PRELIMINARY HAZARD ANALYSIS OF

IPRA'S PROPOSED PEAKING POWER

PLANT AT BURONGA, NSW

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Preliminary Hazard Analysis of IPRA's Proposed Peaking Power Plant at Buronga, NSW

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EXECUTIVE SUMMARY

E1 Introduction

Over the past four years, the National Electricity Market (NEM) operator (NEMMCO) has highlighted the growth of electricity demand across NSW and, in particular, the growth of summer and winter peak demands. In its "*Statement of Opportunities 2006*" NEMMCO predicted an annual NSW peak demand growth of 2.1 - 3.2% (summer load) and 1.4 - 2.7% (winter load). This is reasonably consistent with its most recent "*Statement of Opportunities 2007*" (SOO 2007) released on 31 October 2007 which predicts[1] an annual NSW peak demand growth of 2.3 – 2.8% (summer) and 1.5 - 2.8% (winter). Growth of this order not only requires additional peaking generation capacity to meet demand but places existing high voltage transmission assets at risk in reliably delivering power to the relevant load centres. In particular, the NEMMCO "*Statement of Opportunities 2006*" highlights a shortfall[2] in reserve peaking capacity of some 287MW.

The Buronga Peaking Power Plant Project is consistent with NSW Government policy[3], which is to promote private sector investment in new electricity generation assets.

The Buronga Peaking Power Plant Project is also, in part, a response to a number of reports issued since 2002 by TransGrid entitled "Supply to South West New South Wales". These reports highlighted electricity transmission system and sub-system constraints within this region which impact upon the ability to supply the total load in the area west of Yass. Further to this, the TransGrid Buronga node plays a key interconnection role in the NSW/South Australia/Victoria interconnected HV grid system and management of both the south west NSW system and the attendant National Electricity Market operation can become problematic under certain system load profiles and transient conditions. The Buronga Peaking Power Plant (providing up to 150MW, pending final plant selection) is proposed by International Power (Australia) Pty Ltd (IPRA) as a generation solution to ensure continuing regional and inter-regional electricity supply and transmission support.

The objective of this Preliminary Risk Assessment (PHA) is to present the hazards and risks associated with the proposed peaking power plant. Through the evaluation of likelihood and consequence of the major hazards, the risks to the community associated with proposed peaking power plant may be estimated and compared to Department of Planning risk criteria.

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[1] NEMMCO *Statement Of Opportunities 2007* - Tables 3.10 & 3.11

[2] NEMMCO *Statement Of Opportunities 2006* - Table 2-2

[3] NSW Government Energy Directions Green Paper (December 2004)

The aim of the PHA is to:

- Identify and analyse the acute hazards and risks associated with all processes involved with the handling and transporting of potentially hazardous material which form part of the new development;
- Assess the findings against the risk criteria currently in use by NSW Department of Planning;
- Identify opportunities for risk reduction, and make recommendations as appropriate.

The risk assessment has quantitatively determined the risk of fatality and injury to the public associated with the handling and processing of potentially hazardous material at the proposed development.

The report assesses the risks from the following facility:

- The peaking power plant; and
- Transport of potentially hazardous material (such as fuel) to the facility.

The methodology for the PHA is well established in NSW. The assessment has been carried out as per the Hazardous Industry Advisory Paper (HIPAP) No 4, Risk Criteria for Land Use Planning and in accordance with HIPAP No 6, Guidelines for Hazard Analysis. These documents describe the methodology and the criteria to be used in PHAs as currently required by the NSW Department of Planning for major *potentially hazardous* development.

The risk assessment technique involves the following general steps:

- Identification of the hazards associated with the proposed project, including those which may potentially injure people off-site or damage the off-site environment;
- Identification of the proposed safeguards to mitigate the likelihood and consequences of the hazardous events;
- Estimation of the magnitude of the consequences of these incidents;
- Where the consequences may affect the land uses outside the site boundary, estimation of the probability with which these incidents may occur;
- Estimation of the risk by combining the frequency of the event occurring with the probability of an undesired consequence;
- Comparison of the risk estimated with the guidelines and criteria relevant to the proposal.

E2 Results

The main hazard associated with the proposed project is associated with the handling of the distillate, a combustible fuel (with high flash point) used to power the gas turbines.

Hazards may arise in fixed plant, storage, and pipelines. The failure modes assessed in the PHA derived from historical failures of similar facilities and equipment. For the facilities which form part of the development, the predominant mode in which a hazardous incident may be generated is associated with a leak. This would generally only have the potential to cause injury or damage if there was ignition, which resulted in a fire incident. The factors involved are:

- Failure must occur causing a release. There are several possible causes of failure, with the main ones being corrosion and damage to the equipment by external agencies;
- The released material must come into contact with a source of ignition. In some cases this may be heat or sparks generated by mechanical damage while in others, the possible ignition source could include non-flame proof equipment, vehicles, or flames some distance from the release. In the case of distillate, the probability of ignition is very low given the high flash point of the material (about 65^{o}C), indicating that the source of ignition must be very energetic and that the material would need to have been heated prior to the incident for ignition to occur;
- In case of ignition, the result of ignition of distillate would be a pool fire. The size of the pool fire depends on the release conditions, including the mass of material involved and how rapidly it is ignited.
- Finally, for there to be a risk, people must be present within the harmful range (consequence distance) of the fire. How close the people are will determine whether any injuries or fatalities result.

E3 Risk Assessment Conclusions

The qualitative and quantitative analysis showed that:

- The risk of fatality at the nearest residential area is well below the criterion for new installations of one chance in a million per year (1 x 10^{-6}/yr) and remains within the site boundary. The criterion for residential zoning is therefore satisfied.
- It follows that the 10 x 10^{-6} per year fatality risk contour (relevant for open spaces) remains well within the site boundaries and does not encroach into any open spaces. The criterion for open spaces is therefore satisfied.
- It also follows that the 50 x 10^{-6} per year fatality risk contour (relevant for industry and business) remains well within the site boundaries and does not encroach into any business or industrial zones. The criterion for industrial and business zoning is therefore satisfied.

As the risk of fatality does not extend anywhere outside the plant boundaries, it is considered that the proposed development does not have a significant impact on societal risk.

The risk associated with the transport of dangerous goods and potentially hazardous material to the site is very low.

E4 Recommendations

The risk assessment carried out in this study assumed that the facility will be operated with appropriate consideration to safety and safety management at all stages.

The following recommendations emphasise the assumptions made in this risk assessment. The recommendations are listed in the order in which they were listed in the study.

Recommendation 1: It is recommended that an assessment / audit is carried out of the safety management system implemented and used at the site, specifically as it applies to the proposed hazardous materials handling, fuel reticulation and storages within the first year of operation.

Recommendation 2: A system should be put in place to ensure that any removal of critical safety function (e.g. for repair or exchange) is subject to careful scrutiny by plant management (decisions on whether to shut down plant or a gas turbine if a critical safety function is removed need to be canvassed).

GLOSSARY

HAZID	Hazard Identification
HIPAP	Hazardous Industry Planning Advisory Paper
IBC	Intermediate Bulk Container
IPRA	International Power (Australia) Pty Ltd
MSDS	Material Safety Data Sheet
MW	Mega Watt (unit for energy output)
OH&S	Occupational Health and Safety
PHA	Preliminary Hazard Analysis
SCADA	Supervisory Control and Data Acquisition

REPORT

1 INTRODUCTION

1.1 BACKGROUND

Over the past four years, the National Electricity Market (NEM) operator (NEMMCO) has highlighted the growth of electricity demand across NSW and, in particular, the growth of summer and winter peak demands. In particular, the NEMMCO "*Statement of Opportunities 2006*" highlights a shortfall[4] in reserve peaking capacity of some 287MW.

The Buronga Peaking Power Plant Project is consistent with NSW Government policy[5], which is to promote private sector investment in new electricity generation assets.

The Buronga Peaking Power Plant Project is also, in part, a response to a number of reports issued since 2002 by TransGrid entitled "Supply to South West New South Wales". These reports highlighted electricity transmission system and sub-system constraints within this region which impact upon the ability to supply the total load in the area west of Yass. Further to this, the TransGrid Buronga node plays a key interconnection role in the NSW/South Australia/Victoria interconnected HV grid system and management of both the south west NSW system and the attendant National Electricity Market operation can become problematic under certain system load profiles and transient conditions. The Buronga Peaking Power Plant (providing up to 150MW, pending final plant selection) is proposed by International Power (Australia) Pty Ltd (IPRA) as a generation solution to ensure continuing regional and inter-regional electricity supply and transmission support.

In response to this situation, IPRA is proposing to build and operate a peaking power plant and associated infrastructure at a site located approximately 10km northeast of Buronga in the southwest of NSW.

As one element of the planning approval process, the NSW Department of Planning requires a Preliminary Hazard Analysis (PHA) to be prepared in accordance with the requirements of Hazardous Industry Planning Advisory Paper (HIPAP) No. 6: *Guidelines for Hazard Analysis* (Ref 1) and for the risk to be evaluated and compared with their risk criteria, as specified in their HIPAP No. 4: *Risk Criteria for Landuse Planning* (Ref 2).

This document forms an appendix to the Environmental Assessment and provides details of the PHA undertaken for the proposed Buronga Peaking Power Plant.

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[4] NEMMCO *Statement Of Opportunities 2006* - Table 2-2

[5] NSW Government Energy Directions Green Paper (December 2004)

1.2 SCOPE AND AIM OF STUDY

The objective of this PHA is to present the hazards and risks associated with the proposed Buronga Peaking Power Plant. Through the evaluation of likelihood and consequence of the major hazards, the risks to the community associated with proposed facility may be estimated and compared to Department of Planning risk criteria.

