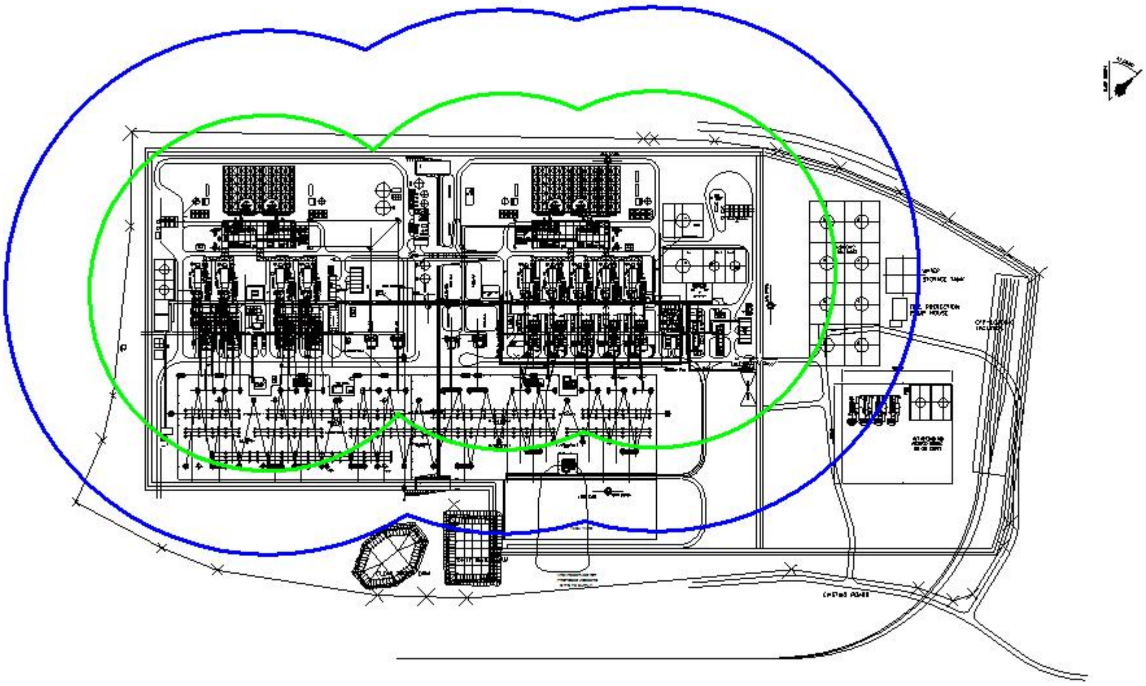


LEGEND

(blue line)	½ LFL	(394 m)
(green line)	LFL	(268 m)

Figure 5-5 Maximum extent of the flammable cloud in the event of a catastrophic failure of the 20 m³ delivery tanker

5.3.5 Vapour Cloud Explosion Consequences

A release of combustible gases into the atmosphere could result in the formation of a vapour cloud. The concentration of the combustible component decreases from the point of release to the lower explosive limits (LEL), where the concentration of the component can no longer ignite. The material contained in the vapour cloud between the higher explosive limits (HEL) and the lower explosive limit (LEL), if ignites will form a flash fire or a fireball. The sudden detonation of the explosive mass of material causes an overpressure that can result in injury or damage to property.

An explosion may give rise to any of the following effects:

- Blast damage;
- Thermal damage;
- Missile damage;
- Ground tremors;
- Crater formation; and/or,

- Personal injury

These obviously depend on the pressure waves and proximity to the actual explosion. Of concern in this investigation are the "far distance" effects, such as limited structural damage and the breakage of windows, rather than crater formations.

Table 5-2 and give a more detailed summary of the damage produced by an explosion for various over-pressures. The most commonly used overpressure is the “0.3 psi” value. This corresponds to a “Safe Distance”, at which approximately 10% of glass windows are broken.

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

Pressure (gauge)		Damage
Psi	**kPa**	
0.02	0.138	Annoying noise (137 dB), if of low frequency (10 - 15 Hz).
0.03	0.207	Occasional breaking of large glass windows already under strain.
0.04	0.276	Loud noise (143 dB). Sonic boom glass failure.
0.1	0.69	Breakage of windows, small, under strain.
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 –	3.45 – 6.9	Large and small windows usually shattered; occasional damage to window
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 –	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 tonne) in industrial building suffered little damage. Steel frame building distorted and pulled away from foundations.
3.0 –	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 tonne) in building slightly damaged.
5.0 –	34.5 – 48.3	Nearly complete destruction of houses.
7.0	48.3	Loaded train wagons, overturned.
7.0 –	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 tonnes) machine tools moved and badly damaged. Very heavy (12 000 lb/5443 kg) machine tools survived.
300	2070	Limit of crater lip.

5.3.6 Unconfined Gas Explosions

A flammable gas cloud that detonates within an area that is uncluttered and the expanding gases can easily escape. The maximum overpressure from an unconfined gas explosion is much lower than that of a confined explosion and hence the over pressure distance to safety is a lower. The overpressure from unconfined explosion is not sufficient to result in fatalities and was thus not considered in this study.

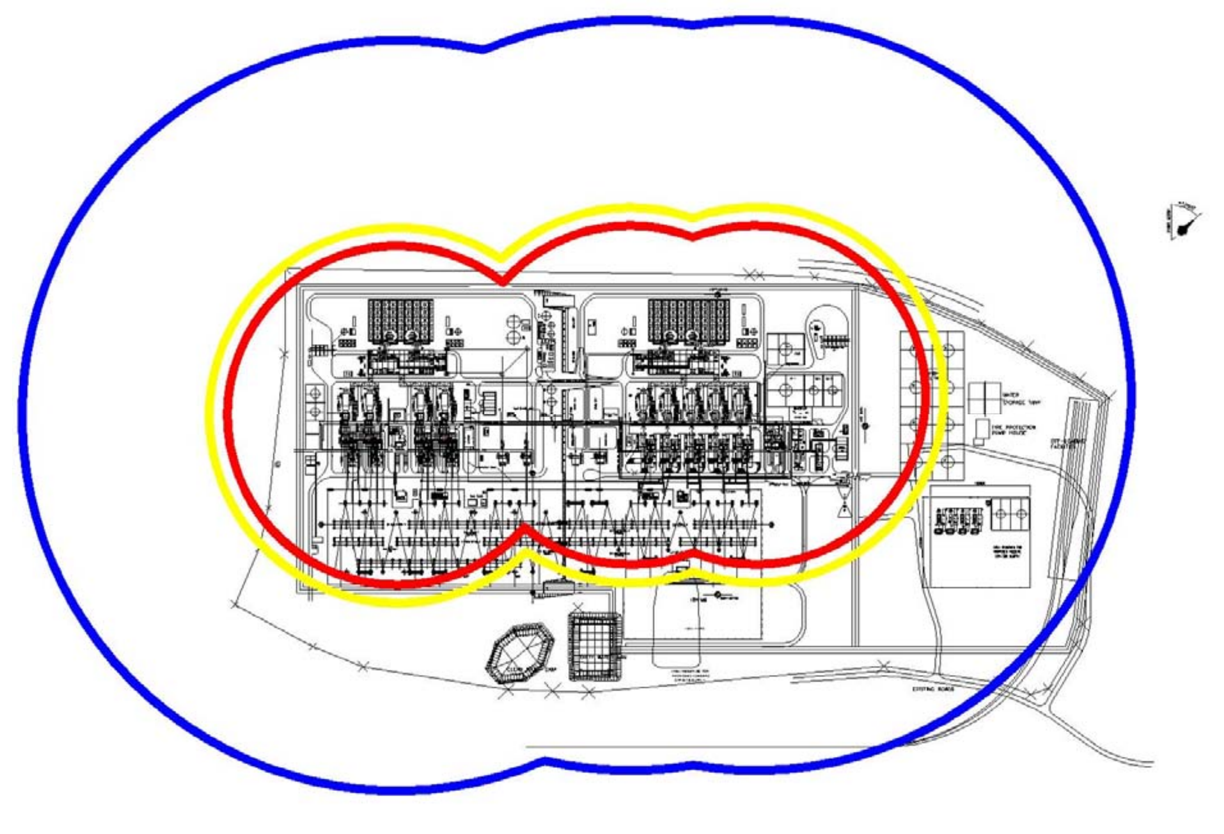
5.3.7 Confined Gas Explosion

A confined gas explosion is where the exploding gas is restricted from expanding by physical barriers such as walls or equipment and obstacles. The confined gas explosions were modelled using the multi energy model using the explosion class of 10. The multi-energy model uses the energy available for explosions and setting the class between 1 and 10 can determine the effects of a weak deflagration to a confined detonation.

The proposed CCGT project would add structures to the site that would partially confine the vapour cloud. A detonation with the confined flammable cloud could result in an explosion

Figure 5-6 gives the worst case overpressure resulting of a catastrophic failure of the 6.5 m^3 propane storage with a delayed explosion. This assumed that the released propane could drift to an ignition point. The overpressure of 69 kPa would represent almost total destruction. The 6.9 kPa would not cause direct fatalities but could destroy building with indirect fatalities. The 2 kPa is accepted as the endpoint or of the explosion and only minor damage (broken glass etc.) would be experienced. The distance to safety (2 kPa was calculated at 621 m from the source.

A large release of propane has could have offsite consequences with a delayed explosion.

