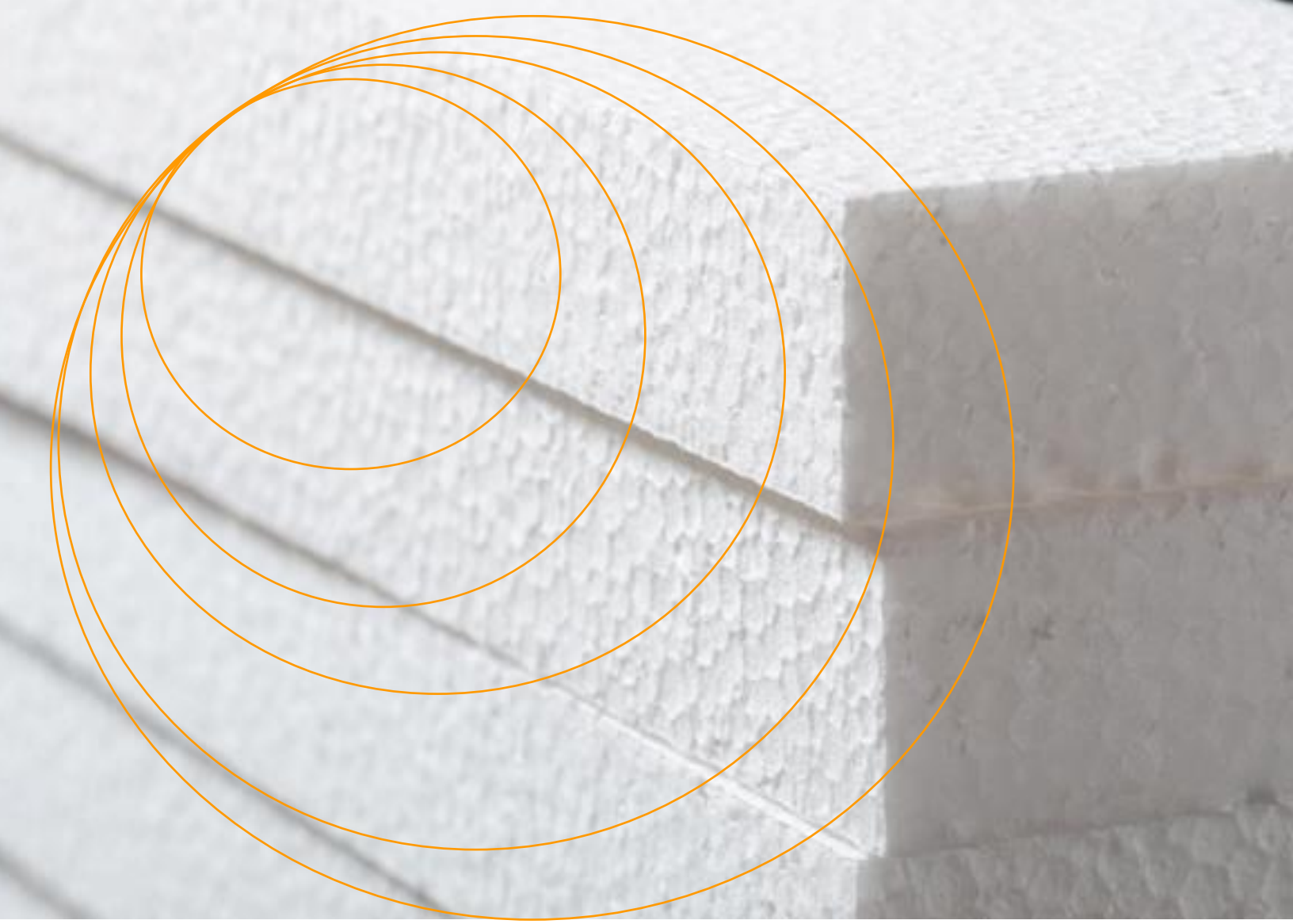

Swartland Insulations (Pty) Ltd

Major Hazard Installation (MHI) Risk Assessment Report

Atlantis Extruded Polystyrene (XPS) Plant

(proposed site)

Compiled and Approved by:

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Report Reference Number:

Sw01-REP-MHI-1

Revision 4 (Final)

Dated: 27th June 2019

MMRisk

MMRisk (Pty) Ltd is an

Approved Inspection Authority for
MHIs: CI MHI 0013 and MHI 0037

sanas Inspection Body
MHI 0037

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REVISION HISTORY:

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	NAME:	POSITION:	SIGNATURE:	DATE:
COMPILED BY:	Motlatsi Mabaso	Risk Assessor		27/06/2019
CHECKED BY:				
APPROVED BY:	Motlatsi Mabaso	Technical Manager		27/06/2019

REVISION HISTORY		
Rev 4	27/06/2019	Final, Revision 4 with corrected cross-references
Rev 3	29/05/2019	Final, Revision 3 with updated information on hazardous materials
Rev 2	15/05/2019	Final, Revision 2 with updated gas installation locations and quantities
Rev 1	30/04/2019	Final Revision
Rev 0 (Draft)	17/04/2019	First Draft to Client
REVISION	DATE	DESCRIPTION

EXECUTIVE SUMMARY

Introduction

MMRisk (Pty) Ltd were contracted by Swartland Insulations (Pty) Ltd ('Client') to conduct a Major Hazard Installation (MHI) Risk Assessment of their proposed an Extruded Polystyrene (XPS) processing plant in Atlantis, Western Cape, South Africa (the 'site'). MMRisk are accredited by the South African National Accreditation System (SANAS) and approved by the Department of Labour to conduct Major Hazard Installation (MHI) Risk Assessments (AIA approval Number CI MHI 0013, approval certificates attached in Appendix A).

SITE ACTIVITIES

The site will be home to an Extruded Polystyrene (XPS) process; the plant is still under design. Polystyrene (PS) raw material will be stored in a covered outdoor storage area and received into the main factory building where an XPS extrusion machine will be installed.

Resin (made up of Polystyrene (94% of the resin), New-cleating, Flame retardant material, Colour and Process Aid) will be combined with blowing agents (CO_2, Dimethyl Ether (DME), R152a and Ethanol (Etoh)) in a specific combination to produce the XPS end product. Figure 2.2 shows a block flow diagram of the process.

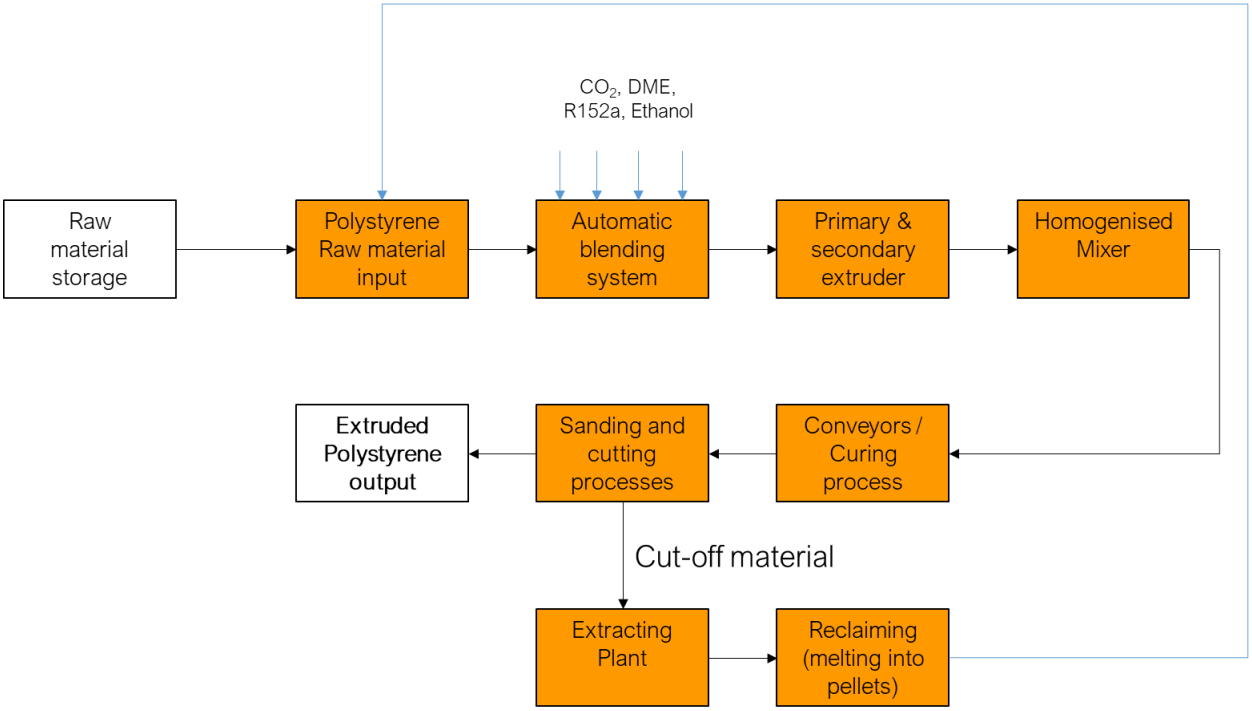

Figure 2.2: Basic Site Process Flow Diagram

METHODOLOGY

The assessment has been conducted in line with the requirements of South African National Standard (SANS) 1461:2018 Major Hazard Installation – Risk Assessments. The standard was published in June 2018; it is now the industry best practice for the compilation of MHI Risk Assessments. All AIAs are now required to perform MHI Risk Assessments according to the requirements of the standard, and it is expected to become a legal requirement once the MHI Regulations are amended (amendment was underway at the time of writing).

The standard provides requirements for the following as part of MHI Risk Assessments:

- Defining the scope of work;
- Gathering relevant data;
- Hazard identification;
- Hazard analysis;
- Consequence analysis;
- Risk calculations (including individual and societal risk);
- Risk judgement criteria;
- Risk treatment;
- Land-use planning;
- Emergency response data (analysing information from the Client);
- Conclusions and recommendations.

INDIVIDUAL RISK

The individual risk contours illustrated in the figures below are of the type 'Location Specific Individual Risk (LSIR)' contours. These show the chance of death of a theoretical person if they are positioned at a particular location 24 hours per day, 365 days per year. LSIR is an overstatement of risk which is widely accepted as sufficiently conservative. In reality, workers will spend the length of a shift per day and not the entire day. However, when a worker is off, another worker may replace her in doing her task, therefore, overall it can be considered that there is an individual at that particular point or area, all of the time.

The risk acceptability criteria are described in Section 4.5.1 and the individual risk profiles for the site are illustrated in Figure 9.1 for people located outdoors.

Individual risk results for those located outdoors

Figure 9.1 illustrates individual risk of death for those located outdoors. Being located outdoors implies a lack of shielding for thermal radiation, as would be the case for those located indoors. The contours extend as follows:

- **The 1 x 10^{-5} / year contour:** At this risk level and below, individual risk is **broadly acceptable for workers** and can be tolerated for members of the public provided that it is proven to be As Low As Reasonably Practicable (ALARP). This contour extends beyond the site to the east, over currently vacant land.

- **The 1 x 10^{-6} / year contour:** This is the level below which risk is *broadly acceptable* and the indicator for MHI status as described in 1.5. This contour extends offsite east over currently vacant land. **This indicates a risk over the servitude that is elevated but still is within 'ALARP' bounds** as described in Section 4.5. This means risk over this area can be tolerated if proven that it is As Low As Reasonably Practicable.

Risk below the 1 x 10^{-6} / year level (indicated by the areas located outside this contour) is considered broadly acceptable.

Risk Judgement:

Because the 1 x 10^{-6} /year risk contour extends beyond the site boundary, the site is considered a Major Hazard Installation (see Section 1.5).

Recommendations for reducing risk further at these locations are provided in Section 12.

Figure 9.1: Individual Risk Contours around the site (individuals located outdoors)

SOCIETAL RISK

Societal risk takes into account populations around the site to determine risk tolerability. In this study, this is presented in the form of an FN-Curve, which illustrates scenarios with the potential to cause death, as well as considers the frequency of each scenario. The frequencies of the scenarios are then summed to show a cumulative risk of death, i.e. the frequency (F) of causing N or more fatalities against the number of fatalities, N.

As illustrated in Figure 9.2 there are tolerability limits as suggested by SANS 1461:2018 (see Section 4.5.2), as illustrated by the red and blue sloped lines. Above the red line is the region where societal risk is intolerable; below the blue line is the region where societal risk is broadly acceptable. Between these lines is the region where risk can be tolerated if it is proven to be ALARP (see Section 4.5.2).

Description of the site's FN Curve (societal risk results)

Day time societal risk is based upon activities onsite which take place only during the day and upon day-time population levels, and similarly night time risk is based upon activities taking place at night and also on populations of people during the night. The FN Curve given below is a combination of day time and night time risk.

As seen in Figure 9.2, the maximum number of fatalities which can occur from a single event occurring onsite is just over 120 people. The associated frequency of this event is low, at approximately 1.2 x 10^{-8} / year. This high number of fatalities was driven by the jet fire, flash fire and vapour cloud explosion events observed in the Consequence Analysis Section 7. In that section the hazard ranges for jet fires and flash fires covered large areas around the site. However, the infrequent nature of those events (such as catastrophic failure of equipment) drove the societal risk down and societal risk is assessed as Broadly Acceptable.

Risk Judgement:

Societal Risk for the site is assessed as 'Broadly Acceptable'.

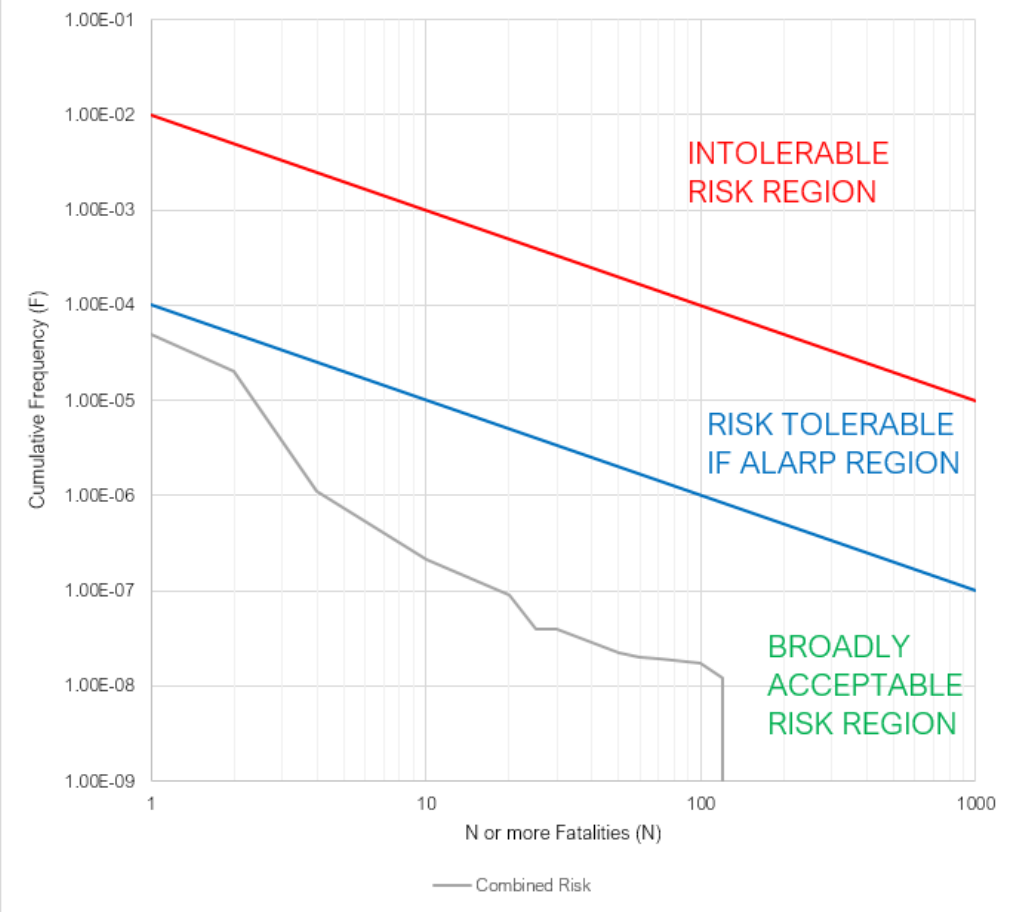

Figure 9.2: FN Curve for Combined Day and Night time risk

IMPACT ON SURROUNDING FACILITIES

As can be seen in the preceding sections there is consequence impact over New Era (to the north), the vacant plot to the east of the site, the site under construction to the south of the site over Charles Matthews Street, as well as Bokomo Foods (to the south-east).

Consequence Effects on surrounding MHIs

Section 7 Consequence Analysis showed jet fire, flash fire and vapour cloud explosion impact over New Era and Bokomo Foods. The result of these events might be initiation of loss of containment events at those sites, due to elevated thermal radiation and overpressure levels.

Emergency procedures for dealing with events taking place at the site should involve notification of neighbours to ensure that they are able to evacuate as necessary to minimise injuries and fatalities.

There is impact over other non-MHI neighbours to the south (the construction site) as well as immediately the vacant plot east of the site. Should the site receive notification of proposed developments in those areas, consequence and risk analysis information compiled in this report should be used to inform developers of the risk due to the site's operations.

RECOMMENDATIONS

Based on the risk analysis herein, the following recommendations are made:

Recommendation Number:	1
Recommendation wording:	Carry out advertisement and notification as required by provision 2(1) of the MHI Regulations.
Rationale:	The 1 x 10-6 /year individual risk contour extends beyond the boundary of the site as indicated in Figure 9.1 therefore MMRisk declares the site a Major Hazard Installation.
Priority:	High

Recommendation Number:	2
Recommendation wording:	Ensure the following safety systems / considerations are given during the design, in order manage risk at the site: a) Road tankers are designed to SANS 1518 and adequately maintained (confirm with suppliers); b) Operator presence at all times during offloading; c) Drained area for tanker offloading linked to a separator system; d) Installation of Emergency Stop Buttons at various locations around the site; e) Ensure inspections are performed on equipment carrying hazardous materials s per relevant SANS standards; f) Consider physical barriers between tanks and pathways and other equipment to avoid collisions leading to losses of containment; g) Ensure that clear routes for personnel and equipment movement are demarcated; h) Ensure adequate training of personnel on the handling of hazardous materials; i) Implement ignition source control within the raw materials, blowing agent and XPS storage areas; j) Ensure adequate separation of XPS storage area from other flammable materials. k) Ensure bunding and containment systems are designed per SANS standards, as appropriate;

	l) Consider installation of gas detection, heat detection and other detection systems, as appropriate, within the blowing agent storage area; m) Where appropriate, consider possible compartmentalisation of tanks to prevent complete loss of hazardous material in case of leaks. n) Consider installation of measures to decrease consequence distances in case of fire, e.g. fire walls in the vicinity of blowing agent storage, however, taking into account the potential for further confinement as a result.
Rationale:	The analysis performed in this report identified several elements to be considered, which are safety critical.
Priority:	High

Recommendation Number:	3
Recommendation wording:	Ensure that the site's existing fire system is checked by a qualified Fire Engineer and if need be, upgraded.
Rationale:	The site has an existing fire system which was inherited from the previous site owner.
Priority:	High

Recommendation Number:	4
Recommendation wording:	Involve notification of neighbours in the site's emergency procedures
Rationale:	Several fire and explosion events were shown to impact on neighbours. This will ensure that neighbours are able to evacuate as necessary to minimise injuries and fatalities as a result of fires/ explosions at the site.
Priority:	High

Recommendation Number:	5
Recommendation wording:	Compile an Emergency Response Plan for the site, in line with SANS standard 1514 for Emergency Response Plans for MHIs, and considering local by-laws.
Rationale:	Emergency Response Plans are a requirement of the MHI Regulations.
Priority:	High

Recommendation Number:	6
Recommendation wording:	Re-do the MHI Risk Assessment after 5 years, or re-do the assessment if details of the installations change significantly, or if a loss of containment event occurs.
Rationale:	Reviews of the MHI Assessments are a requirement of the MHI Regulations.
Priority:	Low

Table of Contents

1 INTRODUCTION

1.1 Scope of Risk Assessment

MMRisk (Pty) Ltd were contracted by Swartland Insulations (Pty) Ltd ('Client') to conduct a Major Hazard Installation (MHI) Risk Assessment of their proposed an Extruded Polystyrene (XPS) processing plant in Atlantis, Western Cape, South Africa (the 'site'). MMRisk are accredited by the South African National Accreditation System (SANAS) and approved by the Department of Labour to conduct Major Hazard Installation (MHI) Risk Assessments (AIA approval Number CI MHI 0013, approval certificates attached in Appendix A).

1.2 The site visit

A site visit was conducted on 25 February 2019 for purposes of information gathering. MMRisk representative Motlatsi Mabaso met with the Quality and R&D Manager Derrick Nel at the proposed Site. During the visit, technical information, and information on the surroundings, was gathered by way of a questionnaire and note-taking. A site walkabout was also conducted to familiarise MMRisk with the layout of the site, the equipment and processes taking place onsite. After the site visit, MMRisk staff drove around the site to familiarise themselves with the neighbours, paying particular attention to potential MHI sites.

1.3 Report layout

The MHI Risk Assessment has been completed in line with the requirements of the Major Hazard Installation Regulations No. R 692 ('MHI Regulations') published in July 2001 and forming part of the Occupational Health and Safety Act No. 85 of 1993, Section 43 (1)(c).

Regulation 5 (5)(b) of the MHI Regulations requires that MHI reports contain at least the following information (all of which is fulfilled in this report):

i. A general process description of the facility;
ii. A description of the major incidents associated with that type of installation and the consequences of such incidents, which shall include potential incidents;
iii. An estimation of the probability of a major incident;
iv. A copy of the site emergency plan;
v. An estimation of the total result in the case of an explosion or fire;
vi. In the case of toxic release, an estimation of concentration effects of such release;
vii. The potential effect of an incident on a major hazard installation or part thereof on an adjacent major hazard installation or part thereof;
viii. the potential effect of a major incident on any other installation, members of the public and residential areas;
ix. Meteorological tendencies;

x. The suitability of existing emergency procedures for the risks identified (covered in the emergency plan); and
xi. Any organisational measures that may be required.

1.4 Risk Assessment Methodology

The assessment has been conducted in line with the requirements of South African National Standard (SANS) 1461:2018 Major Hazard Installation – Risk Assessments. The standard was published in June 2018; it is now the industry best practice for the compilation of MHI Risk Assessments. All AIAs are now required to perform MHI Risk Assessments according to the requirements of the standard, and it is expected to become a legal requirement once the MHI Regulations are amended (amendment was underway at the time of writing).

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- Hazard analysis;
- Consequence analysis;
- Risk calculations (including individual and societal risk);
- Risk judgement criteria;
- Risk treatment;
- Land-use planning;
- Emergency response data (analysing information from the Client);
- Conclusions and recommendations.

1.5 Basis for declaring site a MHI or not a MHI

The basis for declaring the site an MHI or not an MHI shall be based on regulation 2.(1) of the MHI Regulations, which reads:

"Subject to the provisions of subregulation (3) these regulations shall apply to employers, self-employed persons and users, who have on their premises, either permanently or temporarily, a major hazard installation or a quantity of a ***substance which may pose a risk that could affect the health and safety of employees and the public****."*

This report shall consider "a risk" as contemplated in regulation 2(1) to be a quantity of risk which is higher than the level considered 'broadly acceptable' as described in SANS 1461:2018. Therefore, if the individual risk resulting from the site's operations results in off-site risk which is higher than 'broadly acceptable' level, then the site shall be declared a MHI.

Risk Tolerability is explained in detail in Section 4.5.

1.6 Major Assumptions

The following assumptions were made in the compilation of this study:

- On site there is an existing building which is used by another company (Huhtamaki) to store airbags. The airbags are assumed to contain sodium azide, which can break down in the presence of heat to form Sodium and Nitrogen. The dispersion of nitrogen could be expected were an event to take place inside the building.

- The release of nitrogen described above is expected to result in the inflation of the airbags and not to be released en masse in an acute manner. Any release of nitrogen through the vents of the building is expected to happen gradually. Therefore, there is not expected to be a major accident which results in the release.

- There is a flammable store proposed for the site and MMRisk assumes that it will be designed to required standards and by-law requirements.

- Due to the envisaged usage statistics of carbon dioxide, CO2, Ethanol and dimethyl ether, road tanker loading will occur so infrequently that the tanker would only be available onsite a fraction of the time (approx. 8.5×10^{-5}) in a year. Taking into account frequency of hazard outcomes, the risk would be low, in the region of 10^{-11} and would therefore be negligible. Material storage would dominate the Risk. Therefore for those materials, road tanker delivery risk has been ignored.

- The XPS machine will draw blowing agents into itself and no pumps or compressors will be situated near raw material storage area.

- All liquid tanks and their associated bunds will be designed to required South African National Standards (SANS) and / or other recognised standards.