The scope of this report includes the following:

- Systematic identification and documentation of the major hazards, based on the information supplied and relevant experience with similar processes;

- Establishment of the consequence of each identified hazard and determination as to their offsite effects. This process is generally qualitative, with relevant quantitative calculations/modelling being completed where necessary;

- Where offsite effects are identified, the frequency of occurrence is estimated based on historical data. If such data is unavailable, assumptions and qualitative discussions are presented;

- Determination of the acceptability (or otherwise) of the risk by comparison of the qualitative or quantitative assessment of the identified risks with the criteria specified in the NSW Department of Planning HIPAP No. 4 (Ref 2); and

- Identification of risk reduction measures as deemed necessary.

This PHA is based on the design information presented within **Chapter 4 Project Description** of the Environmental Assessment. At the time of writing this PHA, final detailed plant specifications were not confirmed. In situations where such design information could impact on the PHA, assumptions have been made. These assumptions are intentionally conservative and have been stated in the report.

As a result of this conservatism, the results of the PHA are also inherently conservative, and this should be noted in their interpretation and application beyond the scope of this work.

2 SITE AND PROCESS DESCRIPTION

2.1 SITE LOCATION AND SURROUNDING LAND USES

The plant would be located on Crown land immediately adjacent to the TransGrid 220kV switching station, approximately 10km northeast of Buronga, on Arumpo Road. This location best facilitates regional connection into the national electricity grid. IPRA has secured land lease Option arrangements with the leaseholder of this pastoral land which is controlled by the Western Lands Commissioner.

The closest residence is located on Arumpo Road approximately 3km to the southwest and the town of Buronga is some 10km southwest of the proposed site.

Figure 1 – Site Location

2.2 PEAKING POWER PLANT OPERATION

The facility will operate as a peaking power plant with a nominal capacity of up to 150MW pending final plant selection.

Three distillate-fired gas turbines, each up to 50MW nominal capacity, would be installed. The gas turbines would be of proven technology, comprising small compact generators inside soundproof enclosures.

These units would be capable of being operated individually or in conjunction, providing a high level of reliability of power generation for the region, expected to be in the order of 99% on an annual basis.

Except for emergencies as allowed in its operating licence, the Buronga Peaking Power Plant would operate in open cycle mode during times of peak electricity demand on an as-required, intermittent basis for a total maximum period of up to 10% of any year.

The operating regime for the facility in the short to mid term is anticipated to be:

- Typical average operating hours per gas turbine per annum = 600 hrs
- Total typical average generation per annum = 75 GWh
- Typical maximum generation in any single year = 115 GWh
- Typical average fuel consumption of 19,000 tonnes per annum, (with up to 1,500 tonnes of distillate on site at any one time).

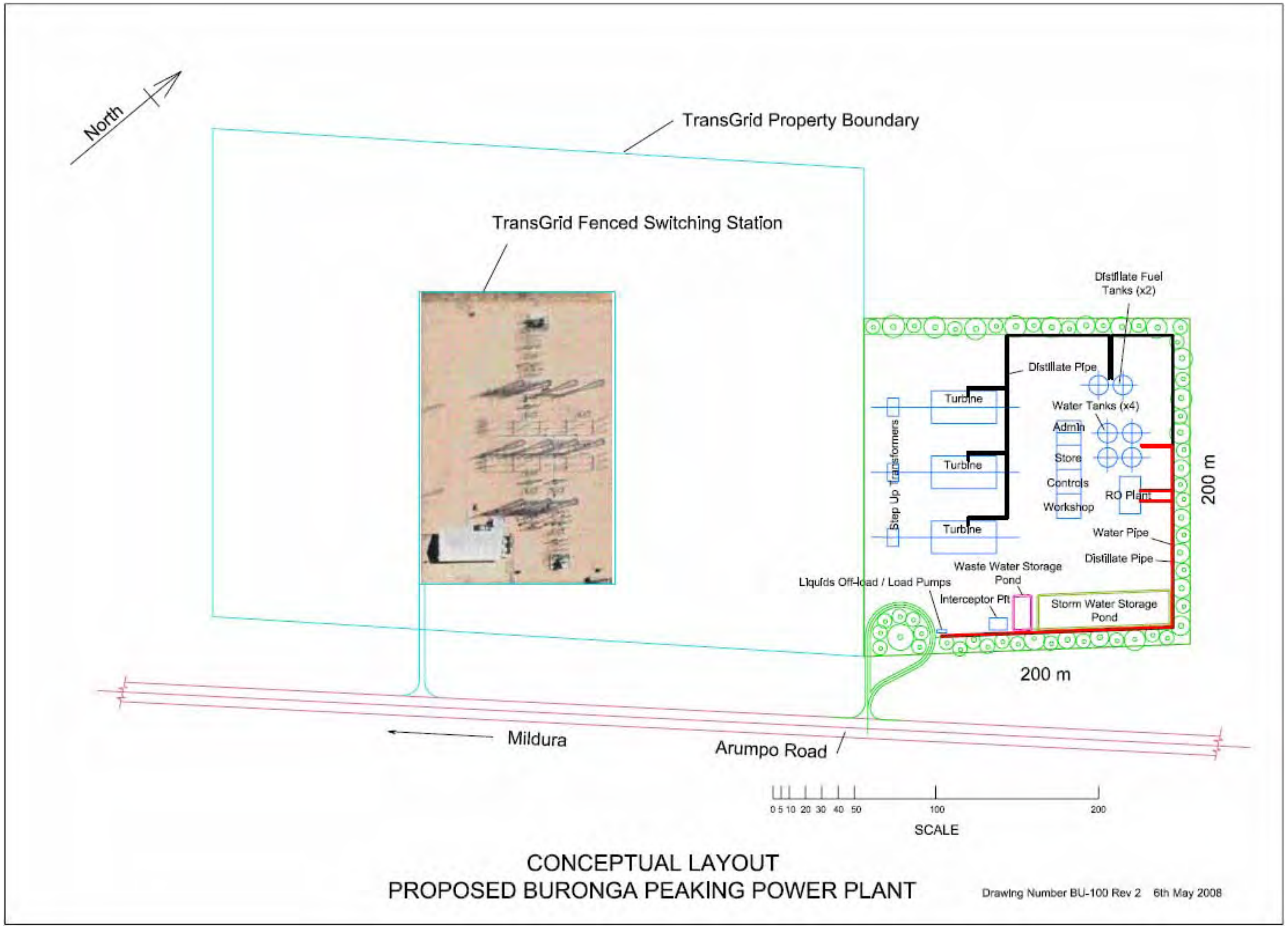
2.3 SITE LAYOUT

The preliminary site layout is presented in **Figure 2** below, and shows the liquids off-load area to the south of the site, the location of the distillate fuel tanks to the north of the site and the three gas turbines located at the centre of the site. The site entrance is at the south of the site.

Following completion of construction and commissioning, the major site features will include:

- Three gas turbines each comprising compressor, combustor, power turbine and electricity generator, all inside acoustic enclosures;
- Three generator transformers ("step-up transformers");
- Three inlet air filter houses and three exhaust stacks;
- Buildings for control room, admin area, store and workshop;
- A liquids unloading area (including offload and lay-by area);
- Pipelines for distillate and water connecting the liquids unloading area with the respective storage tanks, and connecting the storage tanks with their respective points of use;
- Distillate storage tanks located inside a bund, and associated piping and equipment;
- Demineralised and fire water storage tanks with associated pump(s);
- A water treatment plant with reverse osmosis (RO) capability and associated equipment and minor chemicals storage;
- An interceptor pit to collect spills together with stormwater storage and wastewater storage ponds;
- Service connections to the electricity network; and
- Service roads.

Figure 2 – Conceptual Site Layout



2.4 OPERATING HOURS AND STAFFING

The proposed Buronga Peaking Power Plant would be capable of operating for 24 hours per day. However, actual operational hours would be dependent upon periodic electricity demand and economic factors (and the peaking power plant would be designed for peaking demand only, generally operating at less than 10% of the time).

It is expected that the peaking power plant would be staffed during day-shift only. 24-hour monitoring of the site would be provided from the remote monitoring centre. Personnel could be called to the site at any time as required.

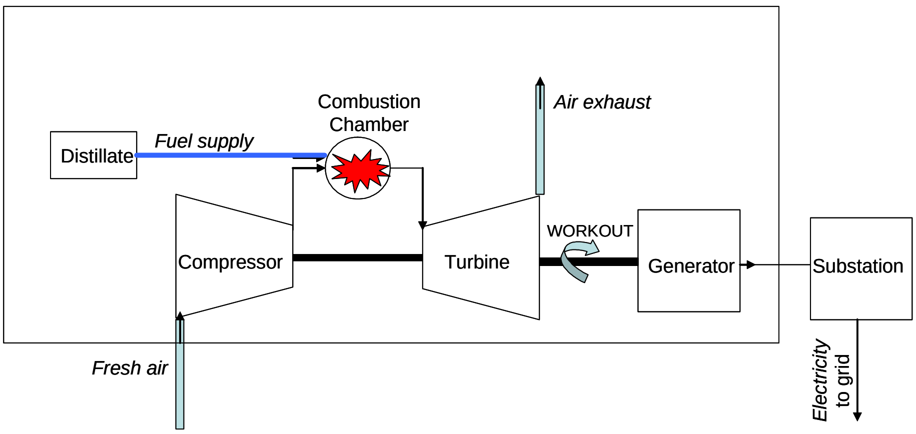
2.5 GAS TURBINE OPERATION

Gas turbines are rotary machines that compress air, combust fuel to heat that compressed air, and then extract energy from the flow of heated air. A combustion turbine thus largely consists of an upstream air compressor coupled to a downstream turbine, and a combustion chamber in-between.

