APPENDIX E13 – Quantitative Risk Assessment

PROJECT DONE ON BEHALF OF
NEMAI CONSULTING

QUANTITATIVE RISK ASSESSMENT FOR THE PROPOSED 750 MW MABASA GAS-TO-POWER PLANT IN RICHARDS BAY, KWAZULU NATAL

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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.

Opinions and interpretations expressed herein this report are outside the scope of SANAS accreditation.

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QUANTITATIVE RISK ASSESSMENT FOR THE PROPOSED 750 MW MABASA GAS-TO-POWER PLANT IN RICHARDS BAY, KWAZULU NATAL

EXECUTIVE SUMMARY

1 INTRODUCTION

The Mabasa Thermal Power Plant (hereinafter referred to as Mabasa PP) constructs and operates a combined cycle gas turbine (CCGT) power plant, and associated infrastructure within Richards Bay, in the Kwa-Zulu Natal Province, South Africa.

The overall project would broadly involve the following components:

- Gas-to-Power plant, with a 750 MW generation capacity (specific generation technologies may vary);
- Gas pipelines for the transmission, distribution and reticulation of natural gas within the plant; and,
- Electricity transmission lines to evacuate electricity to the 400 kV lines in Richards Bay.

Since off-site incidents may result due to the hazards of some of the chemical components to be stored on 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 the hazards, the receiving environment and the current relevant designs, as well as the 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 Mabasa PP within Richards Bay.

The scope of the risk assessment included:

1. Develop accidental spill and fire scenarios for the facility;
2. Using generic failure rates, determine the probability of each scenario identified, as well as potential consequences;
3. Where the consequence / risk will extend beyond the site boundary, to calculate the maximum individual risk, taking into account the generic failure rates, initiating events, meteorological conditions and the lethality;
4. Determine and comment on the societal risk posed by the facility;
5. Recommend mitigation measures to minimise risks where required; and to,
6. Identify and assess impacts, including cumulative impacts of the project.

This risk assessment is not intended to replace an MHI risk assessment nor any other legal requirements.

1.2 Purpose and Main Activities

The main activity of the power plant would be the generation of mid-merit power supply to the South African electricity grid. The fuel used to generate power would be natural gas.

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 Mabasa PP in Richards Bay include exposure to:

- Toxic vapours;
- Asphyxiant vapours;
- Thermal radiation from fires; and,
- Overpressure from explosions.

2 ENVIRONMENT

The proposed 750 MW Mabasa PP in Richards Bay, as shown in Figure 2-1, is located in the IDZ Zone 1F, which lies to the west of the Richards Bay CBD and north of the Richards Bay harbour.

To the north of the proposed 750 MW power plant is a quarry, to the east is residential areas as well as to the south. Businesses in close proximity to the 750 MW power plant will be WEG Africa, Flex-It Rubber roof and epoxy, and Shiptech Petroleum to the east, Brass link to the south, Volvo trucks Zululand to the south-west and the Reinhardt transport group and Rigfab to the west.

Alton, which is the area the proposed 750 MW Mabasa PP will be constructed on is a major industrial zone in Richards Bay, and is situated on a very flat coastal plain with an elevation typically ranging from 10 meters to 30 meters above sea level. The local topography features gentle, undulating terrain with minor natural drainage dips, heavily modified by extensive industrial and urban development.

Figure 2-1: Site locality map for the proposed 750 MW Mabasa PP in Richards Bay

3 PROCESS DESCRIPTION

3.1 Site

A layout of the proposed 750 MW proposed Mabasa PP within Richards Bay, is shown in Figure 3-1, and consists of two modules of 375 MW, each located adjacent to each other.

Each module will have a natural gas supply line, gas turbines, steam turbines, transformers, a substation, switch yard, water treatment area and a back-up fuel (LO) area. The administration building will be common for the two modules.

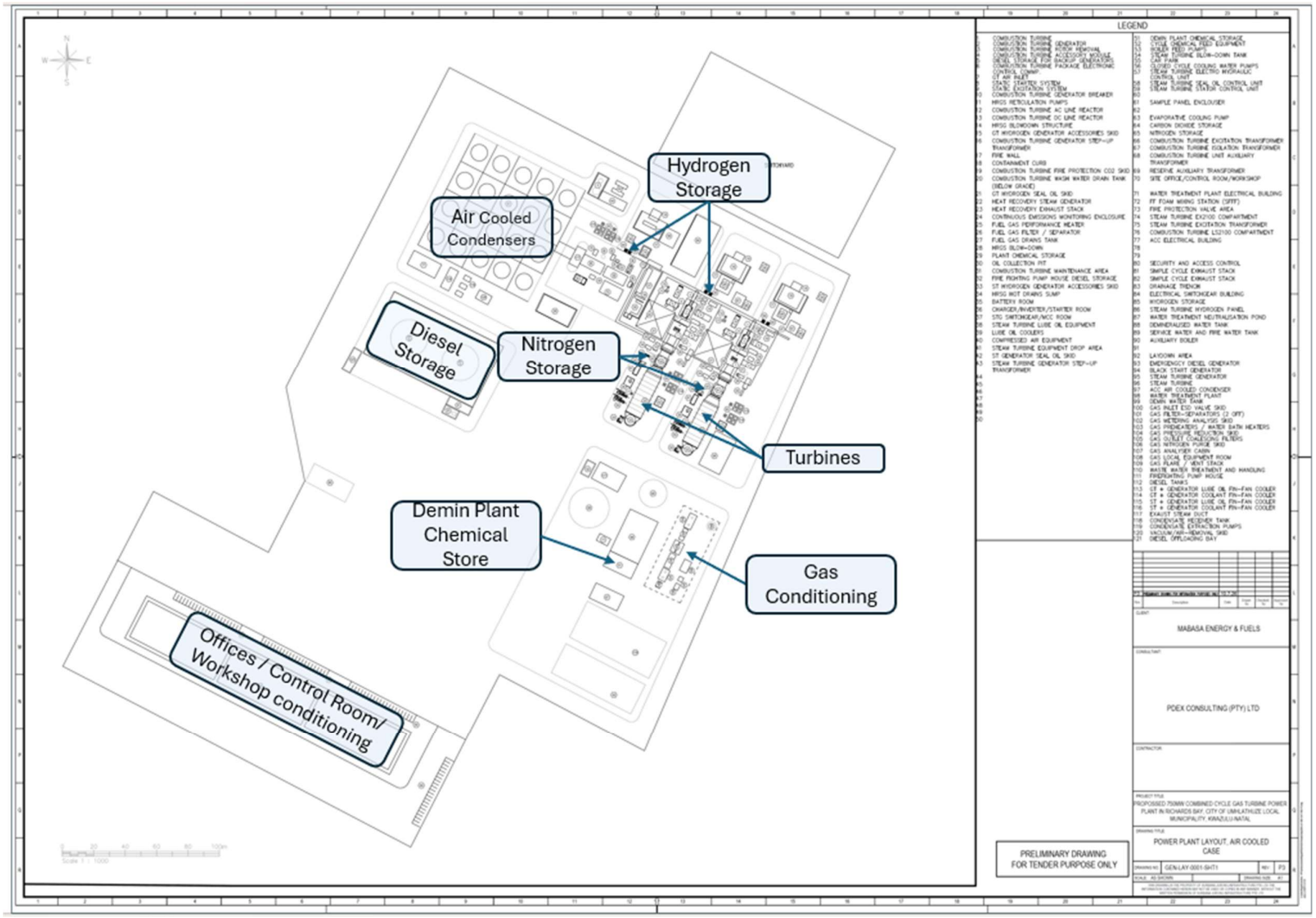

Figure 3-1: Site layout

3.2 Project Description

The power process has not been fully defined and could be the Open Cycle Gas Turbine (OCGT) whereby the gas is burnt to drive the turbines. By capturing the energy from the stack, an addition turbine could be added. This is referred to a Closed Cycle Gas Turbine (CCGT).

The precise combination of generating technology, i.e., gas turbines or combustion engines and combined cycle or open cycle, is unknown and it is expected that the power plant could employ a range of these technologies.

In terms of footprint of the proposed development, as would typically be depicted in a site layout plan, the actual size and arrangement of the various elements will only be determined during a detailed design phase. Spacing between components and equipment may vary. A footprint area of 6.48 hectare has been allocated for the power plant.

The facility would be permanently staffed, 24 hours per day, 365 days per year. For the purposes of this assessment, it will be assumed that the power plant will operate at a maximum capacity of 80% of the time, which for example, in terms of air emissions, would provide a worst-case scenario.

The power plant involves the construction of a gas-fired power station, which will provide power to the electricity grid. The power station will have an installed capacity of up to 750 MW, to be operated on natural gas, with light oil (LO) or Diesel as a back-up fuel. The natural gas is to be supplied via a gas pipeline to the power plant from the supply take-off point. The Liquefied Natural Gas (LNG) terminal infrastructure, and the gas supply pipeline to the boundary fence, does not form part of the scope of this assessment.

The main infrastructure associated with the power plant facility is the following:

- Gas turbines for the generation of electricity through the use of natural gas;
- Heat recovery steam generators (HRSG) to capture heat from high temperature exhaust gases to produce high temperature and high-pressure dry steam to be utilised in the steam turbines;
- Steam turbines for the generation of additional electricity through the use of dry steam generated by the HRSG;
- Condensers for the conversion of steam back to water through a cooling process;
- Bypass stacks associated with each gas turbine;
- Exhaust stacks for the discharge of combustion gases into the atmosphere;
- A water treatment plant for the treatment of potable water and the production of demineralised water (for steam generation);
- Water pipelines and water tanks to transport and store water of both industrial quality and potable water to be supplied by the Local Municipality or produced from the demineralised water;
- Diesel off-loading facility and storage tanks;
- A gas pipeline and a gas pipeline supply conditioning process facility for the conditioning and measuring of the natural gas prior to being supplied to the gas turbines. It must be noted that the environmental permitting processes for the gas pipeline construction and operation will be undertaken under a separate EIA Process; and,
- Ancillary infrastructure including access roads, warehousing, buildings, access control facilities and a workshop area, storage facilities, emergency back-up generators, firefighting systems, laydown areas and switchyards.

3.2.1 Fuels, Chemicals and Utilities Expected at the Facility

The following fuels, chemicals and utilities have been provided for in the study.

3.2.1.1 LNG / Natural Gas

The facility will utilise natural gas as its primary fuel, with diesel oil available as a secondary fuel source to ensure the continuity of operations during periods of natural gas supply interruption. Should the dual-fuel configuration be implemented, the system will allow for both manual and automated changeovers between fuels. A loss of natural gas pressure or flow triggers an automated switchover, ensuring uninterrupted turbine operation under abnormal supply conditions.

Natural gas will enter the facility at the battery limit from the Lilly pipeline at an operating pressure of approximately 50 bar, representing the maximum pressure within the system. Electrical insulation joints will be installed at the terminal point(s) to prevent stray current transfer from the upstream pipeline network. Emergency Shutdown Valves (ESDVs) will be located immediately downstream of the battery limit and will be capable of rapid isolation under both manual and automatic control. The flow rate for the power plant was estimated at 120 t/h.

Downstream of the ESDVs, is the conditioning skid as shown in the block flow diagram of Figure 3-2.

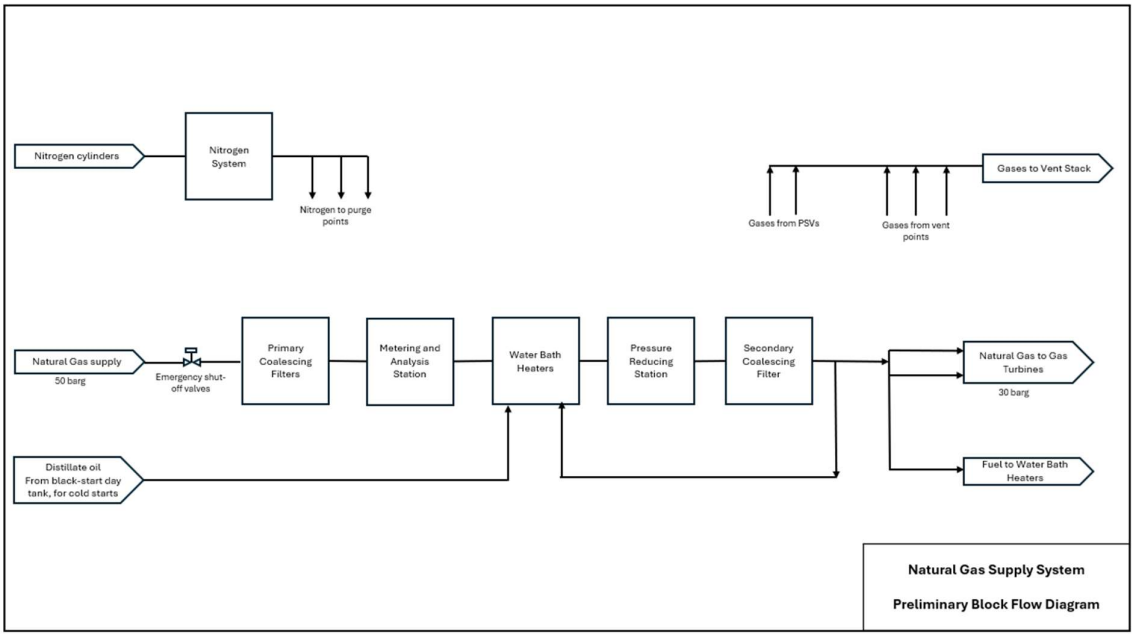

Figure 3-2: Block flow diagram of the gas metering and conditioning station

The gas will pass through coalescing filters designed to remove entrained liquids and particulates to protect the metering equipment. A gas metering and analysis station will record gas delivered to the plant, with dual parallel meters enabling calibration and certification without operational downtime.

The gas turbines require a delivery pressure of 30 bar – 35 bar, necessitating a pressure-reducing station to step down the incoming pipeline pressure. Two pressure-reducing valves will be installed in a parallel position to provide redundancy.

Pressure reduction will result in cooling due to the Joule–Thomson effect, which may lead to hydrate or ice formation. To mitigate this, the gas will be heated by approximately 20°C by using indirect-fired water-bath heaters. These heaters will incorporate submerged process coils, automatic ignition, flame detection, and fail-safe shutdown systems. Natural gas will be used as the primary heating fuel, with diesel utilised only for cold-start conditions. Diesel consumption for this purpose is minimal and can be supplied from existing day tanks.

A second set of fine coalescing filters will be installed downstream of the heating and pressure-reducing stages to ensure that the gas meets the cleanliness requirements specified by the turbine OEM. Overpressure protection will be provided by pressure safety valves (PSVs), with relief gas routed to a dedicated vent stack located in a remote, fenced-off safe area. The vent stack will be equipped with flame arrestors and silencing equipment and will be designed to ensure ground-level gas concentrations remain below the Lower Explosive Limit (LEL) in accordance with statutory and environmental requirements. Hazard signage will be installed at the fenced perimeter.

To support commissioning, maintenance, and safe shutdown, nitrogen purge points will be provided throughout the gas supply and conditioning system, from the battery limit to the gas turbines.

Conditioned natural gas will be delivered to the gas turbines at the required pressure, temperature, and cleanliness. The system design ensures safe, reliable, and compliant operation under all expected ambient conditions and plant load ranges.

3.2.1.2 Diesel

Diesel will be delivered to site in standard heavy road tankers with a typical capacity of 38 000 to 40 000 litres per tanker. These tankers will offload at a dedicated tanker-offloading station equipped with:

- Offloading pumps;
- Spill containment;
- Isolation valves; and,
- Fire protection systems.

The diesel will be stored in two (2) x 6 500 m³ aboveground storage tanks, fully contained within a single bund sized to accommodate 110% of the largest tank volume, in accordance with applicable SANS and environmental containment requirements.

Given the total diesel storage capacity of 13 000 m³, the number of deliveries required to fill the tanks is approximately:

- 13 000 000 litres ÷ 40 000 litres / tanker = 325 road-tanker deliveries for a full fill.

However, diesel operation is a worst-case, unlikely scenario, and deliveries would only occur when back-up fuel is required. Under normal conditions, diesel deliveries would be infrequent, limited to:

- Occasional replenishment of day tanks for water-bath heater cold-start consumption (200 ℓ per cold start), and,
- Periodic top-ups if back-up fuel capability is commercially required.

If the full back-up capability is implemented, the delivery frequency would be:

- Initial filling period: Approximately 300 - 330 tanker deliveries over several weeks.
- Operational phase: Only when back-up fuel is consumed, which is expected to be rare.

This delivery pattern ensures that diesel logistics remain manageable and occur only under exceptional circumstances.

3.2.1.3 Hydrogen

As with all large generators, hydrogen will be used as the cooling fluid. The hydrogen is in a closed system, requiring the occasional top up to replenish any leakages. As such, this make up will be provided by hydrogen cylinder banks.

A total of 3 hydrogen bottle banks of sixteen 50 ℓ cylinders at 200 bar will be on site. This would be a total of 480 Nm^3 or 45 kg.

3.2.1.4 Nitrogen

Nitrogen is an inert gas used for purging the natural gas supply and conditioning system.

Nitrogen is typically stored on site in 20 to 40 high-pressure cylinders, each with a capacity of 50 ℓ at 200 bar – 250 bar, providing an overall inventory of approximately 400 Nm^3 – 800 Nm^3 of gas. Some facilities may instead use a liquid-nitrogen micro-bulk tank, generally holding 2 to 5 tonnes of product. Nitrogen is delivered to the site in compressed-gas cylinders transported on pallets, or, where micro-bulk storage is used, by a cryogenic tanker carrying 8 to 12 tonnes of liquid nitrogen. Cylinders and micro-bulk tanks are stored in a dedicated, fenced gas-storage area. Although nitrogen is non-toxic and chemically inert, it can displace oxygen in confined or poorly ventilated spaces, creating an asphyxiation hazard. Under normal operating conditions, nitrogen poses no environmental emission risks.

3.2.1.5 Lubrication Oil

Each of the three turbines will hold around 200 ℓ of lubrication oil and will consume around 20 ℓ/d. A number of pumps and other small rotating equipment items will also require small volumes of lubrication oil.

Allowing for a storage volume of one oil change for each turbine, and 3 months of top-up, plus consumption by smaller equipment, a maximum of 8 m^3 will be stored on site, in 200 ℓ drums, or in a dedicated storage tank.

All turbines and other potential spill points will have containment measures and any accidental spillages will be directed to the oily water separator.

3.2.1.6 Hydraulic Oil

The steam turbine will require hydraulic oil and up to two x 200 ℓ drums will be stored on site. The turbine and drum storage area will have containment measures and spills will be directed to the oily water separator.

3.2.1.7 Transformer Oil

There will be three oil-filled transformers on site. The volumes of transformer oil in these units are listed below:

- 3 x GSU: 400 MVA 15 kV to 400 kV, approximately 50 m³ (50 000 liters) per transformer;
- 2 x UAT: 30 MVA 15kV down to 11 kV or 6.6 kV or 3.4 kV, approximately 12 m³ (12 000 liters) per transformer; and,
- 2 x NECR: Approximately 2 m³ (2 000 liters) per unit.

There will therefore be approximately 200 m^3 of transformer oil contained within the transformers on site.

Apart from the oil inside the transformers, approximately 400 ℓ of transformer oil will be stored on site, in 200 ℓ drums.

3.2.1.8 Glycol – Small Volumes if any at all

Glycol (ethylene glycol or propylene glycol) may be used in the closed cooling water system. Typically, a 30% glycol / water mix is used. This would occasionally need to be topped-up, and for this purpose up to 10 m^3 could be stored on site, in 200 ℓ drums or 1 000 ℓ IBC containers.

3.2.1.9 Water Treatment Chemicals and Effluent Discharge Chemicals

The Demineralisation Plant resin beds will require regular regeneration with both hydrochloric acid (30% solution) and caustic soda (40% solution) solutions. These solutions will also be used to correct the pH of the water in the neutralising sump before discharge.

Approximately 35 m^3 of hydrochloric acid solution will be stored on site, and about the same volume of caustic solution, both in dedicated tanks.

3.2.1.10 Boiler / HRSG Dosing Chemicals

- **Ammonium Hydroxide**

Ammonia is used to increase the pH of the water in the steam systems to prevent corrosion. Typically, a 20% – 30% solution is used. This will be stored in either flowbins or in a dedicated tank. There will be 15 m^3 of ammonia solution stored on site.

- **Sodium Phosphate**

Sodium phosphate solution (5% – 10% strength) might be required to buffer the pH of the water in the HRSG drum and to prevent scaling.

Sodium phosphate could be delivered to the plant as a dry powder, in 25 kg bags, and mixing could be done on site. Alternatively, it could be delivered as a solution in 1 000 ℓ flowbins or by a bulk tanker. If phosphate is used, approximately 15 m^3 will be stored on site, in a dedicated tank.

- **Sodium Chloride**

If the water-cooled option is selected, the cooling tower circuit may require an electro-chlorination plant to control algae. The plant uses sodium chloride (salt) to produce chlorine. A maximum of about 5 t of sodium chloride will be stored on site, in 1 t bulk bags.

- **Sodium Hypochlorite**

An option to the above-mentioned electro-chlorination plant is dosing with sodium hypochlorite. If this option is selected, then approximately 15 m^3 of a 12.5% solution will be stored on site, in flow bins, or in a dedicated HDPE or rubber-lined tank.

3.3 Summary of Bulk Materials to be Stored on Site

A summary of bulk materials that can give hazardous effects that are to be stored or conveyed and used on site, is given in Table 3-2.

Table 3-2: Summary of hazardous components to be stored / conveyed / used on site

Material	Use	CAS No.	Inventory
Natural Gas	Turbine fuel	—	8 900 kg
Nitrogen	Purging, blanketing	7727-37-9	625 kg
Hydrogen	Turbine cooling	1333-74-0	45 kg
Diesel / LO (Back-up fuel)	Turbine backup	—	Up to 12 500 m³
Diesel (Generator)	Emergency generator	—	45 m³
Lubrication Oil	Turbine lubrication	—	8 m³
Hydraulic Oil	Hydraulic systems	—	400 ℓ
Transformer Oil	Transformers	—	200 m³
Glycol	Cooling circuits	—	—
Caustic Soda (40%)	Water treatment	1310-73-2	35 m³
Hydrochloric Acid (30%)	Water treatment	7647-01-0	35 m³
Ammonium Hydroxide (20% – 30%)	Boiler water chemistry	1336-21-6	15 m³
Phosphate (5% – 10%)	Boiler water chemistry	—	15 m³
Sodium Chloride	Electro-chlorination feed	7647-14-5	5 000 kg
Sodium Hypochlorite (12.5%)	Cooling water dosing	7681-52-9	15 m³

3.4 Establishment Tier

The MHI Regulations (2022), under Chapter 1, Chapter 2 and Chapter 3 defines the establishment tier. Pipelines that meet the criteria of Chapter 3 are considered a High Tier Establishment Major Hazard Installation.

The listed bulk inventories of hazardous materials exceed the threshold values, as shown in Table 3-3, and therefore **qualify the proposed Mabasa PP within Richards Bay as a Medium Tier Establishment Major Hazard Installation.**

Table 3-3: MHI Tier Calculations

						Aggregation Calculations			Tier Classification (t)		
Product	**UN Number**	**Inventory (m^3)**	**Density (kg/m^3)**	**Inventory (t)**	**Hazard**	**Low Hazard**	**Medium Hazard**	**High Hazard**	**Low Hazard**	**Medium Hazard**	**High Hazard**
Hydrogen	1049	–	–	0.045	P2 flammable gas	0.018	0.0045	0.0009	2.5	10	50
Diesel / LO (Back-up fuel)	1202	12500	840	10500	P5c flammable liquid	42	4.2	0.42	250	2500	25000
Diesel (Generator)	1201	45	840	37.8	P5c flammable liquid	0.1512	0.01512	0.001512	250	2500	25000
Sodium Hypochlorite (12.5%)	1791	15	1 200	18	P8 oxidising liquid	0.9	0.36	0.09	20	50	200
					Total	**43.0692**	**4.57962**	**0.512412**			

Note:

- The incoming pipeline is a Top Tier Hazard Establishment, and the MHI risk assessment must be done by the duty holder.
- The conditioning skid and the pipeline to the turbines is consider part of the “installation” and not a MHI establishment alone.

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 the 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; and the,
- 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.

Risk assessments done in accordance with the MHI regulations are required to be conducted according to SANS 1461 (2018). This standard is specific to the MHI risk assessment that is required to be done prior to construction and includes elements that is not usually available at the preparation, such as emergency plans and mitigation suggested during the EIA process.

SANS 1461 (2018) is based on RIVM (2009) for process plants. The latter standards describe the minimum scenarios to be included in the assessment, as well as the assumptions to be used. As full compliance of SANS 1461 (2018) cannot be achieved within the NEMA legislative framework, general compliance of the aforementioned standards would be applicable and briefly described in the sections below.

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, the location and 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); and,
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, as well as toxic releases at the Mabasa PP in Richards Bay. 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 by-laws.

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

The following installations were considered for analysis in the QRA:

- Chlorine;
- Natural gas;
- Diesel; and,
- Ammonia.

As a result of the analysis, the following were concluded:

1. Consequences for the installations were analysed and assessed, with several worst-case scenarios having the potential to affect individuals located offsite. The largest of these was toxic vapour dispersion from the catastrophic rupture of a chlorine drum stored on-site. However, while the impacts could extend beyond the site boundary, no impacts would extend beyond the site boundary.
2. The likelihood of failure of these installations was assessed and the combination of the consequence and the likelihood being used to calculate the overall individual risk.
3. Overall, the individual risk could extend beyond the site boundary. Thus, the risks to the general public were found to be trivial.
4. No new land planning should be approved without the consultation of the PADHI land-planning tables described in Appendix C.
5. Impact assessments of each installation were performed; each was found to be of MEDIUM SIGNIFICANCE, which can be reduced to an acceptable level with potential mitigation measures.

5.1 Hazardous Materials

The project involves several hazardous materials. However, the only hazardous materials in significant quantities include:

- Natural Gas; and,
- Diesel / LO.

These materials were considered in the study.

5.2 Limitations and Assumptions

The risk assessment was developed based on the information provided by the client, and its engineering suppliers. These designs are conceptual and does not include detailed designs or in some cases, insufficient information to conduct a thorough risk assessment. 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 that the vessel size and inventory are not increased.

These assumptions ensure that the assessment remains precautionary and aligned with the NEMA principles of risk avoidance and minimisation.

5.3 Major Hazard Installation (MHI) Tier Classification

The MHI Regulations (2022), under Chapter 1, Chapter 2 and Chapter 3, defines the establishment tier for hazardous installations. The hazardous materials stored at the gas processing plant were evaluated by using the aggregation method prescribed in the Regulations.

The bulk diesel inventory exceeds the threshold values, and therefore **qualifies the proposed Mabasa PP at Richards Bay as a Medium Tier Establishment Major Hazard Installation.**

Note:

- The incoming pipeline is a Top Tier Hazard Establishment, and the MHI risk assessment must be done by the duty holder.
- The conditioning skid and the pipeline to the turbines is consider part of the “installation” and not a MHI establishment alone.

5.4 Diesel

The diesel installation, comprising two large bunded storage tanks and associated tanker off-loading infrastructure, presents credible major-incident scenarios including catastrophic tank failure, serious bund releases, overfilling events, and various tanker and hose failure modes. Consequence modelling indicates that a large diesel bund fire could extend beyond the immediate site boundary, but remains contained within the wider IDZ area.

The maximum individual risk associated with the diesel storage remains within acceptable limits, with the $1x10^{-6}$ fatalities-per-person-per-year isopleth confined to the Mabasa PP boundary and no exceedance of the $1x10^{-4}$ threshold associated with intolerable risk for non-industrial land uses. The lowest risk contour ($3x10^{-7}$), which is relevant to sensitive receptors, would not extend beyond the site boundary, demonstrating that while the diesel

storage contributes to the overall risk profile, it does so within regulatory tolerability criteria and without generating significant off-site risk implications.

5.5 Natural Gas

The natural-gas pipeline, assumed as a 381 mm above-ground line operating at the maximum flow rate, presents credible failure and leak scenarios that were modelled to determine off-site impacts. Consequence modelling shows that a major release could generate jet fires, flash fires or vapour cloud explosion effects capable of extending into the adjacent Alton industrial area, but not into residential neighbourhoods.

The maximum individual risk associated with pipeline failure remains within tolerable limits, with the $1x10^{-6}$ fatalities-per-person-per-year contour extending only a short distance beyond the site boundary and no exceedance of the $1x10^{-4}$ or $1x10^{-5}$ thresholds. The lowest-risk contour ($3x10^{-7}$), relevant to sensitive land uses, remains limited in extent and does not indicate significant off-site vulnerability. Overall, the natural gas pipeline contributes a manageable and ALARP-compliant risk profile, with impacts confined primarily to the site and immediate industrial surroundings.

6 RECOMMENDATIONS

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 design and operational hazards have been identified and adequate mitigation put in place;
- Compliance with IEC 61508 and 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 power plant:
    - Including the demonstration from the designer that sufficient and reliable instrumentation would be specified and installed at the facility;
- Preparation and issue 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 Nemai 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 local authorities);
- Final acceptance of the facility risks with a 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.

Table of Contents

List of Figures

List of Tables

QUANTITATIVE RISK ASSESSMENT FOR THE PROPOSED 750 MW MABASA GAS-TO-POWER PLANT IN RICHARDS BAY, KWAZULU NATAL

1 INTRODUCTION

The Mabasa Thermal Power Plant (hereinafter referred to as Mabasa PP) constructs and operates a combined cycle gas turbine (CCGT) power plant, and associated infrastructure within Richards Bay, in the Kwa-Zulu Natal Province, South Africa.

The overall project would broadly involve the following components:

- Gas-to-Power plant, with a 750 MW generation capacity (specific generation technologies may vary);
- Gas pipelines for the transmission, distribution and reticulation of natural gas within the plant; and,
- Electricity transmission lines to evacuate electricity to the 400 kV lines in Richards Bay.

Since off-site incidents may result due to the hazards of some of the chemical components to be stored on 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 the hazards, the receiving environment and the current relevant designs, as well as the risks and consequences of a major incident.

1.1 Legislation

Legislation discussed in the sub-sections below 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. In South Africa, risk assessments are carried out under the legislation of two separate acts, each with different requirements. These are discussed in the sub-sections 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 co-ordinating 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 the associated 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 re-occurrence 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; or,

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 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 the 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 14 and Section 15.

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 Mabasa PP within Richards Bay.

The scope of the risk assessment included:

1. Develop accidental spill and fire scenarios for the facility;
2. Using generic failure rates, determine the probability of each scenario identified, as well as potential consequences;
3. Where the consequence / risk will extend beyond the site boundary, to calculate the maximum individual risk, taking into account the generic failure rates, initiating events, meteorological conditions and the lethality;
4. Determine and comment on the societal risk posed by the facility;
5. Recommend mitigation measures to minimise risks where required; and to,
6. Identify and assess impacts, including cumulative impacts of the project.

This risk assessment is not intended to replace an MHI risk assessment nor any other legal requirements.

1.3 Purpose and Main Activities

The main activity of the power plant would be the generation of mid-merit power supply to the South African electricity grid. The fuel used to generate power would be natural gas.

1.4 Main Hazards Due to Substance and Process

The main hazards that would occur with a loss of containment of hazardous components at the proposed Mabasa PP in Richards Bay include exposure to:

- Toxic vapours;
- Asphyxiant vapours;
- Thermal radiation from fires; and,
- Overpressure from explosions.

1.5 Software

Physical consequences were calculated by using Gexcon's RISKCURVES v. 13.0.2. All calculations were performed by Mr M P Oberholzer.

1.6 Limitations and Assumptions

The risk assessment was developed based on the information provided by the client, and its engineering suppliers. These designs are conceptual and does not include detailed designs, or in some cases, insufficient information to conduct a thorough risk assessment. 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 that the vessel size and inventory are not increased.

2 ENVIRONMENT

2.1 General Background

The proposed 750 MW Mabasa PP in Richards Bay, as shown in Figure 2-1, is located in the IDZ Zone 1F, which lies to the west of the Richards Bay CBD and north of the Richards Bay harbour.

To the north of the proposed 750 MW power plant is a quarry, to the east is residential areas as well as to the south. Businesses in close proximity to the 750 MW power plant will be WEG Africa, Flex-It Rubber roof and epoxy, and Shiptech Petroleum to the east, Brass link to the south, Volvo trucks Zululand to the south-west and the Reinhardt transport group and Rigfab to the west.

Alton, which is the area the proposed 750 MW Mabasa PP will be constructed on is a major industrial zone in Richards Bay, and is situated on a very flat coastal plain with an elevation typically ranging from 10 meters to 30 meters above sea level. The local topography features gentle, undulating terrain with minor natural drainage dips, heavily modified by extensive industrial and urban development.

Figure 2-1: Site locality map for the proposed 750 MW Mabasa PP in Richards Bay

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 the wind field. The wind speed determines both the distance of downwind transport and the rate of dilution as a result of stretching of the plume, where the generation of mechanical turbulence is a function of the wind speed in combination with the surface roughness. Wind direction and the variability in the wind direction both determine the general path that hazardous vapours will follow and the extent of crosswind 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 Richards Bay, was obtained from Meteoblue: https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/welkom_south-africa_940909.

2.2.1 Surface Winds

The wind-rose analysis shows that the predominant winds blow from the north-northeast (NNE–NE–ENE) and west-northwest (WNW–NW) quadrants, with secondary contributions from the south-southwest (SSW–SW) sectors. Calm conditions (< 2 km/h) occur only about 1% of the time, confirming a generally active surface flow. The most frequent wind speeds range between 5 km/h and 20 km/h, accounting for nearly 80% of annual hours, while stronger winds exceeding 8.7 m/s (≈ 31 km/h) occur less than 1.4% of the time.

Although wind shifts between the north-easterly and south-westerly regimes occur throughout the year, their frequency varies seasonally with synoptic climatology. During summer and winter months, the north and north-easterly winds dominate, while westerly and easterly winds occur less frequently, as illustrated in Figure 2-2.

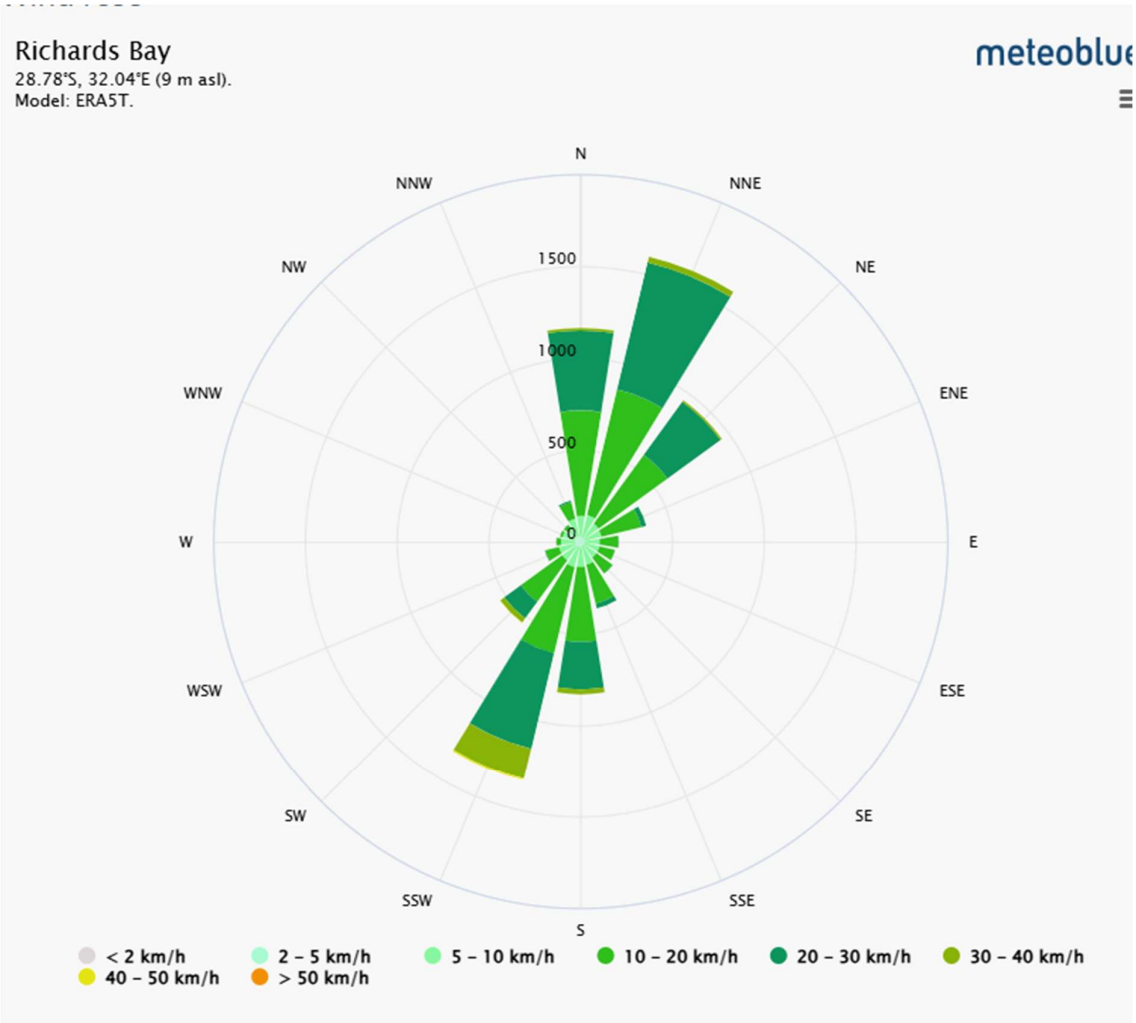

Figure 2-2: Seasonal wind speed as a function of wind direction at Richards Bay

2.2.2 Precipitation and Relative Humidity

The long-term rainfall and relative humidity recorded at Richards Bay was obtained from the Meteoblue for the period from 1994 to 2020, as given in Table 2-1.

Relative humidity, the amount of water that is contained in the atmosphere, influences the extent of fires and toxic clouds. The warmer the air, the more moisture it can hold. Should the relative humidity reach 100%, precipitation occurs. The long-term average precipitation and humidity supplied by Meteoblue, indicates an average annual relative humidity in excess of 50%.

