Riskcon engineering

Dangerous Goods Design Report

8 Johnston Crescent, Horsley Park

Jalco Group Pty Ltd
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8 Johnston Crescent, Horsley Park

Jalco Group Pty Ltd

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Executive Summary

Background

Jalco Group Pty Ltd (Jalco) has proposed to develop a warehouse located at 8 Johnston Crescent, Horsley Park, NSW which will be used to manufacture and store laundry and personal care products. Some raw materials used to manufacture the products are classified as Dangerous Goods (DGs); hence, the site is subject to the Work Health and Safety Regulation 2017 (Ref. [1]) which requires the risks associated with the storage and handling of DGs to be minimised to ensure safety for personnel working within the warehouse. Compliance with the regulation may be achieved via the application of suitable design standards.

Jalco has commissioned Riskcon Engineering Pty Ltd (Riskcon) to prepare a DG design brief to communicate the items required for the facility to comply with the DG standards. This document represents Riskcon's assessment and recommendation for this DG storage and manufacturing.

Conclusions

A review of the proposed DG storage and operations within the Jalco site was conducted to determine compliance with the Work Health and Safety Regulation 2017 (Ref. [1]) and all relevant design standards.

A review of the standards determined that the following standards be used to govern the storage requirements in the respective areas:

- Liquid Storage Shed - Mixed DG Package Store – AS/NZS 3833:2007
- Flammable Liquids Dispensary (Package Store) – AS 1940:2017
- Bulk Tanks of Acids and Bases – AS 3780:2008
- DAF Facility – AS 3780:2008 and AS 4326:2008
- LPG Tank - AS/NZS 1596:2014

Each of these standards was used to construct a series of requirements for the design and construction of the Jalco facility.

Recommendations

The following recommendations have been made based on the assessment within this report:

DG Storage Requirements:

Each DG storage area has different requirements based on the particular substances which are being stored. Consistent to majority of the stores is the need for bunding, ventilation and separation from protected places. Detailed summaries of the items to be included in the design of each DG store are provided in the following sections:

- Liquid Storage Shed: Table 4-2: Liquid Storage Shed Storage Requirements, in accordance with AS/NZS 3833:2007
- Flammable Liquids Dispensary: Table 4-4: Flammable Liquids Storage Requirements, in accordance with AS 1940:2017
- Bulk Tanks (Acids): Table 4-6: Bulk Acid Storage Requirements, in accordance with AS/NZS 3780:2008

- Bulk Tanks (Bases): Table 4-8: Bulk Base Tanks Design Requirements, in accordance with AS 3780:2008.
- DAF: Table 4-12: DAF Facility Design Requirements, in accordance with AS 3780:2008
- LPG Tank: Table 4-14: LP Gas Storage Requirements, in accordance with AS/NZS 1596:2014

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).
- A Hazardous Area Classification (HAC).
- Hazardous Area Verification Dossier.

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Abbreviations

Abbreviation	Description
AQR	Aggregate Quantity Ratio
AS	Australian Standard
CBD	Central Business District
DAF	Dissolved Air Flotation
DG	Dangerous Goods
HAC	Hazardous Area Classification
IBC	Intermediate Bulk Container
MHF	Major Hazard Facility
NZS	New Zealand Standard
UN	United Nations

1.0 Introduction

1.1 Background

Jalco Group Pty Ltd (Jalco) has proposed to develop a warehouse located at 8 Johnston Crescent, Horsley Park, NSW which will be used to manufacture and store laundry and personal care products. Some raw materials used to manufacture the products are classified as Dangerous Goods (DGs); hence, the site is subject to the Work Health and Safety Regulation 2017 (Ref. [1]) which requires the risks associated with the storage and handling of DGs to be minimised to ensure safety for personnel working within the warehouse. Compliance with the regulation may be achieved via the application of suitable design standards.

Jalco has commissioned Riskcon Engineering Pty Ltd (Riskcon) to prepare a DG design brief to communicate the items required for the facility to comply with the DG standards. This document represents Riskcon's assessment and recommendation for this DG storage and manufacturing.

1.2 Objectives

The objectives of the DG design report are to assist Jalco in designing and constructing a DG storage which complies with the Work Health and Safety Regulation 2017 (Ref. [1]) and all applicable DG standards.

1.3 Scope of Work

The scope of the work is to prepare a comprehensive design assistance document for the proposed Jalco warehouse to be located at 8 Johnston Crescent, Horsley Park, NSW to assist in preparing a compliant design. The assessment does not include any other sites, nor additional work which may be identified in the course of the assessment.

2.0 Methodology

2.1 General Methodology

The following methodology was applied:

- The existing site operations were inspected to familiarize the project team with the scope of the project.
- The proposed design of the warehouse was reviewed, including details of dangerous goods (DGs) which will be stored and handled on site.
- Compliance Assessment – the design of the proposed warehouse was assessed against the requirements of the relevant standards for each store. Recommendations were made to ensure the proposed storage design achieved the requirements of the applicable clauses of the standards.
- Draft Reporting – On completion of the assessment, a draft report was prepared for review and comment by the project team.
- Final Report – On completion of the review of the draft report, any comments were incorporated into the finalised version.

3.0 Site Description

3.1 Site Location and Layout

The Jalco warehouse is to be located at 8 Johnston Crescent, Horsley Park, approximately 36 km west of the Sydney Central Business District (CBD). **Figure 3-1** shows the regional location of the site in relation to the Sydney CBD. Provided in **Figure 3-2** is the proposed layout of the warehouse within the site, with the DG storage areas marked on the image.