2 DESCRIPTIONS

2.1 Site location

The Site under study is located in the Atlantis Industrial Area surrounded by a number of other industrial facilities, the site location is 3 Charles Matthews Street, Atlantis Industrial, Cape Town, 7349. The GPS coordinates are: 33°35'25.99"S, 18°28'33.25"E.

The Site forms part of a number of facilities in the Atlantis area belonging to Swartland Investments (Pty) Ltd. The neighbouring facilities are a combination of food manufacturers, packaging companies, flammable gas distributors and other industrial facilities. The site and its neighbours are shown in Figure 2.1 and described in the sections which follow.

Figure 2.1 The Site and Surroundings

2.1.1 Nearby Major Hazard Installations

The site is surrounded by a number of MHI sites or potential MHI sites detailed in Table 2.1. For those facilities, the assumed population statistics are also provided in the table. Where the population density was assessed to be too high, the population of that facility was moderated and the density of the Site was assumed. Furthermore, it was assumed that at any given moment during the day, 93% of the population would be located indoors and 7% outdoors. For night-time, it was assumed that 99% of the population is indoors and only 1% is outdoors.

Table 2.1: MHIs located close to the site

Facility/ Area	Indicated by Number:	Distance from site (m)	Direction	MHI facility?	Site Size (hectare)	Assumed Population
Pioneer Foods Bokomo – *food manufacture*	1	18	South	Possible MHI	5.73	80 people per hectare = 458 people
Huhtamaki *- airbag manufacture*	4	205	East	Possible MHI	1.12	80 people per hectare = 90 people
Laboh Gas *- LPG distribution*	5	315	West-south-west	Possible MHI	0.24	40 people per hectare = 9 people
Fibermill SA *- industrial fabrics*	8	423	East	Possible MHI	1.46	40 people per hectare = 58 people
Golden Era Group *- packaging*	9	40	North	Possible MHI	2.39	80 people per hectare = 191 people
Brits Nonwoven *- thermal insulation manufacture*	11	230	North-east	Possible MHI	1.1	80 people per hectare = 88 people
Atlantis Foundries *- metal foundry*	15	492	South	Yes	9.18	80 people per hectare = 730 people

2.1.2 Other nearby Industrial neighbours

There are several other neighbours which may not be MHIs, shown in Table 2.2. For these surrounding areas it is assumed that at any given moment during the day, 93% of the population is located indoors and 7% outdoors. At night, it is assumed that 99% of the population is indoors and only 1% is outdoors unless otherwise indicated in Table 2.2.

Table 2.2: Other nearby industrial neighbours

Facility/ Area	Indicated by Number:	Distance from site (m)	Direction	MHI facility?	Site Size (hectare)	Assumed Population
Construction site (unknown occupant)	2	30	South	Unsure	1.13	80 people per hectare = 90 people
Time Link Cargo	3	780	South-east	Probably not	0.72	40 people per hectare = 29 people
Fabricated Steel Manufacturing Company	6	337	South-east	Probably not	0.26	40 people per hectare = 10 people
Express Hauliers	7	475	South-east	Probably not	2.89	40 people per hectare = 115 people
GPG Engineering Supplies	10	408	East-north-east	Probably not	0.95	40 people per hectare = 38 people
Eat and Smile (Café)	12	381	East-north-east	Probably not	0.7 total buildings	10 people per shop = 30 people
NDI Plumbers	14	356	East-south-east	Probably not	0.15	40 people per hectare = 6 people

2.1.3 Nearby vacant land and premises

There is vacant land near and some vacant premises near the Site, details are provided in the table below.

Table 2.3: Nearby vacant land and premises

Facility/ Area	Indicated by Number:	Distance from site (m)	Direction
Empty premises	13	211	South
Vacant land	-	Immediate neighbours	East and West

2.2 Company's main activities

The site will be home to an Extruded Polystyrene (XPS) process; the plant is still under design. Polystyrene (PS) raw material will be stored in a covered outdoor storage area and received into the main factory building where an XPS extrusion machine will be installed.

Resin (made up of Polystyrene (94% of the resin), New-cleating, Flame retardant material, Colour and Process Aid) will be combined with blowing agents (CO_2, Dimethyl Ether (DME), R152a and Ethanol (Etoh)) in a specific combination to produce the XPS end product. Figure 2.2 shows a block flow diagram of the process.

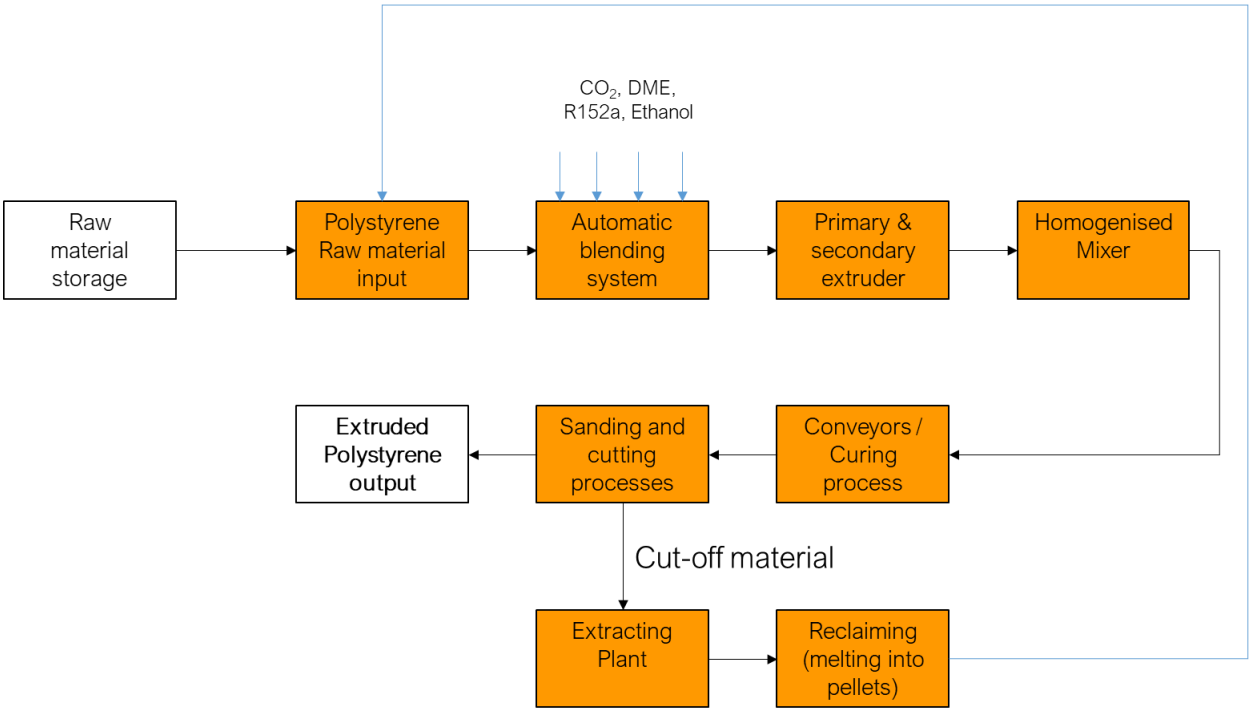


Figure 2.2: Basic Site Process Flow Diagram

The locations of various installations onsite, including raw material storage, raw material input, main process building and XPS product storage, are shown in Figure 2.3 at the site's current state, before installation of any of the facilities.

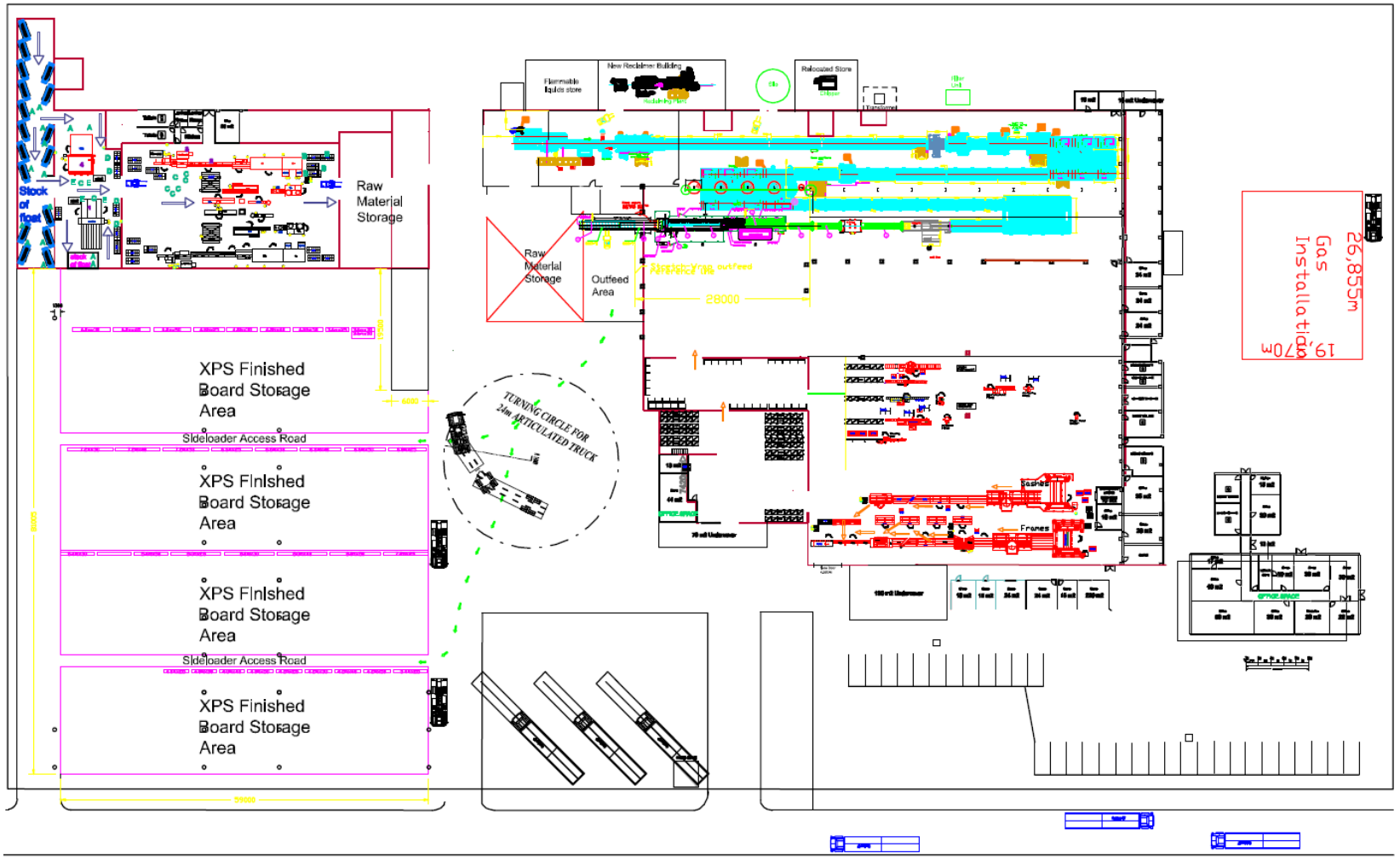


Figure 2.3: Proposed locations of various installations onsite

The process can be described as follows:

Material Receipt

The following materials are received onsite via bulk truck or road tanker:

(A) Materials making up the resin:

- Polystyrene (94% of the resin), the balance of which contains
- New-cleating
- Flame retardant
- Colour
- Process Aid

(B) Blowing agents:

- CO_2
- Dimethyl ether (DME)
- 152a (gas)
- Ethanol

The resin and blowing agents will be combined and the process will proceed through an XPS machine located inside the main processing building. The process is illustrated in Figure 2.2.

Processing and Storage onsite

Raw Material Storage

Polystyrene (PS) storage will be in a covered area in the dedicated raw material storage area north-west of the site. Blowing Agent storage will be via dedicated tanks located west of the main processing building and south of the raw material storage area.

Material transportation

PS will be transferred to the process building via 25 kg bags. Blowing Agent will be transferred to the process building via pipework.

XPS Storage

XPS will be stored in the XPS Finished Board Storage Area to the west and south-west of the site.

Dispatch of Material

XPS dispatch

XPS will be dispatched from the Finished storage area, via truck.

There is a small building onsite used by Huhtamaki (third party) to store faulty airbags. The airbags are assumed to contain sodium azide, which can break down in the presence of heat to form Sodium and Nitrogen (see Major Assumptions Section 1.6). The dispersion of nitrogen could be expected were an event to take place inside the building. However, the release of nitrogen is expected to result in the inflation of the airbags and not to be released en masse in an acute manner. Any release of nitrogen through the vents of the building is expected to happen gradually. Therefore, there is not expected to be a major accident which results in the release.

On site there is also a flammable store planned onsite to carry small drum quantities of flammable substances.

2.3 Staff complement and shift patterns

The site will function as a 24 hour per day, 7 days per week operation with shifts and personnel described in

Table 2.4: Site shift patterns and personnel data

Aspect	Details
Operating Hours:	24 hours per day, 7 days per week
Shift 1:	06h00 to 14h00
Shift 2:	14h00 to 22h00
Shift 3:	22h00 to 06h00
Shift 4:	
Admin Staff hours:	08h00 to 17h00
Total Staff Complement:	12 people
Staff Distribution	
Locations: 1. Factory Building 2. Admin Area 3. Transfer area	*Number of personnel:* Shift 1: Shift 2: Shift 3: 1. 8 8 8 2. 2 (08h00 to 17h00) 3. 2 2 2

2.4 Process Description

The site's operations are illustrated in Figure 2.2 can be broken down into various sections:

- Receipt of Material onsite;
- Storage and processing of materials.

2.4.1 Material receipt by road tanker

Several of the materials will be received by road tanker as described in Table 2.5.

Table 2.5: Material road tanker receipt statistics

Material	Loading frequency	Road tanker capacity (kg)	% time hazard onsite	Hose diameter (mm)	Limited Area
CO_2	30,000 kg load / 124 kg/day consumption = once in 8 months	-	Very small (see Major Assumptions section 1.6)	-	-
DME	30,000 kg load / 315 kg/day consumption = once in 3 months	30,000	Assume 1 hour on site every 3 months = 4 hours/ year = 4/8640 = 4.6e-4	Assume 2 inch	Not required-gas
R-152a	30,000 kg load / 134 kg/day consumption = once in 7.5 months	-	Very small (see Major Assumptions section 1.6)	-	-
Ethanol	~ 30,000 kg load / 172 kg/day consumption = once in 6 months.	-	Very small (see Major Assumptions section 1.6)	-	-

2.4.2 Processing and storage of materials onsite

2.4.2.1 Blowing Agent Storage

The Blowing Agents materials are stored onsite, at a dedicated material storage section shown in Figure 2.3 as 'Gas Installation'. Details of the storage is shown in this section.

Table 2.6: Blowing Agent Storage

Material	Tank capacity (m^3)	Storage temperature (°C)	Storage pressure (barg)	Bund height (m)	Bund area (m^2)	% time hazard onsite
Ethanol	9	Ambient	Atmospheric	1 (assumed)	10 (assumed)	1
CO2	22	-23	17.2	Assumed unbunded (vapour)	-	1
DME	44	Ambient	4	Assumed unbunded (vapour)	-	1
R-152a	9	Ambient	4	Assumed unbunded (vapour)	-	1

2.4.2.2 Piping from storage to process

Blowing agents will be piped from storage to the process, with details as follows:

Table 2.7: Details of piping from storage to process

Material	Throughput (kg/day)	Line diameter (inch) (assume)	Ave. Line length	No. of lines	Total line length (m)	Spill area (m2)	% time hazard onsite
Ethanol	172	2	=11*1.5 = 16 m	1	16	217	1
CO2	124	2	16	1	16	-	1
DME	315	2	16	1	16	-	1
R152a	134	2	16	1	16	-	1

2.5 Meteorological tendencies

The weather conditions around the site, which are used for risk analysis, were obtained from South African Weather Service data, as analysed and summarized in the website weatherbase.com. Data from the closest South African Weather Service weather station (Malmesbury – 0041388 0) was used as analysed in weatherbase.com[1].

2.5.1 Ambient temperature, pressure, humidity and rainfall

Ambient Temperature and Pressure

- Warmest months: January and February
- Coolest month: July
- The average annual maximum temperature is : 17.4°C

Air Pressure was calculated based on the site's elevation above sea level, using the webpage: www.mide.com/pages/air-pressure-at-altitude-calculator.

- Based on the site's elevation of 141 m above sea level the ambient pressure was taken to be = 0.98 bar.

Humidity

Humidity is of interest because it affects the rate at which thermal radiation transfers from a flame to a target, such as a person, building or piece of equipment. The more humid the conditions, the more radiation is absorbed by the water vapour and the less radiation is felt by the target.

- On average, June and July are the most humid months (ave. 73% humidity).
- On average, November to February are the least humid months (ave. 62% humidity).
- The average annual percentage of humidity is: 67.2%.

Rainfall

Similar to humidity, the presence of rain is of interest because water droplets absorb some radiation in the case where this is

- On average, June and July are the wettest months, with October being the wettest month with average precipitation of 85 to 86 mm.
- On average, January is the driest month with 12 mm precipitation.
- Average total annual precipitation is 526 mm.

[1] Weatherbase.com. Malmesbury monthly averages summary, Retrieved on 16 April 2019 from, http://www.weatherbase.com/weather/weather.php3?s=604966&cityname=Malmesbury-Western-Cape-South-Africa.

2.5.2 Wind statistics

Wind statistics were based on observations taken between December 2011 to February 2019, daily from 7am to 7pm local time, recorded at Malmesbury weather station. Wind statistics were obtained from https://www.windfinder.com/windstatistics/malmesbury

Wind statistics were taken into account in the risk modelling. Considering the yearly average wind direction distribution, the majority of wind tends come either **from** south-south-west and from the north-north-east . The wind rose is shown in Figure 2.4.

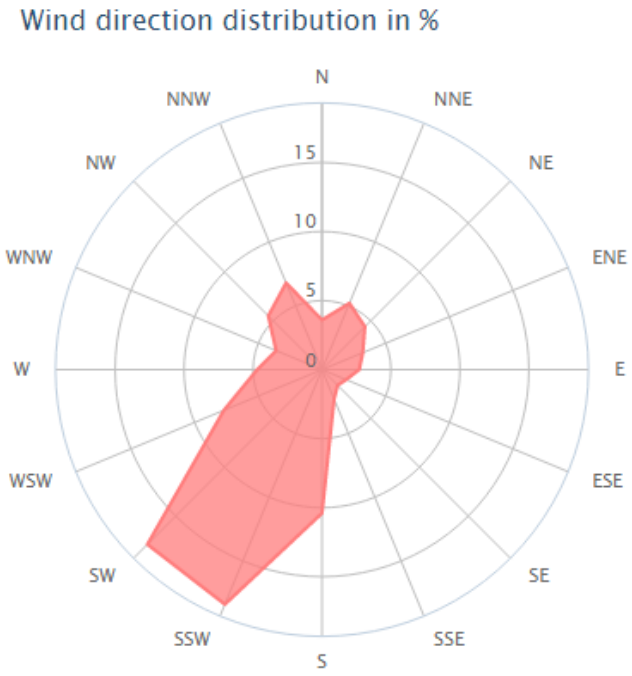


Figure 2.4: Wind Statistics at site

2.5.3 Weather conditions used for modelling in this assessment

2.5.3.1 Introduction to Weather Stability Classes

As required in SANS 1461:2018, several weather conditions have been used in the modelling of consequence and risk in this assessment. The choice of weather conditions is in the form of so-called 'Pasquill stabilities';

Pasquill stabilities are measures of 'the tendency of the atmosphere to resist or enhance vertical motion' [2]. Stability is a function of the vertical change in temperature of the air, the wind speed and the type of surface over the area of interest. Stabilities are characterised into the following categories:

- Neutral: mechanical turbulence is neither enhanced nor inhibited;
- Unstable: Where turbulence is enhanced; and
- Stable: Where the atmosphere inhibits mechanical turbulence.

Stability classes (Pasquill classes) can be defined for various meteorological instances, as functions of wind speed and solar radiation. Commonly, six Pasquill stability classes are defined:

Table 2.8: Pasquill Stability Classes and descriptions

	Stability Class	Description of Stability
1.	A	Very Unstable
2.	B	Unstable
3.	C	Slightly unstable
4.	D	Neutral
5.	E	Stable
6.	F	Very stable

The stability classes can be related to several driving forces: wind speed, solar radiation and cloud cover as follows:

Table 2.9: Relating Stability Classes to wind speed, cloud cover and solar radiation

Wind speed (m/s)	DAY Incoming solar radiation			NIGHT	
	Strong	Moderate	Slight	> 4/8 cloud	< 3/8 cloud
< 2	A	A - B	B		
2 - 3	A - B	B	C	E	F
3 - 5	B	B - C	C	D	E
5 - 6	C	C - D	D	D	D
> 6	C	D	D	D	D

[2] AirWare Online Reference Manual: Pasquill Stability Classes, Release Date 2007 06, Revision Level 1.1. Retrieved from http://www.ess.co.at/MANUALS/AIRWARE/stability_class.html on 23 March 2018.

2.5.3.2 Stability Classes and wind speeds used in this Assessment

To represent a range of weather conditions possible at the site, and in accordance with SANS 1461:2018, the following stability classes and wind speeds were used in this assessment along with the corresponding time of day:

- F stability, 1.5 m/s wind (Night) @ 11.8 °C;
- B stability, 3 m/s wind (Day) @ 22.7 °C;
- D stability 5 m/s wind (Night) @ 11.8 °C;
- D stability 9 m/s wind (Day) @ 22.7 °C.

3 SITE-SPECIFIC INHERENTLY SAFER DESIGN

This section provides a forum for discussion of issues discovered by MMRisk either during the site visit or during the modelling and reporting exercise. The purpose of the section is to emphasise those areas which might require improvement in order to make the design inherently safer. Alternatively, it is also a forum where MMRisk may raise issues of commendable safety-practice which go above and the beyond the respective requirements.

Because the site is in design stage, several preventive and mitigation measures have been identified in this assessment. Some of these measures have been made into recommendations for consideration by the design team to ensure risk is reduced to a level as low as reasonably practicable (ALARP).

4 RISK ANALYSIS AND ASSESSMENT METHODOLOGY

"Risk is a combination of consequence and likelihood of occurrence."

The MHI Risk Assessment was conducted using the methodology described in Figure 4.1. The SANS 1461:2018 standard (Major Hazard Installation – Risk Assessments) was used as a basis for calculation. The standard prescribes the methodology to be followed when conducting MHI Risk Assessments, including methods for identifying hazards, conducting consequence and frequency analysis, performing risk summation, assessing risk outcome (the standard provides risk tolerability criteria), demonstrating that risk is As Low As Reasonably Practicable (ALARP) and types of Risk to be communicated in the MHI Risk Assessment report.

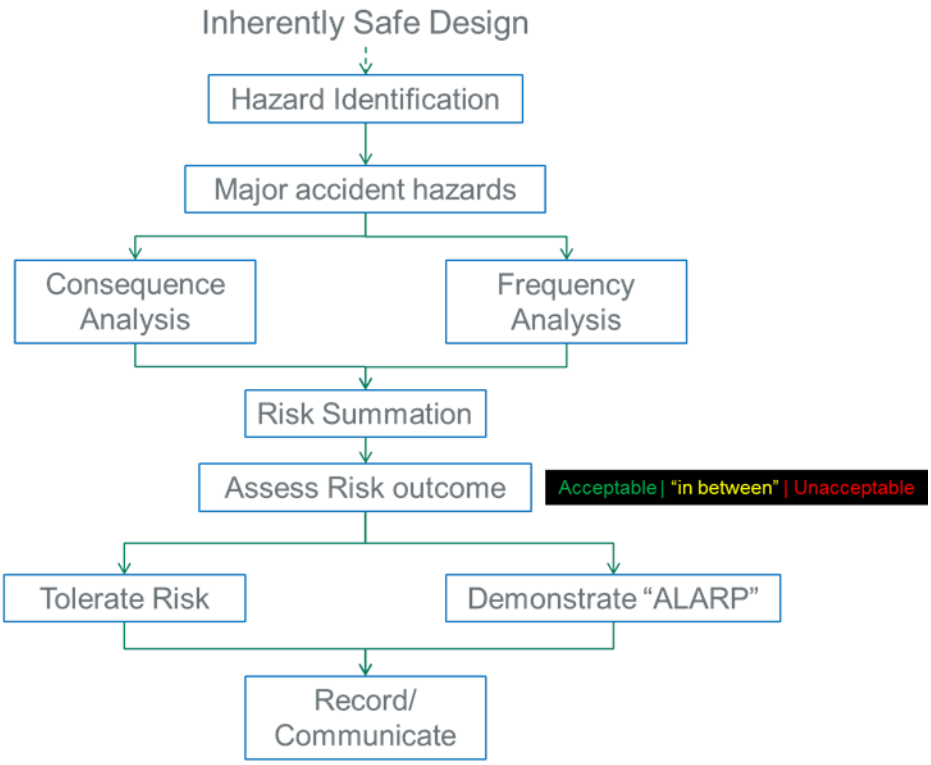


Figure 4.1 Risk Assessment Methodology

4.1 Inherently Safer Design

"Are there opportunities to make the process safer by design, free of hazards as much as possible?"

