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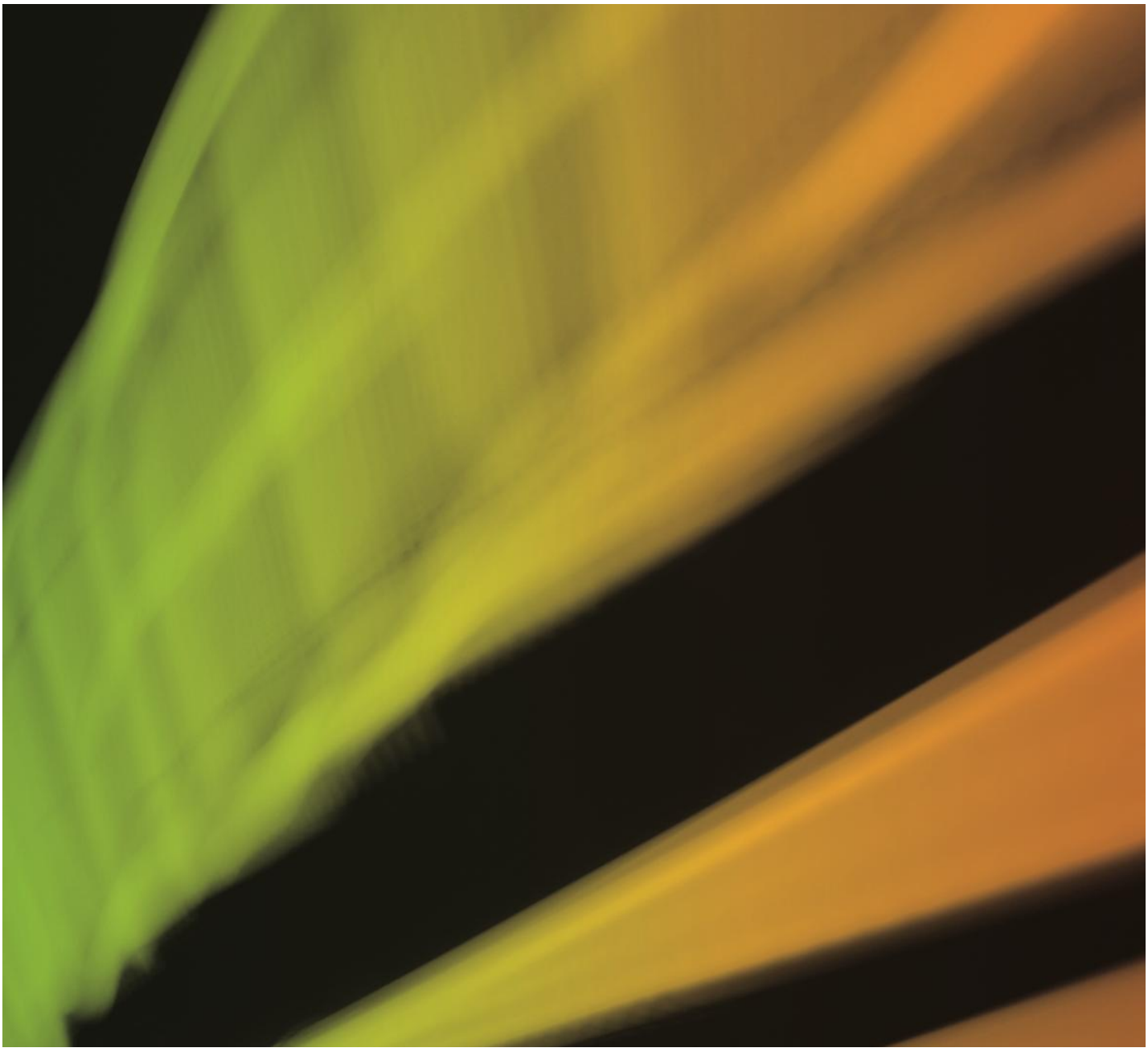
Commercial-in-Confidence

Preliminary Hazard Analysis

Dick Smith Electronics/ Masters Regional Distribution Centre,



Preliminary Hazard Analysis

Dick Smith Electronics/ Masters Regional Distribution Centre, Hoxton Park, New South Wales

Prepared for

Mirvac Group

Prepared by

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Quality Information

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0	05-Dec-2011	Draft	Frank Mendham Associate Director	
1	07-Dec-2011	Final	Frank Mendham Associate Director	
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Table of Contents

Executive Summary

Development of the subject Dick Smith Electronics/ Masters Regional Distribution Centre at Hoxton Park is considered safe on the basis that the credible risks identified in this report are controlled to a level that is low as far as reasonably practicable with the implementation of the fire protection measures identified in the Fire Engineering Report.

A range of hazards have been identified, which include the following credible events:

1) Fire in Class 2.1 aerosol storage

2) Fire in Class 3 storage

3) Fire in Class 4.1 storage

Risks associated with these hazards have also been identified in terms of individual risk, which has been found to be below the recognised individual risk level for industrial land use.

The Len Waters Estate includes more than one (1) RDC that may affect the surrounding land use. These include:

- The proposed Dick Smith Electronics/ Masters Regional Distribution Centre; and
- The Big W Regional Distribution Centre.

The cumulative risk associated with the regional distribution facilities at the Len Waters Estate is the sum of the calculated Individual Fatality Risk for the proposed Dick Smith Electronics/ Masters RDC and the Big W RDC.

The identified Individual Fatality risk was previously calculated for the Big W RDC to be 4.77×10^{-8}.

Therefore the cumulative risk associated with the regional distribution facilities at the Len Waters Estate is 7.51×10^{-8}.

This risk level is also considerably lower than the Individual Risk Fatality IR for 'Industrial' land use, which is 50×10^{-6}.

It is recommended that the Fire Engineering Assessment (Fire Safety Study) for the proposed RDC be reviewed and kept up to date consistent with the increase in the proposed quantities of dangerous goods, and/or where the fire load within the facility has increased. This PHA is based on the design outcomes of the previous Dick Smiths (now Masters) RDC Fire Engineering Report. As a result of increased fire load under the Masters storage scheme, it is recommended that a review of the Dick Smiths FER be carried out in order to identify any 'gaps' between the previous design solution and the currently required design solution.

1.0 Introduction

1.1 Scope

AECOM was engaged by Mirvac Group (Mirvac) to undertake a Preliminary Hazard Analysis (PHA) in accordance with SEPP33 legislative requirements for the storage of mixed classes of dangerous goods at the proposed Dick Smith Electronics/ Masters Regional Distribution Centre (RDC) located in Hoxton Park, New South Wales.

A PHA is required for the RDC due to the quantity of dangerous goods that will be stored exceeding the threshold limits described by the *State Environmental Planning Paper No. 33 (SEPP 33)*.

The proposed RDC will form part of the Len Waters Estate (former Hoxton Park Aerodrome).

1.2 Project background and previous studies

1.2.1 Overview

Previously, project approval was sought for the construction of warehouse and distribution facilities at the Len Waters Estate, which included project approval for the construction of a Big W RDC and project approval for the staged construction of a Dick Smiths Electronics (DSE) RDC.

This PHA is based on a number of previous studies, which formed part of the warehouse and distribution facilities at the Len Waters Estate. In particular, the referenced studies include:

1) A Fire Engineering Report (FER) (Appendix B) developed for the proposed RDC (former DSE RDC) in accordance with the Building Code of Australia (BCA); and

2) Mixed Class Dangerous Goods Storage Assessment - *AS/NZS 3833:2007 Requirements applicable to Masters Distribution Centre* (November 2011) (Appendix C).

The PHA has been developed in accordance with the Department of Planning (DOP) *Multi-Level Risk Assessment, and Guidelines for Hazard Analysis – Hazardous Industry Planning and Advisory Paper (HIPAP) No.6*.

1.2.2 Relevance of previous studies

Fire Engineering Report (FER)

The scope of the FER was to assess the proposed Alternative Solutions against the relevant BCA Performance Requirements for the subject building. The proposed Alternative Solutions were based on the variations from the BCA Deemed-to-Satisfy (DtS) Provisions identified by the Certifying Authority, Phillip Chun. The FER outlines a performance-based fire safety design strategy that gives an overview of the building to support the proposed Alternative Solutions.

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

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

The fire safety objectives were based on acceptable levels of occupant life safety, as absolute fire safety within buildings is not attainable. Accordingly, the BCA is utilised as a benchmark for establishing an acceptable level of fire safety.

Other than addressing life safety, another significant factor for basing the assessment data of the PHA on the FER, is that the fire safety engineering requirements specified in the FER, specifically addresses the control of fires spreading through the use of fire protection systems, and thus minimising the likelihood and consequence of impacts occurring offsite.

AS/NZS 3833:2007 Requirements applicable to Masters Distribution Centre

An assessment for the storage of mixed classes of dangerous goods at the proposed RDC was undertaken for the proposed dangerous goods commodities. This assessment addressed the minimum storage requirements and safeguards required for the proposed quantities of dangerous goods. As such, compliance with these requirements will significantly control the level of risk associated with the dangerous goods storage to a level that is low as far as reasonably practicable.

2.0 Site Description

2.1 Site location and legal description

The site is located approximately 6.5km west of the Liverpool CBD on Cowpasture Road within the new industrial suburb, Len Waters Estate. The site is bound by the M7 Motorway to the west, Cowpasture Road to the south, Hinchinbrook Creek to the east and the proposed residential suburb of Elizabeth Hills to the north. The site was formerly the Hoxton Park Aerodrome. The site is located within the Liverpool LGA.

The site is legally described as:

- Lots 5050-5054 in DP 1161757; and
- Lot 101 DP 1158385.

Figure 1 Site plan

2.1.1 Existing use

The site was most recently used as Hoxton Park Aerodrome, an uncontrolled airfield for light aircraft and helicopters for private flight training and flying. As the aerodrome was never used for commercial flights, the aerodrome does not have a passenger terminal. Several airport hangers and associated buildings, which were occupied by the flying school and other similar companies, were erected to the west of the runway. These buildings were low scale in nature and are generally constructed out of corrugated metal sheeting or brick.

This use ceased in December 2008 and the site is currently being developed for industrial warehousing, distribution and residential purposes.

2.1.2 Existing buildings

With exception of the hangers and buildings which have been partially demolished and the airstrip which has been decommissioned, the site is generally cleared, and predominantly comprises mown grassed areas.

2.2 Process

The proposed RDC is a distribution centre with no hazardous 'processing' occurring onsite. This facility is a storage and transport facility for goods only. As such, operations conducted onsite will include:

- Transport of products via existing road network to and from the RDC facility
- Movement of products from transport (semi-trailer) to onsite designated storage shelves via use of forklifts
- Bulk package breakup
- Distribution package sealing
- Movement of products from shelving to road transport vehicles

2.3 Hazardous Materials

A suite of potentially dangerous goods and non-hazardous retail will be stored onsite including, but not limited to, Class 2.1 aerosols, Class 3 flammable liquids, Class 4.1 flammable solids, and Class 8 corrosive substances. The proposed quantities for each class of dangerous goods are provided below:

Table 1 Proposed storage quantities at the Master Regional Distribution Centre

Dangerous Goods Class	Packing Group	Proposed Storage Quantity (tonnes)
Class 2.1	n/a	167
Class 3	PG II	28
Class 3	PG III	104
Class 4.1	PG III	3
Class 8	PG II	3.4
Class 8	PG III	7,080

3.0 Risk Controls and Reduction Measures

Dangerous goods will be stored in accordance with the requirements of *AS/NZS 3833:2007 The storage and handling of mixed classes of dangerous goods, in packages and intermediate bulk containers.* This standard describes the storage of mixed classes of dangerous goods with special consideration for Class 2.1 and Class 3. As such, this standard is considered; appropriate for the internal design of the warehouse. This section contains information in the materials being stored and the some fundamental controls being used.

An assessment of the mixed class dangerous goods storage against the requirements of AS/NZS 3833 was undertaken, and is provided in Appendix C

3.1.1 Fire Safety Engineering

Appendix B details fire fighting Safety Systems Engineering associated with the facility and risk controls incorporated into the design dealing predominately with life safety.

3.1.2 Fire protection systems

Appendix B describes the fire protection systems associated with the facility and how these systems provide asset protection.

3.1.3 Mechanical protection for aerosols

Propagation within the RDC and to other adjacent site by the means of rocketing aerosol cans will be of importance in reducing the frequency of escalation of the initial hazardous event. The installation of wire mesh, as per Factory Mutual Data Sheet 7-31, will reduce likelihood of propagation of a fire from the aerosol storage area into adjacent storage areas. The aerosols being stored are small and the mechanical protection will have a high probability of ensuring that aerosols do not escape from the area.

3.1.4 Fire resistance and compartmentation

The proposed Alternative Solutions in relation to fire resistance/compartmentation provisions (i.e. BCA Section C) in the building are outlined in Section 9.2 of the FER (Appendix B). Significant aspects of the design include:

a) The building being treated as a ‘Large-isolated Building’ with Type C construction applicable under BCA Specification C1.1.

b) All equipment other than described in BCA Clause C2.12 (b) and (c) must be separated including the Battery Rooms by 120/120/120 FRL construction from the remainder of the building. Local Utility requirements may override separation of equipment under the BCA, which shall be verified by the Architect and Certifying Authority.

c) A smoke proof wall is to be provided between the office space and warehouse in accordance with BCA Specifications C2.5, Clause 3.

3.1.5 Automatic fire sprinkler system

a) The entire building shall be sprinkler protected with a sprinkler system in accordance with FM Global Data Sheets 2-0, 8-9 and AS2118.1:1999. Where FM Global and AS2118.1:1999 requirements differ, the more stringent of the two is to be applied.

b) The automatic sprinkler system shall comprise the following.

   1) Provision of automatic sprinkler system throughout the facility utilising ESFR sprinkler heads in accordance with FM Global Data Sheet 2-0 and AS 2118.1:1999.

   2) Independent individually monitored sprinkler stop-valves are to be provided for each sprinkler control valve installation in the building.

   3) The valves are to be housed within a secure enclosure in accordance with Clause 3.4.2 of AS 2118.1:1999 except where the monitored components are located within a secure area or room with access restricted by means of a security device or system, in which case Class B devices may used.

c) The FM Global compliant sprinkler system is expected to have a higher reliability than a BCA DtS compliant system. Nevertheless, the following measures are proposed in order to further improve the sprinkler reliability in this building:

- Independent individually monitored sprinkler stop-valves are to be provided. The valves are to be housed within a secure enclosure in accordance with Clause 3.4.2 of AS 2118.1:1999.
- Dual water supply comprising on-site tank and town main supply.
- Increased number of sprinkler valve sets in accordance with FM Global Data Sheet 2-0.
- The onsite water storage will consist of 4 hours storage for hydrants per AS2419 and sprinkler duration as per FM Global Data Sheets.
- The following management-in-use procedures are to implemented:
    - Use of primarily one company for sprinkler isolations.
    - Re-instatement of the system at the completion of work each day.
    - An approval system in place, which requires written permission from management before isolation could take place and a statement as to the length of isolation (which must generally be less than one day).
    - A requirement for the contractor to sign-off after completion of the work.
    - Penalties on contractors for failure to comply with the above.
- Occupants and the Fire Brigade are to be notified if the sprinkler system is to be de-commissioned for maintenance works.

3.1.6 Fire brigade intervention

The following measures are to be provided to assist in fire brigade intervention:

a) Designated safe areas away from the building for appliance staging, breathing apparatus staging, rehabilitation, ambulance staging and evacuation assembly.

b) Emergency information box containing diagrams including a site map, building layout; diagrams, contact numbers and hazardous materials register adjoining the main Fire Indicator Panel.

c) Emergency controls and stop switches for automated processes, if any.

d) Emergency procedures are recommended to be developed in consultation with the local responding stations. This should include a map signage at the main entry to the site for fire personnel.

4.0 Hazard Identification

4.1 Credible threat scenarios

A range of significant hazards was developed through analysis of the identified credible threat scenarios. These hazards are prioritised and incorporated into this assessment in the form of a hazard identification table, as summarised in Table 2. This table represent the most significant hazards applicable to storage of mixed classes of dangerous goods at the proposed RDC.

Table 2 Credible risk scenarios based on storage and transportation of forecast quantities and types of dangerous goods

Hazard ID	Area	Event	Cause	Consequence	Measures/ Prevention/ Protection
1	Distribution Centre Class 2.1 Storage	Release of aerosol can contents	Damage to cans during transportation Piercing of cans by forklift tines	Inhalation of material by site personnel. Release of liquid contents of can into local environment.	- Staff training in safe fire fighting and evacuation procedures - Staff trained in forklift use and lifting procedures - Emergency response plan - PPE supplied for personnel - Site spill containment
2	Distribution Centre Class 2.1 Storage	Fire in Class 2.1 aerosol storage	Release of aerosol can contents through damage due to transportation or impact by forklift tines, followed by ignition. Fire from surrounding area spreads to aerosol storage, leading to container failure and subsequent release of flammable contents	Heat radiation effecting employees on site Heat radiation effecting persons and infrastructure off-site Smoke generated in building effecting employees Smoke effecting persons and infrastructure off-site Fire transfers to surrounding sites Damaged aerosol container becoming projectiles, impacting personnel life safety and spreading fire throughout facility	- Staff training in safe fire fighting and evacuation procedures - Emergency response plan - PPE supplied for personnel - Site spill containment - Ignition source exclusion - Automatic dial out to the third party for NSWFB response - Aerosols pallets to be stored within a caged area as per FM 7-31 on all walls - Separation from other dangerous goods as per AS3833 - Charging of forklifts to be undertaken in remote area - Sprinklers to be provided as per FM 7-31 (NFPA 30B)
3	Distribution Centre Class 3 Storage	Release of Class 3 materials	Forklift tines piercing packages on a pallet Fall of containers from storage location	Inhalation of material by employee Contact with skin of operating personnel Release of material into local environment	- Staff training in safe fire fighting and evacuation procedures - Staff trained in forklift use and lifting procedures - Emergency response plan - PPE supplied for personnel - Site spill containment - Spill kits

Hazard ID	Area	Event	Cause	Consequence	Measures/ Prevention/ Protection
4	Distribution Centre Class 3 Storage	Fire in Class 3 storage	Release of Class 3 material due to piercing by forklift tines or fall of containers from storage location, followed by ignition Fire from surrounding area spreads to Class 3 storage location leading to container failure and subsequent release of flammable contents	Heat radiation effecting employees on site Heat radiation effecting persons and infrastructure off-site Smoke generated in building effecting employees Smoke effecting persons and infrastructure off-site Fire transfers to surrounding sites	- Staff training in safe fire fighting and evacuation procedures - Emergency response plan - PPE supplied for personnel - Site spill containment - Spill kits - Ignition source exclusion - Automatic dial out to the third party for NSWFB response - Separation from other dangerous goods as per AS3833 - Charging of forklifts to be undertaken in remote area - ESFR sprinklers - Onsite containment of fire fighting water - Site handling procedures to minimise spills
5	Distribution Centre Class 4.1 Storage	Fire in Class 4.1 storage	Release of materials in packages through forklift tines piercing packages, falling packages, defecting packaging followed by ignition. Fire from surrounding area spreads to Class 4.1 storage	Heat radiation effecting employees on site Heat radiation effecting persons and infrastructure off-site Smoke generated in building effecting employees Smoke effecting persons and infrastructure off-site Fire transfers to surrounding sites	- Staff training in safe fire fighting and evacuation procedures - Emergency response plan - PPE supplied for personnel - Site spill containment - Spill kits - Ignition source exclusion - Automatic dial out to the third party for NSWFB response - Separation from other dangerous goods as per AS3833 - Charging of forklifts to be undertaken in remote area - ESFR sprinklers - Site handling procedures to

Hazard ID	Area	Event	Cause	Consequence	Measures/ Prevention/ Protection
					minimise spills
6	Loading or unloading operations	Release of material into environment	Release of materials in packages through forklift tines piercing packages, falling packages or defective packaging,	Inhalation of material by employee Contact with skin of operating personnel Release of material into local environment	- Staff training in safe fire fighting and evacuation procedures - Staff trained in forklift use and lifting procedures - Emergency response plan - PPE supplied for personnel - Site spill containment - Spill kits - Site handling procedure and process to minimise spills
7	Loading or unloading operations	Fire in loading/ unloading area	Release of materials in packages through forklift tines piercing packages, falling packages or defective packaging, followed by ignition.	Heat radiation effecting employees on site Heat radiation effecting persons and infrastructure off-site Smoke generated in building effecting employees Smoke effecting persons and infrastructure off-site Fire transfers to surrounding sites	- Staff training in safe fire fighting and evacuation procedures - Staff trained in forklift use and lifting procedures - Emergency response plan - PPE supplied for personnel - Site spill containment - Spill kits - Control of ignition sources - Site handling procedure and process to minimise spills - Small volumes

4.2 External Events

The potential for external events has been investigated as part of the RDC risk identification process. No external events were considered as being credible given the location, climate and placement of the RDC. The results of this assessment and the issues reviewed are reproduced in Table 3.

Table 3 External risk event assessment for the Hoxton Park Dick Smith Electronics/ Masters Regional Distribution Centre

External Event	Comment
Cyclone	Risk of cyclones unlikely
External Flooding	Site not considered flood prone
Airplane Crash	Site not in flight path
Earthquake	Area considered low risk
Bushfire	Minor risk – design of structure and suitable fire-separation widths have been identified
Lightning	Design complies with relevant standard to minimise risk
Vehicle Clash	Site is remote from public roads, therefore risk unlikely

5.0 Risk Assessment

5.1 Risk Criteria

A qualitative risk assessment has been used to evaluate the risks that require further development in the consequence analysis. For the qualitative risk assessment, the following criteria have been used:

Table 4 Risk Criteria

Risk	Description of Risk
Low	The storage is minor under relevant Australian Standard. The event described is unlikely to develop consequences that could result in significant impact on the operating personnel, neighbours or the environment.
Medium	The event may result in small impacts on the operating personnel, neighbours, or the environment. The event is unlikely to result in the propagation of the hazardous event; or The controls will maintain the consequences within the site boundaries and will have negligible impact on surrounding land use.
High	The event described may impact on the operating personnel, neighbours or the environment; or May propagate the hazardous event into other areas or involve other activities.

5.2 Risk Assessment

A qualitative risk assessment addressing the hazards identified in Table 2 is included as Table 5. The risk assessment follows the following process:

- hazard is assessed independently of control measures;
- control measures are identified to mitigate risk and exposure; and
- hazards are reassessed with proposed controls in place to identify an associated residual risk.

Each risk is assessed according to the criteria in Table 4.

Table 5 Risk Assessment

		Consequences						
Hazard ID	**Event**	**Onsite**	**Neighbours**	**Environment**	**Propagation**	**Risk**	**Controls**	**Risk**
1	Release of aerosol can contents	Inhalation of material by persons onsite	Negligible impact	Negligible impact	Unlikely to propagate	**Medium**	- Staff training in safe fire fighting and evacuation procedures - Staff trained in forklift use and lifting procedures - Emergency response plan - PPE supplied for personnel - Site spill containment - Spill kits	**Low**
2	Fire in Class 2.1 aerosol storage	Heat radiation effects on personnel	Heat radiation off-site	Release of material into the environment	Propagation into other items stored in the warehouse Propagation into a complete warehouse fire	**High**	- Staff training in safe fire fighting and evacuation procedures - Emergency response plan - PPE supplied for personnel - Site spill containment - Bunding of aerosol storage area - Spill kits - Ignition source exclusion - Automatic dial out to the third party for NSWFB response - Aerosols pallets to be stored within a caged area as per FM 7-31 on all walls - Separation from other dangerous goods as per AS3833 - Charging of forklifts to be undertaken in remote area - Sprinklers to be provided as per FM 7-31 (NFPA 30B)	**Medium**
3	Release of Class 3 materials	Inhalation of material by persons onsite Contact with	Negligible impact	Release of materials into surrounding environment	Reaction with incompatible materials	**High**	- Staff training in safe fire fighting and evacuation procedures - Staff trained in forklift use and lifting procedures - Emergency response plan	**Low**

		Consequences						
Hazard ID	**Event**	**Onsite**	**Neighbours**	**Environment**	**Propagation**	**Risk**	**Controls**	**Risk**
		skin of operating personnel					- PPE supplied for personnel - Site spill containment - Bunding of aerosol storage area - Spill kits	
4	Fire in Class 3 storage	Heat radiation effects on personnel	Heat radiation off-site	Release of material into the environment	Propagation into other items stored in the warehouse Propagation into a complete warehouse fire	**High**	- Staff training in safe fire fighting and evacuation procedures - Emergency response plan - PPE supplied for personnel - Site spill containment - Spill kits - Ignition source exclusion - Automatic dial out to the third party for NSWFB response - Separation from other dangerous goods as per AS3833 - Charging of forklifts to be undertaken in remote area - ESFR sprinklers - Onsite containment of fire fighting water - Site handling procedures to minimise spills	**Medium**
5	Fire in Class 4.1 storage	Smoke generated within building Heat radiation effects on personnel	Smoke impacting surrounding area	Released smoke and associated components impacting the environment	Propagation into other items stored in the warehouse Propagation into a complete warehouse fire	**Medium**	- Staff training in safe fire fighting and evacuation procedures - Emergency response plan - PPE supplied for personnel - Site spill containment - Spill kits - Ignition source exclusion - Automatic dial out to the third party for NSWFB response - Separation from other dangerous goods as per AS3833	**Medium**

		Consequences						
Hazard ID	**Event**	**Onsite**	**Neighbours**	**Environment**	**Propagation**	**Risk**	**Controls**	**Risk**
							- Charging of forklifts to be undertaken in remote area - ESFR sprinklers - Site handling procedures to minimise spills	
6	Spill of material in loading/ unloading area	Inhalation of material by persons onsite Contact with skin of operating personnel	Negligible impact	Negligible impact	Unlikely to propagate	**Medium**	- Staff training in safe fire fighting and evacuation procedures - Staff trained in forklift use and lifting procedures - Emergency response plan - PPE supplied for personnel - Site spill containment - Spill kits - Site handling procedure and process to minimise spills	**Low**
7	Fire in spilt material in loading/ unloading area	Smoke generated within area Heat radiation effects on personnel	Smoke impacting surrounding area	Released smoke and associated components impacting the environment Release of material into the environment	Propagation into other items stored in the warehouse Propagation into a complete warehouse fire	**Medium**	- Staff training in safe fire fighting and evacuation procedures - Staff trained in forklift use and lifting procedures - Emergency response plan - PPE supplied for personnel - Site spill containment - Spill kits - Control of ignition sources - Site handling procedure and process to minimise spills - Small volumes	**Low**

5.3 Risk Screening

The risk assessment undertaken in 5.2 identified the risks associated with the credible risk scenarios identified in Table 2. For the purposes of this assessment, scenarios deemed to be of 'low' risk during the risk assessment have not been analysed any further, as they are unlikely to have any impacts off-site. The following events have been carried forward for further analysis:

- Fire in Class 2.1 aerosol storage
- Fire in Class 3 storage
- Fire in Class 4.1 storage

5.4 Risk Acceptance Criteria

Quoted acceptability criteria exist in several states of Australia. The value for the commonly referenced acceptance criterion of 'Individual Risk' (fatality) for 'Industrial' land use is 50×10^{-6} or a 50 in one million chance of fatality, whilst involved in 'Industrial' land use. This is shown in Table 6, outlining Australian individual risk by land use.

Table 6 Australian Individual Risk by Land Use

Risk Level	Land Use
0.5×10^{-6}	Hospitals, schools, childcare facilities, old age housing
1.0×10^{-6}	Residential, hotels, motels, tourist resorts
5×10^{-6}	Commercial developments including retail centres, offices and entertainment centres
10×10^{-6}	Sporting complexes and active open spaces
50×10^{-6}	Industrial

For the purposes of this report, it is considered that the risk acceptance criteria for an industrial facility would be the most appropriate to be applied to the proposed RDC development, as the potential for exposure of occupants to dangerous goods and other risks in the proposed development is similar, if not less than, industrial facilities that store and handle dangerous goods.

The NSW Department of Planning has published an Advisory Paper No. 4 "Risk Criteria for Land Use Safety Planning' outlining the criteria by which the acceptability of risks associated with potentially hazardous developments is assessed.

In the context of the subject land use, Individual Risk is the measure of risk that an individual occupant would be exposed to in the proposed facility, if they remained in the same position, 24 hours a day, 365.25 days per year. The Individual Risk values are for fixed targets. This approach is considered conservative as occupants are not expected to remain permanently in one position.

Industrial premises of this nature typically include large retail stores, manufacturer's despatch areas, or similar operations. Due to the similarity of land use between the development and similar industrial premises, it is considered that the individual risk should be no worse than for an industrial facility.

For the purposes of this report, it will be assumed that an individual risk criterion that is deemed acceptable for industrial land use applications is applicable for the large retail distribution centre. As such, an Individual Risk value of 50×10^{-6} will be adopted as the upper bound associated with the proposed development.

5.5 Risk – Consequence Analysis

In risk analysis, the graphical construct fault tree analysis (FTA) is considered useful for the modelling of the system condition using binary values (0's and 1's) that may result in the occurrence of an unwanted event. The significance of the output event (otherwise known as the top level event) is nominally recognised as the 'consequence' factor, being a function of risk, and therefore, values of probability (random variable) are not nominally applied.

The combination of events in an ‘AND’ gate configuration or even a single event, as in the case of an ‘OR’ configuration, is required to trigger the output of the fault tree (to achieve a value ‘1’), so input event probability (or risk likelihood factor) is not assessed with fault trees.

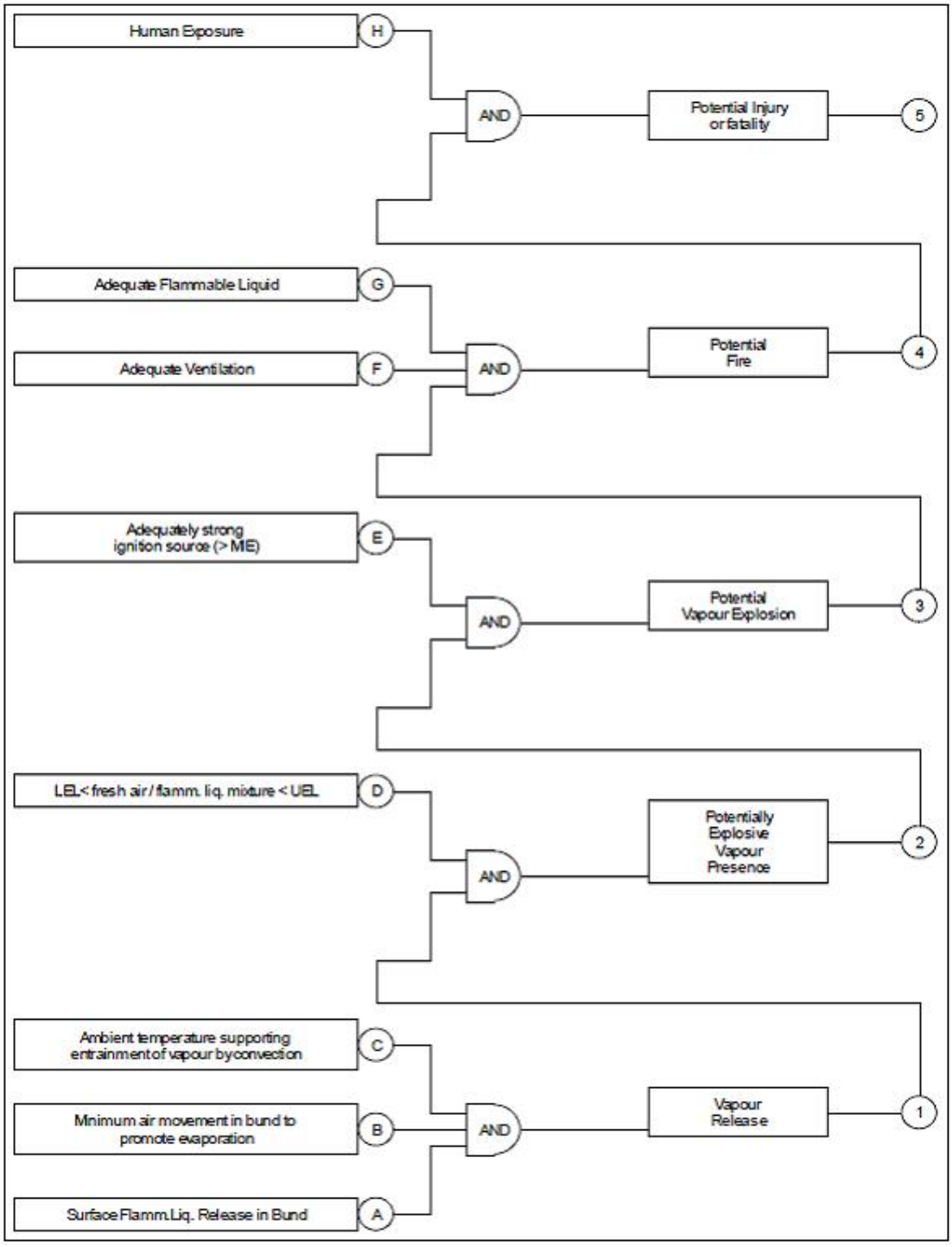
An overall reduction of Individual Fatality Risk may be achieved by preventing fault tree outputs from ‘triggering’. This is realised through implementing risk mitigation control that address the probability of fault tree input occurrence.

The fault tree ‘top level event’ consequence can be graded either qualitatively, or quantitatively, however for the purpose of a quantitative assessment in this report, a final random variable value between a range of consequence levels (0< consequence <1) will be used. A useful guide for understanding the consequence factor in this analysis is the ‘DSG Risk Assessment Framework’ (2005).

The consequence factor for a fatality in this report is assumed to be a maximum level of 0.999, whereas fire event occurrences that would be likely to cause an injury or fatality if human exposure existed are considered to be less than 0.05. Non-fire events are considered to represent a consequence factor of less than 0.01.

The output of fault trees are normally used as given event inputs into an event tree analysis (ETA), which follows the current FTA analysis shown in Figure 2

Figure 2 Fault Tree Analysis



5.6 Risk – Likelihood Analysis

ETA is also referred to as a 'probability tree analysis' and is considered an appropriate graphical analysis tool for the representation of the dependence of events. Sequences of discrete random variables or events are typically associated with random variables, or probabilities.

Deductive logic that starts with an initiating event is used to analyse possible realisations of the variable. The probability of each event is displayed conditional on the occurrence of the events that precede it in the event tree; these are called 'nodes'. The product of probability of each event is shown conditional on the occurrence of events representing the possible subsequent sequences at each node.

The 'initiating events' for each event tree in the analysis shown in Figure 3 are considered to be the same 'top level events' described in the previous FTA. The summed probability of the branches of any sequence in an event tree is 1.00, as the combination of both the possible sequences must equal the total of all possible sequences in the tree (or tree branch).

5.6.1 Analysis of Event 1 – Vapour Release Due to Thermal Decomposition

The probability of vapour evolution is assumed to be equivalent to the probability of a human handling failure in conjunction with the probability of the co-existence environmental factors relating to the spill of flammable materials and the evaporation of the volatile fraction.

The probability of a human handling error by a trained technical worker carrying out non-critical routine activities is in the order of 0.01. Refer to Table 7.

It is expected that any of the flammable liquids to be stored as a part of the proposed development contain a volatile fraction which will evaporate following a spill. As such, the probability of evaporation relating to an existing spill is1. The overall probability for this event is therefore the product of these probabilities and is effectively the probability of a human error as described.

Table 7 Rates of Error in Human Handling (Source: US Atomic Energy Commission Reactor Safety Study, 1975)

Type of Activity	Probability of Error per Task
Critical Routine Task	0.001
Non-critical Routine Task	0.003
Non Routine Operations	0.01
Check List Inspection	0.1

Probability of Vapour Release p(VR) = 0.01

5.6.2 Analysis of Event 2 – Potentially Explosive Vapour Present

The potential for the vapour present, as described in 'Event 1 – Vapour Evolution', to become 'explosive' is a function of the released vapour to mix with air and the subsequent vapour-air mixture to exist within the characteristic explosive limits of the compounds.

Due to the size of the facility and the degree of ventilation, it is considered that the likelihood of a vapour cloud remaining above its LEL for any length of time to sustain an explosion is qualitatively regarded as rare. For the purpose of the ETA it has been assumed the probability of a vapour cloud being present is 0.45 as opposed to 0.9 in confined areas.

Probability of Vapour Release p(PEVR) = 0.45

5.6.3 Analysis of Event 3 – Potential Vapour Explosion

Ignition sources may be present in the RDC as either 'fixed' or 'portable' sources.

Astbury (2005) reports in the "Review of unidentified ignition sources of unplanned flammable releases – Comparison of Offshore and Onshore data" (Reference) of common categories of general ignition sources from the UK 'Major Hazard Incident Data Service' MHIDAS, as shown in Table 8.

The MHIDAS information breaks the data down into primary ignition sources and secondary ignition sources. For example 'auto ignition' is a primary source with 'chemical reaction' as the secondary source.

'Electric' and 'flame' ignition sources are shown in Table 8 as significant factors of fire during an unplanned flammable liquid release in land based 'non-process' situations.

Table 8 Common categories of general ignition sources from the UK 'Major Hazard Incident Data Service' MHIDAS

- **Arson**	- **Friction Spark**
- **Auto ignition**	• Non-specific
• Non-specific	• Compressor
• Chemical reaction	• Pump
- **Electric Source**	• Sparking
• Non-specific	• Welding
• Domestic	- **Hot Surface**
• Instrument	• Non-specific
• Lightning	• Chemical reaction
• Motor/ Generator	• Cigarette
• Static	• Flame
• Vehicle	• Friction surface
• Welding	• Incandescent
- **Flame**	• Lagging
• Non-specific	• Steam pipe
• Domestic	• Stove
• Flare	• Vehicle exhausts
• Furnace	• Welding
• Grassfire	- **Hot Surface**
• Match	• Non-specific
• Welding	• Compressor
	• Chemical reaction

A summary of the MHIDAS UK 'Non Process' ignition sources resulting in fires of unplanned flammable releases is shown in Table 9

Table 9 'Non-process' ignition sources resulting in fires of unplanned flammable releases

Primary Ignition Source	UK Non-Process
Arson	5.5%
Auto ignition	5.6%
Collision	7.0%
Electric	10.8%
Flame	9.4%
Friction Spark	1.9%
Hot surface	4.0%
Non ignition	3.2%
Unknown	53.7%

The FER identified potential sources of ignition in the RDC. Of those identified, the one with the highest likelihood in Table 9 is 'Electric. Therefore the probability of ignition of a flammable vapour as a result of an electric source is 0.108.

Probability of Potential Vapour Explosion p(PVER)= = 0.108

5.6.4 Analysis of Event 4 – Potential Fire Event

'Electric' and 'Flame' ignition sources have been found to be statistically significant in terms of initiating vapour explosions. The ignition of flammable vapours is likely to be due to be a piloted ignition source above the flashpoint, rather than a temperature above the auto ignition temperature of the vapour.

Failure mode for each of the identified ignition sources would involve overheating of the equipment or electric arcing. In the case of 'hot work', the ignition source probably would involve hot metal from welding or cutting.

The ignition source (or pilot) is likely to remain as an ignition source (e.g. the hot metal surface remains hot) after the initial deflagration or explosion, and as such; continuity of burning and spread of fire is likely after the initial detonation, therefore given a vapour explosion, the probability of a subsequent fire and spread of the fire is quite high and estimated to be in the order of 0.1 to 1.0. (assumed to be 0.5 for this assessment).

Probability of Potential Fire p(PF) = 0.5

5.6.5 Analysis of Event 5 – Potential Fatality or injury

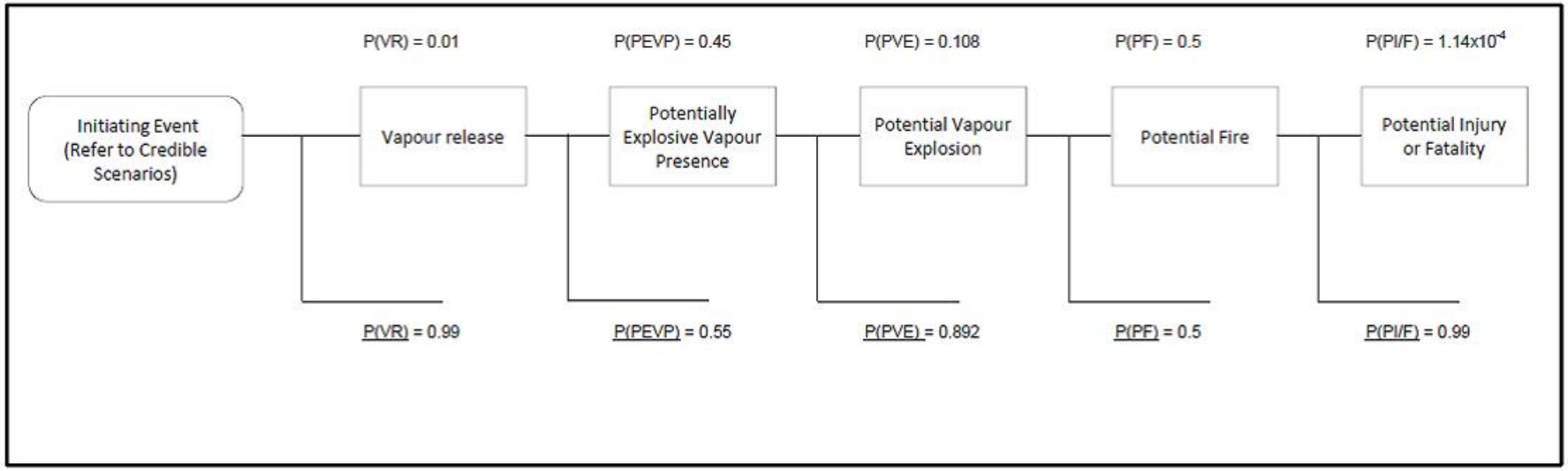
The probability of fatality or injury is directly related to exposure of individual to the hazard. If an occupant of the RDC is located within the spill area and close to a significant deflagration, it is considered likely that the occupant is vulnerable, but not likely to be killed due to the involvement of small estimated spill quantities.

