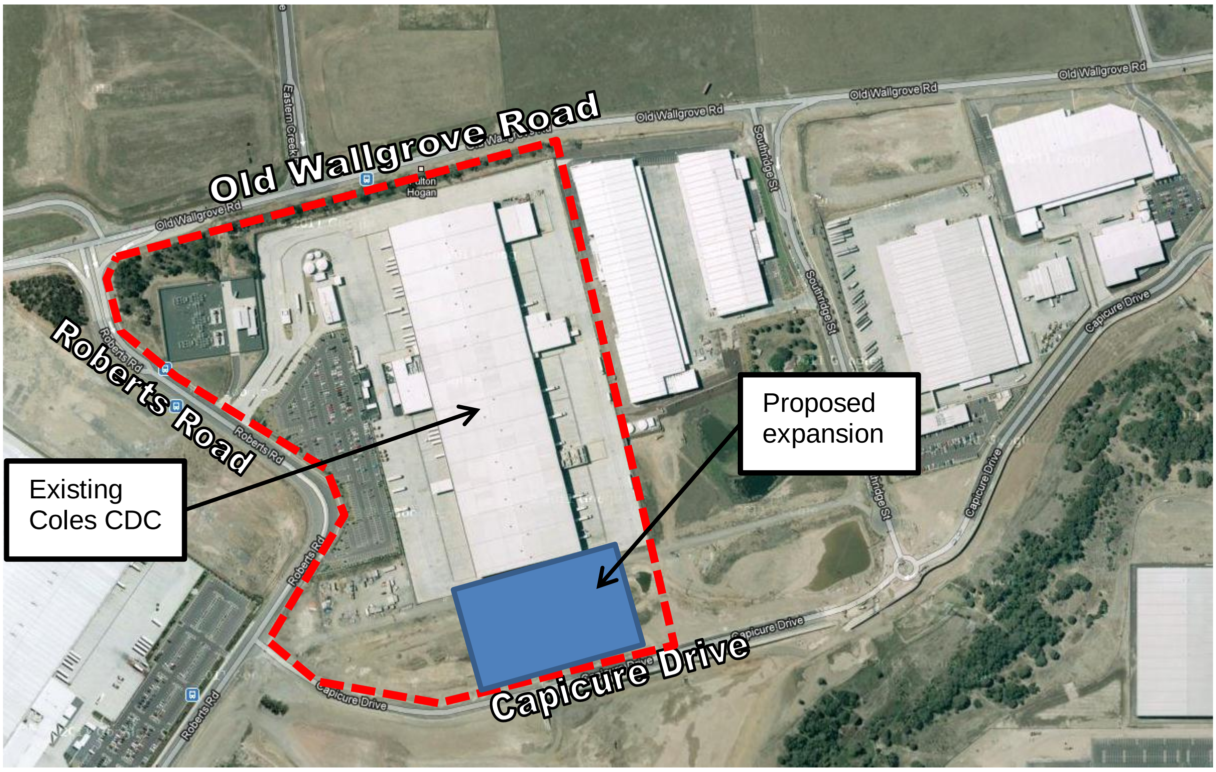


Figure 3-1: Site Layout and Surroundings

The total floor area of the proposed expansion is 12,028m^2 encompassing the area shown in Figure 3-1. This expansion will be segregated into two areas with 14°C produce storage located to the south east of the expansion and 3°C produce storage occupying the remainder of the expansion (Figure

3-2). The 3°C area is accessed by recessed docks to both the east and west of the building with an additional covered loading bay to the 14°C section. The produce storage areas are insulated by polyisocyanurate (PIR) panels to the walls and suspended ceiling of the chilled sections. The suspended ceiling is 12m above FFL while the warehouse structure has a ridge and springer height of approximately 16.25m and 12.2m respectively. A single storey ancillary office is located to the east of the expansion, with access from the 14°C area.