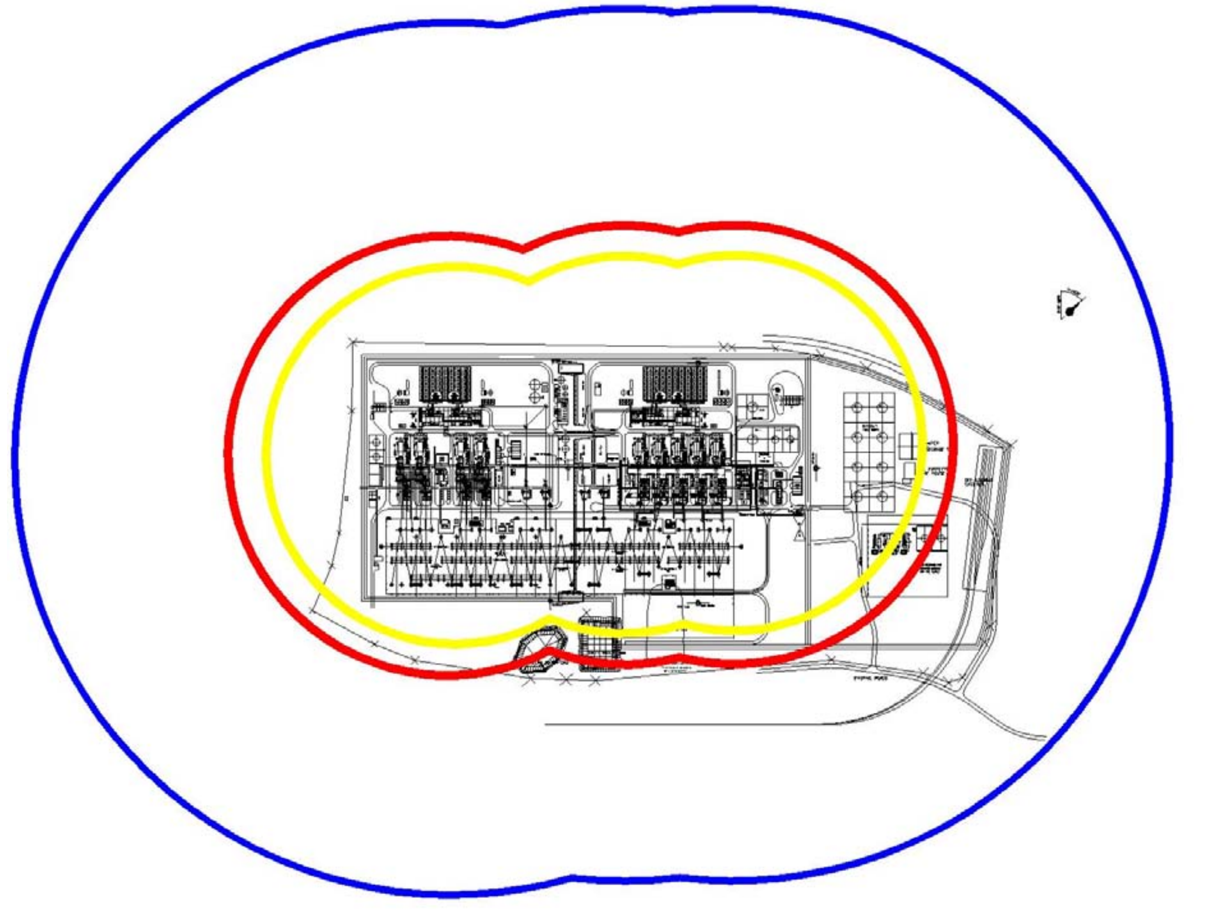


LEGEND	OVERPRESSURE (kPa / psi)
Blue line	2/0,3
Yellow line	6.9/1
Red line	69/10

Figure 5-6 Worst case blast overpressure from a confined vapour cloud explosion from a catastrophic rupture of the 6.5 m^3 storage vessels

Figure 5-7 gives the worst case overpressure resulting of a catastrophic failure of the 6.5 m^3 propane storage with a delayed explosion. This assumed that the released propane could drift to an ignition point. The overpressure of 69 kPa would represent almost total destruction. The 6.9 kPa would not cause direct fatalities but could destroy building with indirect fatalities. The 2 kPa is accepted as the endpoint or of the explosion and only minor damage (broken glass etc.) would be experienced. The distance to safety (2 kPa was calculated at 903 m from the source.

A large release of propane has could have offsite consequences with a delayed explosion. A smaller release may not extend as far as the site boundary but could cause extensive damage to assets.



LEGEND	OVERPRESSURE (kPa/psi)
Blue line	2/0,3
Yellow line	6.9/1
Red line	69/10

Figure 5-7 Worst case blast overpressure from a confined vapour cloud explosion from a catastrophic rupture of the 20 m^3 storage vessels

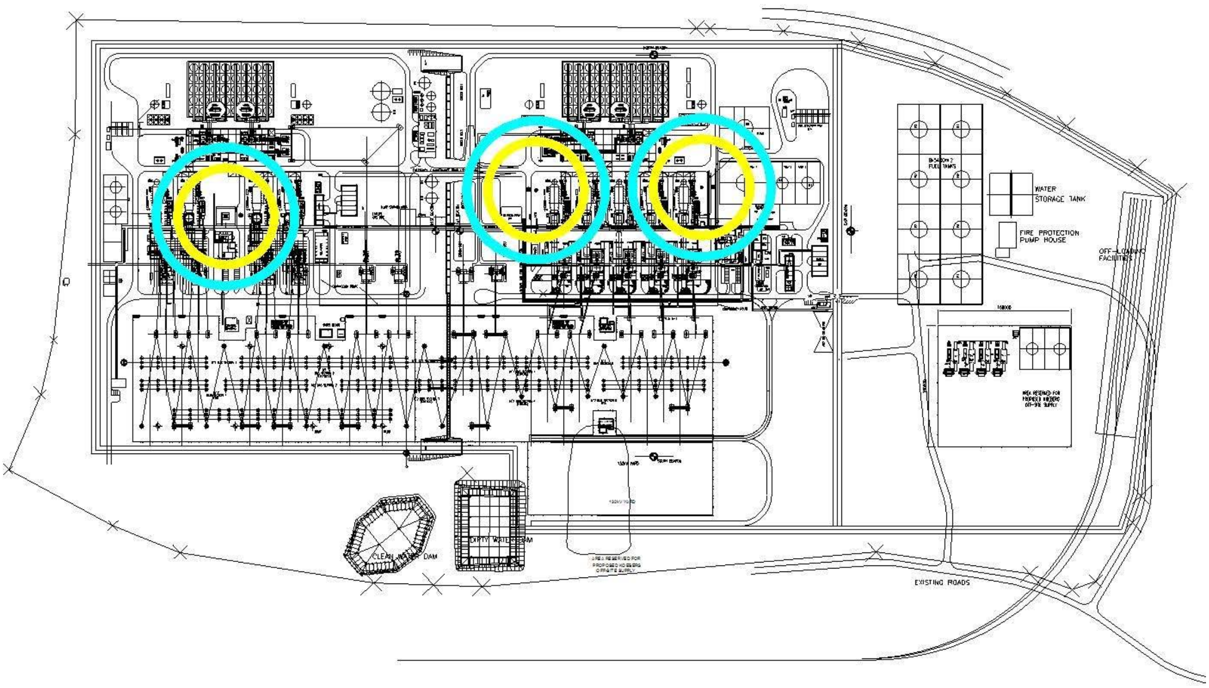
5.4 Boiling Liquid Expanding Vapour Explosion (BLEVE)

A Boiling Liquid Expanding Vapour Explosion (BLEVE) can occur when a flame impinges on the condensate tankers, particularly in the vapour space region where cooling by evaporation of the contained fluid does not occur. The vessel shell weakens, ruptures with a total loss of contents and the issuing mass of material burns as a massive fireball.

A Boiling Liquid Expanding Vapour Explosion (BLEVE) can occur when a flame impinges on a propane pressure vessel, particularly in the vapour space region where cooling by evaporation of the contained LPG does not occur. The vessel shell weakens, ruptures with a total loss of contents, and the issuing mass of propane burns as a massive fireball.

The major consequences of a BLEVE are the intense thermal radiation from the fireball, a blast wave and 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 BLEVE's suggest that the majority land within 700 m from the incident. A blast wave from a BLEVE is fairly localised, but can cause significant damage to immediate equipment.

A BLEVE formed from the 6.5 m^3 propane storage assumed a flammable and explosive mass of 3192 kg. On explosion the radius of the fireball was estimated to be 44.6 m, with duration of 6.94 seconds. The lift-off height was calculated to be 89.2 m. The thermal radiation from the resulting fireball is shown below in Figure 5-8. Due to the relatively short duration the thermal radiation consequence on health must be evaluated with respect to the duration time. The 1% lethality for the exposed duration equates to 21.8 kW/m^2 (86 m from exploding vessel and a 10% fatality would be 29.5 kW/m^2 (60 m from exploding vessel). The 100% fatality of 150 kW/m^2 was not reached. The consequences of a BLEVE fireball from a 6.5 m3 storage vessel would not extend beyond the site boundary and thus no further analysis would be required.



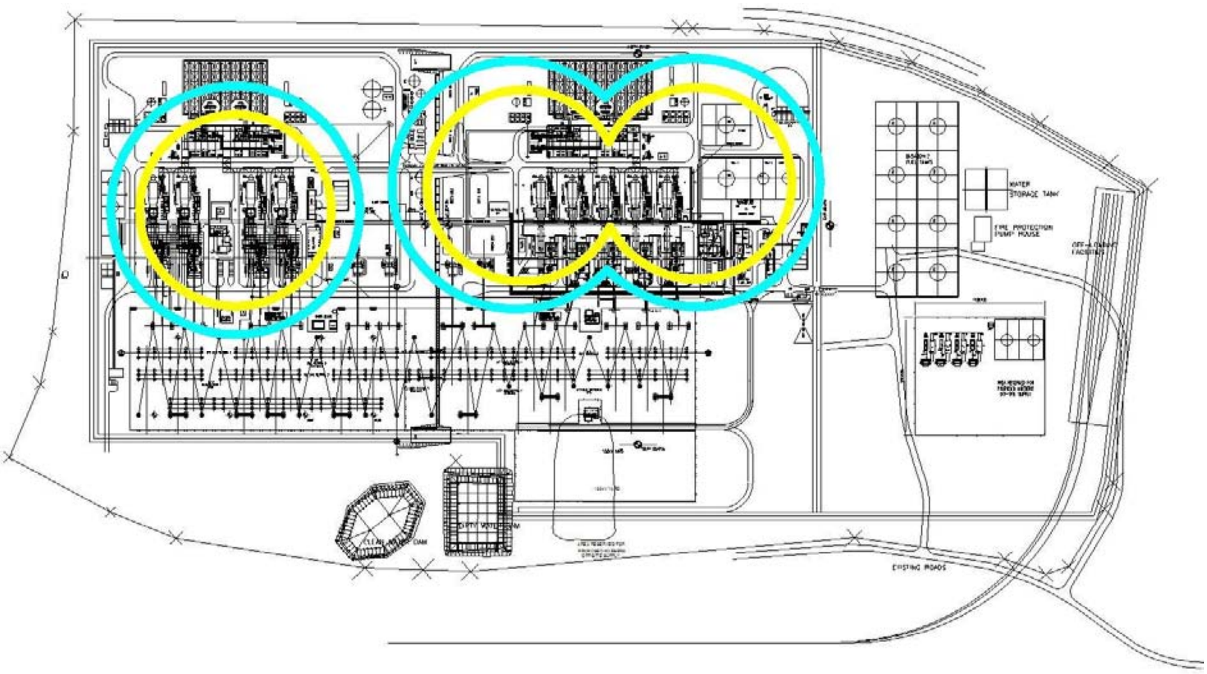
LEGEND THERMAL RADIATION (kW/m^2)

