Appendix F

Preliminary Hazard Assessment

Preliminary Hazard Analysis

AGL Newcastle Power Station Project, Tomago NSW

AGL Energy Limited (AGL) proposes to construct and operate a dual fuel fast-start peaking power station in Tomago, New South Wales (NSW). AGL is seeking approval for the Proposal from the NSW Minister for Planning and Environment under the NSW Environmental Planning and Assessment Act 1979.

Aurecon

Executive Summary

AGL Energy Limited (AGL) proposes to construct and operate a dual fuel fast-start peaking power plant with a nominal capacity of 250 megawatt (MW), the Newcastle Power Station (NPS). The NPS, with gas pipelines, electricity transmission lines, site access and associated ancillary facilities, (the Proposal) would be located off Old Punt Road in Tomago, New South Wales (NSW).

The Proposal would consist of the following three key components and associated ancillary infrastructure:

- Power station: a dual fuel power station capable of operating on natural gas and/or liquid fuel (diesel)
- Gas pipelines
- Electricity transmission lines: to transfer the electricity produced by the NPS to the national electricity network

The Proposal was declared Critical State Significant Infrastructure (CSSI) by the NSW Minister for Planning and Environment in December 2018 under the State Environmental Planning Policy (State and Regional Development) 2011. As CSSI, the Proposal requires approval from the Minister under the NSW Environmental Planning and Assessment Act 1979.

The Secretary's Environmental Assessment Requirements (SEARs) for Hazard and Risk include:

- A Preliminary Hazard Analysis (PHA), covering all aspects of the proposal which may impose public risks, to be prepared consistent with Hazardous Industry Planning Advisory Paper No. 6 – Guidelines of Hazard Analysis [Reference (1)] and Multi-Level Risk Assessment. The PHA must:
  - include a pipeline risk assessment to estimate the risks from the pipeline to the surrounding land uses, with reference to AS2885 Pipelines – Gas and Liquid Petroleum, Operation and Maintenance;
  - Demonstrate that the risks from the proposal comply with the criteria set out in Hazardous Industry Planning Advisory Paper No. 4 – Risk Criteria for Land Use Safety Planning [Reference (2)]

The objective of this study is to develop a high-level understanding of the hazards and risks associated with the Proposal. The hazard analysis process encompasses qualitative and quantitative methods to assess the adequacy of controls. This report evaluates the concept design and operation of the Proposal to ensure appropriate land use safety planning.

Potentially Offensive and Hazardous Analysis

Schedule 3 of the Environmental Planning and Assessment Regulation provides a description of several categories of industry with a potential for significant environmental impact.

Electricity generating stations, including associated water storage, ash or waste management facilities, are considered offensive if they are supplying or are capable of supplying more than 30 megawatts of electrical power from other energy sources (including coal, gas, wind, bio-material or solar powered generators, hydroelectric stations on existing dams or co-generation).

Since the Proposal includes a new power station with a nominal capacity of about 250 MW from a gas energy source, it is considered a potentially offensive industry. Consequently, an analysis of the potential impacts to neighbouring facilities and land uses is required.

The following technical studies provide a detailed description of the quantity, nature and significance of all offences likely to be caused by the development that could produce air, noise, water or other emissions:

- Surface Water and Ground Water Assessment (Section 6.3 and Appendix E of the Environmental Impact Statement (EIS))

- Air Quality Assessment (Section 6.5 and Appendix G of the EIS)
- Noise Assessment (Section 6.9 and Appendix L of the EIS)
- Environmental Management and Monitoring (Section 9.2 of the EIS).

Included in the technical studies are the safeguards required to ensure potential offensiveness can be controlled to a level which is not significant.

The Proposal was also found to be potentially hazardous. Risks were assessed against the criteria which have been set out in HIPAP Paper No 4 – Risk Criteria for Land Use Safety Planning [Reference (2)] as detailed in Table 1.

Table 1: Individual Fatality Risk Criteria

Land Use	Land Use Category	Suggested Criteria (per million per year)
Hospitals, schools, child-care facilities, old age housing	Vulnerable land use	0.5
Residential, hotels, motels, tourist resorts	Sensitive land use	1
Commercial developments including retail centres, offices and entertainment centres	Commercial land use	5
Sporting complexes and active open space	Open space land use	10
Industrial	Industrial land use	50

The risk contours show that the risk level at vulnerable land use (e.g. hospitals, schools, child-care facilities, old age housing), sensitive land use (e.g. residential, hotels, motels, tourist resorts), community activity land use (e.g. sporting complexes and active open space), commercial land use (e.g. retail centres, offices and entertainment centres)and industrial land use areas do not exceed the limits in Table 1.

The major contributors to releases and subsequent major events are:

- from the loss of containment of the natural gas from aboveground gas processing areas due to the large inventory of the flammable material
- the high pressure of the gas within the above ground piping sections
- the number of leak sources

The Proposal is presently at concept design stage. As such, these major event scenarios are conservative as no safety mitigations, which would be incorporated later during detailed design, have been accounted for that would reduce the frequency of the events. Safety and fire mitigation measures would be incorporated during detailed design to reduce loss of containment events and ignition sources and ensure the protection of onsite equipment and occupied buildings.

The societal risk criteria, is also met as the F_N Curve is within the ALARP (as low as reasonably practicable) and negligible range. The likelihood of a multiple fatality event is found to be tolerable.

Recommendations

The results of the risk assessment show that additional mitigation measures are required to be considered during the future Proposal development stages. These include, but are not limited to:

- Compliance with all applicable Australian Standards
- Inherent safe design processes to minimise the potential loss of containment and resulting fire scenarios
- No liquified gas storage within the pipelines
- Recommendations from the AS2885 Pipelines – Gas and Liquid Petroleum, Operation and Maintenance study are incorporated into the design
- Where housings are utilised, the detailed design safety requirements for housings should include as a minimum:
  - Highly reliable ventilation fan system and ventilation detection system
  - Independent 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)
  - Separation distances to nearby housings and occupied buildings
  - Safety systems to isolate both liquid and gas fuel supplies
- A detailed Quantitative Risk Assessment is recommended during detail design to ensure the appropriate location of onsite occupied buildings and siting of major pieces of equipment including the diesel storage tanks
- Spacing of potential fire hazards and the provision of fire barriers as necessary
- Functional safety assessment of control and shutdown systems to ensure that the likelihood of a loss of containment scenario is reduced
- Installation of a hydrocarbon detection systems within the facility, which act to isolate flow and likelihood of a loss of containment and resulting fire scenario
- Development of an Emergency Response Plan in collaboration with the local authorities for the incidents impacting the NPS, NGSF and Pacific Highway

The safety assessment process would continue to identify controls that prevent or limit the effects of a major accident scenario. The detailed design would continue to consider whether there are further controls that could be implemented to reduce risk so far as is reasonably practicable.

Conclusion

The PHA has been completed and demonstrates that the risks from the Proposal complies with the criteria set out in Hazardous Industry Planning Advisory Paper No. 4 – Risk Criteria for Land Use Safety Planning [Reference (2)].

A complimentary pipeline risk assessment, in-line with AS2885, has been conducted and is documented as part of the Environmental Impact Statement.

Contents

1 Introduction

1.1 Background

AGL Energy Limited (AGL) proposes to construct and operate a dual fuel fast-start peaking powerplant, with a nominal capacity of 250 megawatt (MW), the Newcastle Power Station (NPS). The NPS, with gas pipelines, electricity transmission lines, site access and associated ancillary facilities (the Proposal) would be located off Old Punt Road in Tomago in New South Wales (NSW). The Proposal was declared Critical State Significant Infrastructure (CSSI) by the NSW Minister for Planning and Environment in December 2018 under the State Environmental Planning Policy (State and Regional Development) 2011. As CSSI, the Proposal requires approval from the Minister under the NSW Environmental Planning and Assessment Act 1979.

The NSW Department of Planning, Industry and Environment (DPIE) has developed an integrated assessment process for safety assurance of potentially offensive or hazardous development Proposals. This comprises a Preliminary Hazard Analysis (PHA) in accordance with:

- HIPAP No. 4 – Risk Criteria for Land Use Safety Planning [Reference (2)
- HIPAP No. 6 – Hazard Analysis [Reference (1)]
- Applying SEPP 33 – Hazardous and Offensive Development Application Guidelines [Reference (3)]
- Multi-Level Risk Assessment Guidelines [Reference (4)]

1.2 Proponent

AGL is an Australian publicly-listed company involved in the generation and retailing of electricity and gas for residential and commercial use. AGL generates energy from a range of sources including thermal power, natural gas, gas storage, coal seam gas, and from renewables including wind, hydroelectricity and solar. AGL is the largest ASX-listed investor in renewable energy and markets its natural gas, electricity and energy-related products and services to approximately 3.6 million customers.

While AGL Energy Limited is currently the proponent, the ultimate proponent may be a successor or assignee to AGL.

1.3 Objective

The Secretary's Environmental Assessment Requirements (SEARs) for Hazard and Risk include:

- A Preliminary Hazard Analysis (PHA), covering all aspects of the proposal which may impose public risks, to be prepared consistent with Hazardous Industry Planning Advisory Paper No. 6 – Guidelines of Hazard Analysis [Reference (1)] and Multi-Level Risk Assessment. The PHA must:
  - include a pipeline risk assessment to estimate the risks from the pipeline to the surrounding land uses, with reference to AS2885 Pipelines – Gas and Liquid Petroleum, Operation and Maintenance
  - Demonstrate that the risks from the proposal comply with the criteria set out in Hazardous Industry Planning Advisory Paper No. 4 – Risk Criteria for Land Use Safety Planning [Reference (2)]

The objective of this study is to develop a high-level understanding of the hazards and risks associated with the Proposal. The hazard analysis process encompasses qualitative and quantitative methods to assess the adequacy of controls. This report evaluates the concept design and operation of the Proposal to ensure appropriate land use safety planning.

A complimentary pipeline risk assessment, in-line with AS2885 has been conducted and is documented as part of the Environmental Impact Statement in a separate report.

1.4 Scope of Assessment

The Proposal would consist of three key components and associated ancillary infrastructure. The key components include:

- Power station: a dual fuel power station capable of operating on natural gas and/or liquid fuel (diesel)
- Gas pipelines
- Electricity transmission lines: to transfer the electricity produced by the NPS to the national electricity network.

The design of the facility at the time of this PHA is at concept stage. Assumptions have been made around the type and operation of equipment and pipelines. A detailed Quantitative Risk Assessment is recommended during detail design. This assessment would ensure the appropriate location of onsite occupied buildings and siting of major pieces of equipment and tanks, and risks associated with the construction and commission phases are understood further.

2 Methodology

This preliminary hazard analysis was based on the Proposal concept design to determine if the handling, storing or processing of any substances may create an off-site risk or offence to people, property or the environment.

2.1 Preliminary Risk Screening

Applying SEPP 33 Application Guidelines [Reference (3)] has been used to determine whether SEPP 33 applies to the Proposal. SEPP 33 applies if a Proposal for an industrial development requires consent, and it is either a potentially hazardous industry or a potentially offensive industry.

The following information was used in the risk screening process:

- Identification and description of dangerous goods and hazardous chemicals handled or stored at the Proposal
- Maximum quantities of dangerous goods and otherwise hazardous chemicals involved in the Proposal
- Dangerous Goods classifications for the dangerous goods handled or stored at the Proposal
- Distance from the boundary for each hazardous chemical
- Average number of road movements (and the quantities) of dangerous goods and otherwise hazardous chemicals to and from the Proposal
- The Proposal layout plan
- Locality plan showing immediate neighbours including a residential dwelling (would be demolished as part of the Proposal) and industrial facilities.

The dangerous goods which are likely to be stored, handled and produced at the Proposal are outlined in Section 5.1, Table 13.

2.2 Assessment Approach

2.2.1 Potentially Hazardous Industry

The DPIE has developed the Multi-Level Risk Assessment Guidelines, which provide a graded or multi-level framework to ensure an appropriate level of analysis and assessment when determining if the Proposal is deemed as a potentially hazardous industry. The guidelines set out criteria for using the results of the screening, classification and prioritization steps to determine which of the three levels of analysis is appropriate. The levels are as follows [Reference (4)]:

- Level 1 – a qualitative approach based on comprehensive hazard identification to demonstrate that the activity does not pose a significant risk
- Level 2 – a quantitative approach that supplements the qualitative analysis by sufficiently quantifying the key risk contributors to show that risk criteria will not be exceeded
- Level 3 – full quantitative analysis

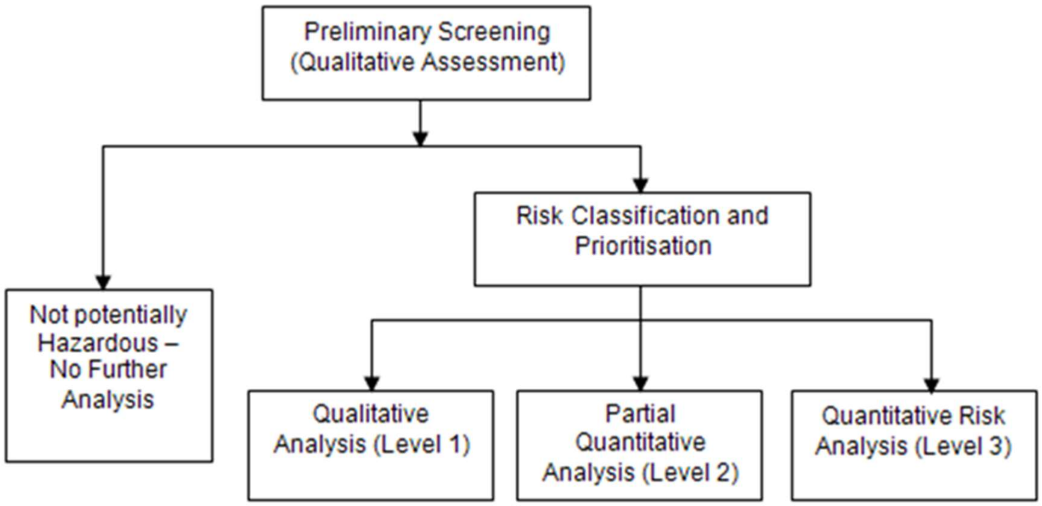

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Figure 1: Multi-Level Risk Assessment Approach [Reference (4)]

A qualitative assessment (Level 1) would be sufficient in the following circumstances [Reference (4)]:

- Where materials are relatively non-hazardous (for example, corrosive substances and some classes of flammables)
- Where there are no major worst-case consequences
- Where the technical and management safeguards are self-evident and readily implemented
- Where the surrounding land uses are relatively non-sensitive

A quantitative assessment (Level 2) should address the elements as described in a Level 1 assessment as well as provide sufficient quantification of risk contributors to demonstrate the following:

- Consequences of events using appropriate modelling tools
- An estimate of the likelihood for each event confirmed to have significant off-site effects
- An indicative estimate of the off-site risk
- Demonstration in principle that no individual event would have a fatality or injury frequency greater than that appropriate for the exposed land use
- Demonstration in principle that no combination of events would cumulatively cause individual risk criteria to be exceeded

A full quantitative risk assessment (Level 3) is required where a Level 2 assessment is unable to demonstrate that the significant offsite risk criteria can be met.