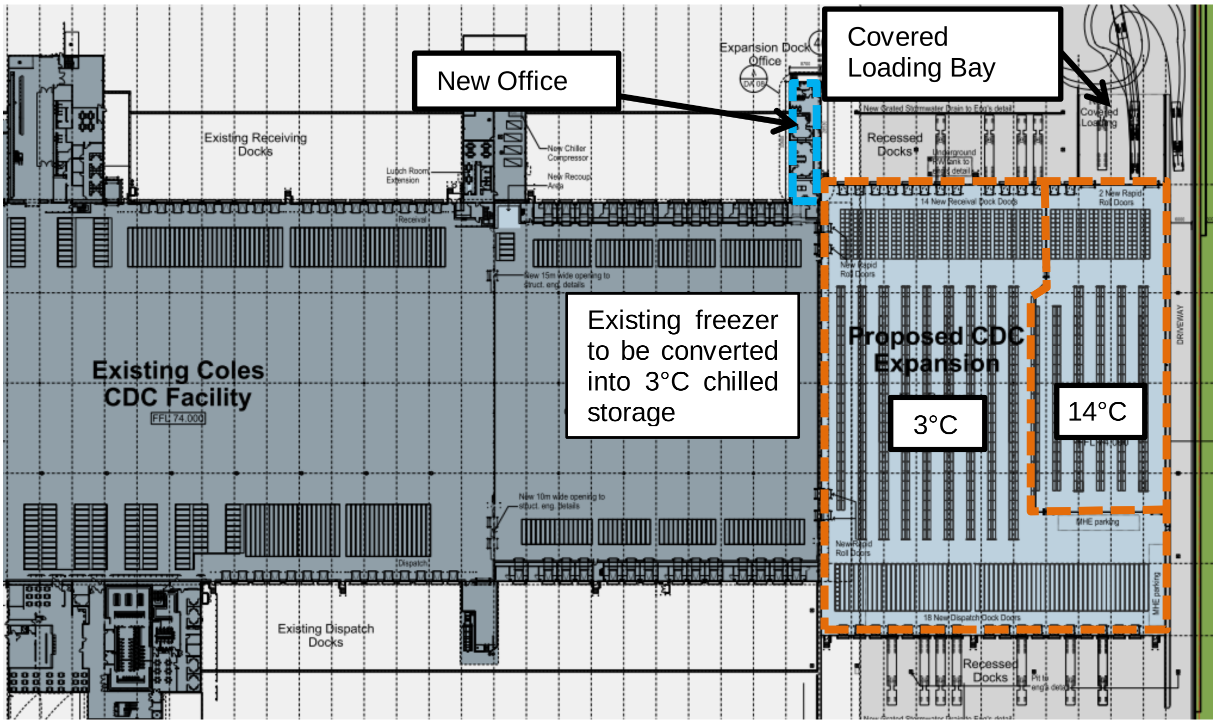


Figure 3-2: Site Plan

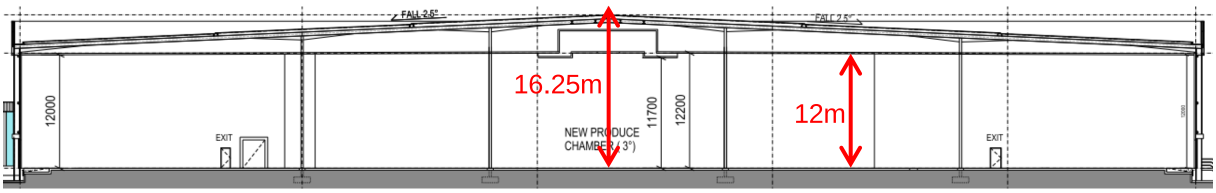


Figure 3-3: Section through 3°C Area

3.3 BUILDING CHARACTERISTIC ASSESSMENT

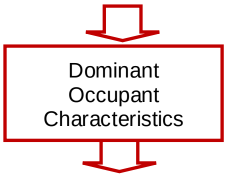
Table 3-1: Building Characteristics

CHARACTERISTIC	DESCRIPTION
Location	The site is located within the M7 Business Hub in Eastern Creek, NSW. The two nearest fire brigade stations are located within 9km of the site. 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. Furthermore being located within a major city outer suburb, the development is provided with the services and facilities expected in an urban setting.
Layout	The expansion is located at the south end of the existing building and has a floor area of 12,028m^2. It is segregated into two storage areas with different temperatures (3°C and 14°C) and there is an ancillary office to the east.

<table>
<tr><th>CHARACTERISTIC</th><th colspan="2">DESCRIPTION</th></tr>
<tr><td></td><td colspan="2">Recessed docks abut the 3°C section on both the east and west sides with a covered loading bay to the east of the 14°C area.</td></tr>
<tr><td>Structure</td><td colspan="2">Materials and finishes shall be in accordance with the DtS requirements for Type C construction. Construction materials will include concrete and steel with external steel sheeting.
PIR panels which comply with Specification C1.10 of the BCA are used internally to insulate the chilled storage areas.
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.</td></tr>
<tr><td>Total Floor area</td><td colspan="2">The floor areas of structures located on this site are as follows:
▪ Existing building: 43,070m^2
▪ Expansion building: 12,028m^2
▪ Expansion dock office: 291m^2
Building total = 55,389m^2</td></tr>
<tr><td>BCA Assessment</td><td>Classification</td><td>Class 7b (warehouse), Class 5 (office)</td></tr>
<tr><td></td><td>Construction Type</td><td>Type C Construction</td></tr>
<tr><td></td><td>Rise in Storeys</td><td>The warehouse and office building has a rise in storeys of 2 due to the existing office.
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.</td></tr>
<tr><td></td><td>Effective Height</td><td>The building has an effective height of less than 12m.</td></tr>
</table>

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	The number of occupants expected within the subject building is considered to be generally less than that assumed in the BCA Table D1.13 [1] due to the type of works being undertaken. However the BCA values shall be used on a preliminary basis to provide an estimated value in the absence of accurate numbers being provided by the building tenant. The BCA assumes the following occupant densities per an areas use: ▪ Warehouse: 1 person per 30m^2 ▪ Office: 1 person per 10m^2 These densities are expected to be onerous and so a more precise population shall be advised by the tenant at a later date.
Population location	The population is expected to be distributed throughout the building. The office is considered to 'on average' be more densely populated than the warehouse, however the building's function and use may dictate an overall lower occupant number in the office areas.
Physical and mental attributes	Occupants in the building are likely to 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. 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 greater than in other warehouse and office buildings. ▪ ***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

CHARACTERISTIC	DESCRIPTION
	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	■ ***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.
Emergency training	The majority of staff members are unlikely to have had any formal emergency training, therefore it will not be relied upon for any assessment.
Pre-movement time	Pre-movement time typically applies only to areas remote from the room of fire origin where occupants may receive only a single cue to the presence of a fire and where those cues do not present an immediate threat to their health and safety. The pre-movement time depends primarily upon the design behavioural scenario category and the fire safety management level, with some effect of building complexity. For the design behavioural scenario, the following factors influence: ■ ***Roles*** – The overarching role within the building will be staff/visitor with visitors reliant on staff to provide guidance in to where and how to evacuate. ■ ***Level of assistance required/available*** – The majority of occupants are expected to be mobile with staff available to expected to inform others of danger an assist in evacuation. ■ ***Curiosity*** – Upon alarm activation, it is likely that the majority of occupants will be able to see the smoke plume / layer due to the open plan nature of the warehouse. If the visual, aural or olfactory cues are not present they are expected to evacuate in any case due to it being a place of work.

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.

