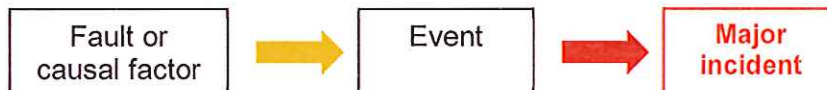


## Executive Summary

1. EPG Gas Distributors requested an independent assessment of the major hazard installation risks associated with its LPG bulk storage at its depot at erf 125 in Amethyst Street, Klérksoord in Rosslyn as required by Section 5 (1) of the MHI Regulations. Nature & Business Alliance Africa (Pty) Ltd was appointed for this purpose.
2. Hazardous material inventory:
  - One LPG bulk tank of 400 000 litres, mounded.
  - One LPG bulk tank of 100 000 litres, mounded.
  - LPG road tankers on site for offloading and loading of LPG.
3. The following methodology was applied in this risk assessment:
  - A fault-tree analysis method [1] was applied to determine the possible causes of an event (fault) that could eventually lead to a major incident. For this risk assessment, an event is defined as a chemical spill or gas leak that could result in a toxic release, an explosion or a fire on the premises of EPG Gas Distributors LPG Depot.
  - An event-tree analysis method [1] was applied to determine the potential major incidents that could be the end result of the event. The logic is explained as follows:



In this risk assessment, an **event** is defined as an occurrence (a condition or situation) that is caused by a fault and that can trigger a major incident. This is best explained by means of an example: A leak in a storage tank that contains a flammable liquid is an event. The leak was caused by corrosion (the fault). If the leaking liquid is set alight, a fire will start, which would be a major incident, because it can cause injury or death due to thermal radiation or an explosion.

A **major incident** is defined as an occurrence of catastrophic proportions, resulting from the use of facility or machinery, or from activities at a work place. A "catastrophic occurrence" is interpreted [28] as an occurrence (incident), which can be fatal, disastrous, of definite threat to the health and lives of employees and members of the public. It is important to note that human lives (injury, fatal or not) as well as assets (damage) are included in this definition.

*This is the FINAL report with full legal status after client review and may be submitted to the Department of Labour, the Local Authority or any interested and affected party*

- The frequency of occurrence of a major incident was calculated, based on analysis of international historical data for similar incidents. Similar data does not exist for South African industry.
- The toxicity, flammability and explosivity potential of liquid and gas releases were evaluated by means of internationally accepted mathematical modeling techniques [1, 2, 3 and 18].
- Toxic releases were modeled by means of the ALOHA mathematical dispersion model [3] of the Environmental Protection Agency of the USA.
- Heat radiation flux caused by a fire was simulated by means of the equations proposed by *Mudan and Groce* [1, p243].
- The overpressure blast effects of vapour cloud explosions and solid explosions were simulated by means of the trinitrotoluene (TNT) equivalency methods described by *Baker et al, Decker, Lees and Stull* [1, p174].
- Meteorological tendencies at the site were taken into consideration.
- Individual and societal risks were assessed, based on the frequencies of major incidents, minimum safety distances and the predicted number of potential fatalities.
- The occurrence and effect of a boiling liquid expanding vapour explosion (BLEVE) was modeled based on work done by the Center for Chemical Process Safety of the American Institute of Chemical Engineers.
- A **human impact** is defined as the effect that a major incident could have on human beings, whether they are present inside the facility or whether they are present beyond the facility boundaries within the surrounding community, including minor injury, major injury and fatality and the destructive effect on assets.

The following conclusions are drawn from this risk assessment:

1. The hazardous events that could occur at the EPG Gas Distributors LPG Depot facility in Rosslyn are as follows:
  - An uncontrolled leak of LPG from the bulk storage tanks.
  - An uncontrolled leak of LPG from the LPG delivery road tanker.
2. The following potential major incidents are possible as a result of the above major incidents:
  - Jet fire.
  - Toxic effect.
  - BLEVE on LPG road tanker.
  - LPG cloud explosion.
3. The safety risks at the EPG Gas Distributors LPG Depot Rosslyn Facility are summarised in Table 17.1.