Energy is extracted in the form of shaft power, to drive the compressor and to drive the electricity generator.

A block flow diagram of the gas turbine and fuel supply is shown in **Figure 3** below.

Figure 3 – Block Flow Diagram of Turbine Power Plant and Fuel Supply



2.6 DETAILS OF PLANT EQUIPMENT

Below is a brief explanation as to the operation of the equipment on site. Details of associated safeguards are presented in **Section 5.2** below

2.6.1 Turbines

The development will comprise three industrial gas turbines with the electricity generated being fed via high voltage transformers and circuit breakers into the 220kV transmission network through a switchyard which includes high voltage transformers and circuit breakers. The gas turbines will be powered by distillate (supplied by road tankers and stored on site).

The nature of the proposed peaking power plant to meet peak demand influences the type and size of gas turbine selected. Required is a gas turbine that can handle intermittent operation, a high number of starts for short periods of operation and is reliable. As the peaking power plant will only run during peak periods at varying demand, it is essential that multiple gas turbines of smaller output are installed to maximise efficiency. This also increases the overall reliability of the peaking power plant.

Each turbine-generator unit generally consists of three heavy lift components, i.e. the compressor-power turbine, electricity generator and high voltage transformer. Each gas turbine draws air in through filters to remove any particulate matter from the airflow before entry into the compressor. Following compression, the air flows into the combustion chamber where distillate is injected and burnt.

The combustion product from the combustion chamber enters the power turbine where it flows through rows of blades gradually reducing to atmospheric pressure. The power turbine in turn rotates the electrical generator. From the power-turbine the combustion products are discharged through a stack which contains a silencer section.

The type of gas turbine proposed is either started electrically or by a diesel engine up to approximately one third of running speed, main fuel is then admitted to the combustion chamber and ignition is initiated. The gas turbine ramps up to operating speed and the start motor disengages and is shutdown.

2.6.2 Electrical generators

Attached to each gas turbine is an electrical generator that generates electricity when rotated by the turbine. The generators are large items of plant, assembled off site and delivered in one piece.

2.6.3 Transformers

Each electrical transformer “steps up” the voltage from around 11 kV at the generator to 220kV. The step-up transformer(s) will be located adjacent to the gas turbines and will be connected with appropriate switchgear to ensure safe and reliable connection to the 220kV electricity network at the TransGrid Switching Station.

2.6.4 Fuel Supply

The distillate will be supplied to the site via road tankers, unloaded at the tanker unloading bay located to the south of the site, and pumped to two 1000kL storage tanks located within a bund.

The distillate will be supplied to the gas turbines via on-site pipelines. Any spill at the tanker unloading bay or from the pipes supplying the tankers or the gas turbines will run into the interceptor pit located adjacent to the unloading area (see **Figure 2**). Any spill from the oil filled step up transformers will be similarly intercepted.

The distillate off-load area, pipelines and storages will be compliant with the Australian standard for flammable and combustible liquids, AS1940 (Ref 3).

2.7 SECURITY

The plant will be located within a fenced off area accessed through a security gate. Security monitoring during out of hours period will be incorporated.

2.8 ACCESS ROADS

The plant will be accessed from Arumpo Road. Internal access roads will be constructed inside the facility to allow vehicle and/or forklift access as required.

Except for emergencies as allowed in its operating licence, the Buronga Peaking Power Plant would operate in open cycle mode during times of peak electricity demand on an as-required, intermittent basis for a total maximum period of up to 10% of any year.

The operating regime for the facility in the short to mid term is anticipated to be:

- Typical average operating hours per gas turbine per annum = 600 hrs
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Following completion of construction and commissioning, the major site features will include:

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- Three generator transformers ("step-up transformers");
- Three inlet air filter houses and three exhaust stacks;
- Buildings for control room, admin area, store and workshop;
- A liquids unloading area (including offload and lay-by area);
- Pipelines for distillate and water connecting the liquids unloading area with the respective storage tanks, and connecting the storage tanks with their respective points of use;
- Distillate storage tanks located inside a bund, and associated piping and equipment;
- Demineralised and fire water storage tanks with associated pump(s);
- A water treatment plant with reverse osmosis (RO) capability and associated equipment and minor chemicals storage;
- An interceptor pit to collect spills together with stormwater storage and wastewater storage ponds;
- Service connections to the electricity network; and
- Service roads.

- **Qualitative Risk Analysis:** The combination of the probability of an outcome, such as injury or death, combined with the frequency of an event gives the risk from the event. The risk for each incident is estimated according to:

  Risk = Consequence x Frequency

  The risk results are then assessed against the guidelines adopted by the Department of Planning (Ref 2).

- **Risk reduction:** Where possible, risk reduction measures are identified throughout the course of the study in the form of recommendations.

3.2 RISK CRITERIA

Having determined the risk from a development, it must then be compared with accepted criteria in order to assess whether or not the risk level is tolerable. If not, specific measures must be taken to reduce the risk to a tolerable level. Where this is not possible, it must then be concluded that the proposed development is not compatible with the existing surrounding land uses.

3.3 SAFETY MANAGEMENT SYSTEMS

3.3.1 Safety Management in General

In risk assessments, incidents are assessed in terms of consequences and frequencies, leading to a measure of risk. Where possible, frequency data used in the analysis comes from actual experience, e.g. near misses or actual incidents. However, in many cases, the frequencies used are generic, based on historical information from a variety of plants and processes with different standards and designs.

As with any sample of a population, the quality of the management systems (referred to here as "safety software") in place in these historical plants will vary. Some will have little or no software, such as work permits, planned maintenance and modification procedures, in place. Others will have exemplary systems covering all issues of safe operation. Clearly, the generic frequencies derived from a wide sample represent the failure rates of an "average plant". This hypothetical average plant would have average hardware and software safety systems in place.

If an installation which has significantly below average safety software in place is assessed using the generic frequencies, it is likely that the risk will be underestimated. Conversely, if a plant is significantly above average, the risk will probably be overestimated. However, it is extremely difficult to quantify the effect of software on plant safety. Incorporating safety software as a means of mitigation has the potential to significantly reduce the frequency of incidents and also their consequences if rigorously developed and applied.

The risk could also be underestimated if safety software is factored into the risk assessment but is not properly implemented in practice. Practical issues also arise when attempting to factor safety software into the risk assessment – applying a factor to the overall risk results could easily be misleading as in practice it may be the failure of one aspect of the safety software that causes the accident, while all other aspects are managed exemplarily.

In this study it is assumed that the generic failure frequencies used apply to installations which have safety software corresponding to accepted industry practice and that this site has similar management practices and systems. This assumption it is believed, will be conservative in that it will overstate the risk from well managed installations.

3.3.2 Recommendations for Safety Management System

Recommendation 1: It is recommended that an assessment / audit is carried out of the safety management system implemented and used at the site, specifically as it applies to the proposed hazardous materials handling, fuel reticulation and storages within the first year of operation.

4 HAZARD IDENTIFICATION

4.1 HAZARDOUS MATERIALS

A list of the types and storage quantities of materials that are likely to be found at the proposed site is included in the following table. Quantities are indicative only.

Table 1 - Typical Chemicals Stored Onsite

Plant Area / Use	Chemical/Product	Anticipated Storage Qty
Fuel for turbines	Low Sulphur Distillate	2 x 1,000,000 L in fixed tanks
Gas Turbines	Turbine oils (combustible oil)	3 x 7,000 L in containment integral to each turbine
Transformers, pumps, air compressor, lubrication, fire pump	Insulating oil (non PCB)	1,000 L in one bulk container or drums
Water treatment plant (RO Plant)	Caustic soda (50%)	Up to1,000L in one bulk container
	Hydrochloric acid (36%)	Up to1,000L in one bulk container
	Antiscalant	Up to1,000L in one bulk container
	Citric acid	Up to1,000L in one bulk container
	Sodium hypochlorite	Minor quantities in lockable chemicals cabinet
Chemicals for maintenance / repair work and clean-up	Carbon dioxide	In cylinders, auto fire protection inside gas turbine enclosures

4.2 SUMMARY OF HAZARDS IDENTIFIED

A total of 17 hazards were identified for the proposed plant, as listed in

Table 2 below.

The *Hazard Identification Word Diagram* in **Table 3** below details these hazards, their potential initiating events as well as their proposed controls.

Table 2 - Summary of Identified Hazards

Number	Hazardous Event Potential	Offsite Impact Potential	Assessed in Section
1	Loss of containment of distillate during unloading and storage	Y	5.2.1
2	Loss of containment of distillate during fuel forwarding to gas turbine	Y	5.2.1
3	Loss of distillate inside gas turbine enclosure	Y	5.2.1
4	Unburned distillate inside the gas turbine during start-up	Y	5.2.2
5	Loss of lube oil inside gas turbine enclosure	Y	5.2.1
6	Loss of containment of corrosive liquids.	N	5.2.3
7	Violent reaction between incompatible materials	N	5.2.3
8	Loss of containment of water treatment plant effluent	N	5.2.3
9	Fire at step-up transformers	Y	5.2.4
10	Flooding results in process upsets and damage to plant and equipment	Y	5.2.5
11	Land subsidence, earthquake or mining activity results in plant damage	Y	5.2.5
12	Aircraft crash results in process upsets, potential damage to process / piping / storage facilities resulting in hazardous releases	Y	5.2.5
13	Damage to plant through terrorism / vandalism / unlawful entry to site / sabotage	Y	5.2.5
14	Bush / grass fire	Y	5.2.5
15	Storm damage	Y	5.2.5
16	Incident during maintenance and repair work	Y	5.2.5
17	Transport of potentially hazardous material to and from the site (distillate, oils, corrosives)	Y	5.2.6

The main hazard associated with the proposed development is related to leak of combustible liquids (distillate).