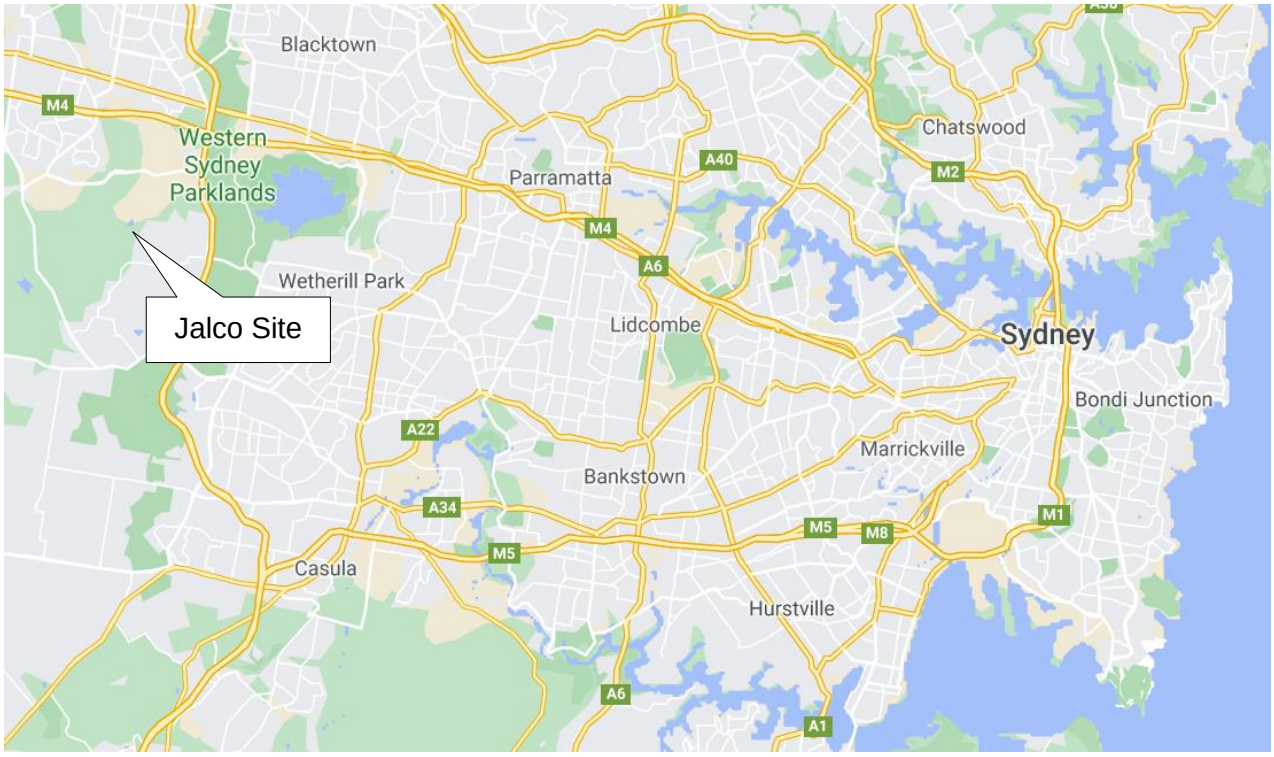

Figure 3-1: Site Location

3.2 General Building Description

The site operations are housed within a warehouse covering an area of 20,390 m^2. The building consists of an office (800 m^2), the automated warehouse and dispatch (7,500 m^2), the bottle storage area (5400 m^2), liquid packaging area (5,000 m^2), a workshop (285 m^2) and the product manufacture and packaging area (approximately 1,400 m^2).

Outside of the warehouse there is a car park with a 109-car capacity, a loading dock, an LPG storage area (375 m^2), liquid storage shed (375 m^2), three liquid truck filling bays, and a Dissolved Air Flotation (DAF) facility.

The details of each area have been outlined in the following sections.

3.2.1 Tank Storage

The raw materials used for the manufacture of the liquid detergent products are stored in 15 tanks ranging from 30 kL to 70 kL along the east wall of the warehouse. The storage tanks are connected to the blending tanks, where the products are manufactured. Most of these substances are DGs and will be separately bunded based upon DG Class and compatibility. Adequate separation distances between incompatible substances will be ensured.

3.2.2 Liquid Storage Shed

The liquid shed will contain Class 5.1, 6.1, 8, 9 DGs. These substances will be stored for use in the liquid products manufacturing process. The DGs will be contained in drums and stored in racking, with a total storage capacity of 288,000 L.

3.2.3 Flammable Materials Storage

Flammable materials which are used as fragrances for products will be stored in two dedicated storage containers externally to the main warehouse. The containers will comply with the requirements of AS 1940-2017 to safely house the materials which will be located to comply with the requirements of AS 1940-2017.

3.2.4 Blending

The blending process is the first stage of the manufacturing operations. A series of storage tanks containing raw materials are connected to nineteen (19) separate stirred tanks. In each of these tanks raw materials, some of which are considered DGs, are mixed and diluted with water to form the final products. The majority of final products are no longer regarded as DGs because of the significant dilution which occurs. These products are then sent down the process line to be packaged and stored.

3.2.5 Blow Moulder

The plastic packages (bottles) for the final products are produced at the warehouse using a blow moulder. 16 blow moulders are located adjacent to the dispatch receiving office and the loading docks. The manufactured bottles are manually loaded onto pallets, which are then transferred to the bottle storage area.

3.2.6 Package Filling

The empty bottles are filled with the final products at the 3 high-speed and 7 normal-speed filling lines. The empty bottles are manually loaded onto the lines, which are then automatically filled and conveyed to storage. The high-speed filling lines are capable of filling 90 bottles per minute. The normal-speed filling lines are capable of filling 12-40 bottles per minute.

3.2.7 Conveyor to Storage

The filled packages are manually loaded onto a conveyor belt to be sent to the automated warehouse storage.

3.2.8 Automated Storage System

The storage system uses a Swisslog Vectura pallet stacker crane to efficiently store the packaged final products prior to dispatch. This crane uses robotic technology to lift pallets onto multi-storey racking, allowing increased storage capacity. The system is fully automated ensuring personnel are not required to access the automated warehouse. The system has been designed to efficiently move product within the warehouse and includes brake to energy efficiency measures (i.e. when slowing brake energy is used to raise the load or lowering a package is used to drive the crane forward).

All product stored within the warehouse is given a unique identifying code and location within the warehouse which is tracked by the system. Product is stored and extracted in a manner to minimise storage time within the warehouse to ensure oldest product is despatched first (i.e. first in, first out).

3.2.9 Dissolved Air Flotation

Dissolved Air Flotation (DAF) tanks are used for wastewater treatment. The DAF facility is located immediately outside the warehouse, adjacent to the LPG tanks and the pump room. The DAF includes a balance tank, a sludge tank and an overflow tank. The tanks will be dosed with Class 8 DGs, which will be stored in IBCs.