Table 2-1: Long-term average precipitation and relative humidity for Richards Bay

Month	Average Precipitation (mm)	Relative Humidity at 14H00 (%)	Relative Humidity at 20H00 (%)
January	172	70	79
February	167	71	79
March	107	71	78
April	109	71	81
May	109	63	79
June	57	61	72
July	60	59	74
August	65	59	74
Sept	77	66	73
October	105	67	79
November	114	70	80
December	86	69	79
Year	**1228**	**67**	**79**

2.2.3 Temperature

The long-term temperatures recorded at Richards Bay was obtained from Meteoblue for the period from 1994 to 2020, as given in Table 2-2.

Air temperature is important for determining the effect of plume buoyancy (the larger the temperature difference between the plume and the ambient air, the higher the plume is able to rise), for estimating evaporation rates and for determining the development of the mixing and inversion layers.

Extreme temperatures frequently occur due to berg wind conditions, during which temperatures over 40°C are reported for all the months of the year.

Table 2-2: Long- term temperature averages for Richards Bay

Month	Average Maximum (°C)	Average Minimum (°C)	Mean Average (°C)
January	29.2	21.2	25.2
February	28.9	21.2	25
March	28.9	20.4	24.6
April	27	18.1	22.5
May	24.8	15.2	20
June	23.1	12.3	17.7
July	23	12.3	17.6
August	24	14.1	19
September	24.9	16	20.3
October	25.4	17.3	21.3
November	26.7	18.6	22.7
December	28.7	20.4	24.5
Year	**26.2**	**17.3**	**21.7**

2.2.4 Atmospheric Stability

The 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: Atmospheric stability classification scheme

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.

Calculations for this risk assessment are calculated on the six represented weather classes covering the stability conditions of stable, neutral and unstable, as well as low and high wind speeds. In terms of the 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

Due to the absence of hourly readings for the wind speed and direction, the wind rose source was used, where hourly readings of various wind speeds at 16 cardinal directions was obtained. The yearly hours were assumed to be 50% during daytime and 50% during night-time hours. The allocation of the six weather classes, as given in Table 2-5, were then derived for the cardinal directions and is shown in Figure 2-3. The risk was then determined by using the contributions of each wind class in various wind directions.

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

Wind Speed	A	B	B/C	C	C/D	D	E	F
< 2.5 m/s	B 3 m/s			D 1.5 m/s			F 1.5 m/s	
2.5 - 6 m/s				D 5 m/s			E 5 m/s	
> 6 m/s				D 9 m/s				

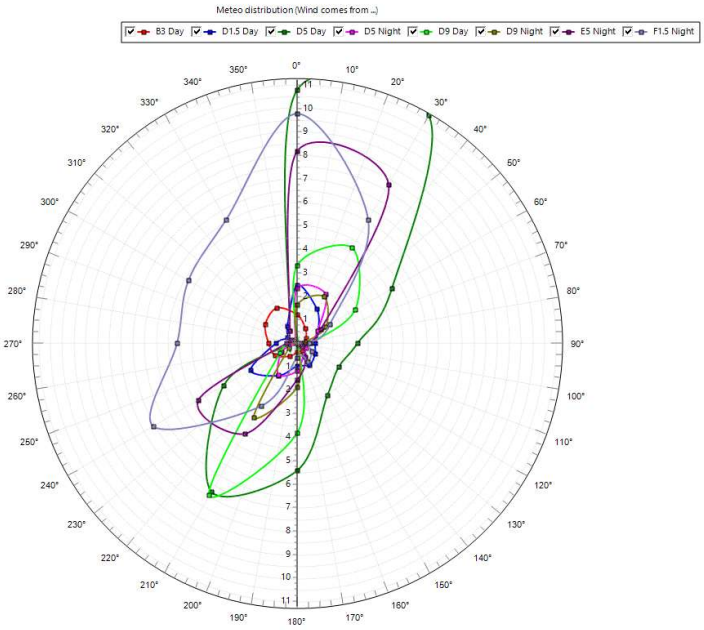

Figure 2-3: Atmospheric stability as a function of wind direction

2.2.5 Default Meteorological Values

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

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

Parameter	Default Value Daytime	Default Value Night-time
Ambient temperature (°C)	26	17
Substrate/bund temperature (°C)	22	22
Water temperature (°C)	22	22
Air pressure (bar)	1.013	1.013
Humidity (%)	67	78
Fraction of a 24-hour period	0.5	0.5
Mixing height	2	1

2 The mixing height is calculated as part of the software.

3 PROJECT DESCRIPTION

3.1 Site

A layout of the proposed 750 MW proposed Mabasa PP within Richards Bay, is shown in Figure 3-1, and consists of two modules of 375 MW, each located adjacent to each other.

Each module will have a natural gas supply line, gas turbines, steam turbines, transformers, a substation, switch yard, water treatment area and a back-up fuel (LO) area. The administration building will be common for the two modules.

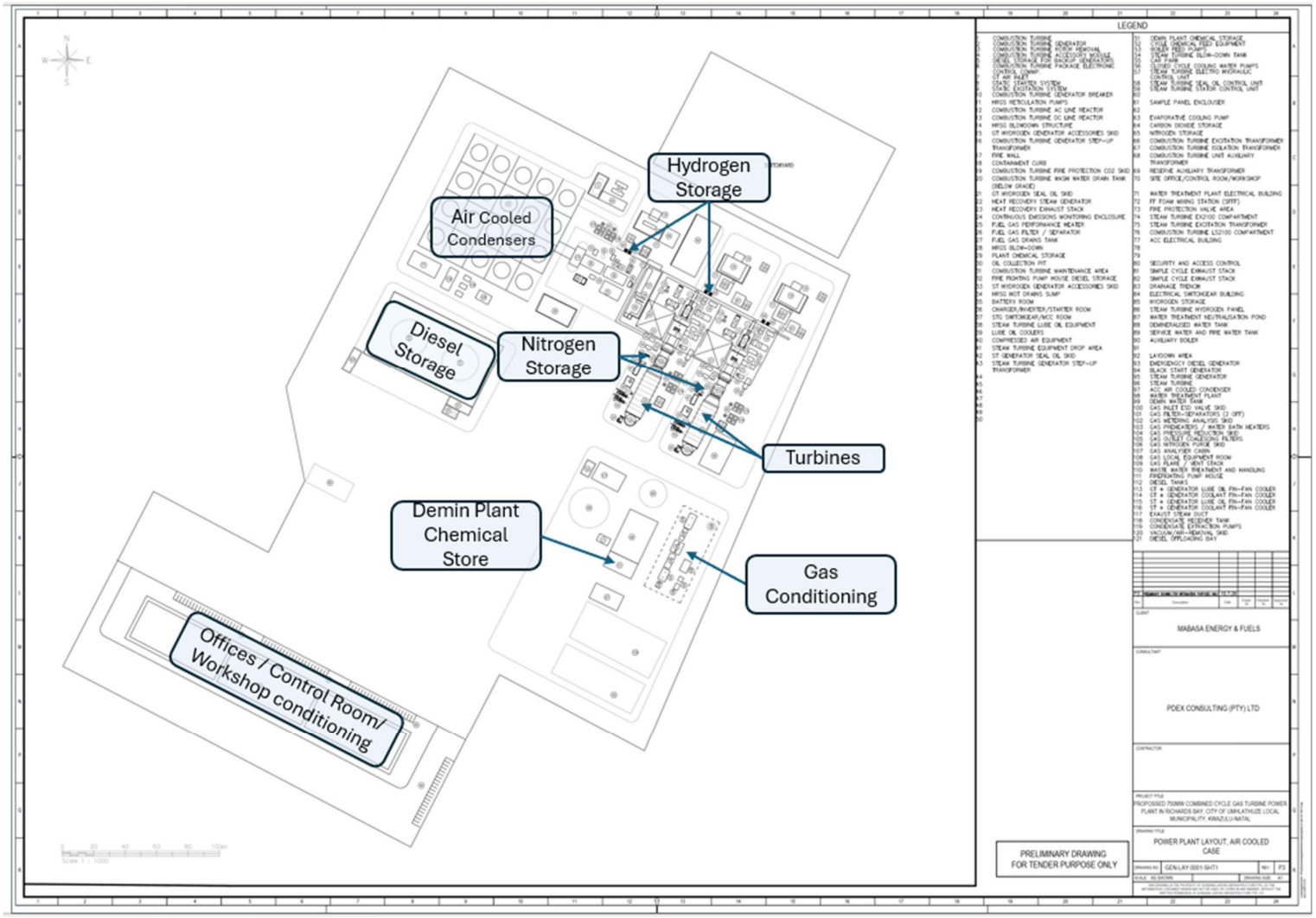

Figure 3-1: Site layout

3.2 Process Description

The power process has not been fully defined and could be the Open Cycle Gas Turbine (OCGT) whereby the gas is burnt to drive the turbines. By capturing the energy from the stack, an addition turbine could be added. This is referred to a Closed Cycle Gas Turbine (CCGT).

The precise combination of generating technology, i.e., gas turbines or combustion engines and combined cycle or open cycle, is unknown and it is expected that the power plant could employ a range of these technologies.

In terms of footprint of the proposed development, as would typically be depicted in a site layout plan, the actual size and arrangement of the various elements will only be determined during a detailed design phase. Spacing between components and equipment may vary. A footprint area of 6.48 hectare has been allocated for the power plant.

The facility would be permanently staffed, 24 hours per day, 365 days per year. For the purposes of this assessment, it will be assumed that the power plant will operate at a maximum capacity of 80% of the time, which for example, in terms of air emissions, would provide a worst-case scenario.

The power plant involves the construction of a gas-fired power station, which will provide power to the electricity grid. The power station will have an installed capacity of up to 750 MW, to be operated on natural gas, with light oil (LO) or Diesel as a back-up fuel. The natural gas is to be supplied via a gas pipeline to the power plant from the supply take-off point. The Liquefied Natural Gas (LNG) terminal infrastructure, and the gas supply pipeline to the boundary fence, does not form part of the scope of this assessment.

The main infrastructure associated with the power plant facility is the following:

- Gas turbines for the generation of electricity through the use of natural gas;
- Heat recovery steam generators (HRSG) to capture heat from high temperature exhaust gases to produce high temperature and high-pressure dry steam to be utilised in the steam turbines;
- Steam turbines for the generation of additional electricity through the use of dry steam generated by the HRSG;
- Condensers for the conversion of steam back to water through a cooling process;
- Bypass stacks associated with each gas turbine;
- Exhaust stacks for the discharge of combustion gases into the atmosphere;
- A water treatment plant for the treatment of potable water and the production of demineralised water (for steam generation);
- Water pipelines and water tanks to transport and store water of both industrial quality and potable water to be supplied by the Local Municipality or produced from the demineralised water;
- Diesel off-loading facility and storage tanks;
- A gas pipeline and a gas pipeline supply conditioning process facility for the conditioning and measuring of the natural gas prior to being supplied to the gas turbines. It must be noted that the environmental permitting processes for the gas pipeline construction and operation will be undertaken under a separate EIA Process; and,
- Ancillary infrastructure including access roads, warehousing, buildings, access control facilities and a workshop area, storage facilities, emergency back-up generators, firefighting systems, laydown areas and switchyards.

3.2.1 Fuels, Chemicals and Utilities Expected at the Facility

The following fuels, chemicals and utilities have been provided for in the study.

3.2.1.1 LNG / Natural Gas

The facility will utilise natural gas as its primary fuel, with diesel oil available as a secondary fuel source to ensure the continuity of operations during periods of natural gas supply interruption. Should the dual-fuel configuration be implemented, the system will allow for both manual and automated changeovers between fuels. A loss of natural gas pressure or flow triggers an automated switchover, ensuring uninterrupted turbine operation under abnormal supply conditions.

Natural gas will enter the facility at the battery limit from the Lilly pipeline at an operating pressure of approximately 50 bar, representing the maximum pressure within the system. Electrical insulation joints will be installed at the terminal point(s) to prevent stray current transfer from the upstream pipeline network. Emergency Shutdown Valves (ESDVs) will be located immediately downstream of the battery limit and will be capable of rapid isolation under both manual and automatic control. The flow rate for the power plant was estimated at 120 t/h.

Downstream of the ESDVs, is the conditioning skid as shown in the block flow diagram of Figure 3-2.

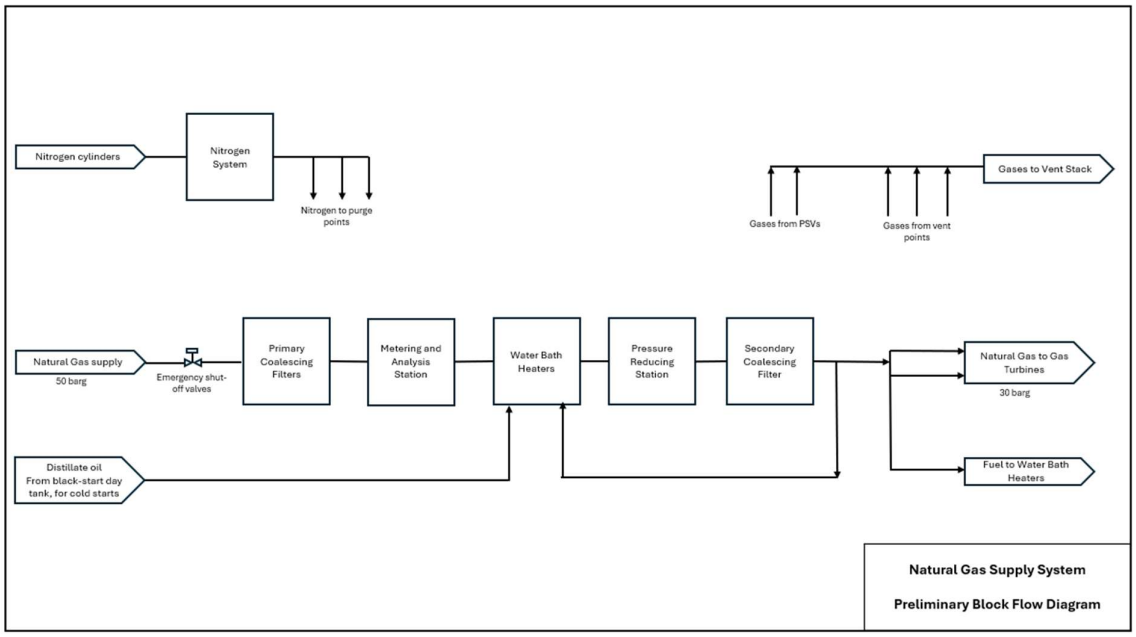

Figure 3-2: Block flow diagram of the gas metering and conditioning station

The gas will pass through coalescing filters designed to remove entrained liquids and particulates to protect the metering equipment. A gas metering and analysis station will record gas delivered to the plant, with dual parallel meters enabling calibration and certification without operational downtime.

The gas turbines require a delivery pressure of 30 bar – 35 bar, necessitating a pressure-reducing station to step down the incoming pipeline pressure. Two pressure-reducing valves will be installed in a parallel position to provide redundancy.

Pressure reduction will result in cooling due to the Joule–Thomson effect, which may lead to hydrate or ice formation. To mitigate this, the gas will be heated by approximately 20°C by using indirect-fired water-bath heaters. These heaters will incorporate submerged process coils, automatic ignition, flame detection, and fail-safe shutdown systems. Natural gas will be used as the primary heating fuel, with diesel utilised only for cold-start conditions. Diesel consumption for this purpose is minimal and can be supplied from existing day tanks.

A second set of fine coalescing filters will be installed downstream of the heating and pressure-reducing stages to ensure that the gas meets the cleanliness requirements specified by the turbine OEM. Overpressure protection will be provided by pressure safety valves (PSVs), with relief gas routed to a dedicated vent stack located in a remote, fenced-off safe area. The vent stack will be equipped with flame arrestors and silencing equipment and will be designed to ensure ground-level gas concentrations remain below the Lower Explosive Limit (LEL) in accordance with statutory and environmental requirements. Hazard signage will be installed at the fenced perimeter.

To support commissioning, maintenance, and safe shutdown, nitrogen purge points will be provided throughout the gas supply and conditioning system, from the battery limit to the gas turbines.

Conditioned natural gas will be delivered to the gas turbines at the required pressure, temperature, and cleanliness. The system design ensures safe, reliable, and compliant operation under all expected ambient conditions and plant load ranges.

3.2.1.2 Diesel

Diesel will be delivered to site in standard heavy road tankers with a typical capacity of 38 000 to 40 000 litres per tanker. These tankers will offload at a dedicated tanker-offloading station equipped with:

- Offloading pumps;
- Spill containment;
- Isolation valves; and,
- Fire protection systems.

The diesel will be stored in two (2) x 6 500 m³ aboveground storage tanks, fully contained within a single bund sized to accommodate 110% of the largest tank volume, in accordance with applicable SANS and environmental containment requirements.

Given the total diesel storage capacity of 13 000 m³, the number of deliveries required to fill the tanks is approximately:

- 13 000 000 litres ÷ 40 000 litres / tanker = 325 road-tanker deliveries for a full fill.

However, diesel operation is a worst-case, unlikely scenario, and deliveries would only occur when back-up fuel is required. Under normal conditions, diesel deliveries would be infrequent, limited to:

- Occasional replenishment of day tanks for water-bath heater cold-start consumption (200 ℓ per cold start), and,
- Periodic top-ups if back-up fuel capability is commercially required.

If the full back-up capability is implemented, the delivery frequency would be:

- Initial filling period: Approximately 300 - 330 tanker deliveries over several weeks.
- Operational phase: Only when back-up fuel is consumed, which is expected to be rare.

This delivery pattern ensures that diesel logistics remain manageable and occur only under exceptional circumstances.

3.2.1.3 Hydrogen

As with all large generators, hydrogen will be used as the cooling fluid. The hydrogen is in a closed system, requiring the occasional top up to replenish any leakages. As such, this make up will be provided by hydrogen cylinder banks.

A total of 3 hydrogen bottle banks of sixteen 50 ℓ cylinders at 200 bar will be on site. This would be a total of 480 Nm^3 or 45 kg.

3.2.1.4 Nitrogen

Nitrogen is an inert gas used for purging the natural gas supply and conditioning system.

Nitrogen is typically stored on site in 20 to 40 high-pressure cylinders, each with a capacity of 50 ℓ at 200 bar – 250 bar, providing an overall inventory of approximately 400 Nm^3 – 800 Nm^3 of gas. Some facilities may instead use a liquid-nitrogen micro-bulk tank, generally holding 2 to 5 tonnes of product. Nitrogen is delivered to the site in compressed-gas cylinders transported on pallets, or, where micro-bulk storage is used, by a cryogenic tanker carrying 8 to 12 tonnes of liquid nitrogen. Cylinders and micro-bulk tanks are stored in a dedicated, fenced gas-storage area. Although nitrogen is non-toxic and chemically inert, it can displace oxygen in confined or poorly ventilated spaces, creating an asphyxiation hazard. Under normal operating conditions, nitrogen poses no environmental emission risks.

3.2.1.5 Lubrication Oil

Each of the three turbines will hold around 200 ℓ of lubrication oil and will consume around 20 ℓ/d. A number of pumps and other small rotating equipment items will also require small volumes of lubrication oil.

Allowing for a storage volume of one oil change for each turbine, and 3 months of top-up, plus consumption by smaller equipment, a maximum of 8 m^3 will be stored on site, in 200 ℓ drums, or in a dedicated storage tank.

All turbines and other potential spill points will have containment measures and any accidental spillages will be directed to the oily water separator.

3.2.1.6 Hydraulic Oil

The steam turbine will require hydraulic oil and up to two x 200 ℓ drums will be stored on site. The turbine and drum storage area will have containment measures and spills will be directed to the oily water separator.

3.2.1.7 Transformer Oil

There will be three oil-filled transformers on site. The volumes of transformer oil in these units are listed below:

- 3 x GSU: 400 MVA 15 kV to 400 kV, approximately 50 m³ (50 000 liters) per transformer;
- 2 x UAT: 30 MVA 15kV down to 11 kV or 6.6 kV or 3.4 kV, approximately 12 m³ (12 000 liters) per transformer; and,
- 2 x NECR: Approximately 2 m³ (2 000 liters) per unit.

There will therefore be approximately 200 m^3 of transformer oil contained within the transformers on site.

Apart from the oil inside the transformers, approximately 400 ℓ of transformer oil will be stored on site, in 200 ℓ drums.

3.2.1.8 Glycol – Small Volumes if any at all

Glycol (ethylene glycol or propylene glycol) may be used in the closed cooling water system. Typically, a 30% glycol / water mix is used. This would occasionally need to be topped-up, and for this purpose up to 10 m^3 could be stored on site, in 200 ℓ drums or 1 000 ℓ IBC containers.

3.2.1.9 Water Treatment Chemicals and Effluent Discharge Chemicals

The Demineralisation Plant resin beds will require regular regeneration with both hydrochloric acid (30% solution) and caustic soda (40% solution) solutions. These solutions will also be used to correct the pH of the water in the neutralising sump before discharge.

Approximately 35 m^3 of hydrochloric acid solution will be stored on site, and about the same volume of caustic solution, both in dedicated tanks.

3.2.1.10 Boiler / HRSG Dosing Chemicals

- **Ammonium Hydroxide**

Ammonia is used to increase the pH of the water in the steam systems to prevent corrosion. Typically, a 20% – 30% solution is used. This will be stored in either flowbins or in a dedicated tank. There will be 15 m^3 of ammonia solution stored on site.

- **Sodium Phosphate**

Sodium phosphate solution (5% – 10% strength) might be required to buffer the pH of the water in the HRSG drum and to prevent scaling.

Sodium phosphate could be delivered to the plant as a dry powder, in 25 kg bags, and mixing could be done on site. Alternatively, it could be delivered as a solution in 1 000 ℓ flowbins or by a bulk tanker. If phosphate is used, approximately 15 m^3 will be stored on site, in a dedicated tank.

- **Sodium Chloride**

If the water-cooled option is selected, the cooling tower circuit may require an electro-chlorination plant to control algae. The plant uses sodium chloride (salt) to produce chlorine. A maximum of about 5 t of sodium chloride will be stored on site, in 1 t bulk bags.

- **Sodium Hypochlorite**

An option to the above-mentioned electro-chlorination plant is dosing with sodium hypochlorite. If this option is selected, then approximately 15 m^3 of a 12.5% solution will be stored on site, in flow bins, or in a dedicated HDPE or rubber-lined tank.

3.2.2 Hazardous Materials Delivery Traffic

Nitrogen and hydrogen, required in relatively small on-site quantities for purging / blanketing and generator cooling, respectively, are supplied as compressed gas in cylinder bundles or tube trailers, delivered by specialised gas-supply vehicles at low frequency given the modest storage volumes involved.

Distillate fuel oil, comprising of both the large-volume natural gas back-up reserve and the smaller emergency generator supply, is delivered by a bulk fuel tanker; however, as this fuel functions as a strategic reserve rather than a continuously consumed process fluid, routine delivery frequency during normal operations is expected to be low, limited to periodic top-ups following testing or minor losses, rather than the high-frequency tanker that would be associated with continuous dual-fuel firing.

Lubrication oil, hydraulic oil and transformer oil are delivered in drums or by a small bulk tanker, respectively, at low frequency, reflecting their role as sealed-system fluids subject to periodic top-up rather than continuous consumption.

Water treatment chemicals such as caustic soda, hydrochloric acid, ammonia and phosphate solutions, are delivered by dedicated chemical bulk tanker on a cyclical basis tied to on-site storage reorder points, driven by demineralisation plant regeneration frequency and boiler water chemistry dosing rates.

Sodium chloride for the electro-chlorination plant is delivered in bulk bags by a flatbed truck on an approximately monthly cycle, consistent with the plant's calculated consumption rate, relative to the on-site storage capacity.

Vehicular traffic associated with hazardous material deliveries, is summarised in Table 3-1.

Table 3-1: Hazardous material vehicular deliveries

Material	Delivery mode	Vehicle Type	Estimated Frequency
Nitrogen	Compressed gas cylinder bundle	Gas cylinder delivery truck	1 per month
Hydrogen	Compressed gas cylinder bundle / tube trailer	Gas cylinder delivery truck	1 per month
Distillate Fuel (NG back-up)	Bulk tanker	Fuel road tanker (30 m³ – 36 m³ capacity)	1 – 2 per month (Top-up only; assumes reserve rarely drawn down in normal ops)
Distillate Fuel (Emergency gensets)	Bulk tanker	Fuel road tanker / bowser	1 per month (Top-up after testing)
Lubrication Oil	Drums (208 ℓ)	Flatbed / panel van	1 per quarter
Hydraulic Oil	Drums	Panel van	1 – 2 per year
Transformer Oil	Bulk tanker	Fuel / oil road tanker	Negligible in normal ops (Sealed system; occasional top-up only)
Caustic Soda (40%)	Bulk tanker	Chemical tanker	1 per month
Hydrochloric Acid (30%)	Bulk tanker	Chemical tanker (Dedicated acid service)	1 per month
Ammonia (20% – 30%)	Bulk tanker or IBC / flowbin	Chemical tanker or flatbed (Multiple IBCs)	1 per month
Phosphate (5% – 10%)	IBC / flowbin	Flatbed truck	1 per month
Sodium Chloride (Possible)	Bulk bags (1 t bags)	Flatbed truck	1 per month
Sodium Hypochlorite (Possible)	25 kg bags, palleted	Flatbed truck	1 per month

3.3 Summary of Bulk Materials to be Stored on Site

A summary of bulk materials that can give hazardous effects that are to be stored or conveyed and used on site, is given in Table 3-2.

Table 3-2: Summary of hazardous components to be stored / conveyed / used on site

Material	Use	CAS No.	Inventory
Natural Gas	Turbine fuel	—	8 900 kg
Nitrogen	Purging, blanketing	7727-37-9	625 kg
Hydrogen	Turbine cooling	1333-74-0	45 kg
Diesel / LO (Back-up fuel)	Turbine backup	—	Up to 12 500 m³
Diesel (Generator)	Emergency generator	—	45 m³
Lubrication Oil	Turbine lubrication	—	8 m³
Hydraulic Oil	Hydraulic systems	—	400 ℓ
Transformer Oil	Transformers	—	200 m³
Glycol	Cooling circuits	—	—
Caustic Soda (40%)	Water treatment	1310-73-2	35 m³
Hydrochloric Acid (30%)	Water treatment	7647-01-0	35 m³
Ammonium Hydroxide (20% – 30%)	Boiler water chemistry	1336-21-6	15 m³
Phosphate (5% – 10%)	Boiler water chemistry	—	15 m³
Sodium Chloride	Electro-chlorination feed	7647-14-5	5 000 kg
Sodium Hypochlorite (12.5%)	Cooling water dosing	7681-52-9	15 m³

3.4 Establishment Tier

The MHI Regulations (2022), under Chapter 1, Chapter 2 and Chapter 3 defines the establishment tier. Pipelines that meet the criteria of Chapter 3 are considered a High Tier Establishment Major Hazard Installation.

The listed bulk inventories of hazardous materials exceed the threshold values, as shown in Table 3-3, and therefore **qualify the proposed Mabasa PP within Richards Bay as a Medium Tier Establishment Major Hazard Installation.**

Table 3-3: MHI Tier Calculations

						Aggregation Calculations			Tier Classification (t)		
Product	**UN Number**	**Inventory (m^3)**	**Density (kg/m^3)**	**Inventory (t)**	**Hazard**	**Low Hazard**	**Medium Hazard**	**High Hazard**	**Low Hazard**	**Medium Hazard**	**High Hazard**
Hydrogen	1049	–	–	0.045	P2 flammable gas	0.018	0.0045	0.0009	2.5	10	50
Diesel / LO (Back-up fuel)	1202	12500	840	10500	P5c flammable liquid	42	4.2	0.42	250	2500	25000
Diesel (Generator)	1201	45	840	37.8	P5c flammable liquid	0.1512	0.01512	0.001512	250	2500	25000
Sodium Hypochlorite (12.5%)	1791	15	1 200	18	P8 oxidising liquid	0.9	0.36	0.09	20	50	200
					Total	**43.0692**	**4.57962**	**0.512412**			

Note:

- The incoming pipeline is a Top Tier Hazard Establishment, and the MHI risk assessment must be done by the duty holder.
- The conditioning skid and the pipeline to the turbines is consider part of the “installation” and not a MHI establishment alone.

4 METHODOLOGY

4.1 Methodology Standards

The methodology for this study is generally based on the South African SANS 1461 (2018) standard for scenario definitions, failure rates, risk criteria and calculation assumptions.

SANS 1461 (2018) is based on RIVM (2009) for process plants. The latter standards describe the minimum scenarios to be included in the assessment, as well as the assumptions to be used. As the full compliance of SANS 1461 (2018) cannot be achieved within the NEMA legislative framework, general compliance of the aforementioned standards would be applicable and briefly described in the sections below.

4.2 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 the 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; and the,
- 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 absence of unintended events, such as component and material failures of equipment, human errors, external events and process unknowns.

4.2.1 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 notifiable substances will be stored on site.

4.2.2 Substance Hazards

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

4.2.2.1 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 F.

- **Liquefied Natural Gas (LNG)** ***(CAS No.: 8006-14-2)***

Liquefied Natural Gas (LNG) is a cryogenic liquid primarily composed of methane (CH_4). In its liquid state, LNG is colorless, odorless, non-toxic, and non-corrosive. It does not contain oxygen and will not burn in its liquid form. To remain a liquid, it must be cooled to approximately -162°C at atmospheric pressure. At this extreme temperature, it becomes a cryogenic substance that can cause severe frostbite upon contact with skin.

When vaporized into a gas, LNG is flammable and will ignite only when mixed with air in specific concentrations, typically between 5% and 15% by volume. Its auto-ignition temperature is about 595°C. The combustion reaction is highly exothermic and primarily yields carbon dioxide and water vapor.

Because it consists mostly of methane, LNG has a specific gravity of roughly 0.554 (compared to air at 1.0), meaning that if it vaporizes in the open air, the resulting gas is lighter than air and will rise and disperse rapidly.

- **Natural Gas** ***(CAS No.: 74-82-8)***

The composition of natural gas is primarily methane (±95% v/v), with other components including ethane, propane and nitrogen.

Given the flammable and potentially explosive nature of natural gas, fires and VCEs represent the primary hazards associated with transfer of the gas. The gas is a fire and explosion hazard when it is exposed to heat and flame. The lower explosive limit (LEL) is 5% v/v (meaning 5% gas to 95% air, measured by volume) and the higher explosive limit (HEL) is 15% v/v. In unconfined atmospheric conditions, the likelihood of an explosion is expected to be small.
It is not compatible with strong oxidants and could result in fires and explosions in the presence of such materials.

It is non-toxic and would be considered as an asphyxiant only. Chronic and long-term effects are low and are not listed.

It is in the gaseous state at atmospheric temperatures and pressures. Economical transportation would require either liquefying or compressing the gas so that it would occupy less volume per weight. At atmospheric pressure, natural gas has no single fixed temperature and will exist as a gas at typical environmental temperatures. The critical pressure of methane is 46 bar; compressed natural gas (CNG) would be above the critical pressure and would be a supercritical gas having a density similar to that of the liquid.

- **Ammonia *(CAS No.: 7664-41-7)***

Ammonia is a colourless gas with a pungent and suffocating odour. It liquefies easily under pressure, with a normal boiling point of -33°C. Although classified as a non-flammable gas, it will burn in 16% – 25% vapour concentrations in air when exposed to open flames.

It is incompatible with certain materials. It is corrosive to copper, brass, silver, zinc and galvanized steel. Contact with strong oxidizers can result in fires and explosions. It forms explosive products when in contact with calcium hypochlorite (household) bleaches, halogens, gold, mercury and silver. Heat is generated when ammonia dissolves in water. At high temperatures, ammonia emits hydrogen and nitrogen. Products of combustion include nitrogen and water, which are harmless to life and the environment.

The effects of anhydrous ammonia upon the human body vary with the size and weight of the subject and to a lesser extent temperature and humidity.

Contact with liquid ammonia can cause frostbite. Ammonia is soluble in water, forming a corrosive liquid. It is toxic if swallowed or inhaled and can irritate or burn skin, eyes, the nose or the throat at levels as low as 35 ppm but normally at 100 ppm – 125 ppm, through inhalation or direct contact. At 700 ppm it can cause serious and permanent injury with extreme rapidity.

Upon contact with moist mucosal membranes (such as those in the skin, eyes and respiratory tract), ammonia reacts with water to form a strong alkali, ammonium hydroxide. This causes severe damage to the surface of tissues, thereby exposing more tissue to the effects of the alkali. Symptoms are rapid on contact due to the high-water solubility of ammonia and include immediate burning of the eyes, nose and throat and coughing and bronchospasm with wheezing and pulmonary oedema (fluid around the lungs).

Massive exposures can override the absorptive surface area of the upper respiratory tract and result in extensive injury to the lower airways and lung tissue.

There have been a number of major accidents involving ammonia involving storage tanks and pipelines as well as ammonia transported on trucks, railcars and ships.

The worst incident occurred in 1973 in Potchefstroom, South Africa, where a failure of an ammonia tank released approximately 39 t killing 18 people.
There have been a number of nonfatal releases of ammonia. A release of about 600 t of ammonia occurred from a pipeline in Floral, Arkansas, in 1971 and resulted in a fish kill but no injuries. In another incident, 230 t of ammonia was released from a pipeline at McPherson, Kansas, without fatalities.

- **Diesel *(CAS No.: 68334-30-5)***

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, central nervous system 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.

- **Light Oil (LO) *(CAS No.: 8042-47-5)***

LO is a hydrocarbon mixture with variable composition with an approximate boiling point range of 152°C. It is a pale-yellow liquid with a petroleum odour. Due to the flash point of LO being approximately 54°C, this material is not considered highly flammable but 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.

It is not considered a toxic material. Contact with vapours may result in slight irritation to nose, eyes and skin. Vapours may cause headaches, dizziness, loss of consciousness or suffocation as well as lung irritation with coughing, gagging, dyspnoea, substernal distress and rapidly developing pulmonary oedema.

If swallowed, LO 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.

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

- **Chlorine *(CAS No.: 7782-50-5)***

Chlorine is a greenish-yellow gas, with an irritating and suffocating odour. This gas is extremely toxic and a powerful oxidising agent. It has to be handled, stored and processed with caution.

It is very reactive and may cause ignition on contact with the following components: methane; oxygen; hydrazine; hydroxylamine; calcium nitride; diethyl ether; diethyl zinc; potassium, sodium and copper hydrides; boron; active carbon; silicon; phosphorus; arsenic powder; arsine; phosphine; silane; trialkylboranes (lower homologues); dicopper acetylide; zirconium dicarbide (at 250°C); arsenic disulphide; boron trisulphide; mercuric sulphide; boron diiodophosphide; phosphorus trioxide; and, trimercury tetraphosphide. Trimagnesium diphosphide and trimanganese diphosphide would ignite in warm chlorine. Metals such as tin, aluminium, brass, calcium, copper, iron, manganese, potassium, antimony, bismuth, magnesium, sodium, zinc, thorium, tin, uranium, nickel, mercury, aluminium-titanium alloys and niobium ignite in chlorine under various conditions.
Titanium components would not be suitable for contact with dry chlorine gas or liquid. Steel ignites in chlorine under various conditions. Ignition has occurred during continuous chlorination of polyisobutene.

It may react explosively with amidosulphuric acid, antimony trichloride and tetramethylsilane (at 100°C), tert-butanol, butyl rubber, naphtha, carbon disulphide, 3-chloropropyne, dibutyl phthalate, dichloride (methyl) arsine, disilyl oxide, glycerol, white phosphorus (at -34°C), hexachlorodisilane (9), diborane, stibine, ethylphosphene, silicones, synthetic rubber, aluminium, oxygen difluoride (on warming), benzene, tetraselenium tetranitride, dimethyl phosphoramidate, methanol and tetrepyridine cobalt (II) chloride, methane (over yellow mercury oxide), ethylene, ethane and petrol. Explosive reactions with acetylene have occurred under a variety of conditions. Injection of liquid chlorine into a naphtha-sodium mixture may cause a violent explosion. Other incidents involving saturated hydrocarbons and chlorine have been reported, as have incidents involving organic auxiliary materials. Combination with hydrogen may be explosive over a wide range of conditions, and equimolar mixtures of chlorine and hydrogen containing 0.1-0.2% nitrogen trichloride explode in absence of light if the pressure is below a limiting value.

In humans, short-term (acute) exposure to high levels (> 30 ppm) results in chest pain, vomiting, toxic pneumonitis, pulmonary oedema and eventually death. At lower levels (< 3 ppm), it is a potent irritant to eyes, the upper respiratory tract and lungs.

Limited information is available on long-term (chronic) effects of exposure on humans. However, early literature shows that chronic exposure to concentrations of around 5 ppm causes respiratory complaints, corrosion of teeth, inflammation of mucous membranes of the nose and increased susceptibility to tuberculosis.

No information is available on developmental or reproductive effects on humans or animals via inhalation exposure. A study reported no adverse effects on growth, life span or fertility in rats exposed to 100 ppm in drinking water for their entire life span, over seven generations according to the US Environmental Protection Agency (EPA) Integrated Risk Information System (IRIS). Furthermore, no information is available for carcinogenic effects on humans from inhalation exposure, and it has not been found to be carcinogenic in oral studies with animals.

It is extremely irritating to skin and can cause severe burns. Acute tests on rats and mice have shown high acute toxicity. It is a potent irritant in humans to eyes, the upper respiratory tract and lungs. Several studies have reported the effects shown in Table 4-1.

Table 4-1: Acute toxicological effects of chlorine

Concentrations		Effect
(ppm)	(mg/m^3)	
0.014–0.054	0.041–0.157	Tickling of the nose (odour threshold)
0.040–0.097	0.116–0.281	Tickling of the throat
0.060–0.3	0.174–0.870	Itching of the nose, coughing, stinging or dryness of the nose and throat
0.35–0.72	1.015–2.088	Burning of the conjunctiva and pain after 15 minutes
0.5	1.45	Temporary emergency exposure level TEEL-0
1.0	2.9	Threshold level value – time weighted average (TLV-TWA)
1.0	3	Emergency response planning guideline ERPG-1
> 1.0	> 2.9	Discomfort ranging from ocular and respiratory irritation to coughing, shortness of breath and headaches
1.0–3.0	2.9–8.7	Mild mucous membrane irritation
3.0	8.7	Short-term exposure level (STEL)
3.0	7.5	ERPG-2
14	40	Concentration which causes immediate irritation
34	98.9	Lowest reported median lethal concentration LC_{50} (human, 30 min)
20	60	ERPG-3
25	72.7	Immediately dangerous to life or health (IDLH)
30	87	Chest pain, vomiting, dyspnoea, coughing
46–60	133.4–174	Toxic pneumonitis and pulmonary oedema
430	1247	Highest reported LC_{50} (human, 30 min)
500	1454	Lowest recorded lethal concentration (mammal, 5 min)
873	2538	Lethal concentration (human, 30 min)
1000	2900	Lethal after a few breaths

Information on toxicity of chlorine was studied, and the relationship between toxicity and exposure were produced, as shown in Figure 4-1. Hazard categories were then defined more closely in terms of toxic effects, and the relationships shown in Figure 4-2 were derived. In assessing effects of toxic substances, consideration needs to be given to members of the public who may be more susceptible than the average adult worker, such as children and the elderly.