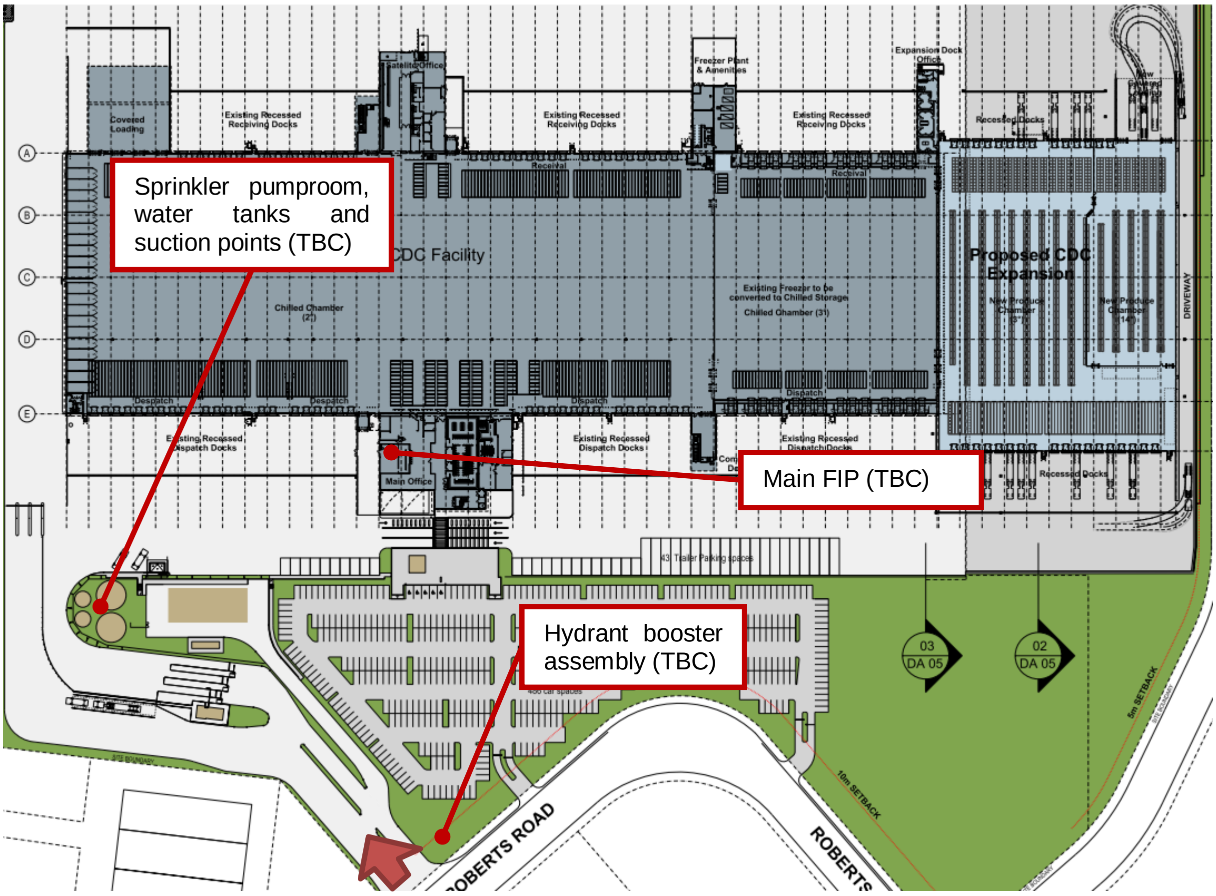


Figure 5-1: Fire Brigade Access and Site Facilities

The two nearest fire brigade stations that are provided with permanent staff are located in Huntingwood and Mount Druitt approximately 6km and 9km from the site respectively. Figure 5-2 illustrates the expected routes to be taken in the event of a fire.

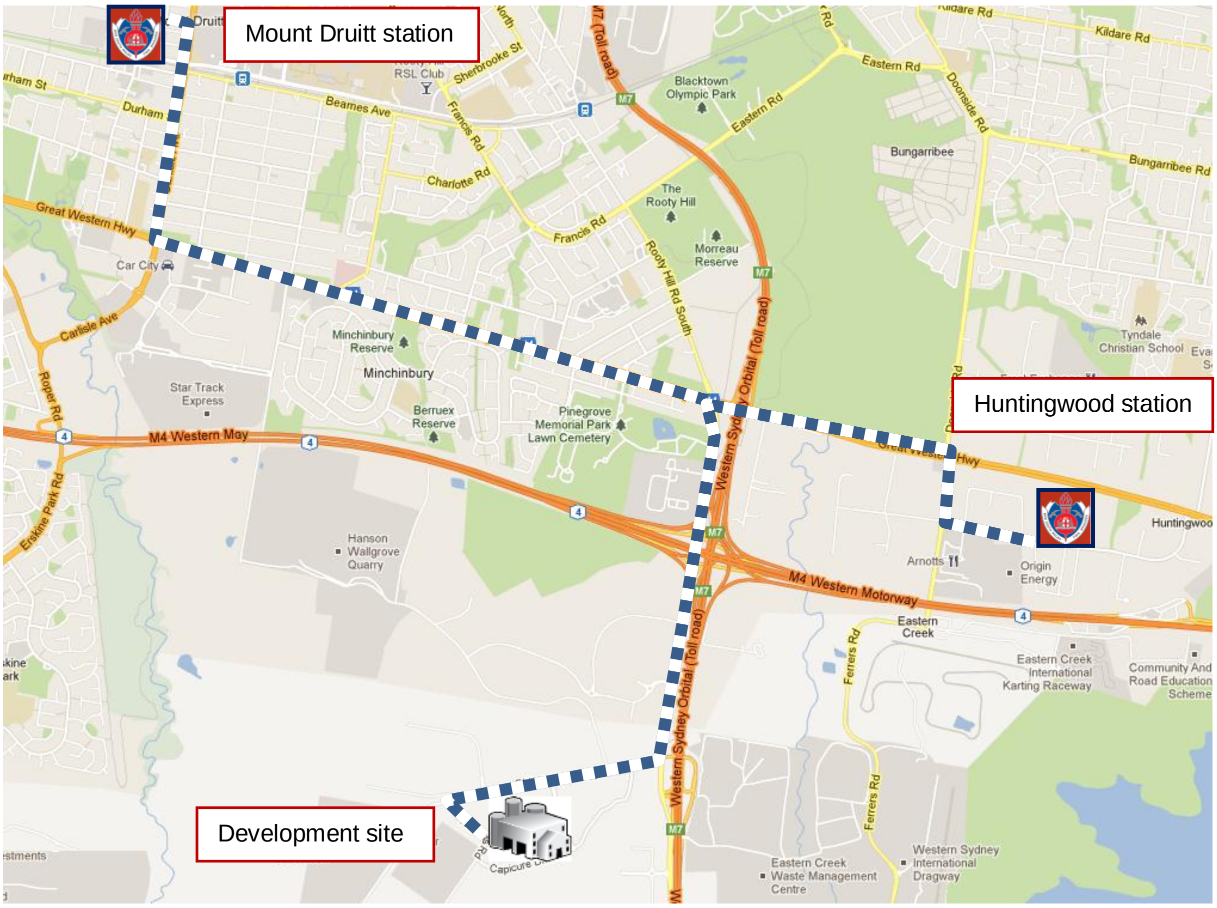


Figure 5-2: Route from the two Nearest Fire Stations

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:

<u>Location of Fire</u>

- 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 north western corner of the warehouse.