3.2.10 LPG Tanks

The LPG tank will be used for filling forklifts which will be used within the warehouse. The LPG tank will be stored outside the warehouse next to the loading docks and DAF facility. The tank will have a volume of 3,920 L water capacity and will be separated from other DGs and protected places.

3.2.11 Workshop

The workshop is located adjacent to the bottle storage area. The workshop will be used for general repairs of equipment. Minor quantities of acetylene, argon and oxygen will be stored in the workshop.

3.3 Quantities of Dangerous Goods Stored and Handled

A combination of different classes and packing groups of DGs are proposed to be stored at the site. A breakdown of these DGs is provided in **Table 3-1.** A full breakdown of the product list has been provided in **Appendix A**.

Table 3-1: Quantities of DGs Stored and Handled

Class	PG	Description	Quantity (L)	Storage
2.1	n/a	Flammable gases – LPG	3,920	Bulk Tank
3	II	Flammable Liquids	32,000	Flammable Material Containers
	III			
4.1	II	Flammable Solid		
	III			
C1	n/a	Combustible Liquid		
C2	n/a			
5.1	II	Oxidising Agents	44,000	Liquid Storage Shed
	II		1,000	DAF
6.1	II	Toxic Substances	5,000	Liquid Storage Shed
8	II	Corrosive Substances – Acids and Bases	60,000	Tank Farm
	III		100,000	
8	II	Corrosive Substances	25,000	Liquid Storage Shed
	III		30,000	
8	II	Corrosive Substance	1,000	DAF
9	III	Environmentally Hazardous Substances	150,000	Liquid Storage Shed
9	III	Miscellaneous DG	30,000	Tank Farm

Class	PG	Description	Quantity (L)	Storage

3.4 Aggregate Quantity Ratio

Where more than one class of DGs are stored and handled at the site, and aggregate quantity ratio (AQR) exists. This ratio is calculated using **Equation 3-1**.

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

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 quantities for each class are taken from the NSW Work Health and Safety Regulation (Ref. [1]). These are summarised in **Table 3-2**, noting that Class 4.1(III), 8 and 9 are not subject to MHF legislation.

Table 3-2: Major Hazard Facility Thresholds

Class	Packing Group	Description	Threshold (tonnes)	Storage (tonnes)
2.1	n/a	LPG	200	2
3	II & III	Flammable liquids	50,000	32^
5.1	II	Oxidizing materials	200	45
6.1	II	Toxic substances	200	5

^As flammable and combustible materials are stored with the flammable liquids the total mass has been conservatively taken as flammable liquid for the purpose of the MHF assessment.

A review of the thresholds, commodities and packing groups listed in **Table 3-2** indicates that only Class 2.1, Class 3, Class 5.1 and Class 6.1 are assessable against the MHF thresholds. Therefore, substituting the storage masses into **Equation 3-1**, the AQR is calculated as follows:

$$AQR = \frac{2}{200} + \frac{32}{50000} + \frac{45}{200} + \frac{5}{200} = 0.260$$

The AQR is less than 1; hence, the facility would not be classified as an MHF.