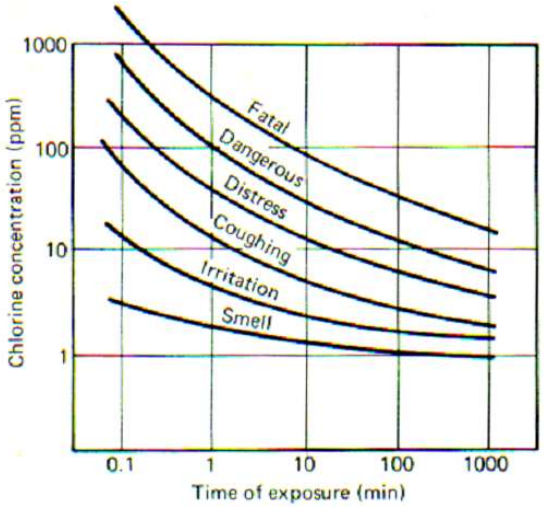

Figure 4-1: Effects of chronic exposure to different concentrations of chlorine vapour (Lees 2001)

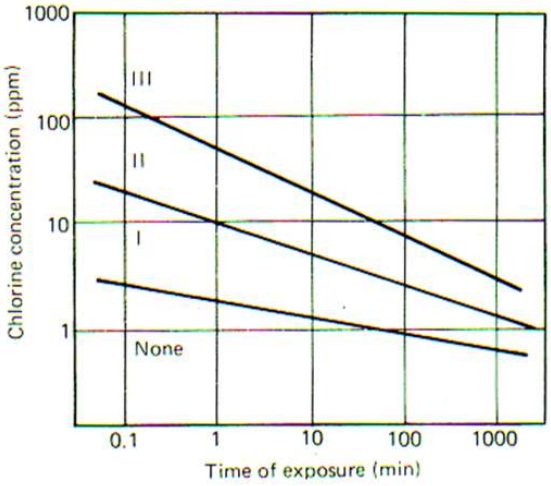

Figure 4-2: Categories of chronic releases (Lees 2001) with four categories of hazard defined: Category 0 involves no nuisance to the public; Category I could cause nuisance to the public (acceptable once per year); Category II could cause distress to people, damage to vegetation and could give rise to claim of compensation (acceptable once in 10 years); and, Category III could result in injury or loss of life (acceptable once in 100 years)

There have been a number of major accidents involving chlorine. Analysis has shown that, with one exception, fatalities occur within about 400 m of the release and generally within 250 m from the incident (Lees 2001). Chlorine released from cylinders tends to have the highest mortality index (fatalities per tonnes released). In this event, the amount of gas released is small but often occurs within a building.

Accidents have involved storage tanks and portable cylinders as well as chlorine transported on trucks, railcars and ships. The worst incident occurred in 1939 at Zarnesti, Romania, where a failure of a chlorine tank killed about 60 people.

- **Nitrogen *(CAS No.: 7727-37-9)***

Nitrogen is a colourless, odourless gas that is non-flammable and can be considered inert since it does not readily react with other components.
It has a molecular weight of 28 and has a similar density to air. It could accumulate in confined areas and low points displacing oxygen, which may result in asphyxiation. Typical oxygen deficiencies effects are given in Table 4-2.

Table 4-2: Exposure to oxygen-deficient atmosphere

Oxygen Content of Air	Signs and Symptoms of Persons at Rest
15%–19.5%	Decreased ability to work strenuously May impair coordination and may induce symptoms in persons with coronary, pulmonary or circulatory problems
12%–15%	Respiration deepens, increased pulse rate and impaired coordination, perception and judgment
10%–12%	Further increase in rate and depth of respiration, further increase in pulse rate, performance failure, giddiness, poor judgment and blue lips
8%–10%	Mental failure, nausea, vomiting, fainting, unconsciousness, ashen face and blue lips
6%–8%	Eight minutes may be fatal in 50% - 100% of exposures; six minutes may be fatal in 25% - 50% of exposures; and, after four to five minutes there may be recovery with treatment
4%–6%	Coma in 40 seconds; convulsions, respiration ceases and death

Nitrogen is normally stored as a liquid at low temperatures and elevated pressures. Exposure to liquid nitrogen can cause frostbite.

It can only be absorbed into the body by inhalation with resultant asphyxiation risks.

4.2.2.2 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 components to be stored on, produced at or delivered to site, are listed in Table 4-3. These components have been analysed for fire and explosion risks.

Table 4-3: Flammable and combustible components to be stored on, produced at or delivered to site

Component	Flashpoint (°C)	Boiling Point (°C)	LFL (vol. %)	UFL (vol. %)
Natural gas	-188	-161	5	15
Hydrogen	N/A	-253	4	75
LNG	-103.5	-42	2.1	9.5
Diesel or fuel oil	> 55	290	0.6	7.5

Ammonia will burn in 16% – 25% vapour concentrations in air when exposed to open flames. However, due to its low reactivity, it is classified as a non-flammable gas and is only assessed on toxicity (RIVM, 2009).

4.2.2.3 Toxic and Asphyxiant Components

Toxic or asphyxiant components of interest to this study are those that could produce dispersing vapour clouds upon release into the atmosphere. These could subsequently cause harm through inhalation or absorption through the skin. Typically, the hazard posed by toxic or asphyxiant components will depend on both the concentration of the material in the air and the exposure duration.

Ammonia, chlorine and sulphuric acid are considered acutely toxic components.

The acute exposure guideline level (AEGL) / emergency response planning guideline (ERPG) values, are given in Table 4-4.

Table 4-4: Guideline levels for toxic and asphyxiant components

Component	AEGL-1		AEGL-2		AEGL-3	
	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	ppm
Ammonia	20.9	30	111	160	766	1100

AEGL values correspond to a one-hour exposure.

Sulphuric acid has a very low vapour pressure and significant amounts of toxic vapour would not be released.

4.2.3 Physical Properties

For this study, natural gas and diesel were modelled as pure components, as given in Table 4-5. The physical properties used in the simulations were based on the DIPPR[1] data base.

Table 4-5: Representative components

Component	Modelled as
Liquefied natural gas	Modelled as pure methane
Natural gas	Modelled as methane
LO / Diesel	Modelled as dodecane

4.2.4 Components Excluded from the Study

The following installations were not considered in this study, as the site inventories would be very small in comparison to the relatively large natural gas.

- Workshop gases;
- Small inventory materials;
- Gas cylinders;
- Flammable store; and,
- Laboratory reagents.

Turbine oil, lube oils and greases were excluded from the study as they have very high flashpoints, making ignition extremely remotely.

It is assumed that corrosive liquids would be stored sufficiently far from the site boundary so that a release would not affect the public. The toxic effects of vapours released from sulphuric acid were not considered, due its low vapour pressure.

1 Design Institute for Physical Properties (DIPPR).

4.3 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 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 any irreversible injuries would be considered insignificant, and no further analysis would then be required. The effects from major incidents are summarised in the following subsections.

4.3.1 Toxic Vapour Clouds

The purpose of considering vapour clouds emanating from toxic components is to identify sections of the surrounding community that may be affected by exposure or individuals in the community who may be subject to injury or death from an accidental release.

A toxic vapour cloud can occur when:

- Toxic gas is released under pressure;
- Toxic liquid spills and evaporates;
- Components combust forming toxic gases; or,
- Components react forming toxic gases.

In the case of a toxic liquefied gas, the rate of the component becoming airborne must be estimated as input for dispersion modelling. The pressure of contained liquefied gas is dependent on its temperature, and it remains liquefied due to the pressure inside the tank.

Quantification of the adverse impacts associated with a substance is made possible through a dose-response analysis and an exposure assessment. A large release of a toxic, flammable or explosive substance may result in death, nonlethal injury or irritation to humans and in damage to property. The characterisation of such impacts would be based on the calculation of downwind distances to various acute exposure guidelines.

Limits for brief exposure to potentially lethal levels are given in terms of lethal concentration and lethal dose. Lethal concentration and lethal dose are determined by tests on animals. Lethal concentration LC_{50} refers to the concentration of airborne material inhalation of which results in death of 50% of the test group. The period of inhalation exposure could be from 30 min to a few hours (normally up to 4 hrs.). Lethal dose LD_{50} refers to the quantity of material administered, either orally or by skin adsorption, which results in death of 50% of the test group.

An approach that may be adopted involves comparison of predicted concentrations to exposure guidelines. These guidelines may include the following occupational exposure limits: the threshold limit values (TLVs); the immediately dangerous to life or health (IDLH) values; or, the acute exposure guideline level (AEGL) values.

AEGL values were developed by the US Environmental Protection Agency (EPA) and are defined as the maximum concentrations that individuals could be exposed to for a period of one hour before certain health effects would occur in sensitive populations. In the event that AEGL values are not yet available for a particular component, emergency response planning guideline (ERPG) values or temporary emergency exposure limits (TEELs) could be used.

This study refers to the PAC values for the assessing of emergency response plans and LC_1 (1% fatality based on inhaled dosages derived from probit values) for determining the significance and extent off-site impacts. In this report all PAC values are based on one hour.

4.3.2 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.

4.3.2.1 Thermal Radiation

The effect of thermal radiation is very dependent on the type of fire and 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 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 4-6.

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

Table 4-6: 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, at the reference level of 1 m above the grade:

- 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; and,
- 35 kW/m^2, the level at which spontaneous ignition of hair and clothing occurs, with an assumed 100% fatality, and at which initial damage to steel may occur.

4.3.2.2 Bund and Pool Fires

Pool fires, being either tank or bund fires, consist of large volumes of flammable material, at atmospheric pressure, burning in an open space. The flammable material will be consumed at the burning rate, depending on factors including the 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 plant building or persons close to the fire or within the intolerable zone will experience burn damage, with the severity depending on the distance from the fire and the 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 affect the distance of thermal radiation generated.

4.3.2.3 Jet Fires

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

In process industries, this may be due to 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.

4.3.2.4 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 overpressures 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.

4.3.3 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; or,
- 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 4-7 and Table 4-8 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 a probability of death equal to 1.0 for unprotected people in the open; and,
- 0.7 bar overpressure, corresponding to an almost entire destruction of buildings and 100% fatality for people in the open.

Table 4-7: 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 collapse 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 – 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 buildings; heavy (3 t) machine tools moved and badly damaged; very heavy (12 000 lb. / 5443 kg) machine tools survived
300	2070	Limit of crater lip

Table 4-8: 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

4.3.3.1 Vapour Cloud Explosions (VCEs)

The release of a flammable component into the atmosphere could result in 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.

4.3.3.2 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 may 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.

4.4 Risk Analysis

4.4.1 Background

It is important to understand the difference between a hazard and a 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, a risk is the probability that a hazard will actually cause damage and goes along with how severe that damage will be (consequence). A 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 4-9.

Table 4-9: 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 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 addresses both the probability of an accident, as well as the magnitude and nature of undesirable consequences of that accident. A risk is usually defined as some simple function of both the probability and consequence.

4.4.2 Predicted Risk

Physical and consequence modelling addresses the impact of a release of a hazardous component without taking into account the 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.

4.4.2.1 Generic Equipment Failure Scenarios

Because of the coarse nature of this study and the general lack of detailed information, only major failures of equipment were included. The pig receiver, pump / compressor and transport scenarios, such as road tanker failures were not included due to their effects likely being surpassed by those of the larger vessels on-site. 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 the:

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

- **Storage Vessels**

Scenarios involving storage vessels can include catastrophic failures that would lead to leakage into the bund with a possible bund 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 4-10 and in Table 4-11.

Table 4-10: 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 4-11: Failure frequencies for pressure vessels

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

- **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 4-12 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 4-12: 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	$1x10^{-6}$	$5x10^{-6}$
75 mm < nominal diameter < 150 mm	$3x10^{-7}$	$2x10^{-6}$
Nominal diameter > 150 mm	$1x10^{-7}$	$5x10^{-7}$

4.4.2.2 Ignition Probability of Flammable Gases and Liquids

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

The probability of ignition for stationary installations is given in Table 4-13 (along with classification of flammable substances in Table 4-14). 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 4-13: 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 4-14: 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 a delayed ignition as zero. RISCOM (PTY) LTD believes that the CPR 18E is more appropriate for warmer climates and is a conservative value.

4.4.3 Risk Calculations

4.4.3.1 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 knowledge of populations at risk. So, it is an easier parameter to use in the predictive mode than the average individual risk or weighted individual risk. The unit of measure is the risk of fatality per person per year.

4.4.3.2 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 used to establish risk normally incorporate safety factors that addresses 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 pre-cautions are necessary; or,
- 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 4-3.

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.

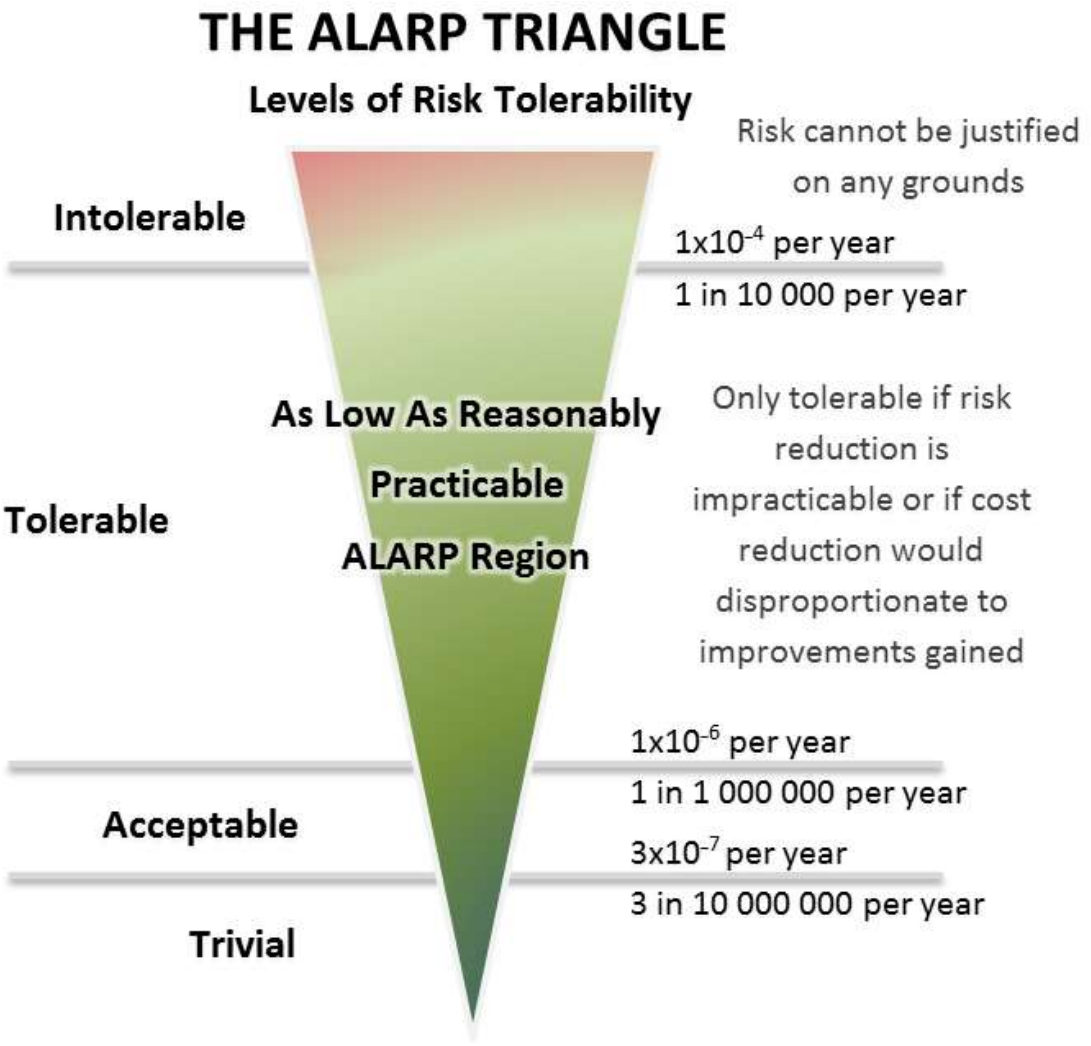

Figure 4-3: UK HSE decision-making framework

It should be emphasised that the risks considered acceptable to workers are different to those considered acceptable to the public. This is due to the fact that workers 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. “

4.4.3.3 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 the 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 $1x10^{-5}$ fatalities per person per year isopleth;
- The middle zone is enclosed by the risk of $1x10^{-5}$ fatalities per person per year and the risk of $1x10^{-6}$ fatalities per person per year isopleths; and,
- The outer zone is enclosed by the risk $1x10^{-6}$ fatalities per person per year and the risk of $3x10^{-7}$ fatalities per person per year isopleths.

The risks decrease from the inner zone to the outer zone, as shown in Figure 4-4 and Figure 4-5.

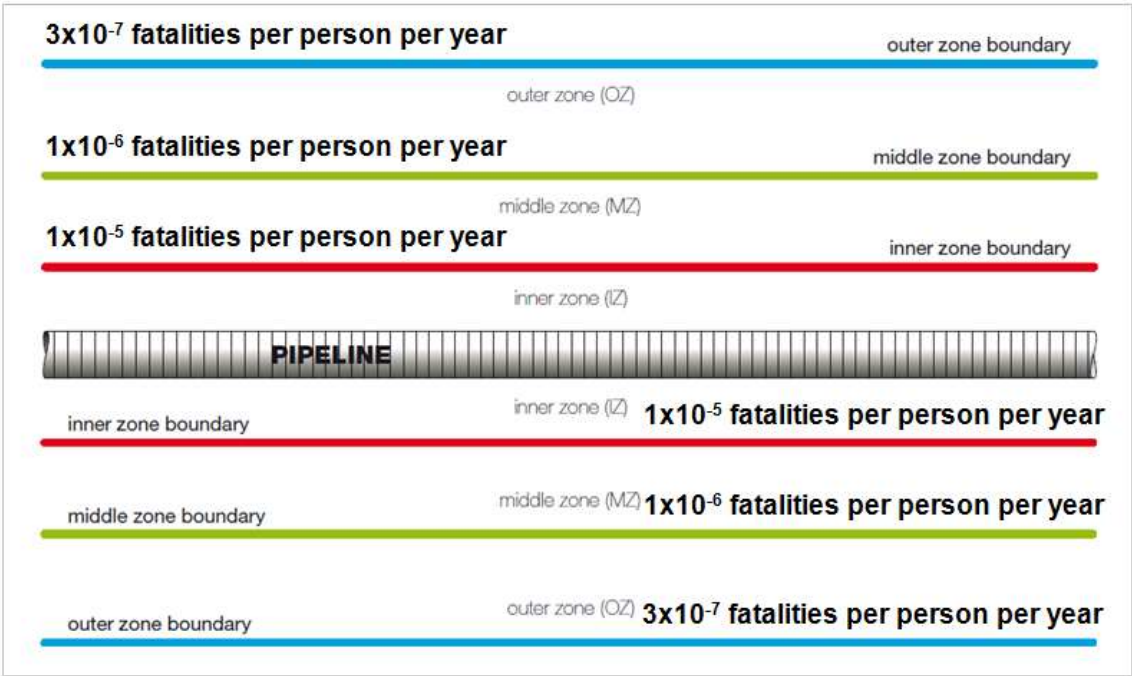

Figure 4-4: Town-planning zones for pipelines

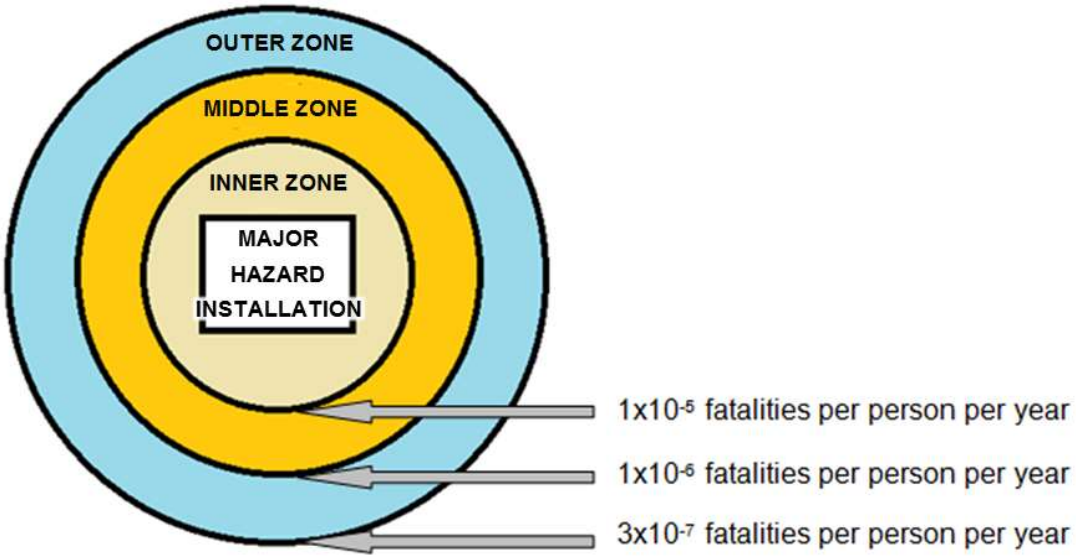

Figure 4-5: Town-planning zones

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 4-15. There are no land-planning restrictions beyond the outer zone.

Table 4-15: 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, in order to allow progressively more severe restrictions to be imposed as the sensitivity of the proposed development increases.

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

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

Refer to Appendix C for detailed PADHI (Planning Advice for Developments near Hazardous Installations) tables. These tables illustrate how the HSE land-use decision matrix, were generated by using the three zones and the four sensitivity levels, and applied a variety of development types.

4.5 Quantitative Risk Assessment (QRA) Scenarios

4.5.1 Methodology

Risk assessments that are done in accordance with the MHI regulations are required to be conducted according to SANS 1461 (2018). This standard is specific to the MHI risk assessment that is required to be done prior to construction and includes elements that is not usually available at the preparation, such as emergency plans and mitigation that is suggested during the EIA process.

SANS 1461 (2018) is based on RIVM (2009) for process plants. The latter standards describe the minimum scenarios to be included in the assessment, as well as the assumptions to be used. As full compliance of SANS 1461 (2018) cannot be achieved within the NEMA legislative framework, general compliance of the aforementioned standards would be applicable and briefly described in the sections below.

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); and,
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.

4.5.2 Scenario Selection

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.

4.5.2.1 Scenarios for Release of a Pressurised Liquefied Gas

The nature of the release of a liquefied gas from a pressurised vessel is dependent on the position of the hole.

A hole above the liquid level will result in a vapour release only, and the release rate would be related to the size of the hole and internal pressure of the tank. Over a period of time, bulk temperature reduces, with an associated decrease in the vapour release rate.

A hole below the liquid level will result in a release of a liquid stream. In the reduced pressure of the atmosphere, a portion of the liquid will vaporise at the normal boiling point. This phenomenon is called flashing and is shown in Figure 4-6. The pool, formed after flashing, then evaporates at a rate proportional to the pool area, surrounding temperature and wind velocity.

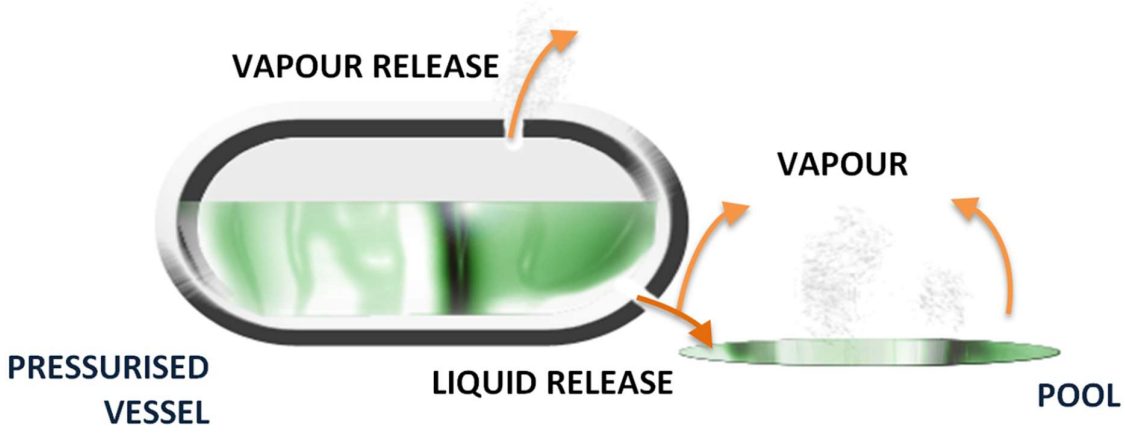

Figure 4-6: Airborne vapours from a loss of containment of liquefied gas stored in a pressurised vessel

4.5.2.2 Instantaneous Release of a Pressured Liquefied Flammable Gas

An instantaneous loss of containment of a liquefied flammable gas could result in the consequences, given in the event tree of Figure 4-7. 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.

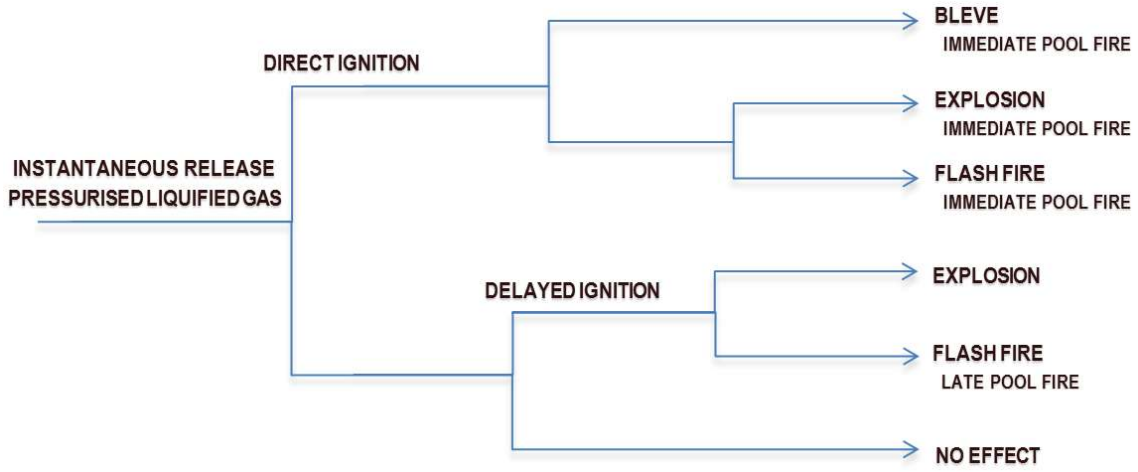

Figure 4-7: Event tree for an instantaneous release of a liquefied flammable gas

4.5.2.3 Continuous Release of a Pressurised Liquefied Flammable Gas

The continuous loss of containment of a liquefied flammable gas could result in the consequences, given in the event tree of Figure 4-8. 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.

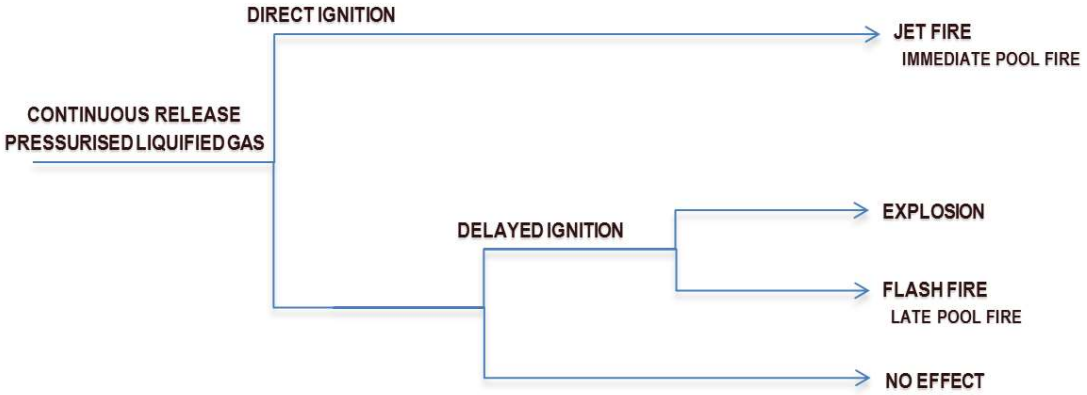

Figure 4-8: Event tree for a continuous release of a liquefied flammable gas

4.5.2.4 Continuous Release of a Flammable Gas

The continuous loss of containment of a flammable gas could result in the consequences, given in the event tree of Figure 4-9. 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 sub-sections of the report.

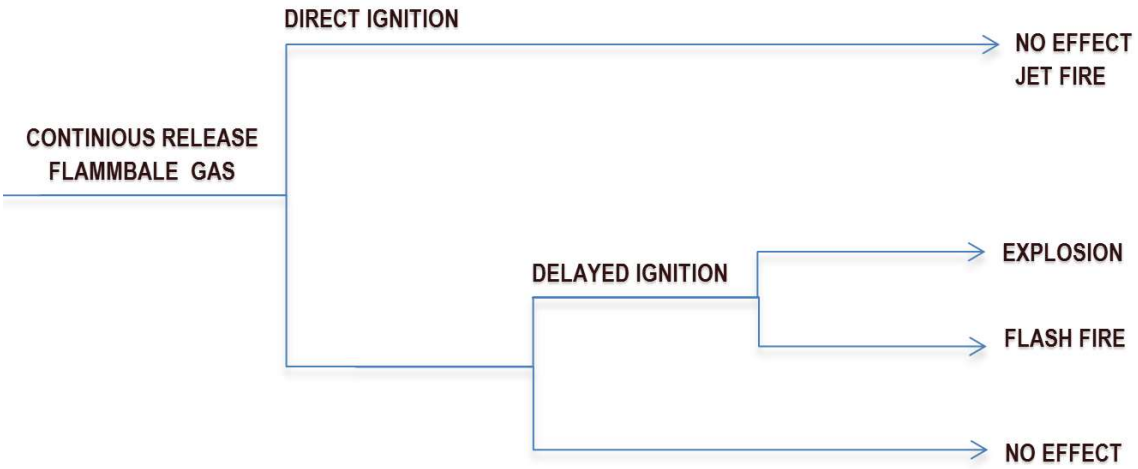

Figure 4-9: Event tree for a continuous release of a flammable gas

4.5.2.5 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 4-10. 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.

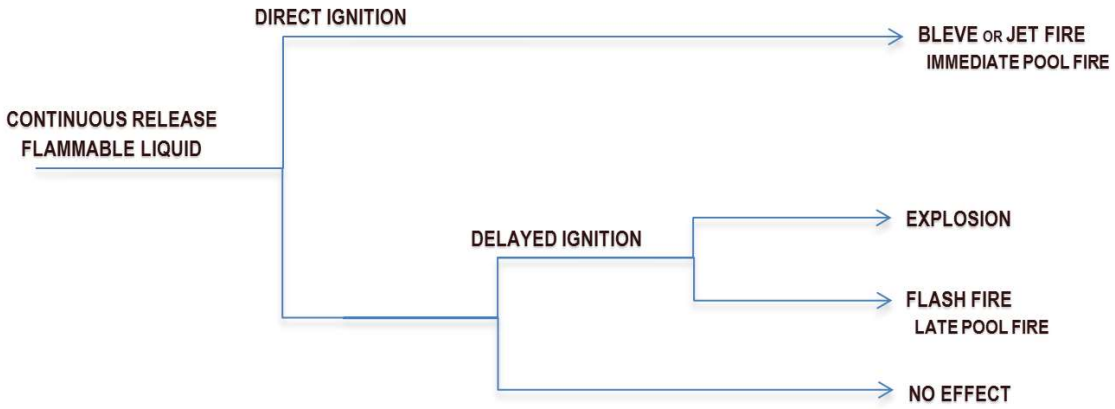

Figure 4-10: Event tree for a continuous release of a flammable liquid

5 RISK ASSESSMENT

A risk assessment was done for each processing unit by firstly selecting a scenario and then completing consequence and outflow modelling. Consequences with possible impacts beyond the site boundary were retained for risk analysis of the unit.

Finally, the risk of the entire facility is determined as a combination of the risk calculated for each unit.

5.1 Natural Gas Pipeline Installation

5.1.1 The Purpose of the Natural Gas Pipeline

Natural gas is proposed as a fuel for the gas turbines to be located onsite. Natural gas will be received by the site via the pipeline located under the facility fence. The gas would then be metered and its pressure reduced prior to entry into the gas engines. A line diameter of 381 mm has been assumed and is in line with the maximum flow from the pipeline. The pipeline was assumed to be above ground, from entering the property to the turbines.

5.1.2 Consequence Modelling

5.1.2.1 Scenarios Modelled for the Natural Gas Pipeline

The scenarios modelled for the natural gas pipeline, are given in Table 5-1.

Table 5-1: Scenarios modelled for the natural gas pipeline

Equipment	Scenario	Remarks
Pipeline	Failure	381 mm pipeline with the max. flow of 120 t/d
	Leak	This analysis assumes the hole size is 10% of the diameter

5.1.2.2 Fires

The maximum distance to the 1% fatality from a release of the natural gas pipeline, is shown in Figure 5-1. The maximum distance would occur with a low wind speed and could cause severe damage along the length of the pipeline. Depending on the orientation of the release, the impacts from a large release could extend into the adjacent industrial area of Alton, but would not reach residential areas.

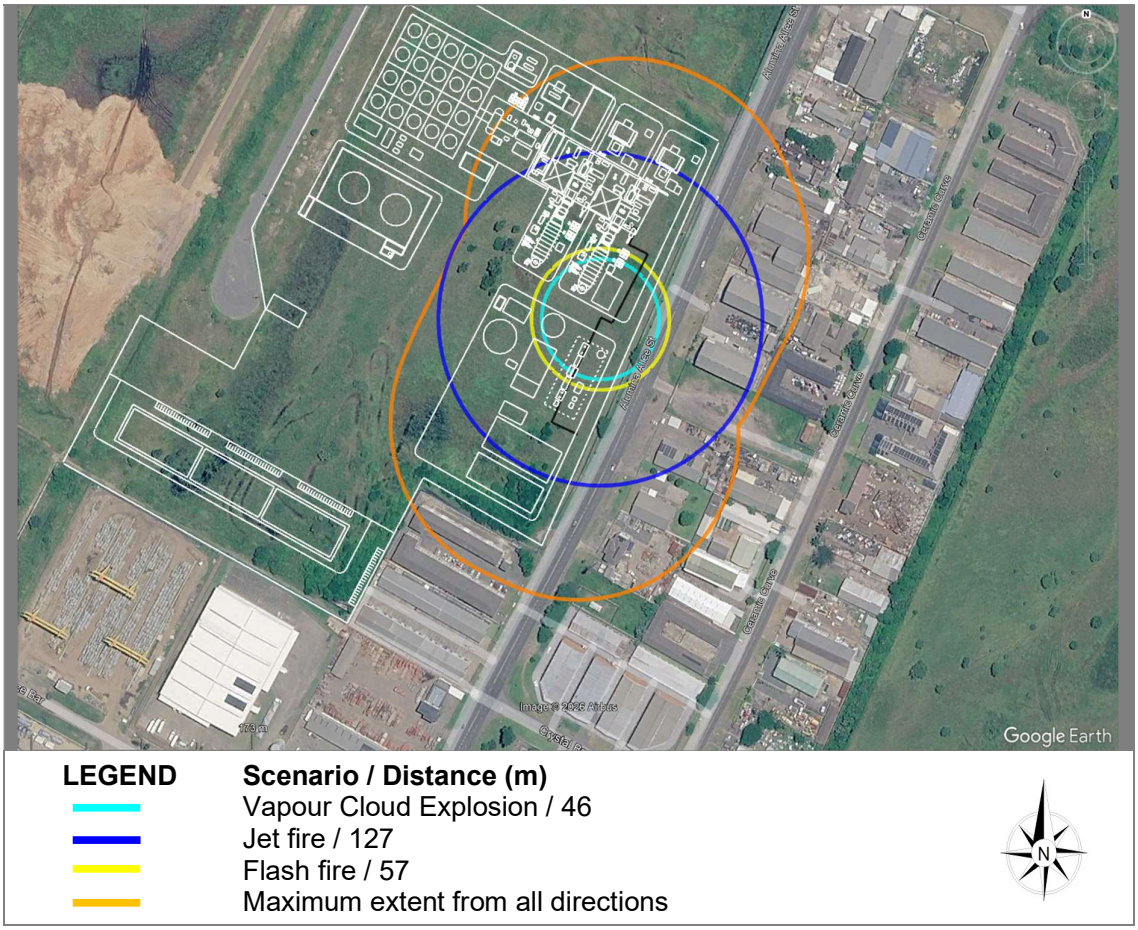

Figure 5-1: The maximum extent to the 1% fatality from the natural gas pipeline failure

5.1.3 Maximum Individual Risk

The risk of $1x10^{-6}$ fatalities per person per year isopleth, due to a release of natural gas from the gas pipeline, as shown in Figure 5-2, were found to extend a short distance beyond the site boundary. The risks from fires and explosions from a natural gas release at the storage area to both the workers on site and the general offsite public, would be within the ALARP range and are considered tolerable.

