Preliminary Hazard Analysis – Summary of Key Outcomes

The preliminary hazard analysis (PHA) assessment has been carried out in accordance with the Department of Planning's Hazardous Industry Planning Advisory Paper (HIPAP) No. 6 (*Guidelines for Hazard Analysis*) and HIPAP No. 4 (*Risk Criteria for Land Use Planning*). The main hazard associated with the proposed Project is associated with the handling of natural gas (predominantly composed of methane gas), which is a flammable gas held under pressure.

As the design of the power plant and associated gas supply pipeline is in the preliminary stage, detailed plant information was not available for review. In situations where such information could impact on the PHA, assumptions were made. These assumptions are intentionally conservative and have been stated in the assessment.

Despite the fact that many of the assumptions in the 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.

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

Chapter 18 Preliminary Hazard Analysis

18.1 Introduction

The Department of Planning's *Multi Level Risk Assessment Guidelines*, aim to provide a guide to the level of assessment necessary for an operation being studied. In accordance with these guidelines and as part of the Environmental Assessment, a quantitative Preliminary Hazard Assessment (PHA) was prepared for the Dalton Power Project. The following sections summarise the results of the PHA undertaken by Planager Risk Management Consulting for the proposed power plant. The full report is presented in **Appendix J**.

The assessment has been carried out in accordance with the Department of Planning's HIPAP No 6 (*Guidelines for Hazard Analysis*) and HIPAP No 4 (*Risk Criteria for Land Use Planning*). These documents describe the methodology and the criteria to be used in PHAs, as required by the Department of Planning for major "potentially hazardous" development.

In accordance with Department of Planning's HIPAP No. 3 *(Environmental Risk Impact Assessment Guidelines),* the safety assessment process would continue throughout the design, construction and commissioning of a potentially hazardous facility to refine and update the outcome of the development approval / environmental risk process.

18.2 Methodology

The objective of this PHA is to present the hazards and risks associated with the proposed peaking power plant and the lateral gas supply pipeline.

Through the evaluation of likelihood and consequence of the major hazards, the risks to the community associated with proposed power plant are estimated and compared to NSW Department of Planning risk criteria.

The process for PHA follows a number of steps which provide assurances that risks imposed by a development upon surrounding land uses would be within acceptable limits and that this would continue to be the case throughout the life of the development.

The aim of the PHA is to:

- identify and analyse the 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; and
- 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 PHA notes that there are five stages in risk assessment, each of which is described below.

- Stage 1 - Hazard Identification - The tasks involved in the hazard identification of the proposed facility included a review of all relevant data and information to highlight specific areas of potential concern and points of discussion, including drafting up of a preliminary hazard identification word diagram. The hazard identification word diagram is then reviewed and completed in a workshop which included people with operational, engineering and risk assessment expertise. The review takes into account both random and systematic errors, and gives emphasis not only to technical requirements, but also to the management of the safety activities and the competence of people involved in them.
- Stage 2 - Consequence and Effect Analysis - The consequences of identified hazards are assessed using current techniques for risk assessment. Well established and recognised correlations between exposure and effect on people are used to calculate impacts.
- Stage 3 - Frequency Analysis - For incidents with significant effects, whether on people, property or the biophysical environment, the incident frequency are estimated, based on historical data. A probabilistic approach to the failure of vessels and pipes is used to develop frequency data on potentially hazardous incidents.
- Stage 4 - Quantitative 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. In order to assess the merit of the proposal, it is necessary to calculate the risk at a number of locations so that the overall impact can be assessed.
- Stage 5 - Risk reduction - Where possible, risk reduction measures are identified throughout the course of the study in the form of recommendations.

Stage 4 (Quantitative Risk Analysis) calculates the risk for each incident according to:

Risk = Consequence x Frequency

Total risk is obtained by adding together the results from the risk calculations for each incident, i.e. the total risk is the sum of the risk calculated for each scenario.

The results of the risk analysis are presented in three forms discussed below.