The exposure of occupants to the hazard is seen as the significant determining factor in this assessment, the dangerous goods storage areas are occupied intermittently and when occupied, the occurrence of hot work is unlikely.

'Hot work' within the dangerous goods storage areas is expected to occur for less than 1 hour each year (annual maintenance). As the probability of a subsequent fatality or injury is less than the probability of hot work being carried out within the dangerous goods storage areas, the overall probability of a potential fatality is no greater than $1.14x10^{-4}$

Probability of Potential Fire p(PI/F) = $1.14x10^{-4}$

Figure 3 Event Tree Analysis



5.7 Risk Evaluation

5.7.1 Individual Fatality Risk

As previously defined, the consequence factor for a fatality in this report is assumed to be a maximum level of 0.999., whereas fire event occurrences that would be likely to cause an injury or fatality if human exposure existed (but does not exist) are considered to be less than 0.05. Non-fire events are considered to represent a consequence factor of less than 0.01.

The consequence factor associated with the Individual Risk of fatality in this assessment is 0.99 (worst case condition) as allocated to the Top Level Event of the previous Fault Tree Analysis.

The likelihood factor (or probability) of a fatality is the product of the sequence of probabilities in the previous Event Tree Analysis. This probability is 2.77×10^{-8}.

The Individual Risk is the product of Consequence and Likelihood, as detailed in the associated FTA and ETA.

Assessed Individual Fatality Risk is $0.99 \times 2.77 \times 10^{-8} = 2.74 \times 10^{-8}$.

This risk level is considerably lower than the Individual Risk Fatality IR' for 'Industrial' land use, which is 50×10^{-6}.

5.7.2 Cumulative Risk

The Len Waters Estate includes more than one RDC that may affect the surrounding land use. These include:

- The proposed Dick Smiths Electronics/ Masters Regional Distribution Centre; and
- The Big W Regional Distribution Centre.

The cumulative risk associated with the regional distribution facilities at the Len Waters Estate is the sum of the calculated Individual Fatality Risk for the proposed Dick Smiths Electronics/ Masters RDC and the Big W RDC.

The identified Individual Fatality risk was previously calculated for the Big W RDC to be 4.77×10^{-8}.

Therefore the cumulative risk associated with the regional distribution facilities at the Len Waters Estate is 7.51×10^{-8}.

This risk level is also considerably lower than the Individual Risk Fatality IR' for 'Industrial' land use, which is 50×10^{-6}.

6.0 Conclusions

Development of the subject Dick Smith Electronics/ Masters Regional Distribution Centre at Hoxton Park is considered safe on the basis that the credible risks identified in this report are controlled to a level that is low as far as reasonably practicable with the implementation of the fire protection measures identified in the Fire Engineering Report.

A range of hazards have been identified, which include the following credible events:

4) Fire in Class 2.1 aerosol storage

5) Fire in Class 3 storage

6) Fire in Class 4.1 storage

Risk associated with these hazards has also been identified in terms of individual risk which has been found to be below the recognised individual risk level for industrial land use.

The Len Waters Estate includes more than one (1) RDC that may affect the surrounding land use. These include:

- The proposed Dick Smith Electronics/ Masters Regional Distribution Centre; and
- The Big W Regional Distribution Centre.

The cumulative risk associated with the regional distribution facilities at the Len Waters Estate is the sum of the calculated Individual Fatality Risk for the proposed Dick Smith Electronics/ Masters RDC and the Big W RDC.

The identified Individual Fatality risk was previously calculated for the Big W RDC to be 4.77×10^{-8}.

Therefore the cumulative risk associated with the regional distribution facilities at the Len Waters Estate is 7.51×10^{-8}.

This risk level is also considerably lower than the Individual Risk Fatality IR for ‘Industrial’ land use, which is 50×10^{-6}.

7.0 Recommendations

It is recommended that the Fire Engineering Assessment (Fire Safety Study) for the proposed RDC be reviewed and kept up to date consistent with the increase in the proposed quantities of dangerous goods, and/or where the fire load within the facility has increased. This PHA is based on the design outcomes of the previous Dick Smiths (now Masters) RDC Fire Engineering Report. As a result of increased fire load under the Masters storage scheme, it is recommended that a review of the Dick Smiths FER be carried out in order to identify any ‘gaps’ between the previous design solution and the currently required design solution.

8.0 References

Applying SEPP 33 – Hazardous and Offensive Development Application Guidelines (New South Wales Department of Urban Affairs and Planning) 1994.

DSG Risk Assessment Framework Version 2", October 2005, ASEHR

Risk Criteria for Land Use Safety Planning", June 1992, The NSW Department of Planning, Sydney, Australia

Appendix A

SEPP 33 Screening Test

Appendix A SEPP 33 Screening Test

Part 1: SEPP 33 Screening Test for Quantity of Dangerous Goods Held on Site with 16m minimum distance to Boundary.

Dangerous Goods Classification	Packing Group	Estimated Stock Holding (tonnes)	SEPP 33 Reference for Screening	Screening Threshold (tonnes)	Acceptable (Yes /No)	
2.1 Flammable Gas		167.22	Figure 6	40	NO	
3 Flammable liquid	II - Medium Danger	27.59	Figure 9	50	YES	(Note 1)
	III - Low Danger	104.12	Figure 9	50	NO	(Note 1)
4.1 Flammable solids	III - Low Danger	2.61	Table 3	5	YES	
8 Corrosive substances	II - Medium Danger	3.42	5 tonnes/ 5 m^3	5	YES	
	III- Low Danger	7.08	50 tonnes/ 50 m^3	50	YES	

Part 2: SEPP 33 Screening Test for Vehicle Movements of Dangerous Goods Held to from site.

Dangerous Goods Classification	Packing Group	Annual Sales Forecast (tonnes)	SEPP 33 Reference - Table 2: Transportation Screening Thresholds		Average Load per Vehicle Movement (Based on Annual Threshold)	Average Load per Limit	Acceptable (Yes /No)
			Threshold Annual Vehicle Movements	Threshold Limit per Load (tonnes)			
2.1 Flammable Gas		461.21	500	5	0.92	0.18	YES
3 Flammable liquid	II - Medium Danger	64.26	750	10	0.09	0.01	YES
	III - Low Danger	310.10	1000	No Limit (Note 2)	0.31	(Note 2)	YES
4.1 Flammable solids	III - Low Danger	15.76	200	2	0.08	0.04	YES
8 Corrosive substances	II - Medium Danger	20.68	500	5	0.04	0.01	YES
	III- Low Danger	26.71	500	5	0.05	0.01	YES

Note 1: The PGII PLUS PGIII total qty must also be less than the individual limit
Note 2: The annual amount of Class 3 PG III fully laden vehicle movements must not exceed 1000 vehicle movements.

Appendix B

Fire Engineering Report

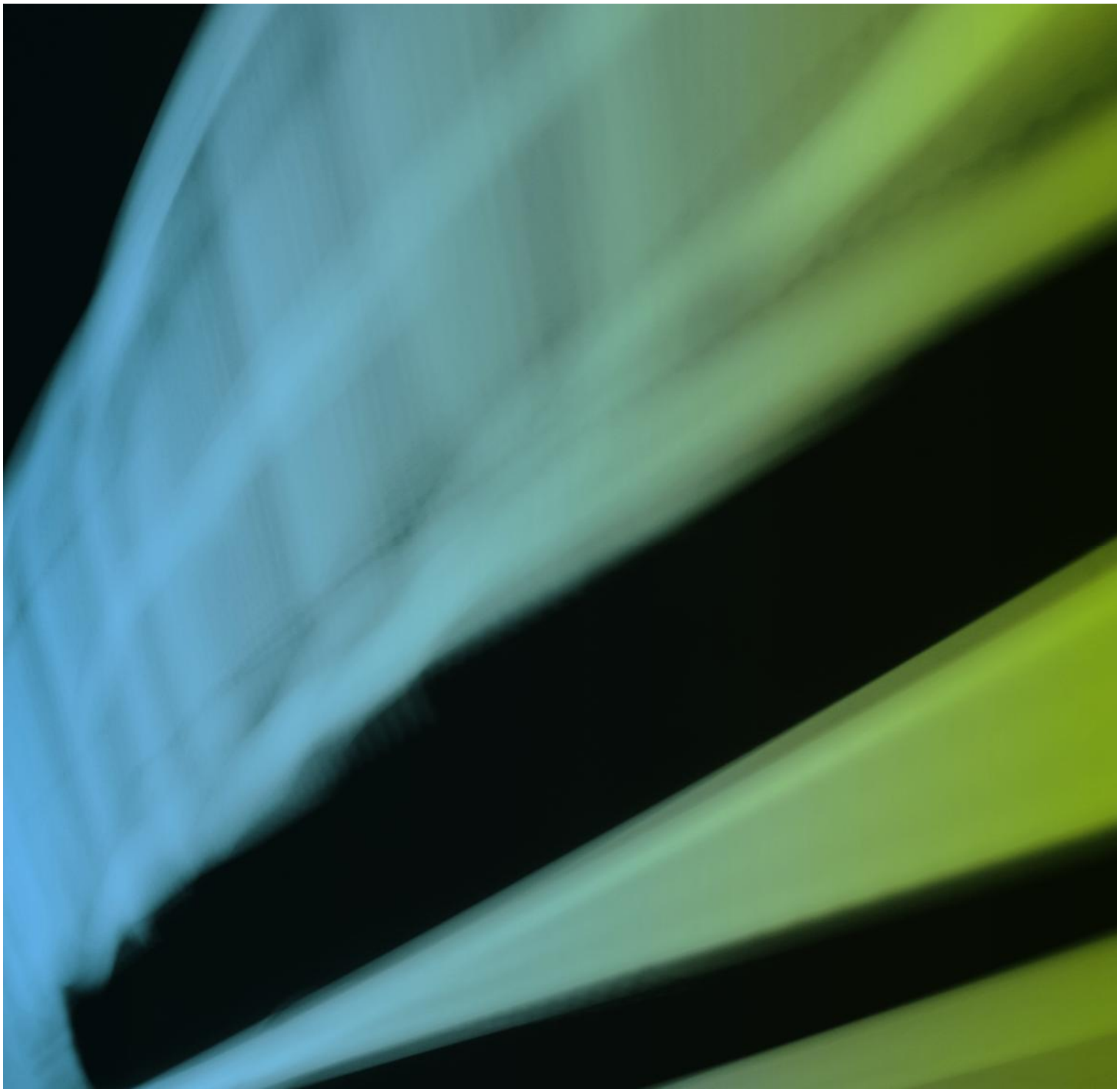
Appendix B Fire Engineering Report

1 December 2010

Document No. 60044407 - HI(DSE)-FER_Rev3

Fire Engineering Report

Home Improvement Warehouse



Fire Engineering Report

Home Improvement Warehouse

Prepared for

Mirvac

Prepared by

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1 December 2010

60044407

Quality Information

Document Fire Engineering Report

Ref 60044407

Date 1 December 2010

Prepared by Faisal Musa

Reviewed by Dr Amer Magrabi

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
0	31-May-2010	Draft for stakeholders review	Stephen Hall Technical Director - Building	
1	17-Jun-2010	Updated stakeholders comments and for submission to NSWFB	Stephen Hall Technical Director - Building	
2	15-Oct-2010	For Submission to NSWFB - Incorporated the Racking Layout Changes	Stephen Hall Technical Director - Building	
3	1-Dec-2010	For Submission to NSWFB - Incorporated the Racking Layout Changes and NSWFB Comments	Stephen Hall Technical Director - Building	

* For and on behalf of AECOM Australia Pty Ltd, this Fire Engineering Report is signed by an Accredited C10 Fire Safety Engineer, Dr S. A. Magrabi in accordance with Clause 144A(1)(b) of the NSW Environmental Planning and Assessment Regulation (2000). It is noted that this Fire Engineering Report does not constitute a Part 4A Compliance Certificate under the NSW Environmental Planning and Assessment Act (1979).

How to Read This Report

The scope of this Fire Engineering Report (FER) is to assess the proposed Alternative Solutions against the relevant Building Code of Australia (BCA) Performance Requirements. The FER has generally been prepared in accordance with the International Fire Engineering Guidelines (IFEG) and is divided into the following sections:

Generally, the report is structured as follows:

- Executive Summary
- Sections 1 – 2 - Introduction and general project information
- Sections 3 – Report Objectives
- Section 4 – Proposed fire safety strategy and scope of works arising from the report
- Section 5 - Occupant characteristics
- Sections 6 -8 - Design inputs
- Section 9 – Fire engineering assessment
- Section 10 – Reference information
- Section 11 – Report validity and limitations
- Section 12 - Conclusion
- Appendices

The project stakeholders will have varying degrees of involvement in the fire engineering process with an interest in different sections. It is recommended that each stakeholder read the entire document, paying particularly attention to the sections indicated in the table below.

Table 0-1 – Stakeholder recommended reading

	Report Section													
Stakeholder	**Executive Summary**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Appendices**
Client	✓	✓	✓	✓	✓	✓					✓	✓	✓	
Architect	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	
Certifying Authority	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Project Manager	✓	✓	✓	✓	✓	✓					✓	✓	✓	
Services Engineers	✓	✓	✓	✓	✓						✓	✓	✓	
Fire Brigades	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Managing Contractor	✓	✓	✓	✓	✓	✓					✓	✓	✓	
Relevant Sub-Contractors	✓	✓	✓	✓	✓	✓					✓	✓	✓	✓

Table of Contents

Executive Summary

This Fire Engineering Report (FER) relates to the proposed Home Improvement Warehouse (formerly Dick Smith Electronics Distribution Centre) located at Cowpasture Road, Hoxton Park, NSW. It should be read in conjunction with the Fire Engineering Report (FER) dated 17 June 2010 that was previously submitted to NSW Fire Brigades.

AECOM Australia Pty Ltd has been appointed by Mirvac to undertake a Performance Requirement Assessment of the Building Code of Australia 2009 (BCA) for the proposed Alternative Solutions identified in Section 4.1 (page 7) of this report.

This FER address the latest changes to the racking layout within the warehouse. These changes include:

- The omission of Pick Module platform and as such any relevant BCA non-compliance in relation to Pick Module platform.
- Changes to the extended travel distance measurement (i.e. 219 m in lieu of 224 m as per previous BCA Consultant Report).

Based on the fire engineering assessment presented in this report, it is the considered opinion of AECOM that the proposed Alternative Solutions satisfy the BCA Performance Requirements CP2, CP9, DP4, EP1.4, EP1.1, EP1.3 and EP2.2. This is subject to, but not limited to, the implementation of the fire safety strategy for this building, as outlined in Section 4.0 – Fire Safety Strategy (page 7) of this report.

The readers' attention is drawn to the scope and conditions of use of this document that are outlined in Section 1.0 - Introduction (page 2), Section 3.0 – Design Objectives (page 6) and Section 11.0 – Validity & Limitations (page 52).

1.0 Introduction

1.1 The Project

The project relates to the proposed Home Improvement Warehouse (formerly Dick Smith Electronics (DSE) Distribution Centre) located at Cowpasture Road, Hoxton Park, NSW.

The changes to the previous FER revision include

i) New racking layout including the omission of Pick Module platform.

ii) New extended travel distance length due to the new racking layout.

1.2 Terms of Reference

AECOM has been appointed by Mirvac to assess the proposed Alternative Solutions[1] identified in this report against the relevant Performance Requirements of the Building Code of Australia 2009 (BCA).

1.3 FER Scope

The scope of the Fire Engineering Report (FER) is to assess the proposed Alternative Solutions against the relevant BCA Performance Requirements for the subject building. The proposed Alternative Solutions were based on the variations from the BCA Deemed-to-Satisfy (DtS) Provisions identified by the Certifying Authority, Phillip Chun. The FER outlines a performance-based fire safety design strategy that gives an overview of the building to support the proposed Alternative Solutions. The FER should be read in conjunction with the Fire Engineering Brief (FEB) 60039418-FEB-Rev4 dated 28 May 08 that was previously agreed to by all project stakeholders.

1.4 Relevant Project Stakeholders

The relevant project stakeholders that have been nominated by the Client for purposes of participating in the fire engineering process are outlined in Table 1-1.

Table 1-1 – Relevant project stakeholders.

Name	Company	Role
Ron Chuck Brett Thomson Leon Pham Zach Hill	Mirvac	Project Manager & Builder
Phil Morrell	FM Global	Building Insurer
Rob Marinelli Rod Shepherd	Philip Chun	Certifying Authority
Benjamin Hughes Brown Jeff Roche George Baldock	NSWFB	Regulatory Authority
Warren Dixon	MNIA Architects	Architect
Grant Roe	Costin Roe	Structural Engineer
Peter Young	BECA	Mechanical Engineer

[1] Alternative Solution is defined in the BCA as a Building Solution, which complies with the Performance Requirements other than by reason of satisfying the Deemed-to-Satisfy Provisions.

Name	Company	Role
Chris Enno		
Jennifer Kemp	BECA	Electrical Engineer
Brendan Melbourne	BECA	Fire Services Engineer
Faisal Musa Dr Amer Magrabi	AECOM	Fire Safety Engineer

1.5 Definitions

The following definitions apply to terminology utilised in the report:

AECOM – refers to AECOM Australia

BCA – refers to the Building Code of Australia 2009
BCA DtS – refers to the Building Code of Australia 2009 (BCA) Deemed-to-Satisfy Provision (DtS)
Certifying Authority – refers to Phillip Chun
Client – Mirvac
Fire Safety Engineer – refers to AECOM
Fire Services Engineer - refers to BECA
FM – refers to Factory Mutual Global
FEB – refers to the Fire Engineering Brief prepared by AECOM (This document)
FER – refers to the Fire Engineering Report to be prepared by AECOM
Project Manager – refers to Mirvac
Electrical Engineer – refers to BECA
Mechanical Engineer – refers to BECA
Structural Engineer – refers to Costin Roe
NSWFB – refers to the NSW Fire Brigades

2.0 Building Characteristics

2.1 Building Description

2.1.1 General

The project involves the construction of a new warehouse located at Cowpasture Road, Hoxton Park, NSW. The building is a single storey with BCA Type C construction applicable comprising a warehouse (Class 7b) and office space (Class 5). The warehouse part of the building will comprise high-rack system for mixed commodities storage and aerosol and flammable liquid storage. There will be ancillary areas, plant rooms, covered despatch and receiving docks and offices at the perimeter of the building. The building will be fully sprinkler protected in accordance with AS2118, and FM Global Data Sheet 2.0.

2.1.2 Egress

Egress from the building will be via designated exits as shown by the architectural drawings listed in Table 10-1 (Section 10.4).

2.2 BCA DtS Reference Criteria

Table 2-1 outlines key classification criteria in accordance with the Building Code of Australia 2009 (BCA) Deemed-to-Satisfy (DtS) Provisions, as identified by the Certifying Authority; Phillip Chun in their BCA Assessment Report dated 11 May 2010.

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

BCA Clause		Description or requirement
A1.1	Classification	Class 5 (Office) and Class 7b (Warehouse)
A3.2	Rise in Storeys	One (1)
C1.1	Effective Height	< 25 m
C1.2	Construction Type	Type C applicable
C2.2	Floor Areas	~39,000m^2
C2.3	Large-Isolated Building	Yes
D1.13	Floor populations	• Day Shift Office – 65 persons Warehouse - 165 persons • Afternoon Shift 48 Persons

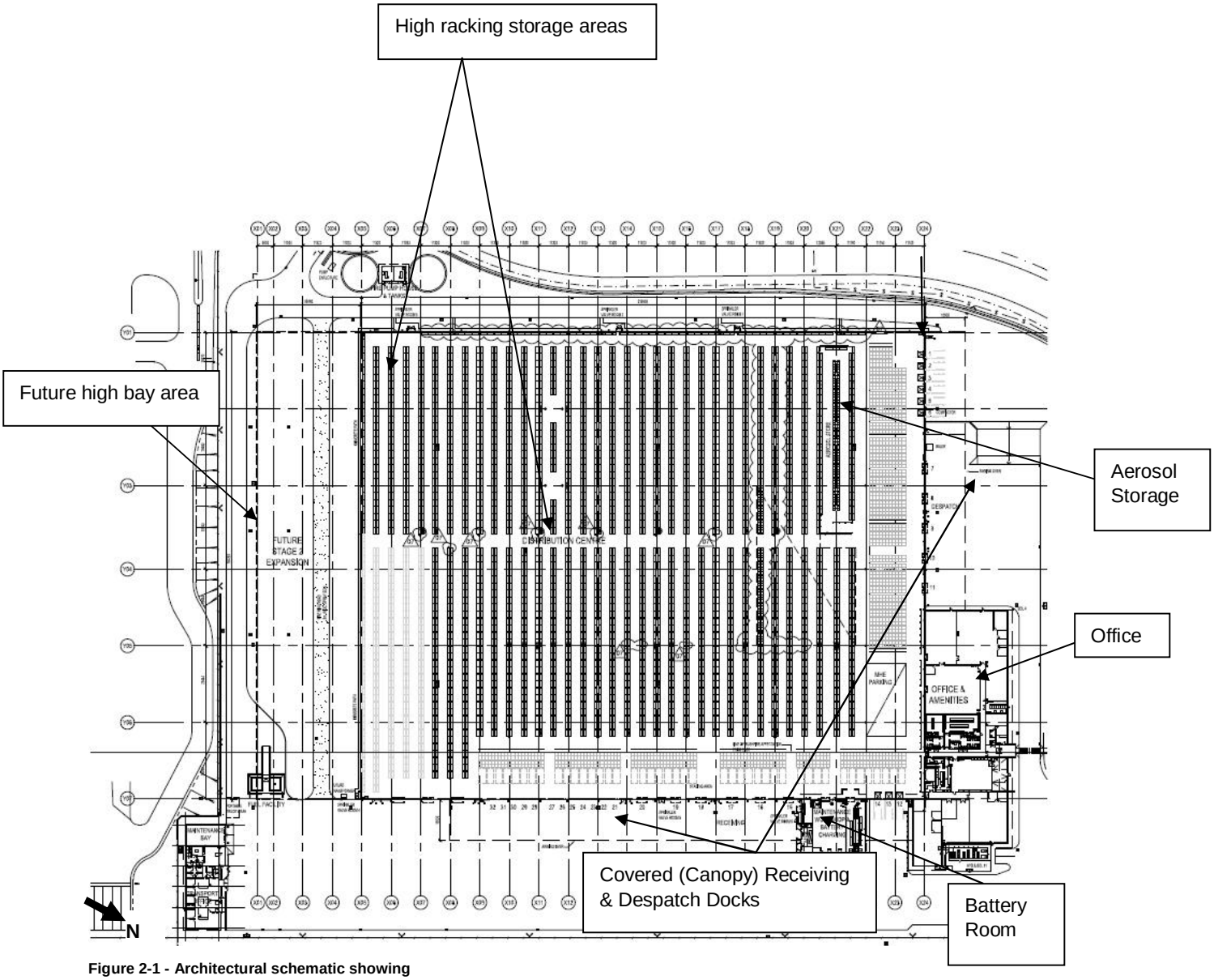


Figure 2-1 - Architectural schematic showing

3.0 Design Objectives

3.1 Fire Safety Objectives

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

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

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

This assessment will be consistent with the objectives and limitations of the BCA and therefore specifically excludes arson (other than as a source of initial ignition), multiple ignition sources, acts of terrorism, protection of property (other than adjoining property), business interruption or losses, personal or moral obligations of the owner/occupier, reputation, environmental impacts, broader community issues etc. As an Alternative Solution is not identical to a BCA Deemed-to-Satisfy (DtS) solution, it should be noted that property losses resulting from a fire in the subject building could under some circumstances be greater than those for a building complying fully with the BCA DtS Provisions.

3.2 BCA Compliance Objectives

In terms of BCA Compliance, the primary objective of this report is to assess the proposed Alternative Solutions identified in Section 5.0 in order to meet the relevant BCA Performance Requirements. With the exception of these Alternative Solutions all other fire safety aspects of the building are to comply with BCA DtS Provisions.

3.3 Fire Brigade Objectives

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

4.0 Fire Safety Strategy

The overall fire safety strategy for this building is based on a combination of fire safety measures arising from compliance with BCA DtS Provisions and other additional requirements resulting from assessing the BCA DtS variations as Alternative Solutions. Accordingly, the fire safety measures nominated by this report are in addition to the measures identified by the Certifying Authority for compliance with BCA DtS Provisions.

4.1 BCA DtS Variations & Proposed Alternative Solutions

The following variations to the BCA DtS Provisions have been identified by the Certifying Authority; Philip Chun in their BCA Compliance Reports dated 11 May 2010 and Assessment Notes – BCA 2010 Review dated 28 September 2010. Table 4-1 shows the BCA DtS Variations, Proposed Alternative Solutions, relevant BCA Performance Requirements and BCA Assessment Methods. All other fire safety aspects of the building are to comply with BCA DtS Provisions.

Table 4-1 – BCA DtS Variations, Proposed Alternative Solutions, relevant BCA Performance Requirements and Assessment Methods.

No.	BCA Clause	BCA DtS Provisions	Alternative Solution	Relevant Performance Requirement	Method of Assessment
1)	C2.3(b) & E2.2b	A large isolated building which exceeds a floor area greater than 18,000 m^2 or volume greater than 108,000 m^3 and with a ceiling height more than 12m requires a smoke exhaust system as per BCA Specification E2.2b.	It is proposed to rationalise the automatic smoke exhaust system based on the following: • ESFR Sprinkler protection in accordance FM Global Data Sheets 2-2[2], 8-9[3] and AS2118.1:1999. • Extended spacing smoke detection in accordance to AS 1670.1:2004 and AS/NZS 1668.1:1998. • Office space will be without smoke exhaust based upon smoke proof separation between the office and warehouse areas. • Fire-rated smoke clearance fan with one air change per hour.	CP2 & EP2.2	Qualitative & Quantitative analysis based on BCA A0.5b(i), A0.9(b)(ii) 'acceptable Verification Methods' . The verification method includes: a) An ASET/ RSET analysis for the Class 7b parts of the building to demonstrate occupant life safety prior to onset of untenable conditions.

[2] FM Global Data Sheet 2-0, Installation Guidelines for Automatic Sprinklers
[3] FM Global Data Sheet 8-9, Storage of Class 1, 2, 3, 4 and Plastic Commodities.

No.	BCA Clause	BCA DtS Provisions	Alternative Solution	Relevant Performance Requirement	Method of Assessment
2)	D1.4	No point on a floor must be more than 20 m from an exit, or a point from which travel in different two directions to 2 exits is available, in which case the maximum distance to one of those exits must not exceed 40m;	Extended travel distances are proposed in the following areas: • Approximately 114 m to an exit in the warehouse area.	DP4, EP2.2	Quantitative analysis based on BCA A0.5b (i), A0.9 (b) (ii) 'acceptable Verification Methods'. The verification method includes: a) An ASET/ RSET analysis for the Class 7b parts of the building to demonstrate occupant life safety prior to onset of untenable conditions.
3)	D1.5	Exits that are required as alternative means of egress must not be less than 9 m apart and not more than 60 m apart.	The distance between exits exceeds 60 m in the following areas: • Approximately 219 m in the warehouse[4]. • Approximately 81 m in the workshop.	DP4, EP2.2	Quantitative analysis based on BCA A0.5b (i), A0.9 (b) (ii) 'acceptable Verification Methods'. The verification method includes: a) An ASET/ RSET analysis for the Class 7b parts of the building to demonstrate occupant life safety prior to onset of untenable conditions.
4)	E1.3	The fire hydrant must be provided to serve a building more than 500 m^2 and where fire brigade is available to attend a building fire complying with AS 2419.1	An alternative solution is proposed for the hydrants under the canopies on the east and north sides of the building to be treated as external hydrants based the following: • Open nature of the canopy. • Sprinkler protection. • Hydrant to have radiation shields.	EP1.3	Qualitative analysis based on BCA A0.5b(i), A0.9(b)(ii) 'acceptable Verification Methods', A0.9(c) 'Comparison to DtS Provisions' The verification method includes: a) A qualitative assessment to demonstrate the adequacy of the fire hydrant system to meet NSWFB operational requirements during intervention.

[4] Philip Chun & Associate- Assessment Notes – Building Codes of Australia 2010 Review dated 28 Sept 2010

No.	BCA Clause	BCA DtS Provisions	Alternative Solution	Relevant Performance Requirement	Method of Assessment
5)	E1.4	All points on the floor to be within reach of a 36 m fire hose length. Additionally, fire hose reels are to be located within 4 m of a required exit or adjoining a fire hydrant.	It is proposed for the building to be provided with fire hose reel system with 50 m hose lengths with a total of up to 54 m coverage	EP1.1	Qualitative analysis based on BCA A0.5b(i), A0.9(b)(ii) 'acceptable Verification Methods', A0.9(c) 'Comparison to DtS Provisions' The verification method includes: a) A qualitative assessment to demonstrate the adequacy of the fire hose reel system and portable fire extinguishers for first aid fire fighting.
6)	E1.5	Sprinkler System in accordance with AS2118.1	An alternative solution is proposed sprinkler system in accordance with FM Global Data Sheet 2-2[2] and AS2118.1:1999. Where FM Global and AS2118.1:1999 requirements differ, the more stringent of the two is to be applied.	EP1.5	Qualitative analysis based on BCA A0.5b(i), A0.9(c) 'Comparison to DtS Provisions' The assessment method includes: a) Comparative assessment to demonstrate equivalence or better than similar BCA DtS Compliance sprinkler system
7)	E4.5 & E4.6	• An exit sign must be clearly visible to persons approaching the exit, and must be installed on, above or adjacent to each door providing egress • If an exit sign is not readily apparent to persons occupying or visiting the building then exit signs must be installed in appropriate positions indicating the direction to a required exit.	The following Alternative Solutions are proposed in relation to exit signage system: • Jumbo exit signs in the intermediate aisles are proposed to be mounted at height of 5 m in lieu of maximum 2.7 m permitted by AS2293.3:2005.	EP4.2	Qualitative analysis based on BCA A0.5b(i), A0.9(b)(ii) 'Acceptable Verification Methods', The verification methods include: a) A qualitative fire risk assessment based on the smoke layer heights and ASET/RSET analysis to demonstrate the visibility of exit signs during evacuation process.

4.2 Fire Resistance & Compartmentation

The proposed Alternative Solutions in relation to fire resistance/compartmentation provisions (i.e. BCA Section C) in the building are outlined in Section 9.2. All other provisions are to comply with DtS Provisions of BCA Section C. Significant aspects of the design include:

a) The building being treated as a 'Large-isolated Building' with Type C construction applicable under BCA Specification C1.1.

b) All equipment other than described in BCA Clause C2.12 (b) and (c) must be separated including the Battery Rooms by 120/120/120 FRL construction from the remainder of the building. Local Utility requirements may override separation of equipment under the BCA, which shall be verified by the Architect and Certifying Authority.

c) A smoke proof wall is to be provided between the office space and warehouse in accordance with BCA Specifications C2.5, Clause 3.

4.3 Egress Provisions

The proposed Alternative Solutions in relation to egress provisions (i.e. BCA Section D) in the building are outlined in Section 9.3. All other the egress provisions are to comply with DtS Provisions of BCA Section D. Significant aspects of the design include:

a) The extended travel distances to exits, distance between alternative exits in line with Alternative Solution #2, and #3, as outlined in Table 4-1 .

b) Two means of egress are to be provided from each racking bay (i.e. no dead end travel).

c) Occupant characteristics and floor population are to be in accordance with Section 5.0.

d) The evacuation of persons with mobility impairment in the office space shall be in accordance with Section 5.2.

e) Designated exits and travel distance from the building are shown by the Figure 9-2 and Appendix A.

4.4 Fire Services

This section summarises the fire safety services that are proposed within the building. More detailed information on the fire services can be found in the relevant Architect's and Engineers' specifications and drawings. The proposed Alternative Solutions in relation to fire services (i.e. BCA Section E) in the building are outlined in Sections 9.4, 9.5 and 9.6.

4.4.1 Automatic Fire Sprinkler System

a) The entire building shall be sprinkler protected with a sprinkler system in accordance with FM Global Data Sheets 2-2, 8-9 and AS2118.1:1999. Where FM Global and AS2118.1:1999 requirements differ, the more stringent of the two is to be applied.

b) The automatic sprinkler system shall comprise the following.

   i. Provision of automatic sprinkler system throughout the facility utilising ESFR sprinkler heads in accordance with FM Global Data Sheet 2-2 and AS 2118.1:1999 as shown in Table 4.2.

   ii. Independent individually monitored sprinkler stop-valves are to be provided for each sprinkler control valve installation in the building.

   iii. The valves are to be housed within a secure enclosure in accordance with Clause 3.4.2 of AS 2118.1:1999 except where the monitored components are located within a secure area or room with access restricted by means of a security device or system, in which case Class B devices may used.

Table 4-2 – Nominated sprinkler heads in various parts of the building as advised by Fire Services Engineer

Location	Sprinkler Type	Spacing Layout as per AS 2118	Activation Temperature	Max RTI $(m.s)^{1/2}$
Distribution Centre (Ceiling Level)	Early Suppression Fast Response (ESFR)	9 m^2 (High Hazard)	79 - 107°C	<36
Aerosol Products and Scheme A	Control Mode (Quick Response)	FM Global Data Sheet 7-31 (High Hazard)	74°C	≤50
Despatch/Receiving Docks	Quick Response	12 m^2 (Ordinary Hazard)	141°C	≤50
Office	Quick Response	21 m^2 (Light Hazard)	68°C	≤50

c) The FM Global compliant sprinkler system is expected to have a higher reliability than a BCA DtS compliant system. Nevertheless, the following measures are proposed in order to further improve the sprinkler reliability in this building:

- Independent individually monitored sprinkler stop-valves are to be provided. The valves are to be housed within a secure enclosure in accordance with Clause 3.4.2 of AS 2118.1:1999.
- A common water supply for sprinkler and hydrant system is proposed for the site with 4 hours storage for hydrants as per AS2419 and sprinkler duration as per FM Global Data Sheets.
- Increased number of sprinkler valve sets in accordance with FM Global Data Sheet 2-2.
- The following management-in-use procedures are to implemented:
  a) Use of primarily one company for sprinkler isolations.
  b) Re-instatement of the system at the completion of work each day.
  c) An approval system in place which requires written permission from management before isolation could take place and a statement as to the length of isolation (which must generally be less than one day).
  d) A requirement for the contractor to sign-off after completion of the work.
  e) Penalties on contractors for failure to comply with the above.
- Occupants and the Fire Brigade are to be notified if the sprinkler system is to be de-commissioned for maintenance works.

4.4.2 Mechanical Ventilation and Smoke Clearance Systems

a) The mechanical ventilation system in the building is to be in accordance with the BCA and AS/NZS 1668.1 as per the Mechanical Engineer's design.

b) Smoke clearance fans shall be provided in the warehouse for post incident fire brigade operation in accordance with AS/NZS1668.1-1998 including the following requirements:

- Must have a capacity of at least one air change per hour with adequate make-up air provisions.
- All fan assemblies are to be fire rated including the cables and motors.
- Fire fan control at the main fire indicating panel including an operational instruction manual.

- The smoke clearance fans shall operate upon activation of smoke detection or sprinkler system anywhere in the warehouse.

4.4.3 Smoke Detection System

a) A smoke detection system is to be provided throughout the building including the office in accordance with AS 1670.1:2004 at extended spacing as per AS/NZS 1668.1:1998.. The detection system is to be provided with a direct connection to the NSWFB (i.e. or via an approved service provider).

b) The Main Fire Indicator Panel (MFIP) shall comply with AS 4428.4:2004. The location is within Fire Control Centre located at the main entry to the office portion of the warehouse.

c) The occupant warning system in the building shall be provided with pre-recorded verbal messaging as per AS 1670.4:2004 & AS 4428.4:2004, in addition to standard alarm tones. Visual warning devices are to be provided in addition to alarm tones where the noise level exceeds ambient condition as per AS 1670.

d) The occupant warning system shall be initiated upon the activation of the smoke detection systems or sprinkler system anywhere in the building.

4.4.4 Fire Hydrants

a) The fire hydrant system is to be in accordance with BCA E1.3 and AS 2419.1:2005.

b) A ring main system is proposed relative to the perimeter vehicular access around the building.

c) The external fire hydrants underneath the canopy are to be provided with compliant radiant heat shields in accordance with AS 2419.1:2005.

d) Appropriate directional signage showing the Booster Assembly location are to be provided at appropriate location on the perimeter vehicular access.

e) Appropriate signage as per AS 2419.1:2005 is to be provided on the hydrant block plan at the main FIP and at the Booster Assembly.

f) A common water supply for sprinkler and hydrant system is proposed for the site with 4 hours storage for hydrants as per AS2419 and sprinkler duration as per FM Global Data Sheets.

g) The fire hydrants are to be provided with dual valve controlled outlets complying with AS2419.1:2005.

h) The couplings in the hydrant system are to be compatible with fire appliances and equipment used by NSWFB (i.e. Storz aluminium alloy delivery couplings manufactured and installed in accordance with Clause 7.1 and 8.5.11.1 of AS 2419.1:2005.

4.4.5 Fire Hose Reels

a) The fire hose reel system is to be in accordance with BCA E1.4 and AS 2441, with exception of the proposed Alternative Solution #7 discussed in Section 9.5. This includes the provision of 50 m hose length.

4.4.6 Portable Fire Extinguishers

a) Portable fire extinguishers in accordance with BCA E1.6 and AS 2444:2001 shall be provided throughout the building.

4.4.7 Emergency Lighting & Exit Signage

a) The emergency lighting and exit signage in the building to be in accordance with BCA Part E4 and AS 2293.1:2005 with the exception of the proposed Alternative Solution #9 as identified in Table 4-1.

b) The exit signs mounted at 5 m above the floor level are to be of jumbo signs with minimum 200 mm height lettering as per FAMCO specification in Appendix E.

c) The jumbo directional exit signs in the intermediate aisles are to be provided at maximum 30 m intervals.

d) The jumbo directional exit signs in the intermediate aisles in the warehouse are to be double sided with directional signs on both sides to its closest exits.

e) The exit signs above the exit doors shall be provided as per AS2293.1:2005.

f) Illuminated exit sign shall be provided to all exits from individual separated areas such as aerosols, as per AS2293.1:2005.

4.4.8 Fire Control Centres

a) Fire Control Centre is to be in accordance with BCA Specification E1.8 and located at the main entry of the building.

4.5 Emergency Control Procedures

Emergency Control Organisation and Procedures in accordance with AS 3745:2002 are recommended to be developed and implemented for this building:

a) Exit paths (including the corridors in this case) are to be kept clear of items that constitute a fire load or impede occupant egress.

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

c) The emergency evacuation drills are to be held at least every 6 months and include lights out emergency lighting on EWIS running.

d) Identify staff responsibilities and training requirements, including staff and visitor induction. Fire wardens are to be trained in early fire fighting and emergency response.

e) Training is to include initial attack on a fire when safe to do so using portable fire extinguishers.

f) Occupants who have not been trained to use fire extinguishers/fire hose reels should evacuate the building immediately and notify the NSWFB.

g) All visitors to the facility are to be escorted by staff members at all times.

h) Emergency evacuation plans and procedures for all persons including persons with mobility impairment are to be prepared and displayed adjacent to each exit comprising the location of fire protection equipment.

4.6 Maintenance

a) Periodic inspection, testing and maintenance of all fire safety systems shall be implemented in accordance with AS 1851:2005.

4.7 Dangerous Goods/ Process Risks

a) Process risks such as explosion, occupational health and safety, dangerous goods storage, assessment of hazardous areas and other related process safety issues are outside the scope of the BCA and hence this assessment. Consequently, these matters shall be assessed by suitably qualified persons and should include limitations as addressed by the relevant State Government Regulatory Authority in NSW.

b) Storage of aerosol products shall be in accordance to FM Global Data Sheet 7-31.

4.8 Fire Brigade Intervention

The following measures are to be provided to assist in fire brigade intervention:

a) Designated safe areas away from the building for appliance staging, breathing apparatus staging, rehabilitation, ambulance staging and evacuation assembly.

b) Emergency information box containing diagrams including a site map, building layout; diagrams, contact numbers and hazardous materials register adjoining the main Fire Indicator Panel.

c) Emergency controls and stop switches for automated processes, if any.

d) Emergency procedures are recommended to be developed in consultation with the local responding stations. This should include a map signage at the main entry to the site for fire personnel.

5.0 Dominant Occupant Characteristics

5.1.1 Population

The purposed design population is outlined in Table 2-1 as confirmed by the Architect and verified by the Certifying Authority.

5.2 Occupant Groups

Building occupants are mainly comprised of staff members who are expected to be familiar and have characteristics as shown in Table 5-1 below. Visitors to premises will be supervised by staff members at all times. It is considered that occupants in the building will be reasonably fit, mobile and awake due to OH&S requirements. The office space may have some occupants with mobility impairments. Nonetheless, the building occupants can be broadly classified into two groups:

- Occupant Group 1 - Staff members
- Occupant Group 2 - Visitors

5.2.1 Staff Members

Occupant Group 1 comprising staff members are expected to have the following characteristics:

Table 5-1 – Occupant group characteristics – Staff Members

Characteristic	Description
Distribution – Age, Gender, Location	Staffs are considered to be representative of the general workforce population with no specific or unusual distributions applicable in gender, age (other than age of workforce) and physical or mental attributes
State of Awareness	Staffs are expected to be awake and conscious of their surroundings.
Familiarity – egress routes, group roles, training	Staffs are generally expected to be familiar with egress routes, and will have some emergency response training.
Mobility	Generally able-bodied occupants within the warehouse parts. In the office spaces, some occupants may have mobility impairments or other mobility impairment and require assistance from other people.

