# APPENDIX 8

# PRELIMINARY HAZARD ANALYSIS

# Preliminary Hazard Analysis

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|---|---|
| **Project Title:** | **Mainfreight Expansion Facility**<br>**Prestons Distribution Centre** |
| **Date:** | 05 April 2013 |
| **Prepared By:** | Neil Browne<br>Senior Risk Consultant<br>One Group ID. |
| **Prepared For:** | Will Dwyer<br>Goodman<br>Level 17, 60 Castlereagh St<br>Sydney NSW 2000<br>02 9230 7312<br>will.dwyer@goodman.com |
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## Revision History

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# EXECUTIVE SUMMARY

The design of the Mainfreight Prestons Distribution Centre extension at 26 Yarrawa St, Prestons includes a 1,570 $m^2$ dangerous goods store. It is proposed to store dangerous goods of classes 2.1 (flammable aerosol cans), class 3 flammable liquids, class 5.1 oxidising substances, class 8 corrosive substances and class 9 miscellaneous dangerous foods.

The quantities of class 2.1 flammable aerosols exceed the threshold given by the NSW Work Health and Safety Regulation 2011 thereby requiring the facility to meet the requirements of a Major Hazard Facility.

Similarly, this quantity requires a Preliminary Hazard Analysis to be prepared and submitted to the NSW Department of Planning under the requirements set out in the State Environment Planning Policy No. 33.

The dominant hazard is fire associated with the storage of aerosol cans. Based upon implementation of the fire prevention controls and timely emergency response to a fire event the frequency of a threat to life was determined to be well inside acceptable limits. The consequences of a fire were also not found to have any significant effect beyond the site boundary. The personal care products do not contain toxic substances indicating that smoke generated from a fire would also not include any unburned toxic substances.

The class 5.1 oxidising substances are water based personal care bleaches and the risk assessment did not find them to be a significant hazard to nearby people, neighbours or to the surrounding biophysical environment.

The risk assessment also found that the risk to the biophysical environment associated with release of contaminated fire water from the Dangerous Goods Store is low.

The operation of the facilities will require a comprehensive set of systems of work to implement the design safely, but these have not been addressed as part of this report.

A Fire Safety Study (HIPAP No. 2) will provide more detailed information on the effects of different fire scenarios and the control measures proposed to minimise the risks. This study would be performed as part of the design stage for the warehouse expansion after development approval had been granted.

Should there be a significant change to the quantities or types of dangerous goods stored the recommendations provided would need to be revised.

# 1. Introduction

One Group ID has been engaged by Goodman Ltd to prepare a Preliminary Hazard Analysis (PHA) for the proposed 13,250 $m^2$ retail warehouse extension of the Mainfreight Prestons Distribution Centre at 26 Yarrawa St, Prestons, NSW.

The proposed extension includes a 1,570 $m^2$ Dangerous Goods Store for the storage of mainly personal care products packaged in aerosol cans. The DG Store is designed to store up to 380,000 kg of aerosols containing class 2.1 flammable gas propellants along with up to 50,000 L of class 5.1 personal care oxidising bleaches. All products will be stored in their original packages with no decanting or sampling of the products on site.

The Dangerous Goods Store has been designed in accordance with the requirements of;

- AS 3833-2007[1] The storage and handling of mixed classes of dangerous goods, in packages and intermediate bulk containers
- Factory Mutual (FM) Global, Property Loss Data Sheets 7-31, 2003[2]

This PHA has been prepared in accordance with the requirements of;

- State Environment Planning Policy 33 (SEPP 33), DOP 1992[3]
- Hazardous Industry Planning Advisory Paper 6 (HIPAP 6) – Guidelines for Hazard Analysis, DOP 2011[4]

# 2. Findings and Recommendations

## 2.1 Findings

The preliminary screening assessment determined that the proposed warehouse extension is potentially hazardous with regard to the storage of class 2.1 flammable gases in aerosol cans and to class 5.1 oxidising substances, being personal care bleaches. The number of transport movements of the dangerous goods did not exceed the threshold and is not determined as potentially hazardous in accordance with HIPAP No. 6[4].

The Qualitative Risk Assessment found that hazards due to spills of the dangerous goods had an overall low risk rating with the nominated risk controls implemented. This hazard was deemed not to require further development of the consequences or frequency. Fire hazard was found to have an overall medium to high risk depending upon the level of risk controls and the risk was further investigated using a level 2 (partial quantification) risk assessment.

The dominant fire hazard arose from the storage of aerosol cans that contain personal care products. None of the products contained within the cans are described as having any toxic materials so smoke from burning contents will not contain any unburned toxic materials.

Based upon implementation of the fire prevention controls and timely emergency response to a fire event the frequency of a threat to life was determined to be well inside acceptable limits. The consequences of a fire were also not found to have any significant effect beyond the site boundary.

The class 5.1 oxidising agents will be segregated from flammable materials within the Dangerous Goods Store in accordance with AS 3833-2007[1]. These products are water based personal care bleaches and are not considered a significant hazard to nearby people, neighbours or to the surrounding biophysical environment.

The risk to the biophysical environment associated with release of contaminated fire water from the Dangerous Goods Store was found to be low.

## 2.2 Recommendations

The design for the Dangerous Goods Store is to proceed in accordance with the requirements of AS 3833-2007[1]. These design features include;

- Storage of aerosols within a wire mesh cage having openings no larger than the smallest aerosol can.
- Segregated spill containment compounds for incompatible materials, e.g. class 3 spills captured independently from class 5.1 spills.
- Installation of an appropriate sized sprinkler system
- Containment of contaminated fire water in accordance with AS 1940-2004
- Exclusion or control of ignition sources near flammable aerosol and liquid storage
- Fire separation from Truck-wash Bay

# 3. Site Description

The proposed warehouse is an expansion of the existing facility at 26 Yarrawa Street, Prestons, NSW.

The site will be operated by Mainfreight as a warehouse and distribution centre for a wide variety of retail products. The layout of the warehouse is shown in Figure 1.

The products are stored in cartons in their original retail packages and are not opened for the purpose of decanting or repackaging the goods. These products include hazardous materials that are described in Section 4.1. The hazardous materials include;

- Consumer Health Care Products
- Consumer Personal Care Products
- Paint and Related Materials
- Industrial Catalysts and Curing Agents

The site will operate 7 days per week and 24 hours per day.

## 3.1 Location

Figure 2 shows the land surrounding the development is mixed use with the Western Sydney orbital Toll Road being approx 500m to the north east. Residences are located to the east (Bernera Rd, 120 m), west (580m), north (700m) and south (650m) of the site. To the east of the site is mixed industrial use (280m). On the opposite side of Yarrawa Street is the Liverpool Substation.

Cabramatta Creek is approximately 150m from the west site boundary with Brownes Farm Reserve located approximately 400m on the other side of the creek.

The risk criteria applicable to the surrounding land uses are shown in Table 1.

**Table 1** Risk Criteria for Surrounding Land Uses

| Land Use | Distance (m) | Risk in million per year |
|---|---|---|
| Residential (closest residence) | 120 | 1 |
| Industrial | 280 | 50 |
| Active Open Space | 400 | 10 |

*Source: HIPAP No. 4 – Risk Criteria for Land use Safety Planning*

An analysis of the risk to the residents of the nearest property is provided in section 8.3.1.1 of this report.

