Riskcon engineering

Preliminary Hazard Analysis

Lot 1 DP 1306448, Badgerys Creek

DHL Supply Chain (Australia) Pty Ltd
Document No. RCE-22198_DHL_PHA_Final_23Sep24_Rev(3)
Date 23/09/2024

Preliminary Hazard Analysis

Lot 1 DP 1306448, Badgerys Creek

DHL Supply Chain (Australia) Pty Ltd

Prepared by

Riskcon Engineering Pty Ltd
37 Pogson Drive
Cherrybrook NSW 2126
www.riskcon-eng.com
ABN 74 626 753 820

Quality Management

Rev	Date	Remarks	Prepared By	Reviewed By
A	13 October 2022	Draft issue for comment	Renton Parker	Jason Costa
0	18 October 2022	Issued final		
1	27 April 2023	Updated per DPE comments		
2	6 July 2023	Updated layout		
3	23 Septekmber 2024	Updated based on new SSDA	Jason Costa	Steve Sylvester

Executive Summary

Background

The DHL Masterplan site occupies approximately 25-hectares (**ha**) of the larger 171.84ha site at 1953-2109 Elizabeth Drive, Badgerys Creek. The wider site is currently the subject of an existing SSDA (SSD- 70316465).

SSD- 70316465: 1953-2109 Elizabeth Drive 'Burra Park'

SSD- 70316465 is an SSDA which was issued SEARs on the 22 May 2024 and is currently in the process of finalising the application for lodgement following Test of Adequacy with the DPHI in September 2024.

SSD- 70316465 is seeking development consent for a concept plan including future development lots and building footprints. The development also seeks consent for the Stage 1 works which will include bulk earthworks across the site, infrastructure delivery, road access/intersections, internal road construction, civil infrastructure and utilities, stormwater infrastructure works and the construction of three (3) warehouse buildings.

The applicant for SSD- 70316465 is the trustee for Burra Park Prop Trust 1 which is a joint venture entity, with ISPT Core Fund and UniSuper each holding an equal share.

Where DGs are stored, the site is subject to Chapter 3 of the State Environmental Planning Policy – Resilience and Hazards (SEPP 33, Ref.) which aims to assess the risk posed by the site upon the adjacent land uses. The proposed quantities to be stored would exceed the SEPP 33 thresholds; hence, it is necessary to assess the risks posed in the form of a Preliminary Hazard Analysis (PHA) in accordance with the Hazardous Industry Planning Advisory Paper (HIPAP) No. 4 and No. 6 (Ref. &) for submission with the Development Application (DA).

DHL has commissioned Riskcon Engineering Pty Ltd (Riskcon) to prepare the PHA for the facility. This document represents the PHA study for the DHL site.

Conclusions

A hazard identification table was developed for the warehouse facility to identify potential hazards that may be present at the site as a result of operations or storage of materials. Based on the identified hazards, scenarios were postulated that may result in an incident with a potential for offsite impacts. Postulated scenarios were discussed qualitatively and any scenarios that would not impact offsite were eliminated from further assessment.

Based upon the enterprise land zoning around the area, fire incidents were conservatively carried forward for further analysis to determine whether risk criteria associated with non-industrial land uses may be exceeded. The risk assessment demonstrated that the frequency of a fatality at the adjacent land uses would be below the acceptable criteria published in HIPAP No. 4 (Ref. [2]).

Based on the analysis conducted, it is concluded that the risks at the site boundary are not considered to exceed the acceptable risk criteria; hence, the facility would only be classified as potentially hazardous and would be permitted within the current land zoning for the site.

Recommendations

Notwithstanding the conclusions following the analysis of the facility, the following recommendations have been made:

- The DG bunkers shall be equipped with spill kits that are compatible with the goods being stored and handled.
- Unloading / loading areas shall be equipped with spills that are compatible with the goods being stored and handled.
- The warehouse and/or site boundaries shall be capable of containing 90 minutes of sprinkler discharge (i.e. ceiling mounted, in-racks, and drenchers where required) in addition to 90 minutes of hydrant hose discharge assuming three (3) hydrants are operating.
- The civil engineers designing the site containment shall demonstrate the design is capable of containing the required water volume.
- A DG design report shall be completed for the warehouse to ensure all required design items from the standard are captured and included within the site design.
- The design report shall be prepared by a competent DG consultant with competencies in all the DG classes proposed to be stored at the warehouse.
- The warehouse shall be subject to a hazardous area classification to ensure that electrical equipment installed within Bunker 1 is compliant with the likely materials to be stored.
- Prior to acceptance and receival of Class 9 products at the warehouse, the flash point of the product shall be reviewed to confirm that the product is not combustible prior to storage into Bunker 2. Where combustibility is identified, the product shall be stored in Bunker 1.
- The toxic substances shall be stored in a toxic substances cabinet complying with AS 4552-1997.

Table of Contents

List of Figures

List of Tables

Abbreviations

Abbreviation	Description
ADG	Australian Dangerous Goods Code
AS	Australian Standard
CBD	Central Business District
DA	Development Application
DGs	Dangerous Goods
DPE	Department of Planning and Environment
HIPAP	Hazardous Industry Planning Advisory Paper
IBC	Intermediate Bulk Container
LPG	Liquefied Petroleum Gas
PFD	Probability of Failure on Demand
PHA	Preliminary Hazard Analysis
SMSS	Storage Mode Sprinkler System

1.0 Introduction

1.1 Background

The DHL Masterplan site occupies approximately 25-hectares (**ha**) of the larger 171.84ha site at 1953-2109 Elizabeth Drive, Badgerys Creek. The wider site is currently the subject of an existing SSDA (SSD- 70316465).

SSD- 70316465: 1953-2109 Elizabeth Drive 'Burra Park'

SSD- 70316465 is an SSDA which was issued SEARs on the 22 May 2024 and is currently in the process of finalising the application for lodgement following Test of Adequacy with the DPHI in September 2024.

SSD- 70316465 is seeking development consent for a concept plan including future development lots and building footprints. The development also seeks consent for the Stage 1 works which will include bulk earthworks across the site, infrastructure delivery, road access/intersections, internal road construction, civil infrastructure and utilities, stormwater infrastructure works and the construction of three (3) warehouse buildings.

The applicant for SSD- 70316465 is the trustee for Burra Park Prop Trust 1 which is a joint venture entity, with ISPT Core Fund and UniSuper each holding an equal share.

Where DGs are stored, the site is subject to Chapter 3 of the State Environmental Planning Policy – Resilience and Hazards (SEPP 33, Ref. [1]) which aims to assess the risk posed by the site upon the adjacent land uses. The proposed quantities to be stored would exceed the SEPP 33 thresholds; hence, it is necessary to assess the risks posed in the form of a Preliminary Hazard Analysis (PHA) in accordance with the Hazardous Industry Planning Advisory Paper (HIPAP) No. 4 and No. 6 (Ref. [2] & [3]) for submission with the Development Application (DA).

DHL has commissioned Riskcon Engineering Pty Ltd (Riskcon) to prepare the PHA for the facility. This document represents the PHA study for the DHL site.

1.2 Objectives

The objectives of the PHA project include:

- Complete the PHA according to the Hazardous Industry Planning Advisory Paper (HIPAP) No. 6 – Hazard Analysis (Ref. [3]),
- Assess the PHA results using the criteria in HIPAP No. 4 – Risk Criteria for Land Use Planning (Ref. [1]), and
- Demonstrate compliance of the site with the relevant codes, standards and regulations (i.e. NSW Planning and Assessment Regulation 1979, WHS Regulation, 2011 Ref. [4]).

1.3 Scope of Services

The scope of work is to complete a PHA study for Warehouse 01 located at Badgerys Creek, required by the Planning Regulations. The scope does not include any other assessments at the site nor any other DHL facilities.

2.0 Methodology

2.1 Multi-Level Risk Assessment

The Multi-Level Risk Assessment approach (Ref. [4]) published by the NSW Department of Planning and Environment, has been used as the basis for the study to determine the level of risk assessment required. The approach considered the development in context of its location, the quantity and type (i.e. hazardous nature) Dangerous Goods stored and used, and the facility's technical and safety management control. The Multi-Level Risk Assessment Guidelines are intended to assist industry, consultants and the consent authorities to carry out and evaluate risk assessments at an appropriate level for the facility being studied.

There are three levels of risk assessment set out in Multi-Level Risk Assessment which may be appropriate for a PHA, as detailed in **Table 2-1**.

Table 2-1: Level of Assessment PHA

Level	Type of Analysis	Appropriate If:
1	Qualitative	No major off-site consequences and societal risk is negligible
2	Partially Quantitative	Off-site consequences but with low frequency of occurrence
3	Quantitative	Where 1 and 2 are exceeded

The Multi-Level Risk Assessment approach is schematically presented in **Figure 2-1**.

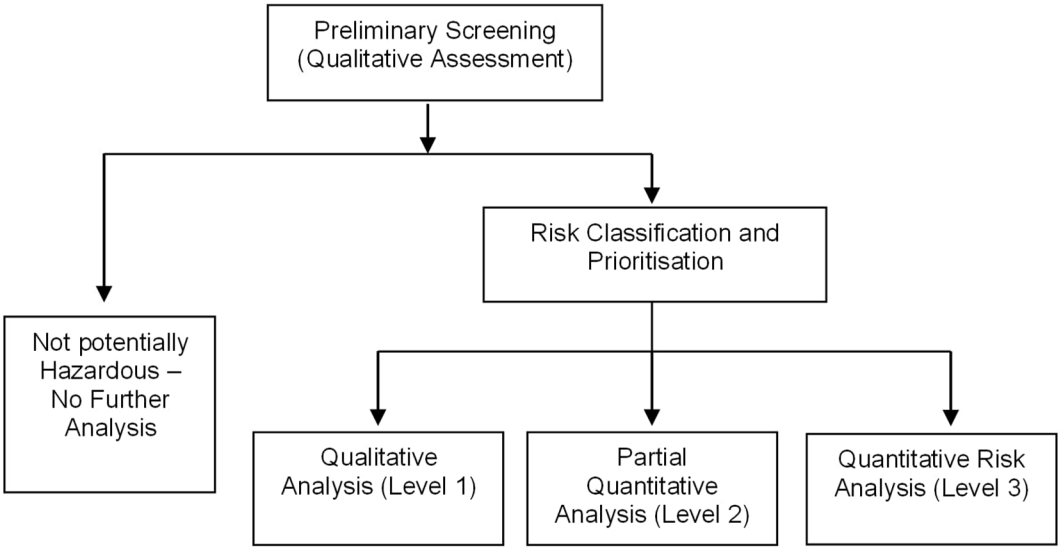

Figure 2-1: The Multi-Level Risk Assessment Approach

Based on the type of DGs to be used and handled at the proposed facility, a **Level 2 Assessment** was selected for the Site. This approach provides a qualitative assessment of those DGs of lesser quantities and hazard, and a quantitative approach for the more hazardous materials to be used on-site. This approach is commensurate with the methodologies recommended in "Applying SEPP 33's" Multi Level Risk Assessment approach (DPE, 2011).

2.2 Risk Assessment Study Approach

The methodology used for the PHA is as follows;

Hazard Analysis – A detailed hazard identification was conducted for the site facilities and operations. Where an incident was identified to have a potential off-site impact, it was included in the recorded hazard identification word diagram (**Appendix A**). The hazard identification word diagram lists incident type, causes, consequences and safeguards. This was performed using the word diagram format recommended in HIPAP No. 6 (Ref. [3]).

Each postulated hazardous incident was assessed qualitatively in light of proposed safeguards (technical and management controls). Where a potential offsite impact was identified, the incident was carried into the main report for further analysis. Where the qualitative review in the main report determined that the safeguards were adequate to control the hazard, or that the consequence would obviously have no offsite impact, no further analysis was performed. **Section 3.1** of this report provides details of values used to assist in selecting incidents required to be carried forward for further analysis.

Consequence Analysis – For those incidents qualitatively identified in the hazard analysis to have a potential offsite impact, a detailed consequence analysis was conducted. The analysis modelled the various postulated hazardous incidents and determined impact distances from the incident source. The results were compared to the consequence criteria listed in HIPAP No. 4 (Ref. [2]). The criteria selected for screening incidents is discussed in **Section 3.1**.

Where an incident was identified to result in an offsite impact, it was carried forward for frequency analysis. Where an incident was identified to not have an offsite impact, and a simple solution was evident (i.e. move the proposed equipment further away from the boundary), the solution was recommended, and no further analysis was performed.

Frequency Analysis – In the event a simple solution for managing consequence impacts was not evident, each incident identified to have potential offsite impact was subjected to a frequency analysis. The analysis considered the initiating event and probability of failure of the safeguards (both hardware and software). The results of the frequency analysis were then carried forward to the risk assessment and reduction stage for combination with the consequence analysis results.

Risk Assessment and Reduction – Where incidents were identified to impact offsite and where a consequence and frequency analysis was conducted, the consequence and frequency analysis for each incident were combined to determine the risk and then compared to the risk criteria published in HIPAP No. 4 (Ref. [2]). Where the criteria were exceeded, a review of the major risk contributors was performed, and the risks reassessed incorporating the recommended risk reduction measures. Recommendations were then made regarding risk reduction measures.

Reporting – on completion of the study, a draft report was developed for review and comment by DHL. A final report was then developed, incorporating the comments received by DHL for submission to the regulatory authority.