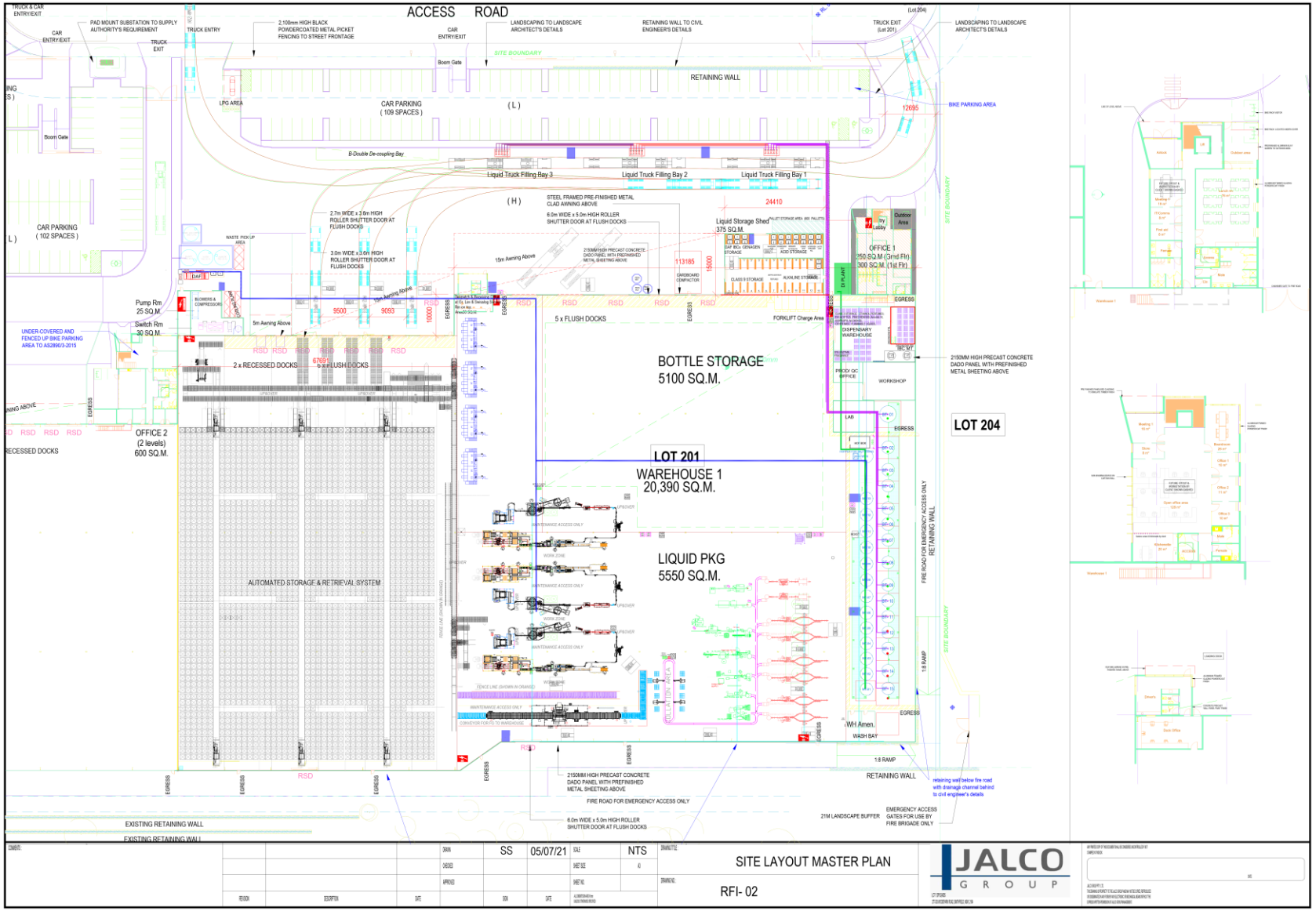

Figure 3-2: Proposed Warehouse Layout

4.0 Dangerous Goods Design Requirements

4.1 Introduction

The following sections outline the design requirements for each DG storage. For each store, the relevant design standard was identified, and the design requirements were outlined.

4.2 Liquid Storage Shed

Class 5.1, 6.1, 8, Class 9 substances will be stored in the liquid storage shed as one DG store. The quantities to be stored are provided in **Table 4-1**.

Table 4-1: Liquid Storage Shed DG Quantities

Class	Description	PG	Quantity (L)
5.1	Oxidising agents	II	44,000
6.1	Toxic substances	II	5,000
8	Corrosive substances	II	25,000
		III	30,000
9	Environmentally hazardous substances – solids and liquids	III	150,000
		Total	254,000

A review of the relevant standards was conducted to identify the most applicable one. The following standards were reviewed to determine which design standards shall be used:

- AS/NZS 3833:2007 – Mixed Classes of Dangerous Goods (Ref. [2]).
- AS/NZS 3780:2008 – Corrosive Substances (Ref. [3]).
- AS/NZS 4681:2000 – Class 9 (Miscellaneous) Dangerous Goods (Ref. [4]).

Based upon the review, it was determined the most applicable standard for governing the storage was AS/NZS 3833:2007 (Ref. [2]) as this standard caters for the mixed storage of DGs within one storage location. Based on the volumes of DGs within the area, the storage would be considered a package store as outlined in Section 5 of the standard. The design requirements for a package store have been summarised **Table 4-2**.

Table 4-2: Liquid Storage Shed Storage Requirements, in accordance with AS/NZS 3833:2007

Item	Requirement
Material of Construction	The store and its surrounds shall be constructed non-combustible material and be corrosion resistant or be lined with corrosion resistant coating (i.e. polymer).
Electrical Equipment	All electrical wiring and lighting within the store shall comply with IP 65.
Walls	Walls separating the DG store from the warehouse and other protected places shall have an FRL of 60/60/60. See **Figure 4-1** for details.
Doors and Exits	Any door separating the DG store from the rest of the warehouse shall have a minimum FRL of at least -/60/30.

Item	Requirement

Spillage Containment	• A spillage containment system such as a bund or a means of diverting any spill into a compound is required. The individual bunded areas shall have volumes as such:
	  ○ Class 5.1 & 6.1 storage: 11.4 m^3 (note: Class 6.1 to be stored on bunded pallets within Class 5.1/6.1 area.
	  ○ Class 8 (acids): 12 m^3
	  ○ Class 8 (bases): 12 m^3
	  ○ Note: Class 9 may go in either the acid or base bunds and so storage volumes have been designed to allow for this flexibility.
	• Substances that might react dangerously shall not be directed to the same spillage compound (i.e. acids and bases shall drain to separate compounds)
	• The spillage containment shall be increased by the outflow of the sprinkler system for 20 minutes of operation. Assuming sprinklers operate at 6 m^3/min = 120 m^3. Total containment: 35.4 + 120 = 155.4 m^3

Ventilation	Ventilation will be required which may be achieved via mechanical or natural means. Provided below are the options for both: <u>Mechanical</u> The following requirements apply to a mechanical ventilation system: • The ventilation system shall exhaust 113 m^3/min (0.3 m^3 per square metre of floor area per minute or 5 m^3/min, whichever is greater). The velocity of the air at the entry point must exceed 300 m/min. • The distance between any two inlets or any two outlets shall be less than 5 m. • 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. • An airflow failure warning device shall be installed. The warning shall be able to be detected from outside the store. <u>Natural</u> The following requirements apply to a natural ventilation system: • Vents in opposing walls. • Vents shall consist of openings immediately above the upper limit of the spillage compound. • Vents shall each have a net free area of at least 0.1 m^3, with an equal are of openings above the highest package. • There shall be one low level vent in each 3 m of wall.
Separation Distances	The following minimum separation distances are required as per Table 6.1: • From off-site protected places: 13.5 m • From on-site protected places: 7.5 m

Item	Requirement
	• To property boundary: 3 m To achieve compliance, the wall to the warehouse shall require an FRL of 60/60/60. See **Figure 4-1** for details.
Segregation within the Store	• Acids and bases shall be segregated by at least 3 m, by storing in separate spillage containment compounds. • Class 9 DGs shall be segregated in accordance with their MSDS.
Fire Protection	• AS/NZS 3833:2007 does not require the inclusion of sprinklers; however, this may be superseded by the requirements of the BCA or AS 2218.1:2017. Sprinkler design shall be prepared by a reputable Fire Protection Engineer to ensure compliance. As per Table 9.3, the store shall be protected by: • Fire extinguishers (dry chemical, rated 2A 60 B(E)). • Fire hose reels providing coverage to all parts of the store. • Fire Hydrants.