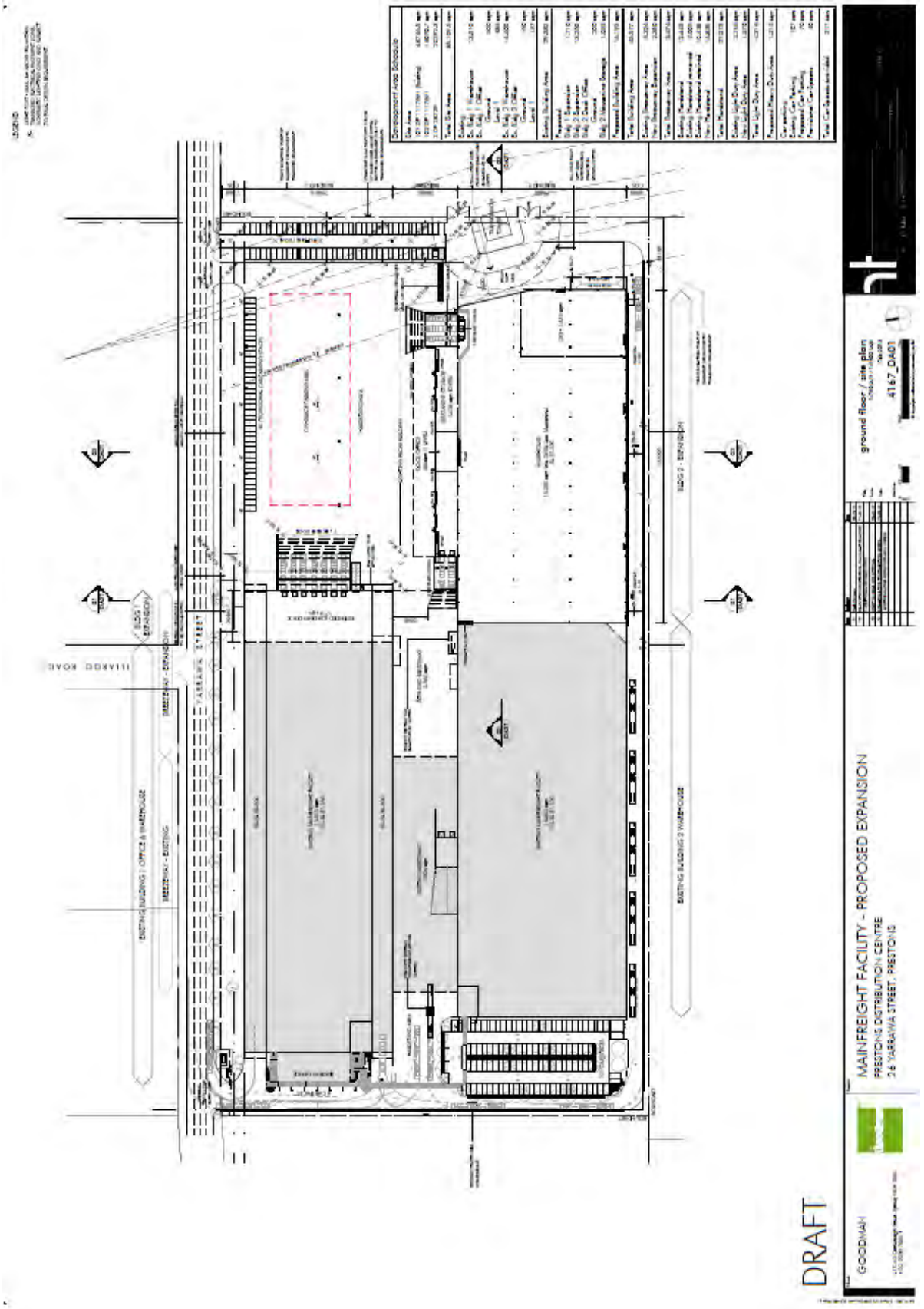
## 3.2 The Proposed Development

It is proposed to expand the warehouse facility by 13,250m$^2$ along the south side of the property. A 1,570m$^2$ Dangerous Goods Store is proposed in the south-east corner of the new warehouse. The warehouse will store predominantly consumer retail products with products classified as dangerous goods by the Australian Dangerous Goods Code (ADGC) kept in the Dangerous Goods Store. These goods will be personal care products described more fully in Section 4.1. These goods will remain unopened in their original packages.

Chemical manifests have been provided and these have been combined and summarized to produce table 2 in section 4.1.

**Figure 2** Surrounding Land uses

**Figure 1** Floor Plan of the New and Existing Warehouse



# 4. Storage

It is proposed to expand the warehouse facility by 13,250m$^2$ along the south side of the property. Of this floor area 11,680 m$^2$ will be used to store non-dangerous goods of the following categories;

1. Hair care products – non flammable
2. Push Bikes
3. Home wares
4. Non Haz adhesives
5. Fruit Juices
6. Packaging

The total quantity of liquid products stored will be 900,000 L of which 540,000 L will be hazardous materials (see section 4.1 for breakdown by dangerous goods class). The new warehouse will store 360,000 L of non-hazardous liquids in the general storage area.

These goods will remain unopened in their original packages.

## 4.1 Hazardous Materials

A preliminary screening is undertaken to determine whether the types and quantities of hazardous materials proposed to be stored on the site are in accordance with the thresholds given in SEPP 33[3] for hazardous material storage quantities that have the potential to create off-site impacts.

The table below summarises the quantities (in kg) of dangerous goods that are proposed to be amalgamated and stored in the new warehouse. The dangerous goods have been classified in accordance with the Australian Dangerous Goods Code.

**Table 2** Hazardous Materials for the Dangerous Goods Store

| DG Class | UN Number | Description | Operating Quantity (kg) | Estimated Maximum Quantity (kg) |
|---|---|---|---|---|
| 2.1 | 1950 | Aerosols | 347,260 | 380,000 |
| 3 | 1170 | Ethanol | 8,714 | 10,000 |
| 3 | 1193 | Methyl Ethyl Ketone | 154 | 360 |
| 3 | 1219 | Iso-Propyl Alcohol | 42,705 | 45,000 |
| 3 | 1263 | Paint & related material | 22 | 300 |
| 3 | 1266 | Perfumery Products with flammable solvents | 29,461 | 30,000 |
| 3 | 1993 | Flammable liquid N.O.S. | 2,764 | 3,000 |
| 5.1 | 2984 | Aqueous Hydrogen Peroxide, 8 – 20% | 61,970 | 70,000 |
| 5.1 | 3085 | Oxidising solid, corrosive, N.O.S. | 3,223 | 3,500 |
| 5.1 | 3215 | Persulphates, inorganic, N.O.S. | 4,505 | 5,000 |
| 8 | 1719 | Caustic Alkaline Liquid, N.O.S. | 1,165 | 1,500 |
| 9 | 3077 | Environmentally Hazardous Substance, Solid, N.O.S. | 86 | 120 |
| 9 | 3082 | Environmentally Hazardous Substance, Liquid, N.O.S. Perfumery Products | 4,163 | 4,500 |

For class 2.1 flammable aerosols the quantities shown are taken direct from the chemical manifests as provided. These weights are for total packages and the weight of contents would typically be approximately 80% of the package weight. Information is not provided as to the proportion of each item that is the flammable propellant and the consumer product. Consumer products typically contain 33% flammable propellant and this proportion will be used for later calculations in this report.

The NFPA 30B[6] classifies aerosol products by their heat of combustion, designating them as levels 1, 2 or 3.

Level 1 aerosol products have a total heat of combustion of not more than 20 kJ/g. Such products would include shaving cream, spray starch, alkaline oven cleaners, carpet shampoos, some air fresheners and some insecticides. The storage hazard of level 1 aerosol is low being similar to typical combustible goods in cartons.

Level 2 aerosol products have a total heat of combustion that is greater than 20 kJ/g and no more than 30 kJ/g. These would include many personal care products such as deodorants, hair sprays, antiseptics, and furniture polish.

Level 3 aerosol products have a total heat of combustion that is greater than 30 kJ/g. These would include many automotive products (cleaners and undercoats), paints, lubricants and some insecticides.

The estimated proportion of each type of aerosol is shown in Table 3.

**Table 3** Estimated Proportion of Aerosol Contents by Heat of Combustion (NFPA Level)

| NFPA 30 B Classification of Aerosols | Estimated Proportion |
|---|---|
| Level 1 | 10% |
| Level 2 | 80% |
| Level 3 | 10% |

## 4.2 Storage Quantity Screening

Section 4.1 provides a semi-detailed list of the hazardous materials proposed for storage in the new warehouse. The aggregate quantities for each dangerous goods class are compared with the threshold quantities from SEPP 33[3] and provided in Table 4.

**Table 4** Hazardous Material Inventory for SEPP 33 Trigger Thresholds

| Hazardous Material | DG Class | Storage Location | Total Storage Capacity | Screening Threshold | |
|---|---|---|---|---|---|
| | | | | Quantity | Triggers SEPP 33 |
| Aerosols | 2.1 | DG Store | 380,000 kg | 200,000 kg | YES |
| Flammable and Combustible Liquids | 3 | DG Store | 80,000 L | 110,000 kg | NO |
| Oxidising Agents | 5.1 | DG Store | 80,000 L | 5,000 kg | YES |
| Corrosive Substances | 8 | DG Store | 1,500 L | 25,000 kg | NO |

The quantities for both aerosols and class 5.1 oxidising agents are above their respective screening thresholds and the storage is considered potentially hazardous by SEPP 33. Consequently SEPP 33 applies to the proposed warehouse development and a Preliminary Hazard Analysis (PHA) is required to support the development application.

## 4.3 Transport Screening

Table 5 provides details of the anticipated traffic movements associated with the operation of the proposed hazardous materials storage. Mainfreight has indicated that there will be up to 50 deliveries per day of which it is estimated* that 4% would contain hazardous materials in excess of the threshold. This equates to 2 per day or 15 per week as a conservative estimate. It is assumed that the maintenance capacity of the Dangerous Goods Store is 85% of the total capacity which requires 13 deliveries per week.