To conduct a Level 3 quantitative risk assessment, specialist software programs can be utilised. Aurecon makes uses of the DNV GL PHAST version 8.22 modelling tool.

2.2.2 Potentially Offensive Industry

Following the multi-level risk assessment approach, the Proposal must be assessed as potentially offensive in accordance with the requirements of the Applying SEPP 33 Guideline [Reference (3)]. The guideline provides a list of categories of industries with the potential for off-site offensive impacts. Off-site offensive impacts may include air emissions, water quality, noise or other environmental impacts.

The quantity, nature and significance of the offences likely to be caused by the development, as well as the need for any licences, are required for the assessment of an offensive industry. It should be demonstrated that there are adequate safeguards in place to ensure that emissions from a facility can be controlled to a level such that they are not considered significant.

2.3 Risk Criteria

2.3.1 Potentially Hazardous Industry

Risks need to be assessed against the criteria which have been developed by the Department as set out in *HIPAP Paper No 4 – Risk Criteria for Land Use Safety Planning* [Reference (2)].

In assessing the tolerability of risk from potentially hazardous development, both qualitative and quantitative aspects need to be considered.

2.3.1.1 Qualitative Risk Criteria

The following qualitative risk criteria are considered:

- All ‘avoidable’ risks should be avoided
- Particular attention needs to be given to eliminating or reducing major hazards, irrespective of whether numerical criteria are met
- As far as possible, the consequences of significant events should be kept within the facility boundaries

2.3.1.2 Quantitative Risk Criteria

The main quantitative criteria considered are risks to individuals and society.

2.3.1.2.1 Individual Risk

Individual risk considers the acceptability of a particular level of risk to an exposed individual. Individual risk is segmented into fatality, injury and property damage and accident propagation.

Fatality Risk

‘Individual fatality risk’ is the risk of death to a person at a particular point. It is assumed that the person will be at the point of interest 24 hours per day for the whole year. Regulators have concluded that if a risk from a potentially hazardous installation is below most risks being experienced by the community, then that risk may be tolerated. Table 1 outlines the risk assessment criteria that is suggested for the assessment of the safety of location of a proposed development of a potentially hazardous nature.

Table 2: Individual Fatality Risk Criteria

Land Use	Suggested Criteria (risk in a million per year)
Hospitals, schools, child-care facilities, old age housing	0.5
Residential, hotels, motels, tourist resorts	1

Commercial developments including retail centres, offices and entertainment centres	5
Sporting complexes and active open space	10
Industrial	50

Injury Risk

'Individual injury risk' captures the associated risk of injury as a result of the Proposal. The impact of injury must be considered for the following scenarios: heat radiation and explosion over-pressure. The suggested injury/damage risk criterion for these scenarios are included in Table 3.

Table 3: Injury Risk Criteria

Injury Risk Criteria	Maximum Tolerable Risk (x10^{-6} per year)
Maximum Over-pressure	
7 kPa	50 (at residential & sensitive use areas)
Maximum Heat Radiation	
4.7 kW/m^2	50 (at residential & sensitive use areas)

2.3.1.2.2 Property Damage and Accident Propagation

In accordance with HIPAP No 4 – Risk Criteria [Reference (2)], the risk criteria for damage to property and of accident propagation is outlined in Table 4.

Table 4: Property Damage and Accident Propagation Criteria

Property Damage	Maximum Tolerable Risk (x10^{-6} per year)
Maximum Over-pressure	
14 kPa	50 (at neighbouring/land zoned potentially hazardous installations)
Maximum Heat Radiation	
23 kW/m^2	50 (at neighbouring/land zoned potentially hazardous installations)

2.3.1.3 Societal Risk

Societal risk criteria are based on the ALARP (as low as reasonably practicable) principle. The DPIE has provisionally adopted the indicative criteria in Figure 2 for addressing societal concerns arising when there is a risk of multiple fatalities occurring in one event.

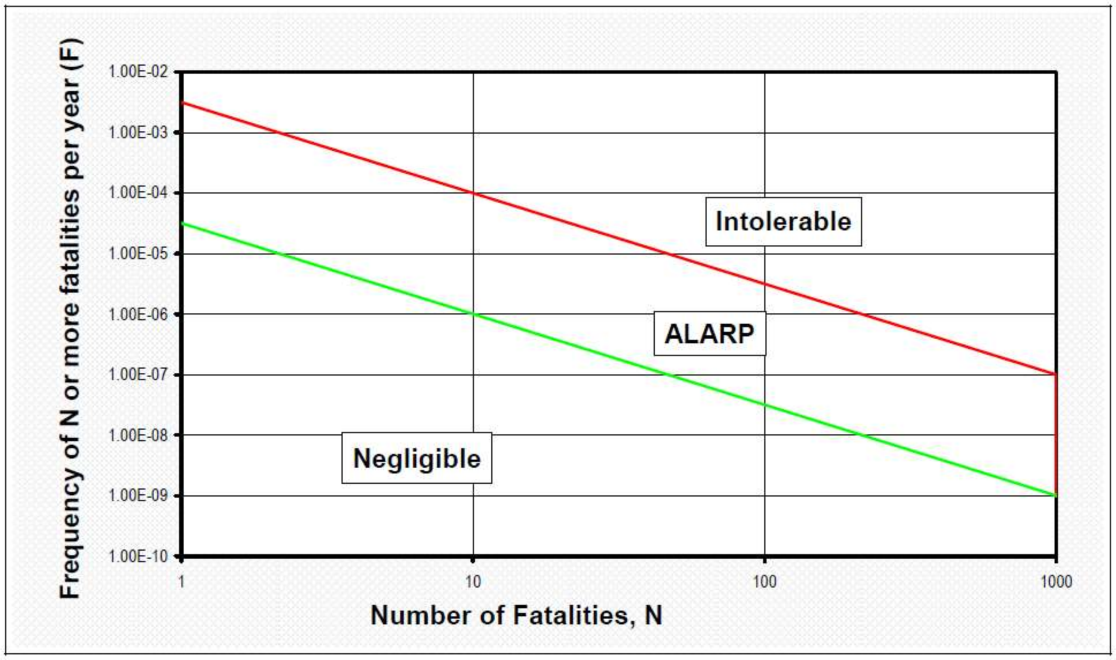

Figure 2: Indicative Societal Risk Criteria [Reference (3)]

2.3.2 Potentially Offensive Industry

Applying SEPP 33 Guideline [Reference (3)] must be used to determine if the Proposal is potentially offensive. The key consideration in the assessment of a potentially offensive industry is that the consent authority is satisfied there are adequate safeguards. These safeguards must ensure that emissions from a facility can be controlled to a level at which they are not significant.

Applying SEPP 33 Guideline lists industry types with the potential for significant environmental impact.

3 Proposal Description

3.1 Proposal Location

3.1.1 Newcastle Power Station Proposal

The Proposal would be located across 90.59 hectares (ha). This includes Lot 3 DP1043561 (the NPS site), Lot 4 DP 1043561, Lot 202 DP 1173564 and Lots 1201, 1202 and 1203 DP 1229590 (electrical transmission lines and gas pipelines). The Proposal is about five kilometres south west of Raymond Terrace and about two kilometres north east of Hexham. Hexham is a suburb of the city of Newcastle approximately 15 kilometres inland from the Newcastle Central Business District. The proposed power station site would cover approximately 16.6 hectares. The site is owned by AGL and is zoned as an industrial area. Road access to the Proposal would be via new road access that would extend from Old Punt Road.

3.1.2 Newcastle Gas Storage Facility

The NGSF is utilised to liquify and store natural gas supplied from the Jemena network. Gas is transferred from the NGSF through Hexham via the high pressure DN 400 gas transmission pipeline.

3.1.3 Jemena Gas Northern Trunkline

The JGN Northern Trunkline transports gas from Sydney to Newcastle distributing it to city gate stations along the way. Gas is currently delivered from the Northern Trunkline to the Hexham

Receiving Station, approximately 13km northwest of Newcastle. AGL owns and operates a 5.5km bidirectional pipeline between the Hexham Receiving Station and the NGSF (PL42), which is used to import, and export gas based on seasonal requirements and market demand.

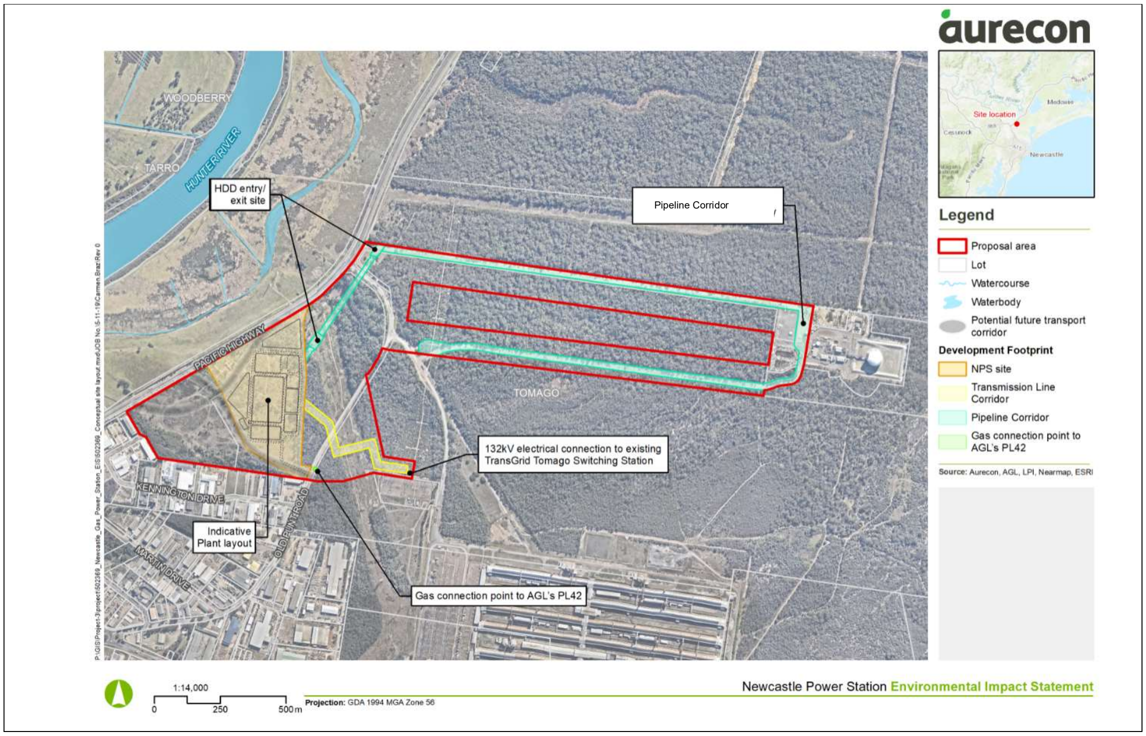

Figure 3 : Overall Proposal Layout Plan and tie-in to existing utilities

3.2 Surrounding land use

The NPS site is more than two kilometres from the closest residential zoned area. There is a house in the north-west corner of the site which will be demolished. Other major infrastructure in the near vicinity includes:

- NGSF
- TransGrid Tomago electrical switching station
- Tomago Aluminium Smelter
- Pacific Highway

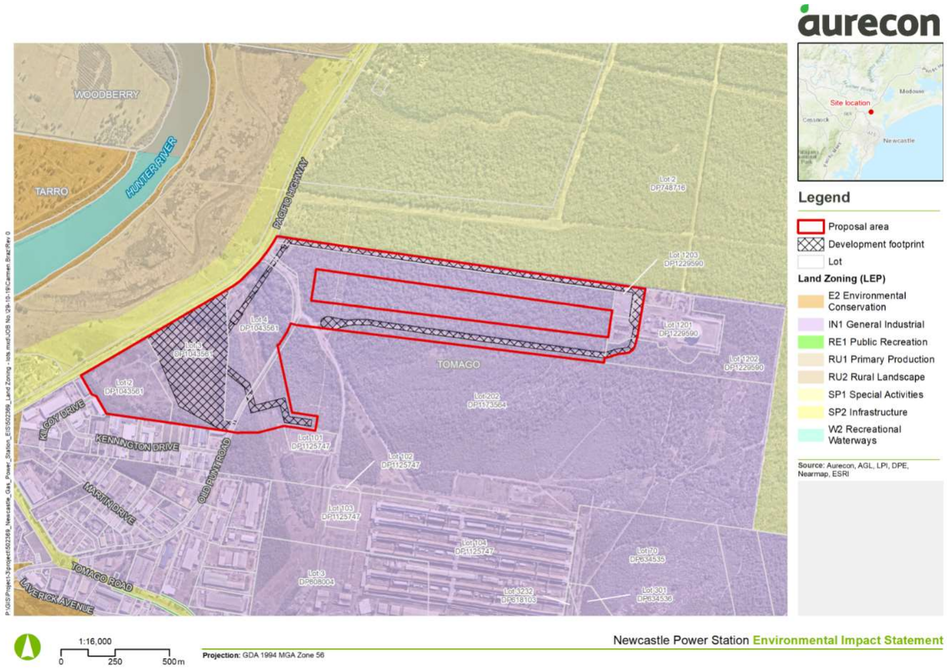

Figure 4: Surrounding Land Use

3.3 Sensitive receptors

The surrounding land use is industrial. There is no residential land in the Proposal area. The nearest residentially zoned land is approximately 2km north west of the Proposal at Woodberry in the Maitland Local Government Area (LGA). The nearest residential zoned land in the Port Stephens LGA is approximately 5km north of the Proposal at Heatherbrae.

