FIRE SAFETY STRATEGY

Multi-Storey Warehouse

1-3 Burrows Road, St Peters NSW

Report Number:

192023_2S_FSS_03

Date:

18/12/2024

Goodman Property Services (Aust) Pty Ltd

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REPORT DETAIL

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Report Revision History

Rev	Date	Comment	Prepared By	Reviewed By
01	27/08/2024	Preliminary Issue	**Norman Boustany** *BEng (Civil) (Hons)* *GradCert (Fire Safety)*	**Thomas Newton** *MEng Fire Safety* *Certifier Fire Safety (BDC 3149)*
02	07/10/2024	Final Issue	**Norman Boustany** *BEng (Civil) (Hons)* *GradCert (Fire Safety)*	**Thomas Newton** *MEng Fire Safety* *Certifier Fire Safety (BDC 3149)*
03	18/12/2024	Final Issue	**James Cordi** *BEng (Mech) (Hons) / BSci (Adv) (Phys)*	**Thomas Newton** *MEng Fire Safety* *Certifier Fire Safety (BDC 3149)*

EXECUTIVE SUMMARY

This Fire Safety Strategy has been prepared by Affinity Fire Engineering Pt Ltd (AFFINITY) on behalf of Goodman Property Services (Aust.) Pty Ltd (the Applicant) to accompany a State Significant Development Application (SSDA) for the below described works at 1-3 Burrows Road, St Peters in NSW. The proposed development seeks consent for:

- Demolition of all existing structures and buildings on site.
- Tree removal both on site and for a limited number of trees in the public domain and adjoining lot.
- Site remediation, and establishment works, including minor excavation / bulk earthworks.
- Design, construction and operation of a two-storey warehouse and distribution centre building with an ancillary office building, including:
  - Approximately 34,032sqm of total GFA, comprising:
    - 30,389sqm of warehouse and distribution centre GFA; and
    - 3,334sqm of GFA for ancillary office space
    - End of Trip Facilities on the ground floor of 309 sqm GFA.
  - Maximum building height of RL 29.70 (25.00 height in metres).
  - Operation 24 hours per day seven days a week.
- Provision of a on grade car parking accessed off Burrows Road which provides 145 general car parking spaces (including 8 accessible bays), 14 motorcycle spaces, and bicycle parking and end-of-trip facilities (including 66 bicycle parking spaces, showers, lockers and change rooms for occupants).
- New crossings to Burrows Road for truck and car access.
- Single fire and utilities services ingress crossing off Canal Road.
- Site landscaping works totalling approximately 6,856sqm (or 19.8% of the site), including two 6-metre landscaped setback areas to both the Burrows and Canal Roads site frontages and the following provisions:
  - 3,829sqm or 11.0% deep soil landscaping; and
  - 3,027sqm or 8.7% of permeable paving
  - 5,450sqm or 15.7% tree canopy coverage.
- Provision of building / business identification signage.

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 2022 (BCA) [1], as noted herein, are resolved through a fire engineered Performance Solution to conform to the building regulations. The complete fire-engineered analysis will be completed within the Fire Engineering Report and form part of the development Construction Certificate submission, and as such detailed engineering analysis 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) [14] 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 influence the Fire Safety Strategy adopted. The client and stakeholders for the design have not requested any additional nonprescribed objectives 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 for the public interest and is considered to be cost-effective and not needlessly onerous in its application.

Section A2G1 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).

Section A2G2 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, plumbing 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.
4) Where a Performance Requirement is proposed to be satisfied with a Performance Solution, the following steps must be undertaken:
   (a) Prepare a performance-based design brief in consultation with relevant stakeholders.
   (b) Carry out analysis, using one or more of the Assessment Methods listed in (2), as proposed by the performance-based design brief.
   (c) Evaluate results from (b) against the acceptance criteria in the performance-based design brief.
   (d) Prepare the final report that includes-
      (i) All Performance Requirements and/or Deemed-to-Satisfy Provisions identified through A2G2(3) or A2G4(3) as applicable: and
      (ii) Identification of all Assessment Methods used; and
      (iii) Details of steps (a) and (c); and
      (iv) Confirmation that the Performance Requirement is met; and
      (v) Details of conditions or limitations, if any exist, regarding the Performance Solution.

Section A2G3 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, plumbing and drainage product, form of construction or design meets the relevant Performance Requirements.
(b) Expert Judgement.

As described in Section A2G4 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 A2G2 for assessment against the relevant Performance Requirements.
(b) Section A2G3 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 to the Performance Solution.

1.3.2 Australian Fire Engineering Guidelines (AFEG)

The AFEG [4] document has been developed for use in fire safety design and assessment of buildings and reflects Australia's best practices. 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 Solutions against the Performance Requirements of the BCA. The prescribed methodology set out in the AFEG has been generally adopted in this Fire Engineering Report (FER) for the assessment of each individual deviation from the prescriptive provisions as identified by the Principal Certifier. The design of each deviation was developed with a holistic understanding of the impact of the requirements and deviations assessed on the overall risk of fire spread, and occupant and fire fighter life safety.

There are professionals employed in the building process that determine the level of compliance with the building code Deemed-to-Satisfy (DtS) provisions. Conformation of compliance with the applicable BCA DtS provisions is the role of the BCA consultant / Principal Certifier and not the project fire safety engineer. Where not commented on within this report it is the expectation that the design complies with the BCA.

1.3.3 Stakeholders

The Performance Solution has been developed collaboratively with the relevant stakeholders as identified in Table 1-1.

Table 1-1: Relevant Stakeholders

Role	Organisation	Name
Developer	Goodman Property Services (Aust) Pty Ltd	Rory Pryor Angus Harrold Guy Smith
Architecture	Welsh & Major	Chris Major Connie Wilkins David Welsh
Detailed Design	SBA	Stephen Jeffery Sean Smyth
Planning	Urbis	Matthew Holt Nick Sisam
Structural Engineer	Costin Roe	Grant Roe Farial Tanjim
Services Engineer	Osborne & Smith	John Osborne William Willis Anson Wong
Traffic	Ason	Ali Rasouli Jasmine Wong
BCA Consultant	Blackett Maguire + Goldsmith	Dean Goldsmith
Fire Safety Consultant	Affinity Fire Engineering	Thomas Newton Norman Boustany

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 the 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 prepared by SBA Architects as listed below:
  - DA000 Coversheet Rev. 4
  - DA001 Perspective View 1 Rev. 2
  - DA002 Perspective View 2 Rev. 2
  - DA003 Perspective View 3 Rev. 2
  - DA004 Material Images Board Rev. 1
  - DA101 Site Analysis & Summary Rev. 9
  - DA102 Demolition Plan Rev. 3
  - DA200 Site & Ground Floor Plan Rev. 9
  - DA201 Ground Level Mezzanine Rev. 9
  - DA202 Level 1 Floor Plan Rev. 9
  - DA203 Level 1 Mezzanine Plan Rev. 10
  - DA204 Roof Plan Rev. 7
  - DA220 Office Plans-1 Rev. 5
  - DA221 Office Plans-2 Rev. 5
  - DA222 Office Plans-3 Rev. 3
  - DA223 Office Plans-4 Rev. 2
  - DA300 Elevations Rev. 8
  - DA301 Elevations & Sections Rev. 6
  - DA320 Sections Rev. 5
  - DA330 Facade Types - Warehouse Rev. 2
  - DA331 Facade Types - Office Rev. 2
  - DA600 Shadow Diagrams - 21 June (Winter Solistice) Rev. 3
  - DA601 Shadow Diagrams - 22 March (Equinox) Rev. 3
  - DA700-GLA-Calculations- Rev. 4
  - DA701 GFA Calculations Rev. 8
  - DA702 Deep Soil Calculations Rev. 5
  - DA710 Signage Rev. 3

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 Sections 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 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 to the following:

1. The location can affect the time for fire brigade intervention and potential external fire exposure issues.
2. The structure will impact the ability to resist a developing fire and support conditions to allow occupants to escape the building and the fire brigade to undertake firefighting 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 Summary of Proposed Works

The proposed development seeks consent for:

- Demolition of all existing structures and buildings on site.
- Tree removal both on site and for a limited number of trees in the public domain and adjoining lot.
- Site remediation, and establishment works, including minor excavation / bulk earthworks.
- Design, construction and operation of a two-storey warehouse and distribution centre building with an ancillary office building, including:
  - Approximately 34,032sqm of total GFA, comprising:
    - 30,389sqm of warehouse and distribution centre GFA; and
    - 3,334sqm of GFA for ancillary office space
    - End of Trip Facilities on the ground floor of 309 sqm GFA.
  - Maximum building height of RL 29.70 (25.00 height in metres).
  - Operation 24 hours per day seven days a week.
- Provision of a on grade car parking accessed off Burrows Road which provides 145 general car parking spaces (including 8 accessible bays), 14 motorcycle spaces, and bicycle parking and end-of-trip facilities (including 66 bicycle parking spaces, showers, lockers and change rooms for occupants).
- New crossings to Burrows Road for truck and car access.
- Single fire and utilities services ingress crossing off Canal Road.
- Site landscaping works totalling approximately 6,856sqm (or 19.8% of the site), including two 6-metre landscaped setback areas to both the Burrows and Canal Roads site frontages and the following provisions:
  - 3,829sqm or 11.0% deep soil landscaping; and
  - 3,027sqm or 8.7% of permeable paving
  - 5,450sqm or 15.7% tree canopy coverage.

- Provision of building / business identification signage.

2.3 Site Description

The land to which this SSDA relates is located at 1-3 Burrows Road, St Peters (the site). The site comprises two parcels of land (allotments) and is legally described as follows:

- Lot 1 DP 1227450; and
- Lot 11 DP 606737.

The site is located in the City of Sydney Local Government Area (LGA), at the junction with the Inner West and Bayside LGA's.

The site is bound by public roads on all sides, with Burrows Road to the south-east and Canal Road to the south-west.

A location plan including the site's existing developments is provided in Figure 2-1 where an aerial image outlines the site's allotment boundaries.

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.

Figure 2-1: Allotment Location within the Local Settings

2.4 Building Description

The development entails the construction of a storage and dispatch facility comprising of a two (2) levels of warehousing that are divided into eight tenancies, four tenancies on each level. Each warehouse tenancy has access to a dedicated office space, shared dispatch hardstand, and on site carparking area.

From a BCA compliance perspective, the building is deemed to have a Rise-in-Storeys of four (4) and an effective height of 17.2m.

Ground Floor

The Ground Floor level contains the on-grade level of warehouse space, administration offices and staff carparking areas.

The Class 7b warehouse space is accessed via the dispatch vehicle entry driveway off Burrows Road where a central shared hazards allows trucks to access the warehouse tenancies G-1 to G-4. Each warehouse tenancy has dispatch roller doors opening onto the central hardstand.

Each warehouse has access to a mezzanine Class 5 office space that sits above the northern and southern ends of the warehouse space. Additional to the office space located on the northern and southern sides of the building, are Class 7a carparking areas. The southern carparking area sits beneath the Level 1 warehouse space and forms an undercroft carpark. The northern carparking space is largely external with the exception of the area utilised beneath the vehicular access ramp.

Level 1

Similar to the Ground Floor, Level 1 warehouse parts consist of a central shared hardstand with storage and dispatch tenancies to the north and south. Truck access to Level 1 is via a vehicular access ramp that is accessed off Burrows Road on the north-eastern corner of the site and wraps around the north-western corner of the building. Pedestrian egress stairs are available around the perimeter of the floor plate via various fire-isolated stairs to ensure safe evacuation opportunities.

Each warehouse tenancy also has access to a central stairway rising up through the office tenancies. The stair through the centra of the offices are being designed as non-fire-isolated stairs, addressed through a fire engineered performance Solution, whereas all other stairs are being designed as fire-isolated stairs to enhance occupant evacuation options and assist in fire brigade intervention.