Blue line	21.7 (1% Fatality)
Yellow line	29.5 (10% Fatality)

Figure 5-8 Thermal radiation from a BLEVE of the propane storage tank

A BLEVE formed from the 20 m^3 propane delivery tanker assumed a flammable and explosive mass of 9821 kg. On explosion the radius of the fireball was estimated to be 64.3 m, with duration of 9.3 seconds. The lift-off height was calculated to be 128.54 m. The thermal radiation from the resulting fireball is shown below in Figure 5-9. Due to the relatively short duration the thermal radiation consequence on health must be evaluated with respect to the duration time. The 1% lethality for the exposed duration equates to 17.5 kW/m^2 (158 m from the exploding vessel) and a 10% fatality would be 23.8 kW/m^2 (122 m from the explosion). The 100% fatality of 120 kW/m^2 was not reached. In the event of a BLEVE of the 20 m^3 propane delivery tanker a large fireball should not have consequences beyond the Ankerlig site and thus mo further analysis is required.

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



LEGEND THERMAL RADIATION (kW/m2)

17.5 (1% Fatality)

23.8 (10 % Fatality)

Figure 5-9 Thermal radiation from a BLEVE of the 20 m^3 propane delivery tanker

6 RISK CALCULATIONS

The previous sections dealt specifically with the predicted zone of impact without taking into account the probability of occurrence and the combined impacts. Risk; on the other hand is a product of the likelihood of occurrence and the consequences.

The risk calculations need to include the effect of wind speed and atmospheric turbulence. The accidental spills were simulated using a wind speed of 10 m/s in equal frequencies from all directions.

The risk parameter used in this assessment was *maximum individual risk* to give an assessment of the risks posed by the preliminary designs.

6.1 Maximum Individual Risk Parameter

Individual risk parameters include “Average Individual Risk”, “Weighted Individual Risk”, “Maximum Individual Risk” and “Fatal Accident Rate (FAR)”. The latter parameter is more applicable to occupational exposures. Only the Maximum Individual Risk (MIR) 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 some specified location. The parameter is not dependent on the knowledge of the population at risk, and so is an easier parameter to use in the predictive mode than the Average Individual and Weighted Individual risks. The unit of measure is fatality risk per person per year.

6.1.1 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 in a plant, which may be assumed healthy, the adopted exposure assessment applies to an average population group that also includes sensitive sub-populations. Sensitive sub-population 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 address this group.

Among the most difficult tasks of risk characterisation is the definition of an *acceptable risk*. An attempt to account for risks in manner similar to those used in everyday life, the UK HSE developed the “risk ALARP triangle”. 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; or

- If a risk falls between these two states, that it has been reduced to levels as low as reasonably practicable (ALARP).

This is illustrated graphically, in Figure 6-1.

ALARP stands for "As Low As Reasonably Practicable". As used in the UK, it is the region between that which is intolerable, at $1x10^{-4}$ per year, and broadly acceptable level of $1x10^{-6}$ per year, with a further lower level of risk of $3x10^{-7}$ per year being applied to either vulnerable or very large populations for land use planning.

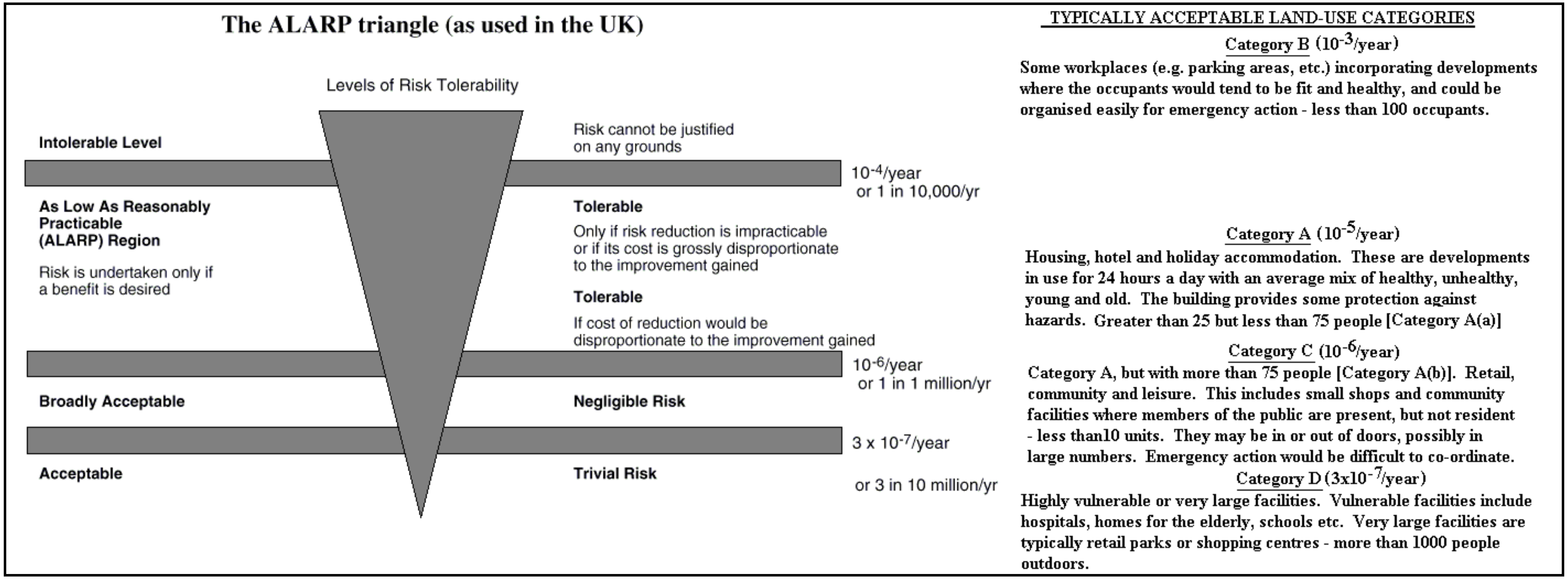


Figure 6-1 Decision making framework. The UK HSE land-use categories A to D are also included for illustration.

6.2 Accidental Fire Scenarii

Relatively large quantities of flammable and combustible material are stored at Gas-1 site, Atlantis**.** These flammable materials stored and transported at various places on the site may ignite and develop into large fire under suitable conditions.

6.2.1 Pool Fires

A pool fire will occur when pool of combustible material ignites. The cause of this is usually due to an unexpected spillage or leak. As spillages are collected in bunds, the pool fires are most likely to take place within the bunded areas of the storage, filling and loading areas. The simulations were completed for the following scenario summarised in Appendix D.

The risk isopleths are shown below in Figure 6-2. The $1x10^{-6}$ fatality per person isopleth reaches the boundary of the site and would qualify the site as a Major Hazardous Installation. The off-site risks of greater than $1x10^{-4}$ fatalities per person per year are greater than the acceptable range and would be considered intolerable.

The major contributing factor to the isopleth distances is the offloading risks as shown Figure 6-3. The risks were calculated at the maximum continuous rate for the Power Station operating 24 hours per day. The split between road and rail was unknown and thus the road offloading assumed the maximum offloading rate while the rail assumed full supply of fuel would be delivered by rail. This study thus considers some double counting reflected the maximum risk isopleths. For the rail offloading no spill containment was assumed giving a large pool fire area reflected in the risk calculations. As the $1x10^{-4}$ fatalities per person per year lies a short distance over the boundary there is possibility to reduce risks to acceptable levels. Reduction of risk is discussed in Chapter 7.

Lube oil is extremely difficult to ignite and has acceptable risks.