<u>Time between Ignition and Detection</u>

- Based on calculations using Alpert's Correlations (Figure 5-3) the initial brigade notification is conservatively assumed to be via the activation of the warehouse sprinkler system at roof level despite the presence of detection systems..

  The detection time calculated has considered a fire with an Ultra-Fast t-squared fire growth rate, which is expected to be indicative of the type of fire in the storage area. The detection time following fire ignition is calculated to occur at 211 seconds.

Input data required			**Fire Type:**	α =
The ambient temperature of the room, T_∞ =	3	(°C)	Ultrafast	0.178
Fire Category =	Ultrafast		Fast	0.044
Output time step =	10	(s)	Medium	0.011
The distance of the detector from the fire, r =	2.11	(m)	Slow	0.003
The height of the ceiling above the fire, H =	11.7	(m)	Custom	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 =	74	(°C)		
Calculated quantities at detector activation				
The gas temperature at sprinkler activation, T =	86.23	(°C)		
HRR at sprinkler activation =	5137.78	(kW)		
The gas velocity, U =	6.18	(m/s)		
Time at detector activation =	171	(s)		
Time to reach 10% of peak HRR =	857	(s)		
Ratio, r / H =	0.18			

Figure 5-3: Sprinkler Activation

- An additional 180 seconds have been considered for the time taken to depressurise the system and activate an alarm.

Time for Initial Brigade Notification

- Fire brigade notification is expected to occur via a direct monitored alarm.
- 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 (171+180+20) = 371 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 x 1.28) = 13.88 km/h which is conservative.

- Appliance travel speeds of 13.88km/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	13.88 km/h	6 km	1556 seconds
Mount Druitt		9 km	2334 seconds

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 x 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 corner of the expansion).

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-(1.28x0.6) = 0.63m/s is utilised.

- Horizontal travel distances 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 450m.
  - Based on the above travel distance of 450m coupled with a travel speed of 0.63m/s the horizontal travel time expected is approximately 714 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 existing section whilst area of proposed expansion is searched. Thus, fire fighting personnel are required to travel an additional 400m. At a speed of 0.63m/s, this will take fire fighting personnel approximately 635 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	371	1556	68	714	2709 (45 min)	635
Mount Druitt		2334			3487 (58 min)	

The FBIM indicates that the arrival time of the brigade from the nearest two fire stations is approximately 32 and 45 minutes respectively after fire ignition. It is estimated that it takes another 13 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 45 and 58 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).