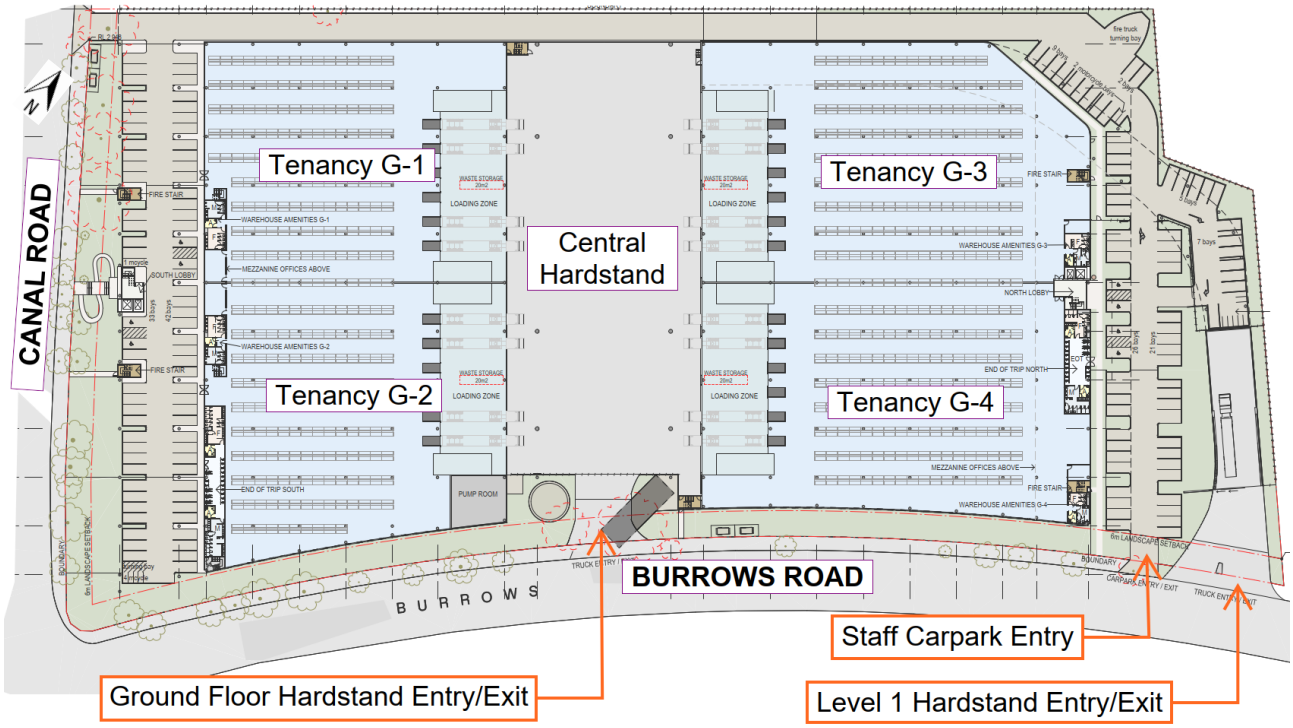


Figure 2-2: Ground Floor Plan

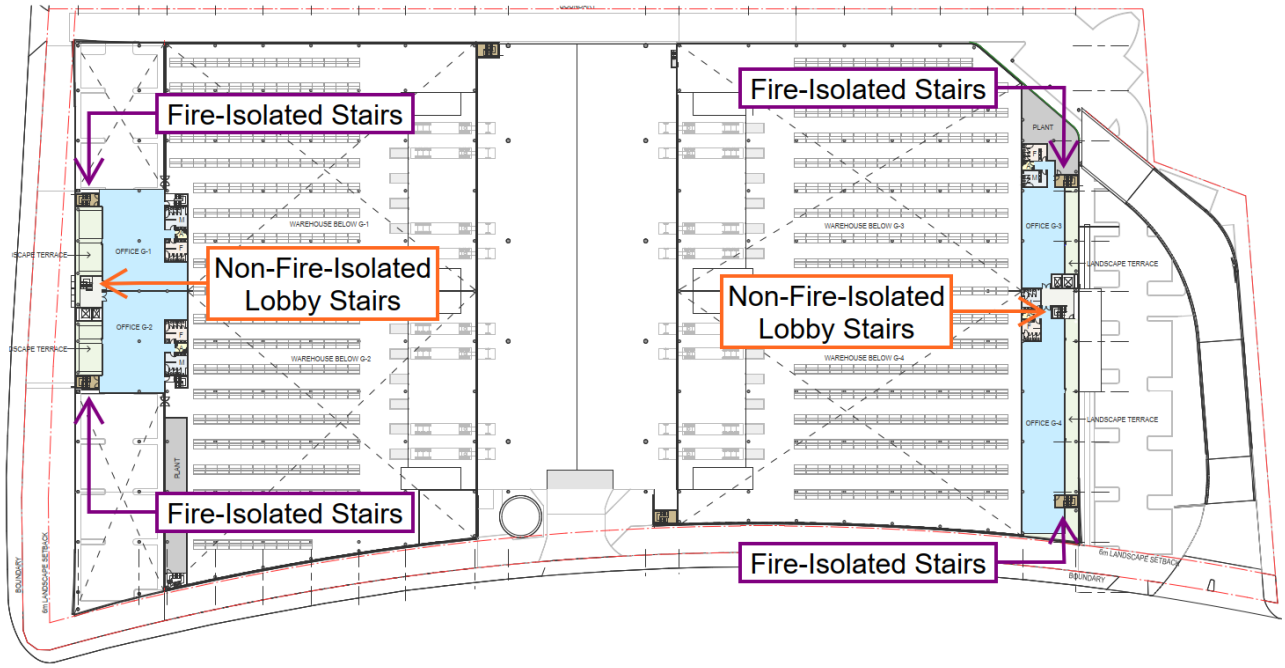


Figure 2-3: Ground Level Mezzanine Floor Plan

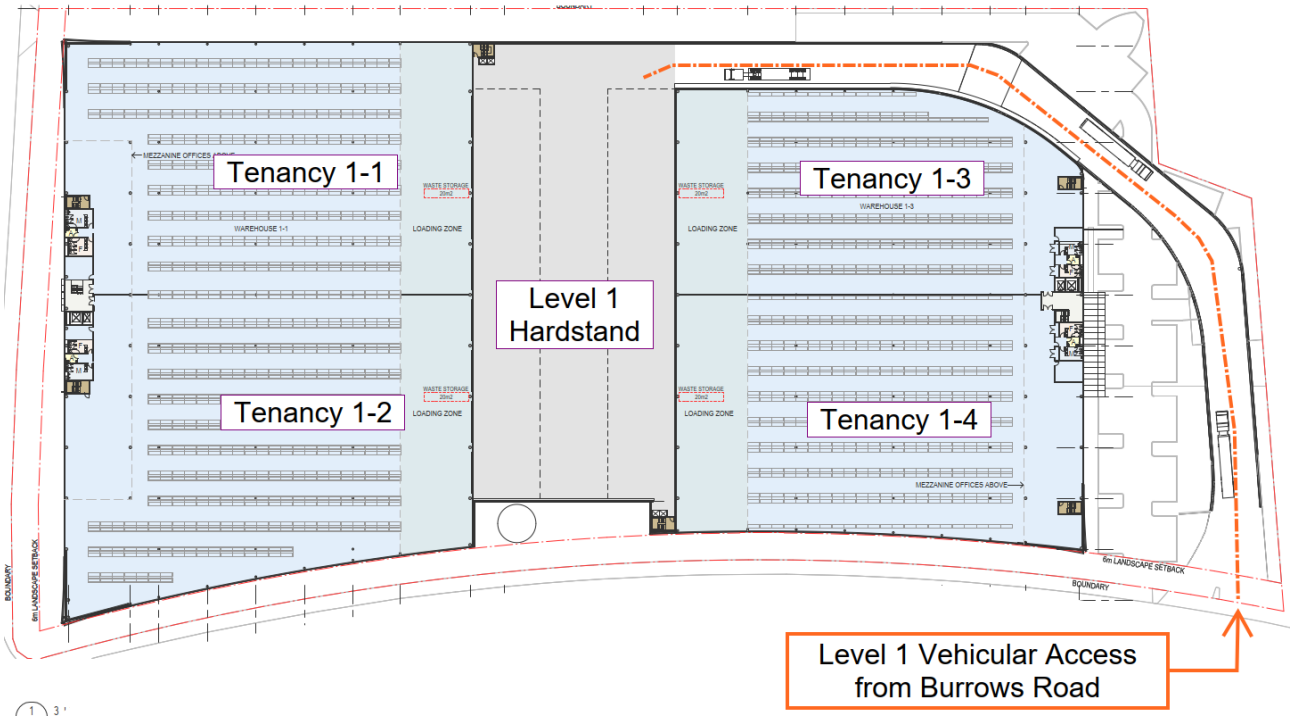


Figure 2-4: Level 1 Plan

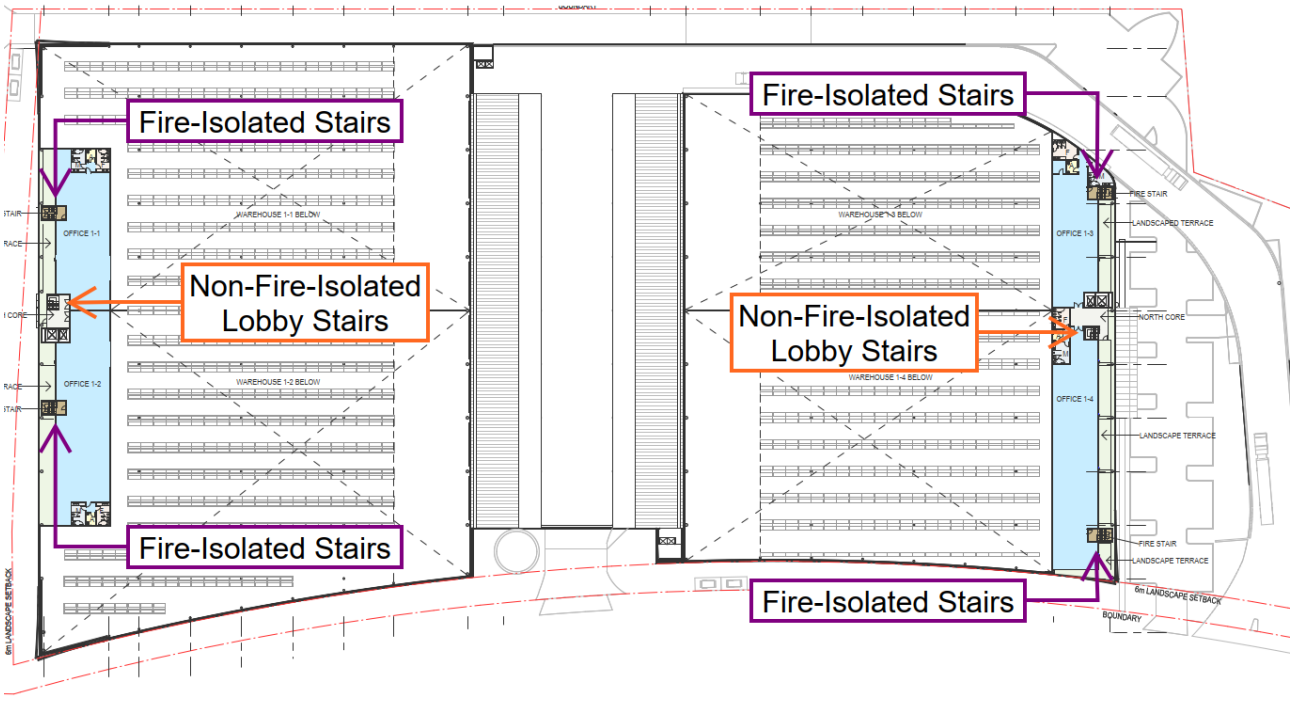


Figure 2-5: Office Layout - Level 1 Mezzanine

2.5 Building Structure

Generally, 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. The main building structure will consist of concrete and steel construction with large degrees of fire rating to meet the BCA required Fire Resistance Levels.