Individual Fatality Risk

Individual Fatality Risk, is the likelihood (or frequency) of fatality to notional individuals at locations around the site, as a result of any of the postulated fire and explosion events. The units for individual risk are probability (of fatality) per million per year. Typically, the result of individual risk calculations is shown in the form of risk contours overlaid on a map of the development area. For pipelines (as for other transport activities), the individual risk contours are best represented as risk transects, showing the risk as a function of the distance from the pipeline.

Injury and irritation risk

Injury and irritation risk, i.e. the likelihood of injury to individuals at locations around the site as a result of the same scenarios used to calculate individual fatality risk.

Societal risk

Societal risk takes into account the number of people exposed to risk. Whereas individual risk is concerned with the risk of fatality to a (notional) person at a particular location (person 'most at risk', i.e. outdoors), societal risk considers the likelihood of actual fatalities among any of the people exposed to the hazard. Societal risk is presented as so called *f-N curves*, showing the frequency of events (f) resulting in N or more fatalities. To determine societal risk, it is necessary to quantify the population within each zone of risk surrounding a facility. By combining the risk results with the population data, a societal risk curve can be produced.

The risk results are assessed against the guidelines adopted by the NSW Department of Planning.

18.3 Risk Criteria

18.3.1 Individual Risk Criteria

The individual fatality risk is the probability of fatality to a person or a facility at a particular point. It is usually expressed as chances per million per year (pmpy). It is assumed that the person would be at the point of interest 24 hours per day for the whole year. By convention in NSW, no mitigation is allowed, i.e. any possible evasive action that could be taken by a person exposed to a hazardous event, e.g. by walking out of a toxic cloud or a heat radiation. The assessment of fatality, incident propagation and injury risk should include all components contributing to the total risk, i.e. fire and explosion.

The Department of Planning uses a set of guidelines on acceptable levels or individual risk which are in line with the criteria used elsewhere in the world. These guidelines are published in the HIPAP No. 4 (*Risk Criteria for Land Use Safety Planning)*.

18.3.2 Societal Risk Criteria

Societal risk is concerned with the potential for an incident to coincide in time and space with a human population. Societal risk takes into account the potential for an incident to cause multiple fatalities. Therefore, two components are relevant, namely:

- the number of people exposed in an incident; and
- the frequency of exposing a particular number of people.

The societal risk criteria specify levels of societal risk which must not be exceeded by a particular activity. The same criteria are currently used for existing and new developments. Two societal risk criteria are used, defining acceptable and unacceptable levels of risk due to a particular activity. The criteria are represented on the societal risk (f-N) curve as two parallel lines. Three zones are thus defined:

1) Above the unacceptable / intolerable limit the societal risk is not acceptable whatever the perceived benefits of the development.

2) The area between the unacceptable and the acceptable limits is known as the ALARP (as low as reasonably possible) region. Risk reduction may be required for potential incidents in this area.

3) Below the acceptable limit, the societal risk level is negligible regardless of the perceived value of the activity.

18.4 Potential for Hazard Incidents and Mitigation Measures

18.4.1 Summary of Hazard Identification Process

The main hazard associated with the proposed development is related to a leak of flammable natural gas.

This would generally only have the potential to cause injury or damage if there was ignition, which resulted in a fire or explosion 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;
- depending on the release conditions, including the mass of material involved and how rapidly it is ignited, the results may be a localised fire (for example a so called jet fire), a flash fire or an explosion of the vapour cloud formed through the release; and
- finally, for there to be a risk, people must be present within the harmful range (consequence distance) of the fire or explosion. How close the people are will determine whether any injuries or fatalities result.

Natural gas is a buoyant, flammable gas which is lighter than air (relative density of 0.6). On release into the open, the non-ignited gas tends to disperse rapidly at altitude. Ignition at the point of release is possible, in which case the gas would burn as a jet (or torch) flame. On release in an enclosed area (for example within the gas turbine housing) an explosion or a flash fire is possible.

