FIRE SAFETY STRATEGY

Proposed Industrial Facility

Building 2B Oakdale South Estate, Horsley Park NSW 2175

Report Number:

192040_Lot 2B_FSS_05

Date:

30/09/2020

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REPORT DETAIL

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Report Revision History

Rev	Date	Comment	Prepared By	Reviewed By
01	18/08/2020	Draft Issue		
02	09/09/2020	Final Issue		
03	11/09/2020	Final Issue: A *Updated To Align With BCA Advice*	**Joshua Raines** *BEng (Civil) (Hons)*	**Thomas Newton** *MEng Fire Safety* *Accredited Fire Safety Engineer (C10)*
04	15/09/2020	Final Issue: B *Updated Architectural Drawings*		
05	30/09/2020	Final Issue: C *Updated Architectural Drawings*		

EXECUTIVE SUMMARY

AFFINITY has been engaged by Goodman Group to develop a preliminary Fire Safety Study for the warehouse development proposed to be located at Building 2B Oakdale South Estate, Horsley Park NSW 2175. The project entails the construction of a storage and dispatch warehouse with associated offices and carpark.

This Fire Safety Strategy (FSS) outlines the fire engineering principles that will be utilised in ensuring that the prescriptive non-compliances with the Deemed-to-Satisfy (DTS) provisions of the Building Code of Australia 2019 Amendment 1 (BCA) [1], as noted herein, are resolved through a fire engineered Performance Solution in order to conform to the building regulations.

The complete fire engineered analysis will form the Fire Engineering Report, and as such is not documented herein. This Fire Safety Strategy does however outline 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.

CONTENTS

1 INTRODUCTION & SCOPE

1.1 Overview

This Fire Safety Strategy has been undertaken and nominates Performance Solutions for assessing compliance with the nominated Performance Requirements of the BCA [1] in accordance with the methodologies defined in the IFEG [3] and provide a workable and safe Fire Safety Strategy.

1.2 Fire Safety Objectives

The objective of the Fire Engineering Assessment is to develop a Fire Safety System, which satisfied the Performance Requirements of the NCC 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 NCC, *"Compliance with the NCC is achieved by satisfying the Performance Requirements"*. In addition to this, certain non-regulatory objectives exist as detailed below.

1.2.1 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) [12] as per the Fire Services State and Territory Acts and Regulations.

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

1.2.2 Building Regulatory Objectives

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

- **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.

1.2.3 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. The client and stakeholders for the design have not requested any additional nonprescribed objectives are required to be met through the preparation of the FER.

1.3 Regulatory Framework of the Fire Engineering Assessment

1.3.1 National Construction Code Series - Building Code of Australia

One of the goals of the BCA [1] 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 A2.1 of the BCA [1] outlines how compliance with the Performance Requirements can be satisfied. These are as follows:

1. Performance Solution; or
2. Deemed-to-Satisfy Solution; or
3. Combination of (1) and (2).

Sections A2.2 of the BCA provides several different methods for determining that a Performance Solution complies with the Performance Requirements. These methods are summarised as follows:

1) A Performance Solution is achieved by demonstrating-

   (a) Compliance with all relevant Performance Requirements; or

   (b) The solution is at least equivalent to the Deemed-to-Satisfy Provisions.

2) A Performance Solution must be shown to comply with the relevant Performance Requirements through one or a combination of the following Assessment Methods:

   (a) Evidence of suitability in accordance with Part A5 that shows the use of a material, product, plumping and drainage product, form of construction or design meets the relevant Performance Requirements.

   (b) Verification Methods including the following:

      (i) The Verifications Methods in the NCC

      (ii) Other Verification Methods accepted by the appropriate authority that show compliance with the relevant Performance Requirements.

   (c) Expert Judgment.

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

3) Where A Performance Requirement is satisfied entirely by a Performance Solution, in order to comply with (1) the following method must be used to determine the Performance Requirement or Performance Requirements relevant to the Performance Solution:
   (a) Identify the relevant Performance Requirements from the Section or Part to which the Performance Solution applies.
   (b) Identify Performance Requirements from the other Section or Parts that are relevant to any aspects of the Performance Solution proposed or that are affected by the application of the Performance Solution.

Section A2.3 of the BCA states that a solution that complies with the Deemed-to-Satisfy Provisions is deemed to have met the Performance Requirements. A Deemed-to-Satisfy Provision can be shown compliance with the Deemed-to-Satisfy Provisions through one or more of the following Assessment Methods:

(a) Evidence of suitability in accordance with Part A5 that shows the use of a material, product, plumping and drainage product, form of construction or design meets the relevant Performance Requirements.
(b) Expert Judgement.

As described in Section A2.4 a combination of Performance Solutions and Deemed-to-Satisfy Solutions may be used to satisfy the Performance Requirements. When using a combination of solutions, compliance can be shown through the following, as appropriate:

(a) Section A2.2 for assessment against the relevant Performance Requirements.
(b) Section A2.3 for assessment against the relevant Deemed-to-Satisfy Provisions.

Where a Performance Requirement is satisfied by a Performance Solution in combination with a Deemed-to-Satisfy Solution, in order to comply with (1), the following method must be used to determine the Performance Requirement or Performance Requirements relevant to the Performance Solution:

(a) Identify the relevant Deemed-to-Satisfy Provisions of each Section or Part that are to be the subject of the Performance Solution.

(b) Identify the Performance Requirements from the same Sections or Parts that are relevant to the identified Deemed-to-Satisfy Provisions.

(c) Identify Performance Requirements from other Sections or Parts that are relevant to any aspects of the Performance Solution proposed or that are affected by the application of the Deemed-to-Satisfy Provisions that are subject of the Performance Solution.

1.3.2 International Fire Engineering Guidelines (IFEG)

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 Performance Solution against the Performance Requirements of the BCA. The prescribed methodology set out in the IFEG has been generally adopted in this Fire Engineering Report (FSS) for the assessment of each individual deviation from the prescriptive provisions (relative to fire safety) as identified by the PCA as is the expected understanding of the NSW Legislation and building process.

The IFEG is not adopted in whole as there are professionals employed in the building process that determine the level of compliance with the building code and regulations that restrict one form working outside their expertise. Conformation of compliance with the applicable BCA is the role of the BCA consultant/Principle Certifying Authority.

1.3.3 Stakeholders

The Performance Solution has been developed collaboratively with the relevant stakeholders as identified in the table below:

Table 1-1: Relevant Stakeholders

Role	Name	Organisation
Developer	Cameron Rubenach Guy Smith Sam Goodman	Goodman
Architect	Greg Baird William Ly	SBA Architects
BCA Consultant	Dean Goldsmith Tom Johnston	Blackett Maguire + Goldsmith
Accredited Fire Safety Engineer / Fire Safety Consultant	Tom Newton (C10) Joshua Raines	Affinity Fire Engineering

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, Environmental Protection Authority (EPA), project control groups, end users and community representatives. Although not always a legislative requirement, the design team should give due consideration to their inclusion in the Fire Engineering process. Where not required by legislation it is the client's decision to involve such parties, especially local fire brigade, to ensure a transparent and adequate fire safety solution for all. Where we are not notified of the inclusion of such parties it is assumed the client / representative has given due consideration to the above.

1.4 Sources of Information

The following sources of information have been relied upon in the preparation of this document:

- Architectural plans provided by SBA Architects as indicated in Table 1-2.
- BCA Assessment Report by Blackett Maguire + Goldsmith V.0, dated September 4th 2020 (Ref: 200359).

Table 1-2: Referenced Architectural Drawings

Drawing no.	Description	Issue	Date
OAK DA 210	Site Plan / Floor Plan	E	25/09/2020
OAK 2BA DA 311	Roof Plan – Warehouse 2B	D	29/09/2020
OAK 2BA DA 312	Floor Plan – Office 2B-1	D	24/09/2020
OAK 2BA DA 313	Floor Plan – Office 2B-2	E	28/09/2020
OAK 2BA DA 315	Elevation & Section Warehouse 2B-1 & 2B-2	B	11/09/2020

1.5 Limitations and assumptions

In this instance, this Fire Safety Strategy has been developed based on applicable limitations and assumptions for the development which are listed as follows:

- This report is specifically limited to the project described in Section 2.
- This report is based on the information provided by the team as listed in Section 1.4.
- Building and occupant characteristics are as per Section 2 and 3 of this document. Variations to these assumptions may affect the Fire Engineering Strategy and therefore they should be reviewed by Affinity Fire Engineering 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 5. The report does not provide guidance in respect of areas, which are used for Dangerous Good 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 NCC [1] with all aspects relating to fire and life safety unless otherwise specifically stated in this report. Where not specifically mentioned, the design is expected to meet the NCC 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 NCC 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 NCC. 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.

- This Fire Safety Strategy (FSS) is only applicable to the completed building. This report is not suitable, unless approved otherwise, to the building in a staged handover.
- Where parties nominated in Section 1.3.3 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.

2 BUILDING CHARACTERISTICS

2.1 Overview

Building characteristics are assessed as part of the Fire Safety Strategy 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, classification and height will dictate passive and active fire safety systems.

2.2 Site Location

The development site is part of an industrial estate within the NSW suburb of Horsley Park approximately 16km south-west of Paramatta's central business district and local to Penrith City Council LGA. The site will be bound by Entolasia Close to the north-west and Chelodina Street to the south with plans of the western and northern boundaries to abut other future industrial facilities. Figure 2-1 illustrates the site within the local context.

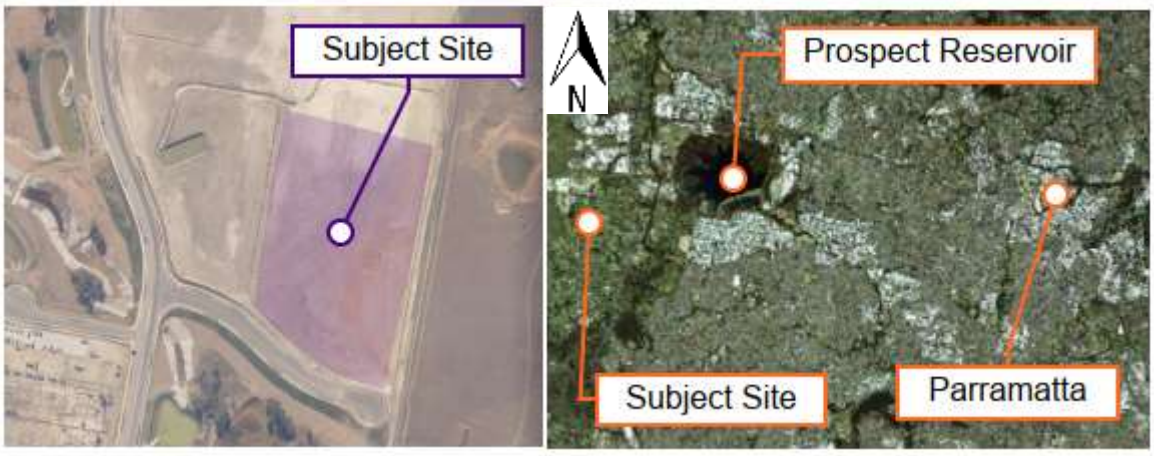


Figure 2-1: Allotment Location relative to Existing Local Setting (Google Maps 2020)

In regard to Fire and Rescue operations, the 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 in an outer suburb of a major city, the development is provided with the services and facilities expected in an urban setting. The likely two nearest fire brigade stations provided with permanent staff are Huntingwood and Smithfield fire stations approximately 10km and 12km from the site respectively when considering actual driving directions.

2.3 Building Description

The development will include the construction of a single large isolated building structure which shall serve as two tenancies each provided an attached administration office and a linked external carpark. The two tenancies are roughly the same size and generally symmetrical along the dividing internal inter-tenancy wall. The southern tenancy shall be speculatively listed as Warehouse 2B-1 herein and is provided access through a southern cul-de-sac road. The northern tenancy shall be speculatively listed as Warehouse 2B-2 herein and is provided access through a northern cul-de-sac road.

The warehouse structure is situated roughly in the centre of the site with a common heavy vehicle hardstand spaning along the western site edge. This hardstand provides heavy vehicle access to the respective warehouse's recessed dispatch dock and beneath the large dispatch awning cantilevering out from the western wall. The intertenancy wall shall extend out from the building through to the western sit edge to effectively split the heavy vehicle hardstand into respective tenancies and will include a gate for progressive vehicle access.