Using the concept of Inherently Safe Design and Operation, MMRisk observed operations, information and descriptions as given at the site visit and formed an opinion on possible areas of change which may lead to a

design and operations which are inherently safe. The Inherently Safer review included looking for opportunities to:

- **Minimise:** Finding opportunities to reduce inventories of hazardous materials;
- **Substitute:** Finding opportunities to substitute hazardous materials with less hazardous ones;
- **Moderate:** Where appropriate, finding opportunities to operate at less hazardous conditions which are far from equilibrium for the materials handled, e.g. less pressure, less temperature.
- **Simplify:** Simplify activities where possible to reduce the opportunities for failure.

4.2 Hazard Identification

"What major hazards exist on site? What can go wrong?"

Hazard Identification (HAZID) followed the widely used methodology involving the segregation of the process into nodes or constituents' parts or individual installations and investigating each node/ part/ installation to identify hazards which are inherent in the process as well as their causes, consequences and possible mitigation measures. This is a high level review described in SANS 1461:2018 "Major Hazard Installation Risk Assessments".

The HAZID was performed remotely by MMRisk and the results are communicated in Section 5 of this study.

4.3 Consequence Analysis

"Were hazards to be realised, what would be effects of major incidents occurring?"

This section details the major incidents associated with the types of installations and/or hazardous materials present onsite, potential incidents and the consequences of those incidents.

4.3.1 Pool Fire Modelling

Ethanol presents a pool fire hazard and as such modelling was performed to determine which of the installations present would a significant risk to members of the public and employees.

Pool fires occur when a pool of flammable liquid is formed on the ground and ignited. Bunded or kerbed areas have to be taken into account to determine the size of the pool and the effects.

The following endpoints were modelled in line with SANS 1461:2018:

- 37.5 kW/m^2 representing a 100% fatality probability for those exposed and ignition of wood, textiles, fibreboard, hardboard and plastics. This also corresponds with severe damage to process equipment, possible domino effects and large numbers of fatalities.
- 12.5 kW/m^2 representing minor damage to process equipment and less than 1 % fatalities; and

- 6.3 kW/m^2 representing a radiation level useful for emergency response planning. People exposed to this radiation level or more for more than 2 minutes may encounter problems with escape and evacuation and therefore be at risk of injury and death.

Pool fire modelling was conducted using DNVGL Phast and Safeti version 6.7.

4.3.2 Jet Fires

DME and R152a present a jet fire hazard due to pressurised storage and the properties of the materials. If a leak were to occur through one of the pieces of equipment carrying either of these materials at pressure, a vapour, or two phase release would occur and if immediately ignited would result in a jet flame whose length would be driven by pressure in the system.

The jet flame would result in thermal radiation effects from the flame itself to some distance away from the flame. Individuals, structures and equipment would be exposed to that thermal radiation level, with those indoors being afforded some protection from the radiation effects.

The following endpoints were modelled in line with SANS 1461:2018:

- 37.5 kW/m^2 representing a 100% fatality probability for those exposed and ignition of wood, textiles, fibreboard, hardboard and plastics. This also corresponds with severe damage to process equipment, possible domino effects and large numbers of fatalities.
- 12.5 kW/m^2 representing minor damage to process equipment and less than 1 % fatalities; and
- 6.3 kW/m^2 representing a radiation level useful for emergency response planning. People exposed to this radiation level or more for more than 2 minutes may encounter problems with escape and evacuation and therefore be at risk of injury and death.

4.3.3 Flash Fire and Vapour Cloud Explosion Modelling

When a release occurs through a pressurised gaseous or two-phase system containing flammable material, a vapour cloud can be dispersed over the area surrounding the source. The cloud disperses because to turbulence due to its interaction with the surrounding air. In the process the concentration of flammable vapour in air reduces over distance and over time. For flammable vapours two concentrations are of interest – the lower flammability limit (LFL) concetration and the upper flammability limit (UFL) concentration.

Vapour which disperses to concentration levels between the LFL and the UFL is said to be between its flammability limits and is considered to have the possibility of igniting. Flammable vapour with concentrations below the LFL or above the UFL is considered to not have the possibility of igniting due to too little vapour fuel, or too little oxygen (respectively) to sustain a fire.

4.3.3.1 Flash Fire Effects [3,4]

Flash Fires result when ignition of a flammable cloud occurs in the absence of a significant level of confinement and/or congestion and the effects are dominated by thermal radiation. Two concentration levels: the lower flammability limit (LFL) as well as half (1/2) of the LFL are considered important for risk calculation. For those exposed in the event of a flash fire, the effects would differ depending upon their location indoors or outdoors:

Impact on people located outdoors:

- Those located within the LFL contour would develop deep burns over a major part of their body, especially if no personal protective equipment (PPE) is worn. Those exposed would almost certainly suffer fatal injury due to the superheating effect of a flash fire and the generation of toxic and superheated combustion products (100% fatality probability);

- Those located between the LFL and ½ LFL contours would still be at risk of fatal injury due to the presence of flammable pockets of gas and would be considered to have a 20% probability of suffering fatal injury (20% fatality probability).

Impact on people located indoors:

- For those located within the LFL contour indoors, the thermal impact on buildings may result in parts of the building catching alight. The generation of combustion products indoors is also important, and as a result, those indoors would have a 30% probability of fatality;

- For those between the LFL and ½ LFL contours the probability of death for those indoors is considered negligible.

4.3.3.2 Vapour Cloud Explosions

When a flammable vapour cloud ignites in the presence of significant confinement, the rapid release of combustion gases results in a rapid build-up of pressure which results in the generation of a blast wave. When a flammable vapour ignited in the presence of significant or congestion, the obstacles causing the congestion result in flame acceleration which results the generation of a pressure wave, resulting in a vapour cloud explosion.

Table 4.1 presents the effects of explosion overpressure, based on observations from previous incidents.

Table 4.1: Explosion Overpressure effects (TNO Green Book [3])

Description of Damage	Peak overpressure (kPa)
The roof of a storage tank has collapsed	7

[3] The Netherlands Organisation for Applied Scientitic Research (TNO), Green Book, Methods for determination of possible damage, CPR16E, Den Haag, 1992.
[4] Mannan, Sam. (2012). Lees' Loss Prevention in the Process Industries, Volumes 1-3 - Hazard Identification, Assessment and Control (4th Edition). Elsevier. Retrieved from https://app.knovel.com/hotlink/toc/id:kpLLPPIVH2/lees-loss-prevention/lees-loss-prevention

Description of Damage	Peak overpressure (kPa)
Connections between steel or aluminium ondulated plates have failed. Minor damage to process equipment and less than 1% fatalities	7 – 14
Minor damage to steel frames	8 - 10
Walls made of concrete blocks have collapsed	15 – 20
Collapse of steel frames and displacement of foundation	20
Industrial steel self-framing structure collapsed. Cracking in empty oil storage tanks. Slight deformation of a pipe bridge.	20 – 30
Large trees have fallen down	20 - 40
Cladding of light industry building ripped-off	30
Plating of cars and trucks pressed inwards. Breakage of wooden telephone poles. Severe damage to process equipment, possible domino effects, large numbers of fatalities.	35
Displacement of a pipe bridge, breakage of piping	35 - 40
Collapse of a pipe bridge	40 - 55
Brickstone walls, 20 – 30 cm, have collapsed. Loaded train carriages turned over.	50
Displacement of a cylindrical storage tank, failure of connecting pipes	50 - 100
The supporting structure of a round storage tank has collapsed	100

4.4 Frequency Analysis

"What is the likelihood that the hazards identified, will be realised?"

Frequency analysis relates to the likelihood that an event will occur. This likelihood is based upon previous accidents for similar materials and equipment, and the manner of failure. Often such previous accident data is summarised in the form of frequency databases. In this study, the likelihood of events occurring was based on frequency information from the BEVI publication [5]. This is shown in the table which follows.

[5] Dutch National Institute of Public Health and the Environment (RIVM), Centre for External Safety in their publication Reference Manual Bevi Risk Assessments version 3.2 of July 2009.

Table 4.2: Generic frequency information

Equipment Description	Release Description	Base Frequency
Fixed storage or processing units at atmospheric pressure or lower (for example, tanks, blending vessels) and atmospheric transport units (for example, standard road tankers, intermediate bulk containers (IBCs)	1a) Catastrophic rupture (with bund overtopping if necessary).	5.00E-06
	1b) ROAD TANKER Instantaneous release of contents (Each compartment is considered a tank so frequency is divided by the number of compartments)	1.00E-05
	2) Entire contents released in 10 min or large hole in the processing unit (a large hole is typically the size of the largest appurtenance on the processing unit).	5.00E-06
	3) Small hole in vessel (leak typically 10 mm diameter).	1.00E-04
	4a) Overfilling (if applicable). *OGP Data (Storage Frequencies), from LASTFIRE, 19% of spills outside the bund were from Overfill events	5.32E-04
	4b) Overfilling frequency from Massimo et al.	3.80E-04
	4c) Overfill frequency API 353	1.00E-04
Fixed storage or processing units classified as pressure vessels (for example, reactors, storage spheres) and pressurized transport units (for example, pressurized road tankers, cylinders)	1) Catastrophic rupture with instantaneous failure (including a boiling liquid expanding vapour explosion (BLEVE) where applicable).	5.00E-07
	2) Entire contents released in 10 min or large hole in the processing unit (a large hole is typically the size of the largest appurtenance on the processing unit).	5.00E-07
	3) Small hole in vessel (leak typically 10 mm diameter).	1.00E-05
	4) Pressure safety valve release (if applicable).	2.00E-05
Pipe, hose, arm (onsite pipelines) PER METRE PER YEAR	1) Pipeline, hose, arm full bore rupture.	1.00E-07
	2) Small hole in pipeline, hose, arm (typically a leak with effective diameter of 10 % to 50 % of the pipeline diameter).	5.00E-07
Pumps	Catastrophic failure	1.00E-04

Equipment Description	Release Description	Base Frequency
	Leak (10 % diameter)	4.40E-03

Furthermore, frequency data published is often generic and several facility-specific factors have to be taken into account. This was done in this study by way of event tree analysis. Frequency modelling was carried out in DNVGL Safeti version 6.7, including Event Tree Analysis to determine the likelihood of the various events.

Details of frequencies used in the study are provided in Section 8.

4.5 Risk Summation and Assessment

"The combination of consequence and likelihood are combined and reported here."

Risk summation was carried out using DNV Safeti version 6.7 and individual risk and societal risk were reported. Once risk is calculated, it has to be assessed against standing criteria. In this study, assessment was performed against the acceptability criteria defined by the UK HSE as follows.

4.5.1 Individual Risk Acceptability Criteria

Individual Risk represents the chance that an individual will experience fatal injury as a result of major accidents emanating from site. The risk can be 'acceptable' or 'unacceptable' depending on its magnitude. Individual Risk tolerability or acceptability is based upon data from the UK HSE in their publication 'Reducing Risk Protecting People (R2P2)' [6]. Individual Risk can be categorised into various regions as illustrated in Risk calculated to be below the 1 x 10-5 / year is considered broadly acceptable for workers, while risk below 1 x 10-6 / year is considered broadly acceptable for members of the general public.

[6] The Health and Safety Executive (HSE), Reducing risks, protecting people – HSE's decision-making process, Norwich 2001.

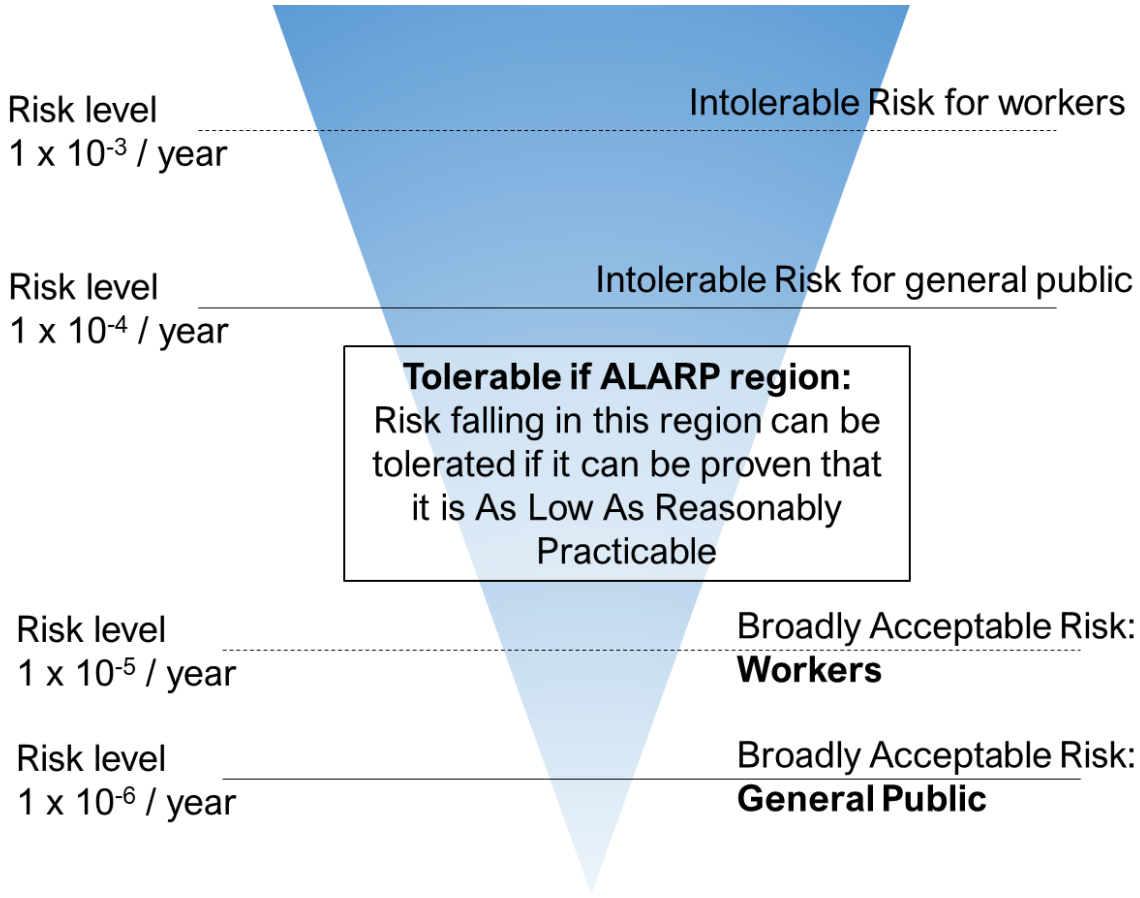


Figure 4.2.

4.5.1.1 Intolerable Risk for workers

Individual Risk calculated to be at or above the 1 x 10^{-3} /year level is considered intolerable for all individuals, including workers at industrial sites. Workers at industrial sites are able to withstand a higher level of risk than members of the general public because they tend to be organised and drilled in emergency response, generally healthier and mobile and tend to be equipped with personal protective equipment (PPE).

4.5.1.2 Intolerable Risk for members of the public

Individual Risk calculated to be at or above the 1 x 10^{-4} /year level is considered intolerable for members of the general public. This level assumes a theoretical individual present for 24 hours per day and 365 days per annum at a location.

4.5.1.3 Risk Tolerable if ALARP

Risk calculated to be between the 1 x 10^{-6} /year and either the 1 x 10^{-4} /year (general public) or the 1 x 10^{-3} /year levels, can be tolerated if proven to be 'ALARP'. The phrase 'ALARP' stands for As Low As Reasonably Practicable. In this region, illustrated in Risk calculated to be below the 1 x 10-5 / year is considered broadly

acceptable for workers, while risk below 1 x 10-6 / year is considered broadly acceptable for members of the general public.

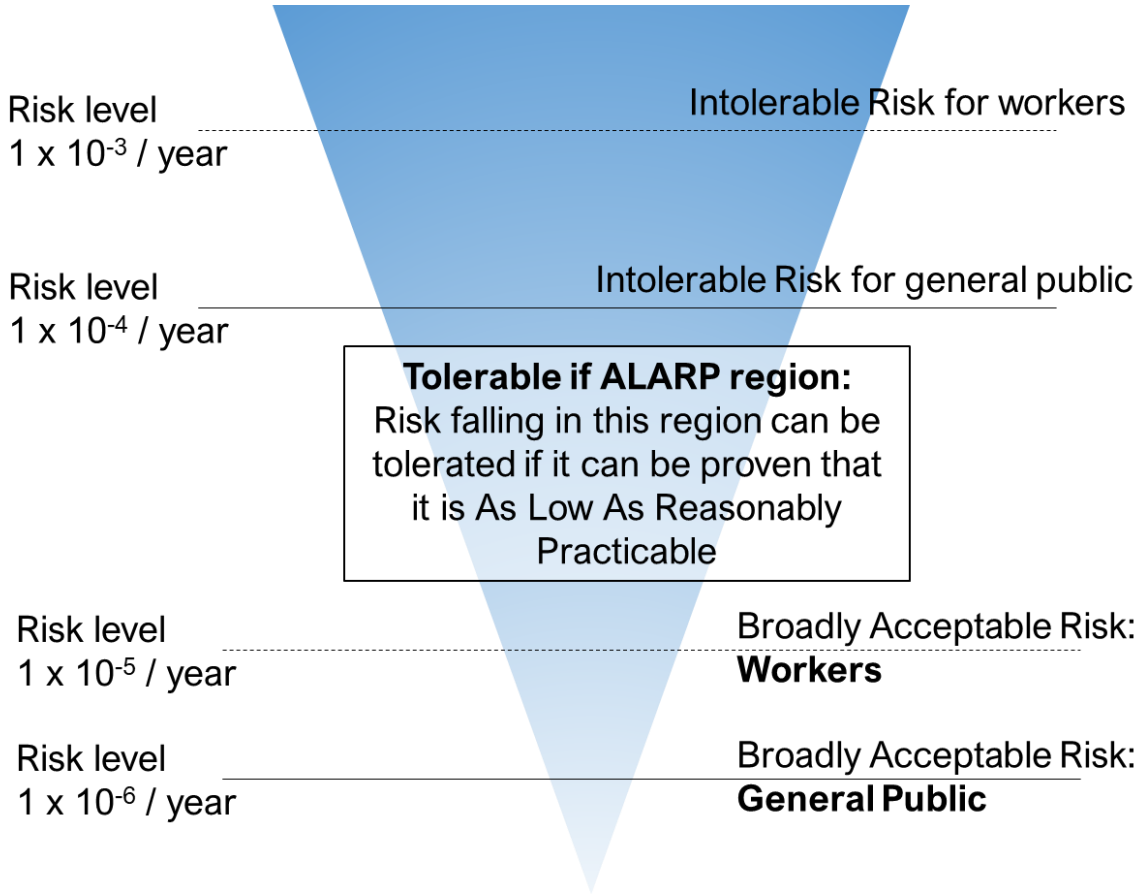


Figure 4.2, risk can be tolerated if it can be proven by site that it has considered options for reducing the risk further that the costs of any measures to further reduce risk are grossly disproportionate to the risk reduction benefits gained.

4.5.1.4 Broadly Acceptable Risk

Risk calculated to be below the 1 x 10^{-5} / year is considered broadly acceptable for workers, while risk below 1 x 10^{-6} / year is considered broadly acceptable for members of the general public.

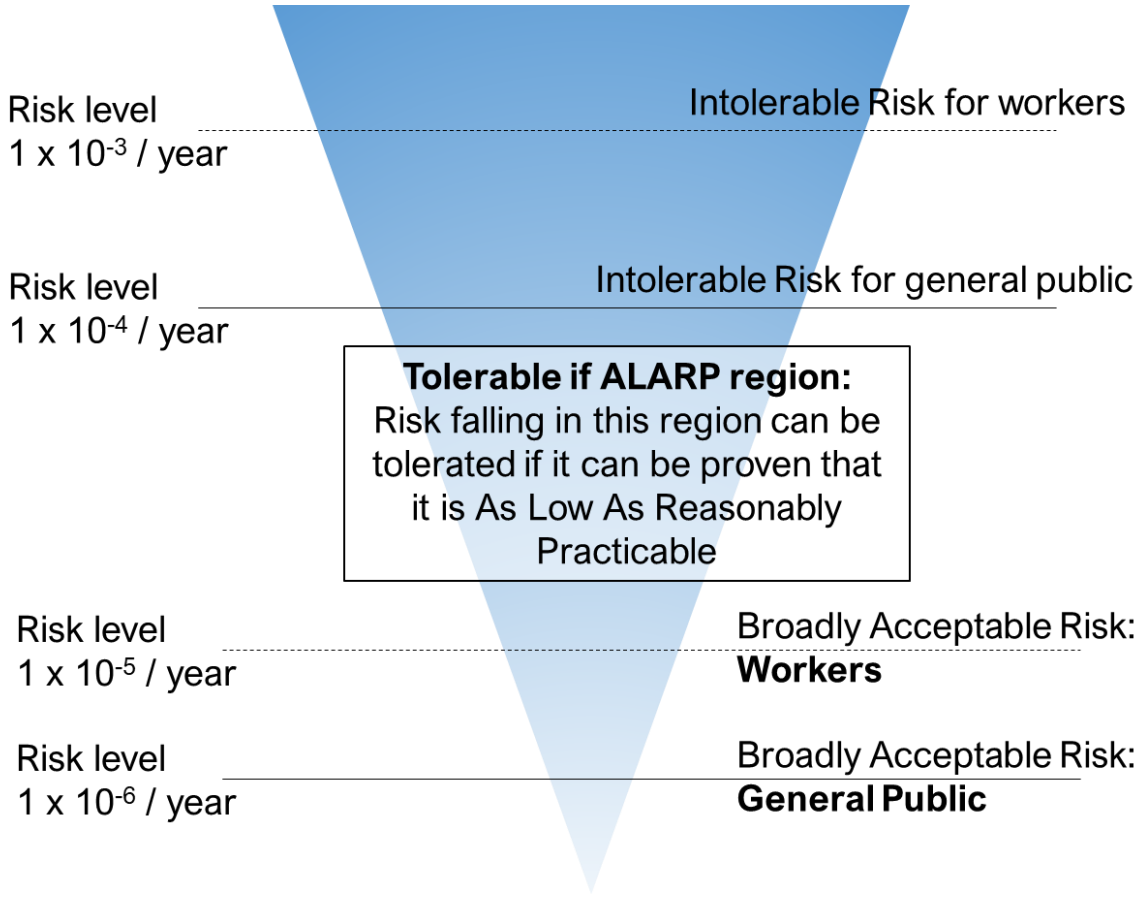


Figure 4.2: Individual Risk Acceptability Criteria [6]

4.5.2 Societal Risk Acceptability

Societal Risk has been presented in this report in the form of an FN Curve. FN Curves are defined in the CMPT publication [7] as plots showing frequency of events vs the number of fatalities arising from those events. They display cumulative frequencies (F) of events involving N or more fatalities. They are useful illustrations the relationship between frequency and size of the accident.

FN Curves often contain risk tolerability criteria; the criteria used in this study was derived from the UK HSE [6] and is illustrated in Figure 4.3. The tolerability criteria are illustrated here using two straight lines (red and blue). The region above the red line indicates a region of intolerable risk, the area below the blue line indicates an area of broadly acceptable risk. Societal risk located between these lines can be tolerated if it is ALARP.

[7] Spouge J, Centre for Marine and Petroleum Technology (CMPT), A Guide To Quantitative Risk Assessment for Offshore Installations, 1999.