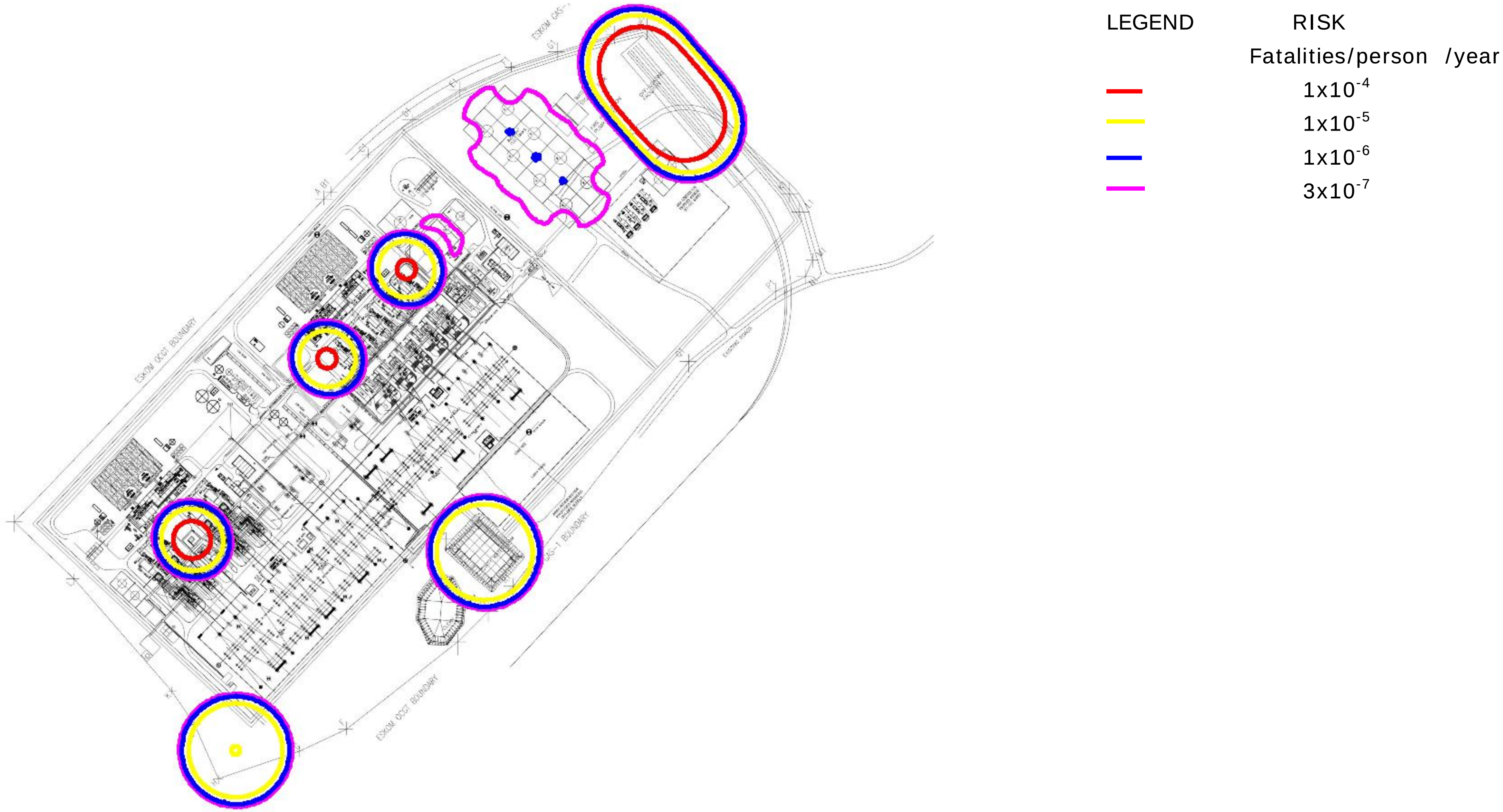
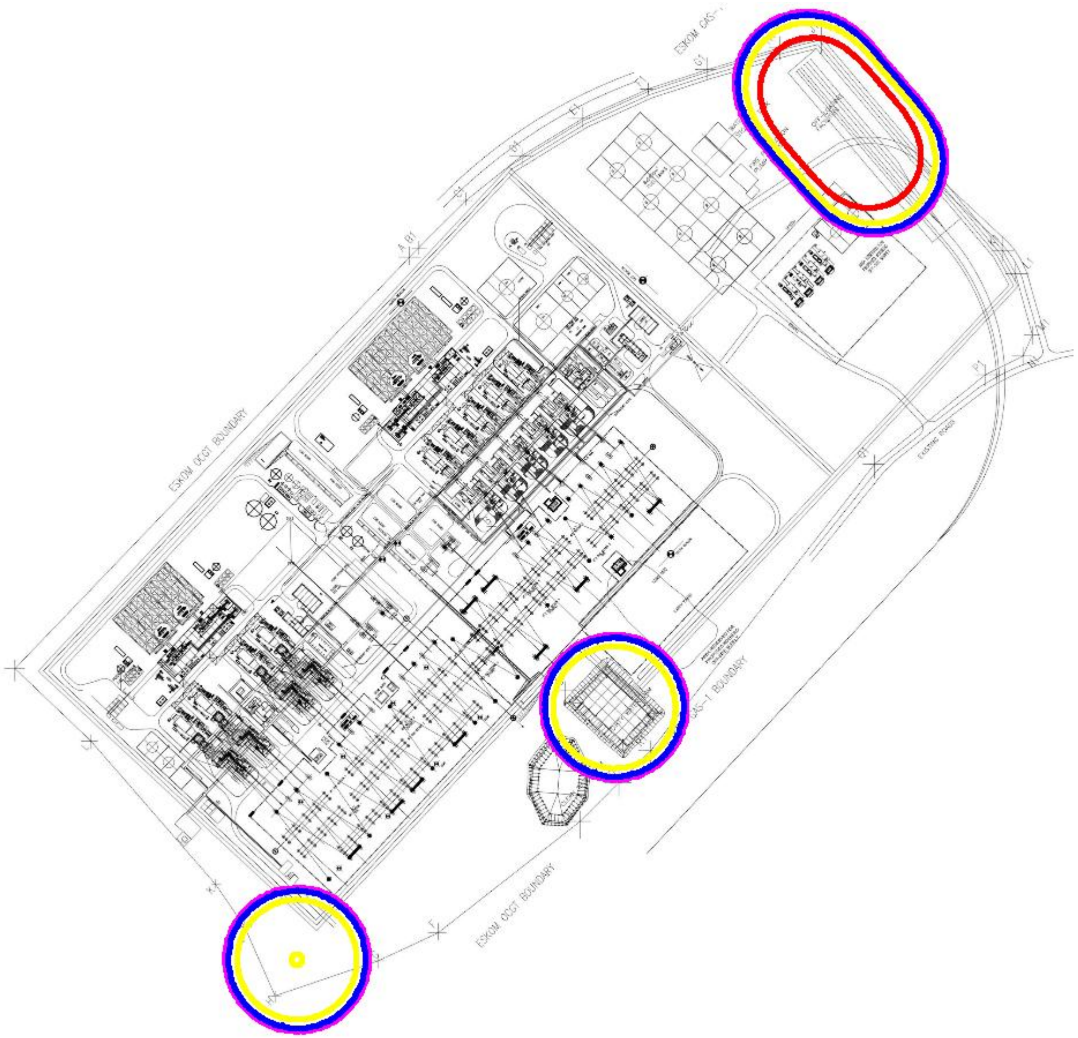


Figure 6-2 Risk profile for all fully developed pool fires



LEGEND	RISK Fatalities/person /year
red	$1x10^{-4}$
yellow	$1x10^{-5}$
blue	$1x10^{-6}$
magenta	$3x10^{-7}$

Figure 6-3 Risk profile for fully developed pool fires due to offloading fuel operations

6.2.2 Jet Fires

Jet fires do not have consequences beyond the boundary of the site and thus the risks are acceptable

6.2.3 Flash Fires

The only scenario that could result in a flammable cloud extending beyond the site boundary would be a catastrophic failure of the propane delivery tanker. Due to the small amount of time the propane delivery tanker spends on site, accompanied by the catastrophic failure rate of the tanker at 5×10^{-7} events per year, the risks of flash fires would be considered trivial.

6.3 Explosion Risk

A large propane gas release could drift into a congested that in contact with an ignition source could detonate the flammable mass. Explosions with offsite consequences require a large release of propane. The probability of a pressure vessel tank failure accompanied by a detonation would be less than 3×10^{-7} events per annum and would be considered acceptable.

Maintenance of pressure vessels is regulated and statutory testing is required to keep vessels in good operating condition. T hus the failure frequency used for pressure vessels in this report would be accurate providing the site is fully compliant to all statutory legislation relating pressure vessels and pressurised systems.

7 REDUCTION OF RISK

From the simulations performed, a number of events have risks sufficiently high to consider mitigation. Mitigation which could be considered to reduce this risk includes, but is not limited to the following:

7.1 Plant Layout

Layout and separation distances must be done with care to prevent injuries and damage due to accidental fires. The following codes should be used as the minimum specification in terms of plant layout, safety distances, secondary containment and related issues:

- SANS 10089 Part 1 (formally SABS 089-1) is specific to the storage of large volumes of petroleum products.
- SANS 10087 Part 3 (formally SABS 087-3) is specific to the storage of LPG products

These codes should be used as the minimum specification in terms of plant layout, safety distances, secondary containment and related issues.

7.2 Bund Height

The bund wall height of the diesel storage tanks is specified at exceeds 1.8 m. A bund wall height of over 1.8 m requires special requirements in accordance to the SANS 10089 Part 1, code as it contains additional hazards. It is recommended that the bund wall height be reviewed in light of the code or additional safety measures be introduced.

7.3 Process Hazard Analysis (PHA)

A detailed Process Hazard Analysis (PHA) such as a Hazop study should be completed prior to construction of the project, with all potential hazards identified, including fuel and any other substances, and sufficient mitigation suggested for safe operation.

7.4 Overfilling of Fuel Tanks

The prevention of potential overfilling of the fuel storage tanks should be addressed to meet acceptable levels of risk. This can be done with adequate instrumentation and/or operating procedures.

7.5 Rail Offloading

Large spillages need to be contained and if possible be directed away from the offloading vessels. Fire protection and fighting of the spilt diesel must be achievable at the location of the contained material. Secondary containment at a remote location may address these issues.

8 CONCLUSIONS

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

The risk assessment was done on the assumption that the site will be maintained to an acceptable level and that all-statuary regulations will be applied. It was also assumed that the detailed engineering designs will be performed by competent people and that the plant requirements will be correctly specified for the intended duty.

A number of incident scenarios were considered and the following conclusions were reached.

8.1 Pool Fires

Large bund fires and pool fires from spillages from road and rail offloading operations were calculated for the Ankerlig Power Station and the proposed CCGT conversion. The study concluded that Ankerlig Power station an the OCGT conversion could have impacts a short distance beyond the site boundary.

The risks from pool and bund fires of $1x10^{-6}$ fatalities per person, which is generally considered as tolerable, extended beyond the site's boundary and in some instances were excessive.

As the $1x10^{-4}$ fatalities per person per year lies a short distance over the boundary there is possibility to reduce risks to acceptable levels with engineering and administrative controls.

8.2 Jet fires

Jet fires from a release of pressurised propane would form a maximum flame length of 20.4 m. This flame would not extend beyond the site's boundary but could injure people and damage equipment within the flame.

8.3 Explosions

As a result in additional structures for the CCGT conversion, a large lease of propane could result in a partial confined explosion that could extend beyond the site's boundary. However the risks for offsite fatalities are considered acceptable.