The fire sprinkler infrastructure shall be accessible via this heavy vehicle hardstand and is located to the west of the Warehouse 2B-2 office and accessible to the northern cul-de-sac estate road.

Warehouse tenancy administration offices are situated on the roadway sides of the structure and adjacent to the respective staff vehicle carparks. All offices shall be two storeys and directly attached to the respective warehouse tenancy.

A descriptive mark-up of the subject site illustrated in Figure 2-2 with notable features as indicated.

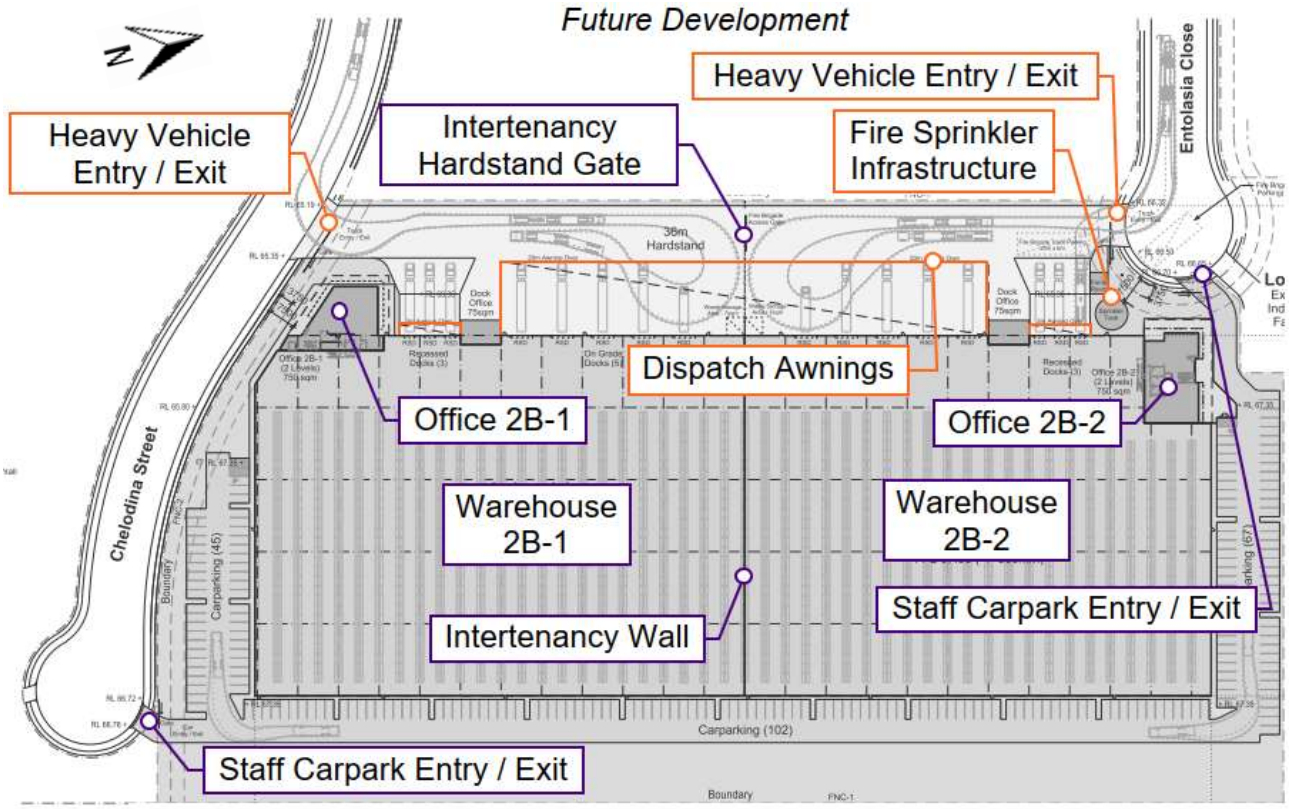


Figure 2-2: Site Plan Description

2.4 Building Structure

All materials used in the construction will conform with the testing methodology outlined in the DTS provisions so to mitigate the spread of fire and smoke in turn minimising the fire related risks to occupants and firefighters. The warehouse is single level albeit the attached offices shall be double storey to result in a rise-in-storey of two necessitating Type C construction. The assessed building exceeds the compartment limitations under BCA Clause C2.2 to be classified a large isolated building and hence shall be provided with the relevant DTS provisions unless otherwise specified through a Performance Solution detailed in this report.

2.5 Building Characteristic Assessment

The following table summarises the characteristics of the subject building, relevant to fire and life safety.

Table 2-1: Building characteristics assessment

CHARACTERISTIC	DESCRIPTION
BCA Classification	Class 7b – Warehouse Class 5 – Office
Rise in Storeys	Two (2)
Type of Construction	Type C Construction
Building Floor Area	Warehouse 2B-1: Approx. 13,435m^2 Warehouse 2B-2: Approx. 12,510m^2 Total (Office Inclusive): Approx. 27,595m^2
Building Volume	Warehouse 2B-1 / Warehouse 2B-2 (combined): Approx. 379,000m^3

3 OCCUPANT CHARACTERISTICS

3.1 Overview

The occupant characteristics are assessed as part of the Fire Engineering Review 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.

3.2 Dominant Occupant Characteristics Assessment

Characteristic	Description
Population numbers	Generally, the occupant numbers in the building is expected to equivalent to the occupant densities (m^2/person) listed in the NCC Table D1.13 for the various areas and the building layout which are listed as follows: ▸ 1 person per 30m^2 in the storage spaces ▸ 1 person per 10m^2 in the office areas.
Physical and mental attributes	Staff Staff in the building are expected to be awake and alert at all times. Staff are expected to have a level of understanding where they can recognise an emergency situation and have the ability to take and implement decisions independently. In addition, staff are expected to respond at all times, and to be unaffected by physical or sensory disabilities. Staff are not expected to be mentally impaired by drugs, alcohol, fatigue or other adverse conditions to degrees greater than in other business places. Visitors This occupant group is expected to be awake and alert. Visitors may also exhibit physical and mental disabilities to the degree and frequency of the general public. It should be noted that some visitors may consist of young children as well as elderly occupants and these occupant groups are expected to be accompanied by an adult.

Characteristic	Description
	Firefighters This occupant group will be equipped with breathing apparatus and specialist equipment to prevent them from being adversely affected by fire hazards. They are expected to be trained in emergency response and be capable of undertaking fire suppression and coordination of evacuation of the building. Maintenance personnel This occupant group is expected to awake and alert at all times. Maintenance personnel are expected to be able-bodied individuals who are capable of making independent decisions and evacuate themselves.
Familiarity with the building	Staff Staff are expected to have a complete knowledge of the building layout and be able to coordinate evacuation of other occupant groups in an emergency. Visitors Visitors may not have complete knowledge of evacuation routes in the subject building and are likely to choose to exit via the route they entered the building if not directed/guided by staff to the nearest exit. Firefighters This occupant group is 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. Maintenance personnel 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.
Pre-movement time	Pre-movement times can vary and is highly dependent on a combination of a variety of factors [4] such as: ▸ Familiarity with building ▸ Commitment to activity being undertaken at the time of fire ignition ▸ Mental capabilities (ability to assess risks and make appropriate decisions, alertness) ▸ Physical capabilities ▸ Group dynamics ▸ Occupant relationships / social affiliations

Characteristic	Description
	▸ Frequency of false alarms Documents such as PD7974-6:2004 [7] and CIBSE Guide E [10] provide guidance on estimating pre-movement times for various occupancies.
Travel speed	Travel speeds for individuals can vary depending on factors such as: ▸ Age and sex, ▸ Physical capabilities (ambulant, semi-ambulant, bed-ridden) ▸ Occupant density / crowding ▸ Perceived danger Based on a literature review of work carried out by Boyce et al. [13], Nelson and Mowrer [14], Pauls [15], Milinskii, Pelecheno [16], Pretechskii [17] and Shi et al. [18], the following travel speeds are adopted for an average horizontal travel speed: ▸ 1.2m/s is assumed for an able-bodied adult where congestion is unlikely [10] such as in the carpark areas; and ▸ 1.0m/s is assumed for an able-bodied adult where congestion is likely [10] such as in the warehouse areas; and ▸ 0.8m/s for semi-ambulant occupants requiring assistance to evacuate, walking aid or wheelchair users [14] such as in the administration and office areas.

4 HAZARDS AND PROTECTIVE MEASURES

4.1 Overview

The fire hazard analysis forms the basis for the review of non-compliances within the buildings. 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 in fire engineering assessments.

4.2 Fire Hazards

4.2.1 Building layout and egress

Exits are provided around the buildings' perimeter to allow for multiple alternative egress opportunities. Due to the open nature of the warehouses, there are limited dead end travel routes to exits, however due to the building's large area, extended travel distances to the nearest exit and between alternative exits are present.

4.2.2 General activities

The warehouse will be used for general goods storage and distribution and 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. At the time of this report the warehouse has speculative tenants and should the purpose change, the fire engineering strategy must be re-evaluated.

4.3 Fuel Loads

Quantity of Materials

Due to the nature of the facility the fire loads within the warehouse will change over time as the tenant changes or business structure of the same tenant evolves. As such it is not suitable to provide specific fire load densities for the product and materials being stored within the facility.

The fire load densities with the office and carparking areas should however remain consistent and as such the following fire load densities in those parts shall be utilised in the fire engineering analysis where suitable.

The office areas may exhibit mean fire load densities of approximately 800MJ/m^2 with isolated peak values reaching up to 1600MJ/m^2.

4.4 Dangerous Goods

Dangerous goods are not expected to be stored on the site in significant quantities. It is however noted that all commercial buildings will contain a degree of flammable materials for maintenance purposes (i.e. paints,

oil, aerosols etc.) and where DGs are stored, they shall be stored in accordance with the Regulatory requirements.

This Fire safety Strategy has been developed based on there being no Dangerous Goods stored on site other those required for daily maintenance purposes. Any storage of Dangerous Goods will require review and assessment by a suitably qualified Risk Consultant to determine the associated hazards and required preventive measures to meet BCA Clause E1.10 and E2.3.

4.5 Insulated Sandwich Panels

Should any of the tenancies be adopted for future use as a temperature controlled storage facility or, where future tenancy fit outs will contain temperature controlled areas with freezers and cool rooms and the like, these enclosures shall be constructed using Insulated Sandwich Panels (ISPs) that meet the following requirements to ensure a suitable degree of fire protection and life safety is incorporated into the design;

- All sandwich panels must be installed in accordance with the "Insulated Panel Council Australasia (IPCA) Code of Practice (CoP) - Version 4.3".
- The panels must be installed by an accredited installer as recognised by the Code of Practice prepared by IPCA (refer website: http://www.insulatedpanelcouncil.org/code-compliant-companies).
- Certification must be provided from the accredited installer prior to final occupation certificate being issued for the building.
- All future works, modifications or repairs must be completed using ISP with the same core and material type (i.e. the panel must not be substituted with a product having an EPS or PUR core).
- Signage and block plans will be required around the site adjacent to each sprinkler and hydrant block plan to alert fire fighters to the;
    - Location of all sandwich panels installed.
    - Type of sandwich panels installed (commercial brand and core material).

4.6 Rooftop Solar Panels

Solar photovoltaic systems contribute to an increased probability of a fire event, primarily due to electrical risks [6]. Additionally, should the solar panels be subjected to a fire event, attending fire brigade can be exposed to hazardous toxins from the combustion of the panel materials.

Storage battery systems pose a significant risk to attending brigade with coming in to contact with the photovoltaic system. Drenching with hoses may disconnect or expose wiring to water in which create live current exposure to personnel or possibly additional fires through sparks or short circuits.

Where the design incorporates provisions for rooftop solar panels to offset the building's energy requirements, the following design measures shall be included to mitigate the risk to the attending fire fighters in the event of a fire as per FRNSW requirements.

- A minimum of an A3 sized block plan shall be provided at all Fire Indicating Panels to alert the attending fire fighters of the presence of all key components inclusive, but not limited to the location of the solar panels, inverters, operating voltage and current, location of storage equipment and respective battery type.