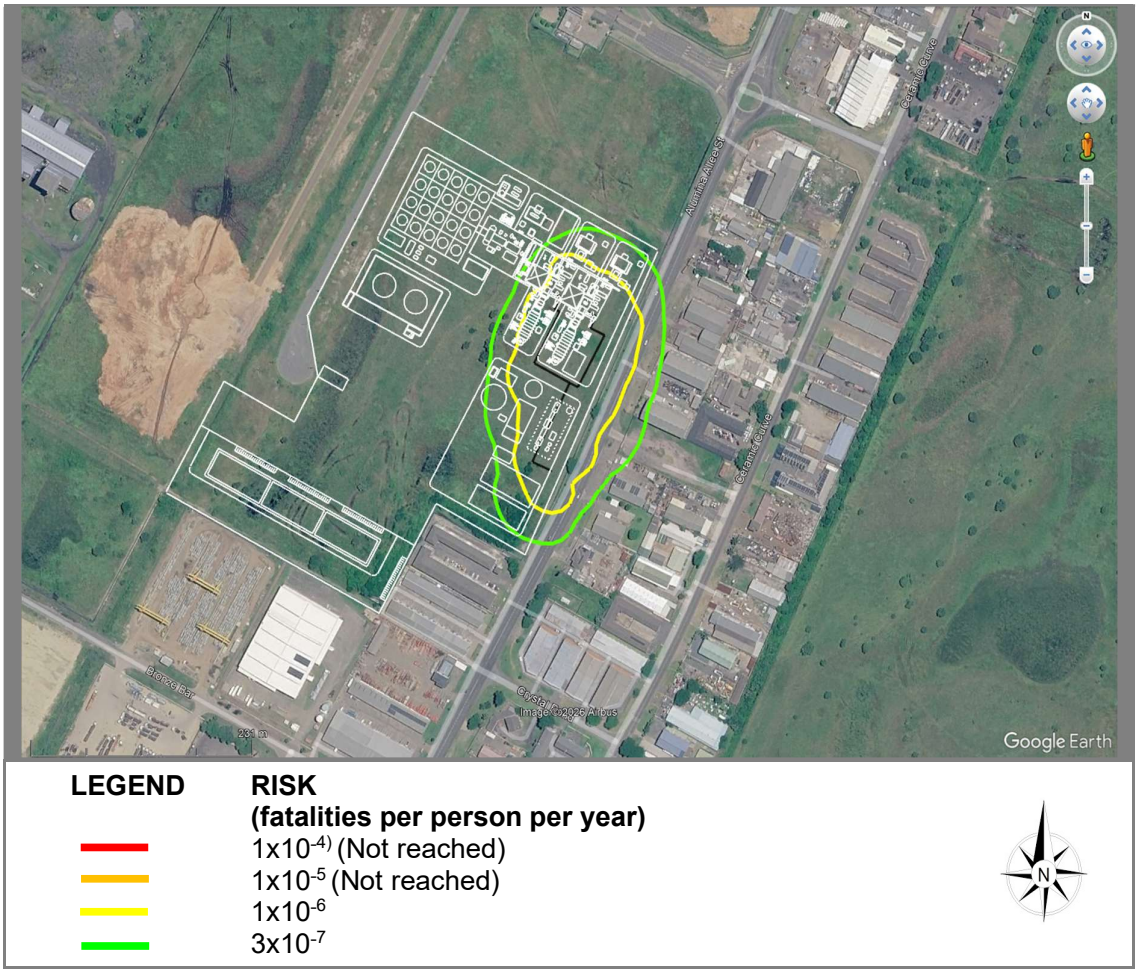

Figure 5-2: Lethal probability isopleths associated with the natural gas installation

Risks greater than $1x10^{-6}$ fatalities per person per year, considered tolerable for industrial areas but excessive for residential areas, extends beyond the site to the south.

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.

5.1.4 Risk Reduction

A leak of hydrogen, unlike most other substances, increases in temperature with a good probability of ignition when in the flammable range. Its flame is almost invisible with high flame thermal radiation flux.

Risk reduction measures could include the prevention off a loss of containment of a build-up of natural gas within confined areas. The good attribute of hydrogen is that it is very buoyant and outdoor storage will be an advantage with separation distances between the storage vessels specified to minimise the impacts.

Instrumentation, to determine significant loss of containment, such as pressure transmitters could be used to activate emergency shutdown systems reducing the loss of containment impacts.

As the risks from the hydrogen storage are currently not excessive to both the workers and the public, risks reduction would be at the discretion of the owner and the engineering contractor.

An Emergency Shutdown Valve (ESDV) has been included at the interface between the main incoming pipeline and the power plant pipeline. This will reduce the impacts in the event of a loss of containment. Recognition of the ESDV has been acknowledged. The operating and ignition of this still needs further work.

5.2 Diesel Installation

5.2.1 The Purpose of the Diesel Installation

Diesel would be used as a back-up fuel for the gas turbines. As such, bulk storage would be required and achieved through storage in 2 x 6 500 m^3 bunded tanks.

5.2.2 Diesel Consequence Modelling

5.2.2.1 Scenario Modelled of the Diesel Installation

The scenarios modelled for the Diesel installation, are listed in Table 5-2.

Table 5-2: Scenarios modelled for the Diesel installation

Equipment	Scenario	Remarks
Diesel tank	Catastrophic failure	2 x 6 500 m^3 tanks Bunded area of 3 450 m^2 Catastrophic failure release area = 1.5 m x bunded area
	Serious release into bund	Release into bund
	Overfilling	Assumes 2 x independent overfilling instruments
Diesel tanker	Tanker failure	Compartment: 5 m^3 failure
	Tanker nozzle failure	Release area: 75 m^2
	Hose failure	Release area: 75 m^2
	Hose leak	Release area: 75 m^2

5.2.2.2 Fires

Diesel or light oil would be used as a backup in the event of a natural gas supply failure. In the event of a large fire, the maximum extent to the 1% fatality, is shown in Figure 5-3. The impacts from a large bund fire could extend beyond the site boundary, but not the IDZ boundary.

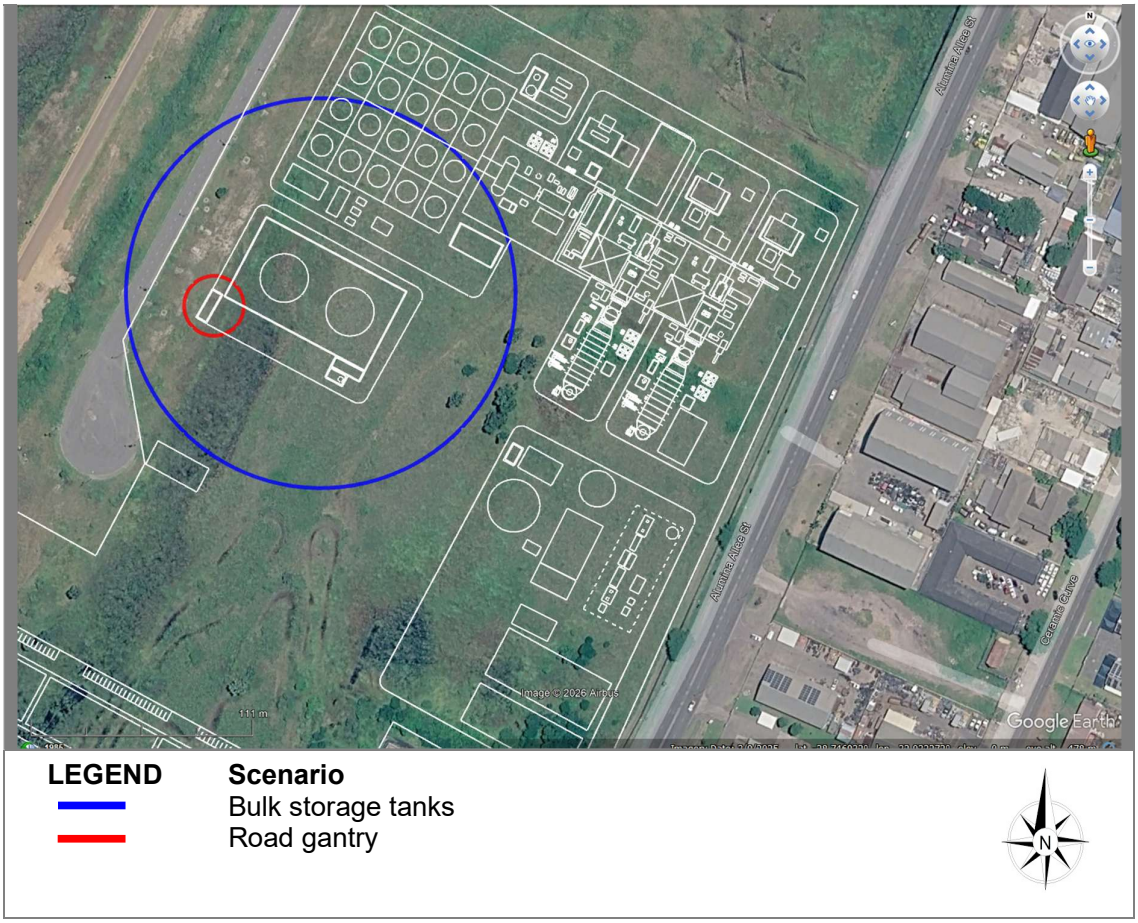

Figure 5-3: The maximum extent to the 1% fatality from a large LO / Diesel fire

5.2.3 Maximum Individual Risk

The risk from the bulk storage tanks, is shown in Figure 5-4. The risk of $1x10^{-6}$ fatalities per person per year isopleth will remain within the Mabasa PP.

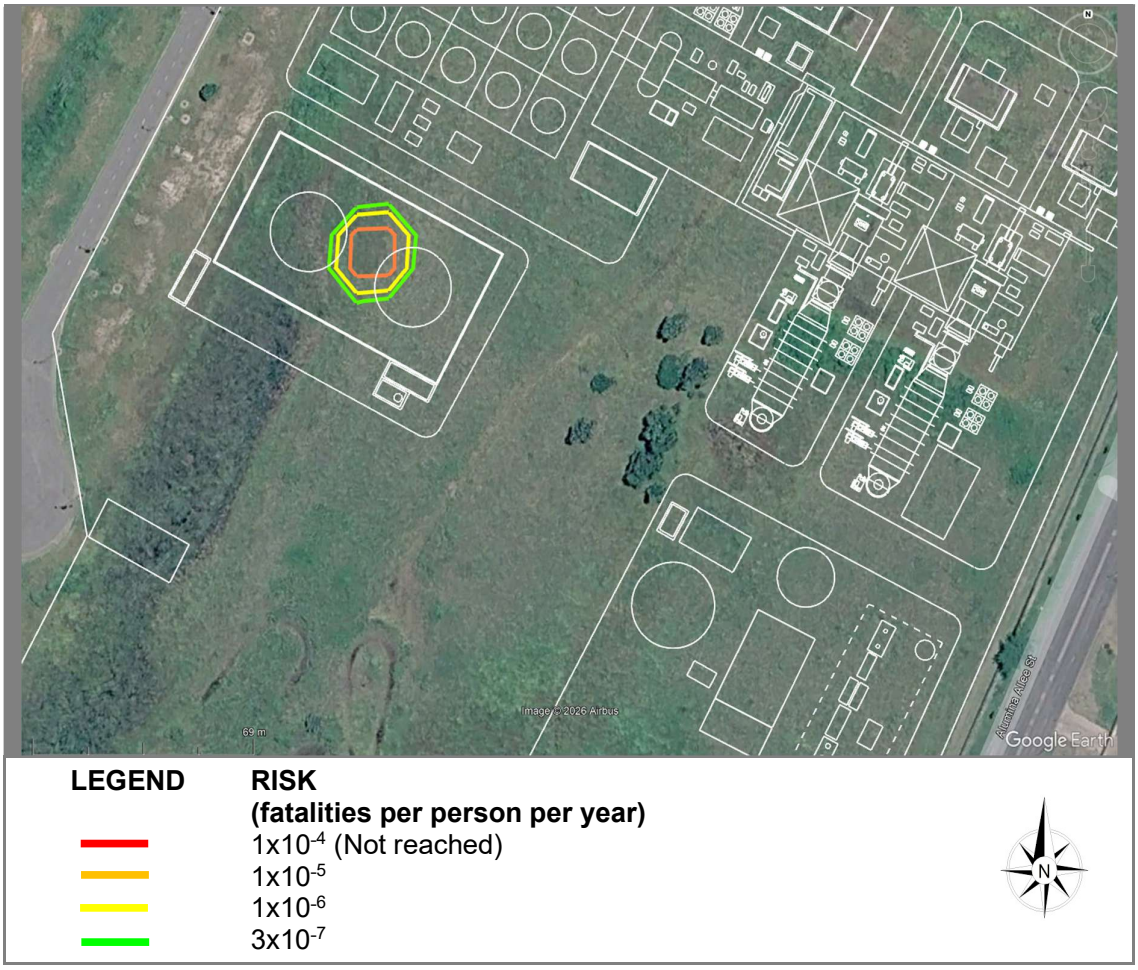

Figure 5-4: Lethal probability isopleths associated with the bulk storage tanks

Risks greater than $1x10^{-4}$ fatalities per person per year, considered tolerable for industrial areas but excessive for residential areas, was not reached.

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. This was found to remain within the Mabasa PP site boundary.

5.3 Combined Site Individual Risk

Considering the extent of the consequences of the releases contemplated in the preceding subsections of Section 5 and others, as well as the frequency of occurrence of each release as contemplated in Section 4.3, the combined site risk is the summation of all the individual risks and is shown in Figure 5-5.

Individual risks, as introduced in Section 4.4.3, describes the chance of fatality of an individual situated at a particular location, due to the operations on site. The maximum individual risk assumes that an individual is situated at a particular location 24 hours per day for 365 days per year. This tends to be an overstatement of risk, but one which is generally accepted as sufficiently conservative.

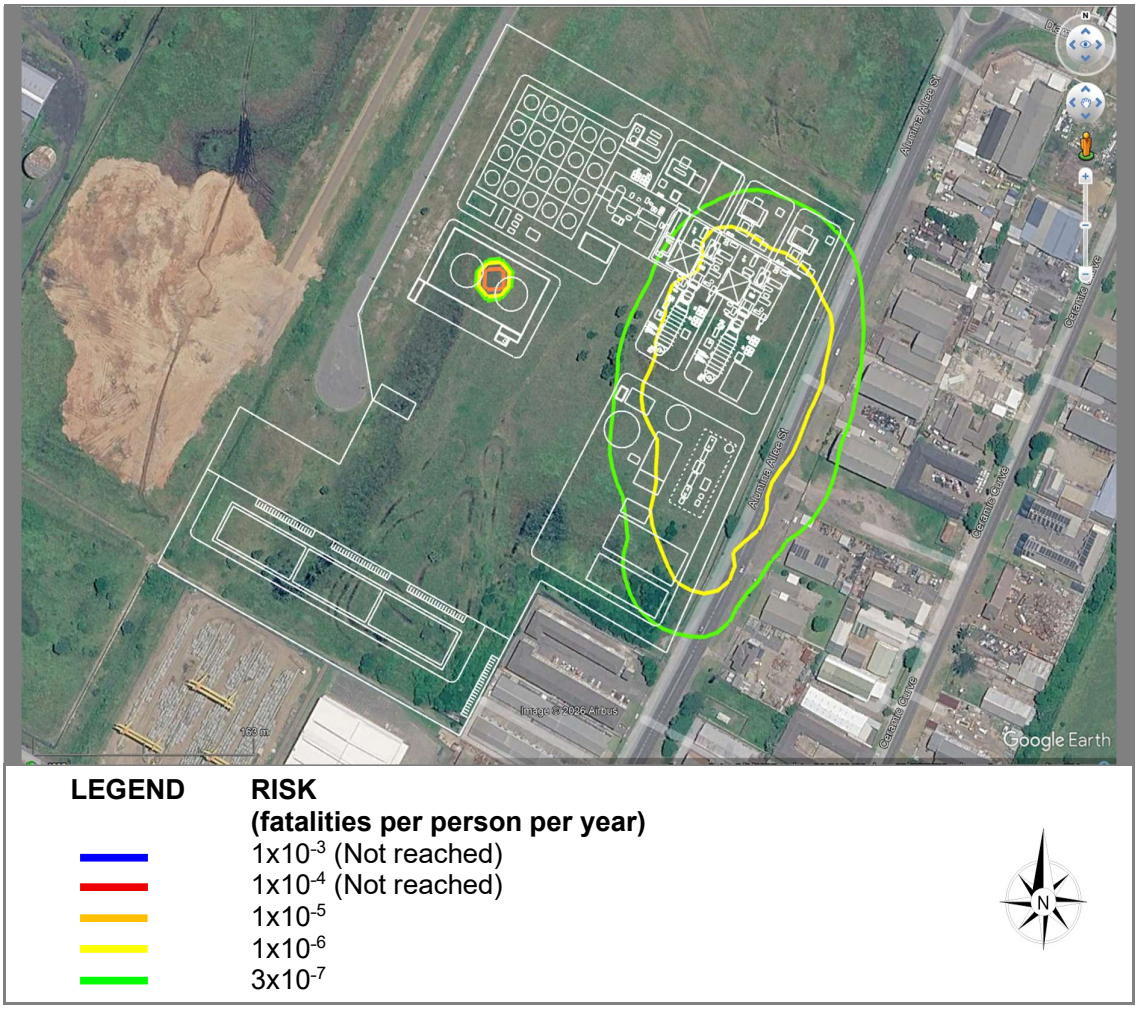

Figure 5-5: Individual risk contours – Combined risk

The individual risk contours illustrated in Figure 5-5 extend as follows:

- The $3x10^{-7}$ fatalities per person per year contour extends beyond the site boundary. This contour represents the threshold for 'trivial' risk and represent acceptability to vulnerable people outside of the isopleth. Risks below this threshold is considered trivial;
- The risks between the $3x10^{-7}$ and $1x10^{-5}$ fatalities per person per year is considered 'broadly acceptable' to the general public, but 'tolerable if proven to be within ALARP'

for vulnerable populations such as hospitals, retirement homes, nursery schools, prisons, large gatherings in the open, and so forth;

- The $1x10^{-4}$ fatalities per person per year extends offsite indicating acceptable risks to both the workers and the public; and,
- The $1x10^{-3}$ fatalities per person per year contour, is considered excessive to workers and would have to be mitigated prior to construction. This is related to the assumed LNG storage and particularly the overfilling protection.

Acceptability criteria for an individual risk are detailed in Section 4.4.3.2. No new land planning should be approved without the consultation of the PADHI land-planning tables described in Appendix C.

6 RISK REDUCTION

From the simulations performed, the areas of highest risk have been identified as those with potential LNG releases at various process units.

Mitigation that may be considered to reduce risks to acceptable levels is listed in following subsections.

6.1 Mitigation

It should be noted that the suggested mitigation is for consideration only. RISCOM does not imply that the suggested mitigation should be implemented or that any suggested mitigation is the only measure to reduce risks. Furthermore, the implementation of some or all of the suggested mitigation would not guarantee full compliance with the Major Hazard Installation regulations.

The implementation of any mitigation should always be done in accordance with recognised engineering practices, by using applicable codes and standards.

6.1.1 Hazardous Materials Inventory

The first stage of mitigation is to either eliminate materials or reduce the inventory. For example, the inventories of chlorine or ammonia could be reduced. This would need to be optimised with the frequencies of deliveries.

6.1.2 Substitution of Hazards Materials

In some cases, the hazardous materials can be substituted. For example, chlorine may be substituted with sodium hypochlorite generated from an electrolysis of quarry water and used primarily for the prevention of marine growth in the quarry water.

Anhydrous ammonia can be substituted with a less harmful ammonium hydroxide.

6.1.3 Process Hazard Analysis (PHA)

Hazardous areas should be reviewed by using a detailed Process Hazard Analysis (PHA)[1], such as a HAZOP study. This should be completed to identify the 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.

1 A Process Hazard Analysis is a heavily regulated activity that systematically identifies potential hazards, evaluates existing safeguards, and recommends risk mitigation.

6.1.4 Codes and Standards

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

6.1.5 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 is 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 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 the 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 EIA and MHI evaluations cannot be altered at construction for the sole function of reducing costs. Moreover, the code ensures that the plant would continue to maintain the safety functions for the *life cycle* of the plant, 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 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 EN 61511 (or ANSI/ISA 84.00.01-2004) would be a requirement in many countries around the world to achieve an acceptable risk to the workers and the public.

Demonstrating compliance with the IEC61508/11 can be achieved only once full-detail designs have been completed, and is thus premature at this stage in the project.

It should be noted that RISCOM would suggest a FULL compliance of the IEC61508/11, with a full audit by an independent body (other than RISCOM), in order to support the project.

7 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, as well as toxic releases at the Mabasa PP in Richards Bay. 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 by-laws.

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

The following installations were considered for analysis in the QRA:

- Chlorine;
- Natural gas;
- Diesel; and,
- Ammonia.

As a result of the analysis, the following were concluded:

1. Consequences for the installations were analysed and assessed, with several worst-case scenarios having the potential to affect individuals located offsite. The largest of these was toxic vapour dispersion from the catastrophic rupture of a chlorine drum stored on-site. However, while the impacts could extend beyond the site boundary, no impacts would extend beyond the site boundary.
2. The likelihood of failure of these installations was assessed and the combination of the consequence and the likelihood being used to calculate the overall individual risk.
3. Overall, the individual risk could extend beyond the site boundary. Thus, the risks to the general public were found to be trivial.
4. No new land planning should be approved without the consultation of the PADHI land-planning tables described in Appendix C.
5. Impact assessments of each installation were performed; each was found to be of MEDIUM SIGNIFICANCE, which can be reduced to an acceptable level with potential mitigation measures.

7.1 Hazardous Materials

The project involves several hazardous materials. However, the only hazardous materials in significant quantities include:

- Natural Gas; and,
- Diesel / LO.

These materials were considered in the study.

7.2 Limitations and Assumptions

The risk assessment was developed based on the information provided by the client, and its engineering suppliers. These designs are conceptual and does not include detailed designs or in some cases, insufficient information to conduct a thorough risk assessment. 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 that the vessel size and inventory are not increased.

These assumptions ensure that the assessment remains precautionary and aligned with the NEMA principles of risk avoidance and minimisation.

7.3 Major Hazard Installation (MHI) Tier Classification

The MHI Regulations (2022), under Chapter 1, Chapter 2 and Chapter 3, defines the establishment tier for hazardous installations. The hazardous materials stored at the gas processing plant were evaluated by using the aggregation method prescribed in the Regulations.

The bulk diesel inventory exceeds the threshold values, and therefore **qualifies the proposed Mabasa PP at Richards Bay as a Medium Tier Establishment Major Hazard Installation.**

Note:

- The incoming pipeline is a Top Tier Hazard Establishment, and the MHI risk assessment must be done by the duty holder.
- The conditioning skid and the pipeline to the turbines is consider part of the “installation” and not a MHI establishment alone.

7.4 Diesel

The diesel installation, comprising two large bunded storage tanks and associated tanker off-loading infrastructure, presents credible major-incident scenarios including catastrophic tank failure, serious bund releases, overfilling events, and various tanker and hose failure modes. Consequence modelling indicates that a large diesel bund fire could extend beyond the immediate site boundary, but remains contained within the wider IDZ area.

The maximum individual risk associated with the diesel storage remains within acceptable limits, with the $1x10^{-6}$ fatalities-per-person-per-year isopleth confined to the Mabasa PP boundary and no exceedance of the $1x10^{-4}$ threshold associated with intolerable risk for non-industrial land uses. The lowest risk contour ($3x10^{-7}$), which is relevant to sensitive

receptors, would not extend beyond the site boundary, demonstrating that while the diesel storage contributes to the overall risk profile, it does so within regulatory tolerability criteria and without generating significant off-site risk implications.

7.5 Natural Gas

The natural-gas pipeline, assumed as a 381 mm above-ground line operating at the maximum flow rate, presents credible failure and leak scenarios that were modelled to determine off-site impacts. Consequence modelling shows that a major release could generate jet fires, flash fires or vapour cloud explosion effects capable of extending into the adjacent Alton industrial area, but not into residential neighbourhoods.

The maximum individual risk associated with pipeline failure remains within tolerable limits, with the $1x10^{-6}$ fatalities-per-person-per-year contour extending only a short distance beyond the site boundary and no exceedance of the $1x10^{-4}$ or $1x10^{-5}$ thresholds. The lowest-risk contour ($3x10^{-7}$), relevant to sensitive land uses, remains limited in extent and does not indicate significant off-site vulnerability. Overall, the natural gas pipeline contributes a manageable and ALARP-compliant risk profile, with impacts confined primarily to the site and immediate industrial surroundings.

8 RECOMMENDATIONS

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 design and operational hazards have been identified and adequate mitigation put in place;
- Compliance with IEC 61508 and 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 power plant:
    - Including the demonstration from the designer that sufficient and reliable instrumentation would be specified and installed at the facility;
- Preparation and issue 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 Nemai 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 local authorities);
- Final acceptance of the facility risks with a 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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10 ABBREVIATIONS AND ACRONYMS

AEGL	**Acute exposure guideline levels** are values published by the US Environmental Protection Agency (EPA). AEGL values represent threshold exposure limits for the general public applicable to five emergency exposure periods (10 minutes, 30 minutes, 1 hour, 4 hours and 8 hours) and are distinguished by varying degrees of severity of toxic effects. **AEGL-1** is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation or certain asymptomatic non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure. **AEGL-2** is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long lasting adverse health effects or an impaired ability to escape. **AEGL-3** is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death. Although the AEGL values represent threshold levels for the general public, including susceptible subpopulations, such as infants, children, the elderly, persons with asthma and those with other illnesses, it is recognized that individuals, subject to unique or idiosyncratic responses, could experience the effects described at concentrations below the corresponding AEGL value.
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).
Asphyxiant	An **asphyxiant** is a gas that is nontoxic but may be fatal if it accumulates in a confined space and is breathed at high concentrations since it replaces oxygen containing air.
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.
CBD	A **central business district** is the commercial and business center of a city. In larger cities, it is often synonymous with the city's "financial district"
CCGT	A **Combined Cycle Gas Turbine (CCGT)** is an advanced, highly efficient power generation method. It pairs a gas turbine with a steam turbine in a single plant. By capturing and utilizing waste exhaust heat from the gas turbine, it generates significantly more electricity from the same amount of fuel than a conventional power plant.
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	An **environmental impact assessment (EIA)** 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.
ERPG	**Emergency response planning guidelines** were developed by the American Industrial Hygiene Association. **ERPG-1** is the maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing anything other than mild transient adverse health effects or perceiving a clearly defined objectionable odour. **ERPG-2** is the maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action. **ERPG-3** is the maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.
ESDV	**Emergency Shutdown Valves (ESDVs)** are critical safety devices designed to automatically and rapidly stop the flow of hazardous fluids or gases during emergencies such as fires, gas leaks, or pressure surges. Acting as the "circuit breaker" of a plant, they isolate damaged sections to prevent catastrophic accidents.
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 natural gas (LNG) and Diesel 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.
GSU	In power engineering, GSU stands for **Generator Step-Up** transformer. Its primary purpose is to take the low-voltage electricity produced by a power plant generator (in this case, 15 kV) and "step it up" to a much higher voltage (400 kV) suitable for long-distance transmission over the electrical grid.
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.
HDPE	HDPE stands for **High-Density Polyethylene**. In the context of storing chemical solutions, it refers to a tough, highly corrosion-resistant industrial plastic used to manufacture heavy-duty, leak-proof chemical storage tanks.
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).
HRSG	A **Heat Recovery Steam Generator (HRSG)** is a specialized heat exchanger that captures exhaust heat from a gas turbine or industrial process to produce high-pressure steam. This steam is typically used to drive a secondary steam turbine for electricity generation, significantly boosting overall energy efficiency.
IBC	An **intermediate bulk container (IBC)** is a container used for the safe transportation and storage of fluids.
IDLH	**Immediately dangerous to life or health** values were developed by the National Institute of Occupational Safety and Health (NIOSH). **IDLH** value refers to a maximum concentration to which a healthy person may be exposed for 30 minutes and escape without suffering irreversible

	health effects or symptoms that impair escape (ranging from runny eyes that temporarily impair eyesight to a coma). IDLH values are intended to ensure that workers can escape from a given contaminated environment in the event of failure of the respiratory protection equipment.
IDZ	**Industrial development zones (IDZs)** or special economic zones (SEZs) are specific geographical areas in a country where certain economic activities are promoted through a set of policy measures not generally applicable to the rest of the country.
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	An **isopleth** is a line or curve of equal values
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.
LC	**Lethal concentration** is the concentration by which a given percentage of the exposed population will be fatally injured. The LC_{50} refers to the concentration of airborne material the inhalation of which results in death of 50% of the test group. The period of inhalation exposure could be from 30 min to a few hours (up to 4 hours).
LD	In toxicology, the **lethal dose** is an indication of the lethal toxicity of a given substance or type of radiation. Because resistance varies from one individual to another, the "lethal dose" represents a dose at which a given percentage of subjects will die.
LEL	**Lower Explosive Limit**, is defined as the lowest concentration (by percentage) of a gas or vapor in air that is capable of producing a flash of fire in presence of an ignition source (arc, flame, heat). ... In concentrations of 0-5% Methane in air, the mixture is too lean to ignite or burn.
LFL	**Lower Flammable Limit** see Flammable Limits
LO	**Light oil**, or light crude, is a low-density petroleum that flows freely at room temperature. It has high API gravity and low viscosity, meaning it contains a high proportion of light hydrocarbons. It is highly valuable because it requires less processing to yield large amounts of gasoline and diesel.
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.
MHI	See **Major Hazard Installation**
MIR	**Maximum Individual Risk** (see Individual Risk)
MSDS	See **Material Safety Data Sheet**
NECR	NECR is a technical abbreviation or product code for a **specific type of storage tank, chemical reactor, or processing unit** (such as a wastewater treatment, chemical blending, or medical imaging phantom tank).
NEMA	**National Environmental Management Act** 107 of 1998, 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.
OCGT	An **open cycle gas turbine** is a combustion turbine plant fired by liquid fuel to turn a generator. rotor that produces electricity. The residual heat is exhausted to atmosphere at about 550 degrees.
OEM	An **OEM (Original Equipment Manufacturer)** for turbines is the original company that designed, built, and branded the complete turbine (such as a gas, steam, wind, or hydro turbine).
OHS Act	**Occupational Health and Safety Act**, 1993 (Act No. 85 of 1993)
PAC	See **Protective Action Criteria**
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: The inner zone (> $1x10^{-5}$ fatalities per person per year); The middle zone ($1x10^{-5}$ fatalities per person per year to $1x10^{-6}$ fatalities per person per year);

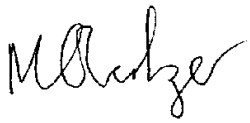
	The outer zone ($1x10^{-6}$ fatalities per person per year to $3x10^{-7}$ fatalities per person per year); The 'sensitivity level' of the proposed development which is derived from an HSE categorisation system of 'development types' (see the 'development type tables' in Appendix C).
PHA	A **Process Hazard 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.
Protective Action Criteria	**Protective action criteria (PAC)** for emergency planning of chemical release events are based on the following chemical exposure limit values: Acute exposure guideline level (AEGL) values published by the US Environmental Protection Agency (EPA); Emergency response planning guideline (ERPG) values produced by the American Industrial Hygiene Association (AIHA); Temporary emergency exposure limit (TEEL) values developed by the Subcommittee on Consequence Assessment and Protective Actions (SCAPA).
PSV	A **pressure safety valve (PSV)** or pressure relief valve is a type of safety valve used to control or limit the pressure in a system; pressure might otherwise build up and create a process upset, instrument or equipment failure, or fire.
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**
Risk Isopleth	Is the **isopleth** of equal risk values
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.
Temporary Installation	A **temporary installation** is an installation that can travel independently between planned points of departure and arrival for the purpose of transporting any substance and which is only deemed to be an installation at the points of departure and arrival, respectively.
TLV-STEL	**Short-term exposure threshold limit values** are the concentrations to which workers can be exposed continuously for a short period (15 minutes) of time without suffering from irritation, chronic or irreversible tissue damage or narcosis to a sufficient degree to increase the likelihood of accidental injury, impair self-rescue or materially reduce work efficiency, provided that the daily TLV-TWA is not exceeded.
TLV-TWA	**Time weighted average threshold limit values** are the concentrations for a normal 8-hour workday and a 40-hour workweek, to which nearly all workers may be repeatedly exposed day after day, without adverse effects.
UAT	In electrical engineering and power plants, UAT stands for **Unit Auxiliary Transformer**. Its primary job is to step down a portion of the high voltage generated by the main turbine-generator and feed it to the plant's internal operating systems (like coolant pumps, feed pumps, and safety devices).
UEL	**Upper Explosive Limit (UEL)** 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).
UFL	**Upper Flammable Limit** (see Flammable Limits)
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**

11 APPENDIX A: DECLARATION OF THIRD-PARTY INDEPENDENCE

4.2 The specialist appointed in terms of the Regulations.

I, Michael Paul Oberholzer declare that -- General declaration:
I act as the independent specialist in this application;
I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
I declare that there are no circumstances that may compromise my objectivity in performing such work;
I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
I will comply with the Act, Regulations and all other applicable legislation;
I have no, and will not engage in, conflicting interests in the undertaking of the activity;
I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
all the particulars furnished by me in this form are true and correct; and
I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.



Signature of the specialist:

Riscom (Pty) Ltd

Name of company (if applicable):

24th of July 2026

Date:

12 APPENDIX B: MHI REGULATIONS (2022)

Government Gazette
Staatskoerant

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9 771682 584003 47970

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Contents

GOVERNMENT NOTICES • GOEWERMENTSKENNISGEWINGS

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) ***Application of the 2% rule***

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.

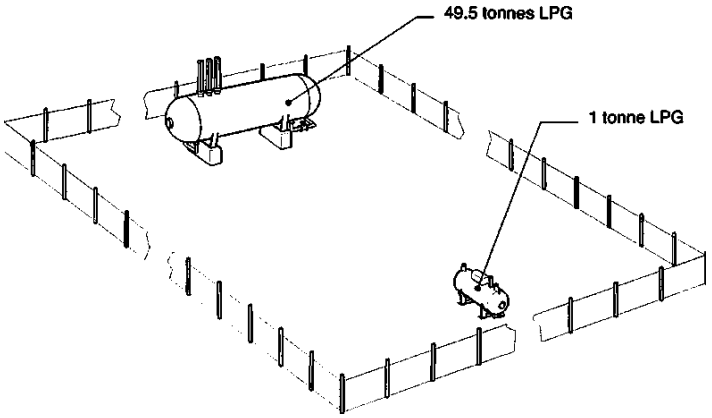
The diagram below does not depict an approved installation but it is meant for illustrative purposes only.

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.

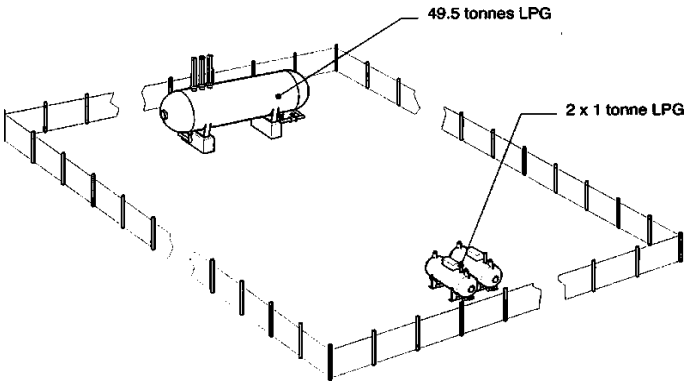
The result is that medium hazard category does not apply, even though the total quantity of 50,5 tonnes is above the medium hazard threshold, which places it in the low hazard category.

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.

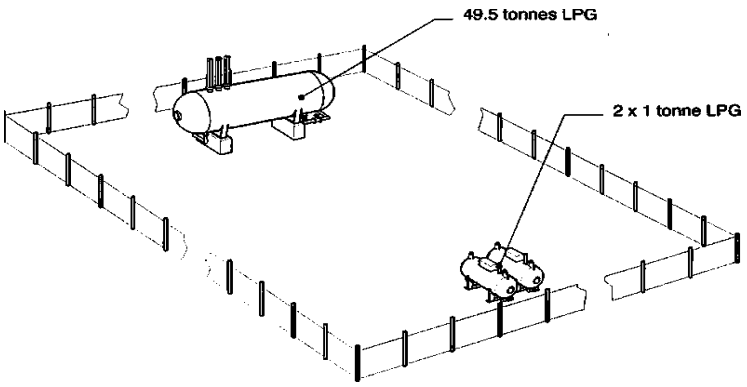
The result is that medium hazard category does not apply, even though the total quantity of 51,5 tonnes is above the medium hazard threshold, which places it in the low hazard category.

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.

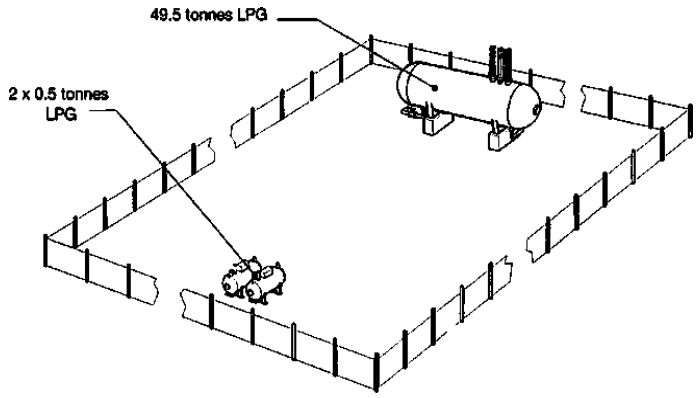
Both small tanks = 2% of threshold (50 tonnes), but as they are adjacent they should be regarded as one quantity of more than 2%; therefore, the 2% rule does not apply. As the total quantity of 51,5 tonnes exceeds the medium hazard threshold, the medium hazard threshold applies to this establishment.

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.

