PRELIMINARY HAZARD ANALYSIS, SWIRE COLD STORAGE FACILITY, MARSEN PARK, NSW

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1 June 2015

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Rev	Date	Description	Reviewed By
A	1/2/15	Draft for Comment	Swire / JBA Planning
B	25/5/15	Site Layout Changed	Swire / JBA Planning
C	1/6/15	Final Revision	Swire / JBA Planning

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EXECUTIVE SUMMARY

Swire Cold Storage Pty Ltd (Swire) is proposing to build a cold storage facility at Lot 10201 Marsden Park Industrial Estate.

As part of the Secretary's Environmental Assessment Requirements from the NSW Department of Planning and Environment, a Preliminary Hazard Analysis is required. This report details the results from the analysis.

The risks associated with the proposed Swire warehouse at Marsden Park have been assessed and compared against the DoP risk criteria. The results are as follows and show compliance with all risk criteria.

Description	Risk Criteria	Risk Acceptable?
Fatality risk to sensitive uses, including hospitals, schools, aged care	0.5×10^{-6} per year	Yes
Fatality risk to residential and hotels	1×10^{-6} per year	Yes
Fatality risk to commercial areas, including offices, retail centres, warehouses	5×10^{-6} per year	Yes
Fatality risk to sporting complexes and active open spaces	10×10^{-6} per year	Yes
Fatality risk to be contained within the boundary of an industrial site	50×10^{-6} per year	Yes
Injury risk – incident heat flux radiation at residential areas should not exceed 4.7 kW/m^2 at frequencies of more than 50 chances in a million per year or incident explosion overpressure at residential areas should not exceed 7 kPa at frequencies of more than 50 chances in a million per year	50×10^{-6} per year	Yes
Toxic exposure - Toxic concentrations in residential areas which would be seriously injurious to sensitive members of the community following a relatively short period of exposure	10×10^{-6} per year	Yes
Toxic exposure - Toxic concentrations in residential areas which should cause irritation to eyes or throat, coughing or other acute physiological responses in sensitive members of the community	50×10^{-6} per year	Yes
Propagation due to Fire and Explosion – exceed radiant heat levels of 23 kW/m^2 or explosion overpressures of 14 kPa in adjacent industrial facilities	50×10^{-6} per year	Yes

Societal risk, area cumulative risk, transport of ammonia risk and environmental risk is also concluded to be acceptable.

The primary reason for the low risk levels from the warehouse is that significant levels of radiant heat from potential fires do not extend far from the warehouse and the frequency of ammonia releases impacting people is acceptably low.

The following recommendations are made from this review:

1. Include in the preventative maintenance system the need for routine exercising of the actuated stormwater valves that prevent contaminated water from leaving site.

2. Include in the emergency response plan specific guidance on handling ammonia releases.

3. Given the location of the firewater tank, firewater pumps, MCC, MSB and ammonia plant room where high levels of radiant heat may occur and potentially warehouse wall collapse, ensure these areas have adequate construction for these potential consequences.

GLOSSARY

AEGL	Acute Exposure Guideline Level
ALARP	As Low As Reasonably Practicable
AS	Australian Standard
ASRS	Automatic Storage and Retrieval System
CCTV	Closed Circuit Television
DoPE	NSW Department of Planning and Environment
ELS	Express Logistic Services
EPA	Environmental Protection Agency
ERPG	Environmental Response Planning Guideline
FRL	Fire Resistance Level
HAZAN	Hazard Analysis
HIPAP	Hazardous Industry Planning Advisory Paper
LED	Light Emitting Diode
MCC	Motor Control Centre
MSB	Main Switch Board
NFPA	National Fire Protection Authority
PHA	Preliminary Hazard Analysis
PIR	Polyisocyanurate
ppm	Parts Per Million
PVC	Polyvinyl Chloride
QRA	Quantitative Risk Assessment
SEAR	Secretary’s Environmental Assessment Requirements
SEPP	State Environmental Planning Policy

REPORT

1 INTRODUCTION

1.1 BACKGROUND

Swire Cold Storage Pty Ltd (Swire) is proposing to build a cold storage facility at Lot 10201 Marsden Park Industrial Estate.

The facility will be used for three main functions (Ref 1):

- Warehouse and transport – where frozen goods are received from customers for storage and are then ordered within the warehouse for dispatch the following day. Goods are received and are transferred into storage within 2 hours;

- Cross-dock logistics – where frozen goods are received from 3rd party and other Swire sites, they are then frozen and chilled and then are consolidated into destination loads and despatched on the same day; and

- ASRS (Automatic Storage and Retrieval System). This is the high bay component of the warehouse that will use an automatic racking system where driverless forklifts are used to move pallets.

As part of the Secretary's Environmental Assessment Requirements (SEARs) from the NSW Department of Planning and Environment (DoPE), a Preliminary Hazard Analysis (PHA) is required.

It is proposed to construct and operate the facility in two stages. This PHA assesses the potential impacts from the final design, i.e. when Stage 2 is complete. This is partly due to Stage 2 having the worst case scenarios and also for Stage 1, the quantities of Dangerous Goods held on site would not trigger the need for a PHA via SEPP (State Environmental Planning Policy) 33.

This PHA has been prepared in accordance with the guidelines published by the DoPE Hazardous Industry Planning Advisory Paper (HIPAP) No 6 (Ref 2). JBA Planning (acting on behalf of Swire) has appointed Pinnacle Risk Management Pty Ltd (Pinnacle Risk Management) to prepare this Preliminary Hazard Analysis report.

1.2 OBJECTIVES

The main aims of this PHA study are to:

- Identify the credible, potential hazardous events associated with the development with the potential for off-site impacts;

- Evaluate the level of risk associated with the identified potential hazardous events to surrounding land users and compare the calculated risk levels with the risk criteria published by the DoPE in HIPAP No 4 (Ref 3);
- Review the adequacy of the proposed safeguards to prevent and mitigate the potential hazardous events; and
- Where necessary, submit recommendations to Swire to ensure that the development is operated and maintained at acceptable levels of process safety and effective safety management systems are used.

1.3 SCOPE

This PHA assesses the credible, potential hazardous events and corresponding risks associated with the Swire cold storage facility at Marsden Park with the potential for off-site impacts.

Off-site transport risk associated with ammonia transport is also assessed in this PHA as per the SEARs.

1.4 METHODOLOGY

In accordance with the approach recommended by the DoPE in HIPAP 6 (Ref 2) the underlying methodology of the PHA is risk-based, that is, the risk of a particular potentially hazardous event is assessed as the outcome of its consequences and likelihood.

The PHA has been conducted as follows:

- Initially, the development and its location were reviewed to identify credible, potential hazardous events, their causes and consequences. Proposed safeguards were also included in this review;
- As the potential hazardous events are located at a significant distance from other sensitive land users, the consequences of each potential hazardous event were estimated to determine if there is any possible unacceptable off-site impacts;
- Included in the analysis is the risk of propagation between the proposed facility and adjacent properties; and
- If adverse off-site impacts could occur, the likelihood of each potential hazardous event was reviewed, using appropriate techniques / methods, to check if there is any significant risk to people and facilities off-site and if the risk levels are within the criteria in HIPAP 4 (Ref 3).

2 SITE DESCRIPTION

The site is located in the central part of the Marsden Park Industrial Precinct in the North West Growth Centre (Ref 1). It is located west of Richmond Road and north of Hollinsworth Road as shown in Figure 1. The Marsden Park Industrial Precinct is a relatively new land release area of which the majority still remains undeveloped.

Once the subdivision is registered the site will have an area of 7 hectares and is to be known as Lot 10201. It will be bounded by Road No 1 (Hollinsworth Road) to the south, road number 2 to the west and road number 5A to the north. The site area is 70,320 m^2 and is approximately 225 metres wide (east-west) and 315 metres long (north-south).

The nearest residential area is a caravan park which is located approximately 500 m to the southwest of the site. Other notable nearby developments include the Ikea, Costco and Bunnings facilities which will be located to the west of Richmond Road and are also shown in Figure 1.