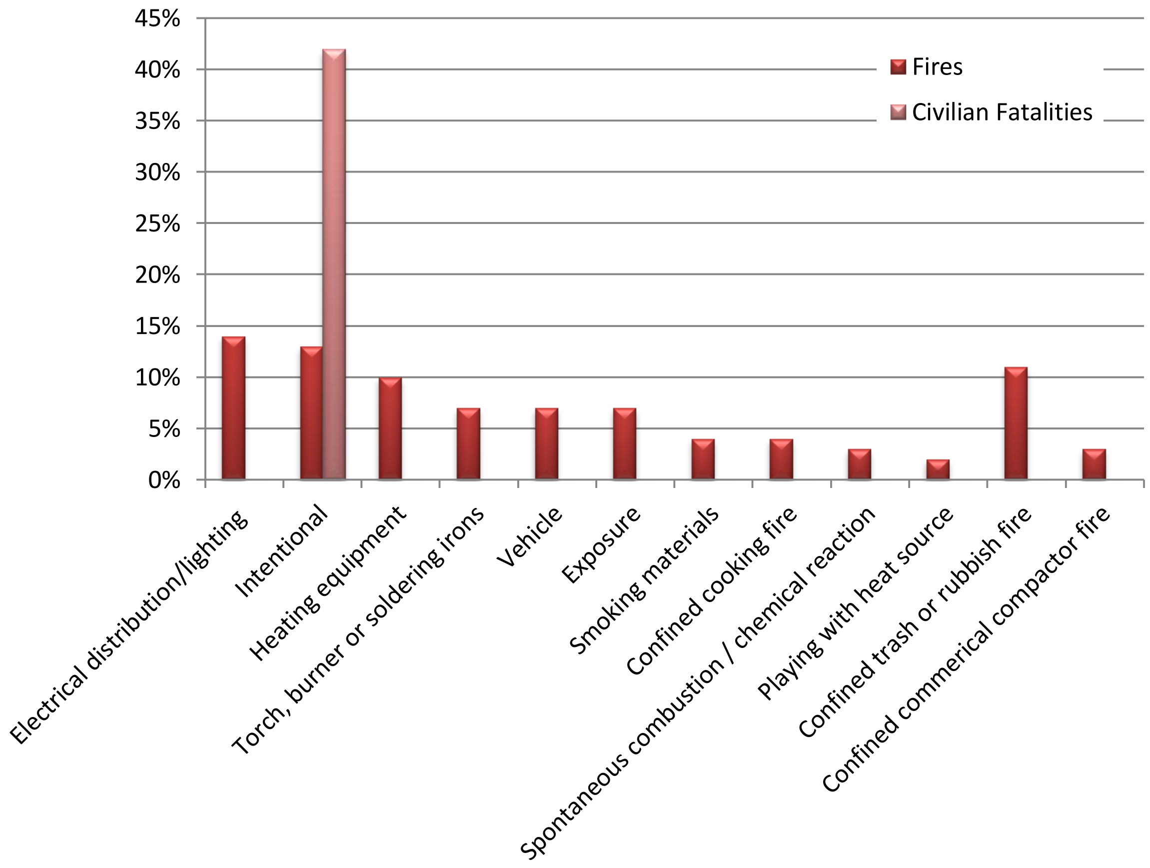


Figure 6-1 Leading Causes of Fires in Warehouse Structures

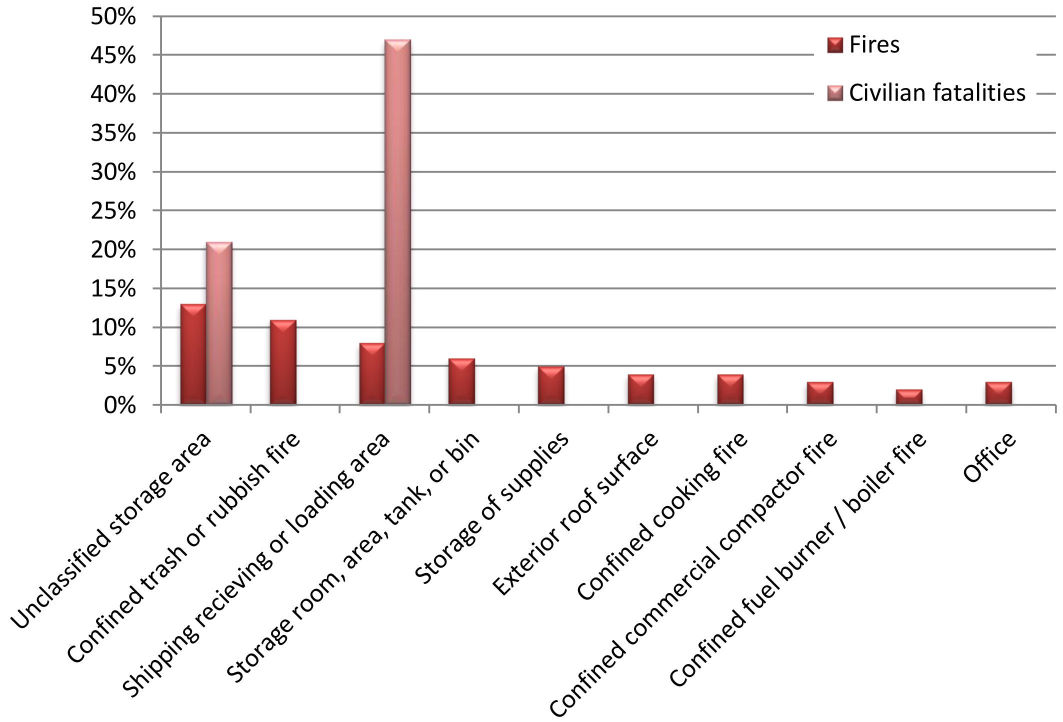


Figure 6-2 Structure Fires in Warehouse Structures by Area of Origin

It is a common misconception that fires do not occur in cold store. However, factors such as an ultra dry atmosphere and the highly combustible nature of polyurethane or polystyrene foam insulation, wooden pallets and plastic wrapping present a high fire risk in these environments. Electrical faults from conveyor/transport equipment, lighting, or hot spots caused by maintenance operation can also contribute to this risk. Additionally the holding capacity of a cold store demands specialized high volume storage racking which can affect the airflow and impede the detection and response to a fire event.

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% [11] 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 [12] 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 [11]. 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 [11] 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 [11].

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%***

Statistics for general sprinkler effectiveness in storage properties is provided in the table below which is drawn from the research of Rohr [13]. 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
Food Store	700 MJ/m^2
Food forwarding	1000 MJ/m^2
Beverage forwarding	300 MJ/m^2

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:

$$Q = ({}^{t}/_{k})^2$$

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 [11] provides information on the relevance of time-squared approximation to real fire as depicted in the figure below.