- The location of the all associated isolation switches, AC and DC isolators for the shut-off of generated electricity shall be displayed at all Fire Indicating Panels with brief instructions of the safe process to subdue the hazard.

4.7 Review Of Relevant Fire Statistics

The following discussion is based on the fire statistics attached in APPENDIX A.

4.7.1 Warehouse

From the National Fire Protection Association (NFPA) report on 'Structure Fires in U.S. Warehouses' [29] statistics specific to warehouses can be analysed.

A total of 1,270 structure fires were reported in warehouses between 2007 and 2011. The fires recorded resulted in 4 occupant fatalities, 23 occupant injuries and $188 million in direct property damage per year. Overall, 19% of fires were intentionally set, however no civilian injuries were reported from these fires. Shop tools and industrial equipment caused 8% of fires; however these fires resulted in 27% of the civilian injuries recorded annually. The leading area of fire origin in warehouses comes from unclassified storage areas, resulting in 13% of fires and 18% civilian injuries.

Figure 4-1 illustrates the leading cause of structure fires in warehouses, while Figure 4-2 indicates the leading areas of origin.

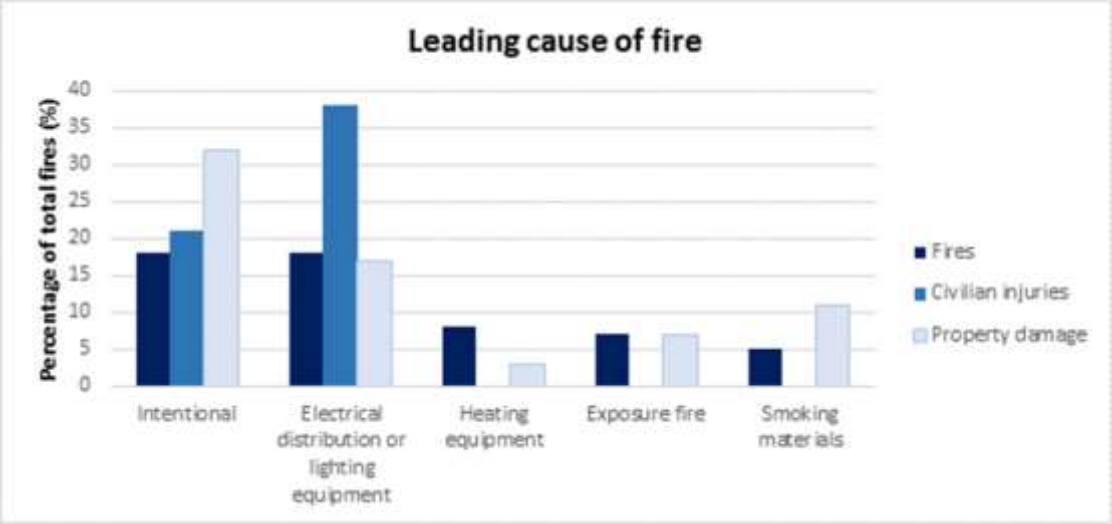


Figure 4-1: Leading Causes of Structure Fires in Warehouses

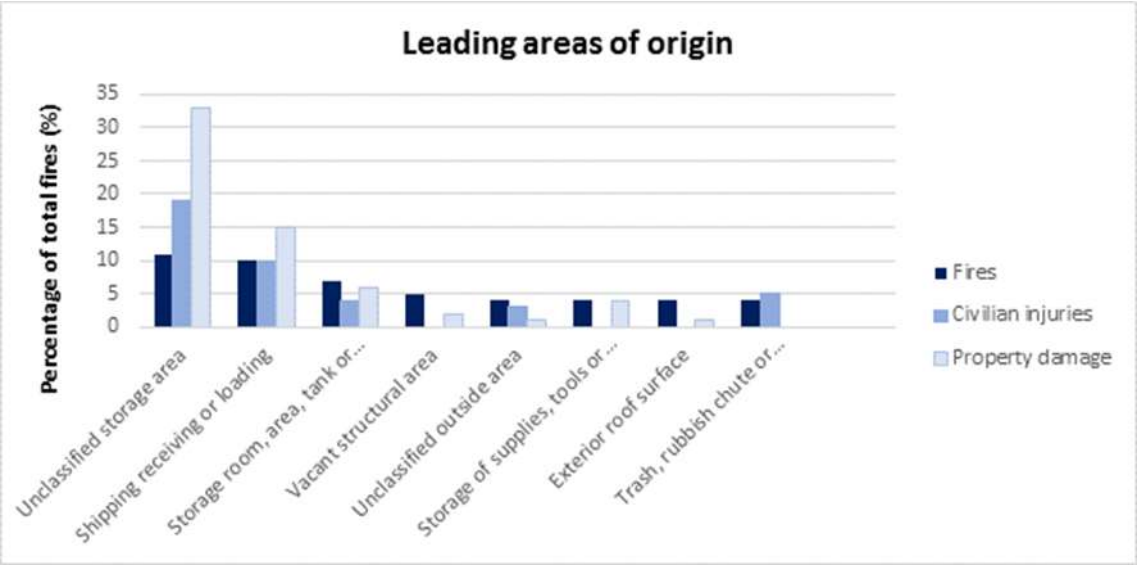


Figure 4-2: Structure fires in warehouses by area of origin

The most common ignition sources in order of likelihood in warehouse structure fires are:

- Intentional (18%)
- Electrical distribution or lighting equipment (18%)
- Heating equipment (8%)
- Exposure fire (7%)
- Smoking materials (5%)

The most common fire origins in order of likelihood in warehouse structure fires are:

- Unclassified storage area (11%)
- Shipping receiving or loading(10%)
- Storage room, area, tank or bin (7%)
- Vacant structural area (5%)
- Unclassified outside area (4%)
- Storage of supplies, tools or dead storage (4%)
- Exterior roof surface (4%)
- Trash, rubbish chute or container (4%)

4.7.2 Offices

NFPA statistics published for the years 2007-2011 estimates an average of 3,340 structure fires in office properties per year. Fires in office properties accounted for less than one in every 100 (0.7%) reported structure fires from 2007-2011. These fires caused annual averages of 4 civilian deaths and 44 civilian injuries. One in every four fires was caused by cooking. Electrical distribution and lighting equipment was the second leading major cause. The percentage of fires, civilian injuries and deaths that occurred in 2007-2011 at different times of the day are presented in the figure below.

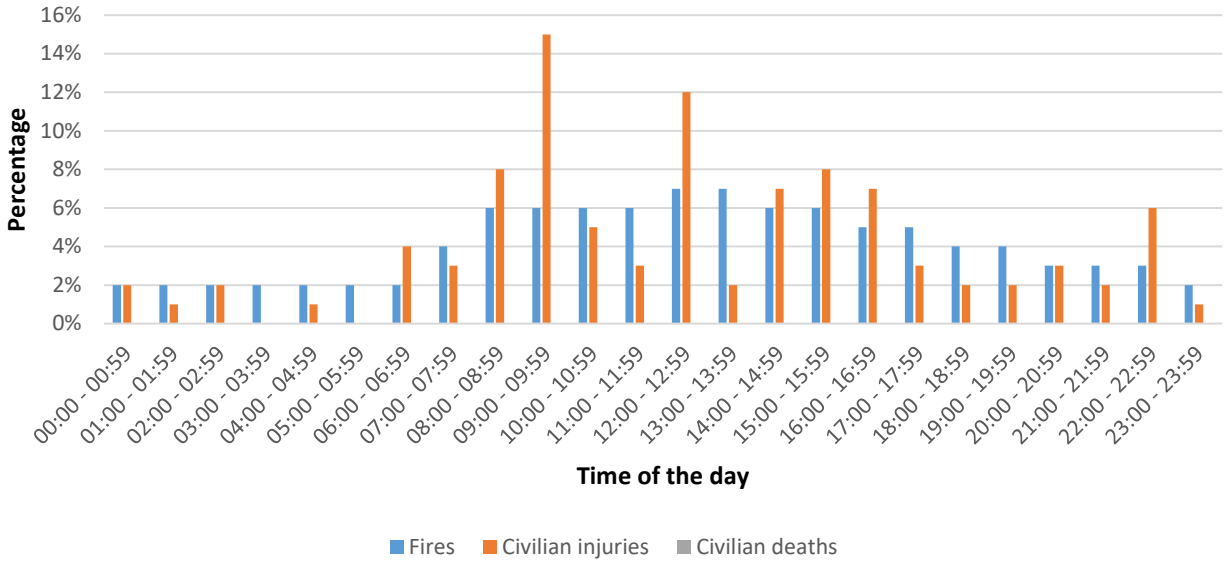


Figure 4-3: Percentage of fires, civilian injuries and deaths at different times of the day (offices)

The following graph that shows the ratio of injuries and deaths to total number of fires has been developed from the data presented in the previous figure. It can be noted that the number of fires during the day is almost four times as many as those during the night. The number of fires peak at midday and are the lowest in the night. This is likely due to the fact that office tenancies are generally unoccupied during the night.

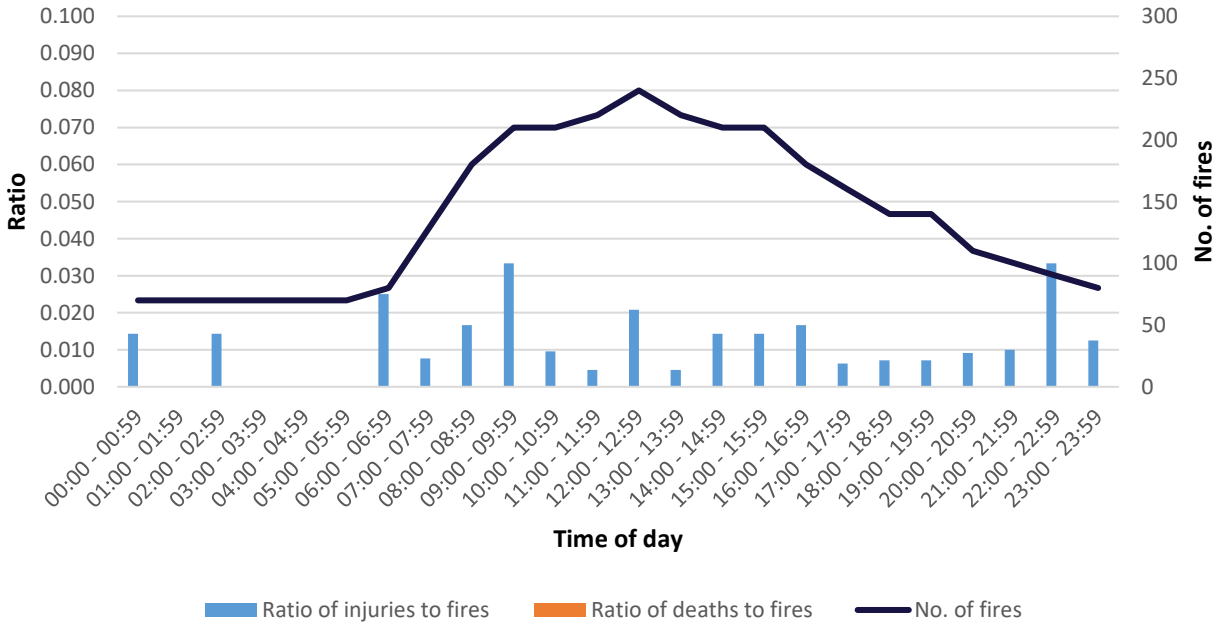


Figure 4-4: Number of fires, ratio of injuries/fires and deaths/fires for different times of the day (offices)

The most common ignition sources in order of likelihood in office structure fires are:

- Cooking equipment (29%)
- Electrical distribution and lighting equipment (12%)
- Heating equipment (11%)

- Intentional (10%)
- Smoking materials (9%)

The most common fire origins in order of likelihood in office structure fires are:

- Kitchen or cooking area (22%)
- Unclassified outside area (4%)
- Lavatory, bathroom, locker room (4%)
- Lobby or entrance way (3%)
- Attic or ceiling/roof assembly or concealed space (2%)
- Duct for HVCA, cable, exhaust, heating or AC (2%)
- Machinery room or elevator machinery (2%)
- Unclassified storage area (2%)

5 BCA DTS NON-COMPLIANCE REVIEW

5.1 Overview

In this instance the BCA DTS non-compliances have been formulated based on a regulatory review undertaken by the project building surveyor and / or design team and through Affinity Fire Engineering experience of similar buildings of the size and nature as the subject development. Where not listed herein the building is required to achieve compliance with relevant DTS provisions and relevant codes, reports and Standards.