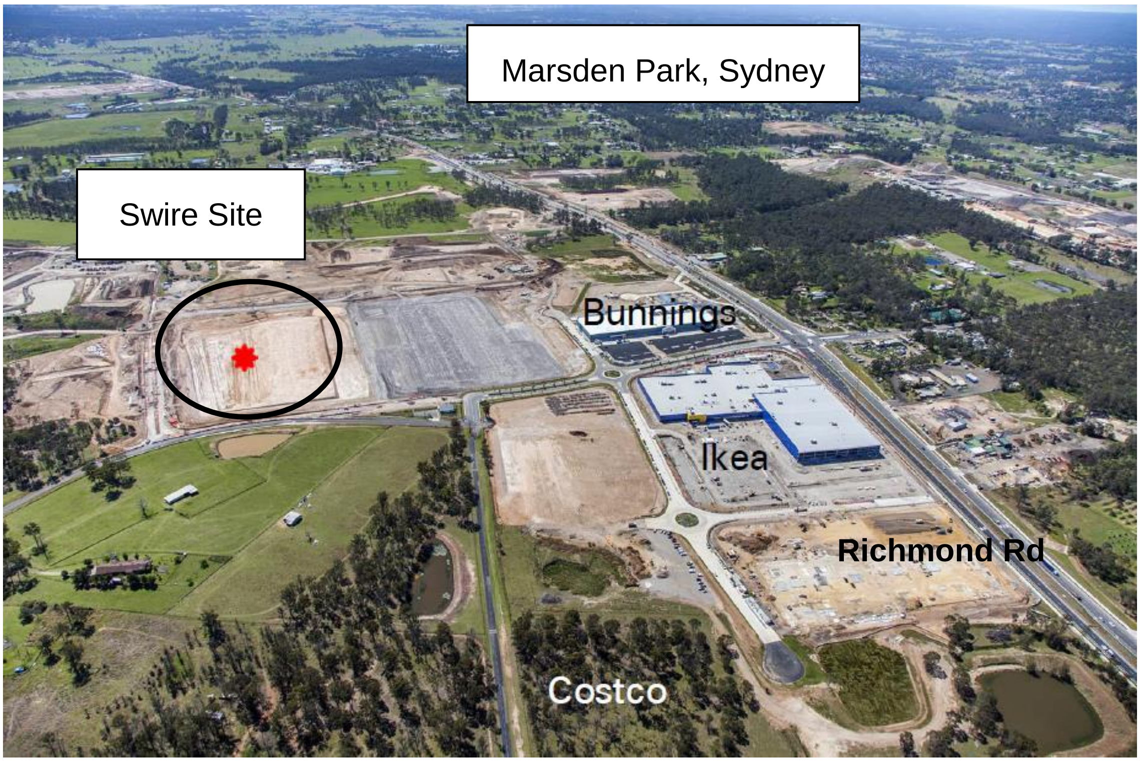
Currently, the land south of the site is occupied by some large lot residences (although it is now zoned IN2 Light Industrial). The closest house is approximately 250 m south of the site. The closest residential area is Hassall Grove, some 800 m south of the site.

The site will operate from Monday to Saturday, 24/7. Depending on the shift, there will be between 13 to 72 people on-site.

Security of the site will be achieved by a number of means. This will include site personnel and security patrols by an external security company (this includes weekends and night patrols). The site will operate 6 days per week (24 hours per day). Also, the site will be fully fenced and non-operating gates will be locked. Security cameras will be installed for staff to view visitors and site activities. The plant room that will contain the ammonia refrigeration compressors will require key access.

There are no known significant external events, e.g. flooding, that are considered high risk for this site.

Figure 1 - Site Location



Source: Ref 1

3 FACILITY DESCRIPTION

The Swire cold storage facility is to be constructed in the following two stages:

Stage 1:

- The northern portion of the warehouse facility is to be constructed first. The building will contain four freezer sections and will have a floor area of approximately 13,310 m^2;
- During Stage 1 it is expected that approximately 73 staff will be employed at the site who will cover three different shifts (0500-1400, 1400-2230 and 2230-0500);
- The development will operate 24 hours a day;
- All onsite roads will be constructed during Stage 1 of the development. Vehicles will arrive from Hollinsworth Road and will enter the site from Road 5A. In addition to this, it is proposed to provide a temporary 6 m wide fire road through the middle of the site;
- There will be approximately 48 outbound truck movements and 27 inbound truck movements each day and
- 94 onsite parking spaces will be provided for staff.

Stage 2:

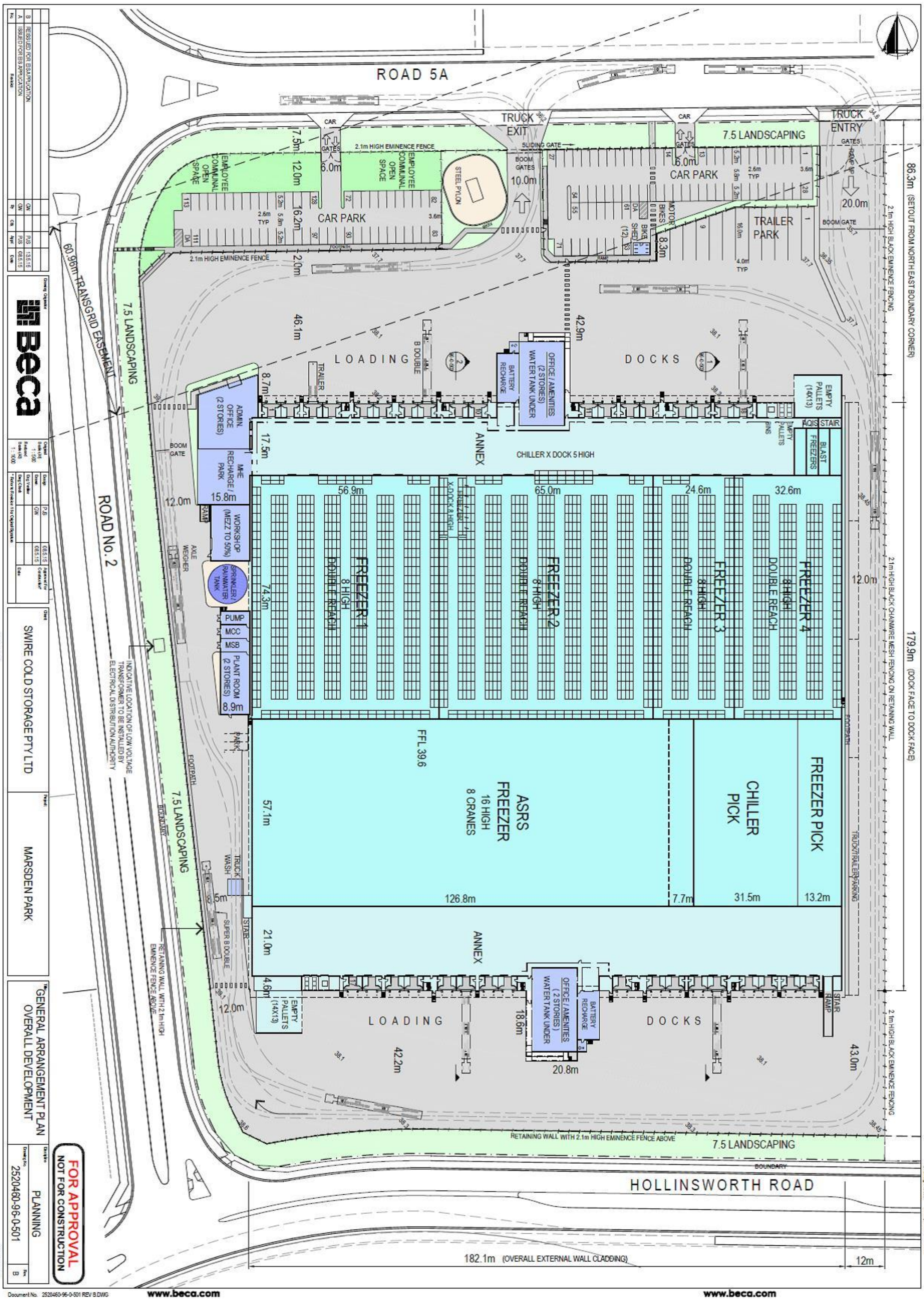
- During Stage 2 the southern portion of the facility will be constructed resulting in a development with a total floor area of approximately 23,550 m^2;
- The site will accommodate 128 employees who will cover the same three shifts as above; and
- There will be approximately 122 outbound truck movements and 92 inbound truck movements each day.

Figure 2 shows the layout of the warehouse once Stage 2 is complete.

The warehouse will be constructed using PIR (polyisocyanurate) panel walls and ceiling with Colourbond cladding. PIR is an insulating material and is fire retardant. It will yield toxic products of combustion if involved in a fire.

There will be automatic fire sprinklers. The floor is to be concrete. There will be six main storage areas within the warehouse; each separated by a fire resistant walls. The docking areas are along the northern and southern sides.

Figure 2 – Site Layout



The western end of the warehouse will include the transformers and electrical control gear, the plant room containing the refrigeration compressors, the firewater tank and pumps, forklift charging facility and the administration offices. The area around the warehouse is to be paved.

The northern section of the warehouse will allow pallets to be stored up to eight high whilst the southern section will allow storage of up to 17 pallets high. The latter will utilise an automatic storage and retrieval system. The walls on the northern section will be approximately 16 m high whilst the southern section walls will be approximately 35 m high.