8.4 Major Hazardous Installation

This investigation concluded that the CCGT conversion would have risk excessive of $1x10^{-6}$ fatalities per person per year at the site boundary and would classify the facility as a Major Hazardous Installation. While there is potential to reduce the impacts and risks, a quantitative risk assessment would be required in terms of the Major Hazardous Installation (MHI) Regulations (July 2001) prior to project construction. The risk assessment must be done with final designs and layouts. Exemption from completing a MHI risk assessment can not be done at this stage as designs are preliminary and subject to change.

9 RECOMMENDATIONS

As a result of the risk assessment study conducted for the fuel storage facility for the proposed OCGT conversion , the following recommendations are made:

9.1 Major Hazardous Installation Risk Assessment

As offsite consequences are possible, a quantitative risk assessment would be required in terms of the Major Hazardous Installation (MHI) Regulations (July 2001) prior to project construction. The risk assessment must be done by an Approved Inspection Authority, as recognised by the Department of Labour, with final designs and layouts.

9.2 Project Approval

Large petrochemical storage facilities have been installed around the world having acceptable risks. While consequences of the fuel storage facility may extend beyond the sites' boundaries, the risk can be engineered to within acceptable risks.

As a result of the risk assessment study conducted for the proposed CCGT conversion project, no fatal flaws were apparent that could prevent the project proceeding. It is thus recommended that the project proceed into the detailed phase of the design with the following provisions:

vii. Compliance to all statutory requirements e.g. Vessel Under Pressure Regulations etc.;

viii. Compliance with applicable SANS codes SANS 10087-3, SANS 10108. etc.;

ix. A recognised process hazard analysis (HAZOP, FMEA, etc) should be completed for the proposed plant prior to construction. This is to ensure design and operational hazards have been identified adequate mitigation put in place. It would be preferable if study could be facilitated by an independent party that can not benefit financially from offering services, equipment or instrumentation for the project;

x. A safety document detailing safety and design features reducing the impacts from fires, explosions and flammable atmospheres must be prepared and issued to the MHI assessment body at the time of the MHI assessment. The built facility can be audited against the safety document to ensure compliance with the EIA Terms of Reference. Codes such as IEC 61511 can be used to achieve these requirements. Eskom and their contractors must demonstrate that sufficient mitigation has been included in the designs to ensure the safety of the surrounding neighbours and the public.

xi. Emergency response documentation must be done with input from local authorities; and;

xii. A risk assessment in accordance to the prescribed Major Hazard Installation (MHI) Regulations must be conducted after completion of the final designs and layout, but prior to construction.

10 DEFINITIONS, ACRONYMS AND ABBREVIATIONS

AIA	**Approved inspection Authority** as defined in the Major Hazard Installation Regulations (July 2001)
Major Incident	**Major incident** means 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
Blast Pressure	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.
Major Hazard Installation	**Major Hazard Installation** means an installation- (a) where more than the prescribed quantity of any substance is or may be kept, whether permanently or temporarily; or (b) 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 will be determined by the risk assessment.
Explosion	A release of energy that causes a pressure discontinuity or blast wave.
Flammable Limits	The range of gas or vapour amounts that will burn or explode in air if a flame or other ignition source is present. The lower point of the range is called the **Lower Flammable Limit** and the upper point of the range is called the **Upper Flammable Limit.**
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 flash point of less than 55°C. Flammable products have been classified according to their flash points and boiling points, which ultimately determines the propensity to ignite. Separation distances described in the various codes are dependant on the flammability classification. Class Description 0 Liquefied Petroleum Gas IA Liquids that have a closed-cup flash point of below 23°C and boiling point below 35°C IB Liquids that have a closed-cup flash point of below 23°C and boiling point of 35°C or above IC Liquids that have a closed-cup flash point of 23°C or above, but below 38°C II Liquids that have a closed-cup flash point of 38°C or above, but below 60.5°C

	IIIA Liquids that have a closed-cup flash point of 60.5°C or above, but below 93°C IIIB Liquids that have a closed-cup flash point of 93°C or above
Frequency	The number of times an outcome is expected to occur in a given period of time.
Ignition source	Source of temperature and energy sufficient to initiate combustion.
Individual Risk	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
LOC	**Loss of Containment**
Local Government	**Local Government** means a local government as defined in section 1 of the Local Government Transition Act, 1993 (Act No. 209 of 1993)
Loss of Containment	The event resulting in a release of material into the atmosphere.
MIR	The Maximum Individual Risk see **Individual Risk**
Mitigation	Reduction of the effects of a hazardous event.
OHS Act	Occupational Health and Safety Act, 1993 (Act No. 85 of 1993)
QRA	See **Quantitative Risk Assessment**
Quantitative Risk Assessment	The process of hazard identification followed by a numerical evaluation of effects of incidents, and consequence and probabilities, and their combination into overall measure of risk.
Risk	A measure of the consequence of a hazard and the frequency with which it is likely to occur. Risk is expressed mathematically as: Risk = Consequence x Frequency of Occurrence
Risk Assessment	The **risk assessment** is the process of collecting, organising, analysing, interpreting, communicating and implementing information in order to identify the probable frequency, magnitude and nature of any major incident which could occur at a major hazard installation, and the measures required to remove, reduce or control the potential causes of such an incident.
Temporary Installation	**Temporary installation** means an installation that can travel independently between planned points of departure and arrival for the purpose of transporting any substance, and which is only deemed to be an installation at the points of departure and arrival, respectively;
Vapour Cloud Explosion	The explosion resulting from ignition of a pre-mixed cloud of a flammable vapour, gas or spray with air, in which flames accelerates to sufficiently high velocities to produce significant overpressure.
VCE	See **Vapour Cloud Explosion**

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12 APPENDIX A: NOTIFICATION OF PROPOSED MAJOR HAZARD INSTALLATION

Prior to the assessment of the potential impact of the various accidental spills, reference needs to be made to the legislation, regulations and guidelines governing the operation of the proposed development.

On 16 January 1998, the Major Hazard Installation Regulations was promulgated under the Occupational Health and Safety Act 1993 (Act No 85 of 1993), with a further amendment on 30 July 2001. The provisions of the regulations apply to installations, which have on their premises a quantity of a substance, which can pose a significant risk to the health, and safety of employees and the public.

The regulations essentially consists of six parts, namely

1. The duties for notification of a major hazard installation (existing or proposed), including
    a. Fixed (see Box A.1); and,
    b. Temporary installations.
2. The minimum requirements for a quantitative risk assessment (see Box A.2);
3. The requirements of an on-site emergency plan (see Box A.3);
4. The reporting steps of risk and emergency occurrences (see Box A.4);
5. The general duties required of suppliers; and,
6. The general duties required of local government.

BOX A.1 - NOTIFICATION OF INSTALLATION

Applications need to be made in writing to the relevant local authority and the provincial director for permission:

- To erect any major hazard installation.
- Prior to the modification of any existing installation, which may significantly increase the risk, related to it (e.g. increased storage or production capacity or alteration of process).

Applications need to include the following information:

- Physical address of installation;
- Complete material safety data sheets of all hazardous substances;
- Maximum quantity of each substance envisaged to be on the premises at any one time;
- The risk assessment of the installation (see Box A.2); and,
- Any further information that may be deemed necessary by an inspector in the interests of health and safety to the public.

Applications need to be advertised in at least one newspaper serving the surrounding communities, and by way of notices posted within these communities.

BOX A.2 - THE RISK ASSESSMENT

- The risk assessment is the process of collecting, organising, analysing, interpreting, communicating and implementing information in order to identify the probable frequency, magnitude and nature of any major incident which could occur at a major hazard installation, and the measures required to remove, reduce or control the potential causes of such an incident.
- Risk assessments need to be undertaken at intervals not exceeding five years and need to be submitted to the relevant local emergency services.
- Copies of the risk assessment must be made available to the relevant health and safety committee, and give them 60 days within which to comment thereon and ensure that the results of the assessment be made available to the relevant representative or committee who may comment thereon.
- Risk assessments should be undertaken by competent person(s) and include the following:
  - General process description;
  - Description of major incidents associated with this type of installation and the consequences of such incidents (including potential incidents);
  - Estimate of the probability of a major incident;
  - The on site emergency plan;
  - Estimate the total result in the case of an explosion;
  - Estimate of the effects of thermal radiation in the case of fire;
  - Estimate concentration effects in the case of a toxic release;
  - Potential effect of a major incident at one major hazard installation on an adjacent major hazard installation or part thereof;
  - Potential effect of a major incident on any other installation, members of the public (including all persons outside the premises) and on residential areas;
  - Meteorological tendencies;
  - Suitability of existing emergency procedures for the risks identified;
  - Any requirements laid down in terms of the Environmental Conservation Act, 1989 (Act No. 73 of 1989); and,
  - Any organisational measures that may be required.
- The employer shall ensure that the risk assessment is of an acceptable standard and is reviewed should:
  - It be suspected that the preceding assessment is no longer valid;
  - Changes in the process affect hazardous substances;
  - Changes in the process involve a substance resulting in the installation being classified a major hazardous installation or in the methods, equipment or procedures in the sue, handling or processing of that substance; or,
  - Incidents that have brought the emergency plan into operation may affect the existing risk assessment.
- Risks assessment must be made available for scrutiny by any interested or affected person that may be affected by the activities, at a time, place and in a manner agreed upon between the parties.

BOX A.3 – ON-SITE EMERGENCY PLAN

After submission of the notification, the following shall be established:

- An on-site emergency plan must be available which is to be followed inside the premises of the installation or part of the installation classified as a major hazard installation in consultation with the relevant health and safety representative or the relevant health and safety committee.
- The emergency plan must be discussed with the relevant local government taking into consideration any comment on the risk related to the health and safety of the public.

The on-site emergency plan has to be reviewed and, where necessary, update the plan, in consultation with the relevant local government, at least once every three years.

- A copy of the on-site emergency plan shall be signed in the presence of two witnesses, who shall attest the signature.
- Ensure that the on-site emergency plan is readily available at all times for implementation and use.
- Ensure that all employees are conversant with the on-site emergency plan.