From a BCA compliance perspective the building is deemed to have a Rise-in-Storeys of four (4) and an effective height of 17.2m. This therefore requires Type A Construction measures, and further to this the building exceeds the compartment limitations under BCA Clause C2.2 and is therefore classified as a Large Isolated Building.

2.6 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 for BCA Compliance

CHARACTERISTIC	SITE 1
NCC Classification	Class 5 – Office Class 7a - Carpark Class 7b – Storage *The end of trip are less than 10% of the Ground Floor areas and as such adopt the major classification.*
Rise in Storeys	Four (4)
Effective Height	17.2m
Type of Construction	Type A (Large Isolated Building)

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 D2D218 for the various areas and the building layout which are listed as follows: ▸ 1 person per 30m^2 in the warehouse storage, plant and carpark areas ▸ 1 person per 10m^2 in the office areas.
Physical and mental attributes	**Staff and Security** 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. **Clients and Visitors** This occupant group is expected to be awake and alert. This group may also exhibit physical and mental disabilities to the degree and frequency of the general public. While this occupant group are expected to be capable of making and implementing decisions independently, they may require assistance in locating or accessing the nearest and safest egress path in an

Characteristic	Description
	emergency. The occupant group are expected to be accompanied by a staff member who will be capable of assisting visitors in determining the appropriate response to fire alarm signals and direct them to the most suitable exit in an emergency. **Fire and 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. It is not expected that this occupant group would be present in the building at the time of fire ignition, they are however expected to enter the building at a later stage to undertake fire suppression activities. **Maintenance Personnel** Are expected to be mobile with normal hearing and visual abilities where occupants in this group are considered to take and implement decisions independently and require minimal assistance during evacuation in a fire emergency. This group expected to be fully awake and aware of their surroundings at all times when inside the building.
Familiarity with the building	**Staff and Security** 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. **Clients and Visitors** May or may not be familiar with the layout of the building and may require assistance in locating the exits. While these occupants may not have a good familiarity of the egress paths, they will be accompanied by a staff member who will direct them to the most suitable exit in an emergency. **Fire and Rescue NSW** Are not expected to have any familiarity of the building layout, however, are assumed to obtain the required site-specific information from fire service block plans available prior to entering the building. **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.

Characteristic	Description
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 ▸ Frequency of false alarms Documents such as PD7974-6:2004 [9] and CIBSE Guide E [12] 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. [15], Nelson and Mowrer [16], 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 [12] such as in the breezeway and carpark areas; and ▸ 1.0m/s is assumed for an able-bodied adult where congestion is likely [12] such as in the warehouse and gymnasium areas; and ▸ 0.8m/s for semi-ambulant occupants requiring assistance to evacuate, walking aid or wheelchair users [16] 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 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 in fire engineering assessments.

4.2 Fire hazards

4.2.1 Building layout and egress

Occupants are afforded exits around the perimeter of the building via fire-isolated stairs to allow for multiple alternative opportunities in an emergency. Due to the open nature of the warehouses, there are limited dead end travel routes to exits. Many of the exits discharge onto the perimeter access road around the building to facilitate fire fighter access into the building for fire suppression and search and rescue operations.

4.2.2 General activities

The building will be used for general goods storage and distribution and thus 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 offices will all contain general office activities with a variety of dedicated office suites, open work areas and meeting rooms.

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 the 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 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 limited Dangerous Goods stored on site additional to 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 E1D17 and E2D21.

4.5 Rooftop Solar Panels

Solar photovoltaic systems contribute to an increased probability of a fire event, primarily due to electrical risks [8]. Additionally, should the solar panels be subjected to a fire event, the attending fire brigade can be exposed to hazardous toxins from the combustion of the panel materials.

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:

- An A4 notice on fade resistant material must be displayed at the main FDCIE notifying attending fire fighters as to the existence of the Photovoltaic Solar Panel Array on the roof of the building. The notice must include:
  - A figure detailing the location of the panels.
  - A floor plan detailing the location of all associated isolation switches and AC and DC isolators for the shut-off of generated electricity.
  - Notification that the PV do not automatically isolate on fire trip.
  - A statement in 25mm font stating (or similar wording):

    "Photovoltaic (PV) Panels Present — PV panels are mechanically fixed to the roof as shown below"
- As per the requirements of AS5033:2021 Clause 5.4, green 'PV' signage is to also be provided adjacent to isolation switches in the MSB and Inverter boards.
- As per the requirements of AS5033:2021 Clause 5.7, a shutdown procedure must also be detailed at the PV equipment that is to be operated in the event of a shutdown.

4.6 Electric Vehicles and Associated Charging Bays

Electric vehicles are becoming increasingly popular however compared to conventionally Internal Combustion Engine (ICE) vehicles, Electric Vehicles (EV) raise doubts regarding fire safety due to the Lithium-Ion batteries which are contained within the EVs to power them. Research [5] has found that many electric vehicle fires are a result of the battery with particular consistency relative to battery abuse, damage due to weather exposure and collisions respectively and in recorded occasions, during charging.

Following thermal runaway, the lithium-ion batteries are known for containing their heat and also continuing heat generations such that reignition is a credible risk to fire fighters. As such a fire hydrant system that is accessible during a fire, and also provides an ongoing supply of water is critical to containing a lithium-ion battery fire.

Due to the increased risk of the electric vehicle presence in the building, noting that this is the same for all projects and not atypical for this development, the fire engineering explicitly includes provisions with the interest of FRNSW fire intervention as an acknowledgement of the challenges faced in suppressing and extinguishing lithium-ion battery fires.

Power Isolation

- All electric vehicle charging equipment must automatically shut down and be isolated from the mains power on general fire alarm anywhere within the building.
- Signage must be displayed at the main FDCIE to indicate the properties of the electric car charging bays to include:
    - The location of the charging bays.
    - The location of manual isolation switches/boards with way finding from the FDCIE and operating instructions.
    - The power rating (kW capacity) of the chargers.
    - Notification that the electric car charging systems automatically ceases operation and are isolated from power supply on general fire alarm.

Fire Hydrant Design

- To enable attending fire fighters to attach to a hydrant and apply water suppression to the potential fire source;
    - Internal fire hydrants are to be positioned within all fire-isolated stair serving a car parking level; and
    - External hydrants are to be located around the building perimeter to provide coverage to all external and undercroft carparking spaces. Note that external hydrants must not be located within 10m of an electric vehicle charging bay.
- The hydrant system is to be connected to a pressurised town mains water supply to ensure a continuous water supply for firefighting.

Fire Sprinkler Design

- The undercroft carparks shall be fully protected by an automatic fire sprinkler system designed to AS2118.1:2017.

Ventilation

Ventilation of the car parking is a critical measure in any carpark scenario given the type and quantity of combustion products being released from a vehicle fire; this in only enhanced where the fire originates from a lithium-ion battery failure.

Typically for a basement carpark, there is risk of smoke venting up through the lift and stair shafts into the levels above. Where that is the case, a degree of smoke separation could be incorporated to prevent the upper level of the building becoming smoke logged from a basement level fire. In this instance however the carparking areas are located at Ground Floor level within an undercroft whereby the space is provided with three (3) open sides to facilitate smoke venting to atmosphere.

- As a result of the open nature, the carpark is not required to be provided with any additional smoke extraction measures.

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' [31], 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% of civilian injuries.

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

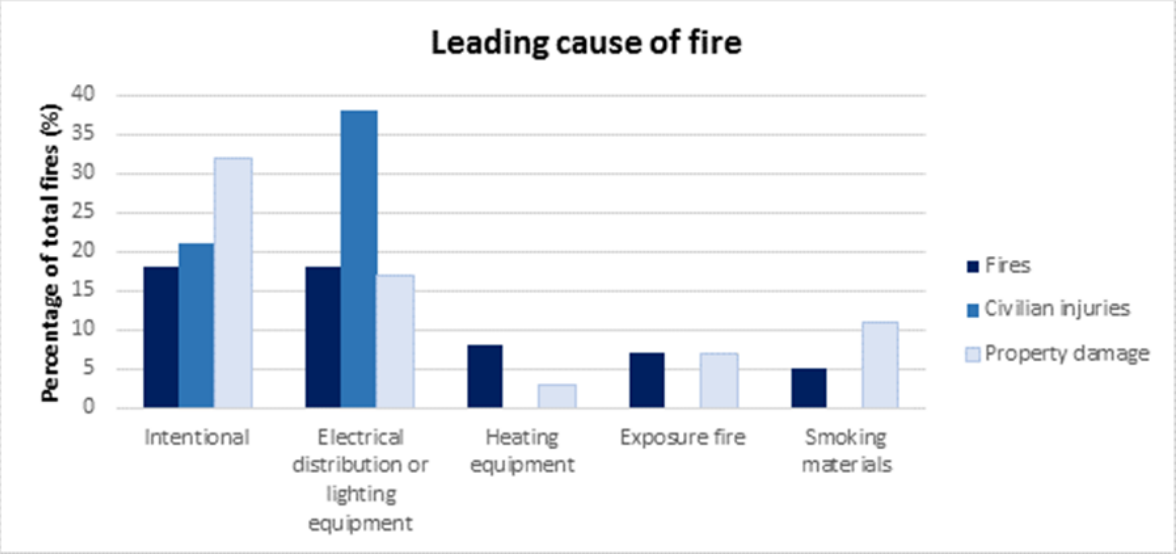


Figure 4-1: Leading Causes of Structure Fires in Warehouses

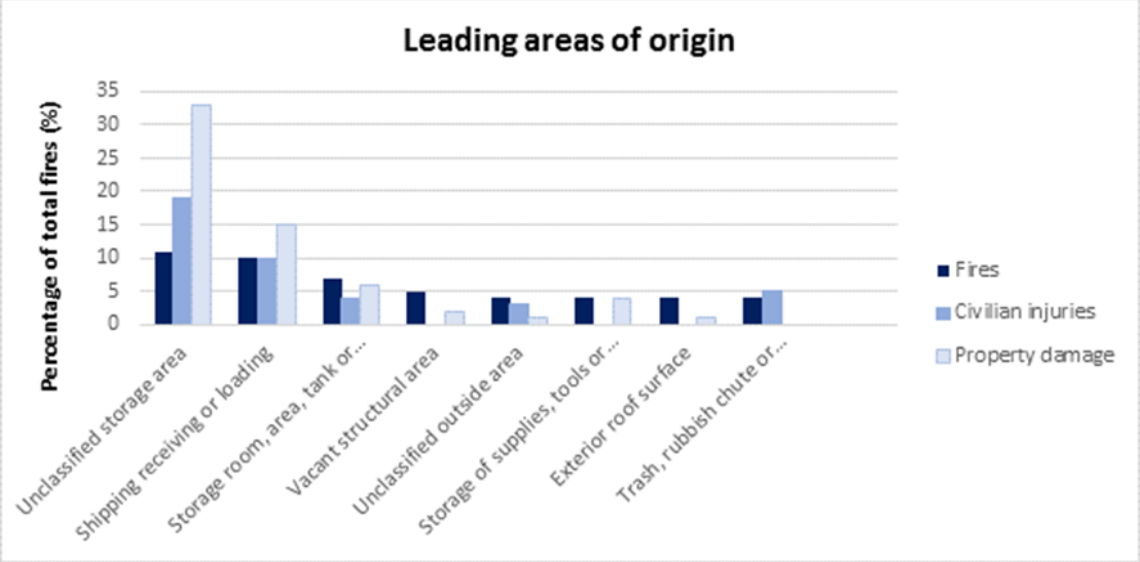


Figure 4-2: Structure fires in warehouses by area of origin

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 Office

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.