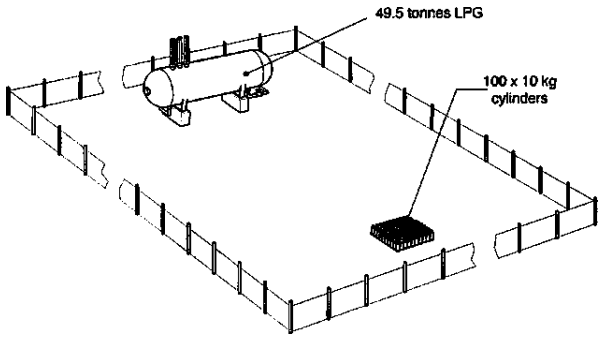
Both small tanks = 1% of threshold (50 tonnes), but as they are adjacent they should be regarded as one quantity of 1 tonne which = 2%. As this cannot start a major incident elsewhere on site, the 2% rule applies and the medium hazard category does not apply even though the total quantity is greater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

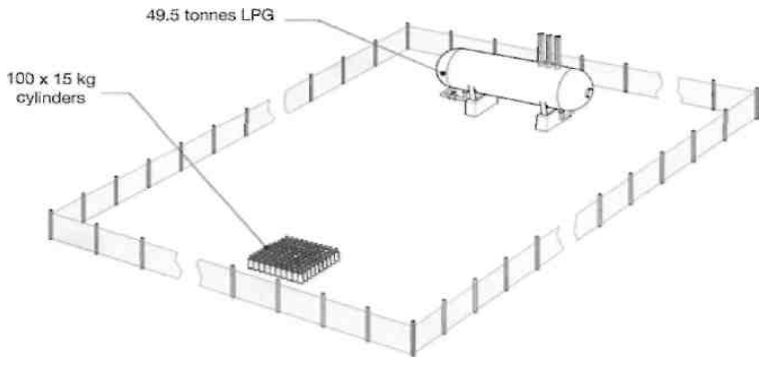
Each cylinder contains less than 2% of the medium hazard threshold (50 tonnes) and the total quantity in the cylinders is 1 tonne, which is 2% of the medium hazard threshold. The cylinder compound cannot start a major incident elsewhere on site, so the 2% rule applies. Therefore, the medium hazard category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

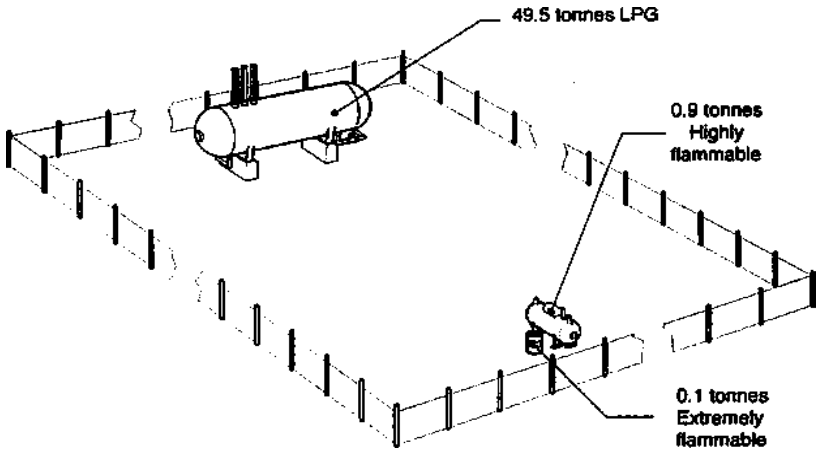
Example 7

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.

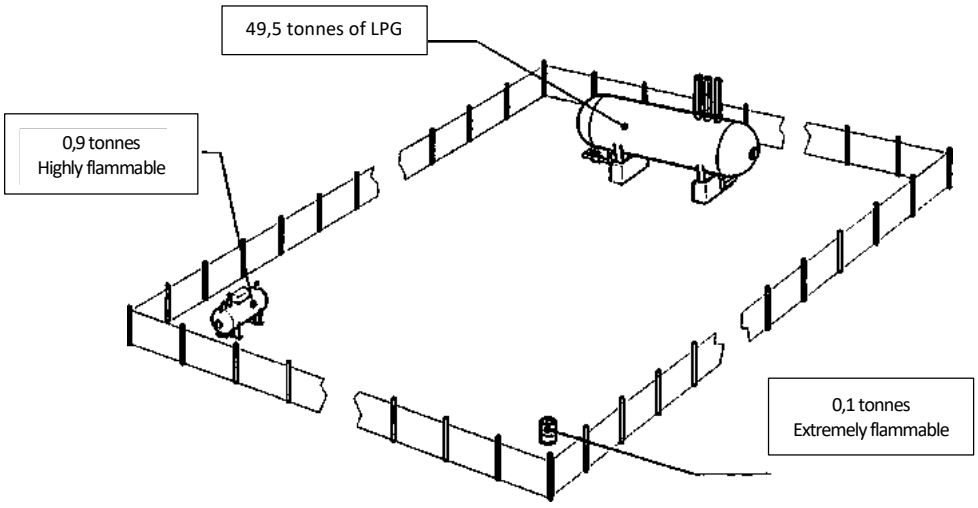
Example 8

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

5. DETAILS OF APPROVED INSPECTION AUTHORITY (AIA)

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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Publications: Tel: (012) 748 6053, 748 6061, 748 6065

13 APPENDIX C: 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	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
	caravan sites, camping sites		
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	Principally an outdoor development for use by the general public	Developments where members of the public will

Development Type	Examples	Development Detail and Size	Justification
	Retail: outdoor markets, car boot sales, funfairs Community and adult 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	i.e. developments where people will predominantly be outdoors and not more than 100 people will gather at the facility at any one time (Level 2)	be present (but not resident) 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

Development Type	Examples	Development Detail and Size	Justification
DT3.1 Institutional Accommodation and Education	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	Institutional, educational and special accommodation for vulnerable people or that provides a protective environment (Level 3)	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
	Exclusions		
	Hospitals, convalescent homes, nursing homes, old people's homes, sheltered housing	DT3.1 x1 24-hour care where the site on the planning application being developed is larger than 0.25 hectare (Level 4)	Substantial increase in numbers of vulnerable people at risk
	Schools, nurseries, crèches	DT3.1 x2 Day care where the site on the planning application being developed is larger than 1.4 hectare (Level 4)	Substantial increase in numbers of vulnerable people at risk
DT3.2 Prisons	Prisons, remand centres	Secure accommodation for those sentenced by court, or awaiting trial, etc. (Level 3)	Places providing detention Emergency action and evacuation may be very difficult

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 of the occupants that 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

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			
			larger societal concern

14 APPENDIX D: DEPARTMENT OF LABOUR CERTIFICATE

employment & labour

Department:
Employment and Labour
REPUBLIC OF SOUTH AFRICA

National Department of Employment and Labour
Republic of South Africa

APPROVED INSPECTION AUTHORITY

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

This is to certify that:

RISCOM (PTY) LTD
CIPRO Reg No: 2002/019697/07
JOHANNESBURG

has been approved by the Department of Labour as a Type A, Approved Inspection Authority: Major Hazard Installation under Regulations 21, Major Hazard Installation Regulations, 2022 for High, Medium and Low Hazard establishment.

CHIEF INSPECTOR

Valid from: 27 May 2025
Expires: 26 May 2029
Certificate Number: **CI MHI 0005**

DEPARTMENT OF EMPLOYMENT & LABOUR

15 APPENDIX E: SANAS CERTIFICATES

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.

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.: 21 Date of issue: 12 May 2026 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. R2989 of 31 Jan 2025	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

Page 1 of 1

ISSUED BY THE SOUTH AFRICAN NATIONAL ACCREDITATION SYSTEM

Accreditation Manager

16 APPENDIX F: MATERIAL SAFETY DATA SHEETS (MSDS)

16.1 Liquefied Natural Gas (LNG) (CAS No.: 8006-14-2)

SAFETY DATA SHEET
Liquefied Natural Gas (LNG)

Printed: 12/07/2018
Revision: 12/07/2018
Supersedes Revision: 04/12/2015

1. PRODUCT AND COMPANY IDENTIFICATION

Product Code: 00016
Product Name: Liquefied Natural Gas (LNG)

Company Name: Gas Innovations
18005 E. Hwy 225
La Porte, TX 77571

Phone Number:
+1 (281)471-2200

Web site address: www.gasinnovations.com

Emergency Contact: 3E (within United States) +1 (866)303-2640
Information: Infotrac (outside of United States) +1 (352)323-3500

Product Category: Refrigerated gas
Intended Use: Industrial Use
Synonyms: (UN 1972), (Liquefied Natural Gas), (Methane Refrigerated Liquid), (Natural Gas Refrigerated Liquid)

2. HAZARDS IDENTIFICATION

Flammable Gases, Category 1
Gas Under Pressure, Refrigerated liquefied gas

GHS Signal Word: **Danger**

GHS Hazard Phrases:
H220 - Extremely flammable gas.
H281 - Contains refrigerated gas; may cause cryogenic burns or injury.
H261 - In contact with water releases flammable gases.

GHS Precaution Phrases:
P202 - Do not handle until all safety precautions have been read and understood.
P210 - Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
P282 - Wear cold insulating gloves/face shield/eye protection.

GHS Response Phrases:
P336 - Thaw frosted parts with lukewarm water. Do not rub affected areas. P315 - Get immediate medical advice/attention.
P377 - Leaking gas fire: Do not extinguish, unless leak can be stopped safely. P381 - Eliminate all ignition sources if safe to do so.

GHS Storage and Disposal Phrases: P403 - Store in well-ventilated place.

OSHA Regulatory Status: This material is classified as hazardous under OSHA regulations.

Inhalation: This material can act as a simple asphyxiant by displacement of air. Symptoms of asphyxia include headache, dizziness, rapid breathing, increased pulse, mood changes, tremors, cyanosis, muscular weakness, narcosis, numbness of the extremities, unconsciousness and death. The effects of asphyxiation may be more rapid during physical effort since oxygen consumption is increased.

Skin Contact: The vapors are not irritants, but direct contact of the eyes, skin with cold vapors or lqiuid may cause frostbite, burns, permanent ocular and skin lesions.

Eye Contact: The vapors are not irritants, but direct contact of the eyes, skin with cold vapors or lqiuid may cause frostbite, burns, permanent ocular and skin lesions.

Ingestion: Not a likely route of exposure. May be harmful if swallowed.

Medical Conditions Generally Aggravated By Exposure: People with pre-existing heart, lung or blood conditions may have an increased sensitivity to asphyxiation.

3. COMPOSITION/INFORMATION ON INGREDIENTS

CAS #	Hazardous Components (Chemical Name)	Concentration
74-82-8	Methane	99.5 %
7727-37-9	Nitrogen	0.5 %

4. FIRST AID MEASURES

Emergency and First Aid Procedures:

In Case of Inhalation: If breathing is difficult, remove to fresh air and keep at rest in a position comfortable for breathing. If breathing is difficult, give oxygen or administer artificial respiration. Get medical aid if irritation develops and persists.

In Case of Skin Contact: Liquefied gases may cause cryogenic burns or injury. Treat frostbitten skin by flushing or immersing affected area in lukewarm water. Do not rub affected area. Do not remove clothing that adheres due to freezing. After sensation has returned to the skin, keep skin warm, dry, and clean. If blistering occurs, apply a sterile dressing. Seek immediate medical attention.

In Case of Eye Contact: For contact with the liquefied gas, remove contact lenses if present, hold eyes open and gently flush the affected eye(s) with lukewarm water. Get immediate medical advice/attention.

In Case of Ingestion: Not a likely route of exposure. In the unlikely event of ingestion, obtain medical attention immediately.

Signs and Symptoms Of Exposure: Light hydrocarbon gases are simple asphyxiant and can cause anesthetic effects at high concentrations. Symptoms of overexposure, which are reversible if exposure is stopped, can include shortness of breath, drowsiness, headaches, confusion, decreased coordination, visual disturbances and vomiting. Continued exposure can lead to hypoxia, raid breathing, numbness, unconsciousness and death. The signs of frostbite are a change in the color of the skin to grey or white, followed later by blisters. The skin may become inflamed and painful.

Note to Physician: Show this safety data sheet to the doctor in attendance. Epinephrine and other sympathomimetic drugs may initiate cardiac arrhythmias in persons exposed to high concentrations of hydrocarbon solvents (e.g., in enclosed spaces or with deliberate abuse). The use of other drugs with less arrhythmogenic potential should be considered. If sympathomimetic drugs are administered, observe for the development of cardiac arrhythmias.

5. FIRE FIGHTING MEASURES

Flash Pt: -136 C (-213 F) Method Used: Unknown

Explosive Limits: LEL: 5% (V) at 25.0 C (77.0 F) UEL: 15% (V) at 25.0 C (77.0 F)

Autoignition Pt: 537 C (999 F)

Suitable Extinguishing Media: Dry chemical (Purple-K) and carbon dioxide are the most effective types of extinguishing media. To suppress or contain, use water fog or high expansion foam.

Unsuitable Extinguishing Media: Water is not a suitable agent for fighting a LNG fire directly because it causes expansion of the fire by increasing the rate of vaporization of the liquid to gas.

Fire Fighting Instructions: Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Flame-retardant clothing, gloves and proper eye protection need to be worn in any situation where there is the potential for LNG vapors to ignite accidentally. If safe to do so, try to remove ignition sources. Use non-sparking tools to shut off the gas. Do not try to extinguish the fire if the gas leak can't be stopped. If there is no risk to the surrounding area, let the fire burn itself out. If needed, use a combustible gas detector to establish a secure perimeter around the site.

Spilled material may pool on the ground and flow toward lower points until the temperature rises above -100C (-148F). If the spill has not ignited, water spray can be used to direct flammable gas-air mixtures away from ignition sources. LNG vapors are heavier than air until the vapors reach -180F. During a significant spill the vapors generated may travel long distances to a distant ignition source.

Flammable Properties and Hazards: Highly flammable, extremely cold liquid and gas. Forms explosive mixtures in air and with oxidizing agents.
A Rapid Phase Transition (RPT) can occur when there is a significant difference in temperature between the LNG and a warmer liquid; this reaction can cause instantaneous vaporization of the LNG. The sudden increase in total volume occupied by the LNG may generate a shock wave (sudden generation of overpressure but without combustion).

Hazardous Combustion Products: High temperatures and fire conditions can result in the formation of carbon monoxide and carbon dioxide, Fireball forms if gas is ignited immediately after release.

6. ACCIDENTAL RELEASE MEASURES

Protective Precautions, Protective Equipment and Emergency Procedures: Use proper personal protective equipment as indicated in Section 8.

Environmental Precautions: Liquefied Natural Gas (LNG) will not pollute natural resources such as ground water, soil, wetlands, streams or beaches. It vaporizes quickly and completely, and because it is lighter than air, it does not contain any pollutants from the spill.

Steps To Be Taken In Case Material Is Released Or Spilled: Remove all sources of ignition. Ensure adequate ventilation. Notify relevant authorities in accordance with applicable regulations. Recommended measures are based on the most likely spillage scenarios for this material; however local conditions and regulations may influence or limit the choice of appropriate actions to be taken.

7. HANDLING AND STORAGE

Precautions To Be Taken in Handling: To be handled by trained personnel only, using equipment specifically designed for LNG and following approved standard operating procedures. Cold burns may occur during filling operations. Wear appropriate personal protective equipment (see section 8) and use good industrial hygiene. Gas can accumulate in confined spaces and limit available oxygen. Use only with adequate ventilation.
Take precautionary measures against static discharge. Electrostatic charge may accumulate and create a hazardous condition when handling this material. To avoid fire, dissipate static electricity during transfer by grounding and bonding containers and equipment before transferring material.
Do not pressurize, cut, weld, braze, solder, drill, grind or expose such containers to heat, flame, sparks or other sources of ignition.

Precautions To Be Taken in Storing: Store only in containers compatible for Liquefied Natural Gas storage. Post area with proper signage such as no smoking, no open flames, personal protective equipment requirements and cryogenic hazard. Use spark-proof tools and explosion proof equipment. Keep away from heat, sparks and flame.

Other Precautions: Liquid methane tanks are equipped with pressure relief devices. Venting vapors may obscure visibility. If venting or leaking methane catches fire, do not extinguish flames. Flammable vapors may spread from leak creating an explosive reignition hazard. Vapors can be ignited by pilot lights, other flames, smoking, sparks, heaters, electrical equipment, static discharge, or other ignition sources at locations distant from product handling point. Explosive atmospheres may linger. Before entering area, especially confined areas, check atmosphere with an approved explosion meter. Never touch live electrical parts.

Avoid materials incompatible with cryogenic use; some metals such as carbon steel may fracture easily at low temperature. To prevent liquid or cold gas from being trapped in piping between valves, equip the piping with pressure relief devices. Use only transfer lines designed for cryogenic liquids. It is recommended to pipe all vents to the exterior of the building. Always store and use with adequate ventilation. Never work on a pressurized system. If a leak occurs, follow established procedures for isolation and blow down before attempting any repair. Never place a compressed gas cylinder where it may become part of an electrical circuit.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

CAS #	Partial Chemical Name	OSHA TWA	ACGIH TWA	Other Limits
74-82-8	Methane	No data.	TLV: Simple asphyxiant ppm	No data.
7727-37-9	Nitrogen	No data.	TLV: Simple asphyxiant ppm	No data.

Respiratory Equipment (Specify Type): A NIOSH approved, self-contained breathing apparatus (SCBA) or equivalent operated in a pressure demand, or other positive pressure mode, should be used in situations of oxygen deficiency (oxygen content less than 19.5 percent), unknown exposure concentrations, or situations that are immediately dangerous to life or health (IDLH). A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements must be followed whenever workplace conditions warrant a respirator's use.

Eye Protection: The use of eye protection (such as splash goggles) that meets or exceeds ANSI Z.87.1 is recommended when there is potential liquid contact to the eye. Depending on conditions of use, a face shield may be necessary.

Protective Gloves: Wear thermal insulating gloves and clothing when working with materials that present thermal hazards (hot or cold).

Other Protective Clothing: Wear thermal insulating gloves and clothing when working with materials that present thermal hazards (hot or cold).

Engineering Controls (Ventilation etc.): Provide adequate ventilation to maintain 19.5% oxygen, less than 1% methane (20% of LEL). Use a combustible gas indicator since LNG is odorless. If ventilation practices are not adequate to maintain airborne concentrations below exposure limits, additional engineering controls may be required.

Work/Hygienic/Maintenance Practices: Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday. Suggestions provided in Section 8 for exposure control and specific types of protective equipment are based on readily available information. Specific situations may require consultation regarding industrial hygiene, safety or engineering professionals to ensure proper protection.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical States: [ ] Gas [X] Liquid [ ] Solid

Appearance and Odor: Appearance: colorless.
Odorless. Odor:
Cryogenic liquid.

pH: NA

Freezing Point: -182 C (-296 F)

Boiling Point: -162 C (-259 F)

Flash Pt: -136 C (-213 F) Method Used: Unknown

Evaporation Rate: NA

Flammability (solid, gas): If a source of ignition is present where the vapor exists at 5 - 15% concentration in air, the vapor will burn along the flame front towards the source of fuel.

Explosive Limits: LEL: 5% (V) at 25.0 C (77.0 F) UEL: 15% (V) at 25.0 C (77.0 F)

Vapor Pressure (vs. Air or 655.57 PSI

mm Hg):

Vapor Density (vs. Air = 1): NA

Specific Gravity (Water = 1): NA

Density: 0.415 at -164 C (-263 F)

Solubility in Water: No data.

Saturated Vapor Concentration: NA

Octanol/Water Partition Coefficient: No data.

Percent Volatile: 100 % by volume.

Autoignition Pt: 537 C (999 F)

Decomposition Temperature: No data.

Viscosity: NA

Molecular Formula & Weight: CH4 16.042

10. STABILITY AND REACTIVITY

Reactivity: Stable under recommended storage conditions.

Stability: Unstable [ ] Stable [X]

Conditions To Avoid - Instability: Heat, flames and sparks. Air. Heat will increase pressure in the storage tank. Stable under recommended storage conditions.

Incompatibility - Materials To Avoid: Air. Oxygen, Strong oxidizing agents. halides, chlorinated compounds, fluorine.

Hazardous Decomposition or Byproducts: High temperatures and fire conditions can result in the formation of carbon monoxide and carbon dioxide.

Possibility of Hazardous Reactions: Will occur [X] Will not occur [ ]

Conditions To Avoid - Hazardous Reactions: Keep away from source of: ignition, heat, high temperatures, flames, sparks, welding and static electricity.

11. TOXICOLOGICAL INFORMATION

Toxicological Information: Mutagenicity: Not expected.
Reproductive toxicity: Not expected. Hypoxia during pregnancy may have adverse effects on the developing fetus.

This material can act as a simple asphyxiant by displacement of air. Anesthetic effects at high concentrations. High concentrations may reduce the amount of oxygen available, especially in confined spaces.

Irritation or Corrosion: May cause frostbite.

Symptoms related to Toxicological Characteristics: The vapors are not irritants, but direct contact of the eyes, skin with cold vapors or lqiuid may cause frostbite, burns, permanent ocular and skin lesions. Even though non-toxic by inhalation, exposure to high concentrations may cause a depression of the nervous system (rapid respiration, dizziness, headaches), but without any long-term effects.

Chronic Toxicological Effects: No data available.

Carcinogenicity: NTP? No IARC Monographs? No OSHA Regulated? No

12. ECOLOGICAL INFORMATION

General Ecological Information: Petroleum gases will readily evaporate from the surface and would not be expected to have significant adverse effects in the aquatic environment.
Classification: No classified hazards.

Persistence and Degradability: The hydrocarbons in this material are expected to be inherently biodegradable. In practice, hydrocarbon gases are not likely to remain in solution long enough for biodegradation to be a significant loss process.

Bioaccumulative Potential: Does not bioaccumulate.

Mobility in Soil: Due to the extreme volatility of petroleum gases, air is the only environmental compartment in which they will be found.

Other adverse effects: Not expected.

13. DISPOSAL CONSIDERATIONS

Waste Disposal Method: This material is a gas and would not typically be managed as a waste. Dispose of contents and containers in accordance with local, regional, national, and international regulations.

14. TRANSPORT INFORMATION

LAND TRANSPORT (US DOT):

DOT Proper Shipping Name: Natural Gas, refrigerated, liquid.
DOT Hazard Class: 2.1 FLAMMABLE GAS
UN/NA Number: UN1972
Precautionary Label: ERG Number: 115

15. REGULATORY INFORMATION

EPA SARA (Superfund Amendments and Reauthorization Act of 1986) Lists

CAS #	Hazardous Components (Chemical Name)	S. 302 (EHS)	S. 304 RQ	S. 313 (TRI)
74-82-8	Methane	No	No	No
7727-37-9	Nitrogen	No	No	No

CAS #	Hazardous Components (Chemical Name)	Other US EPA or State Lists
74-82-8	Methane	TSCA: Yes - Inventory; CA PROP.65: No; CA TAC, Title 8: No; MA Oil/HazMat: Yes; MI CMR, Part 5: No; NC TAP: No; NJ EHS: Yes - 1202; NY Part 597: No; PA HSL: Yes - 1; SC TAP: No; WI Air: No
7727-37-9	Nitrogen	TSCA: Yes - Inventory; CA PROP.65: No; CA TAC, Title 8: No; MA Oil/HazMat: Yes; MI CMR, Part 5: No; NC TAP: No; NJ EHS: No; NY Part 597: No; PA HSL: Yes - 1; SC TAP: No; WI Air: No

CAS #	Hazardous Components (Chemical Name)	International Regulatory Lists
74-82-8	Methane	Canadian DSL: Yes; Canadian NDSL: No; Mexico INSQ: Yes - 1971; Australia ICS: Yes; New Zealand IOC: Yes; China IECSC: Yes; Japan ENCS: Yes - 9-1726; Korea ECL: Yes - KE-23181; Philippines ICCS: Yes; REACH: Yes - 01-2119474442-39: Full, (P)
7727-37-9	Nitrogen	Canadian DSL: Yes; Canadian NDSL: No; Mexico INSQ: Yes; Australia ICS: Yes; New Zealand IOC: Yes; China IECSC: Yes; Japan ENCS: No; Korea ECL: Yes - KE-25994;

Regulatory Information:

California Proposition 65: This material does not contain any chemicals which are known to the State of California to cause cancer, birth defects or other reproductive harm at concentrations that trigger the requirements of California Proposition 65.

EPA Reportable Quantity (CERCLA) (in pounds): EPA's petroleum exclusions apply to this material. (CERCLA 101(14).

CERCLA/SARA Section 313 & 40 CFR 372: This material does not contain any chemicals subject to the reporting requirements of SARA 313 and 40 CFR 372.

CERCLA/SARA Section 311/312 (Title III Hazard Categories):
Acute Health: Yes
Chronic Health: No
Fire Hazard: Yes
Pressure Hazard: Yes
Reaction Hazard: No

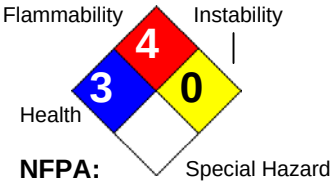
International Hazard Classification: Canada: This product has been classified in accordance with the hazard criteria of the Controlled Products Regulation (CPR) and the MSDS contains all the information required by the regulation.

16. OTHER INFORMATION

Revision Date: 12/07/2018

Preparer Name: Crystal Maira

Hazard Rating System:



Additional Information: 12/07/2018 Routine review and updates to section ALL

Company Policy or Disclaimer:

The information, recommendations, and suggestions herein were compiled from reference material and other sources believed to be reliable. However, the SDS's accuracy or completeness is not guaranteed by Gas Innovations or its affiliates, nor is any responsibility assumed or implied for any loss or damage resulting from inaccuracies or omissions. Since conditions of use are beyond our control, no warranties of merchantability of fitness for a particular purpose are expressed or implied. This SDS is not intended as a license to operate under, or a recommendation to infringe on, any patents. Appropriate warnings and safe handling procedures should be provided to handlers and users.

16.2 Natural Gas (CAS No.: 74-82-8)

Revision Date: April 02, 2019
Supersedes Date: January 31, 2019

SAFETY DATA SHEET - NATURAL GAS

SECTION 1. PRODUCT AND COMPANY IDENTIFICATION

ATCO Gas 10035 – 105 Street Edmonton, Alberta T5J 2V6 1-800-511-3447 (toll-free) for information	**Emergency Telephone : (24 –hr)** CANUTEC: 1-613-996-6666 (Call Collect) or (*666 on a cellular phone)

PRODUCT IDENTIFICATION

Manufacturer	Various Suppliers, Pipeline/Distribution quality
Trade Name	Natural Gas
Chemical Name	Methane
Synonyms	Natural Gas/high Methane content
Chemical Family	Alkanes
Molecular Formula	CH_4 (Methane)
Product Use	Natural Gas is used primarily for space and water heating and for industrial processing applications
Method of Transport	Pipeline (under pressure) or high pressure cylinders attached to mobile vehicles

Transportation of Dangerous Goods Regulations

UN 1971; Class 2.1	**Shipping Name and Description: METHANE, COMPRESSED**
WHMIS Classification	**Compressed Gas (Class A)** **Flammable Gas (Class B1)**

SECTION 2. HAZARDOUS IDENTIFICATION

2.1 Classification of the Substance or Mixture

Simple Asphyxiant	Simple Asphyxiants – Category 1; A gas that is a simple asphyxiant
Gases Under Pressure	Gases under pressure / Compressed gas
Flam Gas 1	Flammable gases - Category 1
H220	Extremely flammable gas
H280	Contains gas under pressure; may explode if heated

2.2 Label Elements **Hazard Pictograms** :

Signal Word : Danger

Hazard Statements : H220 - Extremely flammable gas.
H280 - Contains gas under pressure; may explode if heated.
H380 - May displace oxygen and cause rapid suffocation.

Precautionary Statements : P210 - Keep away from heat, sparks, open flames, hot surfaces. 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.
P410+P403 - Protect from sunlight. Store in a well-ventilated place.

2.3 Other Hazards

Exposure may aggravate those with pre-existing eye, skin, or respiratory conditions. Asphyxiant gas, can be fatal. May cause damage to the blood, central nervous system, and cardiovascular system. High concentrations of gas can cause unconsciousness and death. Mercaptan is added (rotten egg odour) to the gas, however this smell should not be relied on as a good indicator of the presence of gas as olfactory fatigue (loss of smell) occurs rapidly. Being under the influence of alcohol may enhance the effects of this product.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Composition			
Hazardous Ingredients	**Common Name/Synonyms**	**CAS No.**	**% Vol./Vol.**
Natural Gas	**N/A**	**8006-14-2**	**100**
Methane	**N/A**	**74-82-8**	**90-99**
Ethane	**N/A**	**74-84-0**	**0-6**
Propane	**N/A**	**74-98-6**	**0-3**
Butane	**N/A**	**106-97-8**	**0-3**
Propane, 2-methyl-	**Isobutane**	**75-28-5**	**0-3**
Pentane	**N/A**	**109-66-0**	**0-3**
Butane, 2-methyl-	**Isopentane**	**78-78-4**	**0-3**
Nitrogen	**N/A**	**7727-37-9**	**0-3**
Carbon dioxide	**N/A**	**124-38-9**	**0-3**
Helium	**N/A**	**744-59-7**	**0-3**

*typically contains <5 ppm mercaptans

SECTION 4. FIRST AID

Skin Contact: First aid is not normally required

Eye Contact: If irritation/redness develops, move victim away from exposure into fresh air
And flush eyes with clean water.

Inhalation: Do not enter a contaminated area unless properly protected (refer to Section 8)
Move victim to uncontaminated area to fresh air
Perform artificial respiration if necessary

	Seek medical assistance
Note to Physicians:	Symptoms may not appear immediately

5. FIRE AND EXPLOSION HAZARD DATA (See Note, Section 11)

Flammability	In the presence of oxygen and in the presence of an ignition source
Flammability Limits (percent in air)	4% - 15%
Fire Extinguishing Media	Dry Chemical (most effective) or carbon dioxide (CO_2) or Halon
Special Procedures:	Shut off flow of gas from a safe location. (if properly trained). Use full protective equipment and Self -contained breathing apparatus (SCBA). Do not extinguise flame until gas flow is shut off. Use gas detectors in confined spaces.
Ignition Temperature	Approximately 630°C (varies with temperature pressure and oxygen concentration)
Auto Ignition Temperature in Air	Range 482°C - 649°C
Upper Explosive Limit	15% gas in air (approximately)
Product of Combustion:	Carbon dioxide and carbon Monoxide
Protection of Firefighters:	Firefighters should wear SCBA in case of oxygen deficient atmostphere. Do not extinguish unless leak can be stopped safety. In case of leakage, eliminate all ignition sources.
Sensitivity to Static Discharge:	Flammable

Section 6. ACCIDENTAL RELEASE MEASURES

Personal Precations:	Use personal protection recommended in Section 8
Enviromental Precautions:	None
Leak and Spill Procedures:	Evacuate area
Leak/Line Break Occurs	Contact emergency number (refer to Section 1) Attempt to keep area clear Do not activate any sorce of ignition such as electrical switches, vehicles, telephones, cellular phone, two way radios or door bells. Eliminate ignition sources such as open flame or sparks.
Methods for Containment	Stay away and upwind of spill/release
Waste Disposal	Vent to outside atmosphere
Other information	Allow to vapourize and dispense to atmosphere

Section 7. HANDLING AND STORAGE

Handling	Observe handling regulations for compressed gases and flammable materials. To be handled by trained personnel only and followed with approved operating procedures.
Storage:	Comply with storage regulations for compressed gases and flammable materials. No smoking or open flames in storage area.
Precautions to be Taken	Avoid personal body contact (skin/eye contact, etc.) with high pressure gas stream
Other Precautions	Avoid all possible sources of accidental ignition (i.e., static electricity or any other explosive source) Test for hazardous concentrations prior to entering meter stations

Section 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Exposure Guidelines
Component

Natural gas [CAS No. 8006-14-2]
ACGIH: Simple asphyxiant; Explosion hazard
OSHA: No PEL established.

Methane [CAS No. 74-82-8]
ACGIH: Simple asphyxiant; Explosion hazard
OSHA: No PEL established.

Ethane [CAS No. 74-84-0]
ACGIH: Simple asphyxiant; Explosion hazard
OSHA: No PEL established.

Propane [CAS No. 74-98-6]
ACGIH: Simple asphyxiant; Explosion hazard
OSHA: 1000 ppm (TWA), 1800 mg/m^3 (TWA);

Butane [CAS No. 106-97-8]
ACGIH: 1000 ppm (STEL); Explosion hazard (2012)
OSHA: 800 ppm (TWA) [Vacated];

Isobutane [CAS No. 75-28-5]
ACGIH: 1000 ppm (STEL); Explosion hazard (2012)
OSHA: No PEL established.

Pentane [CAS No. 109-66-0]
ACGIH: 1000 ppm (TWA); (2013)
OSHA: 1000 ppm (TWA), 2950 mg/m^3 (TWA);
600 ppm (TWA); 750 ppm (STEL) [Vacated];

Isopentane [CAS No. 78-78-4]
ACGIH: 1000 ppm (TWA); (2013)
OSHA: No PEL established.

Nitrogen [CAS No. 7727-37-9]
ACGIH: Simple asphyxiant
OSHA: No PEL established.

Carbon dioxide [CAS No. 124-38-9]
ACGIH: 5000 ppm (TWA); 30000 ppm (STEL); (1983)
OSHA: 5000 ppm (TWA), 9000 mg/m^3 (TWA);

Helium [CAS No. 7440-59-7]
ACGIH: Simple asphyxiant
OSHA: No PEL established.

PEL: Permissible Exposure Limit
TLV: Threshold Limit Value
TWA: Time-Weighted Average
STEL: Short-Term Exposure Limit

Engineering Controls:
Use ventilation adequate to keep exposures (airborne levels of dust, fume, vapour, gas, etc.) below recommended exposure limits.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Eye/Face Protection:	Wear safety glasses. Use equipment for eye protection that meets the standards referenced by CSA Standard CAN/CSA-Z94.3-92 and OSHA regulations in 29 CFR 1910.133 for Personal Protective Equipment.
Hand Protection:	Wear protective gloves. Wear cold insulating gloves. Consult manufacturer specifications for further information.
Skin and Body Protection:	Wear protective clothing. Flame resistant clothing that meets the NFPA 2112 and CAN/CGSB 155.20 standards is recommended in areas where material is stored or handled.
Respiratory Protection:	If engineering controls and ventilation are not sufficient to control exposure to below the allowable limits then an appropriate NIOSH/MSHA approved air-purifying respirator that meets the requirements of CSA Standard CAN/CSA-Z94.4-11, or self-contained breathing apparatus must be used. Supplied air breathing apparatus must be used when oxygen concentrations are low or if airborne concentrations exceed the limits of the air-purifying respirators.
Engineering Controls:	All installations (i.e., mechanical ventilation) must conform to code requirements. Provide adequate ventilation to maintain below exposure limits and explosive

FLAMMABILITY AND EXPLOSION INFORMATION

Extremely flammable gas. Contains gas under pressure; may explode if heated. Will be easily ignited by heat, sparks or flames. Will form explosive mixtures with air. Vapors from liquefied gas are initially heavier than air and spread along ground. Methane is lighter than air and will rise. Vapors may travel to source of ignition and flash back. Cylinders exposed to fire may vent and release flammable gas through pressure relief devices. Containers may explode when heated. Ruptured cylinders may rocket. DO NOT EXTINGUISH A LEAKING GAS FIRE UNLESS LEAK CAN BE STOPPED.
If tank, rail car or tank truck is involved in a fire, ISOLATE for 1600 meters (1 mile) in all directions; also, consider initial evacuation for 1600 meters (1 mile) in all directions.

Fire involving Tanks: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Cool containers with flooding quantities of water until well after fire is out. Do not direct water at source of leak or safety devices; icing may occur. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

Sensitivity to Mechanical Impact:	This material is not sensitive to mechanical impact.
Sensitivity to Static Discharge:	This material is sensitive to static discharge.

MEANS OF EXTINCTION

Suitable Extinguishing Media:	Small Fire: Dry chemical or CO2. Large Fire: Water spray or fog. Move containers from fire area if you can do it without risk.
Unsuitable Extinguishing Media:	Not available.

Products of Combustion:	Oxides of carbon.
Protection of Firefighters:	Leaking gas fire: Do not extinguish, unless leak can be stopped safely. In case of leakage, eliminate all ignition sources. Vapors may cause dizziness or asphyxiation without warning. Contact with gas or liquefied gas may cause burns, severe injury and/or frostbite. Fire may produce irritating and/or toxic gases. Wear positive pressure self-contained breathing apparatus (SCBA). Structural firefighters' protective clothing will only provide limited protection. Always wear thermal protective clothing when handling refrigerated/cryogenic liquids.

Section 9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Gas
Colour:	Colourless
Odour:	Naturally odourless, although Mercaptan is added to all distribution systems and some transmission systems to give a “rotten egg” sulfur odour.
Specific	Gravity (Water = 1): Not applicable
Odour Threshold (**ppm**):	Less than 10,000 ppm in air
Vapour Pressure (mm Hg):	Gaseous state at normal conditions
Vapour Density (**Air = 1):**	0.6 (Air+1) at 20 °**C** (68 °F) (Methane)
Evaporation Rate (**nButAC = 1):**	Not applicable (gas at room temperature)
Boiling Point (°C):	-161.5°C (as Methane)
Freezing Point (°C):	-182.5°C
Solubility in water:	0.0022% (as Methane)
Percent Volatile (**by volume**):	100%
pH:	Not available
Density (**g/ml**):	N/A
Partition Coefficient (**water/oil**):	Not available
Flash Point (°C):	-188 °C
Flammability (solid, **gas):**	Flammable gas
Lower Explosion Limit (%):	4 (Methane)
Upper Explosion Limit (%):	15 (Methane)
Auto-ignition Temperature (°**C**):	537

SECTION 10. STABILITY AND REACTIVITY

Stability	Natural Gas/Methane is stable under normal storage conditions
Conditions to Avoid	Uncontrolled explosive mixtures Open flame and spark source High heat Strong oxidants Sources of ignition
Incompatibility	Natural Gas readily mixes with air when released and creates a combustible atmosphere. Some other strong oxidizing agents with which it can burn or explode in confined areas are: chlorine, bromine pentafluoride, oxygen difluoride and nitrogen trifluoride. It will ignite spontaneously when mixed with chlorine dioxide.
Hazardous Polymerization	May not occur
Hazardous Decomposition Products	CO_2, trace amounts of oxides of sulphur and nitrogen (SO_2 and NO_X) CO if starved of oxygen during combustion
Unusual Fire and Explosion Hazards	Could be potentially hazardous if uncontrolled in a confined space
Hazardous Combustion Products:	Carbon Monoxide, Carbon Dioxide, Nitrogen Oxides, Sulphur Dioxide, Aldehydes

Sensitivity to Static Discharge: Yes

NOTE: Natural Gas is lighter than air and will dissipate to atmosphere. Natural Gas **without sufficient** or **with too much** air will not burn or explode. A hazard from re-ignition or explosion exists if the flame is extinguished without stopping the flow of gas and/or cooling surroundings and eliminating ignition sources. Water spray can be used to cool the surroundings.