3.0 Site Description

3.1 Site Location

The subject site is located within part of Lot 1 in Deposited Plan 1306448, at 1953-2109 Elizabeth Drive, Badgerys Creek. The site is approximately 25 hectares in size and situated north of the new Western Sydney Airport. It is located within the Penrith local government area (**LGA**) and is approximately 12.5km from Penrith Central Business District (**CBD**), 27km from Parramatta CBD, and 47km from Sydney CBD. The site is owned by Roberts Jones Development Pty Ltd. **Figure 3-1** shows the regional location of the site. Provided in **Figure 3-2** is the layout of the site.

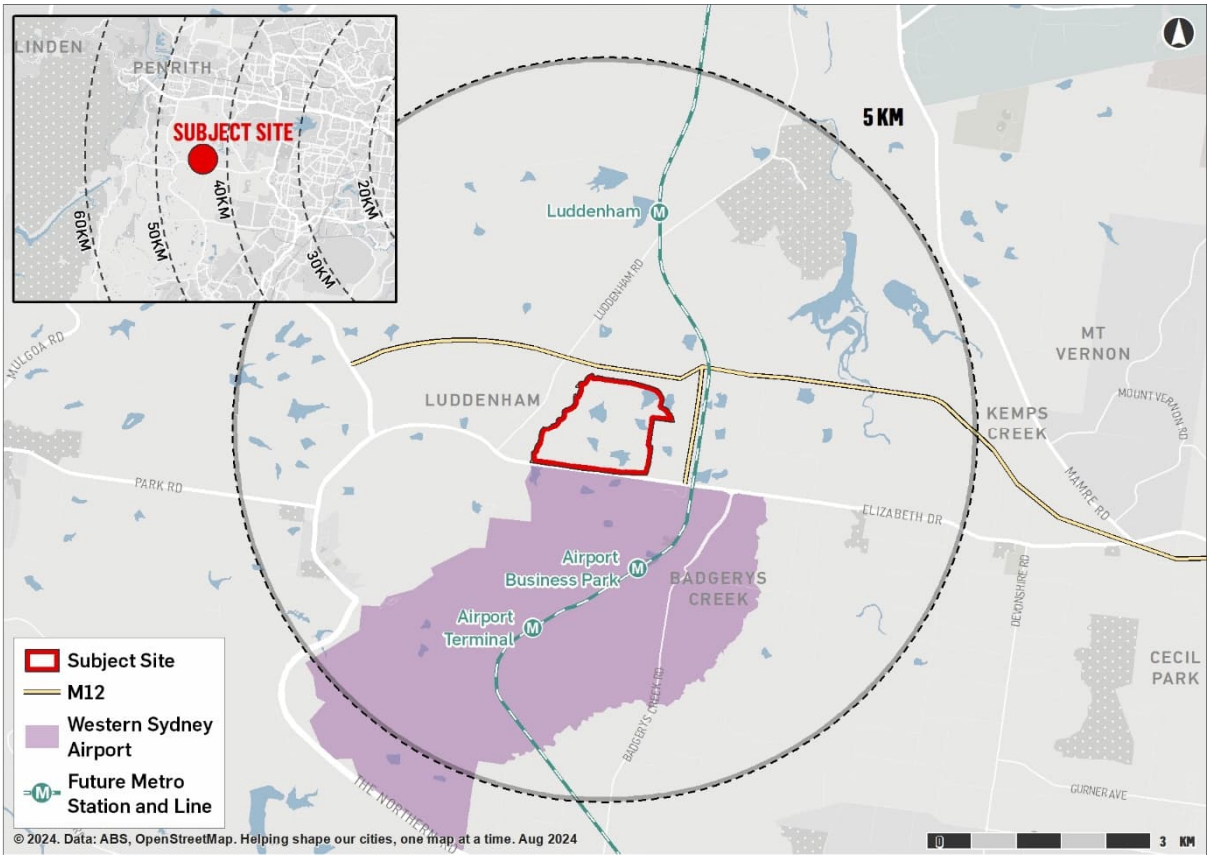

Figure 3-1: Site Location

3.2 Adjacent Land Uses

The land is located in an enterprise area which may have a diverse range of developments; however, it has been assumed that the following land uses are likely to be around the site:

- North – Industrial warehousing
- South – Industrial warehousing
- East – Industrial warehousing
- West – Industrial warehousing

It is noted that the enterprise zone may permit a range of developments including industrial, commercial, or sensitive receptors (i.e. childcare centres).

3.3 Site Description

The warehouse is being developed as a speculative warehouse to cater toward potential customers that require large quantities of DGs to be stored. As the exact nature of the products is unknown, the warehouse is being developed to enable full flexibility of DG products including packages exceeding retail storage volumes (i.e. 205 L drums and 1,000 L Intermediate Bulk Containers – IBCs). Based upon the DG classes, a combination of AS 1940:2017 (Ref. [4]) and AS/NZS 3833:2007 (Ref. [5]) have been used.

The DGs will be separated into two (2) bunkers purpose built for the product suite to be stored within. The flammable gases and liquids and miscellaneous DGs (which typically have a combustible element to the product) will be stored in one bunker which will be subject to AS 1940:2017 design requirements while the other bunker will contain the remaining products and will be assessed using AS/NZS 3833:2007.

The flammable liquid bunker will have the typical design requirements from AS 1940:2017 including bunding to contain a portion of the flammable liquid stored in addition to 20 minutes of fire water storage, mechanical ventilation system, hazardous area rated equipment in accordance with the classification per AS/NZS 60079.10.1:2022 (Ref [6]) and AS/NZS 60079.14:2022 (Ref. [7]), foam hose reels, etc. In addition, the sprinkler system will be designed in accordance with AS 2118.1:2017 (Ref. [8]) which requires a combined in-rack and ceiling mounted sprinkler system. The bunker will have walls having an FRL of 240/240/240 with parapets for internal walls to a height of 0.5 m above ceiling height to prevent incident propagation between bunkers. Any doors or entrances to the bunker will have an FRL of -/120/30 per the standard.

The mixed class DG bunker will be designed according to AS/NZS 3833:2007 and will include walls having an FRL of 60/60/60 along with ventilation and bunding for a portion of goods stored and 20 minutes of sprinkler discharge. As flammable products are not stored in this bunker, ceiling mounted sprinkler protection will be adequate.

The whole site will be capable of containing at least 90 minutes of potentially contaminated fire water as required by AS/NZS 3833:2007 (Ref. [5]) and the NSW "*Best Practice Guidelines for Contaminated Water and Retention Systems*" (Ref. [9]).

3.4 Quantities of Dangerous Goods Stored and Handled

The dangerous goods stored at the warehouse are for various customers and may fluctuate with customer requirements. The classes and quantities to be approved in the facility are summarised **Table 3-1**. The proposed DG storage locations are shown in **Figure 3-2.**

Table 3-1: Maximum Classes and Quantities of Dangerous Goods Stored

Storage Location	Class	Description	PG	Quantity (kg)
DG Bunker 1	2.1	Flammable gases (aerosols)	n/a	100,000 / 25,000*
	2.2	Non-toxic, non-flammable gases	n/a	200,000
	3	Flammable liquids	II & III	1,000,000
	4.1	Flammable solids	II & III	100,000
	C1/C2	Combustible Liquids	n/a	10,000
DG Bunker 2	5.1	Oxidising agents	II & III	40,000
	8	Corrosive substances	II	20,000

Storage Location	Class	Description	PG	Quantity (kg)
			III	
	9	Miscellaneous DGs	III	10,000
Cabinet	6.1	Toxic substances	II	10

*Note: This refers to the quantity of propellant within the aerosols and not the total package weight. The propellant content within the cannisters is typically around 25% of product weight.

3.5 Aggregate Quantity Ratio

Where more than one class of dangerous goods are stored and handled at the site an AQR exists. This ratio is calculated using **Equation 3-1:**

$$AQR = \frac{q_x}{Q_x} + \frac{q_y}{Q_y} + [\dots] + \frac{q_n}{Q_n}$$ **Equation 3-1**

Where:

x,y […] and n are the dangerous goods present

q_x, q_y, […] and q_n is the total quantity of dangerous goods x, y, […] and n present.

Q_x, Q_y, […] and Q_n is the individual threshold quantity for each dangerous good of x, y, […] and n

Where the ratio AQR exceeds a value of 1, the site would be considered a Major Hazard Facility (MHF). The threshold quantity for each class is taken from Schedule 15 of the Work Health and Safety (WHS) Regulation 2017 (Ref. [10]). These are summarised in **Table 3-2** noting Classes 4.1, 8 and 9 are not subject to MHF legislation.

Table 3-2: Major Hazard Facility Thresholds

Class	Packing Group	Quantity (tonnes)		AQR
		Threshold	Stored	
2.1	n/a	200	25.0	0.25
2.2	n/a	Not subject to MHF	200	0
3	II & III	50,000	1,000	0.02
4.1	II & III	Not subject to MHF	100	0
5.1	II & III	200	40	0.2
6.1	II & III	200	0.01	0
8	II & III	Not subject to MHF	20	0
9	III	Not subject to MHF	10	0
C1/C2	n/a	Not subject to MHF	10	0
			Total	**0.47**

The AQR is less than 1; hence, the facility would not be classified as an MHF. The site will exceed 10% of the MHF; hence, a notification to SafeWork would be required.

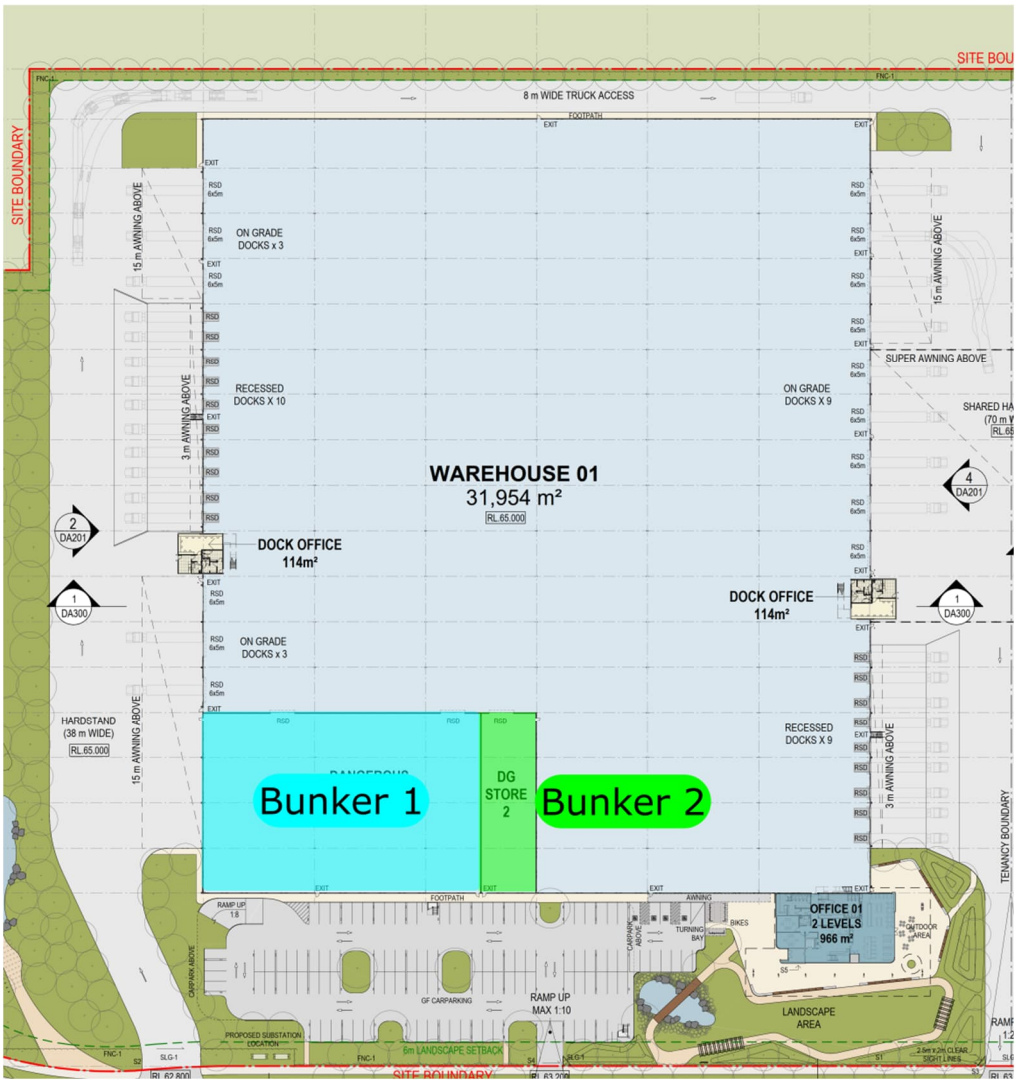

Figure 3-2: Site Layout

4.0 Hazard Identification

4.1 Introduction

A hazard identification table has been developed and is presented at **Appendix A**. This table has been developed following the recommended approach in Hazardous Industry Planning Advisory Paper No .6, Hazard Analysis Guidelines (Ref. [3]). The Hazard Identification Table provides a summary of the potential hazards, consequences and safeguards at the site. The table has been used to identify the hazards for further assessment in this section of the study. Each hazard is identified in detail and no hazards have been eliminated from assessment by qualitative risk assessment prior to detailed hazard assessment in this section of the study.

In order to determine acceptable impact criteria for incidents that would not be considered for further analysis, due to limited impact offsite, the following approach has been applied:

- *Fire Impacts* - It is noted in Hazardous Industry Planning Advisory Paper (HIPAP) No. 4 (Ref. [2]) that a criterion is provided for the maximum permissible heat radiation at the site boundary (4.7 kW/m^2) above which the risk of injury may occur and therefore the risk must be assessed. Hence, to assist in screening those incidents that do not pose a significant risk, for this study, incidents that result in a heat radiation less that at 4.7 kW/m^2, at the site boundary, are screened from further assessment.