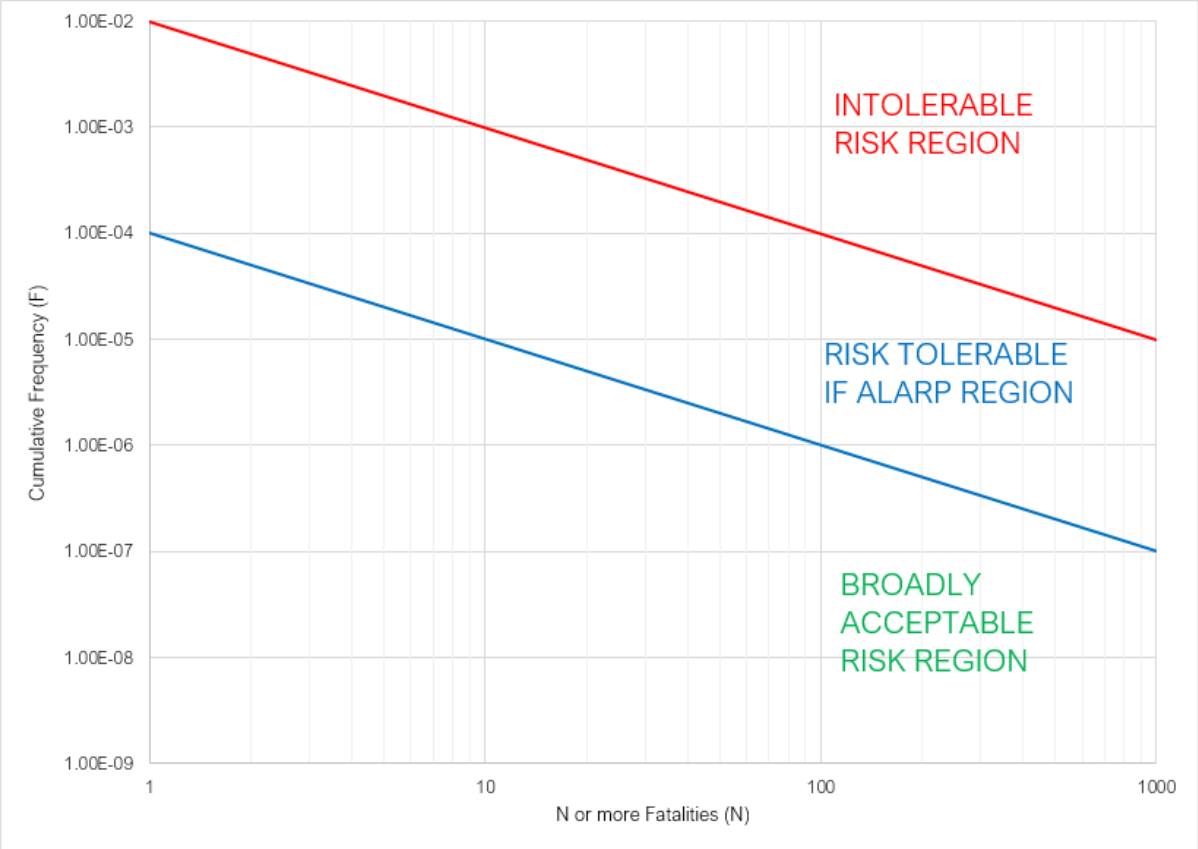


Figure 4.3: An example of an FN Curve showing societal risk acceptability limits

4.5.3 Land Use Planning

Risk was used in this study as a basis for making land use judgments and providing land use advice. The approach is based on the approach defined in SANS 1461:2018 to land use planning which summarises as follows.

4.5.3.1 STEP 1: Consultation Zones

The standard defines three consultation zones: an outer zone, middle zone and inner zone, illustrated in Figure 4.4. Each of the zones is defined according to an individual risk level, as shown in the figure. Once the zones are determined, the appropriateness of land uses or potential land uses in each zone can be determined through a classification of types of land uses.

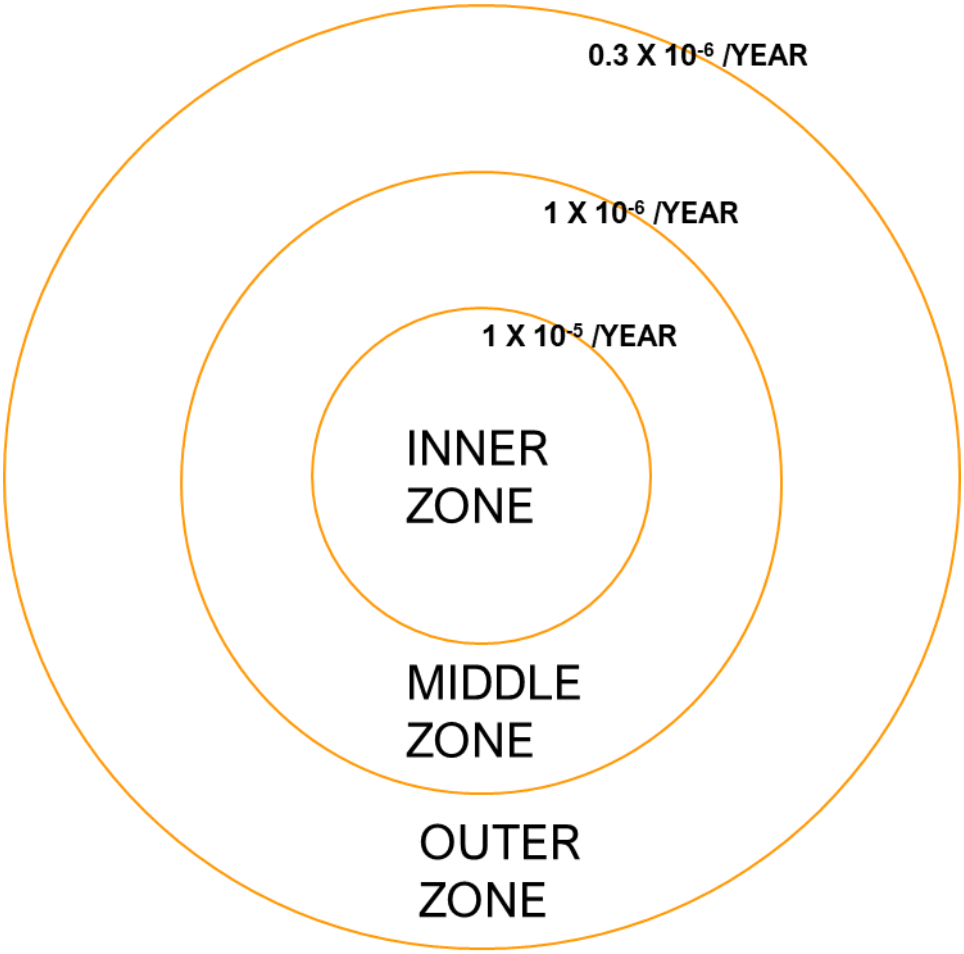


Figure 4.4: SANS 1461:2018 Land Use Planning Consultation Zones

4.5.3.2 STEP 2: UK HSE's Classification of land uses

Land uses can be separated on the basis of their sensitivity to major incidents, as follows:

Table 4.3: Land Use Sensitivity Levels and Descriptions

Sensitivity Level	Type of Land Use
Level 1	Based on normal working population
Level 2	Based on the general public – at home and involved in normal activities
Level 3	Based on vulnerable members of the public (children, those with mobility difficulties or those unable to recognize physical danger
Level 4	Large examples of Level 3 and outdoor examples of Level 2

4.5.3.3 STEP 3: Land Use Advice based on Sensitivity and Consultation Zones

Once the consultation zones and sensitivity levels have been determined, one can provide advice as to whether a type of development can go ahead based on the following guidance:

Sensitivity Level	Development in Inner Zone	Development in Middle Zone	Development in Outer Zone
Level 1	Do Not Advise Against (DAA)	Do Not Advise Against (DAA)	Do Not Advise Against (DAA)
Level 2	Advise Against (AA)	Do Not Advise Against (DAA)	Do Not Advise Against (DAA)
Level 3	Advise Against (AA)	Advise Against (AA)	Do Not Advise Against (DAA)
Level 4	Advise Against (AA)	Advise Against (AA)	Advise Against (AA)

4.6 Risk Treatment

"The major risk issues are highlighted and methods for reducing risk are suggested and assessed."

Following the risk assessment stage, all scenarios resulting in intolerable risk and risk which can be tolerable if proven to be ALARP, were analysed further in the Demonstration of ALARP stage. In this stage, options for risk reduction were considered, criteria for deciding between these options (which may include cost) as well as the resulting decrease in risk if each option is applied.

Should the client require a detailed comparison between options including a cost benefit analysis, this shall be conducted separately.

5 HAZARD IDENTIFICATION

"What major hazards exist on site? What can go wrong?"

5.1 Hazardous Materials onsite

The hazardous materials handled onsite are listed in the table below along with their dangerous goods classification and their physical characteristics.

Table 5.1: Hazardous materials stored onsite

Name	UN/ CASRN number	Storage capacity (m^3)	SANS 10228 category	Physical characteristics
Carbon dioxide	124-38-9	22	Class 2.2	Vapour at room temperature, stored onsite as a liquid
Dimethy Ether (DME)	115-10-6	44	Class 2.1	Vapour at room temperature, stored onsite at liquid-vapour equilibrium
R-152a (difluoroethane)	75-37-6	9	Class 2.1	Vapour at room temperature, stored onsite at liquid-vapour equilibrium
Ethanol	64-17-5	9	Class 3	Liquid at room temperature

It should be noted that another material, known as Brominated SBS, was considered a dangerous good from the perspective of the National Environmental Management Act (NEMA) for the purposes of the environmental authorisation underway at the time of writing. However, from an MHI perspective, while the material's MSDS describes it as 'Benzene, ethenyl-, polymer with 1,3-butadiene, brominated', due to the material's high melting point it was not considered a hazardous material for the purposes of the Risk calculations carried out herein.

5.2 Containment systems for analysis

The system is still under design and it was assumed by MMRisk that the only system to have a bund was Ethanol. The bund was assumed to have been designed to SANS standard such that the bund was capable of carrying 110% of the Ethanol maximum storage.

5.3 Safety systems for prevention and mitigation of major incidents

There is an existing fire-fighting system onsite, consisting of a fire pump, hydrants, hose reels, extinguishers. The system will be required to be checked for functionality and signed off by the Fire Department (City of Cape Town).

5.4 Description of system isolatable sections

Hazardous materials were divided up into sections and each section modelled separately as follows:

- Road tankers and hoses;
- Storage tanks/ vessels; and
- Pipework to the process.

5.5 Details of isolation and other safety systems

Apart from the measures to be introduced by the suppliers of the various materials to be stored onsite, the number of isolation and other safety systems identified is limited. As part of this assessment several preventive and mitigation measures have been identified. Some of these measures have been made into recommendations for consideration by the design team to ensure risk is reduced to a level as low as reasonably practicable (ALARP).

6 HAZARD ANALYSIS

6.1 List of scenarios modelled

The following scenarios were modelled in line with the requirements of the SANS 1461:2018 standard. These scenarios are based on previous accidents in industry and they range in terms of probability of occurrence. The frequency data associated with each scenario is elaborated further in Section 8.1.

Table 6.1: List of scenarios considered in the QRA

Equipment Description	Release Description
Fixed storage or processing units at atmospheric pressure or lower (for example, tanks, blending vessels) and atmospheric transport units (for example, standard road tankers, intermediate bulk containers (IBCs)	1a) Catastrophic rupture (with bund overtopping if necessary).
	1b) ROAD TANKER Instantaneous release of contents (Each compartment is considered a tank so frequency is divided by the number of compartments)
	2) Entire contents released in 10 min or large hole in the processing unit (a large hole is typically the size of the largest appurtenance on the processing unit).
	3) Small hole in vessel (leak typically 10 mm diameter).
	4a) Overfilling (if applicable). *OGP Data (Storage Frequencies), from LASTFIRE, 19% of spills outside the bund were from Overfill events
Fixed storage or processing units classified as pressure vessels (for example, reactors, storage spheres) and pressurized transport units (for example, pressurized road tankers, cylinders)	1) Catastrophic rupture with instantaneous failure (including a boiling liquid expanding vapour explosion (BLEVE) where applicable).
	2) Entire contents released in 10 min or large hole in the processing unit (a large hole is typically the size of the largest appurtenance on the processing unit).
	3) Small hole in vessel (leak typically 10 mm diameter).
	4) Pressure safety valve release (if applicable).
Pipe, hose, arm (onsite pipelines) PER METRE PER YEAR	1) Pipeline, hose, arm full bore rupture.
	2) Small hole in pipeline, hose, arm (typically a leak with effective diameter of 10 % to 50 % of the pipeline diameter).
Pumps	Catastrophic failure
	Leak (10 % diameter)

6.2 Description of causes, consequences, preventive and mitigative measures

A description of the probable causes, end consequences and potential prevention and mitigation measures, associated with the release scenarios described in Section 6.1 is provided in Table 6.2.

Table 6.2: Description of causes, consequences and protective measures

Cause	Prevention measures	Top Event/ Scenario	Mitigation measures	End Consequence(s)
- Onsite road traffic accident (e.g. overturned vehicle) - decoupling of hose connections - Hole through tanker shell from impact or corrosion	- Road tankers to be designed to SANS 1518 and adequately maintained (service providers to confirm) (Recommendation) - Operator presence at all times during offloading (Recommendation)	**Road tanker loss of containment (all materials)**	- Drained area for tanker offloading linked to a separator system (Recommendation) - Emergency Stop Buttons (Recommendation)	- Dispersion of flammable or asphyxiating vapours - Pool Fire (ethanol loss of containment) - Contamination of soil and groundwater from liquid spills - Possible injury and fatality of personnel and public as a result of the above.
- Corrosion leading to leaks through shells - Impact from other equipment or personnel	- Inspections as per relevant SANS standards (Recommendation) - Barriers between tanks and pathways and other equipment (Recommendation)	**Blowing Agents' Storage losses of containment**	- Bunding and containment - Gas detection systems - Emergency shutdown systems - Possible compartmentalisation of tanks to prevent complete loss of material (Recommendations)	- Dispersion of flammable or asphyxiating vapours - Pool Fire (ethanol loss of containment) - Contamination of soil and groundwater from liquid spills - Possible injury and fatality of personnel and public as a result of the above.
- Corrosion leading to leaks through shells - Impact from other equipment or personnel	- Inspections as per relevant SANS standards - Pipe racks and barriers between pipes and personnel/ other equipment - Clear routes for personnel and equipment movement	**Blowing Agents' piping losses of containment**	- Drainage areas below pipework as much as practical - Gas detection systems - Emergency shutdown systems (Recommendations)	- Dispersion of flammable or asphyxiating vapours - Pool Fire (ethanol loss of containment) - Contamination of soil and groundwater from liquid spills - Possible injury and fatality of personnel and public as a result of the above.
- Mechanical breakdowns	- Adequate training - Maintenance of	**XPS Machine breakdowns**	- Emergency Stop Buttons along the machine in case	- Dispersion of flammable or

Cause	Prevention measures	Top Event/ Scenario	Mitigation measures	End Consequence(s)
- Incorrect operation of machinery	equipment to maintain functionality	and losses of containment	of release - Functional sprinkler systems in the building - Gas detection systems in the building - Adequate ventilation in factory building	asphyxiating vapours - Pool Fire (ethanol loss of containment) - Contamination of soil and groundwater from liquid spills - Possible injury and fatality of personnel and public as a result of the above.
- Fire within the storage area (e.g. electrical fire)	- Ignition control within XPS storage area - Adequate separation of XPS storage area from other flammable materials.	XPS product fires	- Heat detection in storage area - Sprinkler system in the XPS storage area	- Dispersion of PAHs and carbon monoxide into the surroundings.

6.3 Organisational measures in place at the site

Swartland Investments (Pty) Ltd operates a number of operations throughout South Africa and in other locations within Africa. At all their operations Health, Safety and Environment protection policies and procedures. The same set of policies and procedures will be applied at the Site.

MMRisk is of the opinion that the policies and procedures to be applied at the Site are adequate for the operations envisaged and no additional measures are recommended at this time.

6.4 Requirements in terms of Environmental Conservation Act, 1989

The Environment Conservation Act of 1989 has been largely replaced by the National Environmental Management Act, 1998 (NEMA) (however, MMRisk understands that several provisions still stand).

The site is currently undergoing a Basic Assessment Environmental Authorisation through the Western Cape Department of Environmental Affairs and Development Planning (DEADP). This report forms part of the envisaged specialist studies.

7 CONSEQUENCE ANALYSIS

"If things do go wrong onsite, what is the extent of the potential damage?"

7.1 Major Accident scenarios

The scenarios described in Section 6.1 were taken forward to consequence modelling using the DNVGL Phast Version 6.7, software.

7.2 Key process data for major scenarios

Key process data for major accident scenarios was captured in Section 2.4: Process Description.

7.3 Consequences for Carbon dioxide

Releases of carbon dioxide might be from leaks or catastrophic rupture of the storage vessel, road tanker during delivery, as well as pipework to the process.

The worst case consequence contour for CO_2 is that of a catastrophic rupture of the storage vessel in high wind conditions (9 m/s and D weather stability). The maximum extent of the contour is 29 metres downwind, as illustrated in Figure 7.1.

The contour would extend offsite, over the empty site to the east. The catastrophic rupture event is likely to be short-lived, only a matter of seconds, and so the impact is likely to be of a lesser extent, in reality.

Inside the contour, a 1% fatality probability can be expected; the cloud is expected to affect those who are unable to escape, for example, those who may be trapped in the area.

Figure 7.1: Carbon dioxide vessel catastrophic rupture – 1% fatality

7.4 Consequences for DME

7.4.1 Jet fire consequences

The DME will be stored at pressure and as such, any releases would result in 2-phase releases as the pressurised liquid flashes and forms a vapour. The initial pressure of 4 barg would provide enough momentum for a jet fire to form. Were a jet fire to form, thermal radiation would be emitted with resulting contours as illustrated in Figure 7.2 for a scenario in which the contents of the storage vessel are emptied in 10 minutes. The contours shown in the figure are for a wind speed of 3 m/s, a case where little wind entrainment would occur and the momentum of the jet itself would dominate. Contours are expected to reach offsite, with significant impact on the buildings onsite. If unmitigated, effects would result in possible knock-on effects including ignition of onsite buildings, major damage to equipment and significant chance of death for personnel and members of the public (for the 37.5 kW/m^2).

Were the event to take place, neighbours Golden Era, the construction site to the south of Charles Matthews Street, and parts of Bokomo would have to evacuate to locations beyond the 6.3 kW/m^2 contour.

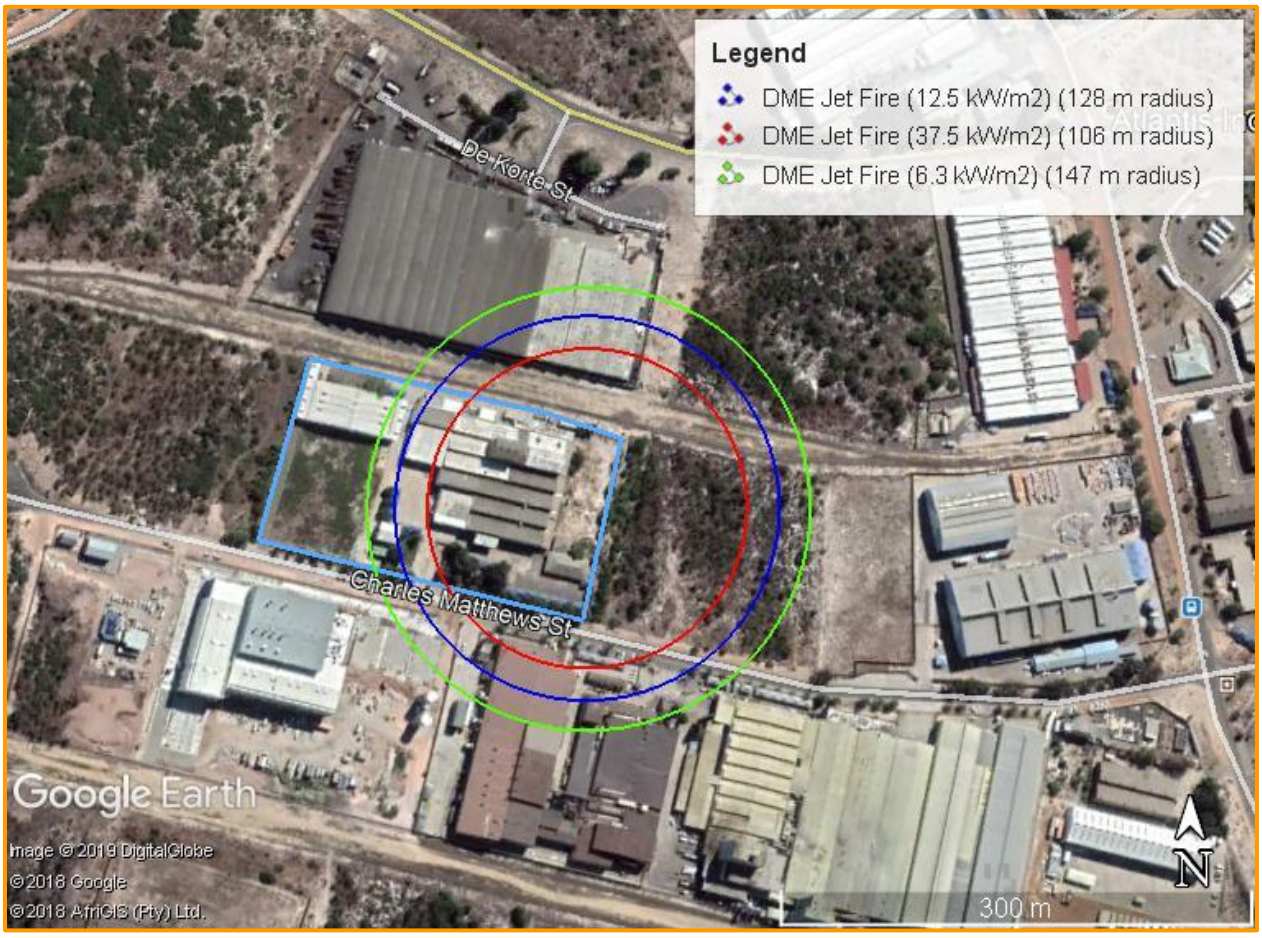


Figure 7.2: DME vessel failure jet fire contours (B 3 m/s weather)

7.4.2 Flash Fire consequences

Were the DME vessel to fail catastrophically, there would likely be a flammable vapour cloud which would form over the surrounding area. Were this cloud to ignite in the absence of significant congestion / confinement, the contours shown in Figure 7.3 could result. The contour assumes a uniform wind direction distribution, i.e. wind could be blowing from any direction and the maximum extent of the lower flammability limit (LFL) and half the LFL (1/2 LFL) contours would be as shown in the figure. As was the case with jet fires, there would be significant impact over the site as well as over Golden Era (north), the construction site to the south and Bokomo Foods, also to the south of the site. Flash fires would be expected to ignite parts of buildings and lead to fires in buildings and loss of containment of adjacent hazardous installations and damage to product stored onsite.

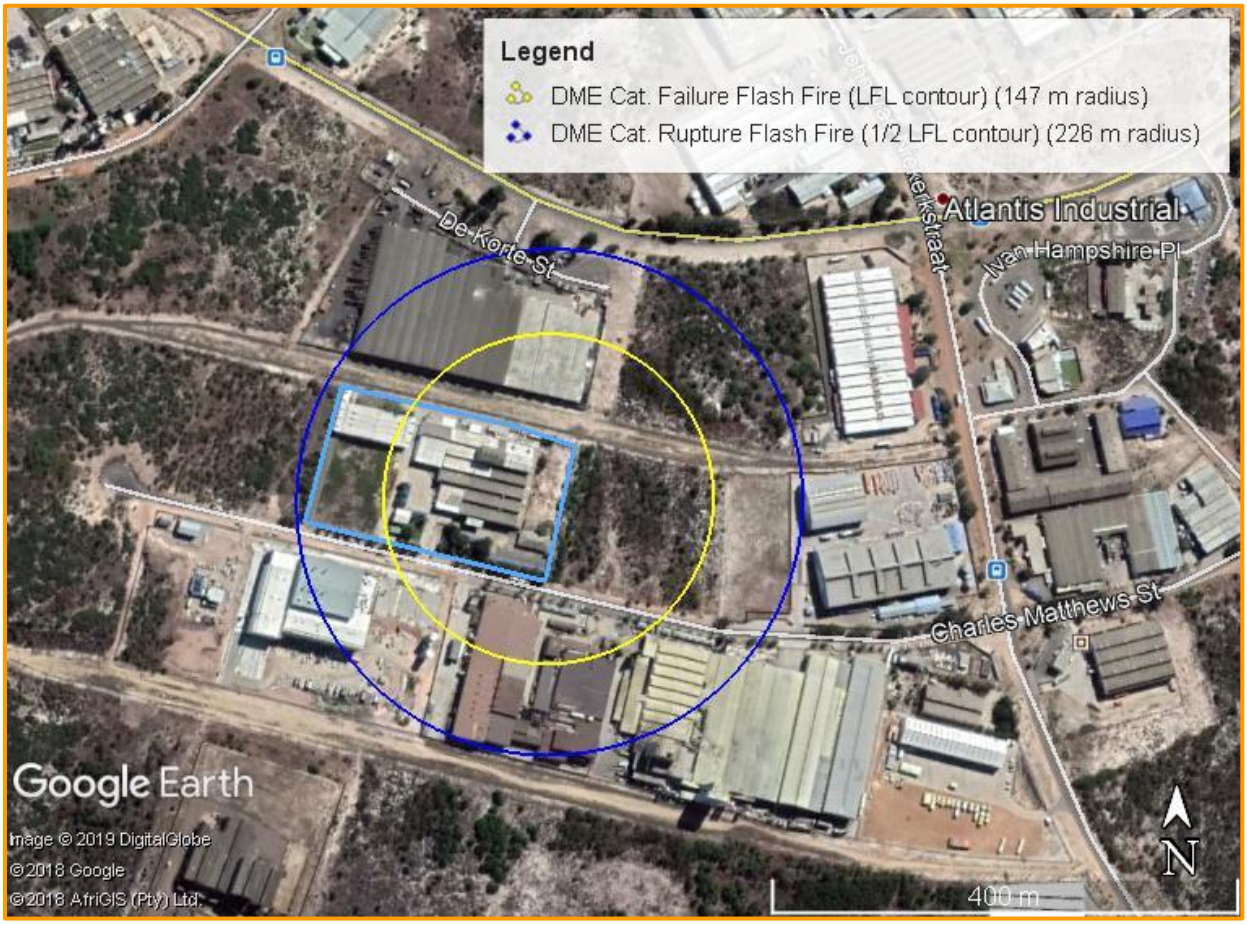


Figure 7.3: DME vessel catastrophic failure - Flash Fire consequence results (F 1.5 m/s weather)

7.4.3 Vapour Cloud Explosion consequences

Were the vapour cloud generated as a result of the catastrophic release described in Section 7.4.2 to encounter congestion or confinement, a vapour cloud explosion could result with the potential overpressure contours seen in Figure 7.4. Within the 0.35 barg contour collapse of brick walls can be expected, as well as significant damage to equipment. Within the 0.14 barg contour steel structures have been known to fail. Such impacts would be seen onsite as well as offsite (with potential impact on the empty plot to the east of the site, Bokomo Foods, the facility under construction south of the site across Charles Matthews Street, as well as Golden Era to the north).