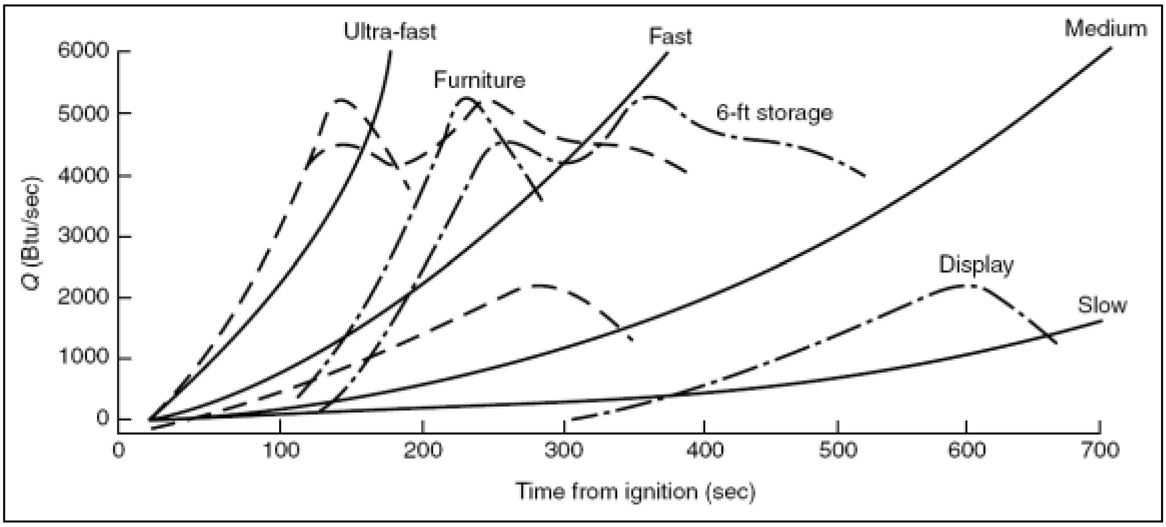


Figure 6-3: NFPA 92B: t-squared fire, rates of energy release

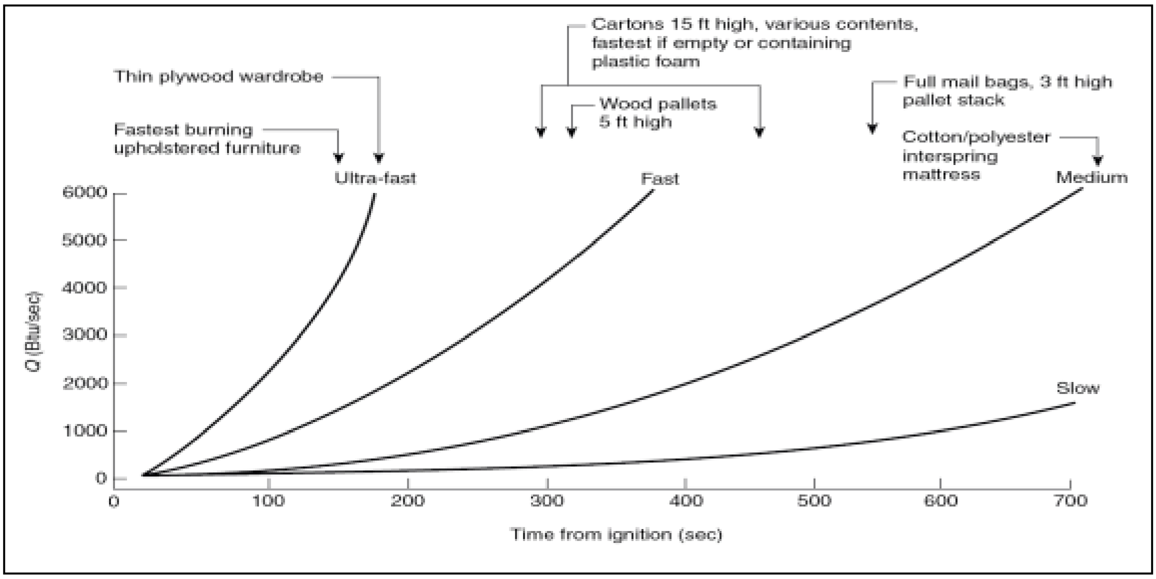


Figure 6-4: NFPA 92B: Relation of t-squared Fires to some Fire Tests

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	Baled thermoplastic chips, stacked plastic products, and baled clothing.
Ultra-Fast t^2	Flammable liquids, expanded cellular plastics and foam.

From the above tables (and figures) it is concluded that as the materials stored (produce) are not likely to present a high rate of fire growth by themselves. However, due to the storage configuration likely to be high bay storage, an Ultra-Fast time-squared fire growth rate curve can be conservatively assumed. The office areas can be approximated with a Medium time-squared fire growth rate.

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 SFPE 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 0 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	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. 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. The PIR insulating panels installed within the building are tested and comply with BCA Clause C1.10. No hazards to adjoining building shave been identified. Occupants in the area of fire origin are expected to be aware of fire and commence evacuation with the open plan nature meaning other occupants become aware of a fire's presence.	▪ Type C construction ▪ Fire hydrants ▪ Booster set ▪ Fire hose reels ▪ Fire extinguishers ▪ Manually operated smoke clearance system ▪ Storage mode sprinkler system ▪ Occupant Warning

POTENTIAL HAZARDS DUE TO:	DESCRIPTION / DETAILS		PREVENTATIVE & PROTECTIVE MEASURES TO ADDRESS HAZARDS
Activities	With regard to activities it is not expected that regular hot work processes, use of highly flammable materials, manufacturing processes or operation of high friction or high temperature machinery will be performed within the building. The development is a storage and forwarding facility likely to contain a large number of high piled and racking containing combustibles. A large number of forklift and similar vehicles will be operational within the building and associated battery storage will be present. Corridors and lobbies will generally be used only for transient purposes, occupants travelling to and from the various parts of the building.		System ■ Extended Grid Spaced Automatic Smoke Detection System ■ Additional detection measures to offset airflow velocities across regular smoke detectors ■ Automatic Link to Fire Brigade ■ Emergency Lighting ■ Exit Signage
Ignition sources	Based on the statistical review contained above the ignition sources relevant to this site, in order of occurrence and likelihood ■ Electrical Equipment / lighting ■ Intentional fire starts ■ Stored waste or rubbish ■ Heating equipment		
Fuel sources	Quantity of materials	Dangerous goods are not expected to be stored within the building in large quantities. Where they are present, they must be stored in accordance with the Workcover OH&S, Australian Standards and other applicable regulatory requirements.	
	Location of materials	Products in high storage racking, store room, waste and rubbish containers. The lobbies 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. Significant fuel loads will therefore be generally limited to the warehouse and offices.	
	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. This would be expected to grow at an Ultra-Fast time squared fire growth rate until sprinkler activation. An office fire would likely be smaller in size due to the limited fuel density and would be expected to grow at a Medium time squared fire growth rate.	
Fire origins	Refer to previous charts whereby fires are likely to occur in the following origins: ■ High storage racking areas ■ Waste and rubbish containers ■ Receiving or loading area		

7 BCA DtS NON-COMPLIANCE ASSESSMENT

7.1 OVERVIEW

BCA DtS Non-Compliance Assessment

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 VARIATION	PERFORMANCE BASED SOLUTION
Access and Egress + Smoke Hazard Management **BCA DtS Provisions** Clause D1.4: Distance to the nearest exit. Clause D1.5: Distance between alternative exits. Clause E2.2: Smoke hazard management **Performance Requirement** DP4 & EP2.2	***BCA DtS Provision*** Clause D1.4 states that the travel distance to the nearest exit must not exceed 40-metres. Clause D1.5 states that the travel distance between alternative exits must not exceed 60-metres. Clause E2.2 (Table E2.2a) requires large isolated buildings with a ceiling height above 12m and a having floor area or volume more than 18,000m^2 or 108,000m^3 respectively to be equipped with an automatic smoke exhaust system in compliance with the requirements of Specification E2.2b. ***Identified Non-Conformance*** The distances of travel to and between exits within the expansion area exceed the BCA DtS prescribed limitations as follows: ■ Maximum exit travel distances of 75m in the new 3°C chamber and 65m in the new 14°C chamber and 85m in the existing freezer area. ■ Distances between alternative exits up to 150m in the 3°C chamber and 130m in the new 14°C chamber and 170m in the existing freezer area. ■ Smoke clearance system installed in lieu of automatic smoke exhaust despite building floor area > 18,000m^2 and volume > 108,000m^3. ***Alternative Solution*** The Alternative Solution will rely upon the volume of the warehouse enclosure to act as a smoke reservoir for hot combustion products with significant reserve so as to provide the population with adequate time to safely evacuate the building prior to the onset of untenable conditions. Additionally, the storage mode sprinkler system is expected to limit the fire growth upon activation. ***Assessment Methodology*** 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 where the results of the deterministic assessment are measured directly against the agreed acceptance criteria, with a supporting qualitative argument. Computational Fluid Dynamic (CFD) programs 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.