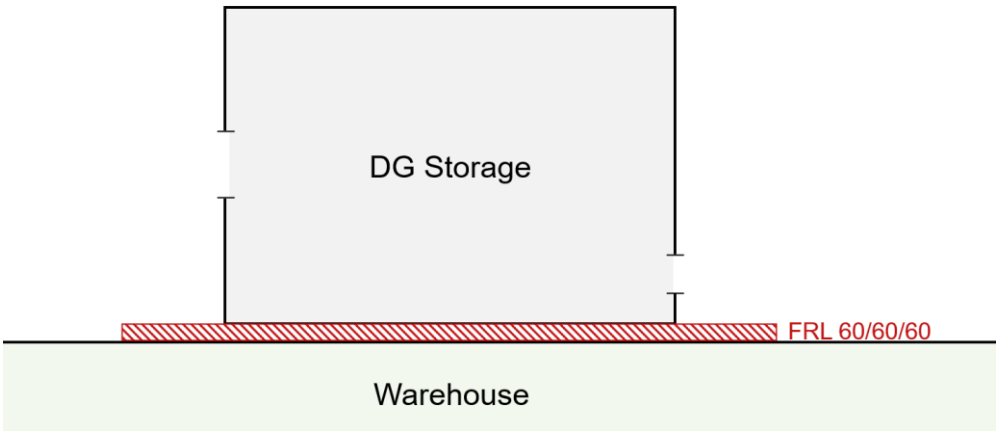

Figure 4-1: Firewall Configuration for mixed DG storage

4.3 Flammable Liquids Dispensary

Flammable liquids (Class 3, PG II & III), flammable solids, and combustible liquids will be stored in two (2) purpose built containers each with a volume of 16,000 kg each which will be located externally to the warehouse. The quantities which will be stored have been outlined in **Table 4-3**.

Table 4-3: Flammable Liquids Container Quantity

Class	Description	PG	Quantity (L)
3	Flammable Liquids	II	2x16,000
		III	
4.1	Flammable Solids	II	
		III	
C1	Combustible Liquids	n/a	

Class	Description	PG	Quantity (L)
C2		n/a	
		Total	32,000

The most applicable standard for governing the storage of Class 3 substances is AS 1940-2017 – The Storage and Handling of Flammable and Combustible Liquids (Ref. [5]). The storage would be regarded as a package store, as outlined in Section 4 of the standard. The design requirements for a package store have been outlined in **Table 4-4**. It is noted that the storage will be a purpose-built container complying with AS 1940-2017.

Table 4-4: Flammable Liquids Storage Requirements, in accordance with AS 1940-2017

Item	Requirement
Electrical Equipment	• Any electrical equipment in the store shall be rated for use in a hazardous area per AS/NZS 60079.14:2017 (Ref. [6]). • Equipment shall be installed by a hazardous area qualified electrician.
Construction	• The construction of the cabinet shall be constructed of a material which will not be corroded or degraded by the commodities being stored.
Spillage Containment	• The capacity of spill containment shall be at least 4.1 m^3 (1 m^3 (largest container) + 2.5 m^3 (25% up to 10,000 L) + 0.6 m^3 (10% of capacity above 10,000 L). • Spill containment shall be sufficiently impervious to retain spillage, chemically resistant and fire resistant.
Ventilation	Ventilation will be required which may be achieved via a natural ventilation system. A review of the technical data sheets for the proposed products indicates this will be achieved.
Separation Distances	The minimum separation distances shall be (on a per container basis, i.e. 16,000 L): • To on-site and off-site protected places: 8.15 m (from Table 4.1). • To any public place (property boundary): 3 m (Table 4.2) Separation distances shall be measured from the internal perimeter of the bund (i.e. container wall). If the separation cannot be achieved it shall be measured around a firewall with the following specifications: • Wall to have an FRL of 240/240/240 • Wall to extent 0.5 m above the top of the cabinet
General Requirements	• A safety shower compliant with AS 4775 shall be located within no close than 2 m and no further than 10 m of the storage.
Fire Protection	The store shall be protected by: • Four (4) powder type extinguishers. • Two (2) foam type extinguishers. • Hose reels with foam capabilities, able to reach all parts of the store. • 1x10L/s water supply for the fire hydrant system, in addition to the requirements of AS 2419.1

Item	Requirement
Control of Ignition Sources	As there is a potential for vapour cloud formation, potential ignition sources must be assessed. A Hazardous Area Classification (HAC) shall be carried out as per AS/NZS 60079.10.1 (Ref. [6]).

4.4 Bulk Tanks (Acids)

The bulk tanks of acids will be located within the warehouse, adjacent to the manufacturing area. While other bulk tanks of DGs will be stored in the vicinity, the acids are grouped together and thus, based on a review of the relevant DG standards, it was determined that the most applicable standard for governing the bulk storage of acids was AS 3780:2008 – The Storage and Handling of Corrosive Substances (Ref. [7]). The total quantity of acids to be stored is 80 m^3, the quantity of each acid is outlined in **Table 4-5**.

Table 4-5: Bulk Acid Storage Quantity

Class	PG	Description	Quantity (L)
8	III	Corrosive Substances – Arylsulfonic Acid	50,000
	II	Corrosive Substances – Gardiquat 1450	30,000

The storage would be regarded as a bulk storage, as outlined in Section 5 of the standard. The design requirements for a bulk acid tank from AS 3780:2008 have been outlined in **Table 4-6**.

Table 4-6: Bulk Acid Storage Requirements, in accordance with AS/NZS 3780:2008

Item	Requirement
Construction	• Tanks shall be completely above ground. • Tanks and their bases shall be resistant to corrosion. • The tanks shall be positioned on a foundation which can support the full load of the tank, and any distorting forces.
Separation Distances	The following minimum separation distances shall be achieved: • Between containers: 0.6 m. • From protected places and premises boundaries: 5 m. • Top inside perimeter of a bund, any protected place or boundary: 3 m. • From tank to the bund: 3 m (assuming tank height of 6 m), as satisfying the crest locus limit (i.e. at least half of the tank height). See **Figure 4-2** for details. If separation distances cannot be achieved, they shall be measured laterally around an intervening screen wall of at least 1 m above the tank (or to the roof) that has an FRL of 120/120/120.
Segregation	The following minimum segregation distances shall be achieved: • To incompatible substances: the acids shall be kept in separate compounds or segregated by at least 5 m. • To substances that may react dangerously: the acids shall be segregated by at least 5 m and be kept in a separate compound with its own drainage system.