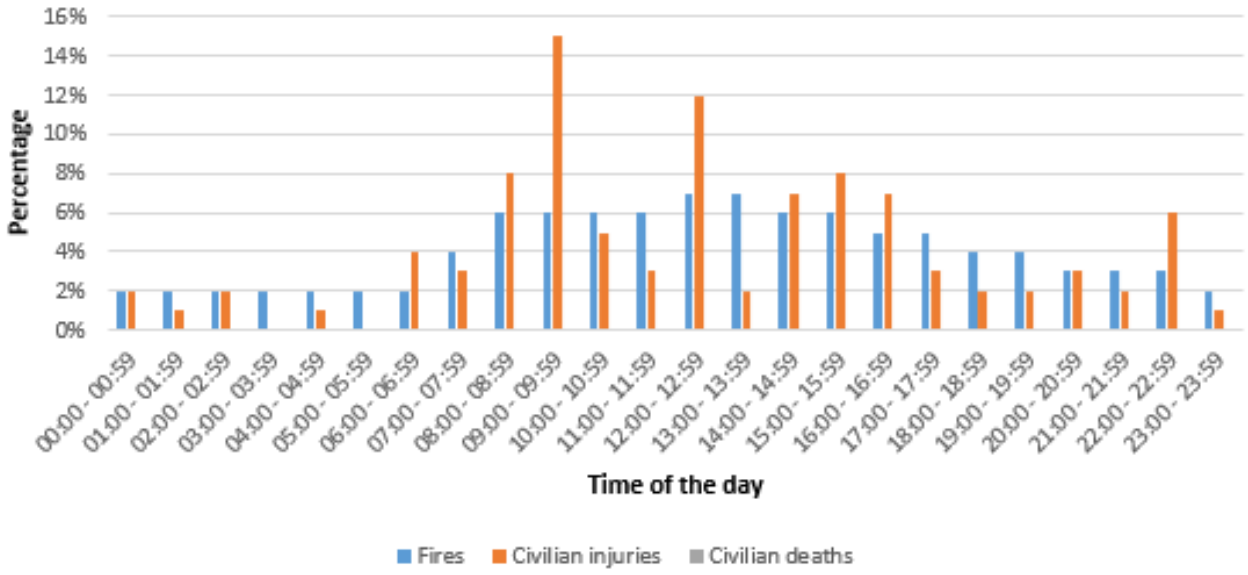


Figure 4-3: Percentage of fires, civilian injuries and deaths at different times of the day (offices)

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.

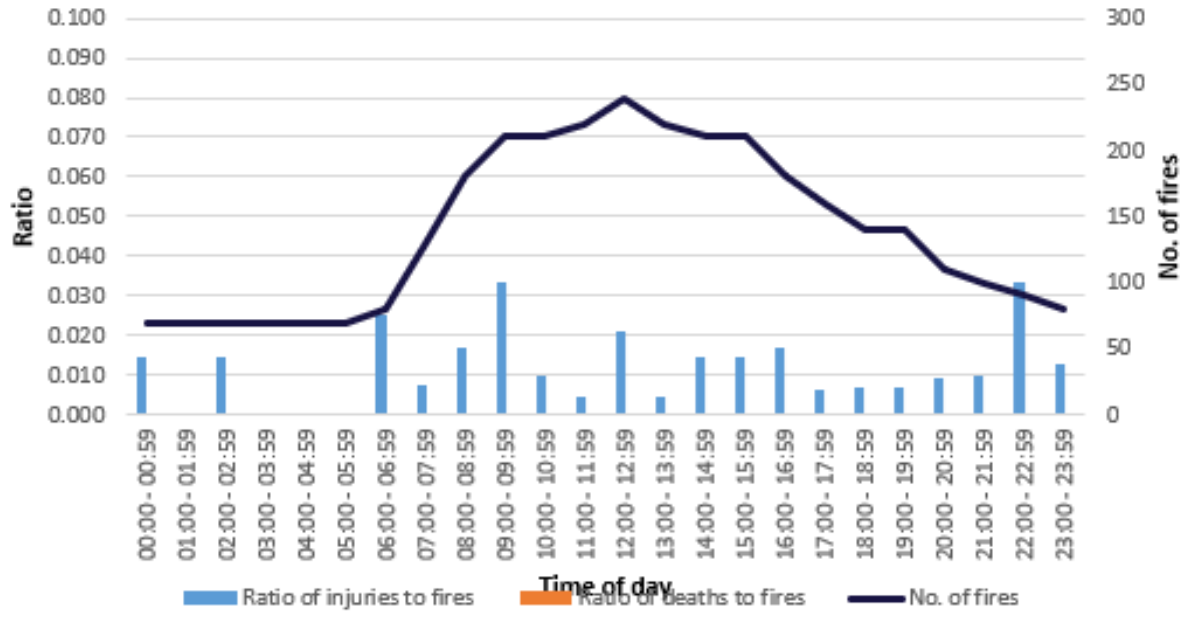


Figure 4-4: Number of fires, ratio of injuries/fires and deaths/fires for different times of the day (offices)

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's experience of similar buildings of the size and nature of 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 relevant Performance Requirements.

5.2 BCA DTS Non-Compliance Assessment and Acceptance Criteria

Table 5-1: Summary of Performance Solutions

VARIATIONS, ASSOCIATED METHODOLOGY AND ACCEPTANCE CRITERIA
Fire Rating to Floors and their Structural Supports
Relevant Regulatory Requirement: BCA Clause C2D2 requires the building be constructed in accordance with the requirements of Type A Construction as outlined in Specification 5. Specifically: ▸ Floors are required to achieve a 240/240/240 FRL. ▸ Internal columns not directly below the roof are required to achieve a 240/--/-- FRL. **Performance Requirement:** The relevant Performance Requirements are C1P1. **Non-compliance with DTS provisions:** <u>Level 1 Floor</u> ▸ The Level 1 floor will achieve a DtS compliant 240/240/240 FRL, however the structure supporting the floor slab shall have; ○ Primary beams achieving a DtS compliant 240/--/-- FRL, and secondary beams to have fire rating omitted. ○ Columns shall achieve a DtS compliant 240/--/-- FRL <u>Office Mezzanine Floor</u> ▸ The office mezzanine floors will achieve a DtS compliant 240/240/240 FRL, however the structure supporting the floor slab shall have;

VARIATIONS, ASSOCIATED METHODOLOGY AND ACCEPTANCE CRITERIA

- Primary beams achieving a DtS compliant 240/--/-- FRL, and secondary beams to have fire rating omitted.
- Columns shall achieve a DtS compliant 240/--/-- FRL.

Steel Portal Frame Above Level 1

Relevant Regulatory Requirement:

BCA Clause C2D2 requires the building be constructed in accordance with the requirements of Type A Construction as outlined in Specification 5. Specifically:

- Columns in the external walls are required to achieve a 240/180/90 FRL.
- Internal columns located directly below the roof are required to achieve a 60/60/60 FRL.

Performance Requirement:

The relevant Performance Requirements are C1P1

Non-compliance with DTS provisions:

Steel Portal Frame Warehouse Structure

- The steel columns in the external walls shall achieve a 120/--/-- FRL in lieu of 240/--/--.
- The steel columns located within the warehouse and situated directly below the warehouse roof are to have the fire rating omitted (in lieu of 60/--/-- FRL).

Combustible Attachments to the External Walls

Relevant Regulatory Requirement:

BCA Clause C2D14 requires attachments to an external wall to be non-combustible or have a permitted concession under this BCA Clause.

Performance Requirement

The relevant Performance Requirements are C1P2

Non-compliance with DTS provisions:

There will be illuminated tenant and wayfinding signage fitted to the external walls of the building that contain combustible elements.

Fire Rating to Service Penetrations

Relevant Regulatory Requirement:

BCA Clause C4D15 requires service penetrations to be sealed to ensure that the fire and smoke resisting performance of the wall through which it passes is maintained. The fire sealing is required to

VARIATIONS, ASSOCIATED METHODOLOGY AND ACCEPTANCE CRITERIA

be in accordance with the tested prototype for that service and specific wall makeup or alternatively compliant with BCA Specification 13.

Performance Requirement

The relevant Performance Requirements are C1P2 & C1P8

Non-compliance with DTS provisions:

There are a number of structural members in the building that are required to achieve a 240/240/240 FRL, however due to the limited availability of tested fire collars and sealing available on the market many service penetrations will only achieve a --/120/120 FRL.

Perimeter Vehicular Access

Relevant Regulatory Requirement:

BCA Clause C3D5 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 C1P9

Non-compliance with DTS provisions:

The following portions of the vehicular access road deviate from the prescriptive DtS provisions:

- The roadway's furthest edge is greater than 18m from the building along Canal Road and where the road enters from Burrows Road into the northern carpark.
- The roadway requires vehicles to travel beneath the Level 1 access ramp on the north-western corner of the site.

Egress Provisions

Relevant Regulatory Requirement:

BCA Clause D2D5 states that in a Class 5 to 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 D2D6 states that the travel distance between alternative exits must not exceed 60m.

Performance Requirement:

The relevant Performance Requirements are D1P4 and E2P2

Non-compliance with DTS provisions:

VARIATIONS, ASSOCIATED METHODOLOGY AND ACCEPTANCE CRITERIA

Travel distances exceed the DtS limitations throughout various areas of the building, with the following maximum distances to be rationalised through fire engineering:

Ground Floor

- Warehouse Tenancies:
  - Up to 90m to the nearest exit, and 180m between alternative exits.
- Hardstand:
  - Up to 60m to the nearest exit, and 120m between alternative exits.
- End of Trip South:
  - Up to 25m to reach a point of choice.

Level 1

- Warehouse Tenancies:
  - Up to 90m to the nearest exit, and 180m between alternative exits.

Airlocks to Fire-Isolated Stairs

Relevant Regulatory Requirement:

BCA Clause D2D12 states that a doorway must not open directly into a fire-isolated stair unless it is from:

- A public corridor, public lobby or the like; or
- A sole-occupancy unit that occupies the whole of a storey; or
- A sanitary compartment or the like.

Performance Requirement:

The relevant Performance Requirement is D1P5 & E2P2.

Non-compliance with DTS provisions:

Each fire-isolated stair opens directly into a warehouse tenancy or office tenancy that does not occupy the whole of the storey.

Non-Fire-Isolated Stair Design (and Atrium Provisions)

Relevant Regulatory Requirement:

BCA Clause D2D4 requires each stairway serving as a required exit to be fire-isolated unless:

- It connects, passes through or passes by not more than three (3) consecutive storeys in a sprinkler protected building.

Part G3 Atrium Provisions apply to stairs that exceed the above connections and the stair is non-required for egress purposes. Noting that Specification 31 is also applicable.

VARIATIONS, ASSOCIATED METHODOLOGY AND ACCEPTANCE CRITERIA

Performance Requirement:

The relevant Performance Requirement is C1P2, D1P4, D1P5 & E2P2.

Non-compliance with DTS provisions:

The central common stairs serving four (4) office levels shall be constructed as a non-fire-isolated stair in lieu of being within a fire isolated shaft. As a result of the performance solution the lobbies shall not be provided the BCA atrium provisions of Part G3 nor Specification 31.

Roof as Open Space

Relevant Regulatory Requirement:

BCA Clause D3D13 requires a roof acting as roof as open space to have direct access to a public road.

Performance Requirement:

The relevant Performance Requirements are D1P4 and E2P2

Non-compliance with DTS provisions:

The Level 1 hardstand is acting as Roof-as-Open-Space, however to reach a public road occupants are required to travel back under the dispatch awnings and through the fire-isolated stairs; and hence the egress route is not entirely through 'open space'.

Fire Hydrant System Design

Relevant Regulatory Requirement:

BCA Clause E1D2 requires that the fire hydrant system must be installed in accordance with AS2419.1 given that Schedule 4 of the BCA lists AS2419.1:2021 as the required document to meet BCA DtS provisions.