5.2.2 Visitors

Occupant Group 2 comprising visitors are expected to have the following characteristics:

Table 5-2 – Visitors.

Characteristic	Description
Distribution – Age, Gender, Location	Visitors are considered to be representative of the general population with no specific or unusual distributions applicable in gender, age and physical or mental attributes.
State of Awareness	Visitors are expected to be awake and conscious of their surroundings at all times.
Familiarity - egress routes, group roles, training	This occupant group is generally expected to be unfamiliar with egress routes, have no particular group role except for immediate family/friends and have no emergency response training
Mobility	This occupant group is considered to have a similar level of mobility as the general population and will not require special assistance for evacuation. Some visitors may have mobility impairments that require wheel chairs, crutches or the like to evacuate on their own or with controlled assistance/managed evacuation from staff. Disabled egress is discussed further in Section 5.2.3.

5.2.3 Egress for Persons with a Mobility Impairment

The BCA DtS Provisions do not have any specific requirements for egress of persons with mobility impairment particularly if they are unable to use a stair. Although, there are a number of publications on this topic[5], a conclusive solution has not been agreed upon, or regulated.

Managing the evacuation of a person with mobility impairment from a building relies on individual building management systems, procedures and training, which are outside the scope of the BCA, but substantially contribute to the overall evacuation efficiency. The egress provided for people with mobility impairment in this building are to be at least equivalent to that of the BCA DtS Provisions. Therefore, mobility impaired access and independent mobility impaired egress has not been specifically addressed by this report. In this case, the office space may have some occupants with mobility impairment.

Notwithstanding the above, the implementation of an emergency evacuation plan for all occupants including persons with mobility impairment is recommended in accordance with AS 3745:2002. This is considered to reasonably address mobility impaired egress in relation to the fire safety strategy for this building.

[5] Australian Building Codes Board (ABCB) Building Access Outcomes Report, 1998.

6.0 Acceptance Criteria

The following acceptance criteria are considered appropriate for the fire engineering analysis that will be undertaken to assess the proposed Alternative Solutions against the relevant BCA Performance Requirements.

6.1 Alternative Solutions Acceptance Criteria

The acceptance criteria for the Alternate Solutions are detailed in Table 6-1 below.

Table 6-1 Acceptance Criteria

Index	Alternative Solutions	Acceptance Criteria
Alternative Solution #1	Building with rationalised smoke exhaust system	Warehouse The acceptance criterion for rationalisation of smoke exhaust in the warehouse is the Available Safe Egress Time (ASET) being greater than the Required Safe Egress Time (RSET). An ASET/RSET safety factor of at least 1.5 will be investigated for a sprinkler controlled fire based on tenability criteria in accordance with Section 6.2. Office The acceptance criterion is based on a comparative and qualitative assessment to demonstrate that the omission of smoke exhaust in the office space satisfies the performance requirements and it does not increase the risk to occupant life safety.
Alternative Solution #2 and #3	Extended travel distances, distance to point of choice, distance between exits and egress widths in the warehouse	The acceptance criterion is the Available Safe Egress Time (ASET) being greater than the Required Safe Egress Time (RSET) for the warehouse space. An ASET/RSET safety factor of at least 1.5 will be investigated for a sprinkler controlled fire based on tenability criteria in accordance with Section 6.2.
Alternative Solution #6	Fire hydrants	The acceptance criterion is the design meets the NSWFB operational requirements during intervention.
Alternative Solution #7	Hose reels	The acceptance criterion is the design is adequate for first aid fire fighting and allow occupant to retreat to the closest exit.
Alternative Solution #8	Automatic sprinkler system	The acceptance criterion is a sprinkler design that meets the BCA Performance requirements.
Alternative Solution #9	Exit Signage	The acceptance criterion is a building exit signage that provides satisfactory wayfinding to exits during occupant evacuation.

6.2 Design Tenability Criteria

6.2.1 Field Modelling

Computational Fluid Dynamic (CFD) modelling was undertaken using Fire Dynamic Simulator[6] (FDS) version 5.0. The software was developed by the building Fire Research Laboratory at National Institute of Standard and Technology[7] (NIST).

The FDS is a program specifically built to assess thermal driven fluid flow such as smoke produced by a fire. It numerically solves a form of the Navier-Stokes equations appropriate for low speed, thermally driven flow with an emphasis on smoke and heat transport from fire.

Table 6-2 Design tenability criteria for CFD modelling

Tenability Criteria	Description
Air/smoke temperature	• Air/smoke temperature reaches 183°C (approximately equal to 2.5 kW/m^2) consistently across the entire fire enclosure at any height; or • Significant pockets of air/smoke reaches 100°C in the vicinity of the egress path at a height of 2.1 m; or
Visibility	• Substantial accumulation of stagnant smoke is formed below 2.1 m in the vicinity of the egress path such that visibility is limited to less than 10 m (i.e. an optical density of 0.1 m^{-1}) or. • Substantial accumulation of stagnant smoke is formed below 2.1 m in the vicinity of the egress path such that visibility is limited to less than 5 m (i.e. an optical density of 0.2 m^{-1}), subject to CO and CO_2 concentration being maintained within tenable limits.
Carbon monoxide	• In the event that visibility falls below 10 m, carbon monoxide (CO) concentration exceeds 2700 ppm in the vicinity of the egress path at a height of 2.1 m or below.
Carbon dioxide	• In the event that visibility falls below 10 m, carbon dioxide (CO_2) concentration exceeds 7% in the vicinity of the egress path at a height of 2.1 m or below.

[6] McGrattan K.B et Al, Fire Dynamic Simulator-User Guide, NIST Special Publication 1019, NIST US, 2007.
[7] National Institute of Standard and Technology, Gaithersburg, MD, US.

6.3 Environmental and Loss Control Acceptance Criteria

Environmental and loss control acceptance criteria are outside the scope of this report and are not addressed herein.

6.4 Fire Brigade Tenability Criteria

Tenability criteria for Fire Brigade intervention are tabulated in Figure 6-1 below:

Figure 6-1 Fire Brigade tenability criteria [8]

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

[8] Government of Western Australia Fire & Emergency Services Authority, Guideline No: GL 15 – Fire Safety Engineered Alternative Building Solutions.

7.0 Hazard Identification & Literature Review

7.1 Dangerous Goods/ Hazardous Materials

Please refer to Section 4.7.

7.2 Fire Hazards

Table 7-1 tabulates potential ignition sources and fire hazards of significance that are likely to be encountered in this building.

Table 7-1 – Potential ignition sources and fire hazards.

Location	Ignition Sources & Fire Hazards	Mitigation Measures
Warehouse	**Major Ignition Sources** Electrical & mechanical equipment Repair & maintenance including hot works. Maintenance vehicles – Delivery trucks, forklift, scissor lifts Unauthorised smoking Arson **Major Fire Hazards** Mixed plastic commodity Truck wash and Maintenance Facility. Stored goods Aerosol and flammable liquids Miscellaneous packaging	House keeping Management-in-use procedures, safe work practices, e.g. hot work permit system Security measures Early warning via smoke detection system Staff intervention using manual suppression Fire Brigade intervention ESFR Sprinkler system Smoke Detection System Occupant Warning system Dangerous Goods Management
Office Space	**Major Ignition Sources** Electrical & mechanical equipment Repair & maintenance including hot works. Unauthorised smoking Arson **Major Fire Hazards** Office stations Stored goods Miscellaneous packaging	House keeping Management-in-use procedures, safe work practices, e.g. hot work permit system Security measures Early warning via smoke detection system Fast response sprinkler system Staff intervention using manual suppression Fire Brigade intervention Sprinkler system Dangerous Goods Management

8.0 Design Fire Scenarios

Based on the fire hazards identified in the previous section, the following fire scenarios were utilised to assess the proposed Alternative Solutions against the relevant BCA Performance Requirements. The fire scenarios represent severe credible cases to test the proposed Alternative Solutions based on the likelihood of the fire occurring and the potential consequences.

The determination of fire scenarios is a crucial step and the validity of the data obtained by analysis and the conclusions drawn in the fire engineering evaluation rely upon the appropriate selection of the design fires. The worst case fire scenarios have been identified below.

8.1 Arson

Arson has been shown statistically to contribute to fires in buildings. In this case, arson can occur during business hours when the building is occupied and in operation, or, after hours when the building is unoccupied. However, this is considered to be a low probability event as access to the plant is restricted to staff members and the site is monitored at all times.

Arson in this report will only be considered from an occupant life safety perspective in accordance with the BCA DtS Provisions. Accordingly, only incidents of minor forms of arson from a single ignition source are considered in this report in accordance with the Engineers Australia SFS Code of Practice[9]. In terms of fire severity, these minor forms of arson from a single ignition source are expected to be representative of the fire scenarios outlined below. However, major incidents of arson involving accelerants and/or multiple ignition sources are beyond the scope of this analysis and have not been addressed here.

8.2 Fuel Load

The fuel load within a compartment will influence the duration and severity of a fire. The effective fire load for the building has been estimated by considering typical goods to be stored in the building and their proposed configuration.

The total fuel load within the building is expected to be moderate as an average, as the expected usages of the various areas of the building are listed as having relatively moderate to moderately low fire loads in the International Fire Engineering Guidelines(IFEG)[10].

Typical fuel load that can be expected in the building are listed in Table 8-1. They are based on broad occupancy groupings according to Table 3.4.1b of the IFEG or by the sources and formulas provided in Section 3.4.1 of the IFEG.

Table 8-1 – Fire load densities[11]

Occupancy Type	Mean (MJ/m^2)	80 Percent Fractile (MJ/m^2)	95 Percent Fractile (MJ/m^2)
Offices	420	570	510
Manufacturing and storage[11] <150kg/m^{-2}	1180	1800	2690

[9] Engineers Australia (2003), Society of Fire Safety, Code of Practice for Fire Safety Design, Certification and Peer Review (2003). Available on www.sfs.au.com/publications.
[10] ABCB, "International Fire Engineering Guidelines", ABCB, Canberra, 2005
[11] Storage of combustible materials

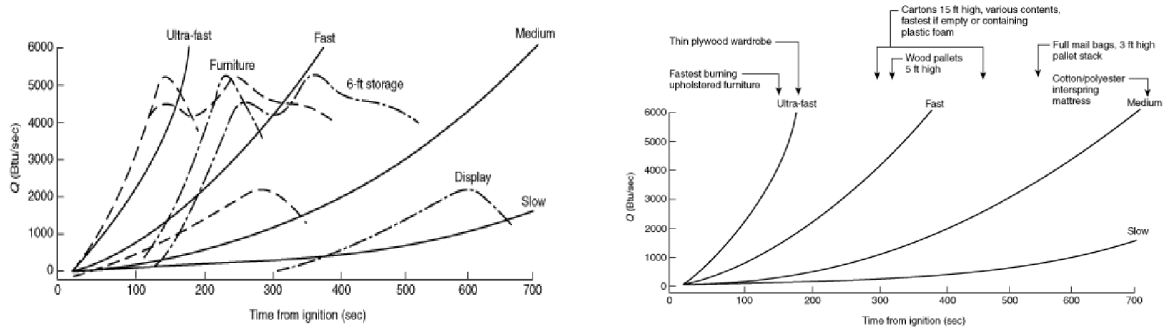
8.3 Fire Growth Rate and Intensity

Many areas of the building will have fire loads and materials that would have the potential to develop medium growth fires, such as furniture, and some areas would have the potential for fast growth rate fires, such as vertically oriented storage. Fuels that could cause ultra-fast fire growth, such as flammable liquids or large quantities of foam plastics, would be relatively unlikely in the building in sufficient quantities to result in unusually high fire hazards.

Most fires that do not involve flammable liquids, gases or lightweight combustibles such as polymeric foams grow relatively slowly. As the fire increases in size, the rate of fire growth accelerates. This rate of fire growth is generally expressed in terms of an energy release rate. For design purposes, an exponential or power-law rate of energy release is often used. This represents an upper limit to the large range of possible actual fire growths in the scenario. The most commonly used exponential relationship between time and heat release rate is the time-squared or t-squared fire, as published in the IFEG. In such a fire, the rate of heat release is given by the expression: $Q = Q_g (t / t_g)^2$ where *t* is time from ignition of the fire (seconds), t_g is the growth time (seconds) for the fire to reach a heat output of 1.055 MW, and Q_g is 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[12] provides information on the relevance of t-squared approximation to real fire as depicted in Figure 8-1



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

Figure 8-1 – NFPA 92B design fires and heat release rates.

Notwithstanding, American Society of Testing and Materials (ASTM)[13] suggests fire growth rates of 1.92kW/s^2 for mixed plastic commodity for six tier rack storage for polyethylene, polystyrene and PET products. For the purposes of this report and a high challenge comprising a Super Ultra-Fast growth rate will be considered.

8.4 Design Fire Scenarios

As mentioned in Section 4.4.1 the warehouse part of the building is proposed to be protected with a sprinkler system in accordance with FM Global Data Sheet 2-2 and AS2118.1:1999.

Fire scenarios coincident with sprinkler failure have not been considered due to the provision of a full onsite water supply tank and water supply via the ring main. However, the report will consider delayed sprinkler for sensitivity analysis. Notwithstanding, the site is proposed to be provided with Early Suppression Fast Response (ESFR)

[12] National Fire Protection Association Standard NFPA 92B, "Smoke Management Systems in Malls, Atria, and Large Areas", 2000.

[13] Hall J.R. ASTM's Role in performance-based fire codes and standards pp 53-54.

sprinkler system in accordance with FM Global Data Sheet 2-2 which is expected to suppress the fire. Sprinkler redundancy & reliability is discussed further in Section 8.5.

The following credible design fire scenarios will be utilised to assess the proposed Alternative Solutions in the building based on the hazards identified in Section 7.0.

8.4.1 Fire Scenario A

Based on the above discussion, Fire Scenario A is a super ultra-fast t^2 fire with growth rate of 1.92kW/s^2 a peak to simulate a full face rack fire in the Dick Smith Distribution Centre (ambient 20 ^oC). Alperts Correlation[14] has been used to determine the expected sprinkler activation time within the warehouse as shown in Figure 8-2.

Alperts Correlation

Key	Colour	Meaning
		Input Variable
		Result

Input data required	Value		Fire Type:	□ =
The ambient temperature of the room, T_∞ =		(^oC)	Ultrafast	0.178
Fire Category =	Custom		Fast	0.044
Output time step =	20	(s)	Medium	0.011
The distance of the detector from the fire, r =	1.5	(m)	Slow	0.003
The height of the ceiling above the fire, H =	13.7	(m)	Custom	1.92
The Response Time Index of the detector, RTI =	50	($m^{1/2}s^{1/2}$)		
Sprinkler density of discharge =	10	mm / min		
Detector activation temperature =	93	(^oC)		
Calculated quantities at detector activation				
The gas temperature at sprinkler activation, T =	121.54	(^oC)		
HRR at sprinkler activation =	10231.68	(kW)		
The gas velocity, U =	8.71	(m/s)		
Time at detector activation =	74	(s)		
Time to reach 10% of peak HRR =	265	(s)		
Ratio, r / H =	0.11			

5

Figure 8-2 Sprinkler controlled activation time and maximum sprinkler controlled heat release rate for warehouse

[14] Alpert R.L and Ward E.J.,"Evaluating Unsprinklered Fire Hazards", SFPE Technology Report 83-2, Society of Fire Protection Engineers, Boston, MA 1983

As per calculation shown in Figure 8-2, the heat release rate at time of activation is approximately 11 MW. Therefore the maximum HRR is increased to 11MW for Fire Scenario A. Table 8-2 summarises the input parameters for Fire Scenario A

Table 8-2 – Fire scenario A

Fire Scenario	Location	Design Fire	Comment
A	Rack	Peak heat release rate of 11 MW	• Sprinkler activation and control

8.4.2 Fire Scenario B (Sensitivity)

Fire Scenario B is a super ultra-fast t^2 fire with growth rate of 1.92kW/s^2 a peak to simulate a full face rack fire in the Dick Smith Distribution Centre (ambient 20 ^oC) with delayed sprinkler activation. Alperts Correlation has been used to determine the expected delayed sprinkler activation time (second row sprinkler based on 3 m x 3m spacing for High Hazard occupancies) within the warehouse as shown in Figure 8-3.

The other inputs to this sprinkler controlled scenario determined using Alperts Correlation, are as follows:

Alperts Correlation

Key	Colour	Meaning
		Input Variable
		Result

Input data required	Value		Fire Type:	=	
The ambient temperature of the room, T_∞ =		(^oC)	Ultrafast	0.178	5
Fire Category =	Custom		Fast	0.044	
Output time step =	20	(s)	Medium	0.011	
The distance of the detector from the fire, r =	6	(m)	Slow	0.003	
The height of the ceiling above the fire, H =	13.7	(m)	Custom	1.92	
The Response Time Index of the detector, RTI =	50	($m^{1/2}s^{1/2}$)			
Sprinkler density of discharge =	10	mm / min			
Detector activation temperature =	93	(^oC)			
Calculated quantities at detector activation					
The gas temperature at sprinkler activation, T =	118.01	(^oC)			
HRR at sprinkler activation =	23656.32	(kW)			
The gas velocity, U =	4.65	(m/s)			
Time at detector activation =	112	(s)			
Time to reach 10% of peak HRR =	303	(s)			
Ratio, r / H =	0.44				

Figure 8-3 Sprinkler controlled activation time and maximum sprinkler controlled heat release rate

As per calculation in Figure 8-3, the heat release rate at time of activation is approximately 24 MW. Therefore the maximum HRR of 24MW will be utilised as Fire Scenario B. Table 8-3 summarises the input parameters for Fire Scenario B.

Table 8-3– Fire scenario B

Fire Scenario	Location	Design Fire	Comment
B	Warehouse	Peak heat release rate of 24 MW	• Delayed sprinkler activation and control

8.5 Sprinkler Reliability & Redundancy

Sprinkler failure is considered to be a rare event as reported in literature for correctly designed, commissioned and maintained sprinkler systems.

The reliability of sprinkler systems in Australia and New Zealand has been reported to be relatively high. England and Young (1998)[15] estimated the reliability of automatic sprinkler systems to be approximately 95% based on Australian Fire Incident Statistics collected by the Australasian Fire Authorities Council for the period 1989/90 – 1993/94. They also reported that the fire size was too small to operate the sprinkler heads in 77% of the cases. This is consistent with data from the United States, where Deal (1993)[16] reported that insurers assume the reliability figure for sprinklers to be in the range of 92-97%. Moreover in the production warehouse, the reliability of the sprinkler system is further enhanced by the provision of FM Global compliant design to the sprinkler systems.

Water supply failure has been reported to be one of the main causes of sprinkler failure[17,18,19.] In this case the building is equipped with two full capacity storage tanks in accordance with FM Global Data Sheet. The FM Global compliant sprinkler system is expected to have a higher reliability than a BCA DtS compliant system. Nevertheless, the following measures are proposed in order to further improve the sprinkler reliability in this building:

- Independent individually monitored sprinkler stop-valves are to be provided. The valves are to be housed within a secure enclosure in accordance with Clause 3.4.2 of AS 2118.1:1999.
- Increase number of Value sets (numbers to be advised).
- The following management-in-use procedures are to implemented:
  a) Use of primarily one company for sprinkler isolations.
  b) Re-instatement of the system at the completion of work each day.
  c) An approval system in place which requires written permission from management before isolation can take place and a statement as to the length of isolation (which must generally be less than one day).
  d) A requirement for the contractor to sign-off after completion of the work.
  e) Penalties on contractors for failure to comply with the above.

[15] England, J.P. and Young, S. A., (1998) Fire Risk Management for Buildings with Aged Accommodation, Fire Australia Proceedings.
[16] Deal, S., Evaluating Small Board and Care Homes Sprinklered vs Non Sprinklered Fire Protection, 1993, NIST.
[17] Budnick, E.K. “Automatic sprinkler system reliability”, Fire Protection Engineering, Issue No. 9, Winter 2001.
[18] Mawhinney J.R. and Tamura G.T., “The Effect of Automatic Sprinkler Protection on Smoke Control Systems”, ASHRAE Transactions, Vol. 100, No. 1, pp. 494-513, 1994
[19] Marryatt, H.W., “Fire: A Century of Automatic Sprinkler Protection in Australia and New Zealand 1886-1986”, Australian Fire Protection Association, Melbourne, Australia, 1988.

f) Occupants and the Fire Brigade are to be notified if the sprinkler system is to be de-commissioned for maintenance works.

g) Other redundancies in the building design in the unlikely event of fire coincident with sprinkler failure includes: detection & occupant warning system, fire hydrants, fire extinguishers and fire brigade intervention.

9.0 Fire Engineering Assessment

9.1 Introduction

This section of the report contains the fire engineering analysis to assess the proposed Alternative Solutions identified in Section 4.1 against the relevant BCA Performance Requirements.

The fire analysis will consider the following sub-systems in accordance with the International Fire Engineering Guidelines to assess the proposed Alternative Solutions.

- Sub-system A – Fire initiation, development and control
- Sub-system B – Smoke development and spread and control
- Sub-system C – Fire spread and Impact and Control
- Sub-system D – Fire detection, warning and suppression
- Sub-system E – Occupant evacuation and control
- Sub-system F – Fire Brigade intervention

9.2 Alternative Solution – Rationalisation of Smoke Exhaust System

9.2.1 BCA DtS Provision

A large isolated building exceeding 18,000 m^2 in floor area or 108,000 m^3 in volume, and is protected throughout with a sprinkler system complying with Specification E1.5, and is provided with a perimeter vehicular access complying with C2.4 (b) and requires a smoke exhaust system in accordance with Specification E2.2b.

9.2.2 Variation to BCA DtS Provisions

It is proposed for the building to have a rationalised automatic smoke exhaust system incorporating smoke clearance system with one air change per hour.

9.2.3 Methodology

Qualitative and quantitative analysis based on BCA A0.5b(i), A0.9(b)(ii) 'acceptable Verification Methods' .
The verification methods include:

- An ASET/ RSET analysis for the Class 7b parts of the building to demonstrate occupant life safety prior to onset of untenable conditions.
- The acceptance criterion is ASET being greater than RSET with a 1.5 safety factor for the design cases and at least 1.0 for sensitivity analysis.
- A comparative analysis for the Class 5 part of the building to demonstrate equivalency to BCA DtS design.

9.2.4 Assessment

General

The subject building was treated as a 'Large-isolated Building' as it has a gross floor area of ~51,000 m^2. It is primarily used as high racking storage for electrical and Electronics goods.

The intent of BCA C2.3 which applies to this building is to grant concessions for large isolated buildings from the floor area and volume limitations. These concessions in turn require the provision of smoke hazard management in accordance with BCA Specification E2.2b.

The provision of smoke exhaust system in accordance with BCA Specification E2.2b is intended to minimise the impact of smoke risk to occupant evacuation. In this case, it is proposed that the building smoke clearance system is to be rationalised based on the actual fire load within the building and the provision of an Early Suppression Fast Response (ESFR) sprinkler system provided throughout the warehouse part of the building. It is also proposed that smoke exhaust system is not provided in the office. The smoke exhaust in the office is considered ineffective due to low ceiling height and the absence of a smoke reservoir for effective smoke exhaust operation.

ASET/RSET Analysis - Warehouse

Occupant life safety is time dependent, therefore an analysis on the time required to escape the building (RSET) compared to the time available until untenable conditions develop (ASET) has been carried out to assess the level of fire safety provided by the proposed design.

The International Fire Engineering Guidelines (IFEG, 2005)[11] states that an acceptable level of safety has been established in a fire safety system if:

ASET >RSET + Safety Margin

Where,

ASET is the available safe egress time (s)

RSET is the required safe egress time (s)

ASET/RSET analysis was based on the consideration of the lack of smoke hazard management and extended travel distance within the warehouse space. Computational Fluid Dynamics modelling using Fire Dynamics Simulator Version 5 (FDS) has been used to assess whether tenable conditions can be maintained during the evacuation period in the building.

The most severe travel distance as specified in BCA Consultant Report of 219 m on the Ground Floor was utilised to calculate the credible evacuation time (RSET) in the fire event. A comparison of ASET/RSET is tabulated in Table 9-1. Detailed calculations and modelling results are tabulated in Appendix A and B respectively.

Table 9-1- ASET/RSET comparisons

Design Fire Scenarios	Evacuation Scenarios	ASET	RSET	Safety Factor	Safety Margin
Scenario A (Design) 11MW Super Ultrafast Sprinkler Controlled Rack fire	From ground floor – 219 m (ASET at 2.1 m height)	1200 s	405 s	636 s	2.9
Scenario B (Sensitivity) 24 MW Super Ultrafast Delayed Sprinkler Controlled Rack Fire	From ground floor – 219 m (ASET at 2.1 m height)	1200 s	405 s	636 s	2.9

ASET was assessed at 2.1 m height above ground level. For all design cases, ASET are significantly greater than RSET with a safety factor of 1.5 are easily achieved on all of the scenarios being studied. It is also demonstrated that for Scenario B (sensitivity analysis), the safety factor of more than 1.0 are being achieved for both design cases.

Comparative Analysis – Office Space

It is also proposed that the office space within the building is not provided with smoke hazard management system. A comparative assessment has been undertaken for the Office to demonstrate an equivalent or better evacuation time from the office in comparison to a similar BCA DtS egress requirement.

Consequently the following parameters were utilised in the comparative assessment

- The occupant load is 65 persons as advised by client
- The minimum aggregate exit width as per BCA Clause D1.6(c) is 1.0 m. The aggregate exit width provided for the office space based on the referenced Architectural Drawing is 3.4 m as shown in Table 9-2
- Travel distance is based on BCA DtS Provisions of maximum 40 m for both cases.

The detection and pre-movement times were considered to be the same for both the BCA DtS case and the subject design for the office as shown by Table 9-2. The office will be provided with automatic smoke detection system in accordance to AS 1670.1:2004 with extended spacing in accordance to AS/NZS 1668.1. Therefore, the detection time and pre-movement time for both solutions is considered similar. A comparison analysis for both cases has been carried out as shown in Table 9-2.

Table 9-2 – Comparison of evacuation times from proposed office design and a BCA DtS compliant design.

Time	**BCA DtS Compliant Design**	**Proposed design**
No of People	65	65
Exit Width	1.0 m (As required by BCA Clause D1.6(c)	3.4 m (As shown on the drawing)
Travel Distance	40 m	40 m
Detection	60 s	60 s
Pre-movement time	60 s	60 s
Movement & Queuing time	167 s (See Appendix)	67 s (See Appendix)
Total egress time	287 s	187 s

To allow for persons with a disability a conservative travel speed of 0.6 m/s was utilised for the calculation of evacuation times. This was based on research findings that indicate that if walking aids are being used, the travel speed will be half that of a mobile person[20].

Based on the above parameters, the total evacuation time from the proposed office on north side of the building was calculated to be 187 s in comparison to 287 s calculated for a BCA DtS Solution, as shown by Table 9-2. The total egress time from the proposed design office was assessed to be better than BCA DtS Compliant.

Fire Brigade Intervention

The Fire Brigade Intervention Model (FBIM) developed by the Australian Fire Authorities Council (AFAC,1997)[21] was utilised to predict Fire Brigade intervention time in consultation with the NSWFB.

The subject building is located Cowpasture Road, Hoxton park, NSW. Horningsea fire station is identified as the adjacent first responding fire station which is located ~7.4 km from the building. Horningsea fire station located ~13.5 km from the site is considered as the second responding fire station.

The modelling showed that the Macquarie Field fire brigade are expected to arrive in 1013 s (~17 min) after notification and would apply water at 1813 s (~30 min) after notification. The Macquarie Field fire brigade are expected to arrive in 1848 s (~31 min) after notification and would apply water at 2648s (~44 min) after notification. Fire Brigade notification in this case is expected to occur upon activation of smoke detection system or sprinkler system that would be connected to an approved monitoring service. Detailed calculations are shown in Appendix C. The summary of Fire Brigade Intervention Modelling is tabulated as per Table 9-3 as below:

[21] Australasian Fire Authorities Council, Fire Brigade Intervention Model, Version 2.1, Nov 1997

Table 9-3 – Fire Brigade Intervention Modelling Summary.

Responding Stations	Arrival Time*	Time to apply water*
Horningsea Park Station	794 s (~13 min) after notification	1594 s (~27 min) after notification
Macquarie Field Station	1793 s (~30 min) after notification	2594s (~44 min) after notification

Based on the above, the tenability condition during NSWFB fire fighting operation was further investigated upon request from NSWFB. It was requested by NSWFB that the travel distance to an exit is limited to 80 m. FDS modelling was carried out up to 2400 s to assess the smoke layer height and visibility upon arrival of the first responding station (i.e. Horningsea Park).

It was observed in the FDS Modelling that the smoke layer temperature and building temperature across the building remains below 100^{o}C (< 2.5 KW/m^{2}) for at least up to 2400 s at the time the first responding Fire Brigade begin to start their operations. The building temperature is expected to remains below 100^{o}C during the entire operation as fire will be remained controlled by sprinkler or Fire Brigade. The tenability criteria discussed above are well below the Fire Brigade Acceptance Criteria. Details of FDS modelling result are shown in Appendix C.

Qualitative Risk Assessment

In addition, the proposed Alternative Solution for the building to be with rationalised smoke exhaust system within the warehouse and omitted in the office space was based on qualitative assessment based on literature review addressing the following considerations:

1. Sprinkler Provisions
2. Occupant Life Safety

Sprinkler Provisions

Warehouse areas

The main objective of a sprinkler system is to detect and control a fire with eventual extinguishment in some cases. To be effective the sprinkler system design must be appropriate to the fire hazard. The warehouse part of the building is proposed to be protected with ESFR sprinkler system. The ESFR was developed to achieve suppression of a fire in warehouse occupancy. The EFSR sprinkler system meets the fast response criteria and is listed for its capability to provide fire suppression of specific high challenge fire hazards (i.e. high rack storage). The system has great capability to suppress fire and was designed to work with only 12 sprinklers flowing mitigating the fire severity and reducing the needs for extensive fire brigade fire fighting operations.

Notwithstanding, the quantitative analysis discussed in the previous section, utilised design fires provide a satisfactory design in terms of occupant life safety and fire brigade intervention. Therefore it is considered that the proposed rationalised smoke exhaust capacity within the warehouse will not adversely impact the occupant evacuation and fire brigade intervention. It is concluded that rationalisation of smoke exhaust capacity is satisfactory in terms of meeting BCA Performance Requirements.

Office areas

Statistical data in Australia show that the fire risk for office premise is considerately low. The research considered the number of fire in office building and total area of office premise in Australia in 2007. This constitutes to frequency of fire occurring in office reported to be 0.0000219 average fires per year per square meter[22].

Furthermore, the subject office space comprises of open office layout with several cubicles (i.e. manager's offices and meeting room). The office is provided with automatic fire sprinkler system with fast response sprinkler heads. An analysis of statistical data has been used to identify the risk of fire spread beyond the room of fire origin (RFO) based on statistical data for fires in USA, between years 2002-2004. The percentage of fires which were confined to the room of fire origin, in sprinklered office is around than 90% of the cases as shown in Figure 9-1. Considering high reliability of sprinkler, 95 to 99% reported in Australia[23], we considered that in the event of fire in one of the cubicles, the fire and smoke will be confined to room of origin and to a state which will not be endangering occupants.

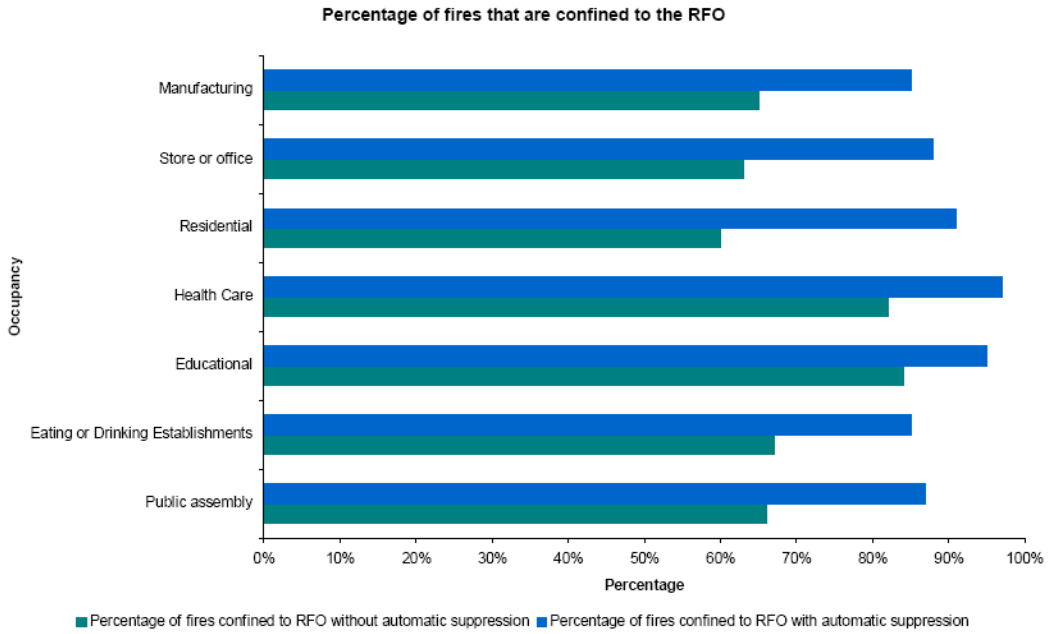


Figure 9-1– Percentage of fires that are confined in room of fire origin (RFO) in the USA between 2002-2004 [24]

Occupant Life Safety

The building is also equipped with an automatic smoke detector system in accordance with AS 1670.1-2004 with extended spacing as per AS/NZS 1668.1. The provision of automatic detection system is likely to provide early alarm and notification system, hence instigate early evacuation. Occupants in the building are expected to be awake, familiar with the layout and well drilled for fire drills with a clear authority figure.

With respect to the office areas, in the occasion of fire in the open office area, the office fit-out arrangement is fairly open for occupants to directly notice the fire and initiate evacuation or initial fire fighting. This is expected to decrease the evacuation time or mitigate fire spread to a state that might be endangering occupant life safety in the office.

In light of the above discussion, it is considered that the proposed Alternative Solution for rationalisation of smoke exhaust system in the warehouse areas and omission in office areas is satisfactory from a BCA Performance Requirement perspective.

[22] Modig, H. (2008), " Fire Statistics – A Preliminary Assessment" pp 52-55 Fire Australia- Autumn 2008
[23] Bukowski, R.W. et.al. (1999) " Estimates of the operational reliability of fire protection systems", Society of Fire Protection Engineers, Boston, MA, pp 87-98.
[24] Hall J.R., " U.S. Experience with sprinklers and other automatic fire extinguishing equipment, NFPA, Quincy, USA

9.2.5 Compliance with BCA Performance Requirements

The proposed Alternative Solution was assessed against the BCA Performance Requirements CP2 and EP2.2 as shown by tables below:

Table 9-4 - Assessment of compliance with BCA Performance Requirement CP2.

Parameter for Consideration	Discussion
CP2 – (a) A building must have elements which will, to the degree necessary, avoid the spread of fire-	
(i) to exits;	Spread of fire to exits was considered in relation to the proposed Alternative Solution as discussed in Section 9.2.4.
(ii) to *sole-occupancy units* and *public corridors;*	Not applicable to this building
(iii) between buildings;	Not applicable to this building
(iv) in a building.	Spread of fire in the building was considered in relation to the proposed Alternative Solution as discussed in Section 9.2.4.
(b) Avoidance of the spread of fire referred to in (a) must be appropriate to—	
(i) the function or use of the building;	The function or use of the building was considered in relation to the proposed Alternative Solution as discussed in Section 9.2.4.
(ii) the *fire load*;	The fire load was considered in relation to the proposed Alternative Solution as discussed in Section 9.2.4.
(iii) the potential *fire intensity*;	The potential fire intensity was considered in relation to the proposed Alternative Solution as discussed in Section 9.2.4.
(iv) the *fire hazard*;	The fire hazard was considered in relation to the proposed Alternative Solution as discussed in Section 9.2.4.
(v) the number of *storeys* in the building;	The number of storey in the building was considered in relation to the proposed Alternative Solution as discussed in Section 9.2.4.
(vi) its proximity to *other property*;	The proximity to other property was considered in relation to the proposed Alternative Solution as discussed in Section 9.2.4.
(vii) any active *fire safety systems* installed in the building;	The building is equipped with ESFR automatic sprinkler system which was considered in relation to the proposed Alternative Solution as discussed in Section 9.2.4.
(viii) the size of any *fire compartment*;	The size of any fire compartment was considered in relation to the proposed Alternative Solution as discussed in Section 9.2.4.
(ix) *fire brigade* intervention;	The fire brigade intervention was considered in relation to the proposed Alternative Solution as discussed in Section 9.2.4.and Appendix C.
(x) other elements they support;	Other elements were considered in relation to the proposed Alternative Solution as discussed in Section 9.2.4.
(xi) the *evacuation time*	The evacuation time was considered in relation to the proposed Alternative Solution as discussed in Section 9.2.4.

Table 9-5 - Assessment of compliance with BCA Performance Requirement EP2.2.

Parameter for consideration	Discussion
EP2.2 (a) In the event of a fire in a building the conditions in any evacuation route must be maintained for the period of time occupants take to evacuate the part of the building so that-	
(i) the temperature will not endanger human life; and	The temperature in the building was considered in relation to the proposed Alternative Solution, as discussed in Section 9.2.4 above.
(ii) the level of visibility will enable the evacuation route to be determined; and	The visibility level in the building was considered in relation to the proposed Alternative Solution, as discussed in Section 9.2.4 above.
(iii) the level of toxicity will not endanger human life.	The toxicity level in the building was considered in relation to the proposed Alternative Solution, as discussed in Section 9.2.4 above.
EP2.2 (b) The period of time occupants take to evacuate referred to in (a) must be appropriate to-	
(i) the number, mobility and other characteristics of the occupants; and	The number, mobility and other characteristics of occupants were considered in relation to the proposed Alternative Solution and found to be equivalent to a similar BCA DtS building, as discussed in Section 5.0 and Section 9.2.4.
(ii) the function or use of the building; and	The function or use of the building was considered in relation to the proposed Alternative Solution and found to be equivalent to a similar BCA DtS building, as discussed in Section 2.0 and Section 9.2.4.
(iii) the travel distance and other characteristics of the building; and	The travel distances and other building characteristics were considered in relation to the proposed Alternative Solution as discussed in Section 9.2.4 and Appendix A.
(iv) the fire load; and	The fire load in the building was considered in relation to the proposed Alternative Solution and found to be equivalent to a similar BCA DtS building, as discussed in Section 8.1.
(v) the potential fire intensity; and	The potential fire intensity was considered in relation to the proposed Alternative Solution and found to be equivalent to a similar BCA DtS building, as discussed in Section 8.0.
(vi) the fire hazard; and	The potential fire hazard in the building was considered in relation to the proposed Alternative Solution and found to be equivalent to a similar BCA DtS building, as discussed in Section 7.0
(vii) any active fire safety systems installed in the building; and	The impact of a sprinkler system in the building was considered when analysing the fire scenarios. To improve the sprinkler reliability and redundancies, measures have been proposed as discussed in Section 8.0.
(viii) fire brigade intervention.	Fire Brigade intervention was considered to be maintained, as discussed in Section 9.2.4 above and Appendix D.

9.2.6 Conclusion

The provision of BCA Performance Requirements CP2 and EP2.2 were assessed as appropriate to determine the consequences of the proposed Alternative Solution. Based on the above analysis and discussion, it is the considered opinion of AECOM that the proposed Alternate Solution is capable of meeting BCA Performance Requirements CP2 and EP2.2.

9.2.7 Works arising from the Alternative Solution

a) Travel distances are to be in accordance with Appendix A.
b) Occupant numbers and population are to be in ~~accordance~~ with Section 5.0 and Appendix B.
c) Extended smoke detection system shall be provided for early detection t~~ime~~ thro~~ughout the~~ building as per AS1670.1:2004.
d) An occupant warning system shall be provided throughout the building in accordance with the BCA DTS provisions and AS1670.1.
e) Emergency lighting and exit signage shall be provided in accordance with BCA DtS provisions and AS 2293-2005 and Section 4.4.7 of this report.
f) A Smoke proof w~~all is~~ to be provided between the office and warehouse space in accordance with BCA specification C2.5 Clause 3.
g) Post incident smoke clearance system with a capacity of one air change per hour and manual fire brigade controls shall be provided in the warehouse space as detailed in Section 4.4.2.
h) Designated exits from the building as indicated by Figure 9-2.

9.3 Alternative Solutions Nos. 2 and 3 – Means of Egress

9.3.1 BCA DtS Provision

BCA D1.4(c) (i) states that no point on a floor should be more than 20 m from an exit, or a point from which travel in different directions to exits is available, in which case the maximum distance to one of those exits must not exceed 40 m.

BCA D1.5(a)(iii) states that any exits that are required as alternative means of egress in Class 7b must be distributed as uniformly as practicable within or around the storey served and in positions where unobstructed access to at least 2 exits is readily available from all points on the floor including lift lobby areas and not more than 60m apart.

9.3.2 Variation to BCA DtS Solutions

Alternative Solutions are proposed for the means of egress identified in the following areas:

1) Travel distance of approximately 114 m to one of the exit from the ground level of the warehouse.
2) The distance between alternative exits at 219 m in the warehouse.