Very few dispatches will exceed the 5 tonne threshold for dangerous goods and any such dispatches would be expected to average less than one per week.

**Table 5** Transport Movements of Dangerous Goods

| Transport Movements of Dangerous Goods | DG Class | No. Of Vehicle Movements | | Minimum Screening Threshold Quantity | Vehicle Movements Screening Threshold | | |
|---|---|---|---|---|---|---|---|
| | | Weekly | Per Annum | | Weekly | Per Annum | Triggers SEPP 33 |
| Aerosols | 2.1 | 8 | 414 | 5,000 kg | >30 | >500 | NO |
| Oxidising Agents | 5.1 | 1.7 | 88 | 5,000 kg | >30 | >500 | NO |

The estimated number of traffic movements does not exceed the transport screening threshold and the requirement from SEPP 33 to provide a transport route evaluation to support the development application is not required.
A Transport and Parking Implications Report is currently being prepared by Traffix and this will not be required to examine the movements of dangerous goods for the purposes of the PHA.

* This estimate is based upon the comparative floor area devoted to the storage of dangerous goods compared with the total area of goods stored in the warehouse/distribution centre.

*Total Warehouse floor area* *41,360 m²* *(96.2%)*
*DG Store floor area* *1,570 m²* *(3.8%)*

# 5. Process

## 5.1 Storage

Hazardous materials will be stored in a dedicated Dangerous Goods Store located at the south-east corner of the new warehouse, Fig. 1. Rack Storage will be used for the majority of items with racks constructed to no more than 5 rows high.

The Dangerous Goods Store will be arranged such that flammable liquids and aerosols will be stored in a separate bunded area to those for the class 5.1 oxidising and for the class 8 corrosive materials. Furthermore the aerosols will be separated into a caged enclosure within the Dangerous Goods Store.

Within the Dangerous Goods Store the aerosol storage area will be enclosed in a wire mesh cage to prevent the cans becoming missiles in the event of a fire and spreading the fire to other flammable and combustible materials. The external wall between the warehouse and the external Truck Wash Bay will be fire separated with a fire rating of at least 60/60/60 to a height greater than 1 m above the highest package. This will provide protection to a worker in the Truck Wash Bay from either the heat of a fire in the Dangerous Goods Store, or of the intervening wall collapsing.

# 6. Hazard Identification

## 6.1 Hazard Identification

Table 6 identifies events that could cause a hazardous material to potentially harm a person or the environment. Causes of the hazardous events are identified and potential consequences qualitatively described. Strategies to control the hazards for the design of the warehouse and for operational management are also provided.

**Table 6** Hazard Identification and Possible Consequences

| Area<br>Hazard Event | Cause | Potential Consequences | Prevention or Protection Strategies |
|---|---|---|---|
| **Dangerous Goods Store** | | | |
| Fire | Nearby ignition sources<br><br>Forklift not intrinsically safe<br><br>Arson<br><br>Heat from mixing of incompatible chemicals | Aerosol cans become missiles and spread fire to wide area<br><br>Irritant fumes or smoke evolved – may spread to neighbouring properties<br><br>Radiant heat injuries<br><br>Release of materials into the environment if fire-water exceeds bund capacities. | Safety training of personnel<br><br>Emergency Response Plan<br><br>Aerosols stored within separate cage<br><br>Thermal/smoke detection proposed with link to alarms and local fire brigade<br><br>Sprinkler system proposed<br><br>Fire hose reels and portable fire extinguishers provided for rapid response<br><br>All ignition sources excluded or suitable for use in a hazardous zone 2 area<br><br>Products are segregated by DG class<br><br>Different DG class storage areas are separately bunded to prevent mixing of incompatible chemicals |
| Spill | Drop of packages during movement of goods<br><br>Impact damage by forklift<br><br>Collapse of pallet racking | Fumes could cause respiratory ailment to operators<br><br>Contact with skin or eyes causing chemical burns<br><br>Slip causing fall injuries<br><br>Inhalation of fine powders causing respiratory harm<br><br>Reaction with incompatible materials with release of harmful fumes<br><br>Some materials will vigorously support | Safety training of personnel<br><br>Emergency Response Plan<br><br>Bunded spill compound<br><br>Segregation of incompatible chemicals into individual spill compounds<br><br>Natural ventilation of DG Store<br><br>No drains connected to outside outlets<br><br>Slip resistance of floor to be at least R10 |

| Area<br>Hazard Event | Cause | Potential Consequences | Prevention or Protection Strategies |
|---|---|---|---|
| | | combustion.<br>Escape into local drains or waterways causing damage to aquatic life-forms<br>Conviction against EPA Legislation | Spill kits provided<br>PPE supplied<br>Safety shower/eyewash to be provided |
| **Order Assembly Area** | | | |
| Fire | Flame shrinkage of pallet shrink-wrapping<br>Arson | Aerosol cans become missiles and spread fire to wide area<br>Irritant fumes or smoke evolved<br>Radiant heat injuries | Safety training of personnel<br>Emergency Response Plan<br>Flame shrinkage of pallet wrapping not proposed for the site<br>Thermal/smoke detection proposed with link to alarms and local fire brigade<br>Sprinkler system proposed<br>Fire hose reels and portable fire extinguishers provided for rapid response<br>PPE supplied |
| Spill | Drop of packages during movement of goods<br>Impact damage by forklift or other vehicle | Fumes could cause respiratory ailment to operators<br>Contact with skin or eyes causing chemical burns<br>Slip causing fall injuries<br>Inhalation of fine powders causing respiratory harm<br>Reaction with incompatible materials with release of harmful fumes<br>Some materials will vigorously support combustion.<br>Escape into local drains or waterways causing damage to aquatic life-forms<br>Conviction against EPA Legislation | Safety training of personnel<br>Emergency Response Plan<br>No drains in local area<br>Slip resistance of floor to be at least R10<br>Spill kits provided<br>Good natural ventilation<br>PPE supplied<br>Safety shower/eyewash to be provided |
| **Loading and Unloading Operations** | | | |
| Fire | Nearby ignition sources - vehicles<br>Arson | Aerosol cans become missiles and spread fire to wide area<br>Iirritant fumes or smoke | Safety training of personnel<br>Emergency Response Plan<br>Flame shrinkage of pallet wrapping not proposed for the site |

| Area<br>Hazard Event | Cause | Potential Consequences | Prevention or Protection Strategies |
|---|---|---|---|
| | | evolved | |
| | External sources | Radiant heat injuries | Thermal/smoke detection proposed with link to alarms and local fire brigade<br><br>Sprinkler system proposed<br><br>Fire hose reels and portable fire extinguishers provided for rapid response<br><br>PPE supplied |
| Spill | Drop of packages during movement of goods<br><br>Impact damage by forklift or other vehicle | Fumes could cause respiratory ailment to operators<br><br>Contact with skin or eyes causing chemical burns<br><br>Slip causing fall injuries<br><br>Inhalation of fine powders causing respiratory harm<br><br>Reaction with incompatible materials with release of harmful fumes<br><br>Some materials will vigorously support combustion.<br><br>Escape into local drains or waterways causing damage to aquatic life-forms<br><br>Conviction against EPA Legislation | Safety training of personnel<br><br>Emergency Response Plan<br><br>Slip resistance of floor to be at least R10<br><br>Interceptors or shut-off valves fitted to drains<br><br>Loading Dock capacity of 280,000 L to capture spills<br><br>Spill kits provided<br><br>Good natural ventilation<br><br>PPE supplied<br><br>Safety shower/eyewash to be provided |

## 7. Qualitative Risk Assessment

Having identified the hazards in section 6 for the storage and handling of hazardous materials in the Dangerous Goods Store the risks associated with these hazards are assessed according to the Risk Criteria given in Table 7. The qualitative risk assessment (Table 8) is used to determine which hazards (if any) require further risk assessment.

The NSW DOP&I Assessment Guideline "Multi-level Risk Assessment"[7] clause 3.1.3 states;

Where the risk appears to be low, quantification need only be continued to the extent needed to demonstrate that no combination of events is possible that would lead to relevant risk criteria being exceeded.

**Table 7** Risk Criteria

| Risk Level | Description |
|---|---|
| Low | The event is unlikely to have consequences that could noticeably impact on nearby persons, neighbours or the local environment. |
| Medium | The event could have small impacts on nearby persons, neighbours or the local environment.<br><br>Controls are likely to restrict the consequences to within the site boundaries and have negligible impact on the surrounding land use. |
| High | The event is likely to impact on nearby persons, neighbours or the local environment.<br><br>The event escalates into other areas or other activities. |

The Qualitative Risk Assessment identified fire as the major risk to the safety of people and to property loss. Further risk analysis for the fire hazard is presented in the following sections of this report.