Within AS2419.1:2021, the following specific clauses are relative to this design:

- AS2419.1:2021 Clause 2.2.2 requires hydrants beneath awnings with a depth exceeding 3m are to be considered internal hydrants and thus permitted only 40m coverage.
- AS2419.1:2021 clause 7.3.1 requires a fire booster assembly located remote of the building to be within sight of the principal pedestrian entrance and:
  - Adjacent to the site boundary and the principal vehicular access for the fire brigade pumping appliances to the building or site; or
  - Not more than 20m from the façade of the building containing the principal pedestrian entrance and not more than 20m from the main pedestrian entrance.
- AS2419.1:2021 Clause 11.5 (e) requires that where a booster assembly is installed, hydrant block plans shall be sized not less than A3 and have a maximum scale of 1 to 250.

VARIATIONS, ASSOCIATED METHODOLOGY AND ACCEPTANCE CRITERIA

Performance Requirement:

The relevant Performance Requirement is E1P3.

Non-compliance with DTS provisions:

The fire hydrant system shall be compliant with AS2419.1:2021 with the following exceptions permitted through the Performance Solution:

- Hydrants under Awnings: External hydrants are located beneath the loading dock dispatch awning on Level 1 (which have a depth of 15m) and shall retain their classification as external hydrants in lieu of being internal hydrants; hence for the purposes of system coverage they will maintain 70m coverage.
- Fire Hydrant Booster Assembly: The booster location is at the entry to the site, however non-compliant with Clause 7.3.1(c)(i) due to it being not within sight of each principal pedestrian entrance to the building.
- Hydrant Block Plan: Hydrant block plan at the booster assembly to be a maximum A1 sized, in lieu of the maximum scale of 1:250. All other blockplans across the site are to be A3.

Fire Hose Reel Design

Relevant Regulatory Requirement:

BCA Clause E1D3 requires that fire hose reels are installed in accordance with AS2441 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 E1P1.

Non-compliance with DTS provisions:

Due to the expansive footprint of the building, fire hose reels with a hose length of 50m in lieu of 36m are proposed to be used to achieve coverage within the warehouse area.

Fire Sprinkler System Design

Relevant Regulatory Requirement:

BCA Clause E1D4 requires that the fire sprinkler system is to be installed in accordance with AS2118.1:2017 of which under Clause 4.14.1 and 4.14.2, the fire sprinkler booster assembly and suction connection respectively must be in accordance with the requirements of the fire hydrant standard AS2419.1:2021.

VARIATIONS, ASSOCIATED METHODOLOGY AND ACCEPTANCE CRITERIA

AS2419.1:2021 clause 7.3.1 requires a fire booster assembly located remote of the building to be within sight of the principal pedestrian entrance and:

- Adjacent to the site boundary and the principal vehicular access for the fire brigade pumping appliances to the building or site; or
- Not more than 20m from the façade of the building containing the principal pedestrian entrance and not more than 20m from the main pedestrian entrance.

Performance Requirement

The relevant Performance Requirement is E1P4

Non-compliance with DTS provisions:

Fire Sprinkler Booster Assembly: The booster location is on the eastern side of the site, however non-compliant with Clause 7.3.1(c)(i) due to it being not within sight of each principal pedestrian entrance to the building.

Smoke Hazard Management

Relevant Regulatory Requirement:

BCA Clause E2D10 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, with a ceiling height more than 12m, to be provided with an automatic smoke exhaust system in accordance with Specification E2.2b throughout.

Performance Requirement:

The relevant Performance Requirement is E2P2

Non-compliance with DTS provisions:

The fire engineering strategy for the smoke hazard management systems within the building is based on the following design principles:

Offices, End-of-Trip, Plant Rooms, Dispatch Hardstands and other Ancillary Areas

- Automatic smoke exhaust is to be omitted from the offices, dispatch hardstand, end-of-trip, warehouse amenities and other ancillary areas.

Warehouse Tenancies

An automatic smoke exhaust system shall be provided to the warehouse tenancies in accordance with the DTS provisions and AS1668.1:2015 with the following exceptions:

- An extraction rate of 10,000L/s shall be achieved from each tenancy in lieu of extraction rates defined in BCA Specification 21.
- The warehouse shall form a single smoke reservoir resulting in a zone exceeding 2,000m^2.

VARIATIONS, ASSOCIATED METHODOLOGY AND ACCEPTANCE CRITERIA

Exit and Emergency Lighting

Relevant Regulatory Requirement:

BCA Clause E4D2, E4D4, E4D5, E4D6 and E4D8 specifies that exit and emergency lighting is to be installed to specific design parameters and in accordance with AS2293.1:2018.

Performance Requirement:

The relevant Performance Requirement is E2P2

Non-compliance with DTS provisions:

Directional exit signs shall be installed 4.0m above the finished floor level within forklift travel zones in lieu of the AS2293.1:2018 limitation of 2.7m.

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, it is possible to change and or make modifications through the detailed design phase of the project.

6.1 Passive Fire Construction

6.1.1 Fire Resisting Construction

The building structure including floors, walls, columns and shafts shall be constructed in accordance with the requirements of Specification 5 for Type A Construction throughout with the following exceptions:

Level 1 Floor

- The Level 1 floor will achieve a DtS compliant 240/240/240 FRL, however the structure supporting the floor slab shall have;
  - Primary beams achieving a DtS compliant 240/--/-- FRL, and secondary beams to have fire rating omitted.
  - Columns shall achieve a DtS compliant 240/--/-- FRL

Office Mezzanine Floor

- The office mezzanine floors will achieve a DtS compliant 240/240/240 FRL, however the structure supporting the floor slab shall have;
  - Primary beams achieving a DtS compliant 240/--/-- FRL, and secondary beams to have fire rating omitted.
  - Columns shall achieve a DtS compliant 240/--/-- FRL.

Steel Portal Frame Level 1 Warehouse Structure

- The steel columns in the external walls shall achieve a 120/--/-- FRL in lieu of 240/--/--.
- The steel columns located within the warehouse and situated directly below the warehouse roof are to have the fire rating omitted (in lieu of 60/--/-- FRL).

As part of the above Performance Solution, the following fire safety measures shall be incorporated into the building design:

- The structure must be designed to ensure that during fire conditions, the floor slab retain a 240/240/240 FRL regardless of the omitted fire rating to secondary members.
- The design of the Level 1 portal frame structure must be such that:
  - Failure of any column in the external wall or an internal columns directly below the roof would result in an inwards collapse of the structure; and
  - The failing force would not result in progressive collapse of the building's floors.

6.1.2 Fire Compartmentation

The building shall be designed to incorporate two (2) separate fire compartments that are separated horizontally by the 240/240/240 FRL Level 1 floor slab. Hence the Ground Floor fire compartment, and the Level 1 fire compartment.

- All service penetrations are to be sealed in accordance with BCA Clause C3D15 and Specification 13 to ensure that the fire resisting performance of the floor through which it passes is maintained with the following exceptions:
  - Due to the limited availability of tested fire collars and sealing available on the market, several service penetrations will only achieve a --/120/120 FRL.
  - The exact location and specifics of these penetrations shall be determined through the detailed design phase of the project. The intent is to provide compliant fire sealing to the penetrations wherever practicable, and thus this Performance Solution allowing a reduced to --/120/120 FRL is only incorporated where there are no available systems on the market.

As part of the above Performance Solution, the following fire safety measures shall be incorporated into the building design;

- A full penetration register is to be prepared for the development in accordance with the Schedule in Appendix B of AS4072.1:2005.
- The perimeter slab-edge of the Level 1 floor is to achieve a smoke seal only. The junction where the floor meets the external façade is not required to be fitted with fire rated sealant provided the linear gap does not exceed a 200mm width.
  - Where smoke sealing is afforded, it must ensure it resists smoke spread when exposed to a temperature of 200°C for a 1hr duration.
  - Any gaps larger than 200mm must be reduced in with by a fire rated element achieving a --/240/240 FRL.

6.1.3 Separation of Equipment

Rooms containing equipment listed below must be fire separated from the remainder of the building by construction in accordance with Specification 5 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 switchboard located within the building which sustains emergency equipment operating in the emergency mode (i.e. the smoke exhaust mechanical board and all switchboards feeding that) must meet the requirements of BCA Clause C3D14. 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.

6.1.4 Construction of Exits

Each of the six (6) "Fire Stairs" serving the warehouse and office levels shall be constructed as fire-isolated stairs in accordance with BCA Specification 5 and the following:

- Each stair shall be contained within a fire-isolated shaft achieving a 240/120/120 FRL and fitted with self-closing fire doors achieving a --/60/30 FRL.

As part of the fire engineered solution, the two (2) central common stairs rising up through the northern and southern office lobbies shall be constructed as non-fire-isolated stairs.

- The central common stairs serving four (4) office levels shall be constructed as a non-fire-isolated stair in lieu of being within a fire isolated shaft.

As part of the above Performance Solution, the following fire safety measures shall be incorporated into the building design:

- As a result of the performance solution the office lobbies shall not be provided the BCA atrium provisions of Part G3 nor Specification 31.
- The ground floor level of the office lobbies must be bound by fire rated construction achieving a 120/120/120 FRL and fitted with self-closing fire doors achieving a --/120/30 FRL.
    - Where there are glazed elements, windows or doors, these shall be protected by wall-wetting sprinklers in lieu of achieving a fire rating.

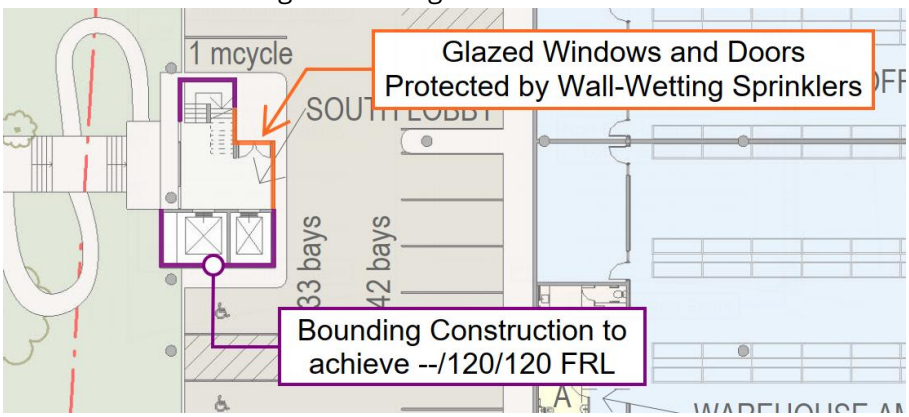


Figure 6-1: Fire Rated Bounding Construction to the Southern Office Lobby at Ground Floor Level

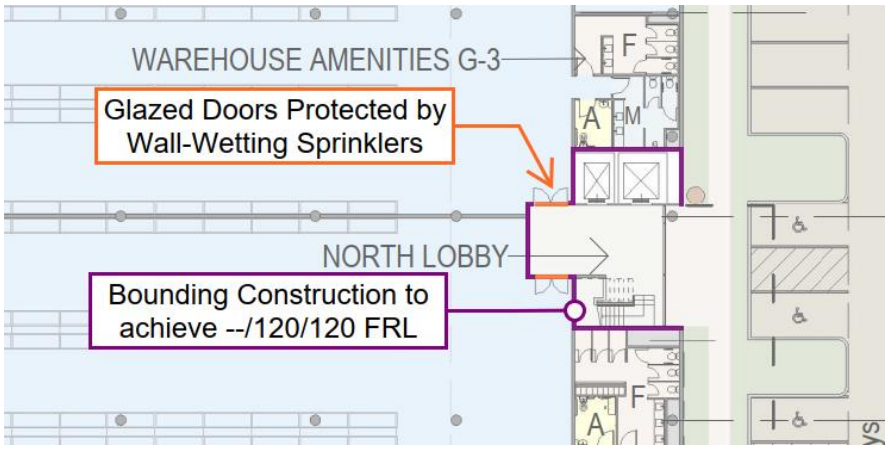


Figure 6-2: Fire Rated Bounding Construction to the Northern Office Lobby at Ground Floor Level

6.1.5 Non-Combustible Materials

Where non-combustible materials and their supporting members are required by the BCA, these must be fully DtS compliant.