Figure 7.4: Vapour cloud explosion contours from DME vessel catastrophic rupture

7.5 Consequences for R152a

7.5.1 R152a jet fire consequences

The worst case jet fire consequences for releases associated with R152a storage were from a scenario where the entire vessel contents were emptied within 10 minutes; the resultant thermal radiation contours are shown for a low wind speed of 1.5 m/s, assuming a uniform wind direction distribution, i.e. the wind could be blowing from any direction. The contours indicate significant jet fire impact on the storage and staging areas of the plant, with expected damage to equipment and stored product and raw materials in the vicinity. Because the XPS machine would be located indoors there would be less exposure to thermal radiation, however, thermal damage to site buildings is expected to occur, which could result in ignition of buildings and further damage with the potential for injuries and fatalities. Impact would be seen over the empty plot to the east of the site as well as over the servitude to the north of the site.

Figure 7.5: R152a vessel leak jet fire radiation contours (F 1.5 m/s weather)

7.5.2 R152a flash fire consequences

Were the release described in Section 7.5.1 to not ignite immediately, build-up of vapour would take place in the vicinity and if that were to ignite belatedly and in the absence of significant congestion and confinement, a flash fire would result with the LFL and ½ LFL extending as shown in Figure 7.6. Less damage would be expected as compared to the DME flash fire consequences described in Section 7.4.2. However, within the LFL contour there may be severe damage to equipment and stored products and raw materials. The damage would affect those offsite, the contours extend beyond the site boundary over the empty plot to the east of the site.

Figure 7.6: R152a Flash Fires from fixed duration release through vessel (F 1.5 m/s weather)

7.5.3 R152a vapour cloud explosion consequences

Were a catastrophic rupture of the R152a vessel to occur the released vapour would disperse over a distance and if it reached an ignition source and in the presence of confinement and congestion, could result in a vapour cloud explosion with overpressure being generated as shown in Figure 7.7. Within the 0.35 barg contour collapse of brick walls can be expected, as well as significant damage to equipment. Within the 0.14 barg contour steel structures have been known to fail. Such impacts would be seen onsite as well as offsite with potential for offsite (i.e. public) injury and death. The majority of impact would be to the east of the site, over the plot that is currently empty.

Figure 7.7: R152a Vapour Cloud Explosion contours – catastrophic storage vessel catastrophic failure

8 FREQUENCY ANALYSIS

"The likelihood of things going wrong is analysed in this section."

Frequency analysis means the analysis of the likelihood that an event will occur. There are several techniques possible to determine the likelihood of events taking place. The technique used in this report is based on previous accidents. Scenarios are based on previous losses of containment and have been summarised in the SANS 1461:2018 standard. Frequencies of failure published in the BEVI publication [5] (Module C Section 3 of that publication) were applied.

This likelihood is based upon previous accidents for similar materials and equipment, and the manner of failure.

Furthermore, frequency data published is often generic and several facility-specific factors have to be taken into account. This has been done in this study by way of event tree analysis, which will be elaborated further in this section.

8.1 Failure data used

The following base frequency data was applied in the study:

Table 8.1: Base Frequencies applied to modelling scenarios

Equipment Description	Release Description	Base Frequency
Fixed storage or processing units at atmospheric pressure or lower (for example, tanks, blending vessels) and atmospheric transport units (for example, standard road tankers, intermediate bulk containers (IBCs)	1a) Catastrophic rupture (with bund overtopping if necessary).	5.00E-06
	1b) ROAD TANKER Instantaneous release of contents (Each compartment is considered a tank so frequency is divided by the number of compartments)	1.00E-05
	2) Entire contents released in 10 min or large hole in the processing unit (a large hole is typically the size of the largest appurtenance on the processing unit).	5.00E-06
	3) Small hole in vessel (leak typically 10 mm diameter).	1.00E-04
	4a) Overfilling (if applicable). *OGP Data (Storage Frequencies), from LASTFIRE,	5.32E-04

Equipment Description	Release Description	Base Frequency
	19% of spills outside the bund were from Overfill events	
	4b) Overfilling frequency from Massimo et al.	3.80E-04
	4c) Overfill frequency API 353	1.00E-04
Fixed storage or processing units classified as pressure vessels (for example, reactors, storage spheres) and pressurized transport units (for example, pressurized road tankers, cylinders)	1) Catastrophic rupture with instantaneous failure (including a boiling liquid expanding vapour explosion (BLEVE) where applicable).	5.00E-07
	2) Entire contents released in 10 min or large hole in the processing unit (a large hole is typically the size of the largest appurtenance on the processing unit).	5.00E-07
	3) Small hole in vessel (leak typically 10 mm diameter).	1.00E-05
	4) Pressure safety valve release (if applicable).	2.00E-05
Pipe, hose, arm (onsite pipelines) PER METRE PER YEAR	1) Pipeline, hose, arm full bore rupture.	1.00E-07
	2) Small hole in pipeline, hose, arm (typically a leak with effective diameter of 10 % to 50 % of the pipeline diameter).	5.00E-07
Pumps	Catastrophic failure	1.00E-04
	Leak (10 % diameter)	4.40E-03

8.2 Determining final frequency of each failure scenario

8.2.1 Fraction of year hazard exists onsite

For several of the scenarios, shown in Section 2.4, if the hazards were not present for 100% of the year, a factor would be multiplied to the base frequency according to the time present on site.

These factors are summarised in Section 2.4 described as "% time hazard present on-site" in the various descriptions of operations on-site.

8.2.2 Event Tree Analysis

Event Tree Analysis is a process which allows for the application of control factors to release scenarios to reduce their frequency of occurrence. In this technique the base frequencies (see Section 8.1) are multiplied by their respective control factors. Categories include the probability of immediate or delayed ignition, and/or the probability that no ignition will occur. Event trees were used for instantaneous as well as continuous releases of LPG as shown in the figures which follow; the following options which represent the branches in the Event Trees were used in determining final frequencies:

- Probability of early ignition;
- Probability of delayed ignition;
- Probability of direct impingement;
- Probability of encountering confinement/ congestion.

The probabilities for the various branches of the Event Trees used were derived from SANS 1461:2018 as well as the BEVI publication and modelled within DNVGL Safeti software.

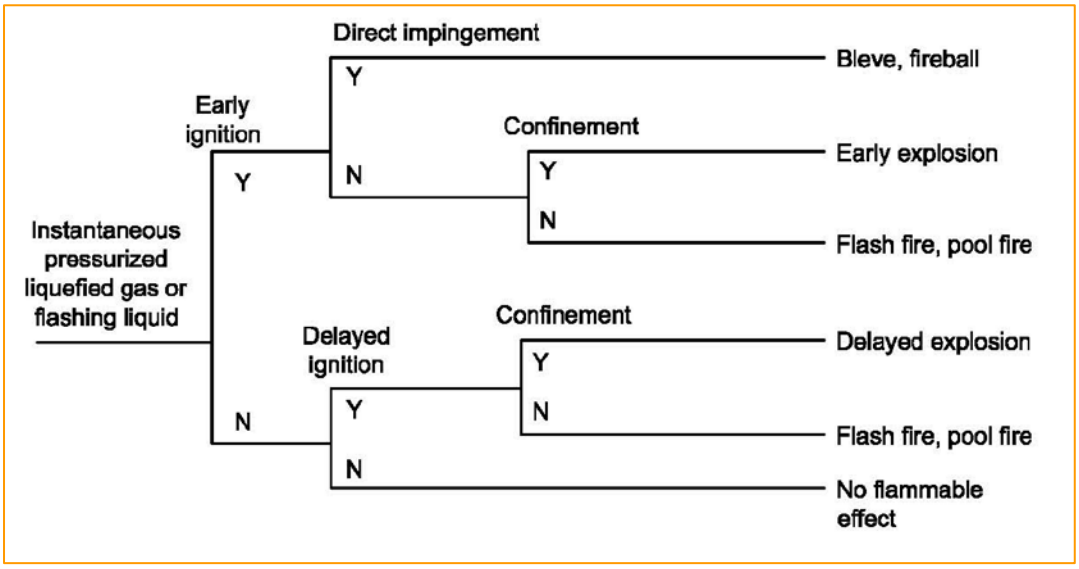


Figure 8.1: Event Tree used to determine final frequencies (instantaneous release)

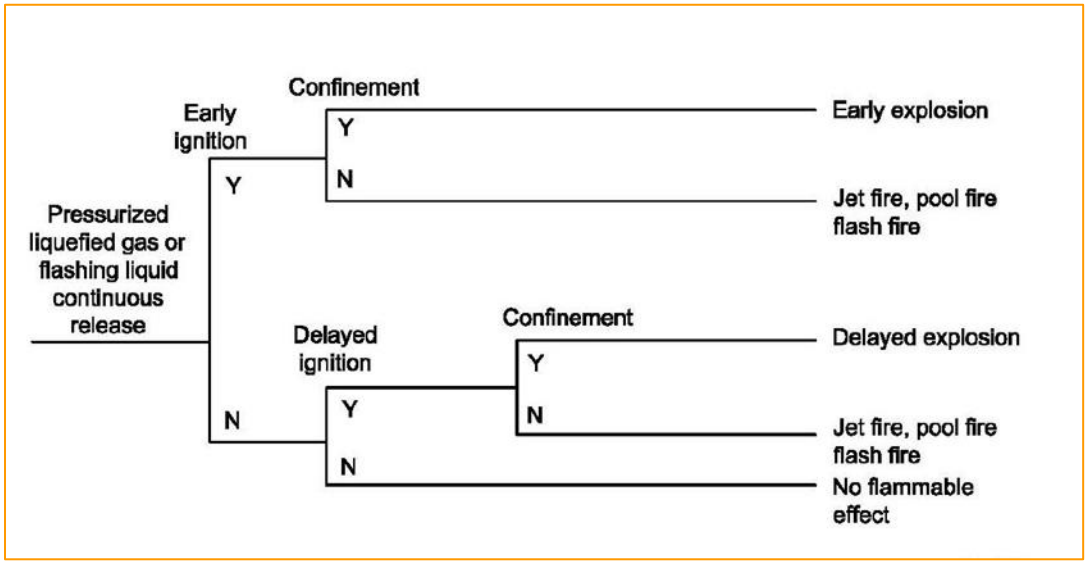


Figure 8.2: Event Tree used to determine final frequencies (continuous release)

8.2.3 Estimation of the probability of a major incident

The event trees shown above illustrate how an initial release frequency can be factored down to a final frequency. An example calculation is:

Consider a leak through a length of pipework leading to a continuous release of LPG, with a base frequency of f_{pipe}.

To calculate the final frequencies of the various possible end results of the leak, the following arithmetic was performed based on the event tree given in Figure 8.2.

- To find the probability of an early explosion → $f_{early\ explosion} = f_{pipe} * P_{early\ ignition} * P_{confinement}$
- To find the probability of a jet fire with late ignition → $f_{late\ jet\ fire} = f_{pipe} * (1 - P_{early\ ignition}) * P_{delayed\ ignition} * (1 - P_{confinement})$
- Etc.

This logic was applied to all leak frequencies listed in Section 8.1.

9 RISK RESULTS

In this study, risk has been calculated and presented in three forms:

- Individual Risk – the risk of death or serious injury based on the location of an individual, illustrated by risk contours around an installation. This calculation does not take into account the actual population in an area but quantifies risk of death and injury were a person to be located at various points around the site.

- Societal Risk – the risk of death or serious injury of a population, illustrated by an 'FN-Curve'. Societal risk takes into account populations around a facility and determines the maximum possible number of fatalities, the scenarios and associated frequencies of each scenario, expressed cumulatively on an FN-Curve. This will be illustrated in Section 9.3.

- Land-use Planning – Individual risk can also be used to determine the appropriateness of land uses around MHI facilities. To this end, the risk levels of: 1×10^{-5}, 1×10^{-6} and 3×10^{-7} have been used as a basis for judging the appropriateness of land use around site.

Day and Night – the risk calculations take into account the operations that occur mainly during the day and those that occur mainly during the night, as well as population distribution during the day and during the night.

9.1 Interpreting the risk results

The reader is referred to Section 4.5 for a full description of the methodology used and the criteria for assessing risk as broadly acceptable, intolerable, or Tolerable if it can be proven to be As Low As Reasonably Practicable (ALARP).

9.2 Individual Risk Results

The individual risk contours illustrated in the figures below are of the type 'Location Specific Individual Risk (LSIR)' contours. These show the chance of death of a theoretical person if they are positioned at a particular location 24 hours per day, 365 days per year. LSIR is an overstatement of risk which is widely accepted as sufficiently conservative. In reality, workers will spend the length of a shift per day and not the entire day. However, when a worker is off, another worker may replace her in doing her task, therefore, overall it can be considered that there is an individual at that particular point or area, all of the time.

The risk acceptability criteria are described in Section 4.5.1 and the individual risk profiles for the site are illustrated in Figure 9.1 for people located outdoors.

Individual risk results for those located outdoors

Figure 9.1 illustrates individual risk of death for those located outdoors. Being located outdoors implies a lack of shielding for thermal radiation, as would be the case for those located indoors. The contours extend as follows:

- **The 1 x 10^{-5} / year contour:** At this risk level and below, individual risk is **broadly acceptable for workers** and can be tolerated for members of the public provided that it is proven to be As Low As Reasonably Practicable (ALARP). This contour extends beyond the site to the east, over currently vacant land.

- **The 1 x 10^{-6} / year contour:** This is the level below which risk is *broadly acceptable* and the indicator for MHI status as described in 1.5. This contour extends offsite east over currently vacant land. **This indicates a risk over the servitude that is elevated but still is within 'ALARP' bounds** as described in Section 4.5. This means risk over this area can be tolerated if proven that it is As Low As Reasonably Practicable.

Risk below the 1 x 10^{-6} / year level (indicated by the areas located outside this contour) is considered broadly acceptable.

Risk Judgement:

Because the 1 x 10^{-6} /year risk contour extends beyond the site boundary, the site is considered a Major Hazard Installation (see Section 1.5).

Recommendations for reducing risk further at these locations are provided in Section 12.

Figure 9.1: Individual Risk Contours around the site (individuals located outdoors)

9.3 Societal risk results

Societal risk takes into account populations around the site to determine risk tolerability. In this study, this is presented in the form of an FN-Curve, which illustrates scenarios with the potential to cause death, as well as considers the frequency of each scenario. The frequencies of the scenarios are then summed to show a cumulative risk of death, i.e. the frequency (F) of causing N or more fatalities against the number of fatalities, N.

As illustrated in Figure 9.2 there are tolerability limits as suggested by SANS 1461:2018 (see Section 4.5.2), as illustrated by the red and blue sloped lines. Above the red line is the region where societal risk is intolerable; below the blue line is the region where societal risk is broadly acceptable. Between these lines is the region where risk can be tolerated if it is proven to be ALARP (see Section 4.5.2).

Description of the site's FN Curve (societal risk results)

Day time societal risk is based upon activities onsite which take place only during the day and upon day-time population levels, and similarly night time risk is based upon activities taking place at night and also on populations of people during the night. The FN Curve given below is a combination of day time and night time risk.

As seen in Figure 9.2, the maximum number of fatalities which can occur from a single event occurring onsite is just over 120 people. The associated frequency of this event is low, at approximately 1.2×10^{-8} / year. This high number of fatalities was driven by the jet fire, flash fire and vapour cloud explosion events observed in the Consequence Analysis Section 7. In that section the hazard ranges for jet fires and flash fires covered large areas around the site. However, the infrequent nature of those events (such as catastrophic failure of equipment) drove the societal risk down and societal risk is assessed as Broadly Acceptable.

Risk Judgement:

Societal Risk for the site is assessed as 'Broadly Acceptable'.

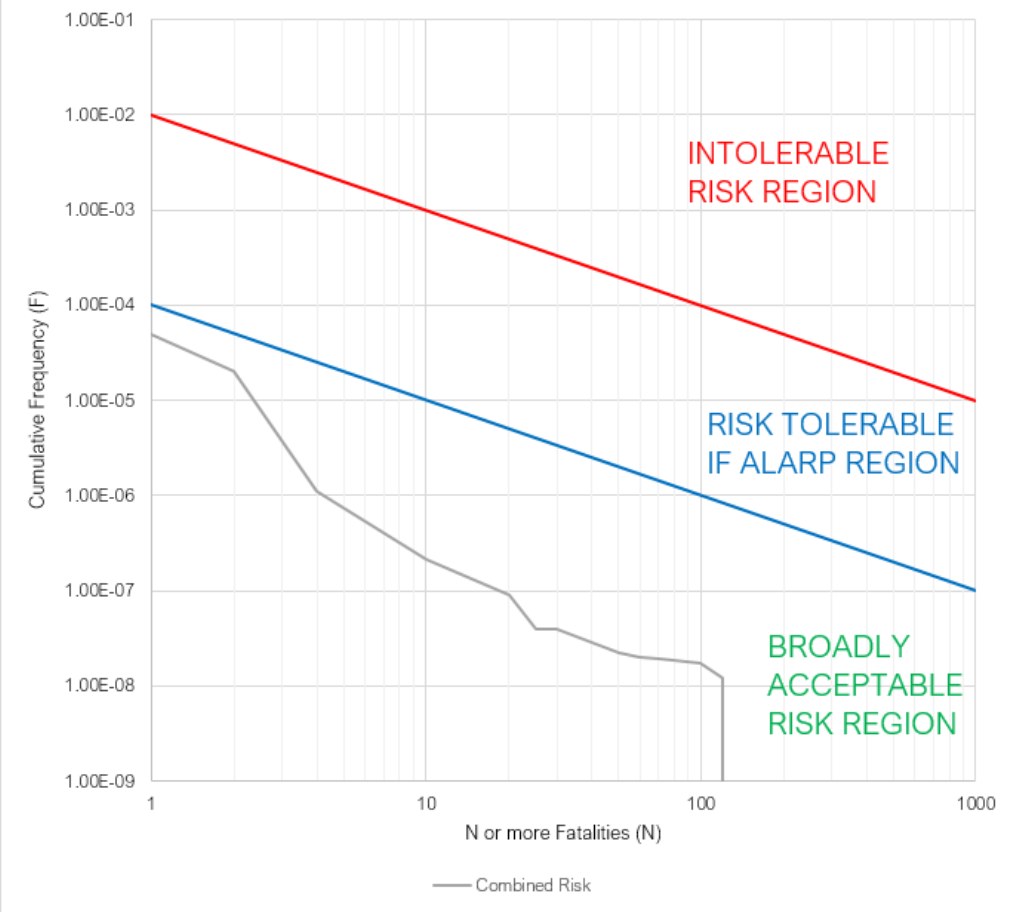


Figure 9.2: FN Curve for Combined Day and Night time risk

9.4 Land Use Planning

The concept of Land-Use Planning is discussed in Section 4.5.3; the purpose of Land-Use Planning section is to inform future land use around the site and to provide a basis for opposing (if necessary) future developments around the site. The Inner, Middle and Outer Zones are derived from the risk contours illustrated in Figure 9.1, described briefly as follows:

- Outer Zone: The zone between the $1x10^{-6}$ and $3x10^{-7}$ / year individual risk contours;
- Middle Zone: The zone between the $1x10^{-5}$ and $1x10^{-6}$ / year individual risk contours;
- Inner Zone: Inside the $1x10^{-5}$ / year individual risk contour.

The Zones extends offsite over the empty plot to the east of the site. If or when development happens on that site, based on risk due to the site's activities, MMRisk would recommend that **the following categories of developments be challenged:**

- **Facilities involving vulnerable members of the public** (children, those with mobility difficulties or those unable to recognise physical danger) – examples may include large hospitals, large old age homes, large schools, large retirement homes, large homes for the mentally handicapped, etc.

- **Facilities involving general public at home and/or involved in normal activities** – examples may include outdoor shopping areas, parks where large numbers of people are expected, outdoor sports stadia, etc.

10 IMPACT ON SURROUNDING FACILITIES

From the consequence and risk results in the report, impacts were seen over surrounding facilities. These are summarised in this section.

10.1 Impact on surrounding major hazard installations

As can be seen in the preceding sections there is consequence impact over New Era (to the north), the vacant plot to the east of the site, the site under construction to the south of the site over Charles Matthews Street, as well as Bokomo Foods (to the south-east).

Consequence Effects on surrounding MHIs

Section 7 Consequence Analysis showed jet fire, flash fire and vapour cloud explosion impact over New Era and Bokomo Foods. The result of these events might be initiation of loss of containment events at those sites, due to elevated thermal radiation and overpressure levels.

Emergency procedures for dealing with events taking place at the site should involve notification of neighbours to ensure that they are able to evacuate as necessary to minimise injuries and fatalities.

10.2 Impact on the public and other installations

There is impact over other non-MHI neighbours to the south (the construction site) as well as immediately the vacant plot east of the site. Should the site receive notification of proposed developments in those areas, consequence and risk analysis information compiled in this report should be used to inform developers of the risk due to the site's operations.

11 EMERGENCY RESPONSE DATA

The site is currently under design and not yet operational. Therefore the Client has not yet compiled an Emergency Response Plan (ERP) due to lack of detail on operations, staffing, etc.

Compilation of an ERP has been discussed between MMRisk and the Client, and the Client understands that an ERP would have to be available when the site begins operations.

MMRisk would assess the site's ERP against:

- The requirements of Provision 6.(1) of the MHI Regulations;
- The South African National Standard (SANS) 1514: Emergency Response Planning for Major Hazard Installations; and
- Any applicable by-laws in the area.

12 RISK TREATMENT / RECOMMENDATIONS

Based on the risk analysis herein, the following recommendations are made:

Recommendation Number:	1
Recommendation wording:	Carry out advertisement and notification as required by provision 2(1) of the MHI Regulations.
Rationale:	The 1 x 10^{-6} /year individual risk contour extends beyond the boundary of the site as indicated in Figure 9.1 therefore MMRisk declares the site a Major Hazard Installation.
Priority:	High

Recommendation Number:	2
Recommendation wording:	Ensure the following safety systems / considerations are given during the design, in order manage risk at the site: o) Road tankers are designed to SANS 1518 and adequately maintained (confirm with suppliers); p) Operator presence at all times during offloading; q) Drained area for tanker offloading linked to a separator system; r) Installation of Emergency Stop Buttons at various locations around the site; s) Ensure inspections are performed on equipment carrying hazardous materials s per relevant SANS standards; t) Consider physical barriers between tanks and pathways and other equipment to avoid collisions leading to losses of containment; u) Ensure that clear routes for personnel and equipment movement are demarcated; v) Ensure adequate training of personnel on the handling of hazardous materials; w) Implement ignition source control within the raw materials, blowing agent and XPS storage areas; x) Ensure adequate separation of XPS storage area from other flammable materials. y) Ensure bunding and containment systems are designed per SANS standards, as appropriate; z) Consider installation of gas detection, heat detection and other detection systems, as appropriate, within the blowing agent storage area; aa) Where appropriate, consider possible compartmentalisation of tanks to prevent complete loss of hazardous material in case of leaks. bb) Consider installation of measures to decrease consequence distances in case of fire, e.g. fire walls in the vicinity of blowing agent storage, however, taking into account the potential for further confinement as a result.
Rationale:	The analysis performed in this report identified several elements to be considered, which are safety critical.