4.3 HAZARD IDENTIFICATION WORD DIAGRAM

The Hazard Identification Word Diagram, included in **Table 3** below, provides a summary of the hazardous incidents identified for the proposed site and their associated mitigating features.

Each section of the peaking power plant and associated pipelines was reviewed in turn in a workshop, to determine the potentially hazardous scenarios relevant to that section.

The sections reviewed were:

- Distillate storage and handling;
- Gas turbine enclosure;
- Storage and handling of water treatment chemicals;
- Electricity generation;
- Potential hazards that could affect the whole site;
- Finally, transport of potentially hazardous materials.

While the table below provides an overview of the preventative and protective features proposed and recommended for the site, these safeguards are further detailed in **Section 5** below.

Table 3 – Hazard Identification Word Diagram for Buronga Peaking Power Plant

Event	Cause/Comments	Possible Consequences	Prevention/ Protection
SECTION OF PLANT: Storage and Handling of Distillate (fuel for generator)			
1. Loss of containment of distillate during unloading and storage	1. Loss of containment during unloading from truck to the distillate tanks. 2. Mechanical failure, damage to tank etc. 3. Overfilling of tank.	Loss of containment of distillate from tank into bund (up to 1000kL in each tank). Environmental damage if spill is not contained on site. Risk of fire (even though distillate does not ignite in normal atmospheric pressures and temperatures). Personnel hazard and damage to property.	- Spill containment as per AS1940 (including bund to 100% of largest tank volume). - Protection of storages and pipeline from mechanical damage. - Regular inspections and maintenance. - Spill during tanker unloading would be captured in the interceptor pit (capable of capturing 5000L spills at the tanker unloading bay). - Emergency response plan and spill protection as per AS1940. People trained in emergency response. - Emergency services call-out as required. - Fire protection (fire extinguishers, separation distances etc.) as per AS1940. Further, the tanks will be equipped with fire detection instrumentation, stationary sprinkler system and transportable foam mixing equipment and fire pump (e.g. to provide additional fire fighting capability should fire/embers come onto site from off site sources such as in a bush fire). - Valving and piping associated with the storage as per AS1940 Section 7. - Control of ignition sources as per AS1940 requirements. - Overfill protection through level switch and auto shut off of transfer. - Operator present during tanker unloading operations.

Event	Cause/Comments	Possible Consequences	Prevention/ Protection
2. Loss of containment of distillate during fuel forwarding to gas turbine	Mechanical failure. Corrosion. Impact damage to pipe. Flange leaks etc.	Loss of containment of distillate from pipeline into trench which then flows into separation (interceptor) pit. Environmental damage if spill is not contained on site. Risk of fire (even though distillate does not ignite in normal atmospheric pressures and temperatures). Personnel hazard and damage to property.	- Pipeline run inside trench which is drained back into oil separation pit (interceptor pit). - Routine maintenance and inspection. - Exposed pipe can be readily assessed. - Route selection precludes impact exposure. - Design to appropriate codes and standards. - The transportable diesel fired fire pump and foam mixing equipment will provide a wider fire protection capability across the site.
3. Loss of distillate inside gas turbine enclosure	Mechanical failure. Corrosion. Impact damage to pipe. Flange leaks etc.	Loss of containment of distillate from pipelines. Environmental damage if spill is not contained on site. Risk of fire if distillate comes in contact with hot surfaces. Personnel hazard and damage to property.	- Routine maintenance and inspection. - Exposed pipe can be readily assessed. - Design to appropriate codes and standards. - Turbine enclosure is drained back to into oil separation pit (interceptor pit). - The transportable diesel fired fire pump and foam mixing equipment provides fire protection capability across the site. - Each turbine enclosure is equipped with infra red fire detectors, fixed heat detectors and fuel spill sensors mounted at the base of the turbine unit. The enclosure is protected with carbon dioxide or similar non ozone-depleting fire suppression and CO_2 gas to provide fire detection and suppression in the unlikely event of a fire within the turbine enclosure.

Event	Cause/Comments	Possible Consequences	Prevention/ Protection
4. Unburned distillate inside the gas turbine during start-up	Fuel is not fully shut off during shut-down (e.g. due to valve passing).	Non-controlled start-up of gas turbine. Possible explosion within the gas turbine combustion zone. Explosion overpressure contained within combustion zone with limited impact outside the gas turbine enclosure.	- Explosion overpressure relief through inherent design of the turbine. - Preventative maintenance programs prevent passing valves.
SECTION OF PLANT: Storage and Handling of Lube Oil			
5. Loss of lube oil inside gas turbine enclosure	Mechanical failure. Corrosion. Impact damage to pipe. Flange leaks etc. Spillage during top ups.	Loss of containment of lube oil from pipelines or reservoir (16kL containment integral to each gas turbine). Environmental damage if spill is not contained on site. Risk of fire if lube oil comes in contact with hot surfaces. Personnel hazard and damage to property.	- Routine maintenance and inspection. - Exposed pipe can be readily assessed. - Design to appropriate codes and standards. - Turbine enclosure is drained back to into oil separation pit (interceptor pit). - Fire protection, see scenario 3 above.

Event	Cause/Comments	Possible Consequences	Prevention/ Protection
SECTION OF PLANT: Water Treatment Plant			
6. Loss of containment of corrosive liquids.	1. Mechanical failure, damage to storage vessel (IBCs). 2. Loss of containment during delivery. 3. Loss of containment during transfer from storage to water treatment. 4. Human error.	Loss of containment of corrosive liquid to ground (max 1000L in each container) (33% hydrochloric acid, 50% sodium hydroxide, anti-scalant, citric acid). Possible danger of exposure to people in the vicinity. Environmental hazard if not contained on site.	- IBC storage area will be bunded as per AS3870 requirements (110% of volume of storage tank). If spill into bund the material will be neutralised and cleaned up in accordance with company procedures. - Material Safety Data Sheets available on site. - Water treatment will be located adjacent to the corrosives storage area, minimising risk of loss of containment. - Routine inspection. Preventative maintenance of plant and equipment. Operation of plant will be done by competent and trained personnel. - Emergency response plan. - Operator attendance during transfer operations of IBCs into storage area. - Emergency shower and eye wash station at storage area. - Personal Protective Equipment (PPE) requirements as per MSDS specifications.
7. Violent reaction between incompatible materials.	Incompatible materials contact due to operational error (acid into caustic or caustic into acid).	Violent exothermic reaction. Possible damage to tank fittings leading to loss of containment. Personal injury hazard.	- Clear labelling on containers and pipes. - Segregation of incompatible materials.
8. Loss of containment of water treatment plant effluent.	Mechanical failure, damage, corrosion of piping, valves or storage, operator error, overfill of storage.	Environmental hazard if not contained on site.	- Neutralised effluent is discharged into evaporation pond which is sealed to prevent ground water contamination. - Loss of containment at external (unbunded) areas would be captured and drained to evaporation pond. - Routine inspection. Preventative maintenance of plant and equipment. - Emergency response plan.

Event	Cause/Comments	Possible Consequences	Prevention/ Protection
Power Generation			
9. Fire at step-up transformers	Faulty connection or internal fault in transformer.	Fire in plant switchyard. Material damage. Potential for propagation to bush / grass outside site boundary. Personnel injury potential.	- Isolation of electrical energy sources. - Clearance zone around HV electrical equipment provides separation distance from neighbouring combustible material (grass, bush, etc.), in accordance with recommended APZ (Asset Protection Zones) guidelines, see item 14 below. - Bunding ensures oil spill are contained. - Fire remains localised. - Fire protection system available on site to minimise damage from fire. Each oil-filled transformer will be provided with a fixed fire detection system and stationary sprinklers to ensure fire detection and fire suppression in the unlikely event of a fire. The transportable diesel fire pump and foam mixing trailer will be used to assist in rapid control of fire and or management of risk of fire developing at the site from external sources. - Monitoring and alarm systems to ensure early warning. - Emergency response plan, mustering point for evacuation. Emergency services contacted as required. Signage for emergency services. - Blast walls at the transformers to control a potential blast from destroying neighbouring equipment or endanger people.
SECTION OF PROJECT: Whole Site			
10. Flooding results in process upsets and damage to plant and equipment.	Uncontrolled flooding of site	Potential for damage to process / storage facilities resulting in release of hazardous material (particularly corrosive liquids, fuels and oils)	- Site elevation and surface run-off design to ensure potential for flooding is minimised. - Appropriate level of surface water management study will be integrated into the design.

Event	Cause/Comments	Possible Consequences	Prevention/ Protection
11. Land subsidence, earthquake or mining activity results in plant damage.	Land subsiding in area creates failure of pipelines and tanks resulting in potential for rupture or leak.	Release of fuels oils and corrosive liquids. If ignition, then possibility of fire. Injury and property damage. Environmental damage.	- No mining activity in the immediate site area. - Geotechnical study will be performed and the outcomes of this study will be integrated into the design of the plant. - Seismic review will be performed and the requirements will be incorporated into the design.
12. Aircraft crash results in process upsets, potential damage to process / piping / storage facilities resulting in hazardous releases.	Aircraft crash	Potential damage to process / storage facilities resulting in hazardous releases, fire. Environmental damage.	- Occupied site relatively small – aircraft crash unlikely.
13. Damage to plant through terrorism / vandalism / unlawful entry to site / sabotage.	Malicious damage.	Massive release of fuel, oil and corrosive liquid. If ignition, then possibility fire. Environmental damage.	- Fenced site with access control and security systems. - Security management plan to be put in place. - Standard checks of employees prior to employment.