As part of the requirements for Type A Construction, external walls including their components and any attachments, both internal and external, are to be non-combustible and/or compliant with BCA Clause C2D10 and C2D14 with the following exceptions:

- There will be illuminated tenant and wayfinding signage fitted to the external walls of the building that contain combustible elements.
  - These signs shall be constructed of a polycarbonate material that has not been tested to achieve a Group 1 or 2 rating under AS5637.1:2015.

As part of the above Performance Solution, the following fire safety measures shall be incorporated into the building design:

- Any combustible signage greater than 2m^2 in area must be positioned such that they are not directly above an exit door or external fire hydrant.

6.1.6 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 C2D11 and Specification 7.

6.1.7 Rooftop Solar Panels

The following measures shall be provided where the design includes the installation of solar panels to the roof of a warehouse.

- An A4 notice on fade resistant material must be displayed at the main FDCIE notifying attending fire fighters as to the existence of the Photovoltaic Solar Panel Array on the roof of the building. The notice must include:
  - A figure detailing the location of the panels.
  - A floor plan detailing the location of all associated isolation switches, AC and DC isolators for the shut-off of generated electricity.
  - Notification that the PV do not automatically isolate on fire trip.
  - A statement in 25mm font stating (or similar wording):

    "Photovoltaic (PV) Panels Present — PV panels are mechanically fixed to the roof as shown below"

6.2 Egress Provisions

6.2.1 Evacuation Strategy

Activation of any sprinkler head or manual call point shall initiate the building occupant warning alarm tones throughout the building.

Dedicated fire wardens shall ensure that all clients, visitors, maintenance contractors and staff are promptly evacuated if a fire is identified anywhere in the building (see Section 6.3.3).

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 are to be not more than 20m and 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.

Egress Travel Distances

The fire engineering assessment shall address travel distances that have been identified as being non-compliant in the following locations:

Ground Floor

- Warehouse Tenancies:
  - Up to 90m to the nearest exit, and 180m between alternative exits.
- Hardstand:
  - Up to 60m to the nearest exit, and 120m between alternative exits.
- End of Trip South:
  - Up to 25m to reach a point of choice.

Level 1

- Warehouse Tenancies:
  - Up to 90m to the nearest exit, and 180m between alternative exits.

Roof As Open Space

The Level 1 hardstand is acting as Roof-as-Open-Space, however to reach a public road occupants are required to travel back under the dispatch awnings and through the fire-isolated stairs; and hence the egress route is not entirely through 'open space'.

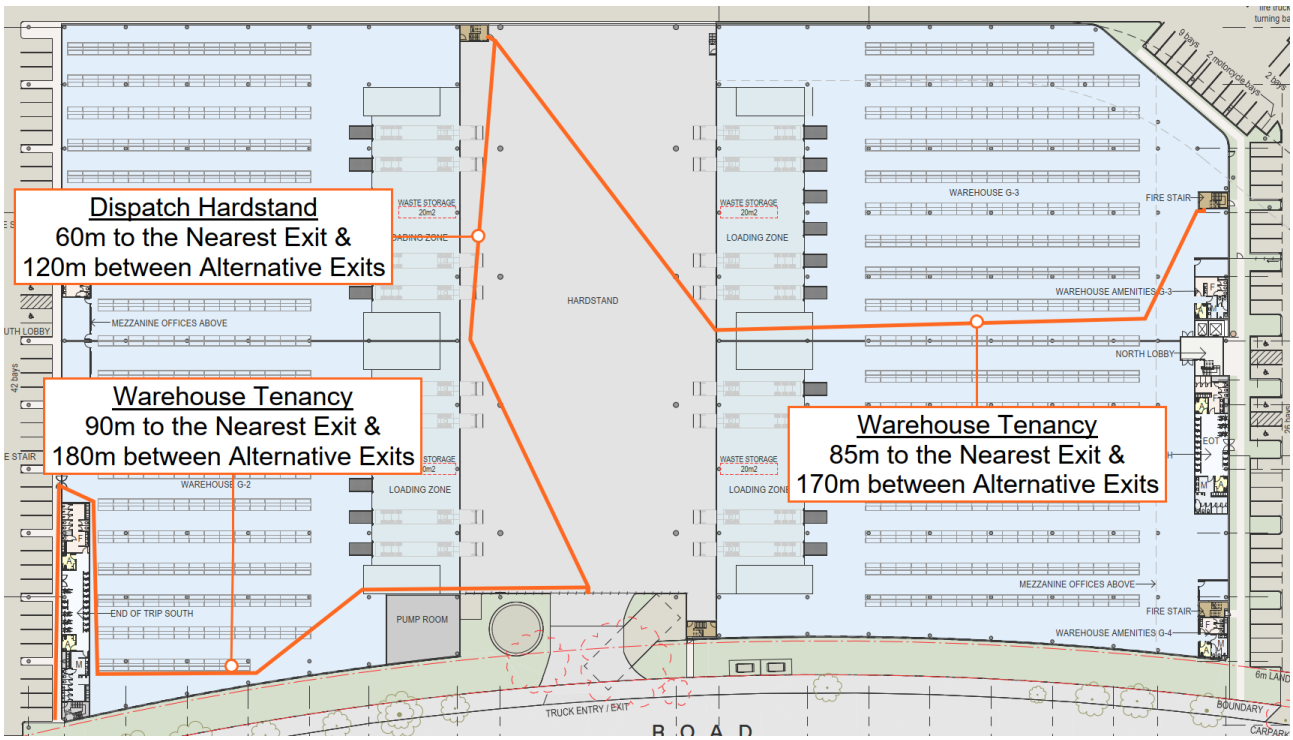


Figure 6-3: Most Onerous Non-Compliant Travel Distances Across the Ground Floor Level

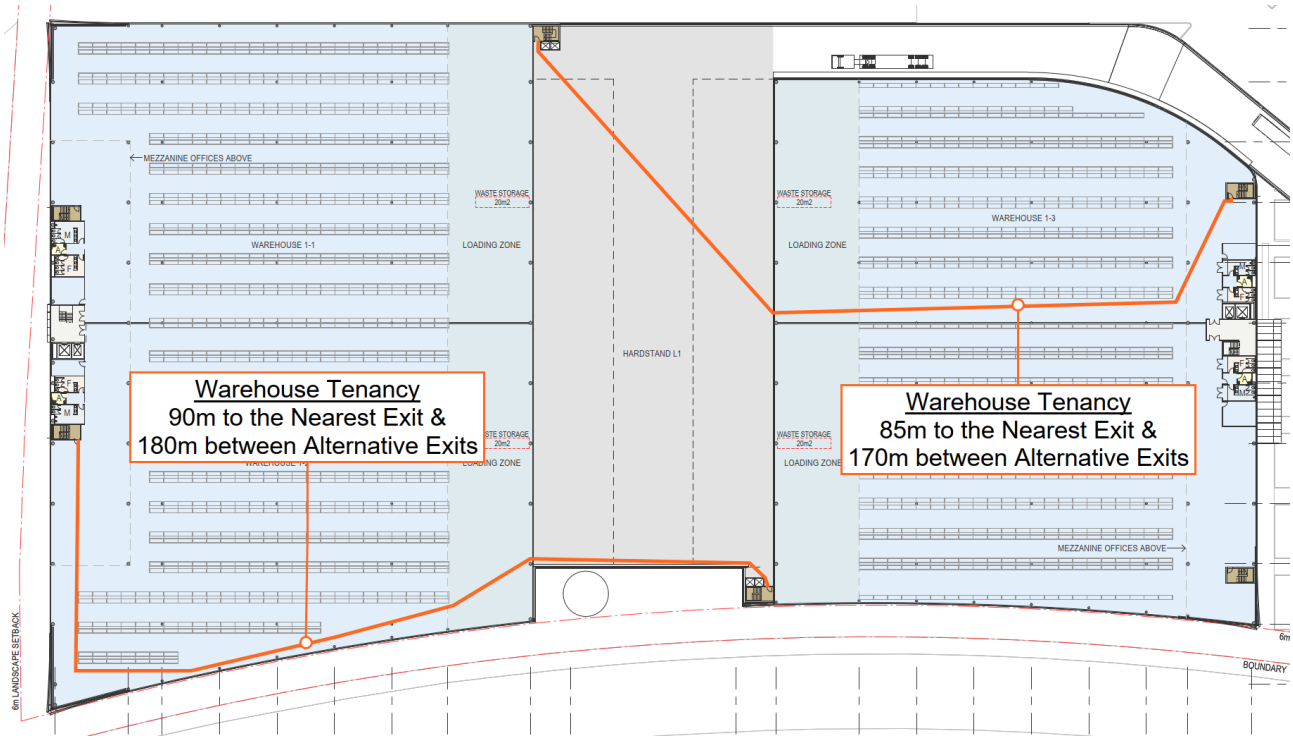


Figure 6-4: Most Onerous Non-Compliant Travel Distances Across Level 1

6.2.3 Door Hardware, Operation and Mechanisms

All doors serving as required exits shall have the hardware, door swings, latch operations and signage in accordance with the prescriptive requirements of BCA Clauses D3D24, D3D25, D3D26 and D3D28.

6.2.4 Signage and Lighting

Exit and emergency lighting are to be provided throughout building in accordance with the prescriptive DtS provisions of BCA Clause E4D2, E4D4, E4D5, E4D6, E4D8 and AS2293.1:2018 with the following exceptions:

- Directional exit signs shall be installed 4.0m above the finished floor level within forklift travel zones in lieu of the AS2293.1:2018 limitation of 2.7m.

As part of the exit and emergency lighting design, the following measures must be incorporated:

- Exit signs are to be pictograph 'running man' signs as per the prescriptive requirements of AS2293.1:2018.
- All exit and directional exit signs are to be power-operated illuminated signs.
- Any directional exit signs located above 2.7m are to be 'Jumbo' sized signs.

6.3 Active Fire Protection Systems

The following figure provides an overview of the fire infrastructure on the project to support the design specification for those systems in the subsequent sections.

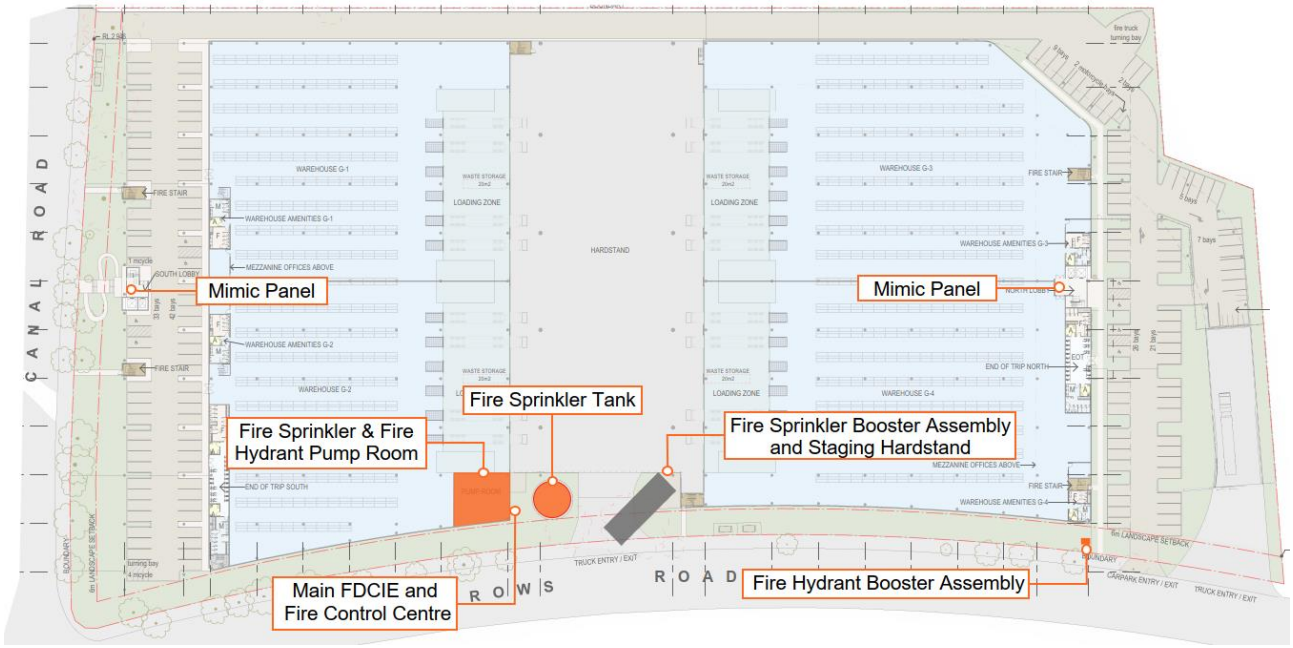


Figure 6-5: Site Fire Services Overview

6.3.1 Fire Control & Indicating Equipment

The building fire safety systems shall be connected to the Fire Control & Indicating Equipment (FDCIE) located within a dedicated cabinet adjacent the fire pump room. This shall also form the Fire Control Centre for the Building.