Priority:	High

Recommendation Number:	3
Recommendation wording:	Ensure that the site's existing fire system is checked by a qualified Fire Engineer and if need be, upgraded.
Rationale:	The site has an existing fire system which was inherited from the previous site owner.
Priority:	High

Recommendation Number:	4
Recommendation wording:	Involve notification of neighbours in the site's emergency procedures
Rationale:	Several fire and explosion events were shown to impact on neighbours. This will ensure that neighbours are able to evacuate as necessary to minimise injuries and fatalities as a result of fires/ explosions at the site.
Priority:	High

Recommendation Number:	5
Recommendation wording:	Compile an Emergency Response Plan for the site, in line with SANS standard 1514 for Emergency Response Plans for MHIs, and considering local by-laws.
Rationale:	Emergency Response Plans are a requirement of the MHI Regulations.
Priority:	High

Recommendation Number:	6
Recommendation wording:	Re-do the MHI Risk Assessment after 5 years, or re-do the assessment if details of the installations change significantly, or if a loss of containment event occurs.
Rationale:	Reviews of the MHI Assessments are a requirement of the MHI Regulations.
Priority:	Low

- END OF MAIN REPORT BODY -

MMrisk

Sw01-REP-MHI-1

APPENDICES

A: Proof of Competency

B: Material Safety Data Sheets (MSDSs)

C: The MHI Regulations

APPENDIX A:

Proof of Competency

labour

Department:
Labour
REPUBLIC OF SOUTH AFRICA

National Department of Labour
Republic of South Africa

APPROVED INSPECTION AUTHORITY

Registered in accordance with the provisions of the Occupational Health and Safety Act, Act 85 of 1993, as amended and the Major Hazard Installation Regulations.

This is to certify that:

MMRISK (PTY) LTD

has been registered by the Department of Labour as an Approved Inspection Authority: Type A, to conduct Major Hazard Installation Risk Assessment, in terms of Regulation 5(5)(a), of the Major Hazard Installation Regulations.

CONDITIONS OF REGISTRATION:

- The AIA must at all time comply with the requirements of the Occupational Health and Safety Act, Act 85 of 1993, as amended.
- This registration certificate is not transferable.
- This registration will lapse if there is a name change of the AIA or change in ownership.

CHIEF INSPECTOR

Valid from: **12 November 2018**
Expires: **11 October 2022**
Certificate Number: **CI MHI 0013**

sanas
South African National Accreditation System

CERTIFICATE OF ACCREDITATION

In terms of section 22(2)(b) of the Accreditation for Conformity Assessment, Calibration and Good Laboratory Practice Act, 2006 (Act 19 of 2006), read with sections 23(1), (2) and (3) of the said Act, I hereby certify that: -

MMRISK (PTY) LTD
Co. Reg. No.: 2016/516497/07
CENTURION

Facility Accreditation Number: **MHI0037**

is a South African National Accreditation System Accredited Inspection Body to undertake **TYPE A** inspection provided that all SANAS conditions and requirements are complied with

This certificate is valid as per the scope as stated in the accompanying schedule of accreditation, Annexure "A", bearing the above accreditation number for

THE ASSESSMENT OF RISK ON MAJOR HAZARD INSTALLATIONS

The facility is accredited in accordance with the recognised International Standard

ISO/IEC 17020:2012

The accreditation demonstrates technical competency for a defined scope and the operation of a management system

While this certificate remains valid, the Accredited Facility named above is authorised to use the relevant SANAS accreditation symbol to issue facility reports and/or certificates

Mr R Josias
Chief Executive Officer

Effective Date: 12 October 2018
Certificate Expires: 11 October 2022

This certificate does not on its own confer authority to act as an Approved Inspection Authority as contemplated in the Major Hazard Installation Regulations. Approval to inspect within the regulatory domain is granted by the Department of Labour.

ANNEXURE A

SCHEDULE OF ACCREDITATION

Facility Number: MHI0037

TYPE A

Permanent Address: MMRisk (Pty) Ltd 1234 Sand Hills Close Copperleaf Centurion 0149 Cell: 072 596 3181 E-mail: motlatsimabaso@gmail.com	**Postal Address:** P O Box 89228 Heuweloord Centurion 0173 Issue No.: 01 Date of issue: 12 October 2018 Expiry date: 11 October 2022	
Nominated Representative: Mr M Mabaso **Quality Manager:** Mr M Mabaso	**Technical Manager:** Mr M Mabaso	**Technical Signatory:** Mr M Mabaso
Field of Inspection	**Service Rendered**	**Codes and Regulations**
Regulatory: The supply of services as an Inspection Authority for Major Hazard Risk Installation as defined in the Major Hazard Risk Installation Regulations, Government Notice No. R692 of 30 July 2001	Major Hazard Installation Risk Assessments for the following material categories: 2) Gases: i) Flammable Gases ii) Non-flammable, non-toxic gases (asphyxiants) iii) Toxic gases 3) Flammable liquids 4) Flammable solids, substances liable to spontaneous combustion, substances that on contact with water release flammable gases	MHI Regulation par. 5 (5) (b) i) Frequency/Probability Analysis ii) Consequence Modelling iii) Hazard Identification and Analysis vi) Emergency planning reviews Guideline for quantitative risk assessment "Purple Book" CPR 18E, first edition 1999 A guide for the Control of Major Accident Hazard Regulations 1999, UK HSE.

Original date of accreditation: 12 October 2018

ISSUED BY THE SOUTH AFRICAN NATIONAL ACCREDITATION SYSTEM

Accreditation Manager

APPENDIX B:

Material Safety Data Sheets (MSDSs)

;

Safety Data Sheet

R-152a

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: R-152a
OTHER NAME: Difluoroethane
USE: Refrigerant gas
DISTRIBUTOR: National Refrigerants, Inc.
661 Kenyon Avenue
Bridgeton, New Jersey 08302

FOR MORE INFORMATION CALL:
(Monday-Friday, 8:00am-5:00pm)
1-800-262-0012

IN CASE OF EMERGENCY CALL:
CHEMTREC: 1-800-424-9300

EMERGENCY OVERVIEW:
Flammable gas. Liquid under high pressure.

2. HAZARDS IDENTIFICATION

CLASSIFICATION: **Flammable Gas, Gas under pressure, Compressed Gas**
SIGNAL WORD: **DANGER**
HAZARD STATEMENT(S): **Extremely flammable gas, Contains gas under pressure, may explode if heated**
SYMBOL(S): **Flames, Gas Cylinder**

PRECAUTIONARY STATEMENT(S):

Prevention: Keep away from heat, sparks, open flame, and hot surfaces. No Smoking
Response: Leaking gas fire: Do not extinguish unless leak can be stopped immediately. Eliminate all ignition sources if safe to do so.
Storage: Protect from sunlight, store in a well ventilated place.

POTENTIAL HEALTH EFFECTS
Effects of Overexposure:

Eye Contact
Eye contact with the rapidly evaporation liquid may cause frostbite.

Skin Contact
Skin contact with the rapidly evaporation liquid may cause frostbite. Frostbite effects are a change in color of the skin to gray or white, followed by blistering.

Inhalation
Vapor is heavier than air and can cause suffocation by reducing oxygen available for breathing. Inhalation of high vapor concentration may cause dizziness, disorientation, incoordination, narcosis, nausea or vomiting, leading to unconsciousness, cardiac irregularities, or death.

Ingestion
Not an expected route of exposure.

3. COMPOSITION / INFORMATION ON INGREDIENTS

INGREDIENT NAME	CAS NUMBER	WEIGHT %
Difluoroethane	75-37-6	100

COMMON NAME and SYNONYMS
R-152a; HFC152A

There are no impurities or stabilizers that contribute to the classification of the material identified in Section 2

4. FIRST AID MEASURES

SKIN:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes. Treat for frostbite if necessary, by gently warming affected area.

EYES:
In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Call a physician.

INHALATION:
If high concentrations are inhaled, immediately remove to fresh air. Keep person clam. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

INGESTION:
Ingestion is not considered a potential route of exposure.

ADVICE TO PHYSICIAN:
Because of the possible disturbances of cardiac rhythm, catecholamine drugs, such as epinephrine, should be used with special caution and only in situations of emergency life support.

5. FIRE FIGHTING MEASURES

FLAMMABLE PROPERTIES

FLASH POINT:	<-50 deg. C (<-58 deg. F)
AUTOIGNITION TEMPERATURE:	454°C (849 deg. F)
UPPER EXPLOSIVE LIMIT:	16.9%
LOWER EXPLOSIVE LIMIT:	3.9%
EXTINGUISHING MEDIA:	Water Spray, Water Fog, Dry Chemical, Carbon Dioxide, "Alcohol" foam.

UNUSUAL FIRE HAZARDS:
Flammable. Cylinders are equipped with temperature and pressure relief devices but may still rupture under fire conditions. Use water spray to cool cylinders and tanks

FIRE FIGHTING INSTRUCTIONS:

Keep container cool with water spray. If gas exiting container ignites, stop flow of gas. Do not put out the fire unless leak can be stopped immediately. Self-contained breathing apparatus (SCBA) is required if containers rupture and contents are released under fire condition.

6. ACCIDENTAL RELEASE MEASURES

SPILL AND LEAK PROCEDURES:

If a spill can cause a concentration in excess of 1,000 ppm, turn off valves and ignition sources. Evacuate area. Ventilate area, especially low places where heavy vapors might collect. Wear self-contained breathing apparatus (SCBA).
If this product is spilled and not recovered, or is recovered as a waste for treatment or disposal.
CERCLA Reportable Quantity is 100 lbs. (Release of an unlisted Hazardous Waste characteristic of ignitability).

7. HANDLING AND STORAGE

NORMAL HANDLING: (Always wear recommended personal protective equipment.)

Avoid breathing high concentration of vapors and avoid liquid contact with skin or eyes. Use with sufficient ventilation to keep employee exposure below recommended limits. Lines and equipment which will contain R-152a aerosol propellant should be pre-tested with nitrogen using soapy water to detect leaks.

STORAGE RECOMMENDATIONS:

Clean, dry area. Do not heat above 52 deg. C / 125 deg. F.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

ENGINEERING CONTROLS:

Normal ventilation for standard manufacturing procedures is generally adequate. Local exhaust should be used when large amounts are released. Mechanical exhaust should be used in low or enclosed places. Ground all equipment and cylinders before use. Use explosion-proof electrical equipment rated Class I, Group D in Division 1 locations. In Division 2 locations, all spark-producing electrical equipment must be explosion-proof and rated Class I, Group D. Non-sparking motors need not be explosion-proof.

PERSONAL PROTECTIVE EQUIPMENT:

SKIN PROTECTION:

Impervious gloves and Fire protective clothing (NOMEX) with antistatic control should be worn when handling the product.

EYE PROTECTION:

Chemical splash goggles should be worn when handling the liquid.

RESPIRATORY PROTECTION:

Under normal manufacturing conditions, no respiratory protection is required when using this product. Self-contained breathing apparatus (SCBA) is required if a large release occurs.

EXPOSURE GUIDELINES

(Exposure Limits)

INGREDIENT NAME	ACGIH TLV	OSHA PEL	OTHER LIMIT
Difluoroethane	None Established	None Established	*1000 ppm TWA (8hr)

9. PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE:	Clear, colorless liquid and vapor
PHYSICAL STATE:	Gas at ambient temperatures
ODOR:	Slight ethereal
SOLUBILITY IN WATER :	0.28 WT% @ 25C (77F) (87 psia)
BOILING POINT:	-25°C (-13°F)
VAPOR PRESSURE:	87 psia @ 25 deg. C (77°F)
FLASH POINT:	None
EVAPORATION RATE:	No data available
FLAMMABILITY:	Flammable
LEL/UEL:	3.9% / 16.9%
PARTITION COEFFICIENT n-OCTANOL/WATER:	Log Pow: 1.13
AUTO IGNITION TEMPERATURE:	454°C / 850° F
DECOMPOSITION TEMPERATURE:	No data available
VISCOSITY:	Not applicable
VAPOR DENSITY (air = 1.0):	2.4
% VOLATILES BY VOLUME:	100 WT%
DENSITY	0.90 g/cc at 25 deg. C (77 deg. F) - Liquid
pH:	Not applicable
MELTING POINT:	-117°C / -179°F
SPECIFIC GRAVITY (Water=1):	0.90
MOLECULAR FORMULA:	CF_2HCH_3
MOLECULAR WEIGHT:	66.05

10. STABILITY AND REACTIVITY

CHEMICAL STABLILITY:

Material is stable. However, avoid open flames and high temperatures.

REACTIVITY: Will not polymerize

INCOMPATIBILITY WITH OTHER MATERIALS:

Incompatible with alkali or alkaline earth metals-powdered Al, Zn, Be, etc.

CONDITIONS TO AVOID:

Decomposition products are hazardous. This material can be decomposed by high temperatures (open flames, glowing metal surfaces, etc.) forming hydrofluoric acid and possible carbonyl fluoride.

11. TOXICOLOGICAL INFORMATION

Rat inhalation LC50 (4 hr.): 2050 gm/m3; 128,000 ppm
Mouse inhalation LC50 (2 hr.): 1750 gm/m3
In screening studies with experimental animals, exposure above 25,000 ppm followed by a large epinephrine challenge has induced serious cardiac irregularities. Preliminary screening tests indicated that 1-Chloro-1,1-difluoroethane may be weakly mutagenic. In vivo cytogenicity and dominant lethal assays for mutagenicity were negative. In a two year rat inhalation study, 1-Chloro-1,1difuoroethane produced no chronic or carcinogenic effects at levels as high as 2% in air.

POTENTIAL HEALTH EFFECTS

Effects of Overexposure:

Eye Contact
Eye contact with the rapidly evaporation liquid may cause frostbite.

Skin Contact
Skin contact with the rapidly evaporation liquid may cause frostbite. Frostbite effects are a change in color of the skin to gray or white, followed by blistering.

Inhalation
Vapor is heavier than air and can cause suffocation by reducing oxygen available for breathing. Inhalation of high vapor concentration may cause dizziness, disorientation, incoordination, narcosis, nausea or vomiting, leading to unconsciousness, cardiac irregularities, or death.

Ingestion
Not an expected route of exposure.

12. ECOLOGICAL INFORMATION

DEGRADABILITY (BOD): 1,1- Difluoroethane is a gas at room temperature; therefore, it is unlikely to remain in water.

13. DISPOSAL CONSIDERATIONS

WASTE DISPOSAL:

Reclaim by distillation, incinerate, or remove to a permitted waste facility. Comply with Federal, State, and local regulations. This material may be a RCRA hazardous waste upon disposal due to the ignitability characteristic.

14. TRANSPORT INFORMATION

US DOT ID NUMBER: UN1030
US DOT HAZARD CLASS: US DOT PROPER SHIPPING NAME: 1,1-Difluoroethane or Refrigerant gas R-152a
US DOT HAZARD CLASS: 2.1
US DOT PACKING GROUP: Not applicable

15. REGULATORY INFORMATION

U. S. FEDERAL REGULATIONS:

TSCA Inventory Status: Reported/Included.

Title III Hazard classification sections 311,312

Acute:	Yes
Chronic:	No
Fire:	Yes
Reactivity:	No
Pressure:	Yes

Lists:

SARA Extremely Hazardous Substance	-No
CERCLA Hazardous Substance	-(*)
SARA Toxic Chemicals	-No

* See Disposal Information

HFC-152a is a flammable gas as defined by OSHA in 29CFR 1910.1200 (c). Use of this product may require compliance with 29CFR 1910.119, Process Safety Management of Highly Hazardous Chemicals.

CALIFORNIA PROPOSITION 65:

The ingredients in this product do not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

16. OTHER INFORMATION

NFPA, NPCA-HIMS RATING

HMIS Classification: Health – 1, Flammability – 4, Reactivity – 1
Personal Protection Rating to be supplied by user depending on use conditions.

The data in this Material Safety Data Sheet relates only to the specific material designated herein and does not relate to use in combination with any other material or in any process.

CURRENT ISSUE DATE: April, 2018
PREVIOUS ISSUE DATE: April, 2015

DISCLAIMER:

National Refrigerants, Inc. believes that the information and recommendations contained herein (including data and statements) are accurate as of the date hereof. NO WARRANTY OF FITNESS FOR ANY PARTICULAR PURPOSE, WARRANTY OF MERCHANTABILITY, OR ANY OTHER WARRANTY, EXPRESSED OR IMPLIED, IS MADE CONCERNING THE INFORMATION PROVIDED HEREIN. The information provided herein relates only to the specific product designated and may not be valid where such product is used in combination with any other methods of use of the product and of the information referred to herein are beyond the control of National Refrigerants. National Refrigerants expressly disclaims any and all liability as to any results obtained or arising from any use of the product or reliance on such information.

CARBON DIOXIDE

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name	:	Carbon Dioxide
Chemical formula	:	CO_2
Synonyms	:	Carbon dioxide, Carbonic Anhydride, Carbonic Acid Gas, Carbon Anhydride
Use of the substance/preparation	:	General Industrial
Manufacturer/Importer/Distributor	:	Air Products South Africa (Pty) Ltd. Silver Stream Business Park, 1st Floor, Building 3, 10 Muswell Road South, Bryanston, 2191
Telephone	:	+27 (0)11 570 5000 (Head Office) +27 (0)11 977 6444 (Customer Care Cylinders) 0800 023 298 (Engineering / Bulk Services)
Emergency telephone Number (24h)	:	0800 650 315

2. COMPOSITION / INFORMATION ON INGREDIENTS

Components	CAS Number	Concentration (Volume)
Carbon dioxide	124-38-9	100 %

Concentration is nominal. For the exact product composition, please refer to Air Products technical specifications.

3. HAZARDS IDENTIFICATION

Main Hazard / Emergency Overview

Can cause rapid suffocation.

Compressed liquefied gas.

Avoid breathing gas.

Direct contact with liquid can cause frostbite.

Self contained breathing apparatus (SCBA) may be required.

Potential Health Effects

Inhalation	:	Concentrations of 10% CO_2 or more can produce unconsciousness or death. In high concentrations may cause asphyxiation. Symptoms may include loss of mobility/consciousness. Victim may not be aware of asphyxiation. Asphyxiation may bring about unconsciousness without warning and so rapidly that victim may be unable to protect themselves.
Eye contact	:	Contact with liquid may cause cold burns/frost bite.
Skin contact	:	Contact with liquid may cause cold burns/frost bite.
Ingestion	:	Ingestion is not considered a potential route of exposure.
Chronic Health Hazard	:	Not applicable.
Target Organs	:	None.
Symptoms	:	Shivering fit. Sweating. Blurred vision. Headache. Increased pulse rate. Shortness of breath. Rapid respiration. Exposure to oxygen deficient atmosphere may cause the following symptoms: Dizziness. Salivation. Nausea. Vomiting. Loss of mobility/consciousness.

4. FIRST AID MEASURES

General advice	:	Remove victim to uncontaminated area wearing self contained breathing apparatus. Keep victim warm and rested. Call a doctor. Apply artificial respiration if breathing stopped.
Eye contact	:	In the case of contact with eyes, rinse immediately with plenty of water and seek medical advice. Keep eye wide open while rinsing. Seek medical advice.
Skin contact	:	Wash frost-bitten areas with plenty of water. Do not remove clothing. Cover wound with sterile dressing.
Ingestion	:	Ingestion is not considered a potential route of exposure.
Inhalation	:	Move to fresh air. If breathing has stopped or is labored, give assisted respirations. Supplemental oxygen may be indicated. If the heart has stopped, trained personnel should begin cardiopulmonary resuscitation immediately. In case of shortness of breath, give oxygen.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media	:	All known extinguishing media can be used.
Specific hazards	:	Upon exposure to intense heat or flame, cylinder will vent rapidly and or rupture violently. Product is nonflammable and does not support combustion. Move away from container and cool with water from a protected position. If possible, stop flow of product. Keep adjacent cylinders cool by spraying with large amounts of water until the fire burns itself out.
Special protective equipment for fire-fighters	:	Wear self contained breathing apparatus for fire fighting if necessary.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions	:	Evacuate personnel to safe areas. Wear self-contained breathing apparatus when entering area unless atmosphere is proved to be safe. Ventilate the area. Monitor oxygen level.
Environmental precautions	:	Should not be released into the environment. Do not discharge into any place where its accumulation could be dangerous. Prevent further leakage or spillage. Prevent from entering sewers, basements and workpits, or any place where its accumulation can be dangerous.
Methods for cleaning up	:	Ventilate the area.
Additional advice	:	If possible, stop flow of product. Increase ventilation to the release area and monitor oxygen level. If leak is from cylinder or cylinder valve, call the Air Products emergency telephone number. If the leak is in the user's system, close the cylinder valve, safely vent the pressure, and purge with an inert gas before attempting repairs.

7. HANDLING AND STORAGE

Handling

Only experienced and properly instructed persons should handle compressed gases. Protect cylinders from physical damage; do not drag, roll, slide or drop. Do not allow storage area temperature to exceed 50°C. Before using the product, determine its identity by reading the label. Know and understand the properties and hazards of the product before use. When doubt exists as to the correct handling procedure for a particular gas, contact the supplier. Do not remove or deface labels provided by the supplier for the identification of the cylinder contents. When moving cylinders, even for short distances, use a cart (trolley, hand truck, etc.) designed to transport cylinders. Do not remove valve guards. Before connecting the container, check the complete gas system for suitability, particularly for pressure rating and materials. Before connecting the container for use, ensure that back feed from the system into the container is prevented. Ensure the complete gas system is compatible for pressure rating and materials of construction. Ensure the complete gas system has been checked for leaks before use. Employ suitable pressure regulating devices on all containers when the gas is being emitted to systems with lower pressure rating than that of the container.

Open valve slowly. If user experiences any difficulty operating cylinder valve discontinue use and contact supplier. Close container valve after each use and when empty, even if still connected to equipment. Never attempt to repair or modify container valves or safety relief devices. Damaged valves should be reported immediately to the supplier. Close valve after each use and when empty. Do not subject containers to abnormal mechanical shocks which may cause damage to their valve or safety devices. Never attempt to lift a cylinder by its valve guard. Always use backflow protective device in piping. Never use direct flame or electrical heating devices to raise the pressure of a container. Containers should not be subjected to temperatures above 50°C. Prolonged periods of cold temperature below -30°C should be avoided. Never attempt to increase liquid withdrawal rate by pressurizing the container without first checking with the supplier. Never permit liquefied gas to become trapped in parts of the system as this may result in hydraulic rupture.

Storage

Full containers should be stored so that oldest stock is used first. Containers should be stored in the vertical position and properly secured to prevent toppling. The container valves should be tightly closed and where appropriate valve outlets should be capped or plugged. Container valve guards or caps should be in place.

Observe all regulations and local requirements regarding storage of containers. Stored containers should be periodically checked for general condition and leakage. Protect containers stored in the open against rusting and extremes of weather. Containers should not be stored in conditions likely to encourage corrosion.

Containers should be stored in a purpose built compound which should be well ventilated, preferably in the open air. Keep containers tightly closed in a cool, well-ventilated place. Store containers in location free from fire risk and away from sources of heat and ignition. Full and empty cylinders should be segregated. Do not allow storage temperature to exceed 50°C. Return empty containers in a timely manner.

Technical measures/Precautions

Containers should be segregated in the storage area according to the various categories (e.g. flammable, toxic, etc.) and in accordance with local regulations. Keep away from combustible material.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering measures

Provide natural or mechanical ventilation to prevent oxygen deficient atmospheres below 19.5% oxygen.

Personal protective equipment

Respiratory protection	:	Self contained breathing apparatus (SCBA) or positive pressure airline with mask are to be used in oxygen-deficient atmosphere. Air purifying respirators will not provide protection. Users of breathing apparatus must be trained.
Hand protection	:	Sturdy work gloves are recommended for handling cylinders. The breakthrough time of the selected glove(s) must be greater than the intended use period.
Eye protection	:	Safety glasses recommended when handling cylinders.
Skin and body protection	:	Safety shoes are recommended when handling cylinders.
Special instructions for protection and hygiene	:	Ensure adequate ventilation, especially in confined areas.

Exposure limit(s)

Carbon dioxide	Time Weighted Average (TWA): EH40 WEL	5,000 ppm	9,150 mg/m^3
Carbon dioxide	Short Term Exposure Limit (STEL): EH40 WEL	15,000 ppm	27,400 mg/m^3
Carbon dioxide	Time Weighted Average (TWA): EU ELV	5,000 ppm	9,000 mg/m^3

9. PHYSICAL AND CHEMICAL PROPERTIES

Form	:	Liquefied gas.
Color	:	Colorless gas
Odor	:	No odor warning properties.
Molecular Weight	:	44.01 g/mol
Relative vapor density	:	1.519 (air = 1)
Relative density	:	0.82 (water = 1)
Vapor pressure	:	57.30 bar (831.04 psia) at 20 °C
Density	:	0.0018 g/cm^3 at 21 °C Note: (as vapor)
Specific Volume	:	0.5456 m^3/kg at 21 °C
Boiling point/range	:	-88.1 °C
Critical temperature	:	31.1 °C
Melting point/range	:	-56.6 °C
Water solubility	:	2.000 g/l

10. STABILITY AND REACTIVITY

Stability	:	Stable under normal conditions.

11. TOXICOLOGICAL INFORMATION

Acute Health Hazard

Ingestion	:	No data is available on the product itself.
Inhalation	:	No data is available on the product itself.
Skin	:	No data is available on the product itself.