SECTION 11. TOXICOLOGICAL INFORMATION

EFFECTS OF ACUTE EXPOSURE

Product Toxicity

Oral: Not available.
Dermal: Not available.
Inhalation: Not available

Component Toxitcity

Component	CAS NO.	LD50 Oral	LD50 dermal	LC50
Natural gas	8006-14-2	N/A	N/A	N/A
Methane	74-82-8	N/A	N/A	N/A
Ethane	74-84-0	N/A	N/A	N/A
Propane	74-98-6	N/A	N/A	N/A
Butane	106-97-8	N/A	N/A	658000mg/m ^{3} (rat); 4H
Isobutane	75-28-5	N/A	N/A	570000 ppm (rat); 15M
Pentane	109-66-0	400mg/kg (rat)	N/A	364000 mg/m ^{3} (rat); 4H
Isopentane	78-78-4	N/A	N/A	N/A
Nitrogen	7727-37-9	N/A	N/A	N/A
Carbon Dioxide	124-38-9	N/A	N/A	N/A
Helium	7440-59-7	N/A	N/A	N/A

Likely Routes of Exposure: Eye contact. Skin contact. Inhalation.
Target Organs: Skin. Eyes. Respiratory system. Cardiovascular system. Bone marrow. Liver. Kidneys. Central nervous system.

Symptoms (including delayed and immediate effects)

Inhalation: May displace oxygen and cause rapid suffocation. Central nervous system depression can occur if product is present in concentrations that will reduce the oxygen content of air below 18 % (vol). Symptoms may include headache, lightheadedness, drowsiness, disorientation, vomiting and seizures. Unconsciousness and death may occur with severe oxygen deprivation. May cause respiratory irritation. Signs/symptoms may include cough, sneezing, nasal discharge, headache, hoarseness, and nose and throat pain.

Eye: Contact with rapidly expanding or liquefied gas may cause irritation and/or frostbite. The pain after contact with liquid can quickly subside. Permanent eye damage or blindness could result.

Skin: Contact with rapidly expanding or liquefied gas may cause irritation and/or frostbite. Symptoms of frostbite include change in skin color to white or grayish-yellow. The pain after contact with liquid can quickly subside.

Ingestion:	Not a normal route of exposure.
Skin Sensitization:	Not available.
Respiratory Sensitization:	Not available.
Medical Conditions Aggravated By Exposure	Not available.

EFFECTS OF CHRONIC EXPOSURE (from short and long-term exposure)

Target Organs:	Skin. Eyes. Respiratory system. Cardiovascular system. Bone marrow. Liver. Kidneys. Central nervous system.
Chronic Effects:	Prolonged exposure to Natural gas can lead to hypoxia, bluish colouration to the skin, numbness, damage to the nervous system, heart sensitization, reduced consciousness and death. Prolonged or repeated inhalation of Isopentane may cause dizziness, weakness, weight loss, anemia, nervousness, pains in the limbs and peripheral numbness.
Carcinogenicity	This product does not contain any carcinogens or potential carcinogens as listed by ACGIH, IARC, OSHA, or NTP.
Mutagenicity:	Not available.
Reproductive Effects:	Not available.
Developmental Effect Teratogenicity:	Not available.

SECTION 12. ECOLOGICAL INFORMATION

Ecotoxicity:	Not available
Persistence/ Degradability:	Not available
Bioaccumulation/ Accumulation:	Not available There is no information available on the ecotoxicological effects of natural gas. Because of the high volatility of natural gas, it is unlikely to cause ground or water pollution. Natural gas released into the environment will disperse rapidly into the atmosphere and undergo photochemical degradation.

SECTION 13. DISPOSAL CONSIDERATIONS

Disposal:	Allow to dissipate to the atmosphere (if permitted by federal/provincial/municipal requirements). Dispose in a safe location, preferably by burning with a flare. If disposal of natural gas cannot be flared, care must be taken to ensure complete dissipation of the gas to a concentration below its flammable limits.

SECTION 14. TRANSPORT INFORMATION

TDG Classification:	Class 2.1 Flammable Gases
UN/PIN Number:	1971
TDG Shipping Description:	Natural gas, compressed with high methane content
Special Shipping Information:	Handle as extremely flammable gas. Precaution should be taken to minimize inhalation of natural gas.

SECTION 15. REGULATORY INFORMATION

15.1 Canadian Regulations

Natural Gas (8006-14-2)

WHMIS 2015 Classification	Simple Asphyxiant Flammable Gas – Category 1 Gas Under Pressure	

SECTION 16: Other information, including date of preparation or last revision

Last Revision Date: April 2, 2019

Prepared by: Gas Specification Management

NOTE: The physical and hazard data provided is specific to the typical natural gas composition that has been provided. As a naturally occurring product, natural gas samples may have compositions that vary slightly from the typical composition. If required, the exact gas sample composition can be determined by gas chromatography analysis. For more information, contact ATCO Gas, Gas Specification Management at (403) 245-7591.

16.3 Ammonia (CAS No.: 7664-41-7)

Ammonia

SECTION 1 : Identification of the substance/mixture and of the supplier

Product name : **Ammonia**

Manufacturer/Supplier Trade name:

Manufacturer/Supplier Article number: **S25164**

Recommended uses of the product and uses restrictions on use:

Manufacturer Details:

AquaPhoenix Scientific
9 Barnhart Drive, Hanover, PA 17331

Supplier Details:

Fisher Science Education
15 Jet View Drive, Rochester, NY 14624

Emergency telephone number:

Fisher Science Education Emergency Telephone No.: 800-535-5053

SECTION 2 : Hazards identification

Classification of the substance or mixture:

Corrosive
Skin corrosion, category 1B

Environmentally Damaging
Acute hazards to the aquatic environment, category 1

Irritant
Specific target organ toxicity following single exposure, category 3

STOT SE 3
AcAq Tox 1
Skin Corr. 1B

Signal word :Danger

Hazard statements:
Causes severe skin burns and eye damage
May cause respiratory irritation
Very toxic to aquatic life
Precautionary statements:
If medical advice is needed, have product container or label at hand
Keep out of reach of children
Read label before use
Do not breathe dust/fume/gas/mist/vapours/spray
Avoid release to the environment
Wear protective gloves/protective clothing/eye protection/face protection
Use personal protective equipment as required

Do not eat, drink or smoke when using this product
Wash skin thoroughly after handling
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do. Continue rinsing
Immediately call a POISON CENTER or doctor/physician
IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower
IF SWALLOWED: Rinse mouth. Do NOT induce vomiting
Collect spillage
Specific treatment (see supplemental first aid instructions on this label)
Wash contaminated clothing before reuse
Store locked up
Store in a dry place
Store in a well ventilated place. Keep container tightly closed
Dispose of contents/container to ...

Combustible Dust Hazard: :
May form combustible dust concentrations in air (during processing).

Other Non-GHS Classification:

WHMIS

E 

NFPA/HMIS

NFPA SCALE (0-4)

HMIS RATINGS (0-4)

SECTION 3 : Composition/information on ingredients

Ingredients:		
CAS 1336-21-6	Ammonium Hydroxide, ACS	12.32 %
CAS 7732-18-5	Deionized Water	87 %
		Percentages are by weight

SECTION 4 : First aid measures

Description of first aid measures

After inhalation: Move exposed individual to fresh air. Loosen clothing as necessary and position individual in

a comfortable position.Seek medical advice if discomfort or irritation persists.If breathing difficult, give oxygen.

After skin contact: Wash affected area with soap and water. Rinse/flush exposed skin gently using water for 15-20 minutes. Seek medical advice if discomfort or irritation persists.

After eye contact: Protect unexposed eye. Rinse/flush exposed eye(s) gently using water for 15-20 minutes. Remove contact lens(es) if able to do so during rinsing. Seek medical attention if irritation persists or if concerned.

After swallowing: Rinse mouth thoroughly. Do not induce vomiting. Have exposed individual drink sips of water. Seek medical attention if irritation, discomfort or vomiting persists.

Most important symptoms and effects, both acute and delayed:

Irritation, Nausea,Headache, Shortness of breath.;

Indication of any immediate medical attention and special treatment needed:

If seeking medical attention, provide SDS document to physician.

SECTION 5 : Firefighting measures

Extinguishing media

Suitable extinguishing agents: If in laboratory setting, follow laboratory fire suppression procedures. Use appropriate fire suppression agents for adjacent combustible materials or sources of ignition

For safety reasons unsuitable extinguishing agents:

Special hazards arising from the substance or mixture:

Combustion products may include carbon oxides or other toxic vapors.Thermal decomposition can lead to release of irritating gases and vapors.Avoid generating dust; fine dust dispersed in air in sufficient concentrations, and in the presence of an ignition source is a potential dust explosion hazard.

Advice for firefighters:

Protective equipment: Use NIOSH-approved respiratory protection/breathing apparatus.

Additional information (precautions): Move product containers away from fire or keep cool with water spray as a protective measure, where feasible.Use spark-proof tools and explosion-proof equipment.

SECTION 6 : Accidental release measures

Personal precautions, protective equipment and emergency procedures:

Wear protective equipment. Transfer to a disposal or recovery container.Use spark-proof tools and explosion-proof equipment.Use respiratory protective device against the effects of fumes/dust/aerosol. Keep unprotected persons away. Ensure adequate ventilation.Keep away from ignition sources. Protect from heat.Stop the spill, if possible. Contain spilled material by diking or using inert absorbent.

Environmental precautions:

Prevent from reaching drains, sewer or waterway. Collect contaminated soil for characterization per Section 13

Methods and material for containment and cleaning up:

If in a laboratory setting, follow Chemical Hygiene Plan procedures.Place into properly labeled containers for recovery or disposal. If necessary, use trained response staff/contractor.Dust deposits should not be allowed to accumulate on surfaces, as these may form an explosive mixture if they are released into the atmosphere in sufficient concentration. Avoid dispersal of dust in the air (i.e., clearing dust surfaces with compressed air). Collect solids in powder form using vacuum with (HEPA filter)

Reference to other sections:

SECTION 7 : Handling and storage

Precautions for safe handling:

Wash hands after handling. Follow good hygiene procedures when handling chemical materials. Do not eat, drink, smoke, or use personal products when handling chemical substances. If in a laboratory setting, follow Chemical Hygiene Plan.Use only in well ventilated areas.Avoid contact with eyes, skin, and clothing.

Conditions for safe storage, including any incompatibilities:

Provide ventilation for containers. Avoid storage near extreme heat, ignition sources or open flame. Store away from foodstuffs. Store away from oxidizing agents.Store in cool, dry conditions in well sealed containers. Store with like hazards

SECTION 8 : Exposure controls/personal protection



Control Parameters:
1336-21-6, Ammonium Hydroxide, ACGIH TLV: 17 mg/m3
1336-21-6 , Ammonium Hydroxide , OSHA PEL: 35 mg/m3
1336-21-6, Ammonium Hydroxide, OSHA TWA 25 ppm (18 mg/m3) ST 35 ppm (27 mg/m3)
1336-21-6, Ammonium Hydroxide, ACGIH TWA 25 ppm (18 mg/m3) ST 35 ppm (27 mg/m3)

Appropriate Engineering controls:
Emergency eye wash fountains and safety showers should be available in the immediate vicinity of use/handling.Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapor or dusts (total/respirable) below the applicable workplace exposure limits (Occupational Exposure Limits-OELs) indicated above.Use under a fume hood. It is recommended that all dust control equipment such as local exhaust ventilation and material transport systems involved in handling of this product contain explosion relief vents or an explosion suppression system or an oxygen deficient environment.Ensure that dust-handling systems (such as exhaust ducts, dust collectors, vessels, and processing equipment) are designed in a manner to prevent the escape of dust into the work area (i.e., there is no leakage from the equipment).

Respiratory protection:
Use suitable respiratory protective device when high concentrations are present. Use suitable respiratory protective device when aerosol or mist is formed. For spills, respiratory protection may be advisable.

Protection of skin:
The glove material has to be impermeable and resistant to the product/ the substance/ the preparation being used/handled.Selection of the glove material on consideration of the penetration times, rates of diffusion and the degradation.

Eye protection:
Safety glasses with side shields or goggles.

General hygienic measures:
The usual precautionary measures are to be adhered to when handling chemicals. Keep away from food, beverages and feed sources. Immediately remove all soiled and contaminated clothing. Wash hands before breaks and at the end of work. Do not inhale gases/fumes/dust/mist/vapor/aerosols. Avoid contact with the eyes and skin.

SECTION 9 : Physical and chemical properties

Appearance (physical state,color):	Clear, colorless liquid.	**Explosion limit lower**: **Explosion limit upper**:	Not Determined Not Determined

Ammonia

Odor:	Ammonia-like	**Vapor pressure**:	115 at 20 C
Odor threshold:	Not Determined	**Vapor density**:	3.38
pH-value:	9	**Relative density**:	0.9
Melting/Freezing point:	- 72 C	**Solubilities**:	Infinite solubility in water.
Boiling point/Boiling range:	36 C	**Partition coefficient (n-octanol/water)**:	Not Determined
Flash point (closed cup):	Not Determined	**Auto/Self-ignition temperature**:	Not Determined
Evaporation rate:	Not Determined	**Decomposition temperature**:	Not Determined
Flammability (solid,gaseous):	Not Determined	**Viscosity**:	a. Kinematic:Not Determined b. Dynamic: Not Determined
Density: 0.9 g/cm3 at 20 °C			

SECTION 10 : Stability and reactivity

Reactivity:
Chemical stability: No decomposition if used and stored according to specifications.
Possible hazardous reactions:
Conditions to avoid: Store away from oxidizing agents, strong acids or bases.
Incompatible materials: Strong oxidizers, acids, gold, mercury, halogens, silv er, calcium hypochlorite bleaches.
Hazardous decomposition products: Ammonia and nitrogen oxides.

SECTION 11 : Toxicological information

Acute Toxicity:		
Oral:	LD50: 350 mg/kg (rat)	Ammonium Hydroxide (1336-21-6)
Chronic Toxicity: No additional information.		
Corrosion Irritation: No additional information.		
Sensitization:		No additional information.
Single Target Organ (STOT):		No additional information.
Numerical Measures:		No additional information.
Carcinogenicity:		No additional information.
Mutagenicity:		No additional information.
Reproductive Toxicity:		No additional information.

SECTION 12 : Ecological information

Ecotoxicity

Fish (acute 1336-21-6): 96 Hr LC50 Pimephales promelas: 8.2 mg/L

Crustacea (acute 1336-21-6): 48 Hr EC50 water flea: 0.66 mg/L; 48 Hr EC50 Daphnia pulex: 0.66 mg/L

Persistence and degradability: Readily degradable in the environment.
Bioaccumulative potential:
Mobility in soil:
Other adverse effects:

SECTION 13 : Disposal considerations

Waste disposal recommendations:

Product/containers must not be disposed together with household garbage. Do not allow product to reach sewage system or open water.It is the responsibility of the waste generator to properly characterize all waste materials according to applicable regulatory entities (US 40CFR262.11). Consult federal state/ provincial and local regulations regarding the proper disposal of waste material that may incorporate some amount of this product.

SECTION 14 : Transport information

UN-Number

2672

UN proper shipping name

Ammonia Solution

Transport hazard class(es)

Class:
8 Corrosive substances

Packing group:III
Environmental hazard:
Transport in bulk:
Special precautions for user:

SECTION 15 : Regulatory information

United States (USA)

SARA Section 311/312 (Specific toxic chemical listings):

Acute, Chronic

SARA Section 313 (Specific toxic chemical listings):

1336-21-6 Ammonium Hydroxide

RCRA (hazardous waste code):

None of the ingredients is listed

TSCA (Toxic Substances Control Act):

All ingredients are listed.

CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act):

1336-21-6 Ammonium Hydroxide, ACS 1000

Proposition 65 (California):

Chemicals known to cause cancer:

None of the ingredients is listed

Chemicals known to cause reproductive toxicity for females:

None of the ingredients is listed

Chemicals known to cause reproductive toxicity for males:

None of the ingredients is listed

Chemicals known to cause developmental toxicity:

None of the ingredients is listed

Canada

Canadian Domestic Substances List (DSL):

All ingredients are listed.

Canadian NPRI Ingredient Disclosure list (limit 0.1%):

None of the ingredients is listed

Canadian NPRI Ingredient Disclosure list (limit 1%):

1336-21-6 Ammonium hydroxide

SECTION 16 : Other information

This product has been classified in accordance with hazard criteria of the Controlled Products Regulations and the SDS contains all the information required by the Controlled Products Regulations.Note:. The responsibility to provide a safe workplace remains with the user.The user should consider the health hazards and safety information contained herein as a guide and should take those precautions required in an individual operation to instruct employees and develop work practice procedures for a safe work environment.The information contained herein is, to the best of our knowledge and belief, accurate.However, since the conditions of handling and use are beyond our control, we make no guarantee of results, and assume no liability for damages incurred by the use of this material.It is the responsibility of the user to comply with all applicable laws and regulations applicable to this material.

GHS Full Text Phrases:

Abbreviations and acronyms:

IMDG: International Maritime Code for Dangerous Goods
PNEC: Predicted No-Effect Concentration (REACH)
CFR: Code of Federal Regulations (USA)
SARA: Superfund Amendments and Reauthorization Act (USA)
RCRA: Resource Conservation and Recovery Act (USA)
TSCA: Toxic Substances Control Act (USA)
NPRI: National Pollutant Release Inventory (Canada)
DOT: US Department of Transportation
IATA: International Air Transport Association
GHS: Globally Harmonized System of Classification and Labelling of Chemicals
ACGIH: American Conference of Governmental Industrial Hygienists
CAS: Chemical Abstracts Service (division of the American Chemical Society)
NFPA: National Fire Protection Association (USA)
HMIS: Hazardous Materials Identification System (USA)
WHMIS: Workplace Hazardous Materials Information System (Canada)
DNEL: Derived No-Effect Level (REACH)

Effective date : 12.31.2014
Last updated : 03.19.2015

16.4 Diesel (CAS No.: 68334-30-5)

SAFETY DATA SHEET

Automotive Diesel Fuel

Section 1. Identification

GHS product identifier Automotive Diesel Fuel

Other means of identification C10, BP 10 ppm diesel fuel, Ultra Low Sulphur diesel fuel, Automotive Diesel fuel, AD20, AD40, Alpine Diesel and Biodiesel up to B5.

Product code 0000002718

SDS no. 0000002718

Historic SDS no. AD0K1

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

Use of the substance/ mixture Fuel for compression ignition diesel engines.

Manufacturer

Supplier

BP Australia Pty Ltd
Level 17, 717 Bourke Street
Docklands, Victoria 3008
ABN 53 004 085 616

www.bp.com.au

Technical Helpline Number: 1300 139 700

EMERGENCY TELEPHONE NUMBER 1800 638 556

Section 2. Hazard(s) identification

Classification of the substance or mixture

FLAMMABLE LIQUIDS - Category 4
ACUTE TOXICITY (inhalation) - Category 4
SKIN CORROSION/IRRITATION - Category 2
CARCINOGENICITY - Category 2
SPECIFIC TARGET ORGAN TOXICITY - REPEATED EXPOSURE (bone marrow, liver, thymus) - Category 2
ASPIRATION HAZARD - Category 1

GHS label elements

Hazard pictograms

Signal word DANGER

Hazard statements

H227 - Combustible liquid.
H332 - Harmful if inhaled.
H315 - Causes skin irritation.
H351 - Suspected of causing cancer.
H304 - May be fatal if swallowed and enters airways.
H373 - May cause damage to organs through prolonged or repeated exposure. (bone marrow, liver, thymus)

Precautionary statements

General

P103 - Read label before use.
P102 - Keep out of reach of children.
P101 - If medical advice is needed, have product container or label at hand.

Section 2. Hazard(s) identification

Prevention

P201 - Obtain special instructions before use.
P260 - Do not breathe vapour.
P280 - Wear protective gloves. Wear eye or face protection. Wear protective clothing.
P210 - Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
P240 - Ground/bond container and receiving equipment.
P273 - Avoid release to the environment.

Response

P314 - Get medical attention if you feel unwell.
P308 + P313 - IF exposed or concerned: Get medical attention.
P304 + P340 + P312 - IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. Call a POISON CENTER or physician if you feel unwell.
P301 + P310 + P331 - IF SWALLOWED: Immediately call a POISON CENTER or physician. Do NOT induce vomiting.
P302 + P352 + P362 + P363 - IF ON SKIN: Wash with plenty of soap and water. Take off contaminated clothing. Wash contaminated clothing before reuse.
P332 + P313 - If skin irritation occurs: Get medical attention.

Storage

P405 - Store locked up.
P403 - Store in a well-ventilated place.
P235 - Keep cool.

Disposal

P501 - Dispose of contents and container in accordance with all local, regional, national and international regulations.

Supplemental label elements

Not applicable.

Other hazards which do not result in classification

This material may contain significant quantities of polycyclic aromatic hydrocarbons, some of which have been shown by experimental studies to induce skin cancer.
Note: High Pressure Applications
Injections through the skin resulting from contact with the product at high pressure constitute a major medical emergency.
See 'Notes to physician' under First-Aid Measures, Section 4 of this Safety Data Sheet.

Section 3. Composition and ingredient information

Substance/mixture Mixture

May contain Fatty Acid Methyl Esters (FAME). May also contain small quantities of proprietary performance additives. Contains small quantities of polycyclic aromatic hydrocarbons (PAHs).

Ingredient name	% (w/w)	CAS number
Fuels, diesel	> 95	68334-30-5
Alkanes, C10-20-branched and linear	0 - 20	928771-01-1

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

Eye contact

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Eyelids should be held away from the eyeball to ensure thorough rinsing. Check for and remove any contact lenses. Get medical attention.

Inhalation

If inhaled, remove to fresh air. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. Get medical attention.

Section 4. First aid measures

Skin contact

In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Drench contaminated clothing with water before removing. This is necessary to avoid the risk of sparks from static electricity that could ignite contaminated clothing. Contaminated clothing is a fire hazard. Contaminated leather, particularly footwear, must be discarded. Clean shoes thoroughly before reuse. Get medical attention.

Ingestion

Do not induce vomiting. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention immediately. Aspiration hazard if swallowed. Can enter lungs and cause damage. Get medical attention immediately.

Most important symptoms/effects, acute and delayed

See Section 11 for more detailed information on health effects and symptoms.

Indication of immediate medical attention and special treatment needed, if necessary

Notes to physician

Treatment should in general be symptomatic and directed to relieving any effects. Product can be aspirated on swallowing or following regurgitation of stomach contents, and can cause severe and potentially fatal chemical pneumonitis, which will require urgent treatment. Because of the risk of aspiration, induction of vomiting and gastric lavage should be avoided. Gastric lavage should be undertaken only after endotracheal intubation. Monitor for cardiac dysrhythmias.

Note: High Pressure Applications
Injections through the skin resulting from contact with the product at high pressure constitute a major medical emergency. Injuries may not appear serious at first but within a few hours tissue becomes swollen, discoloured and extremely painful with extensive subcutaneous necrosis.
Surgical exploration should be undertaken without delay. Thorough and extensive debridement of the wound and underlying tissue is necessary to minimise tissue loss and prevent or limit permanent damage. Note that high pressure may force the product considerable distances along tissue planes.

Specific treatments

No specific treatment.

Protection of first-aiders

No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.

Section 5. Firefighting measures

Extinguishing media

Suitable extinguishing media

In case of fire, use water fog, foam, dry chemical or carbon dioxide extinguisher or spray.

Unsuitable extinguishing media

Do not use water jet.

Specific hazards arising from the chemical

Combustible liquid. Fire water contaminated with this material must be contained and prevented from being discharged to any waterway, sewer or drain. In a fire or if heated, a pressure increase will occur and the container may burst, with the risk of a subsequent explosion. Runoff to sewer may create fire or explosion hazard.

Hazardous thermal decomposition products

Combustion products may include the following:
carbon oxides (CO, CO_2) (carbon monoxide, carbon dioxide)
other hazardous substances.

Special protective actions for fire-fighters

No action shall be taken involving any personal risk or without suitable training. Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool.

Section 5. Firefighting measures

Special protective equipment for fire-fighters Fire-fighters should wear positive pressure self-contained breathing apparatus (SCBA) and full turnout gear.

Hazchem code 3z

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel Immediately contact emergency personnel. No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilt material. No flares, smoking or flames in hazard area. Avoid breathing vapour or mist. Provide adequate ventilation. Put on appropriate personal protective equipment. Floors may be slippery; use care to avoid falling. Eliminate all ignition sources.

For emergency responders Entry into a confined space or poorly ventilated area contaminated with vapour, mist or fume is extremely hazardous without the correct respiratory protective equipment and a safe system of work. Wear self-contained breathing apparatus. Wear a suitable chemical protective suit. Chemical resistant boots. See also the information in "For non-emergency personnel".

Environmental precautions Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air). Water polluting material. May be harmful to the environment if released in large quantities.

Methods and material for containment and cleaning up

Small spill Eliminate all ignition sources. Stop leak if without risk. Move containers from spill area. Absorb with an inert material and place in an appropriate waste disposal container. Use spark-proof tools and explosion-proof equipment. Dispose of via a licensed waste disposal contractor. The method and equipment used must be in conformance with appropriate regulations and industry practice on explosive atmospheres.

Large spill Eliminate all ignition sources. Stop leak if without risk. Move containers from spill area. Approach the release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Dike spill area and do not allow product to reach sewage system and surface or ground water. Contain and collect spillage with non-combustible, absorbent material e.g. sand, earth, vermiculite or diatomaceous earth and place in container for disposal according to local regulations. Use spark-proof tools and explosion-proof equipment. Contaminated absorbent material may pose the same hazard as the spilt product. The method and equipment used must be in conformance with appropriate regulations and industry practice on explosive atmospheres. Dispose of via a licensed waste disposal contractor.

Section 7. Handling and storage

Precautions for safe handling

Protective measures Put on appropriate personal protective equipment (see Section 8). Avoid exposure - obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Do not get in eyes or on skin or clothing. Do not breathe vapour or mist. Do not swallow. Aspiration hazard if swallowed. Can enter lungs and cause damage. Never siphon by mouth. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Store and use away from heat, sparks, open flame or any other ignition source. Use explosion-proof electrical (ventilating, lighting and material handling) equipment. Use only non-sparking tools. Empty containers retain product residue and can be hazardous. Do not reuse container. Avoid contact of spilt material and runoff with soil and surface waterways.

Section 7. Handling and storage

Advice on general occupational hygiene

Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Wash thoroughly after handling. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Conditions for safe storage, including any incompatibilities

Store in accordance with local regulations. Store in a segregated and approved area. Store in original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10) and food and drink. Store locked up. Eliminate all ignition sources. Separate from oxidising materials. Keep container tightly closed and sealed until ready for use. Store and use only in equipment/containers designed for use with this product. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabelled containers. Use appropriate containment to avoid environmental contamination.

Take precautions to avoid static electrical discharge and all ignition sources during filling, ullaging and sampling from storage tanks. Do not enter storage tanks. If entry to vessels is necessary, follow permit to work procedures. When the product is pumped (e.g. during filling, discharge or ullaging) and when sampling, there is a risk of static discharge. Ensure equipment used is properly earthed or bonded to the tank structure. Use of explosion-protected electrical, ventilating, lighting and all material-handling equipment should be considered. Explosive air/vapour mixtures may form at ambient temperatures on contact with hot surfaces. Keep away from heat, hot surfaces, sparks, open flames and other ignition sources.

Product contaminated rags, paper or material used to absorb spillages, represent a fire hazard, and should not be allowed to accumulate. Dispose of safely immediately after use. Entry into a confined space or poorly ventilated area contaminated with vapour, mist or fume is extremely hazardous without the correct respiratory protective equipment and a safe system of work.

Classified as a C1 (COMBUSTIBLE LIQUID) for the purpose of storage and handling, in accordance with the requirements of AS 1940. Refer to State Regulations for storage and transport requirements.

Section 8. Exposure controls and personal protection

Control parameters

Occupational exposure limits

Ingredient name	Exposure limits
Fuels, diesel	**ACGIH TLV (United States). Absorbed through skin.** TWA: 100 mg/m³, (measured as total hydrocarbons) 8 hours. Issued/Revised: 1/2007 Form: Inhalable fraction and vapor

Appropriate engineering controls

All activities involving chemicals should be assessed for their risks to health, to ensure exposures are adequately controlled. Personal protective equipment should only be considered after other forms of control measures (e.g. engineering controls) have been suitably evaluated. Personal protective equipment should conform to appropriate standards, be suitable for use, be kept in good condition and properly maintained.
Your supplier of personal protective equipment should be consulted for advice on selection and appropriate standards. For further information contact your national organisation for standards.
Provide exhaust ventilation or other engineering controls to keep the relevant airborne concentrations below their respective occupational exposure limits.

Section 8. Exposure controls and personal protection

The final choice of protective equipment will depend upon a risk assessment. It is important to ensure that all items of personal protective equipment are compatible.

Environmental exposure controls

Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

Hygiene measures

Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Eye/face protection

Chemical splash goggles.

Skin protection

Hand protection

Wear chemical resistant gloves.

Protective gloves must give suitable protection against mechanical risks (i.e. abrasion, blade cut and puncture). Protective gloves will deteriorate over time due to physical and chemical damage. Inspect and replace gloves on a regular basis. The frequency of replacement will depend upon the circumstances of use.

Recommended: Nitrile gloves.

Skin protection

Recommended: overall
Use of protective clothing is good industrial practice.
Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.
Cotton or polyester/cotton overalls will only provide protection against light superficial contamination that will not soak through to the skin. Overalls should be laundered on a regular basis. When the risk of skin exposure is high (e.g. when cleaning up spillages or if there is a risk of splashing) then chemical resistant aprons and/or impervious chemical suits and boots will be required.
Wear suitable protective clothing.
Footwear highly resistant to chemicals.
When there is a risk of ignition wear inherently fire resistant protective clothes and gloves.
When there is a risk of ignition from static electricity, wear anti-static protective clothing. For greatest effectiveness against static electricity, overalls, boots and gloves should all be anti-static.
When the risk of skin exposure is high (from experience this could apply to the following tasks: cleaning work, maintenance and service, filling and transfer, taking samples and cleaning up spillages) then a chemical protective suit and boots will be required.
Work clothing / overalls should be laundered on a regular basis. Laundering of contaminated work clothing should only be done by professional cleaners who have been told about the hazards of the contamination. Always keep contaminated work clothing away from uncontaminated work clothing and uncontaminated personal clothes.

Other skin protection

Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Respiratory protection

Use with adequate ventilation.
If there is a requirement for the use of a respiratory protective device, but the use of breathing apparatus (independent of ambient atmosphere) is not required, then a suitable filtering device must be worn.
The filter class must be suitable for the maximum contaminant concentration (gas/ vapour/aerosol/particulates) that may arise when handling the product.

Recommended: If ventilation is inadequate, use respirator that will protect against organic vapour and dust/mist.

Section 8. Exposure controls and personal protection

Refer to standards: Respiratory protection:AS/NZS 1715 and AS/NZS 1716
Gloves:AS/NZS 2161.1
Eye protection:AS/NZS 1336 and AS/NZS 1337

Section 9. Physical and chemical properties

Appearance

Physical state Liquid.

Colour Water white to straw including fluorescent green, blue or yellow.

Odour Mild

Odour threshold 0.7 ppm (Based on Fuels, diesel)

pH Not applicable. Based on Solubility in Water (Very slightly soluble in water)

Melting point -29 to -18°C (-20.2 to -0.4°F) (Based on Fuels, diesel)

Boiling point 180 to 380°C (356 to 716°F)

Flash point Closed cup: >61.5°C (>142.7°F) [Pensky-Martens.]

Evaporation rate Not relevant/applicable due to nature of the product. Based on low volatility

Flammability (solid, gas) Not applicable. Based on - Physical state

Lower and upper explosive (flammable) limits Lower: 0.5%
Upper: 7.5%

Vapour pressure 0.1 kPa (0.755 mm Hg) (Based on Concawe Category: Vacuum Gas Oils, Hydrocracked Gas Oils & Distillate Fuels (VHGO))

Vapour density Not available.

Relative density 0.83

Density 820 to 850 kg/m³ (0.82 to 0.85 g/cm³) at 15°C

Solubility Very slightly soluble in water

Partition coefficient: n-octanol/water Not applicable. Based on Fuels, diesel - Substance is a hydrocarbon UVCB. Standard tests for this endpoint are intended for single substances and are not appropriate for this complex substance.

Auto-ignition temperature 240°C (464°F) (Based on Fuels, diesel)

Decomposition temperature Not observed to decompose by final boiling point: 380°C (716°F)

Viscosity Kinematic: 2 to 4.5 mm^2/s (2 to 4.5 cSt) at 40°C

Section 10. Stability and reactivity

Reactivity No specific test data available for this product. Refer to Conditions to avoid and Incompatible materials for additional information.

Chemical stability The product is stable.

Possibility of hazardous reactions Under normal conditions of storage and use, hazardous reactions will not occur. Under normal conditions of storage and use, hazardous polymerisation will not occur.

Conditions to avoid Avoid all possible sources of ignition (spark or flame). Avoid excessive heat.

Incompatible materials Reactive or incompatible with the following materials: oxidising materials.

Hazardous decomposition products Under normal conditions of storage and use, hazardous decomposition products should not be produced.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

Product/ingredient name	Result	Species	Dose	Exposure

Section 11. Toxicological information

Fuels, diesel	LC50 Inhalation Dusts and mists	Rat	4.1 mg/l	4 hours
	LD50 Dermal	Rabbit	>4300 mg/kg	-
	LD50 Dermal	Rabbit	>4300 mg/kg	-
	LD50 Oral	Rat	17900 mg/kg	-
	LD50 Oral	Rat	7600 mg/kg	-

Irritation/Corrosion

Product/ingredient name	Result	Species	Score	Exposure	Observation
Fuels, diesel	Skin - Irritation	Rabbit	-	-	-
	Skin - Irritation	Rabbit	-	-	-
	Eyes - Non-irritating to the eyes.	Rabbit	-	-	-
	Eyes - Non-irritating to the eyes.	Rabbit	-	-	-

Skin Causes skin irritation.

Sensitisation

Product/ingredient name	Route of exposure	Species	Result
Fuels, diesel	skin	Guinea pig	Not sensitising
	skin	Guinea pig	Not sensitising

Mutagenicity

Product/ingredient name	Test	Experiment	Result
Fuels, diesel	OECD 471	Experiment: In vitro Subject: Non-mammalian species	Positive
	Equivalent to OECD 476	Experiment: In vitro Subject: Mammalian-Animal Cell: Germ	Negative
	not guideline	Experiment: In vivo Subject: Unspecified Cell: Somatic	Negative

Conclusion/Summary Not classified. Based on available data, the classification criteria are not met.

Carcinogenicity

Product/ingredient name	Result	Species	Dose	Exposure
Fuels, diesel	Positive - Dermal - Unspecified	Mouse	-	2 years

Conclusion/Summary Suspected of causing cancer.

Reproductive toxicity

Product/ingredient name	Maternal toxicity	Fertility	Developmental toxin	Species	Dose	Exposure
Fuels, diesel	-	-	Negative	Rat	Dermal	20 days
	-	-	Negative	Rat	Dermal	10 days
	-	-	Negative	Rat	Dermal	10 days

Conclusion/Summary Development: Not classified. Based on available data, the classification criteria are not met.
Fertility: Not classified. Based on available data, the classification criteria are not met.
Effects on or via lactation: Not classified. Based on available data, the classification criteria are not met.

Specific target organ toxicity (repeated exposure)

Name	Category	Route of exposure	Target organs

Fuels, diesel	Category 2	Not determined	bone marrow, liver and thymus

Aspiration hazard

Name	Result
Fuels, diesel	ASPIRATION HAZARD - Category 1
Alkanes, C10-20-branched and linear	ASPIRATION HAZARD - Category 1

Information on likely routes of exposure Routes of entry anticipated: Oral, Dermal, Inhalation.

Potential acute health effects

Eye contact No known significant effects or critical hazards.

Inhalation Harmful if inhaled.

Skin contact Causes skin irritation.

Ingestion Irritating to mouth, throat and stomach. Aspiration hazard if swallowed -- harmful or fatal if liquid is aspirated into lungs.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact Adverse symptoms may include the following:
pain or irritation
watering
redness

Inhalation Adverse symptoms may include the following:
nausea or vomiting
headache
drowsiness/fatigue
dizziness/vertigo
unconsciousness

Skin contact Adverse symptoms may include the following:
irritation
redness

Ingestion Adverse symptoms may include the following:
nausea or vomiting

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Eye contact Vapour, mist or fume may cause eye irritation. Exposure to vapour, mist or fume may cause stinging, redness and watering of the eyes.

Inhalation Vapour, mists or fumes may contain polycyclic aromatic hydrocarbons some of which are known to produce skin cancer. Vapour, mists or fumes may contain polycyclic aromatic hydrocarbons some of which are known to produce skin cancer. Vapour, mist or fume may irritate the nose, mouth and respiratory tract.

Skin contact As with all such products containing potentially harmful levels of polycyclic aromatic hydrocarbons, prolonged or repeated skin contact may eventually result in dermatitis or more serious irreversible skin disorders including cancer.

Ingestion If swallowed, may irritate the mouth, throat and digestive system. If swallowed, may cause abdominal pain, stomach cramps, nausea, vomiting, diarrhoea, dizziness and drowsiness.

General May cause damage to organs through prolonged or repeated exposure. Vapour, mists or fumes may contain polycyclic aromatic hydrocarbons some of which are known to produce skin cancer. Vapour, mists or fumes may contain polycyclic aromatic hydrocarbons some of which are known to produce skin cancer.

Carcinogenicity Suspected of causing cancer. Risk of cancer depends on duration and level of exposure.

Mutagenicity No known significant effects or critical hazards.

Teratogenicity No known significant effects or critical hazards.

Section 11. Toxicological information

Developmental effects No known significant effects or critical hazards.

Fertility effects No known significant effects or critical hazards.