  Those incidents exceeding 4.7 kW/m^2 at the site boundary are carried forward for further assessment (i.e. frequency and risk). This is a conservative approach, as HIPAP No. 4 (Ref. [2]) indicates that values of heat radiation of 4.7 kW/m^2 should not exceed 50 chances per million per year at sensitive land uses (e.g. residential). It is noted that the closest residential area is more than several hundred meters from the site, hence, by selecting 4.7 kW/m^2 as the consequence impact criteria (at the adjacent industrial site boundary) the assessment is considered conservative.

- *Explosion* - It is noted in HIPAP No. 4 (Ref. [2]) that a criterion is provided for the maximum permissible explosion over pressure at the site boundary (7 kPa) above which the risk of injury may occur and therefore the risk must be assessed. Hence, to assist in screening those incidents that do not pose a significant risk, for this study, incidents that result in an explosion overpressure less than 7 kPa, at the site boundary, are screened from further assessment. Those incidents exceeding 7 kPa, at the site boundary, are carried forward for further assessment (i.e. frequency and risk). Similarly, to the heat radiation impact discussed above, this is conservative as the 7 kPa value listed in HIPAP No. 4 relates to residential areas, which are over more than several hundred meters from the site.

- *Toxicity* – Toxic substances have been proposed to be stored at the site; hence, toxicity has been assessed.

- *Property Damage and Accident Propagation* - It is noted in HIPAP No. 4 (Ref. [2]) that a criterion is provided for the maximum permissible heat radiation/explosion overpressure at the site boundary (23 kW/m^2/14 kPa) above which the risk of property damage and accident propagation to neighbouring sites must be assessed. Hence, to assist in screening those incidents that do not pose a significant risk to incident propagation, for this study, incidents that result in a heat radiation heat radiation less than 23 kW/m^2 and explosion over pressure less than 14 kPa, at the site boundary, are screened from further assessment. Those incidents

exceeding 23 kW/m^2 at the site boundary are carried forward for further assessment with respect to incident propagation (i.e. frequency and risk).

- *Societal Risk* – HIPAP No. 4 (Ref. [2]) discusses the application of societal risk to populations surrounding the proposed potentially hazardous facility. It is noted that HIPAP No. 4 indicates that where a development proposal involves a significant intensification of population, in the vicinity of such a facility, the change in societal risk needs to be taken into account. In the case of the facility, there is currently no significant intensification of population around the proposed site; however, the adjacent land has been rezoned residential; hence, there will be housing located approximately more than several hundred meters from the site. Therefore, societal risk has been considered in the assessment.

4.2 Properties of Dangerous Goods

The type of DGs and quantities stored and used at the site has been described in **Section 3**. **Table 4-1** provides a description of the DGs stored and handled at the site, including the Class and the hazardous material properties of the DG Class.

Table 4-1: Properties* of the Dangerous Goods and Materials Stored at the Site

Class	Hazardous Properties
2.1 – Flammable Gas	Class 2.1 includes flammable gases which are ignitable when in a mixture of 13 per cent or less by volume with air or have a flammable range with air of at least 12 percentage points regardless of the lower flammable limit. Ignited gas may result in explosion or flash fire. Where gas released under pressure from a hole in a pressurised component is ignited, a jet fire may occur.
3 – Flammable Liquids	Class 3 includes flammable liquids which are liquids, or mixtures of liquids, or liquids containing solids in solution or suspension (for example, paints, varnishes, lacquers, etc.) which give off a flammable vapour at temperatures of not more than 60^{o}C closed-cup test or not more than 65.6^{o}C open-cup test. Vapours released may mix with air and if ignited, at the right concentration, will burn resulting in pool fires at the liquid surface.
5.1 -Oxidising Agents	Class 5.1 materials will not combust but these materials include substances which can in a fire event, liberate oxygen and could accelerate the burning of other combustible or flammable materials. Releases to the environment may cause damage to sensitive receptors within the environment.
6.1 – Toxic Substances	Substances liable either to cause death or serious injury or to harm human health if swallowed or inhaled or by skin contact.
8 – Corrosive Substances	Class 8 substances (corrosive substances) are substances which, by chemical action, could cause damage when in contact with living tissue (i.e. necrosis), or, in case of leakage, may materially damage, or even destroy, other goods which come into contact with the leaked corrosive material. Releases to the environment may cause damage to sensitive receptors within the environment.

* The Australian Code for the Transport of Dangerous Goods by Road and Rail (Ref. [11]).

4.3 Hazard Identification

Based on the hazard identification table presented in **Appendix A**, the following hazardous scenarios have been developed:

- Flammable liquid or gas release, delayed ignition and flash fire or explosion.
- Flammable material spill, ignition and racking fire.

- LPG release (from aerosol), ignition and racking fire.
- Sprinkler failure and Bunker 1 fire and radiant heat.
- Sprinkler failure and Bunker 1 fire and toxic smoke emission.
- Bunker 2 fire and radiant heat.
- Bunker 2 fire and toxic smoke emission.
- Full warehouse fire.
- Toxic substance instances.
- Dangerous goods liquid spill, release and environmental incident.
- Warehouse fire, sprinkler activation and potentially contaminated water release.

Each identified scenario is discussed in further detail in the following sections.

4.4 Flammable Liquid or Gas Release, Delayed Ignition and Flash Fire or Explosion

As noted in **Section 3.0**, flammable liquids will be held at the site for storage and distribution. There is potential that a flammable liquid spill could occur in the warehouse area due to an accident (packages dropped from forklift, punctured by forklift tines) or deterioration of packaging. If a flammable liquid spill occurred, the liquid may begin to evaporate (depending on the material flashpoint and ambient temperature). Where materials do evaporate, there is a potential for accumulation of vapours, forming a vapour cloud above the spill.

If the spill is not identified, the cloud may continue to accumulate, eventually contacting an ignition source. If the cloud is confined (i.e. pallet racking and stored products) the vapour cloud may explode if ignited, or, if it is unconfined, it may result in a flash fire which would burn back to the flammable liquid spill, resulting in a pool fire.

A similar scenario could occur with the release of Liquefied Petroleum Gas (LPG) from an aerosol; however, the formation of a gas cloud would occur immediately as the LPG would instantly flash to gas following release from the canister. It is noted that the potential for a release of LPG is low as aerosol canisters are pressure tested during manufacture and filling, hence, release would predominately result from damaged product rather than deterioration.

A review of the store design indicates it will have a mechanical ventilation system complying with AS 1940:2017 (Ref. [4]) which will extract air at a rate of 0.3 m^3 per m^2 of floor area per minute from low level. Therefore, any dense gases of vapours released will be captured by the system before they can accumulate to the Lower Explosive Limit (LEL). In addition, to minimise the likelihood a flammable vapour cloud may contact an ignition source, the electrical equipment within the DG store hazardous zone will be installed according to the requirements of AS/NZS 60079.14:2022 (Ref. [12]). Finally, the compartment is constructed of walls having an FRL of 240/240/240; hence, in the event that the ventilation fails and is ignited, the consequence impacts would be contained within the compartment.

Therefore, as the potential for the accumulation of vapours has been minimised by the ventilation, ignition sources controlled, and the area is contained within a compartment, the potential for offsite impact to occur has been negated. Subsequently, this incident has not been carried forward for further analysis.

4.5 Flammable Material Spill, Ignition and Racking Fire

As noted in **Section 4.4**, it is considered that there is a low potential for a package to leak resulting in a flammable material spill and there are several controls in place to minimise the likelihood of a damaged container entering the warehouse and additional controls to minimise the potential that ignition of a flammable material spill could occur.

If a flammable material spill was to occur (e.g. dropped pallet or package during handling) and it was ignited (e.g. by the forklift), the fire would initially be small although as it grows it will accelerate quickly. The store is protected by in-rack sprinklers and Storage Mode Sprinkler Systems (SMSS) which are designed per AS 2118.1:2017 (Ref. [8]) specifically for the products stored. Therefore, it is likely that any fire within the bunker will be controlled within the sprinkler array.

The store is enclosed within FRL 240/240/240 walls; hence, in the event of a fire, the radiant heat will be contained within the compartment and be unable to impact offsite. Therefore, this incident has not been carried forward for further analysis.

4.6 LPG Release (from Aerosol), Ignition and Racking Fire

As noted in **Section 4.4**, the potential for release of LPG from an aerosol is considered low due to the quality assurance testing on aerosol canisters during the filling process. The release of LPG would likely result from damage to aerosols during transport and storage rather than from deterioration. Packages are inspected upon delivery and an accident involving aerosols would trigger an additional inspection to verify that damage had not occurred prior to storage within the warehouse.

Notwithstanding this, there is the potential for a release of LPG to occur within the storage racking. Due to the hazardous area rated equipment within the area and protocols, it is considered unlikely for an ignition to occur; however, in the event that an ignition of an LPG release did occur a fire could result.

The fire would consume the packaging with the generated heat impacting the adjacent aerosols. As the LPG within the adjacent aerosols expands the canisters may rupture releasing LPG which would ignite and rocket the canister throughout the aerosol cage potentially spreading the fire.

As the fire grows, the SMSS is expected to activate to suppress the fire and cool adjacent packages to minimise the potential for aerosol rupture and rocketing. Activation of this system would control the fire within the sprinkler array. In addition, the aerosols are contained within a caged area which will minimise the potential for propagation of the fire throughout the bunker.

The store is enclosed within FRL 240/240/240 walls; hence, in the event of a fire, the radiant heat will be contained within the compartment and be unable to impact offsite. Therefore, this incident has not been carried forward for further analysis.

4.7 Sprinkler Failure and Bunker 1 Fire and Radiant Heat

In the event that the sprinkler system fails to control either an aerosol or flammable liquid fire, the fire will propagate throughout the bunker resulting in radiant heat emission from the area. The bunker is contained within an FRL 240/240/240 compartment; hence, the majority of the flame from the fire will be behind fire rated walls with only a minor portion rising above the roof life.

It is noted that the surrounding land use is zoned as enterprise which permits a wide range of industries or developments that may be located adjacent to the warehouse. This may include childcare centres or other sensitive land uses; hence, it is necessary to demonstrate that in the event of a full bunker fire that the acceptable criterion is not exceeded. Therefore, this incident has been carried forward for further analysis.

4.8 Sprinkler Failure and Bunker 1 Fire and Toxic Smoke Emission

As noted in **Section 4.7**, in the event of a sprinkler failure fire scenario the fire will propagate throughout the bunker fully engulfing the bunker. Smoke generated from the fire may result in toxic products of combustion impacting downwind; however, as there are no toxic substances within this bunker, the potential for toxic smoke to be generated is considered to be negligible compared to a standard warehouse fire. As there are no unique smoke hazards from this scenario, this incident has not been carried forward for further analysis.

4.9 Bunker 2 Fire and Radiant Heat

Bunker 2 contains mixed classes of DGs including Class 5.1 (oxidising agents), Class 8 (corrosive substances), and Class 9 (miscellaneous DGs). As these products are not classified as flammable, they do not emit flammable vapours; hence, igniting these products would be difficult. The only source of fire would be if packaging was ignited which would ultimately activate the sprinkler system to suppress and control the fire. As there isn't additional combustible load within the products themselves, it is likely that the sprinkler system will fully extinguish the fire.

It is noted that Class 9 products may have some combustible aspects to them which would require storage within the flammable liquid bunker. To ensure that only Class 9 materials that do not have combustibility associated with them are stored in the bunker the following recommendation has been made:

- Prior to acceptance and receival of Class 9 products at the warehouse, the flash point of the product shall be reviewed to confirm that the product is not combustible prior to storage into Bunker 2. Where combustibility is identified, the product shall be stored in Bunker 1.

In addition, the bunker is a fire compartment; hence, in the event of a fire any radiant heat would be contained within the bunker preventing offsite impact. Therefore, as the potential for ignition to occur is low due to the nature of the products, the fire protection system and fire compartmentation, the potential for an offsite impact to occur is considered negligible; hence, this incident has not been carried forward for further analysis.

4.10 Bunker 2 Fire and Toxic Smoke Emission

Bunker 2 does not contain any toxic substances and the potential for a fire to occur within the bunker is considered almost negligible given that no flammable or combustible materials are stored within the bunker. Therefore, the potential for toxic smoke emission to occur from the storage is also considered negligible; hence, this incident has not been carried forward for further analysis.

4.11 Full Warehouse Fire

In the event of an uncontained fire within Bunker 1, it could potentially impact out of the bunker resulting in propagation throughout the warehouse and a full warehouse fire. It is noted that the internal walls of the bunkers will have parapets 0.5 m above the roof line to prevent incident

propagation from within the bunkers to the external areas. Therefore, the potential for propagation is considered to be low.

The allocated storage area of DGs within the warehouse is approximately 2930 m^2 of the total warehouse which has a floor area of approximately 32,000 m^2. Therefore, only 9% of the warehouse is allocated to DG storage; hence, a full warehouse fire will mostly resemble a standard warehouse fire.

As the potential for propagation into the general warehouse area is considered to be low, and a full warehouse fire would not be dissimilar to a standard warehouse, this incident has not been carried forward for further analysis.

4.12 Toxic Substance Incidents

Toxic substances will be received and stored at the warehouse which if involved in a fire may result in the formation of toxic smoke. A review of the quantities of toxic substances expected to be stored indicates approximately 10 kg or L may be received. The toxic substances will be stored in a purpose-built storage cabinet located within the general warehouse area.