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

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

BOX A.4 – Reporting of Risk and Emergency Occurrences

Following and emergency occurrence, the user of the installation shall:

- Subject to the provisions of regulation 6 of the General Administrative Regulations, within 48 hours by means of telephone, facsimile or similar means of communication inform the chief inspector, the provincial director and relevant local government of the occurrence of a major incident or an incident that brought the emergency plan into operation or any near miss.
- Submit a report in writing to the chief inspector, provincial director and local government within seven days.
- Investigate and record all near misses in a register kept on the premises, which shall at all times be available for inspection by an inspector and the local government.

The duties of the supplier refer specifically to

- The supply of material safety data sheets for the hazardous substances employed or contemplated in the installation;

- Assess the circumstances and substance involved in an incident or potential incident and inform all persons being supplied with that substance, of the potential dangers surrounding it; and,
- Provide a service that shall be readily available on a 24-hour basis to all employers, self-employed persons and users, the relevant local government and any other body concerned, to provide information and advice in the case of a major incident with regard to the substance supplied.

The duties of local government are summarised as follows:

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

(a) Airports;

(b) Neighbouring independent major hazard installations;

(c) Housing and other centres of population; or

(d) Any other similar facility:

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

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

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

13 APPENDIX B: PHYSICAL PROPERTIES

A summary of physical properties of diesel, as used in this study, is shown below in Table 13-1.

Table 13-1 Typical physical properties of diesel

Property	Units	Diesel
Molecular weight	g/mole	224
Normal Boiling pt	°C	~290
Melting/Freezing pt	°C	-46
Critical Temperature	°C	758
Critical Pressure	kPa	1 953.4
Specific Heat (liq) @ 20 °C	kJ/kg °K	1.80
Vapour Density @101 kPa & 20°C	kg/m3	~4(Air=1)
Liquid Density @ 20°C	kg/m3	810
Vapour Pressure @ 20°C	kPa	0.007
Heat of Vaporisation	kJ/kg	890
Heat of Combustion	kJ/kg	45000
Flash Point (min)	°C	55
Auto-ignition temperature	°C	337.68
Flammable Range	%	0.6– 6.8
Remarks		

Table 13-2 Physical properties for propane

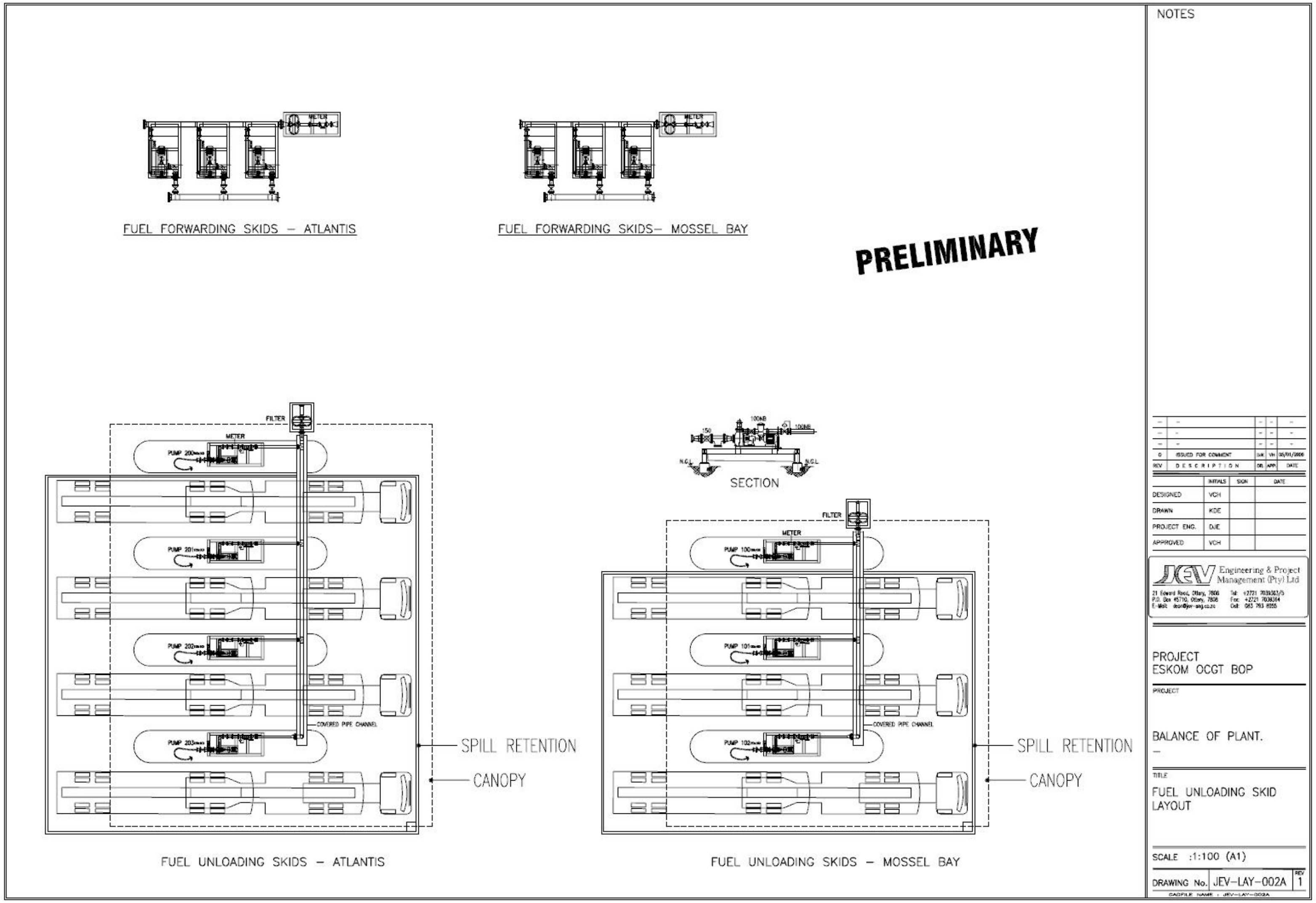
Parameter	Units	PROPANE
Molecular Weight	g/mol	44.1
Normal Boiling Point	K	231.1
Melting Point	K	85.5
Critical Temperature	K	369.8
Critical Pressure	Pa	4248000.0
Heat Capacity : Vapour	J/kg K	1612.0
: Liquid	J/kg K	2581.0
Density : Vapour (STP)	(kg/m^3)	1.86
: Liquid	(kg/m^3)	582.0
Thermal Conductivity : Liquid	W/m K	0.0100
Vapour Pressure @ 20 ^{o}C	kPa	831.4
Antoine Coefficients : A	Pa	20.6
: B	K	1872.5
: C	K	-25.2
Heat of Vapourisation	kJ/kg	348.0
Heat of Combustion	kJ/kg	46332.7
Explosion Limits in Air – Lower	% vol	2.0
– Upper	% vol	9.5

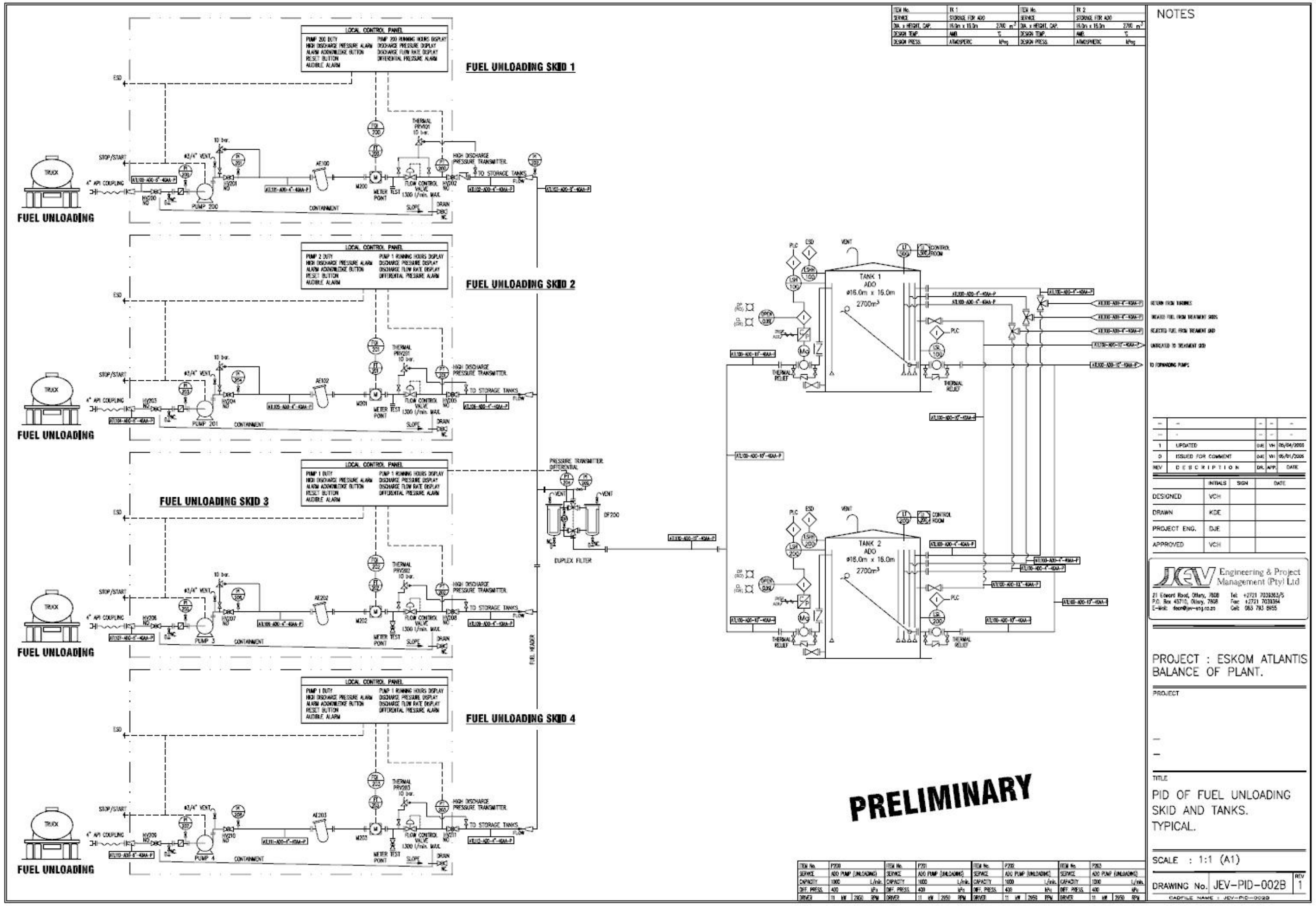
14 APPENDIX C: BACKGROUND INFORMATION DIAGRAMS