The gas is non-toxic, posing only an asphyxiation hazard. Due to its buoyancy, any release of credible proportions from operations of this scale, in the open, would not present an asphyxiation hazard. With standard confined space entry procedures and appropriate security arrangements to prevent unauthorised access to any of the facilities the risk associated with asphyxiation from natural gas should be minimal.

Locally, the pressure of the compressed gas may be hazardous in case of an uncontrolled release. These hazards, while of importance for people working at the site, do not have implications beyond the immediate location of the release unless the released gas is ignited. Therefore, the risk associated with non-ignited compressed gas does not form part of the scope of the present risk assessment. This potential risk would however need to be closely managed through job safety analysis (JSA) and / or other risk assessment practices used by management and operators of the facility in accordance with NSW *Occupational Health and Safety Act 2000* and its associated regulations.

Other potential hazards are associated with the handling and use of diesel and other combustible liquids (i.e. the oils used for pumps, compressors, turbines etc.). Minor quantities of flammable acetone (used for cleaning) would also introduce a potential fire hazard.

A total of 16 hazards were identified for the Project, as listed in **Table 18-1** below.

Table 18-1 Summary of Identified Hazards

Number	Hazardous Event Potential	Offsite Impact Potential
1	Leak of natural gas to atmosphere from gas pipes on-site (outside the turbine housing)	Yes
2	Operational error of the pipeline causes leak	Yes
3	Venting of gas from process	No
4	Explosion within piping or inside a vessel	No
5	Leak of natural gas to inside the turbine housing from damage to pipe, corrosion, sabotage, etc.	Yes
6	Leak of natural gas to inside the turbine housing due to projectile.	No
7	Release of carbon dioxide (or of other fire quenching material to be used for fire protection)	No
8	Loss of containment of flammable or combustible liquid (including diesel, oils and acetone)	No
9	Fire at transformers	No
10	Flooding	No
11	Earthquake	No
12	Land subsidence due to mining activity	No
13	Aircraft crash on Power Station site	No
14	Terrorist activity or vandalism to natural gas installation	No
15	Transport of potentially hazardous material to the site (diesel, acetone)	No
16	Leak of natural gas from the gas supply pipelines	Yes

Table 18-1 above shows that 16 hazards were identified during the assessment. The PHA (refer to **Appendix J**) presents a hazard identification word diagram representing the hazardous incidents and their associated mitigating features. This assessment determined that 12 events had no potential for offsite effects. The remaining four hazards (natural gas leak from pipeline, leak from pipeline caused by operational error, leak of natural gas to inside the turbine housing, and leak of natural gas from the gas supply pipelines) were assessed in more detail. The detailed risk assessment is presented in **Appendix J**.

The Preliminary Hazard Analysis has considered that further assessment is not required to address fire as there are adequate design controls such as fire protection (fire extinguishers, hose reel requirements, separation distances etc) as per AS1940, design of ventilation of building as per AS1940 Section 4.4 with regards to flammable vapours, control of ignition sources as per AS1940 Section 9.7.6. Notwithstanding this, AGL commits to undertaking further assessment of:

- the impact of bushfires on the power station; and
- the bushfire ignition threats from the power station.

18.4.2 Risk Assessment

The risk assessment used the ISORIS computer software tool to determine the cumulative risk from all identified hazards. The tool calculates the leak rate for each identified incident type, using standard orifice flow equations for vapour or liquid, as appropriate. This program is designed to take consequence and frequency information and determine risk levels to individuals at all locations within a user-defined grid. Based on the modelling, risk contours can be determined drawn.