9.3.3 Methodology

The methodology for assessing the proposed Alternative Solution is a quantitative and qualitative analysis based on BCA A0.5b(i), A0.9(b)(ii) 'acceptable Verification Methods' . The verification method includes ASET/RSET analysis to demonstrate tenable condition can be maintained during occupant evacuation from the building.

The acceptance criterion is ASET to be more than RSET with 1.5 safety factor for the design fire scenarios.

9.3.4 Assessment

The intent of the BCA in relation to limiting travel distances is to maximise the safety of occupants and mitigating the risk of smoke exposure during occupant evacuation. The exits are also required to be separated adequately to provide access to an alternative exit in the event of one of the exits being unavailable.

The building understudy is a single storey warehouse for high racking storage as described in Section 2.0 of the report. The designated exits and travel distance from the building shown in Figure 9-2.

Figure 9-2 – Designated Egress layout.

Quantitative Analysis

A quantitative analysis using Available Safe Egress Time (ASET) versus Required Safe Egress Time (RSET) analysis has been carried out to assess whether tenable conditions can be maintained during the evacuation period in a fire event. The ASET/RSET analysis was used as the basis of the assessment. As already been discussed in Section 9.2.4, the ASET/RSET analysis provides satisfactory results with respect to occupant evacuation.

In light of the above, it is considered that the proposed Alternative Solution for the mean of egress within the building is satisfactory from a BCA Performance Requirement perspective.

9.3.5 Compliance with BCA Performance Requirements

The proposed Alternative Solution for means of egress was assessed against the BCA Performance Requirements DP4 and EP2.2, as shown by the tables below.

Table 9-6- Assessment of compliance with BCA Performance Requirement DP4.

Parameter for Consideration	Discussion
DP4 - Exits must be provided from a building to allow occupants to evacuate safely, with their number, location and dimensions being appropriate to-	
(a) the travel distance; and	The travel distance distances are to comply with BCA DtS Provisions. The travel distances were considered in relation to the proposed Alternative Solution as discussed in Section 9.3.4 and Appendix A.
(b) the number, mobility and other characteristics of occupants; and	The number, mobility and other characteristics of occupants were considered in relation to the proposed Alternative Solution and found to be equivalent to a similar BCA DtS building, as discussed in Section 5.0, Section 9.3.4 and Appendix A.
(c) the function or use of the building; and	The function or use of the building as a Class 7b facility was considered in relation to the proposed Alternative Solution and found to be equivalent to a similar BCA DtS building, as discussed in Section 2.0 and Section 9.3.4.
(d) the height of the building; and	The effective building height is less than 25 m. The building height was considered in relation to the proposed Alternative Solution, as discussed in Section 2.0 and Section 9.3.4.
(e) Whether the exit is from above or below ground level.	The locations of exits in this Alternative Solution are above ground level, as discussed in Section 1.1, Section 9.3.4 and Appendix A.

Table 9-7 Assessment of compliance with BCA Performance Requirement EP2.2

Parameter for consideration	Discussion
EP2.2 (a) In the event of a fire in a building the conditions in any evacuation route must be maintained for the period of time occupants take to evacuate the part of the building so that-	
(i) the temperature will not endanger human life; and	The temperature in the building was considered in relation to the proposed Alternative Solution, as discussed in Section 6.0, Section 9.3.4 and Appendix B.
(ii) the level of visibility will enable the evacuation route to be determined; and	The visibility level in the building was considered in relation to the proposed Alternative Solution, as discussed in Sections 6.0, Section 9.3.4 and Appendix B.
(iii) The level of toxicity will not endanger human life.	The toxicity level in the building was considered in relation to the proposed Alternative Solution, as discussed in Sections 6.0, Section 9.3.4, Appendix A and Appendix B.
(i) the number, mobility and other characteristics of the occupants; and	The number, mobility and other characteristics of occupants were considered in relation to the proposed Alternative Solution and found to be equivalent to a similar BCA DtS building, as discussed in Section 5.0 and Appendix A.

Parameter for consideration	Discussion
(ii) the function or use of the building; and	The function or use of the building as a Class 7b facility was considered in relation to the proposed Alternative Solution and found to be equivalent to a similar BCA DtS building, as discussed in Sections 2.0 and Section 9.3.4.
(iii) the travel distance and other characteristics of the building; and	The travel distances and other building characteristics were considered in relation to the proposed Alternative Solution as discussed in Section 4.1, Section 9.3.4 and Appendix A.
(iv) the fire load; and	The fire load in the building was considered in relation to the proposed Alternative Solution and found to be equivalent to a similar BCA DtS building, as discussed in Section 8.0 and Section 9.3.4
(v) the potential fire intensity; and	The potential fire intensity was considered in relation to the proposed Alternative Solution and found to be equivalent to a similar BCA DtS building, as discussed in Section 8.0 and Section 9.3.4
(vi) the fire hazard; and	The potential fire hazard in the building was considered in relation to the proposed Alternative Solution and found to be equivalent to a similar BCA DtS building, as discussed in Section 7.0 and Section 9.3.4
(vii) any active fire safety systems installed in the building; and	The impact of a active fire safety system in the building was considered when analysing the consequences of fire scenarios as discussed in Section 4.0 and Section 9.3.4
(viii) Fire brigade intervention.	Fire Brigade intervention was considered in relation to the proposed Alternative Solution, as discussed in Section Appendix C.

9.3.6 Conclusion

Each of the above provisions of DP4 and EP2.2 were assessed as appropriate to determine the consequences of the proposed Alternative Solution. Based on the above analysis and discussion, it is our considered opinion that the proposed Alternative Solution for means of egress satisfies the BCA Performance Requirements DP4 and EP2.2.

9.3.7 Works arising from the Alternative Solution

a) Occupant numbers and population in accordance with Section 5.0 and Appendix A.
b) Designated exits from the building as indicated by Figure 9-2.
c) Extended smoke detection system to be provided for early detection time as per AS1670.1:2004 throughout the facility.
d) An occupant warning system in accordance with the BCA DTS provisions and AS1670.1 shall be provided throughout.
e) Emergency lighting and exit signage shall be provided in accordance with BCA DtS provisions and AS 2293-2005 and Section 4.4.7 of this report.
f) Management-use-plans and emergency response plans are to be developed to address the fire risk mitigation measures identified in Section 7.0 of this report.

9.4 Alternative Solution No. 6 – Fire Hydrants

9.4.1 BCA DtS Provision

BCA E1.3 stipulates that fire hydrants in the building are required to comply with BCA E1.3 and AS 2419.1 in relation to performance, location and coverage.

9.4.2 Variation to BCA DtS Provisions

An Alternative Solution is proposed for the hydrants under the canopies along the receiving and delivery docks at eastern and northern sides of the building will be considered as external hydrants.

9.4.3 Methodology

The methodology that was used for the assessment is a qualitative analysis based on BCA A0.5b (ii), A0.9 (b) (ii)'Acceptable Verification Methods'. The verification method includes a qualitative assessment to demonstrate the adequacy of the fire hydrant system to meet NSWFB operational requirements during intervention.

9.4.4 Assessment

Figure 9-3 shows the external fire hydrants located underneath the canopy on Grids Y07,X09, Grids Y07, X14, Grids Y07, X17, Grids Y02-Y03,X24 and Grids Y03-Y04,X24 in Fire Services drawing FS210 which is the subject of the assessment. The coverage is to comply with AS 2419.1.

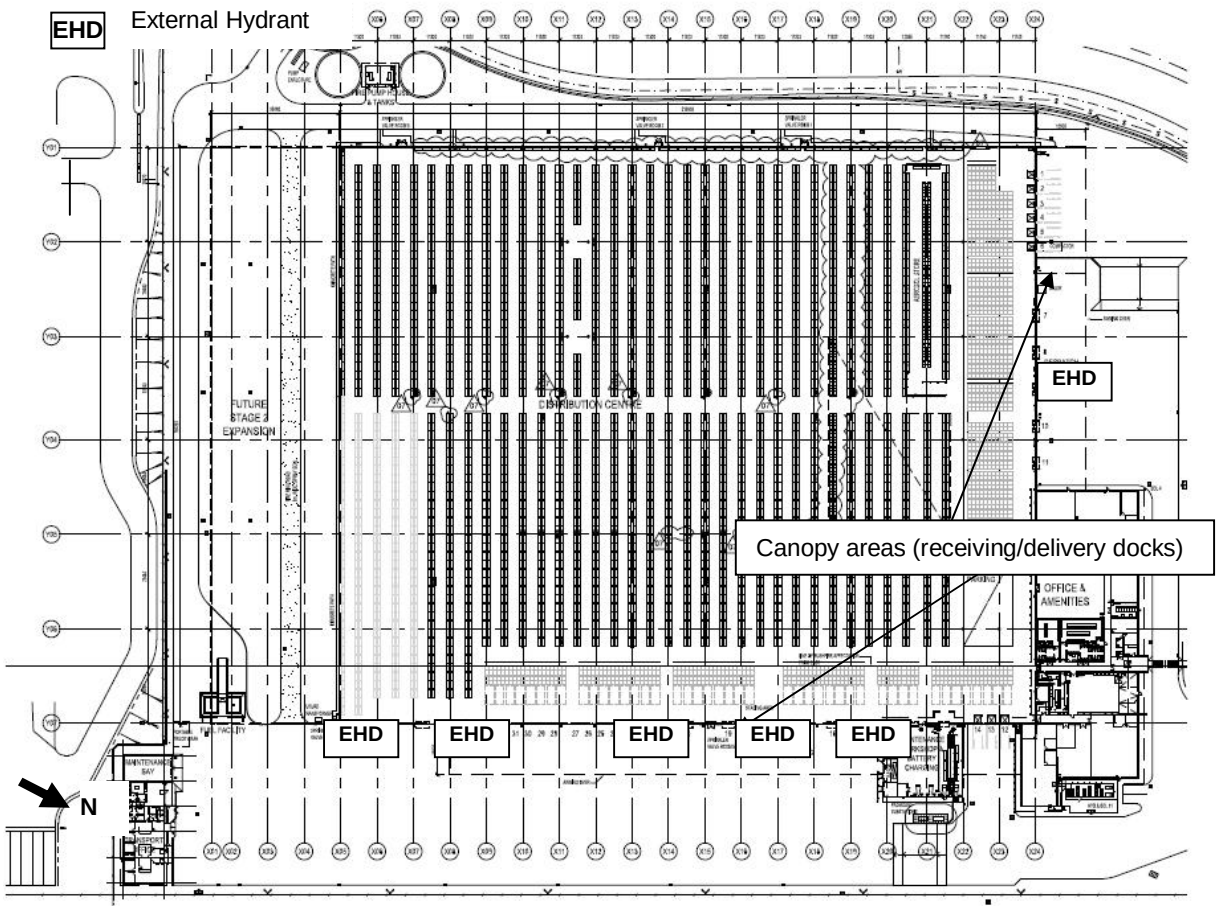


Figure 9-3– Fire hydrant locations and coverage

BCA E1.3 and AS 2419.1:2005 requires all points on the floor to be within reach of a 10 m hose stream issuing from a nozzle at the end of a 30 m hose length for internal hydrants and 60 m hose length (i.e. 2 x 30 m hose lengths) for external hydrants. However, in this case, there are several external hydrants are located underneath the canopy areas which are considered by the NSWFB to be as internal hydrants.

Qualitative Risk Assessment

Accordingly, the alternative solution is proposed for the hydrants under the canopies on the eastern and northern sides of the building to be treated as external hydrants based on the following measures that are expected to assist in fire brigade intervention:

a) The canopy for receiving dock is open type and has adequate cross ventilation which is expected to significantly reduce the hazard from fire and smoke.

b) Early Suppression Fast Response (ESFR) sprinkler in the main warehouse space and quick response sprinkler throughout canopy/dock areas to limit fire severity.

c) Radiant heat shields are to be provided at all hydrant points in accordance with AS2419.1:2005.

With reference to Section 7.0 of this report, a qualitative risk assessment of potential ignition sources and fire hazards was undertaken to develop credible design fire scenarios. Several risk mitigation measures were also identified, which are to be implemented as per the management-in-use plan for this facility.

The canopy areas of the building will be utilised as receiving and delivery docks. The areas are likely to contain trucks, stacked pallets, forklift and mixed plastic commodity (i.e. electronics goods etc). An automatic sprinkler system with quick response sprinkler head is proposed throughout the canopy areas. The provision of sprinkler system is expected to limit the fire development and temperature across the areas to inhibit failure to canopy areas structural member. An ESFR sprinkler system provided throughout the warehouse also expected to reduce the fire severity as discussed in Section 9.2.4.

In addition, all the hydrants underneath canopy areas are required to be provided with compliant radiant heat shield to protect fire personnel from a fire in the warehouse area.

It was also noted that the booster is located adjacent to Fire Pump House and Water tank at the south west side of the building as shown in Figure 9-4. This varies from the AS 2419.1:2005 Clause 7.3(d) that requires the Booster Assembly to be visible from the point of entry by the NSWFB.

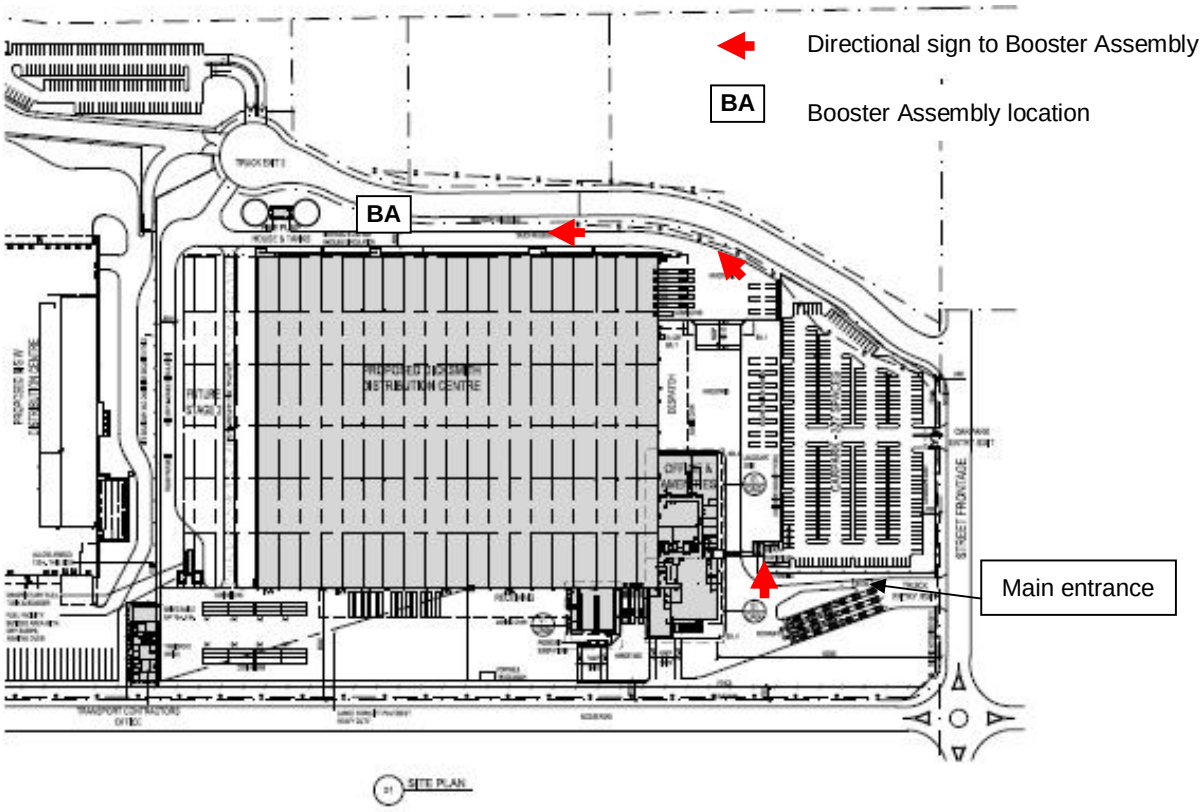


Figure 9-4 Site plan showing booster location

Accordingly, appropriate directional signage showing the Booster Assembly location are to be provided at appropriate location on the perimeter vehicular access.

Based on the above, it is our considered opinion that the proposed Alternative Solution in relation to hydrant system meets the BCA Performance Requirements as it satisfies the operational requirements of the NSWFB.

9.4.5 Compliance with BCA Performance Requirements

The proposed Alternative Solution for the fire hydrant system was assessed against the BCA Performance Requirements EP1.3, as shown by the table below.

Table 9-8-Assessment of compliance with BCA Performance Requirement EP1.3.

Parameter for Consideration	Discussion
EP1.3 - A fire hydrant system must be provided to the degree necessary to facilitate the needs of the fire brigade appropriate to	
(a) fire-fighting operations; and	Fire fighting operations were considered in relation to proposed Alternative Solution, as discussed in Section 9.3.4.
(b) the *floor area* of the building; and	The floor area of the building is to comply with BCA DtS Provisions and was considered in relation to the proposed Alternative Solution, as discussed in Section 9.3.4.

Parameter for Consideration	Discussion
(c) fire hazard	The fire hazard in the building was considered in relation to the proposed Alternative Solution and found to be equivalent to a similar BCA DtS building, as discussed in Sections Section 9.3.4.

9.4.6 Schedule of works arising from the Alternative Solution

a) External fire hydrants including those underneath the canopy areas at the northern and eastern sides of the building are to be provided with compliant radiant heat shields in accordance with AS 2419.1:2005.

b) The fire hydrant system is to be in accordance with BCA E1.3 and AS 2419.1:2005.

c) Internal fire hydrants are to be provided with compliant coverage in accordance with AS 2419.1:2005

d) A ring main system is proposed relative to the perimeter vehicular access around the building.

e) Appropriate directional signage showing the Booster Assembly location are to be provided at appropriate location on the perimeter vehicular access.

f) Appropriate signage as per AS 2419.1:2005 is to be provided on the hydrant block plan at the main FIP and at the Booster Assembly

i) A common water supply for sprinkler and hydrant system is proposed for the site with 4 hours storage for hydrants as per AS2419 and sprinkler duration as per FM Global Data Sheets.

j) The fire hydrants are to be provided with dual valve controlled outlets complying with AS2419.1:2005.

k) The couplings in the hydrant system are to be compatible with fire appliances and equipment used by NSWFB (i.e. Storz aluminium alloy delivery couplings manufactured and installed in accordance with Clause 7.1 and 8.5.11.1 of AS 2419.1:2005.

9.5 Alternative Solution No. 7 – Fire Hose Reel

9.5.1 BCA DtS Provision

BCA E1.4 requires all points on the floor to be within reach of a 36 m fire hose length.

9.5.2 Variation to BCA DtS Provisions

The fire hose reels system within the warehouse will be provided with 50 m hose length.

9.5.3 Methodology

Quantitative analysis based on BCA A0.5b (i), A0.9 (b) (ii) 'acceptable Verification Methods and referral to the NSW Fire Brigades'.

The acceptance criterion is a building design that meets BCA Performance Requirements and operational requirements of the NSW Fire Brigades.

9.5.4 Assessment

The intent of the BCA 1.4 in relation to fire hose reel coverage is based on enabling occupants, where appropriate, the opportunity to undertake initial fire fighting activities. The BCA requires all points on the floor to be within reach of a 36 m fire hose length. The fire hose reels in the warehouse do not provide a reach of a 36 m fire hose length due to the racking layout in the warehouse space. It is proposed that 50 m fire hose length be provided within the warehouse.

Fire hose reels are essentially a first aid fire-fighting tool for use by occupants to fight a fire in its early stages. The intent of BCA E1.4 in relation to fire hose reel location is based on enabling occupants, where appropriate, the opportunity to undertake initial fire fighting activities.

BCA E1.4 restricts fire hose reel lengths to 36 m to allow a trained person to easily handle a fire hose and to minimise the retreating distance that an occupant has to travel to within 40 m. In this case, the fire hose reel under review has a 50 m hose length to provide coverage to the warehouse. The 50 m hose reel will have a similar water jet length (~ 4m) as per a compliant hose reel length. The additional hose length would be marginally heavier than a compliant hose reel. However, those reel handling is expected to be relatively similar to 36 m hose length and expected to be used only by trained occupants in the building.

In addition to the above, all staff is required to be trained in "Emergency Control Procedures in accordance with AS 3745:2002" as recommended in Section 4.5 for initial attack on a fire when safe to do so using portable fire extinguishers or evacuate the building immediately. Also, as discussed in the Section 9.2.4, the provision of ESFR sprinkler will likely suppress the fire or at least minimise the likelihood of a fire to develop to a severe condition.

Also, as discussed in Section 9.2.4 and 9.3.4, the tenability across the warehouse is maintained for a long period, at least 1200 s with safety factor of 1.5 for ASET/RSET analysis being achieved. As such, it is considered the extension of hose length would not adversely affect occupant wayfinding during first aid fire fighting or evacuation.

In summary, in our considered opinion, the variation to hose reels length is unlikely to adversely impact on occupant life safety in the warehouse due to the following considerations:

- The building is sprinkler protected with ESFR sprinkler system which has the high reliability in suppressing fire.
- First aid fire fighting can be achieved with the fire extinguishers, where readily accessible by staff.

- It is also recommended that emergency response procedures and staff training in accordance with AS 3745:2002 be developed and implemented for this building. This should include the using of portable fire extinguishers and/or fire hose reels when safe to do so by occupants who have been trained in the use of 50 m fire hose length. Occupants who have not been trained to use fire extinguishers and/or fire hose reels should evacuate the building immediately and notify the Fire Brigades.

In light of the above, it is our considered opinion that the proposed Alternative Solution in relation to fire hose reel is satisfactory in term of occupant life safety and meets the BCA Performance Requirements.

9.5.5 Compliance with BCA Performance Requirements

The proposed Alternative Solution to provide portable extinguishers with three lengths of hydrant hose (90m total hose) were assessed against the BCA Performance Requirement EP1.1 as shown by the table below.

Table 9-9 - Assessment of compliance with BCA Performance Requirement EP1.1

Parameter for Consideration	Discussion
EP1.1 - A fire hose reel system must be installed to the degree necessary to allow occupants to safely undertake initial attack on a fire appropriate to-	
(a) the size of the fire compartment; and	The size of the subject fire compartment was considered in relation to the proposed Alternative Solution, as discussed in Section 2.0 and Section 9.5.4.
(b) the function or use of the building; and	The function or use of the building as a Class 5 and Class 7b warehouse was considered in relation to the proposed Alternative Solution and found to be equivalent to a similar BCA DtS building, as discussed in Section 9.5.4.
(c) any other fire safety systems installed in the building; and	The impact of active safety systems present in the building was considered in relation to the proposed Alternative Solution, as discussed in Section 9.5.4.
(d) the fire hazard.	The potential fire hazard in the building was considered in relation to the proposed Alternative Solution and found to be equivalent to a similar BCA DtS building, as discussed in Section 7.0and Section 9.5.4.

9.5.6 Conclusion

Each of the above provision of EP1.1 was assessed as appropriate to determine the consequences of the proposed Alternative Solution. Based on the above analysis and discussion, it is our considered opinion that the proposed Alternative Solution satisfies the BCA Performance Requirement EP1.1.

9.5.7 Schedule of works arising from the Alternative Solution

(a) Fire Hose reels with 50 m hose length will be provided in the warehouse.
(b) Portable fire extinguishers shall be provided throughout the building in accordance with BCA E1.6 and AS 2444:2001.
(c) Appropriate signage indicating 50 m hose length and necessary fire fighting procedures are to be provided at all fire hose reel locations.
(d) All staff shall be trained in “Emergency Control Procedures in accordance with AS 3745:2002” in the event of fire emergency.

9.6 Alternative Solution No. 8 – Automatic Sprinkler System

9.6.1 BCA DtS Provision

BCA Clause E1.5 stipulates that a required sprinkler system in a building to comply with BCA Specification E1.5, which in turn refers to AS 2118.1:1999 in relation to performance, location and coverage.

9.6.2 Variation to BCA DtS Provisions

An Alternative Solution is proposed to utilise an FM Global compliant sprinkler system in lieu of AS2118.1:1999 sprinkler system.

9.6.3 Methodology

The methodology that was used for the assessment is a qualitative analysis based on BCA A0.5b (i) and A0.9(c) 'Comparison to DtS Provisions' as well as referral to the NSWFB.

The verification method will consist of a comparative approach to show that the Alternative Solution for utilising a FM Global compliant sprinkler system is equivalent or better than a DtS Provision, based on the FM Global Data Sheet 2-2 that requires a higher requirement and more reliable water supply provisions in comparison to AS 2118.1:1999.

9.6.4 Assessment

The sprinkler arrangement in accordance with FM Global Data Sheet FM Global Data Sheet 2-2 "Installation Guidelines for Automatic Sprinkler" and Data Sheet 8-9 "Storage of Class 1, 2, 3, 4 and Plastic Commodities" arrangement is permitted under the Clause 2.3.3.2 of AS 2118.1. The

Industry opinion is that FM Global requirements are above the requirements of AS2118.1 based on the following:

- FM Global Data Sheets are supported by full scale testing. Also, FM Global has the largest research and development facility for fire and is a leader in advances in fire protection. They have developed Data Sheets (standards) are for a large range of storages, hazards and processes. The latest version of AS2118:2006 which has not been referenced in the BCA includes many of the hazard and storage solution in the FM Global Data Sheets.
- AS 2118 has historically relied on information from British Standards, however it has recently been following the American NFPA codes.
- AS 2118.1 is not written specifically for multi row rack installations and warehouse storage, however FM Global Data Sheet 8-9 is dedicated to warehouse type storage and specifically addresses multi-row racks.
- One of the main advantages of FM Data Sheet 8-9 over AS2118.1 is the use of face sprinklers. Face sprinklers are located on the aisle side of the storage (to complement sprinklers in the rack flue spaces). These face sprinklers are designed to stop fire spread up the vertical face of the pallets. Under AS2118 these aisle spaces are not protected by the in-rack systems and rely on the roof sprinklers.
- The system does not require any additional maintenance from AS1851 and does not add complexity to the maintenance routines. FM Global sprinkler systems are designed to control or suppress a fire and generally exceed the AS2118.1 requirements.
- The sprinkler system is to be provided with two pumps, one in accordance with FM Global requirements, while the other is to be in accordance with AS 2118.1 requirements in addition to a full on site water storage split between 2 tanks to increase the reliability of the system.

In light of the above, it is our considered opinion that the proposed Alternative Solution in relation to automatic fire sprinkler system meets the BCA Performance Requirements.

9.6.5 Compliance with BCA Performance Requirements

The proposed Alternative Solution for the automatic fire sprinkler system was assessed against the BCA Performance Requirements EP1.4, as shown by the tables below.

Table 9-10 -Assessment of compliance with BCA Performance Requirement EP1.4.

Parameter for Consideration	Discussion
EP1.4 – An automatic fire suppression system must be installed to the degree necessary to control the development and spread of fire appropriate to-	
(a) the size of the *fire compartment*;	The size of the fire compartment was considered in relation to proposed Alternative Solution, as discussed in Section 9.6.4.
(b) the function or use of the building;	The function and use of the building was considered in relation to the proposed Alternative Solution, as discussed in Section 9.6.4.
(c) fire hazard	The fire hazard in the building was considered in relation to the proposed Alternative Solution and found to be equivalent to a similar BCA DtS building, as discussed in Section 9.6.4.
(d) the height of the building	The height of the building was considered in relation to the proposed Alternative Solution, as discussed in Section 9.6.4.

9.6.6 Conclusion

Each of the above provisions of EP1.4 was assessed as appropriate to determine the consequences of the proposed Alternative Solution. Based on the above analysis and discussion, it is our considered opinion that the proposed Alternative Solution satisfies the BCA Performance Requirements EP1.4.

9.6.7 Works arising from the Alternative Solution

(a) The Early Suppression Fast Response sprinkler system within the warehouse is to be in accordance with FM Global Data Sheet 2-2 and AS 2118.1:1999. Detail requirements are as per Section 4.4.1.

9.7 Alternative Solution No. 9 – Exit Signage

9.7.1 BCA DtS Provision

BCA Clause E4.8(a) states that every required exit sign must comply with AS 2293.1 and be clearly visible at all times when the building is occupied by any person having the right of legal entry to the building.

9.7.2 Variation to BCA DtS Provisions

Several exit signs within the aisles are to be mounted at 5 m height above the floor level in lieu of maximum 2.7 m required by AS 2293.1 to allow for forklift passage.

9.7.3 Methodology

Qualitative analysis based on BCA A0.5b (i), A0.9 (b) (ii) 'acceptable Verification Methods'.

The acceptance criterion is the signage system provides satisfactory directional performance and visibility during occupant evacuation.

9.7.4 Assessment

AS 2293.1 Section 6, Clause 6.8.1 states that exit signs shall be mounted not less than 2 m and not more than 2.7 m above floor level. The intent of the above requirements is that each exit sign is within the field of view of a person within the applicable viewing distance and looking at the relevant door or along the relevant exit path.

However, due to the passage of forklift in certain part of the warehouse, several exit signs are proposed at height of 5.0 m above the floor level in lieu of 2.7 m to avoid interference with the forklifts as shown in Figure 9-5. As such, the jumbo signs with 200 mm high lettering visible from a distance of 32 m are proposed in accordance with Table 9-11 or the equation in Clause 6.6(b) as applicable are proposed.

Table 9-11 – Minimum Pictorial Element Height [25]

Maximum viewing distance (m)	Minimum pictorial element height (mm)
16	100
24	150
32	200

In this case it is proposed to increase the maximum viewing distance to 48 m. This is based on FAMCO Jumbo Exit Sign specification sheet as attached in Appendix E.

In addition, FDS modelling result was referred to assess the visibility of the directional signage mounted at 5 m height. It is demonstrated that visibility is maintained at average 30 m at 5 m height, at least until evacuation has completed as shown in Figure 9-6.

[25] Australian Standard, Emergency escape lighting and exit signs for buildings Part 1: System design, installation and operation, Clause 6.

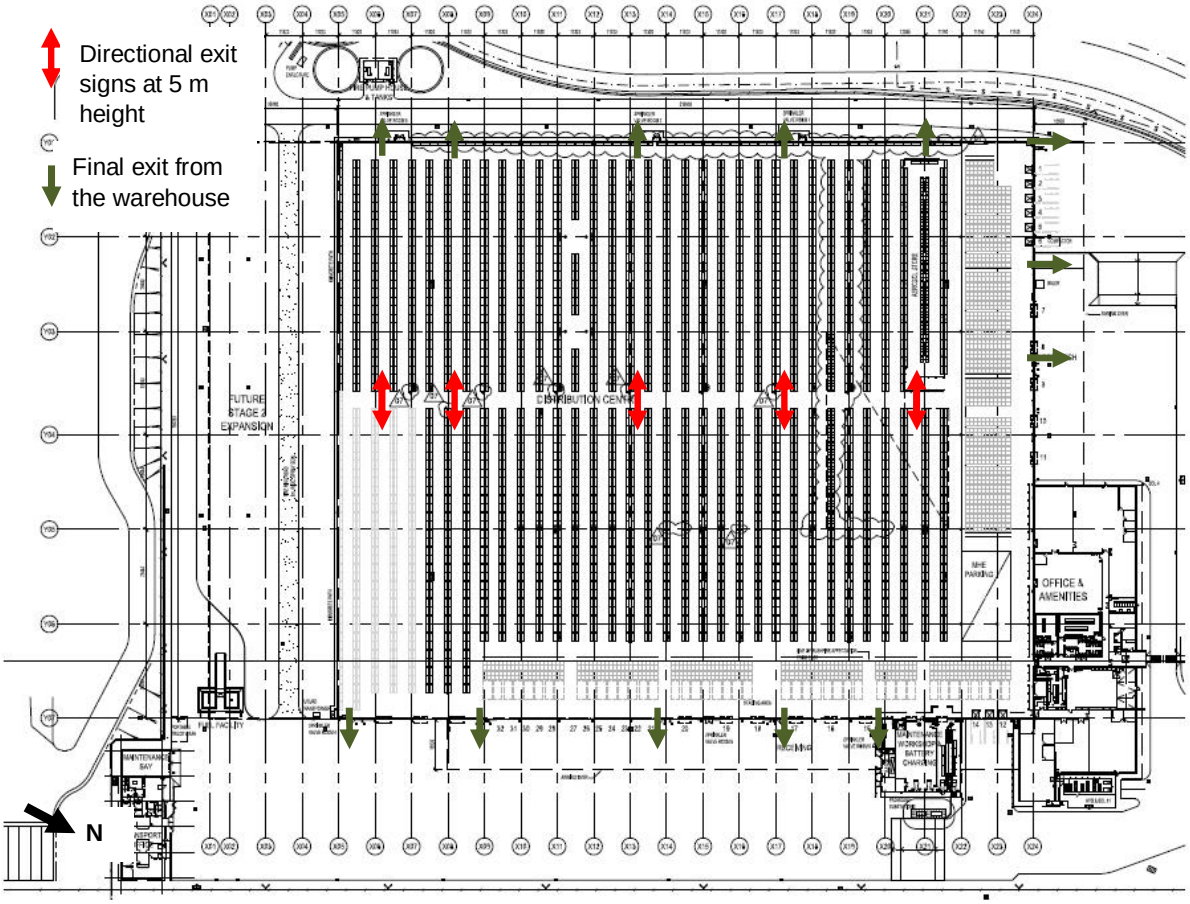


Figure 9-5 Proposed directional exit sign locations.

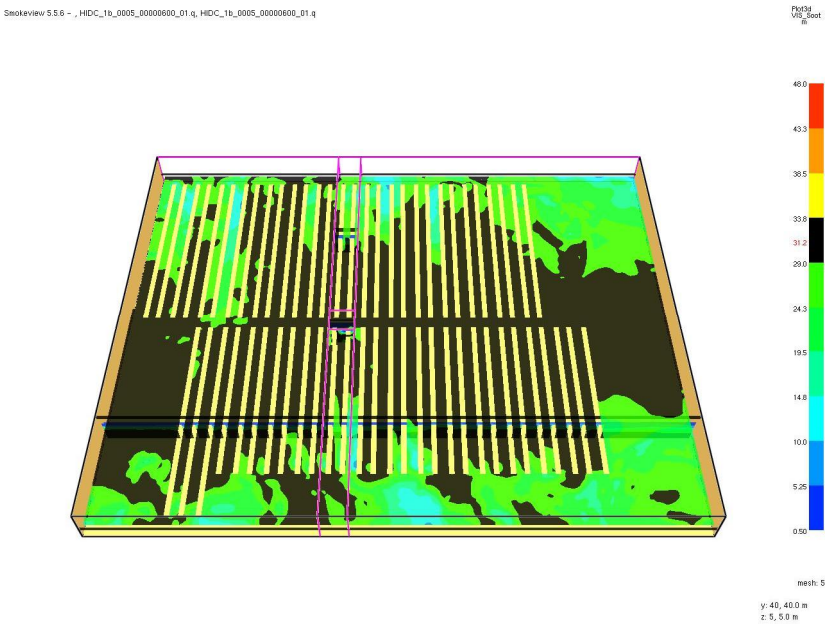


Figure 9-6 – Average visibility of 30 m at 5 m at 600 s. Evacuation completed at 410 s

In light of the above discussion, we considered the proposed Alternative Solution is satisfactory from the occupant life safety perspective.

9.7.5 Compliance with BCA Performance Requirements

The proposed Alternative Solution for the fire rating was assessed against the BCA Performance Requirements EP4.2, as shown by the tables below.

Table 9-12 -Assessment of compliance with BCA Performance Requirement EP4.2.

Parameter for Consideration	Discussion
EP4.2 – To facilitate evacuation, suitable signs or other means of identification must, to the degree necessary	
(a) be provided to identify location of exits	The signs are provided and considered to be at least equivalent to BCA DtS provision. This is discussed in Section 9.7.4.
(b) guide occupants to exit	The signs are design in accordance with BCA DtS provision with the exception of its height. In relation to giving guide to the occupants to exit, the proposed signs are considered to be at least equivalent to the BCA DtS performance. This is discussed in Section 9.7.4.
(c) be clearly visible to occupants	The visibility to the signs is considered at least equivalent to that of DtS design. The visibility toward the signs is found to be satisfactory. This is discussed in Section 9.7.4.
(d) Operate in the event of a power failure of the main lighting system for sufficient time for occupants to safely evacuate.	The proposed signs in terms of operation during power failure are in accordance with BCA DtS provision. Therefore the level of performance is at least equivalent to DtS design. This is discussed in Section 9.7.4.

9.7.6 Conclusion

Each of the above provisions of EP4.2 was assessed as appropriate to determine the consequences of the proposed Alternative Solution. Based on the above analysis and discussion, it is our considered opinion that the proposed Alternative Solution satisfies the BCA Performance Requirement EP4.2.

9.7.7 Schedule of works arising from the Alternative Solution

a) The exit signs mounted at 5 m above the floor level are to be of jumbo signs with minimum 200 mm height lettering.

b) The jumbo directional exit signs in the intermediate aisles are to be provided at maximum 30 m intervals.

c) The jumbo directional exit signs in the intermediate aisles in the warehouse are to be double sided with directional signs on both sides.

d) The exit signs above the exit doors shall be provided in accordance with AS2293.1:2005.

10.0 Reference Information

10.1 Contractual Framework

The design team will be responsible for developing the designs to tender documentation so the client can obtain market pricing and engage a building and trade subcontractor to carry out the construction of the facility.

10.2 Regulatory Framework

The variations from BCA DtS Provisions that have been identified by the Certifying Authority, Phillip Chun are outlined in Section 4.1. The Client has appointed AECOM to address these BCA DtS variations as proposed Alternative Solutions in accordance with the methodology set out in the BCA to meet relevant BCA Performance Requirements.

10.3 Reference Legislation

This assessment is based on the following reference legislation:

a) NSW Environmental Planning and Assessment Act, 1979.

b) NSW Environmental Planning and Assessment Regulation, 2000.

c) Building Code of Australia 2008, Australian Building Codes Board, 2009.

10.3.1 Reference Codes & Guidelines

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

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

b) Guide to the BCA, Australian Building Codes Board, 2009.

c) Engineers Australia, Society of Fire Safety, Code of Practice for Fire Safety Design, Certification and Peer Review, 2003, available on www.sfs.au.com/publications.

10.4 Documentation Considered

This assessment is based on the following documentation:.

a) Minutes of Meeting - FEB meeting held on the 24th March 2010 with the NSWFB brigade.

b) Fire Engineering Brief Ref DSE-FEB-Rev3 dated 20 April 2010 by AECOM.

c) BCA Audit Report Ref 09366 DSE R01 Draft dated 26 November 2009 by Phillip Chun.

d) Pre Part 3A BCA Review for Part 3A Submission Ref 10026R02 dated 16 February 2010 by Phillip Chun.

e) BCA Report Ref 10026R03 Rev 3 dated 11 May 2010.

f) Assessment Notes – BCA 2010 Review dated 28 September 2010 by Philip Chun.

g) Fire Engineering Report Ref DSE-FER-Rev1 dated 17 June 2010 by AECOM.

h) Fire Engineering Report Ref DSE-FER-Rev2 dated 15 October 2010 by AECOM.

i) AECOM Letter – Confirmation for Construction Certificate dated 1 July 2010.

j) AECOM Letter – Confirmation for Construction Certificate dated 16 July 2010.

k) NSWFB Letter- FER IFSR Comments dated 6 October 2010.

l) AECOM Letter to NSWFB – Responding to NSWFB FER Comments dated 11 November 2010.

m) Architectural and services drawings as shown in Table 10-1.

Table 10-1 – Architectural drawings.

Drawing No.	Title	Date	Revision	By
AR100	Master Site Plan	12 Feb 2010	C	MNIA
AR210	Master Floor Plan	7 Dec 2009	7	MNIA
AR260	Elevation Sheets 1	12 Feb 2010	B	MNIA
AR261	Elevation Sheets 1	12 Feb 2010	B	MNIA

11.0 Validity & Limitations

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

a) The report is limited to the assessment of Alternative Solutions for the BCA DtS variations identified in Section 4.1 of this report for compliance with relevant BCA Performance Requirements. With the exception of these Alternative Solutions, all other fire safety aspects of the building are to comply with the BCA DtS Provisions.

b) This assessment deals with the fire safety provisions of the BCA only and does not consider amenity or non-fire related matters in the building such as health, amenity, security, energy efficiency, occupational health & safety, compliance with Disability Discrimination Act (DDA) etc, which are to be addressed by others. Consequently, the outcomes of this assessment have not been checked or verified for their fitness for purpose for any non-fire safety related matters including the ones outlined above.

c) This assessment is not a full compliance or conformance audit for any fire safety system. Therefore, operational checks of fire safety equipment, verification of construction techniques, fire resistance levels or the witnessing of fire drills or exercises are specifically excluded from the scope of this assessment. The operational status of systems, items of equipment and staff training should be addressed as part of the inspection, commissioning, enforcement, maintenance, testing, training and management procedures for the building.

d) This assessment will be consistent with the objectives and limitations of the BCA and therefore specifically excludes major forms of arson involving accelerants and/or multiple ignition sources (other than minor forms of arson as a source of initial ignition), acts of terrorism, protection of property (other than adjoining property), business interruption or losses, personal or moral obligations of the owner/occupier, reputation, environmental impacts, broader community issues etc.

e) Egress and fire safety provisions for persons with disabilities were considered to the same degree as the BCA DtS Provisions.

f) Reports marked 'Draft' are subject to change and AECOM accepts no liability pending release of the final version of the report.

g) The recommendations in this assessment are based on information provided by others. AECOM has not verified the accuracy and/or completeness of this information and accepts no responsibility or liability for any errors or omissions which may be incorporated into this assessment as a result.

h) The recommendations, data and methodology documented in this assessment are based on the documentation in Section 10.0 and specifically apply to the subject building and must not be utilised for any other purpose. Any modifications or changes to the building, fire safety management system, or building usage from that described may invalidate the findings of this assessment necessitating a re-assessment.

i) This Fire Engineering Report has been reviewed by an Accredited C10 Fire Safety Engineer for and on behalf of AECOM Australia Pty Ltd in accordance with Clause 144A(1)(b) of the NSW Environmental Planning and Assessment Regulation (2000). It is noted that this Fire Engineering Report does not constitute a Part 4A Compliance Certificate under the NSW Environmental Planning and Assessment Act (1979).