90% of the stored goods are frozen food (at -18 C) in cardboard cartons on timber pallets in steel racking. The remaining 10% is chilled goods at +3 C. The approximate number of pallets stored will be 75,000. Each pallet, including the foodstuff, will weigh approximately 800 to 1,000 kg. Only battery powered fork-lifts are to be used in the warehouse.

The fire load in the warehouse will be the foodstuff (e.g. frozen vegetables and meat), wooden pallets and packaging (cardboard and plastic).

The refrigeration system will use ammonia. The system will be a sealed system containing up to 7 ton of ammonia for Stage 2. The ammonia is anticipated to require a ‘top up’ approximately every 1.5 to 2 years with a 250 kg gas cylinder of anhydrous ammonia. The ammonia delivery will be from an industrial gas supplier.

The refrigeration system design will be typical as per industry designs, e.g. compressors, condensers, receivers and chillers. The compressors and chillers are to be located within the plant room and warehouse where containment and sprinklers exist. The condensers will be located on the roof of the plant room.

Armco railing will be provided as vehicle impact protection in front of the plant room. Ammonia gas detection will also be installed in the plant room and penthouses (roof spaces).

4 HAZARD IDENTIFICATION

4.1 HAZARDOUS MATERIALS

The only Dangerous Good proposed to be used at the facility with the potential for off-site impact is ammonia, i.e. the refrigerant. There is likely to be minimal quantities of hazardous materials stored and used at the facility, e.g. paint, however, these are not in sufficient quantities to warrant risk evaluation.

Ammonia

Anhydrous ammonia is a gas at normal temperature and pressure but may be liquefied under moderate pressure (630 kPag at 15^{o}C) or at temperatures below -33^{o}C at atmospheric pressure.

Hazards from ammonia systems arise from:

- The toxicity of ammonia gas;
- Ammonia/air fire and explosion; and
- Release of the energy stored in a pressurised system.

The main credible hazard capable of having off site effects is from the toxicity of ammonia gas. This is due to the low likelihood of igniting ammonia.

The Emergency Response Planning Guidelines (ERPG) levels (Ref 4) and the Acute Exposure Guideline Levels (AEGLs) (Ref 5) are shown in Table 1.

Table 1 – ERPG and AEGL Values for Ammonia

ERPG - 1 (ppm)		ERPG - 2 (ppm)		ERPG - 3 (ppm)	
25	At this level, there may be some odour but there should be no significant irritation for a 1 hour exposure	150	There is likely to be strong odour and some eye irritation at this level, but serious health effects are unlikely for a 1 hour exposure	750	This level may cause severe eye and nasal irritation, however lethality would not be expected for a 1 hour exposure
AEGL – 1 (ppm) 10 minutes		**AEGL – 2 (ppm) 10 minutes**		**AEGL – 3 (ppm) 10 minutes**	
30	The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic nonsensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure	220	The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape	2,700	The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening adverse health effects or death

Acute effects of ammonia on humans are also summarised in Table 2 (Ref 6).

Table 2 – Effect of Ammonia on Human Health

Concentration (ppm)	Effect on Health	Exposure Period
25	Odour, detectable by most persons	Maximum for 8 hour working period
100	No adverse effect for average worker	Deliberate exposure for long periods not permitted
400	Immediate nose and throat irritation	No serious effect after 30 minutes to 1 hour
700	Immediate eye irritation	No serious effect after 30 minutes to 1 hour
1700	Convulsive coughing; severe eye, nose and throat irritation	Could be fatal after 30 minutes
2000 - 5000	Convulsive coughing; severe eye, nose and throat irritation	Could be fatal after 15 minutes

Concentration (ppm)	Effect on Health	Exposure Period
5000 - 10000	Respiratory spasm Rapid asphyxia	Fatal within minutes

Ammonia is flammable in air in a concentration range of 16 – 25% by volume but it does not readily ignite. The minimum ignition energy for ammonia is 100 mJ compared with 0.29 mJ for methane (Ref 6). Explosions can occur in flammable mixtures in vessels or enclosed spaces. Ignition is difficult and the possibility of an explosion in the open air is generally discounted (i.e. turbulent releases generally mix with at least 10 times the volume of air and hence the resulting ammonia concentration will be below the lower explosive limit). The auto-ignition temperature of ammonia is 651°C (relatively high).

Ammonia storage and handling installations are not, therefore, generally regarded as significant fire or explosion risks.

Ammonia could be released to atmosphere as a result of an incident or equipment failure as follows:

- Leaks from pipework or pipework failures; and
- Leaks from vessels or vessel catastrophic failure.

4.2 POTENTIAL HAZARDOUS INCIDENTS REVIEW

In accordance with the requirements of *Guidelines for Hazard Analysis*, (Ref 2), it is necessary to identify hazardous events associated with the facility's operations. As recommended in HIPAP 6, the PHA focuses on "atypical and abnormal events and conditions. It is not intended to apply to continuous or normal operating emissions to air or water".

In keeping with the principles of risk assessments, credible, hazardous events with the potential for off-site effects have been identified. That is, "slips, trips and falls" type events are not included nor are non-credible situations such as an aircraft crash occurring at the same time as an earthquake.

The identified credible, significant incidents with the potential for off-site impacts for the proposed facility are summarised in the Hazard Identification Word Diagram following (Table 3).

This diagram present the causes and consequences of the events, together with major preventative and protective features that are included as part of the design.

Table 3 – Hazard Identification Word Diagram

Event ID No.	Hazardous Event	Causes	Possible Consequences	Prevention and Mitigation Control Measures
1.	Fire within the warehouse associated with the products (due to sources of ignition)	Ignition of products, pallets and packaging via a source of ignition: 1. Lighting not intrinsically safe or hot glass from a light falls onto the packaging. 2. Hot work. 3. Smoking. 4. Electrical fault 5. Lightning 8. Spontaneous combustion, e.g. mixing of incompatible chemicals	Fire involving packaged goods, packaging and wooden pallets. Exploding containers. Toxic products of combustion including vaporised products. Impact to people (radiant heat and/or exposure to products of combustion), property (radiant heat) and the environment (products of combustion as well as contaminated fire water)	Control of ignition sources procedures, e.g. hot work permits. Fixed fire protection sprinkler systems at ceiling level designed to Australian Standards. Systems to be regularly tested. Emergency plans. Emergency warning system. Spill kits. Racks are to be equipped with impact barriers and are to be inspected regularly. Fire resistant walls and doors. Smoke detection. Cold conditions reduce the risk of ignition. Lights to be LED type (no glass) lover aisles and Factory Mutual rated
2.	Fire within the warehouse (due to malicious act)	Person trespasses on the property	Potential for a fire (arson) as above	Security Risk Assessment and Security Plan in place. 24 / 7 security presence at the site. Routine security patrols. Site is fully fenced. Lighting for night observation. CCTV cameras

Event ID No.	Hazardous Event	Causes	Possible Consequences	Prevention and Mitigation Control Measures
3.	Vehicle fire	Fork lift truck or packaged goods transport truck fire, e.g. fuel fire, brake fire	Potential to propagate to the packaged goods with the same consequences as per 1 above. Otherwise, this will be a local event only	Electric fork lift truck. Vehicle maintenance. Fire protection includes hydrants, hand-held hoses and extinguishers
4.	Battery explosion in the recharging area	Hydrogen gas emitted with subsequent ignition	Spraying of the battery acid, e.g. onto people in the area. Explosion could adversely impact people and the recharging building	Emergency response plans. Battery inspections. Fire protection includes hydrants, hand-held hoses and extinguishers. The walls for the battery recharging area are to have a FRL (fire resistance level) of 2 hours
5.	MCC (motor control centre) fire	Short, arcing leading to ignition of the insulation	Damage to the electrical switchgear and potential for propagation to the warehouse. Otherwise, this will be a local event only	Electrical maintenance. Fire extinguishers. The MCC walls are to have a FRL of 3 hours
6.	Transformer fire / explosion	Short, arcing leading to ignition of hydrogen and/or oil	Damage to the transformer and possible injury to personnel. Potential for propagation to the warehouse. Otherwise, this will be a local event only	Transformer to be designed and maintained to Australian Standards and the NSW Electrical Authority's requirements. Only accredited personnel will be permitted to work on the transformer. Containment around the transformer for oil leaks. Oil fire can be extinguished using the proposed fire protection systems including hydrants