There is a single residence on Tomago Road near its intersection with the Pacific Highway. This residence is currently owned by Tomago Aluminium Company. It is located approximately 500m south west of the Proposal on land zoned E2 – Environmental Conservation. There is also a residence associated with the Motto Farm Stud approximately 1.4km north of the Proposal on land zoned RU2 - Rural Landscape. There are no sensitive receptors identified near the NPS site.

3.4 Population data

The population present in the vicinity of the Proposal is used to determine the societal risk.

The population density data for the rural area surrounding the Proposal at Tomago was estimated using data from the Australian Bureau of Statistics [Reference (5)] website and [Reference (6)]. The estimated population density for rural land which makes up most of the Tomago region is given in Table 5.

Table 5: Tomago Rural Land Population Density

Data	Quantity	Source
Population at Tomago as of 2016 census	277 persons	Australian Bureau of Statistics [Reference (5)]
Area	7,100,000 m^2	[Reference (6)]
Rural Population Density	0.000039 persons/m^2	-

To estimate the population density for the industrial areas surrounding the Proposal, the number of employees and area covered by the Tomago Aluminium Smelter was used. The smelter has a high proportion of the industrial workforce in the area. The estimated industrial population density is shown in Table 6. It is assumed that all industrial sites in the Tomago region has the same population density.

Table 6: Tomago Industrial Land Population Density

Data	Quantity	Source
Number of employees at Tomago Aluminium Smelter	1,200 persons	Pacific Aluminium Website [Reference (7)]
Area	1,055,178 m^2	Google Earth Pro
Industrial Population Density – outside Power Station Site	0.0011 persons/m^2	
Power Station Facility	23 People	EIS

The presence of the population in the vicinity of the Proposal is further examined using guidelines from Section 5.3 of the Purple Book – Guidelines for Quantitative Risk Assessment [Reference (8)]. This considers the change in population densities depending on time of day and location of the population (i.e. indoors or outdoors). It is assumed that the following fractions listed in Table 7 apply to the population in the surrounding industrial areas of the Proposal.

Table 7. Fraction of the population present indoors ($f_{pop,\ in}$) and outdoors ($f_{pop,\ out}$) for daytime and night-time

	Daytime	Night-time
Industrial Population, indoors	0.93	0.99
Industrial Population, outdoors	0.07	0.01
Population Rural	1	1

Factoring in the above fractions to the estimation results in the population densities listed in Table 8. It is conservatively assumed that people are always outdoors in the rural areas during the day and night.

Table 8: Population Density for the Tomago Region

<table>
<tr><th colspan="2">Population Density</th><th>Day</th><th>Night</th></tr>
<tr><td rowspan="2">Industrial (persons/m^2)</td><td>Indoors</td><td>5.12E-04 persons/m^2</td><td>5.45E-04 persons/m^2</td></tr>
<tr><td>Outdoors</td><td>3.85E-05 persons/m^2</td><td>5.50E-06 persons/m^2</td></tr>
<tr><td>Rural (persons/m^2)</td><td>Outdoors</td><td>3.90E-05 persons/m^2</td><td>3.90E-05 persons/m^2</td></tr>
<tr><td rowspan="2">Power Station Facility (persons/m^2)</td><td>Indoors</td><td>21</td><td>23</td></tr>
<tr><td>Outdoors</td><td>2</td><td>-</td></tr>
</table>

3.5 Meteorological and topographical considerations

The weather trends for the Newcastle region have been summarised in Table 9. The predominant predicted wind condition and humidity levels are taken from the closest Bureau of Meteorology (BOM) weather station to the site, which is the University of Newcastle [Reference (9)]. This weather station is located 8.5 km to the south of the power station and has been operating since 1998.

Table 9. University of Newcastle BOM Weather Data

Bureau of Meteorology Data	Value
Ambient dry bulb maximum temperature	40 °C
Ambient dry bulb minimum temperature	0 °C
Mean Maximum Daily temperature (1998-2019)	24 ºC
Mean Minimum Daily temperature (1998-2019)	13.6 ºC
Mean 9am Temperature (1998-2010)	17.9 ºC
Mean 3pm Temperature (1998-2010)	22.1 ºC
Mean 9am relative humidity (1998-2010)	73%
Mean 3pm relative humidity (1998-2010)	56%
Mean 9am wind (1998-2010)	6.3 km/h (1.75m/s)
Mean 3pm wind speed (1998-2010)	12.9 km/h (3.6m/s)

The Proposal is located 12 m above sea level in a predominantly flat farm and grass area.

Dispersion of gas clouds and impacts of thermal radiation is governed by the prevalent weather conditions including, wind speed and direction (essentially horizontal mixing) and stability of the atmosphere (essentially vertical mixing). The latter is essentially the extent to which wind turbulence, which is responsible for the dispersion, is suppressed or assisted. On cold windless nights, cold air is trapped close to the surface of the earth and any gas release would not be easily dispersed. On the contrary, on a hot summer’s day there is generally a lot of turbulence in the air due to heating of the earth’s surface and the air in contact with it. This aids dispersion of gases. These conditions had been labelled weather stability classes with the letters A to F. Using the wind and weather information presented in BOM, two dominant weather categories were selected and summarised in Table 10.

Table 10. Weather Parameters

Category	1.5/ F	5/D
Wind speed (m/s)	1.5	5
Pasquill stability	F – moderately stable conditions, low wind	D – neutral, little sun and high wind
Atmospheric temperature (°C)	18	23
Relative humidity (%)	73	56
Solar radiation flux (kW/m²)	1	0.25

The average wind speeds for the area provided by BOM were presented as a wind rose, which was then analysed to provide the fraction of time the weather fell into each weather stability class. This data is shown in Table 11. Further details on the wind class stability classification see Appendix 1.

Table 11. Weather Stability Class Classification

Weather Categories	Night/9am	Day/3pm
Fraction of time weather is taken as falling into the 1.5 F category	86.5	61.5 %
Fraction of time weather is taken as falling into the 5/D category	13.5 %	38.5 %

There are many dispersion combinations included in the risk assessment, due to the different probabilities of weather stability's and wind speeds. The wind direction was considered in the eight major wind directions.

3.6 Operations and staff

The power station would be operable 24 hours a day, 7 days a week, with control of the power station possible from remote locations.

Actual times of operation for the power station would be dependent on supply and demand conditions in the market at the time. Operation is anticipated to be lower in spring and autumn when climates are more moderate and be higher during summer and winter when additional heating or cooling loads are commonly observed in the NSW electricity market. The power station would be designed to be operational at any time which in turn would improve electricity supply reliability to the market.

Up to approximately 23 persons on rotating shifts (including a site manager and administrational support) and routine maintenance would be required during operation.

Additional contractors may be required as needed. Maintenance may be determined on a regular occurrence which would generate additional light and heavy car or truck movements.

4 Process Description

4.1 Power station

The NPS would be a dual fuel power station, meaning generation units would be able to be supplied by natural gas and/or diesel.

The selection of the generation technology (i.e. reciprocating engine or gas turbine) and arrangement of the specific generation units within the power station site are subject to ongoing design development.

Other elements of the Proposal are dependent on the generation technology chosen and are yet to be designed in detail. These elements include:

- Generating capacity
- Switching station capacity
- Number of generating units
- Number of stacks and stack height
- Process water management
- Sewage design

Notwithstanding the above, the generation units, regardless of the selected technology, would include the following key features:

- Dual fuel fired energy generation system and associated local supply connections
- Air intake systems
- Fire and gas detection and protection systems
- Lubricating and other oil systems
- Exhaust gas stacks
- Auxiliary systems

To maximise operational flexibility, each unit of the power station would be designed for continuous operation, while complying with environmental emissions limits.

Reciprocating engines would be installed inside a purpose-built engine hall. Gas turbines would be installed within an enclosure. The plant would include and not be limited to:

- A fuel gas system to supply gas from the fuel gas conditioning system and to each of the generating units
- A diesel supply system including storage tanks and local connection to units
- Lubricating oil supply via tanker and site storage tank
- Compressed air for the instrument and service air system
- Auxiliary cooling system
- Exhaust gas module and exhaust gas stack. The height of the exhaust stacks is dependent on the technology, but would be approximately 35mAHD for gas turbines and 45mAHD for reciprocating engines. The emissions control system would depend on the power generation technology chosen.
- Generator

The NPS would include the following buildings:

- Administration/office and control room building
- Workshop and store/s
- Electrical switch room/s
- Equipment room/s
- Battery room/s
- Gas turbines or reciprocating engines
- Other miscellaneous buildings (water treatment plant, gas yard, etc)

Gas compression, conditioning, heating and other facilities necessary to transport and store gas are also likely to be required and would be constructed at the site.

A conceptual layout overview of the NPS side is provided in Figure 5. This conceptual overview provides an indication of the key operational components of the NPS and their general arrangement, however is subject to ongoing design development.

4.2 Natural gas supply

The NPS would be preferentially fuelled by natural gas supplied from the JGN or AGL's NGSF. Details on the gas pipelines are in Section 4.5.

At the NPS, the natural gas system would include the following equipment:

- Distribution manifold from supply terminal point and associated pipework and valving to each of the unit's gas regulating skid
- Heating station (water bath heaters or equivalent)
- Compression system and/or pressure let-down station

The fuel gas system downstream of the terminal point would be designed to provide gas at a pressure and temperature as required by the generating unit's individual fuel system.

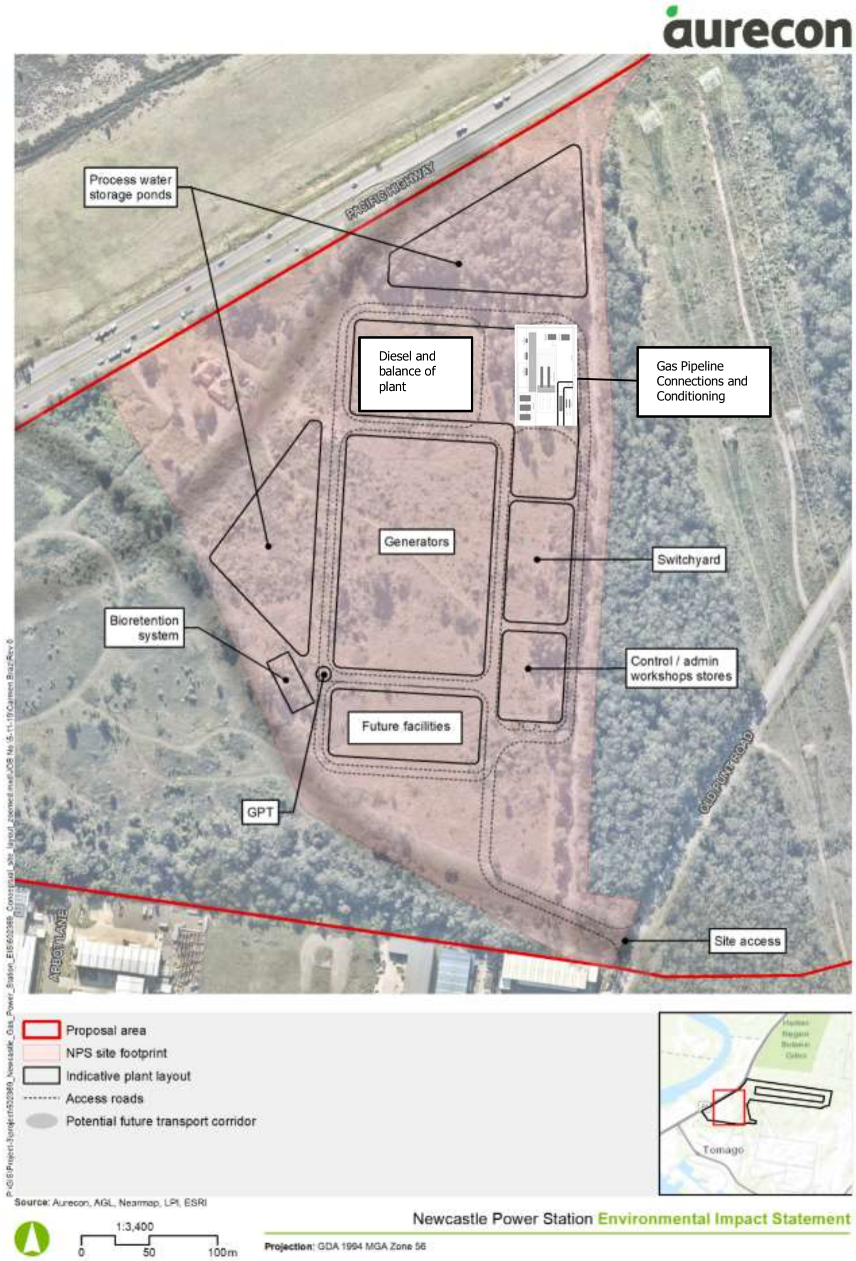

Figure 5: Concept Layout

4.3 Diesel

The NPS would also be capable of being fuelled by liquid fuel, likely diesel and/or bio-diesel, which would be stored on site. Approximately 1.5 megalitres (ML) of diesel storage would be required at the NPS to enable continuous operation.