12.0 Conclusions

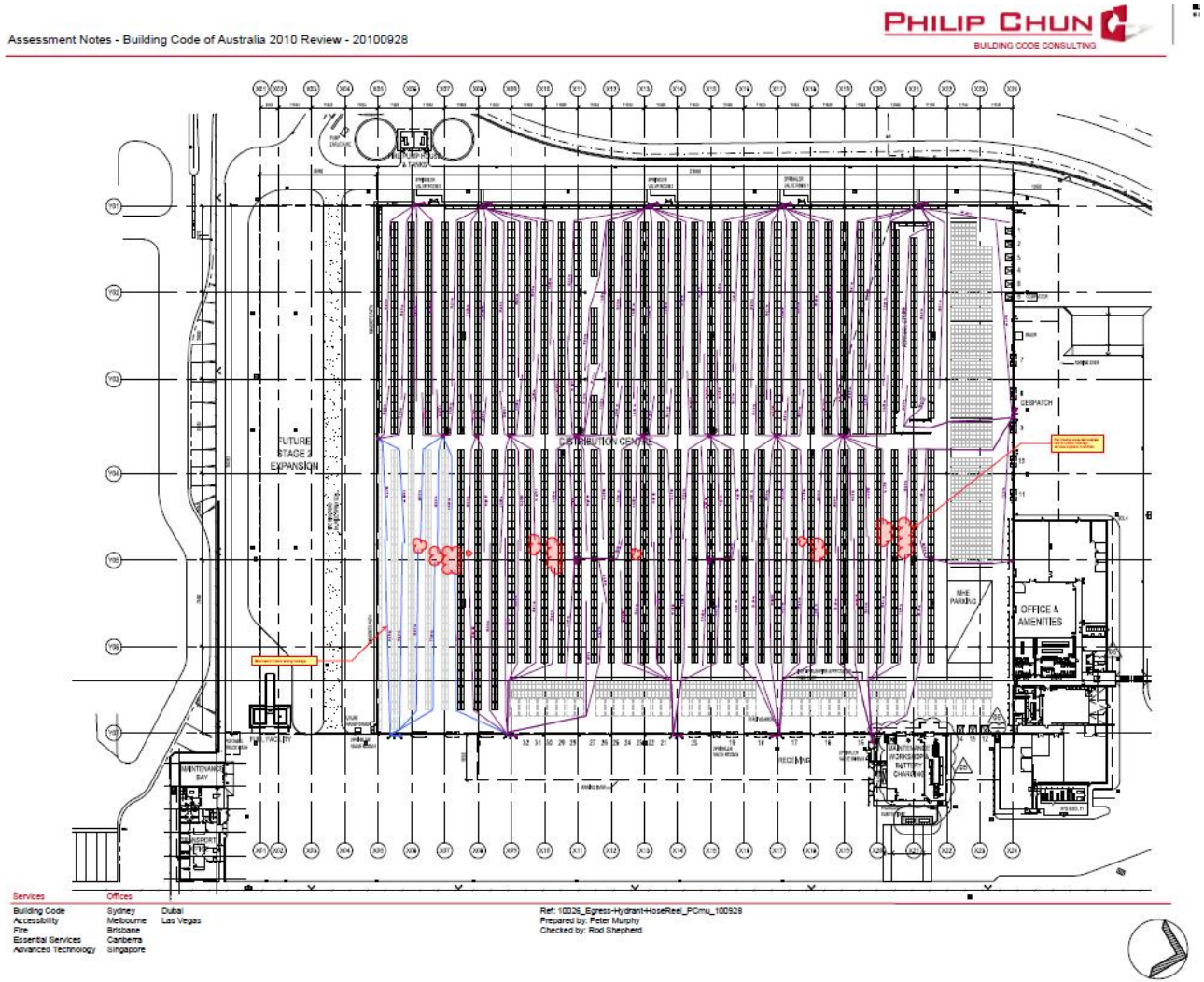
Based on the fire engineering assessment presented in this report, it is the considered opinion of AECOM that the proposed Alternative Solutions satisfy the BCA Performance Requirements CP2, CP9, DP4, EP1.4, EP1.1, EP1.3 and EP2.2. This is subject to, but not limited to, the implementation of the fire safety strategy for this building as outlined in Section 4.0 – Fire Safety Strategy (page 7) of this report.

The readers' attention is drawn to the scope and conditions of use of this document that are outlined in Section 1.0 - Introduction (page 2), Section 3.0 – Design Objectives (page 6) and Section 11.0 – Validity & Limitations (page 52).

Appendix A

Travel Distance

Appendix A Travel Distance



Appendix B

Egress Analysis

Appendix B Egress Analysis

Occupant Egress

The total evacuation time from a building or floor is the summation of three component times as shown by the equation below[26]:

$$t_{evacuation} = t_{detection} + t_{pre\text{-}movement} + t_{movement} \quad (1)$$

Where

$t_{evacuation}$ = total egress time (s);

$t_{detection}$ = detection time or time until people become aware of the fire (s);

$t_{pre\text{-}movement}$ = pre-movement time (s);

$t_{movement}$ = movement or travel time to exits (s).

Detection Time

The detection time $t_{detection}$ is the time interval between the ignition of the fire and the time when occupants become aware of a fire incident within the building. The detection time is generally given by the time at which the fire alarm is sounded by the automatic fire detection system, or the occupants receive a clear visual or olfactory cue, such as smoke. In this case, the building is to be equipped with smoke detection system extended spacing as per AS/NZ 1668.1 linked to an occupant warning system in accordance with AS 1670.1:2004.

For a fire scenario in the compartment of fire origin, the occupants are likely to receive an instantaneous visual or olfactory cue before the smoke detector activate. This is expected to occur when smoke layer falls below 5% of the ceiling height of the compartment. However, this may not occur readily due to the layout of the plant. Therefore, the detection time was based on the activation of the smoke detection system and the subsequent initiation of the occupant warning system as it represents the longest time.

Detector activation was calculated using FPETool based on the Alpert's correlation method[27].The sprinkler activation time was found to be 112 s. This was based on a super ultrafast t^2 fire, a ceiling height of 13.7 m, radial distance of 6 m to the second row sprinkler based on the relevant some detection system standard and detector activation temperature of 68^{o}C. The smoke detector activation was found to be 126 s based on AS/NZS 1668.1 spacing. The smoke detection time will be used as Detection Time for RSET analysis.

Pre-movement Time

The pre-movement time, $t_{pre\text{-}movement}$, is the time from when people become aware of the fire until they begin to evacuate. One common reaction is to try to get more information about the fire and another is to try to extinguish the fire. Other factors that determine the pre-movement time include the occupant familiarity with the building, the reaction of the group that the occupants are in, the threat of the fire and the type of evacuation alarm. If the occupants have a clear visual cue, such as smoke, the pre-movement time will be short, as encountered in the room of fire origin.

The pre-movement time, $t_{pre\text{-}movement}$ is the time from when people become aware of the fire until they begin to evacuate. One common reaction includes trying to get more information about the fire, gathering with social

[26]. Fire Safety Engineering Guidelines (Second Edition), Australia Building Codes Board, November 2001.
[27]. Alpert R.L and Ward E.J.,"Evaluating Unsprinklered Fire Hazards", SFPE Technology Report 83-2, Society of Fire Protection Engineers, Boston, MA 1983

group (family, friends etc), about the fire and another is attempting to extinguish the fire, etc. Other factors that determine affect the pre-movement time include the occupant familiarity with the building, the reaction of the group that the occupants are in, the threat of the fire and the type of evacuation alarm. If the occupants have a clear visual cue, such as smoke, the pre-movement time will be short, as encountered in the room of fire origin.

The pre-movement time in this case will be selected based upon the nature of the facility i.e. open space, occupants characteristic i.e. trained and familiar and the type of alarm that will be used which is a "non directive voice message pre-recorded and/or informative warning visual display". It is reported[28] a time of 180s (3 min) to be the pre-movement time for the particular scenario. However, occupant in the fire origin compartment is expected to response much faster than other compartments. Based on Franztich [29] work, 60 s is considered to represent the pre-movement time for occupants in the fire origin compartment. In situations where occupants are awake and familiar with a building and well trained in the emergency procedures, the pre-movement time of the first occupants can be very short (< than 20 s) [20]. Hence, we consider pre-movement time of 60 s is appropriate for this assessment.

Movement Time

The movement time is the time that it takes occupants to move from their initial position to a safe place and is the sum of the queuing time at the exit and the travel time to reach the exit. Evacuation analysis will be based on the following parameter:

The movement times were based on the following parameters:

a) Maximum population of 165 occupants.

b) Maximum travel distance as per design fire scenarios.

c) Exit width as per design fire scenarios.

d) For a person with average mobility, an unobstructed evacuation speed of 1.19 m/s was reported by Nelson and MacLennan (1995)[30]. While a maximum specific flow through a door of 1.3 persons/s.m and an evacuation speed of 0.5 m/s down a stair were respectively reported by Pauls (1995)[31]. The research findings by Shields (1996)[32] recommend an average unobstructed evacuation speed of 0.69 m/s for a person in a manual wheel chair on a level surface.

Time of Movement Calculation Sheet

Movement time on the floor is the primary concern for these assessments. This is considered as imperative due to high risk to occupants to be exposed to smoke when travelling to final exits. The escape stairs is considered as interim place of safety as it is smoke protected. Queuing time will be assessed to determine waiting time to enter a stair due to bottle neck issue. Travel distance and number of available stairs are considered differently based on design fire scenarios.

[28] Guylene Proulx, Movement of People: Evacuation Timing, Chapter 3-13 SFPE handbook.
[29]. Frantzich, H., Occupant Behaviour and Response Time – Results from Evacuation Experiments, Conference Proceedings to the 2nd International Symposium on Human Behaviour in Fire. Interscience Communications, 159-165, Boston, MA, 2001.
[20] CIBSE Guide E Fire Engineering
[30] Nelson, H.E. and MacLennan, H. A., Emergency Movement Section 3/Chapter 14, The SFPE Handbook of Fire Protection Engineering, 2nd Edition, 1995.
[31] Pauls, J., 'Movement of People', The SFPE handbook of Fire Protection Engineering, 2nd Edition, 1995.
[32] Shields, T.J., Dunlop, K., and Silcock, G., (1996) "Escape of Disabled People from Fire. A Measurement and Classification of Capability for Assessing Escape Risk," BRE Report 301, British Research Establishment, Borehamwood, UK.

Occupant movement in the warehouse

The occupant load is considered distributed uniformly within the warehouse.

Evacuation First Principles
(Ground Floor Warehouse)

Key	Colour	Meaning
		Input Variable
		Result

Inputs	**Value**	**Units**		
No. of Occupants	165	people		
Occupant Horizontal Travel Speed	1	m/sec		
Travel Distance to Stair/Exit Door	219	m		
Stair/exit Door Width	11	m		
Less Boundary Layer	3.9	m		
Calculations - Travel time to exit door				
Calculated travel time	219	sec or	3.73	min
Flow capacity through door				
Effective width of door	7.1	m		
Maximum Specific Flow (Fs)	1.3	persons/sec/m of effective width		
Doorway Specific Flow (Fs)	1.3	persons/sec/m of effective width		
Doorway Calculated Flow (Fc)	9.23	persons/sec		
	553.8	persons/min		
Outputs				
Travel time to exit door	219	sec		
Travel time through exit door	18	sec		
Total Travel Time	**219**	**sec or**	**3.65**	**min**

Assumptions

1. The prime controlling factor will be either the stairways or the door discharging from them.
2. Queuing may occur and therefore the specific flow (Fs) will be the maximum specific Flow (Fsm).
3. All occupants start egress at the same time.
4. The population will use all facilities in the optimum balance.

Occupant movement in the office

The occupant load in the office is considered distributed uniformly to available exits.

Evacuation First Principles
(BCA DtS Solution)

Key	Colour	Meaning
		Input Variable
		Result

Inputs	**Value**	**Units**		
No. of Occupants	65	people		
Occupant Horizontal Travel Speed	0.6	m/sec		
Travel Distance to Stair/Exit Door	40	M		
Stair/exit Door Width	1	M		
Less Boundary Layer	0.3	M		
Calculations - Travel time to exit door				
		sec		
Calculated travel time	67	or	1.11	min
Flow capacity through door				
Effective width of door	0.7	M		
Maximum Specific Flow (Fs)	1.3	persons/sec/m of effective width		
Doorway Specific Flow (Fs)	1.3	persons/sec/m of effective width		
Doorway Calculated Flow (Fc)	0.91	persons/sec		
	54.6	persons/min		
Outputs				
Travel time to exit door	67	Sec		
Travel time through exit door	71	Sec		
		sec		
Total Travel Time	**138**	**or**	**2.30**	**min**

Assumptions

1. The prime controlling factor will be either the stairways or the door discharging from them.
2. Queuing may occur and therefore the specific flow (Fs) will be the maximum specific Flow (Fsm).
3. All occupants start egress at the same time.
4. The population will use all facilities in the optimum balance.
5. 1 m width as per BCA DtS based on population of 65 persons

Evacuation First Principles (Alternative Solution)

Key	Colour	Meaning
		Input Variable
		Result

Inputs	**Value**	**Units**
No. of Occupants	65	people
Occupant Horizontal Travel Speed	0.6	m/sec
Travel Distance to Stair/Exit Door	40	M
Stair/exit Door Width	3.4	M
Less Boundary Layer	1.2	M

Calculations - Travel time to exit door

Calculated travel time	67	sec or	1.11	min

Flow capacity through door

Effective width of door	2.2	M
Maximum Specific Flow (Fs)	1.3	persons/sec/m of effective width
Doorway Specific Flow (Fs)	1.3	persons/sec/m of effective width
Doorway Calculated Flow (Fc)	2.86	persons/sec
	171.6	persons/min

Outputs

Travel time to exit door	67	sec		
Travel time through exit door	23	sec		
Total Travel Time	**67**	**sec or**	**1.11**	**min**

Assumptions

1. The prime controlling factor will be either the stairways or the door discharging from them.
2. Queuing may occur and therefore the specific flow (Fs) will be the maximum specific Flow (Fsm).
3. All occupants start egress at the same time.
4. The population will use all facilities in the optimum balance.
5. 3.4 m aggregate width as per architectural drawings

Results

Evacuation Scenarios	Time of detection	Pre movement time	Movement time	RSET
Scenario 1 - From ground floor – 219 m (ASET at 2.1 m height)	126 s	60 s	219 s	405 s
Scenario 2 - From the office space	60 s*	60 s*	67 s	187 s

* 60 s detection and pre-movement time in the office space are assumed uniformly for the comparative analysis purpose

Appendix C

Computational Smoke Analysis

Appendix C Computational Smoke Analysis

Computational Fluid Dynamics (CFD) program Fire Dynamics Simulator[33] (FDS Version 5) was utilised to simulate the flow of heat and smoke caused by a fire as described in Design Fire Scenario Section.

The CFD program FDS 5 is a field model, based on the approach of Large Eddy Simulation technique, where low Mach number combustion equations (representing a simplified form of equations describing the transport of mass, momentum and energy by the fire induced flows) are solved numerically in a large number of rectangular cells representing the physical space. This approach is considered suitable to simulate the flow of heat and smoke through a large area.

The results generated from FDS 5 are illustrated by colour graphics showing levels of contamination and temperature by Smokeview[34], a module of the computer program where 3-dimensional graphical representations of the results are developed.

Basic Model Geometry

The compartment configuration utilised in the CFD is illustrated in Figure B.1. The bounding dimensions and openings in the building structure were scaled from the architectural drawings.

Design Fire Scenario & Input Data

The design fire scenarios that were utilised in the CFD modelling are in accordance with Section 9. CFD modelling was carried out for Fire Scenarios A and B based on the following parameters.

Table B-1 – Key input parameters for CFD modelling.

Design Fire Scenarios	T_a	H_{con}	H_{rad}	y_{co}	y_s	No. of cells	Cells size (m)
Scenario A (Design) 11MW Super Ultrafast Sprinkler Controlled Rack fire	20°C	0.7	0.3	0.038	0.1	1043100	• 0. 5 m x 0.5 m x 0.5 m (fire area) • 1.0 m x 1.0 m x 1.0 m (other areas)
Scenario B (Sensitivity) 24 MW Super Ultrafast Delayed Sprinkler Controlled Rack Fire	20°C	0.7	0.3	0.038	0.1	1043100	• 0.5 m x 0.5 m x 0.5 m (fire area) • 1.0 m x 1.0 m x 1.0 m (other areas)

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

Table B-2 – Legend for the above table.

Legend	Notation
Ambient air temperature (deg C)	Ta
Convective heat fraction for well-ventilated fires	H_{con}
Radiative heat fraction for well-ventilated fires	H_{rad}
Smoke yield (g/g)	y_s
Carbon monoxide yield (g/g)	y_{co}

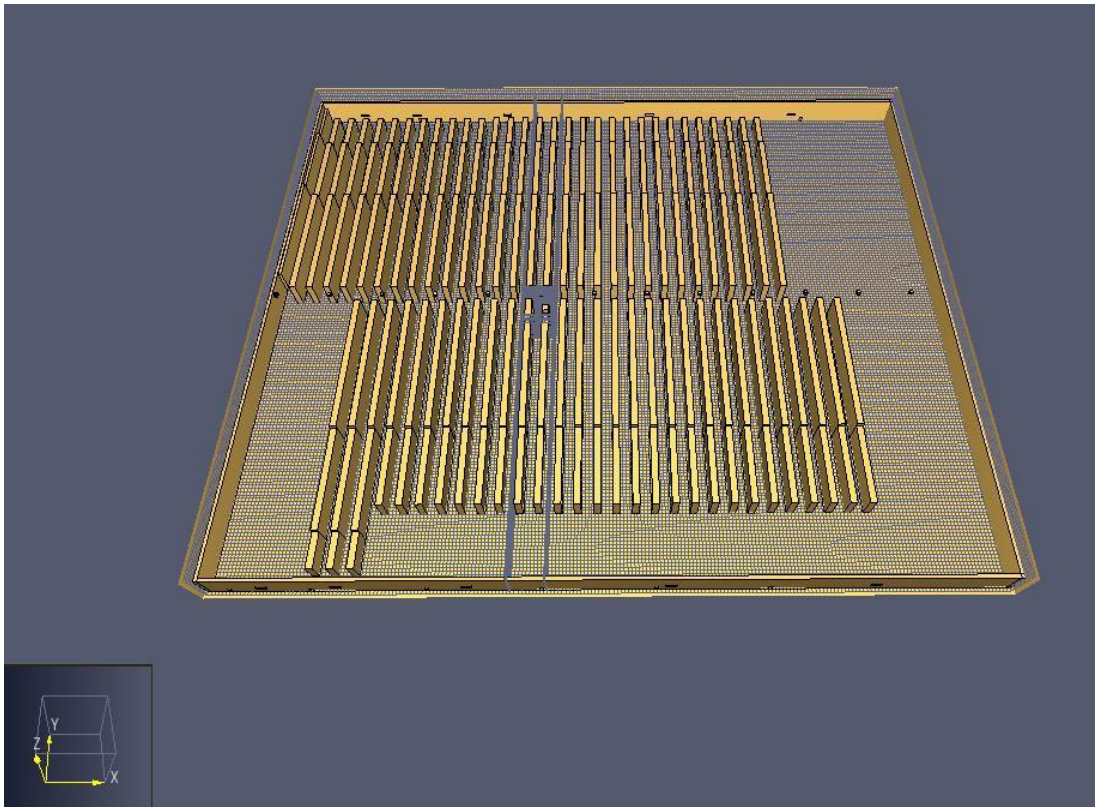


Figure B.1: Schematic illustrating compartment and high rack configuration utilised in the CFD model.

Tenability Criteria

The adapted tenability criteria for the CFD modeling in relation to occupant life safety will be based on the following parameters.[35]. The compartment is deemed to have untenable conditions when one or more of the following occur/s:

a) Air/smoke temperature reaches 183°C (approximately equal to 2.5 kW/m^2) consistently across the entire fire enclosure at any height; or

b) Significant pockets of air/smoke reaches 100°C in the vicinity of the egress path at a height of 2.1 m on the ground level; or

c) Substantial accumulation of stagnant smoke is formed below 2.1 m in the vicinity of the egress path such that visibility is limited to less than 5 m (i.e. an optical density of 0.25 m^{-1}).

[35] Fire Engineering Guidelines, Fire Code Reform Centre Limited, 1st Ed, Sydney, NSW, March 1996.

d) In the event that visibility is less than 5m, concentration of CO and CO_2 will be taken as the criteria of tenability.

Temperature

The temperature criteria are related to the exposure of radiation and convective heat from hot smoke as recommended in the Fire Engineering Guidelines[36].

Visibility

The Fire Engineering Guidelines[37] recommend a minimum visibility of 10 m (0.1 m^{-1}) be maintained in large spaces during evacuation. In the event of visibility fall below 10m, toxicity level of CO of no more than 0.27% and CO_2 of no more than 7% will be considered.

Tenability Criteria

The table below summarises the ASET results obtained from CFD modelling.

Table B-3 – ASET.

Fire Scenario	Location	Temp < 100°C at 2.1 m in egress path	Visibility > 5 m at 2.1 m	CO_2 Concentration < 7%	CO Concentration < 0.27%	ASET
Scenario A (Design) 11MW Super Ultrafast Sprinkler Controlled Rack fire	From ground floor – 219 m (ASET at 2.1 m height)	1200 s	1200 s	1200 s	1200 s	1200 s
Scenario B (Sensitivity) 24 MW Super Ultrafast Delayed Sprinkler Controlled Rack Fire	From ground floor – 219 m (ASET at 2.1 m height)	1200 s	1200 s	1200 s	1200 s	1200 s

[36] Fire Engineering Guidelines, Fire Code Reform Centre Limited, 1st Ed, Sydney, NSW, March 1996.
[37] Australian Fire Engineering Guidelines, 1st Edition, Fire Code Reform Centre, 1996.

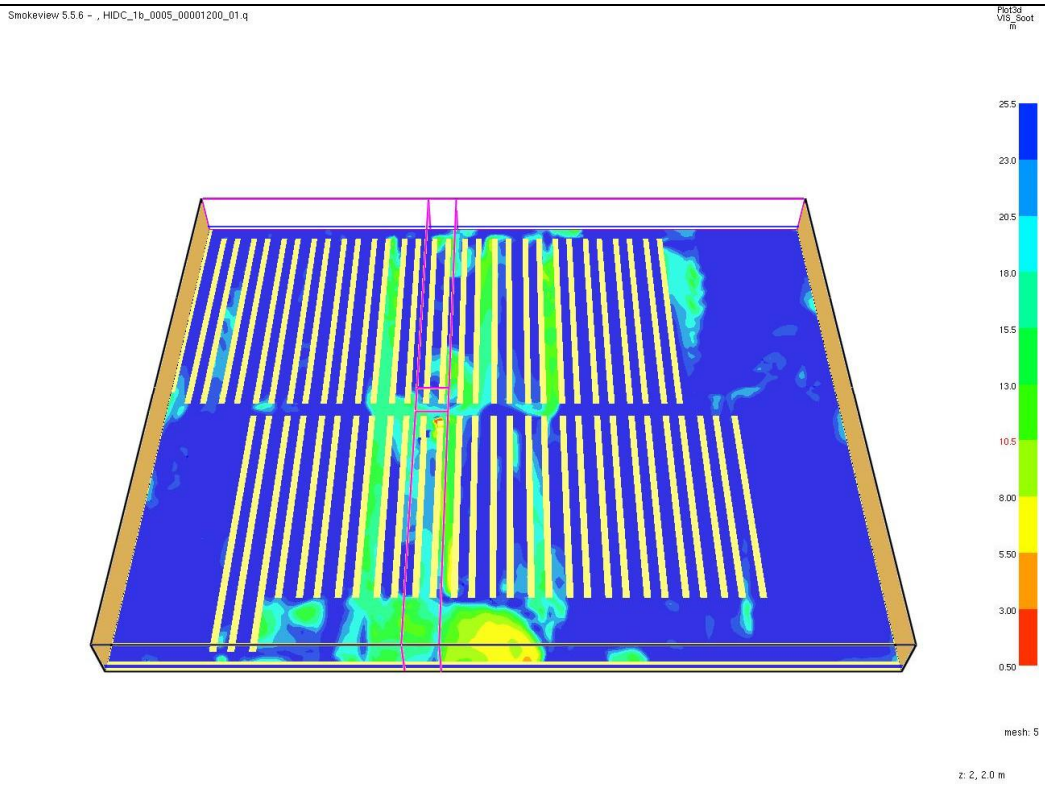
Table B-4 - ASET/RSET Comparison

Design Fire Scenarios	Evacuation Scenarios	ASET	RSET	Safety Margin	Safety Factor
Scenario A (Design) 11MW Super Ultrafast Sprinkler Controlled Rack fire	From ground floor – 219 m (ASET at 2.1 m height)	1200 s	405 s	636 s	2.9
Scenario B (Sensitivity) 24 MW Super Ultrafast Delayed Sprinkler Controlled Rack Fire	From ground floor – 219 m (ASET at 2.1 m height)	1200 s	405 s	636 s	2.9

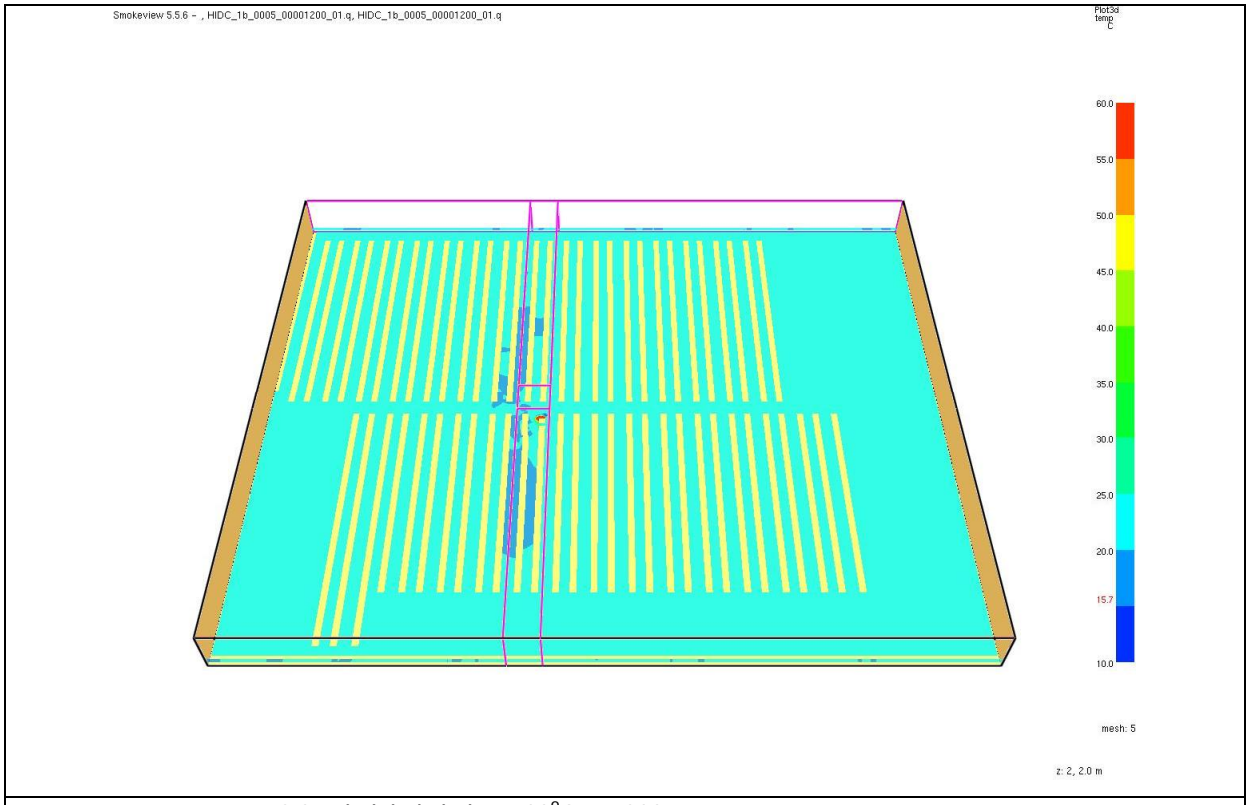
RESULTS

Fire Scenario A

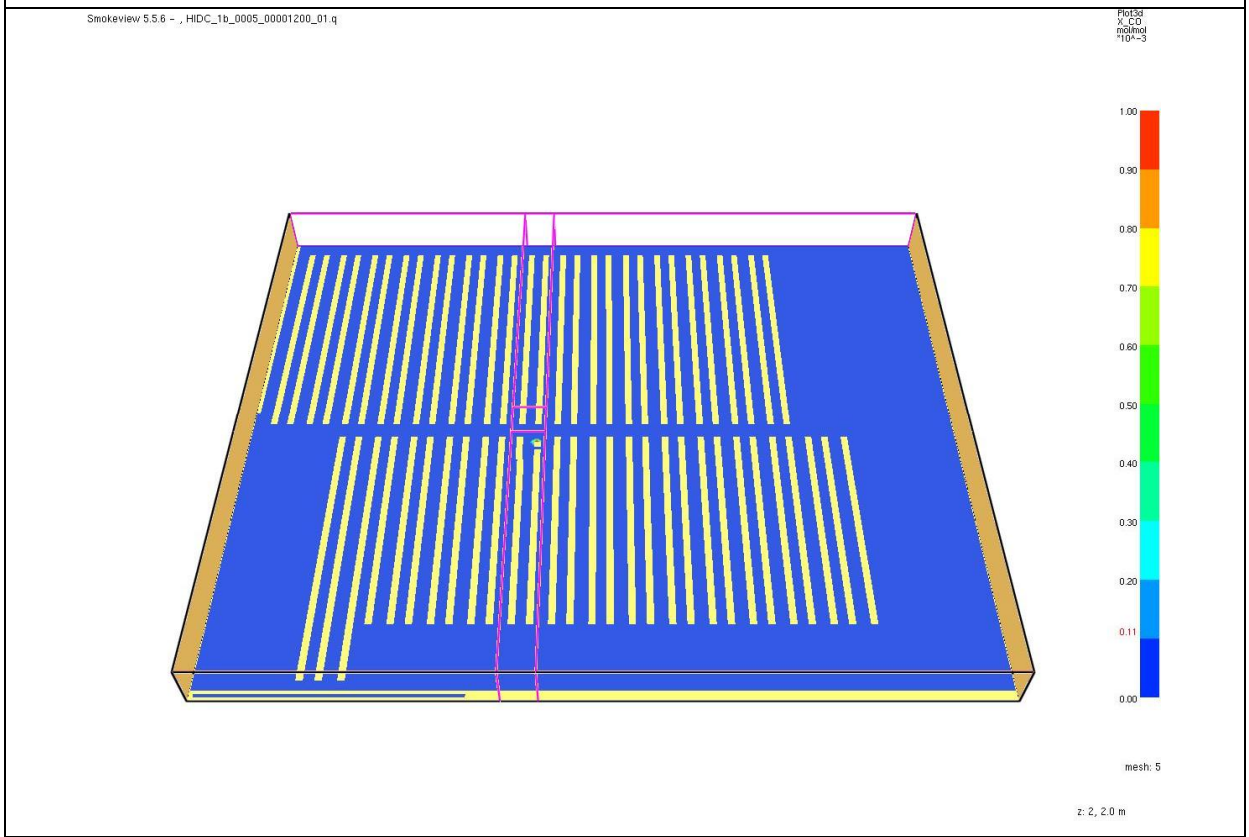
Smoke layer height is maintained at average 3 m height and with visibility at 1200 s



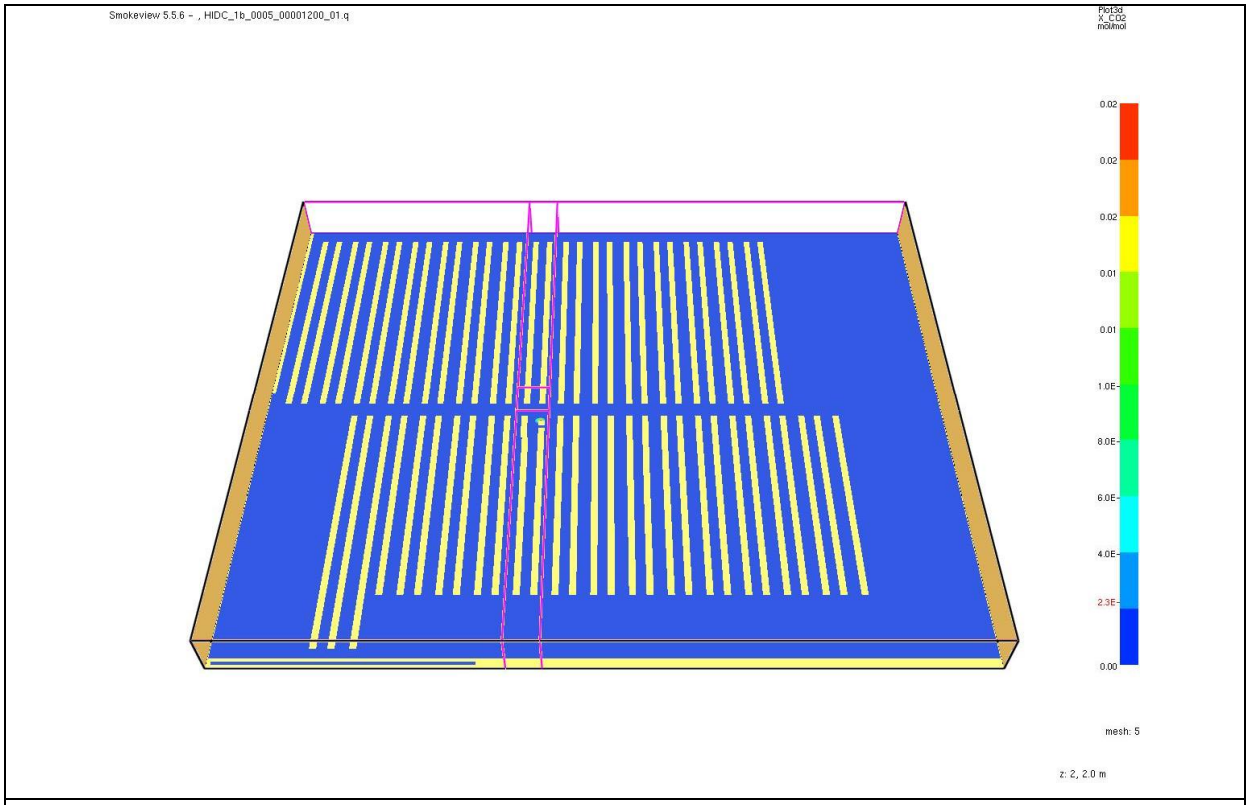
Visibility at 2.0 m height is maintained above 10 m at 1200 s



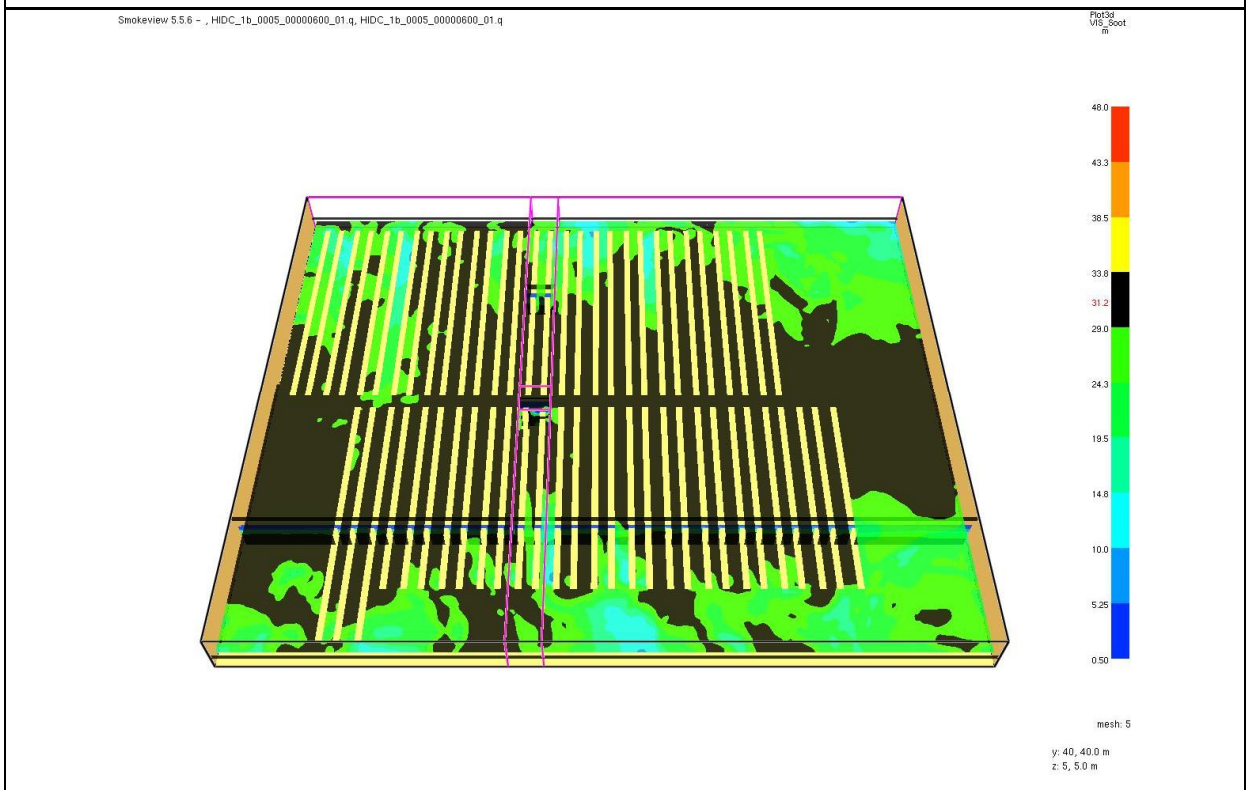
Average temperature at 2.0 m height is below 100^{o}C at 1200 s