Event	Cause/Comments	Possible Consequences	Prevention/ Protection
14. Bush / grass fire	Bush / grass fire outside site boundaries affects site. Fire on site propagates to outside site boundary.	Possible threat to nearby structures, dwellings etc. and risk to people in the vicinity. Possible damage to plant and equipment. Environmental damage.	- Bush /grass fire asset protection zone (APZ) and provision of firewater as agreed with Rural Fire Services (RFS). - Emergency response plan and communication with rural fire brigades. - Work management processes includes care to take during times of bush fire risk. - The site as a whole will be monitored by infra red beam heat detectors to ensure fire protection and management systems for the site are activated in case of fire from adjoining land. - Liaison with relevant local authorities and appropriate personnel action and evacuation processes will also be in place. - The distillate tanks are equipped with fire detection instrumentation, stationary sprinkler system and transportable foam mixing equipment and fire pump. - The transportable diesel fired fire pump and foam mixing equipment will also provide a wider fire protection capability across the site.
15. Storm damage	1. High winds or neighbouring structures or trees affecting the site. 2. Projectile from site equipment / structures causes off-site damage. 3. Lightning	Damage to plant and equipment. Release of hazardous materials (corrosives, distillate, oils). Hazard to neighbouring areas, people etc.	- Engineering design standards to cope with winds, storms and lightning strikes. - Preventative inspection and maintenance of site.

Event	Cause/Comments	Possible Consequences	Prevention/ Protection
16. Incident during maintenance and repair work	1. Faulty equipment / error of operation.	Fire, personnel injury. Potential propagation of fire to nearby structures. Plant damage.	- Trained staff. - Equipment used are checked and maintained. - Fire extinguishers available. - Buildings designed to Building Code requirements. - Dedicated hazardous material storage. - Gas cylinders (oxyacetylene) stored in accordance with standards. - Work control processes used.
		TRANSPORT RISKS	
22. Transport of potentially hazardous material to and from the site (distillate, oils, corrosives)	1. Transport accident causes release to the environment	Release of hazardous material onto the roadways and into the environment causing pollution. If ignition source then possibility of fire (note that distillate and oils are not easily ignited).	- Relatively small number of transport movements (less than 30 potentially hazardous substances deliveries per year). - Distillate transported to site in using tankers designed to relevant standards. - Use of licensed service providers. - Qualified drivers. - Access roads to site to be of adequate construction for the use and to be maintained / repaired. - General transport risks of such material are handled by transport company's safety requirements. Clean up and incident management as per transport company procedure.

5 POTENTIAL HAZARDOUS INCIDENTS AND THEIR CONTROL

Safety management systems allow the risk from potentially hazardous installations to be minimised by a combination of hardware and software factors. It is essential to ensure that hardware systems and software procedures used are reliable and of the highest standard in order to assure safe operation of the facility.

Safety features of particular interest to the present project are detailed below.

5.1 HARDWARE SAFEGUARDS, GENERAL

Hardware safeguards include such factors as the layout and design of the plant and equipment, and their compliance with the relevant codes, technical standards, and industry best practice.

All systems handling dangerous goods will need to comply with the following Acts, Regulations and Codes in their latest edition. Below are listed some of the most relevant:

- NSW Occupational Health and Safety Act and its associated legislation including but not limited to the Dangerous Goods Regulations, Construction Safety Regulations, and the Factories Shops and Industries Regulations.
- NOHSC:1015(2001) - National Occupational Health & Safety Commission (NOHSC): Storage and Handling of Workplace Dangerous Goods.
- AS 1074 - Steel Tubes & Tubulars.
- AS 2919, AS 3765.1 or AS 3765.2 - Protective clothing.
- AS3600 - Concrete Structures (for foundation and plinth).
- AS 1692 - Tanks for flammable and combustible liquids.
- API 620 - Design and construction of large welded low-pressure storage tanks.
- API 650 - Welded steel tanks for oil storage.
- AS1345 - Identification of the Contents of Pipes, Conduits and Ducts.
- ANSI Z 358.1 – For safety shower and eyewash facilities.
- AS 3780 – Storage and Handling of Corrosives.

Pipe fittings, supports, and all other ancillary items will also need to comply with appropriate Australian Standards whether referenced above or not.

5.2 HARDWARE SAFEGUARDS, SPECIFIC

5.2.1 Storage and Handling of Combustible Liquids

The following combustible liquids will be stored and handled on site:

- Distillate (two 1,000 kL tanks) used as fuel for the gas turbines;
- Combustible oils (1,000 litres in IBCs as well as in a 7,000L containment integral to each gas turbine) will be used in the pumps and gas turbines).

All the requirements for risk management of these flammable and combustible materials will be as per AS1940 (*Storage and handling of flammable and combustible liquids,* Ref 3), including:

- Bunding requirements as per AS1940, i.e. 100% of the largest tank, with bunding design and construction as per Section 5.9.3 in AS1940.
- Any valve controlling the drainage from the bunds is to be located outside the bund.
- Overflow line from all tanks is / will be open to atmosphere and directed to bund.
- Run-off from external (unbunded) areas would be captured in the first flush stormwater system which is designed to retain the first flush runoff from these areas.
- Fire protection (fire extinguishers, foam, hose reel requirements, separation distances etc) as per AS1940.
- Valving and piping associated with the storage as per AS1940 Section 7.
- Control of ignition sources as per AS1940 Section 9.7.6.
- Communication systems.
- Visual inspection of tanks, lines and equipment. Preventative maintenance program.
- Overfill protection through level switch and auto shut off of transfer.
- Overflow line and vent line on top of distillate storage tank to minimise risk of over-pressurisation of tank.
- Foundations, supports, bearing etc. designed and constructed in accordance with AS1940. Tanks and associated equipment are protected from external impact by the bund wall (concrete) which is designed to comply with criteria in AS1940.
- Spill during tanker unloading, in case of leaks of the pipeline during fuel forwarding or inside the turbine enclosure would be captured in the interceptor pit (capable of capturing 5000L spills).
- Disposal of spills in accordance with established procedures.

Further, the tanks will be equipped with fire detection instrumentation, stationary sprinkler system and transportable foam mixing equipment and fire pump to provide additional fire fighting capability should fire/embers come onto site from off site sources.

Provided that the requirements from AS1940 and the above recommendations are adhered to, the risk of an incident involving the combustible material stored and handled is small.

5.2.2 Inside the Gas Turbine and the Gas Turbine Enclosure

Despite the best efforts during design and management of the peaking power plant, gas turbines are not beyond mishap. Ignition of fuel released into the gas turbine enclosure can cause fire if in contact with hot surfaces. Unburned distillate inside the gas turbine during start-up may cause an explosion within the turbine combustion zone.

Each gas turbine enclosure will be equipped with infra red fire detectors, fixed heat detectors and fuel spill sensors mounted at the base of the gas turbine units. The enclosure will be protected with carbon dioxide or similar non ozone-depleting fire suppression and sprinklers to provide fire detection and suppression in the unlikely event of a fire within the gas turbine enclosure.

Explosion overpressure relief within the gas turbine is provided through inherent design of the gas turbine. This, together with the relatively limited amount of fuel available, will ensure that the explosion overpressure is contained within combustion zone with limited impact outside the gas turbine enclosure.

Preventative maintenance procedures and schedules will be developed for the proposed site, covering all critical safety functions. Operators and maintenance workers at the plant will be trained to recognize the critical nature of critical safety functions.

Permit to Work systems will be put in place for work inside enclosed areas (including gas turbine enclosure).

Emergency procedures for personnel will be developed and drills will be carried out throughout the life of the operating plant to ensure personnel are trained up in the procedures required during an emergency.

A fire protection system will be installed in the facility (refer **Chapter 13 Bushfire Risk** and **Appendix F** of this Environmental Assessment), including inside the turbine enclosures, and around the generator transformers. The fire control system will be developed to meet all requirements of Building Code of Australia and NSW Fire Brigade. Elements of the system will include:

- Provision of water supply to the boundary of the site;

- Provision of permanent water storage, to meet the supply volume objectives. The site will be equipped with a dedicated reserve of 150kL of “Fire Protection Water” with up to 2,000kL of additional plant process water in storage tanks which would be more than adequate for provision of fire water.

In addition, water from the on site stormwater collection pond is also available for fire fighting and control;

- Provision of booster pumps – duty and standby, if required, to meet the specified pressure objectives;
- Provision of fire hydrants and hose reels if required and as nominated by above requirements.

Recommendation 2: A system should be but in place to ensure that any removal of critical safety function (e.g. for repair or exchange) is subject to careful scrutiny by plant management (decisions on whether to shut down plan or a gas turbine if a critical safety function is removed need to be canvassed).

5.2.3 Water Treatment

The main risk associated with the water treatment plant is related to the storage and handling of corrosive liquids[6] stored in 1,000L IBCs. Loss of containment of corrosive liquids to ground could cause a possible danger of exposure to people in the vicinity and an environmental hazard if not contained on site. This risk will be minimised by a combination of:

- Preventative measures: minimising pipe lengths by placing the storage areas adjacent to their points of use, preventative maintenance and periodic inspections of plant;
- Protective measures: bunding of storages to AS3870 requirements (110% of volume of storage tank, ensuring the operator is in attendance during transfer operations of IBCs into storage area, provision of emergency shower and eye wash station at storage area, and ensuring Personal Protective Equipment (PPE) requirements are adhered to as per MSDS specifications);
- Emergency measures: if spill into bund the material will be neutralised and cleaned up in accordance with company procedures.

Loss of containment of water treatment plant effluent may cause an environmental hazard if not contained on-site. It is proposed that neutralised effluent is discharged into an evaporation pond which is sealed to prevent ground water contamination. Loss of containment at external (unbunded) areas would be captured and drained to evaporation pond. Routine inspection and preventative maintenance of plant and equipment will work to minimise the risk of an uncontrolled loss of containment.