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

5.2 BCA DTS Non-Compliance Assessment and Acceptance Criteria

Table 5-1: Summary of Performance Solutions

VARIATIONS, ASSOCIATED METHODOLOGY AND ACCEPTANCE CRITERIA
Item 1: Perimeter Vehicular Access
Relevant Regulatory Requirement: BCA Clause C2.4 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, be located within 18m of the building and have nothing constructed on the pathway that obstructs passage. **Performance Requirement** The relevant Performance Requirement is CP9 **Non-compliance with DTS provisions:** Vehicular perimeter access has been identified as non-compliant in the following areas; ▸ The vehicular perimeter path navigates up to 20m from the building in lieu of 18m around the Warehouse 2B-1 recessed dispatch docks forming part of the heavy vehicle hardstand. ▸ The vehicular perimeter path navigates up to 33m from the building where the perimeter access path necessitates using Entolasia Close. ▸ The vehicular perimeter path navigates up to 33m from the building where the perimeter access path necessitates using Chelodina Street. **Relevant IFEG Sub-Systems:** ABCDEF

VARIATIONS, ASSOCIATED METHODOLOGY AND ACCEPTANCE CRITERIA

Approaches and Method of Analysis:

The assessment methodology will adhere to BCA Clauses A2.2(1)(a) and A2.2(2)(b)(ii) in an absolute and qualitative approach. Performance Solution will demonstrate that the configuration of perimeter access combined with the fire safety systems installed within the building ensure that firefighting capabilities are not adversely affected.

Acceptance Criteria

The fire engineering analysis must demonstrate that the configuration of the perimeter access path will not significantly impede local fire authority's access to the building in order to undertake fire intervention and/or search and rescue activities.

Item 2: Egress Provisions & Rationalised Warehouse Automatic Smoke Exhaust System

Relevant Regulatory Requirement:

BCA Clause D1.4 states that in a Class 5 and 7 building the travel distance to the point of choice must not exceed 20m and to the nearest exit must not exceed 40m where more than one exit is available.

BCA Clause D1.5 states that the travel distance between alternative exits must not exceed 60m.

BCA Clause E2.2 (Table 2.2a) requires large isolated buildings which have floor area or volume greater than 18,000m^2 or 108,000m^3 respectively to be equipped with an automatic smoke exhaust system in compliance with the requirements of BCA Specification E2.2b.

Performance Requirement

The relevant Performance Requirements are DP4 & EP2.2

Non-compliance with DTS provisions:

Travel distances have been identified as being non-compliant in the following locations;

- Warehouse 2B-1:
    - 75m to an exit in lieu of 40m; and
    - 150m between alternative exits in lieu of 60m.
- Warehouse 2B-2:
    - 66m to an exit in lieu of 40m; and
    - 135m between alternative exits in lieu of 60m.

Furthermore the automatic smoke exhaust system serving the large isolated building of Warehouse 2B-1 and Warehouse 2B-2 shall not meet the following design requirements in lieu of DTS provisions:

- The smoke exhaust capacity in each tenancy shall achieve one volume air change per hour in lieu of BCA Spec E2.2b requirements.
- The smoke exhaust system serving each tenancy shall automatically initiate by fire sprinkler activation in lieu of automatic smoke detection. No smoke detection shall be provided.

VARIATIONS, ASSOCIATED METHODOLOGY AND ACCEPTANCE CRITERIA

Relevant IFEG Sub-Systems:

ABCDEF

Approaches and Method of Analysis:

The assessment methodology shall be undertaken in accordance with BCA Clauses A2.2(1)(a) and A2.2(2)(b)(ii) in an absolute and quantitative evaluation of occupant evacuation. The analysis shall compare the time at which tenable conditions are deemed to be exceeded against the time required for occupant evacuation and fire brigade intervention to demonstrate that occupants can safely evacuate and fire fighters can enter for fire intervention activities.

Acceptance Criteria:

The fire engineering analysis must demonstrate that occupants are able to reach the relative safety of an exit and fire fighters enter before the onset of untenable conditions.

Item 3: Fire Hydrant System Design

Relevant Regulatory Requirement:

BCA Clause E1.3 requires that a fire hydrant system is provided and installed in accordance with AS2419.1:2005 which in turn requires that;

- All portions of the building are within reach of a 10m hose stream issuing from a 60m length of hose for external hydrants and 30m length of hose from internal hydrants.
- External hydrants located at the wall of the building must be provided with a radiant heat shield (90/90/90 FRL) a minimum 2m each side of the hydrant and 3m above the base of the hydrant.

Also, the hydrant booster assembly must be located as follows when remote from the building:

- At the boundary of the site
- Within sight of the main entrance of the building; and
- Adjacent to the principal vehicular access to the site; and
- Not less than 10m from the external wall of any building served.

Performance Requirement

The relevant Performance Requirement is EP1.3

Non-compliance with DTS provisions:

The following non-conformances have been identified and intended to be addressed through a Performance Based Solution:

- The hydrant booster is not is sight of the main entrances to each warehouse and is therefore deemed a non-compliant location.
- The required 90/90/90 FRL protecting wall behind each external hydrant is to be omitted through the Performance Solution with the design relying on the sprinkler system installed throughout the building.

VARIATIONS, ASSOCIATED METHODOLOGY AND ACCEPTANCE CRITERIA

- Hydrants located beneath dispatch awnings shall be classified as external hydrants for the purposes for system coverage and thus allowance for the use of two hose lengths.

Relevant IFEG Sub-Systems:

ABCDEF

Approaches and Method of Analysis:

The assessment will adhere to BCA Clauses A2.2(1)(a) and A2.2(2)(b)(ii) and will be qualitative and absolute, with minor quantitative elements. The Performance Solution for external hydrant design relies on the area's ability to maintain tenable conditions for fire fighters to connect to the hydrant point. That is; the awnings will allow free-venting of smoke, the external wall of the building will reduce exposure to thermal hazards and the sprinkler system will minimise fire sizes both internally and beneath the awning. Furthermore, should a fire be located under the awning itself at the non-compliant hydrant, adjacent external hydrants are available to enable suppression of the fire.

Acceptance Criteria:

The assessment must demonstrate that fire-fighters accessing the external hydrants must not be exposed to conditions that adversely impact the firefighting operations. Furthermore, the assessment shall demonstrate that the location of the fire hydrant booster shall not significantly disadvantage fire brigade activities.

Item 4: 50m Fire Hose Reels

Relevant Regulatory Requirement:

BCA Clause E1.4 requires that fire hose reels are installed in accordance with AS2441:2005 within a building having a fire compartment greater than 500m^2. This requires that all points on the floor are to be within reach of a 4m hose stream issuing from a nozzle at the end of the hose, with the hose length not exceeding 36m.

Performance Requirement

The relevant Performance Requirement is EP1.1

Non-compliance with DTS provisions:

Due to the large floor areas of the warehouse hose reels with a length of 50m in lieu of 36m are proposed to be used to achieve coverage within the warehouse.

Relevant IFEG Sub-Systems:

ABCDEF

Approaches and Method of Analysis:

The assessment methodology will adhere to NCC BCA Clauses A2.2(1)(a) and A2.2(2)(d). The analysis will be comparative and qualitative in demonstrating that the provisions of 50m hose reels in the warehouse will not adversely affect occupant safety.

VARIATIONS, ASSOCIATED METHODOLOGY AND ACCEPTANCE CRITERIA

Acceptance Criteria:

The fire engineering analysis must demonstrate that appropriate manual suppression activities are available to allow occupants to undertaken initial attack on the fire at an equivalent level to DTS provisions. This shall be made available to a degree equivalent to that permitted in a DTS design.

Item 5: Fire Sprinkler System Design

Relevant Regulatory Requirement:

BCA Clause E1.5 requires that fire sprinklers to be installed in accordance with AS2118.1:2017 which in turn requires under Clause 4.14.1 that the sprinkler booster and suction be located in accordance with AS2419.1:2005 requirements.

AS2419.1:2005 requires the booster assembly must be located as follows when remote from the building:

- At the boundary of the site; and
- Within sight of the main entrance of the building; and
- Adjacent to the principal vehicular access to the site; and

Performance Requirement

The relevant Performance Requirement is EP1.4

Non-compliance with DTS provisions:

The fire sprinkler infrastructure inclusive of the fire sprinkler booster and on-site water suction connection are located within the allotment and consequently is non-compliant on the basis that this equipment is not within sight of all main entrances and is not located on the site boundary.

Relevant IFEG Sub-Systems:

ABCDEF

Approaches and Method of Analysis:

The assessment will incorporate an absolute and qualitative approach in adherence to BCA Clause A2.2(1)(a) and A2.2(2)(b)(ii) where the analysis is an absolute and qualitative evaluation demonstrating that the location of the fire sprinkler booster enables fire brigade operations. The assessment rationalizes that with the inclusion of fire brigade infographic block plans, the location of the fire infrastructure can be promptly located and utilised.

Acceptance Criteria:

The fire engineering analysis must demonstrate that the fire sprinkler infrastructure is in a location which shall not significantly impact the firefighting operations and, the location of equipment should enable prompt and effective fire intervention activities.

VARIATIONS, ASSOCIATED METHODOLOGY AND ACCEPTANCE CRITERIA

Item 6: Omission Of Automatic Smoke Exhaust From Office Areas

Relevant Regulatory Requirement:

BCA Clause E2.2 - Table E2.2a General Provisions requires in a Class 5, 6, 7, 8 or 9 building, which exceeds 18,000m^2 in floor area or 108,000m^3 in volume, the building must be provided with an automatic smoke exhaust system in accordance with Specification E2.2b throughout.

Performance Requirement

The relevant Performance Requirement is EP2.2

Non-compliance with DTS provisions:

The building formed by Warehouse 2B-1, Warehouse 2B-2 and associated administration offices collectively exceed 108,000m^3 to necessitate automatic smoke exhaust throughout. Whilst these offices contribute to the building floorplate and volume, the offices shall not be provided with an automatic smoke exhaust system as required by the DTS provisions.

Relevant IFEG Sub-Systems:

ABCDEF

Approaches and Method of Analysis:

The assessment shall follow BCA Clauses A2.2(1)(a) to meet the Performance Requirements through a methodology per BCA Clauses A2.2(b)(ii) and A2.2(2)(d) in a partly absolute and partly comparative qualitative discussion. This synopsis shall demonstrate that the omission of the automatic smoke exhaust system from the office part of the building shall not result in a reduced level of safety. The assessment acknowledges that whilst the office part is physically linked to the warehouse, the application of smoke separation between warehouse and office enclosures is expected to permit the safe egress of occupants and safe ingress of fire brigade personnel.

Acceptance Criteria:

The fire engineering assessment must demonstrate that though suitable passive smoke separation between the warehouse and office parts of the building, the spread of smoke will be restricted and shall provide an equivalent or better outcome in comparison to a DTS compliant, standalone office building that is not connected to a warehouse.

6 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.

The specified fire safety strategy will undergo analysis as part of a Fire Engineering Report to ascertain whether the relevant Performance Requirements of the BCA are satisfied. The information herein is therefore pending completion of the fire engineering analysis and as such is possible to change and or modification through the detailed design phase of the project.

6.1 Passive Fire Construction

6.1.1 Fire Resisting Construction and Compartmentation

The building structure including floors, walls, columns and shafts shall be constructed in accordance with the requirements of BCA Clause C1.1, Specification C1.1 for Type C Construction throughout.

6.1.2 Separation of Equipment

Rooms containing equipment listed below must be fire separated from the remainder of the building by construction in accordance with Specification C1.1 or 120/120/120 FRL construction, whichever is greater, with any door opening into that room consisting of a --/120/30 FRL self-closing fire door.

- Lift motors and lift control panels (unless the lift installation does not have a machine-room); or
- Emergency generators used to sustain emergency equipment operating in emergency mode; or
- Central smoke control plant (other than smoke exhaust systems designed for high temperature operation); or
- Boilers; or
- A battery system installed in the building that have a total voltage of 12 volts or more and a storage capacity of 200kWh or more.