The risk mitigation strategies proposed for spills of hazardous materials resulted in an overall Low risk rating and this hazard does not require further quantification of the risk.

Table 8 Qualitative Risk Assessment

| | | | Consequences | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **ID** | **Location** | **Hazard** | **On-site** | **Neighbours** | **Environment** | **Propagation** | **Risk Rating – No Controls** | **Risk Mitigation Strategies** | **Residual Risk – With Controls** |
| 1 | Aerosol Storage | Spill of Aerosol can contents | Fumes could cause respiratory ailment to operators | Unlikely to affect neighbouring land uses | Captured in bund. Negligible damage. | Unlikely to propagate into large event due to need to breach many small cans. | Medium | Safety training of personnel<br>Emergency Response Plan<br>Bunded aerosol spill compound<br>Spill kits provided<br>PPE supplied<br>Safety shower/eyewash to be provided | Low |
| 2 | Aerosol Storage | Fire in DG Store | Smoke fumes could cause serious to fatal respiratory ailment to operators<br><br>Heat radiation could cause burns to operators.<br><br>Cans could become missiles and harm operators inside the caged area. | Smoke and fumes could spread to neighbouring properties | Smoke damage to local environment<br><br>Release of materials into the environment if fire water exceeds bund capacities. | Heat radiation initiates fires in other dangerous goods (mainly in flammable liquids) | High | Aerosols stored in caged area within the DG Store<br>Control of ignition sources<br>Sprinkler system to be provided<br>Fire hose reels and portable fire extinguishers provided<br>Fire fighting training of personnel<br>Emergency Response Plan<br>PPE supplied | Medium |
| 3 | Aerosol Storage | Fire from areas external to the new warehouse | The materials will vigorously support combustion.<br><br>Smoke fumes could cause serious respiratory ailment to operators<br><br>Heat radiation could cause burns to operators. | Smoke and fumes could spread to neighbouring properties | Smoke damage to local environment<br><br>Release of materials into the environment if fire water exceeds bund capacities. | Heat radiation initiates fires in other dangerous goods (mainly in flammable liquids and aerosols) | High | Outer walls will be concrete to protect from radiant heat<br>Aerosols stored in caged area within the DG Store<br>Control of ignition sources<br>Sprinkler system to be provided<br>Fire hose reels and portable fire extinguishers provided<br>Fire fighting training of personnel<br>Emergency Response Plan<br>PPE supplied | Medium |
| 4 | Storage of solid oxidising agents | Spill of contents from packages | Contact with skin or eyes<br>Inhalation of fine powders causing | Unlikely to affect neighbouring land uses | Captured in bund. Negligible damage. | Unlikely to propagate into large event | Low | Safety training of personnel<br>Emergency Response Plan<br>Bunded aerosol spill compound<br>Spill kits provided | Low |

Table 8 Qualitative Risk Assessment

| | | | Consequences | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **ID** | **Location** | **Hazard** | **On-site** | **Neighbours** | **Environment** | **Propagation** | **Risk Rating – No Controls** | **Risk Mitigation Strategies** | **Residual Risk – With Controls** |
| | | | respiratory harm<br><br>Reaction with incompatible materials with release of harmful fumes | | | | | PPE supplied<br>Segregation from incompatible materials<br>Safety shower/eyewash to be provided | |
| 5 | Storage of solid oxidising agents | Fire from areas external to the new warehouse | The materials will vigorously support combustion. | Smoke and fumes could spread to neighbouring properties | Smoke damage to local environment<br><br>Release of materials into the environment if fire water exceeds bund capacities. | Heat radiation initiates fires in other dangerous goods (mainly in flammable liquids and aerosols) | Medium | Control of ignition sources<br>Sprinkler system to be provided<br>Fire hose reels and portable fire extinguishers provided<br>Fire fighting training of personnel<br>Emergency Response Plan<br>PPE supplied | Low |
| 6 | Storage of Caustic Liquids | Spill of contents from packages | Contact with skin or eyes causing serious chemical burn injuries<br><br>Reaction with incompatible materials with release of harmful fumes | Unlikely to affect neighbouring land uses | Captured in bund. Negligible damage. | Unlikely to propagate into large event | Low | Safety training of personnel<br>Emergency Response Plan<br>Bunded aerosol spill compound<br>Spill kits provided<br>PPE supplied<br>Safety shower/eyewash to be provided | Low |
| 7 | Storage of Caustic Liquids | Fire from areas external to the new warehouse | Reaction with incompatible materials with release of harmful fumes and smoke | Small quantities indicate that fumes and smoke are unlikely to affect neighbouring land uses | Release of materials into the environment if fire water exceeds bund capacities. | Unlikely to propagate into large event | Medium | Control of ignition sources<br>Sprinkler system to be provided<br>Fire hose reels and portable fire extinguishers provided<br>Fire fighting training of personnel<br>Emergency Response Plan<br>PPE supplied | Low |
| 8 | Storage of Environmentally Hazardous Substances (solids and liquids) | Spill of contents from packages | Escape into local drains<br><br>Slip Hazard | Unlikely to affect neighbouring land uses | Escape into local drains or waterways causing damage to aquatic life-forms<br><br>Conviction | Unlikely to propagate into large event | Medium | Emergency Response Plan<br>Bunded spill compound<br>Spill kits provided<br>PPE supplied<br>Floor finish has slip resistance of at least R10. | Low |

Table 8 Qualitative Risk Assessment

| | | | Consequences | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **ID** | **Location** | **Hazard** | **On-site** | **Neighbours** | **Environment** | **Propagation** | **Risk Rating – No Controls** | **Risk Mitigation Strategies** | **Residual Risk – With Controls** |
| | | | | | against EPA Legislation | | | | |
| 9 | Storage of Environmentally Hazardous Substances (solids and liquids) | Fire from areas external to the new warehouse | Smoke fumes could cause serious respiratory ailment to operators<br><br>Heat radiation could cause burns to operators. | Unlikely to affect neighbouring land uses | Smoke damage to local environment<br><br>Release of materials into the environment if fire water exceeds bund capacities. | Heat radiation initiates fires in other dangerous goods (mainly in flammable liquids) | High | Control of ignition sources<br>Sprinkler system to be provided<br>Fire hose reels and portable fire extinguishers provided<br>Fire fighting training of personnel<br>Emergency Response Plan<br>PPE supplied | Medium |
| 10 | New Warehouse other than Dangerous Goods Store Area | Fire within the warehouse | Smoke fumes could cause serious respiratory ailment to operators<br><br>Heat radiation could cause burns to operators.<br><br>Spread to Dangerous Goods Storage Area | Unlikely to affect neighbouring land uses | Release of materials into the environment if fire water exceeds bund capacities. | Unlikely to propagate into large event | Medium | Control of ignition sources<br>Sprinkler system to be provided<br>Fire hose reels and portable fire extinguishers provided<br>Fire fighting training of personnel<br>Emergency Response Plan<br>PPE supplied<br>Spill containment provided | Low |
| 11 | New Warehouse other than Dangerous Goods Store Area | Spill of contents from packages | Escape into local drains<br><br>Slip Hazard | Unlikely to affect neighbouring land uses | Escape into local drains or waterways causing damage to aquatic life-forms<br><br>Conviction against EPA Legislation | Unlikely to propagate into large event | Medium | Emergency Response Plan<br>Bunded spill compound<br>Spill kits provided<br>PPE supplied<br>Floor finish has slip resistance of at least R10. | Low |
| 12 | Assembling Orders outside of DG Store | Spill of contents from dangerous goods | Fumes could cause respiratory ailment to operators<br><br>Contact with skin or | Unlikely to affect neighbouring land uses | Captured in local vicinity. Negligible damage. | Unlikely to propagate into large event | Medium | No drains in immediate area<br>Emergency Response Plan<br>PPE supplied<br>Spill kits provided | Low |