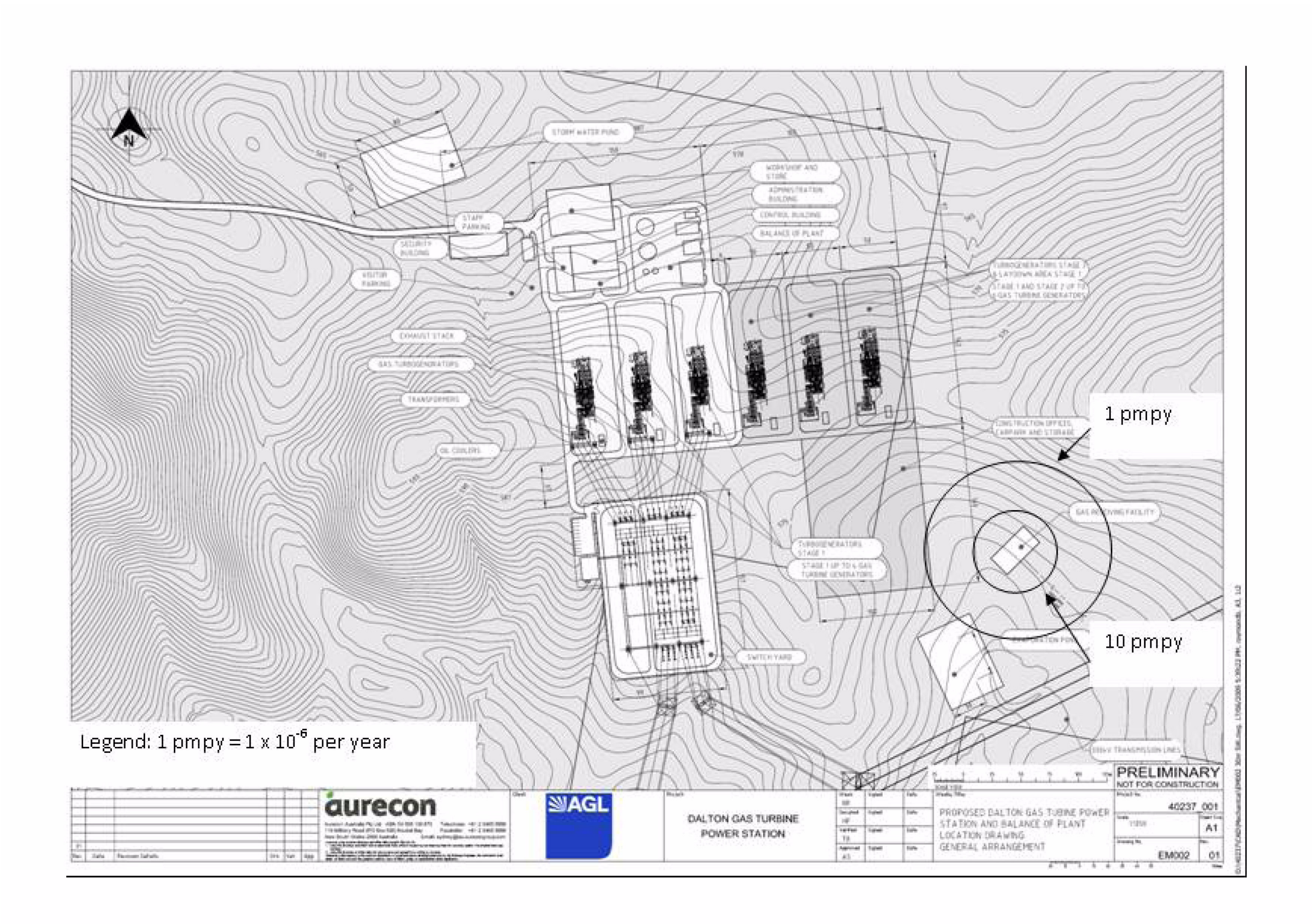
Natural Gas

Risk contours for the site are shown in **Figure 18-1**, which shows the individual fatality contours for risk associated with the Power Plant. Further to this, **Figure 18-2** presents a risk transect for individual fatality at the natural gas supply pipeline (from the off take at the Moomba to Sydney Gas Pipeline) up to the boundary of the Facility.