Average CO Concentration at 2.0 m height is 200 ppm at 1200 s

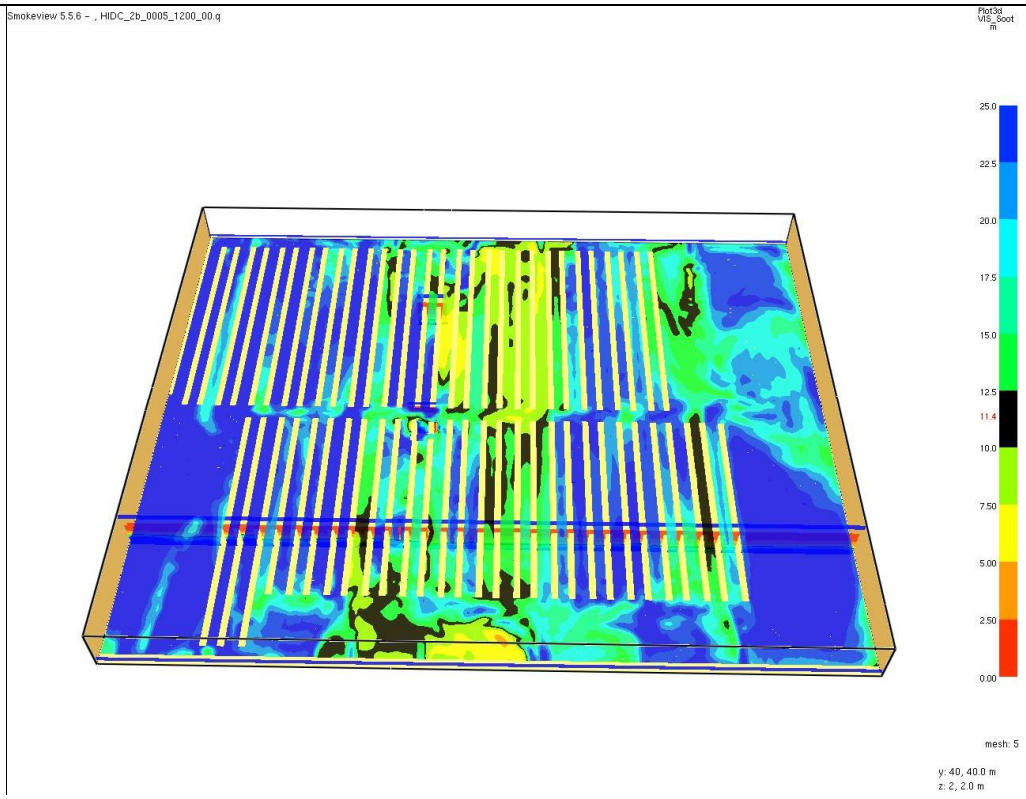


CO_2 Concentration at 2.0 m height is 0.3 % at 1200 s

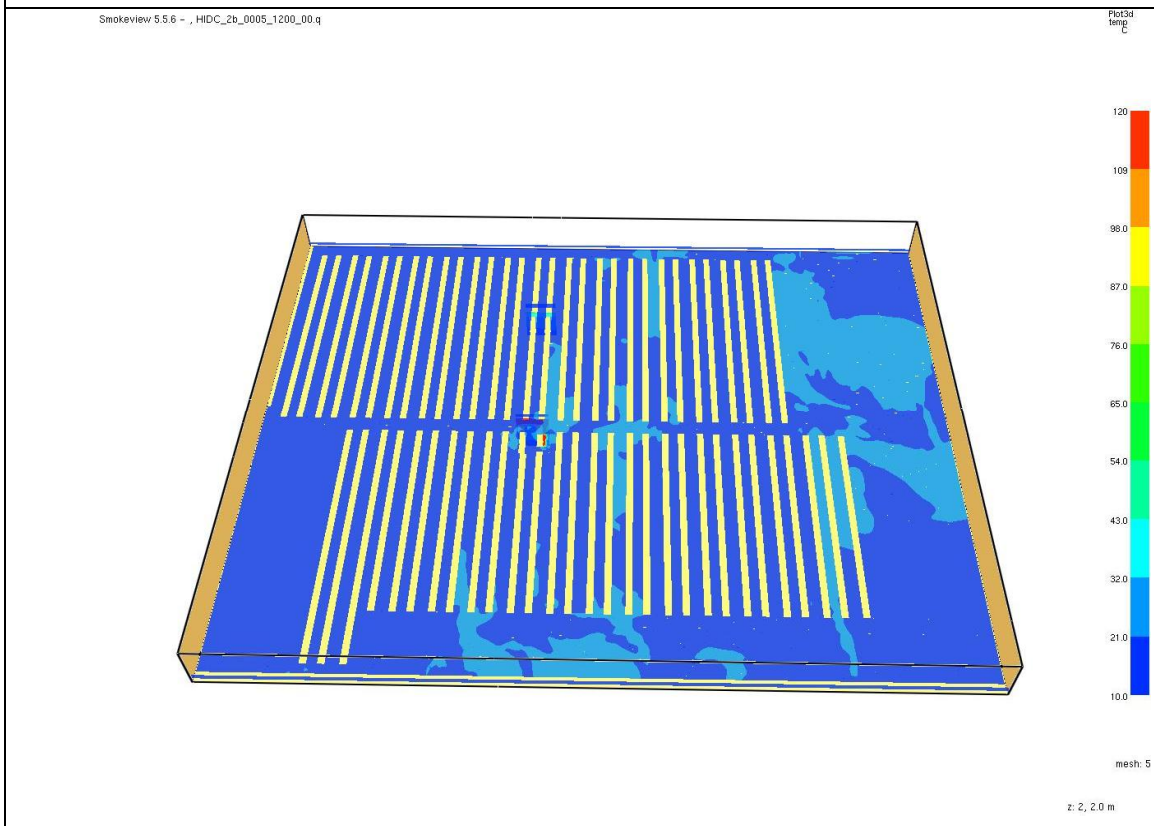


Average visibility at 5.0 m height is above 30 m at most of the areas at 600 s

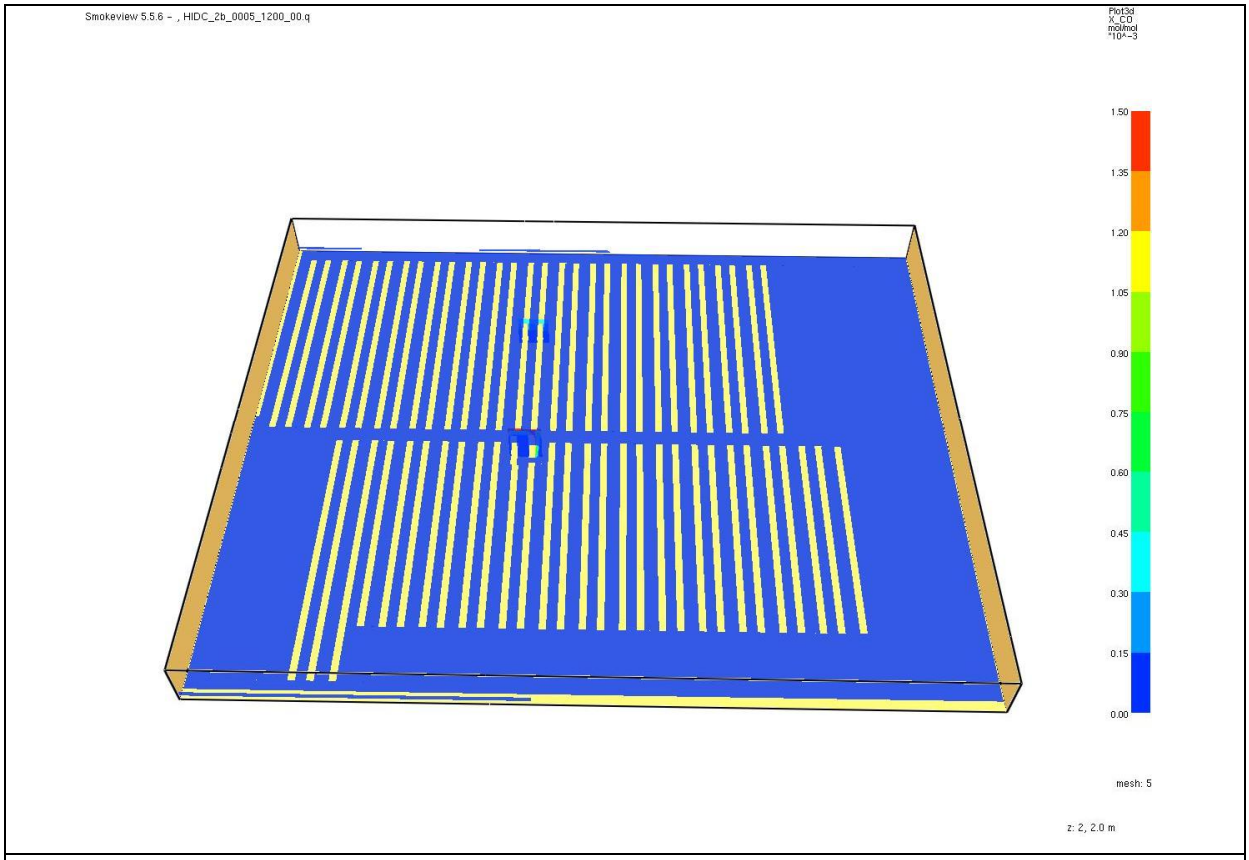
Fire Scenario B (Sensitivity Analysis)



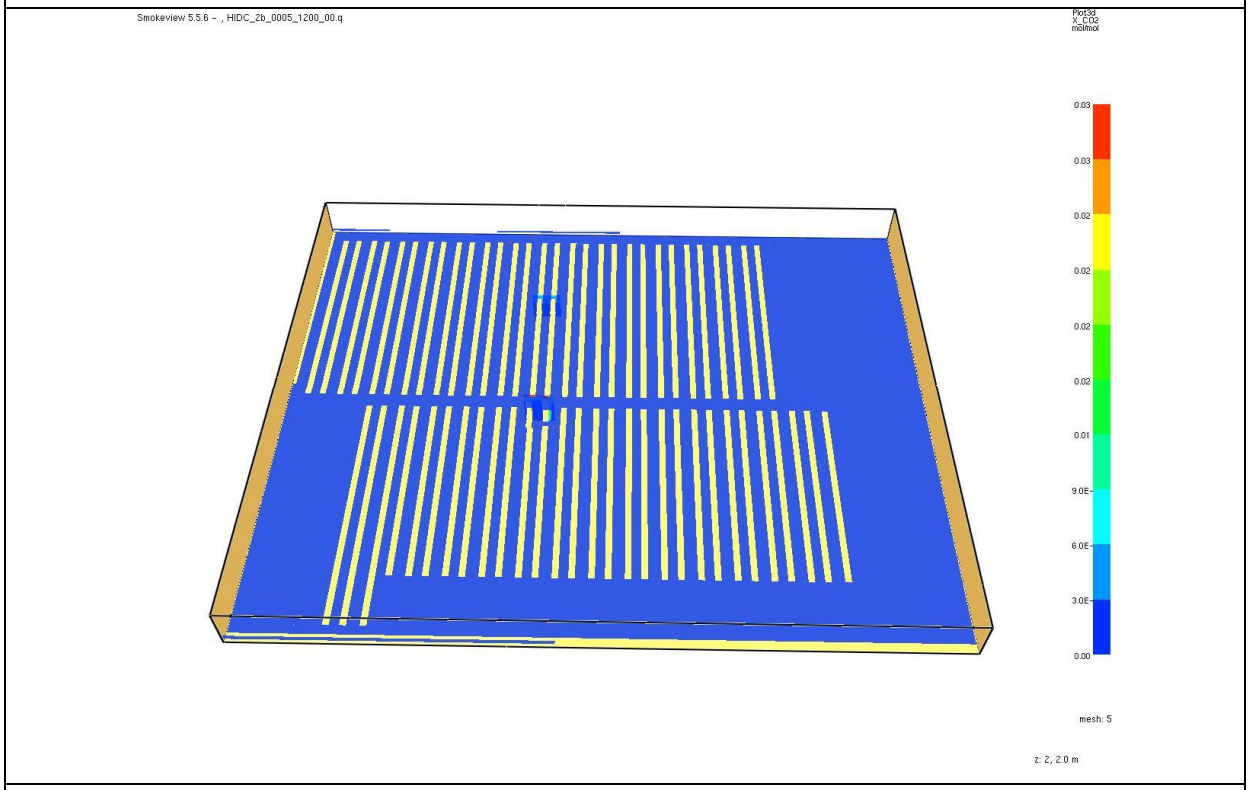
Visibility at 2.0 m height at is maintained above 10 m at most of the areas at 1200 s



Average temperature at 2.0 m height is below 100^{o}C at 1200 s

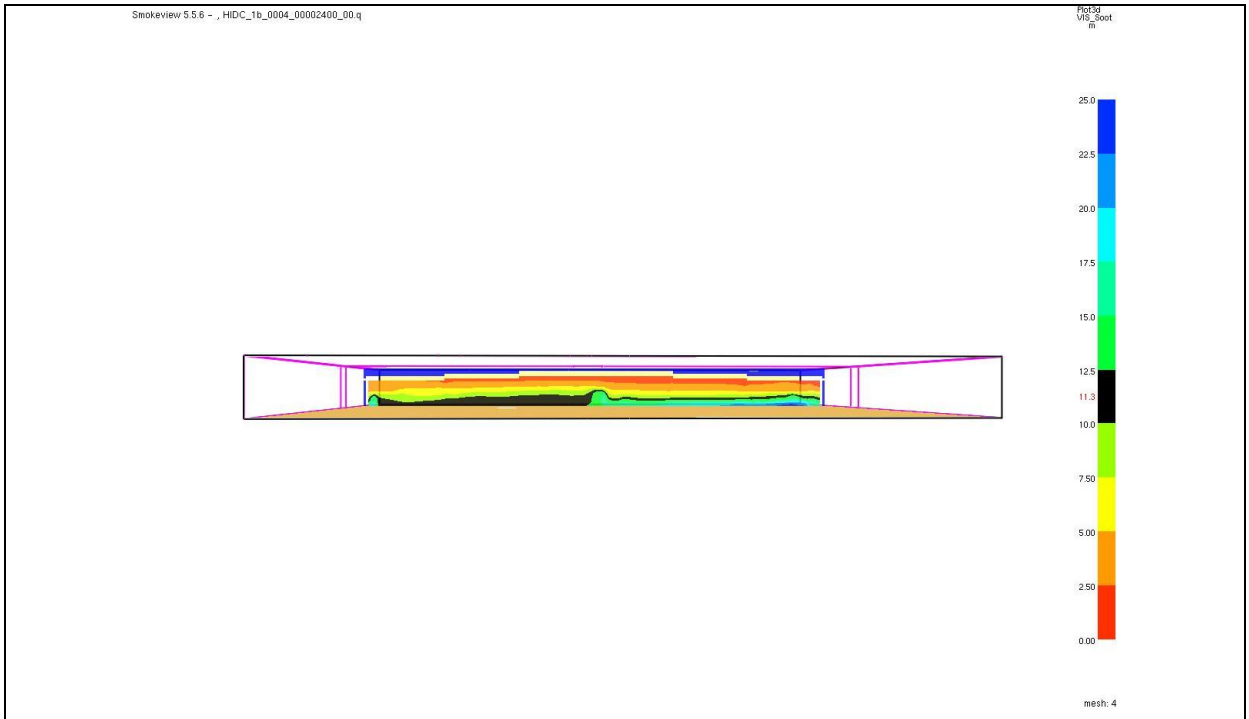


CO Concentration at 2.0 m height is 300 ppm at 1200 s



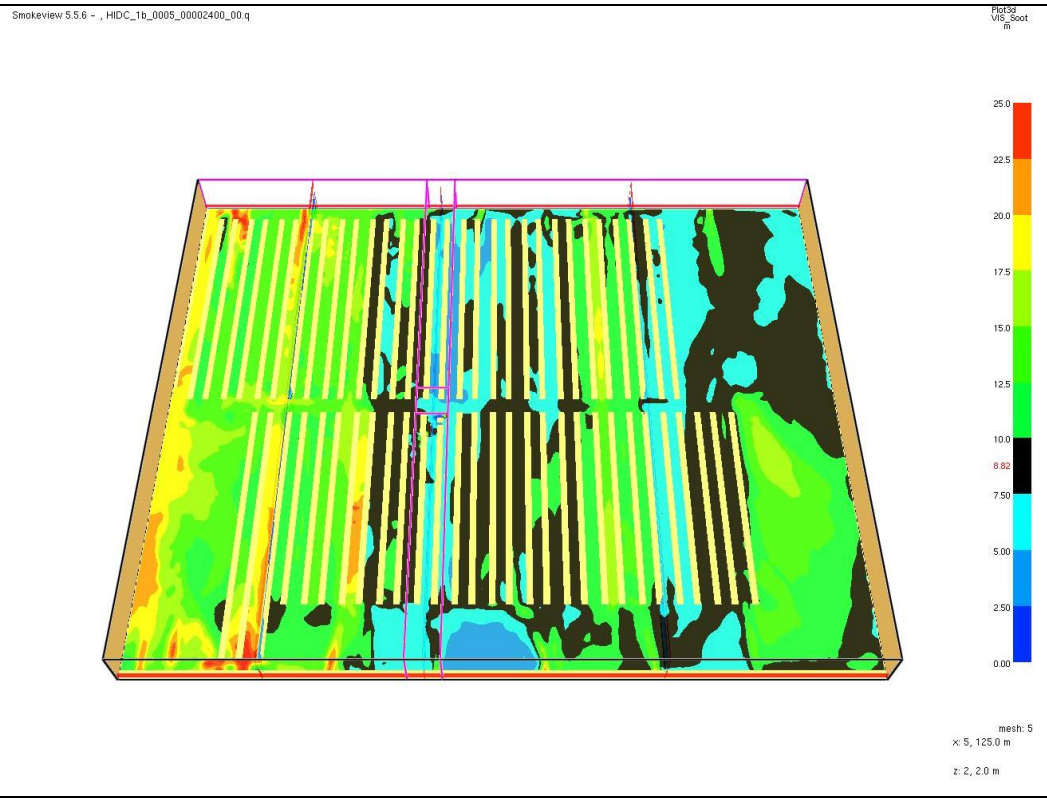
CO_2 Concentration at 2.0 m height at 0.45% at 1200 s

Fire Scenario A (NSWFB Fire Fighting Operation)

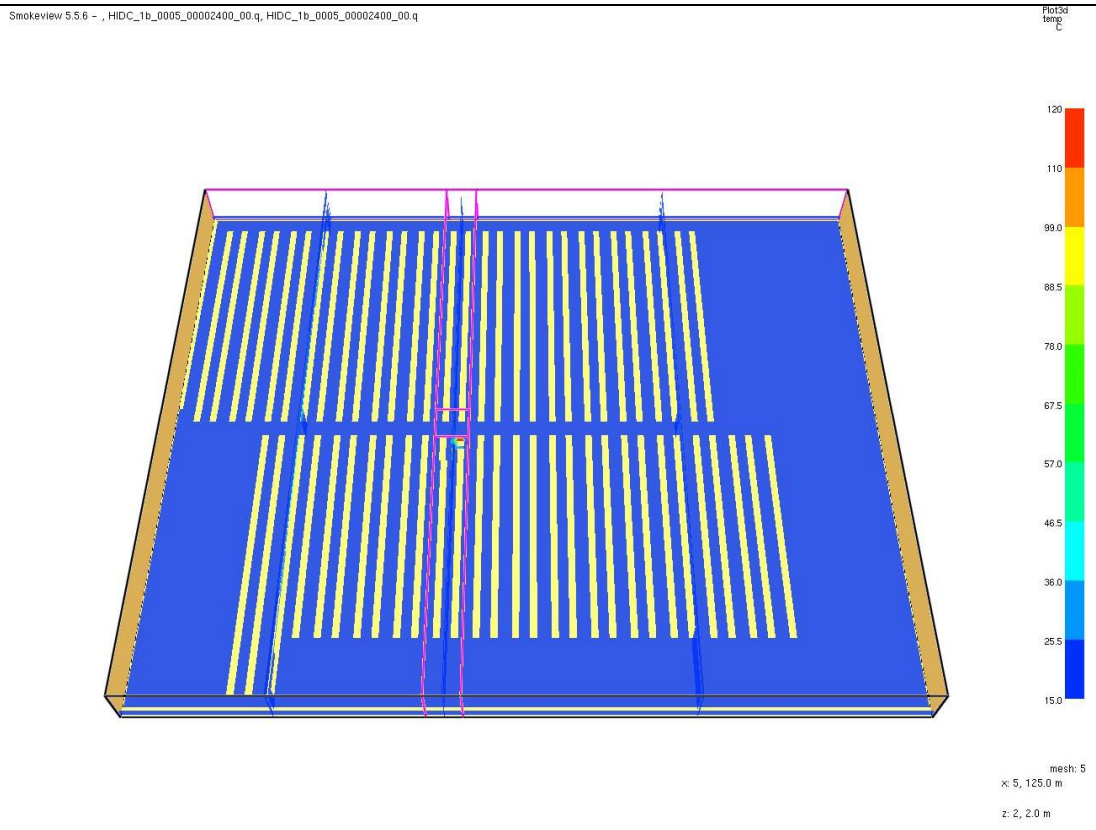


Visibility at above 10 m across most areas away from fire location at 2400 s (X Plane)

Visibility at above 10 m across most areas away from fire location at 2400 s (Y Plane)



Visibility at 2.0 m height above 10 m across most areas away from fire location at 2400 s (Z Plane)



Average temperature at 2.0 m height is below 100^{o}C at 2400 s

Appendix D

Fire Brigade Intervention Modelling (FBIM)

Appendix D Fire Brigade Intervention Modelling (FBIM)

Fire Brigade Intervention Model: DSE DC

Activity (module)	Ref	Factor	
Detection			s
Chart 1-Time taken for initial Brigade notification			
(2) Automatic detection	Yes	120	s
(5) Suppression system	No		s
(7) Alarm verification delay	Table B	20	s
(9) Automatic connection to FB	Yes		
(15) Time to transmit information to fire brigade		140	s
Chart 2-Time taken to dispatch resources			
(4) Call electric	Yes		
(6) Call taken at central communications	Yes		
(10) Time to relay dispatch information by phone or radio	Table D	0	s
(11) Time for fire fighters to respond to call and leave station	Chart 3	90	s
(12) Time to respond		90	s
Chart 3-Time taken for firefighters to respond to dispatch call			
(2) Station manned full time	Yes		
(4) Fire fighters in the fire station	Yes		
(5) Time to dress, assimilate information and leave station	Table E	90	s
(7) Time to respond & depart fire station		90	s
Chart 4-Time taken to reach fire scene(kerb side)			
(2) Percentile response time to be used	No		
(4) Turnout from fire station	Yes		
(7) Radial distance from fire station (Horning Sea Park)	km	5.8	
(7) Radial distance from fire station (Macquarie Field)	km	13.1	
(9) Design Speed	km/hr	26.3	
(11) Travel Time (Horning Sea Park)		794	s
(11) Travel Time (Macquarie Field)		1793	s
Chart 5-Time taken for initial determination of fire location			
(2) Road travel within site necessary	No		
(4) Fire visible on arrival	No		
(5) Premises occupied	Yes		
(6) Time to don safety equipment	Chart 6	301	s
(7) Hindrance Factor	Table S	0.8	
(8) Security Procedures	Table G	0	
(9) In accredited fire warden present	No		
(16) FB pre-planning documented	Yes		
(17) Time for internal travel to primary target	Chart 9	14	s

(19) Time for information gathering	Table L	90	s
(20) Time taken to determine fire location		481	s

Chart 6-Time taken to don safety equipment and gather necessary tools

(2) Time to dismount fire appliance and don BA	Table M	158	s
(3) Other safety equipment necessary	No		
(5) Time to conduct safety procedures	Table O	74	s
(6) Tools necessary for initial access and set up (hoses etc)	Yes		
(7) Time to remove necessary tools from appliance	Table P	69	s
(8) Time taken to don safety equipment and gather necessary tools		301	s

Chart 7-Time taken to assess fire

(2) Fire location and extent obvious without recon	Yes		
(3) Building greater than 3 storeys	No		
(5) Time for OIC to walk to floor below fire compartment (6th floor)		0	s
Vertical Travel Speed	Table T	0.9	steps/ s
Horizontal Speed	Table Q	1.4	m/s
Vertical Travel Distance		0	steps
Horizontal Distance		0	m
Rest Breaks	Table T	1.9	steps/ s
(6) Time for OIC to walk from floor below fire compartment to above (7th floor)		0	s
Vertical Travel Speed	Table T	0.9	steps/ s
Horizontal Speed	Table Q	1.4	m/s
Vertical Travel Distance		0	steps
Horizontal Distance		0	m
Rest Breaks	Table T	1.9	steps/ s
(7) Time for OIC to walk back to set up area		0	s
Vertical Travel Speed	Table T	1	steps/ s
Horizontal Speed	Table Q	1.4	m/s
Vertical Travel Distance		0	steps
Horizontal Distance		0	m
Rest Breaks	Table T	1.9	steps/ s
(8) Additional resources	Yes		
(9) Notify additional resources	Chart 2	0	s
(10) Time for fire assessment		0	s

Chart 8-Time taken to travel to set-up area

(2) Road travel within site necessary	No		
(5) Safety equipment donned	Yes		

(7) Set up area inside the building	No		
(12) Time taken to travel to set-up area		0	s
Chart 9-Time taken for firefighter travel			
(2) Doors to be negotiated	No		
(6) Horizontal travel	Yes		
(7) Horizontal travel time		14	s
	Table Q		
Horizontal Speed		1.4	m/s
Horizontal Distance		20	m
(8) Vertical travel time		0	s
	Table T		steps/s
Vertical Travel Speed		0.9	
Vertical Travel Distance		0	steps
	Table T		steps/s
Rest Breaks		1.9	
(15) Travel time		14	s
Chart 10-Time taken to set up water for initial fire fighter protection			
(2) Fire attack from appliance	No		
	Chart 11		
(9) Time to set up water requirements		135	s
(10) Time taken to set up water for initial fire fighter protection		135	s
Chart 11-Time taken to set up water supply requirements			
(2) Appropriate hydrant system flow and pressure	Yes		
	Table V		
(12) Time taken to connect and charge hoses		135	s
(15) Time taken to set up water requirements		135	s
Horning Sea Park Fire Station Charts 1-4		1114	s
Macquarie Field Fire Station Charts 1-4		2113	s
Horning Sea Park Fire Station (Largest time Charts 5-12)		481	s
Macquarie Field Fire Station (Largest time Charts 5-12)		481	s
Horning Sea Park FBIM		1594	s
Macquarie Field FBIM		2594	s

Appendix E

FAMCO Jumbo Exit Signs

Appendix E FAMCO Jumbo Exit Signs

FAMCO Luminaire Designers, Manufacturers & Suppliers

Emergency Lighting | Exit Signs - Jumbo | Universal Jumbo Exit Sign 150mm - Series 9927

Universal use range of clean well proportioned exit signs for increased viewing distances. Zinc coated steel body, finished in white powdercoat, acrylic diffuser with ***peel off arrows***.

NATA LAB tested to AS2293, Certificate No. OPT226/00

Maximum Viewing Distance:

F9927/150: 36m

CEILING/SURFACE MOUNTED
F9927/150/SS 2x18W EXIT-single sided
F9927/150/DS 2x18W EXIT-double sided

Peel off Arrows
(Patent applied for)

PICTOGRAM (without peel off arrows)

PICTOGRAM (without peel off arrows)
2x18w Sustained - 32m Maximum Viewing Distance
F9927/32/SS/RMS Straight ahead - single sided
F9927/32/DS/RMS Straight ahead - double sided
F9927/32/SS/RMR Arrow right - single sided
F9927/32/SS/RML Arrow left - single sided
F9927/32/DS/RMR/RML Arrow left/right - double sided
2x18w Sustained - 48m Maximum Viewing Distance
F9927/48/SS/RMS Straight ahead - single sided
F9927/48/DS/RMS Straight ahead - double sided
F9927/48/SS/RMR Arrow right - single sided
F9927/48/SS/RML Arrow left - single sided
F9927/48/DS/RMR/RML Arrow left/right - double sided

Weatherproof Jumbo Exit Sign

A range of weatherproof Jumbo Exit signs is available to meet project requirements. These are available double or single sided, with or without arrows.

MAXIMUM PERMISSIBLE SPACING FOR EMERGENCY LUMINAIRES

PHOTOMETRIC CLASSIFICATION			MOUNTING HEIGHT - M													
			2.1	2.4	2.7	3.0	3.3	3.6	4.0	4.5	5	6	7	8	9	10	15	20
F9927/150/E	C0	D16	12.1	12.6	13.0	13.3	13.6	13.9	14.1	14.4	14.6	14.6	14.4	13.8	12.9	11.5		
	C90	C16	8.3	8.8	9.3	9.7	10.0	10.3	10.7	11.0	11.3	11.6	11.6	11.3	10.7	9.6		

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Appendix F

Minutes of Meeting

Appendix F Minutes of Meeting

AECOM

Minutes of Meeting

Dick Smith Distribution Centre - Hoxton Park

Subject	Fire Engineering Brief Meeting	Page	1
Venue	NSWFB, Greenacre NSW	Time	2.00 pm to 3.30pm
Participants	Benjamin Hughes Brown (NSWFB) George Baldock (NSWFB) Jeff Roche (NSWFB) Ron Chuck (Mirvac) Brett Thomson (Mirvac) Amer Magrabi (AECOM) Faisal Musa (AECOM) Rob Marinelli (Philip Chun) Brendan Melbourne (BECA)		
Apologies	Nil		
File/Ref No.	NSWFB Reference – NFB/06655 AECOM reference - 60044407	Date	24-Mar-2010
Distribution	As above and design team		

No	Item	Action	Date
1.	The AECOM Fire Engineering Brief (FEB) dated 16 March 2010, architectural drawings and Philip Chun BCA Report dated 2 March 2010 formed the discussion basis for the meeting	Note	
2.	**Introduction** - Mirvac provided a general introduction to the project, project programme, description of the building and its operations. Mirvac advised that AECOM has been appointed as Project Fire Engineers replacing BECA due to NSW Accredited Certifier C10 requirement.	Note	
3.	**Regulatory background** – Philip Chun briefly covered their regulatory role as the Accredited Certifier and referral of building plans to NSWFB for approval prior to issue of the Building Permit. All correspondence with the NSWFB is to be routed through Philip Chun.	Note	
4.	**FEB Section 1.4** – Nominated project stakeholders are listed in Table 1.1. NSWFB personnel to be updated in the table.	Note	
5.	**FEB Section 3.0** – • It was noted that the Client Dick Smith Electronic is self-insured and underwritten by FM Global. Accordingly, most fire protection requirements are over and above BCA DtS Provisions to meet the	Note	

No	Item	Action	Date
	Client's Property Protection and Business Continuity Objectives. • NSWFB enquired about the hazards posed by Aerosols, Alcohol and Dangerous Goods. • With reference to tabled drawings, AECOM advised that Aerosols will be stored in a separate fenced area with a gate in accordance with FM Global requirements. • The objective being to contain the aerosol containers within the designated storage area during a fire.		
7	**FEB Section 4.1 –** Proposed Alternative Solutions are listed here were confirmed by Philip Chun.	Note	
8	**FEB Section 4.1, Table 4.1, Alternative Solution # 1-** • It is proposed for the warehouse part of the building have a rationalised automatic smoke exhaust for use by the NSWFB for smoke clearance. Smoke exhaust is not proposed in the office space.	Note	
	• To assist the NSWFB with post-incident mop up operations, smoke clearance fan/s with a capacity of one air change per hour and AS/NZS 1668.1. Fire brigade controls are to be provided in the warehouse space. The smoke clearance fan/s are to be fire-rated along with fire rated cabling. The NSWFB requested that the smoke clearance fans be linked to the smoke detectors and sprinklers and be set to auto upon trip. BECA informed that the automatic activation of the smoke clearance system is not preferred by FM Global. BECA will confirm with FM Global and advice accordingly. .	BECA AECOM	9 Apr 2010
	• The Alternative Solution will be based on satisfactory ASET/ RSET analysis and FBIM as documented in the FEB. The building is to have AS 1670.1 smoke detection at extended spacing in accordance as per AS/NZS 1668.1.	AECOM	
	• NSWFB requested that the smoke modelling be undertaken until Fire Brigades arrival time. The two responding fire stations would be Homingsea Park and Macquarie Fields, but requested confirmation via the NSWFB website. .		
	• Mirvac informed the louvers will be opened most of the time. Mechanical engineer to confirm if louvres can remain closed on eastern side of the building to allow bushfire control to override smoke exhaust system. • NSWFB requires the louvers to activate upon fire trip and be also provided with a manual override switch located at the main FIP.	BECA/Mirvac	

No	Item	Action	Date
	• Mechanical Engineer to consider make-air provisions for the above smoke clearance system	BECA	
9	**FEB Table 4.1, Alternative Solution # 2 –** NSWFB and Philip Chun agreed the perimeter vehicular access provided is compliant with the BCA. NSWFB advised design team to refer to Policy 4 with regards to Perimeter Vehicular Access requirements.	Note	
	During the future high bay construction, NSWFB requested that fire engineer address CP9 limitations.	Mirvac	
	Mirvac to ensure change on external pavement levels complies with Policy 4.	Mirvac	
10	**FEB Table 4.1, Alternative Solution # 3, #4 & #6 –** Extended travel distances of ~30 m to a point of choice, ~118 m of total travel distance to an exit and ~224 m between alternative exits are proposed in the Ambient Warehouse Spaces and up to 135 m on conveyor picking platform.	Note	
11.	**FEB Table 4.1, Alternative Solution # 5 –** Reduced exit widths to 943 mm on conveyor picking platform. NSWFB requested consideration of fire brigade personnel access during intervention.		
	• With reference to drawing numbered S01904L021, Mirvac confirmed that the Pallet Picking Rack platform height is~ 3.0 m with overall height is 8.5 m. Overall this is less than the maximum height of 10 m required by fire hydrant hose stream.	AECOM	9 Apr 2010
	• It was agreed that for a fire on the conveyor platforms, fire brigades will apply water from floor levels rather than access the platform due to the timber flooring. Hence, hydrants will be configured to provide adequate coverage from floor level.	BECA	
	• Conveyor belt to be linked to detection system and to shut down upon trip.		
12.	**FEB Table 4.1, Alternative Solution # 7 –** Fire hydrants • The warehouse spaces will be served by a ring main hydrant system with auxiliary internal hydrants to compensate the shortfall of coverage by external hydrant.	Note	
	• The hydrants located under the canopy along the receiving and delivery docks at eastern and northern sides of the building will be considered as external hydrant provided with the radiant heat shields for the hydrants which will vary from BCA E1.3. Radiation shield to be constructed to comply with AS2419.1	Costin Roe	9 Apr 2010

No	Item	Action	Date
	• NSWFB did not support a combined sprinkler and hydrant system from the meeting however advised BECA to provide detail calculations and via a separate proposal for assessment by the NSWFB Peer Review Group. • Concerns highlighted included need for eight fire brigade appliances to boost, potential over-pressure of 1200 KPa at outlets, no redundancy, reliability issues with sprinkler pumps and required flow pressure for boosting. • The fire control centre is located near the main entry to the Admin office. • The booster is to be located near the water tank area at the southwest of the building. • Appropriate block plans and signage to be provided at the main FIP to show locations of all fire-fighting equipment. • Emergency Evacuation Assembly Point to be located away from the building with due regard to bushfire hazards.	BECA BECA MNIA BECA Mirvac	
13.	**FEB Table 4.1, Alternative Solution # 8 –** It is proposed to utilised fire hose reels with 50 m hose lengths. • AECOM suggested additional fire extinguishers in lieu of hose reels due to risk to occupants during first aid fire fighting (i.e. way finding system, training etc). • NSWFB recommended AECOM to provide the assessment separately to be raised to NSWFB for consideration. • BECA to provide drawings indicating locations and compliance coverage. • Post meeting note – it was agreed that a compliant fire hose reel system with 50 m hose lengths is to be documented by the Fire Services Engineer.	Note AECOM BECA AECOM/BECA	
14.	**FEB Table 4.1, Alternative Solution # 9 –** The building is proposed to be provided with ESFR sprinkler system in accordance with FM datasheets 2-2 and AS2118.1:1999. Where FM and AS requirements differ, the more stringent of the two is to be applied.	Note	
15	**FEB Table 4.1, Alternative Solution # 10 –** Exit signage is not proposed within the racking bays due to forklift hazards. • Normal exit signs are proposed at the exits around the building perimeter visible from a distance greater than 32 m at the compliance height. • Jumbo directional exit signs are proposed at the aisles within the building perimeter visible from a distance greater than 32 m at the height of 5 m to allow for forklift passage. • Exit signs will be provided at all exits from the individually separated areas such as confectionery, aerosol storage etc. • Electrical Engineer to confirm final exit signage layout.	BECA	9 Apr 2010

No	Item	Action	Date
16	**FEB Section 4.2 –** Mirvac noted the requirement for fire separation of Aerosol products which will comply with FM requirements.	Note	
17	**FEB Section 4.4.8 –**The main fire control panel will be located in the fire control centre with a repeater panel. A dedicated room is provided on the plan.	Note	
18	**FEB Section 8 –** The proposed design fires outlined were discussed. NSWFB agreed with the proposed design fires. Recommended qualitative consideration of the scenarios in the Alternative Solutions as well.	Note	
19	**Recycled water for Fire-Fighting** - Mirvac advised of the DA Consent requirement to utilise recycled water for fire-fighting. NSWFB requested that Mirvac formally submit a proposal outlining the proposed water grade and quality for consideration by the Fire Brigades.	Mirvac	9 Apr 2010
20	**Overall FEB** - NSWFB agreed in-principle with the proposed Alternative Solutions in the FEB and was comfortable for AECOM to proceed with preparing the Fire Engineering Report (FER) once the FEB is finalised.	AECOM	7 April 2010
22	**Way Forward** - AECOM indicated that the FEB will be updated to incorporate outcomes out of the FEB meeting and formally submitted to the NSWFB within 7-10 days.	Note	

Appendix G

Correspondences

Appendix G Correspondences

NSW FIRE BRIGADES

COMMUNITY SAFETY DIRECTORATE
STRUCTURAL FIRE SAFETY UNIT
Amarina Avenue Greenacre NSW 2190
Locked Bag 12 Greenacre NSW 2190

www.fire.nsw.gov.au info@fire.nsw.gov.au ABN 12 593 473 110

Your Reference:		Telephone:	(02) 9742 7400
File No:	NFB/06655	Facsimile:	(02) 9742 7483
Contact Officer:	Chris Hughes	Email:	firesafety.nswfb@fire.nsw.gov.au

06 October 2010

Phillip Chun
Suite 404 44 Hampden Rd
ARTARMON NSW 2064

robertm@philipchun.com.au

Attention: Rob Marinelli

Dear Sir,

Re: Initial Fire Safety Report for Cowpasture Rd, HOXTON PARK

Reference is made to your correspondence dated 09/08/2010, regarding the above premises, requesting the NSW Fire Brigades (NSWFB) to provide an Initial Fire Safety Report pursuant to Clause 144 of the Environmental Planning and Assessment Regulation 2000 (EP&A Reg.).

The NSWFB notes the following alternative solutions intended to meet the Performance Requirements contained in the following Category 2 Fire Safety Provisions: EP1.3, EP1.4 and EP2.2

Following an application for a construction certificate being received by you, the nominated Principal Certifying Authority (PCA) for the above development, the following documentation and information was forwarded to the NSWFB in accordance with the requirements of Clause 144 (2) (a), (b), (c) and (d) of the EP&A Reg.:

(a) A copy of the Application for Construction Certificate;

(b) Plans and specifications for the building including drawings numbered; AR210-214, AR260-261, AR265, AR280-282.

(c) A Fire Engineering Report (FER) numbered: 60044407-DSE-FER dated 17/6/2010, FER Revision No. 1, prepared by Amer Magrabi of AECOM;

(d) The nominated assessment methods used to establish compliance with the performance requirements are Clauses A0.9 (b) (ii) and A0.9 (c) of the Building Code of Australia (BCA).

PREVENT PREPARE PROTECT

On the basis of the above documentation and pursuant to Clause 144 (4) and (9) of the EP&A Reg., the NSWFB provides the following advice:

(a) (i) That the alternative solution will meet Performance Requirement EP1.4 – The combined use of FM Global and Australian Standard (AS) 2118 sprinkler systems **– Satisfied.**

(a) (ii) That the alternative solution will meet Performance Requirement EP1.3 – Location of the hydrant booster and certain internal hydrants - **Not Satisfied**;

Explanation

Based on the information provided the NSWFB is unable to undertake a thorough assessment of the proposed location of the hydrant booster assembly and it's suitability to support effective fire fighting operations. This information was not provided in the plans and specifications for the building or within the FER.

Further, the NSWFB is unable to adequately assess the suitability of the internal hydrants.

(a) (iii) That the alternative solution will meet Performance Requirement EP1.3 – Location of some external hydrants **– Conditionally Satisfied**;

Recommendation

The NSWFB has reviewed the alternative solution in regards to the location of the fire hydrants under the canopies and is of the opinion that it will not disrupt fire fighting operations. NSWFB support for this alternative solution is conditional on the hydrants in question being provided with dual valve controlled outlets complying with AS 2419.

(a) (iv) That the alternative solution will meet Performance Requirement EP2.2 – Rationalisation of the Smoke Exhaust System - **Not Satisfied**;

Explanation

1) The Fire Engineering Report (FER) has not clearly detailed the fire brigade intervention analysis on a time line basis and the details of the key conditions within the building from the CFD analysis. These conditions include a slice file detailing the X and Y plane through the fire and cross section of the warehouse as well as the Z plane at 1.5m from ground level. The slice files should detail:

- The time of fire brigade arrival;
- The time of fire brigade entry for search and rescue with consideration to the travel required from the most distant location of the picking platform being the worst case travel issue (135m to an exit);
- The time period that routine conditions occur and where;
- The time period that hazardous conditions occur and where;
- The time period that extreme conditions occur and where;
- The time period that critical conditions occur and where.

2) Although the report has stated that occupants will be able to evacuate the building by using the ASET v RSET method, the reviewing Officer is not satisfied that NSWFB intervention will be effective.

   The reason for this would be that operationally a fire fighter would only have approximately 80m worth of distance once the warning alarm for low air activates. This figure is far less than the 135m. Therefore, fire fighter safety would be compromised in this instance.

(a) (v) That the alternative solution will meet Performance Requirement EP2.2 – Deletion of the Smoke Exhaust System within the office area - **Satisfied**;

(a) (vi) That the alternative solution will meet Performance Requirement EP2.2 and DP4 – Extended travel distances – **Not Satisfied**;

Explanation

1) The Fire Engineering Report (FER) has not clearly detailed the fire brigade intervention analysis on a time line basis and the details of the key conditions within the building from the CFD analysis. These conditions include a slice file detailing the X and Y plane through the fire and cross section of the warehouse as well as the Z plane at 1.5m from ground level. The slice files should detail:

   - The time of fire brigade arrival;
   - The time of fire brigade entry for search and rescue with consideration to the travel required from the most distant location of the picking platform being the worst case travel issue (135m to an exit);
   - The time period that routine conditions occur and where;
   - The time period that hazardous conditions occur and where;
   - The time period that extreme conditions occur and where;
   - The time period that critical conditions occur and where.

2) Although the report has stated that occupants will be able to evacuate the building by using the ASET v RSET method, the NSWFB is not satisfied that NSWFB intervention will be effective.

   The reason for this would be that operationally a fire fighter would only have approximately 80m worth of distance once the warning alarm for low air activates. This figure is far less than the 135m. Therefore, fire fighter safety would be compromised in this instance.

(a) (vii) That the alternative solution will meet Performance Requirement EP2.2 and DP4 – Distance between exits – **Satisfied**;

(a) (v) That the alternative solution will meet Performance Requirement EP2.2 and DP6 – Reduced exit width on the pallet picking racks platform – **Satisfied**;

(a) (vi) That the alternative solution will meet Performance Requirement EP1.1 – The use of 50m hose reels – **Satisfied**;

(a) (vii) That the alternative solution will meet Performance Requirement EP4.2 – The use of exit signs at different heights to the Australian Standard – **Not Satisfied**;

1) The NSWFB has reviewed the alternate solution in regards to the use of the jumbo signs within the building and is not satisfied with the assessment within the report for the following reasons:

i. Appendix E, as listed, states that the maximum distance for this sign is 36m. Therefore, the report does not assess how 48m of viewing will be attained, therefore a lack of justification within the report.

ii. At 5m height, the sign will be obscured by smoke once fire fighting operations commence, the report does not assess this problem and how to eliminate it. Demonstration of visibility "At least until evacuation has completed" is not satisfactory considering that these signs may be the only way that persons may be able to get out of the building.