Numerical measures of toxicity

Acute toxicity estimates

Route	ATE value
Inhalation (dusts and mists)	1.89 mg/l

Section 12. Ecological information

Toxicity

Product/ingredient name	Result	Species	Exposure
Fuels, diesel	EL50 >1000 mg/l Nominal Fresh water	Micro-organism	40 hours
	NOELR 3.217 mg/l Nominal Fresh water	Micro-organism	40 hours
	Acute EL50 22 mg/l Nominal Fresh water	Algae	72 hours
	Acute EL50 210 mg/l Nominal Fresh water	Daphnia	48 hours
	Acute EL50 68 mg/l Nominal Fresh water	Daphnia	48 hours
	Acute ErL50 78 mg/l Nominal Fresh water	Algae	72 hours
	Acute LL50 65 mg/l Nominal Fresh water	Fish	96 hours
	Acute LL50 21 mg/l Nominal Fresh water	Fish	96 hours
	Acute NOELR 10 mg/l Nominal Fresh water	Algae	72 hours
	Acute NOELR 1 mg/l Nominal Fresh water	Algae	72 hours
	Acute NOELR 46 mg/l Nominal Fresh water	Daphnia	48 hours
	Chronic NOEL 0.083 mg/l Nominal Fresh water	Fish	14 days
	Chronic NOELR 0.2 mg/l Nominal Fresh water	Daphnia	21 days

Conclusion/Summary Toxic to aquatic life with long lasting effects.

Persistence and degradability

Expected to be biodegradable.

Product/ingredient name	Test	Result	Dose	Inoculum
Fuels, diesel	OECD 301 F	60 % - Readily - 28 days	30 mg/l	-
	OECD 301 F	57.5 % - Not readily - 28 days	25 mg/l	-
	Equivalent to EPA OTS 796.3100	35 % - Not readily - 28 days	5 mg/l	-

Conclusion/Summary Non-persistent per IMO criteria

Bioaccumulative potential

This product is not expected to bioaccumulate through food chains in the environment.

Section 12. Ecological information

Mobility in soil

Soil/water partition coefficient (K_{OC}) Not available.

Mobility Spillages may penetrate the soil causing ground water contamination. This material may accumulate in sediments.

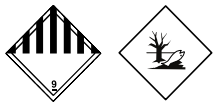
Other ecological information Spills may form a film on water surfaces causing physical damage to organisms. Oxygen transfer could also be impaired.

Section 13. Disposal considerations

Disposal methods The generation of waste should be avoided or minimised wherever possible. Significant quantities of waste product residues should not be disposed of via the foul sewer but processed in a suitable effluent treatment plant. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Care should be taken when handling emptied containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Vapour from product residues may create a highly flammable or explosive atmosphere inside the container. Do not cut, weld or grind used containers unless they have been cleaned thoroughly internally. Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers.

Special Precautions for Landfill or Incineration Empty packages may contain some remaining product. Hazard warning labels are a guide to the safe handling of empty packaging and should not be removed.

Section 14. Transport information

	ADG	IMDG	IATA
UN number	Not regulated.	UN3082	UN3082
UN proper shipping name	-	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S. (Fuels, diesel). Marine pollutant	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S. (Fuels, diesel)
Transport hazard class(es)	-	9 	9 
Packing group	-	III	III
Environmental hazards	No.	Yes.	Yes.
Additional information	**Remarks** Combustible liquid Class C1 (AS 1940). **Hazchem code** 3Z **Initial emergency response guide** 47	This product is not regulated as a dangerous good when transported in sizes of ≤5 L or ≤5 kg, provided the packagings meet the general provisions of 4.1.1.1, 4.1.1.2 and 4.1.1.4 to 4.1.1.8. **Emergency schedules** F-A, S-F	This product is not regulated as a dangerous good when transported in sizes of ≤5 L or ≤5 kg, provided the packagings meet the general provisions of 5.0.2.4.1, 5.0.2.6.1.1 and 5.0.2.8.

Section 14. Transport information

Special precautions for user Not available.

Transport in bulk according to Annex II of Marpol and the IBC Code

Proper shipping name MARPOL Annex 1 rules apply for bulk shipments by sea.
Category: gas oils, including ship's bunkers

Section 15. Regulatory information

Standard Uniform Schedule of Medicine and Poisons

Not scheduled

Consumer products - This product is exempt per Appendix A of the SUSMP.
Industrial Products - Labelling requirements for SUSMP do not apply to a poison that is packed and sold solely for industrial, laboratory or manufacturing use. However, this product is labelled in accordance with NOSHC National Code of Practice for labelling of workplace substances.

Model Work Health and Safety Regulations - Scheduled Substances

No listed substance

Montreal Protocol (Annexes A, B, C, E)

Ingredient name	List name	Status
Not listed.		

Stockholm Convention on Persistent Organic Pollutants

Ingredient name	List name	Status
Not listed.		

Rotterdam Convention on Prior Informed Consent (PIC)

Ingredient name	List name	Status
Not listed.		

International lists

National inventory

REACH Status	For the REACH status of this product please consult your company contact, as identified in Section 1.
Australia inventory (AICS)	All components are listed or exempted.
Canada inventory	All components are listed or exempted.
China inventory (IECSC)	Not determined.
Japan inventory (ENCS)	Not determined.
Korea inventory (KECI)	Not determined.
Philippines inventory (PICCS)	Not determined.
Taiwan Chemical Substances Inventory (TCSI)	All components are listed or exempted.
United States inventory (TSCA 8b)	All components are active or exempted.

Section 16. Any other relevant information

History

Date of printing	8/6/2019
Date of issue/Date of revision	8/6/2019
Date of previous issue	5/25/2016
Version	3
Prepared by	Product Stewardship

Key to abbreviations

ADG = Australian Dangerous Goods
ATE = Acute Toxicity Estimate
BCF = Bioconcentration Factor
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
IATA = International Air Transport Association
IBC = Intermediate Bulk Container
IMDG = International Maritime Dangerous Goods
LogPow = logarithm of the octanol/water partition coefficient
MARPOL = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
NOHSC = National Occupational Health and Safety Commission
REACH = Registration, Evaluation, Authorisation and Restriction of Chemicals Regulation [Regulation (EC) No. 1907/2006]
STEL = Short term exposure limit
SUSMP = Standard Uniform Schedule of Medicine and Poisons
UN = United Nations
TWA = Time weighted average
VOC = Volatile Organic Compound
SADT = Self-Accelerating Decomposition Temperature
Varies = may contain one or more of the following 64741-88-4, 64741-89-5, 64741-95-3, 64741-96-4, 64742-01-4, 64742-44-5, 64742-45-6, 64742-52-5, 64742-53-6, 64742-54-7, 64742-55-8, 64742-56-9, 64742-57-0, 64742-58-1, 64742-62-7, 64742-63-8, 64742-65-0, 64742-70-7, 72623-85-9, 72623-86-0, 72623-87-1

Procedure used to derive the classification

Classification	Justification
Flam. Liq. 4, H227	On basis of test data
Acute Tox. 4, H332	Calculation method
Skin Irrit. 2, H315	Calculation method
Carc. 2, H351	Calculation method
STOT RE 2, H373 (bone marrow, liver, thymus)	Calculation method
Asp. Tox. 1, H304	Calculation method

Indicates information that has changed from previously issued version.

Notice to reader

All reasonably practicable steps have been taken to ensure this data sheet and the health, safety and environmental information contained in it is accurate as of the date specified below. No warranty or representation, express or implied is made as to the accuracy or completeness of the data and information in this data sheet.

The data and advice given apply when the product is sold for the stated application or applications. You should not use the product other than for the stated application or applications without seeking advice from BP Group.

It is the user's obligation to evaluate and use this product safely and to comply with all applicable laws and regulations. The BP Group shall not be responsible for any damage or injury resulting from use, other than the stated product use of the material, from any failure to adhere to recommendations, or from any hazards inherent in the nature of the material. Purchasers of the product for supply to a third party for use at work, have a duty to take all necessary steps to ensure that any person handling or using the product is provided with the information in this sheet. Employers have a duty to tell employees and others who may be affected of any hazards described in this sheet and of any precautions that should be taken. You can contact the BP Group to ensure that this document is the most current available. Alteration of this document is strictly prohibited.

16.5 Light Oil (LO) (CAS No.: 8042-47-5)

SDS ID No.: CLF-2007

Safety Data Sheet (SDS)

Locations: Monessen, Burns Harbor, Warren

Section 1 – Identification

1(a) Product Identifier used on Label: Light Oil

1(b) Other means of identification: formerly AM USA-2007, CLF-2007

1(c) Recommended use of the chemical and restrictions on use: There are no known restrictions on use.

1(d) Name, address, and telephone number:

Cleveland-Cliffs Steel
1 South Dearborn Street
Chicago, IL 60603-9888

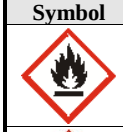
Phone number: 219-787-4901 or
email at: sdssupport@clevelandcliffs.com

1(e) Emergency phone number: 1-760-476-3962 (Verisk 3E Company Code: 333211) or CHEMTREC (Day or Night): 1-800-424-9300

Section 2 – Hazard(s) Identification

2(a) Classification of the Chemical: Light Oil is considered a hazardous material according to the criteria specified in REACH [REGULATION (EC) No 1907/2006] and CLP [REGULATION (EC) No 1272/2008] and OSHA 29 CFR 1910.1200 Hazard Communication Standard. The categories of Health Hazards as defined in "GLOBALLY HARMONIZED SYSTEM OF CLASSIFICATION AND LABELLING OF CHEMICALS (GHS), Third revised edition ST/SG/AC.10/30/Rev. 3" United Nations, New York and Geneva, 2009 have been evaluated. Refer to Section 3, 8 and 11 for additional information.

2(b) Signal word, hazard statement(s), symbols and precautionary statement(s):

Hazard Symbol	Hazard Classification	Signal Word	Hazard Statement(s)
	Flammable Liquid - 2	**DANGER**	Highly Flammable liquid and vapor. Toxic if inhaled. May cause genetic defects. May cause cancer. May damage fertility or the unborn child. May cause central nervous system depression, respiratory irritation drowsiness or dizziness and damage to lungs, liver and blood cells. Causes damage to blood and blood forming system, lungs and central nervous system through prolonged or repeated exposure. May be fatal if swallowed and enters airways. Causes skin irritation. Causes serious eye irritation.
	Acute Toxicity, Inhalation - 3		
	Germ Cell Mutagenicity - 1B Carcinogenicity - 1A Reproductive Toxicity - 1B Single Target Organ Toxicity (STOT) Single Exposure - 2 STOT Repeat Exposure – 1 Aspiration - 1		
	Skin Irritation - 2 Eye Irritation - 2A		

Precautionary Statement(s):

Prevention	Response	Storage/Disposal
Wear protective gloves / protective clothing / eye protection / face protection. Do not breathe /gas/mist/ vapors/spray. Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Wash thoroughly after handling. Do not eat, drink or smoke when using this product. Keep away from heat/sparks/open flames/hot surfaces. No smoking. Keep container tightly closed. Ground/Bond container and receiving equipment. Use explosion-proof electrical/ventilating/lighting/equipment. Use only non-sparking tools. Take precautionary measures against static discharge. Use only outdoors or in well ventilated areas.	If exposed, concerned or feel unwell: Get medical advice/attention, call a poison center or doctor. If inhaled: Remove person to fresh air and keep comfortable for breathing. If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue Rinsing. If eye irritation persists: Get medical advice/attention. If on skin (or hair): Wash with plenty of water. Take off immediately all contaminated clothing and wash it before reuse. If skin irritation occurs: Get medical advice/attention. Rinse skin with water/shower. If swallowed: Immediately call a poison center or doctor. Do NOT induce vomiting. In case of fire: Use foam, dry powder or carbon dioxide for extinction.	Store locked up. Dispose of contents in accordance with federal, state and local regulations. Store in well ventilated place.

Section 2 – Hazard(s) Identification (continued)

2(c) Hazards not otherwise classified: None Known

2(d) Unknown acute toxicity statement (mixture): None Known

Section 3 – Composition/Information on Ingredients

3(a-c) Chemical name, common name (synonyms), CAS number and other identifiers, and concentration:

Chemical Name	CAS Number	EC Number	% weight
Benzene	71-43-2	200-753-7	40-50
Toluene	108-88-3	203-625-9	40-50
Mixed Xylenes (m-Xylene, p-Xylene and o-Xylene)	108-38-3 106-42-3 95-47-6	203-576-3 203-396-5 202-422-2	1-10
Naphthalene	91-20-3	202-049-5	<5

EC - European Community
CAS - Chemical Abstract Service

Section 4 – First-aid Measures

4(a) Description of necessary measures: If exposed, concerned or feel unwell: Get medical advice/attention, call a poison center or doctor.

- **Inhalation:** If inhaled: Remove person to fresh air and keep comfortable for breathing.
- **Eye Contact:** If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue Rinsing. If eye irritation persists: Get medical advice/attention.
- **Skin Contact:** If on skin (or hair): Wash with plenty of water. Take off contaminated clothing and wash it before reuse. If skin irritation occurs: Get medical advice/attention.
- **Ingestion:** Immediately call a poison center or doctor. Do NOT induce vomiting.

4(b) Most important symptoms/effects, acute and delayed (chronic):

Acute Effects:

- **Inhalation:** Acute respiratory effects caused by overexposure to Light Oil may include coughing, sneezing, and swollen or irritated nasal mucosa and sinuses. Short-term exposures may also cause transient photosensitization.
- **Eye:** Vapors or mist may cause irritation to the eyes and mucous membranes.
- **Skin:** Exposure to Light Oil can cause skin irritation characterized by skin itching, burning, swelling and redness.
- **Ingestion:** Unlikely route of exposure. If ingested, may cause headache, drunkenness, nausea, vomiting, weakness, convulsions, unconsciousness and coma. Aspiration of this material into the lungs can cause chemical pneumonia.

Delayed (chronic) Effects:

- May cause genetic defects and damage fertility or the unborn child. Harmful if inhaled or absorbed through the skin. May cause eye and skin irritation. Repeated excessive exposures may cause blood disorders such as anemia and leukemia. Repeated excessive exposures may cause liver and/or kidney effects or damage. Material has been related to cancer in humans.

4(c) Immediate Medical Attention and Special Treatment: If quantity ingested is 1.0 ml/kg or greater, careful gastric lavage may be indicated, being careful to avoid aspiration.

Section 5 – Fire-fighting Measures

5(a) Suitable (and unsuitable) Extinguishing Media: Small Fires - Foam, CO2, Dry Chemical, Water Spray. Large Fires - Water spray, fog or foam. Frothing may occur if material is molten.

5(b) Specific Hazards arising from the chemical: When burned, toxic smoke and vapor may be emitted including, oxides of carbon, aromatic hydrocarbons and other toxic vapors.

5(c) Special protective equipment and precautions for fire-fighters: Self-contained MSHA/NIOSH approved respiratory protection and full protective clothing should be worn when fumes and/or smoke from fire are present. Heat and flames cause emittance of acrid smoke and fumes. Do not release runoff from fire control methods to sewers or waterways. Firefighters should wear full face-piece self-contained breathing apparatus and chemical protective clothing with thermal protection. Direct water stream will scatter and spread flames and, therefore, should not be used. Evacuate area. Remove pressurized gas cylinders from the immediate vicinity. Cool containers exposed to flames with water until well after the fire is out. Close the valve if no risk is involved. Fight fire from a protected location. Prevent buildup of vapors or gases to explosive concentrations.

Section 6 - Accidental Release Measures

6(a) Personal Precautions, Protective Equipment and Emergency Procedures: For spills, clean-up personnel should be protected against contact with eyes and skin. Large spills should be diked and foam applied. Do not release into sewers or waterways. Use absorbent material such as vermiculite or sand to soak up spill. Contain material and follow normal clean-up procedures. Collect material in appropriate, labeled …

Section 6 - Accidental Release Measures (continued)

6(a) Personal Precautions, Protective Equipment and Emergency Procedures (continued): … containers for recovery or disposal in accordance with federal, state, and local regulations. Keep unnecessary people away. Isolate hazard area and deny entry. Stay upwind.

6(b) Methods and materials for containment and clean up: Collect material in appropriate, labeled containers for recovery or disposal in accordance with federal, state, and local regulations. Follow applicable OSHA regulations (29 CFR 1910.120) and all other pertinent state and federal requirements.

Section 7 - Handling and Storage

7(a) Precautions for safe handling: Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Use only outdoors or in well ventilated areas. Do not breathe gas / mist / vapor / spray. Do not eat, drink or smoke when using this product. Wash thoroughly after handling. Contaminated work clothes must not be allowed out of the workplace. Avoid direct contact on skin, eyes or on clothing. Handle and use in accordance with OSHA29CFR1910.106 or local codes. Observe proper industrial hygiene practices. Comply with the OSHA Benzene Standard, 29CFR1910.1028, and all other applicable regulatory standards. Emergency safety showers and eye wash stations should be present.

7(b) Conditions for safe storage, including any incompatibilities: Store locked up. Use only outdoors or in a well ventilated area. Store in a well-ventilated place. Control all ignition sources (including smoking).

Section 8 - Exposure Controls / Personal Protection

8(a) Occupational Exposure Limits (OELs): The following exposure limits are offered as reference, for an experience industrial hygienist to review.

Ingredients	OSHA PEL [1]	ACGIH TLV [2]	NIOSH REL [3]	IDLH [4]
Benzene	1.0 ppm * "STEL" 5.0 ppm *	0.5 ppm, skin "STEL" 2.5 ppm	0.1 ppm "STEL" 1.0 ppm	500 ppm, Ca
Toluene	200 ppm "C" 300 ppm "Peak" 500 ppm (10 min)	50 ppm	100 ppm "STEL" 150 ppm	500 ppm
Mixed Xylenes (m, p & o-Xylene)	100 ppm	100 ppm "STEL" 150 ppm	100 ppm "STEL" 150 ppm	900 ppm
Naphthalene	10 ppm	10 ppm, skin	10 ppm "STEL" 15 ppm	250 ppm

NE - None Established

* Exposure limits based on 29 CFR 1910.1028, however refer to 29 CFR 1910.1000, Table Z-2 for exclusions.

1. OSHA PELs (Permissible Exposure Limits) are 8-hour TWA (time-weighted average) concentrations unless otherwise noted. A ("C") designation denotes a ceiling limit, which should not be exceeded during any part of the working exposure unless otherwise noted. A Short Term Exposure Limit (STEL) is defined as a 15-minute exposure, which should not be exceeded at any time during a workday. An Action level (AL) is used by OSHA and NIOSH to express a health or physical hazard. They indicate the level of a harmful or toxic substance/activity, which requires medical surveillance, increased industrial hygiene monitoring, or biological monitoring. Action Levels are generally set at one half of the PEL but the actual level may vary from standard to standard. The intent is to identify a level at which the vast majority of randomly sampled exposures will be below the PEL.
2. Threshold Limit Values (TLV) established by the American Conference of Governmental Industrial Hygienists (ACGIH) are 8-hour TWA concentrations unless otherwise noted. ACGIH TLVs are for guideline purposes only and as such are not legal, regulatory limits for compliance purposes. DSEN – May cause dermal sensitization. This notation is used to indicate the potential for dermal sensitization resulting from the interaction of an absorbed agent and ultraviolet light (i.e. photosensitization). RSEN – May cause respiratory sensitization.
3. The National Institute for Occupational Safety and Health Recommended Exposure Limits (NIOSH-REL)- Compendium of Policy and Statements. NIOSH, Cincinnati, OH (1992). NIOSH is the federal agency designated to conduct research relative to occupational safety and health. As is the case with ACGIH TLVs, NIOSH RELs are for guideline purposes only and as such are not legal, regulatory limits for compliance purposes.
4. The "immediately dangerous to life or health air concentration values (IDLHs)" are used by NIOSH as part of the respirator selection criteria and were first developed in the mid-1970's by NIOSH. The Documentation for Immediately Dangerous to Life or Health Concentrations (IDLHs) is a compilation of the rationale and sources of information used by NIOSH during the original determination of 387 IDLHs and their subsequent review and revision in 1994. Ca is designated as carcinogen.

8(b) Appropriate Engineering Controls: Use controls as appropriate to minimize exposure to vapors sprays, mists and heat during handling operations. Provide general or local exhaust ventilation systems to minimize airborne concentrations. Local exhaust is necessary for use in enclosed or confined spaces. Provide sufficient general/local exhaust ventilation in pattern/volume to control inhalation exposures below current exposure limits.

8(c) Individual Protection Measures:

- **Respiratory Protection:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, use only a NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. Concentration in air of the various contaminants determines the extent of respiratory protection needed. Half-mask negative-pressure, air-purifying respirator equipped with organic vapor cartridge is acceptable for concentrations up to 10 times the exposure limit. Full-face negative-pressure air purifying respirator equipped with organic vapor cartridges is acceptable for concentrations up to 50 times the exposure limit. Protection by air purifying both negative-pressure and powered air respirators is limited. Use a positive-pressure-demand, full-face, supplied air respirator or self-contained breathing apparatus (SCBA) for concentrations above 50 times the exposure limit. If exposure is above the IDLH (Immediately dangerous to life or health) for any of the constituents, or there is a possibility of an uncontrolled release or exposure levels are unknown, then use a positive-demand, full-face, supplied air respirator with escape bottle or SCBA.

Warning! Air-purifying respirators both negative-pressure and powered-air do not protect workers in oxygen-deficient atmospheres.

Section 8 - Exposure Controls / Personal Protection (continued)

8(c) Individual Protection Measures (continued):

- **Eyes**: Employees should be required to wear chemical safety glasses to prevent eye contact. A face shield should be used when appropriate to prevent contact with splashed materials. Chemical goggles, face shields or glasses should be worn to prevent eye contact. Contact lenses should not be worn where industrial exposure to this material is likely.
- **Skin**: Persons handling this product should wear appropriate clothing to prevent skin contact. Wear protective gloves. Contaminated work clothes must not be allowed out of the workplace. Wash skin that has been exposed with soap and water.
- **Other protective equipment**: An eyewash fountain and deluge shower should be readily available in the work area.

Section 9 - Physical and Chemical Properties

9(a) Appearance (physical state, color, etc.): liquid, Yellow

9(b) Odor: Aromatic

9(c) Odor Threshold: 1-5 ppm

9(d) pH: NA

9(e) Melting Point/Freezing Point: 5.5ºC (41.9ºF)

9(f) Initial Boiling Point and Boiling Range: 80ºC (176ºF)

9(g) Flash Point: 12ºF (-11ºC) (as Benzene)

9(h) Evaporation Rate: (Water = 1): 1

9(i) Flammability (solid, gas): Flammable liquid

9(j) Upper/lower Flammability or Explosive Limits: 7.1% / 1.3%

9(k) Vapor Pressure: 100mm of Hg @20ºC

9(l) Vapor Density (Air = 1): 2.7

9(m) Relative Density: 0.88 SG

9(n) Solubility(ies): Partially soluble in cold water

9(o) Partition Coefficient n-octanol/water: ND

9(p) Auto-ignition Temperature: 489ºC (928.4ºF)

9(q) Decomposition Temperature: ND

9(r) Viscosity: ND

NA - Not Applicable

ND - Not Determined for product as a whole

Section 10 - Stability and Reactivity

10(a) Reactivity: Not Determined (ND)

10(b) Chemical Stability: Light Oil is stable under normal storage and handling conditions.

10(c) Possibility of hazardous reaction: None Known

10(d) Conditions to Avoid: Storage with incompatible materials. Avoid heat, flame or ignition sources.

10(e) Incompatible Materials: Oxidizing agents.

10(f) Hazardous Decomposition Products: Oxides of carbon, aromatic hydrocarbons, and other toxic vapors may be releases at high temperatures.

Section 11 - Toxicological Information

11 Information on Toxicological Effects: The following toxicity data has been determined for **Light Oil** by using the information available for its components applied to the guidance on the preparation of an SDS under the GHS requirements of OSHA and the EU CPL. Individual hazard classification categories where the available toxicological data has met or exceeded a classification threshold are provided in the table below:

Hazard Classification	Hazard Category		Hazard Symbols	Signal Word	Hazard Statement
	EU	OSHA			
Acute Toxicity Hazard (covers Categories 1-4)	NR	3[a]		**Danger**	Toxic if inhaled.
Skin Irritation (covers Categories 1A, 1B, and 2)	NR	2[b]		**Warning**	Causes skin irritation.
Eye Damage/Irritation (covers Categories 1, 2A and 2B)	NR	2A[c]		**Warning**	Causes serious eye irritation.
Aspiration Hazard (Category 1)	1	1[e]		**Danger**	May be fatal if swallowed and enters airways.
Germ Cell Mutagenicity (covers Categories 1A, 1B and 2)	1B	1B[f]		**Danger**	May cause genetic defects.
Carcinogenicity (covers Categories 1A, 1B and 2)	1	1A[g]		**Danger**	May cause cancer.

Section 11 - Toxicological Information (continued)

11 Information on Toxicological Effects (continued):

Hazard Classification	Hazard Category		Hazard Symbols	Signal Word	Hazard Statement
	EU	OSHA			
Reproductive Toxicity (covers Categories 1A, 1B and 2)	1B	1B[h]		**Danger**	May damage fertility or the unborn child.
Specific Target Organ Toxicity (STOT) Following Single Exposure (covers Categories 1-3)	2	2[i]		**Warning**	May cause central nervous system depression, respiratory irritation drowsiness or dizziness and damage to lungs, liver and blood cells.
STOT following Repeated Exposure (covers Categories 1 and 2)	1	1[j]		**Danger**	Causes damage to blood and blood forming system through prolonged or repeated exposure. Causes damage to lungs and central nervous system through prolonged or repeated inhalation exposure.

NR - Not Rated - Available data does not meet criteria for classification.

Below is additional toxicological data regarding this product:

a. No LC_{50} or LD_{50} has been established for **Light Oil**. The following data has been determined for the components:

- **Naphthalene:** Mouse LD_{50} = 397 – 827 mg/kg (REACH)
  Rat LD_{50} > 2500 mg/kg (REACH and IUCLID) Rat LC_{50} >77.7 ppm (> 0.4 mg/L) (REACH and Toxnet)
- **Xylene:** Rabbit LD_{50} > 5000 mg/kg (REACH)
  Rat 4 hr LC_{50} = 6700 ppm
- **Benzene:** LD_{50} (rat) 3.8 (2.9-4.8) and 5.6 (4.0-7.8) ml/kg young and old resp.
  LD_{50} (rabbits): > 9.4 ml/kg (abraded skin)
  LC_{50} (female rat) > 13700 ppm)
- **Toluene**: LD50 (rat) > 5000 mg/kg (REACH)
  LD50 (Rabbit) > 5000 mg/kg (REACH)

b. No Skin (Dermal) Irritation data available for **Light Oil** as a mixture or its components. The following Skin Irritation information was found for the components:

- **Benzene:** Irritating to the skin.
- **Toluene:** Toluene is irritating to rabbit skin (REACH and IUCLID).
- **Xylene:** Moderately irritating.

c. No Eye Irritation data available for **Light Oil** as a mixture. The following Eye Irritation information was found for the components:

- **Benzene:** Irritating to the eyes.
- **Toluene:** Slight irritation (REACH and IUCLID) Severe eye irritant in humans (NLM HSD).

d. No Skin (Dermal) Sensitization data available for **Light Oil** as a mixture or its components.

e. No Respiratory Sensitization data available for **Light Oil** as a mixture or its components.

f. No Germ Cell Mutagenicity data available for **Light Oil** as a mixture. The following Mutagenicity and Genotoxicity information was found for the components:

- **Benzene:** Positive In vitro and In vivo clastogenicity results.

g. Carcinogenicity: IARC, NTP, and OSHA do not list **Light Oil** as carcinogens. The following Carcinogenicity information was found for the components:

- **Benzene:** IARC-1, carcinogen to humans; ACGIH TLV-A1, confirmed human carcinogen; NIOSH–Ca, potential occupational carcinogen; NTP–K, known to be a carcinogen; EPA-A, human carcinogen (by inhalation route of entry), EPA-K, cannot be determined, not classifiable as to human carcinogenicity; OSHA-Ca, carcinogen
- **Toluene:** IARC-3, unclassifiable as to carcinogenicity in humans; ACGIH TLV-A4, not classifiable as a human carcinogen; EPA-II, inadequate information to assess carcinogenic potential
- **Xylene:** IARC-3, unclassifiable as to carcinogenicity in humans; ACGIH TLV-A4, not classifiable as a human carcinogen; EPA-I, data are inadequate for assessment of human carcinogenic potential
- **Naphthalene:** IARC-2B, possibly carcinogenic to humans; ACGIH TLV-A3, confirmed animal carcinogen with unknown relevance to humans; NTP-R, reasonably anticipated to be a human carcinogen (RAHC); EPA-CBD, cannot be determined & EPA-C, possible human carcinogen

h. No Toxic Reproduction data available for **Light Oil** as a mixture. The following Toxic Reproduction information was found for the components:

- **Benzene**: Both reproductive and teratogenicity positive results found.
- **Toluene:** Low incidence of malformations at doses causing maternal toxicity.

i. No Specific Target Organ Toxicity (STOT) following a Single Exposure data available for **Light Oil** as a mixture. The following STOT following a Single Exposure data was found for the components:

- **Naphthalene:** Eye and skin irritation (OSHA).
- **Benzene:** Central and peripheral nervous system depression, lung liver (vacuoled hepatocytes) and red blood cells. Mild to moderate respiratory tract irritation expected with breathing vapors.
- **Toluene:** Headache, dizziness and impaired performance.

Section 11 - Toxicological Information (continued)

11 Information on toxicological effects (continued):

j. No Specific Target Organ Toxicity (STOT) following Repeated Exposure data was available for **Light Oil** as a whole. The following STOT following Repeated Exposure data was found for the components:

- **Naphthalene:** Olfactory lesions and effects on nasal turbinates, cataracts, jaundice, kidney and liver damage (OSHA).
- **Benzene:** Hematopoietic system, spleen, and liver damage. Induced blood dyscrasias in humans were characterized by erythrocytic anisocytosis and poikilocytosis, anemia, decreased hemoglobin, and reduced hematocrit. In addition, benzene is a human carcinogen.
- **Toluene:** Ataxia, hypothermia, leucocyte decrease in female rats and increase liver and kidney weights.

The above toxicity information was determined from available scientific sources to illustrate the prevailing posture of the scientific community. The scientific resources includes: The American Conference of Governmental Industrial Hygienist (ACGIH) Documentation of the Threshold Limit Values (TLVs) and Biological Exposure indices (BEIs) with Other Worldwide Occupational Exposure Values 2021, The International Agency for Research on Cancer (IARC), The National Toxicology Program (NTP) updated documentation, the World Health Organization (WHO) and other available resources, the International Uniform Chemical Information Database (IUCLID), European Union Risk Assessment Report (EU-RAR), Concise International Chemical Assessment Documents (CICAD), European Union Scientific Committee for Occupational Exposure Limits (EU-SCOEL), Agency for Toxic Substances and Disease Registry (ATSDR), Hazardous Substance Data Bank (HSDB), and International Programme on Chemical Safety (IPCS), European Union Classification, Labeling and Packaging. (EU CPL), Regulation on Registration, Evaluation, Authorization and Restriction of Chemicals (REACH), International Uniform Chemical Information Database (IUCLID), TOXicology Data NETwork (TOXNET), European Risk Assessment Reports (EU RAR).

The following health hazard information is provided regardless to classification criteria and is based on the individual component(s):

Acute Effects by Component:

- **Benzene -** Excessive exposures may cause irritation to eyes, skin, nose, throat, lungs, and respiratory tract. Central nervous system effects may occur due to excessive exposures. Excessive exposures may result in headaches, nausea, sleep disturbances, excitability, loss of balance and coordination, unconsciousness, coma, respiratory failure, and death.
- **Toluene -** Excessive exposures may cause irritation to eyes, nose, throat, lungs, and respiratory tract. Central nervous system effects may occur. Excessive exposures may result in headaches, nausea dizziness, loss of balance and coordination, unconsciousness, and coma as well as respiratory failure and/or death.
- **Xylene -** Excessive exposures may cause irritation to eyes, nose, throat, lungs, and respiratory tract. Central nervous system effects may occur. May result in headaches, nausea, dizziness, loss of balance and coordination, unconsciousness, coma, respiratory failure and death. Repeated excessive exposures may cause liver and/or kidney effects or damage.
- **Naphthalene -** Excessive exposures may cause irritation to eyes, nose, throat and lungs, and respiratory tract. Central nervous system effects may occur. Excessive exposures may also result in dizziness, loss of balance and coordination, unconsciousness, coma, respiratory failure and death.

Delayed (chronic) Effects by component:

- **Benzene -** Early signs and symptoms of chronic overexposure include effects on CNS and the GI tract (headache, loss of appetite, drowsiness, nervousness, and pallor) but the major manifestation of toxicity is aplastic anemia. Bone marrow depression may occur resulting in leucopoenia, anemia, or thrombocytopenia (leukemogenic action). With continued overexposure the disease states may progress to pancytopenia resulting from bone marrow aplasia. Evidence has linked benzene in the etiology of leukemia.
- **Toluene -** Chronic overexposure has been associated with headache, lassitude, and nausea, loss of coordination, memory loss, and loss of appetite along with enlargement of the liver, a moderate decrease in red blood cells, and reduction in white blood cells, as well as palpitations, weakness, and impaired reaction time may occur. The neurological effects of chronic overexposure to high levels of toluene gradually progress to an irreversible state. Besides effects on behavior and intelligence, degeneration of the optic nerve and nerve deafness have also been reported. Dermatitis from repeated contact with the skin may also occur. Overexposure to toluene may cause risk of harm to the unborn child.
- **Xylene -** Chronic inhalation can cause headache, loss of appetite, nervousness and pale skin. Repeated or prolonged skin contact may cause a skin rash. Repeated exposure of the eyes to high concentrations of vapor may cause reversible eye damage. Repeated exposure can damage bone marrow, causing low blood cell count. May damage the liver and kidneys.
- **Naphthalene**: Chronic exposure of workers to naphthalene has been reported to cause cataracts and retinal hemorrhage. Exposure may also result in headache, loss of appetite, and nausea. Kidney damage has also been reported in connection with chronic naphthalene exposure.

Section 12 - Ecological Information

12(a) Ecotoxicity (aquatic & terrestrial):

- **Naphthalene**: LC_{50} Pimephales promelas (fathead minnow) 6.08 (5.74-6.44) mg/l 72 & 96 hr, /flow-through bioassay; LC50 Oncorhynchus gorbuscha (pink salmon) 1.4 mg/L/96 hr Conditions of bioassay not specified.
- **Benzene**: LC_{50} Lepomis macrochirus (bluegill sunfish) 20 mg/l/24 to 48 hr /Conditions of bioassay not specified/; LC50 Salmo trutta (brown trout yearlings) 12 mg/l/1 hr (static bioassay).
- **Toluene**: LC_{50} Pimephales promelas (fathead minnow) 34.27 mg/l 96 hr (95% Confidence Limits= 22.83-45.86 mg/l) /Conditions of bioassay not specified/ LC_{50} Daphnia magna, (water flea) 313 mg/l 48 hr /Conditions of bioassay not specified.

12(b) Persistence & Degradability: No Data Available for **Light Oil** or individual components.

12(c) Bioaccumulative Potential: No Data Available for **Light Oil** or individual components.

12(d) Mobility (in soil): No data available for **Light Oil** as a whole. However, benzene and toluene have been estimated to be moderately to highly mobile in soil. Evaporation is expected to be the primary loss mechanism from water. Benzene and toluene are not expected to adsorb to sediment and suspended solids in water. Volatilization half-lives for a model river and model lake have been estimated to be 1 hr and 3.5 days, respectively for benzene and 1 hour and 4 days, respectively for toluene.

12(e) Other adverse effects: No Data Available

Section 12 - Ecological Information (continued)

Additional Information:

Hazard Category: Acute 2, Chronic 2 **Signal Word:** No Signal Word

Hazard Symbol: 

Hazard Statement: Toxic to aquatic life with long lasting effects.

Section 13 - Disposal Considerations

Disposal: Dispose of in accordance with Local, State, Federal and International regulations. Observe safe handling precautions.

Container Cleaning and Disposal: Follow Local, State, Federal and international regulations. Observe safe handling precautions

Section 14 - Transport Information

14 (a-g) Transportation Information:

US Department of Transportation (DOT) under 49 CFR 172.101 may regulate **Light Oil** as a hazardous material under certain circumstances. All Local, State, Federal and international regulations that apply to the transport of this type of material must be adhered to.

Section 15 - Regulatory Information

Regulatory Information: *The following listing of regulations relating to an ArcelorMittal product may not be complete and should not be solely relied upon for all regulatory compliance responsibilities.*

This product and/or its constituents are subject to the following regulations:

OSHA Regulations: Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-2, Z-3): The product, **Light Oil** as a whole is not listed. However, individual components of the product are listed: Refer to Section 8, Exposure Controls and Personal Protection.

EPA Regulations: The product, **Light Oil** is not listed as a whole. However, individual components of the product are listed:

Components	Regulations
Benzene	SARA 313, CERCLA, RCRA, TSCA, SDWA, CWA
Toluene	SARA 313, CERCLA, RCRA, TSCA, SDWA, CWA
m-Xylene	SARA 313, CERCLA, RCRA, TSCA, SDWA
p-Xylene	SARA 313, CERCLA, RCRA
o-Xylene	SARA 313, CERCLA, RCRA
Naphthalene	SARA 313, CERCLA, RCRA, CWA

SARA 311/312 Potential Hazard Categories: Immediate Acute Health Hazard; Delayed Chronic Health Hazard

Regulations Key:

CAA	Clean Air Act (42 USC Sec. 7412; 40 CFR Part 61 [As of: 8/18/06])
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act (42 USC Secs. 9601(14), 9603(a); 40 CFR Sec. 302.4, Table 302.4, Table 302.4 and App. A)
CWA	Clean Water Act (33 USC Secs. 1311; 1314(b), (c), (e), (g); 136(b), (c); 137(b), (c) [as of 8/2/06])
RCRA	Resource Conservation Recovery Act (42 USC Sec. 6921; 40 CFR Part 261 App VIII)
SARA	Superfund Amendments and Reauthorization Act of 1986 Title III Section 302 Extremely Hazardous Substances (42 USC Secs. 11023, 13106; 40 CFR sec. 372.65) and Section 313 Toxic Chemicals (42 USC Secs. 11023, 13106; 40 CFR Sec. 372.65 [as of 6/30/05])
TSCA	Toxic Substance Control Act (15 U.S.C. s/s 2601 et seq. [1976])
SDWA	Safe Drinking Water Act (42 U.S.C. s/s 300f et seq. [1974])

Section 313 Supplier Notification: The product, **Light Oil** contains the following toxic chemicals subject to the reporting requirements of section 313 of the Emergency Planning and Community Right-to-Know Act and 40 CFR part 372:

CAS #	Chemical Name	Percent by Weight
71-43-2	Benzene	50 max
108-88-3	Toluene	50 max
108-38-3	m-Xylene	10 max
106-42-3	p-Xylene	10 max
95-47-6	o-Xylene	10 max
91-20-3	Naphthalene	5 max

State Regulations: The product, **Light Oil** as a whole is not listed in any state regulations. However, individual components of the product are listed in various state regulations:

Pennsylvania Right to Know: Contains regulated material in the following categories:

- Hazardous Substance: Benzene, Toluene, m-Xylene, p-Xylene, o-Xylene, Naphthalene
- Environmental Hazards: Benzene, Toluene, Naphthalene, m-Xylene, p-Xylene, o-Xylene, Naphthalene
- Special Hazardous Substance: Benzene

Section 15 - Regulatory Information (continued)

State Regulations (continued):

California Prop. 65:

The product, **Light Oil** can expose you to chemicals including benzene and naphthalene which is known to the State of California to cause cancer; and benzene and toluene which is known to the State of California to cause reproductive toxicity. For more information go to www.P65Warnings.ca.gov.