Table 8 Qualitative Risk Assessment

| | | | Consequences | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **ID** | **Location** | **Hazard** | **On-site** | **Neighbours** | **Environment** | **Propagation** | **Risk Rating – No Controls** | **Risk Mitigation Strategies** | **Residual Risk – With Controls** |
| | | packages | eyes<br><br>Inhalation of fine powders causing respiratory harm<br><br>Escape into local drains or waterways | | | | | Good natural ventilation<br>Safety shower/eyewash to be provided<br>Spill containment provided | |
| 13 | Loading and Unloading Operations | Spill of contents from dangerous goods packages | Fumes could cause respiratory ailment to operators<br><br>Contact with skin or eyes causing chemical burns<br><br>Inhalation of fine powders causing respiratory harm<br><br>Escape into local drains or waterways<br><br>Slip hazard for personnel and forklifts | Unlikely to affect neighbouring land uses | Captured in recessed loading dock<br><br>Small amount may flow to drain | Unlikely to propagate into large event | Medium | No drains in immediate area<br>Emergency Response Plan<br>PPE supplied<br>Spill kits provided<br>Good natural ventilation<br>Safety shower/eyewash to be provided<br>Interceptor provided for drains in loading dock | Low |
| 14 | Loading and Unloading Operations | Fire from other areas | Smoke fumes could cause serious respiratory ailment to operators<br><br>Heat radiation could cause burns to operators. | Unlikely to affect neighbouring land uses | Smoke damage to local environment<br><br>Release of materials into the environment from drains in loading dock | Unlikely to propagate into large event | High | Fire hose reels and portable fire extinguishers provided<br>Fire fighting training of personnel<br>Emergency Response Plan<br>PPE supplied<br>Interceptor provided for drains in loading dock | Medium |

# 8. Consequence Analysis

## 8.1 Containment of Spills or Contaminated Fire-water

A spill of hazardous materials from the Dangerous Goods Store could result in release of the material into the environment causing damage. This release could also be of contaminated fire-water from emergency response to a fire situation.

Spills of liquids from the new General Storage area will create a slip hazard and a large spill could escape the site boundaries.

## 8.2 Consequences of Spills

The majority of the goods held within the Dangerous Goods Store are flammable aerosols, flammable liquids and personal care oxidising agents (e.g. hair bleach). Spills from these products would release vapours that could cause respiratory irritation to nearby people. None of the materials proposed are identified as containing any toxic ingredients (class 6.1). Many of the released vapours would be flammable and capable of creating an explosive fuel/air mixture. For this reason ignition sources are excluded from the spill containment areas.

Some strongly alkaline corrosive materials are also stored but these are held in small quantities. Release of these materials would increase the pH of any aquatic environment and contaminated soil. The effect would be short term as they are not expected to accumulate.

Spills from the Dangerous Goods Store are very likely to be captured on-site in containment compounds from where they can be safely disposed of by certified chemical disposal companies.

Spills from the new General Storage area are of non-dangerous goods such as non-flammable hair care products, non-hazardous adhesives and fruit juices. Large spills of these materials will be captured inside the warehouse by use of low retaining walls around the outside edges and roll-over bunds at entrances.

### 8.2.1 Consequences of Contaminated Fire-water

A fire in the new Stores is likely to result in the release of package contents with subsequent burning of flammable materials. The water used as part of the fire fighting will become contaminated with the products and the residues from burning. The spill compounds are designed to capture 25% of the product storage along with a further 10% for fire water. The output of the sprinkler system beyond this volume is likely to exceed the bund capacities and be released onto the site.

### 8.2.2 Controls

The proposed controls for the containment of spills and fire-water are;

- Internal bunded spill compounds in the Dangerous Goods Store in accordance with the EPA requirements and those from AS 3833 as follows

| Dangerous Goods Class | 25% Volume (L) | 10% Volume (L) for fire water | Total (L) |
|---|---|---|---|
| 2.1 & 3 | 107,750 | 43,100 | 150,850 |
| 5.1 | 13,695 | 5,478 | 19,173 |
| 8 & 9 | 1,353 | 542 | 1,895 |

- Spill containment for entire new warehouse storage areas capable of containing at least 315,000 L, including that for the Dangerous Goods Store above. This will be achieved by including a 50 mm high bund wall around the inside perimeter of the new store with roll-over humps/ramps at entrances for vehicles, including forklifts. Drawings and documentation will be developed as part of the detail design process.
- Recessed Loading Dock capable of containing up to 280,000 L.
- Valve for isolation of stormwater run-off.

## 8.3 Fire in Aerosol Storage Area

### 8.3.1 Heat Radiation

A fire within the aerosol storage area is likely to cause the retail cans to overheat and pressurize beyond their burst pressure. This would release the contents of the cans, part of which will be flammable gases, which would further contribute to the fire. Depending upon how the cans fail the fire could be spread by the cans becoming missiles spreading contents for as much as 100 m, producing a fireball up to 17.8 m diameter, or projecting a stream of burning liquids up to 2 m. The aerosols will be stored in a caged area within the Dangerous Goods Store to restrict the range of any cans that become missiles to this area and reduce the spread of the fire.

The consequences of such fires are difficult to quantify depending upon the behavior of the cans when they fail and the nature of the flammable gases and liquids within. For the purpose of this PHA the distances to heat radiation levels were determined assuming that the retail cans held 100g of propane as the propellant. This is based on the conservative estimate of 40% propellant in a can containing 250 ml of contents.

For a single can the distance from source for a heat radiation level of 23 $kW/m^2$ was determined to be 4.3 m, Table 9. At this heat radiation level unprotected steel can reach thermal stress temperatures which can cause failure (HIPAP 4[5]). The cans will be stacked close together and will be inside this distance indicating that others will suffer significant heat stress and are likely to also burst.

**Table 9** Distances to Heat Radiation Levels for Aerosol Fireballs from a Single Can

| Heat Radiation Level ($kW/m^2$) | Distance to Heat Radiation Level (m) |
|---|---|
| 4.7 | 9.5 |
| 12.6 | 5.8 |
| 23 | 4.3 |

The heat radiation that could be experienced has been calculated for the amount of propane propellant combusted in 3.54 seconds. The aggregate quantity of propane was determined to be 38 kg and the calculations gave heat radiation levels as described in Table 10, (see Appendix 2 for calculation method). These distances are large but will be contained within the walls of the warehouse and are not expected to impact on neighbouring properties in the initial stages of a fire.

**Table 10** Distances to Heat Radiation Levels for Aerosol Fireballs from Pallet Storage Area

| Heat Radiation Level ($kW/m^2$) | Distance to Heat Radiation Level (m) |
|---|---|
| 4.7 | 51 |
| 12.6 | 31 |
| 23 | 23 |

The effects for short exposure to thermal radiation were determined using the following thermal radiation dose equation as described by OGP RADD[8],

$$\text{Dose (tdu)} = (q_i^{4/3}) \cdot t$$

Where $q_i$ = incident thermal radiation (kW/m$^2$)

t = duration of exposure (s)

HIPAP No.4[5] indicates that a radiant heat level of 12.6 kW/m$^2$ has a significant chance of fatality for extended exposure. For this study an extended exposure time of 30 seconds will be used as this is one order of magnitude greater than the time of duration for a fireball (appendix 2). These figures give a result of 880 tdu for the thermal radiation dose.

The OGP RADD[8] provides the following thermal dose criteria for fireballs, Table 11. At 880 tdu there is predicted to be approx. 1% fatalities, or a 0.01 probability of a fatality.

**Table 11** Thermal dose fatality criteria

| Thermal Dose Units $((kW/m^2)^{4/3}s)$ | Heat Radiation Effect |
|---|---|
| 1,000 | 1% lethality |
| 1,800 | 50% lethality |
| 3,200 | 100% lethality |

#### 8.3.1.1 Nearest Residential Property

A radiant heat level of 12.6 kW/m$^2$ has a significant chance of fatality for extended exposure. The distance from a target to the centre of a fireball is calculated to be 31 m for this radiant heat level, Table 10. At this distance there is estimated to be approximately 1% chance of a fatality as described above.

The nearest residential property is 120 m from the Dangerous Goods Store which is 4 times the distance from where there would be a 1% chance of a fatality. This separation should provide adequate time for any residents to evacuate the houses to a safe area.

### 8.3.2 Smoke

The chemical manifests do not describe any toxic goods as defined by the ADGC. The Qualitative Risk Assessment identified irritant fumes or smoke evolved from a fire may spread to neighbouring properties, but these are not expected to contain any amounts of toxic materials that could have a serious respiratory affect on nearby people.

In the initial stages a fire is contained to the warehouse where the oxygen available to feed the fire is not sufficient to allow complete combustion of the available fuel. The smoke cloud generated is a mixture partially and fully combusted products, many of which will be respiratory and eye irritants to people. Such fires will continue to burn at a restricted rate as determined by the available oxygen until (without controls limiting the fire) the fabric of the building collapses allowing introduction of much more oxygen. The size of the fire

increases significantly generating a large smoke plume and flames above the roof of the building. The heat causes the smoke plume to lift-off to significant height and is not expected to have major consequences for neighbouring properties.

The most significant consequences are likely to be from smoke generated in the earlier stage of a fire and the time before failure of the building fabric.