A fire occurring within the main warehouse is considered low and based upon the non-DG commodities stored the potential for the sprinkler system to be unable to suppress and control the fire is unlikely. Therefore, it is expected that a fire within the warehouse would be unlikely to impact the toxic substance storage. Furthermore, the cabinets have a 30/30/30 rating which will protect the toxic substances from exposure for a period of 30 minutes.

In the unlikely event that a fire becomes uncontrolled and impacts the toxic substances, the heat generated from the fire would likely decompose the toxic substances sufficiently that they do not pose a toxic threat where toxicity is not elicited from halogenic compounds. In the event the toxic substances have halogens toxic smoke may be generated; however, based upon the 10 kg or L stored, the concentration of toxic compounds would be almost negligible within the smoke plume.

Based upon the low volume of toxic substances stored and the perceived concentration of toxic compounds in a smoke plume in the event the toxic substances are involved in a fire, it is considered that the potential for an offsite impact from toxic smoke is considered negligible. Therefore, this incident has not been carried forward for further analysis.

4.13 Dangerous Goods Liquid Spill, Release and Environmental Incident

There is potential that a spill of the liquid DGs (Class 3, 5.1, 6.1, and 8) could occur at the site which if not contained could be released into the public water course resulting in a potential environmental incident.

The two DG bunkers will have a bund capacity to contain a portion of the goods stored based upon the standards they are designed against (i.e. AS 1940:2017 and AS/NZS 3833:2007). In addition, the bund volumes will be increased to contain the 20 minutes of sprinkler water; hence, the bund capacity will be sufficient to control all foreseeable spills that could occur within the bunkers.

In addition, the site will also be designed to capture potentially contaminated water in accordance with "*Best Practice Guidelines for Potentially Contaminated Water Retention and Treatment Systems"* (Ref. [9]) as assessed in **Section 4.14**; hence there is a primary and secondary containment strategy which essentially eliminates the potential for offsite chemical release from the stored products. Finally, for any spills that occur outside of the storage area, there will be spill kits that site personnel can use to clean up spills before they impact offsite.

As the potential for an offsite impact to occur is considered negligible, this incident has not been carried forward for further analysis. Notwithstanding this, the following recommendation has been made:

- The DG bunkers shall be equipped with spill kits that are compatible with the goods being stored and handled.
- Unloading / loading areas shall be equipped with spills that are compatible with the goods being stored and handled.

4.14 Warehouse Fire, Sprinkler Activation and Potentially Contaminated Water Release

In the event of a fire, the SMSS will activate discharging fire with water to control and suppress the fire. Contact of the fire water with DGs may result in contamination which, if released to the local watercourse, could result in environmental damage. The SMSS system delivers approximately 6 m^3/min of water which, if operated for a long period, may result in overflow of site bunding and potential release. The facility has been designed to be able to contain all DG spills and liquid effluent resulting from the management of an incident (i.e. fire) within the premises.

The site will hold 60 minutes of water storage on site as required by FM Global standards; hence, to allow for additional conservatism, following a risk assessment methodology as outlined by the Department of Planning document "*Best Practice Guidelines for Potentially Contaminated Water Retention and Treatment Systems*" (Ref. [9]), an allowance of 90 minutes of potentially contaminated water has been selected noting this includes all sources of application (i.e. onsite storage and towns mains) thus far exceeding the 60 minute on site storage.

To ensure sufficient contaminated water can be contained the following recommendations have been made:

- The warehouse and/or site boundaries shall be capable of containing 90 minutes of sprinkler discharge (i.e. ceiling mounted, in-racks, and drenchers where required) in addition to 90 minutes of hydrant hose discharge assuming three (3) hydrants are operating.
- The civil engineers designing the site containment shall demonstrate the design is capable of containing the required water volume.

Should the above recommendations be adopted, the potential for potentially contaminated water to be discharged from the site is considered low; hence, this incident has not been carried forward for further analysis.

5.0 Consequence Analysis

5.1 Incidents Carried Forward for Consequence Analysis

The following incident(s) were identified to have potential to impact off site:

- Sprinkler failure and Bunker 1 fire and radiant heat.

Each incident has been assessed in the following sections.

5.2 Sprinkler Failure and Bunker 1 Fire and Radiant Heat

There is the potential for a fire to occur within bunker 1 which will propagate throughout the bunker footprint if the sprinkler system fails. A detailed analysis has been conducted in **Appendix B** and the radiant heat impact distances estimated for this scenario are presented in **Table 5-1** with the contours illustrated in **Figure 5-1.**

Table 5-1: Heat Radiation from a Bunker 1 Fire

Heat Radiation (kW/m^2)	Distance (m)
35	Not observed
23	Not observed
12.6	40
4.7	80

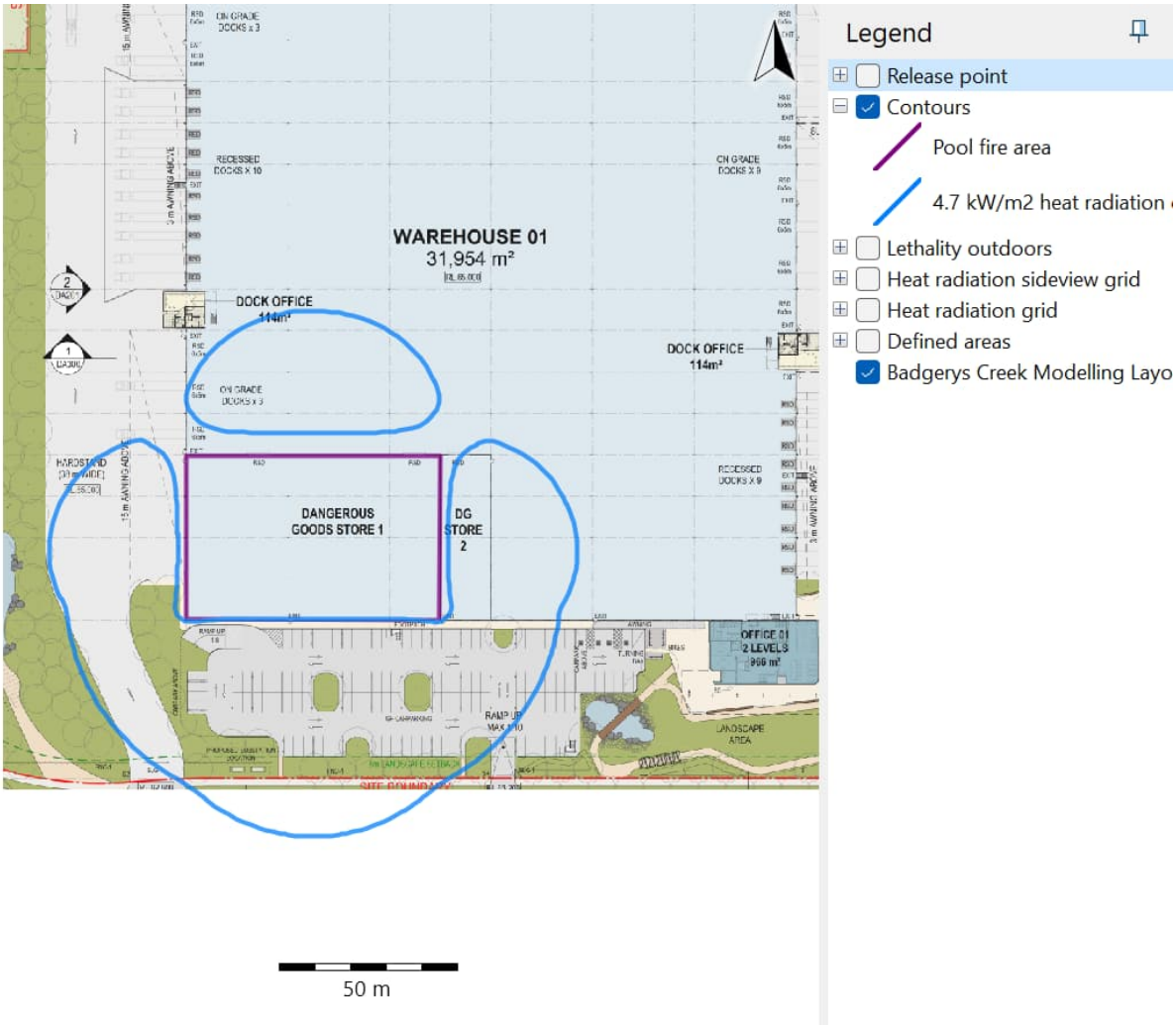

Figure 5-1: Bunker 1 Fire Radiant Heat Contours

A review of the contours illustrated in **Figure 5-1** indicates that the 4.7 kW/m^2 contour would impact over the site boundary which could result in an injury or fatality. Therefore, this incident has been carried forward for further analysis.

The 23 kW/m^2 contour was not observed to impact across the site boundary; hence, propagation has not been carried forward for further analysis.

6.0 Frequency Analysis

6.1 Incidents Carried Forward for Frequency Analysis

The following incident has been carried forward for frequency analysis:

- Sprinkler failure and Bunker 1 fire and radiant heat.

This incident has been assessed in the following section.

6.2 Probability of Failure on Demand

The failure rates for each component identified in the safety systems which protect against the scenarios in the following sections were sourced from 3rd party databases such as; OREDA, Exida, UK Health and Safety Executive (HSE). A summary of the failure rate information has been conducted in **Appendix C**. Also included in this appendix are the calculations for the probability of failure on demand (PFD) for each component which is estimated using **Equation 7-1**.

$$PFD = \frac{1}{2}\lambda_{du}t$$ **Equation 7-1**

Where:

- λ_{du} = dangerous undetected failures of a component
- t = 1/number of test intervals per annum

6.3 Sprinkler Failure and Bunker 1 Fire and Radiant Heat

The frequency of a full bunker fire at the site can be estimated from a number of sources (e.g. general warehouse fire frequencies or the summation of individual fire frequencies for each of the initiating fire events). As this is a preliminary hazard analysis, the fire frequency has been selected from general fire frequency data.

A detailed fire frequency analysis has been conducted in **Appendix C**. The results of this analysis indicate that an initiating fire frequency would be in the order of $1x10^{-3}$ p.a.

It is noted that the site is fitted with multiple automatic sprinkler systems that will initiate on fire detection, controlling the fire and preventing the fire growth to a full warehouse fire. The Centre for Chemical Process Safety (CCPS) provides failure rate data for water fire protection systems including all components (pump, distribution system, nozzles, seals, piping, controls and base plate) of 9.66 per 10^6 hours (Ref. [13]). The hourly failure rate is converted to failures per annum by:

Failures per Annum = Failures per hour x 8760 hours per year

Failures per Annum = $9.66x10^6$ x 8760 = 0.085

The system will only operate when a fire is detected; hence, the system operates in demand mode. The protection system will be tested monthly totalling 12 tests per annum. The probability of failure on demand (PFD) is estimated using:

$$PFD = \frac{1}{2}\lambda_{du}\left(\frac{1}{t}\right)$$

Where:

λ_{du} = dangerous undetected failures of a component

t = 1/number of test intervals per annum

PFD = 0.5 (0.085) (1/12) = 0.00353

Hence, the frequency of a full fire within the warehouse is the frequency of an initiating fire x the probability of fail on demand (PFD) of the automatic fire fighting system as shown in **Figure 6-1**.

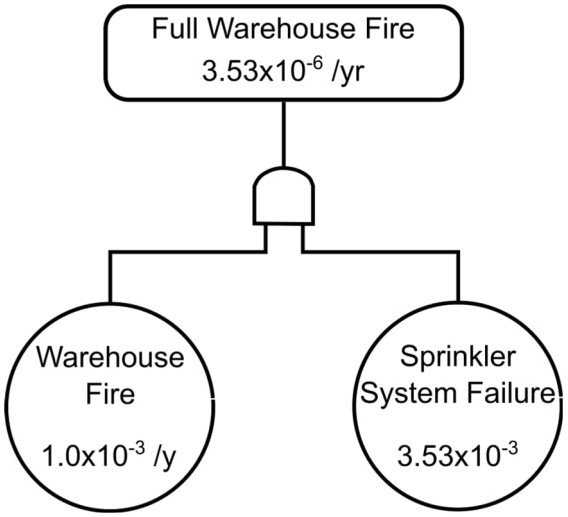

Figure 6-1: Bunker Fire Fault Tree

Conservatively assuming a 100% chance of fatality at the site boundary for a person exposed to radiant heat from a full warehouse fire, the probability of fatality at the site boundary becomes $3.53x10^{-6}$ x 1 = $3.53x10^{-6}$ chances of fatality per year or 3.53 chances of a fatality in a million per year (pmpy).

6.4 Comparison Against Risk Criteria

The NSW Department of Planning and Environment has issued a guideline on the acceptable risk criteria (Ref. [2]). The acceptable risk criteria published in the guideline relates to injury, fatality and property damage. The adjacent land use would be classified as an enterprise which may permit a range of land uses to be developed; however, the area to the south of the warehouse where the offsite impact occurs is proposed to be developed as an industrial which carries an acceptable fatality risk criteria of $50x10^{-6}$ p.a.

The frequency of a fatality occurring at the adjacent sites was estimated to be $3.53x10^{-6}$ which is less than $50x10^{-6}$; hence, the frequency of a fatality would be less than the acceptable criteria as required.

7.0 Conclusion and Recommendations

7.1 Conclusions

A hazard identification table was developed for the warehouse facility to identify potential hazards that may be present at the site as a result of operations or storage of materials. Based on the identified hazards, scenarios were postulated that may result in an incident with a potential for offsite impacts. Postulated scenarios were discussed qualitatively and any scenarios that would not impact offsite were eliminated from further assessment.