Event ID No.	Hazardous Event	Causes	Possible Consequences	Prevention and Mitigation Control Measures
7.	Administration building fire	Electrical fault, sabotage, smoking	Damage to the administration building and potential for propagation to the warehouse. Otherwise, this will be a local event only	Fire protection includes sprinklers, hydrants, hand-held hoses and extinguishers. The Administration Office Building walls are sprinkler protected
8.	Major mechanical failure of pallet racking	Vehicle impact. Metal fatigue, e.g. excessive weight. Faulty fabrication. Corrosion of key supports. Adjacent rack on fire	Spillage of products. Fire if ignited. Impact to people (radiant heat and/or exposure to products of combustion), property (radiant heat) and the environment (products of combustion as well as contaminated fire water) as above	Racking designed to AS4084 steel storage racking Regular maintenance and inspection procedures
9.	Wooden pallet stack fire	Stacked, unused wooden pallets ignited, e.g. hot work or third party entry	Potential for an intense fire with the potential for propagation to other structures. Otherwise, this will be a local event only	Empty pallets are stacked outside the warehouse and sprinkler protected. Control of ignition sources procedures. No ignition sources at the storage areas. Hydrants and extinguishers located throughout the site. Security measures as per 2 above

Event ID No.	Hazardous Event	Causes	Possible Consequences	Prevention and Mitigation Control Measures
10.	Release of ammonia	Piping or equipment failures, e.g. corrosion, impact, poor weld, fabrication fault Procedural errors, e.g. valve left open. Fire impacting the ammonia equipment	Release of gaseous and/or liquid ammonia. Ammonia, being a toxic gas, can affect people. If the release is external to the building, there is an increased risk of affecting people off-site. If the release is inside the building, the ammonia can be contained and absorbed in water. Therefore, there is a lower risk to personnel. However, if the concentration builds-up to the flammable region and there is a sufficiently large source of ignition then a confined explosion can result with damage to the building and injuries to people. Firewater used to absorb gaseous ammonia will form aqueous ammonia and hence there is a risk to the environment from the alkaline liquid. If an ammonia vessel is isolated and subjected to a fire then it is possible for it to overpressure and rupture	The ammonia refrigeration system is to be designed to AS1677. Equipment maintenance. Operating procedures for the refrigeration system. Firewater can be used, e.g. via the hydrants, to absorb ammonia gas. The plant room is to be rated as a hazardous area with intrinsically safe instruments and electrics. Ammonia vessels are to be only isolated for maintenance periods. The ammonia vessels are to be located in an area with low fire hazards. Ammonia detectors will trip the refrigeration system if the ammonia concentration exceeds the AS 1677 nominated value

4.3 SAFETY MANAGEMENT SYSTEMS

Safety management systems are intended to minimise the risk from potentially hazardous installations by a combination of hardware (i.e. design) and managements systems such as procedures, policies, plans, training etc. To ensure safe operation of the facility, both the hardware and the management systems must be of high standard.

In hazard analyses and risk assessments, incidents are assessed in terms of consequences and frequencies (where necessary), leading to a measure of risk. Where possible, frequency data comes from actual experience. However, in many cases, the frequencies used are generic, based on historical information from a variety of plants and processes with different standards and designs.

The quality of the safety management systems in place in these historical plants will vary. Some will have little or no management systems, such as work permits and modification procedures, in place. Others will have exemplary systems covering all issues of safe operation. Clearly, the generic frequencies derived from a wide sample represent the failure rates of an "average plant". This hypothetical average plant would have average hardware and safety management systems in place.

If an installation with below average safety management systems is assessed using generic frequencies, it is likely that risk will be underestimated. Conversely, if a plant is above average, the risk will probably be overestimated. However, it is extremely difficult to quantify the effect of these management systems on plant process safety.

Pinnacle Risk Management normally adopts a policy which does not attempt to quantitatively account for the presence of and quality of safety management systems. It is assumed that the generic failure frequencies used apply to installations which have safety management systems corresponding to accepted industry practice.

As the proposed warehouse is to be of modern design then use of generic failure frequencies is expected to be conservative for this site.

5 RISK ANALYSIS

The assessment of risks to both the public as well as to operating personnel around this industrial development requires the application of the basic steps outlined in Section 1. As per HIPAP 6 (Ref 2), the chosen analysis technique should be commensurate with the nature of the risks involved. Risk analysis could be qualitative, semi-quantitative or quantitative.

The typical risk analysis methodology attempts to take account of all credible hazardous situations that may arise from the operation of processing plants etc.

Having identified all credible, significant incidents, risk analysis requires the following general approach for individual incidents:

Risk = Likelihood x Consequence

The risks from all individual potential events are then summated to get cumulative risk.

For QRA and hazard analysis, the consequences of an incident are calculated using standard correlations and probit-type methods which assess the effect of fire radiation, explosion overpressure and toxicity to an individual, depending on the type of hazard.

In this PHA, however, the approach adopted to assess the risk of the identified hazardous events is scenario based risk assessment. The reasons for this approach are:

1. The distance to residential and other sensitive land users is large for this site; and

2. There are a limited number of events with off-site impact and therefore cumulative and societal risk is not required. The main events of interest are warehouse fires and ammonia releases. Therefore, these are analysed in detail in the remaining sections of this report.

As appropriate analysis of credible scenarios is performed in this PHA, initially the consequences of the potential fire and ammonia release events with off-site impact are assessed. For the events which do not contribute to off-site risk (as determined by the risk criteria in HIPAP No. 4 (Ref 3)) then no further risk analysis is warranted. When the consequence of an event does contribute to off-site, the likelihood and hence risk is then analysed as required.

The risk criteria applying to developments in NSW are summarised in Table 4 on the following page (from Ref 3).

Table 4 - Risk Criteria, New Plants

Description	Risk Criteria
Fatality risk to sensitive uses, including hospitals, schools, aged care	0.5×10^{-6} per year
Fatality risk to residential and hotels	1×10^{-6} per year
Fatality risk to commercial areas, including offices, retail centres, warehouses	5×10^{-6} per year
Fatality risk to sporting complexes and active open spaces	10×10^{-6} per year
Fatality risk to be contained within the boundary of an industrial site	50×10^{-6} per year
Injury risk – incident heat flux radiation at residential areas should not exceed 4.7 kW/m^2 at frequencies of more than 50 chances in a million per year or incident explosion overpressure at residential areas should not exceed 7 kPa at frequencies of more than 50 chances in a million per year	50×10^{-6} per year
Toxic exposure - Toxic concentrations in residential areas which would be seriously injurious to sensitive members of the community following a relatively short period of exposure	10×10^{-6} per year
Toxic exposure - Toxic concentrations in residential areas which should cause irritation to eyes or throat, coughing or other acute physiological responses in sensitive members of the community	50×10^{-6} per year
Propagation due to Fire and Explosion – exceed radiant heat levels of 23 kW/m^2 or explosion overpressures of 14 kPa in adjacent industrial facilities	50×10^{-6} per year

As discussed above, the consequences of the potential hazardous events are initially analysed to determine if any events have the potential to contribute to the above-listed criteria and hence worthy of further analysis.

5.1 FIRE MODELLING

Modelling warehouse fires is a complex task. It is time dependent and hence sometimes performed using computational fluid dynamics. However, the complexity and time taken for computational fluid dynamics modelling can outweigh the slight improvement in accuracy of the results obtained. Empirical models can be used with sensible judgements for the source data.

Factors such as the effect of water and fire vents also complicate the modelling. Therefore, warehouse fire assessment is likely to have a significant amount of uncertainty. It is not the purpose of this section to perform complex computational fluid dynamics on the warehouse fire case, rather, various fire scenarios based on historical evidence and established methodologies will be performed to determine the distances to selected levels of radiant heat. In particular, the off-site far field impacts that are of interest. The results are then assessed to determine if the existing safeguarding is deemed adequate or not.

For a controlled warehouse fire (automatic sprinklers), the fire area range can be from a relatively small area, e.g. 5% of the design area, to at worst 50% of the design area of operation of the sprinkler system (Ref 7). Because of the influence of the fire protection system, the burning rate would be significantly reduced. In this PHA, 50% of the fire area is used in the modelling.

Based on actual warehouse fires (Refs 8 and 6), it was found the surface emissive power for fires involving facilities storing refrigerated food products is in the order of 30 kW/m^2 or less. This primarily due to the significant quantities of smoke generated which has a surface emissive power of approximately 20 kW/m^2. Therefore, a surface emissive power of 30 kW/m^2 is used in this PHA for radiant heat modelling purposes.

Based on anecdotal evidence (e.g. Ref 9), the flame height for warehouse fires involving food products will vary over time. For a warehouse fire involving refrigerated food products, initially smoke is emitted from the warehouse openings. Typically the roof will fail first and during this stage, the centre of the flames can be up to approximately twice the height of the walls. The height of the flames typically decreases towards the warehouse walls. Therefore, an average flame height of approximately 1.5 times the wall height is representative for fire modelling for this stage.

At a later stage, the walls may fail (depending on the effectiveness of the water spray system and firefighting) but as much of the fire load has been consumed, the flame height during this stage is up to 1.5 times the wall height. Again, the flame height decreases towards the warehouse walls. Therefore, an average flame height of approximately 1.25 times the wall height is representative for fire modelling for this stage.