Item	Requirement
	Figure 4-3 illustrates the suggested location for the acid tanks to maintain segregation distances.
Ventilation	Ventilation will be required which may be achieved via mechanical means. The requirements are as follows: <u>Mechanical</u> • The ventilation system shall exhaust 0.3 m^3 per square metre of floor area per minute or 5 m^3/min, whichever is greater. The velocity of the air at the entry point must exceed 300 m/min. • The distance between any two inlets or any two outlets shall be less than 5 m. • 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. • An airflow failure warning device shall be installed. The warning shall be able to be detected from outside the store.
Bunds and Compounds	• The capacity of the compound shall be 55,000 L (110% of the capacity of the largest container) • Bunds and compounds shall be constructed of material resistant to corrosion.
Fire Protection	The base build sprinkler protection requirements would exceed the minimum requirements of AS 3780-2008; hence, no additional fire protection is required.

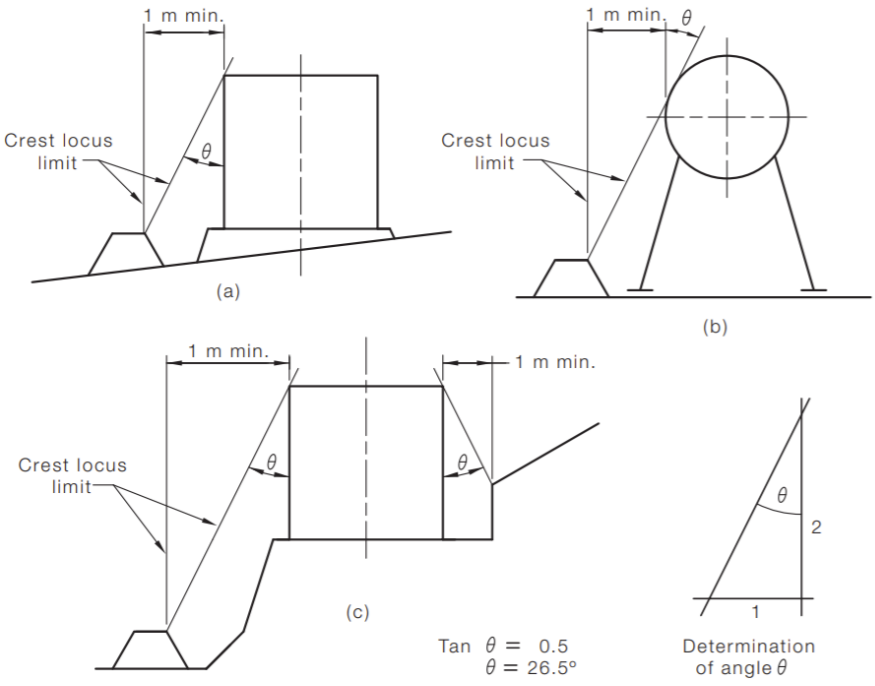

Figure 4-2: Crest Locus Limit, extracted from AS 3780:2008 (Ref. [3])

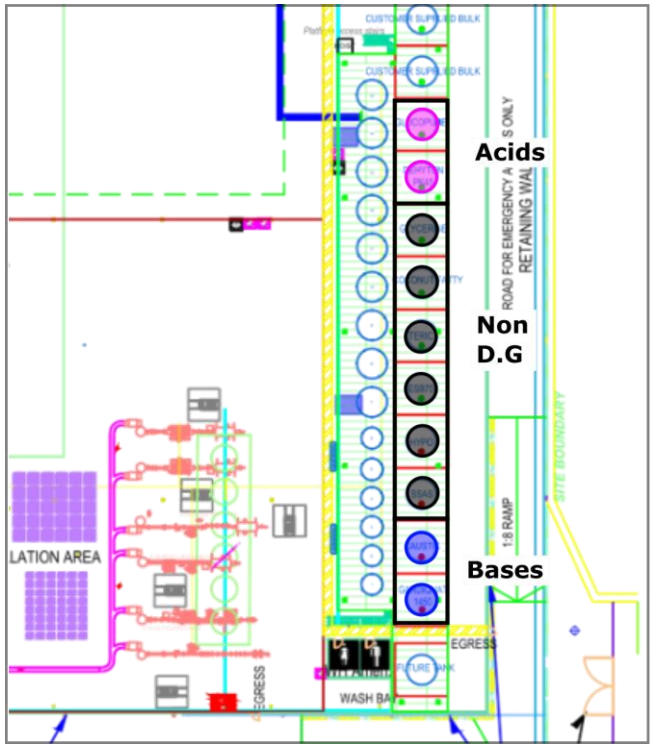

Figure 4-3: Proposed location of bulk acids and base tanks, separated by bulk non-DGs.

4.5 Bulk Tanks (Bases)

Bases will be stored in bulk tanks within the warehouse, adjacent to the blending (manufacturing) area. Although other bulk tanks will be in the vicinity of this store, the bases will be grouped together and so are not considered a mixed store. Based on a review of relevant design standards, it was determined that the most applicable standard for this store is AS 3780:2008 – Corrosive Substances (Ref. [3]). The total quantity of acids to be stored in 80 m^3, the quantity of each acid is outlined in **Table 4-7**.

Table 4-7: Bulk Bases Storage Quantity

Class	PG	Description	Quantity (L)
8	III	Corrosive Substances – Hypochlorite	50,000
	II	Corrosive Substances – Sodium Hydroxide	30,000

As the bases will be stored in permanently positioned tanks, the storage is considered 'bulk storage', as outlined in Section 5 of the standard. The design requirements for a bulk tank from AS 3780:2008 have been summarised in **Table 4-8.**

Table 4-8: Bulk Base Tanks Design Requirements, in accordance with AS 3780:2008.