Electricity supply systems inclusive of electricity substations located within a building and main switchboards located within the building which sustains emergency equipment operating in the emergency mode (i.e. the smoke exhaust switchboard) must meet the requirements of BCA Clause C2.13. This includes the requirements of being separated from any other part of the building by construction having:

- An FRL of not less than 120/120/120: and
- Any doorway in that construction protected with a self-closing fire door having an FRL of not less than --/120/30.

6.1.3 Finishes and Linings

Where practicable, internal finishes, internal linings and internal materials used throughout the building should be non-combustible to reduce the spread of fire and the generation of toxic smoke products.

All 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.

6.1.4 External Claddings

The external cladding forming the building must comply with the DTS provisions of the BCA as defined by BCA Specification C1.1. Aluminium composite panels (ACP) containing a polyethylene (PE) core should not be used on the façade.

6.1.5 Rooftop Solar Panels

Where solar panels are installed on the warehouse roof, the following measures shall be provided:

- A minimum A3 sized block plan shall be provided at the Main FDCIE and Fire Pump Room to alert attending FRNSW personnel and be inclusive of the following as a minimum:
    - Large warning test stating "WARNING: SOLAR PANELS ON WAREHOUSE ROOF" to alert attending fire fighters.
    - Signage shall be constructed of all-weather fade resistant material with red lettering not less than 25mm in height with contrasting coloured background.
    - Signage shall identify the presence and location of the solar electrical generation system.
    - Location of all associated isolation switches, AC and DC isolators for the shut-off generated electricity should be displayed at the Main FDCIE and Fire Pump Room.
    - Block plans shall clearly indicate the location and type of any inverters, storage equipment type and operating voltage and current.
- Where solar panels are designed to be automatically isolated on fire trip, signage shall be provided at the Main FDCIE and Fire Pump Room detailing this provision that can clearly be identified by attending fire brigade.

6.1.6 Insulated Sandwich Panels

Where future tenancy fit outs contain temperature-controlled areas with Freezers and Cool Rooms and the like, these enclosures shall be constructed using Insulated Sandwich Panels (ISP) that meet the following requirements to ensure a suitable degree of fire mitigation.

- All sandwich panels must be installed in accordance with the "Insulated Panel Council Australasia (IPCA) Code of Practice (CoP) - Version 4.3".
- The panels must be installed by an accredited installer as recognised by the Code of Practice prepared by IPCA (refer website: http://www.insulatedpanelcouncil.org/code-compliant-companies).
- Certification must be provided from the accredited installer prior to final occupation certificate being issued for the building.

- All future works, modifications or repairs must be completed using ISP with the same core and material type (i.e. the panel must not be substituted with a product having an EPS or PUR core).
- Signage and block plans will be required around the site adjacent to each sprinkler and hydrant block plan to alert fire fighters to the following:
    - Location of all sandwich panels installed.
    - Type of sandwich panels installed (commercial brand and core material).

6.1.7 Smoke-proof Construction

As part of the Performance Solution to conditionally permit the omission of automatic smoke exhaust from the Office 2B-1 and Office 2B-2, the offices shall be smoke separated from the warehouse parts of the building and meet the following requirements:

- All shared walls and ceilings/roofs between the offices and warehouse parts of the building shall meet the smoke proofing construction requirements of BCA Specification C2.5 – Clause 3 which includes, but not limited to:
    - Air handling systems that link the warehouse and office parts must shut down on general fire trip within tenancy 2B-1 or tenancy 2B-2 and be provided with smoke dampers where air-handling ducts penetrate the smokeproof construction into the warehouse.
    - All doors opening from the office into the warehouse part of the building shall be smoke doors in accordance with BCA Specification C3.4.
        - These doors shall be fitted with self-closers and medium temperature smoke seals (200°C smoke for 30 minutes and tested to AS1530.7:2007 and must meet the smoke leakage rates specified in AS6905-2007).

6.2 Egress Provisions

6.2.1 Alarm & Evacuation Strategy

Activation of any sprinkler head or manual call point shall initiate the building occupant warning alarm tones throughout the entirely of the building. Dedicated fire wardens from each warehouse and office areas shall ensure that all clients, visitors, maintenance contractors and staff are promptly evacuated.

6.2.2 Egress Provisions

With exception of the following items being addressed through a fire engineered Performance Solution, travel distances to a point of choice or single exit to be not more than 20m, the distance to the nearest of two or more alternative exits must not exceed 40m and the distance between alternative exits must be no closer than 9m and no further apart than 60m.

The fire engineering assessment shall address travel distances that have been identified as being non-compliant in the following listed locations. The travel distances assume speculative east-west orientated racking to capture future fit outs.

Warehouse 2B-1

- Approximately 75m to an exit in lieu of 40m from within the warehouse floor.

- Approximately 150m between alternative exits in lieu of 60m across the main warehouse floor.

Warehouse 2B-2

- Approximately 66m to an exit in lieu of 40m from within the warehouse floor.
- Approximately 135m between alternative exits in lieu of 60m across the warehouse floor.

The above travel distances are as indicated in Figure 6-1.

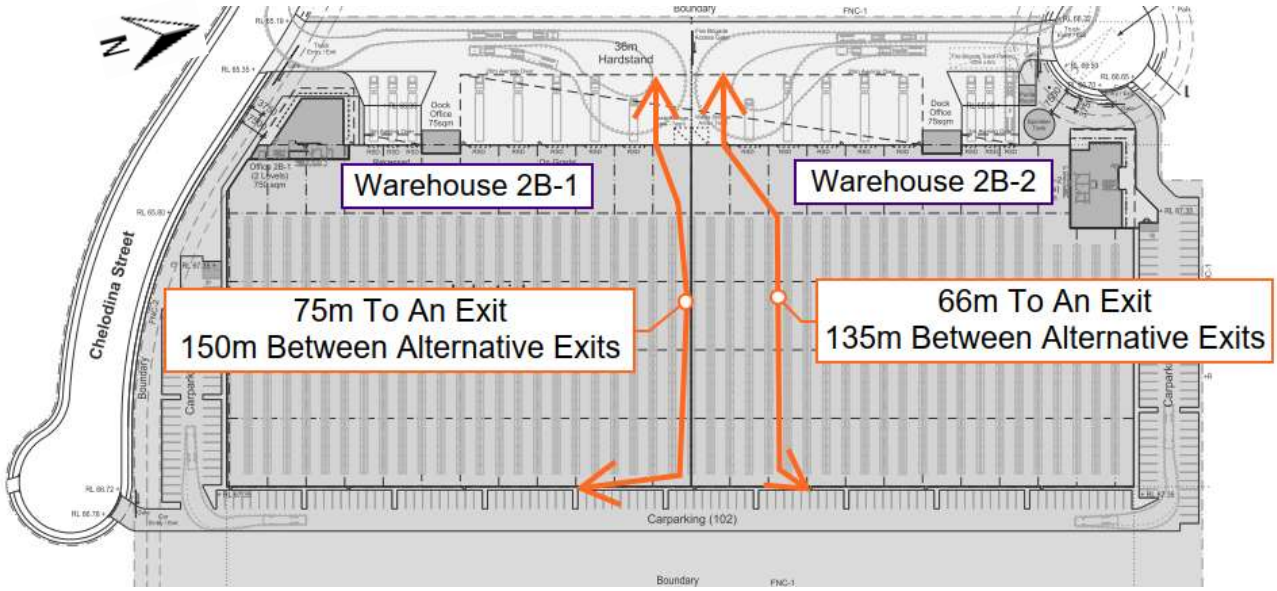


Figure 6-1: Speculative Non-Compliant Travel Distances Based On Standard Racking

Design Note: Additional exit and egress doors may be required and/or modification to future fit-outs to ensure the travel distance limitation defined by Fire & Rescue NSW of "*no point in a fire compartment is to be more than 100m from a hydrant external to that compartment*". This shall be determined though the detailed design phase on the project.

6.2.3 Door Hardware, Operation and Mechanisms

All doors serving as required exits shall have hardware, door swings, latch operations and signage in accordance with the prescriptive requirements of BCA Clauses D2.19, D2.20, D2.21 and D2.23.

6.2.4 Signage and Lighting

Exit and emergency lighting is to be provided throughout the building in accordance with the prescriptive DTS provisions of BCA Clause E4.2, E4.4, E4.5, E4.6, E4.8 and AS2293:2018.

- Exit signs are to be pictograph 'running man' signs as per the prescriptive requirements of AS2293.1:2018.
- All exit and directional exits signs are to be power operated illuminated signs.

6.3 Active Fire Protection Systems

6.3.1 Fire Control & Indicating Equipment

The site shall be served by a Main FDCIE (Fire Detection Control and Indicating Equipment) located within the entrance of the Tenancy 2B-2 office fire indicating panel shall meet the requirements of BCA Specification E1.8, AS1670.1:2018 and the following listed items as a minimum:

- The FDCIE shall be located within the Office 2B-2.
- This shall have the following controls and capabilities:
    - Capable of isolated, resetting and determining the fire location anywhere on the site.
    - Contain a manual call point.
    - Incorporate controls for the manual operation of the automatic smoke exhaust system serving the Warehouse 2B-1 and 2B-2.
- A red strobe shall be installed externally above the Office 2B-2 entrance and be visible from two approaches to alert arriving fire brigade to the FDCIE location in accordance with AS1670.1:2018.
    - The FDCIE shall form the fire brigade call out address.
- Block plans for all fire safety systems and Tactical Fire-Fighting Plans must be provided adjacent to the FIP.

6.3.2 Fire Brigade Alarm Signalling Equipment

An automatic link shall be provided directly to an approved monitoring centre on activation of the fire sprinkler systems installed in the buildings.

- The ASE unit shall ensure compliance with DTS Provisions and AS1670.3:2018.
- The fire brigade turnout address is to be at the location of the FDCIE located within the Office 2B-2 entrance.
- To assist fire fighter navigation throughout the site additional site plans are to be provided at the FDCIE. These block plans must meet the block plan requirements of AS2118.1:2017, AS2419.1:2005 and AS1670.1:2018 as a minimum and include:
    - An illustration the entire allotment and surrounding roads and hardstands that are to be used for fire brigade perimeter access
    - The location of all sub-stations and electrical MSBs
    - The location of the fire services pumps, tanks and booster assemblies.

6.3.3 Building Alarm and Communication System

A building occupant warning system shall be provided throughout all buildings. The system shall be in accordance with the prescriptive requirements of Specification E1.5 and Clause 6 of Specification E2.2a of DTS provisions and AS1670.1:2018.

- Activation of any fire sprinkler head or manual call point shall initiate the Building Occupant Warning System (BOWS) throughout the entire building and fire pump room.

6.3.4 Automatic Fire Sprinkler System

A fire sprinkler system shall be provided throughout the building in accordance with the prescriptive requirements of BCA Specification E1.5 and AS2118.1:2017 with the conditional exception of the following:

- The fire sprinkler booster assembly shall not be in sight of all building main entrances and not on the site boundary.

As part of the fire sprinkler system design, the following must be incorporated:

- The fire sprinkler booster assembly must ensure adequate staging area for pumping appliances as per FRNSW Fire Guideline requirements *"Access for fire brigade vehicles and firefighters"* available at https://www.fire.nsw.gov.au/ and AS2118.1:2017.
- The on site sprinkler pumps, water tanks and infrastructure must ensure compliance with DTS provisions and AS2118.1:2017.
- The sprinkler block plans must be provided at the Main FDCIE and highlight the perimeter vehicular access provisions around the building through to the fire sprinkler infrastructure.

The general layout of the fire sprinkler system relative to the site layout and design advice is as indicated in Figure 6-2.