Based upon the enterprise land zoning around the area, fire incidents were conservatively carried forward for further analysis to determine whether risk criteria associated with non-industrial land uses may be exceeded. The risk assessment demonstrated that the frequency of a fatality at the adjacent land uses would be below the acceptable criteria published in HIPAP No. 4 (Ref. [2]).

Based on the analysis conducted, it is concluded that the risks at the site boundary are not considered to exceed the acceptable risk criteria; hence, the facility would only be classified as potentially hazardous and would be permitted within the current land zoning for the site.

7.2 Recommendations

Notwithstanding the conclusions following the analysis of the facility, the following recommendations have been made:

- The DG bunkers shall be equipped with spill kits that are compatible with the goods being stored and handled.
- Unloading / loading areas shall be equipped with spills that are compatible with the goods being stored and handled.
- The warehouse and/or site boundaries shall be capable of containing 90 minutes of sprinkler discharge (i.e. ceiling mounted, in-racks, and drenchers where required) in addition to 90 minutes of hydrant hose discharge assuming three (3) hydrants are operating.
- The civil engineers designing the site containment shall demonstrate the design is capable of containing the required water volume.
- A DG design report shall be completed for the warehouse to ensure all required design items from the standard are captured and included within the site design.
- The design report shall be prepared by a competent DG consultant with competencies in all the DG classes proposed to be stored at the warehouse.
- The warehouse shall be subject to a hazardous area classification to ensure that electrical equipment installed within Bunker 1 is compliant with the likely materials to be stored.
- Prior to acceptance and receival of Class 9 products at the warehouse, the flash point of the product shall be reviewed to confirm that the product is not combustible prior to storage into Bunker 2. Where combustibility is identified, the product shall be stored in Bunker 1.
- The toxic substances shall be stored in a toxic substances cabinet complying with AS 4552-1997.

8.0 References

[1] NSW Department of Planning and Environment, “Applying SEPP33 – Hazardous and Offensive Developments,” NSW Department of Planning and Environment, Sydney, 2011.

[2] Department of Planning, “Hazardous Industry Planning Advisory Paper No. 4 - Risk Criteria for Land Use Safety Planning,” Department of Planning, Sydney, 2011.

[3] Department of Planning, “Hazardous Industry Planning Advisory Paper No. 6 - Guidelines for Hazard Analysis,” Department of Planning, Sydney, 2011.

[4] Standards Australia, AS 1940:2017 - Storage and Handling of Flammable and Combustible Liquids, Sydney: Standards Australia, 2017.

[5] Standards Australia, “AS/NZS 3833:2007 - Storage and Handling of Mixed Classes of Dangerous Goods, in Packages and Intermediate Bulk Containers,” Standards Australia, Sydney, 2007.

[6] Standards Australia, AS/NZS 60079.10.1:2022 - Explosive Atmospheres Part 10.1: Classification of Areas, Explosive Gas Atmospheres, Sydney: Standards Association of Australia, 2022.

[7] Standards Australia, AS/NZS 60079.14:2022 - Explosive Atmospheres Part 14: Electrical Installations, Design, Selection and Erection, Sydney: Standards Australia, 2022.

[8] Standards Australia, “AS 2118.1:2017 - Automatic Fire Sprinkler Systems General Systems,” Standards Australia, Sydney, 2017.

[9] NSW Department of Planning, “Best Practice Guidelines for Contaminated Water Retention and Treatment Systems,” NSW Department of Planning, Sydney, 1994.

[10] SafeWork NSW, “Work Health and Safety Regulation,” SafeWork NSW, Lisarow, 2017.

[11] Road Safety Council, The Australian Code for the Transport of Dangerous Goods by Road and Rail Edition 7.7, Canberra: Road Safety Council, 2020.

[12] Standards Australia, AS/NZS 60079.14:2022 - Explosive Atmospheres Part 14: Electrical Installations, Design, Selection and Erection, Sydney: Standards Australia, 2022.

[13] Centre for Chemical Process Safety, “Guidelines for Process Equipment Reliability Data with Data Tables,” Centre for Chemical Process Safety, 1989.

[14] Standards Australia, “AS 4452-1997 - The Storage and Handling of Toxic Substances,” Standards Australia, Sydney, 1997.

[15] Standards Australia, AS/NZS 60079.10.1:2022 - Explosive Atmospheres Part 10.1: Classification of Areas, Explosive Gas Atmospheres, Sydney: Standards Association of Australia, 2022.

[16] F. P. Lees, Loss Prevention in the Process Industries, London: Butterworth-Heinemann, 2005.

[17] C. Doolan, “The Effect of Water Mist and Water Spray on Radiative Heat Transfer for Stored Ordinance,” Defence Science and Technology Organisation, 2003.

Appendix A

Hazard Identification Table

A1. Hazard Identification Table

ID	Area / Operation	Hazard Cause	Hazard Consequence	Safeguards
1	DG Bunker 1	• Dropped pallet • Damaged packaging (receipt or during storage) • Deterioration of packaging	• Release of Class 2.1, 2.2, 3, or 4.1 to the environment	• Inspection of packages upon delivery to the site. • Trained forklift operators (including spill response training). • Bunded store per AS 1940:2017 (Ref. [4]) • Spill kits
2			• Spill of flammable liquids, evolution of flammable vapour cloud ignition and vapour cloud explosion/flash fire • Spill of flammable liquids, ignition and pool fire/racking fire	• Inspection of packages upon delivery to the site • Control of ignition sources according to AS/NZS 60079.14:2022 (Ref. [7]) • Automatic fire protection system (in-rack and SMSS per AS 2118.1:2017 (Ref. [6])) • First attack fire-fighting equipment (e.g. hose reels & extinguishers) • Fire detection systems • Mechanical ventilation system per AS 1940:2017 (Ref. [4]) • Walls having an FRL of 240/240/240 • Aerosol cage between Class 2.1/2.2 and other DGs within bunker.
3		• Heating of Class 2.1 from an adjacent fire	• Rupture, ignition and explosion/rocketing of cylinder within warehouse spreading fire	• In-rack sprinklers and SMSS per AS 2118.1:2017 (Ref. [8]). • Aerosols contained within a fire compartment with FRL 240/240/240 walls • Mechanical ventilation system per AS 1940:2017 (Ref. [4]) • Control of ignition sources according to AS/NZS 60079.14:2022 (Ref. [7])
4	DG Bunker 2	• Dropped pallet	• Release of Class 5.1, 8, or 9 to the environment	• Inspection of packages upon delivery to the site.

ID	Area / Operation	Hazard Cause	Hazard Consequence	Safeguards
		• Damaged packaging (receipt or during storage) • Deterioration of packaging		• Trained forklift operators (including spill response training). • Bunded storage per AS/NZS 3833:2007 compliant store (Ref. [5]) • Spill kits
5			• Ignition of product and fire	• No flammable liquids stored • Automatic fire protection system (SMSS per AS 2118.1:2017 (Ref. [6])) • First attack fire-fighting equipment (e.g. hose reels & extinguishers) • Fire detection systems • Mechanical ventilation system per AS 1940:2017 (Ref. [4]) • Walls having an FRL of 60/60/60
6	Toxic substances	• Damaged packaging (receipt or during storage) • Deterioration of packaging	• Release of toxic substances to environment • Toxic substances impacted by fire and toxic smoke	• Low quantity stored (10 kg or L) • Stored in a cabinet complying with AS 4552-1997 (Ref. [14]) • Unlikely to be impacted by fire due to non-DG storage in general warehouse • Sprinkler system protection
7	Sprinkler Activation	• Fire activates SMSS resulting in fire water release and potential contaminated fire water offsite	• Environmental impact to surrounding areas (e.g. stormwater drainage)	• Dangerous Goods Stores are bunded to contain in excess of the maximum required fire water, per AS/NZS 3833:2007 (Ref. [5]) • Site drainage to comply with the Best Practice Guide for Potentially Contaminated Water Retention and Treatment Systems (Ref. [7])
8	Pallet Loading / Unloading	• Dropped containers from the pallet • Impact damage to containers on the pallet	• Spill of flammable liquids, evolution of flammable vapour cloud ignition pool, fire under the pallet	• Trained & licensed forklift drivers • First attack fire-fighting equipment (hose reels & extinguishers) • SMSS if incident occurs internally

ID	Area / Operation	Hazard Cause	Hazard Consequence	Safeguards
		(collision with racks or other forklifts)	• Full pallet fire as a result of fire growth	• No potential for fire growth beyond the single pallet (limited stock externally)

Appendix B

Consequence Analysis

B1. Incidents Assessed in Detailed Consequence Analysis

The following incidents are assessed for consequence impacts.

- Sprinkler failure and Bunker 1 fire and radiant heat.

Each incident has been assessed in the sections below.

B2. Gexcon - Effects

The modelling was prepared using Effects which is proprietary software owned by Gexcon which has been developed based upon the TNO Coloured books and updated based upon CFD modelling tests and physical verification experiments. The software can model a range of incidents including pool fires, flash fires, explosions, jet fires, toxic dispersions, warehouse smoke plumes, etc.

B3. Radiant Heat Physical Impacts

Appendix Figure B-1 provides noteworthy heat radiation values and the corresponding physical effects of an observer exposed to these values (Ref. [2]).

Appendix Figure B-1: Heat Radiation and Associated Physical Impacts

Heat Radiation (kW/m^2)	Impact
35	• Cellulosic material will pilot ignite within one minute's exposure • Significant chance of a fatality for people exposed instantaneously
23	• Likely fatality for extended exposure and chance of a fatality for instantaneous exposure • Spontaneous ignition of wood after long exposure • Unprotected steel will reach thermal stress temperatures which can cause failure • Pressure vessel needs to be relieved or failure would occur
12.6	• Significant chance of a fatality for extended exposure. High chance of injury • Causes the temperature of wood to rise to a point where it can be ignited by a naked flame after long exposure • Thin steel with insulation on the side away from the fire may reach a thermal stress level high enough to cause structural failure
4.7	• Will cause pain in 15-20 seconds and injury after 30 seconds exposure (at least second degree burns will occur)
2.1	• Minimum to cause pain after 1 minute

B4. Sprinkler Failure and Bunker 1 Fire and Radiant Heat

In the event that the sprinkler system fails the fire will propagate through Bunker 1 resulting in a full bunker fire. The walls of the bunker are fire rated and will prevent radiant heat being emitted from the majority of the flame surface; however, any flame above the fire wall will emit radiant heat which may impact over the site boundary.

Provided in **Appendix Table B-1** is an estimate of the average burning rate for the materials stored within Bunker 1. The results of the calculation indicate the average burning rate is around 0.059 $kg/m^2.s$.

Appendix Table B-1: Bunker 1 Average Burning Rate

Class	Quantity (kg)	% of Total Quantity	Burning Rate (kg/m^2.s)	Burning Rate Based on %
2.1	100,000	7%	0.099	0.007021
2.2	200,000	14%	0.022	0.003121
3	1,000,000	71%	0.067	0.047518
4.1	100,000	7%	0.022	0.00156
C1/C2	10,000	1%	0.022	0.000156
Total	**236,450**	**100**	-	**0.059**

The fire has been modelled as a tank top fire (i.e. the radiating fire source is elevated above ground). This is because the flame will rise above the fire walls and only the exposed flame will radiate heat. Furthermore, the increased distance from the flame to ground level will reduce the radiant heat experienced at ground level due to attenuation through the air. The results of the analysis are shown in **Appendix Figure B-2**.

Appendix Figure B-2: Heat Radiation from a Bunker 1 Fire

Heat Radiation (kW/m^2)	Distance (m)
35	Not observed
23	Not observed
12.6	40
4.7	80

Appendix C

Warehouse Fire Frequency Estimation

C1. Estimation of the Frequency of a Full Warehouse Fire

A review of readily available warehouse fire frequency information was conducted, and a number of direct sources were identified. These were:

- Health and Safety Executive (HSE) in the United Kingdom [Hymes & Flynn, UKAEA - SRD/HSE R578, 2002] – this document lists the major warehouse fire frequency to be $2.5x10^{-3}$ p.a.;
- Baldwin, Accident Analysis and Prevention (Vol.6) – indicates a serious fire frequency in warehouses to be in the order of $1x10^{-3}$ p.a.;
- Environmental Impact Assessment Report for the Commission of Inquiry into Proposed Manufacturing Plant by WR Grace Australia Ltd., Kurnell, Sydney, October 1987 – indicates a fire frequency of $4.6x10^{-3}$ per warehouse year; and
- VROM 2005, Guidelines for quantitative risk assessment CPR 18E (Purple Book), Publication Series on Dangerous Substances (PGS 3), The Netherlands. – $4x10^{-4}$ p.a.

It is noted that the mix of overseas data and local data (albeit some is dated) correlates to indicate a fire frequency in warehouses to be in the order of $1x10^{-3}$ to $4x10^{-4}$. The data presented in the reports reviewed was for general warehouses, where stringent controls for spill and ignition sources (such as flame and explosion proof fittings, bunding, smoking and naked flame controls, isolation of power supplied on warehouse closure, etc.) were not part of the warehouse hazard controls. Hence, for a DG warehouse, containing specific ignition and fire control systems, it would be expected that a major fire would occur with a lesser frequency than that of general warehouses. Notwithstanding this, to ensure a conservative assessment has been provided within the study, the estimated initiating fire frequency for the DHL facility has been estimated as $1x10^{-3}$ p.a. (i.e. the upper end of the range).

Selected Initiating Fire Frequency = $1x10^{-3}$ p.a.