As the warehouse will be built with the six main storage areas segregated by fire walls and there will be one section with higher walls than the other five sections then the modelling performed is for a fire in both a low wall section (wall height of 16 m) and a high wall section (wall height of 34.8 m). This is on the basis that the fire walls are effective as is firefighting to stop fire spread.

Given the warehouse fire surface emissive power, the fire area and the flame dimensions, then the view factor method can be used for simple estimation of radiant heat from the flames (Ref 6).

The distances to specified radiant heat levels for the selected fire scenarios are shown in Table 5. Graphical representations of the estimated radiant heat contours are shown in Appendix 1.

Coolstore Fires:

Most frozen merchandise is difficult to ignite (Ref 10) but once alight, it will burn quite well. In addition to this fact, the pallets and packaging material constitute a significant fire load. For example, in a 20,000 m^3 chamber, the pallets represent approximately 150 tonnes of wood, the cartons represent approximately 100 tonnes of cardboard paper and the shrink film in which the products are packed represent approximately 7 tonnes of plastic.

Studies and anecdotal evidence show that a fire inside a coolstore develops rather slowly but once the temperature has reached the flashover point, it becomes difficult to effectively fight the fire. From that point on, firefighting efforts have to be concentrated on containing the fire to that particular area to prevent it from spreading. Firewalls assist with this task.

The historical main causes for coolstore fires in descending order are:

- Welding;
- Defective heating cables in coolstore doors, columns and defrosting equipment;
- Working with open flames;
- Smoking;
- Overheating of electrical equipment;
- Lighting equipment;
- Lightning;
- Spontaneous combustion; and
- Arson.

Table 5 – Fire Scenarios Calculation Data and Results

Item No.	Item Description	Eq. D, m	Total Flame Height, m	Wall Height, m	Maximum Ground Level Radiant Heat, kW/m^2, at (X m) away from the Flames / Walls	Distance to Specified Radiant Heat Level (Received at Ground Level) from the Edge of the Flames, m		
						23 kW/m^2	12.6 kW/m^2	4.7 kW/m^2
1	Roof failure in a section with a wall height of 16 m – 50% of total roof area, walls still intact (freezer 2)	69	24	16	4.7 (8 m)	(Note 2)	(Note 2)	8
2	Total roof and wall collapse in a section with a wall height of 16 m – 50% area available to the fire given the fallen roof and walls (freezer 2)	69	20	-	-	-	12	33
3	Roof failure in a section with a wall height of 34.8 m – 50% of total roof area, walls still intact	57	52	34.8	3.7 (15 m)	(Note 2)	(Note 2)	(Note 2)
4	Total roof and wall collapse in a section with a wall height of 27.7 m – 50% area available to the fire given the fallen roof and walls	57	43	-	-	-	15	45

Notes for Table 5:

1. When the building walls are intact, the visible flame height is the "Total Flame Height" minus the "Wall Height", i.e. radiant heat is being emitted to ground level from the flames breaking through the roof and hence from above the height of the walls.
2. The predicted radiant heat is not estimated to be received at ground level due to the wall height and hence decrease in radiant heat when received at ground level.

The values of interest for radiant heat (DoP, HIPAP No. 4 and ICI HAZAN Course notes) are shown in Table 6

Table 6 - Radiant Heat Impact

HEAT FLUX (kW/m^2)	EFFECT
1.2	Received from the sun at noon in summer
2.1	Minimum to cause pain after 1 minute
4.7	Will cause pain in 15-30 seconds and second degree burns after 30 seconds. Glass breaks
12.6	30% chance of fatality for continuous exposure. High chance of injury Wood can be ignited by a naked flame after long exposure
23	100% chance of fatality for continuous exposure to people and 10% chance of fatality for instantaneous exposure Spontaneous ignition of wood after long exposure Unprotected steel will reach thermal stress temperatures to cause failure
35	25% chance of fatality if people are exposed instantaneously. Storage tanks fail
60	100% chance of fatality for instantaneous exposure

The results in Table 5 are consistent with previous coolstore fires (e.g. Ref 9), i.e. significant radiant heat damage is limited to the area around the warehouse, and are analysed as follows to check compliance with HIPAP 4 (Ref 3) risk criteria (Table 4).

For assessment of the effects of radiant heat, it is generally assumed that if a person is subjected to 4.7 kW/m^2 of radiant heat and they can take cover within approximately 20 seconds then no serious injury, and hence fatality, is expected. However, exposure to a radiant heat level of 12.6 kW/m^2 can result in fatality for some people for limited exposure durations. Therefore, for the larger fires of longer duration, appropriate emergency response actions are required to minimise the potential for harm to people. This should include moving people away from such releases to a safe distance. Given the growth phase for potential warehouse fires, it is expected that people in the area adjacent to the facility would be able to evacuate the area prior to receiving any higher levels of radiant heat.

Given the results shown in Table 5 then there is no credible risk of injury or fatality in residential areas or to other sensitive land users.

Correspondingly, the risk criteria for fatality and injury (Table 4) in residential areas are satisfied for radiant heat from fires.

As the 12.6 kW/m^2 radiant heat level just reaches the site boundary then there is a limited credible risk of fatality in neighbouring industrial development to the east. However, as the received radiant heat within the neighbouring industrial development will be less than 12.6 kW/m^2 and there is likely to be adequate time for escape during the fire development phase then the risk if fatality is acceptably low.

Therefore, *the criterion of 50 x 10^{-6}/year for industrial fatality risk (*Table 4*) is satisfied*.

The risk of propagation due to fires to neighbouring industrial areas (i.e. exceeding 23 kW/m^2) is not expected given the predicted results in Table 5 (the 23 kW/m^2 is contained on-site close to the flames).

Hence, propagation to neighbouring industrial facilities is unlikely due to radiant heat from a large fire.

Therefore, the criterion of 50 x 10^{-6}/year for industrial propagation risk for exceeding 23 kW/m^2 (Table 4) is satisfied for fire events.

According to the Building Code of Australia, a building should not be able to cause a radiant heat flux in excess of 80 kW/m^2 at the boundary. The results in Table 5 show that this level of radiant heat will remain on-site.

5.2 PRODUCTS OF COMBUSTION

Burning materials generate combustion gases (Ref 11). Common materials such as wood, paper, natural and man-made fibres, plastics and chemicals generate a range of combustion gases that are asphyxiants or toxic to varying degrees. For a warehouse, these gases include:

- Carbon monoxide and dioxide;
- Hydrogen chloride (from burning plastics such as PVC);
- Water vapour;
- Oxides of nitrogen; and
- Vapours or dusts of unburnt material (typically up to 10% of the total quantity involved in the fire, Ref 7).

Combustion completeness is enhanced by:

- High combustion temperatures;
- Oxygen surplus; and
- Long residence time of the combustion gases in the high temperature zone of the fire.

These vary depending on the position of the burning materials in relation to the rest of the fire. At the edge of the fire, the temperatures may be less and toxic materials may be evaporated in spite of a surplus of oxygen. Nearer to the centre of the fire, the temperatures and residence time may be higher but oxygen may be in short supply. Thus it is difficult to predict the quantitative composition of the combustion gases from particular fires.

Smoke plume modelling has historically been performed via a number of methods. As stated in Lees (Ref 6):

"Impact from toxic products of combustion will only be significant, generally, local to the fire. The hot products of combustion rising from a fire typically have a temperature in the range 800-1200^{o}C and a density a quarter that of air."

This assumes failure of the warehouse fire water protection system. Should the building fire water protection system remain operable then any emitted smoke will be lower in temperature (e.g. approximately 200^{o}C) and hence the smoke plume is not as buoyant.

Various approaches to smoke plume modelling can be used. One established methodology is the Brigg's Plume Model (Ref 12) for various combinations of weather / wind conditions and fire temperatures. The results for the fire scenario for the low wall height freezer (16 m wall height) are shown in Table 7. An efflux velocity of 5 m/s for the products of combustion is taken for the fire event modelling. The results do not include the effects of local terrain wash and hence dilution. Therefore, these results will be conservative.

Table 7 – Fire Plume Rise Modelling

Scenario	Wind (m/s) / Weather	Initial Height of Plume, m	Initial Plume Radius, m	Comments
Roof failure in a section with a wall height of 16 m – 50% of total roof area (combustion gases approximately 900^{o}C)	F2 D5 D15	750 300 100	350 150 56	For the F2 condition, the plume is predicted to be always above ground level by at least 50 m. The distances to achieve a plume height of more than 10 m above the ground for the D5 and D15 conditions are 70 and 310 m, respectively

The results in Table 7 are indicative of previous warehouse and industrial building fires. Ref 13 also quotes modelled hazard ranges up to 400 m unless smouldering combustion (i.e. cooler combustion products) is taking place.

Therefore, unless a temperature inversion exists where reverse atmospheric currents can occur (i.e. air slumps to the ground as opposed to air eddies that rise), emergency response will be required for the area around the warehouse, i.e. evacuation of people downwind, for some weather / wind combinations for distances up to several hundred metres. This is typical for previous warehouse and industrial building fire events.