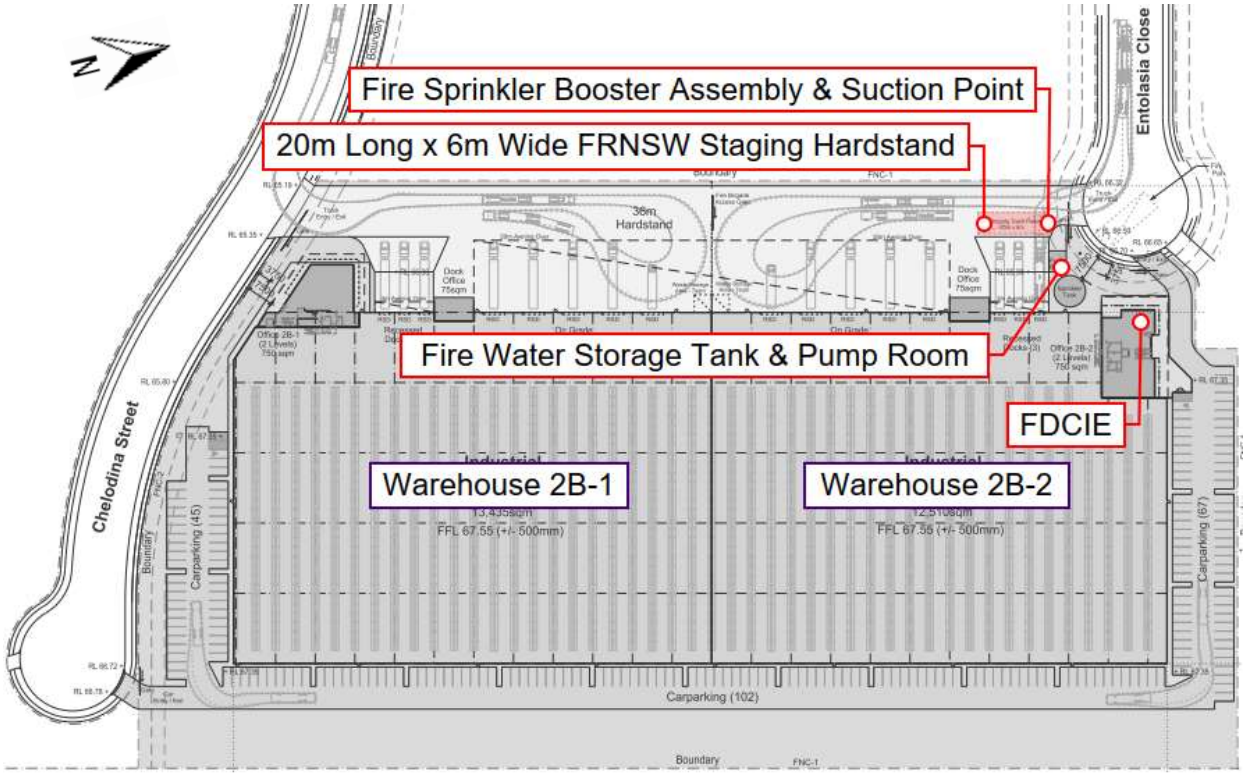


Figure 6-2: Fire Sprinkler Infrastructure & FDCIE Locations

Fire & Rescue NSW Hardstand Requirement

As detailed in FRNSW Fire Guideline requirements *"Access for fire brigade vehicles and firefighters"*, any hardstand serving a suction-connection outlet is to have a working space which extends a minimum 18m from

the point of connection to allow a semi-rigid suction hose to be connected to the rear of the fire appliance. This is demonstrated in Figure 6-3.

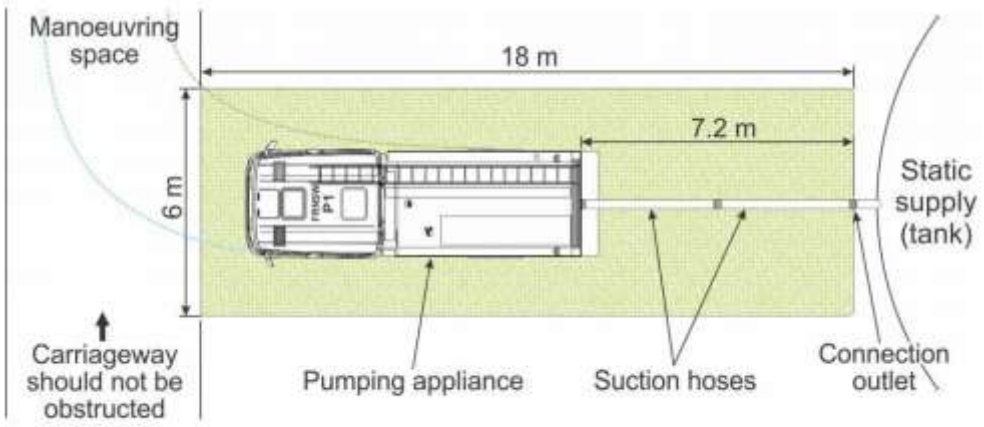


Figure 14 Hardstand area serving a suction-connection outlet

Figure 6-3: FRNSW Access For Fire Brigade Vehicles & Firefighters Excerpt (State Govt NSW 2019)

The preliminary fire engineering assumes that the fire sprinkler suction point is located inward facing to the hardstand and hence necessitate an appliance to back up against it. The orientation of the suction point may be adjusted so long as the design reflects the FRNSW requirements for as detailed in FRNSW Fire Guideline requirements *"Access for fire brigade vehicles and firefighters"*. Connection orientations are as per excerpt from the aforementioned FRNSW document per Figure 6-4.

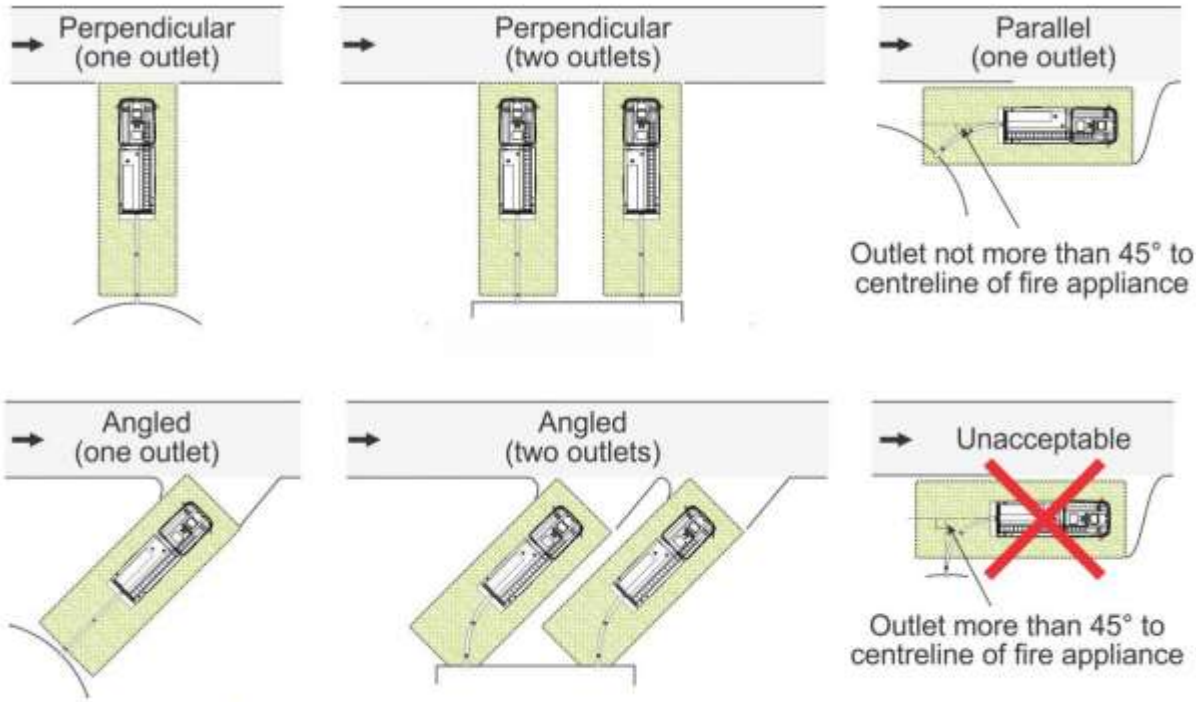


Figure 15 Example of orientation of hardstand area for suction-connection outlets

Figure 6-4: FRNSW Access For Fire Brigade Vehicles & Firefighters Excerpt (State Govt NSW 2019)

Notwithstanding, a detailed design of the fire sprinkler suction connection point and booster assembly respectively must be undertaken by the fire sprinkler design consultant to meet the desired requirements. Note that a minimum 6m clear width must be maintained past any appliance staging area to meet the requirements of BCA Clause C2.4.

6.3.5 Automatic Smoke Hazard Management Systems

An automatic smoke exhaust system shall be provided to the large isolated building serving Warehouse 2B-1 and Warehouse 2B-2 in accordance with DTS provisions with the following exceptions conditionally permitted:

Warehouse Areas:

- The automatic smoke exhaust system serving the Warehouse 2B-1 and Warehouse 2B-2 shall need only meet the capacity of one tenancy volumetric air change per hour in lieu of the exhaust rate determined by BCA Specification E2.2b – Table 2.
- The automatic smoke exhaust system serving the large isolated building shall initiate on the activation of any fire sprinkler within Tenancy 2B-1 or Tenancy 2B-2 in lieu of automatic smoke detection. No smoke detection is required to be installed.

Office Areas:

- Office 2B-1 and Office 2B-2 shall not be provided with automatic smoke exhaust.

As part of the fire engineered Performance Solution for Smoke Hazard Management, the following must be provided;

- An automatic smoke exhaust system shall be provided to Warehouse 2B-1 and Warehouse 2B-2 and shall meet the following requirements:
    - The system must be designed in accordance with BCA Specification E2.2b and AS1668.1:2015 unless noted otherwise.
    - Each tenancy shall form have extraction rates of one volumetric air change per hour in lieu of the prescribed exhaust capacities detailed in Specification E2.2.b.
    - Fan initiation switches shall be located at the Main FDCIE to operate 2B-1 and 2B-2, or an adjacent panel located within the office entrance.
        - Signs alerting the Fire Brigade to the operation of the smoke exhaust system must be provided.
        - Fire rated fans and fire rated cabling shall be designed to operate at 200°C for a period no less than 60-minutes.
        - Automatic smoke exhaust systems shall be connected to the site's essential power source.
        - Multiple fans be are to be provided to each tenancy and be evenly distributed to otherwise comply with the requirements of Specification E2.2b Clause 5 of the BCA.
        - Even distributed make-up air shall be provided at low level through permanent perforation to the dispatch roller shutter doors and/or louvres in the façade. Note that manual opening of the dispatch rollers doors is not considered an acceptable method of achieving the required makeup air supply.

6.4 Occupant Fire Fighting Facilities

6.4.1 Fire Hose Reel

Fire hose reels are to be provided throughout the building in accordance with the prescriptive DTS provisions of BCA Clause E1.4 and AS2441:2005 with the following exceptions conditionally permitted:

- Fire hose reels with 50m length hoses may be utilised to achieve coverage in the warehouse. Where 50m long hoses are used;
  - They must be tested to meet the requirements of AS1221:1997 other than the specification of a maximum hose length of 36m.
  - Coverage to any part of the warehouse by a 50m long hose line must be achieved with no more than 2 bends.
- To ensure that the provision of 50m hose reels does not impact on life safety, on-site staff training in the use of the hose reels is to be undertaken by the nominated fire wardens.

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 50m or 36m hose length with a 4m water stream.

6.4.2 Portable Fire Fighting Equipment

Portable fire extinguishers are to be provided throughout the two buildings in accordance with Table E1.6 of the BCA with the type of extinguisher selected in accordance with AS2444:2001.

General office areas	Dry Powder (ABE type)	2.5Kg
Computer/server rooms	CO_2	3.5 Kg
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

6.5 Fire Brigade Intervention

6.5.1 Fire Hydrant System

A fire hydrant system shall be provided throughout the building in accordance with the prescriptive requirements of BCA Clause E1.3 and AS2419.1:2005 with the following exceptions conditionally permitted:

- The hydrant booster is not is sight of the main entrances to each warehouse unit and is therefore deemed a non-compliant location.
- The required 90/90/90 FRL protecting wall behind each external hydrant is to be omitted through the Performance Solution with the design relying on the sprinkler system installed throughout the building.
- Hydrants located beneath awnings shall be classified as external hydrants for the purposes for system coverage and thus allowance for the use of two hose lengths.