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 Resistance & Compartmentation

General Design Guidance:

- Elements of construction that perform a separating function in case of fire should maintain their integrity and insulation for the required duration.
- Horizontal and vertical elements should be used to limit the spread of fire between fire-separated areas.
- All primary structural concrete and steel elements should be protected as required to:-
  - Maintain life safety;
  - Allow for fire brigade intervention;
  - Mitigate structural damage and prevent progressive collapse;
  - Minimise economic impact; and
  - Allow reasonable ‘return to service time’.

Design Requirement:

- The structure including floors, walls, columns and shafts shall be constructed in accordance with the requirements of BCA Clause C1.1, Spec C1.1, Table 5 as applicable to Type C construction included below.
- The construction of new parts must not impact on the fire resistance of existing elements.
- Sandwich panels must be constructed of PIR and not EPS.

8.1.2 Finishes and Linings

General Design Guidance:

Where practical, finishes, linings and materials used throughout the building should be non-combustible.

Design Requirement:

New wall, floor and ceiling, and roof and ceiling assemblies must be tested and rated for their fire hazard properties in accordance with the prescriptive requirements of BCA Clause C1.10 and Specification C1.10. The PIR insulating walls installed within the expansion will conform to this specification and suitable signage on the panels is required to indicate their construction. The construction of new parts must not impact on the fire rating of existing elements.

8.2 EGRESS PROVISIONS

General Design Guidance:

The system should exhibit the following general design principles:-

- Walking surfaces, paths of travel, doorways provided and their dimensions and operation, where practical, and unless specified herein, are to be in accordance with the BCA prescriptive provisions;
- Spacing between exits should typically be in accordance with the BCA prescriptive provisions unless specified herein;

Design Requirement:

Travel distances to an exit, between alternate exits and to a point of choice are to comply unless assessed herein, whereby the following travel distances are to be permitted subject to verification in the fire engineering :-

- Maximum exit travel distances affected by the expansion are as follows:
    - 75m in the new 3°C chamber;
    - 65m in the new 14°C chamber;
    - 85m in the existing freezer area.
- Distances between alternative affected by the expansion are as follows:
    - 150m in the new 3°C chamber;
    - 130m in the new 14°C chamber;
    - 170m in the existing freezer area.

8.3 SERVICES & EQUIPMENT

8.3.1 Fire Detection System

General Design Guidance:

The system should exhibit the following general design principles:-

- It shall be configured to permit localisation of the fire incident as required for appropriate emergency response and activation of other systems;
- A fault in one zone must not render all other zones inoperative
- Installation and configuration should be designed to minimise false or spurious activations
- Systems and components must be suitable for the environment and normal operating atmosphere.

Design Requirement:

Our experience indicates that a smoke detection system shall typically be required throughout the warehouse parts of the building. The detailed fire engineering analysis prepared prior to the issuance of the building permit shall confirm this requirement.

Where it is established that smoke detection is required the detectors must form part of a system complying with AS1670.1:2004 (spaced in accordance with BCA Specification E2.2a clause 5 i.e. AS/NZS 1668.1:1998 extended grid spacing 20m x 20m).

The smoke detection system must also activate any electromagnetic devices or locks that are required to fail safe open upon general alarm and the building occupant warning system.

In addition, due to the condensers used to maintain the compartment temperatures, velocities across sprinklers may be greater than 1.5m/s thereby decreasing their effectiveness. As a result FM Data Sheet 2-0 requires that alternative means of fire detection shall also be installed; either FM Approved flame detection at ceiling level, or line-type heat detection within storage racks.

The detection systems required in the expanded area of the building must not compromise existing systems within the building.

8.3.2 Fire Suppression

General Design Guidance:

The system should exhibit the following general design principles:-

- It shall provide adequate discharge density and coverage to contain and control potential design fire scenarios for the purpose of life safety and/or asset protection;
- The system should be zoned as appropriate to operate effectively with other complementary fire safety management systems where applicable;

- Spray droplet, velocity, trajectory orifice sizing and supply filtration to prevent blockages should be considered as part of the system design; consideration should be given to the corrosive nature of environmental and external contaminant build up, determining material selection, protective coating selection along with any additional maintenance program requirements and or constraints.

Design Requirement:

The existing automatic suppression system is to be modified and extended to provide coverage to the area of new works.

The sprinkler heads, locations and pressures and flows are required to be fitted generally in accordance with BCA DTS Provisions E1.5 and AS 2118.1:1999. In the warehouse parts a storage mode system shall be provided in accordance with AS2118.1:1999 with the sprinkler head type/locations and designed flow/pressures in accordance with the Factory Mutual Guidelines FM 2-0 and 8-9.

In the offices and beneath any awnings attached to the warehouse the system shall comply with BCA Specification E1.5 and AS2118.1:1999.

The work shall at least meet the following requirements:-

- Sprinkler activation temperature no greater than 68°C below the ceiling throughout the office;
- Sprinkler activation temperature no greater than 101°C below the ceiling throughout the warehouse areas;
- Sprinkler activation temperature no greater than 74°C below the ceiling throughout the cold storage areas;
- Sprinkler response time index (RTI) shall not be more than $50m^{1/2}s^{1/2}$ (i.e. fast response type) throughout warehouse parts.
- Sprinkler RTI shall not be more than $50m^{1/2}s^{1/2}$ (i.e. fast response type) throughout office and awning areas also.
- Areas equipped with different sprinkler heads are to be separated from each other by suitable draught curtains in accordance with the relevant sprinkler standard.

Additionally, a dedicated sprinkler storage tank is required on site and should be located in a position allowing fire brigade appliance access.

The existing sprinkler system must not be compromised by the extension of the system to the new part of the building.

8.3.3 Smoke Hazard Management

General Design Guidance:

Smoke management systems within the building must be capable of providing tenable conditions for safe occupant egress.

Design Requirements:

In lieu of the requirements in Specification E2.2b Clause 5 of the BCA, a manually operated smoke clearance system is to be installed in the expansion area as opposed to an automatic smoke exhaust system. The smoke clearance system shall be designed to achieve the following minimum performance requirements.