The airborne concentrations of irritants in the smoke is difficult to model as there are no toxins stored on site that allow comparison of exposure sensitivities for members of the community. HIPAP No. 4[5], clause 2.4.2.2 provides the following injury risk criterion for toxic gas/smoke/dust exposure as follows;

Toxic concentrations in residential and sensitive use areas should not cause irritation to eyes or throat, coughing or other acute physiological responses in sensitive members of the community over a maximum frequency of 50 in a million per year.

Modeling has not as yet been undertaken to determine whether smoke from a warehouse fire could affect members of the community against this criterion. However, a study was performed in late 2011 by Moore Consulting & Engineering[9] for a similar warehouse at the Westpark Industrial Estate, Erskine Park. This warehouse stored household products of which some contained toxic pesticide chemicals. The results of this study found that for many wind conditions the concentration of toxic chemicals at the site boundaries was below the threshold levels for airborne concentrations that could cause irritation to sensitive members of the community. Based upon the findings of the Moore Consulting and Engineering study[9], and that the Mainfreight Prestons warehouse does not store products containing toxic chemicals, the exposure to the community from smoke is very likely to meet the criterion provided in HIPAP 4[5].

### 8.3.3 Fire in the General Storage Warehouses

A fire in the new and existing general storage areas could result in heat radiation affecting the surrounding areas. The general storage areas contain combustible materials and no toxic substances. The homewares, adhesives and some packaging may generate irritant fumes while burning but are not expected to generate significant quantities of toxic fumes while burning.

The heat radiation could cause rapid propagation of the fire, or prevent access by emergency response teams to limit the severity of the fire.

It is assumed the fire will reach a steady state heat generation of 40 MW. Using a point source heat radiation model shown below this heat generation rate provides the distances to targets in Table 12.

$$q_s = \frac{Q \cdot f \cdot \tau}{4 \cdot \pi \cdot R^2}$$

Where Q = the heat released (kW)
f = fraction of heat radiated (assumed 0.35)
$\tau$ = transmittivity in air (assumed 1.0)
R = distance from point source (m)
I = Intensity

**Table 12** Distances to Heat Radiation Levels for Fire in General Storage Areas

| Heat Radiation Level ($kW/m^2$) | Distance to Heat Radiation Level (m) |
|---|---|
| 4.7 | 15.4 |
| 12.6 | 9.4 |
| 23 | 7.0 |

The distance to a heat radiation level of 4.7 $kW/m^2$ was determined to be 15.4 m, Table 12. At this distance there could be some difficulty in accessing the fixed emergency response equipment.

The distance to a heat radiation level of 23 $kW/m^2$ was determined to be 7.0 m, Table 12. This distance would see ignition of much of the nearby combustible materials in the warehouse significantly contributing the combustion. As such a fire in the general warehouse would be expected to rapidly expand into the Dangerous Goods Store unless other fire suppression strategies succeed in reducing the severity of the fire, see Table 8 for risk controls. These controls are expected to reduce the risks associated with a fire to a low level.

# 9. Estimation of Likelihood of Hazardous Events

## 9.1 Potential Sources of Fire

There are many causes of fires in warehouses that include electrical faults, sparks from cutting or grinding, welding, shrink wrapping, smoking, arson, use of normal (unprotected) vehicles (such as forklifts), storage near sources of heat, spillage of incompatible chemicals and external fires.

The following risk mitigation strategies will be implemented at the new warehouse to reduce the likelihood of ignition of combustible and flammable materials where they are stored or handled, Table 13 and to protect the site in the event of a fire, Table 14.

**Table 13** Fire Risk Controls

| Hazard | Risk Control |
|---|---|
| Smoking | No smoking policy for the warehouse |
| Electrical Faults | All electrical fittings in the Dangerous Goods Store will be suitable for hazardous zone 2 area in accordance with Australian Standards |
| Unprotected Vehicles | Vehicles unload in the recessed dock and do not enter the warehouse<br>Portable fire extinguishers provided nearby |
| Forklifts | Dangerous Goods Store forklift specified for use in hazardous zone 2 areas |
| Arson | Site is secured behind mesh fencing<br>Security patrols out of hours |
| Hot Work | A hot work permit system is used with risk assessment prior to work starting |
| Spillage | Incompatible materials are stored in independent bunded areas |
| External Fire | Dangerous Goods Store is 4 hour fire separated from surrounding areas |

**Table 14** Fire Protection Strategies

| Protection | Description |
|---|---|
| External Fire | Dangerous Goods Store will have concrete outer walls to protect from radiant heat from external surrounding areas |
| Sprinkler | The new warehouse and Dangerous Goods Store will be protected by sprinkler systems. The nature of these systems is yet to be finalised with the Fire Engineer. |
| Rapid Response | Fire hose reels and portable extinguishers will be provided in appropriate locations |
| Staff Training | Staff will be trained in the use of rapid response fire fighting equipment and how to alert emergency services |

## 9.2 Frequency of Fire Events

The frequency of fire events involving aerosol cans has been investigated using an event tree as shown in appendix 1. A fire that starts in the Dangerous Goods Store was found to have a frequency of 33.5 x $10^{-6}$ p.a. This represents the frequency for a fire that is contained within the Dangerous Goods Store, or escalates to the adjacent general warehouse area.

Table 15 provides an overview of the frequency of general warehouse fires that have been published in recent literature. The range of frequencies quoted in Table 15 varies significantly representing the uncertainty in collecting and collating this data. Nearly all of the frequencies are for general warehouses without distinguishing those that contain dangerous goods. As a conservative estimate it will be assumed that approximately 10% of the stores contain significant quantities of flammable liquids or gases, thereby reducing the frequency by one order of magnitude. It is also noted that dangerous goods stores, in the countries where the above data was collected, would be fitted with significant risk controls, such as sprinklers.

Based upon these considerations a frequency of 500 x $10^{-6}$ p.a. has been used for the initiation of a fire in the Prestons Dangerous Goods Store.

**Table 15** Literature Frequencies of General Warehouse Fires

| Source | Frequency (p.a.) |
|---|---|
| Gottuk D.T. & Dinaburg J., Fire detection in Warehouse Facilities, Fire Protection Foundation, Jan 2012 | 5,000 x $10^{-6}$ |
| HSE, safety Report Assessment Guide, Chemical Warehouses - Hazards | 10,000 x $10^{-6}$ |
| Wilday J & Lisbona D, HSE, RR916 – Risk Assessment for VCE Scenario in an aerosol warehouse, 2012 | 1,100 x $10^{-6}$ – 5,600 x $10^{-6}$ |
| PHA – Intermodal logistics Centre at Enfield Environmental Impact Statement, QEST Consulting Pty Ltd, 2005 | 100 x $10^{-6}$ – 1,000 x $10^{-6}$ for DG Stores |
| Insurance Council of Australia | 8,300 x $10^{-6}$ |

# 10. Risk Assessment

## 10.1 Individual Risk Assessment

Individual risk is calculated using the equation below. The frequency of fire is taken from the calculations in section 8.3.1 and the probability of a fatality is taken from section 9.2.

Individual risk = frequency of fire x probability of a fatality

= $33.5 \times 10^{-6} \times 0.01$

= $0.335 \times 10^{-6}$ p.a.

Table 16 reproduces the DOP suggested risk criteria that a new development should achieve. Where the individual fatality risk criterion does not overlap with the surrounding land uses then the criterion has been met.

**Table 16** Individual Fatality Risk Criteria

| Land Use | Suggested Criteria (risk in million per annum) |
|---|---|
| Hospitals, schools, child-care facilities, old age housing | 0.5 |
| Residential, hotels | 1 |
| Commercial developments including retail centres, offices and entertainment centres | 5 |
| Sporting complexes and active open space | 10 |
| Industrial | 50 |
| Incident heat flux radiation at residential and sensitive use areas should not exceed 4.7 $kW/m^2$ | 50 |
| Toxic concentrations in residential and sensitive use areas should not cause irritation to eyes or throat, coughing or other acute physiological responses in sensitive members of the community following a relatively short period of exposure | 50 |

*Source: HIPAP 10 Land Use Safety Planning, July 2008, Tables 4 & 6 and clause 5.5.3.*

The calculated individual risk of $0.335 \times 10^{-6}$ p.a. does not exceed the DOP suggested risk criteria for land use safety planning.

Consequently, a full Quantitative Risk Analysis is not required.

## 10.2 Risk to the Biophysical Environment

Some of the materials handled in the Dangerous Goods Store could impact on the local natural environment. A spill that escaped the site containment could harm aquatic, bird and plant life. The criteria set out by HIPAP No. 4[5] for the risk assessment to the biophysical environment are related to the threat to the long term viability of a species or the ecosystem. These criteria are determined from an accidental event rather than from the actions of continuous operation.

