PROJECT DONE ON BEHALF OF
MOOV FUEL (PTY) LTD

QUANTITATIVE RISK ASSESSMENT FOR THE PROPOSED MOOV FUEL STORAGE PROJECT AT KRAAIFONTEIN IN CAPE TOWN, WESTERN CAPE

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Mike Oberholzer is a professional engineer, holds a Bachelor of Science in Chemical Engineering and is an approved signatory for MHI risk assessments, thereby meeting the competency requirements of SANAS for assessment of the risks of hazardous components, including fires, explosions and toxic releases.

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EXECUTIVE SUMMARY

1 INTRODUCTION

MOOV Fuels & Lubricants (Pty) Ltd (hereinafter referred to as MOOV), proposes to construct bulk fuel storage facilities at their Kraaifontein depot.

Since off-site incidents may result due to hazards of some of the chemical components to be stored on, produced at or delivered to site, RISCOM (PTY) LTD was commissioned to conduct a quantitative risk assessment (QRA) to determine the impacts onto surrounding properties and communities as part of an environmental impact assessment (EIA).

The purpose of this report is to convey the essential details, which include a short description of hazards, the receiving environment and the current relevant design, as well as risks and consequences of a major incident.

1.1 Terms of Reference

The main aim of the investigation was to quantify the risks to employees, neighbours and the public with regard to the proposed MOOV facility in Kraaifontein.

This risk assessment was to assess the risks posed by the fuels stored on the site. The scope of the risk assessment included:

1. Development of accidental spill and fire scenarios for the facility;
2. Using generic failure rate data (for tanks, pumps, valves, flanges, pipework, gantry, couplings and so forth), determination of the probability of each accident scenario;
3. For each incident developed in Step 2, determination of consequences (such as thermal radiation, domino effects, toxic-cloud formation and so forth);
4. For scenarios with off-site consequences (greater than 1% fatality off-site), calculation of maximum individual risk (MIR), taking into account all generic failure rates, initiating events (such as ignition), meteorological conditions and lethality.

1.2 Purpose and Main Activities

The main activity at the proposed MOOV facility in Kraaifontein is the storage of bulk fuel.

1.3 Main Hazards Due to Substance and Process

The main hazards that would occur with a loss of containment of hazardous components at the proposed MOOV facility in Kraaifontein include exposure to:

- Thermal radiation from fires;
- Overpressure from explosions.

2 ENVIRONMENT

The proposed MOOV depot, as shown in Figure 2-1, is located at Kiaat Road, in the Industrial area of Kraaifontein, Cape Town.

The coordinates of the MOOV depot are:

Latitude: 33°50’29.63” S
Longitude: 18°43’40.37” E

The MOOV facility is located approximately 40 km from Cape Town, with access from the N1 freeway. The facility is located in the industrial area of Kraaifontein. Business’s neighbouring the MOOV depot is Werda Cargo approximately 145 m, Essential steel approximately 101 m and Juno Group approximately 287 m, to the north of the depot. To the north east is Durbell Engineering approximately 151 m, as well as Scania South African approximately 274 m with Scania Marine approximately 214 m from the depot. To the east is KMC Agri approximately 130 m, Spec-Cast Wear Parts approximately 99 m, Genis verspreiders approximately 86 m, Boland PVC Produkte approximately 69 m, H & S Trailers approximately 35 m, Ray’s Towing approximately 118 m and Netafim approximately 185 m. DAF Trucks is located approximately 28 m from the MOOV depot, with the No1 Online solutions store approximately 26 m and Ceramics Morgan Milson approximately 91 m to the south east of the depot. To the North west is Vegtech 2000 approximately 259 m, Xtraspace Kraaifontein approximately 333 m and Decodome approximately 139 m from the MOOV site.

The residential area of Peerless Park East is located approximately 100 m to the west of the MOOV depot.

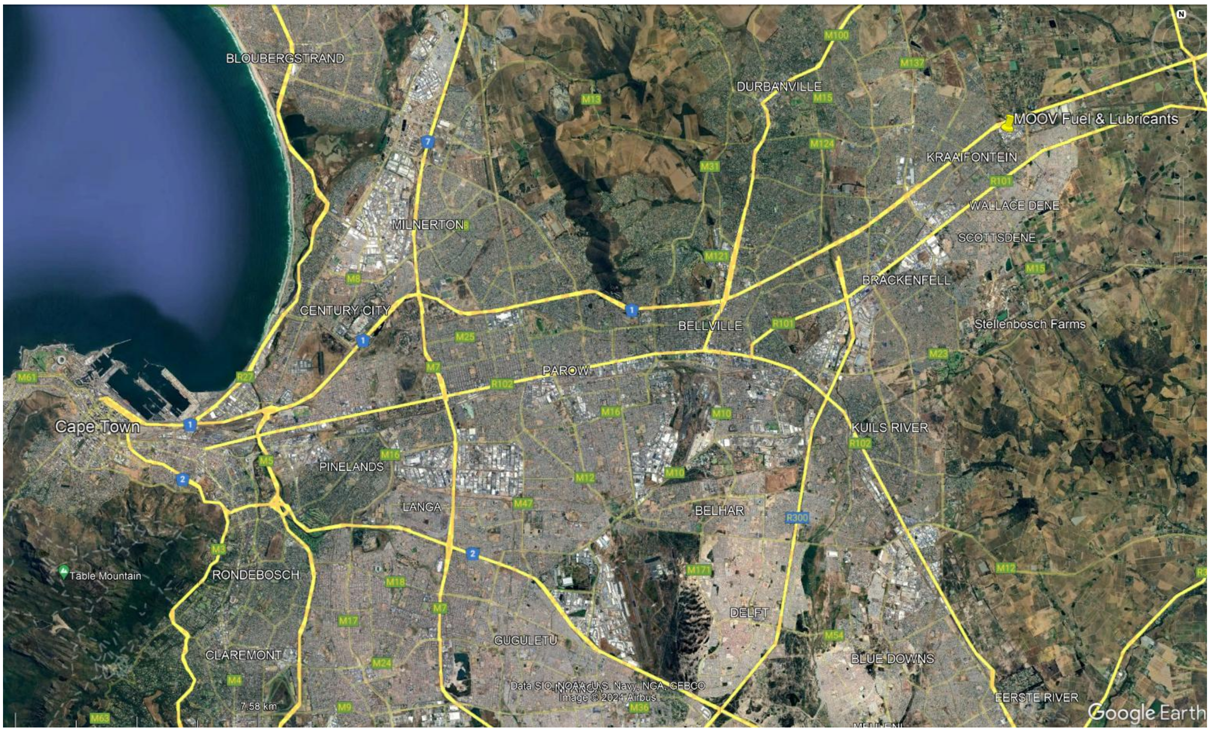
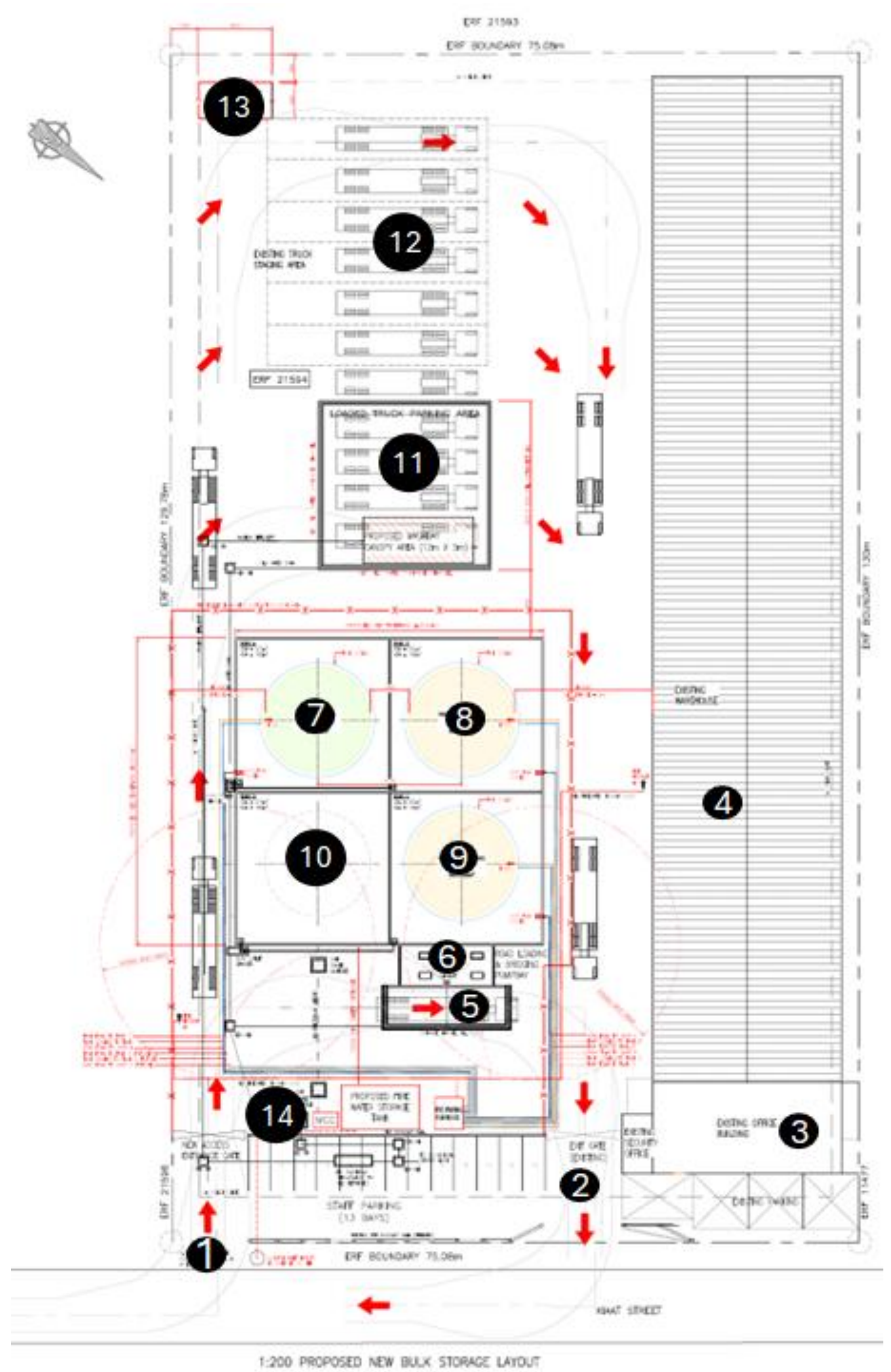


Figure 2-1: Location of the proposed MOOV facility in Kraaifontein

3 PROJECT DESCRIPTION

3.1 Site

The proposed MOOV storage facility in Kraaifontein will consist of offices, a warehouse, workshops, storage tanks and a loading / offloading bay, as shown in Figure 3-1.



	Description
1	Entrance
2	Exit
3	Office Building
4	Warehouse
5	Loading / Offloading Area
6	Pumps
7	Tank 1
8	Tank 2
9	Tank 3
10	Tank 4 (Future)
11	Loaded Truck Parking Area
12	Truck Staging Area
13	LPG Storage
14	Oil Separator

Figure 3-1: Site layout

3.2 Process Description

It is anticipated that the proposed MOOV facility may expand sometime in the future, including the increase on diesel and fuel storage.

3.2.1 Bulk Storage Tanks

A total number of 4 tanks can be accommodated within the available space. Under the current project, only 3 of the 4 tanks will be constructed with space allowance for a future tank.

For the purposes of the cost estimation, all tanks will be fixed cone roof tanks, with internal floating roofs (IFR) for the ULP tanks only.

The tank sizes and capacities are given below in Table 3-1.

Table 3-1: Summary of the hazard tier related from the inventory stored

Tank No.	Service	Diameter	Height	Gross Volume
1	ULP 95	11,52 m	4,8 m	500 m^3
2	Gasoil (GO)	11,52 m	9,6 m	1 000 m^3
3	Gasoil (GO)	11,52 m	9,6 m	1 000 m^3
4	Future	11,52 m	9,6 m	1 000 m^3

The vertical bulk storage tanks will be designed in accordance with API 650. Tanks will be supported on a reinforced concrete foundation, including the required layer works. Tank foundations will include the necessary secondary containment as prescribed by API 650.

Tanks will be equipped with the following appurtenances:

- Inlet and Outlet Fire-safe valves complete with thermal by-pass valves;
- Water draw-off valve;
- Tank Shell man-ways;
- Vent or breather pipes;
- Nozzles for dip hatch, temperature probes, Auto Tank Gauging (ATG);
- Access stairs and inter connecting walkways;
- Tank Foam Pourer Connections; and,
- Tank Cooling Rings.

Tanks will be protected against corrosion by applying protective paint coatings to the external shell and roof, as well as the floor and internal surface up to the 1st strake.

The tanks will be housed within one main bund, as follows:

- Largest Tank to be contained = 1 000 m^3
- Gross Bund Area (GBA) = 1 092 m^2
- Nett Bund Area (NBA) = 780 m^2
- Average Wall height (h) = 1,38 m

All tanks will be located within their own subdivision. These walls will be a minimum of 500 mm high and will terminate at a maximum height of approximately 300 mm below the main wall. Subdivision walls will be set at different levels thereby creating a preferential spill pattern in the event of a major spill occurring.

In keeping with the regulations laid down in the code, the bund floors will be sealed to prevent accidental spillages from entering the subsoil.

Bund drainage lines will be routed to the bund outlet chamber from where it will be routed to the API oil-water separator before discharging to the municipal sewer system in keeping with good environmental practices.

Each tank will have two independent level transmitters that will alarm and trip valves or pumps to prevent overfilling.

3.2.2 Road Tanker Loading / Unloading

All product receipt and transfers will be done via road tankers operating 24 hours per day, 7 days per week, in tankers up to 40 m^3 in volume. This facility will be located adjacent to the tank farm area and will comprise of the following:

- Product Receipt:
  - Decanting hose and dry-break coupling;
  - Decanting Pump installed onto a concrete plinth;
  - Vertical Deaerator c/w open close valve to ensure no air is transmitted through the flow meter;
  - Mechanical Flow meter with calibration valves.
- Product transfer;
  - Loading hose and dry break coupling;
  - Loading Pump installed onto a concrete plinth;
  - Strainer / Air Eliminator;
  - Mechanical Flow meter with calibration valves on suction strainer.
- Spillages at the pump bay and loading / offloading area will be directed to the oil separator, limiting the potential of pool fires at the offloading area preventing a BLEVE scenario.
- Any spillages from loading / offloading will flow into drains around the area, with the spilt fuel flowing directly to the oil separator.
- Pre-loaded road tankers carrying diesel may park at the facility overnight for deliveries the following day:
  - There will be no pre-loaded Petrol trucks standing overnight.
  - There may be as many as ±4 diesel tankers pre-loaded (worst case scenario) at any given day in a month. Tankers have a capacity of 40 000 L each and are arriving full on site.
  - Any spills from the road tankers will flow into channels that will be directed to the oil separator.

Note that separate facilities for diesel and petrol have been allowed for. This will ensure that all products will be metered for stock control purposes. No automation for this has been allowed for.

- COC Dispensing Point:
    - A single product (GO) dispensing point has been allowed for.
    - This will be located on a 3 m long island at the front of the depot.
    - This facility allows for trucks to be refuelled on the right-hand side via the high-speed dispenser.

The time to load and offload road tankers is estimated at one hour. Thus, a maximum of 24 tankers can be received per day. The expected product split 90% of the tankers loading / offloading will be diesel, where the remainder will be ULP.

3.3 Establishment Tier

The MHI Regulations (2022), under Chapter 1 and Chapter 2, define the establishment tier.

The summary for the petrol and diesel storage and the resultant tier classification, is given in Table 3-3.

Table 3-3: Summary of the hazard tier related from the inventory stored

Named Substances	UN Number	Quantities in tonnes (t)		
		Column 1 Low Hazard	Column 2 Medium Hazard	Column 3 High Hazard
Petroleum products: Gasolines, Naphtha's, Kerosene's (including Jet fuels), Gas oils (including Diesel fuels, Home heating oils and Gas oil blending streams).	Gas (1075) Crude (1275)	250	2 500	25 000

The expected MHI hazard tier for each phase of the fuel storage projects, is given in Table 3-4.

Table 3-4: Expected establishment hazardous tier

Phase	ULP 95 Inventory (t)	Diesel Inventory (t)	Total (t)	Hazard Tier
Proposed	440	1 820	2 260	Low Hazard
Future	1 320	1 820	3 140	Medium Hazard

The proposed project will classify the facility as a Low Hazard Establishment Major Hazard Installation, but may increase to a Medium Hazard Establishment Major Hazard Installation with the completion of the future phase, with the increased storage of ULP or diesel.

4 METHODOLOGY

The first step in any risk assessment is to identify all hazards. The merit of including a hazard for further investigation is then determined by how significant it is, normally by using a cut-off or threshold value.

Once a hazard has been identified, it is necessary to assess it in terms of the risk it presents to the employees and the neighbouring community. In principle, both the probability and consequence should be considered, but there are occasions where, if either the probability or the consequence can be shown to be sufficiently low or sufficiently high, decisions can be made based on just one factor.

During the hazard identification component of the report, the following considerations are taken into account:

- Chemical identities;
- Location of on-site installations that use, produce, process, transport or store hazardous components;
- Type and design of containers, vessels or pipelines;
- Quantity of material that could be involved in an airborne release;
- Nature of the hazard most likely to accompany hazardous materials spills or releases, e.g., airborne toxic vapours or mists, fires or explosions, large quantities to be stored and certain handling conditions of processed components.

The evaluation methodology assumes that the facility will perform as designed in the absence of unintended events, such as component and material failures of equipment, human errors, external events and process unknowns.

Due to the absence of the South African legislation regarding the determination of methodology for quantitative risk assessments (QRAs), the methodology of this assessment is based on the legal requirements of the Netherlands, outlined in CPR 18E (Purple Book; 1999) and RIVM (2009). The evaluation of the acceptability of the risks is done in accordance with the UK Health and Safety Executive (HSE) ALARP criteria that clearly cover land use, based on determined risks.

The QRA process is summarised with the following steps:

1. Identification of components that are flammable, toxic, reactive or corrosive and that have the potential to result in a major incident from fires, explosions or toxic releases;
2. Development of accidental loss of containment (LOC) scenarios for equipment containing hazardous components (including release rate, location and the orientation of the release);
3. For each incident developed in Step 2, determination of consequences (such as thermal radiation, domino effects, toxic-cloud formation and so forth);
4. For scenarios with off-site consequences (greater than 1% fatality off-site), calculation of maximum individual risk (MIR), taking into account all generic failure rates, initiating events (such as ignition), meteorological conditions and lethality.

Scenarios included in this QRA have impacts externally to the establishment. The 1% fatality from acute affects (thermal radiation, blast overpressure and toxic exposure) is determined as the endpoint (RIVM 2009). Thus, a scenario producing a fatality of less than 1% at the establishment boundary under worst-case meteorological conditions, would be excluded from the QRA.

5 CONCLUSIONS

Risk calculations are not precise. Accuracy of predictions is determined by the quality of base data and expert judgements.

This risk assessment included the consequences of fires and explosions at the proposed MOOV facility in Kraaifontein. A number of well-known sources of incident data were consulted and applied to determine the likelihood of an incident to occur.

This risk assessment was performed with the assumption that the site would be maintained to an acceptable level and that all statutory regulations would be applied. It was also assumed that the detailed engineering designs would be done by competent people and would be correctly specified for the intended duty. For example, it was assumed that the tank wall thicknesses have been correctly calculated, that vents have been sized for emergency conditions, that instrumentation and electrical components comply with the specified electrical area classification, that material of construction is compatible with the products, etc.

It is the responsibility of the owners and their contractors to ensure that all engineering designs would have been completed by competent persons and that all pieces of equipment would have been installed correctly. All designs should be in full compliance with (but not limited to) the Occupational Health and Safety Act 85 of 1993 and its regulations, the National Buildings Regulations and the Buildings Standards Act 107 of 1977, as well as the local bylaws.

A number of incident scenarios were simulated, taking into account the prevailing meteorological conditions, and were described in the report.

5.1 Hazardous Materials

The hazardous materials identified included gasoline and diesel fuel. Both these materials are considered flammable, but not acutely toxic when inhaled.

5.2 Notifiable Substances

The General Machinery Regulation 8 and its Schedule A on notifiable substances requires any employer who has a substance equal to or exceeding the quantity listed in the regulation to notify the divisional director. A site is classified as a Major Hazard Installation if it contains one or more notifiable substances or if the off-site risk is sufficiently high. The latter can only be determined from a quantitative risk assessment.

No material to be stored on site is listed as notifiable.

5.3 Bulk Fuel Tank Farm

Pool fires and flash fires from a loss of containment at the storage and offloading installations of petrol and diesel were simulated. Tank explosions from petrol were also simulated.

The impacts from accidental fires and explosions could extend beyond the site boundary, but would not extend to the residential areas.

The offsite risks from the proposed project will be between $1x10^{-4}$ to $1x10^{-6}$ fatalities per person per year, meaning the risks would be within the ALARP region and will be considered tolerable.

5.4 LPG Storage

Up to 1.5 tonnes of LPG will be stored in cylinders having a maximum capacity of 9 kg per cylinder. A loss of containment from a cylinder could extend beyond the MOOV site boundary. However, the risks from the LPG storage would be considered tolerable.

5.5 Warehouse

The warehouse will primarily contain oils having a high flashpoint and there will thus be a very low probability of a fire.

The flammable ethanol must be stored in a separate flammable area. The extent of a fire will be limited to the flammable area and will not reach the general public, outside of the facility.

5.6 Impacts onto Neighbouring Properties, Residential Areas and MHIs

Impacts from the proposed projects could extend to immediate properties, but would not extend into the residential areas of Kraaifontein.

5.7 Major Hazard Installation

The expected MHI hazard tier for each phase of the fuel storage projects, is given in Table 8-1.

Table 8-1: Expected establishment hazardous tier per project phase

Phase	ULP 95 Inventory (t)	Diesel Inventory (t)	Total (t)	Hazard Tier
Proposed	440	1 820	2 260	Low Hazard
Future	1 320	1 820	3 140	Medium Hazard

The proposed project will **classify the facility as a Low Hazard Establishment Major Hazard Installation, but may increase to a Medium Hazard Establishment Major Hazard Installation with the completion of the future phase, with the increased storage of ULP or diesel.**

The requirements of approvals and registration under the MHI regulations should be reviewed for adequate preparation in completing the MHI risk assessment, as required by the legislation prior to construction.

6 RECOMMENDATIONS

As a result of the risk assessment study conducted for the proposed MOOV facility in Kraaifontein, a number of events were found to have risks beyond the fuel tank farm boundary. These risks could be mitigated to acceptable levels, as shown in the report.

RISCOM did not find any fatal flaws that would prevent the project proceeding to the detailed engineering phase of the project.

RISCOM would support the project with the following conditions:

- Compliance with all statutory requirements, i.e., pressure vessel designs;
- Compliance with applicable SANS codes, i.e., SANS 10087, SANS 10089, SANS 10108, etc.;
- Incorporation of applicable guidelines or equivalent international recognised codes of good design and practice into the designs;
- Completion of a recognised process hazard analysis (such as a HAZOP study, FMEA, etc.) on the proposed facility prior to construction to ensure that the design and operational hazards have been identified and adequate mitigation are put in place;
- Full compliance with IEC 61511 (Safety Instrument Systems) standards or equivalent to ensure that adequate protective instrumentation is included in the design and would remain valid for the full life cycle of the tank farm: This is particularly relevant to the overfilling of the storage tanks and applicable shutdown systems:
    - Including demonstration from the designer that sufficient and reliable instrumentation would be specified and installed at the facility;
- Preparation and issuing of a safety document detailing safety and design features reducing the impacts from fires, explosions and flammable atmospheres to the MHI assessment body at the time of the MHI assessment:
    - Including compliance to statutory laws, applicable codes and standards and world’s best practice;
    - Including the listing of statutory and non-statutory inspections, giving frequency of inspections;
    - Including the auditing of the built facility against the safety document;
    - Noting that codes such as IEC 61511 can be used to achieve these requirements;
- Demonstration by MOOV or their contractor that the final designs would reduce the risks posed by the installation to internationally acceptable guidelines;
- Signature of all terminal designs by a professional engineer registered in South Africa in accordance with the Professional Engineers Act, who takes responsibility for suitable designs;
- Completion of an emergency preparedness and response document for on-site and off-site scenarios prior to initiating the MHI risk assessment (with input from the local authorities);
- Permission not being granted for increases to the product list or product inventories without redoing part of or the full EIA;
- Final acceptance of the facility risks with an MHI risk assessment that must be completed in accordance to the MHI regulations:
    - Basing such a risk assessment on the final design and including engineering mitigation.

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QUANTITATIVE RISK ASSESSMENT FOR THE PROPOSED MOOV FUEL STORAGE PROJECT AT KRAAIFONTEIN IN CAPE TOWN, WESTERN CAPE

1 INTRODUCTION

MOOV Fuels & Lubricants (Pty) Ltd (hereinafter referred to as MOOV), proposes to construct bulk fuel storage facilities at their Kraaifontein depot.

Since off-site incidents may result due to hazards of some of the chemical components to be stored on, produced at or delivered to site, RISCOM (PTY) LTD was commissioned to conduct a quantitative risk assessment (QRA) to determine the impacts onto surrounding properties and communities as part of an environmental impact assessment (EIA).

The purpose of this report is to convey the essential details, which include a short description of hazards, the receiving environment and the current relevant design, as well as risks and consequences of a major incident.

1.1 Legislation

Legislation discussed in this subsection is limited to the health and safety of employees and the public.

Risk assessments are conducted when required to do so by law or by companies wishing to determine the risks of the facility for other reasons, such as insurance purposes. In South Africa, risk assessments are carried out under the legislation of two separate acts, each with different requirements. These are discussed in the subsections that follow.

1.1.1 National Environmental Management Act (No. 107 of 1998) (NEMA) and its Regulations

The National Environmental Management Act (NEMA) contains South Africa’s principal environmental legislation. It has, as its primary objective, to make provision for cooperative governance by establishing principles for decision making on matters affecting the environment, on the formation of institutions that will promote cooperative governance and on establishing procedures for coordinating environmental functions exercised by organs of state, as well as to provide for matters connected therewith (Government Gazette 1998).

Section 30 of the NEMA act deals with the control of emergency incidents where an "*incident*" is defined as an "*unexpected sudden occurrence, including a major emission, fire or explosion leading to serious danger to the public or potentially serious pollution of or detriment to the environment, whether immediate or delayed*".

The act defines "*pollution*" as *"any change in the environment caused by:*

(i) Substances;
(ii) Radioactive or other waves; or,
(iii) Noise, odours, dust or heat…

Emitted from any activity, including the storage or treatment of waste or substances, construction and the provision of services, whether engaged in by any person or an organ of state, where that change has an adverse effect on human health or wellbeing or on the composition, resilience and productivity of natural or managed ecosystems, or on materials useful to people, or will have such an effect in the future... "

"*Serious*" is not fully defined, but would be accepted as having long lasting effects that could pose a risk to the environment or to the health of the public that is not immediately reversible.

This is similar to the definition of a MHI as defined in the Occupational Health and Safety Act (OHS Act) 85 of 1993 and its MHI regulations.

Section 28 of NEMA makes provision for anyone who causes pollution or degradation of the environment being made responsible for the prevention of the occurrence, continuation or reoccurrence of related impacts and for the costs of repair of the environment. In terms of the provisions under Section 28 that are stated as:

" Every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped… "

1.1.2 The Occupational Health and Safety Act No. 85 of 1993

The Occupation Health and Safety Act 85 (1993) is primarily intended for the health and safety of the employees, whereas its MHI regulations is intended for the health and safety of the public.

The OHS Act shall not apply in respect of:

“ *a) A mine, a mining area or any works as defined in the Minerals Act, 1991 (Act No. 50 of 1991), except in so far as that Act provides otherwise;*

b) Any load line ship (including a ship holding a load line exemption certificate), fishing boat, sealing boat and whaling boat as defined in Section 2 (1) of the Merchant Shipping Act, 1951 (Act No. 57 of 1951), or any floating crane, whether or not such ship, boat or crane is in or out of the water within any harbour in the Republic or within the territorial waters thereof, (date of commencement of paragraph (b) to be proclaimed.), or in respect of any person present on or in any such mine, mining area, works, ship, boat or crane. ”

1.1.2.1 Major Hazard Installation Regulations

Concern about the health and safety of the public has led to the regulation of handling, storage and the use of industrial chemicals. On the 16th of January 1998, the Major Hazard Installation regulations were promulgated under the Occupational Health and Safety Act (Act No. 85 of 1993; hereinafter referred to as the OHS Act), with a further amendment on the 30th of July 2001.

On the 31st of January 2023, new MHI regulations were gazetted, whereby the facility would be classified based on the amount of hazardous products stored on site. The threshold values for these hazardous products are defined within the Regulations.

In accordance with legislation, the risk assessment must be done by an approved inspection authority (AIA), which is registered with the Department of Employment and Labour and accredited by the South African Accreditation Systems (SANAS). Furthermore, the Engineering Professional Act 114 of 2000, requires all persons conducting engineering work to be registered with the Engineering Council of South Africa and may not perform work outside of their field of registration. Copies of the relevant certificates are given in Section 15.

This report contains information summaries with a special focus on QRA and with comment on on-site emergency plans. The requirements, following an incident and the general duties required from the supplier and local government will merely be repeated from the regulations.

1.2 Terms of Reference

The main aim of the investigation was to quantify the risks to employees, neighbours and the public with regard to the proposed MOOV facility in Kraaifontein.

This risk assessment was to assess the risks posed by the fuels stored on the site. The scope of the risk assessment included:

1. Development of accidental spill and fire scenarios for the facility;
2. Using generic failure rate data (for tanks, pumps, valves, flanges, pipework, gantry, couplings and so forth), determination of the probability of each accident scenario;
3. For each incident developed in Step 2, determination of consequences (such as thermal radiation, domino effects, toxic-cloud formation and so forth);
4. For scenarios with off-site consequences (greater than 1% fatality off-site), calculation of maximum individual risk (MIR), taking into account all generic failure rates, initiating events (such as ignition), meteorological conditions and lethality.

1.3 Purpose and Main Activities

The main activity at the proposed MOOV facility in Kraaifontein is the storage of bulk fuel.

1.4 Limitations and Assumptions

The risk assessment was developed based on the information provided by MOOV. These designs are conceptual and do not include detailed designs, which will be completed before construction. Thus, some information, as required by the risk assessment simulations, were assumed and based on similar installations. However, it is assumed that the relatively large storage tanks will determine the endpoints from a release and will be the major contributor towards the risks generated. To this end, the results obtained in this report may lack the accuracy of a detailed engineered plant. However, the risks generated are expected to represent the facility, provided the vessel size and inventory are not increased.

1.5 Main Hazards Due to Substance and Process

The main hazards that would occur with a loss of containment of hazardous components at the proposed MOOV facility in Kraaifontein include exposure to:

- Thermal radiation from fires;
- Overpressure from explosions.

1.6 Software

Physical consequences were calculated with Gexcon's Riskcurves version 12.3.0, and the data derived was copied to the initial report. All calculations were performed by Mr M P Oberholzer.

2 ENVIRONMENT

2.1 General Background

The proposed MOOV depot, as shown in Figure 2-1, is located at Kiaat Road, in the Industrial area of Kraaifontein, Cape Town.

The coordinates of the MOOV depot are:

Latitude: 33°50’29.63” S
Longitude: 18°43’40.37” E

The MOOV facility is located approximately 40 km from Cape Town, with access from the N1 freeway. The facility is located in the industrial area of Kraaifontein. Business’s neighbouring the MOOV depot is Werda Cargo approximately 145 m, Essential steel approximately 101 m and Juno Group approximately 287 m, to the north of the depot. To the north east is Durbell Engineering approximately 151 m, as well as Scania South African approximately 274 m with Scania Marine approximately 214 m from the depot. To the east is KMC Agri approximately 130 m, Spec-Cast Wear Parts approximately 99 m, Genis verspreiders approximately 86 m, Boland PVC Produkte approximately 69 m, H & S Trailers approximately 35 m, Ray’s Towing approximately 118 m and Netafim approximately 185 m.
DAF Trucks is located approximately 28 m from the MOOV depot, with the No1 Online solutions store approximately 26 m and Ceramics Morgan Milson approximately 91 m to the south east of the depot. To the North west is Vegtech 2000 approximately 259 m, Xtraspace Kraaifontein approximately 333 m and Decodome approximately 139 m from the MOOV site.

The residential area of Peerless Park East is located approximately 100 m to the west of the MOOV depot.

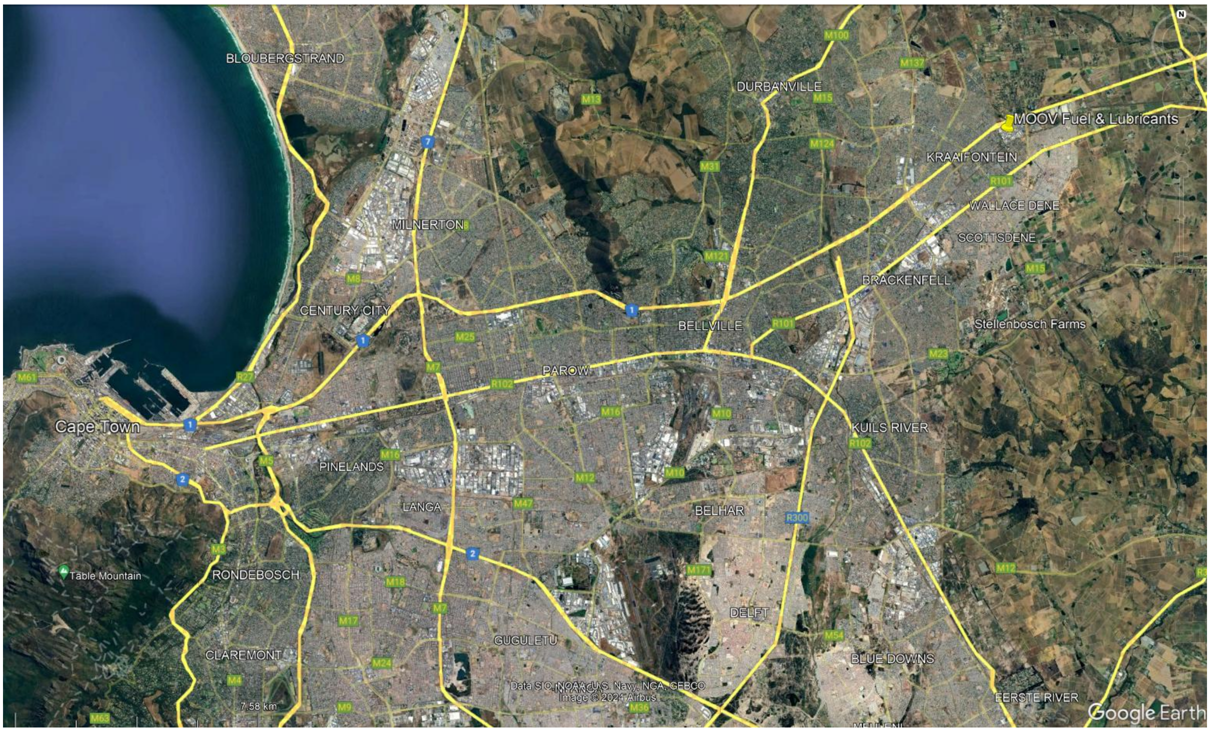


Figure 2-1: Location of the proposed MOOV facility in Kraaifontein

2.2 Meteorology

Meteorological mechanisms govern dispersion, transformation and the eventual removal of hazardous vapours from the atmosphere. The extent to which hazardous vapours will accumulate or disperse in the atmosphere is dependent on the degree of thermal and mechanical turbulence within the earth's boundary layer.

Dispersion comprises of vertical and horizontal components of motion. The stability and the depth of the atmosphere from the surface (known as the mixing layer) defines the vertical component. The horizontal dispersion of hazardous vapours in the atmospheric boundary layer is primarily a function of wind field. Wind speed determines both the distance of downwind transport and the rate of dilution as a result of stretching of the plume, and where the generation of mechanical turbulence is a function of the wind speed in combination with surface roughness. Wind direction and variability in wind direction both determine the general path of hazardous vapours that will follow and the extent of crosswinds spreading.

Concentration levels of hazardous vapours therefore fluctuate in response to changes in the atmospheric stability, to concurrent variations in the mixing layer depth and to shifts in the wind field.

For this report, the meteorological conditions at the Cape Town International Airport as measured by the South African Weather Service, were used as the basis of wind speed and direction, as well as the atmospheric stability.

2.2.1 Surface Winds

Hourly averages of wind speed and direction recorded at the Cape Town International Airport were obtained from the South African Weather Service for the period from the 1st of January 2018 to the 31st of December 2022.

The wind roses in Figure 2-2 depict the annual wind frequency pattern for the Cape Town International Airport. Calm conditions were measured at 4.2% most of the time with the predominant wind speed from the south.

Cape Town experiences mostly medium wind speeds, but can experience occasional high wind speeds.

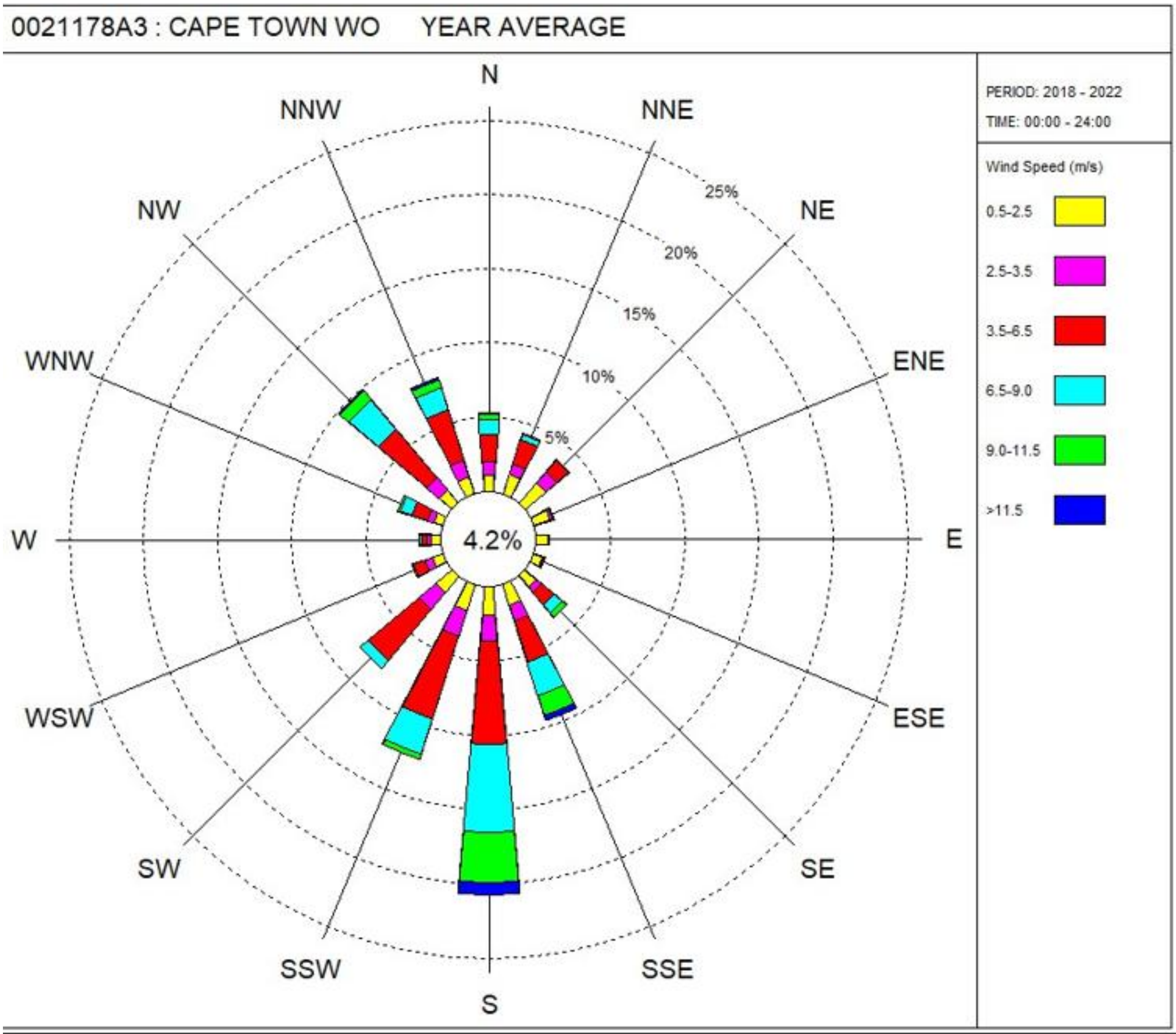


Figure 2-2: Wind analysis over the period from 2018 to 2022

2.2.2 Precipitation and Relative Humidity

The long-term rainfall and relative humidity recorded at the Cape Town International Airport was obtained from the South African Weather Service for the period from 1991 to 2020, as given in Table 2-1.

Cape Town is relatively dry, with an average annual rainfall of 492 mm and the dry season ranging from November to March.

The relative humidity typically ranges from 24% (dry) to 97% (very humid) over the course of the year, rarely dropping below 29% (dry) and reaching as high as 100% (very humid).

The air is the driest in and around December, at which time the relative humidity drops below 51% (mildly humid) three days out of four. It is most humid in and around July, exceeding 95% (very humid) three days out of four.

Table 2-1: Long-term average precipitation and relative humidity for Cape Town

Month	Relative Humidity (%)		Precipitation
	Average Maximum	Average Minimum	Average Monthly (mm)
January	74	52	9.4
February	79	51	9.6
March	85	52	12.5
April	89	56	40.1
May	89	61	61.1
June	87	62	92.3
July	89	62	84.8
August	88	61	72.4
September	87	58	44.3
October	79	54	28.4
November	72	52	25.3
December	72	52	12.8
Year	**83**	**56**	**492.8**

2.2.3 Temperature

The long-term temperatures recorded at the Cape Town International Airport were obtained from the South African Weather Service for the period from 1991 to 2020, as given in Table 2-2.

Over the course of a year, temperatures typically vary from 7°C to 27°C and will rarely go below 4°C or above 31°C.

Table 2-2: Long-term temperature averages for Cape Town

Month	Temperature (°C)		
	Average Daily Mean	Average Daily Maximum	Average Daily Minimum
January	21.8	27.0	16.6
February	21.9	27.3	16.5
March	20.5	26.0	15.0
April	17.9	23.6	12.2
May	15.4	20.6	10.2
June	13.2	18.2	8.1
July	12.7	17.9	7.4
August	13.0	18.0	7.9
September	14.5	19.6	9.4
October	16.9	22.2	11.5
November	18.6	23.7	13.4
December	20.7	25.8	15.6
Year	**17.3**	**22.5**	**12.0**

2.2.4 Atmospheric Stability

Atmospheric stability is frequently categorised into one of six stability classes. These are briefly described in Table 2-3. The atmospheric stability, in combination with the wind speed, is important in determining the extent of a pollutant from a release.