Fatality, injury and propagation risk contours are contained well away from surrounding residences. In this study the risk of fatality of 1 per million per year does not extend to surrounding residences. The concept of societal risk is therefore not applicable for the proposed development.

The individual risk of fatality associated with the gas supply pipeline is a maximum of 2 per million per year up to a distance of about 18 m from the centre line of the pipeline. The 1 per million per year risk contour, relevant for residential development, reaches up to a distance of 22 m from the centre line of the pipeline.

Legend:



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Job No: **43177661**	File: 43177661.015.wor	

Client

AGL

Project

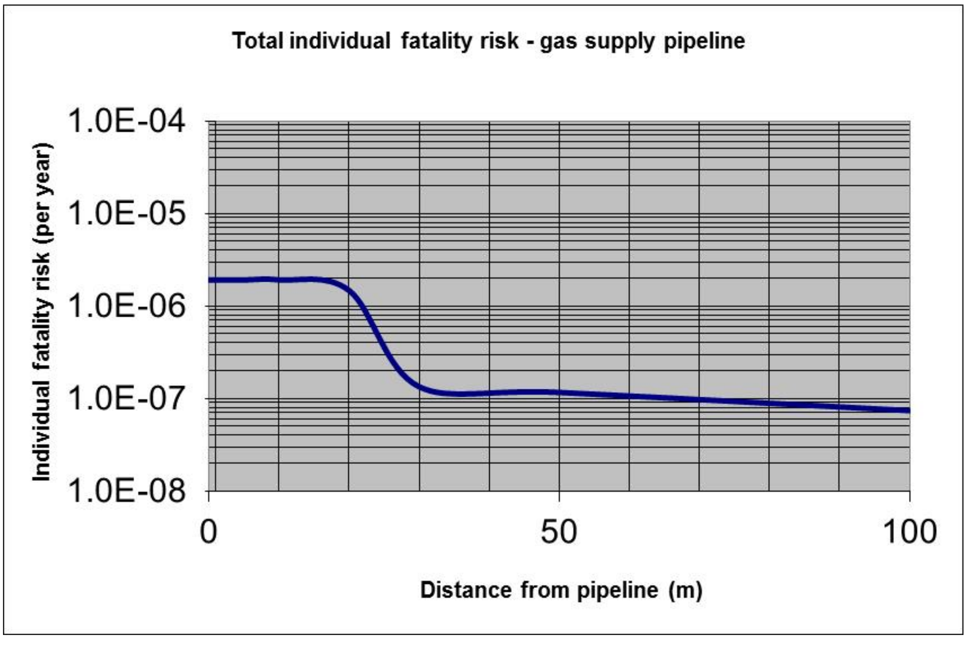
DALTON POWER PROJECT

Title

INDIVIDUAL FATALITY RISK CONTOURS

Figure: **18-1**

Figure 18-2 Individual Fatality Risk Transect for gas supply pipeline



Risk of Natural Gas Explosion in Turbine Housing

The likelihood of a confined explosion inside the turbine housing was estimated taking into account that the basis of safety would likely include:

- highly reliable ventilation fan system;
- gas detection linked to automatic emergency shut down system;
- prevention of ignition sources within the housing;
- explosion panel (to minimise effect of confinement) and fire quenching (e.g., carbon dioxide); and
- separation distances to nearby turbines and pressure piping.

With six turbines, the total frequency of explosion inside the turbine housing was determined as being very low.

A confined explosion may generate high over pressures which could damage neighbouring equipment and turbines. It is, however, understood that the housings would be designed with explosions vents (and / or panels) which would blow out in case of a pressure event, thereby reducing the effect of the confinement. Further, the turbines would be separated from each other by a buffer zone.

With proper design it is unlikely that an explosion at one turbine would have a serious effect a neighbouring turbine.