[6] 33% hydrochloric acid, 50% sodium hydroxide, anti-scalant, citric acid

5.2.4 Power

Fire or explosion at transformers may be caused by a faulty connection or internal fault in the transformer. Such a transformer incident may cause fire in the plant switchyard, material damage, potential for propagation to bush or grass outside site boundary and personnel injury.

- Preventative measures include monitoring and alarm systems to ensure early warning.

- Protective measures include automatic isolation of electrical energy sources; provision of clearance zone around high voltage (HV) electrical equipment for separation distance from neighbouring combustible material (grass, bush, etc.); and bunding to contain oil spill. Further, each oil-filled transformer will be provided with stationary sprinklers to ensure fire suppression in the unlikely event of a fire. The transportable distillate fire pump and foam mixing trailer will be used to assist in rapid control of fire and or management of risk of fire developing at the site from external sources.

- Emergency measures include blast walls at the transformers to control any potential blast from destroying neighbouring equipment or endangering people; fire protection system to be available on site to minimise damage from fire; and emergency response plan and mustering point for evacuation and emergency services contacted as required.

5.2.5 Whole Site

Flooding: Site elevation and surface run-off design to ensure potential for flooding is minimized. Appropriate level of surface water management study will be integrated into the site design.

Land subsidence, earthquake or mining activity results in plant damage: No mining activity in the immediate site area; a geotechnical study will be performed and the outcomes of this study will be integrated into the design of the plant; Seismic review will be performed and the requirements will be incorporated into the design. Structures and plant will be designed to withstand earthquake effects using well-established procedures in accordance with relevant Australian or international standards. (Note that geological stability has not been assessed as part of the present PHA).

Aircraft crash on site: General aircraft and airline safety measures makes airplane crash unlikely. This scenario, while theoretically possible, does not appear credible for the present development.

Bush / grass fire: A bush or grass fire outside site boundaries may, if not managed, affect the site, and a fire on the site may cause risk outside site boundaries, possible threat to nearby structures, dwellings etc. and risk to people in the vicinity. A bush /grass fire asset protection zone will be decided in consultation with Rural Fire Services.

Emergency response plan and work management processes will include care to take during times of bush fire risk. The site as a whole will be monitored by infra red beam heat detectors to ensure fire protection and management systems for the site are activated in case of fire from adjoining land. The distillate tanks will be equipped with fire detection instrumentation, stationary sprinkler system and transportable foam mixing equipment and fire pump. The transportable diesel fired fire pump and foam mixing equipment will provide a wider fire protection capability across the site.

The site will be equipped with a reserved supply of 150kL of “Fire Protection Water” with up to 2,000kL of additional plant process water in storage tanks which would be more than adequate for provision of fire water. In addition, water from the on site stormwater collection pond will also be available for fire fighting and control.

Storm damage: The risk of damage to plant and structures from storms will be managed through the design phase (through the use of engineering design standards to cope with winds, storms and lightning strikes), and throughout the operation of the plant (through preventative inspection and maintenance of site).

Incident during maintenance and repair work: Incidents during maintenance and repair work may result in a fire, personnel injury and plant damage. This risk is managed through the use of the use of a robust Safety Management System (see **Recommendation 1**), including trained staff; adequate work processes; adequately checked and maintained equipment; buildings designed to Building Code requirements (including use of fire extinguishers); the use of a dedicated hazardous material storage; gas cylinders (oxyacetylene) stored in accordance with standards, etc.

5.2.6 Road Transport Risks

It is expected that about 30 deliveries per year will be sufficient for the operation of the site, mainly consisting of the distillate deliveries and the occasional delivery of corrosive liquids to the Water Treatment Plant, oil top up for rotating machinery and possibly the transport of material used for maintenance or cleaning.

Road transportation would use Arumpo Road to access the site. The entrance road to the site is to be of adequate construction for the use in accordance with Wentworth Shire Council and RTA requirements, and would be maintained and repaired as required.

General transport risks of these materials are handled by transport companies’ internal safety requirements. Clean up and incident management will be as per the transport company's procedures.

The quantities and transport movement of potentially hazardous materials for this site are well below those listed in the *Transportation Screening Threshold* table (Table 2 in the guidelines on applying SEPP 33 (Ref 4)) as defined by the Department of Planning.

The review of road transport risks concludes that the risk associated with the transport of dangerous goods and potentially hazardous material to the site is very low.

5.3 SOFTWARE SAFEGUARDS

IPRA have a commitment to Occupational Health and Safety (OH&S) and have numerous policies and procedures to achieve a safe workplace. Written safety procedures will be established. An established incident reporting and response mechanism will be established, providing 24 hour coverage. The plant itself will develop procedures specific to the plant and its environment and they will be incorporated into the safety system.

The plant will need to comply with all codes and statutory requirements with respect to work conditions. In addition, special precautions are observed as required by the site conditions, in particular, standards and requirement on the handling of pressurised, flammable gases. All personnel required to work with these substances are trained in their safe use and handling, and are provided with all the relevant safety equipment.

Emergency procedures will be developed. All staff will need to be trained in these procedures and they will be incorporated in the plant's quality system. The emergency procedures will include responses to emergency evacuation, injury, major asset damage or failure, critical power failure, spillages, major fire, and threats.

The site will have a manager with overall responsibility and who is supported by experienced personnel trained in the operation and support of the plant.

A Permit to Work system (including Hot Work Permit) and Control of Modification systems will be in use on site to control work on existing plant and to control existing plant and structure from substandard and potentially hazardous modifications.

Injury and incident management will be proceduralised and people will be trained in how to report incidents.

Protective Systems will be tested to ensure they are in a good state of repair and function reliably when required to do so. This will include scheduled testing of trips, alarms, relief devices and fire protection systems.

All persons on the premises will be provided with appropriate personal protective equipment suitable for use with the specific corrosive substances.

A first aid station will be provided comprising an appropriate first aid kit and first aid instructions, i.e. MSDSs, for all substances kept or handled on the premises. At least one person on the premises is trained in first aid; and a list of persons trained in, and designated as being responsible for the administering of, first aid is shown on the noticeboards on the premises. Further, the relevant and up-to-date MSDS will be kept in safe location next to the storage tanks.

6 CONSEQUENCE AND FREQUENCY ANALYSIS

For distillate (a combustible liquid), credible incidents arise from ignition of leaks or spills, giving rise to pool fires, where a liquid pool burns at its surface. Pool fires can occur within tanks, in the bunds around tanks or elsewhere that a pool of liquid collects.

PHAs focus on the risk to surrounding land use from a potentially hazardous development. Analysing the incident scenarios identified and presented in **Table 3** above shows that the bund fire scenario caused by a loss of containment of distillate during unloading and during storage has the potential to reach outside the site boundaries.

The likelihood of ignition depends on the properties of the material, and the size and location of the leak. In the case of distillate, the ignition source must be very strong (high in energy) and the material would most likely need to be heated to above its flash point before ignition could occur (distillate flashpoint[7] is about 65^{o}C). A detailed study of storage tank incidents in industrial facilities over a 40 year period (Ref 5) showed that lightning was the most frequent cause of accident and maintenance error was the second most frequent cause.

6.1 CONSEQUENCE EVALUATION TECHNIQUES

The explanation of the nomenclature used in the equations below is listed in Table 5 at the end of this Chapter.

6.1.1 Leak Rates

The rate at which a liquid leaks from a hole can be determined using a standard orifice flow equation:

$$\dot{m} = 0.8A\sqrt{(2\rho deltaP)}$$

6.1.2 Duration

The duration of a leak will depend on the hardware systems available to isolate the source of the leak, the nature of the leak itself and the training, procedures and management of the facility. While in some cases it may be argued that a leak will be isolated within one minute, the same leak under different circumstances may take 10 minutes or even hour(s) to isolate.

[7] From AS1940 The storage and handling of flammable and combustible liquids: ***Flash point:*** *The lowest temperature, corrected to a barometric pressure of 101.3 kPa, at which application of a test flame causes the vapour of the test portion to ignite under the specified conditions of test.*

The approach used in this study is to assume that in 50% of the leak cases, the leak is not discovered until the bund area is 10% covered and that in the other 50% of the leak cases the leak is not discovered until the entire bund surface is covered. This is a highly conservative approach as revealed by analysing the fault tree prepared for the tank overfill scenario (see **Figure 5** below) accounts for about 80% of the leak cases and that operators are present during tanker unloading.

6.1.3 Radiation Effects - The Point Source Method

Radiation effects are evaluated using the point source method, which assumes that a fire is a point source of heat, located at the centre of the flame, and radiating a proportion of the heat of combustion. The radiation intensity at any distance is then determined according to the inverse square law, making allowance for the attenuating effect of atmospheric water vapour over significant distances (e.g. 100m or more).

$$I = \frac{Qf\tau}{4\Pi r^2}$$

The rate of heat release, Q, is given by:

$$Q = \dot{m}H_C$$

6.2 IMPACT ASSESSMENT

The above techniques allow the level of radiation or overpressure resulting from fires and explosions to be determined at any distance from the source. The effect or impact of heat radiation on people is shown in **Table 4**.