A very stable atmospheric condition, typically at night, would have a low wind speed and produce the greatest endpoint for a dense gas. Conversely, a buoyant gas would have the greatest endpoint distance at a high wind speed.

Table 2-3: Classification scheme for atmospheric stability

Stability Class	Stability Classification	Description
A	Very unstable	Calm wind, clear skies, hot daytime conditions.
B	Moderately unstable	Clear skies, daytime conditions.
C	Unstable	Moderate wind, slightly overcast daytime conditions.
D	Neutral	Strong winds or cloudy days and nights.
E	Stable	Moderate wind, slightly overcast night-time conditions.
F	Very stable	Low winds, clear skies, cold night-time conditions.

This risk assessment's calculations are based on six representative weather classes covering the stability conditions of stable, neutral and unstable, as well as low and high wind speeds. In terms of Pasquill classes, the representative conditions are given in Table 2-4.

Table 2-4: Representative weather classes

Stability Class	Wind (m/s)
B	3
D	1.5
D	5
D	9
E	5
F	1.5

The allocation of observations into the six weather classes is summarised in Table 2-5, with the representative weather classes given in Figure 2-3.

Table 2-5: Allocation of observations into six weather classes

<table>
<tr><th>Wind Speed</th><th>A</th><th>B</th><th>B/C</th><th>C</th><th>C/D</th><th>D</th><th>E</th><th>F</th></tr>
<tr><td>< 2.5 m/s</td><td colspan="3" rowspan="3">B 3 m/s</td><td colspan="3">D 1.5 m/s</td><td colspan="2">F 1.5 m/s</td></tr>
<tr><td>2.5 - 6 m/s</td><td colspan="3">D 5 m/s</td><td colspan="2" rowspan="2">E 5 m/s</td></tr>
<tr><td>> 6 m/s</td><td colspan="3">D 9 m/s</td></tr>
</table>

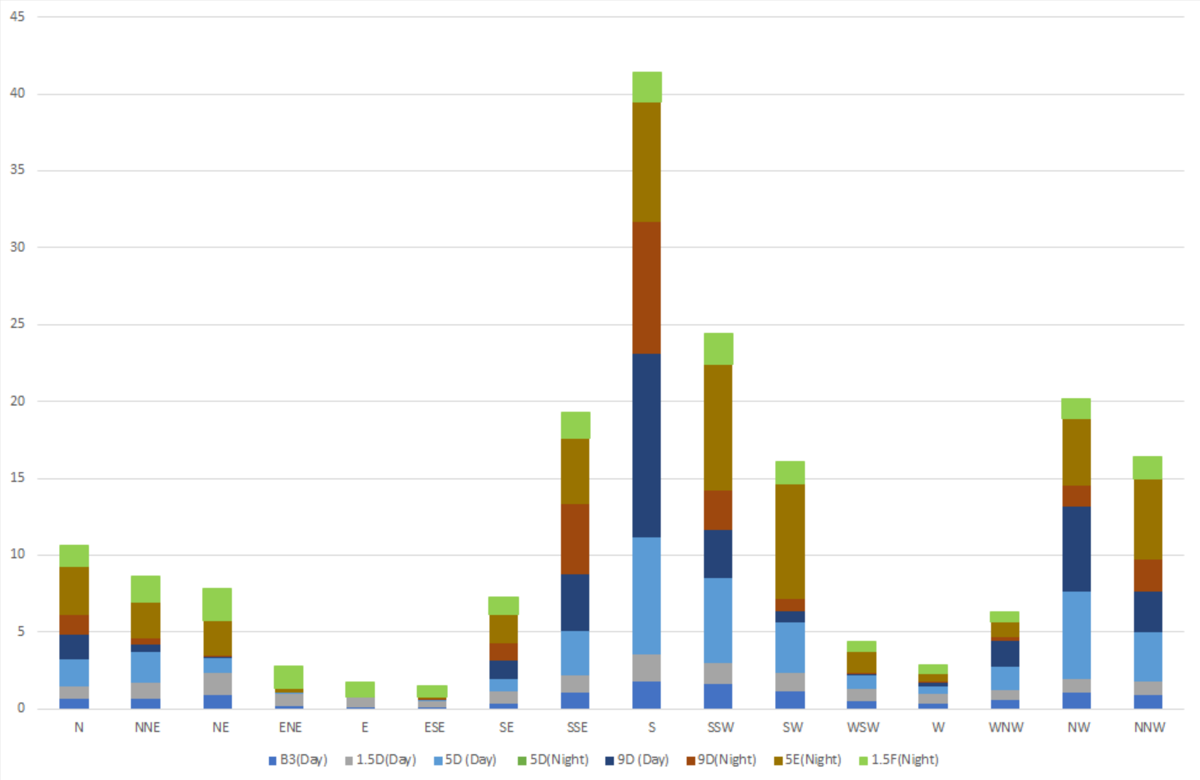


Figure 2-3: Representative weather classes for Cape Town (2018–2022)

2.2.5 Meteorological Simulation Values

Default meteorological values used in simulations, based on local conditions, are given in Table 2-6.

Table 2-6: Default meteorological values used in simulations, based on local conditions

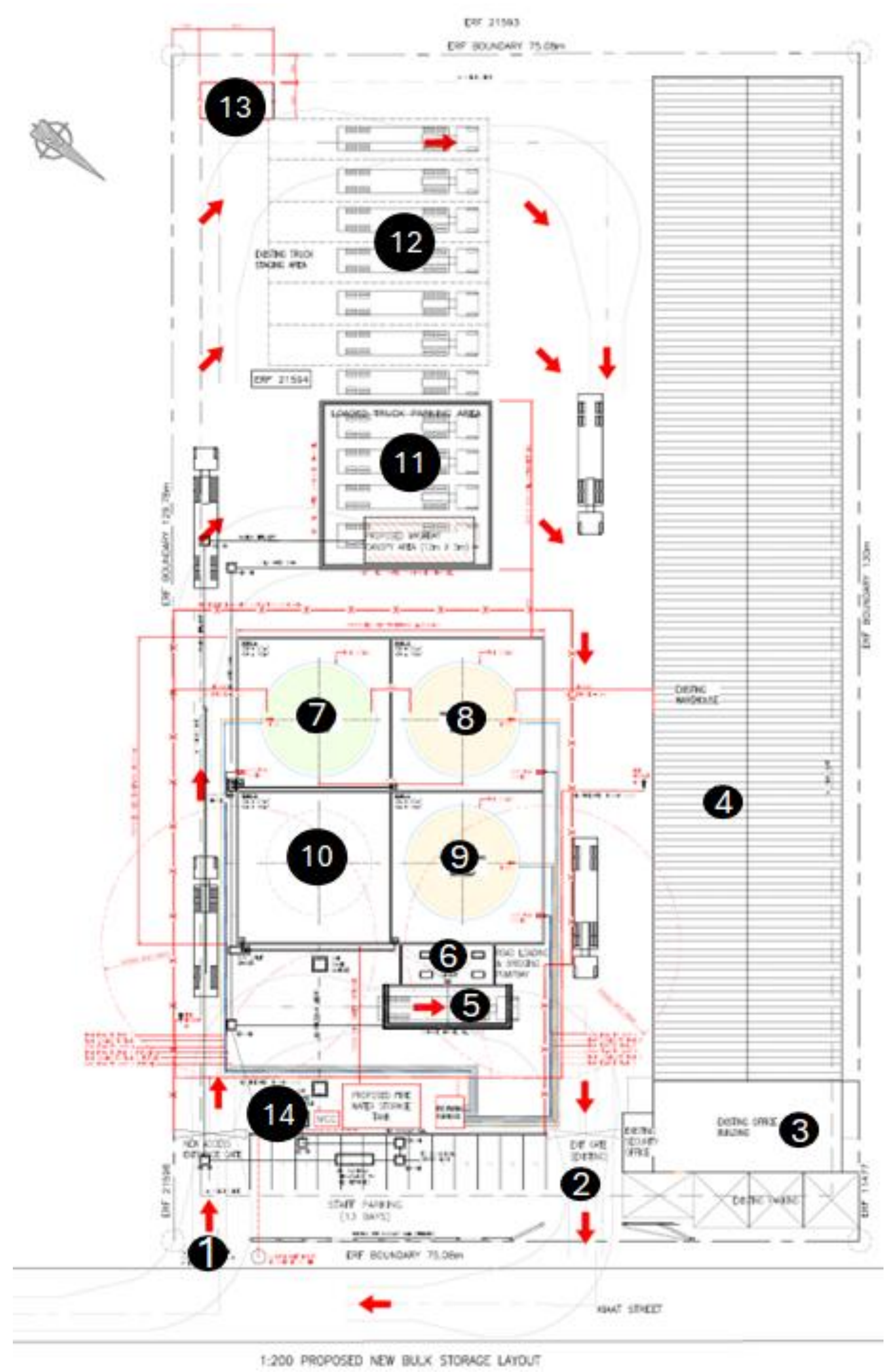
Parameter	Default Value (Day)	Default Value (Night)
Ambient temperature (°C)	22.5	12
Substrate or bund temperature (°C)	17.3	17.3
Water temperature (°C)	17,3	17.3
Air pressure (bar)	1.013	1.013
Humidity (%)	56	83
Fraction of a 24-hour period	0.5	0.5
Mixing height	[1]	[1]

1 Calculated as part of the software.

3 PROJECT DESCRIPTION

3.1 Site

The proposed MOOV storage facility in Kraaifontein will consist of offices, a warehouse, workshops, storage tanks and a loading / offloading bay, as shown in Figure 3-1.



	Description
1	Entrance
2	Exit
3	Office Building
4	Warehouse
5	Loading / Offloading Area
6	Pumps
7	Tank 1
8	Tank 2
9	Tank 3
10	Tank 4 (Future)
11	Loaded Truck Parking Area
12	Truck Staging Area
13	LPG Storage
14	Oil Separator

Figure 3-1: Site layout

3.2 Process Description

It is anticipated that the proposed MOOV facility may expand sometime in the future, including the increase on diesel and fuel storage.

3.2.1 Bulk Storage Tanks

A total number of 4 tanks can be accommodated within the available space. Under the current project, only 3 of the 4 tanks will be constructed with space allowance for a future tank.

For the purposes of the cost estimation, all tanks will be fixed cone roof tanks, with internal floating roofs (IFR) for the ULP tanks only.

The tank sizes and capacities are given below in Table 3-1.

Table 3-1: Summary of the hazard tier related from the inventory stored

Tank No.	Service	Diameter	Height	Gross Volume
1	ULP 95	11,52 m	4,8 m	500 m^3
2	Gasoil (GO)	11,52 m	9,6 m	1 000 m^3
3	Gasoil (GO)	11,52 m	9,6 m	1 000 m^3
4	Future	11,52 m	9,6 m	1 000 m^3

The vertical bulk storage tanks will be designed in accordance with API 650. Tanks will be supported on a reinforced concrete foundation, including the required layer works. Tank foundations will include the necessary secondary containment as prescribed by API 650.

Tanks will be equipped with the following appurtenances:

- Inlet and Outlet Fire-safe valves complete with thermal by-pass valves;
- Water draw-off valve;
- Tank Shell man-ways;
- Vent or breather pipes;
- Nozzles for dip hatch, temperature probes, Auto Tank Gauging (ATG);
- Access stairs and inter connecting walkways;
- Tank Foam Pourer Connections; and,
- Tank Cooling Rings.

Tanks will be protected against corrosion by applying protective paint coatings to the external shell and roof, as well as the floor and internal surface up to the 1st strake.

The tanks will be housed within one main bund, as follows:

- Largest Tank to be contained = 1 000 m^3
- Gross Bund Area (GBA) = 1 092 m^2
- Nett Bund Area (NBA) = 780 m^2
- Average Wall height (h) = 1,38 m

All tanks will be located within their own subdivision. These walls will be a minimum of 500 mm high and will terminate at a maximum height of approximately 300 mm below the main wall. Subdivision walls will be set at different levels thereby creating a preferential spill pattern in the event of a major spill occurring.

In keeping with the regulations laid down in the code, the bund floors will be sealed to prevent accidental spillages from entering the subsoil.

Bund drainage lines will be routed to the bund outlet chamber from where it will be routed to the API oil-water separator before discharging to the municipal sewer system in keeping with good environmental practices.

Each tank will have two independent level transmitters that will alarm and trip valves or pumps to prevent overfilling.

3.2.2 Road Tanker Loading / Unloading

All product receipt and transfers will be done via road tankers operating 24 hours per day, 7 days per week, in tankers up to 40 m^3 in volume. This facility will be located adjacent to the tank farm area and will comprise of the following:

- Product Receipt:
  - Decanting hose and dry-break coupling;
  - Decanting Pump installed onto a concrete plinth;
  - Vertical Deaerator c/w open close valve to ensure no air is transmitted through the flow meter;
  - Mechanical Flow meter with calibration valves.
- Product transfer;
  - Loading hose and dry break coupling;
  - Loading Pump installed onto a concrete plinth;
  - Strainer / Air Eliminator;
  - Mechanical Flow meter with calibration valves on suction strainer.
- Spillages at the pump bay and loading / offloading area will be directed to the oil separator, limiting the potential of pool fires at the offloading area preventing a BLEVE scenario.
- Any spillages from loading / offloading will flow into drains around the area, with the spilt fuel flowing directly to the oil separator.
- Pre-loaded road tankers carrying diesel may park at the facility overnight for deliveries the following day:
  - There will be no pre-loaded Petrol trucks standing overnight.
  - There may be as many as ±4 diesel tankers pre-loaded (worst case scenario) at any given day in a month. Tankers have a capacity of 40 000 L each and are arriving full on site.
  - Any spills from the road tankers will flow into channels that will be directed to the oil separator.

Note that separate facilities for diesel and petrol have been allowed for. This will ensure that all products will be metered for stock control purposes. No automation for this has been allowed for.

- COC Dispensing Point:
  - A single product (GO) dispensing point has been allowed for.
  - This will be located on a 3 m long island at the front of the depot.
  - This facility allows for trucks to be refuelled on the right-hand side via the high-speed dispenser.

The time to load and offload road tankers is estimated at one hour. Thus, a maximum of 24 tankers can be received per day. The expected product split 90% of the tankers loading / offloading will be diesel, where the remainder will be ULP.

3.2.3 Warehouse

The warehouse located to the west of the site will be used to contain the following products in small packaging i.e. no bulk materials.

Table 3-2: Summary of Warehouse products

	FP (ºC)	Litres	SG @ 20	Tons
Lubricants / Oils	>60.5	495 000	0.85	420.75
Degreaser	>60.5	2 500	0.85	2.13
Ethanol Solution	13	2 500	0.8	2
Total		500 000		424.88

The products will be moved in and out of the warehouse by trucks.

3.2.4 LPG

LPG cylinders will be stored in a cage, located near the southern boundary. The largest cylinder size will be 9 kg with a maximum inventory of 1.5 tonnes.

3.3 Establishment Tier

The MHI Regulations (2022), under Chapter 1 and Chapter 2, define the establishment tier.

The summary for the petrol and diesel storage and the resultant tier classification, is given in Table 3-3.

Table 3-3: Summary of the hazard tier related from the inventory stored

Named Substances	UN Number	Quantities in tonnes (t)		
		Column 1 Low Hazard	**Column 2 Medium Hazard**	**Column 3 High Hazard**
Petroleum products: Gasolines, Naphtha's, Kerosene's (including Jet fuels), Gas oils (including Diesel fuels, Home heating oils and Gas oil blending streams).	Gas (1075) Crude (1275)	250	2 500	25 000

The expected MHI hazard tier for each phase of the fuel storage projects, is given in Table 3-4.

Table 3-4: Expected establishment hazardous tier

Phase	ULP 95 Inventory (t)	Diesel Inventory (t)	Total (t)	Hazard Tier
Proposed	440	1 820	2 260	Low Hazard
Future	1 320	1 820	3 140	Medium Hazard

The proposed project will classify the facility as a Low Hazard Establishment Major Hazard Installation, but may increase to a Medium Hazard Establishment Major Hazard Installation with the completion of the future phase, with the increased storage of ULP or diesel.

4 HAZARD IDENTIFICATION

The first step in any risk assessment is to identify all hazards. The merit of including a hazard for further investigation is then determined by how significant it is, normally by using a cut-off or threshold value.

Once a hazard has been identified, it is necessary to assess it in terms of the risk it presents to the employees and the neighbouring community. In principle, both the probability and consequence should be considered, but there are occasions where, if either the probability or the consequence can be shown to be sufficiently low or sufficiently high, decisions can be made based on just one factor.

During the hazard identification component of the report, the following considerations are taken into account:

- Chemical identities;
- Location of on-site installations that use, produce, process, transport or store hazardous components;
- Type and design of containers, vessels or pipelines;
- Quantity of material that could be involved in an airborne release;
- Nature of the hazard most likely to accompany hazardous material spills or releases, e.g., airborne toxic vapours or mists, fires or explosions, large quantities to be stored and certain handling conditions of processed components.

The evaluation methodology assumes that the facility will perform as designed in absence of unintended events, such as component and material failures of equipment, human errors, external events and process unknowns.

4.1 Notifiable Substances

The General Machinery Regulation 8 and its Schedule A on notifiable substances requires any employer who has a substance equal to or exceeding the quantity listed in the regulation to notify the divisional director. A site is classified as a Major Hazard Installation if it contains one or more notifiable substances or if the off-site risk is sufficiently high. The latter can only be determined from a quantitative risk assessment.

No material to be stored on site is listed as notifiable.

4.2 Substance Hazards

All components on site were assessed for potential hazards according to the criteria discussed in this section.

4.2.1 Chemical Properties

A short description of bulk hazardous components to be stored on, produced at or delivered to site is given in the following subsections. The material safety data sheets (MSDSs) of the respective materials are attached in Appendix E.

4.2.1.1 Petrol (Gasoline)

Petrol is a hydrocarbon mixture with variable composition with a boiling point range of between 20°C and 215°C. It is a pale-yellow liquid with strong petroleum odour. Due to the flash point at minus 40°C, this material is considered highly flammable and will readily ignite under suitable conditions. The vapours are heavier than air and may travel some distance to an ignition source.

Petrol may contain up to 5% volume of benzene, a known animal carcinogen. It may also contain ethers and alcohols, as oxygenates, to a maximum concentration of 2%. It may also contain small quantities of multifunctional additives to enhance performance.

It is stable under normal conditions. It will react with strong oxidising agents and nitrate compounds, which may cause fires and explosions.

Although it is of a low to moderate oral toxicity to adults, ingestion of small quantities may prove dangerous or fatal to small children.

Contact with vapours may result in slight irritation to nose, eyes and skin. Vapours may cause headache, dizziness, loss of consciousness or suffocation; lung irritation with coughing, gagging, dyspnoea, substernal distress and rapidly developing pulmonary oedema. If swallowed, it may cause nausea or vomiting, swelling of the abdomen, headache, CNS depression, coma and death.

The long-term effects of exposure have not been determined. However, it may affect lungs and may cause the skin to dry out and become cracked.

Petrol floats on water and can result in environmental hazards with large spills into waterways. It is harmful to aquatic life in high concentrations.

4.2.1.2 Diesel (Gasoil)

Diesel is a hydrocarbon mixture with variable composition and a boiling-point range between 252°C and 371°C. It is a pale-yellow liquid with a petroleum odour. Due to a flashpoint between 38°C and 65°C, it is not considered highly flammable, but it will readily ignite under suitable conditions.

It is stable under normal conditions. It will react with strong oxidising agents and nitrate compounds. This reaction may cause fires and explosions.
Diesel is not considered a toxic material. Contact with vapours may result in slight irritation to nose, eyes and skin.

Vapours may cause headache, dizziness, loss of consciousness or suffocation as well as lung irritation with coughing, gagging, dyspnoea, substernal distress and rapidly developing pulmonary oedema.

If swallowed, it may cause nausea or vomiting, swelling of the abdomen, headache, CNS depression, coma and death.

The long-term effects of exposure have not been determined. However, this may affect the lungs and may cause the skin to dry out and become cracked.
Diesel floats on water and can result in environmental hazards with large spills into waterways. It is harmful to aquatic life in high concentrations.

4.2.1.3 Liquid Petroleum Gas (LPG)

LPG is used as a fuel in a range of applications including in heating and cooking appliances, industrial applications, in vehicles and as a propellant and refrigerant. LPG can be obtained primarily as propane, butane or a mixture of the two. It is a colourless odourless liquid to which a powerful odorant is added so that it is easily detected.

LPG is highly flammable and heavier than air so that it will settle and may accumulate in low spots such drains and basements. In these areas it could present a significant fire or explosion or suffocation hazard. As a flammable gas, LPG would fall into Class 2.1 (SANS 10228 (SABS (2012)).

For the purposes of this MHI report the LPG mixture has been simulated as pure propane.

Propane is a colourless gas at room temperature with an odour of commercial natural gas. It has a low boiling point of -41.9°C and is often compressed and transported and sold as a liquid, primarily as a fuel.

Propane is a severe fire and explosion hazard, with an invisible vapour that spreads easily and can be set on fire by many sources such as pilot lights, welding equipment, electrical motors, switches, etc. It is heavier than air and can travel along ground for some distance to an ignition source, or it can persist as pockets in areas of restricted airflow, that could pose a risk of delayed ignition.

Propane is not compatible with strong oxidants and can react with these, resulting in fires and explosions.

Propane is not considered a carcinogenic material. The toxicology and the physical and chemical properties of propane suggest that overexposure is unlikely to aggravate existing medical conditions.

Overexposure to propane may cause dizziness and drowsiness. Effects of a single (acute) overexposure may result in asphyxiation, due to lack of oxygen that could be fatal. Self-contained breathing apparatus may be required by rescue workers. Moderate concentrations may cause headache, drowsiness, dizziness, excitation, excess salivation, vomiting and unconsciousness. Vapour contact with the skin will not cause any harm. However, contact with the liquid may cause frostbite due to the low temperature of liquid propane.

4.2.2 Corrosive Liquids

Corrosive liquids considered under this subsection are those components that have a low or high pH and that may cause burns if they come into contact with people or may attack and cause failure of equipment.

No bulk materials to be stored on, produced at or delivered to site are considered extremely corrosive.

4.2.3 Reactive Components

Reactive components are components that when mixed or exposed to one another react in a way that may cause a fire, explosion or release a toxic component.

All substances to be stored on, produced at or delivered to site are considered thermally stable in atmospheric conditions. The reaction with air is covered under the subsection dealing with ignition probabilities.

4.2.4 Flammable and Combustible Components

Flammable and combustible components are those that can ignite and give a number of hazardous effects, depending on the nature of the component and conditions. These effects may include pool fires, jet fires and flash fires, as well as explosions and fireballs.

The flammable and combustible substances to be stored on, produced at or delivered to site are listed in Table 4-1. These substances have been analysed for fire and explosion risks.

Table 4-1: Flammable and combustible substances to be stored on, produced at or delivered to site

Component	Flashpoint (°C)	Boiling Point (°C)	LFL (vol. %)	UFL (vol. %)
Petrol	-40	38 - 210	1.3%	7
Diesel	> 55	> 150	1.3	6
LPG	-104	-42	2.1	9.5

4.3 Physical Properties

For this study, gasoline and diesel were modelled as components given in Table 4-2. The physical properties used in the simulations were based on the DIPPR[1] data base.

Table 4-2: Representative components

Component	Modelled as
Diesel	n-Dodecane
Gasoline	2% mol Toluene 9% mol o-Xylene 2% mol n-Propylbenzene 2% mol n-Nonane 4% mol n-Octane 14% mol Cyclohexane 9% mol Cyclopentane 9% mol n-Hexane 1% mol n-Decane 14% mol Cyclopentane 22% mol n-Pentane

1 Design Institute for Physical Properties.

5 PHYSICAL AND CONSEQUENCE MODELLING

In order to establish which impacts, follow an accident, it is first necessary to estimate the physical process of the spill (i.e., rate and size), spreading of the spill, evaporation from the spill, subsequent atmospheric dispersion of the airborne cloud and, in the case of an ignition, the burning rate and resulting thermal radiation from a fire and the overpressures from an explosion.

The second step is then to estimate the consequences of a release on humans, fauna, flora and structures in terms of the significance and extent of the impact in the event of a release. The consequences could be due to toxic or asphyxiant vapours, thermal radiation or explosion overpressures. They may be described in various formats.

The simplest methodology would show a comparison of predicted concentrations, thermal radiation or overpressures to short-term guideline values.

In a different but more realistic fashion, the consequences may be determined by using a dose-response analysis. Dose-response analysis aims to relate the intensity of the phenomenon that constitutes a hazard to the degree of injury or damage that it can cause. Probit analysis is possibly the method mostly used to estimate the probability of death, hospitalisation or structural damage. The probit is a lognormal distribution and represents a measure of the percentage of the vulnerable resource that sustains injury or damage. The probability of injury or death (i.e., the risk level) is in turn estimated from this probit (risk characterisation).

Consequence modelling gives an indication of the extent of the impact for selected events and is primarily used for emergency planning. A consequence that would not cause irreversible injuries would be considered insignificant, and no further analysis would be required. The effects from major incidents are summarised in the following subsections.

5.1 Multiple Consequence Scenarios

Guidelines for the selection of scenarios is given in RIVM (2009) and CPR 18E (Purple Book; 1999). A particular scenario may produce more than one major consequence. In such cases, consequences are evaluated separately and assigned failure frequencies in the risk analysis. Some of these phenomena are described in the subsections that follow.

5.1.1 Continuous Release of a Flammable Liquid

The continuous loss of containment of a flammable liquid could result in the consequences given in the event tree of Figure 5-1. Probability of the events occurring is dependent on a number of factors and is determined accordingly. All the scenarios shown in the figure are determined separately and reported in relevant subsections of the report.

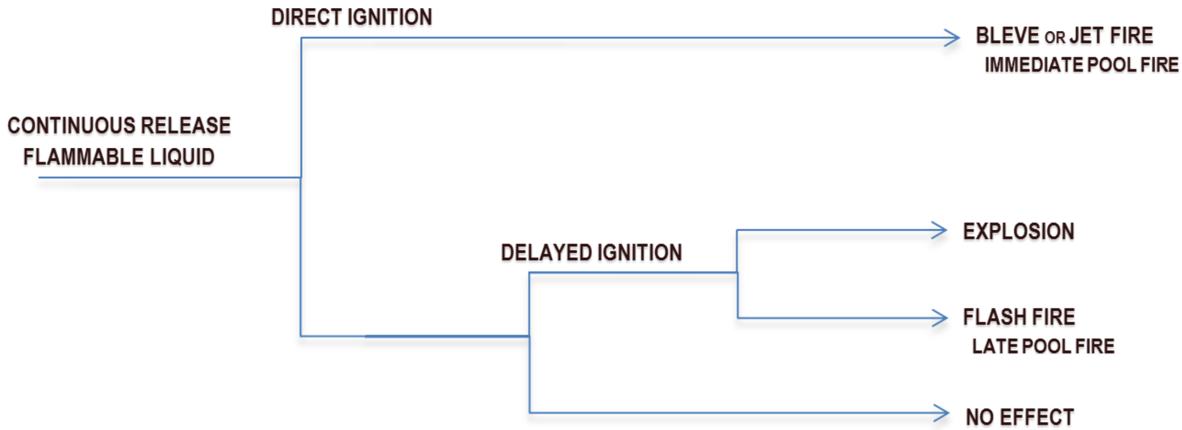


Figure 5-1: Event tree for a continuous release of a flammable liquid

5.2 Fires

Combustible and flammable components within their flammable limits may ignite and burn if exposed to an ignition source of sufficient energy. On process plants, releases with ignition normally occur as a result of a leakage or spillage. Depending on the physical properties of the component and the operating parameters, combustion may take on a number of forms, such as pool fires, jet fires, flash fires and so forth.

5.2.1 Thermal Radiation

The effect of thermal radiation is very dependent on the type of fire and the duration of exposure. Certain codes, such as the American Petroleum Institute API 520 and API 2000 codes, suggest values for the maximum heat absorbed by vessels to facilitate adequate relief designs in order to prevent the failure of the vessel. Other codes, such as API 510 and the British Standards BS 5980 code, give guidelines for the maximum thermal radiation intensity and act as a guide to equipment layout, as shown in Table 5-1.

The effect of thermal radiation on human health has been widely studied, relating injuries to the time and intensity of the exposure.

Table 5-1: Thermal radiation guidelines (BS 5980 of 1990)

Thermal Radiation Intensity (kW/m^2)	Limit
1.5	Will cause no discomfort for long exposure.
2.1	Sufficient to cause pain if unable to reach cover within 40 seconds.
4.5	Sufficient to cause pain if unable to reach cover within 20 seconds.
12.5	Minimum energy required for piloted ignition of wood and melting of plastic tubing.
25	Minimum energy required to ignite wood at indefinitely long exposures.
37.5	Sufficient to cause serious damage to process equipment.

For pool fires, jet fires and flash fires CPR 18E (Purple Book; 1999) suggests that the following thermal radiation levels should be reported:

- 4 kW/m^2, the level that glass can withstand, preventing the fire entering a building, and that should be used for emergency planning;
- 10 kW/m^2, the level that represents the 1% fatality for 20 seconds of unprotected exposure and at which plastic and wood may start to burn, transferring the fire to other areas;
- 37.5 kW/m^2, spontaneous ignition of hair and clothing occurs, with an assumed 100% fatality, and at which initial damage to steel may occur.

5.2.2 Bund and Pool Fires

Pool fires, either tank or bund fires, consist of large volumes of a flammable liquid component burning in an open space at atmospheric pressure.

The flammable component will be consumed at the burning rate, depending on factors including prevailing winds. During combustion, heat will be released in the form of thermal radiation. Temperatures close to the flame centre will be high, but will reduce rapidly to tolerable temperatures over a relatively short distance. Any building or persons close to the fire or within the intolerable zone will experience burn damage with severity depending on the distance from the fire and time exposed to the heat of the fire.

In the event of a pool fire, the flames will tilt according to the wind speed and direction. The flame length and tilt angle will affect the distance of the thermal radiation generated.

Flammable and combustible materials to be stored on site include gasoline and diesel.

A loss of containment could occur at the offloading tanker or at the pump and its lines. On loss of containment, a pool will form and the material will evaporate at a rate determined by the surface area of the pool, the temperature of the pool and the wind conditions. In the event of an ignition, the evaporation rate would be replaced with the burning rate.

Instantaneous failure of a storage tank can result if a proportion of the component overflows the top of the bund, referred to as 'overtopping'. For the scenario of an instantaneous release, the amount of overtopping is taken to be an average of 33%. This is translated to the risk assessment by increasing the surface area of the bund by 50% (RIVM 2009).

A tank release, such as overfilling or piping failure, would not result in overtopping, and even in the worst case, would be contained within the bunded area.

The maximum effect of a pool fire from a loss of containment (catastrophic failure of the tank) in the storage area, is shown in Figure 5-2. The isopleth represents the worst-case radiation at a high wind speed (9 m/s) and shows the maximum distance expected. The thick lines indicate the extent of the fire from a westerly wind, while the thinner lines indicate the maximum extent from all wind directions.

The 4 kW/m^2 is capable of breaking glass and is the lower limit in emergency planning for escape routes. The 10 kW/m^2 is the value for the 1% fatality for unprotected people, with an exposure duration at 20 seconds. The 37.5 kW/m^2 represents the critical thermal radiation flux for damage to metal equipment and the 100% fatality for unprotected people. The 10 kW/m^2, representing the 1% fatality, could extend beyond the site boundary, to the neighbour to the south.

The maximum impacts from a large bund fire could extend beyond the MOOV site boundary into neighbouring properties, but would not extend into any residential areas.

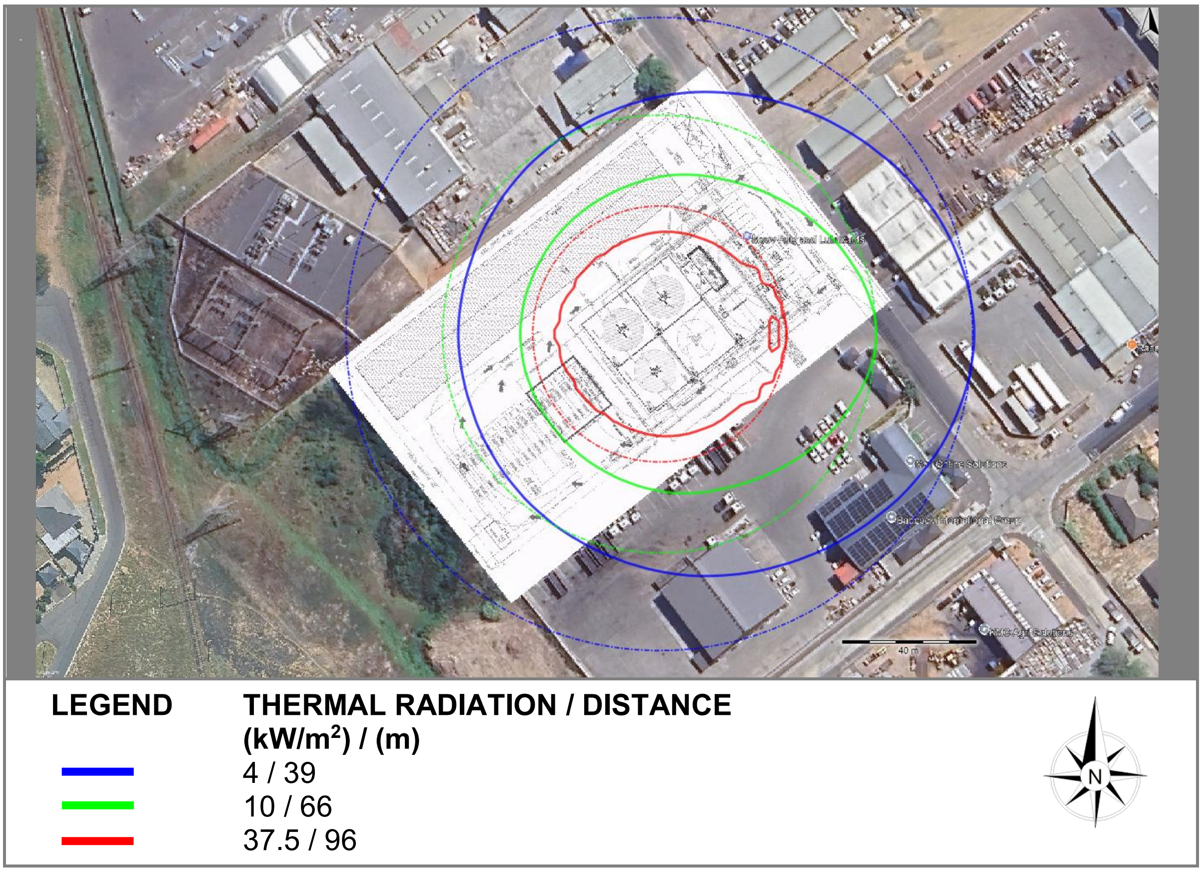


Figure 5-2: The maximum thermal radiation from a bund fire

5.2.3 Tank-Top Fires

A tank-top fire occurs within the tank, and thus the pool fire is limited to the area of the tank. A tank-top fire could escalate to a bund fire should the tank fail, releasing flammable or combustible material into the bund.

The maximum side view effect of a tank-top fire in the storage area, is shown in Figure 5-3. The maximum downwind distance to the 1% fatality (represented by the 10 kW/m^2) was calculated at 17 m and could extend beyond the site boundary to the south of the MOOV facility, but would not reach any residential areas.

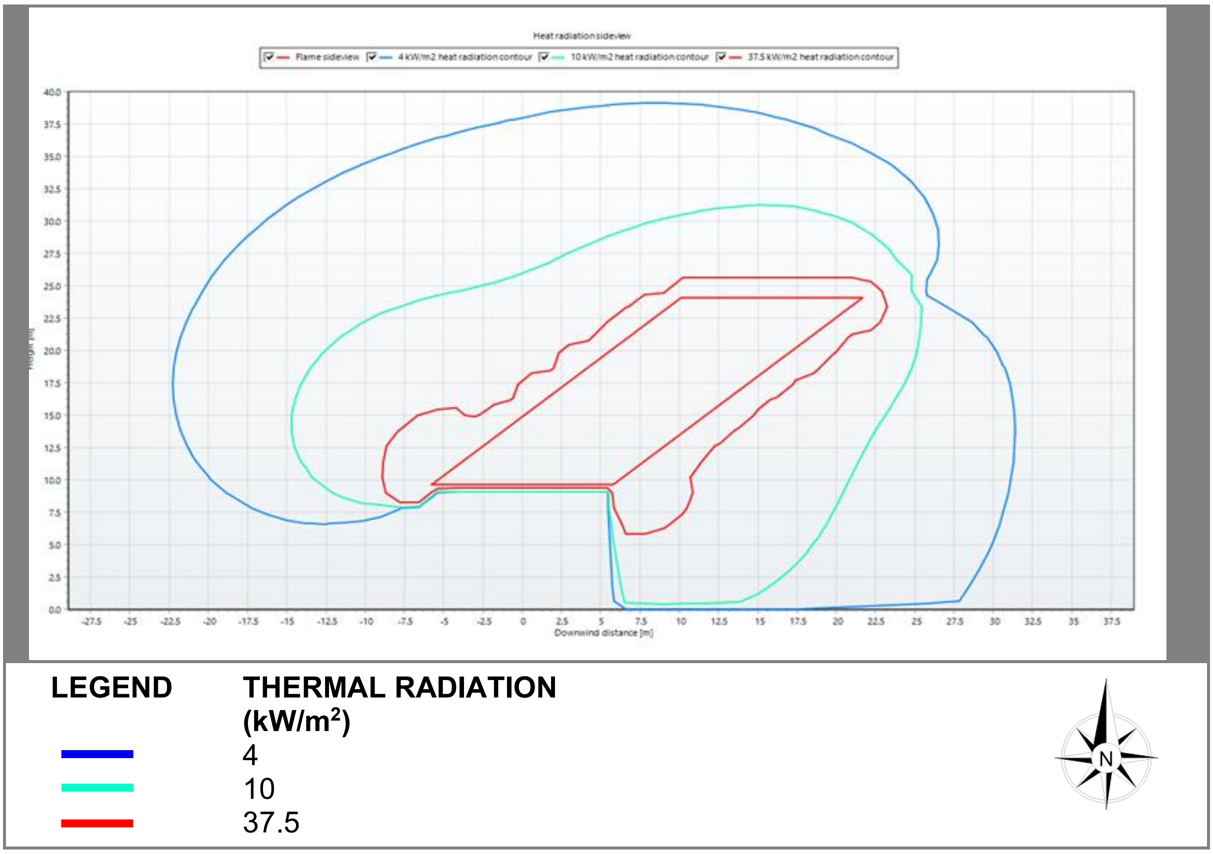


Figure 5-3: Side view of the thermal radiation from large Gasoline tank-top fires in the storage area

5.2.4 Jet Fires

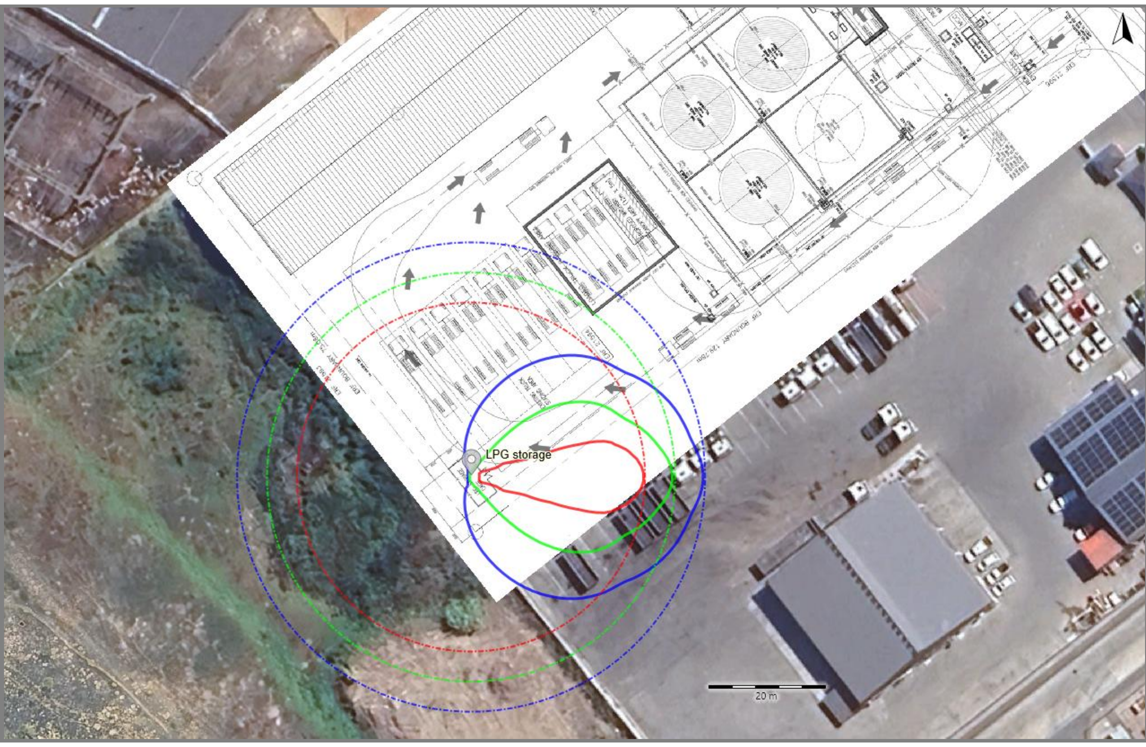
Jet fires occur when a flammable component is released with a high exit velocity ignites.

In process industries, this may be due to the design (such as flares) or due to accidental releases. Ejection of a flammable component from a vessel, pipe or pipe flange may give rise to a jet fire and in some instances, the jet flame could have substantial 'reach'.

Depending on the wind speed, the flame may tilt and impinge on other pipelines, equipment or structures. The thermal radiation from these fires may cause injury to people or damage equipment some distance away from the source of the flame.

The worst-case jet fires from a release of a 9 kg cylinder, are shown in Figure 5-4. The solid lines indicate the western orientation, while the dashed lines indicated the direction form all orientations.

The 4 kW/m^2 is capable of breaking glass and is the lower limit in emergency planning for escape routes. The 10 kW/m^2 is the value for the 1% fatality for unprotected people, with an exposure duration at 20 seconds. The 37.5 kW/m^2 represents the critical thermal radiation flux for damage to metal equipment and the 100% fatality for unprotected people. The 10 kW/m^2, representing the 1% fatality, could extend beyond the site boundary, to the neighbour to the south.