Appendix D

Dangerous Goods Report

Riskcon engineering

Dangerous Goods Report

Lot 1 DP 1306448, Badgerys Creek

DHL Supply Chain (Australia) Pty Ltd
Document No. RCE-23104_DHL_DGReport_Final_23Sep24_Rev(1)
Date 23/09/2024

Dangerous Goods Report

Lot 1 DP 1306448, Badgerys Creek

DHL Supply Chain (Australia) Pty Ltd

Prepared by

Riskcon Engineering Pty Ltd
37 Pogson Drive
Cherrybrook NSW 2126
www.riskcon-eng.com
ABN 74 626 753 820

Quality Management

Rev	Date	Remarks	Prepared By	Reviewed By
A	27 April 2023	Draft issue for comment	Renton Parker	Jason Costa
0	6 July 2023	Issued Final		
1	23 September 2024	Updated based on new SSDA	Jason Costa	Steve Sylvester

Executive Summary

Background

DHL Supply Chain (Australia) Pty Ltd (DHL) has proposed to develop a warehouse to enable the storage and handling of materials classified as Dangerous Goods (DGs) at Lot 1 DP 1306448, Badgerys Creek.

As DGs are stored the facility is subject to the NSW Work Health and Safety Regulation 2017 (WHS, Ref. [1]) which requires the risks associated with the storage and handling of DGs to minimised to ensure safety for personnel working within the warehouse. Compliance with the Regulation may be achieved by using an applicable design standard applicable to the materials being stored.

DHL has commissioned Riskcon Engineering Pty Ltd (Riskcon) to prepare a DG assessment of the facility to ensure compliance with the applicable DG standards and thus the Regulation. This document represents the assessment of the DG storages for the DHL warehouse at Badgerys Creek.

Conclusions

A review of the quantities of DG storage areas for the proposed DHL warehouse was conducted to identify the storage areas and provide design guidance to ensure the storage areas comply with the applicable standard. The warehouse was assessed using a combination of AS 1940:2017 and AS/NZS 3833:2007 based on compartmentation goods with similar properties.

The report was developed to assist the project team to design the DG storages with the aim of minimising the risk of the storages as required by the NSW WHS Regulation. It is concluded that if the advice documented in this report is followed the DG storages at the warehouse will comply with the standard and thus the NSW WHS Regulation.

Recommendations

The following recommendations have been made for the facility:

- The design requirements detailed within this report shall be adhered to in the development of the design for the facility.

DG Documents:

Ensure the following documentation is supplied on-site in accordance with the Work Health and Safety Regulation 2017 (Ref. [1]):

- A Dangerous Goods Register, indicating the type of chemical, any notations that may be required from the risk assessment and the Safety Data Sheet for the chemical.
- A Manifest.
- A DG Risk Assessment of the storage and handling area.
- A Placard Schedule.
- An Emergency Response Plan (ERP).
- Emergency Services Information Pack (ESIP).
- A Hazardous Area Classification (HAC).

- Hazardous Area Verification Dossier (HAVD).

Table of Contents

List of Figures

List of Tables

Abbreviations

Abbreviation	Description
AQR	Aggregate Quantity Ratio
CBD	Central Business District
DGs	Dangerous Goods
ERP	Emergency Response Plan
ESIP	Emergency Services Information Pack
IBC	Intermediate Bulk Container
HAC	Hazardous Area Classification
HAVD	Hazardous Area Verification Dossier
LPG	Liquefied Petroleum Gas
WHS	Work Health and Safety

1.0 Introduction

1.1 Background

DHL Supply Chain (Australia) Pty Ltd (DHL) has proposed to develop a warehouse to enable the storage and handling of materials classified as Dangerous Goods (DGs) at Lot 1 DP 1306448, Badgerys Creek.

As DGs are stored the facility is subject to the NSW Work Health and Safety Regulation 2017 (WHS, Ref. [1]) which requires the risks associated with the storage and handling of DGs to minimised to ensure safety for personnel working within the warehouse. Compliance with the Regulation may be achieved by using an applicable design standard applicable to the materials being stored.

DHL has commissioned Riskcon Engineering Pty Ltd (Riskcon) to prepare a DG assessment of the facility to ensure compliance with the applicable DG standards and thus the Regulation. This document represents the assessment of the DG storages for the DHL warehouse at Badgerys Creek.

1.2 Objectives

The objectives of the study are to provide a design document for the DG storages at the warehouse to assist the project team to design compliant DG storages.

1.3 Scope of Services

The scope of work is to prepare a DG design assessment of the DG storages at the DHL site located at Lot 1 DP 1306448, Badgerys Creek. The assessment does not include any other DHL sites nor additional work which may be identified in the course of the assessment.

2.0 Methodology

The following methodology was used:

- The manifest provided was reviewed to identify the classes and quantities that will be stored within the warehouse.
- The applicable design standards were identified based upon the class review.
- The design requirements for the warehouse were detailed to assist the project team.
- A draft report was submitted to the project team for review and comment with comments incorporated into the final document.

3.0 Site Description

3.1 Site Location

The subject site is located within part of Lot 1 in Deposited Plan 1306448, at 1953-2109 Elizabeth Drive, Badgerys Creek. The site is approximately 25 hectares in size and situated north of the new Western Sydney Airport. It is located within the Penrith local government area (**LGA**) and is approximately 12.5km from Penrith Central Business District (**CBD**), 27km from Parramatta CBD, and 47km from Sydney CBD. The site is owned by Roberts Jones Development Pty Ltd. **Figure 3-1** shows the regional location of the site. Provided in **Figure 3-2** is the layout of the site.

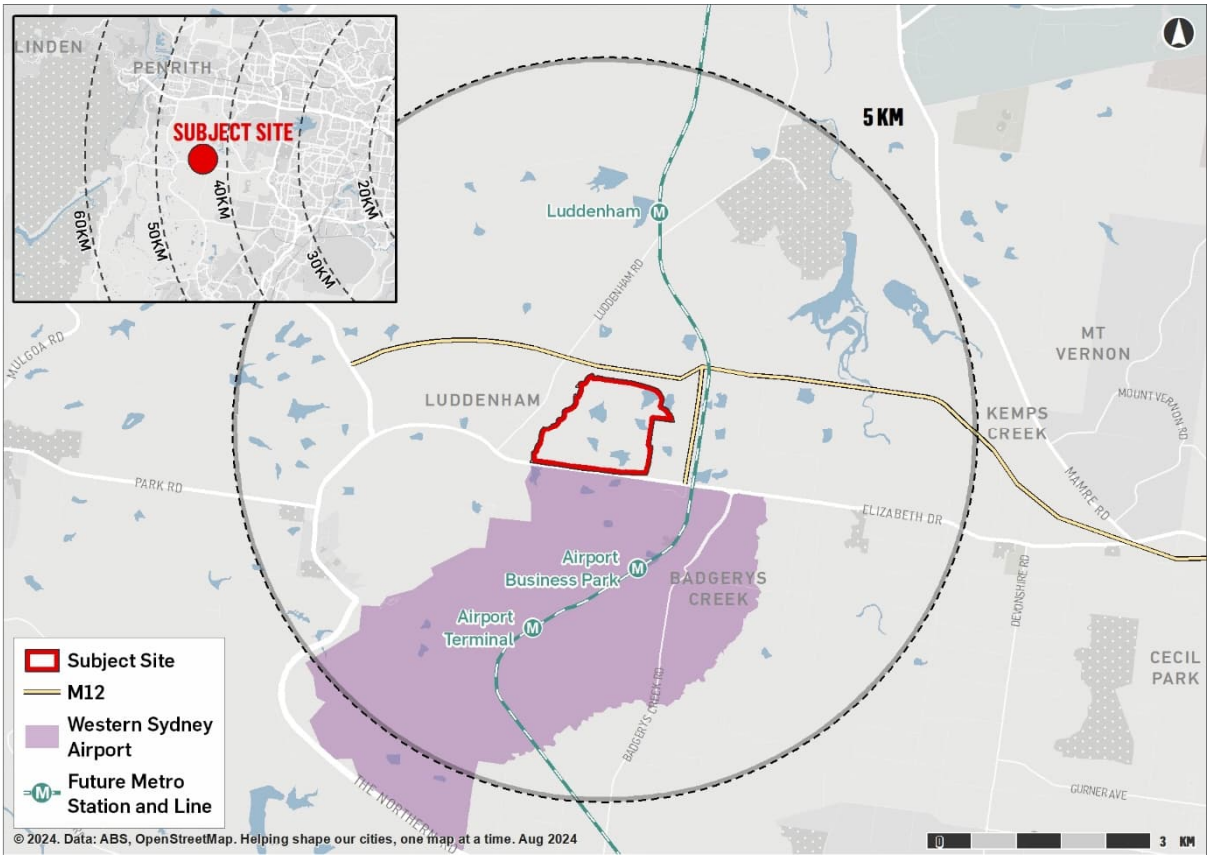

Figure 3-1: Site Location

3.2 Adjacent Land Uses

The land is located in an enterprise area which may have a diverse range of developments; however, it has been assumed that the following land uses are likely to be around the site:

- North – Industrial warehousing
- South – Industrial warehousing
- East – Industrial warehousing
- West – Industrial warehousing

3.3 Site Description

The warehouse is being developed as a speculative warehouse to cater toward potential customers that require large quantities of DGs to be stored. As the exact nature of the products is unknown, the warehouse is being developed to enable full flexibility of DG products including packages exceeding retail storage volumes (i.e. 205 L drums and 1,000 L Intermediate Bulk Containers – IBCs). Based upon the DG classes, a combination of AS 1940:2017 (Ref. [2]) and AS/NZS 3833:2007 (Ref. [3]) have been used.

The DGs will be separated into two (2) bunkers purpose built for the product suite to be stored within. The flammable gases and liquids and miscellaneous DGs (which typically have a combustible element to the product) will be stored in one bunker which will be subject to AS 1940:2017 design requirements while the other bunker will contain the remaining products and will be assessed using AS/NZS 3833:2007.

The flammable liquid bunker will have the typical design requirements from AS 1940:2017 including bunding to contain a portion of the flammable liquid stored in addition to 20 minutes of fire water storage, mechanical ventilation system, hazardous area rated equipment in accordance with the classification per AS/NZS 60079.10.1:2022 (Ref [4]) and AS/NZS 60079.14:2022 (Ref. [5]), foam hose reels, etc. In addition, the sprinkler system will be designed in accordance with AS 2118.1:2017 (Ref. [6]) which requires a combined in-rack and ceiling mounted sprinkler system. The bunker will have walls having an FRL of 240/240/240 with parapets for internal walls to a height of 0.5 m above ceiling height to prevent incident propagation between bunkers. Any doors or entrances to the bunker will have an FRL of -/120/30 per the standard.

The mixed class DG bunker will be designed according to AS/NZS 3833:2007 and will include walls having an FRL of 60/60/60 along with ventilation and bunding for a portion of goods stored and 20 minutes of sprinkler discharge. As flammable products are not stored in this bunker, ceiling mounted sprinkler protection will be adequate.

The whole site will be capable of containing at least 90 minutes of potentially contaminated fire water as required by AS/NZS 3833:2007 (Ref. [3]) and the NSW "*Best Practice Guidelines for Contaminated Water and Retention Systems*" (Ref. [7]).

3.4 Quantities of Dangerous Goods Stored and Handled

The dangerous goods stored at the warehouse are for various customers and may fluctuate with customer requirements. The classes and quantities to be approved in the facility are summarised **Table 3-1**. The proposed DG storage locations are shown in **Figure 3-2.**

Table 3-1: Maximum Classes and Quantities of Dangerous Goods Stored

Storage Location	Class	Description	PG	Quantity (kg)
DG Bunker 1	2.1	Flammable gases (aerosols)	n/a	100,000 / 25,000*
	2.2	Non-toxic, non-flammable gases	n/a	200,000
	3	Flammable liquids	II & III	1,000,000
	4.1	Flammable solids	II & III	100,000
	C1/C2	Combustible Liquids	n/a	10,000
DG Bunker 2	5.1	Oxidising agents	II & III	40,000
	8	Corrosive substances	II	20,000

Storage Location	Class	Description	PG	Quantity (kg)
			III	
	9	Miscellaneous DGs	III	10,000
Cabinet	6.1	Toxic substances	II	10

*Note: This refers to the quantity of propellant within the aerosols and not the total package weight. The propellant content within the cannisters is typically around 25% of product weight.

3.5 Aggregate Quantity Ratio

Where more than one class of dangerous goods are stored and handled at the site an AQR exists. This ratio is calculated using **Equation 3-1:**

$$AQR = \frac{q_x}{Q_x} + \frac{q_y}{Q_y} + [\dots] + \frac{q_n}{Q_n}$$ **Equation 3-1**

Where:

x,y […] and n are the dangerous goods present

q_x, q_y, […] and q_n is the total quantity of dangerous goods x, y, […] and n present.

Q_x, Q_y, […] and Q_n is the individual threshold quantity for each dangerous good of x, y, […] and n

Where the ratio AQR exceeds a value of 1, the site would be considered a Major Hazard Facility (MHF). The threshold quantity for each class is taken from Schedule 15 of the Work Health and Safety (WHS) Regulation 2017 (Ref. [1]). These are summarised in **Table 3-2** noting Classes 4.1, 8 and 9 are not subject to MHF legislation.

Table 3-2: Major Hazard Facility Thresholds

Class	Packing Group	Quantity (tonnes)		AQR
		Threshold	Stored	
2.1	n/a	200	25.0	0.25
2.2	n/a	Not subject to MHF	200	0
3	II & III	50,000	1,000	0.02
4.1	II & III	Not subject to MHF	100	0
5.1	II & III	200	40	0.2
6.1	II & III	200	0.01	0
8	II & III	Not subject to MHF	20	0
9	III	Not subject to MHF	10	0
C1/C2	n/a	Not subject to MHF	10	0
			Total	**0.47**

The AQR is less than 1; hence, the facility would not be classified as an MHF. The site will exceed 10% of the MHF; hence, a notification to SafeWork would be required.