*This is the FINAL report with full legal status after client review and may be submitted to the Department of Labour, the Local Authority or any interested and affected party*



4. The individual safety risk transect is shown in Figure 17.1. It indicates that the risk profile of the facility lies partly above the norm for tolerable public risk ( $1.00\text{E}-4$ ) as well as the norm for tolerable worker risk ( $1.00\text{E}-3$ ) as recommended by the UK Health and Safety Executive (HSE).
5. The societal risk profile for the Rosslyn Facility is given in Figure 17.2. It indicates that the safety risk at the facility lies below the local tolerability line as recommended by the Dutch Advisory Committee on Dangerous Substances.
6. The estimated number of impacts at the Rosslyn Facility is not expected to reach a level of 10 000, the norm recommended by the Dutch Advisory Committee on Dangerous Substances. The highest estimate is 41 impacts due to the toxic effect of a catastrophic release of LPG.
7. The various risk contours of the facility are shown in Figure 17.3.
8. The facilities around EPG Gas Distributors would be affected by a major incident.
9. The storage tanks have to be installed as close as possible to the site boundary. Based on the above findings, it is concluded that the EPG Gas Distributors LPG Depot in Rosslyn is classified as a major hazard installation.
10. The road tankers that will deliver LPG to the site, constitutes a temporary installation and was subjected to an individual risk assessment. The following was concluded:
  - The estimated frequencies of a major incident associated with the road tanker are less than  $1.0\text{E}-4$  per year.
  - The estimated number of human impacts associated with the road tanker is less than 10 000.

It is concluded that the road tankers, as temporary installations, do not constitute a major hazard installation *per se*, because the maximum estimated frequency of a major incident is lower than  $1.0\text{E}-4$  per year (norm used by the UK Health and Safety Executive) and the estimated number of human impacts is less than 10 000.

Notwithstanding this conclusion, the offloading of LPG from a road tanker via pipeline remains a very critical operation that needs to be managed with great care.

Table 17.1

Potential Major Incident	Possible Consequences	Estimated Frequency	Safety distance, m	Estimated number of human impacts
Uncontrolled release of LPG from bulk storage tank	Toxic effect	5.12E-6	10	0
Uncontrolled release of LPG from bulk storage tank	Gas cloud explosion	5.12E-5	79	7
Uncontrolled release of LPG from bulk storage tank	Thermal radiation from jet flame	2.0E-5	2	0
Uncontrolled release of LPG from bulk storage tank filler pipeline	Toxic effect	2.6E-4	191	41
Uncontrolled release of LPG from bulk storage tank filler pipeline	Gas cloud explosion	3.2E-3	79	7
Uncontrolled release of LPG from bulk storage tank filler pipeline	Thermal radiation from jet flame	1.0E-3	28	1
Uncontrolled release of LPG from the road tanker	Toxic effect	2.2 E-8	191	41
Uncontrolled release of LPG from the road tanker	Gas cloud explosion	5.0 E-9	79	7
Uncontrolled release of LPG from the road tanker	Thermal radiation from jet flame	4.4 E-8	28	1
Uncontrolled release of LPG from the delivery road tanker	BLEVE on road tanker	2.2 E-8	136	21

\* Based on a population density of 0.0001 persons per m<sup>2</sup> and an impact rate of 50%. In the case of toxic releases, one quadrant of the affected circle (25%) was taken into consideration to make provision for varying wind blow patterns.

The following organisational measures are recommended for the site:

1. The National Chief Inspector of the Department of Labour must be notified about the MHI status of the facility.
2. The Provincial Chief Inspector in Gauteng of the Department of Labour must be notified about the MHI status of the facility.
3. The local emergency services must be notified about the MHI status of the facility.
4. A site notice must be placed at the entrance to the premises to notify members of the public about the MHI status of the LPG installation and operations.
5. An advertisement must be published in a local newspaper to notify members of the public about the MHI status of the proposed LPG installation and operations.
6. The on-site emergency plan must be updated to comply with the requirements stipulated in Section 13 of this report.
7. Operating procedures must be compiled for the facility, to include preventative measures against the following potential major incidents:
  - LPG leaks.
8. All possible ignition sources at the facility must be eliminated. Some guidelines for the control of ignition sources are as follows:
  - Use only electrical equipment that is certified to be flameproof and spark proof.
  - Control static electricity.

*This is the FINAL report with full legal status after client review and may be submitted to the Department of Labour, the Local Authority or any interested and affected party*



- Ensure that vulnerable equipment is properly bonded to ground.
  - Prohibit smoking, open flames and sparks.
  - Prevent mechanical sparks and friction.
  - Use separator devices to remove foreign materials capable of igniting from process materials.
  - Separate heated surfaces from dust.
  - Separate heating systems from dust.
  - Select and use industrial trucks properly.
  - Use cartridge activated tools properly.
  - Implement an equipment preventative maintenance programme.
9. The outcome of the risk assessment must be brought to the attention of all the employees at the facility.
10. The bulk storage tanks and all gas pipelines must be protected against corrosion, to prevent gas leaks.
11. A Maintenance Plan must be compiled for all the equipment used on the site. The Plan must contain at least the following:
- List of all equipment and facilities on the facility.
  - Maintenance frequency.
  - Particulars of maintenance activities that must be performed on the listed equipment.
  - Responsible person.
12. All hazardous equipment and facilities on the facility must be inspected on a daily basis by means of an Inspection Register. The Register must contain at least the following:
- List of all equipment and facilities on the facility.
  - Equipment items that must be inspected.
  - Facilities that must be inspected.
  - Areas that must be inspected.
  - Inspection findings.
  - Responsible person who carried out the inspection.
13. Detailed operating procedure must be implemented for all sections of the facility, in collaboration with the equipment suppliers. All authorised operators must be trained in the application of the procedure. Special attention must be given to the offloading of LPG via road tanker.
14. All operating personnel at the facility must be made aware and kept aware of the dangers involving LPG.
15. The facility must be under safety and security access control for 24 hours per day. The security guard on duty must comply with the following requirements:
- The guard must be trained in the potential major incidents that could occur at the site as well as the emergency procedure that must be followed.
  - The guard must be linked via SMS or cellular phone with a responsible standby person.
  - The guard must be able to contact the Fire Department immediately.