12. ECOLOGICAL INFORMATION

Ecotoxicity effects

Aquatic toxicity	:	No data is available on the product itself.
Toxicity to other organisms	:	No data available.

Persistence and degradability

Mobility	:	No data available.
Bioaccumulation	:	No data is available on the product itself.

Further information

When discharged in large quantities may contribute to the greenhouse effect.

13. DISPOSAL CONSIDERATIONS

Waste from residues / unused products	:	Return unused product in original cylinder to supplier. Contact supplier if guidance is required.
Contaminated packaging	:	Return cylinder to supplier.

14. TRANSPORT INFORMATION

ADR

Proper shipping name	: CARBON DIOXIDE
Class	: 2.2
UN/ID No.	: UN1013
Class	: 2
ADR/RID Hazard ID no.	: 20

IATA

Proper shipping name	: Carbon dioxide
Class	: 2.2
UN/ID No.	: UN1013

IMDG

Proper shipping name	: CARBON DIOXIDE
Class	: 2.2
UN/ID No.	: UN1013

RID

Proper shipping name	: CARBON DIOXIDE
Class	: 2.2
UN/ID No.	: UN1013

Further Information

Avoid transport on vehicles where the load space is not separated from the driver's compartment. Ensure vehicle driver is aware of the potential hazards of the load and knows what to do in the event of an accident or an emergency. The transportation information is not intended to convey all specific regulatory data relating to this material. For complete transportation information, contact an Air Products customer service representative.

15. REGULATORY INFORMATION

OHS Act	: Occupational Health and Safety Act 85 of 1993 (and Regulations)
SANS 10265	: The classification and labelling of dangerous substances and preparations for sale and handling
SANS 10019	: Transportable containers for compressed, dissolved and liquefied gases – Basic design, manufacture, use and maintenance
SANS 1518	: Transport of dangerous goods – Design, construction, testing, approval and maintenance of road vehicles and portable tanks
SANS 10228	: The identification and classification of dangerous goods for transport
SANS 10229-1&2	: Transport of dangerous goods – Packaging and large packaging for road and rail transport Part 1: Packaging / Part 2: Large Packaging
SANS 10263-2	: The warehousing of dangerous goods Part 2: The storage and handling of gas cylinders

NB: Refer to latest edition

16. OTHER INFORMATION

R-phrase(s)	: Not a hazardous substance in accordance with SANS 10265:1999

Ensure all national/local regulations are observed.

Details given in this document are believed to be correct at the time of going to press. Whilst proper care has been taken in the preparation of this document, no liability for injury or damage resulting from its use can be accepted.

(Reference www.airproducts.com :- Air Products PLC Carbon Dioxide MSDS Number 300000000020 / Version 1.12 / Revision Date 11.05.2008)

Dimethyl Ether

Safety Data Sheet P-4589

This SDS conforms to U.S. Code of Federal Regulations 29 CFR 1910.1200, Hazard Communication.

Date of issue: 01/01/1979 Revision date: 10/17/2016 Supersedes: 02/20/2015

SECTION: 1. Product and company identification

1.1. Product identifier

Product form : Substance

Name : Dimethyl Ether

CAS No : 115-10-6

Formula : C2H6O

1.2. Relevant identified uses of the substance or mixture and uses advised against

Use of the substance/mixture : Industrial use. Use as directed.

1.3. Details of the supplier of the safety data sheet

Praxair, Inc.
10 Riverview Drive
Danbury, CT 06810-6268 - USA
T 1-800-772-9247 (1-800-PRAXAIR) - F 1-716-879-2146
www.praxair.com

1.4. Emergency telephone number

Emergency number : Onsite Emergency: 1-800-645-4633

CHEMTREC, 24hr/day 7days/week
— Within USA: 1-800-424-9300, Outside USA: 001-703-527-3887
(collect calls accepted, Contract 17729)

SECTION 2: Hazard identification

2.1. Classification of the substance or mixture

GHS-US classification

Flam. Gas 1 H220
Liquefied gas H280
STOT SE 3 H336

2.2. Label elements

GHS-US labeling

Hazard pictograms (GHS-US) :

GHS02 GHS04 GHS07

Signal word (GHS-US) : DANGER

Hazard statements (GHS-US) : H220 - **EXTREMELY FLAMMABLE GAS**
H280 - CONTAINS GAS UNDER PRESSURE; MAY EXPLODE IF HEATED
H336 - MAY CAUSE DROWSINESS OR DIZZINESS
OSHA-H01 - MAY DISPLACE OXYGEN AND CAUSE RAPID SUFFOCATION
CGA-HG04 - MAY FORM EXPLOSIVE MIXTURES WITH AIR
CGA-HG01 - MAY CAUSE FROSTBITE

Precautionary statements (GHS-US) : P202 - Do not handle until all safety precautions have been read and understood
P210 - Keep away from Heat, Open flames, Sparks, Hot surfaces. - No smoking
P261 - Avoid breathing gas
P262 - Do not get in eyes, on skin, or on clothing
P264 - Wash hands thoroughly after handling
P271+P403 - Use and store only outdoors or in a well-ventilated place
P280 - Wear protective gloves, protective clothing, eye protection, face protection
P377 - Leaking gas fire: Do not extinguish, unless leak can be stopped safely
P381 - Eliminate all ignition sources if safe to do so
CGA-PG05 - Use a back flow preventive device in the piping

CGA-PG06 - Close valve after each use and when empty
CGA-PG11 - Never put cylinders into unventilated areas of passenger vehicles
CGA-PG02 - Protect from sunlight when ambient temperature exceeds 52°C (125°F)

2.3. Other hazards

Other hazards not contributing to the classification : Contact with liquid may cause cold burns/frostbite.

2.4. Unknown acute toxicity (GHS US)

No data available

SECTION 3: Composition/Information on ingredients

3.1. Substance

Name	Product identifier	%
Dimethyl Ether (Main constituent)	(CAS No) 115-10-6	100

3.2. Mixture

Not applicable

SECTION 4: First aid measures

4.1. Description of first aid measures

First-aid measures after inhalation : Remove victim to uncontaminated area wearing self contained breathing apparatus. Keep victim warm and rested. Call a doctor. Apply artificial respiration if breathing stopped.

First-aid measures after skin contact : The liquid may cause frostbite. For exposure to liquid, immediately warm frostbite area with warm water not to exceed 105°F (41°C). Water temperature should be tolerable to normal skin. Maintain skin warming for at least 15 minutes or until normal coloring and sensation have returned to the affected area. In case of massive exposure, remove clothing while showering with warm water. Seek medical evaluation and treatment as soon as possible.

First-aid measures after eye contact : Immediately flush eyes thoroughly with water for at least 15 minutes. Hold the eyelids open and away from the eyeballs to ensure that all surfaces are flushed thoroughly. Contact an ophthalmologist immediately.

First-aid measures after ingestion : Ingestion is not considered a potential route of exposure.

4.2. Most important symptoms and effects, both acute and delayed

No additional information available

4.3. Indication of any immediate medical attention and special treatment needed

None. Obtain medical assistance.

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable extinguishing media : Carbon dioxide, Dry chemical, Water spray or fog.

5.2. Special hazards arising from the substance or mixture

Fire hazard : **EXTREMELY FLAMMABLE GAS.** If venting or leaking gas catches fire, do not extinguish flames. Flammable vapors may spread from leak, creating an explosive reignition hazard. Vapors can be ignited by pilot lights, other flames, smoking, sparks, heaters, electrical equipment, static discharge, or other ignition sources at locations distant from product handling point. Explosive atmospheres may linger. Before entering an area, especially a confined area, check the atmosphere with an appropriate device.

Explosion hazard : **EXTREMELY FLAMMABLE GAS.** Forms explosive mixtures with air and oxidizing agents.

Reactivity : No reactivity hazard other than the effects described in sub-sections below.

5.3. Advice for firefighters

Firefighting instructions : Evacuate all personnel from the danger area. Use self-contained breathing apparatus (SCBA) and protective clothing. Immediately cool containers with water from maximum distance. Stop flow of gas if safe to do so, while continuing cooling water spray. Remove ignition sources if safe to do so. Remove containers from area of fire if safe to do so. On-site fire brigades must comply with OSHA 29 CFR 1910.156 and applicable standards under 29 CFR 1910 Subpart L—Fire Protection.

Protection during firefighting : Compressed gas: asphyxiant. Suffocation hazard by lack of oxygen.

Special protective equipment for fire fighters	:	Standard protective clothing and equipment (Self Contained Breathing Apparatus) for fire fighters.
Specific methods	:	Use fire control measures appropriate for the surrounding fire. Exposure to fire and heat radiation may cause gas containers to rupture. Cool endangered containers with water spray jet from a protected position. Prevent water used in emergency cases from entering sewers and drainage systems Stop flow of product if safe to do so Use water spray or fog to knock down fire fumes if possible Do not extinguish a leaking gas flame unless absolutely necessary. Spontaneous/explosive re-ignition may occur. Extinguish any other fire.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

General measures : **DANGER: Flammable, liquefied gas.** FORMS EXPLOSIVE MIXTURES WITH AIR. Immediately evacuate all personnel from danger area. Use self-contained breathing apparatus where needed. Remove all sources of ignition if safe to do so. Reduce vapors with fog or fine water spray, taking care not to spread liquid with water. Shut off flow if safe to do so. Ventilate area or move container to a well-ventilated area. Flammable vapors may spread from leak and could explode if reignited by sparks or flames. Explosive atmospheres may linger. Before entering area, especially confined areas, check atmosphere with an appropriate device. Prevent from entering sewers, basements and workpits, or any place where its accumulation can be dangerous.

6.1.1. For non-emergency personnel

No additional information available

6.1.2. For emergency responders

No additional information available

6.2. Environmental precautions

Try to stop release. Reduce vapor with fog or fine water spray. Prevent waste from contaminating the surrounding environment. Prevent soil and water pollution. Dispose of contents/container in accordance with local/regional/national/international regulations. Contact supplier for any special requirements.

6.3. Methods and material for containment and cleaning up

No additional information available

6.4. Reference to other sections

See also sections 8 and 13.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Precautions for safe handling : Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking. Use only non-sparking tools. Use only explosion-proof equipment

All piped systems and associated equipment must be grounded

Leak-check system with soapy water; never use a flame

Wear leather safety gloves and safety shoes when handling cylinders. Protect cylinders from physical damage; do not drag, roll, slide or drop. While moving cylinder, always keep in place removable valve cover. Never attempt to lift a cylinder by its cap; the cap is intended solely to protect the valve. When moving cylinders, even for short distances, use a cart (trolley, hand truck, etc.) designed to transport cylinders. Never insert an object (e.g, wrench, screwdriver, pry bar) into cap openings; doing so may damage the valve and cause a leak. Use an adjustable strap wrench to remove over-tight or rusted caps. Slowly open the valve. If the valve is hard to open, discontinue use and contact your supplier. Close the container valve after each use; keep closed even when empty. Never apply flame or localized heat directly to any part of the container. High temperatures may damage the container and could cause the pressure relief device to fail prematurely, venting the container contents. For other precautions in using this product, see section 16.

7.2. Conditions for safe storage, including any incompatibilities

Storage conditions : Store only where temperature will not exceed 125°F (52°C). Post "No Smoking/No Open Flames" signs in storage and use areas. There must be no sources of ignition. Separate packages and protect against potential fire and/or explosion damage following appropriate codes and requirements (e.g, NFPA 30, NFPA 55, NFPA 70, and/or NFPA 221 in the U.S.) or according to requirements determined by the Authority Having Jurisdiction (AHJ). Always secure containers upright to keep them from falling or being knocked over. Install valve protection cap, if provided, firmly in place by hand when the container is not in use. Store full and empty containers separately. Use a first-in, first-out inventory system to prevent storing full containers for long periods. For other precautions in using this product, see section 16

OTHER PRECAUTIONS FOR HANDLING, STORAGE, AND USE: When handling product under pressure, use piping and equipment adequately designed to withstand the pressures to be encountered. Never work on a pressurized system. Use a back flow preventive device in the piping. Gases can cause rapid suffocation because of oxygen deficiency; store and use with adequate ventilation. If a leak occurs, close the container valve and blow down the system in a safe and environmentally correct manner in compliance with all international, federal/national, state/provincial, and local laws; then repair the leak. Never place a container where it may become part of an electrical circuit.

7.3. Specific end use(s)

None.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Dimethyl Ether (115-10-6)	
ACGIH	Not established
USA OSHA	Not established

8.2. Exposure controls

Appropriate engineering controls : Use an explosion-proof local exhaust system. Local exhaust and general ventilation must be adequate to meet exposure standards. MECHANICAL (GENERAL): **Inadequate - Use only in a closed system.** Use explosion proof equipment and lighting.

Hand protection : Wear working gloves when handling gas containers.

Eye protection : Wear safety glasses with side shields. Wear safety glasses with side shields or goggles when transfilling or breaking transfer connections.

Respiratory protection	: When workplace conditions warrant respirator use, follow a respiratory protection program that meets OSHA 29 CFR 1910.134, ANSI Z88.2, or MSHA 30 CFR 72.710 (where applicable). Use an air-supplied or air-purifying cartridge if the action level is exceeded. Ensure that the respirator has the appropriate protection factor for the exposure level. If cartridge type respirators are used, the cartridge must be appropriate for the chemical exposure. For emergencies or instances with unknown exposure levels, use a self-contained breathing apparatus (SCBA).
Thermal hazard protection	: Wear cold insulating gloves when transfilling or breaking transfer connections. None necessary.
Environmental exposure controls	: Refer to local regulations for restriction of emissions to the atmosphere. See section 13 for specific methods for waste gas treatment. Refer to local regulations for restriction of emissions to the atmosphere.
Other information	: Consider the use of flame resistant anti-static safety clothing. Wear safety shoes while handling containers.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state	: Gas
Molecular mass	: 46 g/mol
Color	: Colorless.
Odor	: Ethereal. Poor warning properties at low concentrations.
Odor threshold	: No data available
pH	: Not applicable.
Relative evaporation rate (butyl acetate=1)	: No data available
Relative evaporation rate (ether=1)	: Not applicable.
Melting point	: -141.5 °C
Freezing point	: No data available
Boiling point	: -24.8 °C
Flash point	: Not applicable.
Critical temperature	: 126.9 °C
Auto-ignition temperature	: 350 °C
Decomposition temperature	: No data available
Flammability (solid, gas)	: 3.4 - 18
Vapor pressure	: 510 kPa
Critical pressure	: 5370 kPa
Relative vapor density at 20 °C	: No data available
Relative density	: 0.73
Density	: 668.3 kg/m³ (at 20 °C)
Relative gas density	: 1.6
Solubility	: Water: No data available
Log Pow	: 0.1
Log Kow	: Not applicable.
Viscosity, kinematic	: Not applicable.
Viscosity, dynamic	: Not applicable.
Explosive properties	: Not applicable.
Oxidizing properties	: None.
Explosion limits	: No data available

9.2. Other information

Gas group	: Liquefied gas
Additional information	: Gas/vapor heavier than air. May accumulate in confined spaces, particularly at or below ground level

SECTION 10: Stability and reactivity

10.1. Reactivity

No reactivity hazard other than the effects described in sub-sections below.

10.2. Chemical stability

Stable under normal conditions.

10.3. Possibility of hazardous reactions

May occur. The presence of oxygen or prolonged standing in or exposure to direct sunlight may lead to formation of unstable peroxides, which may explode spontaneously or when heated.

10.4. Conditions to avoid

High temperature. direct sunlight.

10.5. Incompatible materials

Oxidizing agents. Halogens. Acids. carbon monoxide. Aluminum hydride. Lithium aluminium hydride.

10.6. Hazardous decomposition products

Thermal decomposition may produce : Carbon monoxide. Carbon dioxide.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Acute toxicity : Not classified

Dimethyl Ether (\f)115-10-6	
LC50 inhalation rat (mg/l)	308.5 mg/l/4h
LC50 inhalation rat (ppm)	163754 ppm/1h
ATE US (vapors)	308.500 mg/l/4h
ATE US (dust, mist)	308.500 mg/l/4h

Skin corrosion/irritation : Not classified

pH: Not applicable.

Serious eye damage/irritation : Not classified

pH: Not applicable.

Respiratory or skin sensitization : Not classified

Germ cell mutagenicity : Not classified

Carcinogenicity : Not classified

Reproductive toxicity : Not classified

Specific target organ toxicity (single exposure) : MAY CAUSE DROWSINESS OR DIZZINESS.

Specific target organ toxicity (repeated exposure) : Not classified

Aspiration hazard : Not classified

SECTION 12: Ecological information

12.1. Toxicity

Ecology - general : No ecological damage caused by this product.

12.2. Persistence and degradability

Dimethyl Ether (115-10-6)	
Persistence and degradability	Not readily biodegradable.

12.3. Bioaccumulative potential

Dimethyl Ether (115-10-6)	
Log Pow	0.1
Log Kow	Not applicable.

Dimethyl Ether (115-10-6)	
Bioaccumulative potential	Not expected to bioaccumulate due to the low log Kow (log Kow < 4). Refer to section 9.

12.4. Mobility in soil

Dimethyl Ether (115-10-6)	
Mobility in soil	No data available.
Ecology - soil	Because of its high volatility, the product is unlikely to cause ground or water pollution.

12.5. Other adverse effects

Other adverse effects : May cause pH changes in aqueous ecological systems.

Effect on ozone layer : None

Global warming potential [CO2=1] : 1

Effect on the global warming : No known effects from this product

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Waste disposal recommendations : Dispose of contents/container in accordance with local/regional/national/international regulations. Contact supplier for any special requirements.

SECTION 14: Transport information

In accordance with DOT

Transport document description : UN1033 Dimethyl ether, 2.1

UN-No.(DOT) : UN1033

Proper Shipping Name (DOT) : Dimethyl ether

Class (DOT) : 2.1 - Class 2.1 - Flammable gas 49 CFR 173.115

Hazard labels (DOT) : 2.1 - Flammable gas

DOT Special Provisions (49 CFR 172.102) : T50 - When portable tank instruction T50 is referenced in Column (7) of the 172.101 Table, the applicable liquefied compressed gases are authorized to be transported in portable tanks in accordance with the requirements of 173.313 of this subchapter

Additional information

Emergency Response Guide (ERG) Number : 115

Other information : No supplementary information available.

Special transport precautions : Avoid transport on vehicles where the load space is not separated from the driver's compartment. Ensure vehicle driver is aware of the potential hazards of the load and knows what to do in the event of an accident or an emergency. Before transporting product containers: - Ensure there is adequate ventilation. - Ensure that containers are firmly secured. - Ensure cylinder valve is closed and not leaking. - Ensure valve outlet cap nut or plug (where provided) is correctly fitted. - Ensure valve protection device (where provided) is correctly fitted.

Transport by sea

UN-No. (IMDG) : 1033

Proper Shipping Name (IMDG) : Dimethyl Ether

Class (IMDG) : 2 - Gases

MFAG-No : 115

Air transport

UN-No. (IATA) : 1033

Proper Shipping Name (IATA) : Dimethyl ether

Class (IATA)	: 2
Civil Aeronautics Law	: Gases under pressure/Gases flammable under pressure

SECTION 15: Regulatory information

15.1. US Federal regulations

Dimethyl Ether (115-10-6)	
Listed on the United States TSCA (Toxic Substances Control Act) inventory	
SARA Section 311/312 Hazard Classes	Immediate (acute) health hazard Delayed (chronic) health hazard Sudden release of pressure hazard Fire hazard

15.2. International regulations

CANADA

Dimethyl Ether (115-10-6)
Listed on the Canadian DSL (Domestic Substances List)

EU-Regulations

Dimethyl Ether (115-10-6)
Listed on the EEC inventory EINECS (European Inventory of Existing Commercial Chemical Substances)

15.2.2. National regulations

Dimethyl Ether (115-10-6)
Listed on the AICS (Australian Inventory of Chemical Substances) Listed on IECSC (Inventory of Existing Chemical Substances Produced or Imported in China) Listed on the Japanese ENCS (Existing & New Chemical Substances) inventory Listed on the Korean ECL (Existing Chemicals List) Listed on NZIoC (New Zealand Inventory of Chemicals) Listed on PICCS (Philippines Inventory of Chemicals and Chemical Substances) Listed on INSQ (Mexican National Inventory of Chemical Substances) Listed on CICR (Turkish Inventory and Control of Chemicals)

15.3. US State regulations

Dimethyl Ether(115-10-6)	
U.S. - California - Proposition 65 - Carcinogens List	No
U.S. - California - Proposition 65 - Developmental Toxicity	No
U.S. - California - Proposition 65 - Reproductive Toxicity - Female	No
U.S. - California - Proposition 65 - Reproductive Toxicity - Male	No
State or local regulations	U.S. - Massachusetts - Right To Know List U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK (Right to Know) List

SECTION 16: Other information

Other information : When you mix two or more chemicals, you can create additional, unexpected hazards. Obtain and evaluate the safety information for each component before you produce the mixture. Consult an industrial hygienist or other trained person when you evaluate the end product. Before using any plastics, confirm their compatibility with this product

Praxair asks users of this product to study this SDS and become aware of the product hazards and safety information. To promote safe use of this product, a user should (1) notify employees, agents, and contractors of the information in this SDS and of any other known product hazards and safety information, (2) furnish this information to each purchaser of the product, and (3) ask each purchaser to notify its employees and customers of the product hazards and safety information

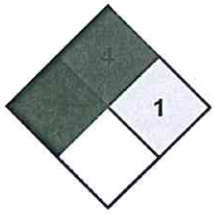
The opinions expressed herein are those of qualified experts within Praxair, Inc. We believe that the information contained herein is current as of the date of this Safety Data Sheet. Since the use of this information and the conditions of use are not within the control of Praxair, Inc, it is the user's obligation to determine the conditions of safe use of the product

Praxair SDSs are furnished on sale or delivery by Praxair or the independent distributors and suppliers who package and sell our products. To obtain current SDSs for these products, contact your Praxair sales representative, local distributor, or supplier, or download from www.praxair.com. If you have questions regarding Praxair SDSs, would like the document number and date of the latest SDS, or would like the names of the Praxair suppliers in your area, phone or write the Praxair Call Center (Phone: 1-800-PRAXAIR/1-800-772-9247; Address: Praxair Call Center, Praxair, Inc, P.O. Box 44, Tonawanda, NY 14151-0044)

NFPA health hazard : 1 - Exposure could cause irritation but only minor residual injury even if no treatment is given.

NFPA fire hazard : 4 - Will rapidly or completely vaporize at normal pressure and temperature, or is readily dispersed in air and will burn readily.

NFPA reactivity : 1 - Normally stable, but can become unstable at elevated temperatures and pressures or may react with water with some release of energy, but not violently.



HMIS III Rating

Health : 1 Slight Hazard - Irritation or minor reversible injury possible

Flammability : 4 Severe Hazard

Physical : 2 Moderate Hazard

SDS US (GHS HazCom 2012) - Praxair

This information is based on our current knowledge and is intended to describe the product for the purposes of health, safety and environmental requirements only. It should not therefore be construed as guaranteeing any specific property of the product.

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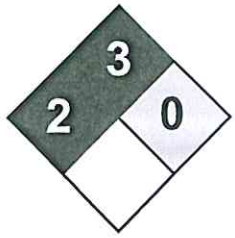
Chemicals & Laboratory Equipment



Health	2
Fire	3
Reactivity	0
Personal Protection	E

Material Safety Data Sheet
Ethyl alcohol 200 Proof MSDS

Section 1: Chemical Product and Company Identification

Product Name: Ethyl alcohol 200 Proof

Catalog Codes: SLE2248, SLE1357

CAS#: 64-17-5

RTECS: KQ6300000

TSCA: TSCA 8(b) inventory: Ethyl alcohol 200 Proof

CI#: Not applicable.

Synonym: Ethanol; Absolute Ethanol; Alcohol; Ethanol 200 proof; Ethyl Alcohol, Anhydrous; Ethanol, undenatured; Dehydrated Alcohol; Alcohol

Chemical Name: Ethyl Alcohol

Chemical Formula: CH3CH2OH

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call: 1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Ethyl alcohol 200 Proof	64-17-5	100

Toxicological Data on Ingredients: Ethyl alcohol 200 Proof: ORAL (LD50): Acute: 7060 mg/kg [Rat]. 3450 mg/kg [Mouse]. VAPOR (LC50): Acute: 20000 ppm 8 hours [Rat]. 39000 mg/m 4 hours [Mouse].

Section 3: Hazards Identification

Potential Acute Health Effects:
Hazardous in case of skin contact (irritant), of eye contact (irritant), of inhalation. Slightly hazardous in case of skin contact (permeator), of ingestion.

Potential Chronic Health Effects:
Slightly hazardous in case of skin contact (sensitizer). CARCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH. MUTAGENIC EFFECTS: Mutagenic for mammalian somatic cells. Mutagenic for bacteria and/or yeast. TERATOGENIC EFFECTS: Classified PROVEN for human. DEVELOPMENTAL TOXICITY: Classified Development toxin [PROVEN]. Classified Reproductive system/toxin/female, Reproductive system/toxin/male [POSSIBLE]. The substance is toxic to blood, the reproductive system, liver, upper respiratory tract, skin, central nervous system (CNS). Repeated or prolonged exposure to the substance can produce target organs damage.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Cold water may be used. Get medical attention.