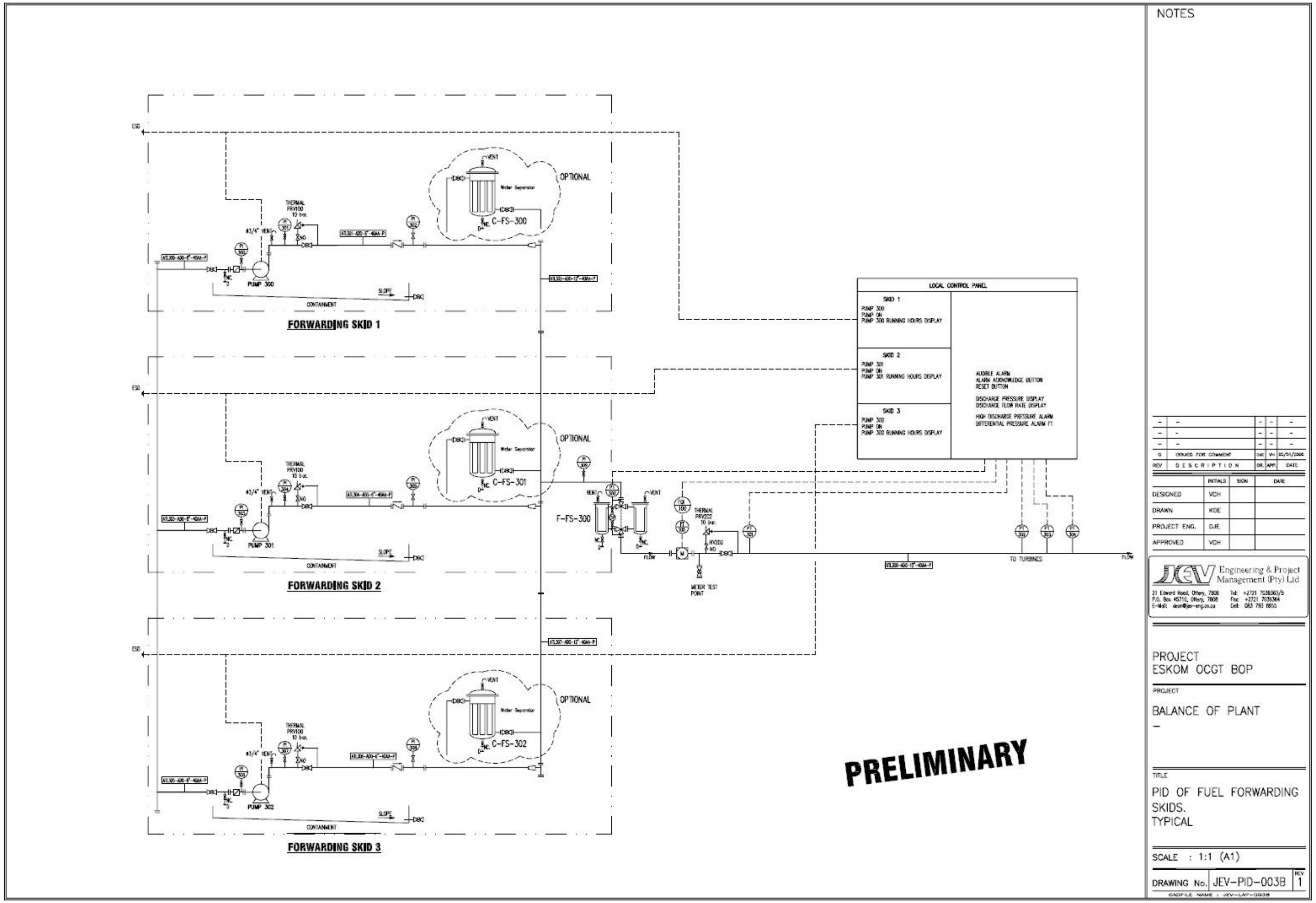
14.1 Piping and Instrument Diagrams

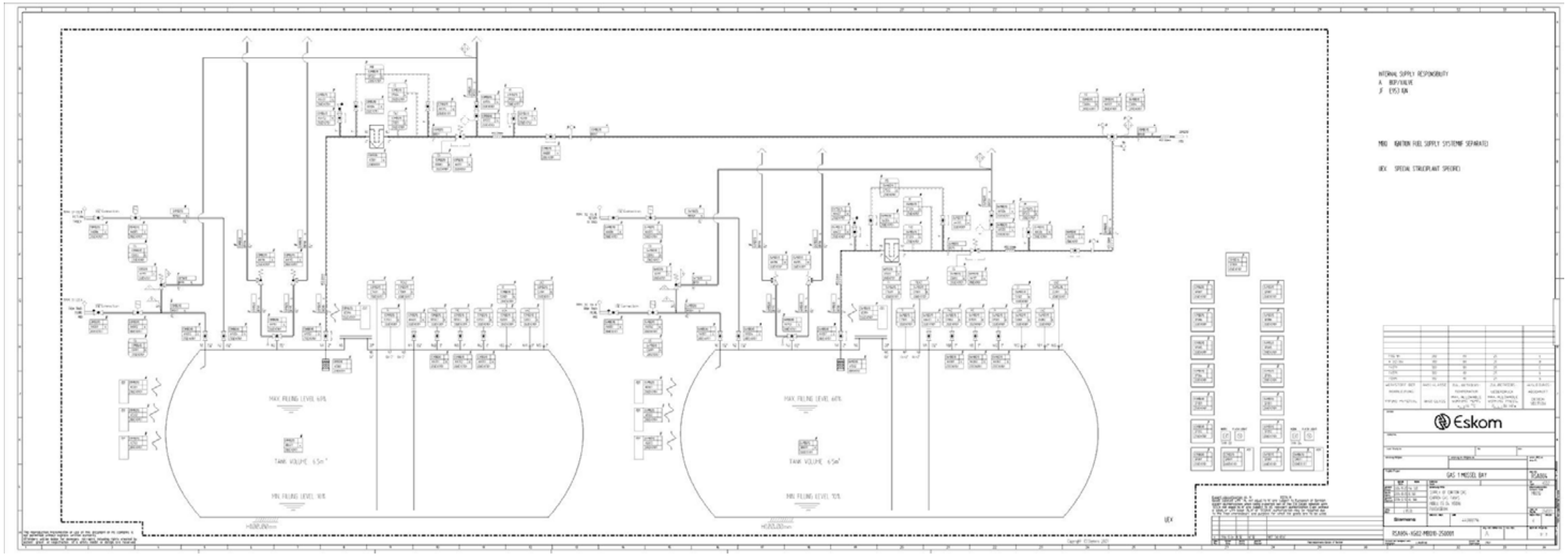
The following drawings are attached.

Drawing No	Title	Rev /Date
JEV-LAY-002A	Fuel Unloading Skid Layout	1
JEV-PID-002B	PID of Fuel Unloading Skid & Tanks Typical	1
JEV-PID-003B	PID of Fuel Forwarding Skids Typical	1
RSA804-XG02-MBQ10-250001	Supply of Ignition Gas Ignition Gas Tanks MODUL 03 04 MBQ10 P&I Diagram	A


NOTES
FUEL FORWARDING SKIDS – ATLANTIS
FUEL FORWARDING SKIDS– MOSSEL BAY
PRELIMINARY
SECTION
FILTER
METER
SPILL RETENTION
CANOPY
COVERED PIPE CHANNEL
FUEL UNLOADING SKIDS – ATLANTIS
FUEL UNLOADING SKIDS – MOSSEL BAY
DESIGNED VCH
DRAWN KDE
PROJECT ENG. DJE
APPROVED VCH
Engineering & Project Management (Pty) Ltd
PROJECT
ESKOM OCGT BOP
BALANCE OF PLANT.
TITLE
FUEL UNLOADING SKID LAYOUT
SCALE :1:100 (A1)
DRAWING No. JEV–LAY–002A
REV 1


NOTES
FUEL UNLOADING SKID 1
FUEL UNLOADING SKID 2
FUEL UNLOADING SKID 3
FUEL UNLOADING SKID 4
FUEL UNLOADING
FUEL UNLOADING
FUEL UNLOADING
FUEL UNLOADING
LOCAL CONTROL PANEL
TANK 1
ADO
TANK 2
ADO
DUPLEX FILTER
PRELIMINARY
PROJECT : ESKOM ATLANTIS BALANCE OF PLANT.
PID OF FUEL UNLOADING SKID AND TANKS. TYPICAL.
SCALE : 1:1 (A1)
DRAWING No. JEV-PID-002B
Engineering & Project Management (Pty) Ltd