- The FDCIE must incorporate;
  - The ability to enable, disable & reset ALL zones/alarms across the network/precinct.
  - Contain the site ASE and brigade monitoring system.
  - Contain controls for the automatic smoke exhaust system.

Additional to the Main FDCIE each of the two (2) main office lobbies shall be provided with Mimic Panels. These are to be located in a readily visible location within the office lobby entries.

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 system, smoke detection or manual call points installed in the building in compliance with DtS Provisions and AS1670.3:2018.

6.3.3 Building Occupant Warning System

A building occupant warning system shall be provided throughout the building. The system shall be in accordance with the prescriptive requirements of Specification 17, Specification 20 and AS1670.1:2018.

Activation of any fire sprinkler head or manual call point shall initiate the building alarm tones throughout the building.

6.3.4 Automatic Smoke Detection System

An automatic smoke detection system be installed to the below listed areas as per the nominated design standard.

Office and End of Trip Areas

- An automatic smoke detection system shall be installed to the occupied areas of the Office, inclusive of the common lobbies, and End-of-Trip areas. These locations shall have detector spacing compliant with AS1670.1:2018 Section 5 except that:
  - No smoke detection required to the concealed ceiling spaces.
  - No smoke detection required to the amenities.
  - No smoke detection is required to cupboard with a volume less than $3m^3$.

Thermal detectors may be incorporated in areas of spurious alarm risk (e.g. above a kitchenette or break out area).

Warehouse Tenancies

- An automatic smoke detection system shall be installed to the ceiling/roof of each warehouse tenancy with detector spacing compliant with AS1670.1:2018 Section 7 except that:
  - Within the Ground Floor tenancies the smoke detector unit (or sampling point if an ASD is installed) may be located at the underside of the secondary beam structure in lieu of being within 300mm of the ceiling.

Dispatch Hardstands, Carparks & Warehouse Amenities

- No smoke detection is required to be installed to the dispatch hardstands, carparks or warehouse amenities.

6.3.5 Automatic Fire Sprinkler System

A fire sprinkler system shall be provided throughout the building in accordance with the prescriptive requirements of BCA Specification 17 and AS2118.1:2017 with the following exceptions:

- The fire sprinkler booster location is on the eastern side of the site, this is however non-compliant with Clause 7.3.1(c)(i) due to it being not within sight of each principal pedestrian entrance to the building.

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

- The fire sprinkler booster assembly must ensure an 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 design of any fixed suction provided for a fire brigade pumping appliance to draught from a below-ground water supply is to satisfy Clause 4.4 of Australian Standard AS2419.1:2021. The maximum length of the dry pipe between the lowest section water level and the large bore suction connection must not exceed 2.8m (due to the limitations of the primer on the fire brigade pumping appliances).

Fire & Rescue NSW Hardstand Requirements

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 that extends a minimum of 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 6-6.

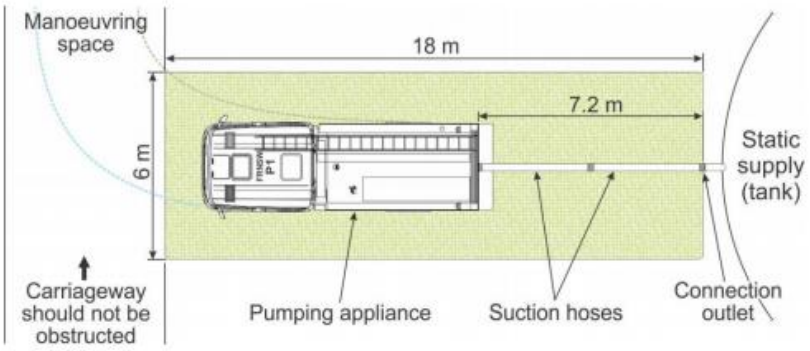


Figure 14 Hardstand area serving a suction-connection outlet

Figure 6-6: 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 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 6-7.

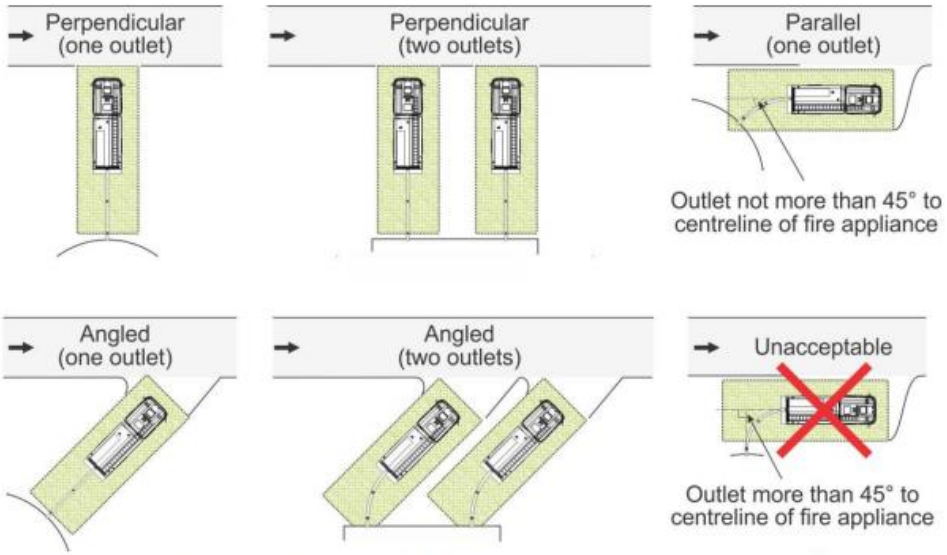


Figure 15 Example of orientation of hardstand area for suction-connection outlets

Figure 6-7: 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 has been maintained past the appliance staging area to meet the requirements of BCA Clause C3D5.

6.3.6 Automatic Smoke Exhaust System

Main Offices, End-of-Trip, Warehouse Amenities and other Ancillary Areas

- Automatic smoke exhaust shall not be provided to the offices, end-of-trip, warehouse amenities and other ancillary areas.

Ground Floor Dispatch Hardstand

- Automatic smoke exhaust shall not be provided to the dispatch hardstand on Ground Floor.

As part of the performance solution to omit the above smoke exhaust, the following design measures must be incorporated:

- The mechanical ventilation system provided to the dispatch hardstand shall be designed to operate under fire conditions. The system provided to the dispatch hardstand must be designed to comply with Clause 5.5 of AS1668.1:2015:
  - The exhaust fans shall be compliant with Clause 4.8.1 of AS1668.1:2015 and have fans, complete with all associated componentry, constructed and installed so that it is capable of continuous operation and status indication at their rated capacity as follows:
    - The fans shall operate for a period of not less than 2 hours with a smoke exhaust air temperature of 200°C; and
    - The electrical power and control cabling must be fire rated per a smoke exhaust system designed per AS1668.1:2015.
- The system must be fed from an essential power supply (electrical Safety Service).
  - The above requirement disregards any permitted concession within the BCA to omit the fire rating requirements of components.
- The FDCIE shall also be provided with control functions for the mechanical ventilation system.

Warehouse Tenancies

An automatic smoke exhaust system shall be provided to the warehouse tenancies in accordance with the DTS provisions and AS1668.1:2015 with the following exceptions:

- An extraction rate of 10,000L/s shall be achieved from each tenancy in lieu of extraction rates defined in BCA Specification 21.

As part of the automatic smoke exhaust system design, the following design measures must be incorporated:

- The automatic smoke exhaust system provided to the warehouse areas must be designed in accordance with BCA Specification 21 and AS1668.1:2015 unless noted otherwise herein.
- A mechanical system blockplan shall be provided at the FDCIE in accordance with AS1668.1:2015 and also incorporate the following;
  - Signs alerting the Fire Brigade to the operation of the smoke exhaust system.
  - A schematic of the system detailing fan extraction rates, and make-up air locations and free area requirements.
  - Reference the Fire Engineering Report.
  - Notification that the system is automatically initiated by sprinkler activation.

- Incorporate the same legend and fan numbering as those used on the FDCIE fan control switches.

- The automatic smoke exhaust system must be connected to the site's essential power (safety service).
  - The electrical board must be fire separated from the remaining building per BCA Clause C3D14 (--/120/120 FRL walls and --/120/30 FRL fire door).

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 E1D3 and AS2441:2005 with exception of the following;

- Due to the expansive footprint of the building, hose reels with a length of 50m in lieu of 36m are proposed to be used to achieve coverage within the warehouse.

As part of the fire hose reel design, the following design measures must be incorporated:

- 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 life safety, on-site training in the use of the hose reels must be undertaken by key staff members (Fire Wardens and Warehouse Supervisors).

The location of all fire hose reels should be readily accessible to occupants. The 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 building in accordance with Table E1D14 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 site to serve the building in accordance with the prescriptive requirements of Clause E1D2 and AS2419.1:2021 with exception of the following:

Hydrants under Awnings

- External hydrants are located beneath the loading dock dispatch awning on Level 1 (which have a depth of 15m) and shall retain their classification as external hydrants in lieu of being internal hydrants; hence for the purposes of system coverage they will maintain 70m coverage.

Fire Hydrant Booster Assembly

- The booster location is at the entry to the site, however non-compliant with Clause 7.3.1(c)(i) due to it being not within sight of each principal pedestrian entrance to the building.

Hydrant Block Plan

- Hydrant block plan at the booster assembly to be a maximum A1 sized, in lieu of the maximum scale of 1:250. All other blockplans across the site are to be A3.

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

- 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 FRNSW Technical Information D15/45534 for *"FRNSW compatible Storz hose connections"*. Further information is available from FRNSW available at www.fire.nsw.gov.au.
- Each hydrant under a dispatch awning must be provided with a twin valve connection (as per the requirements of an external hydrant).
- Per the request of FRNSW, as far as possible the hydrant system should consist of external hydrant points, with internal hydrants only provided 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 relied upon for progressive movement to pictorially and numerically illustrate 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.
        - Internal fire hydrants are to be positioned within all fire-isolated stairs.

6.5.2 Vehicular Perimeter Access

A vehicular perimeter access roadways is provided to all four sides of the building. This shall be designed and constructed of an all-weather surface capable of supporting all FRNSW appliances in accordance

with BCA Clause C3D5 and FRNSW Fire Safety Guideline "Access for fire brigade vehicles and firefighters" version 5.01" (available from www.fire.nsw.gov.au).

The following variations from the prescriptive requirements shall be addressed through a fire engineered Performance Solution (as illustrated in the trailing figure);

- The roadway's furthest edge is greater than 18m from the building along Canal Road and where the road enters from Burrows Road into the northern carpark.
- The roadway requires vehicles to travel beneath the Level 1 access ramp on the north-western corner of the site.