(b) That the fire hydrants in the proposed fire hydrant system will be accessible for use by the NSWFB – **Not Satisfied**; and

(c) That the couplings in the system will be compatible with those of the fire appliances and equipment used by the NSWFB – **Conditionally satisfied subject to the fire hydrant booster assembly connections and all fire hydrant valves being fitted with Storz aluminium alloy delivery couplings manufactured and installed in accordance with Clauses 7.1 and 8.5.11.1 of AS 2419.1-2005. Refer to NSWFB Guide Sheet no. 4 'Hydrant System Connectors' which is available at www.fire.nsw.gov.au**.

Your attention is drawn to Clause 152 of the EP&A Reg. In part, Clause 152 stipulates a necessity for the certifying authority to be furnished with a Final Fire Safety Report for the building from the NSWFB. You are therefore advised to make application to the NSWFB for a Final Fire Safety Report as soon as practicable after receiving an application for an Occupation Certificate. Please note that a relevant Fire Safety Schedule and relevant Fire Safety Certificate, (as per Clause 149 (2) (c) & (d), Clause 168, Clause 170, Clause 171 and Clause 172 of the EP&A Reg.), will need to be supplied at the time of your application.

As a condition of the NSWFB issuing this initial fire safety report, a report is required from the fire engineer of record at the time of application for a final fire safety report. The report is to certify that the final design and construction, including all fire safety features and characteristics submitted under Clause 144 of the EP&A Reg. is consistent with the FER submitted to the NSWFB for assessment. This report is required by the NSWFB to assist in satisfying itself that the performance requirements subject to alternative solution have been satisfied.

Note that any revisions to the FER subsequent to the issue of this Initial Fire Safety Report will require certification from the fire engineer stating that the alternative solutions assessed by the NSWFB are unaffected by the revised report. It is a NSWFB condition that all such certification is issued prior to a Final Fire Safety Report being issued by the NSWFB pursuant to Clause 152 of the EP&A Reg.

The issue of this Initial Fire Safety Report satisfies the Fire Commissioners obligations under Clause 144 (3) of the EP&A Reg. In situations where the FER is revised subsequent to its issue and Alternative Solutions assessed by the NSWFB are affected and/or additional areas of non-compliance affecting Category 2 Fire Safety Provisions are identified, a revised 'complete' application will need to be submitted where further NSWFB review is requested.

Should you have any further enquiries regarding any of the above matters please do not hesitate to contact the Structural Fire Safety Unit.

Yours faithfully

Electronically approved for release.

For Commissioner

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11 November 2010

NSW Ref: NFB/06655
The Commissioner
NSW Fire Brigades
Amarina Ave
Greenacre, NSW

Attention: Chris Hughes

Dear Mr Hughes

Re: Dick Smith Electronic Distribution Centre, Cowpasture Road, Hoxton Park, NSW (NSWFB Ref: NFB/06655)

With reference to the NSWFB letter dated 06 October 2010 on our Fire Engineering Report, please find our response to Items a) – c) for your consideration:

Project Update - Please note that this project is currently undergoing several changes. The changes include:

1) Omission of Pick Module Platform
2) New racking layout

However, the existing building footprint will remain the same and no new external works are proposed as such to the original building shell. New revision of the Fire Engineering Report (FER) is currently being prepared addressing the above issues and will be submitted to NSWFB.

a) (i) Noted. The assessment will be included in Section 9.6 of the new FER revision.

(ii) Noted. The Fire Services Drawings indicating location of the booster and certain internal hydrants will be submitted for NSWFB review.

(iii) Noted. The requirement of dual valve controlled outlets will be included in Section 4.4.4 Fire Hydrant Requirements of the new FER revision.

(iv) The smoke modelling was undertaken up to fire brigade arrival time as agreed during the FEB Meeting on 24 March 2010. However, as per subsequent discussion with NSWFB and our letter to NSWFB dated 17 June 2010, we have investigated tenability condition up to 2400 s in lieu of 794 s of arrival times from the first responding stations. It is also worth noting the smoke modelling that were carried out without the provision of smoke exhaust system, as such has increased the conservativeness of the assessment.

The smoke modelling will be re-carried out up to 2400 s as agreed during FEB process. The provision of smoke exhaust system based on 1 ACH as required by NSWFB will be included in the modelling. Slice files at 1. 5 m height will also be included in the modelling. The detail assessments will be included in Section 9.2, Appendix C and Appendix D of the new FER revision.

(v) Noted. Please note that Pallet Picking Racks Platform assessments will be omitted in the new FER revision.

AECOM

(vi) 1) & 2) As per to Item (iv) new computational smoke modelling will be carried out up to 2400 s to. The detail assessment will be included in Section 9.3, Appendix C and Appendix D of the FER revision.

(vii) Noted.

(viii) Noted. Please note that Pallet Picking Racks Platform variations will be omitted in the new FER revision.

(IX) Noted.

(X) (i) The assessment in the current FER was based on the smoke modelling without the provision of smoke exhaust system. New computational smoke modelling with provision of smoke exhaust system will be carried out up to 2400 s. We will further investigate the visibility at 5 m based on new smoke modelling result. The detail assessment will be included in Section 9.7 of the new FER revision.

(ii) The intent of the BCA EP4.3 is to provide building occupants with clear and concise information on what route to take to evacuate a building in an emergency. We consider the demonstration of visibility "at least until evacuation has completed" is adequate.

b) Noted. As per Item (a)(ii), Fire Services Drawings indicating detailed locations of the booster and internal hydrants will be submitted for NSWFB review.

c) Noted. Requirement of Storz Aluminium alloy delivery couplings will be included in the Section 4.4.4 Fire Hydrant Requirements.

I trust the above addresses all matters raised by the NSWFB. Should you require any further clarifications, please do not hesitate to contact me.

Thanking You

Yours faithfully

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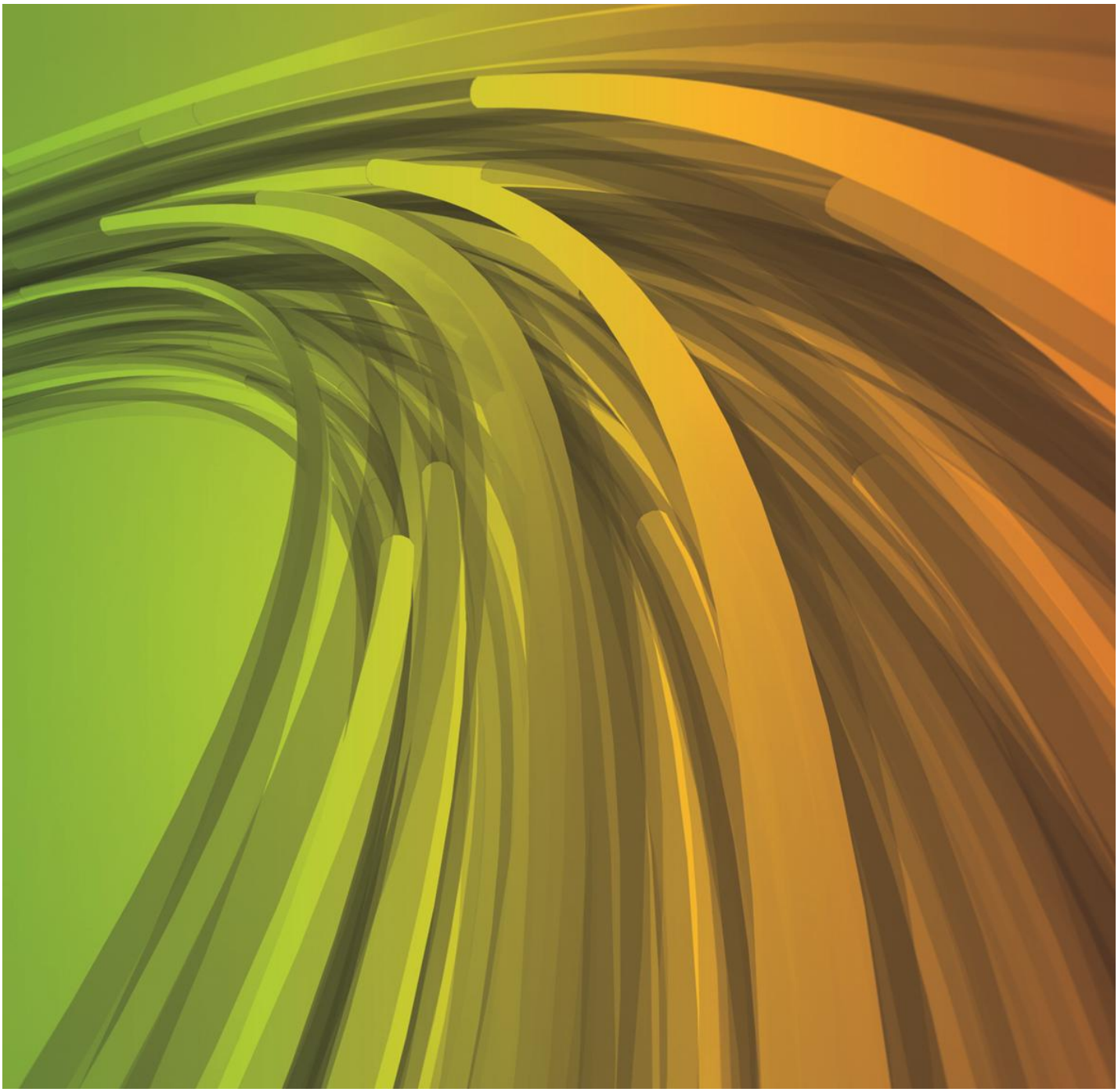
cc: Robert Marinelli (Philip Chun Associates)

Appendix C

Mixed Class Dangerous Goods Assessment Report

Appendix C Mixed Class Dangerous Goods Assessment Report

AS/NZS 3833:2007 Requirements applicable to Masters Distribution Centre



AS/NZS 3833:2007 Requirements applicable to Masters Distribution Centre

Masters Distribution Centre, Hoxton Park

Prepared for

Woolworths Limited

Prepared by

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08/12/12

60239133

AECOM in Australia and New Zealand is certified to the latest version of ISO9001 and ISO14001.

Quality Information

Document AS/NZS 3833:2007 Requirements applicable to Masters Distribution Centre

Ref 60239133

Date 08/12/12

Prepared by Kevin Blackie

Reviewed by Frank Mendham

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
Draft	01/08/2011	Draft	Frank Mendham Associate Director	
Final	07-Dec-2011	Final	Frank Mendham Associate Director	
Final_2	08-Dec-2011	Final	Frank Mendham Associate Director	

Table of Contents

Executive Summary

AECOM was engaged by Woolworths Limited (Woolworths) as dangerous goods consultants for the assessments of mixed class dangerous goods storage at the proposed Masters Distribution Centre located in Hoxton Park, New South Wales.

This report was prepared based upon the requirements of *AS/NZS 3833:2007 'The Storage and Handling of Mixed Classes of Dangerous Goods, in Packages and Intermediate Bulk Containers'.* The intent of AS/NZS 3833:2007 is to 'set out the requirements and recommendations for the safe storage and handling of Dangerous Goods, where dangerous goods of more than one Class are kept within the same storage area, without the need for segregating walls.

The site is located approximately 6.5km west of the Liverpool CBD on Cowpasture Road within the new industrial suburb, Len Waters Estate. The site is bound by the M7 Motorway to the west, Cowpasture Road to the south, Hinchinbrook Creek to the east and the proposed residential suburb of Elizabeth Hills to the north.

Based on the quantities of mixed classes of dangerous goods provided in Appendix B, the mixed class dangerous goods storage shall be separated from protected places by a distance of at least ***30m.***

The mixed class dangerous goods storage areas shall be at separated from on-site protected places by a distance of at least ***15m.***

Measures outlined in Section 3 of AS/NZS 3833:2007 provide opportunities to eliminate the need for a dedicated Dangerous Goods Package Store. It should be noted however if the risk based work methods outlined in AS/NZS 3833:2007 are unable to be achieved or are undesirable, our recommendation is to construct a designated Dangerous Goods Storage Facility (Package Store) as detailed in Section 5 of AS/NZS 3833:2007. As such, Woolworths is required to confirm compliance with the requirements of AS/NZS 3833:2007 prior to the facility coming into operation.

In addition to the requirements outlined in this report, the development application will require a Preliminary Hazard Analysis to be conducted due to the quantity of dangerous goods exceeding the threshold limits described by the State Environmental Planning Paper No.33 (SEPP 33).

1.0 Introduction

1.1 Scope of Study

AECOM was engaged by Woolworths Limited (Woolworths) as dangerous goods consultants for the assessments of mixed class dangerous goods storage at the proposed Masters Distribution Centre located in Hoxton Park, New South Wales.

This report was prepared based upon the requirements of *AS/NZS 3833:2007 'The Storage and Handling of Mixed Classes of Dangerous Goods, in Packages and Intermediate Bulk Containers'* and does not address the structural and civil engineering aspects of the proposed design, other than how fundamental significant features of the structure such as 'bunding' and 'Fire Rating Levels' are required to meet compliance with applicable Dangerous Goods Standards.

A brief description of the site location is provided in Section 1.2 below.

Note: This report is not a Dangerous Goods storage application to NSW Government, however is designed to support such an application.

1.2 Site Description and Operations

1.2.1 Site location and legal description

The site is located approximately 6.5km west of the Liverpool CBD on Cowpasture Road within the new industrial suburb, Len Waters Estate. The site is bound by the M7 Motorway to the west, Cowpasture Road to the south, Hinchinbrook Creek to the east and the proposed residential suburb of Elizabeth Hills to the north. The site was formerly the Hoxton Park Aerodrome. The site is located within the Liverpool LGA.

The site is legally described as:

- Lots 5050-5054 in DP 1161757; and
- Lot 101 DP 1158385.

Figure 1 Site plan

1.2.2 Existing use

The site was most recently used as Hoxton Park Aerodrome, an uncontrolled airfield for light aircraft and helicopters for private flight training and flying. As the aerodrome was never used for commercial flights, the aerodrome does not have a passenger terminal. Several airport hangers and associated buildings, which were occupied by the flying school and other similar companies, were erected to the west of the runway. These buildings were low scale in nature and are generally constructed out of corrugated metal sheeting or brick.

This use ceased in December 2008 and the site is currently being developed for industrial warehousing, distribution and residential purposes.

1.2.3 Existing buildings

With exception of the hangers and buildings which have been partially demolished and the airstrip which has been decommissioned, the site is generally cleared, and predominantly comprises mown grassed areas.

2.0 Standards Review

2.1 Review of AS/NZS 3833:2007 Applicability

As the proposed RDC will store mixed classes of Dangerous Goods in retail packages, AS/NZS 3833:2007 was considered to be the most applicable Standard for this assessment.

The intent of AS/NZS 3833:2007 is to 'set out the requirements and recommendations for the safe storage and handling of Dangerous Goods, where dangerous goods of more than one Class are kept within the same storage area, without the need for segregating walls.

AS/NZS 3833 is a relatively new Standard that considers 'consumer commodities' in various ways and under various storage scenarios, but most importantly it takes into account recent changes to AS1940:2004. The significance of this is AS1940 has a significant impact on the design requirements of dangerous goods storage facilities, as it can be quite onerous in terms of fire rating levels and separation distances to various locations and to ignition sources. This is why a 'risk-based' approach, is considered an alternate approach to the design of Dangerous Goods Storage facilities where Class 3 Flammable Liquids are proposed.

The most significant impact of basing the assessment of the proposed Dangerous Goods Storage facility on AS/NZS 3833:2007 is that this Standard addresses 'Retail Storage' and specifically addresses the storage requirements for quantities of Dangerous Goods in retail packages in the context of 'Retail Distribution Centres' (RDC). AS 1940 does not differentiate perceived low risk RDC situations from perceived high risk storages, such as fuel storage facilities.

AS/NZS 3833:2007 applies a maximum storage quantity to Dangerous Goods stored in retail packages for Retail Stores. When this storage amount is exceeded the requirement for the construction of a dedicated Dangerous Goods Storage facility exists for Retail Stores, however this quantity may be exceeded for Retail Distribution Centres with no upper limit specified, nor the requirement for a Dangerous Goods Storage facility prescribed. A Retail Store is not equivalent to a Regional Distribution Centre. The Glossary provided at Section 8.0 of this report defines each as set out in AS/NZS 3833:2007.

Australian Standard AS/NZS 3833:2007 specifies requirements which are to be met for Retail Distribution Centres storing Dangerous Goods. The option exists to eliminate the need for a Dangerous Goods Storage facility provided the measures as outlined in Section 3 of AS/NZS 3833:2007 and summarised in Section 2.2 of this report are implemented.

If the requirements set out in Section 3 of AS/NZS 3833:2007 are unable to be achieved or are undesirable, a Dangerous Goods Storage Facility should be constructed and managed as detailed in Section 5 of AS/NZS 3833:2007.

2.1.1 Hazard Assessment

A written hazard assessment is necessary. This assessment needs to identify the dangerous goods that are to be stored, address all of the relevant requirements clause-by-clause, and record in detail how compliance with the requirements will be achieved.

The hazard assessment needs to identify the compatibility or otherwise of all of the dangerous goods that are to be stored. Some goods might react dangerously, and this also needs to be identified. If goods that are not dangerous goods are to be kept in the same store, their compatibility may also need to be investigated. This information is necessary so that the goods can be suitably segregated within the store.

The hazard assessment also needs to provide for ongoing store management and housekeeping. It may be necessary to obtain expert advice when planning the store. It is usually best to contact the relevant regulatory authority for the storage and handling of dangerous goods at an early stage.

2.2 AS/NZS 3833:2007 Requirements without Dedicated Dangerous Goods Store

AS/NZS 3833:2007 does not apply a maximum storage quantity for Dangerous Goods stored in retail packages in Retail Distribution Centres with or without a dedicated Dangerous Goods Storage Facility. The following outlines the requirements as outlined in Section 3 of AS/NZS 3833:2007 for Retail Distribution Centres not provided with a dedicated Dangerous Goods Store. Compliance with the requirements specified below provides an option to eliminate the requirement for a dedicated Dangerous Goods Storage Facility.

2.2.1 Retail Packages

Dangerous Goods in retail packages shall be packed in accordance with the ADG Code/NZS 5433, and the SUSDP, as appropriate.

The maximum sizes of the inner or sole packages kept as retail packages shall not exceed those given in the table below:

Table 1 Maximum sizes of retail packages for dangerous goods

Class or Division	Maximum Package Size	Examples and requirements
2.1	1 L	Butane lighters, cartouches of camping gas
2.2	120 mL	Soda bulbs, beverage gases
Aerosols (UN1950) and other non-refillable pressure containers	1 L	No division 2.3 or 6.1 subsidiary risk
3	20 L	Acetone, mineral turpentine (turps), kerosene
3 Manufactured Product	20 L	Oil-based paint, primers, sealants and adhesives
Combustible C1 and C2	20 L	Cooking oils, motor oils
4.1	500 g or mL 3 kg**	**only if firelighters
4.3	500 g or mL 1 kg**	** only in solid form Zinc dust for two-pack metal primers
5.1	20 kg or 20 L 10 kg**	**only if pool chlorine in granulated or tablet form (not powdered form)
5.2 Not requiring temperature control	125 mL (liquid) 500 g**	**only if in solid or paste form Automotive filling compounds, two-part epoxy or polyester resins and adhesives
6.1	20 kg or L	Some pesticides, paint strippers
8	PG II – 5 kg or L PG III – 20 kg or L	Liquid sodium hypochlorite (pool chlorine)
9	20 kg or L	Lithium baterries

2.2.2 Racks and Shelving

- Structurally sound racks and shelves which do not absorb liquids and are compatible with the Dangerous Goods being kept shall be provided. Racks and shelves are to be positioned such that they permit ready access to all stock and provide a clear passage. Clear exit paths are to be provided where Dangerous Goods are kept.
- Provisions inside the centre must be provided to confine any spill of dangerous goods. This may include the implementation of barriers on shelves which store Dangerous Goods to ensure that the spill does not spread beyond the shelf of origin.

2.2.3 Segregation

- Goods which may undergo reaction from contact must be separated
- Incompatible goods must not be stored horizontally or vertically on the same shelf.
- Class 6.1 or 8 Dangerous Goods must be stored away from foodstuff, food containers or items for direct human application if not provided in liquid tight containers. If not provided in liquid tight containers, a lateral distance of no less than 1m must be maintained if located on the same shelf or else must be located on separate shelves.
- Aerosols stored in the RDC must either be stored in a cage or dispersed throughout the centre. All aerosols must be stored undercover and protected from exposure to direct sunlight; the effects of the weather and a minimum of 3m away from any heat or ignition sources. In addition aerosols must be located on a stable shelf which reduces the likelihood of a stack collapse and damage to containers.

2.2.4 Security

- The RDC shall be restricted to authorised personnel only. Any additional regulatory requirements for Dangerous Goods stored also apply.

2.2.5 Housekeeping

- A high level of housekeeping must be maintained in the centre.
- Stock integrity should be monitored. Old material which could deteriorate and become a hazard must be disposed of.
- Aisles to be kept clear at all times.
- Liquids and powders must not to be stored together. Liquids in glass bottles are to be stored at lower levels below powders and solids.
- Packages should be stored such that a package leak will not affect other substances. To minimize the risk of leaks, packages must be handled with care at all times.
- All packages to be regularly inspected to ensure package leaks are minimised. If signs of spill, leak or deterioration are observed the package is to be rendered safe.
- Leaks or spills should be dealt with in accordance with the developed facility Emergency Procedures.
- Labels to remain on empty containers until decontaminated at which time the labels to be removed.
- Packages must not be kept in direct contact with the floor. Pallets or low shelves to be used.
- Used packages which cannot be recycled must be disposed of by means of an approved method via consultation with the local waste disposal authority, environmental protection authority and health department. Waste storage and disposal requirements are specified later in this report.

2.2.6 Lighting and Ventilation

- Adequate natural ventilation or mechanical ventilation must be provided, depending upon the materials being stored and any vehicle exhaust fumes that might be emitted.
- The ventilation system shall be sufficient to ensure that any vapours generated within the store are diluted with, and removed by, the flow of air passing through the facility.
- Where flammable liquids are being stored, the atmosphere shall be maintained below 10% of the lower explosive limits during normal operation.

- Vents shall be located so as to ensure effective air movement to all parts of the store.
- Adequate lighting must be provided through out the centre, in addition where flammable goods are stored AS/NZS 60079.10.1 should be referenced.

2.2.7 Construction

- The Regional Distribution Centre should be constructed in accordance with the BCA.
- Where a retail distribution centre stores flammable solids, flammable liquids, or aerosols of Class 2.1, above the minor storage quantities given in Section 2 of AS/NZS 3833:2007, and shares a common wall with an adjoining protected place, the common wall shall have an FRL/FRR of at least 120/120/120. Where such a common wall is between the retail distribution centre and an on-site protected place (e.g. an administration block), the wall shall have an FRL/FRR of at least 60/60/60. Note: This is applicable to the proposed RDC, as the proposed quantities exceed teh minor storage quantities specified in AS/NZS 3833.
- Where vehicles such as forklifts traverse bollards and crash barriers are to be provided on shelves to reduce the risk of goods and shelves being damaged.
- A dedicated area inside the centre but isolated from the remaining areas must be provided for the products of any solid and/or liquid dangerous goods spills.

2.2.8 Fire Protection

- AECOM previously undertook a Fire Engineering Assessment for the Dick Smith Electronics (now Masters) Distribution Centre. Generally, the fire protection requirements shall be in accordance with requirements specified in the fire engineering study. Note: It is recommended that the Fire Engineering Assessment for the proposed RDC be reviewed and kept up to date consistent with the increase in the proposed quantities of dangerous goods, and/or where the fire load within the facility has increased. As a result of increased fire load under the Masters storage scheme, it is recommended that a review of the Dick Smiths FER be carried out in order to identify any ‘gaps’ between the previous design solution and the currently required design solution.
- The BCA and relevant Fire Brigade requirements must be considered. Other items to consider are total floor area, construction of the store, quantity and classes of dangerous goods being kept, location of the store and fuel load.
- The Fire Protection equipment shall be designed so it is appropriate to the type and class of Dangerous Goods stored. The Fire protection measures implemented must be able to quickly control or extinguish a fire and prevent a fire nearby from affecting the store.
- Fire fighting equipment, in addition to BCA requirements, must be stored adjacent to exit doors or when in large areas, along exit routes. All equipment should be readily visible.
- Fire fighting equipment shall be labelled as required by the relevant Australian Standard and should be sheltered or enclosed if located in outside or extreme areas.
- All fixed fire protection and detection systems must be in accordance with relevant Australian Standards and must activate without delay.
- If a fire alarm system is provided, Manual Call Points must be provided in safe locations near work areas. Evacuation and alert tones must be clearly distinguishable and a back up electricity supply must be provided.
- Fire extinguishers shall be provided as per BCA and relevant Fire brigade requirements. Consideration must be given to the Dangerous Goods being stored and the electrical equipment.
- Fire hose reels must be provided as per BCA and relevant Fire Brigade requirements. Fire hose reels must be provided to serve every storey of a building where the floor area used to store dangerous goods exceeds 300m^2. The stream from a fire hose reel must be able to reach every part of the floor area including the top of rack storage.
- If foam fire hose reels are utilised they must be able to produce foam as per manufacturer’s specifications.
- Where monitors are used they must be capable of applying the required water density and quantity at the store. 50% more water must be provided above the calculated quantity to take into account adverse wind conditions. Adjustable monitors must be operable in a safe remote location. Fixed monitors should be

provided with adjustable constant flow and fog to straight stream nozzles. Monitors should be 15-30m from the facility being protected. If closer, radiant heat protection should be considered.

- Fire protection systems must be maintained to AS 1851:2005 'Maintenance of fire protection systems and equipment'.
- A plan to ensure run off fire fighting water does not enter the surface or ground water should be implemented.

From the proposed quantity of dangerous goods to be stored onsite (Appendix B) and the requirements specified above, it is recommended that the following fire protection be provided in addition to the requirements of the BCA, insurer's requirements or any other relevant authority, to comply with the requirements of AS/NZS 3833:

- Portable Fire Extinguishers
- Fire Hose Reels
- Fire Hydrants
- Automatic Fire Suppression or equivalent.

Portable fire extinguishers

Fire extinguishers shall comply with the appropriate Australian Standard as listed in the table below, and shall be installed and located in accordance with AS 2444, and adjacent t the relevant area of risk.

Table 2 Standards for portable fire extinguishers

Type	Standard
Water type	AS/NZS 1841.2
Foam type	AS/NZS 1841.4
Powder type	AS/NZS 1841.5
Carbon dioxide type	AS/NZS 1841.6
Wheeled fire extinguisher	AS 4265
Selection and location	AS 2444
Classification of extinguisher	AS/NZS 1850

Extinguishers shall be selected with the following criteria in mind:

a) Its suitability for use with the class of dangerous goods on which is intended to be used.

b) With regard to indoor electrical equipment such as electrical switchboards, dry powder-type extinguishers are preferred.

c) Where powder-type and foam extinguishers are liable to be used together in an emergency, they shall be compatible.

d) Alcohol-compatible foam shall be used for alcohol and other polar liquids.

Fire hose reels

Hose reels shall comply with AS/NZS 1221, AS 2444 and the following requirements:

a) Hose reels shall be provided in locations to the satisfaction of the local fire authority

b) Hose reels shall be provided on every story of the building where the total floor area used to store dangerous goods exceeds 300m^2

c) Hose reels shall be located in sufficient number so that it is possible to reach any part of the storage area, including to the top of the racks, with discharge from at least one hose reel.

d) Sufficient hose reels shall be provided so that no point is beyond an arc formed by a radius of two thirds of the length of hose, measured from the hose concerned

e) Where foam hose reels are installed, they shall be capable of producing foam in accordance with the manufacturer's specifications

f) Hose reels shall be maintained in accordance with AS/NZS 1221.

Fire hydrants

Fire hydrants shall comply with AS 2419.1 and be compatible with the requirements of the local fire authority. Hydrants may be equipped with hose, branch and nozzle at the discretion of the relevant fire authority.

Monitors

Where monitors are used, they shall be installed and maintained in accordance with the manufacturers' specifications. The following requirements and recommendations also apply:

a) Monitors shall be capable of applying the required water density and quantity at the store under adverse wind conditions. NOTE: For design purposes, adverse wind conditions are considered as requiring at least 50% more water than the quantity calculated as being normally required at the store.

b) If the monitor is adjustable, its means of operation and control shall be operable from a safe remote location.

c) Fixed monitors should be provided with adjustable, constant flow, fog to straight stream nozzles so that the facility is suitably protected, but not damaged by a solid stream at shorter ranges.

d) Monitors should be located 15–30 m from the facility to be protected. If monitors are required to be closer to the facility, radiant heat protection should be considered.

e) Monitors may be required to have foam-making capabilities.

Automatic sprinkler systems

Where fire sprinkler systems are required, they shall be installed in accordance with AS 2118/NZS 4541 and maintained in accordance with AS 1851. Such systems shall comprise:

a) individual-actuation sprinklers;

b) deluge sprinklers;

c) foam sprinklers; or

d) a combination of any of the above

Water supply

Where a fire service water supply is required, it shall comply with the requirements of the relevant Australian or New Zealand Standards for the fire protection equipment installed.

Retention of fire water

A plan shall be in place to ensure that fire water cannot enter surface or ground water. Where liquids are the principal fire fighting and cooling media, the provision of fire water retention facilities, with such capacity as to contain any water that may be generated, shall be determined in consultation with emergency services (in terms of quantity) and regulatory requirements.

2.2.9 Management in Use

- Decanting, repacking (other than to meet orders), blending, heat shrink wrapping, battery charging, parking or maintenance of vehicles are not to be carried out within 3m of the storage area. The primary function of the RDC is for the storage of goods.
- Any combustible liquids or Dangerous Goods of Class 2.1, 2.2, 3, 4.1, 4.3 and 5 are to be kept away from heating and ignition sources. Smoking inside the facility is to be prohibited. Signs notifying occupants of No smoking and No ignition sources are to be displayed at the entrances.
- Work permits are to be obtained before any construction and maintenance works are undertaken.
- All personnel handling Dangerous Goods must be educated in the hazards and trained in the safe and proper handling procedures.
- Upon detection of a leak or spill the area affected must be isolated and the spill must be cleaned without delay. Emergency procedures to be carried out.

- All packaging must be inspected upon arrival. If packaging if found to be damaged it must be moved to a clean, safe location for repair or repackaging.
- Tinting of flammable paints or opening of containers must be carried out away from potential ignition sources in well ventilated areas. AS 1940 should be referenced.

2.2.10 Emergency Procedures

- Emergency procedures for the premises should be prepared specifically for the premises. All personnel must be provided with training in the emergency procedures upon commencement of their employment. Annual training sessions for personnel should be provided. Personal and protective equipment must be provided for personnel.
- Upon detection of a leak or spill the affected area should be isolated and cleaned up immediately. Table 3 outlines the spill equipment that should be available.
- The following procedure should be carried out immediately upon detection of a spill or leak:

1) Identify the hazard and ensure all personnel are warned whilst spill equipment are collected.
2) Cordon off the area and display warning signs.
3) Consult the Material Safety Data Sheet (MSDS) or undamaged container to identify any safety precautions.
4) Clean up the spill.
5) Dispose of material safely.
6) Do not return spilt material to its original packaging unless it is known the risk will not increased.

Table 3 - Spill equipment

Spill Equipment
Absorbent Material
Mop and bucket
Adequate water
Broom, brush, dustpan and Bin
Safety lines and warning signage
Protective gloves and mask

2.2.11 Personnel Training

- All personnel which will come into contact with or handle Dangerous Goods on the premises must be fully trained in the properties, applicable safety regulations and safe handling procedures. MSDS must be made available to all personnel.
- All personnel on the premises must be trained in:
  - The nature of the work and safe methods of operation.
  - The properties and hazards of the substances handled.
  - The location of first aid equipment, and first aid measures.
  - The correct use of personal protective equipment, its care and maintenance.
  - Actions to be taken in various emergencies.

Evacuation drills and simulated emergencies are to be comprised in the training.

- Contractors on the premises must be trained in:

- Safety rules of the installation, including any restrictions on movement, access, activities and the use of personal protective equipment.
- Conditions and obligations associated with work permits and confined space entry permits.
- Hazards likely to be encountered, including any materials stored or handled on site.
- Procedures to be followed in the event of an incident.

2.2.12 Hygiene

- The following directions must be adhered to when handling Dangerous Goods.
  - Where Dangerous Goods are kept all food and smoking to be prohibited.
  - Wash hands after handling Dangerous Goods, before eating, drinking or using the toilet and after work.
  - Injuries involving Dangerous Goods must be addressed immediately.
  - Signs stating the above requirements must be displayed in the work area.

2.2.13 Personal Protective Equipment

- All personnel must be provided with adequate personal protective equipment in areas where Dangerous Goods are stored or handled. Personal protective equipment must be ready for use, be regularly maintained and located in designated locations which are well identified.
- The following types of personal protective equipment must be provided as appropriate to the operational requirements:
  - Protective clothing suitable for the specific Dangerous Good complying with AS/NZS 4501.2:2006 'Occupational protective clothing – General requirements'.
  - Eye protection selected in accordance with AS/NZS 1337: 1992 'Eye protectors for industrial applications'.
  - Protective gloves complying with AS/NZS 2161:2000 'Occupational protective gloves'.
  - Safety helmets complying with AS/NZS 1801:1997 'Occupational protective helmets' and selected in accordance with AS/NZS 1800:1998 'Occupational protective helmets – Selection, care and use'.
  - Safety footwear complying AS/NZS 2210:1994 'Occupational protective footwear'.
  - Respirators having appropriate filters, complying with AS/NZS 1716:1994 'Respiratory protective devices' and selected, used and maintained in accordance with AS/NZS 1715:1994 'Selection, use and maintenance of respiratory protective devices'.
- All personal protective equipment to be kept separate from normal clothing and maintained as follows:
  - After use all protective equipment to be maintained and cleaned in accordance with manufacturer's instructions and specific to material exposed to.
  - Safety helmets to be maintained in accordance with AS/NZS 1800.
  - Self contained breathing apparatus to be maintained in accordance with AS/NZS 1715.

2.2.14 Work Permits

- Except for routine non hazardous work, all work within the restricted area must be authorised through means of a work permit.
- The work permit should include:
  - The nature and extent of the work.
  - Any conditions to be observed
  - Any personal protective equipment to be used.
  - The period for which the permit is valid.
  - Any necessary regular checking to ensure safety requirements and conditions are maintained.

- Any necessary procedures and precautions required to return the area to normal service.
- Any fire fighting equipment required at hand.

2.2.15 Waste Storage & Disposal

- Where Dangerous Goods are stored a facility must be provided for the storage of wastes and items contaminated with Dangerous Goods. Requirements applicable to Dangerous Goods stores are applicable to the waste storage facility for Dangerous Goods.
- Assessments are to be made on the disposal or recycling of the following goods:
  - Goods that have been stored for extended periods of time where the contents may be deteriorated.
  - Wastes and residues from spills and leaks.
  - Unidentifiable goods.
  - Contaminated clothing.
  - Goods that are in excess of possible use or demand.
- Where goods are to be disposed, consultation with the local waste disposal authority, the environment protection authority and the health department must occur to determine the most appropriate method of disposal. Advice from manufacturers and other outside sources may be beneficial.

3.0 Legislation Review

3.1 Background

On 1 September 2005, the Dangerous Goods Act 1975 (NSW) was repealed and the Occupational Health and Safety Act 2000 (NSW) and the Occupational Health and Safety Regulation 2001 were amended with the addition of Chapter 6A to regulate dangerous goods of all quantities at places of work, and certain quantities of dangerous goods at non-workplaces.The applicable Acts Regulations and Codes of Practice under NSW State legislation for the storage, handling and transport of dangerous goods applicable to the RDC are:

- NSW Occupational Health and Safety Act 2003
- NSW Occupational Health and Safety Amendment (Dangerous Goods) Regulations 2005, and
- Storage and Handling of Dangerous Goods Code of Practice 2005.

The NSW Occupational Health and Safety Act 2003 issued by the NSW Government details the requirements under NSW law for the safe storage, handling and transport of dangerous goods. All items in relation to dangerous goods storage, handling and transporting in NSW must conform to this Act unless exemptions are specifically granted by the Chief Officer or the appropriate Minister. As the activities in the RDC will predominately encompass the safe storage, handling and transport of dangerous goods, this Act was considered to be the applicable Act to base this study.

3.2 Review of the NSW Occupational Health and Safety Amendment (Dangerous Goods) Regulations 2005 and Harmonisation Laws

It is proposed that the Occupational Health and Safety Amendment (Dangerous Goods) Regulations 2005 will be repealed on the commencement of section 276C of the Work Health and Safety Act 2011 No 10 on 1 January 2012. The implementation of the model Work Health and Safety Regulation (WHS Regulation) should not have a significant impact on how NSW businesses operate and manage work health and safety matters. Essentially, many requirements are unchanged, or substantially the same as is currently prescribed in the existing Regulations. Provisions relating to chemicals will be based on the globally harmonised system for classification of chemicals, subject to a five year transitional period. This will extend to chemicals that are dangerous goods.

The Occupational Health and Safety Amendment (Dangerous Goods) Regulations 2005, currently governs the storage and handling of dangerous goods in NSW. There Regulations apply to all dangerous goods at places of work (regardless of whether or not the premises are places of work or are used for work). A summary of the requirements of Regulations for the RDC is provided below.

3.2.1 Duty of Care

NSW Occupational Health and Safety Amendment (Dangerous Goods) Regulations 2005 places specific duties on employers, occupiers of premises, manufacturers, importers and people dealing with self-service fuel dispensing units, fuel dispensing units, liquefied flammable gas, the filling of balloons and other containers, and the decommissioning of LPG tanks.

Duties required by Regulations 2005 are as follows;

1 identifying, assessing and controlling the risk associated with the storage and handling of dangerous goods,

2 retaining records of induction and training,

3 keeping and maintaining registers of dangerous goods,

4 labeling duties, and

5 risk identification, assessment and control procedures.

3.2.2 Definition of 'dangerous goods'

"Dangerous goods" is defined in the OHS Act as:

"a) substances or articles subject to a national standard declared by the NOHSC; and

b) any other substances or articles of risk to public safety."

In addition, section 135A(2) of the OHS Act allows regulations to be made for any substance or article as dangerous goods - irrespective of quantities currently prescribed by the OHS Regulations and regardless of whether they are at a place of work.

3.2.2.1 Obligations of occupies storing and handling dangerous goods

Occupiers of premises must now comply with risk identification procedures set out in Division 2 of Part 6A.2.

3.2.2.2 Duties in relation to dangerous goods:

1 An occupier must ensure that all persons (including members of the public) are not exposed to risks to their health and safety arising from dangerous goods at the occupier's premises.

2 Occupiers have obligations with regard to dangerous goods that relates to risks to property or the environment, both inside and beyond the premises of the occupier.

3.2.2.3 Extension of hazard identification and risk assessment provisions

1 Division 1 (General duties of controllers of premises) of Part 4.2 of Chapter 4 of this Regulation extends to controllers of dangerous goods premises (regardless of whether or not the premises are a place of work or are used for work).

2 A reference in Chapter 2 (Places of work—risk management and other matters) and Division 1 (General duties of controllers of premises) of Part 4.2 of Chapter 4 of this Regulation to occupational health and safety (however expressed) includes, where the hazard concerned is a hazard that arises from dangerous goods, a reference to public health and safety.

3 For the avoidance of doubt:

a) when complying with clause 11 or 36, an occupier, when considering how to control a risk associated with the storage and handling of dangerous goods (where it is not reasonably practicable to eliminate the risk), must control the risk by taking the measures set out in clause 5, and

b) clauses 6 and 8 apply in relation to duties and responsibilities of occupiers and other persons at dangerous goods premises that are not places of work.

3.2.2.4 Risk Assessment

The occupier must,

a) if the occupier is an employer, make a record of each risk assessment and any review of a risk assessment by:

i) making a notation in the register of dangerous goods kept under clause 174ZW if no specific measure are necessary to control the risks associated with the storage or handling of dangerous goods, or

ii) preparing a report on the risk assessment of specific measures are necessary to control the risks associated with the storage or handling of the dangerous goods, and

b) the occupiers is not an employer, make a record of each risk assessment and any review of a risk assessment, and

c) keep a copy of that record while the risk assessment is current or being reviewed.

1 An occupier must ensure, so far as is reasonably practicable, that the dangerous goods at the occupier's premises do not inadvertently become unstable, decompose or change so as to:

a) create a hazard that is different from the hazard originally created by the dangerous good, or

b) increase the risk associated with the dangerous goods.

3.2.3 Stability of dangerous goods

The occupier must ensure;

a) if the stability of the dangerous goods is dependent on the maintenance of levels of stabilisers, those levels are maintained as specified by the manufacturer of the dangerous goods, and

b) if the dangerous goods are required to be stored or handled with a particular temperature range specified by the manufacturer, they are stored or handled within that temperature range.

c) In this clause, ***stabiliser*** means any substance (including any diluents, inhibitor, desensitiser, phlegmatizer, solvent, wetting agent or adulterant) added to, or present in, dangerous goods that overcomes the chemical instability inherent in the dangerous goods.

3.2.3.1 Separation of dangerous goods

An occupier must ensure that the risk to other dangerous goods storage or handling areas and to persons and property at or beyond the premises that arises from an incident involving dangerous goods:

a) is eliminated, or

b) if it is not reasonably practicable to eliminate the risk, is controlled so far as is reasonably practicable by separation.

3.2.3.2 Preventing interaction with other substances

An occupier must ensure that dangerous goods on the occupier's premises that are not compatible with other substances (including other dangerous goods) are stored or handled separately from the other substances so that a loss of containment or any other interaction cannot cause a serious incident.

3.2.4 Ignition sources in hazardous areas

1 An occupier must ensure that ignition sources in any hazardous area within the occupier's premises:

a) are eliminated, or

b) if it is not reasonably practicable to eliminate those ignition sources, the risk arising from those sources is controlled.