LEGEND	THERMAL RADIATION / DISTANCE (kW/m^2) / (m)
Blue	4 / 29
Green	10 / 34
Red	37.5 / 39

Figure 5-4: Maximum extent of jet fires from LPG releases

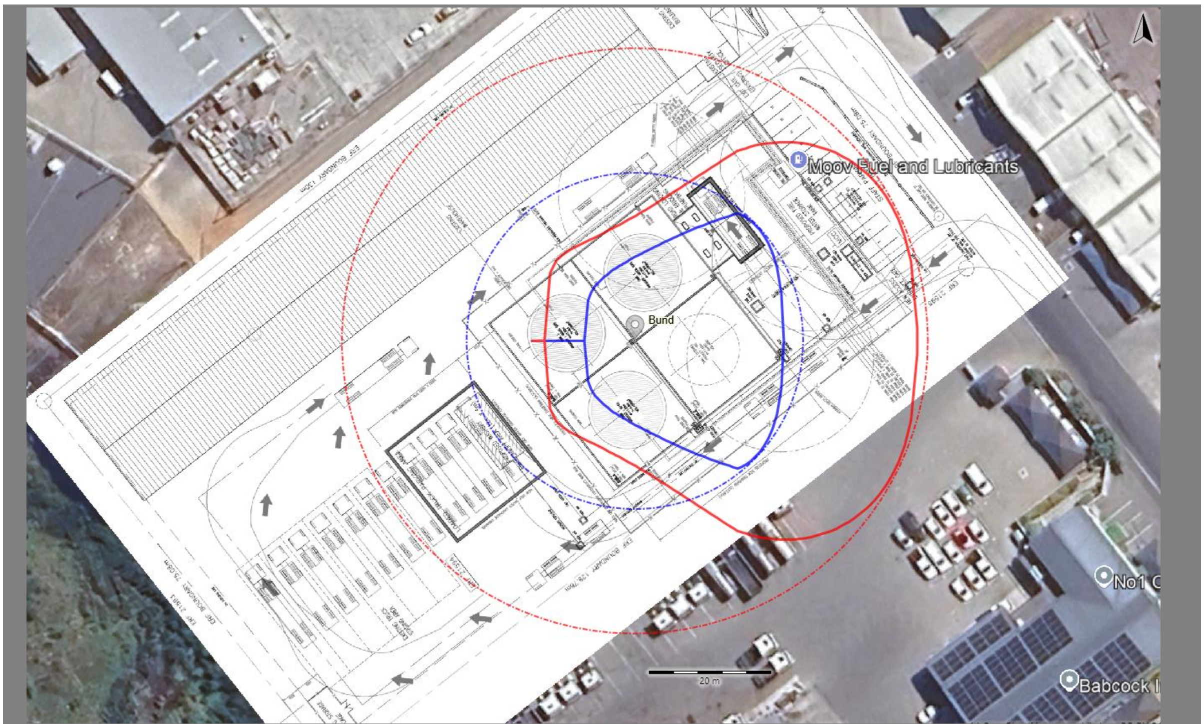
5.2.5 Flash Fires

A loss of containment of a flammable component may mix with air, forming a flammable mixture. The flammable cloud would be defined by the lower flammable limit (LFL) and the upper flammable limit (UFL). The extent of the flammable cloud would depend on the quantity of the released and mixed component, physical properties of the released component, wind speed and weather stability.

An ignition within a flammable cloud can result in an explosion if the front is propagated by pressure. If the front is propagated by heat, then the fire moves across the flammable cloud at the flame velocity and is called a flash fire. Flash fires are characterised by low overpressure, and injuries are caused by thermal radiation. The effects of overpressure due to an exploding cloud are covered in the subsection dealing with vapour cloud explosions (VCEs).

A flash fire would extend to the lower flammable limit; however, due to the formation of pockets, it could extend beyond this limit to the point defined as the ½ LFL. It is assumed that people within the flash fire would experience lethal injuries, while people outside of the flash fire would remain unharmed. The ½ LFL is used for emergency planning to evacuate people to a safe distance in the event of a release.

Flash fires could result from a loss of a containment of petrol with subsequent ignition. From the simulations, the greatest extent of a flash fire would be less than 45 m from the center of the pool, as shown in Figure 5-5. The maximum extent from flash fires could extend a short distance beyond the MOOV site boundary.



LEGEND	SCENARIO / DISTANCE FROM POOL CENTER (m)
(blue line)	LFL / 24
(red line)	½ LFL / 45

Figure 5-5 Maximum flammable limits from a large petrol release into the bunded area

5.3 Explosions

The concentration of a flammable component would decrease from the point of release to below the lower explosive limits (LEL), at which concentration the component can no longer ignite. The sudden detonation of an explosive mass would cause overpressures that could result in injury or damage to property.

Such an explosion may give rise to any of the following effects:

- Blast damage;
- Thermal damage;
- Missile damage;
- Ground tremors;
- Crater formation;
- Personal injury.

Obviously, the nature of these effects depends on the pressure waves and the proximity to the actual explosion. Of concern in this investigation are the ‘far distance effects’, such as limited structural damage and the breakage of windows, rather than crater formations.

Table 5-2 and Table 5-3 give a more detailed summary of the damage produced by an explosion due to various overpressures.

CPR 18E (Purple Book; 1999) suggests that the following overpressures should be determined:

- 0.03 bar overpressure, corresponding to the critical overpressure causing windows to break;
- 0.1 bar overpressure, corresponding to 10% of the houses being severely damaged and a probability of death indoors equal to 0.025:
    - No lethal effects are expected below the 0.1 bar overpressure on unprotected people in the open;
- 0.3 bar overpressure, corresponding to structures being severely damaged and 100% fatality for unprotected people in the open;
- 0.7 bar overpressure, corresponding to an almost entire destruction of buildings.

Table 5-2: Summary of consequences of blast overpressure (Clancey 1972)

Pressure (Gauge)		Damage
Psi	**kPa**	
0.02	0.138	Annoying noise (137 dB), if of low frequency (10 – 15 Hz).
0.03	0.207	Occasional breaking of large glass windows already under strain.
0.04	0.276	Loud noise (143 dB); sonic boom glass failure.
0.1	0.69	Breakage of small under strain windows.
0.15	1.035	Typical pressure for glass failure.
0.3	2.07	'Safe distance' (probability 0.95; no serious damage beyond this value); missile limit; some damage to house ceilings; 10% window glass broken.
0.4	2.76	Limited minor structural damage.
0.5–1.0	3.45–6.9	Large and small windows usually shattered; occasional damage to window frames.
0.7	4.83	Minor damage to house structures.
1.0	6.9	Partial demolition of houses, made uninhabitable.
1.0–2.0	6.9–13.8	Corrugated asbestos shattered; corrugated steel or aluminium panels, fastenings fail, followed by buckling; wood panels (standard housing) fastenings fail, panels blown in.
1.3	8.97	Steel frame of clad building slightly distorted
2.0	13.8	Partial collapsing of walls and roofs of houses.
2.0–3.0	13.8–20.7	Concrete or cinderblock walls (not reinforced) shattered.
2.3	15.87	Lower limit of serious structural damage.
2.5	17.25	50% destruction of brickwork of house.
3.0	20.7	Heavy machines (1.4 t) in industrial building suffered little damage; steel frame building distorted and pulled away from foundations.
3.0–4.0	20.7–27.6	Frameless, self-framing steel panel building demolished.
4.0	27.6	Cladding of light industrial buildings demolished.
5.0	34.5	Wooden utilities poles (telegraph, etc.) snapped; tall hydraulic press (18 t) in building slightly damaged.
5.0–7.0	34.5–48.3	Nearly complete destruction of houses.
7.0	48.3	Loaded train wagons overturned
7.0–8.0	48.3–55.2	Brick panels (20 cm – 30 cm) not reinforced fail by shearing or flexure.
9.0	62.1	Loaded train boxcars completely demolished.
10.0	69.0	Probable total destruction of buildings; heavy (3 t) machine tools moved and badly damaged; very heavy (12 000 lb. / 5 443 kg) machine tools survived.
300	2070	Limit of crater lip.

Table 5-3: Damage caused by overpressure effects of an explosion (Stephens 1970)

Equipment	Overpressure (psi)																								
	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10	12	14	16	18	20
Control house steel roof	A	C	V				N																		
Control house concrete roof	A	E	P	D			N																		
Cooling tower	B			F			O																		
Tank: cone roof		D				K							U												
Instrument cubicle			A			LM						T													
Fire heater				G	I					T															
Reactor: chemical				A				I				P						T							
Filter				H					F									V			T				
Regenerator						I				IP					T										
Tank: floating roof						K							U												D
Reactor: cracking							I							I							T				
Pine supports							P					SO													
Utilities: gas meter									Q																
Utilities: electric transformer									H					I						T					
Electric motor										H								I							V
Blower										Q										T					
Fractionation column											R			T											
Pressure vessel horizontal												PI						T							
Utilities: gas regulator												I								MQ					
Extraction column													I							V	T				
Steam turbine															I						M	S			V
Heat exchanger															I			T							
Tank sphere																I						I	T		
Pressure vessel vertical																					I	T			
Pump																					I		Y		

A	Windows and gauges break
B	Louvers fall at 0.3–0.5 psi
C	Switchgear is damaged from roof collapse
D	Roof collapses
E	Instruments are damaged
F	Inner parts are damaged
G	Bracket cracks
H	Debris-missile damage occurs
I	Unit moves and pipes break
J	Bracing fails
K	Unit uplifts (half filled)
L	Power lines are severed
M	Controls are damaged
N	Block wall fails
O	Frame collapses
P	Frame deforms
Q	Case is damaged
R	Frame cracks
S	Piping breaks
T	Unit overturns or is destroyed
U	Unit uplifts (0.9 filled)
V	Unit moves on foundations

5.3.1 Vapour Cloud Explosions (VCEs)

The release of a flammable component into the atmosphere could result in the formation of a flash fire, as described in the subsection on flash fires, or a vapour cloud explosion (VCE). In the case of a VCE, an ignited vapour cloud between the higher explosive limits (HEL) and the lower explosive limit (LEL), could form a fireball with overpressures that could result in injury or damage to property.

The blast pressures from a large gasoline spill, are shown in Figure 5-6. The 0.7 bar overpressure represents almost total destruction. The 0.3 bar represents major destruction of buildings and fatalities for people in the open. The 0.1 bar overpressure corresponds to 10% of the houses being severely damaged and a probability of death indoors equal to 0.025. No lethal effects are expected below the 0.1 bar overpressure for people in the open. The 0.03 bar corresponds to the critical overpressure causing windows to break; thus, it is the limit of building damage.

In the event of a VCE from a large spillage within the storage bund, the risks could extend beyond the MOOV site boundary. However, no injuries will be expected within the nearby residential area.

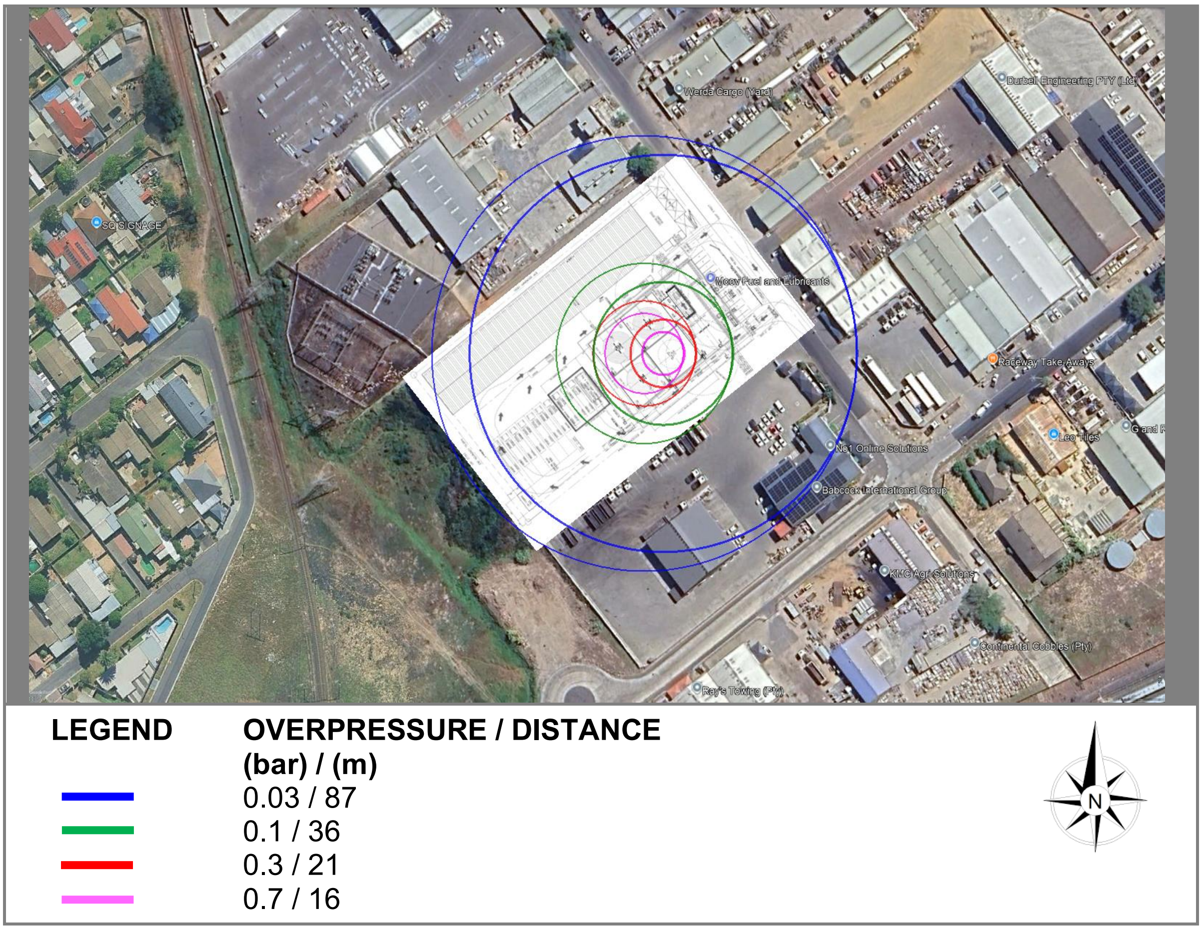


Figure 5-6: Blast overpressure from a vapour cloud explosion from an accidental loss of petrol within the bunded area

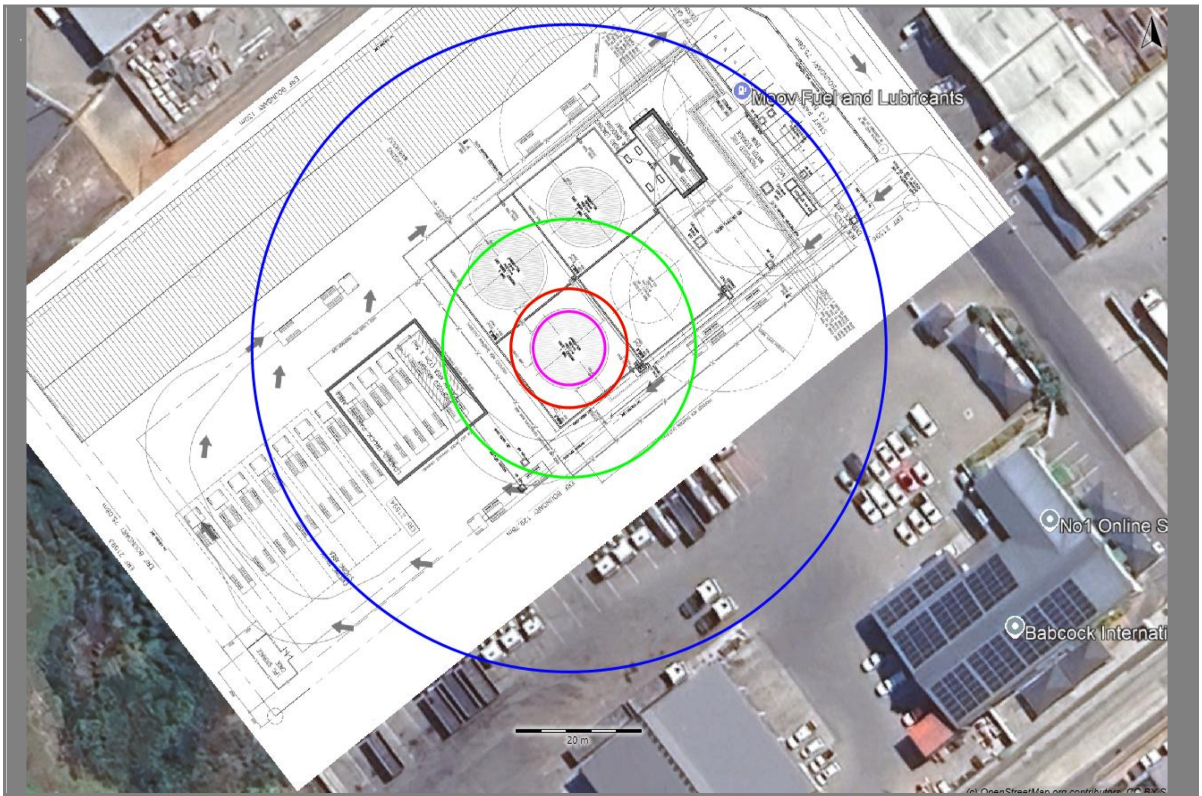
5.3.2 Fixed-Roof Tank Explosions

A confined gas explosion occurs when the exploding flammable mixture is restricted from expanding by physical barriers such as walls, equipment or other obstacles.

A fixed-roof tank explosion is a confined gas explosion within a tank. The explosive mass is calculated as the volume of the tank at its lower flammable limit (LFL). It should be noted that an explosion can only occur if a flammable atmosphere can be formed.

The blast pressures from a single petrol storage vessel, are shown in Figure 5-7.

The 1% fatality could extend beyond the site boundary, but will not impact the nearby residential area.



LEGEND **OVERPRESSURE / DISTANCE (bar) / (m)**

0.03 / 50

0.1 / 20

0.3 / 9

0.7 / 6

Figure 5-7: Blast overpressure from a single fixed-roof tank explosion in the petrol storage area

5.3.3 Boiling Liquid Expanding Vapour Explosions (BLEVEs)

A boiling liquid expanding vapour explosion (BLEVE) can occur when a flame impinges on a pressure cylinder, particularly in the vapour space region where cooling by evaporation of the contained material does not occur; the cylinder shell would weaken and rupture with a total loss of the contents, and the issuing mass of material would burn as a massive fireball.

The major consequences of a BLEVE are intense thermal radiation from the fireball, a blast wave and propelled fragments from the shattered vessel. These fragments may be projected to considerable distances. Analyses of the travel range of fragment missiles from a number of BLEVEs suggest that the majority land within 700 m from the incident will be affected. A blast wave from a BLEVE is fairly localised, but can cause significant damage to immediate equipment.

A BLEVE occurs sometime after the vessel has been engulfed in flames. Should an incident occur, that could result in a BLEVE, people should be evacuated to beyond the 1% fatality line.

The extent of an LPG cylinder BEVE, is shown in Figure 5-8. The extent of a 1% fatality could extend beyond the site boundary into the unoccupied area.

LEGEND	SCENARIO / DISTANCE (m)
(magenta line)	Fireball / 6
(green line)	1% Fatality / 6

Figure 5-8: The extent of an LPG BLEVE from a 9 kg cylinder

5.4 Warehouse

The warehouse will primarily contain oils having a high flashpoint and will thus have a very low probability of a fire.

The flammable ethanol must be stored in a separate flammable area. The extent of a fire will be limited to the flammable area and will not reach the general public, outside of the facility.

6 RISK ANALYSIS

6.1 Background

It is important to understand the difference between hazard and risk.

A hazard is anything that has the potential to cause damage to life, property and the environment. Furthermore, it has constant parameters (like those of petrol, chlorine, ammonia, etc.) that pose the same hazard wherever present.

On the other hand, risk is the probability that a hazard will actually cause damage and goes along with how severe that damage will be (consequence). Risk is therefore the probability that a hazard will manifest itself. For instance, the risks of a chemical accident or spill depend upon the amount present, the process the chemical is used in, the design and safety features of its container, the exposure, the prevailing environmental and weather conditions and so on.

Risk analysis consists of a judgement of probability based on local atmospheric conditions, generic failure rates and severity of consequences, based on the best available technological information.

Risks form an inherent part of modern life. Some risks are readily accepted on a day-to-day basis, while certain hazards attract headlines even when the risk is much smaller, particularly in the field of environmental protection and health. For instance, the risk of one-in-ten-thousand chance of death per year associated with driving a car is acceptable to most people, whereas the much lower risks associated with nuclear facilities (one-in-ten-million chance of death per year) are deemed unacceptable.

A report by the British Parliamentary Office of Science and Technology (POST), entitled ‘Safety in Numbers? Risk Assessment and Environmental Protection’, explains how public perception of risk is influenced by a number of factors in addition to the actual size of the risk. These factors were summarised as follows in Table 6-1.

Table 6-1: Influence of public perception of risk on acceptance of that risk, based on the POST report

Control	People are more willing to accept risks they impose upon themselves or they consider to be ‘natural’ than to have risks imposed upon them.
Dread and Scale of Impact	Fear is the greatest where the consequences of a risk are likely to be catastrophic, rather than spread over time.
Familiarity	People appear more willing to accept risks that are familiar rather than new risks.
Timing	Risks seem to be more acceptable if the consequences are immediate or short term, rather than if they are delayed (especially if they might affect future generations).
Social Amplification and Attenuation	Concern can be increased because of media coverage, graphic depiction of events or reduced by economic hardship.
Trust	A key factor is how far the public trusts regulators, policy makers or industry; if these bodies are open and accountable (being honest, as well as admitting mistakes and limitations and taking account of differing views without disregarding them as emotive or irrational), then the public is more likely consider them credible.

A risk assessment should be seen as an important component of ongoing preventative action, aimed at minimising or hopefully avoiding accidents. Reassessments of risks should therefore follow at regular intervals and after any changes that could alter the nature of the hazard, so contributing to an overall prevention programme and emergency response plan of the facility. Risks should be ranked with decreasing severity and the top risks reduced to acceptable levels.

Procedures for predictive hazard evaluation have been developed for the analysis of processes when evaluating very low probability accidents with very high consequences (for which there is little or no experience), as well as more likely releases with fewer consequences (for which there may be more information available). These address both the probability of an accident, as well as the magnitude and nature of undesirable consequences of that accident. Risk is usually defined as some simple function of both the probability and consequence.

6.2 Predicted Risk

Physical and consequence modelling addresses the impact of a release of a hazardous component without taking into account probability of occurrence. This merely illustrates the significance and the extent of the impact in the event of a release. Modelling should also analyse cascading or knock-on effects due to incidents in the facility and the surrounding industries and suburbs.

During a risk analysis, the likelihood of various incidents is assessed, the consequences calculated and finally the risk for the facility is determined.

6.2.1 Generic Equipment Failure Scenarios

In order to characterise various failure events and assign a failure frequency, fault trees were constructed starting with a final event and working from the top down to define all initiating events and frequencies. Unless otherwise stated, analysis was completed by using published failure rate data (RIVM 2009). Equipment failures can occur in tanks, pipelines and other items handling hazardous chemical components. These failures may result in:

- Release of combustible, flammable and explosive components with fires or explosions upon ignition;
- Release of toxic or asphyxiant components.

6.2.1.1 Storage Vessels

Scenarios involving storage vessels can include catastrophic failures that would lead to leakage into the bund with a possible bund fire. A tank-roof failure could result in a possible tank-top fire. The fracture of a nozzle or transfer pipeline could also result in leakage into the bund.

Typical failure frequencies for atmospheric and pressure vessels are listed, respectively, in Table 6-2 and Table 6-3.

Table 6-2: Failure frequencies for atmospheric vessels

Event	Leak Frequency (per item per year)
Small leaks	$1x10^{-4}$
Severe leaks	$3x10^{-5}$
Catastrophic failure	$5x10^{-6}$

Table 6-3: Failure frequencies for pressure vessels

Event	Failure Frequency (per item per year)
Small leaks	$1x10^{-5}$
Severe leaks	$5x10^{-7}$
Catastrophic failure	$5x10^{-7}$

6.2.1.2 Transport and Process Piping

Piping may fail as a result of corrosion, erosion, mechanical impact damage, pressure surge (water hammer) or operation outside the design limitations for pressure and temperature. Failures caused by corrosion and erosion usually result in small leaks, which are easily detected and corrected quickly. For significant failures, the leak duration may be from 10 to 30 minutes before detection.

Generic data for leak frequency for process piping is generally expressed in terms of the cumulative total failure rate per year for a 10 m section of pipe for each pipe diameter. Furthermore, failure frequency normally decreases when increasing the pipe diameter. Scenarios and failure frequencies for a pipeline apply to pipelines with connections, such as flanges, welds and valves.

The failure data given in Table 6-4 represents the total failure rate, incorporating all failures of whatever size and due to all probable causes. These frequencies are based on an assumed environment where no excessive vibration, corrosion, erosion or thermal cyclic stresses are expected. For incidents causing significant leaks (such as corrosion), the failure rate will be increased by a factor of 10.

Table 6-4: Failure frequencies for process pipes

Description	Frequencies of Loss of Containment for Process Pipes (per meter per year)	
	Full Bore Rupture	**Leak**
Nominal diameter < 75 mm	1×10^{-6}	5×10^{-6}
75 mm < nominal diameter < 150 mm	3×10^{-7}	2×10^{-6}
Nominal diameter > 150 mm	1×10^{-7}	5×10^{-7}

For scenarios and failure frequencies, no distinction is made between process pipes and transport pipes, the materials from which a pipeline is made, the presence of cladding, the design pressure of a pipeline or its location on a pipe bridge. However, a distinction is made between aboveground pipes and underground pipes. The scenarios for aboveground pipes are given in Table 6-5, and those for underground pipes are given in Table 6-6.

Transport pipelines aboveground can be compared, under certain conditions, with underground pipes in a pipe bay. The necessary conditions for this are external damage being excluded, few to no flanges and accessories present and the pipe is clearly marked. In very specific situations, the use of a lower failure frequency for transport pipes aboveground can be justified.

Table 6-5: Failure frequencies for aboveground transport pipelines

Description	Frequency (per meter per annum)		
	Nominal Diameter < 75 mm	**75 mm > Nominal Diameter > 150 mm**	**Nominal Diameter > 150 mm**
Full bore rupture	1×10^{-6}	3×10^{-7}	1×10^{-7}
Leak with an effective diameter of 10% of the nominal diameter, up to a maximum of 50 mm	5×10^{-6}	2×10^{-6}	5×10^{-7}

Table 6-6: Failure frequencies for underground transport pipelines

Description	Frequency (per meter per annum)		
	Pipeline in Pipe Lane[1]	**Pipeline Complies with NEN 3650**	**Other Pipelines**
Full bore rupture	7×10^{-9}	1.525×10^{-7}	5×10^{-7}
Leak with an effective diameter of 20 mm	6.3×10^{-8}	4.575×10^{-7}	1.5×10^{-6}

1 A pipeline located in a 'lane' is a pipeline located with a group of pipelines on a dedicated route. Loss-of-containment frequencies for this situation are lower because of extra preventive measures.

6.2.1.3 Pumps and Compressors

Pumps can be subdivided roughly into two different types, reciprocating pumps and centrifugal pumps. This latter category can be further subdivided into canned pumps (sealless pumps) and gasket pumps (pumps with seals). A canned pump can be defined as an encapsulated pump where the process liquid is located in the space around the rotor (impeller), in which case gaskets are not used.

Compressors can also be subdivided roughly into reciprocating compressors and centrifugal compressors.

Failure rates for pumps and compressors are given in Table 6-7 and Table 6-8.

Table 6-7: Failure frequency for centrifugal pumps and compressors

Event	Canned (No Gasket) Frequency (per annum)	Gasket Frequency (per annum)
Catastrophic failure	1.0×10^{-5}	1.0×10^{-4}
Leak (10% diameter)	5.0×10^{-5}	4.4×10^{-3}

Table 6-8: Failure frequency for reciprocating pumps and compressors

Event	Frequency (per annum)
Catastrophic failure	1.0×10^{-4}
Leak (10% diameter)	4.4×10^{-3}

6.2.1.4 Loading and Offloading

Loading can take place from a storage vessel to a transport unit (road tanker, tanker wagon or ship) or from a transport unit to a storage vessel. The failure frequencies for loading and offloading arms, are given in Table 6-9.

Table 6-9: Failure frequencies for loading and offloading arms and hoses

Event	Frequency (per hour)	
	Loading and Offloading Arms	Loading and Offloading Hoses
Rupture	3×10^{-8}	4×10^{-6}
Leak with effective diameter at 10% of nominal diameter to max. 50 mm	3×10^{-7}	4×10^{-5}

6.2.1.5 Road or Rail Tankers within the Establishment

Road or rail tankers are transport vehicles with fixed and removable tanks. In addition, they include battery wagons and, insofar as these are fitted on a transport vehicle, tank containers, swap-body tanks and MEGCs (multiple element gas containers).

The failure rate of tankers on an establishment is dependent on the pressure rating of the tank and is given in Table 6-10 and Table 6-11.

Table 6-10: Failure frequencies for road tankers with an atmospheric tank

Event	Frequency (per annum)
Instantaneous release of the entire contents	$1x10^{-5}$
Release of contents from the largest connection	$5x10^{-7}$

Table 6-11: Failure frequencies for road tankers with a pressurised tank

Event	Frequency (per annum)
Instantaneous release of the entire contents	$1x10^{-7}$
Release of contents from the largest connection	$5x10^{-7}$

It should be noted that no scenarios are included for the loss of containment as a result of external damage to the tanker or fire in the surrounding areas. It is assumed that sufficient measures are taken to prevent external damage to the tanker.

6.2.1.6 Human Failure

Human error and failure can occur during any life cycle or mode of operation of a facility.

Human failure can be divided into the following categories:

- Human failure during design, construction and modification of the facility;
- Human failure during operation and maintenance;
- Human failure due to errors of management and administration.

Human failure during design, construction and modification is part of the generic failure given in this subsection. Human failure due to errors of organisation and management are influencing factors. Some of the types of tasks that have been evaluated for their rates of human failure, are given in Table 6-12.

Table 6-12: Human failure rates of specific types of tasks (CPR 12E 2005; Red Book)

Tasks	Human Failure (events per year)
Totally unfamiliar, performed at speed with no real idea of likely consequences.	0.55
Failure to carry out rapid and complex actions to avoid serious incident such as an explosion.	0.5
Complex task requiring high level of comprehension and skill.	0.16
Failure to respond to audible alarm in control room within 10 minutes.	$1.0x10^{-1}$
Failure to respond to audible alarm in quiet control room by some more complex action, such as going outside and selecting one correct value among many.	$1.0x10^{-2}$
Failure to respond to audible alarm in a quiet control room by pressing a single button.	$1.0x10^{-3}$
Omission or incorrect execution of step in a familiar start-up routine.	$1.0x10^{-3}$
Completing a familiar, well-designed, highly-practiced, routine task occurring several times per hour, performed to highest possible standards by a highly-motivated, highly-trained and experienced person totally aware of implications of failures, with time to correct potential error but without the benefit of significant job aids.	$4.0x10^{-4}$

6.2.1.7 Ignition Probability of Flammable Gases and Liquids

Estimation of probability of an ignition is a key step in an assessment of risk for installations where flammable liquids or gases are stored. There is a reasonable amount of data available relating to characteristics of ignition sources and effects of release type and location.

Probability of ignition for stationary installations is given in Table 6-13 (along with classification of flammable substances in Table 6-14). These can be replaced with ignition probabilities related to surrounding activities. For example, the probability of a fire from a flammable release at an open flame would increase to a value of 1.

Table 6-13: Probability of direct ignition for stationary installations (RIVM 2009)

Substance Category	Source-Term Continuous	Source-Term Instantaneous	Probability of Direct Ignition
Category 0 Average to high reactivity	< 10 kg/s 10 – 100 kg/s > 100 kg/s	< 1000 kg 1000 – 10 000 kg > 10 000 kg	0.2 0.5 0.7
Category 0 Low reactivity	< 10 kg/s 10 – 100 kg/s > 100 kg/s	< 1000 kg 1000 – 10 000 kg > 10 000 kg	0.02 0.04 0.09
Category 1	All flow rates	All quantities	0.065
Category 2	All flow rates	All quantities	0.0043[1]
Category 3 Category 4	All flow rates	All quantities	0

Table 6-14: Classification of flammable substances

Substance Category	Description	Limits
Category 0	Extremely flammable	Liquids, substances and preparations that have a flashpoint lower than 0°C and a boiling point (or the start of the boiling range) less than or equal to 35°C. Gaseous substances and preparations that may ignite at normal temperature and pressure when exposed to air.
Category 1	Highly flammable	Liquids, substances and preparations that have a flashpoint of below 21°C.
Category 2	Flammable	Liquids, substances and preparations that have a flashpoint equal to 21°C and less than 55°C.
Category 3		Liquids, substances and preparations that have a flashpoint greater than 55°C and less than or equal to 100°C.
Category 4		Liquids, substances and preparations that have a flashpoint greater than 100°C.

1 This value is taken from the CPR 18E (Purple Book; 1999). RIVM (2009) gives the value of delayed ignition as zero. RISCOM (PTY) LTD believes the CPR 18E is more appropriate for warmer climates and is a conservative value.

6.3 Risk Calculations

6.3.1 Maximum Individual Risk Parameter

Standard individual risk parameters include: average individual risk; weighted individual risk; maximum individual risk; and, the fatal accident rate. The lattermost parameter is more applicable to occupational exposures.

Only the maximum individual risk (MIR) parameter will be used in this assessment. For this parameter, the frequency of fatality is calculated for an individual who is presumed to be present at a specified location. This parameter (defined as the consequence of an event multiplied by the likelihood of the event) is not dependent on the knowledge of populations at risk. So, it is an easier parameter to use in the predictive mode than average individual risk or weighted individual risk. The unit of measure is the risk of fatality per person per year.

6.3.2 Acceptable Risks

The next step, after having characterised a risk and obtained a risk level, is to recommend whether the outcome is acceptable.

In contrast to the employees at a facility, who may be assumed to be healthy, the adopted exposure assessment applies to an average population group that also includes sensitive subpopulations. Sensitive subpopulation groups are those people that for reasons of age or medical condition, have a greater than normal response to contaminants. Health guidelines and standards that are used to establish risk normally incorporate safety factors that address this group.

Among the most difficult tasks of risk characterisation is the definition of acceptable risk. In an attempt to account for risks in a manner similar to those used in everyday life, the UK Health and Safety Executive (HSE) developed the risk ALARP triangle. Applying the triangle involves deciding:

- Whether a risk is so high that something must be done about it;
- Whether the risk is or has been made so small that no further precautions are necessary;
- If a risk falls between these two states so that it has been reduced to levels as low as reasonably practicable (ALARP).

This is illustrated in Figure 6-1.

ALARP stands for 'as low as reasonably practicable'. As used in the UK, it is the region between that which is intolerable, at $1x10^{-4}$ per year, and that which is broadly acceptable, at $1x10^{-6}$ per year. A further lower level of risk, at $3x10^{-7}$ per year, is applied to either vulnerable or very large populations for land-use planning.

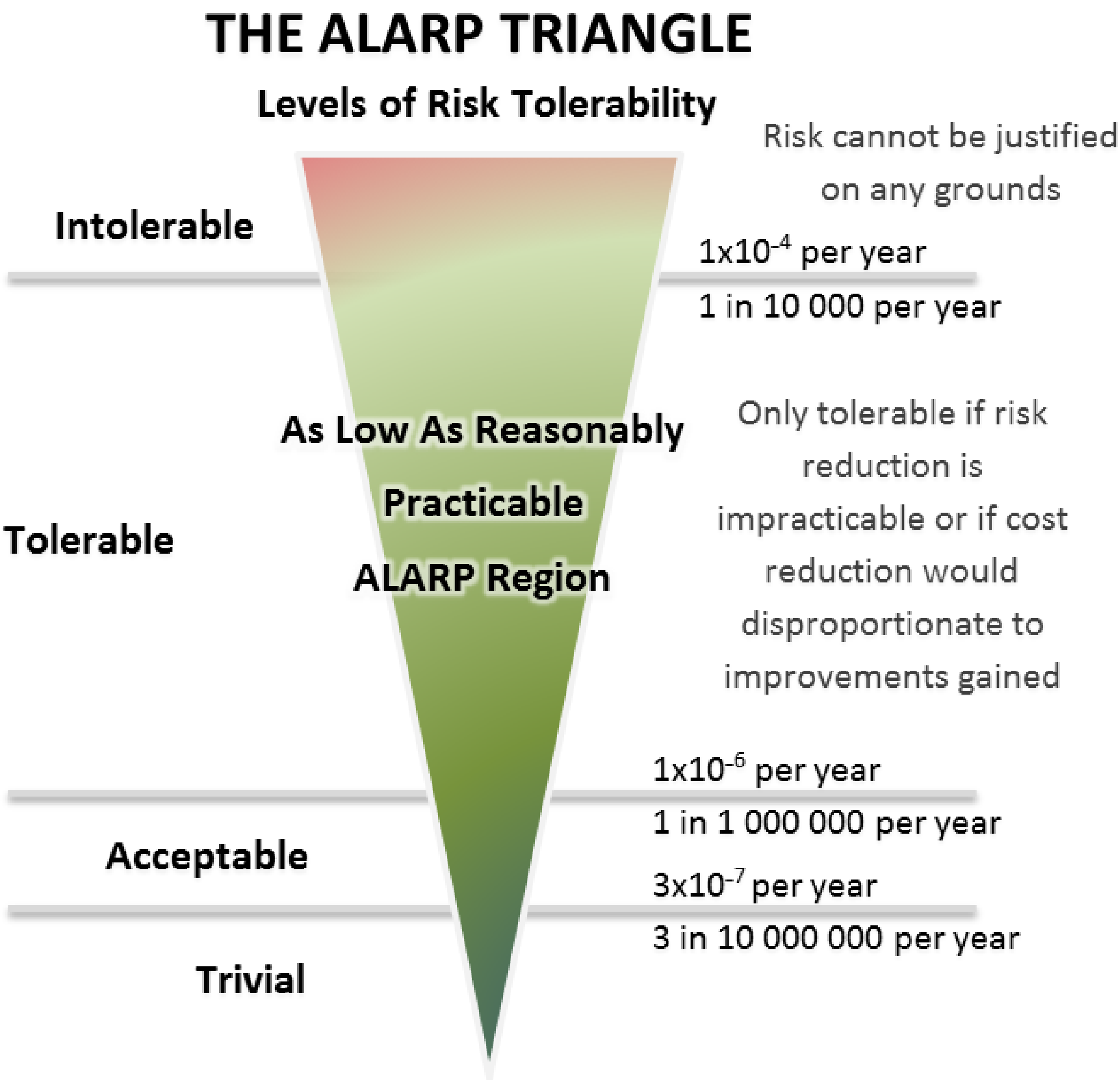


Figure 6-1: UK HSE decision-making framework

It should be emphasised that the risks considered acceptable to employees are different to those considered acceptable to the public. This is due to the fact that employees have personal protection equipment (PPE), are aware of the hazards, are sufficiently mobile to evade or escape the hazards and receive training in preventing injuries.

The HSE (UK) gives more detail on the word practicable in the following statement:

“ In essence, making sure a risk has been reduced to ALARP is about weighing the risk against the sacrifice needed to further reduce it. The decision is weighted in favour of health and safety because the presumption is that the duty-holder should implement the risk reduction measure. To avoid having to make this sacrifice, the duty-holder must be able to show that it would be grossly disproportionate to the benefits of risk reduction that would be achieved. Thus, the process is not one of balancing the costs and benefits of measures but, rather, of adopting measures except where they are ruled out because they involve grossly disproportionate sacrifices. Extreme examples might be:

- *To spend £1m to prevent five staff members suffering bruised knees is obviously grossly disproportionate; but,*
- *To spend £1m to prevent a major explosion capable of killing 150 people is obviously proportionate.*

Proving ALARP means that if the risks are lower than 1x10^{-4} fatalities per person per year, it can be demonstrated that there would be no more benefit from further mitigation, sometimes using cost benefit analysis. “

6.3.3 Land Planning

There are no legislative land-planning guidelines in South Africa and in many parts of the world. Further to this, land-planning guidelines vary from one country to another, and thus it is not easy to benchmark the results of this study to international criteria. In this instance, RISCOM would only advise on applicable land planning and would require governmental authorities to make final decisions.

Land zoning applied in this study follows the HSE (UK) approach of defining the area affected into three zones, consistent to the ALARP approach (HSE 2011).

The three zones are defined as follows:

- The inner zone is enclosed by the risk of $1\text{x}10^{-5}$ fatalities per person per year isopleth;
- The middle zone is enclosed by the risk of $1\text{x}10^{-5}$ fatalities per person per year and the risk of $1\text{x}10^{-6}$ fatalities per person per year isopleths;
- The outer zone is enclosed by the risk $1\text{x}10^{-6}$ fatalities per person per year and the risk of $3\text{x}10^{-7}$ fatalities per person per year isopleths.

The risks decrease from the inner zone to the outer zone, as shown in Figure 6-2.

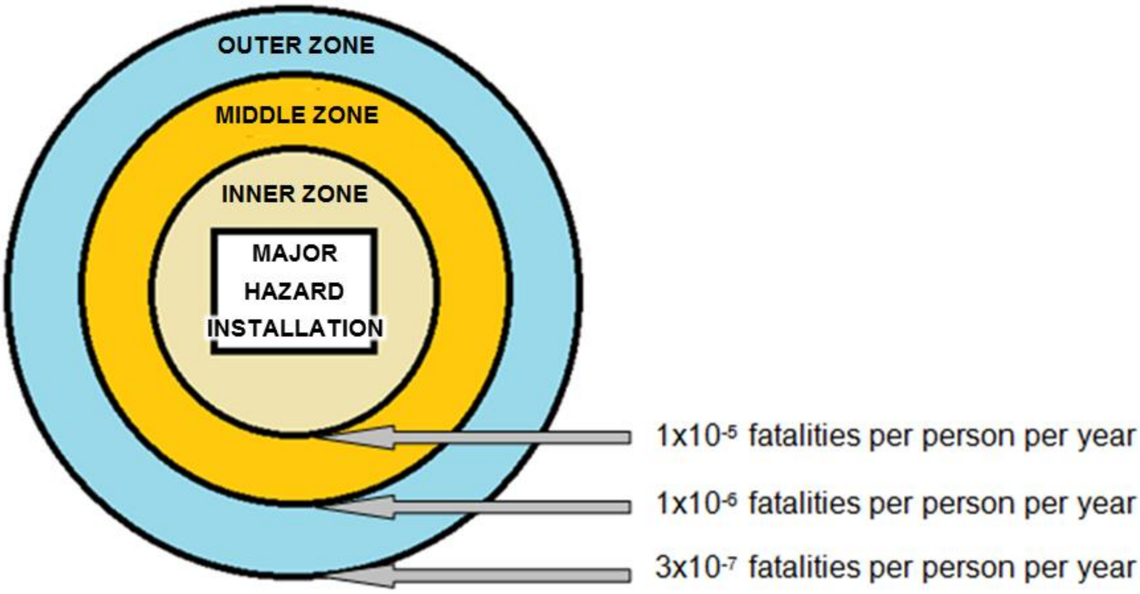


Figure 6-2: Town-planning zones

Once the zones are calculated, the HSE (UK) methodology then determines whether a development in a zone should be categorised as ‘advised against’ (AA) or as ‘don’t advise against’ (DAA), depending on the sensitivity of the development, as indicated in Table 6-15. There are no land-planning restrictions beyond the outer zone.