The diesel system would nominally include the following equipment:

- Tanker unloading bays, suitable for B double tankers, with provisions for spill management and unloading pump facilities
- Diesel storage tanks with bunding
- Forwarding pumps
- Filtering

- Metering
- Heating
- Supply and distribution pipework to units (including tank return), valving, and instrumentation

Around 30 B-double tankers with a volume of 50m^3 would be required to fill 1.5ML of diesel storage capacity. Adequate B-double tanker bays would be constructed to enable multiple tanker delivery and unloading operations.

4.4 Ancillary facilities

The NPS would require supporting ancillary facilities to the abovementioned features including:

- Generator circuit breakers, generator step-up transformers and switchyard including overhead line support gantry
- Water collection and treatment facilities
- Process water storage ponds
- Closed circuit cooling systems
- Control room
- Offices and messing facilities
- Electrical switch rooms
- Occupational health and safety systems including an emergency warning and evacuation system
- Workshop and warehouse
- Firefighting system
- Communication systems
- Security fence, security lighting, stack aviation warning lights (if required) and surveillance system;
- Landscaped areas and staff parking areas
- New access road off Old Punt Road into the NPS and emergency access track to the north
- Concrete foundations, bitumen roadways, concrete pads in diesel unloading station and maintenance areas
- Concrete bunded areas with drains for diesel tanks, liquid chemicals store, oil filled transformers (if installed) and other facilities where liquids could leak
- Level construction and laydown area
- Engineered batters to support and protect the power plant platform
- Site drainage for clean water diversion and dirty stormwater collection and treatment

4.5 Gas pipeline and storage

The JGN Northern Trunkline transports gas from Sydney to Newcastle distributing it to city gate stations along the way. Gas is currently delivered from the Northern Trunkline to the Hexham Receiving Station, approximately 13km northwest of Newcastle. AGL owns and operates a 5.5km bidirectional pipeline between the Hexham Receiving Station and the NGSF (PL42), which is used to import, and export gas (bi-directional pipeline) based on seasonal requirements and market demand.

There are two gas pipelines to be constructed as part of the Proposal:

- New gas pipeline connection to the PL42 on the eastern side of Old Punt Road
- New gas storage pipeline from the NPS towards the NGSF

4.5.1 Gas pipeline

The primary source of natural gas for the NPS would be via the connection to AGL's existing PL42. This connection would allow gas to be sourced from both the JGN (subject to availability) and NGSF. New gas pipeline connections would be made between the NPS (in the gas receiving yard) to the JGN located on the eastern side of Old Punt Road. The pipeline would be designed as per AS2885.

4.5.2 Gas storage

To supplement supply, AGL would construct new gas storage pipeline/s capable of storing natural gas in compressed gaseous form, on land between the NPS and NGSF, partially within existing cleared corridors. Gas would be drawn via the bi-directional pipeline during periods of low gas demand, compressed, and stored for use by the NPS during periods of high-power demand. The gas storage pipeline/s would require up to 5km of pipeline to provide the required storage capacity. The pipeline/s would be of multiple diameters where the larger pipeline would be approximately DN 1050 (42").

Both the northern and southern cleared corridors, where the pipeline/s would be located, have sufficient width to house the pipeline/s. The pipeline/s would be buried at a minimum 900mm to 1200mm below ground surface (depth to top of pipe) and would be installed primarily via trenching.

The proposed gas pipeline corridors would contain underground High Pressure Pipelines (HPPs) and would be designed, constructed and operated to meet the requirements in AS 2885.

The pipeline/s design would include pigging facilities to enable inspection and maintenance.

Natural gas may need to be vented and/or flared during maintenance activities. A temporary (mobile) flare unit is proposed to be installed or connection made to the existing NGSF flare header system at these times. Complete depressurising and flaring of the HPPs is likely to be a rare event.

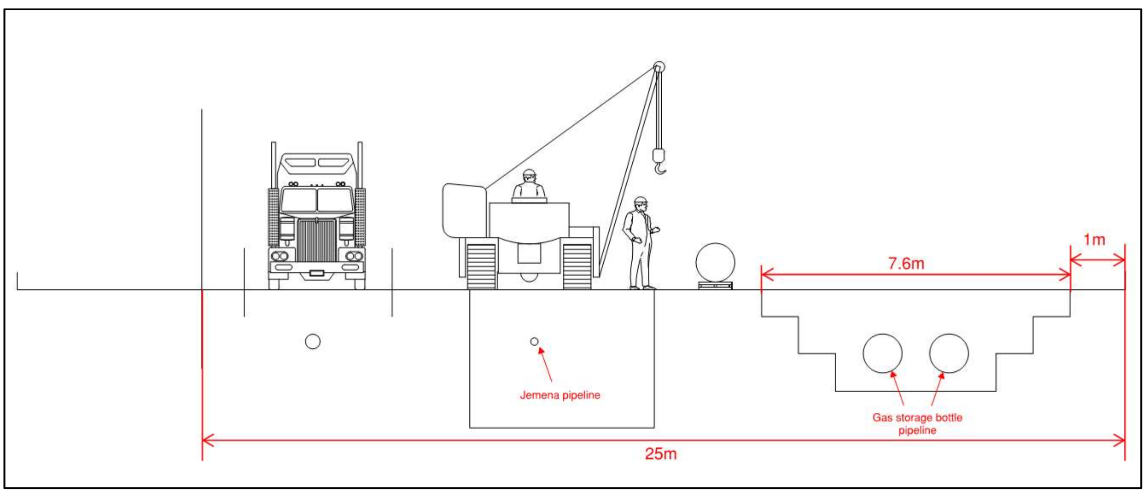

Figure 6: Storage Pipeline Northern Corridor Easement

Figure 6 illustrates where the pipeline/s would be located within the existing easement in the northern corridor and the concept Proposal layout.

4.6 Safety and emergency response

The design, materials, engineering, fabrication, manufacturing, inspection, testing, certification, stamping, cleaning, painting and erection of the Proposal would be in full compliance with applicable Australian codes and standards, incorporating recognised international standards. A safety management plan would be implemented for construction and operation of the facility.

The NPS would be designed to include an automatic shutdown to a safe condition, in the event of an emergency. This includes automatic plant protection actions to preserve plant integrity and site safety by restoring plant to a safe and stable operating state. The plant would be designed with a high level of automation so that it can be operated unattended whilst remaining safe and fully operable.

All ancillary facilities and buildings including office buildings and site amenities would have life saving devices installed including smoke, fire and gas detection devices and firefighting equipment, as required. Operating personnel would be required to be trained in emergency response as the first responders to on- site incidents. The first response priority would be to remotely isolate fuel sources and coordinate with emergency services.

Emergency access and egress would be designed and constructed to allow for emergency services to access the NPS without any barriers. Maintenance of the NPS site would include vegetation clearing where required and making sure the site is accessible at all times.

The Proposal would include CCTV for crime prevention, appropriate lighting and clear and evident signage for the safety of staff and contractors.

5 Hazard Analysis and Risk Assessment

This hazard analysis and risk assessment is developed in accordance with Hazardous Industry Planning Advisory Paper No 6 – Guidelines for Hazard Analysis [Reference (1)].

This hazard analysis and risk assessment includes:

- A list of all materials being handled, stored or processed at the facility, with maximum and average quantities shown
- Hazard identification assessment to identify all hazardous chemicals and the type of associated hazard they may pose

5.1 Hazardous Chemicals

The list of all significant chemicals being handled, stored or processed at the facility are included in Table 13. Maximum and average quantities to be handled, stored or processed are featured. These chemical substances are subject to SEPP 33.

Small quantities of chemicals would be stored in the facility for general operation and maintenance. These may include but are not limited to:

- Lubricating oils for turbines and pumps
- Carbon dioxide or nitrogen for fire protection and line purging
- Urea to reduce flue gas NOx levels
- Cleaning solvents
- Demineralisers including sulfuric acid, hydrochloric acid, and caustic

All chemicals and/or dangerous goods stored on site would have relevant safety data sheets (SDSs) provided and a spill management system would be applied to each specific product as per recommendations in the SDS. All chemicals would be stored and labelled in accordance with relevant Australian Standards in designated chemical storage facilities with emergency control systems if applicable.

Liquified Natural Gas (LNG) is excluded from the assessment due to the fact that no work has been undertaken to investigate the possibility of bringing LNG from the NGSF to the NPS.

Additionally, minor quantities of hazardous chemicals are not considered. From a land use safety planning perspective, the storage of minor quantities of hazardous chemicals is not considered to be a significant contributor to the overall risk profile of the Proposal. For this reason, such hazardous chemicals are also not considered in Table 13.

Natural gas is composed predominantly of methane gas. A gas sample from the NGSF is sufficient for preliminary design and PHA purposes. The difference in gas specification of gas originating from the Jemena network and the NGSF should not significantly impact equipment operation or the PHA.

Table 12: NGSF Natural Gas

Components	Name	Composition (mol%)
C_1	Methane	93.3
C_2	Ethane	6.239
C_3	Propane	0.349
iC_4	Iso Butane	0.011
nC_4	Normal Butane	0.005
iC_5	Iso Pentane	0.001
nC_5	Normal Pentane	0.001
C_6	Hexane	0
C_7	Heptane	0
C_8	Octane	0
C_9+	Nonane+	0
CO_2	Carbon Dioxide	0.006
N_2	Nitrogen	0.093
LHV @ Standard Conditions		49,640 kJ/kg
Mass Density		0.7226 kg/m^3
LHV		35.4 MJ/m^3
HC Dew Point @ 2,500 kPag		-71.76 °C

Table 13: Hazardous Chemicals

Hazardous materials	Maximum quantity stored on site	Dangerous goods class including subsidiary class(es)	Packing Group	UN No.	Chemical Abstract Number (CAS No.)	Physical and Chemical Properties	Type of storage	On-site Location	Average number of road movements
Natural Gas	10.9 tonnes	Class 2.1 Flammable Gas	N/A	N/A	8006-14-2	Clear, highly flammable gas which readily forms explosive mixtures in air Odorant in form of tertiary butyl mercaptan (TBM) 30% and tetrahydrothiophene (THT) 70% is added to allow leak detection	On site pipeline and equipment	Fuel Gas, piping, skids and compression	N/A
Natural Gas	574 tonnes	Class 2.1 Flammable Gas	N/A	N/A	8006-14-2	Clear, highly flammable gas which readily forms explosive mixtures in air Odorant in form of tertiary butyl mercaptan (TBM) 30% and tetrahydrothiophene (THT) 70% is added to allow leak detection	Fuel Gas 'Storage Pipeline'	Fuel Gas 'Storage Pipeline'	N/A
Diesel Fuel	1,500 kL (24 hours emergency storage)	Class C1 Combustible Liquid	N/A	N/A	68334-30-5	Liquid Mild Odour	Bulk Storage Tanks	Designated Diesel storage area located in the east of the site	100% transport by road: 30 x 50m^3 capacity heavy vehicles road tankers per emergency shutdown period transport product to Site

5.2 Hazardous Chemicals

The following information describes the types of hazardous chemicals to be stored, handled or processed at the site.

5.2.1 Natural Gas 100 Mole %

Natural Gas 100 Mole % is a Class 2.1 Flammable Gas. Natural Gas is an invisible, highly flammable gas which readily forms explosive mixtures in air. Natural gas must be stored in a location that is segregated from oxygen gas and oxidising agents.

Natural Gas would be transported to Site via the Hexham to NGSF Bi-directional Pipeline (at 71,000 Sm^3/h) and the Fuel Gas 'Storage Pipeline' (at 42,600 Sm^3/h). The considered 'Storage Pipeline' design includes pigging facilities to comply with the inspection requirements of AS2885.

5.2.2 Diesel Fuel

Diesel Fuel is a C1 Combustible Liquid. Diesel is incompatible with oxidizing materials.

All diesel fuel would be transported to site by road tanker. Heavy vehicles of approximately 50 m^3 capacity would be used, equating to approximately thirty movements per day to deliver diesel fuel to the site.

The diesel storage facility would be designed in accordance with AS 1940:2017 [Reference (10)] especially in relation to bund sizing and appropriate separation distances. The total diesel storage volume is equivalent to approximately 24 hours demand.

6 Hazardous Event Screening

6.1 Screening Assessment

State Environmental Planning Policy No. 33 – Hazardous and Offensive Development (SEPP 33) applies if a proposal for an industrial development requires consent, and it is a potentially hazardous industry and/or potentially offensive industry [Reference (3)].

Applying SEPP 33 – Hazardous and Offensive Development Application Guidelines [Reference (3)], Section 7 and Appendix 4 provides a risk screening method through tables and graphs to determine whether a proposal development is potentially hazardous. The preliminary screening assessment for the hazardous chemicals identified is summarized and detailed in Table 14.

The natural gas proposed to be transported to the site would be via the gas storage pipeline which has been designed as a pipeline, rather than storage vessel, and would therefore be assessed as such.

6.1.1 Class 2.1 Flammable Gases Pressurised (Natural Gas 100 Mole %)

According to *Applying SEPP 33* [Reference (3)], Figure 7 must be utilised for risk screening.

Figure 7 indicates that the minimum separation distance for 10.9 tonnes of natural gas inventory within the above ground equipment /piping is 150 m. The actual separation distance of the natural gas is <20 m. Therefore, the actual separation distance exceeds the threshold and it can be assumed that there is the potential for off-site risk. Risks associated with the storage of natural gas has been carried forward for further analysis.