5.3 ASSESSMENT OF POTENTIAL AMMONIA RELEASES

There are numerous refrigeration systems of various sizes in operation in Australia and overseas. The design, operation and maintenance of these processes are controlled by both regulations and standards. In Australia, the following guidelines and standards are relevant to ammonia refrigeration systems:

- AS 1677 Refrigerating Systems;
- AS 4024 Safety of Machinery;
- AS 2022 Anhydrous Ammonia - Storage and Handling; and
- WorkSafe Victoria, Safe Operation of Cold Storage Facilities, 2008.

The requirements of these guidelines and standards, when met, follow the principles of good practice and ALARP (as low as is reasonably practicable). Therefore, the risk associated with refrigeration systems is then normally deemed acceptable.

As Swire propose to install, operate and maintain the ammonia refrigeration system to the above guidelines and standards then the associated risk is therefore broadly deemed acceptable. To support this finding, consequence and likelihood analysis is performed below.

5.3.1 Ammonia Releases – Consequence Assessment

There are numerous possibilities for potential hole sizes and hence releases from an ammonia refrigeration system. For example, there could be a pinhole leak due to a construction defect or pitting corrosion. The worst case would be a large release of the entire ammonia charge.

The US EPA (Ref 14), has a published methodology to show the potential impact distances by modelling two cases as follows:

Case 1:

Loss of the entire ammonia charge over a 10 minute period (worst case) for F1.5 weather / wind speed conditions.

Case 2:

Model an alternative scenario for a smaller but more representative leak of 0.75 kg/s. This is equivalent to a leak from a 6 mm hole, e.g. flange or seal leak. This model is for D3 weather / wind speed conditions, i.e. more common conditions.

The above cases in Ref 14 are modelled to an endpoint of 200 ppm ammonia. In this PHA, however, the modelling is done to the AEGLs 1 and 2 (30 ppm and 220 ppm, respectively, for ammonia – see Section 4.1). These AEGLs limits for a 10 minute exposure are taken as equivalent to the DoP irritation and injury definitions in residential areas listed in Table 4. Modelling to the 1% fatality level is also done to determine if off-site fatality risk is possible.

Consequence calculations involving fatality estimates were carried out using the commercially available consequence assessment software, TNO's EFFECTS. The consequence models used within EFFECTS are documented in the TNO Yellow Book (Ref 12). The distances to AEGL 1 and 2 were estimated using ALOHA. This was due to greater stability of the cloud modelling results from ALOHA.

The SLAB model within Effects is used for dense gas dispersion calculations. Dispersion from a ground level evaporating pool, a horizontal or vertical jet or an instantaneous release can be modelled. The model predicts dispersion behaviour by solving the conservation equations for mass, momentum and energy.

The resulting gas cloud is treated as a steady state plume, a transient "puff" or a combination of the two, depending on the release duration. In the case of a finite duration release, cloud dispersion is initially described using a steady state plume model as long as the source is active. Once the source has been shut off, subsequent dispersion is calculated by the transient puff model. For instantaneous releases the transient puff model is used for the entire calculation.

For dispersion of low momentum releases (e.g. ambient temperature vapour from an evaporating pool) a Gaussian dispersion model is used. This is also the case for ALOHA.

Meteorological Data:

Similarly to release hole sizes, the combinations of atmospheric stability and wind speed are numerous. Atmospheric stability is the extent to which vertical temperature gradients and wind shear against the earth's surface promote or suppress turbulence in the atmosphere and hence the ease of dispersion.

Atmospheric stability can be characterised by the Pasquill stability classes. This system is based on wind speed, cloud cover and time of the day. The classes are shown in Table 8.

Table 8 – Pasquill Stability Classes

Atmospheric Stability	Pasquill Stability Class
Very unstable	A
Unstable	B
Slightly unstable	C
Neutral	D
Stable	E
Very Stable	F

From a review of available data, e.g. the Bureau of Meteorology and previous quantitative modelling work, the following data is used in this modelling.

Table 9 – Wind Direction / Stability Class Percentage for the Penrith Area (2011)

Frequency Distribution (Percentage)							
Direction (blowing from)	**Stability Class**						
	A	**B**	**C**	**D**	**E**	**F**	**Total**
N	2.82	1.49	2.44	5.69	1.27	2.79	16.49
NE	0.70	0.44	0.86	2.67	1.10	1.60	7.37
E	0.51	0.08	0.36	2.29	0.70	1.06	4.99
SE	0.86	0.38	0.60	3.81	1.03	0.58	7.27
S	3.27	1.38	3.58	10.69	1.40	1.95	22.28
SW	2.51	1.43	2.66	11.09	1.78	3.04	22.50
W	1.04	0.58	1.00	4.23	1.00	2.45	10.30
NW	1.46	0.52	0.88	3.49	0.62	1.82	8.80
TOTAL	13.18	6.30	12.38	43.96	8.89	15.29	100.00

With corresponding wind speed data, the following summarised conditions are used in this PHA.

Table 10 – Weather / Wind Speed Data

Atmospheric Stability	Weather / Wind Speed
Very unstable	A3
Unstable	B3
Slightly unstable	C4
Neutral	D5
Stable	E3
Very Stable	F2

Other Modelling Inputs:

Other input data for the modelling are as follows:

- Ambient temperature = 20 C; and
- A surface roughness factor of 1 m was used corresponding to an area with regular large objects such as densely located low buildings or an industrial area with low structures, i.e. the nearby warehouses.

The dispersion modelling results are shown in Table 11.

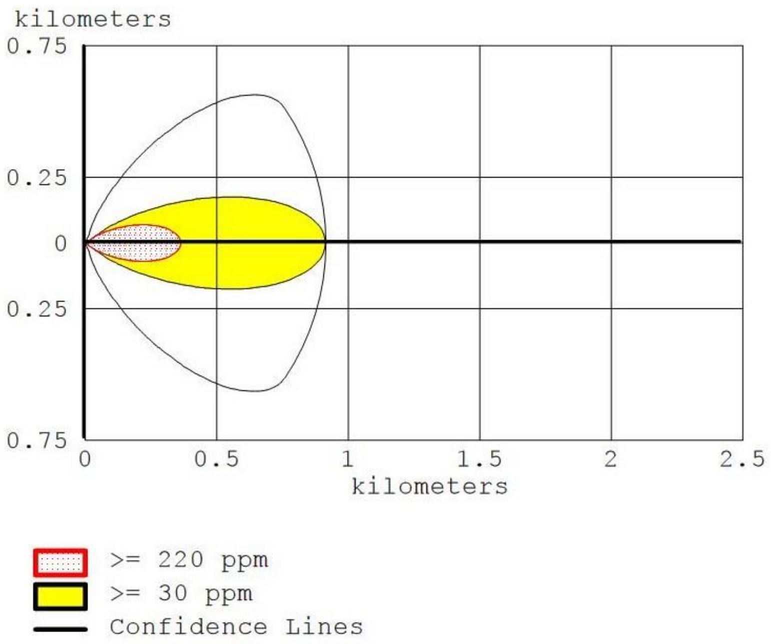
Table 11 – Dispersion Modelling Results

Scenario:	Wind / Weather Condition:	Distance (m) to:		
		AEGL 1 (30 ppm)	AEGL 2 (220 ppm)	1% Fatality
Loss of entire ammonia charge (7 te) over 10 minutes	A3	910	360	85
	B3	1,070	410	107
	C4	1,460	510	95
	D5	2,100	660	97
	E3	6,000	1,730	70
	F2	7,590	2,900	69
0.75 kg/s leak	A3	250	95	-
	B3	425	130	-
	C4	650	190	-
	D5	825	220	-
	E3	1,700	340	-
	F2	1,700	465	-

For the 0.75 kg/s leak, the 1% fatality risk only exists very close to the source.

An example plot of the results for the A3, complete loss of ammonia charge case above is shown in Figure 3.

Figure 3 – Example Plume Result



To assess the consequential impacts on people off-site, the receptors are summarised as follows:

- There is currently a house shown in Figure 1 near to the Swire site, however, this area is planned for industrial use and it is expected that this property will not exist for much longer. It is included in this assessment though given it is currently there. This house is approximately 250 m south of the site;
- The next closest residential receptor is the caravan park approximately 500 m to the southwest of the site. Again this is not likely to stay in the long term but it is included in this assessment;
- The closest long-term residential areas are approximately 800 m to the south (Hassall Grove) and future residential development to the north and southeast (approximately 1 km away);
- There is also a mosque and community centre approximately 800 m southeast from the site; and
- The immediate neighbours are industrial, warehouse and retail.