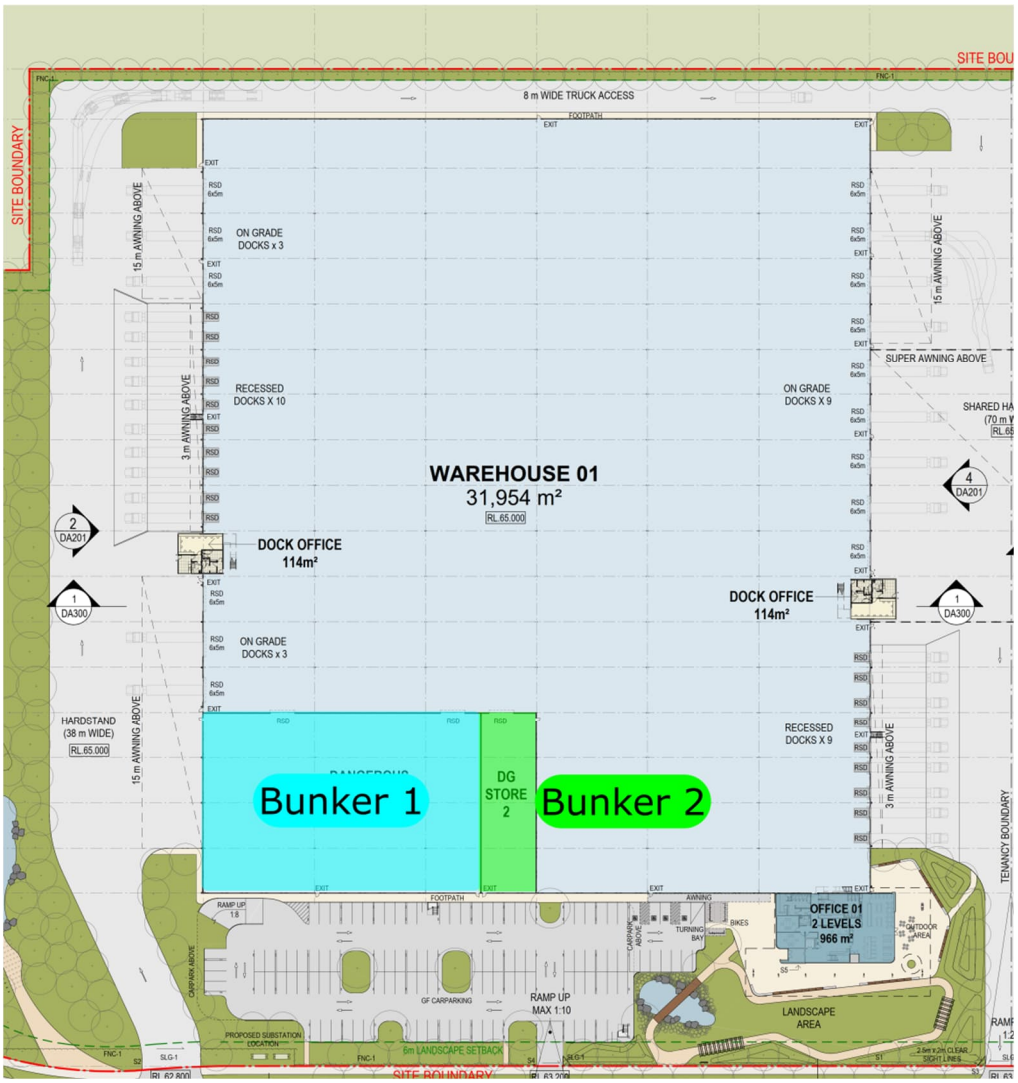

Figure 3-2: Site Layout

4.0 Dangerous Goods Design Requirements

4.1 Introduction

The following sections outline the design requirements for each DG storage. The relevant design standards were identified, and the design requirements were outlined for the following stores:

- Bunker 1 (Flammable Material Bunker)
- Bunker 2 (Mixed Class Bunker)
- Toxic Substances

4.2 Bunker 1 (Flammable Material Bunker)

4.2.1 Introduction

Bunker 1 will house flammable materials as summarised in **Table 4-1**. Where flammable materials are stored the most conservative standard for providing design requirements is AS 1940:2017 (Ref. [2]).

Table 4-1: Materials Stored within Bunker 1

Storage Location	Class	Description	PG	Quantity (kg)
DG Bunker 1	2.1	Flammable gases (aerosols)	n/a	100,000 / 25,000*
	2.2	Non-toxic, non-flammable gases	n/a	200,000
	3	Flammable liquids	II & III	1,000,000
	4.1	Flammable solids	II & III	100,000
	C1/C2	Combustible Liquids	n/a	10,000
			Total	1,410,000

4.2.2 Design

The design requirements for a package store based on AS 1940:2017 have been summarised in **Table 4-2.**

Table 4-2: Bunker 1 Design Requirements per AS 1940:2017

Item	Requirement
Construction	• The store and its surrounds shall be constructed of non-combustible materials • Exit doors: FRL -/120/30 • Rolling Shutter Doors (RSD): FRL -/120/30 which closes automatically upon fire trip (i.e. door is electromagnetically held open. During fire trip, the electromagnet is de-energised allowing the door to slide closed on rollers). The -/-/30 rating may be provided by inclusion of drenchers on both sides of the RSD. • Fire walls with an FRL of 240/240/240. • Internal fire walls shall extend 0.5 m through the roof.
Electrical Equipment	• All electrical equipment shall be installed in accordance with AS/NZS 3000:2018 (Ref. [8])

<table>
<tr><th>Item</th><th>Requirement</th></tr>
<tr><td></td><td>

Electrical equipment with a hazardous area rating as required by hazardous area zoning per AS/NZS 60079.10.1:2022 (Ref. [4]).
Electrical equipment installed per the requirements of AS/NZS 60079.14:2022 (Ref. [5]).
Electrical equipment installed by an appropriate qualified/certified hazardous area electrician.
Hazardous area verification dossier prepared documenting all hazardous area equipment.

</td></tr>
<tr><td>Spillage Containment</td><td>

A spill containment system such as a bund or a means of diverting any spill into a compound is required.

The bunding volume for the store shall be 198.1 m^3 as summarised in the following table.
<table>
<tr><th>Requirement</th><th>Volume (m^3)</th></tr>
<tr><td>Volume of the largest container</td><td>1</td></tr>
<tr><td>25% up to 10 m^3</td><td>2.5</td></tr>
<tr><td>10% from 10 m^3 to 100 m^3</td><td>9</td></tr>
<tr><td>5% beyond 100 m^3</td><td>65.6</td></tr>
<tr><td>20 minutes of sprinkler discharge (assumed 6 m^3/min).</td><td>120</td></tr>
<tr><td>Total</td><td>198.1</td></tr>
</table>
</td></tr>
<tr><td>Ventilation</td><td>
Ventilation will be required; it is recommended that is achieved by mechanical means. Provided below are requirements for mechanical ventilation:

The ventilation system shall exhaust at a rate of 0.3 m^3 per square metre of floor area per minute.
The velocity of the air at the entry point must exceed 300 m/min.
Ventilation ducts to be located at low level (i.e. immediately above the top of the bund).
Inlet and outlet ducts to be located on opposing walls.
The distance between any two inlets/outlets shall not be less than 5 m.
Where inlet air is provided via louvres through a fire wall, the louvres shall have an FRL of -/240/-.
Any exhaust duct (i.e. discharge point external to the building) shall terminate in the open air at least 2 m from any opening into the building and at least 3 m above ground.
The external termination of any inlet duct shall be at least 5 m from the termination of any external exhaust duct.
Ventilation fans are to be constructed of non-sparking materials.
An airflow failure warning device shall be installed. The warning shall be able to be detected from outside the store.

</td></tr>
<tr><td>Separation Distances</td><td>
The following minimum separation distances are required.
<table>
<tr><th>Receptor</th><th>Distance (m)</th></tr>
<tr><td>To property boundary</td><td>3</td></tr>
<tr><td>To onsite protected places: 15 m (as per Table 4.1 of AS 1940:2017 and Clause 4.3.1(bii) and Clause 4.3.1(j))</td><td>15</td></tr>
</table>
</td></tr>
</table>

Item	Requirement	
	To offsite protected places	44
	To achieve compliance with the minimum distance for on- and off-site protected places, the walls of the store shall have an FRL of 240/240/240. The fire walls required for the flammable material bunker are shown in **Figure 4-1**.	
Aerosols	• Aerosol racking shall be protected by a mesh cage to prevent cans rocketing in a fire scenario. • Aerosol cage protecting aerosols ensuring no gaps occur within the cage structure (i.e. mesh to be taken to roof height, walls where applicable, etc.) • The cage mesh shall have a maximum aperture of 50 mm. • The thickness of cage wiring shall be a minimum of 3 mm. • The aerosol cage shall have a sliding gate which loses upon fire detection (i.e. gate is held open by electromagnetic link which deenergises upon fire trip).	
Fire Protection	As per Table 11.3 in the standard, the store shall be protected by: • One powder type extinguisher located at each doorway (i.e. RSD, emergency exit). • Powder type extinguishers located internally of the store to achieve a maximum 15 m travel distance to an extinguisher. • Fire hose reel coverage to all parts of the store – Fire hose reels are to be provided with foam making capabilities. Note: Foam is provided via a trolley containing foam concentrate with a T-branch pipework which is attached to the hose reel and inserted into the concentrate. • Fire hydrant coverage to all parts of the store. • Automatic sprinkler system (Note: consultation with sprinkler designer required for detailed sprinkler design. DG standards only indicate if a system is required and provides no detailed guidance on the system). Note, In-rack sprinklers may be required for some of the products in accordance with AS 2118.1:2017 (Ref. [6]). Consultation with a sprinkler design will provide correct guidance on this requirement. • 40 L/s of hydrant flow in excess of the AS 2419.1 requirements (i.e. AS 2419.1 requirements + 40 L/s). • Based upon the quantity of combustible liquids stored, a Fire Safety Study is required.	
Placarding	The store shall be placarded in accordance with the WHS Regulation.	

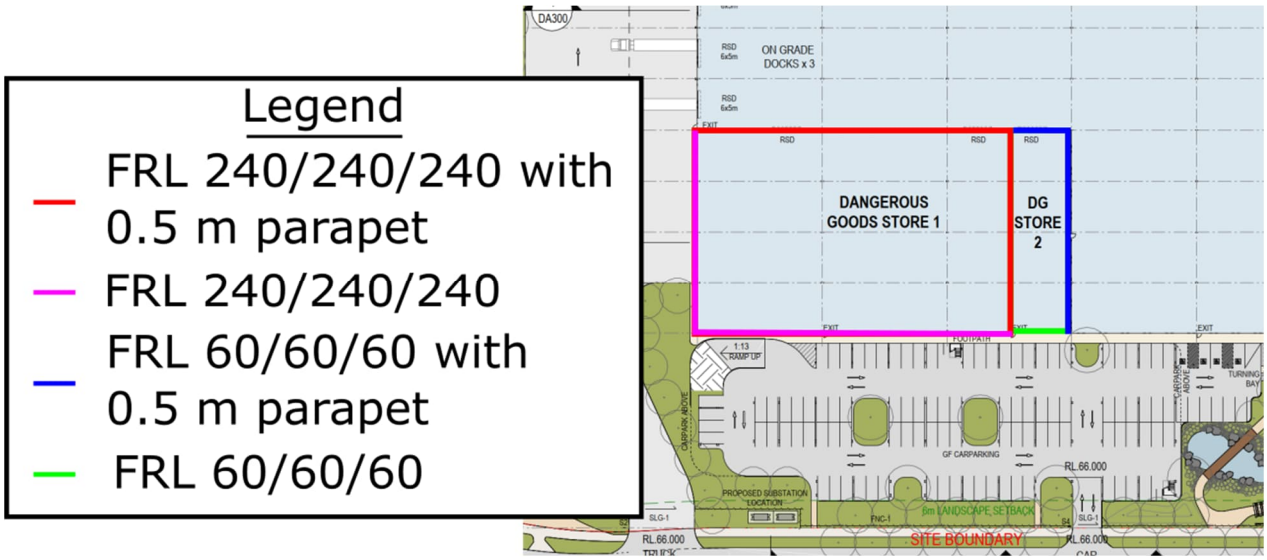

Figure 4-1: Fire Wall Requirements

4.3 Bunker 2 (Mixed Class Bunker)

4.3.1 Introduction

Bunker 2 will house mixed classes of Dangerous Goods as summarised in **Table 4-3**. As mixed classes of goods are stored the most applicable standard is AS/NZS 3833:2007 (Ref. [3]).

Table 4-3: Materials Stored within the Bunker 2

Storage Location	Class	Description	PG	Quantity (kg)
DG Bunker 2	5.1	Oxidising agents	II & III	40,000
	8	Corrosive substances	II	20,000
			III	
	9	Miscellaneous DGs	III	10,000
			Total	70,000

4.3.2 Design

The design requirements for a package store based on AS/NZS 3833:2007 have been summarised in **Table 4-4.**

Table 4-4: Bunker 2 Design Requirements per AS/NZS 3833:2007

Item	Requirement
Construction	• The store and its surrounds shall be constructed of non-combustible materials • Exit doors: FRL -/60/30 • Rolling Shutter Doors (RSD): FRL -/60/30 which closes automatically upon fire trip (i.e. door is electromagnetically held open. During fire trip, the electromagnet is de-energised allowing the door to slide closed on rollers). The -/-/30 rating may be provided by inclusion of drenchers on both sides of the RSD. • Fire walls with an FRL of 60/60/60 • Internal fire walls shall extend 0.5 m through the roof.