Table 6-15: Land-use decision matrix

Level of Sensitivity	Development in Inner Zone	Development in Middle Zone	Development in Outer Zone
1	DAA	DAA	DAA
2	AA	DAA	DAA
3	AA	AA	DAA
4	AA	AA	AA

The sensitivity levels are based on a clear rationale: progressively more severe restrictions are to be imposed as the sensitivity of the proposed development increases.

There are four sensitivity levels, with the sensitivity for housing defined as follows:

- Level 1 is based on workers who have been advised of the hazards and are trained accordingly;
- Level 2 is based on the general public at home and involved in normal activities;
- Level 3 is based on the vulnerability of certain members of the public (e.g., children, those with mobility difficulties or those unable to recognise physical danger);
- Level 4 is based on large examples of Level 2 and of Level 3.

Refer to Appendix B for detailed planning advice for developments near hazardous installations (PADHI) tables. These tables illustrate how the HSE land-use decision matrix, are generated by using the three zones and the four sensitivity levels, and is applied to a variety of development types.

6.4 Risk Scenarios

6.4.1 Lethal Dosages from Accidental Toxic Releases

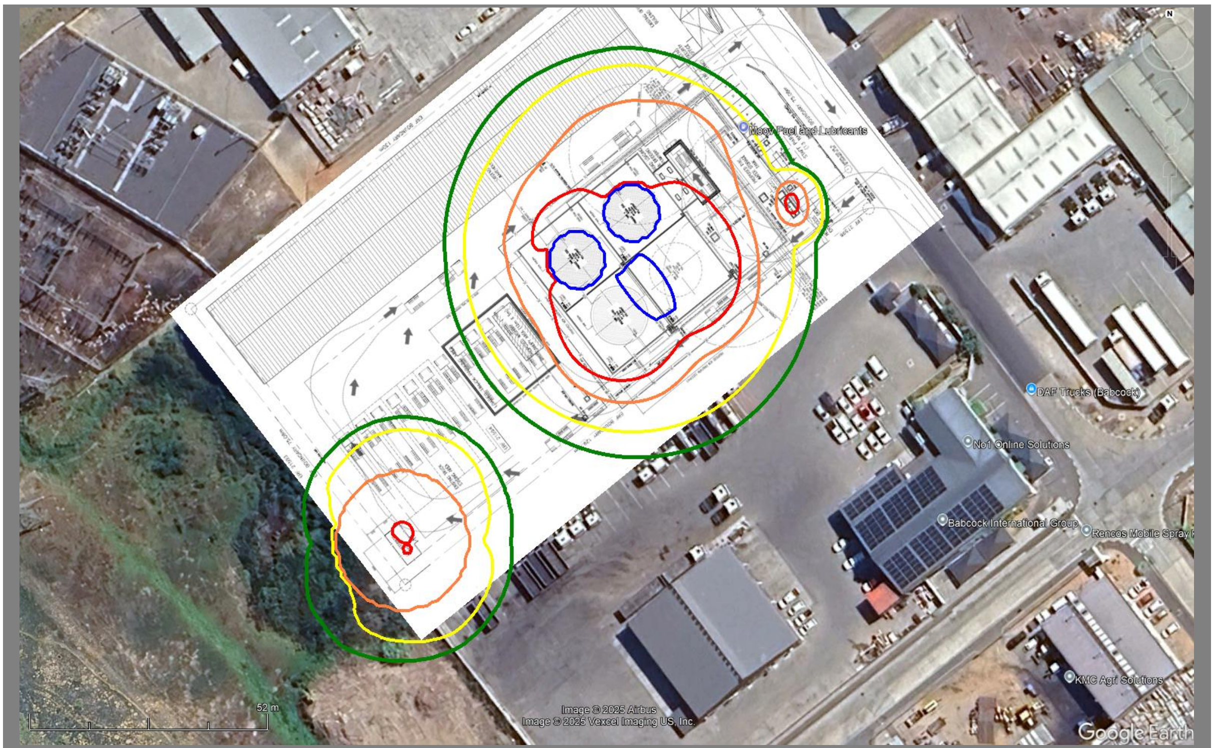
Quantitative health risk assessment incorporates various distinct stages, including hazard assessment, dose-response analysis, exposure assessment and risk characterisation. The process of a hazard assessment is aimed at determining whether particular substances cause adverse impacts on human health.

The quantification of the adverse impacts associated with a substance is made possible through dose-response analysis and exposure assessment. By combining information generated through a hazard assessment and dose-response analysis, the overall risk posed by a particular component on human health may be characterised.

6.4.2 Accidental Fires and Explosions

Relatively large quantities of combustible, flammable and explosive components are stored on, delivered to or produced at the proposed MOOV site. Fires and explosions may result with accidental releases and ignition of these components. Scenarios that could result in large fires were developed and summarised in Appendix C. Risks were calculated by using generic failure rates.

The risks for the proposed project (including the future expansion), are shown in Figure 6-3.



LEGEND	RISK (fatalities per person per year)
Blue	1x10^{-3}
Red	1x10^{-4}
Orange	1x10^{-5}
Yellow	1x10^{-6}
Green	3x10^{-7}

Figure 6-3: Lethal probability isopleths associated with the p MOOV

The risks greater than $1x10^{-3}$ fatalities per person per year are considered excessive for the workers. As this does not extend beyond the storage tank, the risks to workers would be considered acceptable.

Risks greater than $1x10^{-4}$ fatalities per person per year, are considered tolerable for industrial areas, but excessive for residential areas. The $1x10^{-4}$ fatalities per person per year did not extend into areas occupied by the general public on the proposed MOOV site.

The risk of $3x10^{-7}$ fatalities per person per year isopleth indicates the extent for land-use that would be suitable for vulnerable populations, such as hospitals, retirement homes, nursery schools, prisons, large gatherings in the open, and so forth. As the risks did not extend into areas occupied by the general public, no land planning would be required.

The risks to occupants beyond the proposed MOOV site boundary will be less than $1x10^{-4}$ fatalities per person per year, but greater than $3x10^{-7}$ fatalities per person per year, classifying the risks as ALARP and is deemed tolerable.

6.5 Societal Risk Parameter

Risk criteria discussed so far have been for individual risks. There is also a need to consider incidents in light of their effect on many people at the same time. Public response to an incident that may harm many people is thought to be worse than the response to many incidents causing the same number of individual deaths. Compliance with an individual risk criterion is necessary, but not always sufficient. Even if it were sufficient, societal risk would also have to be examined in some circumstances.

Societal risk is risk of widespread or large-scale harm from a potential hazard. The implication is that the consequence would be on such a scale as to provoke a major social or political response and may lead to public discussion about regulation in general. Societal risk therefore takes into account the density of the population around a Major Hazard Installation site and is the probability in any one year (F) of an event affecting at least a certain number (N) of people (also known as an FN curve).

Societal risk used in this study are based on SANS 1461 (2018).

6.5.1 Societal Risk

The societal risks were based on the following population assumptions:

- Industrial areas (medium density): 40 persons per hectare (day) and 8 persons per hectare (night);
- Residential areas: 10 persons per hectare (day) and 80 persons per hectare (night).

The societal risk for the proposed MOOV facility, is shown in Figure 6-4. The red line illustrates the combined societal risk, while the black line is the lower guide value.

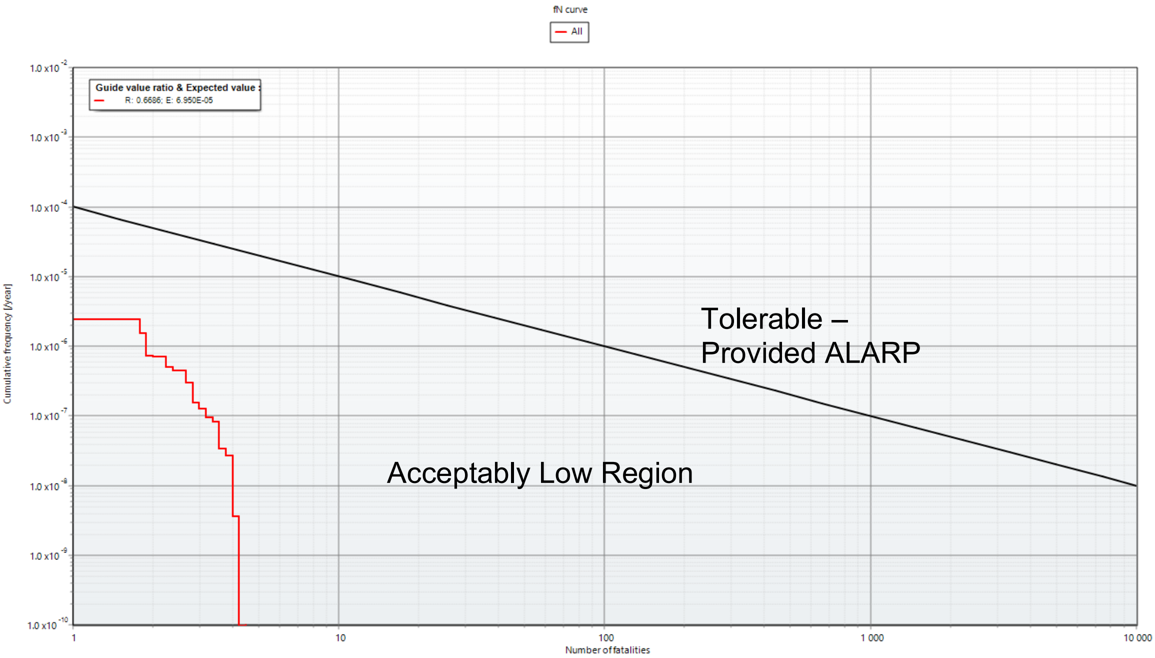


Figure 6-4: Societal risks for the proposed MOOV facility

The societal risks to the public are well below the lower guideline and therefore, the societal risks would be considered acceptable. The societal risks could further change with the development of the surrounding area, and thus the societal risk should be reviewed with each new surrounding development.

7 REDUCTION OF RISK

This study found that the proposed MOOV facility in Kraaifontein would be classified as a Low Hazard Establishment Major Hazard Installation. After the completion of Phase 2 with the addition of Tank-4, the MHI classification may increase to a Medium Tier Establishment.

Mitigations that may be considered, but not limited, to reduce risks to acceptable levels are listed in the following subsections.

Implementation of any mitigations should always be done in accordance with recognised engineering practices, by using applicable codes and standards that should be based on the benefit versus cost principle.

7.1 Mitigation

As mentioned, the scenarios with the highest risk rankings are the overfilling of the tanks. Suggested mitigation is listed in the following subsections.

7.1.1 Containment

Secondary containment for the storage and offloading / loading of road tankers has been described. However, it is recommended that the oil separator must contain the volume of the largest compartment of the road tanker, over and above the volume required for the first flush.

7.1.2 Overfilling

Overfilling instrumentation has been described as at least two independent level detection alarms and trips. The overfilling protection cannot be reduced to anything less than the aforementioned protection.

7.1.3 Process Hazard Analysis (PHA)

Hazardous areas should be reviewed by using a detailed Process Hazard Analysis (PHA)[1] , such as a HAZOP study that should be completed to identify potential hazards, and suggest further mitigation for safer operations. Due to the seriousness of the hazardous material stored, transported and produced on site, it is suggested that a detailed PHA / HAZOP study should be completed by an independent chairman, who is registered with the Engineering Council of South Africa. Furthermore, any instruments used should incorporate the findings of a SIL assessment defined in IEC 61511.

7.1.4 Ignition Sources

Ignition sources near the depot must be minimised as far as possible. This is particularly relevant with the fuel storage area.

1 A Process Hazard Analysis is not a regulated activity, but mealy identifies potential hazards and recommends mitigation.

A hazardous area classification as per SANS 10108 must be developed for all flammable materials. Only suitable instrumentation and electrical equipment should be installed in accordance with the requirement of the code.

7.1.5 Emergency Shut Down System (ESD)

The fast detection of a loss of containment with appropriate shut-down action to limit the amount of gasoline and diesel released, will assist in the reduction of the site risks.

7.1.6 Codes and Standards

Applicable international best practice production and guidelines or equivalent international recognised codes of good design and practice of installations, must be incorporated in the designs. This implies that best practices would be applied to the design and operation of the proposed site.

7.1.7 Safety Instrumented Systems

IEC 61508/61511 (Safety Instrumented Systems) are codes specifically related to the instrumentation requirements for adequate protection from hazards in chemical plants and are applicable for the life cycle of the plant. These codes are aimed at reducing risks to surrounding populations to acceptable levels.

The significance of these codes is that the designs would be evaluated against the criteria of the code, and that instrumentation with specific failure rates would be specified, as well as the minimum periods of checking. Thus, the selection of instrumentation is not based on price alone. Further to this, instrumentation cannot be reduced or changed without reviewing the code. The specification of this code implies that designs presented at the EIA and MHI evaluations cannot be altered at construction for the sole function by reducing costs. Moreover, the code ensures that the plant would continue to maintain the safety functions for the *life cycle* of the plant, and by retaining a safe working environment for both the workers and the public.

The European standards body, CENELEC, has adopted the standard as EN 61511. This means that in each of the member states of the European Union, the standard is published as a national standard. For example, in Great Britain, it is published by the national standards body, BSI, as BS EN 61511. The content of these national publications is identical to that of IEC 61511. Note, however, that BS EN 61511 is not harmonized under any directive of the European Commission.

In the United States, ANSI/ISA 84.00.01-2004 was issued in September 2004. It primarily mirrors IEC 61511 in content with the exception that it contains a grandfathering clause.

Compliance with IEC 61508 and IEC 61511 (or ANSI/ISA 84.00.01-2004) would be a requirement in many countries around the world to achieve an acceptable risk to both the workers and the public.

This is of particular reference to the tank overfilling scenario and should be considered as guidelines to the instrumentation architecture of the instrumentation.

8 CONCLUSIONS

Risk calculations are not precise. Accuracy of predictions is determined by the quality of base data and expert judgements.

This risk assessment included the consequences of fires and explosions at the proposed MOOV facility in Kraaifontein. A number of well-known sources of incident data were consulted and applied to determine the likelihood of an incident to occur.

This risk assessment was performed with the assumption that the site would be maintained to an acceptable level and that all statutory regulations would be applied. It was also assumed that the detailed engineering designs would be done by competent people and would be correctly specified for the intended duty. For example, it was assumed that the tank wall thicknesses have been correctly calculated, that vents have been sized for emergency conditions, that instrumentation and electrical components comply with the specified electrical area classification, that material of construction is compatible with the products, etc.

It is the responsibility of the owners and their contractors to ensure that all engineering designs would have been completed by competent persons and that all pieces of equipment would have been installed correctly. All designs should be in full compliance with (but not limited to) the Occupational Health and Safety Act 85 of 1993 and its regulations, the National Buildings Regulations and the Buildings Standards Act 107 of 1977, as well as the local bylaws.

A number of incident scenarios were simulated, taking into account the prevailing meteorological conditions, and were described in the report.

8.1 Hazardous Materials

The hazardous materials identified included gasoline and diesel fuel. Both these materials are considered flammable, but not acutely toxic when inhaled.

8.2 Notifiable Substances

The General Machinery Regulation 8 and its Schedule A on notifiable substances requires any employer who has a substance equal to or exceeding the quantity listed in the regulation to notify the divisional director. A site is classified as a Major Hazard Installation if it contains one or more notifiable substances or if the off-site risk is sufficiently high. The latter can only be determined from a quantitative risk assessment.

No material to be stored on site is listed as notifiable.

8.3 Bulk Fuel Tank Farm

Pool fires and flash fires from a loss of containment at the storage and offloading installations of petrol and diesel were simulated. Tank explosions from petrol were also simulated.

The impacts from accidental fires and explosions could extend beyond the site boundary, but would not extend to the residential areas.

The offsite risks from the proposed project will be between $1x10^{-4}$ to $1x10^{-6}$ fatalities per person per year, meaning the risks would be within the ALARP region and will be considered tolerable.

8.4 LPG Storage

Up to 1.5 tonnes of LPG will be stored in cylinders having a maximum capacity of 9 kg per cylinder. A loss of containment from a cylinder could extend beyond the MOOV site boundary. However, the risks from the LPG storage would be considered tolerable.

8.5 Warehouse

The warehouse will primarily contain oils having a high flashpoint and there will thus be a very low probability of a fire.

The flammable ethanol must be stored in a separate flammable area. The extent of a fire will be limited to the flammable area and will not reach the general public, outside of the facility.

8.6 Impacts onto Neighbouring Properties, Residential Areas and Major Hazard Installations

Impacts from the proposed projects could extend to immediate properties, but would not extend into the residential areas of Kraaifontein.

8.7 Major Hazard Installation

The expected MHI hazard tier for each phase of the fuel storage projects, is given in Table 8-1.

Table 8-1: Expected establishment hazardous tier per project phase

Phase	ULP 95 Inventory (t)	Diesel Inventory (t)	Total (t)	Hazard Tier
Proposed	440	1 820	2 260	Low Hazard
Future	1 320	1 820	3 140	Medium Hazard

The proposed project will **classify the facility as a Low Hazard Establishment Major Hazard Installation, but may increase to a Medium Hazard Establishment Major Hazard Installation with the completion of the future phase, with the increased storage of ULP or diesel.**

The requirements of approvals and registration under the MHI regulations should be reviewed for adequate preparation in completing the MHI risk assessment, as required by the legislation prior to construction.

9 RECOMMENDATIONS

As a result of the risk assessment study conducted for the proposed MOOV facility in Kraaifontein, a number of events were found to have risks beyond the fuel tank farm boundary. These risks could be mitigated to acceptable levels, as shown in the report.

RISCOM did not find any fatal flaws that would prevent the project proceeding to the detailed engineering phase of the project.

RISCOM would support the project with the following conditions:

- Compliance with all statutory requirements, i.e., pressure vessel designs;
- Compliance with applicable SANS codes, i.e., SANS 10087, SANS 10089, SANS 10108, etc.;
- Incorporation of applicable guidelines or equivalent international recognised codes of good design and practice into the designs;
- Completion of a recognised process hazard analysis (such as a HAZOP study, FMEA, etc.) on the proposed facility prior to construction to ensure that the design and operational hazards have been identified and adequate mitigation are put in place;
- Full compliance with IEC 61511 (Safety Instrument Systems) standards or equivalent to ensure that adequate protective instrumentation is included in the design and would remain valid for the full life cycle of the tank farm: This is particularly relevant to the overfilling of the storage tanks and applicable shutdown systems:
  - Including demonstration from the designer that sufficient and reliable instrumentation would be specified and installed at the facility;
- Preparation and issuing of a safety document detailing safety and design features reducing the impacts from fires, explosions and flammable atmospheres to the MHI assessment body at the time of the MHI assessment:
  - Including compliance to statutory laws, applicable codes and standards and world's best practice;
  - Including the listing of statutory and non-statutory inspections, giving frequency of inspections;
  - Including the auditing of the built facility against the safety document;
  - Noting that codes such as IEC 61511 can be used to achieve these requirements;
- Demonstration by MOOV or their contractor that the final designs would reduce the risks posed by the installation to internationally acceptable guidelines;
- Signature of all terminal designs by a professional engineer registered in South Africa in accordance with the Professional Engineers Act, who takes responsibility for suitable designs;
- Completion of an emergency preparedness and response document for on-site and off-site scenarios prior to initiating the MHI risk assessment (with input from the local authorities);
- Permission not being granted for increases to the product list or product inventories without redoing part of or the full EIA;
- Final acceptance of the facility risks with an MHI risk assessment that must be completed in accordance to the MHI regulations:
  - Basing such a risk assessment on the final design and including engineering mitigation.

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11 ABBREVIATIONS AND ACRONYMS

AIA	See **Approved Inspection Authority**
ALARP	The UK Health and Safety Executive (HSE) developed the risk **ALARP** triangle, in an attempt to account for risks in a manner similar to those used in everyday life. This involved deciding: • Whether a risk is so high that something must be done about it; • Whether the risk is or has been made so small that no further precautions are necessary; • Whether a risk falls between these two states and has been reduced to levels '**as low as reasonably practicable'** (ALARP). Reasonable practicability involves weighing a risk against the trouble, time and money needed to control it.
API	The **American Petroleum Institute** is the largest U.S. trade association for the oil and natural gas industry. It claims to represent nearly 600 corporations involved in production, refinement, distribution, and many other aspects of the petroleum industry.
Approved Inspection Authority	An **approved inspection authority (AIA)** is defined in the Major Hazard Installation regulations (2022)
ATG	An **Automatic Tank Gauge (ATG)** is a computerized system that automatically evaluates changes in product volume that might suggest a possible leaking tank. The tank gauge is connected to a probe inside the tank that is permanently installed through the top of the tank.
Blast Overpressure	**Blast overpressure** is a measure used in the multi-energy method to indicate the strength of the blast, indicated by a number ranging from 1 (for very low strengths) up to 10 (for detonative strength).
BLEVE	**Boiling liquid expanding vapour explosions** result from the sudden failure of a vessel containing liquid at a temperature above its boiling point. A **BLEVE** of flammables results in a large fireball.
COC	**Customer Own Collection**
Detonation	**Detonation** is a release of energy caused by extremely rapid chemical reaction of a substance, in which the reaction front of a substance is determined by compression beyond the auto-ignition temperature.
EIA	**Environmental impact assessment** Environmental assessment is the assessment of the environmental consequences of a plan, policy, program, or actual projects prior to the decision to move forward with the proposed action.
Emergency Plan	An **emergency plan** is a plan in writing that describes how potential incidents identified at the installation together with their consequences should be dealt with, both on site and off site.
ESD	**Emergency Shutdown System (ESD)** is designed to minimize the consequences of emergency situations, related to typically uncontrolled flooding, escape of hydrocarbons, or outbreak of fire in hydrocarbon carrying areas or areas which may otherwise be hazardous.
Explosion	An **explosion** is a release of energy that causes a pressure discontinuity or blast wave.
Flammable Limits	**Flammable limits** are a range of gas or vapour concentrations in the air that will burn or explode if a flame or other ignition source is present. The lower point of the range is called the lower flammable limit (LFL).

	Likewise, the upper point of the range is called the upper flammable limit (UFL).
Flammable Liquid	The Occupational Health and Safety Act 85 of 1993 defines a **flammable liquid** as any liquid which produces a vapour that forms an explosive mixture with air and includes any liquid with a closed cup flashpoint of less than 55°C. Flammable products have been classified according to their flashpoints and boiling points, which ultimately determine the propensity to ignite. Separation distances described in the various codes are dependent on the flammability classification. **Class Description** 0 Liquefied petroleum gas (LPG) IA Liquids that have a closed cup flashpoint of below 23°C and a boiling point below 35°C IB Liquids that have a closed cup flashpoint of below 23°C and a boiling point of 35°C or above IC Liquids that have a closed cup flashpoint of 23°C and above but below 38°C II Liquids that have a closed cup flashpoint of 38°C and above but below 60.5°C IIA Liquids that have a closed cup flashpoint of 60.5°C and above but below 93°C
Flash Fire	A **flash fire** is defined as combustion of a flammable vapour and air mixture in which the flame passes through the mixture at a rate less than sonic velocity so that negligible damaging overpressure is generated.
FMEA	**Failure mode and effects analysis** is the process of reviewing as many components, assemblies, and subsystems as possible to identify potential failure modes in a system and their causes and effects
Frequency	**Frequency** is the number of times an outcome is expected to occur in a given period of time.
GBA	**Gross Bund Area**
GO	Diesel fuel, also called **diesel (gas) oil**, heavy oil or simply diesel, is any liquid fuel specifically designed for use in a diesel engine, a type of internal combustion engine in which fuel ignition takes place without a spark as a result of compression of the inlet air and then injection of fuel.
HAZOP	A **hazard and operability study (HAZOP)** are a structured and systematic examination of a complex planned or existing process or operation in order to identify and evaluate problems that may represent risks to personnel or equipment.
HEL	The **highest** concentration of a gas or vapor (percentage by volume in air) above which a flame will not spread in the presence of an ignition source (arc, flame, or heat). Concentrations higher than UEL are “too rich” to burn. Also called upper flammable limit (UFL).
IFR	An **internal floating roof** or internal floating plate is a head cover floating with oil and liquid up or down on the oil surface. Adopting the internal floating roof cover in the liquid surface is recognized as the most ideal economic and practical method to reduce the evaporation loss of oil products.
Ignition Source	An **ignition source** is a source of temperature and energy sufficient to initiate combustion.

Individual Risk	**Individual risk** is the probability that in one year a person will become a victim of an accident if the person remains permanently and unprotected in a certain location. Often the probability of occurrence in one year is replaced by the frequency of occurrence per year.
Isopleth	See **Risk Isopleth**
Jet	A **jet** is the outflow of material emerging from an orifice with significant momentum.
Jet Fire or Flame	A **jet fire or flame** is combusting material emerging from an orifice with a significant momentum.
K&T	**Kantey & Templer** are Consulting Engineers that convert engineering concepts into reality. They provide professional, quality engineering expertise to Africa.
LEL	The **Lower Explosive Limit (LEL)** is the lowest concentration of a gas or vapour that will burn in air. The Lower Explosive Limit (LEL) varies from gas to gas, but for most flammable gases it is less than 5% by volume.
LFL	**Lower Flammable Limit** see Flammable Limits
LOC	See **Loss of Containment**
Local Government	**Local government** is defined in Section 1 of the Local Government Transition Act, 1993 (Act No. 209 of 1993).
Loss of Containment	**Loss of containment (LOC)** is the event resulting in a release of material into the atmosphere.
Major Hazard Installation	**Major Hazard Installation (MHI)** means an installation: • Where more than the prescribed quantity of any substance is or may be kept, whether permanently or temporarily; • Where any substance is produced, used, handled or stored in such a form and quantity that it has the potential to cause a major incident (the potential of which will be determined by the risk assessment).
Major Incident	A **major incident** is an occurrence of catastrophic proportions, resulting from the use of plant or machinery or from activities at a workplace. When the outcome of a risk assessment indicates that there is a possibility that the public will be involved in an incident, then the incident is catastrophic.
Material Safety Data Sheet	According to ISO-11014, a **material safety data sheet (MSDS)** is a document that contains information on the potential health effects of exposure to chemicals or other potentially dangerous substances and on safe working procedures when handling chemical products. It is an essential starting point for the development of a complete health and safety program. It contains hazard evaluations on the use, storage, handling and emergency procedures related to that material. An MSDS contains much more information about the material than the label and it is prepared by the supplier. It is intended to tell what the hazards of the product are, how to use the product safely, what to expect if the recommendations are not followed, what to do if accidents occur, how to recognize symptoms of overexposure and what to do if such incidents occur.
MEGC	**Multiple Element Gas Containers** are multimodal assemblies of cylinders, tubes, and bundles of cylinders, which are interconnected by a manifold and assembled within a framework. The MEGC includes service equipment and structural equipment necessary for the transport of gases.

MHI	See **Major Hazard Installation**
MIR	**Maximum Individual Risk** (see Individual Risk)
MSDS	See **Material Safety Data Sheet**
NBA	**Nett Bund Area**
NEMA	The **National Environmental Management Act** abbreviated **NEMA**) is the statutory framework to enforce Section 24 of the Constitution of the Republic of **South Africa**. The **NEMA** is intended to promote co-operative governance and ensure that the rights of people are upheld, but also recognising the necessity of economic development.
OHS Act	**Occupational Health and Safety Act**, 1993 (Act No. 85 of 1993)
PADHI	**PADHI** (**planning advice for developments near hazardous installations**) is the name given to a methodology and software decision support tool developed and used in the HSE. It is used to give land-use planning (LUP) advice on proposed developments near hazardous installations. PADHI uses two inputs into a decision matrix to generate either an ‘advise against’ or ‘don’t advise against’ response: • The zone in which the development is located of the three zones that HSE sets around the major hazard: o The inner zone (> $1x10^{-5}$ fatalities per person per year); o The middle zone ($1x10^{-5}$ fatalities per person per year to $1x10^{-6}$ fatalities per person per year); o The outer zone ($1x10^{-6}$ fatalities per person per year to $3x10^{-7}$ fatalities per person per year); • The ‘sensitivity level’ of the proposed development which is derived from an HSE categorisation system of ‘development types’ (see the ‘development type tables’ in Appendix B).
PHA	A **Process Hazard Analysis (PHA)** is directed toward analysing potential causes and consequences of fires, explosions, releases of toxic or flammable chemicals and major spills of hazardous chemicals, and it focuses on equipment, instrumentation, utilities, human actions, and external factors that might impact the process.
POST	The **Parliamentary Office of Science and Technology** is the Parliament of the United Kingdom's in-house source of independent, balanced and accessible analysis of public policy issues related to science and technology.
PPE	**Personal protective equipment**, commonly referred to as "PPE", is equipment worn to minimize exposure to hazards that cause serious workplace injuries and illnesses.
QRA	See **Quantitative Risk Assessment**
Quantitative Risk Assessment	A **quantitative risk assessment** is the process of hazard identification, followed by a numerical evaluation of effects of incidents, both consequences and probabilities and their combination into the overall measure of risk.
Risk	**Risk** is the measure of the consequence of a hazard and the frequency at which it is likely to occur. Risk is expressed mathematically as: **Risk = Consequence x Frequency of Occurrence**
Risk Assessment	**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 potential causes of such an incident.
Risk Contour	See **Risk Isopleth**
SANAS	The **South African National Accreditation System (SANAS)** is the only national body responsible for carrying out accreditations in respect of conformity assessment, as mandated through the Accreditation for Conformity Assessment, Calibration and Good Laboratory Practice Act (Act 19 of 2006).
SIL	Within the IEC 61508 / 61511 standards, the **Safety Integrity Level (SIL)** is a fundamental means of specifying the safety integrity requirements of a SIF. SIL Determination is an assessment of the risk reduction required from SIFs to give a sufficiently low level of risk in relation to a specific hazardous event.
Societal Risk	**Societal risk** is risk posed on a societal group who are exposed to a hazardous activity.
UFL	**Upper Flammable Limit** (see Flammable Limits)
ULP	**Regular unleaded petrol** is the most commonly used petrol at present. It is commonly labelled as RULP or ULP or 91. RON or the Research Octane Number is the octane rating of the fuel. 95 RON is a premium unleaded petrol (PULP). 98 RON is an ultra-premium unleaded petrol (PULP).
Vapour Cloud Explosion	A **vapour cloud explosion (VCE)** results from ignition of a premixed cloud of a flammable vapour, gas or spray with air, in which flames accelerate to sufficiently high velocities to produce significant overpressure.
VCE	See **Vapour Cloud Explosion**

12 APPENDIX A: MHI REGULATIONS (2022)

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DEPARTMENT OF EMPLOYMENT AND LABOUR

NO. R. 2989 **31 January 2023**

OCCUPATIONAL HEALTH AND SAFETY ACT (ACT No. 85 OF 1993), as amended

PROMULGATION OF MAJOR HAZARD INSTALLATION REGULATIONS, 2022

I, Thembelani Waltermade Nxesi, Minister of Employment and Labour, hereto, after consultation with the Advisory Council of Occupational Health and Safety, promulgates the new regulation relating to Major Hazard Installations; in terms of section 43(1)(c) of the Occupational Health and Safety Act, 1993 (Act no. 85 of 1993).

MR TW NXESI, MP
MINISTER OF EMPLOYMENT AND LABOUR
DATE: 13/11/2022

OCCUPATIONAL HEALTH AND SAFETY ACT, 1993

MAJOR HAZARD INSTALLATION REGULATIONS 20XX

The Minister of Employment and Labour intends, after consultation with the Advisory Council for Occupational Health and Safety, in terms of section 43 of the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993), to make the Regulations in the Schedule.

SCHEDULE

Definitions

1. In these Regulations, a word or expression to which a meaning has been assigned in the Act has the meaning so assigned and, unless the context otherwise indicates–

"affected or interested party" means a person, group of persons or organisations interested in or affected by an establishment and an organ of state that has jurisdiction over an establishment;

"change" means–

(a) a modification in the methods, equipment or procedures in use or the handling or processing of dangerous substances in the establishment that may increase the establishment's risk profile;

(b) an increase or decrease in the quantity of dangerous substances contemplated in Chapters 1 and 2 that results in the establishment being classified as a major hazard installation where–

   (i) a low hazard establishment becomes a medium hazard establishment or vice versa;

   (ii) a medium hazard establishment becomes a high hazard establishment or vice versa;

   (iii) a low hazard establishment becomes a high hazard establishment or vice versa; or

   (iv) an installation below the low hazard establishment threshold becomes a low, medium or high hazard establishment;

(c) when an emergency plan is brought into action for a major incident;

"dangerous substances" means substances or mixtures used or present at the workplace that could, if not properly controlled, cause harm to people, the environment and property as a result of loss of containment, fire or explosion;

"direction" means a notice, or a recommendation an instruction served by an inspector in writing;

"duty holder" means an employer, a self-employed person, a user or a pipeline operator who is in control of an establishment;

"establishment" means a major hazard installation under the control of a duty holder where Chapter 1, 2 or 3 dangerous substances are present;

"emergency plan" means a plan contemplated in regulation 15;

"existing establishment" means an establishment where dangerous substances are present in quantities listed in Chapter 1, 2 or 3;

"high hazard establishment" means–

(a) an establishment where Chapter 1 or 2 dangerous substances are present in quantities equal to or in excess of the quantities listed in column 3 of Chapter 1 or 2; and

(b) pipelines contemplated in Chapter 3;

"impact zone" means the zone where other installations or neighbours could be affected due to a major incident;

"installation" means a technical unit within an establishment, above or below ground level, in which substances are produced, used and stored and which includes all the equipment, structures, pipework, machinery, tools, railway sidings and quays, warehouses and similar structures necessary for the operation of that installation;

"low hazard establishment" means an establishment where Chapter 1 or 2 dangerous substances are present and the quantity is equal to or exceeds the quantity in column 1 but is less than quantities listed in column 2 of Chapter 1 or 2;

"licence to operate" means a licence contemplated in regulation 13;

"major incident prevention policy" means a policy contemplated in regulation 11;

"medium hazard establishment" means an establishment where Chapter 1 or 2 dangerous substances are present and the quantity is equal to or exceeds the quantity in column 2, but is less than the quantity in column 3 of Chapter 1 or 2;

"near miss" means an event (causing damage to property, a negative impact on the environment or loss of human life) or operational interruption that could plausibly have resulted if the circumstances had been slightly different;

"new establishment" means an establishment which, after the date of entry into force of these Regulations, is erected or declared to be an establishment;

"prescribed quantity", in relation to a given dangerous substance or a category or categories, means a quantity equal to the value set out in Annexure A;

"process safety management system" means a system contemplated in regulation 11(3)(h);

"responsible person" means a person designated, in writing, by a duty holder to be responsible, in a full-time capacity, for the premises on which an establishment is operated;

"risk assessment" means the process contemplated in regulation 10;

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

"transit" means a time or place in which dangerous substances are transported by rail, road, waterways or airways, which may be between planned points of departure and arrival;

"Safety Data Sheet" means a document aligned to globally harmonised systems, that provides information on the hazard classification, properties of hazardous chemicals and procedures for the handling of, or working with, hazardous chemicals in a safe manner and how hazardous chemicals affect health and safety in the workplace;

"safety report" means a report contemplated in regulation 12;

"SANS 1461" means South African National Standard: Major Hazard Installation – Risk Assessments, as amended from time to time;

"**SANS 1514**" means South African National Standard: Major Hazard Installation: Emergency Response Planning, as amended from time to time;

"UN number" means the dangerous substance four-figure identification number in the United Nations Transport of Dangerous Goods – Model Regulations, as amended from time to time;

"UN Trough Test" means Part III of the United Nations classification procedures, tests methods and criteria relating to class 2, class 3 and class 4, division 5.1, class 8 and class 9, as amended from time to time;

"United Nations Recommendations on the Transport of Dangerous Goods" means guidance documents developed by the United Nations to harmonise dangerous goods transport regulations, as amended from time to time, commonly known as the UN Orange Book.

Scope of application

2. (1) These Regulations apply to–

(a) major hazard installations;

(b) establishments with the prescribed quantity of substances listed in Chapter 1 or 2; and

(c) major pipeline establishments.

(2) These Regulations, excluding regulations 11, 12 and 13, apply to low hazard establishments.

(3) These Regulations, excluding regulations 12 and 13, apply to medium hazard establishments.

(4) Regulations 14 and 15 apply to local government.

(5) Regulations 21 and 22 apply to an approved inspection authority.

(6) These Regulations do not apply to nuclear installations registered in terms of the Nuclear Energy Act, 1993 (Act No. 131 of 1993).

Management of establishment

3. (1) In order to ensure that the provisions of the Act and these Regulations in relation to major hazard installation are complied with, the duty holder must designate a responsible person in writing and in full-time capacity in respect of every premises where an establishment is operated.

(2) Subject to subregulation (1), the chief inspector may require that any high hazard establishment be operated by a designated responsible person who holds a relevant qualification.

(3) A duty holder may appoint, in writing, one or more deputies to assist the responsible person designated in terms of subregulation (1), and must clearly define the duties of such deputies without exempting the responsible person designated in subregulation (1) to properly discharge their duties.

(4) If, in the opinion of the chief inspector, circumstances require the appointment of one or more deputies as contemplated in subregulation (3), the chief inspector may instruct the duty holder to appoint a specified number of deputies.

(5) Every duty holder must on a regular basis consult with the neighbouring establishments and counterparts within the potential impact zone–

(a) to discuss any associated major incident associated with the type of establishment;

(b) to share any changes made to the establishment that alters the risk profile; and

(c) to share alert systems in a case of emergency.

(6) The duty holder must keep a record of all consultations contemplated in subregulation (5).

Notification of establishment

4. (1) A duty holder must notify the chief inspector, the relevant chief director: provincial operations and the local government on Form A, 90 days–

(a) before the erection of an establishment; or

(b) when there is an anticipated change to an existing establishment.

(2) A duty holder, after the entry into force of these Regulations, must update the notification of an existing establishment and send it to the chief inspector, the relevant chief director: provincial operations and the local government on a prescribed form A, within 24 months.

(3) The notification referred to in subregulation (1) or (2) must be accompanied by–

(a) proof of permission or approval from the relevant local government on land use indicating the exact location of the site;

(b) a letter of designation contemplated in regulation 3(2) and the responsible person's competency profile;

(c) an inventory list and safety data sheets of all the dangerous substances that resulted in the installation being classified as an establishment;

(d) a statement containing the envisaged maximum quantity of all the substances that may be present at the establishment at any one time;

(e) the most recent risk assessment report contemplated in regulation 10;

(f) a site map showing the establishment location and indicating developments around the vicinity of the establishment;

(g) a substance location plan drawn to a scale of not less than 1 to 2 500 which identifies the area on the site where the dangerous substances will be stored, handled, used or processed, showing the location of the major items of plant used in such activities;

(h) information regarding the neighbours or other establishments within the impact zone, including–

(i) sites that are likely to be affected by a major incident and their exact distances from the establishment;

(ii) known future development that might increase the risk or consequences of a major incident; and

(iii) other establishments and their exact distances;

(i) proof of the publication of the advertisement contemplated in subregulation (4); and

(j) where applicable, the latest version of the major incident prevention policy.

(4) A duty holder who erects an establishment or updates a risk assessment or converts an existing installation into an establishment must–

(a) place an advertisement, in English and the predominant language in the area, in at least one newspaper serving the communities in the vicinity of the establishment; and

(b) post notices within those communities, containing at least the–

 (i) name and location of the establishment;

 (ii) name, title and telephone number of the contact person from whom further information can be obtained;

 (iii) nature of the dangerous substances and the major incidents that may occur; and

 (iv) time and place where a risk assessment report will be explained and may be viewed.

(5) Any affected or interested party may make representations, in writing, to the relevant local government and the chief inspector, within 60 days after the publication of an advertisement referred to in subregulation (4), if the establishment is not acceptable and poses a risk to that party.

Registration of establishment

5. (1) After considering the notification referred to in regulation 4(1) or (2), the chief inspector may on payment of the appropriate registration fee specified in Annexure B–

(a) register the premises as a major hazard installation subject to such conditions as the chief inspector deems fit to impose;

(b) enter into the register, particulars pertaining to the name of the major hazard installation, the premises address and other details as the chief inspector deems fit; and

(c) issue to the duty holder a certificate of registration within 60 days; or

(d) refuse to register the major hazard installation.

(2) Where the chief inspector refuses to register the major hazard installation in respect of which a notification has been made, the chief inspector must notify the duty holder of the reasons for the refusal.

(3) The duty holder must conspicuously display the latest registration certificate received in terms of subregulation (1)(c).

Duration of registration and renewal

6. (1) Subject to regulation 5(1), the registration is valid for a period of five years or for such other period as the chief inspector may determine in a particular case, unless the registration is earlier suspended or revoked in accordance with the Regulations.

(2) The chief inspector shall renew the registration upon the updating of a risk assessment and documents as may be required and on payment of the appropriate renewal fee specified.

Alteration to particulars of registered establishment

7. The duty holder must, where there is an alteration in any of the particulars of a major hazard installation, furnish the alterations to the chief inspector, relevant chief director: provincial operations and relevant local government not later than 14 days after such alteration occurs.

Revocation or suspension of registration

8. (1) The inspector may issue a direction instructing the duty holder immediately to comply with the requirements specified in the direction, if the premises of the registered major hazard installation become unfit for occupation or use because of a–

(a) failure by the duty holder to ensure that work is carried out safely; or

(b) change effected on the establishment without notifying the chief inspector, the chief director: provincial operations and the local government; or

(c) new hazardous fact or circumstance that was not present when the establishment was registered.

(2) The chief inspector may revoke the registration if–

(a) the duty holder fails to comply with the issued direction;

(b) the chief inspector has established that the duty holder has contravened a condition of registration; or

(c) the inspector has proven that the duty holder has ceased occupation or use of the premises as an establishment.