Item	Requirement
Construction	• Tanks shall be completely above ground. • Tanks and their bases shall be resistant to corrosion. • The tanks shall be positioned on a foundation which can support the full load of the tank, and any distorting forces.
Separation Distances	The following minimum separation distances shall be achieved:

Item	Requirement
	• Between containers: 0.6 m. • From protected places and premises boundaries: 5 m. • Top inside perimeter of a bund and any protected place or boundary: 3 m. • From tank to the bund: 3 m (assuming tank height of 6 m), as satisfying the crest locus limit (i.e. at least half of the tank height). See **Figure 4-2** for details. If separation distances cannot be achieved, they shall be measured laterally around an intervening screen wall of at least 1 m above the tank (or to the roof) that has an FRL of 120/120/120.
Segregation	• To incompatible substances: the bases shall be segregated by at least 5 m or kept in separate compounds. • To substances that may react dangerously: the bases shall be segregated by at least 5 m and be kept in a separate compound with its own drainage system. **Figure 4-3** illustrates the suggested location for the acid tanks to maintain segregation distances.
Ventilation	Ventilation will be required which may be achieved via mechanical means. The requirements are as follows: <u>Mechanical</u> • The ventilation system shall exhaust 0.3 m^3 per square metre of floor area per minute or 5 m^3/min, whichever is greater. The velocity of the air at the entry point must exceed 300 m/min. • The distance between any two inlets or any two outlets shall be less than 5 m. • 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. An airflow failure warning device shall be installed. The warning shall be able to be detected from outside the store.
Bunds and Compounds	• The capacity of the compound shall be 25.3 kL (110% of the capacity of the largest container, see **Appendix Table A-1** item 21). • Bunds and compounds shall be constructed of material resistant to corrosion.
Fire Protection	The base build sprinkler protection requirements would exceed the minimum requirements of AS 3780-2008; hence, no additional fire protection is required.

4.6 DAF

The DAF facility utilises sulfuric acid, hydrochloric acid, and hydrogen peroxide as part of the wastewater treatment. A summary of the quantities of DGs stored in the DAF facility is provided in **Table 4-9**.

Table 4-9: DAF DG Storage Quantities

Class	PG	Description	Quantity (L)
5.1 (8)	II	Oxidising Agents – Hydrogen Peroxide	1,000
8	II	Corrosive Substances – Acids	2,000

The following standards were reviewed as part of an analysis to determine which design standard shall be used:

- AS 3780:2008 – The Storage and Handling of Corrosive Substances (Ref. [3]).
- AS 4326:2008 – The Storage and Handling of Oxidising Agents (Ref. [7])

Based on a review of the relevant DG standards, it was determined that the most applicable standards for this store is AS 3780:2008 – Corrosive Substances (Ref. [3]), because hydrogen peroxide is a sub-risk class 8 substance. However, as it is a Class 5.1 oxidising agent, AS 4326:2008 (Ref. [7]) shall be used to determine the fire protection requirements, as these requirements are more stringent for oxidising agents.

The DGs are stored in intermediate bulk containers (IBCs), and dosed into the DAF tanks as required. The store is considered a package store, as outline in Section 4 of the standards. The relevant requirements from AS 3780:2008 and AS 4326:2008 have been summarised in **Table 4-10.**

Table 4-10: DAF Facility Design Requirements, in accordance with AS 3780:2008 and AS 4326:2008

Item	Requirement
Construction	• The store shall be located on the ground floor, with immediate access from outside the building. • All materials of construction shall be resistant to corrosion or be lined with corrosion-resistant materials. • If the store has a roof, it shall have an FRL of at least 120/120/120
Spillage Containment (Bunds and Compounds)	• As acids and bases are incompatible substances, they shall be separately bunded. The capacity of each compound shall be 1,000 L (the capacity of the largest container). • Packages shall be kept in a manner that they cannot fall and cause spillages. • Bunds and compounds shall be constructed of material resistant to corrosion or be lined with corrosion-resistant materials.
Separation Distances	The minimum separation distance to protected places and the boundary of the premises shall be 5 m (Table 4.1)
Segregation within the Store	• To incompatible substances: the bases shall be kept in separate compounds or segregated by at least 5 m.

Item	Requirement
	• To substances that may react dangerously: the bases shall be segregated by at least 5 m and be kept in a separate compound with its own drainage system. If segregation distances are being measured from Class 2.1, 3, 4 or 5 DGs, the screen wall must have an FRL of 120/120/120.
Fire Protection	• The store shall be protected by fire extinguishers (one dry powder type) • The store shall be protected by fire hose reels if the floor area of the store is greater than 200 m^2. The hose reels shall provide coverage to all parts of the store, and shall be located externally to the store, or within 4 m of an exit.
General requirements	The following items shall be provided withing 10 m, but not closer than 2 m to the store: • A safety shower and eye-wash facility complying with AS 4775. • Water for hand washing.

4.7 LPG Tank

The LPG tank will be stored in a dedicated storage area outside the warehouse, separate to the rest of the DGs on site. Based on a review of the relevant DG standards, it was determined that the most applicable standard for governing the storage of LPG was AS/NZS 1596:2014 – The Storage and Handling of LP Gas (Ref. [8]). A summary of the quantity of LPG to be stored is provided in **Table 4-11**.

Table 4-11: LPG Storage Quantity

Class	PG	Description	Quantity (L)
2.1	n/a	Liquefied Petroleum Gas	3,900

The storage would be considered a tank system, as outlined in Sections 5 and 6 of the standard. Based on the requirements of these sections, the design points to be included within the report have been summarised in **Table 4-12**.

Table 4-12: LP Gas Storage Requirements, in accordance with AS/NZS 1596:2014

Item	Requirement
Storage Location	The tank shall be stored outside and have a minimum distance of 5 m to a public place or railway line, and 8 m to a protected place. It shall not be less than 1 m from a site boundary.
Hazardous Areas	A HAC shall be performed for the storage area as per AS/NZS 60079.10.1:2009 and AS/NZS 60079.14:2017.
Storage of Other DGs	The following distances are required between the LP gas tank and other materials: • Above ground tank, package store or filling area for flammable or combustible liquids: 6 m. • Top of the bund of a compound for flammable or combustible liquids: 3 m. • A store of any oxidising substance: 6 m.

Item	Requirement
Ground Conditions	The tanks shall be stored on flat ground, with any bunding permitting spillage to flow away from the immediate vicinity of the tank.
Vehicle Filling	The area and system for vehicle filling shall be designed by a reputable contractor in accordance with the relevant standards.
Fire Protection	• At least one portable powder type fire extinguisher with a rating of 2A 60B(E) shall be provided which is readily accessible in an emergency. • Other fire protection requirements shall be designed by a reputable fire engineer in accordance with the relevant standards.