As part of the Performance Solution and typical Fire & Rescue NSW requirements, the system shall incorporate the following measures:

- The system shall incorporate a ring main and associated isolated valves as required for a large isolated building. Isolation valves shall be numbered with those corresponding numbers indicated on the hydrant block plan.
- All connection points must be fitted with Storz hose couplings which comply with Clause 7.1 and 8.5.11 of AS2419.1:2005, as well as comply with FRNSW Technical Information D15/45534 for *"FRNSW compatible Storz hose connections"*. Further information is available from FRNSW available at www.fire.nsw.gov.au.
- Hydrants located beneath dispatch awnings shall have alternative fall-back hydrants available to provide full coverage under the entire awning.
    - Additional external fire hydrants shall be included on the western edges of the heavy vehicle hardstand to provide coverage to the areas beneath the dispatch awnings as indicated in Figure 6-5.
- Per the request of FRNSW, as far as possible the hydrant system should consist of external hydrant points, with internal hydrants only provided to where there are shortfalls in coverage from external hydrants.
    - Where internal hydrants are required;
        - They must be designed to allow progressive movement through the building such that an internal hydrant is within 50m of an external hydrant and 25m of an internal hydrant.
        - A localised block plan must also be provided at every hydrant pictorially and numerically illustrating the location of the next available additional hydrant. These localised block plans should be of a size appropriate to their notice and location and be of all-weather fade resistant construction.

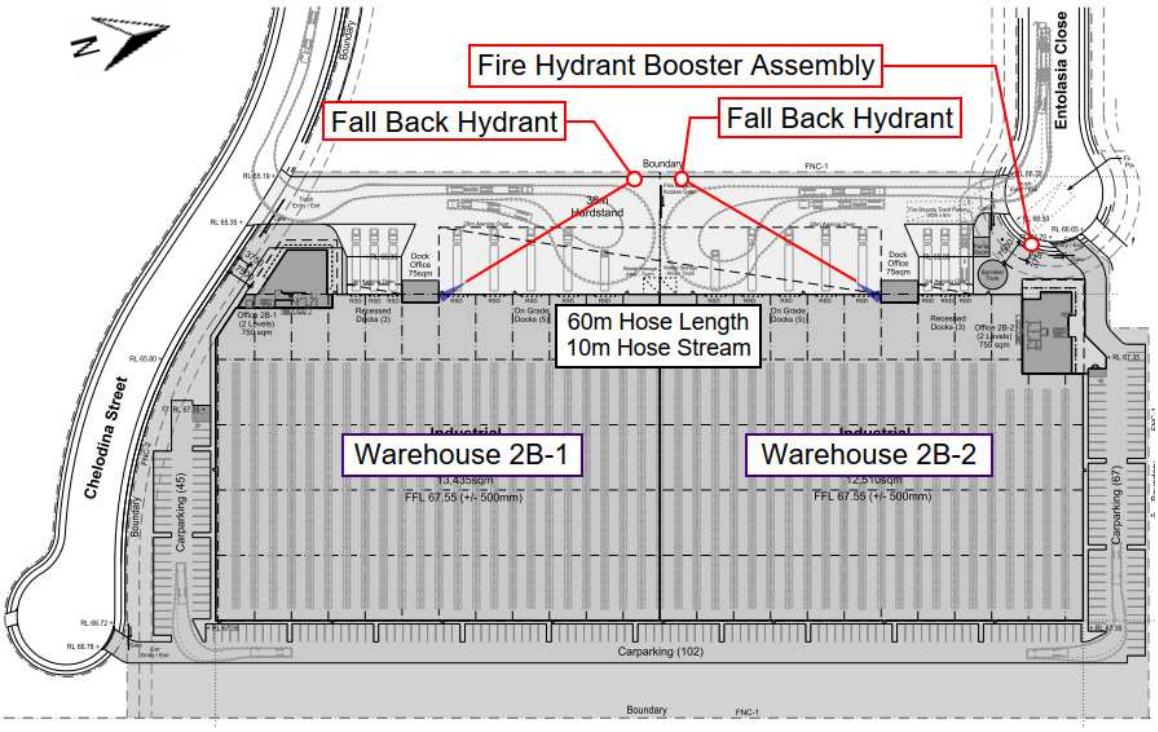


Figure 6-5: Fire Hydrant Infrastructure

The fire hydrant booster assembly is assumed to be located to front the Entolasia Close cul-de-sac and located along the perimeter access path as per Section 6.5.2.

6.5.2 Vehicular Perimeter Access

The vehicular perimeter access pathway shall be provided around the whole of the building. These shall be designed and constructed in all-weather surface capable of supporting all FRNSW appliances in accordance with BCA Clause C2.4 and FRNSW Fire Guideline requirements *"Access for fire brigade vehicles and firefighters"* (available from www.fire.nsw.gov.au) with the following exceptions conditionally permitted:

- The vehicular perimeter path navigates up to 20m from the building in lieu of 18m around the Warehouse 2B-1 recessed dispatch docks forming part of the heavy vehicle hardstand.
- The vehicular perimeter path navigates up to 33m from the building where the perimeter access path necessitates using Entolasia Close.
- The vehicular perimeter path navigates up to 33m from the building where the perimeter access path necessitates using Chelodina Street.

The vehicular perimeter path for emergency vehicles is as indicated in Figure 6-6 where the purple line represents compliant proximity to the building (18m or less) and orange represents non-compliant distance as indicated.

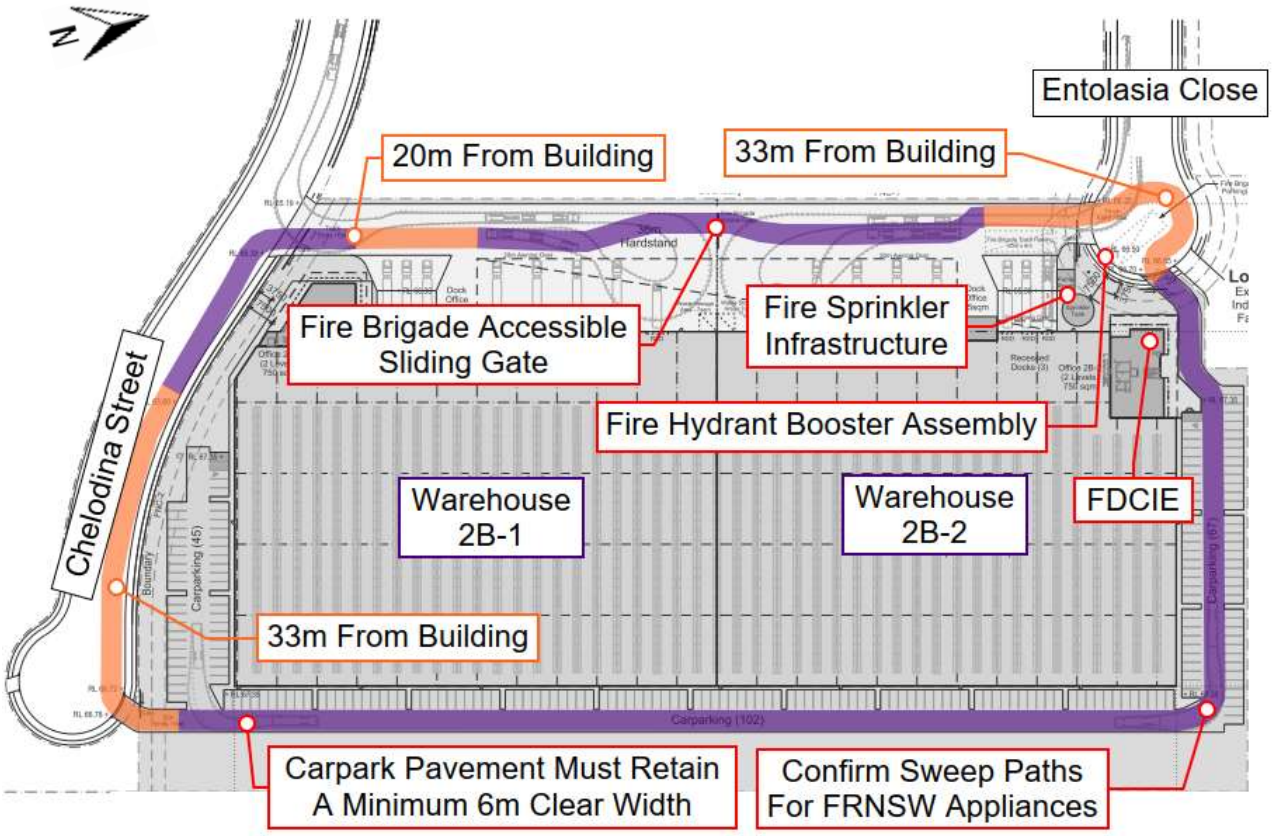


Figure 6-6: Vehicular Perimeter Path

To facilitate the perimeter access non-conformances the following measures shall be provided as part of the Performance Solution:

- Sweep paths along the perimeter access path must be confirmed by traffic engineer to facilitate the turning circle of FRNSW general fire appliance and specialist fire appliances as detailed in FRNSW Fire Safety Guideline *"Access for fire brigade vehicles and firefighters"*.
- Security gates positioned across the vehicular access pathway must have an unobstructed width no less than 6.0m and be;
    - Manually openable gates: are to be locked with a loose chain and padlock unlockable by fire brigade 003 keys; and
    - Mechanically driven gates: must be provided with a manual override that is accessible to attending fire brigade personnel with block plans indicating the manual overridable gates inclusive with pictorial step-by-step instructions at each FDCIE.
- Roadway gradients shall not hinder vehicle response and must be suitable for heavy vehicles in accordance with Australian Standards and FRNSW Fire Safety Guideline *"Access for fire brigade vehicles and firefighters"*.
- The fire appliance access road and surface are all weather and are capable of supporting the maximum appliance weights expected during fire conditions. The roadway should be designed to withstand a uniformly distributed load over the entire area as per the Fire and Rescue requirements. This would provide the necessary stability for fire-fighting appliances (pumping), and if necessary, the use of a heavier fire-fighting (aerial) appliances.

6.6 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.

6.6.1 Maintenance of Fire Safety Equipment

The fire detection systems, fire sprinkler systems, emergency warning systems, 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 AS1851 or other relevant testing regulatory.

6.6.2 No Smoking Policy

A no-smoking policy shall be implemented and enforced through all internal areas of the building.

6.6.3 Fire Safety Manual

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

6.6.4 Emergency Management Plan

An Emergency Management Plan (EMP) must be developed in accordance with AS3745:2010. The EMP must;

- Developed by an emergency planning committee (EPC).
- Implement emergency control organisation (ECO) procedures for the building.
- Specifically address the types of emergencies that may arise from the industry and/or activities associated with the business operations.
- Ongoing training, education and execution of the emergency management procedures to be regularly conducted with all building occupants.

An evacuation plan should be developed for the site in accordance with AS3745:2010 and standard fire orders should be displayed throughout the building.

6.6.5 Dangerous Goods

Should future use of the facility incorporate the use and/or storage of dangerous goods outside the purpose of frequent maintenance purposes, the site will require review and assessment by a suitably qualified Risk Consultant to determine the associated hazards and required preventative measures to meet BCA Clause E1.10 and E2.3. The fire engineering strategy shall be required the following requirements:

- Storage of dangerous or hazardous goods on this site will require re-assessment of the fire engineering analysis by a registered C10 Fire Safety Engineer.
- Where the storage quantity trigger requirements for a fire safety study, the above re-assessment of fire engineering analysis must also be submitted to Fire and Rescue NSW for the key stakeholder's review and support.

6.6.6 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.

6.6.7 Fire Drills and General Fire Safety Training

All fire wardens are to be trained in first-aid firefighting 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.