(3) An inspector must, before advising the chief inspector to revoke or suspend the registration of an establishment as contemplated in subregulations (2) and (3)–

(a) issue to the duty holder a direction, in writing, of the intention to revoke or suspend the registration; and

(b) give the duty holder a reasonable opportunity to submit reasons as to why the registration should not be revoked or suspended.

(4) The revocation or suspension of registration does not take effect–

(a) until the expiration of 21 days after the date on which direction of the chief inspector's intention to revoke or suspend the registration was given to the duty holder as contemplated in subregulation (4)(a); or

(b) where an appeal against the decision of the chief inspector is made to the Labour Court in terms of section 35 of the Act, until the appeal has been determined or withdrawn.

(5) An inspector may advise the chief inspector at any time, and for a valid reason, to shorten the period for which the registration is suspended.

Sharing of information with adjacent establishments

9. The chief inspector may designate one or more registered major hazard installations in a certain location as a group of establishments, and require such establishments to share information, including the–

(a) basic particulars of the establishment;

(b) responsible person for that establishment;

(c) description of major incidents associated with that type of establishment, and consequences of such incidents; and

(d) information on how affected neighbours will be alerted in the event of a major incident.

Risk assessment

10. (1) A duty holder must, after consultation with the relevant health and safety representative or health and safety committee, ensure that an approved inspection authority carries out a risk assessment in accordance with SANS 1461 at intervals not exceeding five years or when there is a change in the establishment.

(2) Every duty holder must–

(a) inform the relevant health and safety representative or health and safety committee, in writing, of the arrangements made to carry out a risk assessment contemplated in subregulation (1); and

(b) ensure that the results of the risk assessment are made available to the relevant health and safety representative or committee, who may comment thereon.

(3) Where a risk assessment has been reviewed or revised, without a change to the establishment, the duty holder must submit an updated copy of the risk assessment report to the chief inspector, the relevant chief director: provincial operations and the relevant local government within 60 days.

(4) Every duty holder must ensure that a copy of the most recent risk assessment report is available on site for inspection by an inspector or a local government.

(5) Subregulation (1) 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 a local government or both that inspector and that local government, as the case may be; and

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

(6) A duty holder shall ensure that the risk assessments contemplated in subregulations (1) and (3) be made available for scrutiny by any affected or interested person that may be affected by the activities of the establishment, at a time and place and in a manner agreed upon between the parties.

Major incident prevention policy

11. (1) The duty holder must prepare and retain a written major incident prevention policy, as contemplated in Annexure C, on the–

(a) construction and building of the establishment;

(b) change in the establishment; or

(c) safe operation of the establishment.

(2) Every duty holder must, within 36 months after the entry into force of these Regulations, establish and have in record a major incident prevention policy.

(3) The major incident prevention policy must provide for a high level of protection for employees and the public and must include at least–

(a) the aims and objectives of the policy;
(b) the roles and responsibilities of the establishment's management;
(c) process safety performance indicators;
(d) commitments towards the maintenance and continual improvement of the policy;
(e) the aims and objectives of the–
  (i) emergency plan;
  (ii) evacuation plan regarding the–
    (aa) speedy evacuation of persons;
    (bb) roll-call after evacuation; and
    (cc) plant shut down;
(f) reasons for revision;
(g) mandatory agreements; and
(h) the process safety management system with principles specified in Annexure D.

(4) A duty holder must review the major incident prevention policy, every five years or when there is a change in the establishment which renders the existing policy inadequate: Provided that an updated copy is available for inspection by an inspector and a local government.

Safety report

12. (1) The duty holder of a high hazard establishment must prepare a comprehensive, site-specific, safety report, which must be–
(a) developed during the design phase and be continually updated until the start date of operations; and
(b) maintained for the duration of the life of the establishment.

(2) The safety report must demonstrate a suitable and sufficiently documented plan to ensure–
(a) that reliable built-in safety has been incorporated into the–
  (i) design;
  (ii) construction;
  (iii) operation; and
  (iv) maintenance of any equipment and infrastructure used in the establishment; and

(b) the application of–

(i) the major incident prevention policy;

(ii) the process safety management system;

(iii) the organisational and necessary measures to prevent major incidents and to limit their consequences;

(iv) the on-site emergency plan.

(3) The safety report must also contain information regarding an off-site emergency plan to take the necessary measures in the event of a major incident.

(4) The duty holder of a proposed high hazard establishment must submit to the chief inspector a–

(a) preliminary safety report at the design stage of that establishment; and

(b) final safety report within a reasonable time before the establishment starts operations.

(5) The duty holder must send a safety report to the chief inspector within 36 months after the entry into force of these Regulations.

(6) Every duty holder must review the safety report–

(a) every five years;

(b) prior to any change to the establishment; or

(c) whenever there is a change in the process safety management system which could have significant repercussions with respect to the prevention of major incidents or the limitation of the consequences of major incidents:

Provided that the updated copy of the safety report, revised under this subregulation, is sent to the chief inspector within 60 days.

Licence to operate

13. (1) A duty holder who operates a high hazard establishment must apply for a licence to operate such an establishment.

(2) An existing duty holder must apply for a licence not later than 36 months after the entry into force of these Regulations.

(3) The chief inspector, upon receipt of an application in terms of subregulations (1) and (2), with a written proof of occupancy from the local government, may–

(a) issue a licence;

(b) decide not to issue a licence and give reasons for the decision; or

(c) issue a licence subject to any condition that the chief inspector deems reasonable and necessary.

(4) A licence issued under subregulation (3)–

(a) may not be transferred to another establishment; and

(b) lapses after 12 months if the new installation has not started operations or the establishment has not been operated within 12 months after the issue of the licence.

(5) The chief inspector may–

(a) suspend or withdraw a licence if the conditions subject to which the licence was issued are not complied with; or

(b) alter a condition in an existing licence after consultation with the duty holder and the relevant health and safety representative or the relevant health and safety committee.

General duties of local government

14. (1) Without derogating from the provisions of the National Building Regulations and Building Standards Act, 1977 (Act No. 103 of 1977), and the Spatial Planning and Land Use Management Act, 2013 (Act No. 16 of 2013), a local government must not permit the erection of a new establishment or the expansion of an establishment at a separation distance that poses an unacceptable risk in terms of the risk assessment contemplated in regulation 10.

(2) The local government must–

(a) permit a new development only where there is a separation distance which will not pose an unacceptable risk in terms of the risk assessment contemplated in regulation 10; and

(b) prohibit any new property development adjacent to an establishment that will result in that new development being declared an establishment.

(3) The relevant local government must give consent for the on-site emergency plan and participate in the annual emergency test drill as contemplated in regulation 15(4)(e).

(4) Where a relevant local government does not have the facilities available to control a major incident or to comply with the requirements of these Regulations, that local government must make prior arrangements with a neighbouring local government, the relevant provincial government or the duty holder for assistance.

(5) The relevant local government is responsible for the off-site emergency plan to be followed outside the premises of the establishment.

(6) The relevant local government must prepare an off-site emergency plan in accordance with SANS 1514 and in consultation with the duty holder and interested or affected persons, within 24 months after the entry into force of these Regulations, and thereafter immediately for new establishments, and review the plan when there are significant changes to the hazard profile of the area.

(7) The duty holder must, on written request by, and within the time limits imposed by the local government, furnish the local government with the necessary information needed to prepare the off-site emergency plan.

Emergency plan

15. (1) A duty holder must, immediately after submission of the notification contemplated in regulation 4, in consultation with the relevant health and safety representatives or health and safety committee, in writing, appoint an emergency coordinating team consisting of at least–

(a) the responsible person contemplated in regulation 3(2); or

(b) a responsible person's deputy contemplated in regulation 3(3); and

(c) a representative from the health and safety committee.

(2) The duty holder must develop and maintain an on-site emergency plan before the establishment commences operations in consultation with the emergency coordinating team and in accordance with SANS 1514.

(3) The on-site emergency plan for an existing establishment must be aligned and updated to SANS 1514 within 12 months after the entry into force of these Regulations.

(4) A duty holder must–

(a) ensure that the manner in which employees, visitors and neighbours will be warned of major incidents is included in the plan;

(b) sign a copy of the on-site emergency plan in the presence of at least two witnesses who have knowledge in emergency planning and who must be satisfied with the content of the emergency plan and attest to the signature of the duty holder;

(c) obtain approval of the on-site emergency plan from the relevant local government;

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

(e) cause the on-site emergency plan to be tested or exercised in practice at least once a year and take the necessary steps to arrange for the local government to participate in such tests; and

(f) give an early warning to affected or interested parties in case a major incident is likely to go beyond the borders of the establishment.

(5) The duty holder and the relevant local government must take reasonable steps to activate the on-site emergency plan in case of an incident which may result in–

(a) a major incident; or

(b) an uncontrolled event which may reasonably be expected to lead to a major incident; or

(c) a near miss that could reasonably be expected to have resulted in a major incident.

(6) The duty holder must review the on-site emergency plan at least once every three years and, if necessary, revise the plan.

(7) The duty holder and the local government must jointly ensure that all first responders at the scene of a major incident have the necessary skill to deal with the dangerous substances and are dressed in the appropriate emergency personal protective equipment as required in their respective emergency plans.

Reporting of risk and emergency occurrences

16. (1) A duty holder must–

(a) subject to regulation 8 of the General Administrative Regulations, published under Government Notice R. 929 in *Government Gazette* 25129 of 25 June 2003, within 48 hours, inform the chief inspector by means of telephone, facsimile or similar means of communication of–

(i) a major incident; or

(ii) an incident that brought the emergency plan into activation;

(b) investigate and submit a written preliminary incident report to the chief inspector within seven days after an emergency occurrence and a major incident;

(c) submit a final report as soon as reasonably practicable but not later than six months after the incident;

(d) investigate and record all near misses in a register which must at all times be available for inspection by an inspector and the local government.

(2) A duty holder must, in the case of an emerging major incident or an emergency occurrence that was or may have been caused by a dangerous substance, inform the supplier of that dangerous substance about the incident.

Information and training

17. (1) A duty holder must, after consultation with the relevant health and safety representative or health and safety committee, ensure that all employees are adequately trained with regard to–

(a) the scope of these Regulations;

(b) the nature of the establishment;

(c) potential major hazards and associated major incidents;

(d) potential risks to health and safety caused by the identified major hazards;

(e) the practices and control procedures for a major incident;

(f) the content of the emergency plan and that visitors also are conversant with such content; and

(g) the safety protocols and measures to be followed on-site.

(2) The duty holder must ensure that all trained employees undergo refresher training whenever there is a change in the establishment or when the risk assessment has been reviewed.

(3) The duty holder must provide induction orientation about the kept substances, major hazard areas and actions to be follow in case of emergency to all mandatories, visitors and any person who, in any manner, assists in carrying out or conducting allocated duties, before they enter the establishment.

(4) The duty holder must ensure the induction orientation as contemplated in subregulation (3) is refreshed in the event of any change to an establishment which significantly alters the risk associated with the establishment: Provided that the induction training will be valid for periods not exceeding 12 months.

General duties of suppliers

18. (1) Every person that supplies a dangerous substance to an establishment must issue a safety data sheet that is supplied with the substance and must also provide basic information for training on the use and handling of the substance.

(2) On receipt of information contemplated in regulation 16(2), a supplier of a dangerous substance involved in an emerging major incident or potential major incident must inform all clients supplied with that substance of the emerging potential dangers surrounding the dangerous substance.

(3) A supplier must, in the event of a major incident with regard to the dangerous substance supplied, provide information and advice that must be readily available on a 24-hour basis to all duty holders, the relevant local government and any other body concerned.

Payable fees

19. (1) A duty holder must pay a prescribed fee each time a notification, a renewal or a revision of a risk assessment is sent to the chief inspector: Provided that the chief inspector may grant an exemption from payment of such fees or may determine any other fee, if necessary.

(2) The chief inspector may waive but not refund the whole or any part of any fee paid or payable under these Regulations.

MHI Advisory Committee

20. (1) The chief inspector may, with the approval of the Advisory Council for Occupational Health and Safety, establish an MHI Advisory Committee to advise on any matter related to major hazard installations, codes, standards and training requirements: Provided that any accredited or approved training must be in accordance with South African Qualifications Authority standards.

(2) The chief inspector shall appoint members of the MHI Advisory Committee for a period that he may determine at the time of appointment: Provided that the members are approved by the Advisory Council for Occupational Health and Safety.

(3) Any person affected by the decision of the MHI Advisory Committee may appeal to the chief inspector within 60 days of such decision becoming known and the chief inspector shall, after considering the grounds of the appeal and the MHI Advisory Committee's reasons for the decision, confirm or set aside or vary the decision or substitute such decision for any other decision which the MHI Advisory Committee in the chief inspector's opinion ought to have taken.

(4) Any person aggrieved by the decision taken by the chief inspector under subregulation (3) may, within 60 days after the chief inspector's decision, appeal against such decision to the Labour Court.

Approved inspection authorities

21. (1) An inspection body accredited in terms of the Accreditation for Conformity Assessment, Calibration and Good Laboratory Practice Act, 2006 (Act No. 19 of 2006), or a foreign inspection body must apply for registration to the chief inspector on Form B.

(2) On receipt of the application contemplated in subregulation (1) the chief inspector must, subject to conditions if deemed necessary, approve the application.

(3) In the event of a dispute between an approved inspection authority (AIA) and a duty holder regarding a technical or safety matter, which cannot be reasonably resolved, the disputing parties may refer the case to the chief inspector in writing for arbitration, setting out the full details of the dispute.

(4) The chief inspector must, upon receiving a dispute contemplated in subregulation (3), appoint an arbitrator mutually agreed upon between the South African National Accreditation System and the parties.

(5) The dispute must be investigated and arbitrated within a maximum of 90 days after the submission of a request for arbitration.

(6) The chief inspector may at any time withdraw any approval granted to an approved inspection authority, subject to section 35 of the Act.

Duties of approved inspection authority

22. (1) An approved inspection authority must ensure that the risk assessment contemplated in regulation 10 is carried out in terms of SANS 1461.

(2) An approved inspection authority must provide results on the classification and acceptability of risk, and make recommendations with regard to the following:

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

(b) any organisational measures that may be required;

(c) risk reduction proposals; and

(d) any other relevant matter.

(3) The approved inspection authority must, after each risk assessment, furnish the duty holder with the latest risk assessment report and attachments as required in terms of SANS 1461: Provided that such reports must be made available upon request by the chief inspector.

(4) An approved inspection authority must, on a monthly basis, submit a list of all major hazard installations assessed, to the chief inspector, in the form contemplated in Annexure E.

Closure

23. A duty holder must notify the chief inspector, the relevant chief director: provincial operations and the local government in writing, not less than 60 days prior to the installation ceasing to be a major hazard installation.

Offences and penalties

24. (1) A duty holder who contravenes any of the provisions of these Regulations commits an offence and is, on conviction, liable to a fine not exceeding R5 000 000 or to imprisonment for a period not exceeding 24 months.

(2) The maximum permissible fines that may be imposed for contravening the Regulations are set out in the table below:

PREVIOUS CONTRAVENTIONS	**CONTRAVENTIONS OF REGULATIONS:** **3(1), 4(1), 4(4), 6(3), 7, 10, 11(1), 12(1), 13(1), 15(2), 16, 20(6) and 22**
No previous contraventions	R500 000
A previous contravention within 12 months	R1 000 000
A previous contravention in respect of the same contravention within three years	R2 500 000
Three previous contraventions in respect of the same provision within three years	R5 000 000

Repeal of regulations

25. The Major Hazard Installation Regulations, 2001, published in Government Notice No. R. 692 of 30 July 2001, are hereby repealed.

Short title and commencement

26. These Regulations are called the "Major Hazard Installation Regulations, 2022", and come into operation on a date determined by the Minister by notice in the *Government Gazette*.

ANNEXURE A

Dangerous substances to which these Regulations apply

This Annexure applies to the presence of dangerous substances at any establishment and determines the application of the relevant regulations in accordance with regulation 2(1). The quantities set relate to each establishment.

Chapter 1
Named Dangerous Substances

Where a substance or group of substances listed in this Annexure also falls within Chapter 2 substances, the qualifying quantities set out in Chapter 1 must be used.

Named substances	UN NUMBER	Quantities in tonnes		
		Column 1 Low Hazard	Column 2 Medium Hazard	Column 3 High Hazard
Ammonia anhydrous	1005	15	50	200
Ammonium nitrate (as described in Note 3)	1438 Fertiliser based 2067 2071	2 000	5 000	10 000
Ammonium nitrate (as described in Note 4)		500	1 250	5 000
Ammonium nitrate (as described in Note 5)		150	350	2 500
Ammonium nitrate (as described in Note 6)		4	10	50
Potassium nitrate (as described in Note 7)	1486	2 000	5 000	10 000
Potassium nitrate (as described in Note 8)	1488	500	1 250	5 000

Named substances	UN NUMBER	Quantities in tonnes		
		Column 1 Low Hazard	Column 2 Medium Hazard	Column 3 High Hazard
Arsenic pentoxide, arsenic (V) acid and/or salts	1559	1	1	2
Arsenic trioxide, arsenious (III) acid and/or salts	1561	0,1	0,1	0,1
Bromine	(l) 1701 (a)1744	5	20	100
Chlorine	1017	5	10	25
Nickel compounds in inhalable powder form (nickel monoxide, nickel dioxide, nickel sulphide, tri-nickel disulphide, di-nickel trioxide)	3089	1	1	1
Ethyleneimine	1185	5	10	20
Fluorine	1045	5	10	20
Formaldehyde (concentration ≥ 90%)	1198	2,5	5	50
Hydrogen	1049	2,5	5	50
Hydrogen chloride (liquefied gas)	1050	5	25	250
Hydrogen fluoride	1052	2,5	5	20
Lead alkyls	-	2,5	5	50
Liquefied extremely flammable gases (including LPG) and natural gas (whether liquefied or not)	1075	20	50	200
Acetylene	1001	2,5	5	50
Ethylene oxide	3089	2,5	5	50

Named substances	UN NUMBER	Quantities in tonnes		
		Column 1 Low Hazard	Column 2 Medium Hazard	Column 3 High Hazard
Propylene oxide	1280	2,5	5	50
Methanol	1230	50	500	5 000
4,4-Methylenebis (2-chloraniline) and/or salts, in powder form	3077	0,01	0,01	0,01
Methyl isocyanate	2480	0,15	0,15	0,15
Oxygen	(compressed) 1072 (refrigerated) 1073	50	200	2 000
Toluene di-isocyanate	2078	1	10	100
Carbonyl dichloride (phosgene)	1076	0,3	0,3	0,75
Arsenic trihydride (arsine)	2188	0,2	0,2	1
Phosphorus trihydride (phosphine)	2199	0,2	0,2	1
Sulphur dichloride	1828	1	1	1
Sulphur dioxide	1079	2,5	5	20
Sulphur trioxide	1829	7,5	15	75
Polychlorodibenzofurans and polychlorodibenzodioxins (including TCDD), calculated in TCDD equivalent (see Note 8)	-	0,001	0,001	0,001
The following CARCINOGENS at concentrations above 5% by weight:	-	0,5	0,5	2

Named substances	UN NUMBER	Quantities in tonnes		
		Column 1 Low Hazard	Column 2 Medium Hazard	Column 3 High Hazard
4-Aminobiphenyl and/or its salts, Benzotrichloride, Benzidine and/or salts, Bis (chloromethyl) ether, Chloromethyl methyl ether, 1,2-Dibromoethane, Diethyl sulphate, Dimethyl sulphate, Dimethylcarbamoyl chloride, 1,2-Dibromo-3-chloropropane, 1,2-Dimethylhydrazine, Dimethylnitrosamine, Hexamethylphosphoric triamide, Hydrazine, 2-Naphthylamine and/or salts, 4-Nitrodiphenyl and 1,3-Propanesultone				
Petroleum products: gasolines, naphthas, kerosenes (including jet fuels), gas oils (including diesel fuels, home heating oils and gas oil blending streams)	Gas (1075) Crude (1275)	250	2 500	25 000
Boron trifluoride	1008	5	5	20
Hydrogen sulphide	1053	5	5	20
Piperidine	2401	20	50	200

Named substances	UN NUMBER	Quantities in tonnes		
		Column 1 Low Hazard	Column 2 Medium Hazard	Column 3 High Hazard
Bis(2-dimethylaminoethyl) (methyl)amine	-	20	50	200
3-(2-Ethylhexyloxy) propylamine	-	20	50	200
Propylamine	1277	200	500	2 000
Tert-butyl acrylate	-	100	200	500
2-Methyl-3-butenenitrile	-	200	500	2 000
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	1277	50	100	200
Methyl acrylate	1919	200	500	2 000
3-Methylpyridine	2313	200	500	2 000
1-Bromo-3-chloropropane	2688	200	500	2 000

Chapter 2
Categories of Dangerous Substances

This Chapter covers all dangerous substances falling under the hazard categories in column 1 in accordance with the GHS as reflected in the CLP Regulations:

Hazard categories	**Column 1 Low Hazard**	**Column 2 Medium Hazard**	**Column 3 High Hazard**
1. Health Hazards: "H"			
1.1 H1 Acute Toxic Category 1, all exposure routes	5	5	20
1.2 H2 Acute Toxic Category 2, all exposure routes Category 3, inhalation exposure route (see Note 9)	15	50	200
1.3 H3 Specific Target Organ Toxicity (STOT) Category 1, Single Exposure (SE STOT)	15	50	200
2. Physical Hazards: "P"			
2.1 P2 Flammable gases Flammable gases, Category 1 or 2	2,5	10	50
2.2 P3a Flammable aerosols (see Note 10) Flammable aerosols Category 1 or 2, containing flammable gases Category 1 or 2 or flammable liquids Category 1	50 (net)	150 (net)	500 (net)
2.3 P3b Flammable aerosols (see Note 11)	1 250 (net)	5 000 (net)	50 000 (net)

Hazard categories	**Column 1 Low Hazard**	**Column 2 Medium Hazard**	**Column 3 High Hazard**
Flammable aerosols Category 1 or 2, not containing flammable gases Category 1 or 2 nor flammable liquids category 1 (see Note 12)			
2.4 P4 Oxidising gases Oxidising gases, Category 1	20	50	200
P5a Flammable liquids Flammable liquids, Category 1 maintained at a temperature above their boiling point, or Flammable liquids Category 2 or 3 maintained at a temperature above their boiling point, or Other liquids with a flash point ≤ 60°C, maintained at a temperature above their boiling point (see Note 12)	5	10	50
2.6 P5b Flammable liquids Flammable liquids Category 2 or 3 where particular processing conditions, such as high pressure or high temperature, may create major accident hazards, or Other liquids with a flash point ≤ 60°C where particular processing conditions, such as high pressure or high temperature, may create major accident hazards (see Note 13)	20	50	200
2.6 P5c Flammable liquids Flammable liquids, Categories 2 or 3 not covered by P5a and P5b	1 250	5 000	50 000

Hazard categories	Column 1 Low Hazard	Column 2 Medium Hazard	Column 3 High Hazard
2.7 P6a Self-reactive substances and mixtures and organic peroxides Self-reactive substances and mixtures, Type A or B or organic peroxides, Type A or B	5	10	50
2.8 P6b Self-reactive substances and mixtures and organic peroxides Self-reactive substances and mixtures, Type C, D, E or F or organic peroxides, Type C, D, E or F	20	50	200
2.9 P7 Pyrophoric liquids and solids Pyrophoric liquids, Category 1 Pyrophoric solids, Category 1	20	50	200
2.10 P8 Oxidising liquids and solids Oxidising liquids, Category 1, 2 or 3, or Oxidising solids, Category 1, 2 or 3	20	50	200
3. Other Hazards: "O"			
3.1 O1 Substances or mixtures that react violently with water. Examples: acetyl chloride, alkali metals and titanium tetrachloride	40	100	500
3.2 O2 Substances and mixtures which in contact with water emit flammable gases, Category 1	40	100	500
3.3 O3 Substances or mixtures that liberate toxic gas when in contact with water.	20	50	200

Hazard categories	**Column 1 Low Hazard**	**Column 2 Medium Hazard**	**Column 3 High Hazard**
Examples: aluminium phosphide and phosphorus pentasulphide			

Net: indicates the flammable content and not the full gross mass, thus the mass of the containers is ignored.

Chapter 3
Classification of pipelines as major hazard establishment

A pipeline is considered an establishment if it contains any of the following:

(1) A fluid which–
- (a) is flammable in air;
- (b) has a boiling point below 5°C at 1 bar absolute; and
- (c) is or is to be conveyed in a pipeline as a liquid.

(2) A fluid which is or is to be conveyed in a pipeline as a gas which is–
- (a) at pressures at above 8 bar absolute*;
- (b) flammable in air**.

(3) Pressurised substances:
- (a) Mixtures of gas and liquid which have a vapour pressure in excess of 0,5 bar above atmospheric pressure when in equilibrium with its vapour included;
- (b) A liquid which has a vapour pressure greater than 1,5 bar absolute when in equilibrium with its vapour at either the actual temperature of the liquid or at 20°C.

(4) A very toxic fluid which–
- (a) at 20°C has a saturated vapour pressure greater than 0,001 bar; or
- (b) is or is to be conveyed in the pipeline as a liquid at a pressure greater than 4,5 bar absolute.

(5) A very toxic or toxic fluid which–
- (a) is a gas at 20°C and 1 bar absolute; and

(b) is or is to be conveyed as a liquid or a gas, i.e. ammonia.

(6) A toxic fluid which–

(a) at 20°C has a saturated vapour pressure greater than 0,4 bar; and

(b) is or is to be conveyed in the pipeline as a liquid.

(7) An oxidising fluid which is or is to be conveyed as a liquid.

(8) A fluid which reacts violently with water.

(9) Acrylonitrile.

(10) Carbon dioxide.

(11) Gasoline. (Note14)

* Paragraph 2(a) also covers liquefied gases which are flammable in air when they are conveyed as a liquid. This includes butane and propane when conveyed in a pipeline as a liquid.

**Paragraph 2(b) is applicable to flammable gases conveyed as a gas. In such cases the additional duties only apply when the flammable gas is conveyed at a pressure in excess of 8 bars absolute. This covers such fluids as methane, butane and propane when conveyed as a gas.

NOTES

(1) The quantities set in Chapters 1 and 2 relate to each establishment.

(2) Mixtures and preparations must be treated in the same way as pure substances, provided they remain within the concentration limits set according to their properties under the CLP Regulations (EC 1272\2008, as amended), unless a percentage composition or other description is specifically given.

(3) Ammonium nitrate: fertilisers capable of *self-sustaining decomposition.*

This applies to ammonium nitrate-based compound/composite fertilisers (compound or composite fertilisers containing ammonium nitrate with phosphate and/or potash) which are capable of self-sustaining decomposition according to UN Trough Test (Part III, subsection 38.2) and in which the nitrogen content as a result of ammonium nitrate is–

(a) between 15,75% and 24,5% by weight and either with not more than 0,4% total combustible or organic materials or which satisfies the requirements of United Nations Recommendations on the Transport of Dangerous Goods: Manual of Tests and Criteria (3rd revised Edition, or as amended from time to time), Ammonium Nitrate Materials (High Nitrogen Content) Safety Regulations 2003,as amended, "the detonation resistance test"; or

(b) 15,75% or less by weight and unrestricted combustible materials.

(4) Ammonium nitrate: *fertiliser grade*.

This applies to straight ammonium nitrate-based fertilisers and to ammonium nitrate-based compound/composite fertilisers which satisfies the requirements of UN TDG and in which the nitrogen content as a result of ammonium nitrate is–

(a) more than 24,5% by weight, except for mixtures of ammonium nitrate with dolomite, limestone and/or calcium carbonate with a purity of at least 90%;

(b) more than 15,75% by weight for mixtures of ammonium nitrate and ammonium sulphate;

(c) more than 28% by weight for mixtures of ammonium nitrate with dolomite, limestone and/or calcium carbonate with a purity of at least 90%, and which satisfy the detonation resistance test.

(5) Ammonium nitrate: *technical grade.*

This applies to–

(a) ammonium nitrate and preparations of ammonium nitrate in which the nitrogen content as a result of the ammonium nitrate is–

(i) between 24,5% and 28% by weight, and which contain not more than 0,4% combustible substances; or

(ii) more than 28% by weight, and which contain not more than 0,2% combustible substances;

(b) aqueous ammonium nitrate solutions in which the concentration of ammonium nitrate is more than 80% by weight.

(6) Ammonium nitrate (10/50): "*off-specs" material not satisfying the detonation test.*

This applies to–

(a) material rejected during the manufacturing process and to ammonium nitrate and preparations of ammonium nitrate, straight ammonium nitrate-based fertilisers and ammonium nitrate-based compound/composite fertilisers referred to in Notes 2 and 3, that are being or have been returned from the final user to a manufacturer, temporary storage or reprocessing plant for reworking, recycling or treatment for safe use, because they no longer comply with the specifications of Notes 4 and 5; or

(b) fertilisers which do not fall within Notes 3(a) and 5 because they do not satisfy the detonation resistance test, other than fertilisers which–

(i) at the time of delivery to a final user satisfied the detonation resistance test; but

(ii) later became degraded or contaminated; and

(iii) are temporarily present at the establishment of the final user prior to their return for reworking, recycling or treatment for safe use or to their being applied as fertiliser.

*15,75% nitrogen content by weight as a result of ammonium nitrate corresponds to 45% ammonium nitrate.

**24,5% nitrogen content by weight as a result of ammonium nitrate corresponds to 70% ammonium nitrate.

***28% nitrogen content by weight as a result of ammonium nitrate corresponds to 80% ammonium nitrate.

(7) Potassium nitrate:

(a) Potassium nitrate (5 000/10 000): composite potassium nitrate-based fertilisers composed of potassium nitrate in prilled/granular form.

(b) Potassium nitrate (1 250/5 000): composite potassium nitrate-based fertilisers composed of potassium nitrate in crystalline form.

(8) Polychlorodibenzofurans and polychlorodibenzodioxins. The quantities of polychlorodibenzofurans and polychlorodibenzodioxins are calculated using the following factors:

TABLE 8.1 ITEF

International Toxic Equivalent Factors (ITEF) for the congeners of concern (NATO/CCMS)*			
2, 3, 7, 8-TCDD	1	2, 3, 7, 8-TCDF	0,1
1, 2, 3, 7, 8-PeCDD	0,5	2, 3, 4, 7, 8-PeCDF	0,5
		1, 2, 3, 7, 8-PeCDF	0,05
1, 2, 3, 4, 7, 8-HxCDD	0,1		
1, 2, 3, 6, 7, 8-HxCDD	0,1	1, 2, 3, 4, 7, 8-HxCDF	0,1
1, 2, 3, 7, 8, 9-HxCDD	0,1	1, 2, 3, 7, 8, 9-HxCDF	0,1
		1, 2, 3, 6, 7, 8-HxCDF	0,1
1, 2, 3, 4, 6, 7, 8-HpCDD	0,01	2, 3, 4, 6, 7, 8-HxCDF	0,1
		1, 2, 3, 4, 6, 7, 8-HpCDF	0,01
OCDD	0,001	1, 2, 3, 4, 7, 8, 9-HpCDF	0,01
		OCDF	0,001

* (T = tetra, Pe = penta, Hx = hexa, Hp = hepta, O = octa)

(9) In a case where dangerous substances fall within category P5a flammable liquids or P5b flammable liquids, then for the purposes of these Regulations the lowest qualifying quantities apply.

(10) Dangerous substances that fall within the Acute Toxic Category 3 via the oral route (H 301) fall under entry H2 Acute Toxic in those cases where neither acute inhalation toxicity classification nor acute dermal toxicity classification can be derived, for example, due to lack of conclusive inhalation and dermal toxicity data.

(11) Flammable aerosols classified in accordance with the Classification and Labelling of Chemicals (GHS) classification criteria for substances and mixtures, physical hazards, and flammable gases and aerosols.

(12) In order to use paragraph (11), the aerosol dispensers must not contain flammable gas Category 1 or 2 nor flammable liquid Category 1.

(13) In accordance with CLP Regulation, the liquids with a flash point of more than 35°C need not be classified in Category 3 if negative results have been obtained in the sustained combustibility test L.2, Part III, section 32 of the UN

Manual of Tests Criteria. This is, however, not valid under elevated conditions such as high temperature or pressure and therefore such liquids are included in this categories.

(14) "Gasoline" means any petroleum derivative, other than liquefied petroleum gas, with a flash point between -51°C and -40°C and which is suitable for use in motor vehicles.

(15) The following examples are for illustrative purposes only and each situation should be considered carefully. In case of any doubt, the individual situation should be discussed with the approved inspection authority.

(16) The substances present at an establishment only in quantities equal to or less than 2% of the relevant qualifying quantity must be ignored for the purposes of calculating the total quantity present if their location within an establishment is such that it cannot act as an initiator of a major incident elsewhere on site.

(16.1) **Application of the aggregation of substances**

Example 1

A site with 4 tonnes of hydrogen (medium hazard threshold 5 tonnes) and 1 500 tonnes of flammable liquids meeting Category 6 of Chapter 3 of Annexure A (medium hazard threshold 5 000 tonnes).

The aggregation rule gives: (4/5) + (1 500/5 000) = 0,8 + 0,3 = 1,1

As this result is greater than 1, medium hazard category applies.

Example 2

A site with 150 tonnes of toxic substances meeting Category 2 of Chapter 2 of Annexure A (high hazard threshold 200 tonnes) and 1 tonne of arsenic pentoxide (high hazard threshold 2 tonnes).

The aggregation rule gives: (150/200) + (1/2) = 0,75 + 0,5 = 1,25

As this result is greater than 1, high hazard category applies.

(17) In the case of an establishment where no individual substance or preparation is present in a quantity above or equal to the relevant qualifying quantities, the following rules must be applied to determine if the establishment is covered by the relevant requirements of these Regulations:

(17.1) **Application of the aggregation of categories**

1. *High Hazard Category:*

If the sum - $q_1/Q_{U1} + q_2/Q_{U2} + q_3/Q_{U3} + q_4/Q_{U4} + q_5/Q_{U5} + \ldots$ *is greater than or equal to 1, where–*

(a) qx = the quantity of dangerous substance x (or category of dangerous substances) falling within Chapter 1 or 2; and

(b) QUX = the relevant qualifying quantity for substance or category x from column 5 of Chapter 1 or 2, then these Regulations shall apply.

2. *Medium Hazard Category:*

If the sum - q1/QM1 + q2/QM2 + q3/QM3 + q4/QM4 + q5/QM5 + … is greater than or equal to 1, where–

(a) qx = the quantity of dangerous substance x (or category of dangerous substances) falling within Chapter 1 or 2; and

(b) QMX = the relevant qualifying quantity for substance or category x from column 4 of Chapter 1 or 2, then these Regulations shall apply.

3. *Low Hazard Category:*

If the sum - q1/QL1 + q2/QL2 + q3/QL3 + q4/QL4 + q5/QL5 + … is greater than or equal to 1, where–

(c) qx = the quantity of dangerous substance x (or category of dangerous substances) falling within Chapter 1 or 2; and

(d) QLX = the relevant qualifying quantity for substance or category x from column 3 of Chapter 1 or 2, then these Regulations shall apply.

(18) These rules must be used to assess the overall hazards associated with toxicity, flammability and eco-toxicity. They must therefore be applied three times–

(a) for the addition of substances and preparations named in Annexure A and classified as toxic or very toxic, together with substances and preparations falling into Category 1 or 2 in Chapter 2;

(b) for the addition of substances and preparations named in Annexure A and classified as oxidising, explosive, flammable, highly flammable or extremely flammable, together with substances and preparations falling into Category 3, 6, 7a, 7b or 8 of Chapter 2; and

(c) for the addition of substances and preparations named in Annexure A1 and classified as Annexure A for the environment (toxic to aquatic organisms), together with substances and preparations falling into Category 7(a) or 9(b) in Chapter 2, and the relevant provisions of these Regulations shall apply if any of the sums thereby obtained is greater than or equal to 1.

The relevant provisions of these Regulations apply where any of the sums obtained by (a), (b) or (c) is greater than or equal to 1, s*tated in material safety data sheets of substances as per Dangerous Substances Directive (67/548/EEC).*

(18.1) ***<u>Application of the 2% rule</u>***

The 2% rule should be applied as follows:

1. The substances present at an establishment only in quantities equal to or less than 2% of the relevant qualifying quantity must be ignored for the purposes of calculating the total quantity present if their location within an establishment is such that it cannot act as an initiator of a major incident elsewhere on site.
2. This allows for some quantities of substances to be ignored when deciding whether the Regulations apply. Individual quantities of dangerous substances can be ignored if they fulfil the following criteria:
   (a) the quantity is 2% or less of its threshold quantity; and
   (b) its location means that it cannot start a major incident elsewhere on site.
3. *Note that–*

(a) both criteria must be met;

(b) the quantity involved may be capable of producing a major incident by itself;

(c) it may be capable of starting a major incident off site; and

(d) *if it meets the criteria, it can be ignored only when determining whether the establishment is within the scope of these Regulations. If the establishment is subject to the Regulations because of the presence of other dangerous substances, any quantity of 2% or less must be taken into account when considering the sources and consequences of major incidents.*

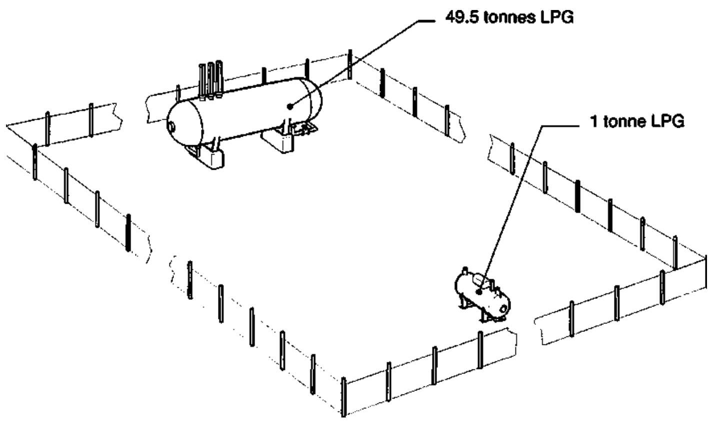
The diagram below does not depict an approved installation but it is meant for illustrative purposes only.

Example 1

An establishment with–

(a) *a large tank containing 49,5 tonnes of LPG; and*

(b) *a small tank containing 1,0 tonne of LPG.*



The small tank = 2% of medium hazard threshold (50 tonnes), but the separation from the large tank is sufficient to prevent the small tank starting a major incident at the large tank. It can therefore be ignored in terms of the 2% rule.

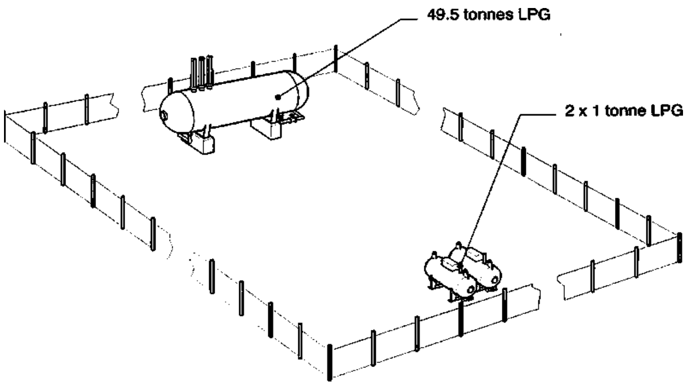
The result is that medium hazard category does not apply, even though the total quantity of 50,5 tonnes is above the medium hazard threshold, which places it in the low hazard category.

Example 2

An establishment with–

(a) a large tank containing 49,5 tonnes of LPG; and

(b) two small tanks each containing 1,0 tonne of LPG.



Each small tank = 2% of medium hazard threshold (50 tonnes), but their separation from the large tank and from each other is sufficient to prevent either of them starting a major incident at the other small tank or the large tank. Therefore, each can be ignored in terms of the 2% rule.

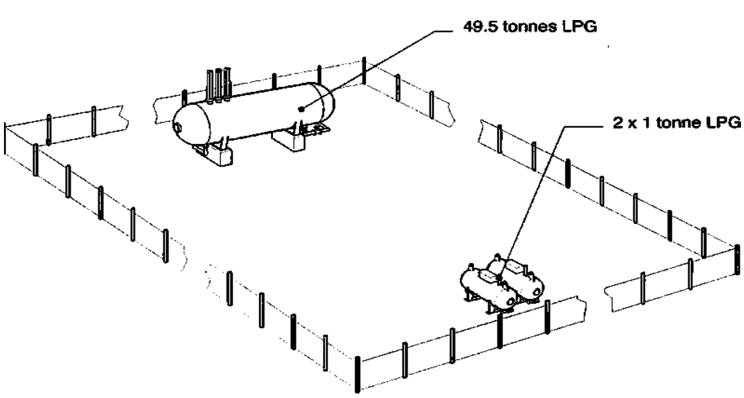
The result is that medium hazard category does not apply, even though the total quantity of 51,5 tonnes is above the medium hazard threshold, which places it in the low hazard category.

Example 3

An establishment with–

(a) a large tank containing 49,5 tonnes of LPG; and

(b) two small tanks each containing 1,0 tonne of LPG.



The small tanks are adjacent to each other but their separation from the large tank is not sufficient to prevent the small tanks starting a major incident at the large tank.

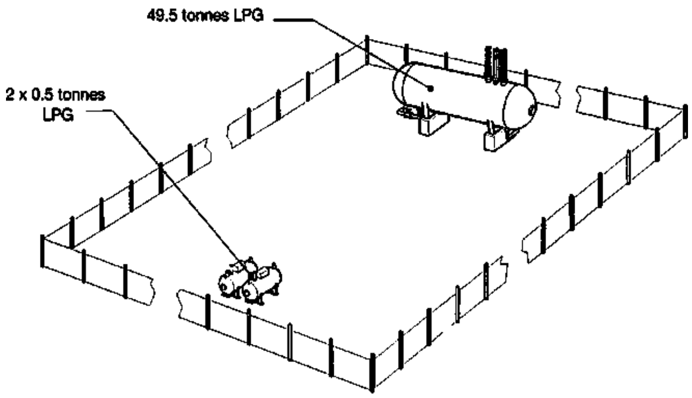
Both small tanks = 2% of threshold (50 tonnes), but as they are adjacent they should be regarded as one quantity of more than 2%; therefore, the 2% rule does not apply. As the total quantity of 51,5 tonnes exceeds the medium hazard threshold, the medium hazard threshold applies to this establishment.

Example 4

An establishment with–

(a) a large tank containing 49,5 tonnes of LPG; and

(b) two small tanks each containing 0,5 tonnes of LPG.



The small tanks are adjacent to each other but well separated from the large tank.