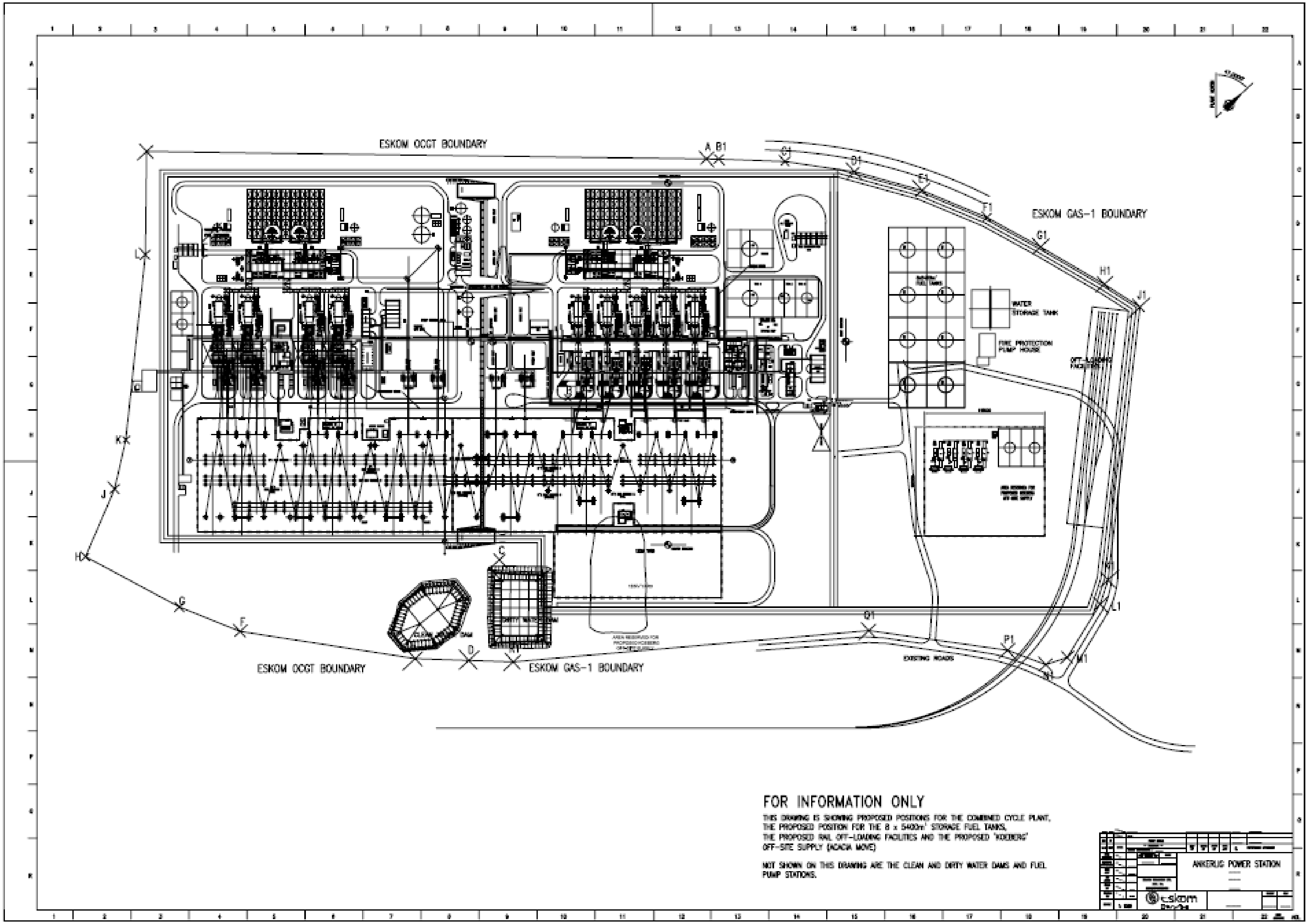

NOTES
OPTIONAL
C-FS-300
C-FS-301
C-FS-302
F-FS-300
PUMP 300
PUMP 301
PUMP 302
FORWARDING SKID 1
FORWARDING SKID 2
FORWARDING SKID 3
LOCAL CONTROL PANEL
TO TURBINES
PRELIMINARY
DESIGNED VCH
DRAWN KOE
PROJECT ENG. DJE
APPROVED VCH
Engineering & Project Management (Pty) Ltd
PROJECT
ESKOM OCGT BOP
BALANCE OF PLANT
TITLE
PID OF FUEL FORWARDING SKIDS. TYPICAL
SCALE : 1:1 (A1)
DRAWING No. JEV-PID-003B
1



14.2 Plot Plan of the Ankerlig Power Station and CCGT Conversion Project

The following drawing is attached.

Drawing No	Title	Rev / Date
Unknown	Ankerlig Power Station	Unknown


ESKOM OCGT BOUNDARY
ESKOM GAS-1 BOUNDARY
WATER STORAGE TANK
FIRE PROTECTION PUMP HOUSE
EXISTING ROADS
ESKOM OCGT BOUNDARY
ESKOM GAS-1 BOUNDARY
FOR INFORMATION ONLY
THIS DRAWING IS SHOWING PROPOSED POSITIONS FOR THE COMBINED CYCLE PLANT,
THE PROPOSED POSITION FOR THE 8 x 5400m³ STORAGE FUEL TANKS,
THE PROPOSED RAIL OFF-LOADING FACILITIES AND THE PROPOSED 'KOEBERG'
OFF-SITE SUPPLY (ACACIA MOVE)
NOT SHOWN ON THIS DRAWING ARE THE CLEAN AND DIRTY WATER DAMS AND FUEL
PUMP STATIONS.
ANKERLIG POWER STATION

15 APPENDIX D: INCIDENT SCENARII

15.1 Bund Fires (diesel)

Tank	Scenario	Component	Failure frequency / y	Total Amount (kg)	Area of Release (m^2)
1	Vessel Failure	Diesel	3.25E-08	2296536	900
2	Vessel Failure	Diesel	3.25E-08	2296536	900
11	Vessel Failure	Diesel	3.25E-08	4655086	3224
12	Vessel Failure	Diesel	3.25E-08	2296536	1612
13	Vessel Failure	Diesel	3.25E-08	2296536	1612
101	Vessel Failure	Diesel	3.25E-08	4655086	3224
102	Vessel Failure	Diesel	3.25E-08	4655086	3224
103	Vessel Failure	Diesel	3.25E-08	4655086	3224
104	Vessel Failure	Diesel	3.25E-08	4655086	3224
105	Vessel Failure	Diesel	3.25E-08	4655086	3224
106	Vessel Failure	Diesel	3.25E-08	4655086	3224
107	Vessel Failure	Diesel	3.25E-08	4655086	3224
108	Vessel Failure	Diesel	3.25E-08	4655086	3224
1	Overfill	Diesel	1.35E-07	14400	900
2	Overfill	Diesel	1.35E-07	14400	900
11	Overfill	Diesel	1.35E-07	14400	3224
12	Overfill	Diesel	1.35E-07	14400	1612
13	Overfill	Diesel	1.35E-07	14400	1612
101	Overfill	Diesel	1.35E-07	14400	3224
102	Overfill	Diesel	1.35E-07	14400	3224
103	Overfill	Diesel	1.35E-07	14400	3224
104	Overfill	Diesel	1.35E-07	14400	3224
105	Overfill	Diesel	1.35E-07	14400	3224
106	Overfill	Diesel	1.35E-07	14400	3224
107	Overfill	Diesel	1.35E-07	14400	3224
108	Overfill	Diesel	1.35E-07	14400	3224
1	Valve & Pipework failure	Diesel	4.00E-06	2296536	900
2	Valve & Pipework failure	Diesel	4.00E-06	2296536	900
11	Valve & Pipework failure	Diesel	4.00E-06	4655086	3224
12	Valve & Pipework failure	Diesel	4.00E-06	2296536	1612
13	Valve & Pipework failure	Diesel	4.00E-06	2296536	1612
101	Valve & Pipework failure	Diesel	4.00E-06	4655086	3224
102	Valve & Pipework failure	Diesel	4.00E-06	4655086	3224
103	Valve & Pipework failure	Diesel	4.00E-06	4655086	3224
104	Valve & Pipework failure	Diesel	4.00E-06	4655086	3224
105	Valve & Pipework failure	Diesel	4.00E-06	4655086	3224
106	Valve & Pipework failure	Diesel	4.00E-06	4655086	3224
107	Valve & Pipework failure	Diesel	4.00E-06	4655086	3224
108	Valve & Pipework failure	Diesel	4.00E-06	4655086	3224

15.2 Pool Fire -Road Offloading

Scenario	Risk Type (with Ignition source	Release Rate (kg/s)	Duration of Release Min	Inventory released (kg)	Probability of uncontrolled Fire/ year	Pool size (m2)
Instantaneous Release	Pool Fire	27.0	10	16200	3.25E-07	3750
Continuous Release	Pool Fire	9.0	30	16200	1.63E-08	3750
Unloading Hose Full Bore Rupture	Pool Fire	7.8	30	16200	1.14E-03	3750
Unloading Hose Leak	Pool Fire	0.0	30	52.35	1.14E-02	3.877767
External Impact (Entire contents in 30 minutes)	Pool Fire	9.0	30	16200	1.77E-06	3750

15.3 Pool Fire -Rail Offloading

Scenario	Risk Type (with Ignition source	Release Rate (kg/s)	Duration of Release Min	Inventory released (kg)	Probability of uncontrolled Fire/ year	Pool size (m2)
Instantaneous Release	Pool Fire	94.5	10	56700	3.34E-07	3750
Continuous Release	Pool Fire	13.5	30	24298.64	1.67E-08	3750
Unloading Hose Full Bore Rupture	Pool Fire	11.7	30	24299	1.17E-03	3750
Unloading Hose Leak	Pool Fire	0.0	30	52.35	1.17E-02	3.877767
External Impact (Entire contents in 30 minutes)	Pool Fire	31.5	30	56700	1.82E-06	3750

15.4 Propane Pool Fires

Scenario	Risk Type (with Ignition source	Release Rate (kg/s)	Duration of Release Min	Inventory released (kg)	Probability of uncontrolled Fire/ year	Pool size (m^2)
PROPANE VESSEL						
Instantaneous Release	Pool Fire	3.6	10	2138.731	3.50E-07	368.7
Continuous Release (10 mm Hole)	Pool Fire	0.857	30	1543.423	3.50E-07	266.1
Valve Failure (liquid)	Pool Fire	5.4	6.65	2138.731	2.10E-04	368.7
Overfill	Pool Fire	3.6	5	1090.34	1.27E-07	188.0
OFF-LOADING TANKER						
Instantaneous Release		10.9	10	6542.022	4.79E-09	1127.9
Continuous Release (10 mm Hole)	Pool Fire	0.9	30	1543.42	2.40E-10	266.1
Offloading Hose Full Bore Rupture	Pool Fire	5.4	30.00	9646.40	1.92E-09	1200.0
Offloading Hose Leak (10% of pipe area)	Pool Fire	0.5	30	964.64	1.92E-08	166.3
External Impact (Entire contents in 30 minutes)	Pool Fire	3.6	30	6542.022	5.21E-08	1127.9