2 An occupier must identify any hazardous area that is within, or arises as a result of dangerous goods stored or handled at, the occupier's premises.

3.2.5 Atmospheric emissions

An occupier must ensure that any risk produced by atmospheric emissions from dangerous goods that are toxic, corrosive, flammable, explosive or asphyxiant:

a) is eliminated, or

b) if it is not reasonably practicable to eliminate the risk, is reduced so far as is reasonably practicable.

3.2.6 Preventing contamination of feed and personal products

An occupier must ensure that dangerous goods on the occupier's premises cannot contaminate food, food packaging or personal use products.

3.2.7 Containers for dangerous goods in bulk

An occupier of premises at which dangerous goods in bulk in a container are present must ensure that:

a) the container and any associated pipework are provided with stable foundations and supports, and

b) any pipework or equipment connected to the container is installed so as to prevent excessive stress on the container, pipework or equipment, and

c) the container and any associated pipework are protected from deterioration.

3.2.8 Containment of spills

1 An occupier must ensure that, in each place at the occupier's premises where dangerous goods are stored or handled, provision is made for containment of spills or leaks so as:

a) to eliminate the risk from any spill or leak of dangerous goods, or if it is not reasonably practicable to eliminate the risk, reduce it so far as is reasonably practicable, and

b) so far as is reasonably practicable, to contain safely within the premises the dangerous goods that have been spilled or leaked and any effluent arising from an incident.

2 In the case of dangerous goods containment, any area or receptacle intended to contain spills or leaks must not be shared with any other substances, including other dangerous goods, that are not compatible with the dangerous goods to be contained.

3 In the event of a spill or leak of dangerous goods, the occupier must ensure that:

a) immediate action is taken to reduce any risk associated with the spill or leak so far as is reasonably practicable, and

b) the dangerous goods and any resulting effluent are, as soon as reasonably possible, cleaned up and disposed of or otherwise made safe.

3.2.9 Transfer of dangerous goods

1 An occupier must ensure that any risk associated with the transfer of dangerous goods within, to or from the occupier's premises is eliminated, or if it is not reasonably practicable to eliminate the risk, is controlled so far as is reasonably practicable.

2 In eliminating or controlling a risk in accordance with subclause (1), the occupier must, as relevant, have regard to:

a) the need for measures to:

b) control spills and leaks, and

c) minimise static electricity, and

d) control vapour generation, and

e) the suitability of pipework, attachments and associated safety systems at the premises with the risk elimination or control measures proposed.

3.2.10 Impact protection

An occupier must ensure, as far as is reasonably practicable, that any containers, pipework, attachments, equipment containing, or associated with, of dangerous goods on the occupier's premises are protected from physical damage resulting from activities in or on the premises, including impacts, imposed loads and mechanical stress.

3.2.11 Preparedness for emergencies

3.2.11.1 Fire protection

1. An occupier must ensure that:

a) The occupier's premises are provided with a fire protection system that:

i) has been designed and constructed having taken account of any risk assessment of the premises, and

ii) is designed and constructed to take account of:

A) the types and quantities of dangerous goods and the conditions under which they are stored and handled, and

B) other materials and substances that make up the premises or are stored or handled at the premises, and

iii) is compatible with the dangerous goods and the other materials and substances and is effective in the control of incidents involving the types and quantities of dangerous goods and other materials and substances, and

b) the fire protection system is:

i) properly installed, tested and maintained, and

ii) at all times accessible to persons on the premises and to the relevant emergency services, and

iii) capable of being used, without adaptation or modification, with the equipment used by the New South Wales Fire Brigades and the NSW Rural Fire Service.

2 The occupier must, if any of the components of the fire protection system are rendered inoperative, ensure that:

a) the implications of any of the components of the system being unserviceable or inoperative are assessed, and

b) alternative measures are taken to control, to the same level of effectiveness, those risks that were controlled by the system when functioning fully, and

c) the fire protection system is returned to full operation as soon as is reasonably practicable.

3 If the implications of the system becoming unserviceable or inoperative, as assessed by the occupier under subclause (2) (a), include a significant reduction in the effectiveness of the fire protection system, the occupier must notify the relevant emergency services of the condition of the fire protection system.

4 In determining the alternative measures required under subclause (2) (b) the occupier must have regard to the need for:

a) the provision of alternative fire protection measures, and

b) a reduction of the quantities of dangerous goods stored or handled at the premises, and

c) stopping or reducing the processes used for the storage and handling of dangerous goods at the premises, and

d) modifications to systems of work at the premises.

5 In this clause, *fire protection system* includes fixed or portable fire detection, fire suppression and fire fighting equipment.

3.2.11.2 Planning for emergencies

As the proposed quantities of dangerous goods to be stored at the premises exceed the quantities specified in the column headed “Manifest quantity” in the Table to Schedule 5, Appendix B, the following requirements apply:

1 The occupier of the premises must ensure that a written plan for dealing with any emergency associated with the storage and handling of dangerous goods on those premises (an *emergency plan*) is:

a) developed, implemented and maintained, and

b) communicated to:

i) persons who are engaged by the occupier to work at the premises and who may be exposed to risk as a result of an emergency, and

ii) persons in control of adjacent premises to the extent that the emergency plan applies to those person, if persons or property on the adjacent premises may be exposed to risk as a result of an emergency.

2 In developing or reviewing the emergency plan, the occupier must:

a) provide a draft of the emergency plan to the Commissioner of the New South Wales Fire Brigades, and

b) have regard to any written advice received from the Commissioner of the New South Wales Fire Brigades.

3 The occupier of the premises must provide a copy of the emergency plan to:

a) if the premises to which this clause applies are within a rural fire district within the meaning of the Rural Fires Act 1997—the NSW Rural Fire Service, or

b) in any other case—the Commissioner of the New South Wales Fire Brigades.

4 The occupier must review the emergency plan:

a) if there is a change in circumstances at the premises, or any adjacent premises, such as to raise the possibility of an emergency of a kind that is not dealt with by the plan, and

b) at intervals of not more than 5 years from the date on which the plan was developed or last reviewed.

5 The occupier must communicate the revised plan to the persons specified in subclause (2) (b).

3.2.12 Safety equipment and safe access

3.2.12.1 Safety equipment

1 The occupier must ensure that, where safety equipment is required to control an identified risk in relation to the storage or handling of dangerous goods (including personal protective equipment and clean up equipment such as neutralisers, decontaminants and associated equipment), that equipment is provided, maintained and accessible to persons authorised to be on the premises.

2 A person must not wilfully damage or make ineffective any safety equipment referred to in subclause (1).

3.2.12.2 Safe access

An occupier must ensure that safe means of access to and from and within the occupier’s premises are provided and maintained.

3.2.13 Plant, equipment and containers

Cleaning or decommissioning plant, equipment and containers

1 An occupier must ensure that any plant, equipment or container that was used in connection with dangerous goods and:

a) is to be disposed of, or

b) has not had dangerous goods placed in or taken from it for a continuous period of 12 months, is made free from dangerous or otherwise made safe.

2 If a dangerous goods container has been made free from dangerous goods and the container is to be reused for a purpose other than its original purpose, the occupier must ensure that any references, signs, symbols or warning relating to the dangerous goods that it formerly contained are removed or obliterated.

3 If an underground, partially underground or fully mounded tank (other than an LPG tank) has been used to contain dangerous goods and 2 years have elapsed since any dangerous goods were last put in or taken from the tank, the occupier of the premises in which it is situated (or in the case of a LPG tank, the owner of the tank) must:

a) remove any remaining dangerous goods from, and abandon, the tank in compliance with AS 1940, and

b) within 7 days of the abandonment, notify WorkCover in the approved form of the abandonment.

3.2.14 Provision of information

3.2.14.1 Occupier to obtain MSDS

1 For all dangerous goods stored or handled on an occupier's premises, the occupier:

a) must obtain from the supplier of the goods an MSDS before or on the first occasion on which they are supplied, and

b) must ensure that the MSDS is readily accessible to any person at the premises who could store or handle the goods, and

c) must ensure that the MSDS is not altered, otherwise than where it is appropriate that an overseas MSDS be reformatted by the occupier.

2 The provisions of subclause (1) (a) and (b) do not apply to:

a) dangerous goods in transit, and

b) dangerous goods that are supplied to a retailer, retail warehouse operator or transport warehouse operator in a consumer package that:

i) holds less than 30 kg or 30 L of the goods, and

ii) is intended for retail sale, and

iii) is not intended to be opened on the premises of the retailer or operator.

3.2.14.2 Occupier to ensure containers are labelled and enclosed systems are identified

1 An occupier must ensure that packaged dangerous goods at the occupier's premises, including those supplied to or produced within the occupier's premises, are labelled in accordance with the ADG Code, and that the labels are not removed, defaced or altered.

2 Without limiting subclause (1), an occupier must ensure that any such label:

a) clearly identifies the dangerous goods, and

b) provides basic health and safety information about the dangerous goods, including any relevant risk phrases and safety phrases.

3 However:

a) a container into which dangerous goods are transferred for use within the next 12 hours need only be labelled with the product name and the relevant risk phrases and safety phrases, and

b) a container into which dangerous goods are transferred for immediate use need not be labelled, so long as it is cleaned immediately after it has been emptied of the dangerous goods.

4 An occupier must ensure that the identity of any dangerous goods contained in an enclosed system at the occupier's premises (such as a pipe or piping system, or a process or reactor vessel) is notified to a person who could handle the dangerous goods.

3.2.15 Placards

3.2.15.1 Outer warning placards

1 As the proposed quantities of dangerous goods to be stored at the RDC (Appendix B) exceed the relevant quantities specified in the column headed "Placarding quantity" in the Table to Schedule 5 (Appendix B), the occupier must ensure that a "HAZCHEM" outer warning placard as specified in Schedule 6 of the NSW Occupational Health and Safety Regulations 2005 is displayed at the entrances to the premises that emergency services would use or be likely to use in the event of an emergency.

3.2.15.2 Other placarding requirements

1 An occupier must ensure that the following are placarded in accordance with this clause:

a) any container or other form of storage of dangerous goods in bulk,

b) any storage location of packaged dangerous goods.

2 Subclause (1) does not apply to any of the following:

a) dangerous goods in bulk in any container, including an IBC, that is intended for transport and marked in accordance with the ADG Code,

b) C1 combustible liquids in bulk in a quantity not exceeding 10,000 L that are separated from other dangerous goods,

c) dangerous goods of Class 2.1 or 3 or C1 combustible liquids, that are stored in an underground tank at a retail service station where the goods are used to refuel vehicles.

3 The dimensions, design, layout and content of a placard must be in accordance with Schedule 6 or the ADG Code.

4 A placard must be kept clean, in good order and unobstructed.

5 A placard required by subclause (1) must be located:

a) so that it is clearly legible by persons approaching the premises, bulk container or other form of storage or storage location (as appropriate), and

b) so that it is separate from any other sign or writing which contradicts, qualifies or distracts attention from the placard.

6 A placard required by subclause (1) (a) must be located on or adjacent to each bulk container or other form of storage.

7 A placard required by subclause (1) (b) must be located:

a) at the entrance to any building in which the dangerous goods are stored, and

b) within a building referred to in paragraph (a), at the entrance to each room or other closed or walled section of the building in which the dangerous goods are stored, and

c) adjacent to any external storage location where the dangerous goods are stored.

8 If the dangerous goods to which placards apply are permanently removed from the premises, the occupier must remove the placards.

3.2.15.3 Different location permitted

1 An occupier of premises that are required to be placarded may place placards in locations different from those specified in this Part if the relevant emergency services agree with the placards being in those different locations.

2 The occupier must ensure that the agreement of the relevant emergency services is in writing and is readily available for inspection by an inspector.

3.2.16 Revision

An occupier must ensure that all placards required by this Subdivision are revised as soon as reasonably practicable after any change to the type or quantity of dangerous goods stored at the occupier's premises that requires different information to be displayed.

3.2.17 Manifests

3.2.17.1 Manifest to be maintained

1 Since the proposed quantity of dangerous goods exceed the 'manifest quantity', the occupier must keep a manifest of dangerous goods, that contains the information and site plans required by Schedule 7 of the NSW Occupational Health and Safety Regulations 2005, readily available for use by an inspector or the emergency services.

2 The occupier must ensure that a copy of the manifest is kept, and is readily accessible, at the main entrance to the occupier's premises unless the occupier and the Commissioner of the New South Wales Fire Brigades or the NSW Rural Fire Service, as appropriate, have agreed to a different location for keeping a copy of the manifest.

3 The occupier must ensure that the manifest is revised as soon as possible after a change in any of the information specified in Schedule 7.

3.2.18 Serious incidents and other incidents

3.2.18.1 Response to serious incidents and other incidents

1 An occupier must respond to a serious incident or other incident involving dangerous goods at the occupier's premises by ensuring that:

a) immediate action is taken to assess and control any risk associated with the serious incident or other incident, including making any plant or equipment associated with the serious incident or other incident and the surrounding area safe so far as is reasonably practicable, and

b) only persons essential to carrying out the action referred to in paragraph (a) remain in the vicinity of the serious incident or other incident, and

c) the risk to each person engaged by the occupier at the premises to carry out the action referred to in paragraph (a) is reduced so far as is reasonably practicable.

2 The obligations of the occupier under subclause (1) (b) and (c) do not apply in respect of members of the emergency services responding to the serious incident or other incident.

3.2.18.2 Investigation of serious incidents and other incidents

An occupier must ensure that:

a) any serious incident or other incident involving dangerous goods occurring at the premises is investigated and that the investigation, so far as possible, determines the cause or likely cause of the serious incident or other incident, and

b) a record of the investigation is:

i) made, and

ii) kept for at least 5 years, and

iii) readily available, on request, to an inspector.

3.2.18.3 Risk assessment and control following serious incidents and other incidents

An occupier of premises where a serious incident or other incident involving dangerous goods has occurred must:

a) review the risk assessment carried out in accordance with this Regulation, taking into account the results of the investigation into the serious incident or other incident, and

b) if the review identifies deficiencies in any risk control measures, alter those measures or implement new measures.

3.2.19 Information may be requested

1 WorkCover may request any information from an occupier of premises that are a place of work that is not a mining workplace or a coal workplace in relation to:

a) the cause or effect of a serious incident or other incident that has occurred on the occupier's premises, and

b) any action taken by the occupier as a result of the serious incident or other incident.

2 A request for information must:

a) be in writing, and

b) specify a reasonable period within which the occupier must respond

3 The occupier must provide the requested information:

a) in writing, and

b) within the period specified by WorkCover.

3.2.20 Notification

3.2.20.1 Notification to WorkCover

1 As the proposed quantity of dangerous goods to be stored onsite exceeds the 'manifest quantity', the occupier must ensure that WorkCover is notified of the presence of the proposed quantities of dangerous goods to be stored onsite.

2 A notification to WorkCover must:

a) be given within 14 days after the obligation to notify arises, and

b) be accompanied by a fee in such amount as WorkCover may determine as the appropriate amount to cover expenses in connection with the processing and review of notifications required by this clause, and

c) include the following information:

i) the name of the occupier (and any other occupiers of the premises concerned),

ii) the address of the premises where the dangerous goods are stored and handled,

iii) the occupier's contact details,

iv) the nature of the principal activities involving the dangerous goods,

v) the Class, Packing Group and the maximum quantity of the dangerous goods stored and handled in bulk or as packaged dangerous goods,

vi) descriptions and details and the maximum quantity of any C1 combustible liquids stored and handled in bulk or as packaged dangerous goods,

vii) the product name and the maximum quantity of goods too dangerous to be transported,

viii) any other documents or information specifically requested by WorkCover.

3 The occupier must ensure that WorkCover is provided with further notification, containing the information required under subclause (2), every 12 months, or at such longer intervals as are specified by WorkCover.

4 On receiving a notification under this clause, WorkCover must send the occupier a written acknowledgment of the notification.

5 WorkCover may give any information contained in a notification to a relevant local government council and the emergency services.

3.2.21 Miscellaneous

3.2.21.1 Security at premises

The occupier must, so far as is reasonably practicable, prevent:

a) access to dangerous goods on the occupier's premises by unauthorised persons, and

b) unauthorised activities occurring on those premises.

3.2.21.2 Lighting

An occupier must ensure that lighting is provided that:

a) does not create excessive glare or reflection, and

b) is adequate to allow persons to move safely within the occupier's premises, and

c) facilitates safe access to and egress from the premises, including emergency exits.

3.2.22 Obligations of employers

An employer must retain records in a suitable form of all induction or other training required by the NSW Occupational Health and Safety Regulations 2005. All necessary training records are to be provided for employees who are likely to store or handle dangerous goods at the employer's place of work for at least 5 years after the date of creation of the record.

3.2.22.1 Employer to keep register of dangerous goods

1 An employer must ensure that a register is kept and maintained for all dangerous goods stored or handled at the employer's place of work.

2 The employer must ensure that the register includes:

a) a list of all dangerous goods used at the employer's place of work, and

b) the relevant MSDS (if any) for each of those dangerous goods, and

c) any notations required under clause 174ZX.

3 The employer must ensure that the register is readily accessible to all employees who may store or handle dangerous goods while at the employer's place of work.

4 This clause does not apply to the following dangerous goods:

a) dangerous goods that are supplied to a retailer or retail warehouse operator in a consumer package holding less than 30 kg or 30 L of the dangerous goods, that is intended for retail sale and that is not intended to be opened on the premises of the retailer or operator,

b) dangerous goods in transit.

5 The employer may keep and maintain a single register both for the purposes of this clause and for the purposes of clause 167 (Employer to keep register of hazardous substances).

3.2.22.2 Employer to record risk assessments

1 An employer must record the results of a risk assessment relating to the storage or handling of dangerous goods by:

a) making a notation in the register of dangerous goods kept under clause 174ZW if no specific measures are necessary to control the risks associated with the dangerous goods, or

b) preparing a report on the risk assessment if specific measures are necessary to control the risks associated with the dangerous goods.

2 The employer must ensure that any risk assessment report prepared in relation to dangerous goods that are stored or handled at the employer's place of work is readily accessible to any employee or other person working at the employer's place of work who could store or handle the dangerous goods.

3.2.23 Specific provisions applying to all dangerous goods to which section 135A of Act applies

3.2.23.1 Positioning of liquefied gas cylinders

A person must not keep, convey or use a cylinder containing dangerous goods of Class 2.1, being liquefied flammable gas, unless the cylinder is positioned so that the safety relief device communicates directly with the vapour space in the cylinder.

3.2.23.2 Valves

1 A person who keeps a cylinder or other container containing dangerous goods of Class 2 must, unless it is connected by permanent piping to a consuming device, ensure that its valve is kept securely closed at all times except when the container is being filled or goods are being taken from it.

2 If piping or a pipeline is equipped with one or more excess flow valves, a person must not convey dangerous goods of Class 2 by means of the piping or pipeline unless each valve is set for the minimum diameter of that part of the piping or pipeline that the goods would enter through the valve without first passing through another such valve.

4.0 State Environmental Planning Policy No. 33 – Hazardous and Offensive Development

The purpose of SEPP 33 is to ensure that in considering any application to carry out potentially hazardous or offensive development, the consent authority has sufficient information to assess whether the development is hazardous and if so to impose conditions to reduce or minimise any adverse impacts. The proposed development will involve the storage of special goods such as aerosol cans and other flammable goods.

Due to the quantity of dangerous goods that will be stored at the RDC exceeding the threshold limits described by the State Environmental Planning Paper No.33 (SEPP 33), the development application will require a Preliminary Hazard Analysis to be conducted. The SEPP 33 screening test has been provided in Appendix B.

5.0 Dangerous Goods Separation and Segregation

5.1 Prescriptive method of dangerous goods storage

Clause 6.3.1 of AS/NZS 3833 gives specific guidance on segregation and separation distances for potentially reactive substances and dangerous goods.

Dangerous goods should be segregated from incompatible substances, substances with which they might react dangerously and other dangerous goods in accordance with the following requirements:

a) Where the substances being kept are incompatible

i. they shall be kept in separate compounds, or

ii. they shall be segregated by a distance of at least 3 m, except that, when both substances are solids, this distance may be reduced to 1 m.

b) Where the substances being kept might react dangerously

i. they shall be segregated by at least 5 m; and

ii. they shall not be kept within the same compound, or in compounds that share a common drainage system.

Guidance of the compatibilities and relativities of various compounds are available from the respective Safety Data Sheets (SDS), which can be sourced from the supplier/manufacturer or various online commercial databases. Care should be taken that these documents are set within the Australian legislative framework and have been reviewed within the last five years.

The figure below provides a guide to the distance required (expressed in metres) between the different classes of dangerous goods.

DG Class	2.1	2.2	3	4.1	4.2	4.3	5.1	5.2	6	8	9
2.1	0	3	5	5	5	5	5	ISOLATE	3	3	3
2.2	3	0	3	5	5	5	5	5	3	3	3
3	5	3	0	3	5	5	5	ISOLATE	3	3	3
4.1	5	3	3	0	3	5	5	5	3	3	3
4.2	5	5	5	3	0	3	5	ISOLATE	3	5	5
4.3	5	5	5	5	5	0	5	5	3	5	3
5.1	5	5	5	5	5	3	5**	5	3	3	3*
5.2	ISOLATE	5	ISOLATE	5	ISOLATE	5	5	5**	3	3	3*
6	3	3	3	3	3	3	3	3	0	3	3
8	3	3	3	3	3	3	3	3	3	3**	3
9	3	3	3	3	5	3	5*	5*	3	3	0

Figure 2 Segregation Chart for Storing Mixed Classes of Dangerous Goods.

***** May react dangerously if the Class 9 dangerous goods are fire risk substances (e.g. waste paper, hay, saw dust, wood chips)

****** May be incompatible or react dangerously with other dangerous goods in this class with different UN numbers.

5.2 Separation Distance Requirements

5.2.1 Measurement of separation distances

Separation distances shall be measured in a horizontal plane. The separation distance shall be measured from the package nearest to the protected place or boundary.

Separation distances may be measured around an intervening screen wall, provided that the wall extends at least 1 m above the highest container, and is marked to indicate the maximum allowable storage height.

Where the storage area contains flammable liquids, the screen wall shall have an FRL/FRR of at least 240/240/240.

Where other dangerous goods are stored, the screen wall shall have an FRL/FRR of at least 60/60/60. A wall on an adjacent property shall not be used as a screen wall unless an agreement is in place.

Note: As there is no requirement for a designated package store under AS/NZS 3833:2007 for the Masters facility as a result of the large floor area in comparison to the proposed quantity of dangerous goods, it is not anticipated that there will be a requirement for screen walls or fire walls.

5.2.2 Storage of non-dangerous goods in segregation spaces

Non-dangerous goods may be kept in segregation spaces, provided that they will not react dangerously with any of the dangerous goods being kept. Non-dangerous goods that are combustible (excluding combustible liquids) may be kept in such spaces, provided that:

- a hazard assessment, including an assessment of the additional fire load, has been carried out; and
- any necessary additional fire protection is provided.

5.2.3 Separation distances from mixed class storage to protected places

Based on the quantities of mixed classes of dangerous goods provided in Appendix B, the mixed class dangerous goods storage shall be separated from protected places by a distance of at least ***30m.***

For the purposes of the above paragraph, ‘protected places’ are defined as follows:

- A dwelling, residential building, place of worship, public building, school or college, hospital, theatre, and any building or open area in which persons are accustomed to assemble, whether it is within or outside the property boundary of the installation.
- A factory, workshop, office, store, warehouse, shop, or building where persons are employed, that is outside the boundary of the installation.
- A ship lying at permanent berthing facilities.
- Any storage facility for dangerous goods, other than minor storage, outside the property boundary of the installation.
- An environmentally sensitive area.

The mixed class dangerous goods storage areas shall be at separated from on-site protected places by a distance of at least ***15m.***

An ‘onsite-protected place’ is defined as follows:

- A building where people are employed within the property boundary of the installation, including warehouses, manufacturing or processing areas, amenities or other dangerous goods stores where quantities exceed minor storage.

Note: Any office within or immediately adjacent to the storage areas, which is used for the direct supervision of the store, is not considered an on-site protected place.

6.0 Conclusion

This report outlines the general requirements for the storage of mixed classes of dangerous goods in Retail Distribution Centres, and was prepared based upon the requirements of AS/NZS 3833:2007 'The Storage and Handling of Mixed Classes of Dangerous Goods, in Packages and Intermediate Bulk Containers'.

Measures outlined in Section 3 of AS/NZS 3833:2007 provide opportunities to eliminate the need for a dedicated Dangerous Goods Package Store. It should be noted however if the risk based work methods outlined in AS/NZS 3833:2007 are unable to be achieved or are undesirable, our recommendation is to construct a designated Dangerous Goods Storage Facility (Package Store) as detailed in Section 5 of AS/NZS 3833:2007.

In addition to the requirements outlined in this report, the development application will require a Preliminary Hazard Analysis to be conducted due to the quantity of dangerous goods exceeding the threshold limits described by the State Environmental Planning Paper No.33 (SEPP 33).

7.0 References

- AS/NZS 3833:2007 'The Storage and Handling of Dangerous Goods, in Packages and Intermediate Bulk Containers'

- NSW Occupational Health and Safety Act 2003

- NSW Occupational Health and Safety Regulations 2005

8.0 Glossary of Terms

Term	Description
Retail Shop	A retail shop can be defined as either of the following: a) A place where the general public or end user are able to purchase displayed goods. b) A place or space behind the sales counter such as a back of house or store where goods can be kept so that they can be sold to the general public or end user. Retail shops include areas where goods are received and stored prior to being displayed for sale.
Retail Distribution Centre	A warehouse or storage area whose primary use is for the storage of goods and for the packing of deliveries to be delivered to retail shops. Access is limited to personnel and restricted from the general public. Goods in retail distribution centres are generally contained in outer packages.
Packing Group (PG)	Three hazard groups to which Dangerous Groups are assigned in the Australian Dangerous Goods (ADG) code are 'I' (High Danger), 'II" (Medium Danger) and 'III' (Low Danger).
Combustible Liquid	Any liquid that has a flash point and a fire point less than its boiling point except for a flammable liquid. Class C1 are combustible liquids having a flash point of 150°C or less. Class C2 are combustible liquids having a flash point greater than 150°C.
Protected Place	A protected place can be defined as any other of the following: a) Any building or open area such as a dwelling or public building where people will assemble. Can be within or outside the property boundary of the installation. b) Any factory, workshop, office, store shop or building where people are employed which is outside the boundary of the installation. c) Any Dangerous Goods storage facility outside the property boundary of the installation (excludes areas with only minor storage). d) An environmentally sensitive area.

Appendix A

Schedule 5 - NSW Occupational Health and Safety Regulations 2005

Appendix A Schedule 5

1 For the purposes of the Table below, the placarding quantity or manifest quantity is equal to the total of the quantities determined in accordance with items 2 and 3.

2 In relation to:

(a) packaged dangerous goods in a container that are:

(i) non-liquid dangerous goods (other than Class 2 dangerous goods)—the quantity is to be determined by the net mass in kilograms of the goods in the container, and

(ii) liquid dangerous goods (other than Class 2 dangerous goods)—the quantity is to be determined by the net capacity of the container, and

(iii) Class 2 dangerous goods—the quantity is to be determined by the water capacity of the container, and

(b) dangerous goods in bulk that are:

(i) non-liquid dangerous goods (other than Class 2 dangerous goods)—the quantity is to be determined by the mass in kilograms that the container is designed to hold, and

(ii) liquid dangerous goods (other than Class 2 dangerous goods)—the quantity is to be determined by the design capacity of the container in litres, and

(iii) Class 2 dangerous goods—the quantity is to be determined by the water capacity of the container, and

(iv) solid dangerous goods not in a container—the quantity is to be determined by the undivided mass in kilograms, and

(c) dangerous goods that are articles or things—the quantity is to be determined by the net quantity of that part of the article or thing that is in itself dangerous goods.

3 In the Table below, *kg or L* means, where this combination of letters immediately follows numbers, the combined total of:

(a) the number of kilograms of non-liquid dangerous goods (other than Class 2 dangerous goods), and

(b) the number of litres of liquid dangerous goods (other than Class 2 dangerous goods), and

(c) the water capacity of containers of Class 2 dangerous goods,

in accordance with item 2.

4 For the purposes of the Table below, *separately*, in relation to the storage or handling of dangerous goods separately from other dangerous goods, means the physical separation of the dangerous goods from other dangerous goods, by either distance or a physical barrier

Table 7 Dangerous goods quantities

Group	Description of dangerous goods	Packing Group	Placarding quantity	Manifest quantity
1	Class 2			
	Class 2.1	Not Applicable	500 L	5,000 L
	Class 2.2 Subsidiary Risk 5.1	Not Applicable	2,000 L	10,000 L
	Other Class 2.2	Not Applicable	5,000 L	10,000 L
	Class 2.3	Not Applicable	50 L	500 L
	Aerosols	Not Applicable	5,000 L	10,000 L
	Cryogenic Fluids	Not Applicable	1,000 L	10,000 L

Group	Description of dangerous goods	Packing Group	Placarding quantity	Manifest quantity
2	Class 3, 4.1, 4.2, 4.3, 5.1, 5.2, 6.1 or 8	I	50 kg or L	500 kg or L
		II	250 kg or L	2,500 kg or L
		III	1,000 kg or L	10,000 kg or L
		Mixed Packing Groups in a single Class with the quantity of each Packing Group below the specified quantity for the Packing Group.	1,000 kg or L	10,000 kg or L
3	Class 9	II	1,000 kg or L	10,000 kg or L
		III	5,000 kg or L	10,000 kg or L
		Mixed Packing Groups in Class 9 with the quantity of each Packing Group below the specified quantity for the Packing Group.	5,000 kg or L	10,000 kg or L
4	Mixed Classes of dangerous goods where none of the Classes, types or Packing Groups (if any) present exceeds the quantities specified for the relevant quantity in Item 1, 2 or 3 of this Table.	Not Applicable	5,000 kg or L—The quantity applies only if the placarding quantity for an individual Class that is present is 5,000 kg or L.	10,000 kg or L
			2,000 kg or L—The quantity applies only if the placarding quantity for all of the Classes present is 2,000 kg or L or less.	
5	C1 combustible liquids stored and handled with fire risk dangerous goods where none of the Classes, types or Packing Groups (if any) present exceeds the relevant quantities in Item 1, 2 or 3 of this Table.	Not Applicable	1,000 kg or L	10,000 kg or L
6	Goods too dangerous to be transported that are not kept in a laboratory.	Not Applicable	Any quantity	Any quantity
7	C1 combustible liquids in bulk stored and handled separately from other dangerous goods.	Not Applicable	10,000 L	100,000 L
	C1 combustible liquids stored and handled in packages separately from other dangerous goods.	Not Applicable	50,000 L	100,000 L
	C1 combustible liquids in bulk	Not Applicable	50,000 L	100,000 L

Group	Description of dangerous goods	Packing Group	Placarding quantity	Manifest quantity
	and in packages stored and handled separately from other dangerous goods provided the quantity in bulk is 10,000 L or less.			

Note.

For the purposes of item 3 in the Table, where Class 9 dangerous goods do not have a Packing Group assigned to them, they are deemed to be assigned to Packing Group III.

Appendix B

Proposed Dangerous Goods Inventory and SEPP 33 Screening Test

Appendix B Proposed Dangerous Goods Inventory and SEPP 33 Screening Test

Part 1: SEPP 33 Screening Test for Quantity of Dangerous Goods Held on Site with 16m minimum distance to Boundary.

Dangerous Goods Classification	Packing Group	Estimated Stock Holding (tonnes)	SEPP 33 Reference for Screening	Screening Threshold (tonnes)	Acceptable (Yes /No)	
2.1 Flammable Gas		167.22	Figure 6	40	NO	
3 Flammable liquid	II - Medium Danger	27.59	Figure 9	50	YES	(Note 1)
	III - Low Danger	104.12	Figure 9	50	NO	(Note 1)
4.1 Flammable solids	III - Low Danger	2.61	Table 3	5	YES	
8 Corrosive substances	II - Medium Danger	3.42	5 tonnes/ 5 m^3	5	YES	
	III- Low Danger	7.08	50 tonnes/ 50 m^3	50	YES	

Part 2: SEPP 33 Screening Test for Vehicle Movements of Dangerous Goods Held to from site.

			SEPP 33 Reference - Table 2: Transportation Screening Thresholds				
Dangerous Goods Classification	Packing Group	Annual Sales Forecast (tonnes)	Threshold Annual Vehicle Movements	Threshold Limit per Load (tonnes)	Average Load per Vehicle Movement (Based on Annual Threshold)	Average Load per Limit	Acceptable (Yes /No)
2.1 Flammable Gas		461.21	500	5	0.92	0.18	YES
3 Flammable liquid	II - Medium Danger	64.26	750	10	0.09	0.01	YES
	III - Low Danger	310.10	1000	No Limit (Note 2)	0.31	(Note 2)	YES
4.1 Flammable solids	III - Low Danger	15.76	200	2	0.08	0.04	YES
8 Corrosive substances	II - Medium Danger	20.68	500	5	0.04	0.01	YES
	III- Low Danger	26.71	500	5	0.05	0.01	YES

Note 1: The PGII PLUS PGIII total qty must also be less than the individual limit
Note 2: The annual amount of Class 3 PG III fully laden vehicle movements must not exceed 1000 vehicle movements.

Appendix C

General Layout Drawing

Appendix C General Layout Drawing

Area	2
FM Global Commodity Classification	Cartoned Unexpanded, Cartoned Expanded and Uncartoned Unexpanded
Ceiling Height	Max 12.0 m
Storage Arrangement	Single Row Rack Storage
Ceiling Sprinklers	K25. 12 heads @ 410 kPa
Hose Stream	950 l/min
Duration	60 min
FM Global reference	8-1 2.2.5, 8-9 Table 2.3.7.5 (a), 8-9 Table 2.3.5.1
Notes	ESFR Sprinkler minimum pressure requirement to be 410kPa.

Area	3
FM Global Commodity Classification	Cartoned Unexpanded, Cartoned Expanded, Uncartoned Unexpanded and Uncartoned Expanded
Ceiling Height	Max 9 m
Storage Arrangement	Double Row Rack Storage
Minimum Aisle Space	3.530 m
Flue Space	73 mm
Ceiling Sprinklers	K25. 12 heads @ 410 kPa
Hose Stream	950 l/min
Duration	60 min
FM Global reference	8-1 2.2.5, 8-9 Table 2.3.7.5 (a),8-9 Table 2.3.5.1
Notes	ESFR Sprinkler minimum pressure requirement to be 410kPa.

Area	3
FM Global Commodity Classification	Cartoned Unexpanded Plastics
Ceiling Height	Max 13.7 m
Storage Arrangement	Flow through rack storage
Ceiling Sprinklers	K25. 12 heads @ 410 kPa
Hose Stream	950 l/min
Duration	60 min
FM Global reference	8-1 2.2.5, 8-9 Table 2.3.7.5 (a), 8-9 Table 2.3.5.1
Notes	ESFR Sprinkler minimum pressure requirement to be 410kPa.

Area	2
FM Global Commodity Classification	Cartoned Unexpanded, Cartoned Expanded and Uncartoned Unexpanded
Ceiling Height	Max 12.0 m
Storage Arrangement	Single Row Rack Storage
Ceiling Sprinklers	K25. 12 heads @ 410 kPa
Hose Stream	950 l/min
Duration	60 min
FM Global reference	8-1 2.2.5, 8-9 Table 2.3.7.5 (a), 8-9 Table 2.3.5.1
Notes	ESFR Sprinkler minimum pressure requirement to be 410kPa.

Area	12
FM Global Commodity Classification	Cartoned Unexpanded, Cartoned Expanded and Uncartoned Unexpanded
Ceiling Height	Max 12.0 m
Storage Arrangement	Palletised
Ceiling Sprinklers	K25. 12 heads @ 410 kPa
Hose Stream	950 l/min
Duration	60 min
FM Global reference	8-1, 8-9 Table 2.3.7.5 (b), 8-9 Table 2.3.5.1
Notes	ESFR Sprinkler minimum pressure requirement to be 410kPa.

Area	1
FM Global Commodity Classification	Cartoned Unexpanded, Cartoned Expanded, Uncartoned Unexpanded and Uncartoned Expanded
Ceiling Height	Max 9 m
Storage Arrangement	Double Row Rack Storage
Minimum Aisle Space	3.530 m
Flue Space	73 mm
Ceiling Sprinklers	K25. 12 heads @ 410 kPa
Hose Stream	950 l/min
Duration	60 min
FM Global reference	8-1 2.2.5, 8-9 Table 2.3.7.5 (a),8-9 Table 2.3.5.1
Notes	ESFR Sprinkler minimum pressure requirement to be 410kPa.

Area	11
FM Global Commodity Classification	Aerosol Products
Ceiling Sprinklers	K25. 12 heads @ 410 kPa
In rack protection	Scheme A
Hose Stream	950 l/min
Duration	120 min
FM Global reference	7-31 Table 9, 7-31 2.4.1.8, 7-31 2.4.1.9, 7-31 E.2, 7-31 Fig 8c
Notes	Allowance to be made to connect in rack sprinkler protection to high level pipe work

Area	4
FM Global Commodity Classification	Uncartoned Expanded Plastics, Uncartoned Unexpanded Plastics
Ceiling Sprinklers	K25. 12 heads @ 410 kPa
In rack protection	Scheme 8-9A
Hose Stream	950 l/min
Duration	120 min
FM Global reference	8-9 2.3.4.9 7-31
Notes	Allowance to be made to connect in rack sprinkler protection to high level pipe work

Area	12
FM Global Commodity Classification	Cartoned Unexpanded Plastics
Ceiling Height	Max 12.0 m
Storage Arrangement	Palletised
Ceiling Sprinklers	K25. 12 heads @ 410 kPa
Hose Stream	950 l/min
Duration	60 min
FM Global reference	8-1, 8-9 Table 2.3.7.5 (b), 8-9 Table 2.3.5.1
Notes	ESFR Sprinkler minimum pressure requirement to be 410kPa.

Area	6
FM Global Commodity Classification	Truck/trailer parking
Ceiling Height	Max 7.5 m
Ceiling Sprinklers	Control Mode 10mm/min over 280m²
Hose Stream	950 l/min
Duration	60 min
FM Global reference	3-26 Tables 2 & 3
Notes	141 °C heads K factor 11.5 (metric)

Area	5
FM Global Commodity Classification	Cartoned Unexpanded Plastics
Ceiling Height	Max 13.7 m
Storage Arrangement	Palletised
Ceiling Sprinklers	K25. 12 heads @ 410 kPa
Hose Stream	950 l/min
Duration	60 min
FM Global reference	8-1, 8-9 Table 2.3.7.5 (b), 8-9 Table 2.3.5.1
Notes	ESFR Sprinkler minimum pressure requirement to be 410kPa.

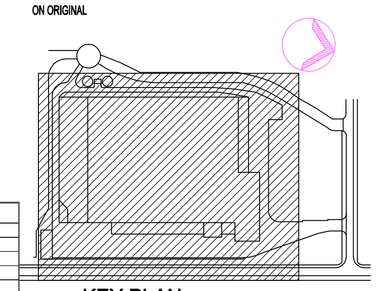
Area	7
FM Global Commodity Classification	Miscellaneous Non Manufacturing
Ceiling Sprinklers	Control Mode 4mm/min over 140m²)
Hose Stream	950 l/min
Duration	60 min
FM Global reference	3-26, 2-2
Notes	Control mode pre-action sprinkler system to Communications room. Design density 4mm over 279 m² (or room area). Activated by single photo-optical type Smoke Detector. Wet Chemical Suppression to Kitchen hood.

Area	8 &10
FM Global Commodity Classification	Truck/trailer parking
Ceiling Height	Max 9.4 m
Ceiling Sprinklers	Control Mode 10mm/min over 280m²
Hose Stream	950 l/min
Duration	60 min
FM Global reference	3-26 Tables 2 & 3
Notes	141 °C heads K factor 11.5 (metric)

Area	9
FM Global Commodity Classification	Class 1
Ceiling Sprinklers	Control Mode 18mm/min over 185m²
Hose Stream	950 l/min
Duration	90 min
FM Global reference	8-9 Table 2.3.7.3 (a)
Notes	

0 5 10 20 30 40 50 100mm

ON ORIGINAL



KEY PLAN

GENERAL NOTES

FM GLOBAL HAVE CONFIRMED ACCEPTANCE FOR THE USE OF ESFR SPRINKLERS WITHIN THIS WAREHOUSE WHICH HAS A BUILDING HEIGHT OF 13.7M.

REV.	DATE	AMENDMENT	SIGNED
05	25.10.10	RE-ISSUED FOR CONSTRUCTION	PAY
04	20.10.10	RE-ISSUED FOR CONSTRUCTION	PAY
03	16.09.10	ISSUED FOR OXYGEN REDESIGN	PAY
02	14.09.10	ISSUED FOR CONSTRUCTION	PAY
01	08.07.10	ISSUED FOR CONSTRUCTION	PAY
G	24.05.10	99% COMPLETE ISSUE	PAY
F	05.03.10	MIRVAC PROGRESS ISSUE	PAY
E	18.12.09	PROGRESS ISSUE	PAY
D	01.09.08	ISSUED FOR REVIEW	RWD
C	20.03.08	ISSUED FOR COORDINATION	RWD
B	07.03.08	ISSUED FOR REVIEW	RWD
A	12.02.08	30% ISSUE	RWD

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TITLE

FIRE SERVICES
COMMODITY CLASSIFICATION

DATE	05.03.10	PROJECT No.	STATUS
SCALE	1:500 (B1)	2561166	FS/CD
DRAWN	SJD		
CHECKED	ME	DWG No.	REV No.
APPROVED	RD	FS101	05