Table 4 - Effects of Heat Radiation

Radiant Heat Level (kW/m^2)	Physical Effect (effect depends on exposure duration)
1.2	Received from the sun at noon in summer
2.1	Minimum to cause pain after 1 minute
4.7	Will cause pain in 15-20 seconds and injury after 30 seconds' exposure
12.6	Significant chance of fatality for extended exposure High chance of injury
23	Likely fatality for extended exposure and chance of fatality for instantaneous (short) exposure
35	Significant chance of fatality for people exposed instantaneously

Table 5 – Nomenclature for Section 6

Label	Explanation
A	Area of hole, m^2
f	Fraction of heat radiated
H_c	Heat of combustion, kJ/kg
H_v	Heat of vaporisation, kJ/kg
I	Radiant heat intensity kW/m^2
M	Molecular weight
m	Mass, kg
$\dot{m}$	Mass flow rate of leak, kg/s
P	Pressure, Pa
Q	Heat release rate, kW
r	Distance from fire/explosion, m
T	Temperature, K
t	Duration of leak/time, seconds
τ	Atmospheric transmissivity

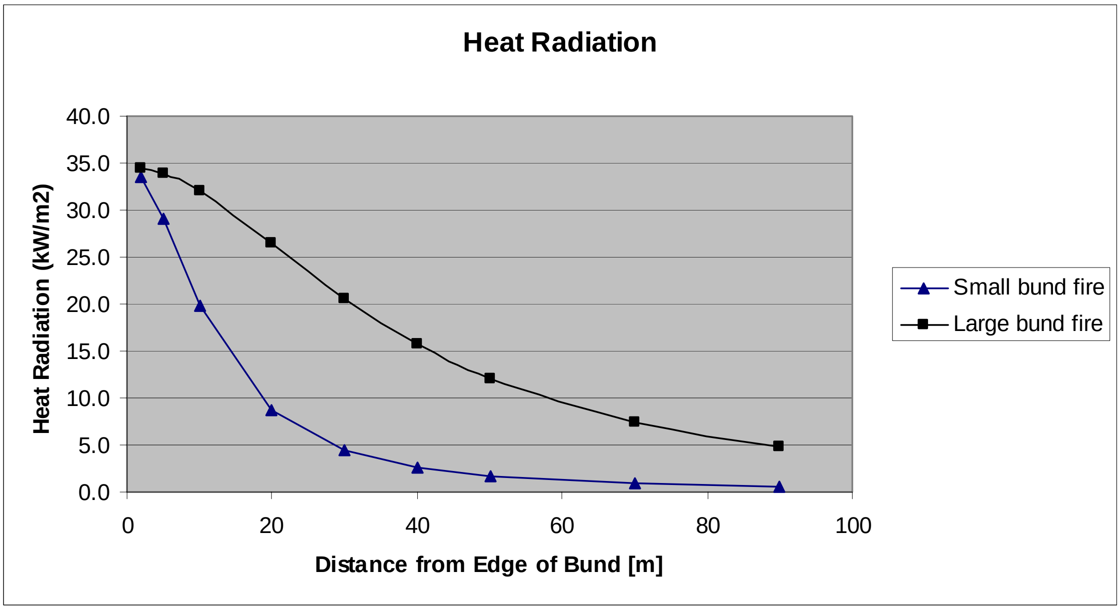
6.3 Consequence Calculations – Distillate Fire

The consequences of a bund fire of distillate, as calculated using the Point Source method, have been presented below (detailed calculation sheet is included in Appendix 1). Two scenarios were investigated, namely a "small" and a "large" fire, covering 10% and 100% of the surface of the bund respectively[8].

Serious (potentially fatal) consequences from a "small" bund fire do not extend beyond site boundaries.

[8] The bund has not been designed at the time of this PHA. This PHA assumed that the bund would be 35 m x 30 m (1,050 m^2).

Figure 4 – Heat Radiation from Distillate Bund Fire



6.4 PROBABILITY OF OPERATION OF PLANT

The peaking power plant is expected to operate for a maximum of 10% of the time.

Conservatively, this risk assessment has assumed that the power plant will operate 100% of the time and that all parts of the plant will be pressurised, capable of releasing distillate if damage occurs, 100% of the time.

6.5 FREQUENCY AND PROBABILITY DATA

The data used for the fault tree analysis presented in **Figure 5** below is listed in **Table 6** together with the basis for the calculation and, where possible, the reference used.

Table 6 – Frequency and Probability Data

Ref.	Item	Frequency/ Probability		Basis of Calculation / Reference
2B	External Fire Plan Fails	0.05	[t/d]	Conservative estimate. Risk engineering best judgment
4B	Ignition	0.001	[t/d]	Estimated from Cox, Lees & Ang - Chapter 15, considered conservative for tank farm (Ref 6)

Ref.	Item	Frequency/ Probability		Basis of Calculation / Reference
4C	Local fire fighting inadequate/not available	0.3	[t/d]	Conservative estimate. Risk engineering best judgment (site workforce present approx 10% of time, but most incidents will occur during filling)
5A	Pump seal failure into bund	0.005	[t/yr]	Single mechanical seal, ISORIS data
5B	Major leak from tank	1.0E-04	[t/yr]	Atmospheric storage tank leak (historical data)
5C	External events	1.0E-04	[t/yr]	Conservative estimate. Risk engineering best judgment
5D	Faulty fabrication or corrosion at tank	1.0E-04	[t/yr]	Data from the Rijnmond study (Cremer & Warner), subsequently used by Bureau Veritas for the Kwinana study
5E	Flange leak inside bund	2.5E-05	[t/yr]	Estimated from Cox, Lees & Ang - Chapter 15 (Ref 6), assuming 5 flanges per tank
5G	Foam u/s or empty	0.2	[t/d]	Conservative estimate. Risk engineering judgment
5H	Too windy / no access makes foam useless	0.2	[t/d]	Conservative estimate. Risk engineering judgment
6A	Pipe failure inside bund	3.0E-04	[t/yr]	Estimated from Cox, Lees & Ang - Chapter 15 (Ref 6)
6B	Vandalism	0.002	[t/yr]	Conservative estimate. Risk engineering judgment
6C	Operator fails to act on overflowing tank	0.01	[t/d]	Orica Engineering HAZAN Course Notes, Section 11 (Ref 7)
7A	Level transmitter fails	0.1	[t/y]	Orica Engineering HAZAN Course Notes, Section 5 (Ref 7)
8A	Operator fails to intervene at high level	0.05	[t/d]	Orica Engineering HAZAN Course Notes, Section 11 (Ref 7)
8B	No of fills per tank per year	50	[t/yr]	Site data

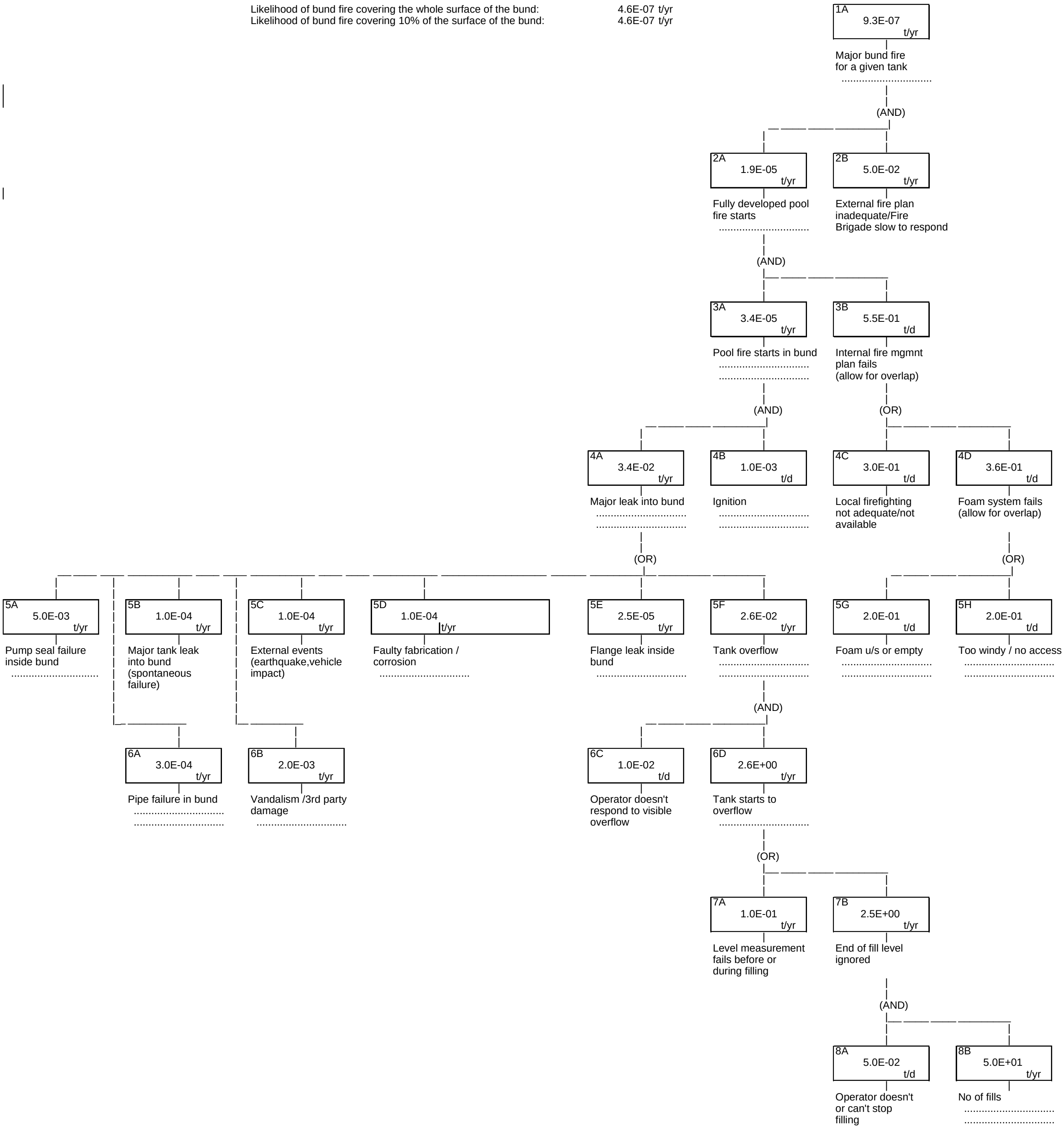
6.6 RELATIONSHIP BETWEEN EXPOSURE AND EFFECT

The relationship between exposure and effect was estimated based on the probit equation for heat radiation (Ref 8):

$$\text{Probit } Y = -37.23 + 2.56 \ln(I^{1.333} \times t)$$

With **ln** being the natural logarithm, **I** being the heat radiation at the target (in kW/m^2) and **t** being the duration of exposure (in seconds). The probability of fatality from heat radiation can then be estimated using the probit-probability relationship for example published in Table 5-31 in Ref 9.