5.0 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 NSW 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 are outlined in **Table 5-1**. As the DG stores exceed the manifest threshold, the site is classified as a Manifest site.

Class	PG	Description	Quantity (L)	Storage
2.1	n/a	Flammable gases – LPG	3,920	Bulk Tank
3	II	Flammable Liquids	2 x 16,000	External Containers
	III			
4.1	II	Flammable Solid		
	III			
C1	n/a	Combustible Liquid		
C2	n/a			
5.1	II	Oxidising Agents	44,000	Liquid Storage Shed
	II		1,000	DAF
6.1	II	Toxic Substances	5,000	Liquid Storage Shed
8	II	Corrosive Substances – Acids and Bases	60,000	Tank Farm
	III		100,000	
8	II	Corrosive Substances	25,000	Liquid Storage Shed
	III		30,000	
8	II	Corrosive Substance	1,000	DAF
9	III	Environmentally Hazardous Substances	150,000	Liquid Storage Shed
9	III	Miscellaneous DG	30,000	Tank Farm

Table 5-1: Manifest and Placard DG quantities

Class	PG	Description	Quantity (L)	Placard Quantity (L)	Manifest Quantity (L)	Classification
2.1	n/a	Flammable gases – LPG	3,900	5,000	10,000	-
3	II	Flammable liquids	32,000	250	2,500	Manifest
3	III	Flammable liquids		1,000	10,000	Manifest
4.1	II	Flammable solids		250	2,500	Manifest
4.1	III	Flammable solids		1,000	10,000	Manifest

Class	PG	Description	Quantity (L)	Placard Quantity (L)	Manifest Quantity (L)	Classification
C1	n/a	Combustible liquid		10,000	100,000	Placard
C2	n/a	Combustible Liquid		-	-	-
8	II	Corrosive Substances	81,400	250	2,500	Manifest
8	III	Corrosive Substances	105,400	1,000	10,000	Manifest
9	III	Miscellaneous DG	180,000	10,000	20,000	Manifest
C1	n/a	Combustible liquid	50,000	10,000	100,000	Placard
C2	n/a	Combustible Liquid	30,000	-	-	-

5.2 Applicable WHS Clauses

The applicable clauses for a manifest site are 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 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 of the regulation.
348	A notification shall be made to the regulator of the DGs that exceed the manifest quantities detailed in Schedule 11 of the Regulation.
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. A Placard Schedule shall be prepared. An outer warning placard shall be prominently displayed at the site. The placard is to show the words “HAZCHEM” in red lettering on white or silver background and must have minimum dimensions 120 mm x 600 mm, in compliance with Schedule 13, as shown in **Figure 5-1.**
351	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:

Clause	WHS Requirement
	• 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.
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 liquids, gases, and solids in accordance with AS/NZS 60079.10.1:2009 (Ref. [6]). • A Hazardous Area Dossier shall be prepared prior to occupation in accordance with AS/NZS 3000:2007 (Ref. [9]).
358	A PCBU must ensure containers of hazardous chemicals are protected against impact damage and damage from excessive load.
361	A PCBU must prepare an emergency response plan (ERP) and submit it to the primary service organisation (Fire and Rescue NSW)

Figure 5-1: 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).
- A Hazardous Area Classification (HAC).
- Hazardous Area Verification Dossier.

6.0 Conclusions and Recommendations

6.1 Conclusions

A review of the proposed DG storage and operations within the Jalco site was conducted to determine compliance with the Work Health and Safety Regulation 2017 (Ref. [1]) and all relevant design standards.

A review of the standards determined that the following standards be used to govern the storage requirements in the respective areas:

- Liquid Storage Shed - Mixed DG Package Store – AS/NZS 3833:2007
- Flammable Liquids Dispensary (Package Store) – AS 1940:2017
- Bulk Tanks of Acids and Bases – AS 3780:2008
- DAF Facility – AS 3780:2008 and AS 4326:2008
- LPG Tank - AS/NZS 1596:2014

Each of these standards was used to construct a series of requirements for the design and construction of the Jalco facility.

6.2 Recommendations

The following recommendations have been made based on the assessment within this report:

DG Storage Requirements:

Each DG storage area has different requirements based on the particular substances which are being stored. Consistent to majority of the stores is the need for bunding, ventilation and separation from protected places. Detailed summaries of the items to be included in the design of each DG store are provided in the following sections:

- Liquid Storage Shed: Table 4-2: Liquid Storage Shed Storage Requirements, in accordance with AS/NZS 3833:2007
- Flammable Liquids/Flammable Solids/Combustible Liquids: Table 4-4: Flammable Liquids Storage Requirements, in accordance with AS 1940-2017
- Bulk Tanks (Acids): Table 4-6: Bulk Acid Storage Requirements, in accordance with AS/NZS 3780:2008
- Bulk Tanks (Bases): Table 4-8: Bulk Base Tanks Design Requirements, in accordance with AS 3780:2008.
- DAF: Table 4-10: DAF Facility Design Requirements, in accordance with AS 3780:2008
- LPG Tank: Table 4-12: LP Gas Storage Requirements, in accordance with AS/NZS 1596:2014

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).
- A Hazardous Area Classification (HAC).
- Hazardous Area Verification Dossier.

References

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

[2] 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.

[3] S. Australia, "AS 3780-2008 - The storage and handling of corrosive substances," Standards Australia, Sydney, 2008.

[4] Standards Australia, "AS/NZS 4681:2000 The Storage and Handling of Class 9 (Miscellaneous) Substances and Articles," Standards Australia, Sydney, 2000.

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

[6] Standards Australia, AS/NZS 60079.10.1:2009 - Explosive Atmospheres Part 10.1: Classification of Areas, Explosive Gas Atmospheres, Sydney: Standards Association of Australia, 2009.

[7] Standards Australia, "AS 4326-2008 - Storage and Handling of Oxidising Agents," Standards Australia, Sydney, 2008.

[8] Standards Australia, AS/NZS 1596:2014 - The Storage and Handling of LP Gas, Sydney: Standards Australia, 2014.

[9] Standards Australia, "AS/NZS 3000:2007 - Wiring Rules," Standards Australia, Sydney, 2007.

Appendix A

Detailed outline of DGs stored on site

Appendix A