Transport Risk

Once the site has been built and is operational, the frequency of road transportation to the site of dangerous goods and potentially hazardous material would be minimal. It is expected that one delivery (up to a maximum of three deliveries) per year would be sufficient for the operation of the site, consisting of the occasional diesel and oil top up and possibly the transport of some other material used for maintenance or cleaning (e.g. acetone). Note that oil and diesel would be transported to the site in relatively small quantities. Diesel is used only occasionally in the stand-by emergency generator (in case of a power failure, diesel is the fuel for the generator used to run the UPS - *Uninterrupted Power Supply*). Oils are used to top up the gear boxes of the turbines, pumps, air compressors etc.

Road transportation would use Walshs Road and a purpose built access road up to the site. The access road to the site is to be of adequate construction for the use and to 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 would 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 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 negligible.

18.4.3 Risk Results

The quantitative 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 x 10^{-6}/yr). The 1 x 10^{-6}/yr individual fatality risk for the Facility 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 x 10^{-6}/yr and 50 x 10^{-6}/yr) and contained within side boundaries.

- It should however be noted that the maximum tolerable risk for residential developments is exceeded for a distance of 22 m of either side of the centreline of the gas supply pipeline for a pipeline designed to AS2885 requirements for rural development. The 1 x 10^{-6}/yr individual fatality risk for the gas supply pipeline does not extend into any residential areas.

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

- Propagation Risk: The 50 x 10^{-6}/yr risk contour is contained within the site boundary. The risk of propagation of an incident at the power station does not encroach into any other industrial areas.

- Societal Risk: The risk of fatality does not extend anywhere close to any residential area 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.

- Transport Risk: The risk associated with transport of potentially hazardous materials is low for this development.

The detailed design has not been completed 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 (as a worst case assumption, with appropriate fire proof isolation valves separating the plant from pressurised gas supplies).

Despite the conservatism built into the risk assessment, 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.

The results show that the 1 x 10^{-6} per year individual risk contour does not extend beyond the site boundary for the power station.

This risk contour does extend by 22 m in either direction of the centreline of the pipeline, implying that future residential developments (if ever an option) would be restricted within this buffer.

18.5 Mitigating Measures

A summary of the mitigation measures in terms of hazard is provided **Table 18-2**.

Table 18-2 Summary of Hazard Mitigation Measures

Mitigation Measures	Implementation of mitigation measures		
	Design	Construction	Operation
Implement a safety management system for use at the site, specifically as it applies to the proposed hazardous materials handling, pipelining and storages.			✓
High and low pressures of the natural gas pipe are to be monitored during (and, if applicable, outside) operation of the Power Plant. These conditions would need to be associated with an automatic trip / shut down of the pipeline at the metering station in case of a major failure of the natural gas pipeline within the site boundary (as assumed in the PHA).			✓
Use of fusible tubing around high risk natural gas piping to be investigated – such tubing would be linked to automatic shut down of the fuel source.			✓
The detailed design of the turbine housing and associated equipments should clearly outline the safety measures used to ensure that explosive situations do not arise (the risk is rendered negligible). Reference should be made to European ATEX Directive and the UK HSE PM84 or other guidance / regulation of equivalent safety.	✓		
Fire protection inside the turbine housing to be determined, including use of explosion panels and use of fire retardant material where appropriate.	✓		
A system implemented to ensure that any removal of critical safety functions (e.g. for repair or exchange) is subject to careful scrutiny by plant management (decisions on whether to shut down plant or a turbine if a critical safety function is removed need to be canvassed).	✓		✓

Mitigation Measures	Implementation of mitigation measures		
	Design	Construction	Operation
Rotating machines to be designed such that risk associated with projectile is minimised (gas pipelines protected or not in probable line of projectile, people protected etc.)	✓		
Loud alarm and visual indication (e.g. strobe light) to be installed within the turbine housing, alerting any persons within these housings of the pending discharge of asphyxiants and allowing escape.	✓		✓
Further assessment of the impact of bushfires on the power station and bushfire ignition threats from the power station.	✓		
A safety assessment process would continue throughout the design, construction and commissioning of a potentially hazardous facility to refine and update the outcome of the development approval / environmental risk process.	✓	✓	✓