*This is the FINAL report with full legal status after client review and may be submitted to the Department of Labour, the Local Authority or any interested and affected party*

16. A site layout plan must be compiled for the proposed facility in accordance with the relevant SANS codes and must be submitted to the Fire Department for approval.
17. The Emergency Evacuation Procedure aimed at workers as well as the surrounding business communities must be updated regularly in collaboration with the emergency services and interested and affected parties such as members of community liaison committees.
18. The Emergency Management Plan and Emergency Evacuation Procedure must be tested at least once every 12 months by means of mock emergencies. The Fire Department must participate in such tests.
19. A water spray system must be maintained at the LPG road tanker docking bay, in accordance with the requirements of the Automatic Sprinkler Investigating Bureau (ASIB). The sprinkler system capacity must be adequate to keep the road tanker cool so that a BLEVE can be prevented.
20. Customer parking bays must be located in an area where public vehicles will not cause obstruction of emergency vehicles.
21. Adequate space must be provided for the road tanker to park safely for delivery of LPG to the bulk storage tank. The tanker must never reverse or maneuver on site.
22. The bulk LPG storage tanks must be protected against lightning.
23. No waste, especially flammable waste, must be allowed near the LPG tank and road tankers.
24. The LPG bulk storage tanks must be protected against sabotage and pilferage.
25. Trucks that off-load and on-load LPG must not park close to the bulk LPG tank. Trucks must always park in such a manner that they will not obstruct emergency vehicles or rescue personnel.
26. The tank filler pipelines need special attention as high risk components. International failure rates indicate that LPG distribution pipelines are more prone to leaks than bulk storage tanks, as confirmed in the Canvey Reports [8]. The higher risk of leaks on pipelines are caused by factors such as material deficiency, installation errors, bad workmanship, lack of maintenance, internal and external corrosion and mechanical damage, especially over long distances. Furthermore, a small LPG leak (pinhole) in the pipeline will cause embrittlement of the surrounding pipe metal due to the Joule-Thompson cooling effect, which may soon lead to a full-bore rupture. A leak in a pipeline would normally not be critical, but since the LPG distribution pipeline to the cylinder filling facility is connected to a large reservoir of LP gas, a large quantity of gas may escape through the leak hole in case of failure.
27. The locality of the LPG tanks must be approved by the local fire department.
28. A fire plan must be compiled by a qualified draughtsman and submitted to the local fire department for approval.
29. It may be necessary to install a dedicated fire water storage tank to make the site independent from municipal fire water supply.
30. In summary, the Layer of Protection steps must be implemented at the site, as set out in Table 15.1 below.

*This is the FINAL report with full legal status after client review and may be submitted to the Department of Labour, the Local Authority or any interested and affected party*



Table 15.1

## Recommended safety layers of protection (also refer to Annexure 6)

Safety layer of protection	Description
First safety layer	<ol style="list-style-type: none"> <li>1. The offloading of LPG from a road tanker via pipeline into the bulk storage tank remains a very critical operation that needs to be managed with great care.</li> <li>2. Adequate space must be provided for the road tankers to enter, exit and park safely for delivery of LPG to the bulk storage tanks.</li> <li>3. <u>The driver of the LPG road tanker must comply with the following requirements and abide by the following rules:</u> <ul style="list-style-type: none"> <li>• The driver must be fully trained for the driving of a truck with hazardous material and must be able to provide proof to that effect.</li> <li>• The driver must be in possession of a procedure that describes all activities related to the offloading of LPG into the bulk storage tank and he must know the procedure well. The coupling and decoupling of the delivery hose must specifically form part of the procedure.</li> <li>• The delivery truck may not be reversed or maneuvered on site.</li> <li>• Chocks must be placed behind the wheels of the truck before delivery starts.</li> <li>• A warning sign must be put out to prevent people from smoking near the site when delivery takes place.</li> <li>• Venting on the bulk storage tank must be controlled carefully.</li> <li>• The driver must always wear the prescribed personal protective clothing and equipment, including safety shoes, flame-retarding ant-static overalls, and full-face shield and elbow leather gloves.</li> <li>• No flammable or combustible materials may be stored near the delivery point.</li> <li>• No vehicles may be parked near the delivery point.</li> <li>• There must not be any obstacles in the path of the LPG delivery truck.</li> <li>• Install a dedicated fire water storage tank to make the site independent from municipal fire water supply.</li> </ul> </li> </ol>
Second safety layer	<ol style="list-style-type: none"> <li>1. Compile a fire layout plan for the installation in accordance with the SANS-10087 Standard and get approval for it from the Fire Department.</li> </ol>