Given the results shown in Table 11, the following consequential impacts may occur due to releases of ammonia:

- Irritation impact, e.g. odour, can be expected at the nearest residential areas for the majority of leaks for all weather conditions;
- Injury impact, e.g. hospitalisation required for people in residential areas, can be expected for large releases for all weather conditions. If the local house and caravan park are demolished then injury impact in residential areas will only occur for the large releases in stable (Class E and F) weather conditions which is approximately 25% of the time;
- Injury impact can be expected for small releases only in stable (Class E and F) weather conditions which is approximately 25% of the time. If the local house and caravan park are demolished then no injury impact in residential areas is expected;
- Fatality risk does extend to the adjacent industrial properties only but not to any residential areas.

5.3.2 Ammonia Releases – Likelihood Assessment

One study in Ref 6 for reported releases from ammonia refrigeration equipment shows a release frequency of approximately 1×10^{-5} per year. This is assumed to be releases of significance (as it is not uncommon to smell ammonia in plant rooms). Using this figure as a likelihood approximation for releases from the proposed ammonia refrigeration system at the Swire warehouse then the following assessment of risk can be made:

- The industrial fatality risk of 50 x 10^{-6} per year will be contained within the boundary of the site as the release frequency of 1 x 10^{-5} per year is lower;
- The toxic injury exposure risk of 10 x 10^{-6} per year will be satisfied as the release frequency of 1 x 10^{-5} per year when multiplied by the percentage that the wind blows in a certain direction (see Table 9) will always be a lower value;
- The toxic irritation exposure risk of 50 x 10^{-6} per year will be satisfied as the release frequency of 1 x 10^{-5} per year is lower; and
- The individual fatality risk of 1 x 10^{-6} per year is contained on-site and therefore satisfied as the release frequency of 1 x 10^{-5} per year when multiplied by the percentage that the wind blows in a certain direction (see Table 9 – the values for a given direction are up to approximately 10%) and also by the probability of fatality will always be a lower value than 1 x 10^{-6} per year at the site's boundary. Therefore, the warehouse risk criterion of 5 x 10^{-6} per year is also satisfied.

Whilst the above analyse shows the DoP risk criteria is satisfied, the important requirement is the ammonia system is designed, operated and maintained as per the abovementioned standards and guidelines. As mentioned above, this is Swire's intention for this proposal.

5.4 ASSESSMENT OF DANGEROUS GOODS TRANSPORT

As part of the Secretary's Environmental Assessment Requirements from the NSW Department of Planning and Environment, the PHA must include an evaluation of the impacts of the transport of Dangerous Goods to and from the site on the surrounding areas.

The only Dangerous Good of significance associated with this facility is the ammonia for the refrigeration system. The system will be a sealed system containing up to 7 te of ammonia for Stage 2. The ammonia is anticipated to require a 'top up' approximately every 1.5 to 2 years with a 250 kg gas cylinder of anhydrous ammonia. The ammonia delivery will be from an industrial gas supplier.

The CCPS *Guidelines for Chemical Transportation Risk Analysis* (Ref 15) quote a figure of approximately 2 accidents/year (for all causes) per 10^6 miles (i.e. 1.2×10^{-6} accidents per kilometre per year). This is typical for Australian roads as well.

Various studies of release probabilities from heavy vehicles etc involved in an accident have been undertaken. Ref 15 indicates that the release probability for various road types is between 5 and 10% (i.e. approximately one heavy vehicle accident in every 10 to 20 will result in a release of the material).

Therefore, the likelihood of a release is approximated as follows.

Release likelihood = vehicle accident rate ($1.2x10^{-6}$ accidents per km per year)

x length of travel per trip (i.e. one-way distance)

x the number of road tankers per year (say, 1)

x release probability (0.075)

As an assumption, say the length of the route taken is approximately 20 km.

Therefore, the release likelihood is estimated to be less than $2x10^{-6}$/year.

Given this low estimated release likelihood, the risk from potential releases from road transportation of ammonia is acceptable.

5.5 AIRCRAFT IMPACT AND OTHER EXTERNAL EVENTS

Previous risk assessments (e.g. Ref 16) have shown that the likelihood of an aircraft crash is acceptably low within Australia. Typical frequencies associated with aircraft crashes are:

- Scheduled aircraft $1x10^{-8}$/year; and
- Unscheduled aircraft $4x10^{-7}$/year.

The outcomes of any aircraft crash on this site will be dominated by the ensuing fire from the plane wreckage. This is an existing risk for all sites. Given the above frequencies, the likelihood of this type of event is acceptably low for a site of this size and location.

Other external events that may lead to propagation of incidents on any site include:

Subsidence	Landslide
Burst Dam	Vermin/insect infestation
Storm and high winds	Forest fire
Storm surge	Rising water courses
Flood	Storm water runoff
Breach of security	Lightning
Tidal waves	Earthquake

These events were reviewed and none of them were found to pose any significant risk to the new facility given the proposed safeguards.

5.6 CUMULATIVE RISK

As shown in this PHA, the facility will have negligible impact on the cumulative risk results for the local area as the significant radiant heat levels are retained on the site and the risk of ammonia releases is within the DoP guidelines.

Therefore it is reasonable to conclude that the development does not make a significant contribution to the existing cumulative risk in the area.

5.7 SOCIETAL RISK

The abovementioned criteria for individual risk do not necessarily reflect the overall risk associated with any proposal. In some cases for instance, where the 1 pmpy contour approaches closely to residential areas or sensitive land uses, the potential may exist for multiple fatalities as the result of a single accident. One attempt to make comparative assessments of such cases involves the calculation of societal risk.

Societal risk results are usually presented as F-N curves, which show the frequency of events (F) resulting in N or more fatalities. To determine societal risk, it is necessary to quantify the population within each zone of risk surrounding a facility. By combining the results for different risk levels, a societal risk curve can be produced.

In this study of the Swire facility at Marsden Park, the risk of fatality does not extend off the site and is well away from the residential areas. The concept of societal risk applying to residential population is therefore not applicable for the facility.

5.8 RISK TO THE BIOPHYSICAL ENVIRONMENT

The main concern for risk to the biophysical environment is generally with effects on whole systems or populations.

The main potential for environmental impact from this facility is from contaminated firewater runoff. Whilst release of ammonia and smoke can occur, these are acceptably low in likelihood (see Section 5.3 for ammonia). A typical fire frequency for a modern warehouse fire is 1.8×10^{-4} per year (Ref 17).

Fire water runoff from the building in a fire event will be contained on site in the car parks / communal areas at the north end of the site (1.2 ML capacity) and in the main yard area at the south end of the site (2.3ML capacity). The concept civil design drawings included in this EIS submission show paving / ground levels to achieve this containment in conjunction with the stormwater system which incorporates two penstock gate valves (with electric actuators) on the two main lines that will automatically close on activation of a fire alarm. The stormwater system also incorporates a float activated control valve in the east car park line to prevent this car park from overflowing while the west car park fills since these car parks are at different levels to suit the site topography.

Whereas any adverse effect on the environment is obviously undesirable, the results of this study show that the risk of losses of containment is broadly acceptable.

From the analysis in this report, no incident scenarios were identified where the risk of whole systems or populations being affected by a release to the atmosphere, waterways or soil is intolerable.

6 CONCLUSION AND RECOMMENDATIONS

The risks associated with the proposed Swire warehouse at Marsden Park have been assessed and compared against the DoP risk criteria. The results are as follows and show compliance with all risk criteria.

Description	Risk Criteria	Risk Acceptable?
Fatality risk to sensitive uses, including hospitals, schools, aged care	0.5×10^{-6} per year	Yes
Fatality risk to residential and hotels	1×10^{-6} per year	Yes
Fatality risk to commercial areas, including offices, retail centres, warehouses	5×10^{-6} per year	Yes
Fatality risk to sporting complexes and active open spaces	10×10^{-6} per year	Yes
Fatality risk to be contained within the boundary of an industrial site	50×10^{-6} per year	Yes
Injury risk – incident heat flux radiation at residential areas should not exceed 4.7 kW/m^2 at frequencies of more than 50 chances in a million per year or incident explosion overpressure at residential areas should not exceed 7 kPa at frequencies of more than 50 chances in a million per year	50×10^{-6} per year	Yes
Toxic exposure - Toxic concentrations in residential areas which would be seriously injurious to sensitive members of the community following a relatively short period of exposure	10×10^{-6} per year	Yes
Toxic exposure - Toxic concentrations in residential areas which should cause irritation to eyes or throat, coughing or other acute physiological responses in sensitive members of the community	50×10^{-6} per year	Yes
Propagation due to Fire and Explosion – exceed radiant heat levels of 23 kW/m^2 or explosion overpressures of 14 kPa in adjacent industrial facilities	50×10^{-6} per year	Yes

Societal risk, area cumulative risk, transport of ammonia risk and environmental risk is also concluded to be acceptable.

The primary reason for the low risk levels from the warehouse is that significant levels of radiant heat from potential fires do not extend far from the warehouse and the frequency of ammonia releases impacting people is acceptably low.