Figure 5 – Fault Tree Analysis Bund Fire, Single Tank, Combustible Liquid



7 RISK RESULTS AND COMPARISON WITH RISK CRITERIA

7.1 FATALITY RISK CALCULATION

The likelihood of a bund fire, taking into account the properties of the distillate and its use within the site, is very low. For the two tank bund proposed for the site, the likelihood of a large fire (covering the entire surface of the bund) is about 0.5 pmpy. It then follows that the offsite individual risk from the site is less than 0.5 pmpy off the site.

Hence, the risk of a distillate fire is minimal, provided the storage is designed in accordance with code requirements (in particular AS1940, Ref 3).

7.2 ENVIRONMENTAL RISK

Some materials to be stored and handled on site are potentially highly damaging to the environment, such as the water treatment chemicals and distillate.

The possible sources of risks are liquid loss of containment or firewater runoff while a fire is being extinguished.

The liquid inventories on-site are listed in Table 1 above. Losses of containment of materials can be caused in the ways discussed in the Hazard Identification Word Diagram in **Table 3** above. However if a spillage occurs into a sealed bund which has sufficient volume to contain the spill, there is no contamination of ground or water. Spillages to ground while filling tanks or unloading from tankers are thus the most probable source of loss of containment. Pollution is prevented by ensuring that liquids handling areas are paved, contained or drained to the interceptor pit.

7.3 TRANSPORT RISK

The review of road transport risks concludes that the risk associated with the transport of dangerous goods and potentially hazardous material to the site is very low.

7.4 ADHERENCE TO RISK CRITERIA

The analysis showed that:

Individual Risk of Fatality: The risk of fatality at the nearest residential area is well below the criterion for new installations of one chance in a million per year (1×10^{-6}/yr). The 1×10^{-6}/yr individual fatality risk for the proposed peaking plant is contained well within the site boundaries.

It follows that the risk of fatality at the nearest open space and the nearest industrial area are also well below the criterion of ten and fifty chances per million years respectively (10×10^{-6}/yr and 50×10^{-6}/yr) and contained within side boundaries.

Injury Risk: The risk of injury at the nearest residential area is well below the criterion for new installations of fifty chances per million years (50×10^{-6}/yr).

Propagation Risk: Potential for propagation of an incident at the proposed peaking plant does not encroach into any other industrial areas. The 50 pmpy contour does not extend beyond the site boundary. This achieves the criterion of less than 50 pmpy individual risk to workers on adjacent industry sites.

Societal Risk: The risk of fatality does not extend anywhere close to any residential and is well within the criteria for business / industrial areas. It is therefore considered that the current installation does not have a significant impact on societal risk.

8 CONCLUSION AND RECOMMENDATIONS

8.1 OVERVIEW OF RISK

The main hazard associated with the proposed project is associated with the handling of combustible liquids (distillate).

Hazards may arise in fixed plant, storage, and pipelines. The predominant mode in which a hazardous incident may be generated is associated with a leak. This would generally only have the potential to cause injury or damage if there was ignition, which resulted in a fire. The factors involved are:

- Failure must occur causing a release. There are several possible causes of failure, with the main ones being corrosion and damage to the equipment by external agencies;
- The released material must come into contact with a source of ignition. In some cases this may be heat or sparks generated by mechanical damage while in others, the possible ignition source could include non-flame proof equipment, vehicles, or flames some distance from the release. In the case of distillate, the probability of ignition is very low seeing the relatively high flash point of the material (about 65^{o}C), indicating that the source of ignition must be very energetic and that the material would need to have been heated prior to the incident for ignition to occur;
- In case of ignition, the result of ignition of distillate would be a pool fire. The size of the pool fire depends on the release conditions, including the mass of material involved and how rapidly it is ignited.
- Finally, for there to be a risk, people must be present within the harmful range (consequence distance) of the fire. How close the people are will determine whether any injuries or fatalities result.

8.2 SUMMARY OF RISK RESULTS

The final design and detailed specifications have not been finalised as yet for this development. A set of very conservative assumptions as to the design and operation of the plant have been made, including a 100% on-line operation of the plant (despite the fact that it is expected that the plant will be operational for 10% of the time only).

Even though many of the assumptions in this PHA are highly conservative, the results show that the risk associated with this development is very low. The most stringent risk criteria, as required by the Department of Planning, are adhered to.

8.3 RECOMMENDATIONS

The risk assessment carried out in this study assumed that the facility will be operated with appropriate consideration to safety and safety management at all stages.

The following recommendations emphasise the assumptions made in this risk assessment:

Recommendation 1: It is recommended that an assessment / audit is carried out of the safety management system implemented and used at the site, specifically as it applies to the proposed hazardous materials handling, fuel reticulation and storages within the first year of operation.

Recommendation 2: A system should be put in place to ensure that any removal of critical safety function (e.g. for repair or exchange) is subject to careful scrutiny by plant management (decisions on whether to shut down plant or a gas turbine if a critical safety function is removed need to be canvassed).

Appendix 1

Drawing

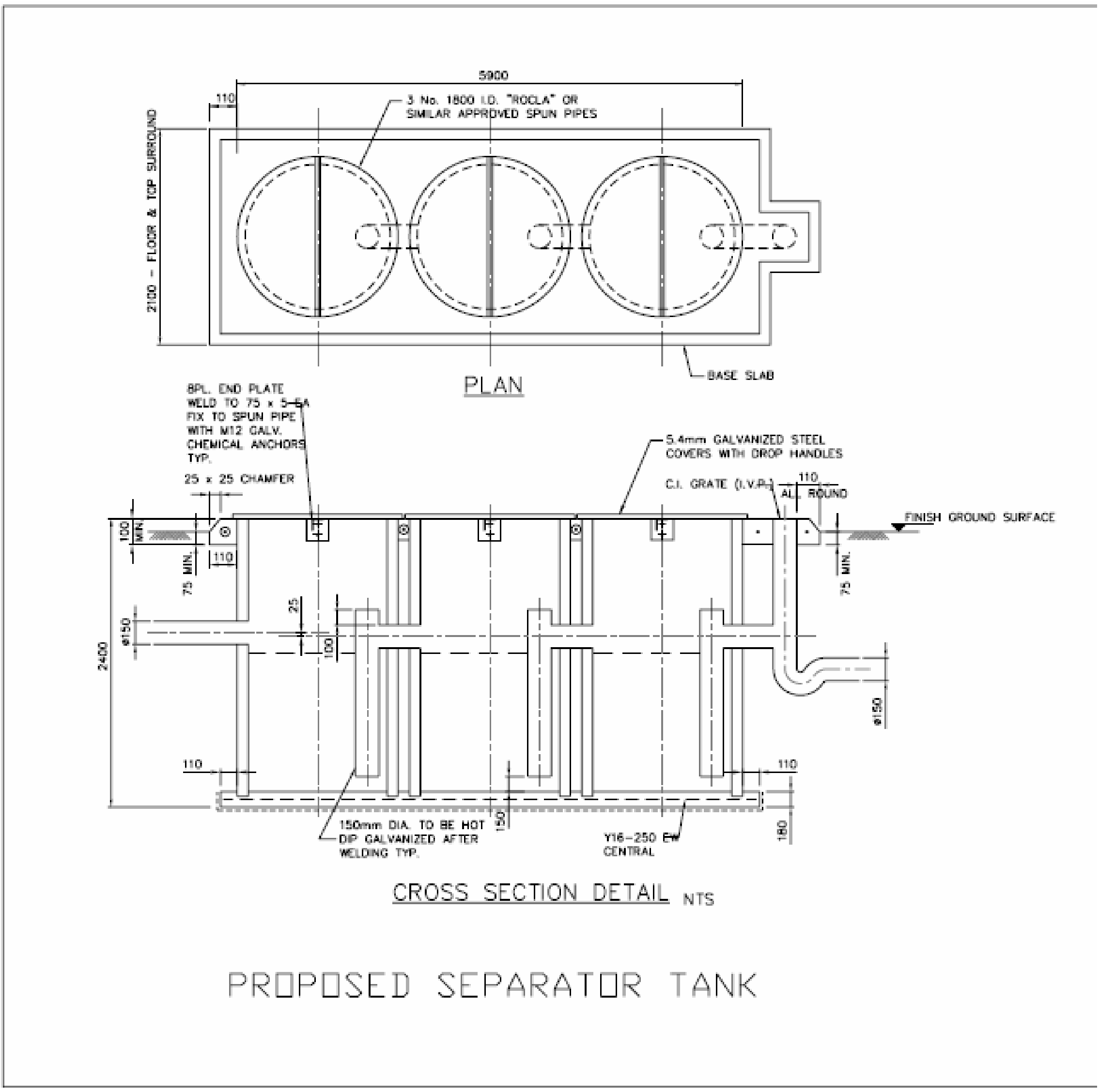
Preliminary Hazard Analysis of IPRA's Proposed

Peaking Power Plant at Buronga, NSW

Appendix 1 - Drawing

Note that the following drawing is preliminary only and have been produced well before detailed design work has commenced.

Conceptual Drawing for the Interceptor Pit



9 REFERENCES

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