Table 14: Preliminary Screening Assessment Natural Gas

Material	Type	Max Quantity on site	Distance to Site Boundary [m]	Distance to Sensitive Receptor	Screening Threshold or minimum separation distance (Other Land Uses)	Screening Threshold or minimum separation distance (Sensitive Receptors)	Notes
Natural Gas – Above ground equipment /piping	Class 2.1 Flammable Gas	10.9 tonnes (Note 1)	< 20 m	2,000 m	150 m (Figure 7)	200 m (Figure 7)	Above threshold

Note 1: Assuming density equal to max density for each pipe section

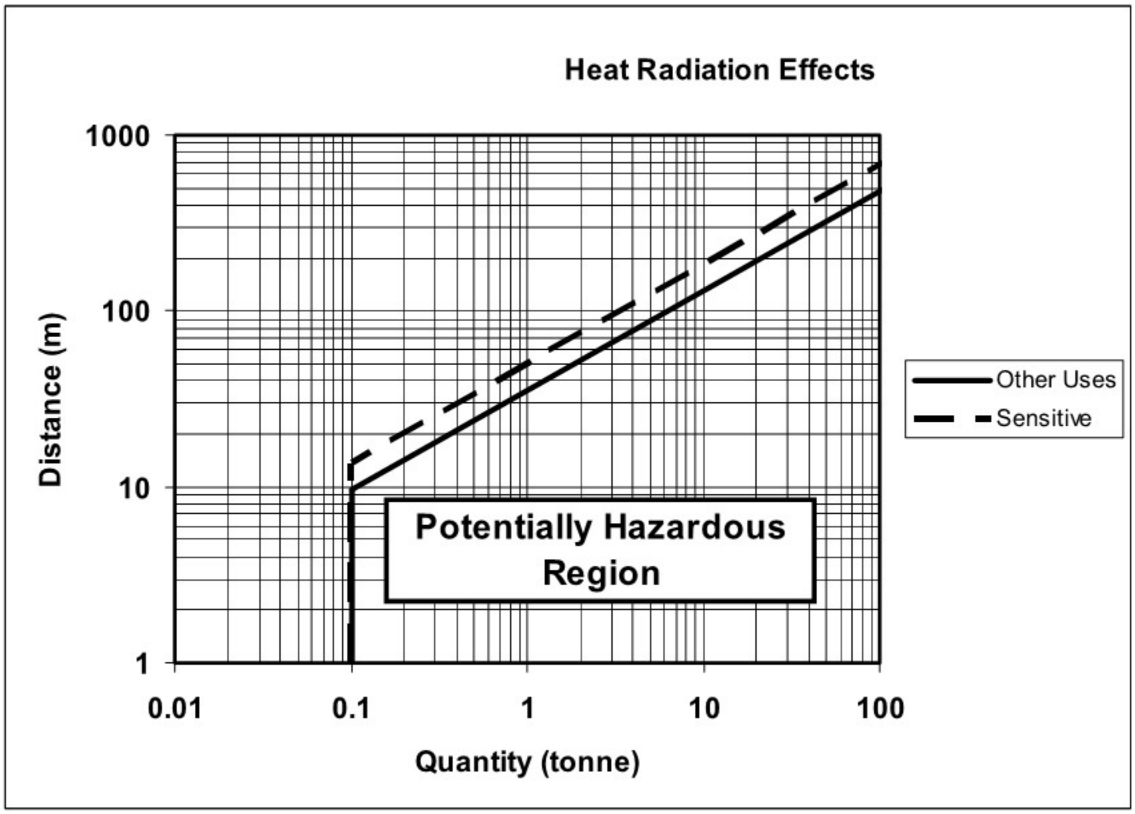

Figure 7: Class 2.1 Flammable Gases Pressurised (Excluding LPG) [Reference (3)]

The natural gas pipeline as well as the gas storage pipeline/s, have undergone a risk assessment using AS2885 to estimate the risks from the pipeline/s to the surrounding land uses. Although the gas storage pipeline/s may be used for storage of potentially over 200 tonnes of gas, SafeWork NSW has confirmed that the Proposal and the associated gas pipeline/s do not fall under the NSW Work Health and Safety (WHS) Regulation Schedule 15 for defining a Major Hazard Facility (MHF). No MHF approval is therefore required, however, information requested within clause 390 of the WHS Regulation, Pipeline builder's duties, must be provided to the regulator.

6.1.2 Class C1 Combustible Liquid (Diesel)

According to Applying SEPP 33 [Reference (3)] if combustible liquids of class C1, such as diesel, are present on site and are stored in a separate bund or within a storage area where there are no flammable materials stored, they are not considered to be potentially hazardous. Flammable materials include Class 3PGI, II or III flammable liquids. Diesel would be stored in two liquid fuel storage tanks within a bunded area in a designated location on site away from the gas processing area. No Class 3PGI, II or II flammable liquids are proposed to be held on-site.

For 1500kL of diesel storage, a minimum separation to the boundary would be in the order of 20m. The proposed location of the tanks is greater than 80m from the boundary. The likelihood of off-site major accident event scenarios relating to diesel storage, as assessed in Appendix 2, is found to be unlikely.

6.1.3 Transport Risk

Natural gas would be transported to the site via pipeline/s.

Liquid fuel, diesel and/ or bio-diesel would be stored on site to accommodate unconstrained operations if there is a loss of gas fuel. The amount of fuel required should provide up to 24 hours of base load operations. This equates to approximately 1.5 ML of diesel storage.

Diesel would be transported to the Proposal by road and is classified as a Class 9 Dangerous Good for road transport purposes.

SEPP 33 provides Transportations Screening Thresholds for all dangerous goods transport classes [Reference (3)]. The threshold for Class 9 (Diesel) is >1000 cumulative annual or >60 peak weekly transport movements.

Currently, there are no expected number of transport movements for during normal operations, as the site would only require diesel for unconstrained operations when gas fuel is not available.

SEPP 33 states that proposed development may be potentially hazardous if the number of generated traffic movements (for significant quantities of hazardous materials entering or leaving the site) is above the annual or weekly cumulative vehicle movements.

Therefore, the Proposal is not found to be potentially hazardous with respect to transportation, due to the minimal quantity of transport movements required during normal operation.

If the requirement for diesel changes to regular deliveries, and the number of transport movements exceed criteria, a route evaluation study would be completed in accordance with the DPIE's HIPAP 11: Route Selection. [Reference (11)].

6.1.4 Potentially Offensive Industry

Schedule 3 of the Environmental Planning and Assessment Regulation provides a description of several categories of industry with a potential for significant environmental impact.

Electricity generating stations, including associated water storage, ash or waste management facilities, are considered offensive if they are supplying or are capable of supplying more than 30 megawatts of electrical power from other energy sources (including coal, gas, wind, bio-material or solar powered generators, hydroelectric stations on existing dams or co-generation).

Since the Proposal includes a new power station with a nominal capacity of about 250 MW from a gas energy source, it is considered a potentially offensive industry. Consequently, an analysis of the potential impacts to neighbouring facilities and land uses is required.

The following technical studies provide a detailed description of the quantity, nature and significance of all offences likely to be caused by the development that could produce air, noise, water or other emissions:

- Surface Water and Ground Water Assessment (Section 6.3 and Appendix E of the EIS)

- Air Quality Assessment (Section 6.5 and Appendix G of the EIS)
- Noise Assessment (Section 6.9 and Appendix L of the EIS)
- Environmental Management and Monitoring (Section 9.2 of the EIS).

Included in the technical studies are the safeguards required to ensure potential offensiveness can be controlled to a level which is not significant.

7 Hazardous Identification

7.1 Major Hazardous Event Identification

Hazardous accident events were identified during a desktop analysis based on the Hazard and Operability and Pipeline Safety Studies. A Hazard Identification Summary Table can be found in Appendix 2 which lists the preventative and mitigation measures incorporated in the Proposal to prevent a hazardous event. The hazards identified to have potential offsite impacts, i.e. major hazardous events, are listed below:

MHE1. Jemena Gas Network Pipeline and Bi-directional pipeline link to gas compression inlet/ bypass (2,500 kPag) (From Tie-In Point 1)

MHE2. Piping from gas compression units to gas turbine, when sourced from bi-directional pipeline (5,500 kPag). Water bath bypassed

MHE3. Piping from gas compression bypass to let down station, when sourced from bi-directional pipeline (2,500 kPag). Water bath bypassed

MHE4.Piping from gas let down station to gas engines, when sourced from bi-directional pipeline (1,000 kPag)

MHE5. Piping from gas compression units to storage pipeline (15,000 kPag)

MHE6. Gas storage pipelines (15,000 kPag) including pig launchers/receivers

MHE7.Gas storage pipeline to let down station, including water bath heater (15,000 kPag)

MHE8. Piping from gas let down station to gas engines, when sourced from storage pipeline (1,000 kPag)

MHE9. Piping from gas let down station to gas turbines, when sourced from storage pipeline (5,500 kPag)

MHE10. Gas leak within enclosure.

A fire at a transformer is a potentially hazardous scenario with significant onsite risks. A detailed design Fire Safety Study in line with HIPAP Paper No 2 [Reference (12)] would be conducted for the Proposal to evaluate appropriate fire safety designs and controls.

8 Consequence Effects

8.1 Dangerous Dose Human Health

8.1.1 Heat Radiation Dangerous Dose to Human Health

The consequences of flammable hazardous events are fire, blast and shock wave damage. In general, every flammable release has the potential for heat radiation and explosive effects. The consequences of fires are damage to equipment and heat radiation burns. In terms of burns there are two aspects that are important, the intensity of the heat radiation and the duration of exposure.

The effects arising from exposure to thermal radiation is generally in relation to exposure of bare skin. Generally vulnerable land uses shall not be exposed to a heat radiation impacts that exceed

4.7 kW/m^2 and this is deemed to be dangerous dose. This level of radiation relates to a cause of pain in 15-20 seconds an injury after 30 seconds exposure (at least second degree burns will occur). The level of heat radiation to have a fatal effect is 12.6 kW/m^2, further details are shown in Table 15.

Table 15. Consequences of heat radiation

Heat radiation (kW/m^2)	Effect
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 (at least second-degree burns will occur) Dangerous Dose
12.6	Significant chance of fatality for extended exposure. High chance of injury Causes the temperature of wood to rise to a point where it can be ignited by a naked flame after long exposure Thin steel with insulation on the side away from the fire may reach a thermal stress level high enough to cause structural failure Fatal Dose
23	Likely fatality for extended exposure and chance of fatality for instantaneous exposure Spontaneous ignition of wood after long exposure Unprotected steel will reach thermal stress temperatures which can cause failure Pressure vessel needs to be relieved or failure would occur
35	Cellulosic material will pilot ignite within one minute’s exposure Significant chance of fatality for people exposed instantaneously

8.1.2 Explosion Dangerous Dose to Human Health

Explosion effect models predict the impact of blast overpressure on people and structures. Explosions are hazardous to people due to blast overpressure, collapsing buildings and projectiles. Explosion effects are determined by correlating overpressure resulting from the explosion to its potential to cause damage. The level of explosion overpressure that is considered to be a dangerous dose is 7 kPa. Additional pressure and effect details are shown in Table 16.

Table 16. Effects of explosion overpressure [Reference (13)].

Explosion overpressure	Effect
3.5 kPa (0.5 psi)	% glass breakage No fatality and very low probability of injury
7 kPa (1 psi)	Damage to internal partitions and joinery but can be repaired Probability of injury is 10%. No fatality Dangerous dose
14 kPa (2 psi)	House uninhabitable and badly cracked

Explosion overpressure	Effect
21 kPa (3 psi)	Reinforced structures distort Storage tanks fail 20% chance of fatality to a person in a building Fatal dose
35 kPa (5 psi)	House uninhabitable Wagons and plants items overturned Threshold of eardrum damage 50% chance of fatality for a person in a building and 15% chance of fatality for a person in the open
70 kPa (10 psi)	Threshold of lung damage 100% chance of fatality for a person in a building or in the open Complete demolition of houses

8.2 Dangerous Dose to Built Environment

8.2.1 Heat Radiation Dangerous Dose to Built Environment

Fire damage estimates are based upon correlations with recorded incident radiation flux and damage levels. Dangerous dose to the built environment means thermal radiation from fire exceeds 23 kW/m^2 This would cause spontaneous ignition of wood after long exposure, unprotected steel will reach thermal stress temperatures which can cause failure and pressure vessels need to be relieved or failure would occur.

8.2.2 Explosion Dangerous Dose to Built Environment

Dangerous dose to the built environment is considered to be an overpressure of 14 kPa. At this pressure a house is considered uninhabitable and badly cracked.

8.3 Modelling

Consequence modelling for the major hazardous events was performed using the Det Norske Veritas Global (DNV-GL) PHAST software package Version 8.2 to model the plume dispersion and determine the specific heat radiation and over-pressure consequences related to each of the major hazardous event scenarios.

Table 17: Consequence scenarios – Summary

Scenario	PHAST set up Scenario	Release Scenario
MHE1: Jemena Gas Network Pipeline and Bi-directional Pipeline Link (underground)	Fuel Gas LoC 2,500 kPag operating pressure 15 - 30°C operating temperature Modelled @ MAOP = 6,895 kPag, 15°C No depth of cover (conservative) Release height 0m	Orifice diameter: 30 mm, 50 mm, 110 mm Excavation point: 30mm, 50 mm & 110 mm Vertical and horizontal gas release

Scenario	PHAST set up Scenario	Release Scenario
MHE2&3&4&8&9: Gas Conditioning Skid	Fuel gas LoC 1,000, 2,500 or 5,500 kPag operating pressure 15 - 30°C operating temperature Modelled @ 6,895 kPag, 15°C Release Height: 1m	Orifice diameters: 25 mm, 50 mm, 110 mm Vertical and horizontal gas release
MHE5&7: Compressor Station Piping Leak/Rupture	Fuel gas LoC 15,000 kPag operating pressure 30 – 60°C operating temperature Modelled @ 15,300 kPag, 30°C Release Height: 1m	Orifice diameters: 25 mm, 50 mm, 110 mm Vertical and horizontal gas release
MHE6a: Fuel Gas 'Storage Pipeline' (underground)	Fuel Gas LoC 15,000 kPag operating pressure 15 - 60°C operating temperature Modelled @ 15,300 kPag, 15°C To account for any location along the entire corridor: Loop length 7.8 km rather than 5 km pipeline No depth of cover (conservative) Release Height: 0m	Orifice diameters: 30 mm, 50 mm, 110 mm Excavation point: 30mm, 50 mm & 110 mm Vertical and horizontal gas release
MHE6b: Pig Launcher/Receiver Stations Leak /Rupture	Fuel Gas LoC 15,000 kPag operating pressure 15 - 60°C operating temperature Modelled @ 15,300 kPag, 15°C Release Height: 1m	Orifice diameters: 25 mm, 50 mm, 110 mm Vertical and horizontal gas release
MHE10: Gas leak within enclosure Vapour Cloud Explosion	Gas filled enclosure leading to Vapour Cloud Explosion	Max inventory of one gas turbine 460kg

The PHAST software has a set of default parameters for variables such as discharge, dispersion, weather, building, surface, pool vaporisation, toxicity, flammability, explosion, fireball and BLEVE blast, jet fire and pool fire. Table 18 summarises the parameters that have been modified for this analysis.