*This is the FINAL report with full legal status after client review and may be submitted to the Department of Labour, the Local Authority or any interested and affected party*

	<ol style="list-style-type: none"> <li>2. Eliminate all possible ignition sources at the installation, such as the following: <ul style="list-style-type: none"> <li>• Use only electrical equipment that is certified to be flameproof and spark proof.</li> <li>• Control static electricity.</li> <li>• Ensure that vulnerable equipment is properly bonded to ground.</li> <li>• Prohibit smoking, open flames and sparks.</li> <li>• Prevent mechanical sparks and friction.</li> <li>• Use separator devices to remove foreign materials capable of igniting from process materials.</li> <li>• Separate heated surfaces from dust.</li> <li>• Separate heating systems from dust.</li> <li>• Select and use industrial trucks properly.</li> <li>• Use cartridge activated tools properly.</li> <li>• No smoking on site except in a safe dedicated area.</li> <li>• No cellular phones on site except inside the office building.</li> </ul> </li> <li>3. The storage tanks and all gas pipelines and fittings must be protected against corrosion, to prevent gas leaks.</li> <li>4. The LPG must contain a suitable stenching agent such as Spotleak to make it possible to easily smell leaking gas quickly.</li> <li>5. The bulk LPG storage tank and pipe work must be adequately earthed against lightning.</li> <li>6. A water spray system must be installed at the LPG road tanker off-loading and on-loading area. The fire water spray system must be tested regularly to ensure that the spray nozzles are not blocked by rust or other impurities in the water. Sufficient water flow and pressure must exist to ensure effective operation of the water spray system.</li> </ol>
Third safety layer	<ol style="list-style-type: none"> <li>1. Implement an equipment preventative maintenance programme.</li> <li>2. Inform all employees at the installation about the safety risks.</li> <li>3. The Maintenance Plan must be updated for all the equipment used on the facility. The Plan must contain at least the following: <ul style="list-style-type: none"> <li>• List of all equipment and facilities on the facility.</li> <li>• Maintenance frequency.</li> <li>• Particulars of maintenance activities that must be performed on the listed equipment.</li> <li>• Responsible person.</li> </ul> </li> <li>4. Detailed operating procedures must be updated regularly for all sections of the facility, in collaboration with the equipment suppliers. All authorised operators must be</li> </ol>

*This is the FINAL report with full legal status after client review and may be submitted to the Department of Labour, the Local Authority or any interested and affected party*



	<p>trained in the application of the procedure. Special attention must be given to the loading of LPG.</p> <ol style="list-style-type: none"> <li>5. Material safety data sheets (MSDS) for LPG must be available to all workers on site at all times.</li> <li>6. All operating personnel at the facility must be made aware and kept aware of the dangers involving LPG.</li> <li>7. Access to the facility must be controlled 24 hours per day. The safety guard on duty must comply with the following requirements: <ul style="list-style-type: none"> <li>• The guard must be trained in the potential major incidents that could occur at the site as well as the emergency procedure that must be followed.</li> <li>• The guard must be linked via SMS or cellular phone with a responsible standby person of the operating company.</li> <li>• The guard must be able to contact the local Fire Department immediately.</li> <li>• Customer parking bays must be located in an area where public vehicles will not cause obstruction of emergency vehicles.</li> </ul> </li> <li>8. Install fire water tanks for the deluge systems if municipal water supply is insufficient.</li> </ol>
Fourth safety layer	<ol style="list-style-type: none"> <li>1. Implement an on-site emergency response plan.</li> <li>2. Update the response plan at least once per year.</li> <li>3. The Emergency Evacuation Procedure aimed at workers as well as the surrounding wards and rooms must be updated at least once per year in collaboration with the emergency services of City of Tshwane.</li> <li>4. The Emergency Response Plan and Emergency Evacuation Procedure must be tested at least once every 12 months by means of mock emergencies. The Fire Department must participate in such tests.</li> </ol>

*This is the FINAL report with full legal status after client review and may be submitted to the Department of Labour, the Local Authority or any interested and affected party*