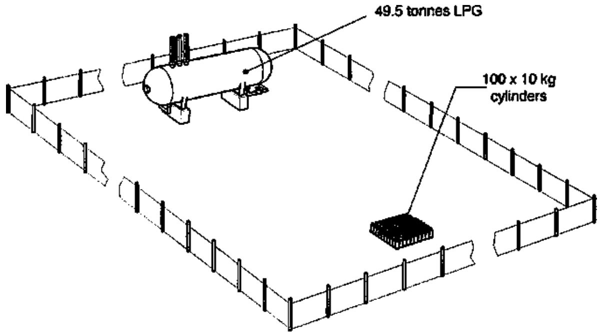
Both small tanks = 1% of threshold (50 tonnes), but as they are adjacent they should be regarded as one quantity of 1 tonne which = 2%. As this cannot start a major incident elsewhere on site, the 2% rule applies and the medium hazard category does not apply even though the total quantity is greater than the medium hazard threshold, which places it in the low hazard category.

Example 5

An establishment with–

(a) a large tank containing 49,5 tonnes of LPG; and

(b) a compound containing 100 x 10 kg cylinders of LPG, i.e. 1 tonne in total.



The separation between the compound and the large tank is sufficient to prevent the cylinders starting a major incident at the large tank.

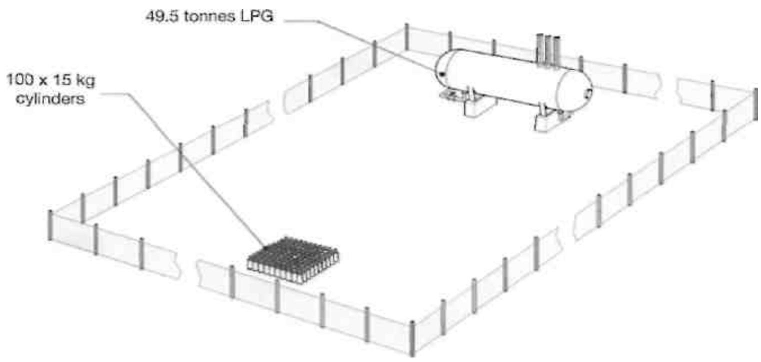
Each cylinder contains less than 2% of the medium hazard threshold (50 tonnes) and the total quantity in the cylinders is 1 tonne, which is 2% of the medium hazard threshold. The cylinder compound cannot start a major incident elsewhere on site, so the 2% rule applies. Therefore, the medium hazard category does not apply, which places it in the low hazard category.

Example 6

An establishment with–

(a) a large tank containing 49,5 tonnes of LPG; and

(b) a compound containing 100 x 15 kg cylinders of LPG, i.e. 1,5 tonnes in total.



The separation between the compound and the large tank is sufficient to prevent the cylinders starting a major incident at the large tank.

Each cylinder contains less than 2% of the medium hazard threshold (50 tonnes) but as they are adjacent to each other they should be treated as one quantity of 1,5 tonnes, which is greater than 2% of the medium hazard threshold. Therefore, the medium hazard category applies to this establishment.

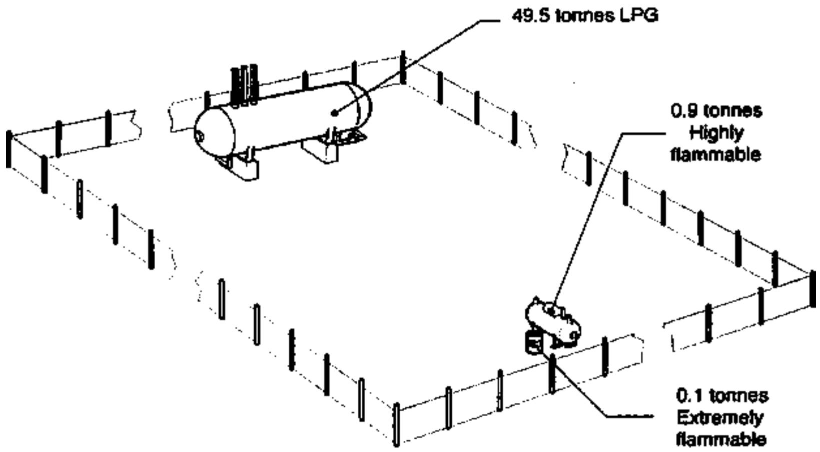
Example 7

An establishment with–

(a) a large tank containing 49,5 tonnes of LPG;

(b) a tank containing 0,9 tonnes of highly flammable liquid (medium hazard threshold 50 tonnes); and

(c) a tank containing 0,1 tonnes of extremely flammable liquid (medium hazard threshold 10 tonnes).



The small tanks are adjacent, but their separation from the large tank is enough to prevent the small tanks starting a major incident at the large tank. The total quantity for application purposes is determined by the aggregation rules, but first it is necessary to determine if the small tanks together exceed 2% of their threshold.

To do this, each one is expressed as a percentage of its own threshold and added together:

1. Small tanks

(0,9/50) + (0,1/10) = 0,018 + 0,01 = 1,8% + 1,0% = 2,8%. As this is greater than 2%, they cannot be ignored for application purposes.

The aggregation rule gives:

(49,5/50) + (0,9/50) + (0,1/10)

= 0,99 + 0,018 + 0,01

= 1,018

1,018 is greater than 1, so the medium hazard category applies to the establishment.

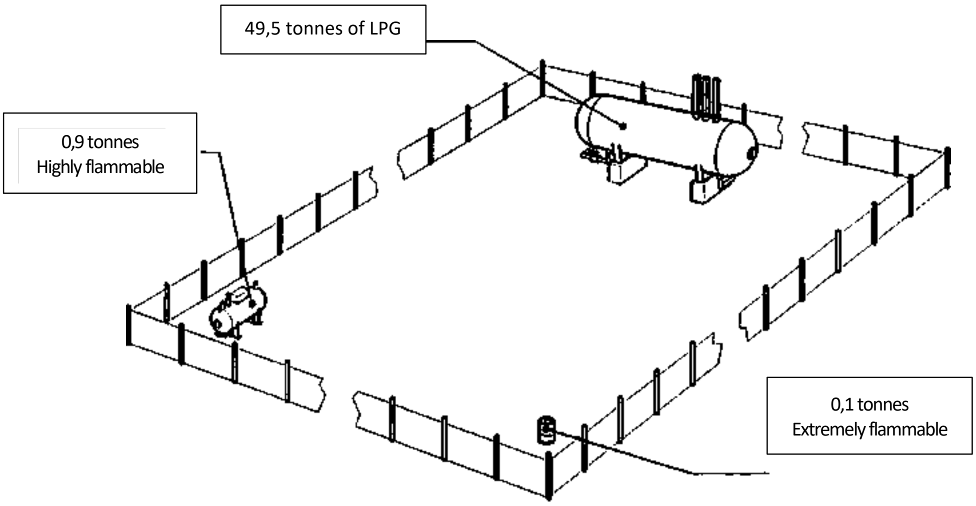
Example 8

An establishment with–

(a) a large tank containing 49,5 tonnes of LPG;

(b) a tank containing 0,9 tonnes of highly flammable liquid (medium hazard threshold 50 tonnes); and

(c) a tank containing 0,1 tonnes of extremely flammable liquid (medium hazard threshold 10 tonnes).



The separation is sufficient that neither small tank can start a major incident at either the other small tank or the large tank.

Because neither small tank exceeds 2% of its threshold, they can both be ignored for application purposes and the total quantity for application purposes is, therefore, the 49,5 tonnes of LPG. This is below its medium hazard threshold, so the medium hazard category does not apply to the establishment, which places it in the low hazard category.

ANNEXURE B

The fees for the registration and renewal of a certificate of registration are set out in the third and fourth columns of the table below:

CATEGORY OF MHI	*CLASSES OF MHI*	*REGISTRATION FEE*	*RENEWAL FEE*
Considered an MHI	*-*	*R350*	*R350*
Storage, use, handling, manufacturing and processing of one or more dangerous substances	*LOW*	*R350*	*R350*
	MEDIUM	*R400*	*R400*
	HIGH	*R450*	*R450*

ANNEXURE C

Major Incident Prevention Policy

The following principles should be taken into account when preparing a major incident prevention policy:

(1) *For the purpose of implementing the duty holder's major incident prevention policy and process safety management system, the following elements must be considered:*

(a) *the requirements laid down in the major incident prevention policy document must be proportionate to the hazards associated with major incidents present in the establishment;*

(b) *the major incident prevention policy must include the duty holder's aims and principles of action with respect to the control of hazards associated with major incidents.*

(c) *the process safety management system must include resources for determining and implementing the major incident prevention policy.*

(2) The following issues must be addressed by the process safety management system:

(a) *organisation and personnel – the roles and responsibilities of personnel involved in the management of major hazards at all levels in the organisation. The identification of training needs of such personnel and* *the provision of the training so identified. The involvement of employees and, where appropriate, subcontractors;*

(b) identification and evaluation of major hazards – adoption and implementation of procedures for systematically identifying major hazards arising from normal and abnormal operation and the assessment of their likelihood and severity;

(c) operational control – adoption and implementation of procedures and instructions for safe operation, including maintenance of plant, processes, equipment and temporary stoppages;

(d) management of change – adoption and implementation of procedures for planning modifications to, or the design of, new installations, processes or storage facilities;

(e) planning for emergencies – adoption and implementation of procedures to identify foreseeable emergencies by systematic analysis and to prepare, test and review emergency plans to respond to such emergencies;

(f) monitoring performance – adoption and implementation of procedures for the ongoing assessment of compliance with the objectives set by the duty holder major incident prevention policy and process safety management system, and the mechanisms for investigation and taking corrective action in the case of non-compliance. The procedures must cover the employer, self-employed person or user's system for reporting major incidents or near misses, particularly those involving failure of protective measures, and their investigation and follow-up on the basis of lessons learnt;

(g) audit and review – adoption and implementation of procedures for periodic systematic assessment of the major incident prevention policy and the effectiveness and suitability of the process safety management system; the documented review of performance of the policy and process safety management system and its updating by senior management.

ANNEXURE D

SAFETY REPORTS

MINIMUM INFORMATION TO BE INCLUDED IN SAFETY REPORT

The information referred to in regulation 12(1), (5) and (7) is as follows:

(1) *Information on the management system and on the organisation of the establishment with a view to major incident prevention.*

(2) A process safety management system must–

(a) be proportionate to the hazards, industrial activities and complexity of the organisation in the establishment;

(b) be based on assessment of the risks;

(c) include within its scope the general management system, including the organisational structure, responsibilities, practices, procedures, processes and resources for determining and implementing the major incident prevention policy.

(3) The following matters must be addressed by the process safety management system:

(a) in relation to the organisation and personnel–

(i) the roles and responsibilities of personnel involved in the management of major hazards at all levels in the organisation, together with the measures taken to raise awareness of the need for continuous improvement;

(ii) the identification of the training needs of such personnel and the provision of the training;

(iii) the involvement of employees and of subcontracted personnel working in the establishment, who are important from the point of view of safety;

(b) the identification and evaluation of major hazards: the adoption and implementation of procedures for systematically identifying major hazards arising from normal and abnormal operation, including subcontracted activities where applicable, and the assessment of their likelihood and severity;

(c) in relation to operational control–

(i) the adoption and implementation of procedures and instructions for safe operation, including maintenance of plant, processes and equipment, and for alarm management and temporary stoppages;

(ii) the taking into account of available information on best practices for monitoring and control, with a view to reducing the risk of system failure;

(iii) the management and control of the risks associated with ageing equipment installed in the establishment and its corrosion;

(iv) the inventory of the establishment's equipment, and the strategy and methodology for the monitoring and control of the condition of the equipment;

(v) appropriate follow-up actions and any necessary countermeasures;

(d) the management of change: the adoption and implementation of procedures for planning modifications to, or the design of, new installations, processes or storage facilities;

(e) in relation to planning for emergencies–

(i) the adoption and implementation of procedures to identify foreseeable emergencies by systematic analysis;

(ii) the preparation, testing and review of emergency plans to respond to emergencies and the provision of specific training for staff, such training to be given to all personnel working in the establishment, including relevant subcontracted personnel;

(f) in relation to monitoring performance–

(i) the adoption and implementation of procedures for the ongoing assessment of compliance with the objectives set by the operator's major accident prevention policy and safety management system, and the mechanisms for investigation and taking corrective action in case of non-compliance;

(ii) the procedures must cover the operator's system for reporting major incidents or 'near misses', particularly those involving failure of protective measures, and their investigation and follow-up on the basis of lessons learned;

(iii) the procedures could also include performance indicators such as safety performance indicators and/or other relevant indicators;

(g) in relation to audit and review–

(i) the adoption and implementation of procedures for periodic systematic assessment of the major accident prevention policy and the effectiveness and suitability of the process safety management system;

(ii) the documented review of performance of the policy and process safety management system and its updating by senior management, including consideration and incorporation of necessary changes indicated by the audit and review.

The information in the safety report must contain the elements set out in Annexure C.

(4) Presentation of the site and surrounding area of the establishment:

(a) description of the site and its surrounding area, including the geographical location, meteorological, geographical and hydrographic conditions and, if necessary, its history;

(b) identification of installations and other activities of the establishment which could present a major incident hazard;

(c) description of areas where a major incident may occur.

(5) Description of the establishment:

(a) description of the main activities and products of the parts of the establishment which are important from the point of view of safety, sources of major incident risks and conditions under which such a major incident could happen, together with a description of proposed preventive measures;

(b) description of processes, in particular the operating methods;

(c) description of dangerous substances:

(i) inventory of dangerous substances, including–

(aa) the identification of dangerous substances: chemical name, the UN number;

(bb) the maximum quantity of dangerous substances present;

(ii) physical, chemical, toxicological characteristics and indication of the hazards, both immediate and delayed for people;

(iii) physical and chemical behaviour under normal conditions of use or under potential incidental conditions.

(6) Identification and incidental risks analysis and prevention methods:

(a) detailed description of the possible major incident scenarios and their probability or the conditions under which they occur, including a summary of the events which may play a role in triggering each of these scenarios, the causes being internal or external to the establishment;

(b) assessment of the extent and severity of the consequences of identified major incidents;

(c) description of technical consideration, methods and tools used for the safety evaluation of the establishment.

(7) Measures of protection and intervention to limit the consequences of an incident:

(a) description of the equipment installed in the plant to limit the consequences of major incidents;

(b) organisational alert and intervention;

(c) description of internal or external resources that can be mobilised;

(d) summary of elements described in subparagraphs (a), (b) and (c);

(e) necessity for drawing up the on-site emergency plan.

ANNEXURE E

IA REPORTS: ______

: ______________________ AIA number: ___________

ysical dress	*Type*	*Responsible person*	*Assessor*	*Type of assessment*	*Date of previous assessment*	*Date of assessme*

FORM A
NOTIFICATION OF AN ESTABLISHMENT

(Regulation 4)

Detailed guidance can be obtained from the Major Hazard Installation Regulations, 2022, *which is available on the Department of Employment and Labour's website,* *www.labour.gov.za*.

The completed form must be hand-delivered to the Department of Employment and Labour's offices.

Physical address:

215 Francis Baard Street
Laboria House Building
Pretoria
0001

Or, alternatively, you may make enquiries by email to webmail@labour.gov.za. As electronic communication cannot be guaranteed to be secure, you may decide not to use this means if you regard any of the information as confidential.

A determination must be made by the applicant who the correct recipient at the local government is. This recipient must be an appropriate member from the relevant section or senior management at the local government.

2. ***BASIC PARTICULARS OF THE ESTABLISHMENT***

Name of the establishment:	
Registered name of the business:	
Company Registration No.:	
Chief Executive Officer:	
CEO's physical address:	
CEO's telephone number:	
Name of the responsible person and contact:	
Physical address of the establishment:	
Telephone number of the establishment:	
Email:	
Industry sector:	
Brief description of activity or proposed activity concerned:	
Health and safety representative(s). (At least two, where applicable)	
Trade Union	

2. ***CLASSIFICATION***

2.1 Type of hazard of the establishment (mark with an X)

Low		***Medium***		***High***	

2.2 Type of notification

Proposed		***Renewal***		***Review due to changes***	

Comment on the lifetime of the establishment:

____

____

____

____

2.3 *When did the assessment expire?* ________________________

2.4 *Age of the establishment*________________________

2.5 *Subsequent risk assessments*

DATE OF MHI RISK ASSESSMENT	***TYPE OF MHI RISK ASSESSMENT***	***AIA***

2.6 *Date of evaluation of current risk assessment:* _______________

2.7 *Were the employees consulted and informed of the status of the establishment?*

Yes		***No***	

Attach proof

If not, provide a reason:

____

____

____

____

3. PUBLIC AWARENESS

3.1 *Were the neighbours and public notified?*

Yes		***No***	

Attach proof

If not, provide a reason:

____

____

____

____

3.2 Were there any objections?

Yes		**No**	

Attach proof

If yes, provide a reason:

____

____

____

____

3.3 Were the objections regarding health and safety of the public?

Yes		**No**	

Attach proof

If yes, provide a reason and resolutions:

____

____

____

____

4. INVENTORY OF SUBSTANCES

Provide an inventory list of all substances that will be present, their physical form and quantity.

Physical form includes gas, liquid, powder and solids. Quantity is the maximum which is anticipated will be present. The information as in Annexure A must be used.

Name of substance	***Physical form***	***Maximum quantity***

	Details of the elements of the immediate environment liable to cause a major incident or aggravate the consequences thereof:
Describe other establishments or features of environment which could lead to a major incident on your site. Describe elements of surrounding environment which could make the consequences of a major incident worse (e.g. nearby housing, other occupied buildings, farming and sewage works)	***Neighbouring establishments***
	Surrounding vulnerabilities
	Other

<u>5. DETAILS OF APPROVED INSPECTION AUTHORITY (AIA)</u>

5.1 Name of the AIA (as relevant): ____________________

5.2 AIA number: ________________________

(Attach certificate)

5.3 SANAS certificate number: ________________________

(Attach certificate and schedule)

5.4 Name of assessor: ___________________________

(Attach competency records)

5.5 Telephone number: ___________________________

6. SITE MAPS

Attach proof

7. LOCAL GOVERNMENT

7.1 Name of local government: ______________________________

7.2 Contact person: ______________________________

7.3 Contact details: ______________________________

7.4 Province: __________________________________

Attach proof of advertisement of the status

7.5 Land use approval status

Yes		***No***	

Attach proof

If not, state the reasons and attach proof of when the permit will be submitted:

____

____

____

____

7.6 Acknowledgement by local government *Official Stamp*

Received by: ______________________

DESIGNATION: ______________________

Contact: ______________________

Signature: ______________________

8. EMERGENCY PREPAREDNESS

8.1 Emergency preparedness plans

(a) On-site plan

Yes		***No***	

Attach proof

If not yet concluded, attach action plan with clear target dates of not more than six months and comment below:

____

____

____

____

____

(b) Off-site plan

Yes		***No***	

Attach proof

If not yet concluded, attach action plan with clear target dates of not more than six months and comment below:

____

____

____

____

8.2 Relevant local government responsible for activating emergency plans

Name: ____

Contact Person: _______________________________________

Designation: ____

Was there an agreement between the establishment and the local government?

Yes		***No***	

Attach proof

If no, comment and attach certificate of designation:

____

____

____

____

8.3 What is the upcoming revision period (maximum of three years)? _______________

8.4 Were employees consulted?

Yes		**No**	

Attach proof

Attach consent statement from relevant health and safety representative(s) or health and safety committee.

8.5 Were employees trained on emergency preparedness and procedures to follow during all types of emergencies?

Yes		**No**	

Attach proof

9. SIGNATURES

9.1 Establishment Representative

Name and Surname: ___________________ *Position:* ____________________

Date: ______________

Attach letterhead of the establishment

9.2 Responsible Person

Name and Surname: ___________________ *Position:* ____________________

*Date:*______________

Attach appointment letter

FORM B

APPLICATION FOR REGISTRATION AS APPROVED INSTALLATION INSPECTION AUTHORITY

DEPARTMENT OF EMPLOYMENT AND LABOUR
OCCUPATIONAL HEALTH AND SAFETY ACT, 1993 (ACT NO. 85 OF 1993)

The Chief Inspector *Department of Employment and Labour* *Private Bag X117* *PRETORIA, 0001*	

The Chief Inspector

I hereby apply to be registered as an approved inspection authority for major hazard establishments in terms of regulation 19 of the Major Hazard Installation Regulations, 2022. I declare that the particulars given below are, to the best of my knowledge and belief, correct.

1. PARTICULARS OF INSPECTION BODY

*Registered name of Inspection Body:*___________________________
*Trading name:*_______________________________
State whether you are a sole proprietor/partnership/company/close corporation (delete which is not applicable)
*Business registration number:*_______________________________
*Chief Executive Officer:*_______________________________
*Partners:*____
____
*Province:*_______________________________
*Physical Address:*_______________________________

2. *SCOPE OF APPLICATION (Tick appropriate block(s))*

TYPE A	*3rd party*	
TYPE B	*In-house*	
TYPE C	*Manufacturer*	

3. *SIGNATORIES:*

3.1 ______________________________

3.2 ______________________________

4. *SPECIMEN SIGNATURE OF THE SIGNATORIES:*

1		*2*	*3*	*4*
3.1				
3.2				

Attach more if there are many

SUPPORTING DOCUMENTS

(a) *Certified copy of IDs*

(b) *Certified copy of business registration*

(c) *Organogram of the inspection body*

(d) *Certified copy of accreditation certificate and schedule from the accreditation body*

*Signature of the applicant*___________________________

Date of application: ___________________________

FOR OFFICE USE

Application : APPROVED/NOT APPROVED

*REASON FOR REFUSAL:*____

____

*COMMENTS:*____

____

____

Allocated Registration Number: _________________________

Approving Official: _________________________

Signature: _________________________

Date: _________________________

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13 APPENDIX B: PADHI LAND-PLANNING TABLES

13.1 Development Type Table 1: People at Work, Parking

Development Type	Examples	Development Detail and Size	Justification
DT1.1 Workplaces	Offices, factories, warehouses, haulage depots, farm buildings, nonretail markets, builder's yards	Workplaces (predominantly nonretail), providing for less than 100 occupants in each building and less than 3 occupied storeys (Level 1)	Places where the occupants will be fit and healthy and could be organised easily for emergency action Members of the public will not be present or will be present in very small numbers and for a short time
	Exclusions		
		DT1.1 x1 Workplaces (predominantly nonretail) providing for 100 or more occupants in any building or 3 or more occupied storeys in height (Level 2 except where the development is at the major hazard site itself, where it remains Level 1)	Substantial increase in numbers at risk with no direct benefit from exposure to the risk
	Sheltered workshops, Remploy	DT1.1 x2 Workplaces (predominantly nonretail) specifically for people with disabilities (Level 3)	Those at risk may be especially vulnerable to injury from hazardous events or they may not be able to be organised easily for emergency action
DT1.2 Parking Areas	Car parks, truck parks, lockup garages	Parking areas with no other associated facilities (other than toilets; Level 1)	
	Exclusions		
	Car parks with picnic areas or at a retail or leisure development or serving a park and ride interchange	DT1.2 x1 Where parking areas are associated with other facilities and developments the sensitivity level and the decision will be based on the facility or development	

13.2 Development Type Table 2: Developments for Use by the General Public

Development Type	Examples	Development Detail and Size	Justification
DT2.1 Housing	Houses, flats, retirement flats or bungalows, residential caravans, mobile homes	Developments up to and including 30 dwelling units and at a density of no more than 40 per hectare (Level 2)	Development where people live or are temporarily resident It may be difficult to organise people in the event of an emergency
	Exclusions		
	Infill, back-land development	DT2.1 x1 Developments of 1 or 2 dwelling units (Level 1)	Minimal increase in numbers at risk
	Larger housing developments	DT2.1 x2 Larger developments for more than 30 dwelling units (Level 3)	Substantial increase in numbers at risk
		DT2.1 x3 Any developments (for more than 2 dwelling units) at a density of more than 40 dwelling units per hectare (Level 3)	High-density developments
DT2.2 Hotel or Hostel or Holiday Accommodation	Hotels, motels, guest houses, hostels, youth hostels, holiday camps, holiday homes, halls of residence, dormitories, accommodation centres, holiday caravan sites, camping sites	Accommodation up to 100 beds or 33 caravan or tent pitches (Level 2)	Development where people are temporarily resident It may be difficult to organise people in the event of an emergency
	Exclusions		
	Smaller: guest houses, hostels, youth hostels, holiday homes, halls of residence, dormitories, holiday caravan sites, camping sites	DT2.2 x1 Accommodation of less than 10 beds or 3 caravan or tent pitches (Level 1)	Minimal increase in numbers at risk
	Larger: hotels, motels, hostels, youth hostels, holiday camps, holiday homes, halls of residence, dormitories, holiday caravan sites, camping sites	DT2.2 x2 Accommodation of more than 100 beds or 33 caravan or tent pitches (Level 3)	Substantial increase in numbers at risk

Development Type	Examples	Development Detail and Size	Justification
DT2.3 Transport Links	Motorway, dual carriageway	Major transport links in their own right i.e., not as an integral part of other developments (Level 2)	Prime purpose is as a transport link Potentially large numbers exposed to risk but exposure of an individual is only for a short period
	Exclusions		
	Estate roads, access roads	DT2.3 x1 Single carriageway roads (Level 1)	Minimal numbers present and mostly a small period of time exposed to risk Associated with other development
	Any railway or tram track	DT2.3 x2 Railways (Level 1)	Transient population, small period of time exposed to risk Periods of time with no population present

Development Type	Examples	Development Detail and Size	Justification
DT2.4 Indoor Use by Public	Food and drink: restaurants, cafes, drive-through fast food, pubs Retail: shops, petrol filling station (total floor space based on shop area not forecourt), vehicle dealers (total floor space based on showroom or sales building not outside display areas), retail warehouses, super-stores, small shopping centres, markets, financial and professional services to the public Community and adult education: libraries, art galleries, museums, exhibition halls, day surgeries, health centres, religious buildings, community centres. adult education, 6th form college, college of FE Assembly and leisure: Coach or bus or railway stations, ferry terminals, airports, cinemas, concert or bingo or dance halls, conference centres, sports or leisure centres, sports halls, facilities associated with golf courses, flying clubs (e.g., changing rooms, club house), indoor go kart tracks	Developments for use by the general public where total floor space is from 250 m^2 up to 5000 m^2 (Level 2)	Developments where members of the public will be present (but not resident) Emergency action may be difficult to coordinate
	Exclusions		
		DT2.4 x1 Development with less than 250 m^2 total floor space (Level 1)	Minimal increase in numbers at risk
		DT2.4 x2 Development with more than 5000 m^2 total floor space (Level 3)	Substantial increase in numbers at risk
DT2.5 Outdoor Use by Public	Food and drink: food festivals, picnic areas Retail: outdoor markets, car boot sales, funfairs Community and adult	Principally an outdoor development for use by the general public i.e., developments where people will	Developments where members of the public will be present (but not resident)

Development Type	Examples	Development Detail and Size	Justification
	education: open-air theatres and exhibitions Assembly and leisure: coach or bus or railway stations, park and ride interchange, ferry terminals, sports stadia, sports fields or pitches, funfairs, theme parks, viewing stands, marinas, playing fields, children's play areas, BMX or go kart tracks, country parks, nature reserves, picnic sites, marquees	predominantly be outdoors and not more than 100 people will gather at the facility at any one time (Level 2)	either indoors or outdoors Emergency action may be difficult to coordinate
	Exclusions		
	Outdoor markets, car boot sales, funfairs picnic area, park and ride interchange, viewing stands, marquees	DT2.5 x1 Predominantly open-air developments likely to attract the general public in numbers greater than 100 people but up to 1000 at any one time (Level 3)	Substantial increase in numbers at risk and more vulnerable due to being outside
	Theme parks, funfairs, large sports stadia and events, open air markets, outdoor concerts, pop festivals	DT2.5 x2 Predominantly open-air developments likely to attract the general public in numbers greater than 1000 people at any one time (Level 4)	Very substantial increase in numbers at risk, more vulnerable due to being outside Emergency action may be difficult to coordinate

13.3 Development Type Table 3: Developments for Use by Vulnerable People

<table>
<tr><th>Development Type</th><th>Examples</th><th>Development Detail and Size</th><th>Justification</th></tr>
<tr><td rowspan="4">DT3.1 Institutional Accommodation and Education</td><td>Hospitals, convalescent homes, nursing homes, old people's homes with warden on site or 'on call', sheltered housing, nurseries, crèches, schools and academies for children up to school leaving age</td><td>Institutional, educational and special accommodation for vulnerable people or that provides a protective environment (Level 3)</td><td>Places providing an element of care or protection
Because of age, infirmity or state of health the occupants may be especially vulnerable to injury from hazardous events
Emergency action and evacuation may be very difficult</td></tr>
<tr><td colspan="3">Exclusions</td></tr>
<tr><td>Hospitals, convalescent homes, nursing homes, old people's homes, sheltered housing</td><td>DT3.1 x1
24-hour care where the site on the planning application being developed is larger than 0.25 hectare (Level 4)</td><td>Substantial increase in numbers of vulnerable people at risk</td></tr>
<tr><td>Schools, nurseries, crèches</td><td>DT3.1 x2
Day care where the site on the planning application being developed is larger than 1.4 hectare (Level 4)</td><td>Substantial increase in numbers of vulnerable people at risk</td></tr>
<tr><td>DT3.2 Prisons</td><td>Prisons, remand centres</td><td>Secure accommodation for those sentenced by court, or awaiting trial, etc. (Level 3)</td><td>Places providing detention
Emergency action and evacuation may be very difficult</td></tr>
</table>

13.4 Development Type Table 4: Very Large and Sensitive Developments

Development Type	Examples	Development Detail and Size	Justification
Note: all Level 4 developments are by exception from Level 2 or 3 and are reproduced in this table for convenient reference			
DT4.1 Institutional Accommodation	Hospitals, convalescent homes, nursing homes, old people's homes, sheltered housing	Large developments of institutional and special accommodation for vulnerable people (or that provide a protective environment) where 24-hour care is provided and where the site on the planning application being developed is larger than 0.25 hectare (Level 4)	Places providing an element of care or protection Because of age or state of health the occupants may be especially vulnerable to injury from hazardous events Emergency action and evacuation may be very difficult The risk to an individual may be small but there is a larger societal concern
	Nurseries, crèches, schools for children up to school leaving age	Large developments of institutional and special accommodation for vulnerable people (or that provide a protective environment) where day care (not 24-hour care) is provided and where the site on the planning application being developed is larger than 1.4 hectare (Level 4)	Places providing an element of care or protection Because the occupants may be especially vulnerable to injury from hazardous events Emergency action and evacuation may be very difficult The risk to an individual may be small but there is a larger societal concern
DT4.2 Very Large Outdoor Use by Public	Theme parks, large sports stadia and events, open air markets, outdoor concerts, pop festivals	Predominantly open-air developments where there could be more than 1000 people present (Level 4)	People in the open air may be more exposed to toxic fumes and thermal radiation than if they were in buildings Large numbers make emergency action and evacuation difficult The risk to an individual may be small but there is a larger societal concern

14 APPENDIX C: INCIDENT SCENARIOS

14.1 Pool Fires

14.1.1 Tank – Catastrophic Failure

Scenario [No]	Equipment	Medium	Area of Release (m^2)	Event Frequency / Annum	System Reaction 1	System Reaction 1 Probability	System Reaction 2	System Reaction 2 Probability	Probability of Ignition	Total System Event Frequency / Annum
FL-01	T-01	ULP	1638	5.00E-06	None	1.00E+00	None	1.00E+00	4.30E-03	2.15E-08
FL-02	T-02	AGO	1638	5.00E-06	None	1.00E+00	None	1.00E+00	4.30E-03	2.15E-08
FL-03	T-03	AGO	1638	5.00E-06	None	1.00E+00	None	1.00E+00	4.30E-03	2.15E-08
FL-04	T-04	ULP	1638	5.00E-06	None	1.00E+00	None	1.00E+00	4.30E-03	2.15E-08

14.1.2 Tank – Severe Leak Failure

Scenario [No]	Equipment	Medium	Area of Release (m^2)	Event Frequency / Annum	System Reaction 1	System Reaction 1 Probability	System Reaction 2	System Reaction 2 Probability	Probability of Ignition	Total System Event Frequency / Annum
FL-101	T-01	ULP	1092	3.00E-05	None	1.00E+00	None	1.00E+00	4.30E-03	1.29E-07
FL-102	T-02	AGO	1092	3.00E-05	None	1.00E+00	None	1.00E+00	4.30E-03	1.29E-07
FL-103	T-03	AGO	1092	3.00E-05	None	1.00E+00	None	1.00E+00	4.30E-03	1.29E-07
FL-104	T-04	ULP	1092	3.00E-05	None	1.00E+00	None	1.00E+00	4.30E-03	1.29E-07

14.1.3 Tank Overfilling

Scenario [No]	Equipment	Medium	Area of Release (m^2)	Event Frequency / Annum	System Reaction 1	System Reaction 1 Probability	System Reaction 2	System Reaction 2 Probability	Probability of Ignition	Total System Event Frequency / Annum
FL-201	T-01	ULP	1092	1.00E-02	None	1	None	1	6.50E-02	6.50E-04
FL-202	T-02	AGO	1092	1.00E-02	None	1	None	1	4.30E-03	4.30E-05
FL-203	T-03	AGO	1092	1.00E-02	None	1	None	1	6.50E-02	6.50E-04
FL-204	T-04	ULP	1092	1.00E-02	None	1	None	1	4.30E-03	4.30E-05

14.1.4 Tank Top Fires

Scenario [No]	Equipment	Medium	Area of Release (m^2)	Event Frequency / Annum	System Reaction 1	System Reaction 1 Probability	System Reaction 2	System Reaction 2 Probability	Probability of Ignition	Total System Event Frequency / Annum
FL-301	T-01	ULP	104	3.00E-05	None	1	None	1	4.30E-03	1.29E-07
FL-302	T-02	AGO	104	1.00E+00	None	1	None	1	4.30E-03	4.30E-03
FL-303	T-03	AGO	104	1.00E+00	None	1	None	1	6.50E-02	6.50E-02
FL-304	T-04	ULP	104	3.00E-05	None	1	None	1	4.30E-03	1.29E-07

14.1.5 Tank Explosions

Scenario [No]	Equipment	Medium	Explosive Mass (kg)	Event Frequency / Annum	System Reaction 1	System Reaction 1 Probability	System Reaction 2	System Reaction 2 Probability	Probability of Ignition	Total System Event Frequency / Annum
FL-301	T-01	ULP	6.7	1.00E-03	Frac of explosion	4.00E-01	None	1	6.50E-02	2.60E-05
FL-302	T-02	AGO	0	0.00E+00	Frac of explosion	4.00E-01	None	1	0.00E+00	0.00E+00
FL-303	T-03	AGO	0	0.00E+00	Frac of explosion	4.00E-01	None	1	0.00E+00	0.00E+00
FL-304	T-04	ULP	6.7	1.00E-03	Frac of explosion	4.00E-01	None	1	6.50E-02	2.60E-05

15 APPENDIX D: PROOF OF COMPETANCY

15.1 Department of Employment and Labour Certificate

employment & labour

Department:
Employment and Labour
REPUBLIC OF SOUTH AFRICA

National Department of Employment and Labour
Republic of South Africa

CERTIFICATION OF REGISTRATION

in accordance with the provisions of the Occupational Health and Safety Act, Act 85 of 1993, as amended.

This is to certify that:

RISCOM (PTY) LTD
CIPRO Reg No: 2002/019697/07

has been registered as a low, Medium and high hazard establishment in terms of Regulations 21,of Major Hazard Installation Regulations, 2022.

CHIEF INSPECTOR

Valid from: 27 May 2025
Expires: 26 May 2029

DEPARTMENT OF EMPLOYMENT & LABOUR

15.2 SANAS Certificate

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:-

RISCOM (PTY) LTD
Co. Reg. No.: 2002/019697/07
JOHANNESBURG

Accreditation Number: **MHI0013**

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 scope 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 and National Standard

ISO/IEC 17020:2012 AND SANS 1461:2018

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 F Osman
Acting Chief Executive Officer

Effective Date: 27 May 2025
Certificate Expires: 26 May 2029

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 Employment and Labour.

15.3 Scope of Accreditation

ANNEXURE A

SCOPE OF ACCREDITATION

Accreditation Number: MHI0013

TYPE A

Permanent Address: Riscom (Pty) Ltd 541 Heron Place Maroeladal Randburg 2191 Tel: (011) 431-2198 Fax: 086 624-9423 Mobile: 082 457-3258 E-mail: mike@riscom.co.za	**Postal Address:** Postnet Suite 010 Private Bag X153 Bryanston 2021 Issue No.: 20 Date of issue: 27 May 2025 Expiry date: 26 May 2029	
Nominated Representative: Mr MP Oberholzer	**Quality Manager:** Mr MP Oberholzer **Technical Manager:** Mr MP Oberholzer	**Technical Signatory:** Mr MP Oberholzer

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. R 2989 of 31 January 2023.	Major Hazard Installation Risk Assessments for the following material categories: 1) Explosive chemicals 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 5) Oxidizing substances and organic peroxides 6) Toxic liquids and solids	MHI regulation par. **5 (5) (b)** i) Frequency/Probability Analysis ii) Consequence Modelling iii) Hazard Identification and Analysis iv) Emergency planning reviews Reference Manual Bevi Risk Assessments version 3.2 (2009) CPR 18E (1999), Guideline for quantitative risk assessment ("Purple Book"), TNO Apeldoorn. CPR 14E (1997). Methods for the Calculation of Physical Effects ("Yellow Book"), 3rd Edition, TNO, Apeldoorn. CPR 16E (1992). Methods for the Determination of Possible Damage ("Green Book"), 1st Edition, TNO, Apeldoorn. Lees FP (2001). Loss Prevention in the Process Industries: Hazard Identification, Assessment and Control, 2nd Edition, Butterworths, London, UK.
Voluntary Supply of service as an inspection body for Hazard identification and analysis	Hazard identification and analysis including HAZARD of and operability studies (HAZOP)	SANS 1461 SANS 31000 SANS 31010

Original date of accreditation: 27 May 2005

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ISSUED BY THE SOUTH AFRICAN NATIONAL ACCREDITATION SYSTEM

Accreditation Manager

16 APPENDIX E: MATERIAL SAFETY DATA SHEETS

16.1 Gasoline (Petrol)

Safety Data Sheet

1. IDENTIFICATION

GHS Product Identifier	PETROL
SDS Number:	990058
CAS Number:	86290-81-5
Synonyms:	
Recommended use	Fuel. Motor fuel for spark-ignition engines. Not for aviation use. Should not be used as a solvent or cleaning agent.
Recommended restrictions	-
Company Name:	Astron Energy (Pty) Limited
Address:	5 Century Boulevard, Century City
	Cape Town
	South Africa
Telephone:	0860 300 860 (SDS Requests: Customer Service Centre)
Emergency Numbers:	Ambulance (Botswana): 997
	Ambulance (South Africa): 10177
	Poison Information Centre: +27 861 555 777

2. HAZARD(S) IDENTIFICATION

Physical Hazards	Flammable liquids.	Category 1
Health Hazards	**Type**	**Category**
	Skin corrosion/irritation.	Category 2
	Germ cell mutagenicity.	Category 1B
	Carcinogenicity.	Category 1B
	Reproductive toxicity (the unborn child).	Category 2
	Specific target organ toxicity following single exposure.	Category 3 narcotic effects
	Aspiration hazard.	Category 1
Environmental Hazards	**Type**	**Category**
	Hazardous to the aquatic environment, acute hazard.	Category 2
	Hazardous to the aquatic environment, long-term hazard.	Category 2

Label Elements	
Labels	
Signal word	Danger.
Hazard statement	Extremely flammable liquid and vapour. Causes skin irritation. May cause genetic defects. May cause cancer. Suspected of damaging the unborn child. May cause drowsiness or dizziness. May be fatal if swallowed and enters airways. Toxic to aquatic life with long lasting effects.

Precautionary statement	
Prevention	Obtain special instructions before use. Keep away from heat/sparks/open flames/hot surfaces. No smoking. Avoid release to the environment.
Response	IF exposed or concerned: Get medical advice/attention. IF SWALLOWED: Immediately call a POISON CENTRE or doctor/physician. Do NOT induce vomiting.
Storage	Store in a well-ventilated place. Keep cool.
Disposal	Not assigned.
Other hazards which do not result in classification	Hydrogen sulphide (H2S) can accumulate in the headspace of storage tanks and reach potentially hazardous concentrations. Some effects may be experienced due to skin absorption. Vapour in the headspace of tanks and containers may ignite and explode at temperatures exceeding auto-ignition temperature, where vapour concentrations are within the flammability range. May ignite on surfaces at temperatures above auto-ignition temperature. This material is a static accumulator. Even with proper grounding and bonding, this material can still accumulate an electrostatic charge. If sufficient charge is allowed to accumulate, electrostatic discharge and ignition of flammable air-vapour mixtures can occur.
Supplemental Information	None.

3. COMPOSITION / INFORMATION ON INGREDIENTS

Substance

Chemical Name	Common Name & Synonyms	CAS Number	Content in percent (%)
Gasoline		86290-81-5	100

Constituents

Chemical Name	Common Name & Synonyms	CAS Number	Content in percent (%)
Toluene		108-88-3	< 20
Ethylbenzene		100-41-4	< 10
Xylene		1330-20-7	< 5
Benzene		71-43-2	< 5

Composition comments	Occupational Exposure Limits for constituents are listed in Section 8. All concentrations are in percent by weight. Hydrogen sulphide (H2S) can accumulate in the headspace of storage tanks and reach potentially hazardous concentrations. Technical specifications vary greatly depending on the product and are not reflected in this document. Consult specification sheets for technical information.