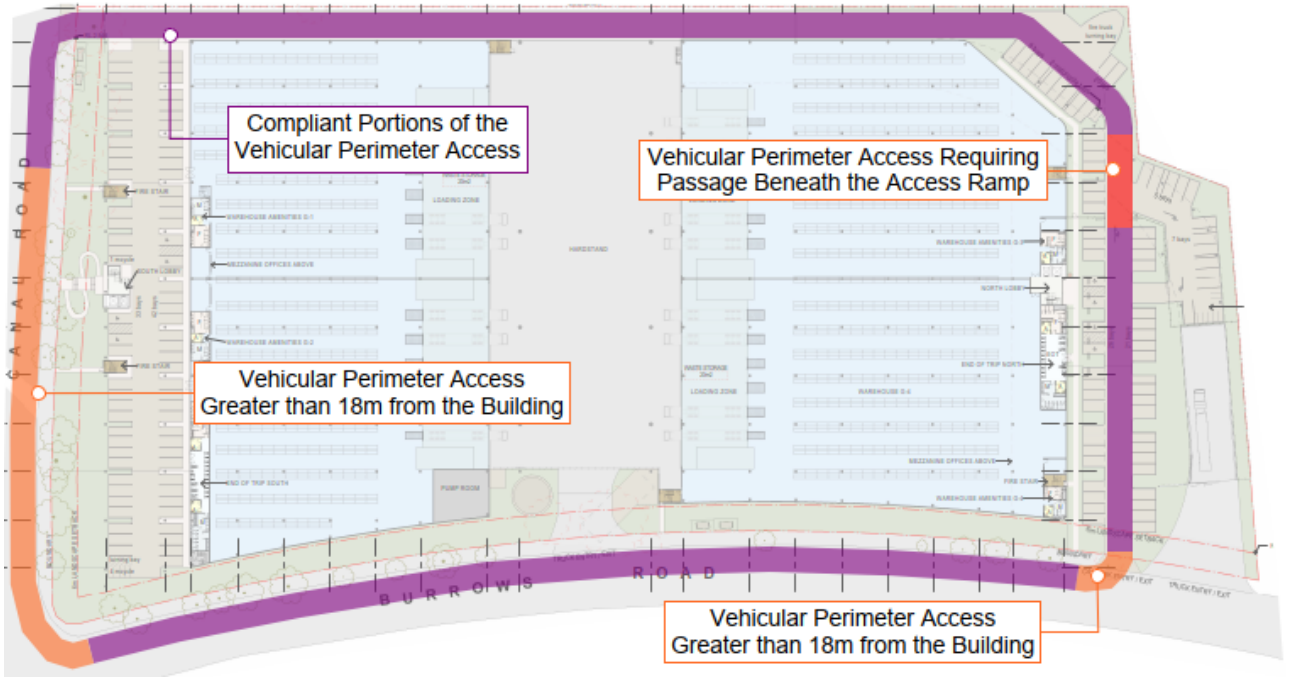


Figure 6-8: Perimeter Vehicular Access Provisions and Areas Identified as being DTS Non-Compliant

As part of the fire-engineered Performance Solution for perimeter vehicular access, the following must be incorporated into the design;

Perimeter Access Path Performance

- Gradients upon the access road are suitable for heavy vehicles in accordance with Australian Standards and FRNSW Fire Safety Guideline "Access for fire brigade vehicles and firefighters v5.01":
- The fire appliance access road and surface will be suitable in all weather and are capable of supporting the maximum distributed load over the entire area as per FRNSW Fire Safety Guideline "Access for fire brigade vehicles and firefighters v5.01"

Appliance Sweep Paths

- Fire brigade Specialist Appliances are provided with adequate room and sweep paths around the building corners to travel in forward direction.
- Provision must be maintained at the north-western corner of the site to allow a 12.5m Specialist Appliance to undertake a 3-point turn (as seen in Figure 6-9).

- The turning head shall have line-marking provided to ensure vehicles are not parked in the free space and incorporate the wording “NO PARKING – FIRE BRIGADE HARDSTAND” in text not smaller than 100mm.

Security Gate Requirements

- Security gates that cross the vehicular access path at the vehicular entries to the carpark and dispatch hardstand must:
  - Manually operated Gates: are to be locked with a loose chain and padlock, or fixed cylinder hardware set.
  - Mechanically driven Gates: are to have a manual overdrive provided at the gate motor to disengage the gearing and allow manual opening of the gate by FRNSW:
- Operational instructions and diagrams illustrating the gate gear override mechanism must be provided at the Main FDCIE.
- Copies of any access keys/fobs etc. are to be provided to the two (2) nearest FRNSW stations to the site, and also a copy hung at the Main FDCIE.

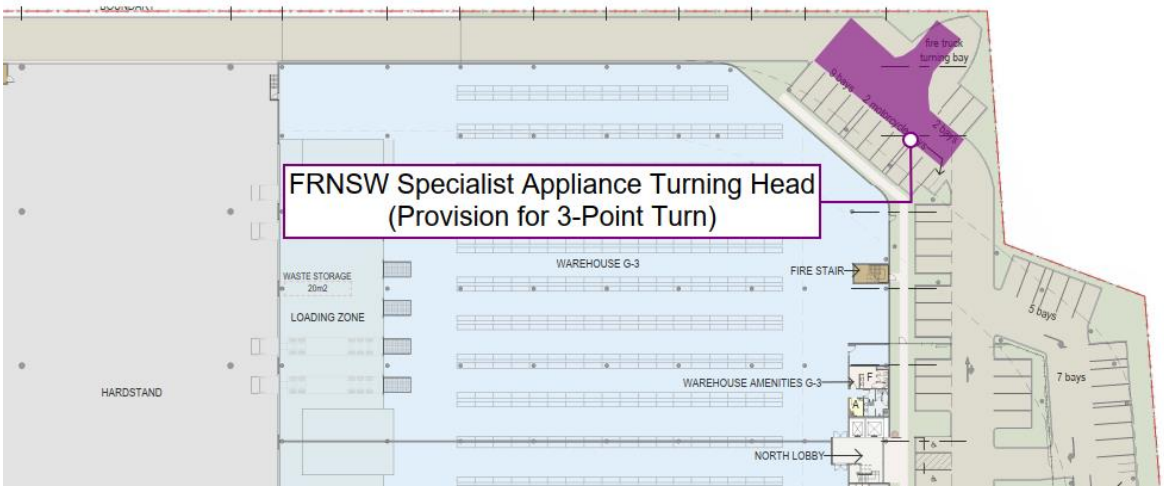


Figure 6-9: Provisional Space to Accommodate FRNSW Appliances to Undertake a 3-Point Turn

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

Any 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 another relevant testing regulatory.

6.6.2 No Smoking Policy

A no-smoking policy shall be implemented and enforced throughout 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, and outcomes from fire drills and provide details of the ongoing maintenance and inspection procedures. The manuals should be reviewed annually, and lessons-learned exercises 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 Amd 2:2018. 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 are to be regularly conducted with all building occupants.

An evacuation plan should be developed for the site in accordance with AS3745:2010 Amd 2:2018 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 E1D17 and E2D21. 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 Certifier- Fire Safety (formerly 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 for 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, 2022", Canberra ACT 2023."
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. Australian Building Codes Board, "Australian Fire Engineering Guidelines", Canberra, 2021.
5. Brzezinska. D & Bryant. P., Performance-Based Analysis in Evaluation of Safety in Carparks under Electric Vehicle Fire Conditions, Energies 2022, 15, 659.
6. Society of Fire Protection Engineers, "The SFPE Handbook of Fire Protection Engineering", 4th edition, 2008.
7. Drysdale D, "An Introduction to Fire Dynamics", 3rd edition, John Wyley & Sons, UK, 2011.
8. Davis R. (2014), "Fire Concerns With Roof-Mounted Solar Panels", SFPE Fire Protection Engineering Emerging Trends Newsletter, Issue 92, 2014.
9. PD7974-6:2004, "The application of fire safety engineering principles to fire safety design of buildings – Part 6: Human factors", BSI British Standards.
10. PD7974.7:2003, "Application of fire safety engineering principles to the design of buildings – Part 7: Probabilistic risk assessment", BSI British Standards.
11. Spearpoint, M., "Fire Engineering Design Guide", 3rd edition, New Zealand Centre for Advanced Engineering, May 2008.
12. The Chartered Institute of Building Services Engineers, "Fire Safety Engineering CIBSE Guide E", 3rd Edition, May 2010.
13. Drysdale D, "An Introduction to Fire Dynamics", 3rd edition, John Wiley & Sons, UK, 2011.
14. "Fire Brigade Intervention Model V3-0", Australasian Fire Authorities Council, June 2020.
15. 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.
16. 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.
17. Pauls, J. L. "Movement of People in Building Evacuations", Human Response to Tall Buildings, Chap 21. Dowden, Hutchinson and Ross, Stroudsburg, PA, 1977.
18. 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.

19. 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.
20. 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.
21. Hall, J.R. "U.S. Experience with Sprinklers", National Fire Protection Association, June 2013.
22. Turner, M. "Fire Brigade's Fight for Sprinklers in New Underground Car Park." Fire, 79 (972): 32-34, 1986.
23. Thomas, IR., "Fires in Carparks", Fire Australia February 2004, Eastside Printing, 2004.
24. BHP Steel: Structural steel Development Group, Report No MRL/Ps69/89/006. "Fire Safety in Car Parks".
25. 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.
26. 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.
27. 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.
28. Bushfire CRC, "Window and Glazing Exposure to Laboratory-Simulated Bushfires", Doc: 2006-205, May 2006.
29. Rakic J, "The Performance of Unit Entry Doors when Exposed to Simulated Sprinkler Controlled Fires", Lorient International, Lindfield, NSW, Australia.
30. England JP, Chow V, Yunlong Liu, (2007) Modelling Smoke Spread through Barrier Systems Retrieved from http://www.yunlong.com.au/pdf/PEngland.pdf
31. Campbell, R., 'Structure Fires in Warehouse Properties', NFPA Research, January 2016.
32. Sun, P., Bisschop, R., Niu, H. et al. "A Review of Battery Fires in Electric Vehicles". Fire Technology, 56, 1361–1410 (2020)

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 [10]; 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 [10] 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

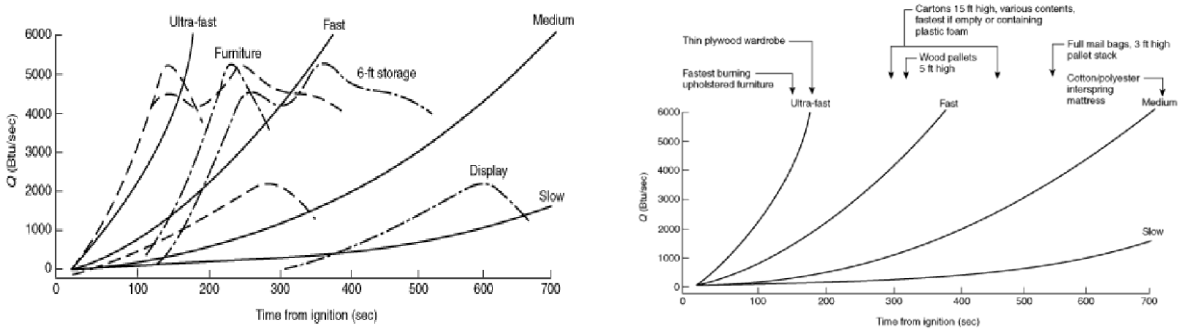
The rate of fire growth is generally expressed in terms of an energy release rate. The most commonly used relationship is what is commonly referred to as a quadratic t-squared fire. In such a fire, the rate of heat release is given by the expression:

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

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 [12] 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

Densities in mega-joules per square metre				
Occupancy	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%)

Cause	Fires	Civilian Injuries
Smoking materials	60 (5%)	0 (0%)
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%)

Cause	Fires	Civilian Injuries
Unclassified structural area	30 (2%)	0 (0%)
Garage or vehicle storage area	30 (2%)	1 (6%)
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%)