## 10.3 Release of Aerosol Products

The aerosols are predominantly personal care products for general consumer use. None of the products contain listed toxic materials as described by the Australian Dangerous Goods Code. The warehouse will contain up to 380,000 kg of products in aerosol cans. These are stored in a section of the Dangerous Goods Store that is designed to capture 43,620 L plus 20 minutes sprinkler output. Given the small size of each can it is very unlikely that a spill would reach the surrounding environment.

## 10.4 Release of Oxidising Agents

The oxidising agents are predominantly personal hair-care bleaches for the hair and beauty industry and for general consumer use. These chemicals would have a serious, short term effect on aquatic life but would not persevere or have an accumulating effect. The warehouse will contain up to 80,000 L of these products. These are stored in a section of the Dangerous Goods Store that is designed to capture 7,000 L plus 20 minutes sprinkler output. It is unlikely that a spill would reach the surrounding environment.

## 10.5 Alkaline Corrosive Substances and Class 9 Miscellaneous Chemicals

Some strongly alkaline corrosive materials, and environmentally sensitive substances are also stored but these are held in small quantities. Release of these materials would increase the pH of any aquatic environment and contaminated soil. The effect would be short term as they are not expected to accumulate.

Spills are very likely to be captured on-site in containment compounds from where they can be safely disposed of by certified chemical disposal companies.

## 10.6 Release of Contaminated Fire Water

A fire in the Dangerous Goods Store is likely to result in the capture of contaminated fire water. The contaminants would be from the contents of the personal care products and small amounts from some strongly alkaline materials and environmentally sensitive materials. Should the fire fighting systems operate for an extended time there is a likelihood that contaminated fire water will begin to escape the containment compounds and be released into the surrounding environment. An allowance for at least an extra 10% of the liquid storage volume has been made to capture fire water in the spill retention area.

As for the spill scenarios above, the effects would be short term and the contaminants are not expected to accumulate.

## 10.7 Release of Dangerous Goods during Unloading and Loading Operations

Spills could occur during loading or unloading of vehicles in the Loading Dock. The recessed Loading dock has a capacity of 280,000 L which is enough to capture the largest spill during loading and unloading operations and any incidental water, e.g. rainwater or fire water.

# 11. Conclusions

The PHA has assessed the risks identified for the proposed expansion of the Prestons Distribution Centre against the criteria described in HIPAP No. 4, Risk criteria for land use safety planning, DOP, 2011[5].

The preliminary screening performed in accordance with SEPP 33[3] found that the proposed warehouse extension is potentially hazardous with regard to the storage of class 2.1 flammable gases in aerosol cans and to class 5.1 oxidising substances, being personal care bleaches. The screening for risks associated with transport found the movements were below the nominated thresholds and do not represent an undue risk to the general public.

The risk assessment process, as determined by HIPAP No. 6[4], showed that the dominant hazard is fire associated with the storage of aerosol cans. Based upon implementation of the fire prevention controls and timely emergency response to a fire event the frequency of a threat to life was determined to be well inside acceptable limits. The consequences of a fire were also not found to have any significant effect beyond the site boundary. The personal care products and general warehouse storage do not contain toxic substances indicating that smoke generated from a fire would also not include any unburned toxic substances.

The class 5.1 oxidising substances are water based personal care bleaches and the risk assessment did not find them to be a significant hazard to nearby people, neighbours or to the surrounding biophysical environment.

The risk assessment also found that the risk to the biophysical environment associated with release of contaminated fire water from the Dangerous Goods Store is low.

It is the conclusion of this report that the proposed warehouse extension is not hazardous to the surrounding land uses as determined from the safety assessment process described within HIPAP No. 6[4].

## 12. References


1. AS 3833-2007, The storage and handling of mixed classes of dangerous goods, in packages and intermediate bulk containers
2. Factory Mutual (FM) Global, Property Loss Data Sheets 7-31, 2003
3. State Environment Planning Policy 33 (SEPP 33), NSW DOP 1992
4. Hazardous Industry Planning Advisory Paper 6 (HIPAP 6) – Guidelines for Hazard Analysis, NSW DOP 2011
5. Hazardous Industry Planning Advisory Paper 4 (HIPAP 4) – Risk Criteria for Land use Planning, NSW DOP 2011
6. National Fire Protection Association (NFPA) 30B, Code for the Manufacture and Storage of Aerosol Products, 2011
7. Guideline for Multilevel Risk Assessment, NSW DOP 2011
8. Risk Assessment Data Directory Report No. 434-14.1, Vulnerability of Humans, International Association of Oil & Gas Producers, March 2010
9. PHA – Warehouse B1 Westpark Industrial Estate, Moore Consulting & Engineering, 2011
10. Hazardous Industry Planning Advisory Paper 10 (HIPAP 10) - Land Use Safety Planning, NSW DOP July 2011
11. Fire Safety Strategy, Mainfreight Expansion Facility, Prestons NSW, Rawfire Fire Safety Engineering, Rev. 1, 2012
12. Risk Assessment for VCE Scenario in an Aerosol Warehouse, HSE RR916 Research Report, 2012
13. Martinsen W. E. And Marx J. D., An Improved Model for the Prediction of Radiant heat from Fireballs, 1999 International Conference on Modelling Consequences of Accidental Release of Hazardous Materials.

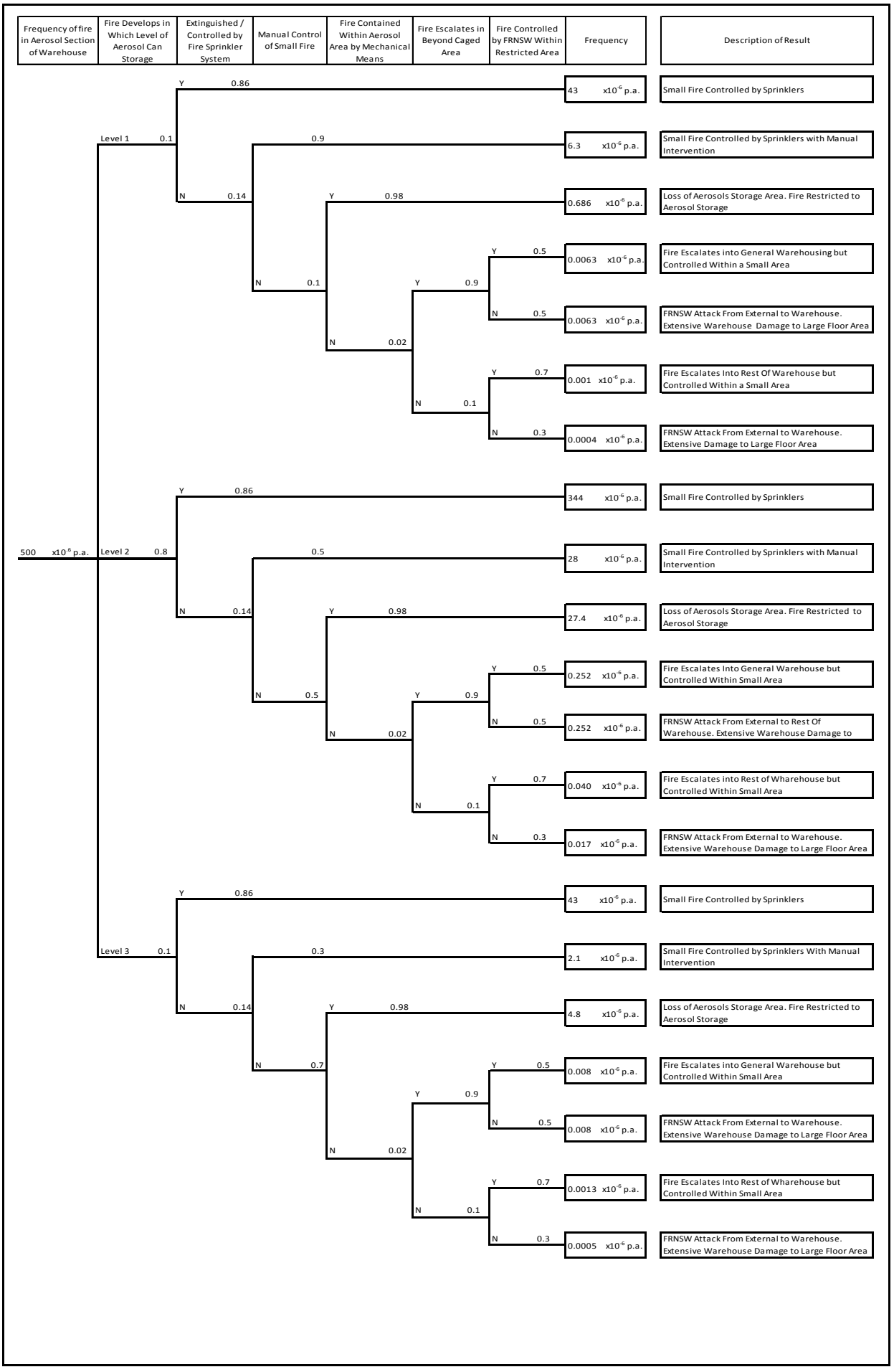
# 13. Appendix 1

The likelihood of events for a fire in the aerosol storage area was determined using an event tree. Table 17 gives the basis on which the probabilities were assigned for each event type.