Table 18: Deviation from PHAST Default Parameters

Parameter Set	Parameter	Default	Value Used	Justification
Discharge	Capping of pipe flow rates	Use leak scenario cap, disallow flashing	No capping	Flow rate will be large, therefore should not be capped
Dispersion	Maximum height for dispersion	100 m	2,000 m	Maximum dispersion height is above 100 m
Weather	Wind speed reference height	1 m	10 m	-
Surface	Surface roughness length	User defined length	30 mm – open flat terrain; grass, few isolated objects	Most accurately represents site terrain
Flammable	Solar radiation	Exclude from calculations	Include in calculations	Solar radiation being included in the calculations produces a more accurate result

Parameter Set	Parameter	Default	Value Used	Justification
General	Height of interest	1 m	0 m	Majority of pipework is underground, and PHAST is limited to a minimum height of release and interest of 0 m
Longpipe	Failure frequency	Pipeline thickness	User defined	More consrvative

8.4 Results

8.4.1 Types of Consequences

A number of different events can occur after the release of flammable gas from high-pressure pipework. These include:

- Jet fire
- Flash fire
- Vapour cloud explosion (VCE).

The consequences are presented in a typical event tree (refer Table 19).

Table 19: Event tree for release of flammable gas from high-pressure methane (natural gas)

Initiating event	Direct ignition (P_1)	Delayed ignition (P_2)	Flame front acceleration (P_3)	Final scenario
Release of methane	Yes			Jet fire
	No	Yes	Yes (or strong)/ Cloud confined	Explosion
			No (or weak) / Cloud unconfined	Flash fire (+ Jet fire)
		No		No fire or explosion consequences

8.4.2 Worst-Case Jet Radiation Results

The jet fire results are shown in Table 20.

Table 20: Jet Fire Results

Scenario	Leak Size (mm)	Jet Fire Thermal Radiation	
		4.7 (kW/m^2)	23 (kW/m^2)
MHE1: Jemena Gas Network Pipeline and Bi-directional Pipeline Link	30	35.5	4.7
	50	57.5	9.8
	110	72	13
MHE2&3&4&8&9: Gas Conditioning Skid	25	46.5	33.6
	50	89.5	60.1

	110	185.5	115
MHE5&7: Compressor Station Piping Leak/Rupture	25	69.4	48
	50	131.9	84
	110	274.4	161.2
MHE6a: Fuel Gas 'Storage Pipeline'	30	85.3	57.5
	50	137	87.3
	110	285.4	168.8
MHE6b: Pig Launcher/Receiver Stations Leak /Rupture	25	72	49.3
	50	137	87
	110	285.4	168.6

8.4.3 Worst Case Flash Fire Results

For the flash fire the burn zone is typically the boundary of flammable limit of the cloud. Therefore, the downwind distances for un-ignited gas release for the assumed hole sizes are given in Table 21 as flash fire distances.

Table 21: Worst Case LFL/Flash Fire Results

Scenario	Leak Size (mm)	Distance downwind to LFL [m]
MHE1: Jemena Gas Network Pipeline and Bi-directional Pipeline Link	30	6
	50	10
	110	12
MHE2&3&4&8&9: Gas Conditioning Skid	25	23
	50	60
	110	146
MHE5&7: Compressor Station Piping Leak/Rupture	25	45
	50	106
	110	244
MHE6a: Fuel Gas 'Storage Pipeline'	30	268
	50	433
	110	896
MHE6b: Pig Launcher/Receiver Stations Leak /Rupture	25	140
	50	316
	110	726

8.4.4 Worst Case Overpressure Results

The explosion over-pressure distances resulting from vapour cloud explosions are given in Table 22.

Table 22: Worst Case Overpressure Results

Scenario	Leak Size (mm)	Overpressure Radius [m]	
		7 (bar)	14 (bar)
MHE1: Jemena Gas Network Pipeline and Bi-directional Pipeline Link	30	Not reached	Not reached
	50	27	20
	110	31	22
MHE2&3&4&8&9: Gas Conditioning Skid	25	80	72
	50	185	166

	110	275	261
MHE5&7: Compressor Station Piping Leak/Rupture	25	154	139
	50	300	282
	110	487	476
MHE6a: Fuel Gas 'Storage Pipeline'	30	313	290
	50	518	480
	110	1080	998
MHE6b: Pig Launcher/Receiver Stations Leak /Rupture	25	177	161
	50	386	354
	110	894	819

The explosion over-pressure distances resulting from an explosion within an enclosure are shown in Table 23.

Table 23: Enclosure explosion over pressure radii

Consequence	Over- Pressure Level (kPa)	Over-pressure radius (m)
Explosion Enclosure	7	106
	14	67

9 Frequency Analysis

9.1 Frequency of gas leaks and ignition probability

Table 24 includes the failure frequency rates. The natural gas pipeline section failure rates are the proposed values based on the Research Report RR1035, Table 72 which is published by UK HSE in 2015 [Reference 19]. The UK HSE generic failure rates database was utilised for the above ground sections including, piping, valves, equipment, pig launchers/receivers etc. A parts count and line length calculations were estimated for the process and based on the Piping and Instrumentation Diagrams [References 22,23,24] and inventory calculations [Reference (14)] and applied to the leak frequencies as relevant for each scenario.

As the actual location of the ignition sources within the Proposal boundary is unknown, an areawide ignition source distribution approach is considered to be appropriate. The ignition probability of 40% was used for the above ground areas where there were between "Very Few" to "Few" ignition sources available. The ignition probability of 81% was applied for the pipeline sections, based on the proposed values given in the Research Report RR1034, Table 14 which presents the ignition probability for high pressure gas transmission pipeline as published by UK HSE in 2015 [Reference 19].

The pig launchers and receivers would not be installed permanently on site and may only be used once every few years due to the high quality of gas in the pipeline/s. To account for this, the frequency for loss of containment associated with the pig launchers and receivers has been reduced by a factor of 10.

Table 24: Failure Frequencies associated per Scenario

Scenario	PHAST set up Scenario	Release Scenario/ Leak Sizes/ Direction of Release	Failure Frequency (per km.year)	Ignition Probability (%)
MHE1: Jemena Gas Network Pipeline and Bi-directional Pipeline Link (under-ground)	Fuel Gas LoC 2,500 kPag operating pressure 15 - 30°C operating temperature Modelled @ MAOP = 6,895 kPag, 15°C	Orifice diameter: 30 mm 50 mm, 110 mm Vertical and horizontal gas release	Frequency for Equivalent Hole Size 30 mm: 7.20E-06 Frequency for Equivalent Hole Size 50 mm: 3.00E-07 Frequency for Equivalent Hole Size 110 mm: 3.00E-07 Frequency for pipe length of 0.47km: 1.2E-06	81%
MHE2&3&4&8&9: Gas Conditioning Skid	Fuel Gas LoC 2,500 kPag operating pressure 15 - 30°C operating temperature Modelled @ 6,895 kPag, 15°C Release Height: 1m Inventory 1 tonne	Orifice diameters: 25 mm, 50 mm, 110 mm Vertical and horizontal gas release	Frequency for Equivalent Hole Size 25 mm: 7.31E-03 Frequency for Equivalent Hole Size 50 mm: 1.92E-03 Frequency for Equivalent Hole Size 110 mm: 2.79E-03	40%
MHE5&7: Compressor Station Piping Leak/Rupture	Fuel Gas LoC 15,000 kPag operating pressure 30 – 60°C operating temperature Modelled @ 15,300 kPag, 30°C Release Height: 1m Inventory 4.9 tonne	Orifice diameters: 25 mm, 50 mm, 110 mm Vertical and horizontal gas release	Frequency for Equivalent Hole Size 25 mm: 2.00E-02 Frequency for Equivalent Hole Size 50 mm: 7.49E-03 Frequency for Equivalent Hole Size 110 mm: 7.50E-03	40%

Scenario	PHAST set up Scenario	Release Scenario/ Leak Sizes/ Direction of Release	Failure Frequency (per km.year)	Ignition Probability (%)
MHE6a: Fuel Gas 'Storage Pipeline' (underground)	Fuel Gas LoC 15,000 kPag operating pressure 15 - 60°C operating temperature Modelled @ 15,300 kPag, 15°C	Orifice diameter: 30 mm 50 mm, 110 mm Vertical and horizontal gas release	Frequency for Equivalent Hole Size 30 mm: 1.13E-05 Frequency for Equivalent Hole Size 50 mm: 4.7E-07 Frequency for Equivalent Hole Size 110 mm: 4.7E-07 Frequency for pipe length of 7.8km: 2.03E-05	81%
MHE6b: Pig Launcher/Receiver Stations Leak /Rupture	Fuel Gas LoC 15,000 kPag operating pressure 15 - 60°C operating temperature Modelled @ 15,300 kPag, 15°C Release Height: 1m	Orifice diameters: 25 mm, 50 mm, 110 mm Vertical and horizontal gas release	Frequency per launcher for Equivalent Hole Size 25 mm: 1.35E-04 Frequency per launcher for Equivalent Hole Size 50 mm: 8.07E-05 Frequency per launcher for Equivalent Hole Size 110 mm: 5.38E-05	40%
MHE10: Vapour Cloud Explosion	Fuel Gas LoC Gas filled enclosure leading to Vapour Cloud Explosion	Max inventory of one gas turbine 460kg	N/A	100%

10 Risk Analysis

10.1 Individual Fatality Risk

Individual fatality risk is the risk of a fatality to a person at a particular point. Table 25 outlines the risk assessment criteria that is suggested for the assessment of the safe location of a proposed land-use in relation to a potentially hazardous operation.

Table 25: Individual Fatality Risk Criteria

Land Use	Land Use Category	Suggested Criteria (per year)
Hospitals, schools, child-care facilities, old age housing	Vulnerable land use	5 E -07
Residential, hotels, motels, tourist resorts	Sensitive land use	1 E -06
Commercial developments including retail centres, offices and entertainment centres	Commercial land use	5 E -06
Sporting complexes and active open space	Open space land use	1 E -05
Industrial	Industrial land use	5 E -05

Figure 8 below shows the individual risk contour results from the quantitative risk assessment. Each contour corresponds to one of the criteria in the table above.

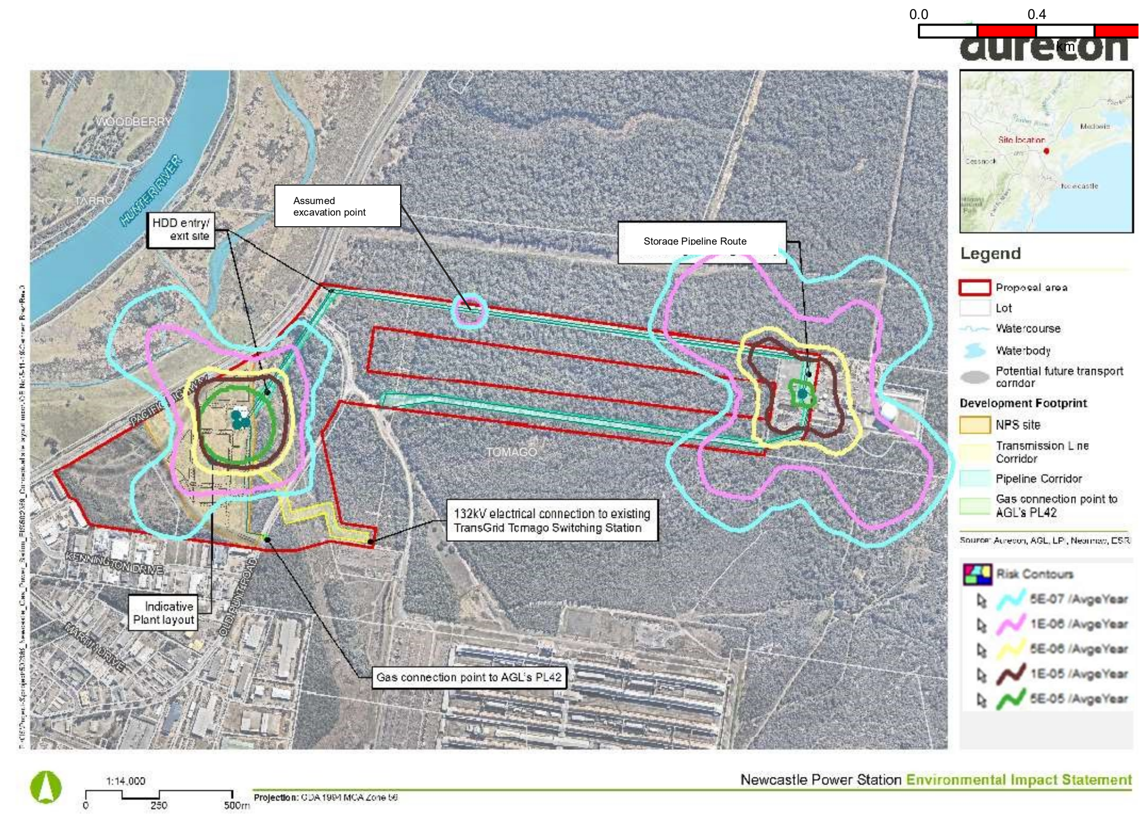

Figure 8: Individual Fatality Risk Contours Site and Pipelines

The individual fatality risk contours for the pipeline/s are below the criteria of 5E-07 per year, as shown in Figure 9.