4. FIRST-AID MEASURES

Inhalation	Move to fresh air. If breathing is difficult, give oxygen. Call a POISON CENTRE or doctor/physician if you feel unwell. If there is any suspicion of inhalation of H2S: Rescuers must wear breathing apparatus, belt and safety rope, and follow rescue procedures. Remove casualty to fresh air as quickly as possible. Immediately begin artificial respiration if breathing has ceased. Provision of oxygen may help. Obtain medical advice for further treatment.
Skin contact	Take off immediately all contaminated clothing. Wash off with soap and water. If skin irritation occurs: Get medical advice/attention. In case of rashes, wounds or other skin disorders: Seek medical attention and bring along these instructions. When using high pressure equipment, injection of product under the skin can occur. If product is injected into or under the skin, or into any part of the body, regardless of the appearance of the wound or its size, the individual should be evaluated immediately by a physician as a surgical

	emergency. For hot product, immediately immerse in or flush the affected area with large amounts of cold water to dissipate heat. Get medical attention immediately.
Eye contact	Immediately flush eyes with plenty of water for at least 15 minutes. Remove any contact lenses, if present and easy to do, and open eyes wide apart. Continue rinsing. Get medical attention if irritation develops or persists.
Ingestion	Immediately rinse mouth and drink plenty of water or milk. Keep person under observation. Do not induce vomiting. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs. Transport immediately to hospital and take these instructions. Never give anything by mouth to an unconscious person. Symptoms may be delayed.
Most important symptoms / effects, acute and delayed	Skin irritation. May cause redness and pain. Dermatitis. Defatting of the skin. Irritation of eyes and mucous membranes. Ingestion may cause irritation and malaise. Aspiration may cause pulmonary oedema and pneumonitis. Be aware that symptoms of chemical pneumonia (shortness of breath) may occur several hours after exposure. May cause drowsiness and dizziness. Chronic effects of overexposure are similar to acute effects including central nervous system (CNS) effects and CNS depression. Prolonged exposure may cause chronic effects.
Indication of immediate medical attention and special treatment needed	Provide general supportive measures and treat symptomatically. Keep the affected person warm and at rest. Symptoms may be delayed. Thermal burns: Flush with water immediately. While flushing, remove clothes which do not adhere to affected area. Call an ambulance. Continue flushing during transport to hospital.
General information	Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves. IF exposed or concerned: Get medical advice/attention. Keep the affected person warm and at rest. Wash contaminated clothing before reuse.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media	Water fog. Foam. Dry chemical powder. Carbon dioxide (CO_2).
Unsuitable extinguishing media	Do not use water jet as an extinguisher, as this will spread the fire.
Specific hazards arising from the chemical	The product is extremely flammable, and explosive vapour/air mixtures may be formed even at normal room temperatures. Vapours may travel considerable distance to a source of ignition and flash back. Material will float and can be re-ignited on surface of water. Thermal decomposition may produce smoke, oxides of carbon and lower molecular weight organic compounds whose composition have not been characterised. Sulphur Oxides (SO_x). Nitrogen Oxides (NO_x).
Special protective equipment and precautions for firefighters	Self-contained breathing apparatus and full protective clothing must be worn in case of fire.
Fire-fighting equipment / instructions	In case of fire and/or explosion do not breathe fumes. Move containers from fire area if you can do so without risk. Cool containers with flooding quantities of water until well after fire is out.
General fire hazards	Extremely flammable liquid and vapour.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures	Keep unnecessary personnel away. Stay upwind. Ventilate closed spaces before entering them. Eliminate all ignition sources (no smoking, flares, sparks, or flames in immediate area). Take precautionary measures against static discharge. In case of spills, beware of slippery floors and surfaces. Avoid contact with skin. Avoid inhalation of vapours or mists. Avoid prolonged exposure. Wear appropriate protective equipment and clothing during clean-up. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Local authorities should be advised if significant spillages cannot be contained. For personal protection, see section 8 of the SDS.
Methods and materials for containment and cleaning up	Eliminate all ignition sources (no smoking, flares, sparks, or flames in immediate area). Keep combustibles (wood, paper, oil etc) away from

	spilled material. Take precautionary measures against static discharge. Use only non-sparking tools. Prevent product from entering drains. Large Spills: Stop the flow of material, if this is without risk. Dike the spilled material, where this is possible. Remove with vacuum trucks or pump to storage/salvage vessels. Use a non-combustible material like vermiculite, sand or earth to soak up the product and place into a container for later disposal. Following product recovery, flush area with water. Small Spills: Absorb with earth, sand or other non-combustible material and transfer to containers for later disposal. Clean surface thoroughly to remove residual contamination. Never return spills to original containers for re-use. Ensure that waste and contaminated materials are collected and removed from the work area as soon as possible in a suitably labelled container. For waste disposal, see section 13 of the SDS.
Environmental precautions	Prevent spreading over a wide area (e.g. by containment or oil barriers). Prevent further leakage or spillage if safe to do so. Avoid discharge into drains, water courses or onto the ground. Inform appropriate managerial or supervisory personnel of all environmental releases.

7. HANDLING AND STORAGE

Precautions for safe handling	Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Access to work area should be restricted to people handling the product only. Should be handled in closed systems, if possible. Before entering storage tanks and commencing any operation in a confined area check the atmosphere for oxygen content and flammability. (Subject to applicability) If sulphur compounds are suspected to be present in the product, check the atmosphere for H2S content. The inherent toxic and olfactory (sense of smell) fatiguing properties of hydrogen sulphide require that air monitoring alarms be used if concentrations are expected to reach harmful levels, such as in enclosed spaces, heated transport vessels and spill or leak situations. If the air concentration exceeds 10 ppm, the area should be evacuated unless respiratory protection is in use. Avoid splash filling. Avoid inhalation of vapours or mists. Avoid contact with eyes, skin, and clothing. Avoid prolonged exposure. Pregnant women should not work with the product, if there is the least risk of exposure. Wear appropriate personal protective equipment. Immediately change contaminated clothes. The product is extremely flammable, and explosive vapour/air mixtures may be formed even at normal room temperatures. Vapours are heavier than air and may travel along the floor and in the bottom of containers. Do not handle or store near an open flame, heat or other sources of ignition. Take precautionary measures against static discharges. Ground container and transfer equipment to eliminate static electric sparks. Use non-sparking tools and explosion-proof equipment. Do not use compressed air for filling, discharging, or handling operations. Restrict line velocity during pumping in order to avoid generation of electrostatic discharge. Partly filled containers present a greater hazard than those that are full, therefore handling, transfer and sampling activities need special care. Containers, even those that have been emptied, can contain explosive vapours. Do not cut, drill, grind, weld or perform similar operations on or near containers. Even with proper grounding and bonding, this material can still accumulate an electrostatic charge. If sufficient charge is allowed to accumulate, electrostatic discharge and ignition of flammable air-vapour mixtures can occur. Due to viscosity product is heated when transferred. Be aware of need using thermal gloves. Be aware of potential for surfaces to become slippery. Do not eat, drink or smoke when using the product. Wash hands thoroughly after handling. Avoid release to the environment. Observe good industrial hygiene practices.

Conditions for safe storage, including any incompatibilities	Ensure that all local regulations regarding handling and storage facilities are followed. Follow rules for flammable liquids. Keep away from heat, sparks and open flame. Prevent electrostatic charge build-up by using common bonding and grounding techniques. Keep in a cool, well-ventilated place. Store locked up. Store in tightly closed container. Keep in an area equipped with sprinklers. Store away from incompatible materials (see section 10 of the SDS). Keep away from food, drink and animal feeding stuffs.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational exposure limits

South Africa. Control Limits. Regulations for Hazardous Chemical Substances, Table 1

Constituents	Type	Value
Benzene (CAS 71-43-2)	TWA	16 mg/m3
		5 ppm

South Africa. Recommended Exposure Limits (RELs) Regulations for Hazardous Chemical Substances, Table 2

Constituents	Type	Value
Ethylbenzene (CAS 100-41-4)	STEL	545 mg/m3
		125 ppm
	TWA	435 mg/m3
		100 ppm
Toluene (CAS 108-88-3)	STEL	560 mg/m3
		150 ppm
	TWA	188 mg/m3
		50 ppm
Xylene (CAS 1330-20-7)	STEL	650 mg/m3
		150 ppm
	TWA	435 mg/m3
		100 ppm

Biological limit values

South Africa. Biological Exposure Indices (BEIs) (Regulations for Hazardous Chemical Substances, Table 3)

Constituents	Value	Determinant	Specimen	Sampling Time
Toluene (CAS 108-88-3)	1 mg/l	Toluene	Venous blood	*
Benzene (CAS 71-43-2)	0.12 ppm	Benzene	End-exhaled air	*
	0.08 ppm	Benzene	mixed-exhaled air	*
Xylene (CAS 1330-20-7)	2 mg/min	Methylhippuric acids	Urine	*

* - For sampling details, please see the source document.

Exposure guidelines

South Africa RELs Table 2: Skin designation

Toluene (CAS 108-88-3)	Can be absorbed through the skin.
Xylene (CAS 1330-20-7)	Can be absorbed through the skin.

Appropriate engineering controls	Provide adequate ventilation and minimise the risk of inhalation of vapours and mists. Use explosion-proof equipment. The level of protection and types of controls necessary will vary depending upon potential exposure conditions. Select controls based on a risk assessment of local circumstances. Good general ventilation should be used. Ventilation rates

	should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. Provide easy access to water supply and eye wash facilities.
Individual protection measures, such as personal protective equipment	
Eye / face protection	Wear chemical splash goggles/face shield.
Skin protection	
Hand protection	Wear appropriate chemical resistant gloves. Prolonged or repeated contact: Nitrile gloves (thickness of 0.38 mm and breakthrough time of > 480 minutes) are recommended. Nitrile disposable gloves with a thickness of 0.1 mm and a breakthrough time of > 120 minutes may be suitable for less prolonged exposure and incidental contact/splash protection. For incidental contact/splash protection Neoprene or PVC gloves may also be suitable. Be aware that the liquid may penetrate the gloves. Frequent change is advisable. Suitable gloves can be recommended by the glove supplier. After using gloves, hands should be washed and dried thoroughly.
Other	Wear appropriate chemical resistant clothing. Anti-static and flame-retardant protective clothing is recommended. Regular protective clothing with high visibility is recommended. Always keep contaminated work clothing away from uncontaminated work clothing and uncontaminated personal clothes.
Respiratory protection	In case of inadequate ventilation or risk of inhalation of oil mist, suitable respiratory equipment with particulate filter and organic vapor cartridges can be used. Wear air-supplied mask in confined areas. Check with respiratory protective equipment suppliers.
Thermal hazards	Wear appropriate thermal protective clothing, when necessary.
General hygiene considerations	Observe any medical surveillance requirements. Handle in accordance with good industrial hygiene and safety practices. Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Private clothes and working clothes should be kept separately.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	
Physical state	Liquid.
Form	Clear bright liquid.
Colour	Pale yellow to amber.
Odour	Hydrocarbon-like.
Odour threshold	Not available.
pH	Not applicable
Melting point / Freezing point	Not available
Initial boiling point and boiling range	30 °C (86 °F)
Flash point	-40.0 °C (-40.0 °F)
Evaporation rate	Not available
Flammability (solid, gas)	Not applicable
Upper / lower flammability or explosive limits	
Flammability limit – lower (%)	1.4%
Flammability limit – upper (%)	7%
Vapour pressure	45 - 71 kPa (38°C/100°F)
Vapour density	Not available
Relative density	Not available

Solubility(ies)	
Solubility (water)	Insoluble (in water)
Partition coefficient (n-octanol / water)	Log Kow: > 3
Auto-ignition temperature	250 - 429 °C (482 - 804.2 °F)
Decomposition temperature	Not available
Viscosity	< 2 cSt max (kinematic) (40°C/104°F)
Other information	
Density	0.62 - 0.88 (15 °C (59 °F)) and (0.710 to 0.785 at 20°C in South Africa)
Explosive properties	Not explosive
Oxidizing properties	Not oxidizing
Percent volatile	100 %
Pour point	< -20 °C (< -4 °F)

10. STABILITY AND REACTIVITY

Reactivity	The product is stable and non-reactive under normal conditions of use, storage and transport.
Chemical stability	Material is stable under normal conditions.
Possibility of hazardous reactions	Hazardous polymerisation does not occur. This product will not undergo hazardous reaction when used as expected and in recommended environments.
Conditions to avoid	Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. Avoid temperatures exceeding the flash point. Contact with incompatible materials.
Incompatible materials	Strong acids. Strong oxidising agents.
Hazardous decomposition products	Thermal decomposition or combustion may liberate carbon oxides and other toxic gases or vapours.

11. TOXICOLOGICAL INFORMATION

Information on likely routes of exposure	
Inhalation	Breathing of high concentrations may cause dizziness, light-headedness, headache, nausea and loss of co-ordination. Continued inhalation may result in unconsciousness.
Skin contact	Causes skin irritation. Repeated exposure may cause skin dryness or cracking. May be absorbed through the skin.
Eye contact	May cause eye irritation on direct contact.
Ingestion	Ingestion may cause irritation and malaise. Droplets of the product aspirated into the lungs through ingestion or vomiting may cause a serious chemical pneumonia.
Symptoms related to the physical, chemical and toxicological characteristics	Skin irritation. May cause redness and pain. Dermatitis. Defatting of the skin. Irritation of eyes and mucous membranes. Ingestion may cause irritation and malaise. Aspiration may cause pulmonary oedema and pneumonitis. Be aware that symptoms of chemical pneumonia (shortness of breath) may occur several hours after exposure. May cause drowsiness and dizziness. Chronic effects of overexposure are similar to acute effects including central nervous system (CNS) effects and CNS depression. Prolonged exposure may cause chronic effects.
Information on toxicological effects	
Acute toxicity	Hydrogen sulphide, a highly toxic gas, may be present. Signs and symptoms of overexposure to hydrogen sulphide include respiratory and eye irritation, dizziness, nausea, coughing, a sensation of dryness and pain in the nose, and loss of consciousness. Odour does not provide a reliable indicator of the presence of hazardous levels in the atmosphere.

Product	Species	Acute
Gasoline (CAS 86290-81-5)		Dermal
Test Results		
LD50	Rabbit	> 2000 mg/kg, 24 Hours
Inhalation		
LC50	Rat	> 5610 mg/m3, 4 Hours
Oral		
LD50	Rat	> 5000 mg/kg

Skin corrosion / irritation	Causes skin irritation. Pre-existing skin conditions including dermatitis might be aggravated by exposure to this product.
Serious eye damage / eye irritation	Direct contact with eyes may cause temporary irritation.
Respiratory or skin sensitisation	
Respiratory sensitisation	Not a respiratory sensitiser.
Skin sensitisation	Not a skin sensitiser.
Germ cell mutagenicity	May cause genetic defects.
Carcinogenicity	May cause cancer.

IARC Monographs. Overall Evaluation of Carcinogenicity

Benzene (CAS 71-43-2)	1 Carcinogenic to humans.
Ethylbenzene (CAS 100-41-4)	2B Possibly carcinogenic to humans.
Gasoline (CAS 86290-81-5)	2B Possibly carcinogenic to humans.
Toluene (CAS 108-88-3)	3 Not classifiable as to carcinogenicity to humans.
Xylene (CAS 1330-20-7)	3 Not classifiable as to carcinogenicity to humans.

US NTP Report on Carcinogens: Known carcinogen

Benzene (CAS 71-43-2)	Known To Be Human Carcinogen.

Reproductive toxicity	Suspected of damaging the unborn child.
Specific target organ toxicity – single exposure	May cause drowsiness or dizziness.
Specific target organ toxicity – repeated exposure	Not classified.
Aspiration hazard	May be fatal if swallowed and enters airways.
Chronic effects	Prolonged or repeated contact with skin may cause redness, itching, irritation, eczema/chapping and oil acne. Prolonged exposure may cause chronic effects.

12. ECOLOGICAL INFORMATION

Ecotoxicity	Toxic to aquatic life with long lasting effects.

Product		Species	Test Results
Gasoline (CAS 86290-81-5)			
Aquatic			
Algae	EC50	Pseudokirchneriella subcapitata	3.1 mg/l, 72 Hours
Crustacea	EC50	Daphnia magna	4.5 mg/l, 48 Hours
Fish	LC50	Oncorhynchus mykiss	10 mg/l, 96 Hours
		Pimephales promelas	8.2 mg/l, 96 Hours

Persistence and degradability	The degradability of the product has not been stated. The product meets the definition of the International Oil Pollution Compensation (IOPC) Fund as being a "non-persistent" oil.

Bio-accumulative potential	Has the potential to bio-accumulate.
Mobility in soil	Based on the calculation model the product has a potential of being absorbed in the soil.
Mobility in general	The product is insoluble in water. It will spread on the water surface while some of the components will eventually sediment in water systems. The volatile components of the product will spread in the atmosphere.
Other adverse effects	Oil spills are generally hazardous to the environment. The product contains volatile organic compounds which have a photochemical ozone creation potential.

13. DISPOSAL CONSIDERATIONS

Disposal instructions	
Waste from residues / unused products	Collect and reclaim or dispose in sealed containers at licensed waste disposal site. This material and/or its container must be disposed of as hazardous waste. Dispose in accordance with all applicable regulations. Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).
Contaminated packaging	Since emptied containers may retain product residue, follow label warnings even after container is emptied. Empty containers should be taken to an approved waste handling site for recycling or disposal.

14. TRANSPORT INFORMATION

ADR	
UN Number	UN1203
UN Proper Shipping Name	GASOLINE
Transport hazard class(es)	
Class	3
Subsidiary risk	-
Label(s)	3
Hazard No. (ADR)	33
Tunnel restriction code	D/E
Packing group	II
Environmental hazards	Yes
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

RID	
UN Number	UN1203
UN Proper Shipping Name	GASOLINE
Transport hazard class(es)	
Class	3
Subsidiary risk	-
Label(s)	3
Packing group	II
Environmental hazards	Yes
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

IATA	
UN Number	UN1203
UN Proper Shipping Name	GASOLINE
Transport hazard class(es)	
Class	3
Subsidiary risk	-
Packing group	II
Environmental hazards	Yes
ERG Code	3H
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

IMDG	
UN Number	UN1203
UN Proper Shipping Name	GASOLINE
Transport hazard class(es)	
Class	3
Subsidiary risk	-
Packing group	II
Environmental hazards	
Marine Pollutant	Yes
EmS	F-E, S-E
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code	Not applicable. However, this product is a liquid and if transported in bulk covered under MARPOL 73/78, Annex I.

15. REGULATORY INFORMATION

Safety, health and environmental regulations specific for the product in question	This product is classified in accordance with SANS 10234: 2019 – Globally Harmonized System of Classification and Labelling of Chemicals (GHS).
Drug Precursors (Government Gazette No. 25873, Regulation Gazette No. 7861, ITAC Import Control, Schedule 3 (1988 Convention) as amended	
Toluene (CAS 108-88-3)	
Hazardous Substances Act, 1973 (Act No. 15 of 1973)	
Not listed.	
International Regulations	
Stockholm Convention	
Not applicable.	
Rotterdam Convention	
Not applicable.	
Montreal Protocol	
Not applicable.	
Kyoto Protocol	
Not applicable.	
Basel Convention	

Not applicable.		
International Inventories		
Country(ies) or Region	**Inventory Name**	**On inventory (Yes / noNo)***
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	No
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	Yes
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
Taiwan	Taiwan Chemical Substance Inventory (TCSI)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	No

* A "Yes" indicates this product complies with the inventory requirements administered by the governing country(s). A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. OTHER INFORMATION

Issue date	11-December-2020
Revision date	-
Version #	01
References	Safe handling practices for liquids that are determined to be static accumulators: American Petroleum Institute 2003 (Protection Against Ignitions Arising out of Static, Lightning and Stray Currents). National Fire Protection Agency 77 (Recommended Practices on Static Electricity). CENELEC CLC/TR 50404 (Electrostatics – Code of practice for the avoidance of hazards due to static electricity).
Disclaimer	Astron Energy (Pty) Limited cannot anticipate all conditions under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use. The information in the sheet was written based on the best knowledge and experience currently available.

16.2 Diesel

Safety Data Sheet

1. IDENTIFICATION

GHS Product Identifier	**DIESEL FUEL**
SDS Number:	991084
CAS Number:	68334-30-5
Recommended use	Fuel.
Recommended restrictions	None known.
Manufacturer information	
Company Name:	Astron Energy (Pty) Limited
Address:	5 Century Boulevard, Century City
	Cape Town
	South Africa
Telephone:	0860 300 860 (SDS Requests: Customer Service Centre)
Emergency numbers:	Ambulance (Botswana): 997
	Ambulance (South Africa): 10177
	Poison Information Centre: +27 861 555 777

2. HAZARD(S) IDENTIFICATION

Physical Hazards	Flammable liquids.	Category 3
Health Hazards	**Type**	**Category**
	Acute toxicity, inhalation.	Category 4
	Skin corrosion/irritation.	Category 2
	Carcinogenicity.	Category 2
	Specific target organ toxicity following repeated exposure (dermal).	Category 2 (Bone marrow, Liver, Thymus).
	Aspiration hazard.	Category 1
Environmental Hazards	**Type**	**Category**
	Hazardous to the aquatic environment, acute hazard.	Category 2
	Hazardous to the aquatic environment, long-term hazard.	Category 2
Label Elements		
Labels		
Signal word	Danger.	
Hazard statement	Flammable liquid and vapour. Harmful if inhaled. Causes skin irritation. Suspected of causing cancer. May cause damage to organs (Bone marrow, Liver, Thymus) through prolonged or repeated exposure. May be fatal if swallowed and enters airways. Toxic to aquatic life with long lasting effects.	

Precautionary statement	
Prevention	Keep away from heat/sparks/open flames/hot surfaces. No smoking. Do not breathe mist/vapours. Avoid release to the environment. Wear protective gloves/protective clothing/eye protection/face protection.
Response	IF SWALLOWED: Immediately call a POISON CENTRE or doctor/physician. Do NOT induce vomiting.
Storage	Store in a well-ventilated place. Keep cool.
Disposal	Not assigned.
Other hazards which do not result in classification	Hydrogen sulphide (H2S) can accumulate in the headspace of storage tanks and reach potentially hazardous concentrations. Some effects may be experienced due to skin absorption. Vapour in the headspace of tanks and containers may ignite and explode at temperatures exceeding auto-ignition temperature, where vapour concentrations are within the flammability range. May ignite on surfaces at temperatures above auto-ignition temperature. This material is a static accumulator. Even with proper grounding and bonding, this material can still accumulate an electrostatic charge. If sufficient charge is allowed to accumulate, electrostatic discharge and ignition of flammable air-vapour mixtures can occur.
Supplemental Information	None.

3. COMPOSITION / INFORMATION ON INGREDIENTS

Substance

Chemical Name	Common Name & Synonyms	CAS Number	Content in percent (%)
Fuels, diesel		68334-30-5	100

Composition comments	All concentrations are in percent by weight. Hydrogen sulphide (H2S) can accumulate in the headspace of storage tanks and reach potentially hazardous concentrations. For more detailed chemical composition, refer to the certificate of analysis.

4. FIRST-AID MEASURES

Inhalation	Move to fresh air. If breathing is difficult, give oxygen. Get medical attention if discomfort develops or persists. If there is any suspicion of inhalation of H2S: Rescuers must wear breathing apparatus, belt and safety rope, and follow rescue procedures. Remove casualty to fresh air as quickly as possible. Immediately begin artificial respiration if breathing has ceased. Provision of oxygen may help. Obtain medical advice for further treatment.
Skin contact	Take off immediately all contaminated clothing. Wash with soap and water. If skin irritation occurs: Get medical advice/attention. In case of rashes, wounds or other skin disorders: Seek medical attention and bring along these instructions. For hot product, immediately immerse in or flush the affected area with large amounts of cold water to dissipate heat. Get medical attention immediately.
Eye contact	Immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Get

	medical attention if irritation develops and persists.
Ingestion	Immediately rinse mouth and drink plenty of water or milk. Keep person under observation. Do not induce vomiting. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs. Seek immediate medical attention.
Most important symptoms / effects, acute and delayed	Skin irritation. May cause redness and pain. Dermatitis. Defatting of the skin. Irritation of eyes and mucous membranes. Ingestion may cause irritation and malaise. Aspiration may cause pulmonary oedema and pneumonitis. Be aware that symptoms of chemical pneumonia (shortness of breath) may occur several hours after exposure. Prolonged exposure may cause chronic effects.
Indication of immediate medical attention and special treatment needed	Provide general supportive measures and treat symptomatically. Keep the affected person warm and at rest. Symptoms may be delayed. Thermal burns: Flush with water immediately. While flushing, remove clothes which do not adhere to affected area. Call an ambulance. Continue flushing during transport to hospital.
General information	Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves. IF exposed or concerned: Get medical advice/attention. Keep the affected person warm and at rest. Wash contaminated clothing before reuse.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media	Water spray, foam, dry powder or carbon dioxide.
Unsuitable extinguishing media	Do not use water jet as an extinguisher, as this will spread the fire.
Specific hazards arising from the chemical	The product is flammable, and heating may generate vapours which may form explosive vapour/air mixtures. Vapours may travel considerable distance to a source of ignition and flash back. Material will float and can be re-ignited on surface of water. Thermal decomposition may produce smoke, oxides of carbon and lower molecular weight organic compounds whose composition have not been characterised. Sulphur Oxides (SOx). Nitrogen Oxides (NOx).
Special protective equipment and precautions for firefighters	Self-contained breathing apparatus and full protective clothing must be worn in case of fire.
Fire-fighting equipment / instructions	In case of fire and/or explosion do not breathe fumes. Move containers from fire area if you can do so without risk. Cool containers with flooding quantities of water until well after fire is out.
General fire hazards	Flammable liquid and vapour.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures	Keep unnecessary personnel away. Stay upwind. Ventilate closed spaces before entering them. Eliminate all ignition sources (no smoking, flares, sparks, or flames in immediate area). In case of spills, beware of slippery floors and surfaces. Do not breathe mist or vapour. Avoid contact with skin. Avoid prolonged exposure. Wear appropriate protective equipment and clothing during clean-up. For personal protection, see section 8 of the SDS. Local authorities should be advised if significant spillages cannot be contained.
Methods and materials for containment and cleaning up	Eliminate all ignition sources (no smoking, flares, sparks, or flames in immediate area). Keep combustibles (wood, paper, oil etc) away from spilled material. Take precautionary measures against static discharge. Use only non-sparking tools. Prevent entry into

	waterways, sewer, basements or confined areas. Large Spills: Stop the flow of material, if this is without risk. Dike the spilled material, where this is possible. Remove with vacuum trucks or pump to storage/salvage vessels. Use a non-combustible material like vermiculite, sand or earth to soak up the product and place into a container for later disposal. Following product recovery, flush area with water. Small Spills: Absorb with earth, sand or other non-combustible material and transfer to containers for later disposal. Clean surface thoroughly to remove residual contamination. Never return spills to original containers for re-use. Ensure that waste and contaminated materials are collected and removed from the work area as soon as possible in a suitably labelled container. For waste disposal, see section 13 of the SDS.
Environmental precautions	Prevent spreading over a wide area (e.g. by containment or oil barriers). Prevent further leakage or spillage if safe to do so. Avoid discharge into drains, water courses or onto the ground. Do not contaminate water. Inform appropriate managerial or supervisory personnel of all environmental releases.

7. HANDLING AND STORAGE

Precautions for safe handling	Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Access to work area should be restricted to people handling the product only. Should be handled in closed systems, if possible. Before entering storage tanks and commencing any operation in a confined area check the atmosphere for oxygen content and flammability. (Subject to applicability) If sulphur compounds are suspected to be present in the product, check the atmosphere for H2S content. The inherent toxic and olfactory (sense of smell) fatiguing properties of hydrogen sulphide require that air monitoring alarms be used if concentrations are expected to reach harmful levels, such as in enclosed spaces, heated transport vessels and spill or leak situations. If the air concentration exceeds 10 ppm, the area should be evacuated unless respiratory protection is in use. Avoid splash filling. Avoid contact with eyes, skin, and clothing. Avoid prolonged exposure. Do not breathe mist/vapours. Pregnant women should not work with the product, if there is the least risk of exposure. Wear appropriate personal protective equipment. Immediately change contaminated clothes. The product is flammable, and heating may generate vapours which may form explosive vapour/air mixtures. Vapours are heavier than air and may travel along the floor and in the bottom of containers. Do not handle or store near an open flame, heat or other sources of ignition. Take precautionary measures against static discharges. Ground container and transfer equipment to eliminate static electric sparks. Use non-sparking tools and explosion-proof equipment. Do not use compressed air for filling, discharging, or handling operations. Restrict line velocity during pumping in order to avoid generation of electrostatic discharge. Partly filled containers present a greater hazard than those that are full, therefore handling, transfer and sampling activities need special care. Containers, even those that have been emptied, can contain explosive vapours. Do not cut, drill, grind, weld or perform similar operations on or near containers. Even with proper grounding and bonding, this material can still accumulate an electrostatic charge. If sufficient charge is allowed to accumulate, electrostatic discharge and ignition of flammable air-vapour mixtures can occur. Due to viscosity product is heated when transferred. Be aware of need using thermal gloves. Be aware of potential for surfaces to become slippery. Do not eat, drink or smoke when using the product. Wash hands thoroughly after handling. Avoid release to the environment. Observe good industrial hygiene practices.

Conditions for safe storage, including any incompatibilities	Ensure that all local regulations regarding handling and storage facilities are followed. Follow rules for flammable liquids. Keep away from heat, sparks and open flame. Prevent electrostatic charge build-up by using common bonding and grounding techniques. Keep in a cool, well-ventilated place. Store locked up. Store in tightly closed container. Keep in an area equipped with sprinklers. Store away from incompatible materials (see section 10 of the SDS). Keep away from food, drink and animal feeding stuffs.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational exposure limits	No exposure limits noted for ingredient(s).
Biological limit values	No biological exposure limits noted for the ingredient(s).
Exposure guidelines	No exposure standards allocated.
Appropriate engineering controls	Provide adequate ventilation and minimise the risk of inhalation of vapours and mists. Use explosion-proof equipment. The level of protection and types of controls necessary will vary depending upon potential exposure conditions. Select controls based on a risk assessment of local circumstances. Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level. Provide easy access to water supply and eye wash facilities.
Individual protection measures, such as personal protective equipment	
Eye / face protection	Wear chemical splash goggles/face shield.
Skin protection	
Hand protection	Wear appropriate chemical resistant gloves. Prolonged or repeated contact: Nitrile gloves (thickness of 0.38 mm and breakthrough time of > 480 minutes, level 6 under the EN 374 European standard) are recommended. Nitrile disposable gloves with a thickness of 0.1 mm and a breakthrough time of > 120 minutes may be suitable for less prolonged exposure. For incidental contact/splash protection Neoprene or PVC gloves may also be suitable. Be aware that the liquid may penetrate the gloves. Frequent change is advisable. Suitable gloves can be recommended by the glove supplier. After using gloves, hands should be washed and dried thoroughly.
Other	Wear appropriate chemical resistant clothing. Anti-static and flame-retardant protective clothing is recommended. Regular protective clothing with high visibility is recommended. Always keep contaminated work clothing away from uncontaminated work clothing and uncontaminated personal clothes.
Respiratory protection	In case of inadequate ventilation or risk of inhalation of oil mist, suitable respiratory equipment with particulate filter and organic vapor cartridges can be used. Wear air-supplied mask in confined areas. Check with respiratory protective equipment suppliers.
Thermal hazards	Wear appropriate thermal protective clothing, when necessary.
General hygiene considerations	Observe any medical surveillance requirements. Handle in accordance with good industrial hygiene and safety practices. Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Private clothes and working clothes should be kept separately.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	
Physical state	Liquid.
Form	Oily liquid.
Colour	Pale yellow to amber
Odour	Hydrocarbon-like.
Odour threshold	Not available.
pH	Not applicable.
Melting point / Freezing point	-40°C - +6°C (-40°F - +42.8°F)
Initial boiling point and boiling range	141 - 462 °C (285.8 - 863.6 °F) (101.3 kPa)
Flash point	> 55.0 °C (> 131.0 °F)
Evaporation rate	Not available.
Flammability (solid, gas)	Not applicable
Upper / lower flammability or explosive limits	
Flammability limit – lower (%)	0.6 %
Flammability limit – upper (%)	7.5 %
Vapour pressure	< 5 kPa (20 °C/68 °F)
Vapour density	> 1 (Air = 1)
Relative density	0.82 - 0.89 (15 °C /59 °F)
Solubility(ies)	
Solubility (water)	Insoluble in water.
Partition coefficient (n-octanol / water)	Log Kow: 3.9 - > 6
Auto-ignition temperature	>= 225 °C (>= 437 °F) (101.3 kPa)
Decomposition temperature	Not available
Viscosity	>= 1.5 mm^2/s
Other information	
Bulk density	Not applicable.
Density	0.80 - 0.91 g/cm^3
Explosive properties	Vapours may form explosive mixture with air.
Kinematic viscosity	1.7 - 6 cSt (40 °C/104 °F)
Oxidizing properties	Not oxidizing
Percent Volatile	100 %
Pour point	< 0 °C (< 32 °F)

10. STABILITY AND REACTIVITY

Reactivity	The product is stable and non-reactive under normal conditions of use, storage and transport.
Chemical stability	Stable at normal conditions.
Possibility of hazardous reactions	Hazardous polymerisation does not occur. This product will not undergo hazardous reaction when used as expected and in recommended environments.
Conditions to avoid	Avoid heat, sparks, open flames and other ignition sources. Avoid temperatures exceeding the flash point. Contact with incompatible materials.
Incompatible materials	Strong acids. Strong oxidising agents.
Hazardous decomposition products	Thermal decomposition or combustion may liberate carbon oxides and other toxic gases or vapours.

11. TOXICOLOGICAL INFORMATION

Information on likely routes of exposure	
Inhalation	Harmful if inhaled. May cause damage to organs through prolonged or repeated exposure by inhalation. Breathing of high concentrations may cause dizziness, light-headedness, headache, nausea and loss of co-ordination. Continued inhalation may result in unconsciousness.
Skin contact	Causes skin irritation. Repeated exposure may cause skin dryness or cracking. May be absorbed through the skin.
Eye contact	May cause eye irritation on direct contact.
Ingestion	Ingestion may cause irritation and malaise. Droplets of the product aspirated into the lungs through ingestion or vomiting may cause a serious chemical pneumonia.
Symptoms related to the physical, chemical and toxicological characteristics	Irritation of eyes and mucous membranes. Skin irritation. May cause redness and pain. Dermatitis. Defatting of the skin. Ingestion may cause irritation and malaise. Aspiration may cause pulmonary oedema and pneumonitis. Be aware that symptoms of chemical pneumonia (shortness of breath) may occur several hours after exposure. Prolonged exposure may cause chronic effects.
Information on toxicological effects	
Acute toxicity	Harmful if inhaled. Hydrogen sulphide, a highly toxic gas, may be present. Signs and symptoms of overexposure to hydrogen sulphide include respiratory and eye irritation, dizziness, nausea, coughing, a sensation of dryness and pain in the nose, and loss of consciousness. Odour does not provide a reliable indicator of the presence of hazardous levels in the atmosphere.

Product	Species	Test Results
Fuels, diesel (CAS 68334-30-5)		
Acute		
Dermal		
LD50	Rabbit	> 5 ml/kg
Inhalation		
Vapor/aerosol		

LC50	Rat	4.1 mg/l, 4 Hours
Oral		
LD50	Rat	> 9 ml/kg (approx. 7600 mg/kg) body weight

Skin corrosion / irritation	Causes skin irritation. Pre-existing skin conditions including dermatitis might be aggravated by exposure to this product.
Serious eye damage / irritation	Direct contact with eyes may cause temporary irritation.
Respiratory or skin sensitisation	
Respiratory sensitisation	Not a respiratory sensitiser.
Skin sensitisation	Not a skin sensitiser.
Germ cell mutagenicity	No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.
Carcinogenicity	Suspected of causing cancer.
Reproductive toxicity	This product is not expected to cause reproductive or developmental effects.
Specific target organ toxicity – single exposure	Not classified.
Specific target organ toxicity – repeated exposure	May cause damage to organs (Bone marrow, Liver, Thymus) through prolonged or repeated exposure.
Aspiration hazard	May be fatal if swallowed and enters airways.
Chronic effects	Prolonged or repeated contact with skin may cause redness, itching, irritation, eczema/chapping and oil acne. Prolonged exposure may cause chronic effects.

12. ECOLOGICAL INFORMATION

Ecotoxicity	Toxic to aquatic life with long lasting effects.

Product		Species	Test Results
Fuels, diesel (/CAS 68334-30-5)			
Aquatic			
Algae	**EL50**	Freshwater algae	22 mg/l, 72 Hours
Crustacea	**EL50**	Daphnia	68 mg/l, 48 Hours
Fish	**LL50**	Freshwater fish	21 mg/l, 96 Hours

Persistence and degradability	The product is readily biodegradable.
Bio-accumulative potential	Evaluation of representative hydrocarbons indicates that no structure meets the very bioaccumulative (vB) criterion but some meet the bioaccumalitive (B) criterion. Potential to bioaccumulate is low.
Mobility in soil	Based on the calculation model the product has a potential of being absorbed in the soil.
Mobility in general	The product is insoluble in water. It will spread on the water surface while some of the components will eventually sediment in water systems. The product is a volatile substance, which may spread in the atmosphere.
Other adverse effects	Oil spills are generally hazardous to the environment. The product is

	avolatile organic compound which has a photochemical ozone creation potential.

13. DISPOSAL CONSIDERATIONS

Disposal instructions	Collect and reclaim or dispose in sealed containers at licensed waste disposal site.
Local disposal regulations	Dispose in accordance with all applicable regulations.
Waste from residues / unused products	Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).
Contaminated packaging	Since emptied containers may retain product residue, follow label warnings even after container is emptied. Empty containers should be taken to an approved waste handling site for recycling or disposal.

14. TRANSPORT INFORMATION

ADR	
UN Number	UN1202
UN Proper Shipping Name	DIESEL FUEL
Transport hazard class(es)	
Class	3
Subsidiary risk	-
Label(s)	3
Hazard No. (ADR)	30
Tunnel restriction code	D/E
Packing group	III
Environmental hazards	Yes
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
RID	
UN Number	UN1202
UN Proper Shipping Name	DIESEL FUEL
Transport hazard class(es)	
Class	3
Subsidiary risk	-
Label(s)	3
Packing group	III
Environmental hazards	Yes
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
IATA	
UN Number	UN1202
UN Proper Shipping Name	DIESEL FUEL
Transport hazard class(es)	
Class	3
Subsidiary risk	-

Packing group	III
Environmental hazards	Yes
ERG Code	3L
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
IMDG	
UN Number	UN1202
UN Proper Shipping Name	DIESEL FUEL
Transport hazard class(es)	
Class	3
Subsidiary risk	-
Packing group	III
Environmental hazards	
Marine Pollutant	Yes
EmS	F-E, S-E
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code	Not applicable. However, this product is a liquid and if transported in bulk covered under MARPOL 73/78, Annex I.

15. REGULATORY INFORMATION

Safety, health and environmental regulations specific for the product in question	This product is classified in accordance with SANS 10234: 2019 – Globally Harmonized System of Classification and Labelling of Chemicals (GHS).	
Hazardous Substances Act, 1973 (Act No. 15 of 1973)		
Not listed.		
International Regulations		
Stockholm Convention		
Not listed		
Rotterdam Convention		
Not applicable		
Montreal Protocol		
Not applicable		
Kyoto Protocol		
Not applicable		
Basel Convention		
Not applicable		
International Inventories		
Country(ies) or Region	**Inventory Name**	**On inventory (Yes / No)***
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes

Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	No
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
Taiwan	Taiwan Chemical Substance Inventory (TCSI)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

* A "Yes" indicates this product complies with the inventory requirements administered by the governing country(s).
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. OTHER INFORMATION

Issue date	11-December-2020
Revision date	-
Version #	01
References	Safe handling practices for liquids that are determined to be static accumulators: American Petroleum Institute 2003 (Protection Against Ignitions Arising out of Static, Lightning and Stray Currents). National Fire Protection Agency 77 (Recommended Practices on Static Electricity). CENELEC CLC/TR 50404 (Electrostatics – Code of practice for the avoidance of hazards due to static electricity).
Disclaimer	Astron Energy (Pty) Limited cannot anticipate all conditions under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use. The information in the sheet was written based on the best knowledge and experience currently available.

16.3 Liquid Petroleum Gas (LPG)

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MATERIAL SAFETY DATA SHEET (MSDS)
SAFETY GAS

Please ensure that this MSDS is received by the appropriate person

DATE: December 2017 Version 3

Ref. No.: MS111

1 PRODUCT AND COMPANY IDENTIFICATION

PRODUCT IDENTIFICATION

Product Name:	SAFETY GAS (LIQUEFIED PETROLEUM GAS)
Chemical Formula:	C3H8 PLUS C4 H10 PLUS C3 H6
Trade name:	Safetygas
Colour Coding:	Plascon Dark Admiralty Grey (SABS 1091 – G.12) body, with a Handigas decal affixed to the cylinder. All cylinders fitted with an internal eductor tube for liquid withdrawal shall be clearly marked with two Yellow (B.49) stripes painted diametrically opposite each other along the length of the cylinder.
Valve:	Brass 5/8 inch BSP left hand female, either single or two-way outlet.
Company Identification:	African Oxygen Limited 23 Webber Street Selby, Johannesburg South Africa Tel. No: (011) 490 0400 Fax. No: (011) 490 0506

EMERGENCY NUMBER 0860 020202 or 011) 873 4382 (24 hours)

2 COMPOSITION/INFORMATION ON INGREDIENTS

Chemical Name	Butane / Propane / Propylene		
Chemical Family	Aliphatic Hydrocarbon		
CAS NO.	BUTANE	106-97-8	UN NO.1075
	Propane	74-98-6	UN No. 1978
	Propylene	115-07-01	UN No. 1077
UN No.	1075		
ERG No.	115		
Hazchem Warning	2A Flammable gas		

3 HAZARDS IDENTIFICATION

Vapourised liquefied petroleum gas is highly flammable and can form explosive mixtures with air. The vapourised liquid does not support life. It can act as a simple asphyxiant by diluting the concentration of oxygen in the air below the levels necessary to support life. It can act as a simple asphyxiant.

Adverse Health effects

The liquefied petroleum gases are non-toxic. Prolonged inhalation of high concentrations has an anaesthetic effect

Chemical Hazards

Propane and butane (known as extensively in commercial and popular terms as Lpgas or LPG) have an extremely wide range of domestic, industrial, commercial, agricultural and internal combustion engine uses. It is estimated that two gases, un-mixed and in mixtures, have several thousand industrial applications and many more in other fields. Their very broad application stems from their occurrences as hydrocarbons between natural gas and natural gasoline, and from their corresponding properties. As a result of their wide application, misuse could result in serious chemical hazards.

Biological Hazards.

Contact with the liquid phase of liquefied petroleum gases with the skin can result in frostbite.

Vapour Inhalation

As the vapourised liquid act as a simple asphyxiant death may result from errors in judgement, confusion, or loss of consciousness which prevents self-rescue. At low oxygen concentrations, unconsciousness and death may occur in seconds without warning.

Eye Contact	The liquid can cause severe burn-like injuries.
Skin Contact	Contact with the liquid phase can cause severe burn-like injuries.
Ingestion	No known effect

Hazard Category 1

Danger
Extremely flammable gas

4 FIRST AID MEASURES

Prompt medical attention is mandatory in all cases of overexposure to vapourised liquefied petroleum gas. Rescue personnel should be equipped with self-contained breathing apparatus. In the case of frostbite from contact with the liquid phase, place the frost bitten part in warm water, about 40 -42 °C. If warm water is not available. Or is impractical to use, wrap the affected part gently in blankets. Encourage the patient to exercise the affected part whilst it is being warmend. Do not remove clothing whilst frosted. Conscious persons should be assisted to an uncontaminated area and inhale fresh air. Quick removal from the contaminated area is most important. Unconscious persons should be removed to an uncontaminated area, and given mouth-to-mouth resuscitation and supplemental oxygen.