<table>
<tr><th>Item</th><th>Requirement</th></tr>
<tr><td>Electrical Equipment</td><td>

All electrical wiring and lighting within the store shall comply with IP 65 in accordance with AS 60529
All electrical equipment shall be installed in accordance with AS/NZS 3000:2018 (Ref. [8])

</td></tr>
<tr><td>Spillage Containment</td><td>
A spill containment system such as a bund or a means of diverting any spill into a compound is required.

Each class shall have a 50 mm high angle iron bund beneath the racked storage area.
The bunding shall have a sealant to prevent leaks between the slab and the bund.
Materials of construction shall be compatible with the materials stored.

The bunding volume for the store shall be 129.5 m^3 as summarised in the following table.
<table>
<tr><th>Requirement</th><th>Volume (m^3)</th></tr>
<tr><td>Volume of the largest container</td><td>1</td></tr>
<tr><td>25% up to 10 m^3</td><td>2.5</td></tr>
<tr><td>10% from 10 m^3 to 100 m^3</td><td>6</td></tr>
<tr><td>20 minutes of sprinkler discharge (assumed 6 m^3/min).</td><td>120</td></tr>
<tr><td>Total</td><td>129.5</td></tr>
</table>
</td></tr>
<tr><td>Ventilation</td><td>
Ventilation will be required; it is recommended that is achieved by mechanical means. Provided below are requirements for mechanical ventilation:

The ventilation system shall exhaust at a rate of 0.3 m^3 per square metre of floor area per minute.
The velocity of the air at the entry point must exceed 300 m/min.
Ventilation ducts to be located at low level (i.e. immediately above the top of the bund).
Inlet and outlet ducts to be located on opposing walls.
The distance between any two inlets/outlets shall not be less than 5 m.
Where inlet air is provided via louvres through a fire wall, the louvres shall have an FRL of -/60/-.
Any exhaust duct (i.e. discharge point external to the building) shall terminate in the open air at least 2 m from any opening into the building and at least 3 m above ground.
The external termination of any inlet duct shall be at least 5 m from the termination of any external exhaust duct.
Ventilation fans are to be constructed of non-sparking materials.
An airflow failure warning device shall be installed. The warning shall be able to be detected from outside the store.

</td></tr>
<tr><td>Separation Distances</td><td>
The following minimum separation distances are required.
<table>
<tr><th>Receptor</th><th>Distance (m)</th></tr>
<tr><td>To property boundary</td><td>3</td></tr>
<tr><td>To onsite protected places</td><td>14.5</td></tr>
</table>
</td></tr>
</table>

Item	Requirement	
	To offsite protected places	14.5
	To achieve compliance with the minimum distance for on- and off-site protected places, the walls of the store shall have an FRL of 60/60/60 The fire walls required for the mixed class bunker are shown in **Figure 4-1**.	
Aerosols	• Aerosol racking shall be protected by a mesh cage to prevent cans rocketing in a fire scenario. • Aerosol cage protecting aerosols ensuring no gaps occur within the cage structure (i.e. mesh to be taken to roof height, walls where applicable, etc.) • The cage mesh shall have a maximum aperture of 50 mm. • The thickness of cage wiring shall be a minimum of 3 mm. • The aerosol cage shall have a sliding gate which loses upon fire detection (i.e. gate is held open by electromagnetic link which deenergises upon fire trip).	
Fire Protection	As per Table 9.3 in the standard, the store shall be protected by: • Powder type extinguishers • Fire hose reel coverage to all parts of the store • Fire hydrant coverage to all parts of the store.	
Placarding	The store shall be placarded in accordance with the WHS Regulation.	

4.4 Toxic Substances

4.4.1 Introduction

Toxic substances will be stored as summarised in **Table 4-5**. Where toxic substances are stored, the storage is subject to AS 4452-1997 (Ref. [9]).

Table 4-5: Toxic Substances Stored

Storage Location	Class	Description	PG	Quantity (kg)
Cabinet	6.1	Toxic Substances	II & III	10
			Total	10

4.4.2 Design

Based upon the quantity of toxic substances stored, these may be safely and compliantly stored by providing a toxic substance cabinet provided by a reputable supplier (i.e. Storemasta). Based upon the low quantity of product stored, the cabinet may be located anywhere within the general warehouse.

5.0 NSW Work Health and Safety Requirements

5.1 Introduction

In addition to the requirements of the relevant standards, a Person Conducting a Business or Undertaking (PCBU) must also satisfy several obligations outlined in Chapter 7 of the Work Health and Safety (WHS) Regulation 2017 (Ref. [1]). The relevant requirements are dependent on the quantities of DGs stored on site. The DG quantities and the placard and manifest thresholds have been outlined in **Table 5-1**. As the DG stores exceed the manifest threshold, the site is classified as a Manifest site.

Table 5-1: Manifest and Placard DG quantities

Class	Description	PG	Stored (kg or L)			Classification
			Stored	Placard	Manifest	
2.1	Flammable gases (aerosols)	n/a	100,000	5,000	10,000	Manifest
2.2	Non-toxic, non-flammable gases	n/a	200,000	5,000	10,000	Manifest
3	Flammable liquids	II & III	1,000,000	250	2,500	Manifest
4.1	Flammable solids	II & III	100,000	1,000	10,000	Manifest
C1/C2	Combustible Liquids	n/a	10,000	10,000	100,000	Placard
5.1	Oxidising agents	II & III	40,000	250	2,500	Manifest
8	Corrosive substances	II & III	20,000	250	2,500	Manifest
9	Miscellaneous DGs	III	10,000	n/a	n/a	n/a
6.1	Toxic Substances	II & III	10	250	2,500	n/a

*Based upon 25% of the aerosol being an LPG propellant

5.2 Applicable WHS Clauses

The applicable clauses for a manifest site from the WHS Regulation 2017 (Ref. [1]) have been outlined in **Table 5-2**.

Table 5-2: Relevant WHS clauses and requirements

Clause	WHS Requirement
346	A Hazardous Chemicals [*Dangerous Goods*] register shall be prepared which must include; • A list of hazardous chemicals stored, used or handled • The current Safety Data Sheet (SDS) for DGs stored, used or handled, unless the hazardous chemical is a consumer product (e.g. hand sanitiser). The register must be readily accessible to workers involved in handling or storing the chemicals, and anyone who is likely to be affected by the chemicals.
347	A manifest of chemicals stored on site shall be prepare in accordance with Schedule 11 and Schedule 12 of the regulation. The manifest shall be kept in a place determine in agreement with the primary emergency service organisation (Fire and Rescue NSW). It must be readily accessible to emergency service organisation and be available for inspection.

Clause	WHS Requirement
348	A notification shall be made to the regulator of the DGs that exceed the manifest quantities detailed in Schedule 11 of the Regulation. Notice must also be given after the DGs are no longer used, stored, or handled on site
349 & 350	PCBU shall ensure placards are displayed for all chemicals which exceed placard quantity of Schedule 11, and that placards comply with Schedule 13, as shown in **Figure 5-1** and **Figure 5-2**. A Placard Schedule shall be prepared to indicate the placard requirements. A PCBU shall ensure an outer warning placard shall is prominently displayed at the site. The placard is to show the words "HAZCHEM" in red lettering on white or silver background and shall have minimum dimensions 120 mm x 600 mm, in compliance with Schedule 13, as shown in **Figure 5-3.**
351 & 354	A PCBU must manage the risk to health and safety associated with using and storing a hazardous chemical [*Dangerous Good*] and have regard of the following: • Hazardous properties of the chemical • Reactions between chemicals (physical) or between the chemical and other substances/materials; • The nature of the work to be carried out with the hazardous chemical; • Any structure, plant or system of work used in the handling, generation or storage of the hazardous chemical [Dangerous Good] or that could react with the hazardous chemical [Dangerous Good] at the workplace. In order to comply with this requirement, it is necessary to conduct a risk assessment and to identify those hazards and risks associated with the storage and handling of the hazardous chemicals [*Dangerous Goods*]. The following recommendation has been made: • A risk assessment of the hazardous chemical [*Dangerous Good*] storage areas be conducted, including the use of the chemicals in the manufacturing areas; or • If there is an existing risk assessment, it should be reviewed.
353	A PCBU must display safety signs required to control an identified risk in relation to using, handling or storing hazardous chemicals. The safety signs must warn of a particular hazard associated with the hazardous chemical, and be located next to hazard, clearly visible to a person approaching the hazard.
355	A PCBU must ensure ignition sources are not introduced to areas which where there is a possibility of fire or explosion in a hazardous area. In the flammable liquids containers, there is potential for vapours to accumulate and ignite. Therefore, the following recommendation has been made: • A Hazardous Area Classification (HAC) report and associated drawings should be prepared for flammable liquid in accordance with AS/NZS 60079.10.1:2022 (Ref. [4]). • A Hazardous Area Dossier shall be prepared prior to occupation in accordance with AS/NZS 3000:2018 (Ref. [8]).
357	A PCBU must ensure, SFARP, that where there is a risk from a spill or leak of a hazardous chemical, a spill containment system contains the resulting effluent within the workplace. • The containment system must not create a hazard by bringing together incompatible chemicals. The containment system must provide for the clean-up and disposal of hazardous chemicals.
358	A PCBU must ensure containers of hazardous chemicals are protected against impact damage and damage from excessive load.

Clause	WHS Requirement
359	A PCBU shall ensure that a workplace is provided with fire protection and firefighting equipment that is designed and built for the types of hazardous chemicals at the workplace. • The PCBU shall have regard to the fire load of the hazardous chemicals and from other sources, and the compatibility of the hazardous chemicals with other substances on site. • The equipment shall be compatible with firefighting equipment used by Fire and Rescue NSW Fire protection and firefighting equipment shall be properly installed, tested and maintained, and a dated record shall be kept of the latest testing results.
361 & 360	A PCBU shall prepare an emergency response plan (ERP) and submit it to the primary service organisation (Fire and Rescue NSW). A PCBU must ensure that emergency equipment is always available for use in an emergency.
364	A PCBU must ensure that containers in which hazardous chemicals are used, handled, or stored in bulk shall have stable foundations and supports, and be secured to the foundations and supports to prevent movement and subsequent damage to the container.

Figure 5-1: DG Placards

Figure 5-2: Combustible Liquid Placard

Figure 5-3: HAZCHEM Placard

5.3 Summary of Requirements

In summary, the site will require the following:

- A Dangerous Goods Register, indicating the type of chemical, any notations that may be required from the risk assessment and the Safety Data Sheet for the chemical.
- A Manifest.
- A DG Risk Assessment of the storage and handling area.
- A Placard Schedule.
- An Emergency Response Plan (ERP).
- Emergency Services Information Pack (ESIP).
- A Hazardous Area Classification (HAC).
- Hazardous Area Verification Dossier (HAVD).

6.0 Conclusion and Recommendations

6.1 Conclusions

A review of the quantities of DG storage areas for the proposed DHL warehouse was conducted to identify the storage areas and provide design guidance to ensure the storage areas comply with the applicable standard. The warehouse was assessed using a combination of AS 1940:2017 and AS/NZS 3833:2007 based on compartmentation goods with similar properties.

The report was developed to assist the project team to design the DG storages with the aim of minimising the risk of the storages as required by the NSW WHS Regulation. It is concluded that if the advice documented in this report is followed the DG storages at the warehouse will comply with the standard and thus the NSW WHS Regulation.

6.2 Recommendations

The following recommendations have been made for the facility:

- The design requirements detailed within this report shall be adhered to in the development of the design for the facility.

DG Documents:

Ensure the following documentation is supplied on-site in accordance with the Work Health and Safety Regulation 2017 (Ref. [1]):

- A Dangerous Goods Register, indicating the type of chemical, any notations that may be required from the risk assessment and the Safety Data Sheet for the chemical.
- A Manifest.
- A DG Risk Assessment of the storage and handling area.
- A Placard Schedule.
- An Emergency Response Plan (ERP).
- Emergency Services Information Pack (ESIP).
- A Hazardous Area Classification (HAC).
- Hazardous Area Verification Dossier (HAVD).

7.0 References

[1] SafeWork NSW, “Work Health and Safety Regulation,” SafeWork NSW, Lisarow, 2017.

[2] Standards Australia, AS 1940:2017 - Storage and Handling of Flammable and Combustible Liquids, Sydney: Standards Australia, 2017.

[3] Standards Australia, “AS/NZS 3833:2007 - Storage and Handling of Mixed Classes of Dangerous Goods, in Packages and Intermediate Bulk Containers,” Standards Australia, Sydney, 2007.

[4] Standards Australia, AS/NZS 60079.10.1:2022 - Explosive Atmospheres Part 10.1: Classification of Areas, Explosive Gas Atmospheres, Sydney: Standards Association of Australia, 2022.

[5] Standards Australia, AS/NZS 60079.14:2022 - Explosive Atmospheres Part 14: Electrical Installations, Design, Selection and Erection, Sydney: Standards Australia, 2022.

[6] Standards Australia, “AS 2118.1:2017 - Automatic Fire Sprinkler Systems General Systems,” Standards Australia, Sydney, 2017.

[7] NSW Department of Planning, “Best Practice Guidelines for Contaminated Water Retention and Treatment Systems,” NSW Department of Planning, Sydney, 1994.

[8] Standards Australia, “AS/NZS 3000:2018 - Wiring Rules,” Standards Australia, Sydney, 2018.

[9] Standards Australia, “AS 4452-1997 - The Storage and Handling of Toxic Substances,” Standards Australia, Sydney, 1997.