The following recommendations are made from this review:

1. Include in the preventative maintenance system the need for routine exercising of the actuated stormwater valves that prevent contaminated water from leaving site.

2. Include in the emergency response plan specific guidance on handling ammonia releases.

3. Given the location of the firewater tank, firewater pumps, MCC, MSB and ammonia plant room where high levels of radiant heat may occur and potentially warehouse wall collapse, ensure these areas have adequate construction for these potential consequences.

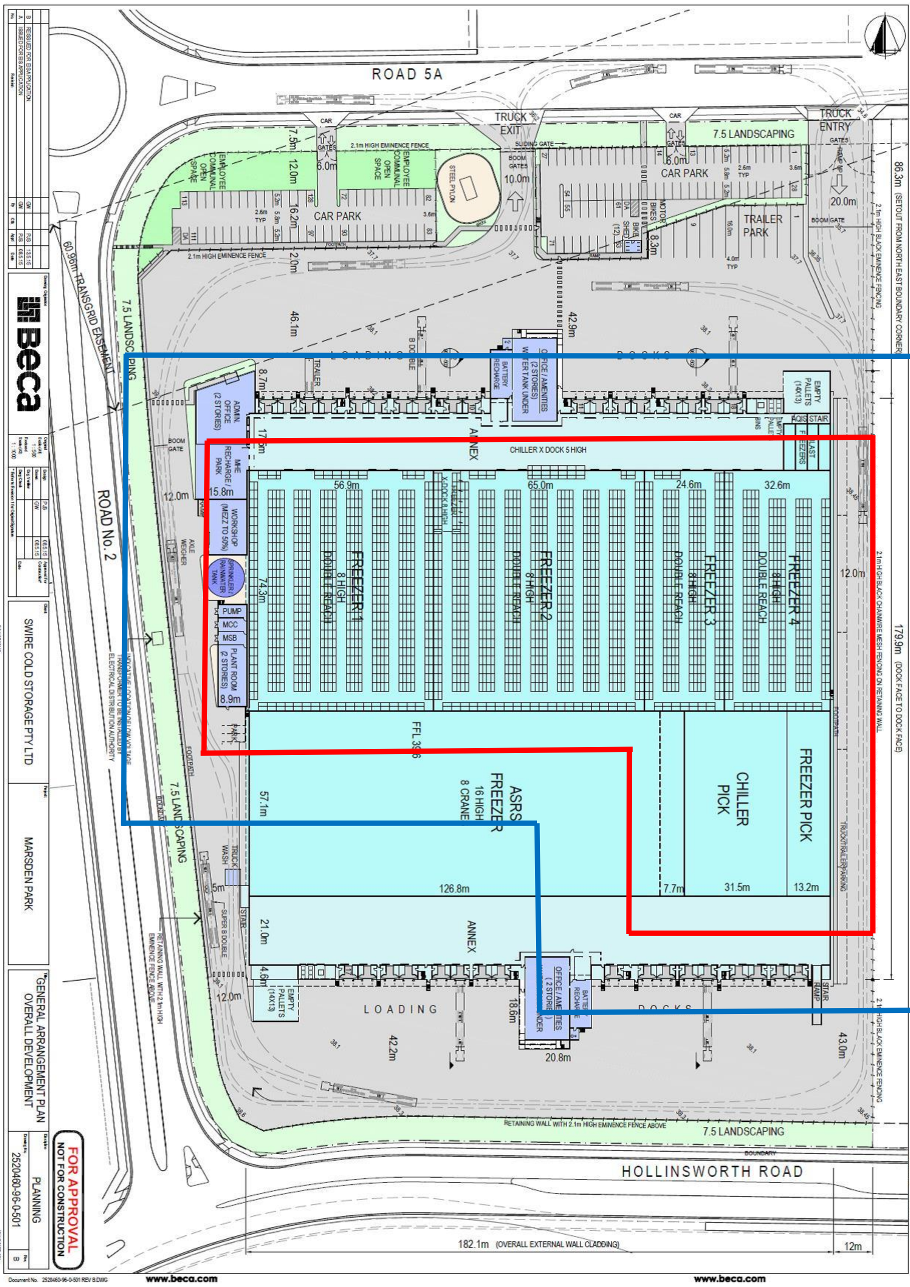
Appendix 1

Radiant Heat Contours

Preliminary Hazard Analysis, Swire Cold Storage Facility, Marsden Park

Appendix 1 – Radiant Heat Contours.

Radiant Heat Contours for Scenario 2 (Table 5)

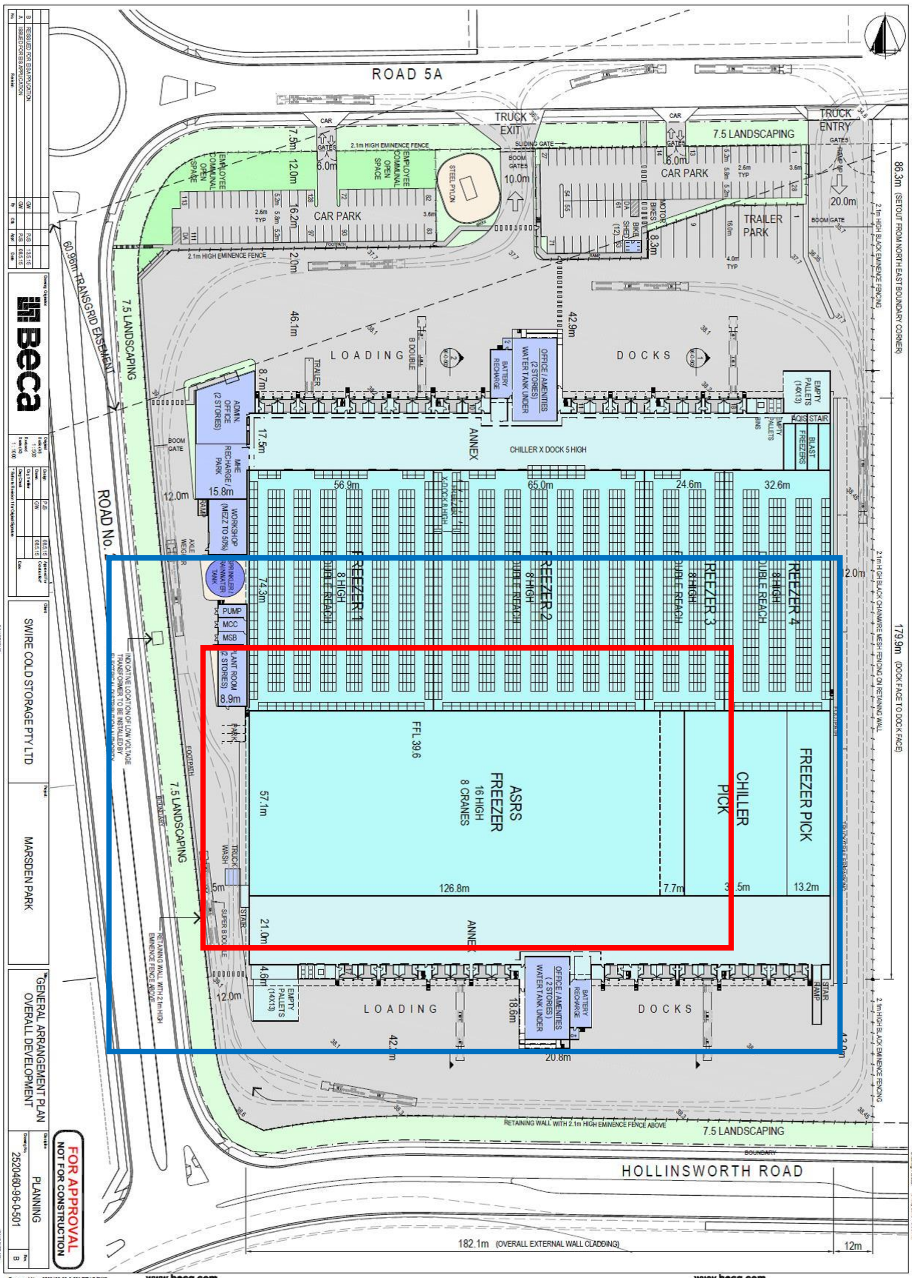


The contours show the distance to 12.6 and 4.7 kW/m^2 assuming the fire is located along any of the warehouse walls in the sections with a wall height of 16 m.

Key:

- Red line: **12.6 kW/m^2**
- Blue line: **4.7 kW/m^2**

Radiant Heat Contours for Scenario 4 (Table 5)



The contours show the distance to 12.6 and 4.7 kW/m^2 assuming the fire is located along any of the warehouse walls in the ASRS section.

Key:

- Red line: **12.6 kW/m^2**
- Blue line: **4.7 kW/m^2**

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