Eye contact **(with liquid phase)**
Eye contact Immediately flush with large quantities Of tepid water, or with sterile saline solution. Seek medical attention
Skin Contact See above for handling of frostbite
Ingestion No known effect

Precautionary Statements:

P210: Keep away from heat/ sparks/open flames/ hot surface. No Smoking

P377: leaking gas fire: Do not extinguish, unless leak can be stopped safely.

P381: Eliminate all ignition sources if safe to do so.

P403: Store in a well-ventilated place.

Hazard Statements:

H220: Extremely flammable gas.

5 FIRE FIGHTING MEASURES

Extinguish media

Do not extinguish fire unless the leakage can be stopped. DO NOT USE WATER JET. Use dry chemical, CO2 or foam.

Specific Hazards

The rupturing of cylinders or bulk containers due to excessive exposure to fire could result in a BLEVE (Boiling Liquid expanding Vapour Explosion), with disastrous effects. As the flammability limits in the air for the main constituents of liquefied petroleum gas vary between approximately 2 and 11% by vol, extreme care must be taken when handling leaks.

Emergency actions

If possible shut off the source of spillage. Evacuate area. Post notices "No Naked lights – No Smoking". Prevent liquid or vapour from entering sewers, basements and workpits. Keep cylinders or bulk vessels cool by spraying with water if exposed to fire. If tanker has overturned, do not attempt to right or move it. CONTACT THE NEAREST AFROX BRANCH.

Protective Clothing

Self contained breathing apparatus. Safety gloves and shoes, or boots, should be worn when handling containers.

Environmental precautions.

Vapourised liquefied petroleum gas is heavier than air and could form pockets of oxygen-deficient atmosphere in low lying areas.

6 ACCIDENTAL RELEASE MEASURES

Personal Precautions

Do not enter any area where liquefied petroleum gas has been spilled unless tests have shown that it is safe to do so.

Environmental Precautions.

The danger of widespread formation of explosive LPG/Air mixtures should be taken into account. Accidental ignition could result in massive explosion.

Small spills

DO NOT extinguish the fire unless the leakage can be stopped immediately. Once the fire has been extinguished and all spills have been stopped, ventilate the area.

Large spills

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MATERIAL SAFETY DATA SHEET (MSDS)
SAFETY GAS

Please ensure that this MSDS is received by the appropriate person

Stop the source if it can be done without risk. Contain the leaking liquid, with sand or earth, or disperse with special water/fog spray nozzle. Allow to evaporate. Restrict access to the area until completion of the clean-up procedure. Ventilate the area using forced-draught if necessary. All electrical equipment must be flameproof.

7 HANDLING AND STORAGE

Cylinders containing liquefied petroleum gas should only be handled and stored in the vertical position. Cylinders should never been rolled. Do not allow cylinders to slide or come into contact with sharp edges and they should be handled carefully. Ensure that cylinders are stored away from oxidants. Comply with local legislation..

8 EXPOSURE CONTROLS/PERSONAL PROTECTION

Occupational Exposure Hazards.

As vaporised LPG is a simple asphyxiant, avoid any areas where spillage has taken place.

Engineering control measures.

Engineering control measures are preferred to reduce exposure to Oxygen-depleted atmospheres. General methods include forced-draught ventilation, separate from other exhaust ventilation, separate from other exhaust ventilation systems. Ensure that all electrical equipment is flameproof.

Personal Protection.

Self-contained breathing apparatus should always be worn when entering area where oxygen depletion may have occurred. Safety goggles, gloves and shoes, or boots, should be worn when handling containers.

Skin. Wear loose-fitting overalls, preferably without pockets.

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9 PHYSICAL AND CHEMICAL PROPERTIES

Physical Data

Specific Volume @ 20°C & 101,325 kPa	471ml/g
Auto ignition temperature	450°C
Relative density (Air=1) @101,325kPa	+-1,75
Flammability in air	2,2-9.5%
Colour – Liquid	Clear
Taste	None
Odour	EthylMercaptan
Specification	SANS 1174

10 STABILITY AND REACTIVITY

Conditions to avoid

The dilution of the oxygen concentration in the atmosphere to levels which cannot support life. The formation of explosive gas/air mixtures.

Incompatible Materials

Any common, commercially available metal may be used with commercial (or higher) grades of liquefied petroleum gases because they are non-corrosive, though installations must be designed to withstand the pressure involved and must comply with all state local regulations**.**

Hazardous Decomposition Products.

The constituents of liquefied petroleum gas are relatively stable. However, on combustion, toxic compositions, typically carbon monoxide, may be formed, depending on conditions.

11 TOXICOLOGICAL INFORMATION

Acute Toxicity	TLV 1000 VPM
Skin & eye contact	No known effect.
Carcinogenicity	Severe cold burns can result in carcinoma

(For Further information see Section3.Adverse Health Effects)

12 ECOLOGICAL INFORMATION

Vapourised liquefied petroleum gas is heavier than air, and can cause pockets of oxygen-depleted atmosphere in low-lying areas. It does not pose a hazard to the ecology, unless the gas/air is ignited.

13 DISPOSAL CONSIDERATIONS

Disposal Methods Disposal of Propane, as with other flammable gases, should be undertaken only by personnel familiar with the gas and the procedures for disposal. Contact the supplier for instructions. In general, should it become necessary to dispose of Propane, the best procedure, as for other flammable gases, is to burn them in suitable burning unit available in the plant. This should be done in accordance with appropriate regulations.

Disposal of packaging The disposal of cylinders must only be handled by the gas supplier.

14 TRANSPORT INFORMATION

ROAD TRANSPORTATION

Road Transportation		
UN No.	1075	
ERG No.	115	
Hazchem warning	2A-Flammable gas	
SEA TRANSPORTATION		
IMDG	1075	
Label	Flammable gas	
AIR TRANSPORTATION		
ICAO/IATA Code	1075	
Class	2.1	
Packaging group		
Packaging instructions	Cargo	200
	Passenger	Forbidden
Maximum Quantity allowed	Cargo	150kg
	Passenger	Forbidden

15 REGULATORY INFORMATION

EEC Hazard class Non-flammable
National legislation OHSact and Regulations 85 of 1993
Reference SANS 10234 and its supplement.

16 OTHER INFORMATION

Bibliography

Handbook of Compressed Gases - 3rd Edition
Matheson. Matheson Gas Data Book - 6th Edition
Supplement to SANS 10234 – List of classification and labelling of chemicals in accordance with Globally Harmonized System (GHS)

EXCLUSION OF LIABILITY

Whilst AFROX made best endeavour to ensure that the information contained in this publication is accurate at the date of publication, AFROX does not accept liability for an inaccuracy or liability arising from the use of this information, or the use, application, adaptation or process of any products described herein.

CURRICULUM VITAE (CV) FOR PROPOSED PROFESSIONAL STAFF

MICHAEL PAUL OBERHOLZER

Proposed Position:	Risk Assessor
Name of Company:	RISCOM (PTY) LTD
Name of Staff:	Michael Paul Oberholzer
Profession:	Chemical Engineer
Date of Birth:	20 August 1959
Years with Company:	23
Nationality:	South African

Membership in Professional Societies:

- Registered Professional Engineer (Registration No.: 910085) with the Engineering Council of South Africa
- Member of the South African Institute of Chemical Engineers
- Charted Chemical Engineer Institute of Chemical Engineers (UK) (Registration No: 20561539)
- Approved Inspection Authority for Major Hazard Installation (MHI) Risk Assessments, South Africa
- Technical Steering Committee for Risk Assessments

Key Qualifications:

Michael Oberholzer is currently director of RISCOM. He is a registered professional engineer and holds a BSc (Chemical Engineering) from the University of the Witwatersrand (1982). Mike has over 20 years of experience with Dow chemicals and Sentrachem in all aspects of project implementation. This includes Process Engineering Manager, Project Manager and Commissioning Manager. Since leaving Dow, Mike has concentrated on process safety and has completed a number of risk assessments studies and process hazard analyses in various industries, including assignments in the chemical, petrochemical, agrochemical, mining, offshore oil and gas and food industries.

A selection of relevant projects is included in the following sections.

NUCLEAR

2008 to present	Safety report for marine and land-based incidents for proposed nuclear sites
2008	Safety report for aircraft accidents into nuclear facility
2008	Appointed to conduct risk assessment of fuel plant, Pelindaba
2006	Risk assessment of tank farm for PBNR
2005	Consequence analysis of fuel plant layout, Pelindaba
2003–2005	Chairman of HAZOP studies for PBNR

LNG

Lead Process Engineer for quantitative risk assessment of:

2022	The LNG Facility at the BUA Cement Facility at Sokoto, Northern Nigeria
2020	Importation and Distribution of liquid natural gas (LNG) into the COEGA SEZ
2020	The proposed Tema terminal from LNG to VRA in Ghana, West Africa
2020	LNG importation, storage and transportation for SRK
2020	LNG importation, storage and power production for SE Solutions
2020	LNG based power plant for Mulilo
2014	LNG importation and storage facilities for the CSIR in the Western Cape
2016	LNG based power plant, Western Cape
2016	LNG importation and transportation for Delta Natural Gas

OIL AND GAS

Lead Process Engineer for quantitative risk assessment of:

2025	The New Bay Port Truckstop situated at South Coast Road in Durban, KwaZulu Natal
2025	The Screening Risk Assessments for a proposed WKN Benguela H2 project at various locations near Klawer, Saldanha Bay
2024	The Bayer Facility near Kabwe, Zambia
2023	MHI risk assessment of the NGK Ceramics facility in Cape Town, Western Cape
2023	MHI risk assessment of the Unico Tec Facility at Island View in Durban
2022	The Natural Gas Pipeline from Tokaradi to Tema
2021	The Puma Energy Depot at Walvis Bay, Namibia
2021	The Proposed Novo LNG Hub at the Highveld Industrial Park near Emalahleni, Mpumalanga Province
2021	MHI risk assessment of the Sunrise Energy LPG overland pipeline at Saldanha Bay
2021	MHI risk assessment of the Sunrise Energy LPG terminal at Saldanha Bay
2021	MHI risk assessment of the OTMS Pipelines at Saldanha Bay, Western Cape
2019	Fire risk assessment for SamCol, Mozambique
2019	Occupied building risk assessment for Tema Fuel Company, Ghana
2019	Fire risk assessment for Thebe Unico, Durban
2019	LPG pipeline changes as part of the Port of Berbera, Somiland
2017	Fire risk assessment for condensate tanks, Kenya
2015	A natural gas pipeline for the Transnet in Durban North
2014	LNG facilities for the CSIR in the Western Cape
2014	CNG overland pipeline in Groutville, KwaZulu-Natal
2013	LPG installations for NGK, Cape Town
2013	LPG installations for Easigas (Port Shepstone)
2013	LPG installations for Sunrise Energy in Saldanha Bay
2012	LPG installations for Trellidor, Durban
2011	LPG installations for Afripak, Durban
2010–2011	LPG installations for Monsanto, Brits and Groblersdal
2010	LPG installations for Air Liquide
2009	A compressed natural gas plant, Gauteng
2004-2005	The Egoli Gas depots in Langlaagte and Cottesloe

Lead Process Engineer for:

2006	An emergency plan and oil spill contingency for Petronas, with regards to offshore drilling (Mozambique)
2006	Determination of hazardous areas from releases of H_2S from vents and pipelines

Lead Process Engineer for:

2005	Flare studies for Total facilities in Angola The studies consisted of calculating the radiation from flares at various locations and the subsequent evaluation of the safety distances from the flares The studies included air dispersion for H_2S in the event of flameout

TANK FARM AND FLAMMABLE STORAGE AND TRANSPORTATION

Lead Process Engineer for quantitative risk assessment of:

2025	The Ammonia Terminal at Walvis Bay, Ammonia and Hydrogen Pipeline at Walvis Bay, Namibia
2025	The Blast Overpressures on the Occupied building located near the Tanks at the TotalEnergies Depot in Nelspruit, Mpumalanga
2024	MHI risk assessment of the Teraco Data Centre in Brackengate, Cape Town
2024	MHI risk assessment of the Proposed ARXO Metals Chloroplat Refinery at Chloorkop in Edenvale, Johannesburg
2024	MHI risk assessment of the Enertek Waste Oil Refinery Located in Pomona, Johannesburg
2024	The Ammonia Terminal at Walvis Bay, Ammonia and Hydrogen Pipeline at Walvis Bay, Namibia
2024	MHI risk assessment for the proposed fuel expansion project at the Lanseria Airport in Johannesburg, Gauteng
2024	The Proposed Fuel Storage Project at the Cape Winelands Airport in Durbanville, Cape Town
2024	MHI risk assessment for the Amazon data centre at the Film Studios, Cape Town
2024	MHI risk assessment for the Amazon data centre in Atlantic Hills, Cape Town
2024	MHI risk assessment of the Amazon Web Service Data Centre in Brackengate, Cape Town
2024	The Proposed Microsoft Data Centre in Centurion, Gauteng
2024	Fire Hazard Assessment of the Langer Heinrich Uranium Mine near Swakopmund, Namibia
2023	MHI risk assessment of the Standard Bank Data Centre in Sandton, Johannesburg
2023	MHI risk assessment of the Vantage Data Centre Facility in Germiston, Ekurhuleni
2023	MHI risk assessment of the Amazon Web Service Data Centre at the Film Studios, Cape Town
2023	Fire risk assessment of the ENPC Strategic Fuel Reserve Facility at Phuzamoya, Eswatini
2022	MHI risk assessment of the Amazon Web Service Data Centre in Brackengate, Cape Town
2021	MHI risk assessment of the Cape Ocean terminal at the Saldanha Bay IDZ
2021	MHI risk assessment of the Bayer facility in Brits, North West
2021	75 MW thermal dual fuel facility near Kathu, Northern Cape
2020	Ola Energy LPG Terminal in Mombasa, Kenya
2020	X-Storage facility in Beira, Mozambique
2020	MHI risk assessment of the Saldehco Pipelines in Saldanha Bay, Western Cape
2020	MHI risk assessment for the Teraco data centre in Brackengate, Cape Town
2020	MHI risk assessment for the Amazon data centre in Atlantic Hills, Cape Town
2020	MHI risk assessment for the Amazon data centre at the Film Studios, Cape Town
2020	MHI risk assessment for the Amazon data centre in Brackengate, Cape Town
2019	EIA risk assessment for new tank farm, Coega
2019	MHI risk assessment for OTGT, Coega
2018	Bulk tank farm and LPG facility at Coega
2018	LPG facility for Monsanto at Brits
2017	New fuel depot and import pipeline at Durban
2017	New fuel depot at Alrode
2017	Fire risk assessment at fuel storage tanks, KwaZulu Natal
2017	LPG and liquid tank farm in Tema, Ghana
2017	LPG facility in Kenya
2016	The OTGC facility in Cape Town
2016	LPG facility for Monsanto at Groblersdal

TANK FARM AND FLAMMABLE STORAGE AND TRANSPORTATION

2015	A bulk crude-oil tank farm for Oil tanking MOGS in Saldanha Bay
2014	The First Rand Bank data centre facilities in Pretoria and Johannesburg
2014	The Vopak facility in the Island View Complex in Durban
2014	The Econ Oil facility in Marble Hall, Limpopo
2014	An occupied building risk assessment of BP facilities in Mozambique
2013	The Air BP facility in East London
2013	A crude storage facility at Saldanha Bay
2013	VSAD Terminal Lesedi at Heidelberg
2012	Kenmare Moma Mine in Mozambique
2012	Golder Africa study for tank farm (LPG and other fuels) near Heidelberg, Gauteng
2012	CSIR study for tank farm (LPG and other fuels) at Coega, Eastern Cape
2011-2012	BP fuel depots at Langlaagte and Pretoria
2010	Transnet Pipelines fuel depots around South Africa
2008	Multi-product tank farms in the Island View Complex in Durban
2007	Petroleum tank farm in the Western Cape
2005	An overland pipeline near Mossel Bay
2005	Holcim waste fuel blending
2004	Petroleum tank farms in Island View Complex in Durban and the Western Cape

WAREHOUSING

Lead Process Engineer for quantitative risk assessment of:

2025	MHI risk assessment for the Arch Wood Protection Facility in Port Shepstone, KwaZulu Natal
2020	MHI risk assessment for the Arch Wood protection facility in Port Shepstone
2017	Warehouse for Lonza, Chloorkop
2017	Storage of hazardous goods at Umbogintwini, KwaZulu Natal
2017	Storage of hazardous goods, Johannesburg

POWER PLANTS

Lead Process Engineer for quantitative risk assessment of:

2025	The Proposed Coega Hydrogen Electrolyser Green Ammonia Plant in the CEDZ at Gqeberha, Eastern Cape
2025	The Proposed Itlansi Renewstable Power Plant in Mpumalanga
2025	The Proposed Anzani Renewstable Power Plant in Mpumalanga
2025	The Proposed Matla Renewstable Power Plant in Mpumalanga
2025	The Proposed Kopano Renewstable Power Plant in Mpumalanga
2023	The Proposed Hydrogen Electrolyser Green Ammonia Plant in the CEDZ at Gqeberha, Eastern Cape
2022	The Proposed 1000 MW Gas to Power Plant – Zone 13 at Coega, Eastern Cape Province
2022	MHI risk assessment of the proposed Canelands Gas to Power Plant at Canelands, KwaZulu Natal
2022	The Proposed Phakwe Power Plant at Richards Bay, KwaZulu Natal
2022	The HDF Renewable Energy Power Plant at Swakopmund, Namibia
2022	The Puma Energy Depot at Walvis Bay, Namibia
2022	The proposed Sokoto Gas to Power Plant at the Cement Company of Northern Nigeria
2021	The proposed Impofu Wind Farm battery storage (West) near Clarkson
2021	The proposed Impofu Wind Farm battery storage (North) near Clarkson
2021	The proposed Impofu Wind Farm battery storage (East) near Oyster Bay
2021	Mulilo Total gas to power plant at the Coega SEZ
2021	Engie gas to power plant at the Coega SEZ

POWER PLANTS

2021	320 MW Phinda Power plant at Richards Bay, KwaZulu Natal
2020	Newcastle gas engine power plant at Newcastle, KwaZulu Natal
2020	315 MW Gas engine power plant at Saldanha Bay
2020	200 MW Gas-to-Power plant at Atlantis, Western Cape
2020	1000 MW Gas-to-Power plant Zone 13 at Coega, Eastern Cape
2020	1000 MW Gas-to-Power plant Zone 10 (North) at Coega, Eastern Cape
2020	1000 MW Gas-to-Power plant Zone 10 (South) at Coega, Eastern Cape
2020	MHI risk assessment of the Richards Bay Gas power 2 plant in Richards Bay
2020	The proposed Coal to Urea project at Emalahleni, Mpumalanga
2020	The proposed Nseleni Independent floating power plant at the port of Richards Bay
2018	EIA risk assessment for new power plant, Richards Bay
2016	LNG based power plant, Western Cape
2015	An Eskom power plant in the Free State
2013	A refurbished power plant in Maputo, Mozambique
2012	Matla power station in the Witbank areas
2012	Energy recovery project for Anglo American
2010	Coal-based power plants in the Witbank areas
2009	Coal-based power plants in the Waterberg areas
2008	Proposed gas-fired power plants in Mozambique
2008	The conversion of the peaking power to a CCGT plant located at Atlantis, Western Cape
2006	Coal-based power plants near Witbank and Vaal South
2006	Proposed peaking power plants in KZN and Eastern Cape
2006	The expansion of the peaking power plant located at Atlantis, Western Cape
2005	The EcoElecrica Independent Power Generation Project at Mittal Steel in Vanderbijlpark
2004	Iscor Power Project at Vanderbijlpark

FOODS AND BEVERAGES

Lead Process Engineer for quantitative risk assessment of:

2025	MHI risk assessment of the Spar South Rand Distribution Centre at Jet Park in Boksburg, Gauteng
2023	MHI risk assessment of the Simba Facility at Isando in Ekurhuleni, Gauteng Province
2023	MHI risk assessment of the Spar KwaZulu Natal Distribution Centre Perishables Warehouse in Mount Edgecombe, KwaZulu Natal
2021	MHI risk assessment of the Chill Beverages International facility in Stellenbosch
2017	Johnson & Johnson static ignition study, in Cape Town
2014-2016	The Spar distribution centres in the South Rand, North Rand, Western Cape and Eastern Cape
2015	A soya crushing facility for Russell Stone Protein in Bronkhorstspruit
2014	The Sasko Bakery facility in Bloemfontein
2014	The Peninsula Beverage Company facility in Cape Town
2014	The Chill Beverages International facility in Stellenbosch
2014	The Kynoch fertilizer facility in Endicott, Gauteng
2013-2014	The Coca-Cola Fortune facilities in Port Elizabeth, Port Shepstone and Polokwane
2013	The Quantum Food chicken processing plant at Hartesbeesfontein
2013	The ABI bottling facility in Johannesburg reviewed
2013	The new Unilever ice cream factory facilities at Chloorkop
2011	The Rainbow Chickens processing plant, Rustenburg
2010	The Famous Brands facility in Midrand
2010	The McCain Foods facility in George
2010	The Coca-Cola Canners facility in Germiston
2005	The ABI bottling facilities in Johannesburg, Midrand and Pretoria

CHEMICALS AND MANUFACTURING

Lead Process Engineer for quantitative risk assessment of:

2025	The Samancor Middelburg Ferrochrome situated in Middelburg, Mpumalanga
2024	The Exit Report for the Major Hazard Installation of the Associated Additives Facility at Jacobs in Durban, KwaZulu Natal
2024	MHI risk assessment of the Bronkhorstspruit Biogas Plant in Gauteng
2024	The Proposed Sunderland Ridge Biogas Plant at Centurion, Gauteng
2023	MHI risk assessment of the Bio2Watt Energy Holdings Cape Diary Biogas Plant in Malmesbury, Western Cape
2023	The Proposed Greenfields Glass Plant at Fisantekraal in Durbanville, Western Cape
2023	The Bronkhorstspruit Biogas Plant in Gauteng
2023	The Anglo-American Hydrogen Production Development Platform Project at the Mogalakwena Mine, Limpopo
2023	MHI risk assessment of the review for Trellidor, Phoenix, KwaZulu Natal
2022	The Fishwater Flats Wastewater Treatment Works Biogas Project at Port Elizabeth
2022	MHI risk assessment of the Belgotex Floorcoverings LPG Installation in Pietermaritzburg, KwaZulu Natal
2022	MHI risk assessment of the MAHLE Behr Facility in New Germany, KwaZulu Natal
2022	MHI risk assessment of the Lanxess Facility in Merebank, Durban
2022	MHI risk assessment of the Solvpac Facility in Ladysmith
2025	MHI risk assessment of the Isegen Facility at Isipingo, KwaZulu Natal
2025	MHI risk assessment of the Innovative Water Care SA Holding (Pty) Ltd Facility at Chloorkop in Kempton Park, Gauteng
2025	MHI risk assessment of the Innovative Water Care Facility at Chloorkop in Kempton Park, Gauteng
2022	MHI risk assessment of the Innovative Water Care SA Holding Pty Ltd Facility at Chloorkop in Kempton Park
2022	MHI risk assessment of the Dow Chemicals in New Germany, KwaZulu Natal
2022	MHI risk assessment of the Isegen Facility at Isipingo, KwaZulu Natal
2021	MHI risk assessment of the FFS refiners' facility in Prospecton, KwaZulu Natal
2021	MHI risk assessment of the Belgotex Floorcoverings LPG Installation in Pietermaritzburg, KwaZulu Natal
2021	MHI risk assessment of the Emalahleni Water Reclamation Plant
2021	The Caustic Soda Make-up Plant in Chloorkop, Kempton Park
2021	MHI risk assessment for the Tweefontein water reclamation plant located near Ogies
2020	MHI risk assessment for Foskor, KwaZulu Natal
2019	MHI risk assessments for Isegen, Durban and Germiston.
2017	Relocation of chemical plant from Port Shepstone to Cato Ridge
2016	A-Gas storage and handling facility in Cape Town
2016	NCP chlor-alkali facility at Chloorkop
2016	The Arch Water Products facility at Chloorkop
2015	Two SA Calcium Carbide facilities in KwaZulu-Natal
2015	The Arch Wood Protection facility in Port Shepstone
2015	The Arengo ethanol plant in Cradock
2015	A water reclamation facility at the Optimum Colliery in Mpumalanga
2014	The Foskor facility in Richards Bay
2013	The Eagle Inks facility in Pinetown
2013–2016	New bio-generation plants converting animal waste to electricity
2013	The Unilever facility in Phoenix, Durban
2013	A rapid wall facility in Richards Bay
2013	The Transnet Rail Engineering facilities in Germiston and Uitenhage
2012	The BAE Systems Land Systems facility in Alrode
2012	The CONSOL Glass facility in Nigel
2012	An ArcelorMittal polyurethane facility
2012	Isegen facilities at Durban and Germiston

CHEMICALS AND MANUFACTURING

2012	A MAP plant in Richards Bay
2012	An occupied building risk assessment and hazardous area classification for Synthomer, Durban
2012	New hydrogen fluoride and aluminum fluoride plant in Richards Bay
2012	The Chevron lubricant manufacturing facility
2011	Steel plant in Witbank
2011	Steel plant in Saldanha Bay
2011	Platinum refinery in Springs
2011	New hydrogen fluoride and aluminum fluoride plant in Gauteng
2010	Steel plant in Cato Ridge
2010	A bulk argon storage facility in Johannesburg
2009	An aluminum fluoride plant in KwaZulu-Natal
2009	Shell Chemicals, Durban
2009	The Unico facility in Durban
2008	The Revertex facility in Durban
2007	A new chlor-alkali facility in the Eastern Cape
2002–2008	Ammonia refrigeration plants throughout South Africa
2007	Alkylation plant in KwaZulu-Natal
2006	The Element Six facility in Springs
2006	The Singisi Forest Products wood product facility in Kokstad
2006	The Lanxess facility in Merebank, Durban
2006	A 900 t butane storage facility in Durban This study considered fires and explosions from an accidental loss of containment of material
2005	Impala Platinum BMR expansion This included the consequent modelling of fires and explosions of flammable liquid and gases as well as air dispersion of toxic gases
2005	NCP Chlorchem expansion This included the consequent modelling of fires and explosions of flammable liquid and gases as well as air dispersion of toxic gases
2005	The Dow Chemical Company facilities at Canelands, Chloorkop, Sasolburg and Berlin This included the consequent modelling of fires and explosions of large flammables and toxic gases
2004	The Magalies Water purification plant at Vaalkop

REFINERIES

Lead Process Engineer for quantitative risk assessment of:

2009	A refinery expansion in Suriname
2006	Fire zoning classification of Saudi Aramco's Luberef facility, Saudi Arabia. The study defined the fire zones as per the requirements of Saudi Aramco
2006	Building risk assessment of the Saudi Aramco Luberef facility, Saudi Aramco. The study consisted of a full quantitative risk assessment as per API 752
2005	PetroSA refinery near Mossel Bay

HAZOP AND LOPA/SIL STUDIES

HAZOP Chairman for:

2010 to present	BP Southern Africa covering depots at Langlaagte, Pretoria, East London and Cape Town
2025	The TRV Cascading Study Project at the TotalEnergies Depot in Alrode, Alberton
2025	The Toyota Hydrogen Mobile Refueler in Marlboro, Sandton

HAZOP AND LOPA/SIL STUDIES

2025	The Puma Ondangwa Airport at Windhoek, Namibia
2025	The Puma Hosea Kutako International Airport (HKIA) at Windhoek, Namibia
2025	The Solids Manufacturing and Dispensary at the Kenvue Facility in Retreat, Cape Town
2025	The Puma Eros Aviation Depot at Windhoek, Namibia
2025	The Yara Animal Nutrition South Africa (Pty) Ltd Acid Defluorination Section at Umbogintwini in Durban, KwaZulu Natal
2025	The Gantry Overfilling Protection at the Shell Island View Terminal in Durban, KwaZulu Natal
2025	The High-Pressure Investigation at the Road Gantry at Shell Kroonstad, Free State
2025	The Puma Eros Aviation Depot at Windhoek, Namibia
2025	The Vopak King's Site Gantry Diesel Loading Arm Project at Island View, Durban
2025	The Yara Animal Nutrition South Africa (Pty) Ltd Acid Defluorination Section at Umbogintwini in Durban, KwaZulu Natal
2025	A Fire Protection Upgrade at Rheinmetall Denel Munition in Somerset West, Western Cape
2025	The Vopak Berth 4 Chemical Manifold Project at Island View, Durban
2025	The 46N Upgrade at Rheinmetall Denel Munition in Somerset West, Western Cape
2024	The Review of the TRV Upgrade Project at the TotalEnergies Island View Terminal in Durban, Kwa-Zulu Natal
2024	The TRV Cascading Study Project at the TotalEnergies Depot in Nelspruit
2024	The TRV Cascading Study Project at the TotalEnergies Depot in Waltloo
2024	The VOPAK King's Site Off-Loading Pump Bypass and Major Spill Pump Project at Island View, Durban
2024	The TRV Cascading Study Project at the TotalEnergies Depot in East London
2024	The TRV Cascading Study Project at the TotalEnergies Depot in Bethlehem
2024	The ULP West Gantry Piping Changes at the Shell Island View Terminal in Durban, Kwa-Zulu Natal
2024	The ULP West Gantry Piping Changes at the Shell Island View Terminal in Durban, Kwa-Zulu Natal
2024	The Review of the TRV Upgrade Project at the TotalEnergies Depot in Ladysmith, KwaZulu-Natal
2024	The SFF LPG Import Pipeline Project at the Port of Saldanha, Western Cape
2024	All the Temporary ULSD Gantry Piping Changes at the Shell Island View Terminal in Durban, KwaZulu Natal
2024	The OTMS Crude Oil Blending and Storage Terminal at Saldanha Bay
2024	All the Systems at the Shell Mossel Bay Depot in the Western Cape Province
2024	The VOPAK Terminal Pump Prime Bypass Project at Island View, Durban
2024	The Pump Replacement Project at the Engen Depot in East London, Eastern Cape
2024	The COU System Upgrade at Engen Upington in the Northern Cape
2024	All the Systems at the Shell Island View Terminal in Durban, KwaZulu Natal
2024	All the Systems at the Shell Depot in Witbank, Mpumalanga
2024	All the Systems of the Shell Rocky Drift Depot in White River, Mpumalanga
2024	The Firefighting System Upgrade at the TotalEnergies Depot in Bethlehem, Free State
2024	The Shell Rocky Drift Depot Firefighting Compliance Report
2024	The Solids Manufacturing and Dispensary at the Kenvue Facility in Retreat, Cape Town
2024	The Vopak Foam Addition System at Island View in Durban
2024	The Manzanillo HPNG Terminal LNG Pipeline at Manzanillo Bay
2024	The Tank 501 Conversion at the Shell Kroonstad Depot in the Free State
2024	The Tank Replacement at Engen Montague Gardens in Cape Town
2024	The Ammonia Isotainer Loading Piping Changes at Richards Bay
2024	The New Underground Ethanol Tank at Unilever, Maydon Wharf in Durban
2023	The Tank Emergency Shut Down Valves at the TotalEnergies Depot in Waltloo
2023	The TotalEnergies East London Depot Manifold Valves Replacement
2023	The Commissioning Procedures for the Engen Montague Gardens Black Oil Pipeline Commissioning
2023	The Underground Additive Tank Replacement (NRV) at the Shell Depot Located at Alberton

HAZOP AND LOPA/SIL STUDIES

2023	The Shell Island View Terminal Additive Tank Bypass, Pipeline and Tank Relocation Project Located at Durban
2023	The Shell Witbank Bay 1 Isolation Valve
2023	The Firefighting System Upgrade at the Engen Depot in Epping, Cape Town
2023	The TRV Cascading Study Project at the Shell Alberton Depot
2023	The New Diesel Loading Arm Project at the Samcal Nacala Depot, Mozambique
2023	The New Diesel Loading Arm Project at the SAMCAL Nacala Depot, Mozambique
2023	Review for the Shell Witbank Depot Firefighting Compliance Project
2023	The AECI Mining Chemical R4 PIBSA Reactor Conversion Project at Umbogintwini in Durban
2023	The ULP and Diesel Pipeline Transportation at the TotalEnergies Terminal in Island View, Durban
2023	The New Pumps at the TotalEnergies Depot in Alrode, Alberton
2023	The Product Pipelines at Walvis Bay, Namibia
2023	The Importation and Storage of High Flash Point Hydrocarbon and Solvents at the Unico TEC Facility at Island View in Durban
2023	Tank Changes for the Storage of DOW Products at the Vopak Terminal's King Site located within the Island View Complex, Durban
2023	The MOV Interlock Changes at the Shell Depot in Alrode
2023	The ENPC Strategic Fuel Reserve Facility at Phuzamoya in Eswatini
2023	All the Systems at the Shell Kroonstad Depot in the Free State
2023	Overfill Protection on Storage Tanks at the Shell Rocky Drift Depot
2023	All the Systems at the Shell Alrode Depot in Alberton, Gauteng
2023	The Piping Changes at the Bidvest Tank Terminal Bulk Liquid, Handling and Storage Facility at Island View
2023	The Tank Emergency Shut Down Valves at the Total Energy Depots
2023	The Venetia Stormwater Management Project near Musina, Limpopo
2022	The New Firefighting System at Berth 9 at the Port of Durban
2022	The Systems at the Shell Alrode Depot in Alberton, Gauteng
2022	The Total Energies Island View Terminal Tank 644 Conversion from Diesel to ULP
2022	The HFO and MFO Road Tanker Loading Project at the Shell Island View Terminal
2022	The HFO and MFO Road Tanker Loading Project at the Shell Island View Terminal
2022	The Natcos Berth 9 Line Replacement at the Island View Complex, Durban
2022	The Rail Gantry Project at the Horizon Terminals in Djibouti
2022	FRA for the TPL Jet A-1 Facility at the OR Tambo International Airport
2022	The VIVO Energy Depot Locate in Windhoek, Namibia
2022	The VIVO Energy Depot Locate in Tsumeb, Namibia
2022	The Brix ACRW Sinter Plant in Cato Ridge, KwaZulu Natal
2022	The New Firefighting Pumps at the Engen Depot in Montague Gardens, Cape Town
2022	The Importation and Storage of Caustic Soda at the Unico Tec Facility at Island View in Durban
2022	The Engen SDCO Depot Located at Elliot, Eastern Cape
2022	The New Firefighting System at the Engen SDCO Depot in Elliot, Eastern Cape
2022	The New Firefighting System at Puma Blantyre, Malawi
2022	The Firefighting Upgrade at the Engen SDCO Depot Located at Aliwal North, Eastern Cape
2022	The Kanengo Depot Extension at Lilongwe, Malawi
2022	The Total Energies Gantry Secondary Shut Down Valves
2022	The Astron Energy Depot for the VRU Piping at East London
2022	The Butane Tank Conversion at the Bidvest Tank Terminal Bulk Liquid, Handling and Storage Facility at Richards Bay
2022	The Totalgaz Depot at Chamdor, Gauteng
2022	The Totalgaz Depot at Blackheath in Cape Town
2022	The Total Gantry Secondary Shut Down Valves
2022	The Total IVT Rail Siding Upgrade at the Island View Terminal in Durban
2021	The Puma HFO Terminal at Matola, Mozambique
2021	The Puma Energy Terminal at Walvis Bay, Namibia

HAZOP AND LOPA/SIL STUDIES

2021	The Biodiesel Blending Project at the Shell Depot in Witbank
2021	Valve Replacement at the Shell Depot at Alrode, Gauteng
2021	The MLA Stripping Pump Project, Island View in Durban
2021	The Engen SDCO Depot Located at Elliot, Eastern Cape
2021	The Shell Kroonstad Depot ULP Conversion Project, Free State
2021	The Firewater Pump House Changes at the Airports Company South Africa at the Cape Town International Airport
2021	The Valve Operation Tank at the Shell Mossel Bay Depot
2021	The Totalgaz Depot at Blackheath in Cape Town
2021	The Totalgaz Depot at Polokwane
2021	The Totalgaz Depot at Chamdor, Gauteng
2021	The Pump House changes at the Engen Terminal, East London
2021	The Engen Aliwal North depot at Aliwal North, Eastern Cape
2021	The tank 10 repairs, modification and upgrade project at the Shell depot at Alrode
2021	The West Coast petroleum (SDCO) depot build review at Morreesburg
2021	The Total IVT rail siding upgrade project in Durban
2021	The Shell Witbank Depot firefighting compliance project
2021	The Idwala Carbonates Ore Sorter project in Port Shepstone
2021	Process Hazard Analysis for firefighting at the Engen SDCO in Vryburg
2021	Adjustment of the set pressure of the crude line surge relief valve at the Natcos Fynnland site 2 at the Island View complex in Durban
2021	Process Hazard Analysis for remedial work at the Engen terminal in Vryburg
2021	Natcos Fynnland site tie-in to the multiple product pipeline at the Island View complex in Durban
2021	Process Hazard Analysis for remedial work at the Engen SDCO in Queenstown
2021	Process Hazard Analysis for a fire protection upgrade at Rheinmetall Denel Munition in Somerset West and Wellington, Cape Town
2020	LRP to Diesel change over at the Total Island View terminal in Durban
2020	Shell Rocky Drift depot additive underground tank replacement project at White River
2020	T-009 MOV changes at the Shell depot at Alrode
2020	The Bushveld Electrolyte company’s vanadium electrolyte plant in East London
2020	Shell Island view terminal VRU rail connection project located in Durban
2020	Underground additive tank replacement at the Shell depot located at Alberton
2020	Underground additive tank replacement at the Shell depot located at Mossel Bay
2020	Shell Rocky Drift Tank 03 conversion project in White River
2020	Process Hazard Analysis for the AIR BP Beira depot underground tank replacement in Beira
2020	Bidvest bank terminal bulk liquid, handling and storage facility (LPG section) in Richards Bay
2020	Fire Hazard Assessment of the Indy Oil facility in Pietermaritzburg
2020	Biodiesel storage and blending pipeline upgrade at the Shell depot in Witbank
2020	Biodiesel storage and blending pipeline upgrade at the Shell depot in Alberton
2020	Underground tank replacement for the Shell depot in Polokwane
2020	New HFO tank farm at Mali (completed using teleconferencing)
2020	Automation of the road gantry at the Puma depot in Malawi
2020	Tank changes for the Puma depot at Matola, Mozambique
2020	Extension of the fuel lines at Cape Town International Airport
2020	Changes to the additive tanks at the Shell depot at Kroonstad
2020	Changes to the Shell depot at Kroonstad
2019	Automation of the tank inlet valves at the Shell depot, Alrode
2019	New LNG facility at Tema, Ghana
2019	New fuel tank for Puma Energy, Malawi
2019	New tank for SamCol, Mozambique
2019	Fertilizer blending facility and warehouse, Durban
2019	Astron berth changes, island View
2019	ULP product line changes at the Shell depot, Witbank
2019	Dust HAZOP for Johnson & Johnson, Cape Town
2019	Revalidation of BP depot at East London

HAZOP AND LOPA/SIL STUDIES

2019	Revalidation of BP depot at Pretoria
2018	Changes to ULP tank at the Shell depot in Witbank
2018	New diesel tank farms for Vivo, at the port and mine in Guinea (completed using Teleconferencing)
2018	New double walled tanks at the Total depot, Alrode
2018	Diesel tank for Total, Aldag
2018	Changes to the Oily Water System at BP Cape Town
2018	Firefighting system upgrades at the Total depot, Ladysmith
2018	New LPG facility at Richards Bay
2017	Changes to acrylates storage at Vopak, Island View Complex, Durban
2017	New fuel tanks for Vopak at the Island View Complex, Durban
2017	Pipeline changes for Total at the Island View Complex, Durban
2017	New LPG facility at Coega
2016	Vopak tank farms at Island View, Durban
2016	Engen depots in Namibia
2016	A reactor upgrade at the Engen facility in Durban
2015	An ice-cream factory for Unilever at Chloorkop
2015	The national multi-product pipeline for Transnet in Durban
2015	Fuel transport pipelines for Oiltanking MOGS in Saldanha Bay
2014	The Enerwaste medical waste facility in Waltloo, Pretoria
2014	The Tongaat-Hulett Starch mill in Germiston
2014 to 2016	The VTTI Burgan Oil facility in Cape Town
2013	The Sunrise Energy LPG terminal in Saldanha
2013	The SimsGas facility in Chamdor
2013	The Vanchem Vanadium Products facility in Emalahleni
2013	The ArcelorMittal facility in Newcastle
2013	The Proxa brine treatment facility in New Vaal
2010	Sasol projects at Secunda and Sasolburg
2007–2010	A chrome chemical facility, KZN
2007	Chlorine expansion, Gauteng
2007	LOPA study for a large LPG installation and chemicals, Durban
2004–2004	Project upgrades at petroleum tank farms
2003–2005	Proposed nuclear installation at PBMR
2002–2004	Chevron on eight oil platforms off the coast of Cabinda

Education:

BSc (Chemical Engineering), University of the Witwatersrand, South Africa, 1982

Employment Record:

2002 to present Director, RISCOM, South Africa
Involved in process safety consulting including MHI risk assessments and facilitating process hazard analysis studies (HAZOP, SIL & LOPA)

2001–2002 Managing Member, Penoc Consulting, South Africa
Involved in Process Engineering Project Management and Process Safety Consulting for various projects

1995–2001 Process Manager for Dow Chemicals, South Africa
Managed the cost estimation, project approvals, process designs and commissioning of various plants within the group

1993–1995 Technical Manager for Sentrachem, Durban South Africa
Managed the Technical Department of a facility conducting technical investigations, projects and continual plant improvements

Employment Record:

1986–1993 **Process Engineer for Sentrachem, Germiston, South Africa**
This involved conducting plant investigations, design of new plants, installing and commissioning new equipment

Languages:

	Speaking	**Reading**	**Writing**
English (first)	Excellent	Excellent	Excellent
Afrikaans	Good	Good	Average

Certification:

I, the undersigned, certify that to the best of my knowledge and belief, this data correctly describes me, my qualifications and my experience.

Date: 28th of May 2025

Full name of staff member: Michael Paul Oberholzer

Engineering Council of South Africa

This is to certify that **Michael Paul Oberholzer**

is registered as **Professional Engineer**

in terms of the Engineering Profession of South Africa Act, 1990 (Act 114 of 1990)

date **5 March 1991**

registration number **910085**

President

Registrar