Skin Contact:
In case of contact, immediately flush skin with plenty of water. Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Cold water may be used.Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek medical attention.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention if symptoms appear.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Flammable.

Auto-Ignition Temperature: 363°C (685.4°F)

Flash Points: CLOSED CUP: 12.78°C (55°F). OPEN CUP: 17.78°C (64°F) (Cleveland).

Flammable Limits: LOWER: 3.3% UPPER: 19%

Products of Combustion: These products are carbon oxides (CO, CO2).

Fire Hazards in Presence of Various Substances:
Highly flammable in presence of open flames and sparks, of heat. Slightly flammable to flammable in presence of oxidizing materials.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available. Slightly explosive in presence of open flames and sparks, of heat, of oxidizing materials, of acids.

Fire Fighting Media and Instructions:
Flammable liquid, soluble or dispersed in water. SMALL FIRE: Use DRY chemical powder. LARGE FIRE: Use alcohol foam, water spray or fog.

Special Remarks on Fire Hazards:
Containers should be grounded. CAUTION: MAY BURN WITH NEAR INVISIBLE FLAME Vapor may travel considerable distance to source of ignition and flash back. May form explosive mixtures with air. Contact with Bromine pentafluoride is likely to cause fire or explosion. Ethanol ignites on contact with chromyl chloride. Ethanol ignites on contact with iodine heptafluoride gas. It ignites than explodes upon contact with nitrosyl perchlorate. Additon of platinum black catalyst caused ignition.

Special Remarks on Explosion Hazards:
Ethanol has an explosive reaction with the oxidized coating around potassium metal. Ethanol ignites and then explodes on contact with acetic anhydride + sodium hydrosulfate (ignites and may explode), disulfuric acid + nitric acid, phosphorous(III) oxide platinum, potassium-tert-butoxide+ acids. Ethanol forms explosive products in reaction with the following compound :

ammonia + silver nitrate (forms silver nitride and silver fulminate), iodine + phosphorus (forms ethane iodide), magnesium perchlorate (forms ethyl perchlorate), mercuric nitrate, nitric acid + silver (forms silver fulminate) silver nitrate (forms ethyl nitrate) silver(I) oxide + ammonia or hydrazine (forms silver nitride and silver fulminate), sodium (evolves hydrogen gas). Sodium Hydrazide + alcohol can produce an explosion. Alcohols should not be mixed with mercuric nitrate, as explosive mercuric fulminate may be formed. May form explosive mixture with manganese perchlorate + 2,2-dimethoxypropane. Addition of alcohols to highly concentrate hydrogen peroxide forms powerful explosives. Explodes on contact with calcium hypochlorite

Section 6: Accidental Release Measures

Small Spill:
Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container.

Large Spill:
Flammable liquid. Keep away from heat. Keep away from sources of ignition. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not touch spilled material. Prevent entry into sewers, basements or confined areas; dike if needed. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep locked up.. Keep away from heat. Keep away from sources of ignition. Ground all equipment containing material. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Wear suitable protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, acids, alkalis, moisture.

Storage:
Store in a segregated and approved area. Keep container in a cool, well-ventilated area. Keep container tightly closed and sealed until ready for use. Avoid all possible sources of ignition (spark or flame). Do not store above 23°C (73.4°F).

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:
Splash goggles. Lab coat. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves. Use a respirator if the exposure limit is exceeded.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
TWA: 1900 (mg/m3) from OSHA (PEL) [United States] TWA: 1000 (ppm) from OSHA (PEL) [United States] TWA: 1900 (mg/m3) from NIOSH [United States] TWA: 1000 (ppm) from NIOSH [United States] TWA: 1000 (ppm) [United Kingdom (UK)] TWA: 1920 (mg/m3) [United Kingdom (UK)] TWA: 1000 STEL: 1250 (ppm) [Canada]Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid. (Liquid.)

Odor:

Mild to strong, rather pleasant; like wine or whiskey. Alcohol-like; Ethereal, vinous.

Taste: Pungent. Burning.

Molecular Weight: 46.07 g/mole

Color: Colorless. Clear

pH (1% soln/water): Not available.

Boiling Point: 78.5°C (173.3°F)

Melting Point: -114.1°C (-173.4°F)

Critical Temperature: 243°C (469.4°F)

Specific Gravity: 0.789 (Water = 1)

Vapor Pressure: 5.7 kPa (@ 20°C)

Vapor Density: 1.59 (Air = 1)

Volatility: Not available.

Odor Threshold: 100 ppm

Water/Oil Dist. Coeff.: The product is more soluble in water; log(oil/water) = -0.3

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water, methanol, diethyl ether, acetone.

Solubility:
Easily soluble in cold water, hot water. Soluble in methanol, diethyl ether, acetone.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Incompatible materials, heat, sources of ignition.

Incompatibility with various substances: Reactive with oxidizing agents, acids, alkalis.

Corrosivity: Non-corrosive in presence of glass.

Special Remarks on Reactivity:
Ethanol rapidly absorbs moisture from the air. Can react vigorously with oxiders. The following oxidants have been demonstrated to undergo vigorous/explosive reaction with ethanol: barium perchlorate, bromine pentafluoride, calcium hypochlorite, chloryl perchlorate, chromium trioxide, chromyl chloride, dioxygen difluoride, disulfuryl difluoride, fluorine nitrate, hydrogen peroxide, iodine heptafluoride, nitric acid nitrosyl perchlorate, perchloric acid permanganic acid, peroxodisulfuric acid, potassium dioxide, potassium perchlorate, potassium permanganate, ruthenium(VIII) oxide, silver perchlorate, silver peroxide, uranium hexafluoride, uranyl perchlorate. Ethanol reacts violently/expodes with the following compounds: acetyl bromide (evolves hydrogen bromide) acetyl chloride, aluminum, sesquibromide ethylate, ammonium hydroxide & silver oxide, chlorate, chromic anhydride, cyanuric acid + water, dichloromethane + sulfuric acid + nitrate (or) nitrite, hydrogen peroxide + sulfuric acid, iodine + methanol + mercuric oxide, manganese perchlorate + 2,2-dimethoxy propane, perchlorates, permanganates + sulfuric acid, potassium superoxide, potassium tert-butoxide, silver & nitric acid, silver perchlorate, sodium hydrazide, sulfuric acid + sodium dichromate, tetrachlorisilane + water. Ethanol is also incompatible with platinium, and sodium. No really safe conditions exist under which ethyl alcohol and chlorine oxides can be handled. Reacts vigorously with acetyl chloride

Special Remarks on Corrosivity: Not available.

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Absorbed through skin. Dermal contact. Eye contact. Inhalation. Ingestion.

Toxicity to Animals:
WARNING: THE LC50 VALUES HEREUNDER ARE ESTIMATED ON THE BASIS OF A 4-HOUR EXPOSURE. Acute oral toxicity (LD50): 3450 mg/kg [Mouse]. Acute toxicity of the vapor (LC50): 39000 mg/m3 4 hours [Mouse].

Chronic Effects on Humans:
CARCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH. MUTAGENIC EFFECTS: Mutagenic for mammalian somatic cells. Mutagenic for bacteria and/or yeast. TERATOGENIC EFFECTS: Classified PROVEN for human. DEVELOPMENTAL TOXICITY: Classified Development toxin [PROVEN]. Classified Reproductive system/toxin/female, Reproductive system/toxin/male [POSSIBLE]. Causes damage to the following organs: blood, the reproductive system, liver, upper respiratory tract, skin, central nervous system (CNS).

Other Toxic Effects on Humans:
Hazardous in case of skin contact (irritant), of inhalation. Slightly hazardous in case of skin contact (permeator), of ingestion.

Special Remarks on Toxicity to Animals:
Lowest Published Dose/Conc: LDL[Human] - Route: Oral; Dose: 1400 mg/kg LDL[Human child] - Route: Oral; Dose: 2000 mg/kg LDL[Rabbit] - Route: Skin; Dose: 20000 mg/kg

Special Remarks on Chronic Effects on Humans:
May affect genetic material (mutagenic) Causes adverse reproductive effects and birth defects (teratogenic) , based on moderate to heavy consumption. May cause cancer based on animal data. Human: passes through the placenta, excreted in maternal milk.

Special Remarks on other Toxic Effects on Humans:
Acute potential health effects: Skin: causes skin irritation Eyes: causes eye irritation Ingestion: May cause gastrointestinal tract irritation with nausea, vomiting, diarrhea, and alterations in gastric secretions. May affect behavior/central nervous system (central nervous system depression - amnesia, headache, muscular incoordination, excitation, mild euphoria, slurred speech, drowsiness, staggaring gait, fatigue, changes in mood/personality, excessive talking, dizziness, ataxia, somnolence, coma/narcosis, hallucinations, distorted perceptions, general anesthetic), peripherial nervous system (spastic paralysis)vision (diplopia). Moderately toxic and narcotic in high concentrations. May also affect metabolism, blood, liver, respiration (dyspnea), and endocrine system. May affect respiratory tract, cardiovascular(cardiac arrhythmias, hypotension), and urinary systems. Inhalation: May cause irritation of the respiratory tract and affect behavior/central nervous system with symptoms similar to ingestion. Chronic Potential Health Effects: Skin: Prolonged or repeated skin contact may casue dermatitis, an allergic reaction. Ingestion: Prolonged or repeated ingestion will have similiar effects as acute ingestion. It may also affect the brain.

Section 12: Ecological Information

Ecotoxicity: Ecotoxicity in water (LC50): 14000 mg/l 96 hours [Rainbow trout]. 11200 mg/l 24 hours [fingerling trout].

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The product itself and its products of degradation are not toxic.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: CLASS 3: Flammable liquid.

Identification: : Ethanol UNNA: 1170 PG: II

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

Federal and State Regulations:
California prop. 65: This product contains the following ingredients for which the State of California has found to cause cancer, birth defects or other reproductive harm, which would require a warning under the statute: Ethyl alcohol 200 Proof (in alcoholic beverages) California prop. 65: This product contains the following ingredients for which the State of California has found to cause birth defects which would require a warning under the statute: Ethyl alcohol 200 Proof (in alcoholic beverages) Connecticut hazardous material survey.: Ethyl alcohol 200 Proof Illinois toxic substances disclosure to employee act: Ethyl alcohol 200 Proof Rhode Island RTK hazardous substances: Ethyl alcohol 200 Proof Pennsylvania RTK: Ethyl alcohol 200 Proof Florida: Ethyl alcohol 200 Proof Minnesota: Ethyl alcohol 200 Proof Massachusetts RTK: Ethyl alcohol 200 Proof Massachusetts spill list: Ethyl alcohol 200 Proof New Jersey: Ethyl alcohol 200 Proof Tennessee: Ethyl alcohol 200 Proof California - Directors List of Hazardous Substances (8 CCR 339): Ethyl alcohol 200 Proof TSCA 8(b) inventory: Ethyl alcohol 200 Proof

Other Regulations:
OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200). EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

Other Classifications:

WHMIS (Canada):
CLASS B-2: Flammable liquid with a flash point lower than 37.8°C (100°F). CLASS D-2A: Material causing other toxic effects (VERY TOXIC).

DSCL (EEC):
R11- Highly flammable. S7- Keep container tightly closed. S16- Keep away from sources of ignition - No smoking.

HMIS (U.S.A.):

Health Hazard: 2

Fire Hazard: 3

Reactivity: 0

Personal Protection: E

National Fire Protection Association (U.S.A.):

Health: 2

Flammability: 3

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves. Lab coat. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Splash goggles.

Section 16: Other Information

References:
-SAX, N.I. Dangerous Properties of Indutrial Materials. Toronto, Van Nostrand Reinold, 6e ed. 1984. -Material safety data sheet emitted by: la Commission de la Santé et de la Sécurité du Travail du Québec. -Hawley, G.G.. The Condensed Chemical Dictionary, 11e ed., New York N.Y., Van Nostrand Reinold, 1987. -The Sigma-Aldrich Library of Chemical Safety Data, Edition II. HSDB, RTECS, and LOLI databases.

Other Special Considerations: Not available.

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APPENDIX C:

The MHI Regulations

Government Gazette

REPUBLIC OF SOUTH AFRICA

Regulation Gazette No. 7122

Vol. 433 Pretoria 30 July 2001 No. 22506

AIDS HELPLINE: 0800-123-22 Prevention is the cure

CONTENTS

INHOUD

GOVERNMENT NOTICE
GOEWERMENTSKENNISGEWING

DEPARTMENT OF LABOUR
DEPARTEMENT VAN ARBEID

No. R. 692 **30 July 2001**

OCCUPATIONAL HEALTH AND SAFETY ACT, 1993

MAJOR HAZARD INSTALLATION REGULATIONS

The Minister of Labour has, after consultation with the Advisory Council for Occupational Health and Safety, under section 43 of the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993), made the regulations in the Schedule.

SCHEDULE

Definitions

1. In these regulations any expression to which a meaning has been assigned in the Act shall have the meaning so assigned and, unless the context otherwise indicates —

"emergency plan" means a plan in writing which, on the basis of identified potential incidents at the installation, together with their consequences, describes how such incidents and their consequences should be dealt with on-site and off-site;

"local government" means a local government as defined in section 1 of the Local Government Transition Act, 1993 (Act No. 209 of 1993);

"material safety data sheet" means a material safety data sheet as contemplated in regulation 7 of the General Administrative Regulations;

"near miss" means any unforeseen event involving one or more hazardous substances which, but for mitigating effects, actions or systems, could have escalated to a major incident;

"on-site emergency plan" means the emergency plan contemplated in regulation 6;

"risk assessment" means the process contemplated in regulation 5;

"rolling stock" means any locomotive, coach, railway carriage, truck, wagon or similar contrivance used for the purpose of transporting persons, goods or any other thing, and which can run on a railway;

"temporary installation" means an installation that can travel independently between planned points of departure and arrival for the purpose of transporting any substance, and which is only deemed to be an installation at the points of departure and arrival, respectively;

"the Act" means the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993);

"transit" includes any time or place in which rolling stock may be between planned points of departure and arrival.

Scope of application

2. (1) Subject to the provisions of subregulation (3) these regulations shall apply to employers, self-employed persons and users, who have on their premises, either permanently or temporarily, a major hazard installation or a quantity of a substance which may pose a risk that could affect the health and safety of employees and the public.

(2) These regulations shall apply to local governments, with specific reference to regulation 9.

(3) These regulations shall not apply to nuclear installations registered in terms of the Nuclear Energy Act, 1993 (Act No. 131 of 1993).

Notification of installation

3. (1) Every employer, self-employed person and user shall notify the chief inspector, provincial director and relevant local government in writing of —

(a) the erection of any installation that will be a major hazard installation, prior to commencement of erection thereof; and

(b) the conversion of any existing installation into a major hazard installation, prior to such conversion.

(2) Every employer, self-employed person and user shall notify the chief inspector, the local government and the provincial director within 60 days of the promulgation of these regulations of an existing major hazard installation.

(3) No employer, self-employed person and user shall modify an installation by increasing its storage or production capacity, or altering the process or by effecting any other change that may increase the risk of an existing major hazard installation, without notifying the chief inspector, relevant local government and provincial director in writing.

(4) The information submitted by an employer, self-employed person and user in terms of subregulations (1), (2) and (3), shall include —

(a) the physical address of the installation;

(b) the complete material safety data sheets of all substances that resulted in the installation being classified as a major hazard installation;

(c) the envisaged maximum quantity of such substance that may be on the premises at any one time;

(d) the risk assessment of the major hazard installation as contemplated in regulation 5(1); and

(e) any further information that may be deemed necessary by an inspector in the interests of the health and safety of the public.

(5) Subregulations (1), (2) and (3) shall not apply to rolling stock in transit.

(6) An employer, self-employed person and user shall advertise the notifications contemplated in subregulations (1), (2) and (3) in at least one newspaper serving the communities in the vicinity of the installation which is to be declared a major hazard installation, a proposed major hazard installation or an existing installation which is to be modified, and by way of notices posted within those communities.

(7) Any interested or affected person may make representations in writing to the relevant local government or provincial director within 60 days about an existing major hazard installation or after the erection, conversion, modification of a major hazard installation, if that installation is not acceptable to that person.

Temporary installations

4. (1) Any employer, self-employed person and user who has a temporary installation on his or her premises which would, taking into consideration the risks attached to the quantity of substance and the procedure of discharge, result in that temporary installation being declared a major hazard installation if it were not a temporary installation, shall be deemed to be responsible for the storage and discharge of that installation while on his or her premises.

(2) An employer, self-employed person and user contemplated in subregulation (1) shall ensure that a risk assessment for the storage and discharge procedure be carried out for a temporary installation prior to the risk coming into existence.

(3) An employer, self-employed person and user contemplated in subregulation (1) shall, after taking into consideration the risk assessment, take the reasonably practicable steps that may be necessary to reduce the risks attached to the storage and discharge of a temporary installation.

Risk assessment

5. (1) An employer, self-employed person and user shall, after consultation with the relevant health and safety representative or relevant health and safety committee, carry out a risk assessment at intervals not exceeding five years and submit such risk assessment to the chief inspector, relevant local government and provincial director.

(2) The risk assessment is the process of collecting, organising, analysing, interpreting, communicating and implementing information in order to identify the probable frequency, magnitude and nature of any major incident which could occur at a major hazard installation, and the measures required to remove, reduce or control the potential causes of such an incident.

(3) An employer, self-employed person and user shall inform the relevant health and safety representative or relevant health and safety committee in writing of the arrangements made for the assessment contemplated in subregulation (1), give them 60 days within which to comment thereon and ensure that the results of the assessment are made available to the relevant representative or committee who may comment thereon.

(4) An employer, self-employed person and user shall make available on the premises a copy of the latest risk assessment for inspection by an inspector.

(5) An employer, self-employed person and user shall ensure that the risk assessment contemplated in subregulation (1), shall —

(a) be carried out by an Approved Inspection Authority which is competent to express an opinion as to the risks associated with the major hazard installation; and

(b) at least include —

(i) a general process description of the major hazard installation;

(ii) a description of the major incidents associated with that type of installation and the consequences of such incidents, which shall include potential incidents;

(iii) an estimation of the probability of a major incident;

(iv) a copy of the site emergency plan;

(v) an estimation of the total result in the case of an explosion or fire;

(vi) in the case of toxic release, an estimation of concentration effects of such release;

(vii) the potential effect of an incident on a major hazard installation or part thereof on an adjacent major hazard installation or part thereof;

(viii) the potential effect of a major incident on any other installation, members of the public and residential areas;

(ix) meteorological tendencies;

(x) the suitability of existing emergency procedures for the risks identified;

(xi) any requirements laid down in terms of the Environment Conservation Act, 1989 (Act No. 73 of 1989); and

(xii) any organisational measures that may be required.

(6) (a) An employer, self-employed person and user shall ensure that the risk assessment required in terms of subregulation (1) is reviewed forthwith if -

(i) there is reason to suspect that the preceding assessment is no longer valid;

(ii) there has been a change in the process involving a substance resulting in the installation being classified a major hazard installation or in the methods, equipment or procedures in the use, handling or processing of that substance; or

(iii) after an incident that has brought the emergency plan into operation or after any near miss.

(b) Where the risk assessment has been updated an employer, self-employed person and user shall submit a copy of the updated risk assessment to the chief inspector, the relevant local government and the provincial director within 60 days.

(7) Subregulation (5)(b) shall not apply in the case of rolling stock in transit: Provided that the operator of a railway shall ensure —

(a) that a risk assessment applicable to rolling stock in transit is carried out and made available for inspection at the request of an inspector or local

government or both that local government and inspector, as the case may be; and

(b) that in the interests of the health and safety of the public the necessary precautions are taken.

(8) An employer, self-employed person and user shall ensure that the risk assessments contemplated in subregulations (1) and (5)(a) be made available for scrutiny by any interested person or any person that may be affected by the activities of a major hazard installation, at a time and place and in a manner agreed upon between the parties.

On-site emergency plan

6. (1) An employer, self-employed person and user shall after submission of the information contemplated in regulation 3(4) —

(a) establish an on-site emergency plan to be followed inside the premises of the installation or part of the installation classified as a major hazard installation in consultation with the relevant health and safety representative or the relevant health and safety committee;

(b) discuss the emergency plan with the relevant local government, taking into consideration any comment on the risk related to the health and safety of the public;

(c) review the on-site emergency plan and, where necessary, update the plan, in consultation with the relevant local government, at least once every three years;

(d) sign a copy of the on-site emergency plan in the presence of two witnesses, who shall attest the signature;

(e) ensure that the on-site emergency plan is readily available at all times for implementation and use;

(f) ensure that all employees are conversant with the on-site emergency plan; and

(g) cause the on-site emergency plan to be tested in practice at least once a year and keep a record of such test.

(2) Any employer, self-employed person and user owning or in control of a pipeline that could pose a threat to the general public shall inform the relevant local government and shall be jointly responsible with the relevant government for the establishment and implementation of an on-site emergency plan.

(3) Subregulation (1) shall not apply to rolling stock in transit: Provided that the operator of a railway shall —

(a) establish an emergency plan for each route traversed within 12 months of the coming into operation of these regulations;

(b) draw up the plan contemplated in paragraph (a) in consultation with the local government through whose jurisdiction that rolling stock is being transported;

(c) sign a copy of the on-site emergency plan in the presence of two witnesses, who shall attest the signature;

(d) ensure that the plan is readily available at all times for implementation and use; and

(e) cause that plan to be tested when reasonably practicable and keep a record of such test.

Reporting of risk and emergency occurrences

7. (1) Every employer, self-employed person and user of a major hazard installation and owner or user of a pipeline shall –

(a) subject to the provisions of regulation 6 of the General Administrative Regulations, within 48 hours by means of telephone, facsimile or similar means of communication inform the chief inspector, the provincial director and relevant local government of the occurrence of a major incident or an incident that brought the emergency plan into operation or any near miss;

(b) submit a report in writing to the chief inspector, provincial director and local government within seven days; and

(c) investigate and record all near misses in a register kept on the premises, which shall at all times be available for inspection by an inspector and the local government.

(2) Every employer, self-employed person and user shall in the case of a major incident or an incident contemplated in subregulation (1) that was or may have been caused by a substance, inform the supplier of that substance of the incident.

(3) An employer, self-employed person and user shall –

(a) record all near misses in a register kept on the premises, which shall at all times be available for inspection by an inspector; and

(b) ensure that the contents of the register contemplated in paragraph (a) shall also be available in the event of an inspection contemplated in regulation 5(4).

General duties of suppliers

8. (1) Every person that supplies a substance to a major hazard installation that has been classified as a major hazard installation for the reason of the presence of that substance in that installation shall ensure that he or she supplies with the substance a material safety data sheet contemplated in regulation 7 of the General Administrative Regulations.

(2) On receipt of the information contemplated in regulation 7(2), every supplier of the relevant substance shall assess the circumstances and substance involved in an incident or potential incident and inform all persons being supplied with that substance, of the potential dangers surrounding it.

(3) Every supplier of a hazardous substance to a major hazard installation shall provide a service that shall be readily available on a 24-hour basis to all employers, self-employed persons and users, the relevant local government and any other body concerned, to provide information and advice in the case of a major incident with regard to the substance supplied.

General duties of local government

9. (1) Without derogating from the provisions of the National Building Regulations and Building Standards Act, 1977 (Act No. 103 of 1977), no local government shall permit the erection of a new major hazard installation at a separation distance less than that which poses a risk to —

(a) airports;

(b) neighbouring independent major hazard installations;

(c) housing and other centres of population; or

(d) any other similar facility:

Provided that the local government shall permit new property development only where there is a separation distance which will not pose a risk in terms of the risk assessment: Provided further that the local government shall prevent any development adjacent to an installation that will result in that installation being declared a major hazard installation.

(2) Where a local government does not have facilities available to control a major incident or to comply with the requirements of this regulation, that local government shall make prior arrangements with a neighbouring local government, relevant provincial government or the employer, self-employed person and user for assistance.

(3) All off-site emergency plans to be followed outside the premises of the installation or part of the installation classified as a major hazard installation shall be the responsibility of the local government.

Closure

10. An employer, self-employed person and user shall notify the chief inspector, relevant provincial director and local government in writing, 21 days prior to the installation ceasing to be a major hazard installation.

Offences and penalties

11. Any person who contravenes or fails to comply with any provision of regulations 3(1), 3(2), 3(3), 3(4), 3(6), 4(2), 4(3), 5, 6, 7, 8 or 9, shall be guilty of an offence and on conviction be liable to a fine or to imprisonment for a period of 12 months and, in the case of a continuous offence, to an additional fine of R200 or additional imprisonment for each day on which the offence continues: Provided that the period of such additional imprisonment shall not exceed 90 days.