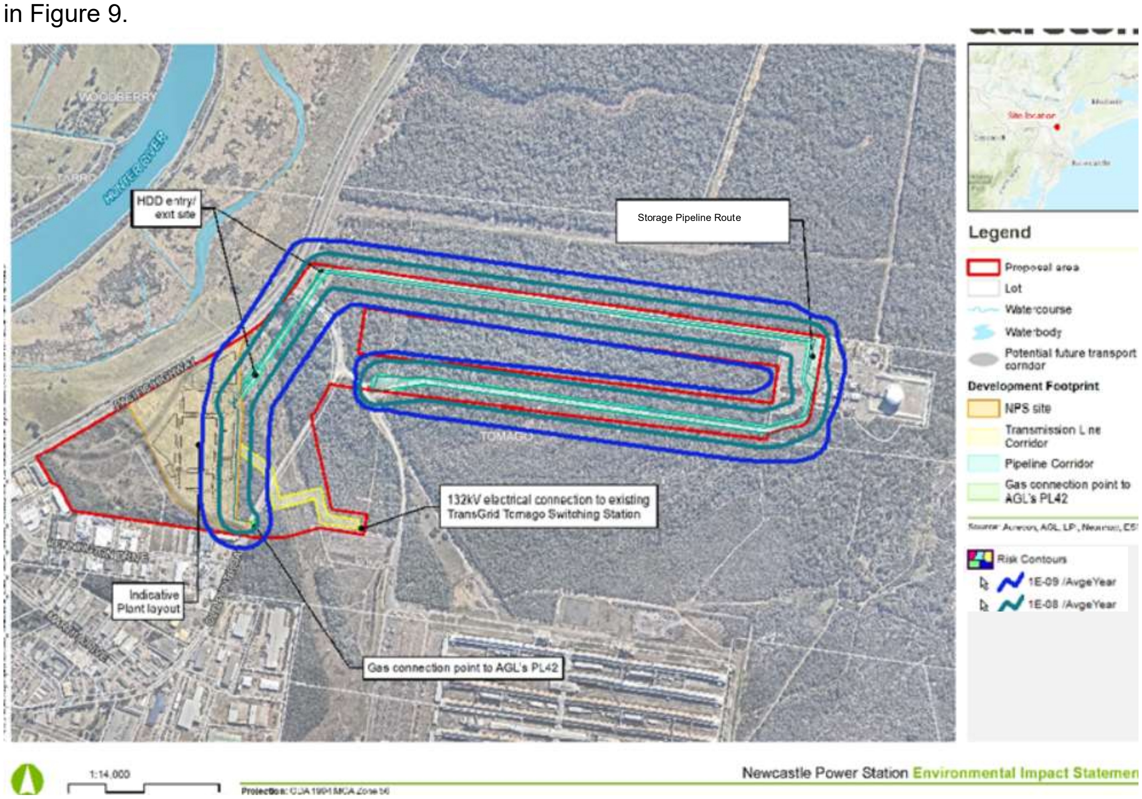

Figure 9: Individual Fatality Risk Contours Pipelines only

The Individual Fatality Risk Criteria in relation to adjacent land uses is acceptable for both the site and the pipelines.

10.2 Injury Risk

'Individual injury risk' captures the associated risk of injury as a result of the Proposal. The impact of injury must be considered for the following scenarios: heat radiation and explosion over-pressure at sensitive or residential areas.

Table 26: Injury Risk Criteria

Injury Risk Criteria	Maximum Tolerable Risk ($x10^{-6}$ per year)	Criteria Satisfied
Maximum Over-pressure		
7 kPa	50 (at residential & sensitive use areas)	Yes
Maximum Heat Radiation		
4.7 kW/m^2	50 (at residential & sensitive use areas)	Yes

Sensitive and residential areas are located more than 2 km from the site. The maximum over pressure and heat radiation injury levels did not reach these areas.

10.3 Property Damage and Accident Propagation

In accordance with HIPAP No 4 – Risk Criteria [Reference (2)], the risk criteria for damage to property and of accident propagation should be assessed at neighbouring/land zoned potentially hazardous installations. The NGSF is considered to be a potentially hazardous installation within proximity of the Proposal.

Table 27: Property Damage and Accident Propagation Criteria

Property Damage	Maximum Tolerable Risk ($x10^{-6}$ per year)
Maximum Over-pressure	
14 kPa	50 (at neighbouring/land zoned potentially hazardous installations)
Maximum Heat Radiation	
23 kW/m^2	50 (at neighbouring/land zoned potentially hazardous installations)

The high temperatures and radiant heat, as well as explosion overpressure at the levels given in Table 27, pose a hazard for surrounding equipment and personnel. Where there is direct flame impingement or elevated levels of radiant heat, significant convective heat transfer may occur, potentially resulting in injury / fatality and failure of structural members or equipment resulting in possible further escalation. Radiant heat can also affect the ability of personnel to escape from or through an area on the facility.

10.3.1 Power station

Most of the areas around the above-ground gas processing equipment/piping are located within the 5x10-5/yr risk (green contour on Figure 8). All of the equipment and structure within these areas are subject to failure due to the direct jet fire impingement, high intensity jet fire thermal radiation (23 kW/m^2) and overpressure levels exceeding 14 kPa as result of the potential escalation of an event. Propagation of major accident events and locations for occupied buildings need to be considered in detailed design by firstly eliminating the risk, if possible, through appropriate locations outside of consequence impact zones, away from prevailing wind direction (south-east) or through fire safety design and mitigations as identified in the Fire Safety Study in line with HIPAP Paper No 2 [Reference (12).

10.3.2 Pipeline corridor

The pipeline corridor considered the storage pipeline as a single pipeline running in a loop. As this is a single pipeline, propagation risk to itself is not considered.

The EIS considered eight options for different pipe route configurations. Part of this assessment included an assessment in the existing northern accessway easement. To accommodate the two DN1050 pipelines loop they have been aligned to the south of the existing Tomago-Hexham Pipeline without encroaching on the Jemena pipeline or requiring additional land. Both the Tomago-Hexham Pipeline and the Gas Storage pipeline have a no-rupture design. The Jemena low pressure pipeline could rupture but is located 6 m north of the Tomago-Hexham which is sufficient to be outside an impact on the Gas Storage pipeline.

10.3.3 Newcastle gas storage facility

The design of the gas storage pipeline is at a concept level. This report has considered some aboveground equipment, e.g., pig launders and/or receivers located within the boundary of the NGSF. This equipment may pose a level of propagation risk with equipment and structures surrounding this area subject to failure due to the direct jet fire impingement, high-intensity jet fire thermal radiation (23 kW/m^2), and overpressure levels exceeding 14 kPa.

The location of any aboveground gas pipeline equipment would be located to optimize the separation distance between the equipment and any onsite protected place, other infrastructure and emergency assembly areas and incorporate any fire safety design and mitigations as identified in the Fire Safety Study in line with HIPAP Paper No 2 [Reference (12)..

10.4 Societal Risk

Societal risk criteria are based on the ALARP principle. Societal risk is generally analysed through the use of FN-curves, where the level of risk is determined by plotting the frequency (F) at which the realization of specified hazards will result in the deaths of (N) number of people in a given population.

The DPIE has provisionally adopted the indicative criteria in Figure 2 for addressing societal concerns arising when there is a risk of multiple fatalities occurring in one event. The societal risk for the Proposal is plotted against these criteria in Figure 10.

This study has considered Societal Risk in relation to rural residential properties, onsite personnel and the industrial land around the Proposal area.

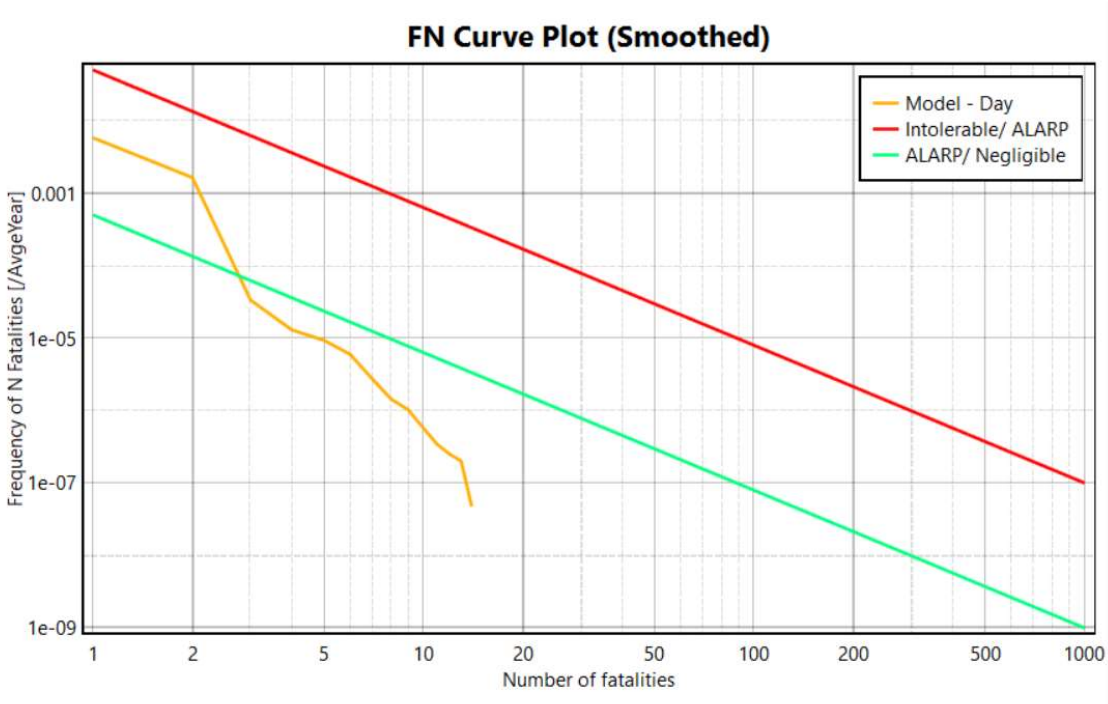

Figure 10: FN Curve

10.5 Risk Evaluation

The results show that the iso-risk contours are concentrated around two main areas, where the above ground piping is proposed to be located. The results also show the risk contours are generated around a point, assumed to be the hypothetical location for a hole, which could result from an excavation activity along the pipeline/s. The risk of other pipeline failures is not significant for land-use planning.

The risk contours in Figure 8 shows that the risk level at vulnerable land use (e.g. hospitals, schools, child-care facilities, old age housing), sensitive land use (e.g. residential, hotels, motels, tourist resorts), community activity land use (e.g. sporting complexes and active open space), commercial land use (e.g. retail centres, offices and entertainment centres) and industrial areas do not exceed the limits in Table 25.

The major contributors to releases and subsequent major events is from the loss of containment of the natural gas from aboveground gas processing areas due to the large inventory of the flammable material, high pressure of the gas within the sections and the number of leak sources at both the NPS as well as the NGSF. Propagation of major accident events and locations for occupied buildings would be considered during detailed design by firstly eliminating the risk, if possible, through appropriate locations outside of consequence impact zones, away from prevailing wind direction (south-east) or through fire safety design and mitigations as identified in the Fire Safety Study in line with HIPAP Paper No 2 [Reference (12).

The societal risk criteria, is met as the FN Curve is within the ALARP and negligible range. The likelihood of a multiple fatality event is tolerable.

The risk criteria are easily met for the Proposal. The societal risk, in particular, is low due to the relatively low population density associated with the large, essentially rural land surrounding the Proposal. Development in the vicinity of the Proposal should be carefully assessed in terms of potential increase to the societal risk.

Although the facility's operations pose an acceptable to tolerable risk level to the residential and industrial area, the neighbouring land uses are also potentially subjected to risk from other industrial facilities. Since this has not been assessed in this study, the study results should not be used to endorse residential intensification and industrial development in the vicinity of the Proposal and any decision in this regard should carefully assess in terms of potential increase to the societal risk.

11 Conclusion

The PHA has been completed and demonstrates that the risks from the Proposal complies with all of the criteria set out in Hazardous Industry Planning Advisory Paper No. 4 – Risk Criteria for Land Use Safety Planning [Reference (2)].

The Proposal is presently at concept design stage. As such, the release scenarios are conservative as no safety mitigations, which will be incorporated later during detailed design, have been accounted for that would reduce the frequency of the loss of containment events and resulting fire or explosion scenarios. Safety and fire mitigation measures would be incorporated during detailed design to reduce loss of containment events and ignition sources. A complimentary pipeline risk assessment, in-line with AS2885, has been conducted and is documented as part of the Environmental Impact Statement in a separate report.

Further, the safety assessment process would continue to identify controls that prevent or limit the effects of a major accident scenario. The detailed design would also continue to consider further controls that could be implemented to reduce risk so far as is reasonably practicable.

The results of the risk assessment show that additional mitigation measures are required to be considered during the future proposal development stages. These include, but are not limited to:

- Compliance with all applicable Australian Standards
- Inherent safe design processes to minimise the potential loss of containment and resulting fire scenarios
- No liquified gas storage within the pipelines
- Recommendations from the AS2885 Pipelines – Gas and Liquid Petroleum, Operation and Maintenance study are incorporated into the design
- Where housings are utilised, the detailed design safety requirements for housings should include as a minimum:
  - Highly reliable ventilation fan system and ventilation detection system
  - Independent 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)
  - Separation distances to nearby housings and occupied buildings
  - Safety systems to isolate both liquid and gas fuel supplies
- A detailed Quantitative Risk Assessment is recommended during detail design to ensure the appropriate location of onsite occupied buildings and siting of major pieces of equipment including the diesel storage tanks
- Spacing of potential fire hazards and the provision of fire barriers as necessary
- Functional safety assessment of control and shutdown systems to ensure that the likelihood of a loss of containment scenario is reduced
- Installation of a hydrocarbon detection systems within the facility, which act to isolate flow and likelihood of a loss of containment and resulting fire scenario
- Development of an Emergency Response Plan in collaboration with the local authorities for the incidents impacting the NPS, NGSF and Pacific Highway

The safety assessment process would will continue to identify controls that prevent or limit the effects of a major accident scenario. The detailed design would continue to consider whether there are further controls that could be implemented to reduce risk so far as is reasonably practicable.