- Initiation switches shall be located on the main FIP, or an adjacent fan control panel, at the building entry.
- Signs alerting the Fire Brigade to the operation of the smoke clearance system must be provided.
- Fire rated fans and fire rated cabling shall be used and designed to operate at 200°C for a period of 60 minutes.
- System capacity must be capable of one enclosure air change per hour.
- It is recommended that multiple fans be provided and be evenly distributed to otherwise comply with the requirements of Specification E2.2b Clause 5 of the BCA.
- Adequate make-up air shall be provided at low level to facilitate the clearance system's designed operational capacity. The make-up air shall be provided at low level by:-
  - Permanently open natural ventilation louvers; and/or

- Mechanically operated louvers that open upon activation of the fans. All motors and cables must be fire rated to operate at 200°C for a period of no less than 60 minutes.

If used for general ventilation, the air flow rate at any sprinkler head must be less than 1.5m/s and the system must shut down automatically upon any fire alarm, with manual override available to fire fighters.

8.3.4 Building Occupant Warning System (BOWS)

General Design Guidance:

The system should exhibit the following general design principles:-

- It must be sufficiently audible and intelligible so that it is appropriate to the particular enclosure within which it is installed;
- The speakers shall be spaced appropriately;
- Where messages are delivered by the system they should be simple, clear and informative to encourage appropriate occupant behaviour and response;
- Full coverage of evacuation paths and routes need be provided;
- Messaging should be appropriate for the incident and location.

Design Requirement:

The existing BOWS must be extended and modified to include the expansion area in accordance with the prescriptive requirements of the BCA. The system must be in accordance with Specification E1.5 and Clause 6 of Specification E2.2a and is to be interfaced with the sprinkler system and smoke detection system such that the activation of any sprinkler head or detector will initiate the BOWS.

8.3.5 Emergency Lighting & Exit Signage

General Design Guidance:

Emergency lighting and exit signage should be provided in accordance with the Australian Standard and take into account the familiarity (or lack thereof) of the occupants within the building. Lighting need take into consideration any unique design elements.

Design Requirement:

Emergency lighting is to be provided throughout the expansion area and maintained or modified in the existing building to ensure compliance with BCA DTS Provisions E4.2 and E4.4 and AS 2293.1:2005. Exit signage is to be provided in the expansion area in accordance with the BCA DTS Provisions E4.5, E4.6 and E4.8 and AS 2293.1:2005. Exit signage within the existing building must be maintained or modified to reflect any changes in exit routes due to the expansion.

8.3.6 Fire Hose Reels & Portable Fire Extinguishers

General Design Guidance:

Equipment should be provided based on the potential storage hazards to be installed within the building. Locations should be signposted and readily accessible to occupants. Use of facilities should be monitored for abuse, mistreatment and servicing.

Design Requirement:

- Fire Hose Reels are to be installed in accordance with the provisions within the BCA and AS 2441:2005. 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). If this is not achievable due to the temperature of the environment, an alternative solution is to be considered having regard to EP1.1 and the relevant documentation.
- Portable fire extinguishers are to be provided throughout in accordance with BCA Table E1.6 and selected, located and distributed in accordance with AS 2444:2001. Sufficient extinguishers of an appropriate type should be provided throughout the building with regard to the hazards that can be expected in the various areas. Typically the following extinguishers should be used for standardization and shall be provided:

General office areas	Dry Powder (AB:E type)	2.5 Kg
Plant rooms	Dry Powder (AB:E)	2.5 Kg
Designated exits	Dry Powder (AB:E)	4.5 Kg
Adjacent to each fire hose reel cabinet	Dry Powder (AB:E)	4.5 Kg

8.4 FIRE BRIGADE INTERVENTION

General Design Guidance:

Fire brigade access points should be provided and located to facilitate emergency response and the buildings fire safety systems should consider the fire brigades response times.

8.4.1 Fire Hydrants and Booster

Design Requirement:

- The existing fire hydrant system (incorporating external hydrant connections) must be extended and modified to serve the expansion area in accordance with the Fire & Rescue New South Wales requirements, AS 2419.1:2005 and E1.3.
- Fire hydrant booster assembly connections and all new 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 to meet FRNSW requirements. Further information is available from the FRNSW Guide Sheet No.4 '*Hydrant system connectors*' available at www.fire.nsw.gov.au.

8.4.2 Fire Indicator Panel

Design Requirements:

- All existing block plans must be updated to include the expansion and shall be provided at the fire hydrant booster assembly and at the Fire Indicator Panel (FIP).
- The sprinkler system is to be interfaced with the FIP and connected to a monitoring station via alarm signalling equipment.
- The fire brigade rendezvous point shall be at the FIP which shall be maintained at the main entry to the office.

The main FIP shall be updated to represent all additions and alteration to the building. It must be in accordance with BCA Specification E2.2a and AS1670.1:2004 and must be capable of isolating, resetting, and determining the fire location within the development.

- A red strobe shall be installed at the entry to the FIP in a visible location to alert arriving fire brigade of the FIP location.
- The FIP must 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.
- Make-up of sandwich panels to be indicated on block plans (e.g. PIR).

8.4.3 Vehicular Perimeter Access

Design Requirements:

- Complete vehicular perimeter access around the building shall be maintained 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.

8.5 MANAGEMENT CONTROLS AND PROCEDURES

General Design Guidance:

Emergency and operational management plans should be prepared and developed in conjunction with emergency response agencies and centre operators. Regulator training exercises should be conducted to reflect the most likely fire incidents.

Design Requirement:

- A hot work permitting system shall be established for works undertaken within the building during occupation.
- Keep unnecessary combustible loads to a minimum in public areas via regular housekeeping, including the removal of random storage and accumulated debris.
- The recommended fire safety systems must be replaced with equivalent systems in all future works and the recommended fire safety systems must be applied to any renovations or new works.
- Periodic inspection, testing and maintenance of all fire safety systems, fire hydrants, fire hose reels, emergency lighting, exit signage, doors, fire resistance, portable fire extinguishers, etc. should be implemented. Under all circumstances it is important to keep as much of the system fully operational as is practical. Should any building works extend over a number of days, the system must be re-instated as far as practical at the end of each day.
- Scaffolding, wire fencing, barricades and the like must not prevent fire brigade access for vehicles or personnel to essential fire safety components (hydrants, boosters, FIP, etc.) or prevent fire brigade personnel from intervening in the event of a fire.
- A building emergency management plan including relevant elements such as occupant evacuation plans, occupant muster points, fire warden training is to be provided in accordance with AS 3745:2010. The plan must accommodate any staged construction and hand over of the premises.

9 REFERENCES

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