New Jersey: Contains regulated material in the following categories:

- Hazardous Substance: Benzene, Toluene, m-Xylene, p-Xylene, o-Xylene, Naphthalene
- Environmental Hazards: Benzene, Toluene, m-Xylene, p-Xylene, o-Xylene, Naphthalene
- Special Hazards: Benzene, Toluene, m-Xylene, p-Xylene, o-Xylene, Naphthalene

Minnesota: Benzene, Toluene, m-Xylene, Naphthalene

Massachusetts: Benzene, Toluene, m-Xylene, Naphthalene

Other Regulations:

WHMIS Classification (Canadian): The product, **Light Oil** is not listed as a whole. However individual components are listed.

Ingredients	WHMIS Classification
Benzene	Flammable liquids - Category 2 [Flash point = -11°C closed cup (non-reported method) and boiling point = 80°C]; Skin corrosion/irritation - Category 2; Serious eye damage/eye irritation - Category 2; Germ cell mutagenicity - Category 1B; Carcinogenicity - Category 1A; Specific target organ toxicity - repeated exposure - Category 1; Aspiration hazard - Category 1 (Liquid hydrocarbon with a kinematic viscosity of 0.74 mm^2/s at 20°C)
Toluene	Flammable liquids - Category 2 (Flash point = 4,4°C Setaflash closed cup and boiling point = 111°C); Skin corrosion/irritation - Category 2; Specific target organ toxicity - repeated exposure - Category 2; Reproductive toxicity - Category 2 (Toxic to the development - Adverse effects on the development of the offspring); Specific target organ toxicity - single exposure (narcotic effects) - Category 3 - Narcotic effect; Aspiration hazard - Category 1 (Liquid hydrocarbon with a kinematic viscosity of 0,676 mm^2/s at 20°C)
m-Xylene	Flammable liquids – [Category 3 Flash point = 25°C closed cup (non-reported method)]; Skin corrosion/irritation - Category 2; Specific target organ toxicity - single exposure (narcotic effects) - Category 3 - Narcotic effect; Aspiration hazard - Category 1 (Liquid hydrocarbon with a kinematic viscosity of 0,71 mm^2/s at 20°C)
p-Xylene	Flammable liquids - Category 3 Flash Point = 25°C closed cup (non-reported method); Skin corrosion/irritation - Category 2; Reproductive toxicity - Category 2 (Toxic to the development); Specific target organ toxicity - single exposure (narcotic effects) - Category 3 - Narcotic effect; Aspiration hazard - Category 1 (Liquid hydrocarbon with a kinematic viscosity of 0,75 mm^2/s at 20°C)
o-Xylene	Flammable liquids - Category 2 [Flash point = 17°C closed cup (non-reported method) and boiling point = 144°C]; Skin corrosion/irritation - Category 2; Reproductive toxicity - Category 2 (Toxic to the development); Specific target organ toxicity - single exposure (narcotic effects) - Category 3 - Narcotic effect; Aspiration hazard - Category 1 (Liquid hydrocarbon with a kinematic viscosity of 0,92 mm^2/s at 20°C)
Naphthalene	Flammable solids - Category 2 (Class 4.1 packing group III according to TDG regulation); Carcinogenicity - Category 2; Combustible dusts *

* This product belongs to the hazard class "Combustible dust" if 5% or more by weight of its composition has a particle size < 500 µm.

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the SDS contains all the information required by the Controlled Products Regulations.

Section 16 - Other Information

Prepared By: Cleveland-Cliffs Steel

Original Issue Date: 03/01/2017 **Revision Date:** 6/14/2021

Additional Information:

Hazardous Material Identification System (HMIS) Classification

Health Hazard	2
Fire Hazard	3
Physical Hazard	1

HEALTH = **2**, Temporary or minor injury may occur.

FIRE = **3**, Materials capable of ignition under almost all normal temperature conditions. Includes flammable liquids with flash points below 73°F and boiling points above 100°F, as well as liquids with flash points between 73°F and 100°F. (Classes IB & IC).

REACTIVITY = **1**, Materials that are normally stable but can become unstable (self-react) at high temperatures and pressures. Materials may react non-violently with water or undergo hazardous polymerization in the absence of inhibitors.

National Fire Protection Association (NFPA)

HEALTH = **2**, Intense or continued exposure could cause temporary incapacitation or possible residual injury unless prompt medical attention is given.

FIRE = **3**, Liquids and solids that can be ignited under almost all ambient conditions.

REACTIVITY = **1**, Normally stable, but can become unstable at elevated temperatures and pressures or may react with water with some release of energy, but not violently.

Section 16 - Other Information (continued)

ABBREVIATIONS/ACRONYMS:

ACGIH	American Conference of Governmental Industrial Hygienists	**NIF**	No Information Found
BEIs	Biological Exposure Indices	**NIOSH**	National Institute for Occupational Safety and Health
CAS	Chemical Abstracts Service	**NTP**	National Toxicology Program
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act	**ORC**	Organization Resources Counselors
CLP	Classification, Labelling and Packaging.	**OSHA**	Occupational Safety and Health Administration
CFR	Code of Federal Regulations	**PEL**	Permissible Exposure Limit
CNS	Central Nervous System	**PNOR**	Particulate Not Otherwise Regulated
GI, GIT	Gastro-Intestinal, Gastro-Intestinal Tract	**PNOC**	Particulate Not Otherwise Classified
HMIS	Hazardous Materials Identification System	**PPE**	Personal Protective Equipment
IARC	International Agency for Research on Cancer	**ppm**	parts per million
LC50	Median Lethal Concentration	**RCRA**	Resource Conservation and Recovery Act
LD50	Median Lethal Dose	**REACH**	Regulation on Registration, Evaluation, Authorization and Restriction of Chemicals.
LD $_{Lo}$	Lowest Dose to have killed animals or humans	**RTECS**	Registry of Toxic Effects of Chemical Substances
LEL	Lower Explosive Limit	**SARA**	Superfund Amendment and Reauthorization Act
LOEL	Lowest Observed Effect Level	**SCBA**	Self-contained Breathing Apparatus
LOAEC	Lowest Observable Adverse Effect Concentration	**SDS**	Safety Data Sheet
µg/m^3	microgram per cubic meter of air	**STEL**	Short-term Exposure Limit
mg/m^3	milligram per cubic meter of air	**TLV**	Threshold Limit Value
mppcf	million particles per cubic foot	**TWA**	Time-weighted Average
MSHA	Mine Safety and Health Administration	**UEL**	Upper Explosive Limit
NFPA	National Fire Protection Association		

Disclaimer: This information is taken from sources or based upon data believed to be reliable. Our objective in sending this information is to help you protect the health and safety of your personnel and to comply with the OSHA Hazard Communication Standard and Title III of the Emergency Planning and Community Right-to-Know Act. Cleveland-Cliffs Steel makes no warranty as to the absolute correctness, completeness, or sufficiency of any of the foregoing, or any additional, or other measures that may not be required under particular conditions. THIS CLEVELAND-CIFFS STEEL SDS MAKES NO WARRANTIES, EXPRESS OR IMPLIED, INCLUDING THE IMPLIED WARRANTY OF MERCHANTABILITY, OR ANY IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE, AND ANY IMPLIED WARRANTIES OTHERWISE ARISING FROM COURSE OF DEALING OR TRADE.

Light Oil

Signal Word: **DANGER**

Symbols:

HAZARD STATEMENTS:

Highly Flammable liquid and vapor.
Toxic if inhaled.
May cause genetic defects.
May cause cancer.
May damage fertility or the unborn child.
May cause central nervous system depression, respiratory irritation drowsiness or dizziness and damage to lungs, liver and blood cells.
Causes damage to blood and blood forming system, lungs and central nervous system through prolonged or repeated exposure.
May be fatal if swallowed and enters airways.
Causes skin irritation.
Causes serious eye irritation.

PRECAUTIONARY STATEMENTS:

Wear protective gloves / protective clothing / eye protection / face protection.
Do not breathe /gas/mist/ vapors/spray.
Obtain special instructions before use.
Do not handle until all safety precautions have been read and understood.
Wash thoroughly after handling.
Do not eat, drink or smoke when using this product.
Keep away from heat/sparks/open flames/hot surfaces. No smoking.
Keep container tightly closed.
Ground/Bond container and receiving equipment.
Use explosion-proof electrical/ventilating/lighting/equipment.
Use only non-sparking tools.
Take precautionary measures against static discharge.
Use only outdoors or in well ventilated areas.
Wear protective gloves / protective clothing / eye protection / face protection. If exposed, concerned or feel unwell: Get medical advice/attention, call a poison center or doctor.
If inhaled: Remove person to fresh air and keep comfortable for breathing.
If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue Rinsing. If eye irritation persists: Get medical advice/attention.
If on skin (or hair): Wash with plenty of water. Take off immediately all contaminated clothing and wash it before reuse. If skin irritation occurs: Get medical advice/attention. Rinse skin with water/shower.
If swallowed: Immediately call a poison center or doctor. Do NOT induce vomiting.
In case of fire: Use foam, dry powder or carbon dioxide for extinction. Store locked up.
Dispose of contents in accordance with federal, state and local regulations.
Store in well ventilated place.

SDS ID No.: CLF-003

Cleveland-Cliffs Steel
1 South Dearborn Street
Chicago, IL 60603-9888

General Information: Phone: 219-787-4901 or email at: sdssupport@clevlandcliffs.com

CHEMTREC (Day or Night): 1-800-424-9300

Emergency Contact: 1-760-476-3962, (Verisk 3E Company Code: 333211)

Original Issue Date: 03/01/2017 **Revised:** 6/14/2021

16.6 Chlorine (CAS No.: 7782-50-5)

SAFETY DATA SHEET

Chlorine

Section 1. Identification

GHS product identifier : Chlorine

Chemical name : chlorine

Other means of identification : Molecular chlorine; CHLORINE GAS; active chlorine released from chlorine; Dichlorine; Dichlor; Diatomic chlorine; Chlorine molecule; Chlorine mol.; Chlor mol.; Chlorine, liquefied; Liquid chlorine

Product type : Gas.

Product use : Synthetic/Analytical chemistry.

Synonym : Molecular chlorine; CHLORINE GAS; active chlorine released from chlorine; Dichlorine; Dichlor; Diatomic chlorine; Chlorine molecule; Chlorine mol.; Chlor mol.; Chlorine, liquefied; Liquid chlorine

SDS # : 001015

Supplier's details : Airgas USA, LLC and its affiliates
259 North Radnor-Chester Road
Suite 100
Radnor, PA 19087-5283
1-610-687-5253
Inside the US: 1-800-424-9300 (Chemtrec, 24 hours)
Outside the US: 1-703-527-3887 (Chemtrec, 24 hours)

24-hour telephone : Airgas Emergency Response Center 1-866-734-3438

Section 2. Hazards identification

OSHA/HCS status : This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Classification of the substance or mixture : OXIDIZING GASES - Category 1
GASES UNDER PRESSURE - Compressed gas
ACUTE TOXICITY (inhalation) - Category 2
SKIN CORROSION - Category 1
SERIOUS EYE DAMAGE - Category 1
AQUATIC HAZARD (ACUTE) - Category 1

GHS label elements

Hazard pictograms :

Signal word : Danger

Hazard statements : H270 - May cause or intensify fire; oxidizer.
H280 - Contains gas under pressure; may explode if heated.
H314 - Causes severe skin burns and eye damage.
H330 - Fatal if inhaled.
H400 - Very toxic to aquatic life.

Precautionary statements

General : Read and follow all Safety Data Sheets (SDS'S) before use. Read label before use. Keep out of reach of children. If medical advice is needed, have product container or label at hand. Close valve after each use and when empty. Use equipment rated for cylinder pressure. Do not open valve until connected to equipment prepared for use. Use a back flow preventative device in the piping. Use only equipment of compatible materials of construction. Open valve slowly. Use only with equipment cleaned for Oxygen service.

Section 2. Hazards identification

Prevention : P280 - Wear protective gloves, protective clothing and eye or face protection.
P284 - In case of inadequate ventilation wear respiratory protection.
P220 - Keep away from clothing and other combustible materials.
P244 - Keep reduction valves, valves and fittings free from oil and grease.
P271 - Use only outdoors or in a well-ventilated area.
P273 - Avoid release to the environment.
P260 - Do not breathe gas.
P264 - Wash thoroughly after handling.

Response : P391 - Collect spillage.
P370 + P376 - In case of fire: Stop leak if safe to do so.
P304 + P340, P310 - IF INHALED: Remove person to fresh air and keep comfortable for breathing. Immediately call a POISON CENTER or doctor.
P301 + P310, P330, P331 - IF SWALLOWED: Immediately call a POISON CENTER or doctor. Rinse mouth. Do NOT induce vomiting.
P303 + P361 + P353, P310 - IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water. Immediately call a POISON CENTER or doctor.
P363 - Wash contaminated clothing before reuse.
P305 + P351 + P338, P310 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTER or doctor.

Storage : P405 - Store locked up.
P410 + P403 - Protect from sunlight. Store in a well-ventilated place.

Disposal : P501 - Dispose of contents and container in accordance with all local, regional, national and international regulations.

Hazards not otherwise classified : None known.

Section 3. Composition/information on ingredients

Substance/mixture : Substance

Chemical name : chlorine

Other means of identification : Molecular chlorine; CHLORINE GAS; active chlorine released from chlorine; Dichlorine; Dichlor; Diatomic chlorine; Chlorine molecule; Chlorine mol.; Chlor mol.; Chlorine, liquefied; Liquid chlorine

Product code : 001015

Ingredient name	%	CAS number
Chlorine	100	7782-50-5

Any concentration shown as a range is to protect confidentiality or is due to batch variation.

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

Eye contact : Get medical attention immediately. Call a poison center or physician. Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 10 minutes. Chemical burns must be treated promptly by a physician.

Section 4. First aid measures

Inhalation : Get medical attention immediately. Call a poison center or physician. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Skin contact : Get medical attention immediately. Call a poison center or physician. Wash contaminated skin with soap and water. Remove contaminated clothing and shoes. Wash contaminated clothing thoroughly with water before removing it, or wear gloves. Continue to rinse for at least 10 minutes. Chemical burns must be treated promptly by a physician. Wash clothing before reuse. Clean shoes thoroughly before reuse.

Ingestion : As this product is a gas, refer to the inhalation section.

Most important symptoms/effects, acute and delayed

Potential acute health effects

Eye contact : Causes serious eye damage. Contact with rapidly expanding gas may cause burns or frostbite.

Inhalation : Fatal if inhaled.

Skin contact : Causes severe burns. Contact with rapidly expanding gas may cause burns or frostbite.

Frostbite : Try to warm up the frozen tissues and seek medical attention.

Ingestion : As this product is a gas, refer to the inhalation section.

Over-exposure signs/symptoms

Eye contact : Adverse symptoms may include the following:
pain
watering
redness

Inhalation : No specific data.

Skin contact : Adverse symptoms may include the following:
pain or irritation
redness
blistering may occur

Ingestion : Adverse symptoms may include the following:
stomach pains

Indication of immediate medical attention and special treatment needed, if necessary

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Wash contaminated clothing thoroughly with water before removing it, or wear gloves.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media : Use an extinguishing agent suitable for the surrounding fire.

Unsuitable extinguishing media : None known.

Section 5. Fire-fighting measures

Specific hazards arising from the chemical : Contains gas under pressure. Oxidizing material. This material increases the risk of fire and may aid combustion. Contact with combustible material may cause fire. In a fire or if heated, a pressure increase will occur and the container may burst or explode. This material is very toxic to aquatic life. Fire water contaminated with this material must be contained and prevented from being discharged to any waterway, sewer or drain.

Hazardous thermal decomposition products : Decomposition products may include the following materials:
halogenated compounds

Special protective actions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. Contact supplier immediately for specialist advice. Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool. If involved in fire, shut off flow immediately if it can be done without risk.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Shut off all ignition sources. No flares, smoking or flames in hazard area. Do not breathe gas. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.

For emergency responders : If specialized clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

Environmental precautions : Ensure emergency procedures to deal with accidental gas releases are in place to avoid contamination of the environment. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air). Water polluting material. May be harmful to the environment if released in large quantities. Collect spillage.

Methods and materials for containment and cleaning up

Small spill : Immediately contact emergency personnel. Stop leak if without risk. Use spark-proof tools and explosion-proof equipment.

Large spill : Immediately contact emergency personnel. Stop leak if without risk. Use spark-proof tools and explosion-proof equipment.

Section 7. Handling and storage

Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8). Contains gas under pressure. Do not get in eyes or on skin or clothing. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Do not puncture or incinerate container. Use equipment rated for cylinder pressure. Close valve after each use and when empty. Protect cylinders from physical damage; do not drag, roll, slide, or drop. Use a suitable hand truck for cylinder movement.

Avoid release to the environment. Empty containers retain product residue and can be hazardous. Keep away from clothing, incompatible materials and combustible materials. Do not breathe gas. Keep reduction valves free from grease and oil.

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Section 7. Handling and storage

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in a segregated and approved area. Store away from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10). Store locked up. Separate from reducing agents and combustible materials. Store away from grease and oil. Keep container tightly closed and sealed until ready for use. See Section 10 for incompatible materials before handling or use. Cylinders should be stored upright, with valve protection cap in place, and firmly secured to prevent falling or being knocked over. Cylinder temperatures should not exceed 52 °C (125 °F).

Section 8. Exposure controls/personal protection

Control parameters

Occupational exposure limits

Ingredient name	Exposure limits
chlorine	**California PEL for Chemical Contaminants (*Table AC-1*) (United States)** PEL 8 hours: 0.5 ppm. STEL 15 minutes: 1 ppm.

Biological exposure indices

No exposure indices known.

Appropriate engineering controls : Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Eye/face protection : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists, gases or dusts. If contact is possible, the following protection should be worn, unless the assessment indicates a higher degree of protection: chemical splash goggles and/or face shield. If inhalation hazards exist, a full-face respirator may be required instead.

Skin protection

Hand protection : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Body protection : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Other skin protection : Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Section 8. Exposure controls/personal protection

Respiratory protection : Based on the hazard and potential for exposure, select a respirator that meets the appropriate standard or certification. Respirators must be used according to a respiratory protection program to ensure proper fitting, training, and other important aspects of use. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Section 9. Physical and chemical properties

Appearance

Physical state : Gas. [GREENISH-YELLOW GAS WITH SUFFOCATING ODOR]

Color : Colorless. Green. Yellow.

Odor : Pungent.

Odor threshold : Not available.

pH : Not applicable.

Melting point/freezing point : -101°C (-149.8°F)

Boiling point or initial boiling point and boiling range : -34°C (-29.2°F)

Flash point : [Product does not sustain combustion.]

Evaporation rate : Not available.

Flammability (solid, gas) : Extremely flammable in the presence of the following materials or conditions: reducing materials, combustible materials, organic materials and alkalis.

Lower and upper explosive (flammable) limits : Not available.

Vapor pressure : 85.3 (psig)

Relative vapor density : 2.5 [Air = 1]

Specific Volume (ft ^{3}/lb) : 5.4054

Gas Density (lb/ft ^{3}) : 0.185

Relative density : Not applicable.

Solubility(ies) :

Media	Result
cold water	Very slightly soluble

Solubility in water : 7.41 g/l

Partition coefficient: n-octanol/water : Not available.

Auto-ignition temperature : Not available.

Decomposition temperature : Not available.

Flow time (ISO 2431) : Not available.

Molecular weight : 70.9 g/mole

Section 10. Stability and reactivity

Reactivity : No specific test data related to reactivity available for this product or its ingredients.

Chemical stability : The product is stable.

Possibility of hazardous reactions : Hazardous reactions or instability may occur under certain conditions of storage or use.
Conditions may include the following:
contact with combustible materials
Reactions may include the following:
risk of causing fire

Conditions to avoid : No specific data.

Section 10. Stability and reactivity

Incompatible materials : Highly reactive or incompatible with the following materials:
combustible materials
reducing materials
grease
oil

Hazardous decomposition products : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

Hazardous polymerization : Under normal conditions of storage and use, hazardous polymerization will not occur.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

Product/ingredient name	Result
chlorine	**Rat - Inhalation - LC50 Gas.** 293 ppm [1 hours]

Conclusion/Summary [Product] : Not available.

Skin corrosion/irritation

Not available.

Conclusion/Summary [Product] : Not available.

Serious eye damage/eye irritation

Not available.

Conclusion/Summary [Product] : Not available.

Respiratory corrosion/irritation

Not available.

Conclusion/Summary [Product] : Not available.

Respiratory or skin sensitization

Not available.

Skin

Conclusion/Summary [Product] : Not available.

Respiratory

Conclusion/Summary [Product] : Not available.

Germ cell mutagenicity

Not available.

Conclusion/Summary [Product] : Not available.

Section 11. Toxicological information

Carcinogenicity

Not available.

Conclusion/Summary [Product] : Not available.

Reproductive toxicity

Not available.

Conclusion/Summary [Product] : Not available.

Specific target organ toxicity (single exposure)

Not available.

Specific target organ toxicity (repeated exposure)

Not available.

Aspiration hazard

Not available.

Information on the likely routes of exposure

Not available.

Potential acute health effects

Eye contact : Causes serious eye damage. Contact with rapidly expanding gas may cause burns or frostbite.

Inhalation : Fatal if inhaled.

Skin contact : Causes severe burns. Contact with rapidly expanding gas may cause burns or frostbite.

Ingestion : As this product is a gas, refer to the inhalation section.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact : Adverse symptoms may include the following:
pain
watering
redness

Inhalation : No specific data.

Skin contact : Adverse symptoms may include the following:
pain or irritation
redness
blistering may occur

Ingestion : Adverse symptoms may include the following:
stomach pains

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Section 11. Toxicological information

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Not available.

Conclusion/Summary [Product] : Not available.

General : No known significant effects or critical hazards.

Carcinogenicity : No known significant effects or critical hazards.

Mutagenicity : No known significant effects or critical hazards.

Reproductive toxicity : No known significant effects or critical hazards.

Numerical measures of toxicity

Acute toxicity estimates

Product/ingredient name	Oral (mg/kg)	Dermal (mg/kg)	Inhalation (gases) (ppm)	Inhalation (vapors) (mg/l)	Inhalation (dusts and mists) (mg/l)
chlorine	N/A	N/A	146.5	N/A	N/A

Section 12. Ecological information

Toxicity

Product/ingredient name	Result
chlorine	**Acute - LC50 - Fresh water** Fish - Rainbow trout,donaldson trout - *Oncorhynchus mykiss* Size: 10.16 to 12.7 cm 14 µg/l [96 hours] Effect: Mortality **Acute - LC50 - Fresh water** Crustaceans - Aquatic sowbug - *Asellus racovitzai* 2.03 µg/l [2 days] Effect: Mortality **Acute - EC50 - Marine water** Algae - Giant kelp - *Macrocystis pyrifera* - Young 5.1 ppm [4 days] Effect: Physiology

Conclusion/Summary [Product] : Not available.

Persistence and degradability

Not available.

Conclusion/Summary [Product] : Not available.

Bioaccumulative potential

Not available.

Mobility in soil

Section 12. Ecological information

Soil/Water partition coefficient : Not available.

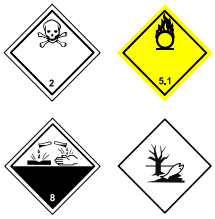
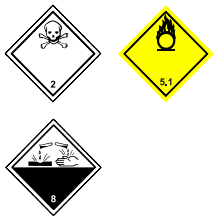
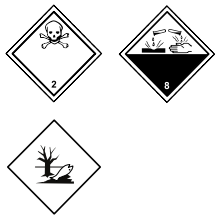
Other adverse effects

No known significant effects or critical hazards.

Section 13. Disposal considerations

Disposal methods : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Empty pressure vessels should be returned to the supplier. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Empty containers or liners may retain some product residues. Do not puncture or incinerate container.

Section 14. Transport information

	DOT	TDG	Mexico	IMDG	IATA
UN number	UN1017	UN1017	UN1017	UN1017	UN1017
UN proper shipping name	CHLORINE	CHLORINE	CHLORINE	CHLORINE	CHLORINE
Transport hazard class(es)	2.3 (5.1, 8) 	2.3 (5.1, 8) 	2.3 (5.1, 8) 	2.3 (8) 	2.3 (8) 
Packing group	-	-	-	-	-
Environmental hazards	Yes.	Yes.	Yes. The environmentally hazardous substance mark is not required.	Yes.	Yes. The environmentally hazardous substance mark is not required.

"Refer to CFR 49 (or authority having jurisdiction) to determine the information required for shipment of the product."

Additional information

DOT Classification : Toxic - Inhalation hazard Zone B
This product is not regulated as a marine pollutant when transported on inland waterways in sizes of ≤5 L or ≤5 kg or by road, rail, or inland air in non-bulk sizes, provided the packagings meet the general provisions of §§ 173.24 and 173.24a.
Reportable quantity 10 lbs / 4.54 kg. Package sizes shipped in quantities less than the product reportable quantity are not subject to the RQ (reportable quantity) transportation requirements.
Limited quantity Yes.
Quantity limitation Passenger aircraft/rail: Forbidden. Cargo aircraft: Forbidden.
Special provisions 2, B9, B14, T50, TP19

Section 14. Transport information

TDG Classification : Product classified as per the following sections of the Transportation of Dangerous Goods Regulations: 2.13-2.17 (Class 2), 2.23-2.25 (Class 5), 2.40-2.42 (Class 8), 2.7 (Marine pollutant mark).
The marine pollutant mark is not required when transported by road or rail.
Explosive Limit and Limited Quantity Index 0
ERAP Index 500
Passenger Carrying Vessel Index Forbidden
Passenger Carrying Road or Rail Index Forbidden

IMDG : The marine pollutant mark is not required when transported in sizes of ≤5 L or ≤5 kg.

IATA : The environmentally hazardous substance mark may appear if required by other transportation regulations.
Quantity limitation Passenger and Cargo Aircraft: Forbidden. Cargo Aircraft Only: Forbidden.

Special precautions for user : **Transport within user's premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

Transport in bulk according to IMO instruments : Not available.

Section 15. Regulatory information

U.S. Federal regulations :

TSCA 8(a) CDR Exempt/Partial exemption: Not determined

Clean Water Act (CWA) 311: chlorine

Clean Air Act (CAA) 112 regulated toxic substances: chlorine

TSCA 12(b) - Chemical export notification

Not applicable.

Clean Air Act Section 112 (b) Hazardous Air Pollutants (HAPs) : Listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 302/304

Composition/information on ingredients

Name	%	EHS	SARA 302 TPQ (lbs)	SARA 302 TPQ (gallons)	SARA 304 RQ (lbs)	SARA 304 RQ (gallons)
chlorine	100	Yes.	100	-	10	-

SARA 304 RQ : 10 lbs / 4.5 kg

SARA 311/312

Classification : Refer to Section 2: Hazards Identification of this SDS for classification of substance.

SARA 313

Section 15. Regulatory information

	Product name	CAS number	%
Form R - Reporting requirements	chlorine	7782-50-5	100
Supplier notification	chlorine	7782-50-5	100

SARA 313 notifications must not be detached from the SDS and any copying and redistribution of the SDS shall include copying and redistribution of the notice attached to copies of the SDS subsequently redistributed.

State regulations

Massachusetts : This material is listed.

New York : This material is listed.

New Jersey : This material is listed.

Pennsylvania : This material is listed.

California Prop. 65

This product does not require a Safe Harbor warning under California Prop. 65.

International regulations

Chemical Weapon Convention List Schedules I, II & III Chemicals

Not listed.

Montreal Protocol

Not listed.

Stockholm Convention on Persistent Organic Pollutants

Not listed.

Rotterdam Convention on Prior Informed Consent (PIC)

Not listed.

UNECE Aarhus Protocol on POPs and Heavy Metals

Not listed.

Inventory list

Australia : This material is listed or exempted.

Canada : This material is listed or exempted.

China : This material is listed or exempted.

Eurasian Economic Union : **Russian Federation inventory**: Not determined.

Japan : **Japan inventory (CSCL)**: Not determined.
Japan inventory (ISHL): Not determined.

New Zealand : This material is listed or exempted.

Philippines : This material is listed or exempted.

Republic of Korea : This material is listed or exempted.

Taiwan : This material is listed or exempted.

Thailand : This material is listed or exempted.

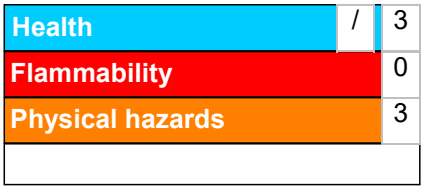
Turkey : This material is listed or exempted.

United States : This material is active or exempted.

Viet Nam : This material is listed or exempted.

Section 16. Other information

Hazardous Material Information System (U.S.A.)



Section 16. Other information

Caution: HMIS® ratings are based on a 0-4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks. Although HMIS® ratings and the associated label are not required on SDSs or products leaving a facility under 29 CFR 1910.1200, the preparer may choose to provide them. HMIS® ratings are to be used with a fully implemented HMIS® program. HMIS® is a registered trademark and service mark of the American Coatings Association, Inc.

The customer is responsible for determining the PPE code for this material. For more information on HMIS® Personal Protective Equipment (PPE) codes, consult the HMIS® Implementation Manual.

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

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Copyright ©2001, National Fire Protection Association, Quincy, MA 02269. This warning system is intended to be interpreted and applied only by properly trained individuals to identify fire, health and reactivity hazards of chemicals. The user is referred to certain limited number of chemicals with recommended classifications in NFPA 49 and NFPA 325, which would be used as a guideline only. Whether the chemicals are classified by NFPA or not, anyone using the 704 systems to classify chemicals does so at their own risk.

Procedure used to derive the classification

Classification	Justification
OXIDIZING GASES - Category 1	Expert judgment
GASES UNDER PRESSURE - Compressed gas	According to package
ACUTE TOXICITY (inhalation) - Category 2	On basis of test data
SKIN CORROSION - Category 1	Expert judgment
SERIOUS EYE DAMAGE - Category 1	Expert judgment
AQUATIC HAZARD (ACUTE) - Category 1	Expert judgment

History

Date of printing : 5/7/2025

Date of issue/Date of revision : 5/7/2025

Date of previous issue : 2/23/2022

Version : 2.02

Key to abbreviations : ATE = Acute Toxicity Estimate
BCF = Bioconcentration Factor
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
IATA = International Air Transport Association
IBC = Intermediate Bulk Container
IMDG = International Maritime Dangerous Goods
LogPow = logarithm of the octanol/water partition coefficient
MARPOL = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
UN = United Nations

References : Not available.

Notice to reader

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.
Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

16.7 Nitrogen (CAS No.: 7727-37-9)

MATERIAL SAFETY DATA SHEET (MSDS)

NITROGEN

(Please ensure that this MSDS is received by an appropriate person)

DATE: February 2017 Version 3 Ref. No.: MS095

1 PRODUCT AND COMPANY IDENTIFICATION

Product Name	Nitrogen
Chemical Formula	N_2
Trade Names	Nitrogen, Compressed (Tec) Nitrogen, Instrument Grade Nitrogen, Pharmaceutical Grade Nitrogen, ELCAP
Colour coding	Compressed, Instrument, ultra high purity & Pharmaceutical Grades have French Grey (H.30) bodies with black shoulders. Relevant decals/stencilling shall be on bodies of cylinders. ELCAP shall have a Protea Pink (A.58) body, with "ELCAP" stencilled on body of the cylinder.
Valve	ELCAP No. 2 type-Brass 5/8inch BSP right hand female. All the other grades shall be fitted with 3 SN – Brass, ¾ inch BSP right hand female valves.
Company Identification	African Oxygen Limited 23 Webber Street Johannesburg, 2001 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	Nitrogen
Chemical Family	Inert gas
CAS No.	7727-37-9
UN No.	1066
ERG No.	121
Hazchem Warning	2 C Non-flammable Gas

3 HAZARDS IDENTIFICATION

Main Hazards

All cylinders are portable gas containers, and must be regarded as pressure vessels at all times. Nitrogen does not support life. It can act as a simple asphyxiant by diluting the concentration of oxygen in air below the levels necessary to support life.

Adverse Health Effects

Inhalation of nitrogen in excessive concentrations can result in dizziness, nausea, vomiting, loss of consciousness and death.

Chemical Hazards

Nitrogen is relatively inert to most materials under ordinary conditions. It becomes more reactive at elevated temperatures, and combines with hydrogen, oxygen and some metals.

Biological Hazards No known effect.

Vapour Inhalation

As nitrogen acts 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.

4 FIRST AID MEASURES

Eye/Skin Contact No known effect.

Ingestion (See Section 3 above)

Inhalation

Prompt medical attention is mandatory in all cases of overexposure to Nitrogen. Rescue personnel should be equipped with self-contained breathing apparatus. 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.

5 FIRE FIGHTING MEASURES

Extinguishing Media

As Nitrogen is an inert gas, it does not contribute to a fire, but could help with the extinguishing by reducing the oxygen content of the air by dilution to below the level to support combustion.

Specific Hazards

Nitrogen does not support life. It can act as a simple asphyxiant by diluting the concentration of oxygen in the air below the levels to support life.

Emergency Actions

If possible, shut off the source of excess Nitrogen. Evacuate area. All cylinders should be removed from the vicinity of the fire. Cylinders that cannot be removed should be cooled with water from a safe distance. Cylinders which have been exposed to excessive heat should be clearly identified and returned to supplier. CONTACT THE NEAREST AFROX BRANCH.

Protective Clothing

Self-contained breathing apparatus. Safety gloves and shoes, or boots, should be worn when handling cylinders.

Environmental Precautions

Nitrogen is lighter than air and disperses rapidly in the atmosphere. Care should be taken when entering a potentially oxygen-deficient environment. If possible, ventilate the affected area.

6 ACCIDENTAL RELEASE MEASURES

Personal Precautions

Do not enter any area where nitrogen has been spilled unless tests have shown that it is safe to do so.

Environmental Precautions

Nitrogen does not pose a hazard to the environment.

Small Spills

Shut off the source of escaping nitrogen. Ventilate the area.

Large Spills

Evacuate the area. Shut off the source of the spill if this can be done without risk. Restrict access to the area until completion of the clean-up procedure. Ventilate the area using forced-draught if necessary.

7 HANDLING AND STORAGE

Do not allow cylinders to slide or come into contact with sharp edges. Nitrogen cylinders may be stacked horizontally provided that they are firmly secured at each end to prevent rolling. Use a "first in - first out" inventory system to prevent full cylinders from being stored for excessive periods of time. Keep out of reach of children.

8 EXPOSURE CONTROLS/PERSONAL PROTECTION

Occupational Exposure Hazards

As nitrogen is a simple asphyxiant, avoid any areas where spillage has taken place. Only enter once testing has proved the atmosphere to be safe.

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 systems. Ensure that sufficient fresh air enters at, or near floor level.

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 cylinders.

Skin No known effect.

9 PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL DATA

Chemical Symbol	N_2
Molecular Weight	28,013
Specific Volume @ 20°C & 101,325 kPa	861,5ml/g
Density, gas @ 101,325 kPa and 20°C	1,25 kg/m^3
Relative density (Air = 1) @ 101,325 kPa	0,967
Colour	None
Taste	Non

MATERIAL SAFETY DATA SHEET (MSDS)
NITROGEN
(Please ensure that this MSDS is received by an appropriate person)

10 STABILITY AND REACTIVITY

Conditions to avoid
The dilution of the oxygen concentration in the atmosphere to levels which cannot support life. Never use cylinders as rollers or supports, or for any other purpose than the storage of Nitrogen. Never expose cylinders to excessive heat, as this may cause sufficient build-up of pressure to rupture the cylinders.
Incompatible Materials
As Nitrogen is inert it may be contained in systems constructed of any of the common metals which have been designed to safely withstand the pressures involved.
Hazardous Decomposition Products
None

11 TOXICOLOGICAL INFORMATION

Acute Toxicity	No known effect
Skin & eye contact	No known effect
Chronic Toxicity	No known effect
Carcinogenicity	No known effect
Mutagenicity	No known effect
Reproductive Hazards	No known effect

(For further information see Section 3. Adverse Health effects)

12 ECOLOGICAL INFORMATION

Nitrogen is lighter than air and can cause pockets of oxygen depleted atmosphere in low-lying areas. It does not pose a hazard to the ecology.

13 DISPOSAL CONSIDERATIONS

Disposal Methods
Small amounts may be blown to the atmosphere under controlled conditions. Large amounts should only be handled by the gas supplier.
Disposal of Packaging
The disposal of cylinders must only be handled by the gas supplier.

14 TRANSPORT INFORMATION

ROAD TRANSPORTATION

UN No	1066
ERG No	121
Hazchem warning	2C Non-flammable Gas

SEA TRANSPORTATION

IMDG	1066
Class	
Packaging group	
label	Non-flammable gas

AIR TRANSPORTATION

ICAO/IATA Code	1066
Class	2.2
Packaging group	
Packaging instructions	
- Cargo	200
- Passenger	200
Maximum quantity allowed	
- Cargo	150kg
- Passenger	75kg

15 REGULATORY INFORMATION

EEC Hazard class Non-flammable
Refer to SANS 10234 for explanation of the above

16 OTHER INFORMATION

Bibliography
Compressed Gas Association, Arlington, Virginia
Handbook of Compressed Gases – 3rd Edition
Matheson. Matheson Gas Data Book – 6th Edition
SABS 0265 - Labelling of Dangerous Substances

17 EXCLUSION OF LIABILITY

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