**Table 17** Probabilities for the Event Tree

| Hazard Event | Probability | Basis |
|---|---|---|
| Frequency of Fire | 500 x $10^{-6}$ p.a. | Section 9.2 of this report |
| Aerosol can type in which fire first develops | 0.1 | Level 1 Aerosols NFPA 30B, section 4.1 of this report |
| | 0.8 | Level 2 Aerosols NFPA 30B, section 4.1 of this report |
| | 0.1 | Level 3 Aerosols NFPA 30B, section 4.1 of this report |
| Controlled by sprinkler system | 0.86 | The Fire Safety Strategy by Rawfire[11] performed a literature review of the effectiveness of sprinklers in events where they operate and provides a probability of 86% for storage facilities. This result is generic and may possibly improve if the design incorporates alternative sprinkler systems that have greater reported effectiveness, e.g. EFSR. The lower generic result is used for this analysis to provide a conservative estimate.<br>Note: Sprinkler failure on demand was considered as part of the overall probability of failure by Rawfire[11]. |
| Manual control of a small fire | 0.9 | Level 1 Aerosols are difficult to ignite making manual intervention possible.<br><br>Moore Consulting and Engineering[9] reported that statistical fire studies found the probability of early control of a fire by the occupants to be from 45% to 75%. Higher rate of 90% was justified for fire events that are small or local and based upon fire fighting training completed by operational personnel. |
| | 0.5 | Level 2 Aerosols will release flammable gas increasing propagation of the fire. This reduces the ability to manually intervene.<br><br>Moore Consulting and Engineering[9] reported that statistical fire studies found the probability of early control of a fire by the occupants to be from 45% to 75%. |
| | 0.3 | Level 3 Aerosols will release highly flammable gases increasing propagation of the fire. This substantially reduces the ability to manually intervene.<br><br>Moore Consulting and Engineering[9] reported that statistical fire studies found the probability of early control of a fire by the occupants to be from 45% to 75%. The lower rate of 30% is justified based upon the likely rapid escalation of a fire with such highly flammable materials. |
| Fire contained within the aerosol caged area preventing missiles from spreading the fire | 0.98 | Provided there are no openings large enough for a can to pass through, the cage offers a very good means to slow the escalation of a fire. |
| Fire escalates beyond the caged area | 0.9 | Failure of the cage, or radiant heat escalates the fire into the warehouse storage areas beyond the aerosol storage. |
| Fire controlled by NSW Fire Brigade | 0.7 | Where fire has not escalated into warehouse storage areas beyond the aerosol storage the FRNSW is able to prevent further loss.<br><br>The HSE report RR916[12] was summarised by Moore Consulting and Engineering[9] reporting that the probability of success of the fire brigade response is between 0.9 to 0.5. This range was accepted as representative and a mid-point of 0.7 is used for this report. |
| | 0.5 | With escalation of the fire into the warehouse storage areas beyond the aerosol storage the FRNSW is able to prevent loss of the warehouse and further spread.<br><br>For events that are developed and larger a lower probability value of 0.5 is used to provide a more conservative estimate. This is at the bottom of the range quoted above for success by fire brigade response. |

Event Tree for Aerosol Fire



# 14. Appendix 2

A sample calculation showing the assumptions used to determine the heat of radiation is provided. The figures used here provide the result quoted in table 10 of this report.

Maximum total of aerosol storage is 380,000 kg

The weight of contents in the aerosol cans is approximately 80% of the total weight, i.e. 380,000 x 0.80 = 304,000 kg

Of the contents approximately 33% of the weight is flammable propellant

Weight of flammable propellant = 0.33 x 304,000 = 100,320 kg

At maximum capacity there would be 1,055 pallets of aerosols.

The weight of flammable propellant per pallet = 100,320 / 1,055 = 95 kg

A fire at Stiller Warehousing and Distribution in the Aycliffe Business Park on 5th November 2010 burned for more than 4 days and destroyed 7,500 pallets of aerosols and beauty products. Flames were produced for "several hours" and it is this time frame in which the aerosols are presumed to have burned. Using these observations a conservative estimate of 90 minutes is used for the time over which the energy from the aerosols was released.

The average rate of consumption of aerosols over 90 minutes is approx 12 pallets per minute. This figure is used to evaluate the consequences from a fully developed fire.

A large fire event would consume 12 pallets per minute burning 12 x 95 kg = 1,140 kg of propane.

This is considered a conservative result due to the cans not releasing all of the energy in the form of a fireball.

**CALCULATION**

The evaluation of the fireball diameter is based upon the work of Martinsen and Marks[13].

$$D = 5.8 \cdot M^{1/3}$$

Where D = the maximum fireball diameter (m), and

M = mass of fuel involved (kg)

For 1,140 kg of propane the fireball calculates to have a 60 m diameter. However this diameter is based upon all of the contents being burned simultaneously. To determine a more realistic fireball size it is needed to establish the rate of consumption. This can be determined using the time of duration for a fireball assuming constant burning over a minute,

1,140 / 60 = 19 kg per second

The time of duration for a fireball is given by the following equation,

$$t_d = 0.825 \cdot M^{0.26}$$

Where $t_d$ = the fireball duration (s), and

M = mass of fuel involved (kg)

Consequently, the time of duration of the fireball would be 1.77 seconds for 19 kg of propane that combusted per second. This demonstrates that the rate of fireball formation is slower than the conservative estimate of burning. The radiant heat will be determined using the quantity of propane combusted based on twice the time of the fireball duration. (It is noted that this will slightly skew the calculations for the fireball diameter and time of duration compared with how they were obtained but this should provide more conservative results)

In 3.54 seconds 38 kg of propane would be combusted.

### Incident Radiant Heat

Martinsen and Marks[13] provide the following equation for incident radiant heat using the point source energy release model;

$$q_i = q_s \,.\, F.\, \tau$$

where $q_i$ = radiant heat incident on a target due to radiant heat from a fireball ($kW/m^2$)

$q_s$ = average radiant heat emitted from the surface of the fireball ($kW/m^2$)

F = view factor from target to the fireball

$\tau$ = atmospheric transmittance (taken to be 1.0 for this report)

The view factor (F) can be calculated from;

$$F = R^2 / h^2$$

where R = radius of the fireball (m)

h = distance from target to centre of the fireball (m)

### Faction of Heat Radiated

To calculate the radiant heat from the surface of the fireball, the fraction (f) of the available heat first needs to be determined

$$f = 0.27 \,.\, P^{0.32}$$

where f = fraction of heat radiated

P = burst pressure (MPa)

For retail cans the burst pressure is typically given as 1.51 MPa[13]

Consequently $f = 0.27 \,.\, (1.51)^{0.32}$

$= 0.308$

### Fireball Diameter

From the equation above $D = 5.8 \,.\, (38)^{1/3}$

$= 19.5$ m

### Average Radiant Heat

The average radiant heat emitted from the surface of a fireball is given by the following equation

$$q_s = \frac{f \,.\, M \,.\, H_c}{\pi \,.\, D^2 \,.\, t_d}$$

Where $H_c$ = heat of combustion of the fuel (kJ/kg)

For propane $H_c$ = 47,000 kJ/kg

Consequently,

$$q_s = \frac{0.308 \,.\, 38 \,.\, 47{,}000}{\pi \,.\, 19.5^2 .\, 3.54}$$

$$= 130 \text{ kW/m}^2$$

### Distance to Incident Radiant Heat

Substituting the view factor into the equation for the incident radiant heat gives

$$q_i = q_s \,.\, R^2 \,.\, \tau / \, h^2$$

This equation is rearranged to provide the distance from target to incident heat radiation level

$$h^2 = q_s \,.\, R^2 / \, q_i$$

where $\tau = 1.0$

For the heat radiation levels given in table 6 of HIPAP No. 4 the following distances from target are obtained;

| Heat Radiation Level ($kW/m^2$) | Distance to Heat Radiation Level (m) |
|---|---|
| 4.7 | 51 |
| 12.6 | 31 |
| 23 | 23 |