7 REFERENCES

1. Australian Building Codes Board, "NCC - Building Code of Australia – Volume One, 2019 – Amendment 1", Canberra ACT 2020."
2. Australian Building Codes Board, "NCC - Guide to Volume One", Canberra ACT 2019.
3. Australian Building Codes Board, "International Fire Engineering Guidelines", Canberra ACT 2005.
4. Society of Fire Protection Engineers, "The SFPE Handbook of Fire Protection Engineering", 4th edition, 2008.
5. Drysdale D, "An Introduction to Fire Dynamics", 3rd edition, John Wyley & Sons, UK, 2011.
6. Davis R. (2014), "Fire Concerns With Roof-Mounted Solar Panels", SFPE Fire Protection Engineering Emerging Trends Newsletter, Issue 92, 2014.
7. PD7974-6:2004, "The application of fire safety engineering principles to fire safety design of buildings – Part 6: Human factors", BSI British Standards.
8. PD7974.7:2003, "Application of fire safety engineering principles to the design of buildings – Part 7: Probabilistic risk assessment", BSI British Standards.
9. Spearpoint, M., "Fire Engineering Design Guide", 3rd edition, New Zealand Centre for Advanced Engineering, May 2008.
10. The Chartered Institute of Building Services Engineers, "Fire Safety Engineering CIBSE Guide E", 3rd Edition, May 2010.
11. Drysdale D, "An Introduction to Fire Dynamics", 3rd edition, John Wiley & Sons, UK, 2011.
12. "Fire Brigade Intervention Model V2.2", Australasian Fire Authorities Council, October 2004.
13. Boyce, K., Shields, T., and Silcock, G., "Toward the Characterization of Building Occupancies for Fire Safety Engineering: Capabilities of Disabled People Moving Horizontally and on an Incline", Fire Technology, Vol. 35, No. 1, February 1999, pp. 51-67.
14. Nelson, H.E. "BUD" and Mowrer, F.W., "Emergency Movement", The SFPE Handbook of Fire Protection Engineering (3rd Edition), National Fire Protection Association, Quincy, MA 02269, 2002 pp. 3/367-380.
15. Pauls, J. L. "Movement of People in Building Evacuations", Human Response to Tall Buildings, Chap 21. Dowden, Hutchinson and Ross, Stroudsburg, PA, 1977.
16. Pelecheno N, Malkawi A, "Evacuation simulation models: Challenges in modelling high rise building evacuation with cellular autometa approaches", Automation in Construction Journal 2008 (Vol. 17), pp.377-385.
17. Predtechenskii, V.V. and Milinskii, A.I., Planning for foot traffic in buildings (translated from Russian). Stroizdat publishers, Moscow, 1969. English translation published for National Bureau of Standards and the National Science Foundation, Washington, by Amerind Publishing Co. Pvt. Ltd, New Delhi, India, 1978.

18. Shi, L, Xie, Q, Cheng, X, Chen, L, Zhou, Y, Zhang, R, "Developing a database for emergency evacuation model", pp. 1724-1729 Building and Environment, 2009.
19. Hall, J.R. "U.S. Experience with Sprinklers", National Fire Protection Association, June 2013.
20. Turner, M. "Fire Brigade's Fight for Sprinklers in New Underground Car Park." Fire, 79 (972): 32-34, 1986.
21. Thomas, IR., "Fires in Carparks", Fire Australia February 2004, Eastside Printing, 2004.
22. BHP Steel: Structural steel Development Group, Report No MRL/Ps69/89/006. "Fire Safety in Car Parks".
23. Li, Y and Spearpoint, M. Analysis of vehicle fire statistics in New Zealand parking buildings. Fire Technology, Vol. 43, No. 2, 2007, pp.93-106.
24. BS EN 1991-1-2:2002, 'Eurocode 1: Actions on structures – Part 1-2: General actions – Actions on structures exposed to fire', British Standards, March 2009.
25. AS 1530.4, "Methods for fire tests on building materials, components and structures, Part 4: Fire resistance tests of elements of construction", Standards Australia, 2005.
26. Bushfire CRC, "Window and Glazing Exposure to Laboratory-Simulated Bushfires", Doc: 2006-205, May 2006.
27. Rakic J, "The Performance of Unit Entry Doors when Exposed to Simulated Sprinkler Controlled Fires", Lorient International, Lindfield, NSW, Australia.
28. England JP, Chow V, Yunlong Liu, (2007) Modelling Smoke Spread through Barrier Systems Retrieved from http://www.yunlong.com.au/pdf/PEngland.pdf
29. Campbell, R., 'Structure Fires in Warehouse Properties', NFPA Research, January 2016.

APPENDIX A FIRE STATISTICS

PROBABILITY OF FIRE STARTS

The probability of a fire start in a range of building uses, based on UK data, can be established using the data presented in Table 7-1 [8]; the applicable occupancy type is highlighted.

Table 7-1: Overall probability of fire starts for various occupancies, UK data

Occupancy	Probability Of Fire Starts (% Per Year)
Industrial	4.4
Storage	1.3
Offices	0.6
Assembly entertainment	12.0
Assembly non-residential	2.0
Hospitals	30.0
Schools	4.0
Dwellings	0.3

PROBABILITY OF CIVILIAN INJURY AND FATALITY

The probability of injuries and deaths for various occupancy types based on UK data [8] is presented in the following table.

Table 7-2: Probability of occupant injury and fatality by occupancy type, UK data averages for the years 1995 and 1997-1999

Type Of Occupancy	No Of Fires	Probability Of Occupant Injury Per Fire Event (%)	Probability Of Occupant Death Per Fire Event (%)
Further education	535	3.18	0.00
Schools	1669	3.06	0.00
Licensed premises	3317	7.90	0.08
Public recreational buildings	2581	1.86	0.05
Shops	5671	5.01	0.06
Hotels	1021	11.36	0.24
Hostels	1338	4.48	0.04
Hospitals	3063	3.69	0.11
Care homes	1616	8.04	0.28
Offices	1988	11.02	0.02
Factories	5299	5.40	0.08

APPENDIX B FIRE BEHAVIOUR

FIRE GROWTH RATE

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

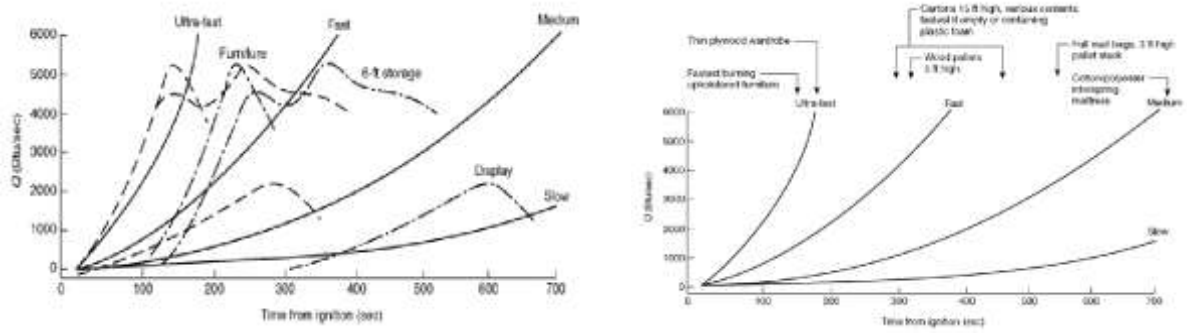
The rate of fire growth is generally expressed in terms of an energy release rate. The most commonly used relationship is what is commonly referred to as a quadratic t-squared fire. In such a fire, the rate of heat release is given by the expression:

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

Where; t is time from ignition of the fire (seconds) and k is the growth time (seconds) for the fire to reach a heat output of 1.055 MW.

The continued growth of a fire defined by the above equation relies on both a sufficient source of fuel and air and assumes that flashover has not been reached. The rate of fire growth can be estimated from the results of a number of fire tests that have been performed on various fuel commodities.

National Fire Protection Association Standard NFPA 92B, provides information on the relevance of t-squared approximation to real fire as depicted in Figure 7-1.



(a) t-squared fire, rates of energy release (b) Relation of t-squared fires to some fire tests

Figure 7-1: NFPA 92B design fires and heat release rates

A slow fire growth is not considered to be the most challenging in terms of fire and life safety or fire brigade intervention. The continued growth of a fire defined by the above equation relies on both a sufficient source of fuel and air and assumes that flashover has not been reached. The rate of fire growth can be estimated from data published in CIBSE Guide E [10] and BS9999:2008 are listed below:

- Assembly hall seating : Medium-Fast
- Dwelling : Medium
- Office : Medium
- Hotel bedroom : Medium
- Hotel reception : Medium
- Meeting room : Medium
- Picture Gallery : Slow
- Reception area : Slow
- Restaurant/Canteen : Medium
- Shop : Fast
- Teaching laboratories : Fast
- Warehouse : Medium/Fast/Ultra-fast
- Waiting Room : Slow

From the above list, it can be concluded that the likely fire scenarios in the building may be approximated by the standard Ultra-fast time-squared fire growth rate curve.

APPENDIX C FIRE LOADS

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 IFEG has published further fire load densities for broad occupancy groupings (extracted from CIB 1983) as provided in the table below. The CIB compilation emphasises that at least the 95% fractile should be selected for design purposes. The following fire loads have been extracted from the IFEG and are considered applicable to the subject building:

Table 7-3: Fuel load densities for different occupancy groups

Occupancy	Densities in mega-joules per square metre			
	Mean	Percent fractile		
	(MJ/m^2)	80	90	95
Dwelling	780	870	920	970
Hospital	230	350	440	520
Hospital storage	2000	3000	3700	4400
Hotel bedroom	310	400	460	510
Offices	420	570	670	760
Shops	600	900	1100	1300
Manufacturing	300	470	590	720
Manufacturing and storage <150kg/m^2	1180	1800	2240	2690
Libraries	1500	2250	2550	-
Schools	285	360	410	450

WAREHOUSES (U.S.A.)

The following data has been extracted from the fire statistics data published by the NFPA for the years 2009-2013. The sum of each column of data may not equal totals due to rounding errors.

Table 7-4: Leading causes of structure fires in warehouse properties (2009-2013 annual averages)

Cause	Fires	Civilian Injuries
Intentional	220 (18%)	4 (21%)
Electrical distribution and lighting equipment	220 (18%)	8 (38%)
Heating equipment	90 (8%)	0 (0%)
Exposure fire	90 (7%)	0 (0%)
Smoking materials	60 (5%)	0 (0%)

Cause	Fires	Civilian Injuries
Cooking equipment	50 (4%)	0 (0%)
Lightning	20 (2%)	0 (0%)

Based on the table above, it can be noted that the leading cause is generally equipment used by the building occupants. Electrical distribution and lighting equipment is the leading cause of fires and civilian injuries, accounting for over a third of civilian injuries (38%). The following table indicates the majority of deaths and injuries occur in storage and loading bays of warehouse buildings.

Table 7-5: Structure fires in warehouse properties by area of origin (2009-2013 annual averages)

Cause	Fires	Civilian Injuries
Unclassified storage area	140 (11%)	4 (19%)
Shipping receiving or loading area	120 (10%)	2 (10%)
Storage room, area, tank or bin	80 (7%)	1 (4%)
Vacant structural area	60 (5%)	0 (0%)
Unclassified outside area	50 (4%)	1 (3%)
Storage of supplies or tools or dead storage	50 (4%)	0 (0%)
Exterior roof surface	50 (4%)	0 (0%)
Trash or rubbish chute, area or container	40 (4%)	0 (0%)
Unclassified equipment or service area	40 (4%)	0 (2%)
Processing or manufacturing area, or workroom	40 (3%)	1 (5%)
Unclassified area of origin	40 (3%)	1 (5%)
Office	40 (3%)	1 (7%)
Exterior wall surface	40 (3%)	0 (0%)
Maintenance or paint shop area	30 (3%)	1 (5%)
Unclassified structural area	30 (2%)	0 (0%)
Garage or vehicle storage area	30 (2%)	1 (6%)

Cause	Fires	Civilian Injuries
Kitchen or cooking area	20 (2%)	0 (0%)
Wall assembly or concealed space	20 (2%)	0 (0%)
Machinery room or area or elevator machinery room	20 (2%)	0 (0%)
Other known area of origin	280 (23%)	6 (27%)

The following table lists the extent of fire spread in warehouse properties and the corresponding number of civilian injuries.

Table 7-6: Structure fires in warehouse properties by extent of flame (2009-2013 annual averages)

Extent Of Fire Spread	Fires	Civilian Injuries
Confined fire identified by incident type	280 (23%)	0 (0%)
Confined to object of origin	170 (14%)	6 (32%)
Confined to room of origin	260 (21%)	4 (19%)
Confined to floor of origin	70 (6%)	1 (6%)
Confined to building of origin	370 (31%)	7 (38%)
Beyond building of origin	60 (5%)	1 (5%)