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Appendices

Appendix 1

Weather Data – University of Newcastle

Table 28. Wind direction and frequency for Night/9am

Wind Directions	Percentage of time wind was in stability class 1.5/F.	Percentage of time wind was in stability class 5/D.	Percentage of time wind blows from each of the 8 major directions
N	9.125	0.5	9.625
NE	13.125	1	14.125
E	4.625	0.5	5.125
SE	14.125	3.5	17.625
S	6.625	1	7.625
SW	10.625	1	11.625
W	6.625	1	7.625
NW	21.625	5	26.625
Total %	**86.5**	**13.5**	**100**

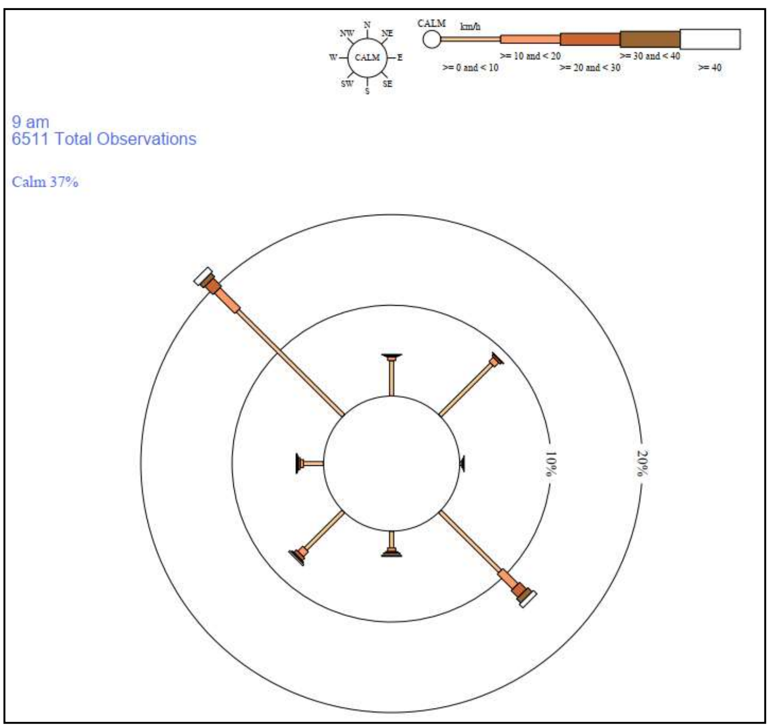

Figure 11. Wind Rose - Night/9am

Table 29. Wind direction and frequency for Day/3pm

Wind Directions	Percentage of time wind was in stability class 1.5/F.	Percentage of time wind was in stability class 5/D.	Percentage of time wind blows from each of the 8 major directions
N	2.625	0.5	3.125
NE	9.625	2.5	12.125
E	2.125	1.5	3.625
SE	26.625	16	42.625
S	3.125	3.5	6.625
SW	4.625	4	8.625
W	2.125	1.5	3.625
NW	10.625	9	19.625
Total %	**61.5**	**38.5**	**100**

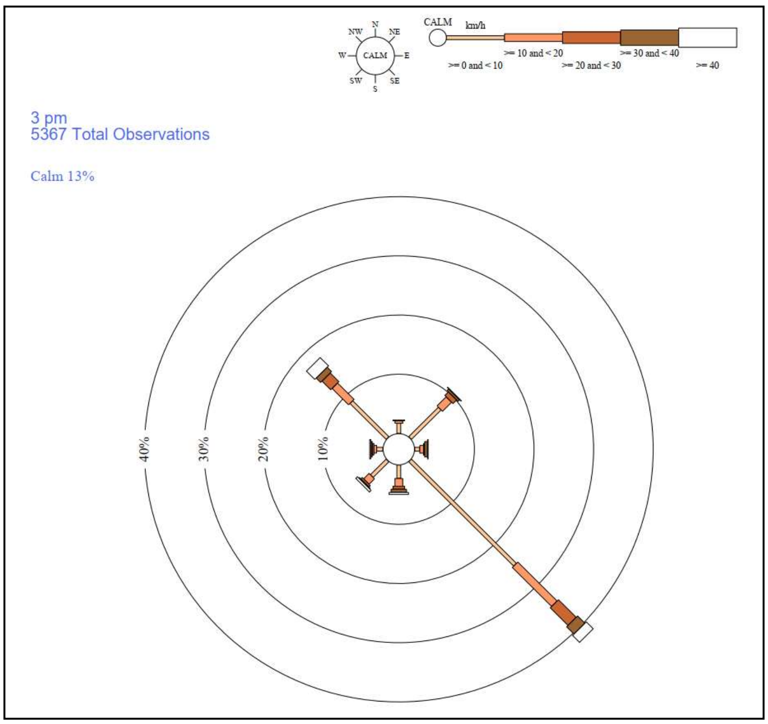

Figure 12. Wind Rose - Day/3pm

Appendix 2

Hazard Identification Table

#	Location/ Equipment	Hazard Cause	Consequence	Safeguards	Potential Offsite Impact
MHE1	Tie-in Point 1 to gas compression inlet / bypass (2,500 kPag)	- Excavation impact - Vehicle collision - Construction fault - Material fault - Thermal expansion - Ground movement - Corrosion	- Pipe rupture or leak potential for - Immediate ignition leading to jet fire - Delayed ignition leading to flash fire or explosion	- Underground pipe marker installed - Piping in restricted access areas - Construction works in areas to have permitting and trained and competent operators - NDT testing and hydrotesting of installed pipe - Hold points on material certs for piping and equipment - Majority of the piping is thermally insulated underground - Low risk area for earthquakes - Cathodic protection on underground piping and painted above ground piping - Dry gas used to minimise internal corrosion risk - Flanges are minimised and majority of connections full penetration butt weld. (Pipe wall thickness to exceed design requirements)	Yes
MHE2	Piping from gas compression units to gas turbine, when sourced from bidirectional pipeline (5,500 kPag). Water bath bypassed	- Excavation impact - Vehicle collision - Construction fault - Material fault - Thermal expansion - Ground movement - Corrosion - Over-pressure due to gas compressor failure	- Pipe rupture or leak potential for - Immediate ignition leading to jet fire - Delayed ignition leading to flash fire or explosion	- Underground pipe marker installed - Piping in restricted access areas - Construction works in areas to have permitting and trained and competent operators - NDT testing and hydrotesting of installed pipe - Hold points on material certs for piping and equipment - Majority of the piping is thermally insulated underground - Low risk area for earthquakes - Cathodic protection on underground piping and painted above ground piping - Dry gas used to minimise internal corrosion risk - Flanges are minimised and majority of connections full penetration butt weld. (Pipe wall thickness to exceed design requirements) - Pressure reducing valves and pressure relief valve at let down station - Slam shut Over-pressure valve at let down station - Redundant let down train	Yes

#	Location/ Equipment	Hazard Cause	Consequence	Safeguards	Potential Offsite Impact
MHE3	Piping from gas compression bypass to let down station, when sourced from bidirectional pipeline (2,500 kPag). Water bath bypassed	- Vehicle collision - Construction fault - Material fault - Thermal expansion - Ground movement - Corrosion	- Pipe rupture or leak potential for - Immediate ignition leading to jet fire - Delayed ignition leading to flash fire or explosion	- Piping in restricted access areas - Construction works in areas to have permitting and trained and competent operators - NDT testing and hydrotesting of installed pipe - Hold points on material certs for piping and equipment - Low risk area for earthquakes - Painted above ground piping - Dry gas used to minimise internal corrosion risk - Flanges are minimised and majority of connections full penetration butt weld. (Pipe wall thickness to exceed design requirements)	Yes
MHE4	Piping from gas let down station to gas engines, when sourced from bidirectional pipeline (1,000 kPag).	- Excavation impact - Vehicle collision - Construction fault - Material fault - Thermal expansion - Ground movement - Corrosion - Over-pressure due to failure of let down station	- Pipe rupture or leak potential for - Immediate ignition leading to jet fire - Delayed ignition leading to flash fire or explosion '- Pressure relief valve release potential for - Immediate ignition leading to jet fire - Delayed ignition leading to flash fire or explosion	- Underground pipe marker installed - Piping in restricted access areas - Construction works in areas to have permitting and trained and competent operators - NDT testing and hydrotesting of installed pipe - Hold points on material certs for piping and equipment - Majority of the piping is thermally insulated underground - Low risk area for earthquakes - Cathodic protection on underground piping and painted above ground piping - Dry gas used to minimise internal corrosion risk - Flanges are minimised and majority of connections full penetration butt weld. (Pipe wall thickness to exceed design requirements) - Pressure relief valves - Multiple pressure reducing valves at let down station - Slam shut Over-pressure valve at let down station	Yes

#	Location/ Equipment	Hazard Cause	Consequence	Safeguards	Potential Offsite Impact
MHE5	Piping from gas compression units to storage pipeline (15,000 kPag)	- Vehicle collision - Construction fault - Material fault - Thermal expansion - Ground movement - Corrosion - Over-pressure due to gas compressor failure	- Pipe rupture or leak potential for - Immediate ignition leading to jet fire - Delayed ignition leading to flash fire or explosion	- Piping in restricted access areas - Construction works in areas to have permitting and trained and competent operators - NDT testing and hydrotesting of installed pipe - Hold points on material certs for piping and equipment - Low risk area for earthquakes - Painted above ground piping - Dry gas used to minimise internal corrosion risk - Flanges are minimised and majority of connections full penetration butt weld. (Pipe wall thickness to exceed design requirements) - Manual pig launcher / receiver vent, vented to an elevated location. Venting methodology for usage.	Yes
MHE6	Gas storage pipelines with pig launcher/receive r (15,000 kPag)	- Excavation impact - Vehicle collision - Construction fault - Material fault - Thermal expansion - Ground movement - Corrosion	- Pipe rupture or leak potential for - Immediate ignition leading to jet fire - Delayed ignition leading to flash fire or explosion	- Underground pipe marker installed - Piping in restricted access areas - Construction works in areas to have permitting and trained and competent operators - NDT testing and hydrotesting of installed pipe - Hold points on material certs for piping and equipment - Majority of the piping is thermally insulated underground - Low risk area for earthquakes - Cathodic protection on underground piping and painted above ground piping - Dry gas used to minimise internal corrosion risk - Flanges are minimised and majority of connections full penetration butt weld. (Pipe wall thickness to exceed design requirements)	Yes
MHE7	Gas storage pipeline to let down station, including water bath heater (15,000 kPag)	- Vehicle collision - Construction fault - Material fault - Thermal expansion - Ground movement - Corrosion - Water bath heater failure overheating the gas pipe lowering pressure rating	- Pipe rupture or leak potential for - Immediate ignition leading to jet fire - Delayed ignition leading to flash fire or explosion	- Piping in restricted access areas - Construction works in areas to have permitting and trained and competent operators - NDT testing and hydrotesting of installed pipe - Hold points on material certs for piping and equipment - Low risk area for earthquakes - Painted above ground piping - Dry gas used to minimise internal corrosion risk - Flanges are minimised and majority of connections full penetration butt weld. (Pipe wall thickness to exceed design requirements) - Level, pressure and temperature alarms with system trips on heaters - Redundant heater - Manual pig launcher/ receiver vent, vented to an elevated location. Venting methodology for usage.	Yes

#	Location/ Equipment	Hazard Cause	Consequence	Safeguards	Potential Offsite Impact
MHE8	Piping from gas let down station to gas engines, when sourced from storage pipeline (1,000 kPag).	- Excavation impact - Vehicle collision - Construction fault - Material fault - Thermal expansion - Ground movement - Corrosion - Water bath heater failure resulting in low pressure gas being supercooled and embrittling the pipe lowering pressure rating - Over-pressure due to failure of let down station	- Pipe rupture or leak potential for - Immediate ignition leading to jet fire - Delayed ignition leading to flash fire or explosion - Pressure relief valve release potential for - Immediate ignition leading to jet fire - Delayed ignition leading to flash fire or explosion	- Underground pipe marker installed - Piping in restricted access areas - Construction works in areas to have permitting and trained and competent operators - NDT testing and hydrotesting of installed pipe - Hold points on material certs for piping and equipment - Majority of the piping is thermally insulated underground - Low risk area for earthquakes - Cathodic protection on underground piping and painted above ground piping - Dry gas used to minimise internal corrosion risk - Flanges are minimised and majority of connections full penetration butt weld. (Pipe wall thickness to exceed design requirements) - Pressure relief valves - Multiple pressure reducing valves at let down station - Slam shut Over-pressure valve at let down station - Low temperature trip downstream of let down station - Redundant let down train and heater	Yes

#	Location/ Equipment	Hazard Cause	Consequence	Safeguards	Potential Offsite Impact
MHE9	Piping from gas let down station to gas turbines, when sourced from storage pipeline (5,500 kPag).	- Excavation impact - Vehicle collision - Construction fault - Material fault - Thermal expansion - Ground movement - Corrosion - Water bath heater failure resulting in low pressure gas being supercooled and embrittling the pipe lowering pressure rating - Over-pressure due to failure of let down station	- Pipe rupture or leak potential for - Immediate ignition leading to jet fire - Delayed ignition leading to flash fire or explosion - Pressure relief valve release potential for - Immediate ignition leading to jet fire - Delayed ignition leading to flash fire or explosion	- Underground pipe marker installed - Piping in restricted access areas - Construction works in areas to have permitting and trained and competent operators - NDT testing and hydrotesting of installed pipe - Hold points on material certs for piping and equipment - Majority of the piping is thermally insulated underground - Low risk area for earthquakes - Cathodic protection on underground piping and painted above ground piping - Dry gas used to minimise internal corrosion risk - Flanges are minimised and majority of connections full penetration butt weld. (Pipe wall thickness to exceed design requirements) - Pressure relief valves - Multiple pressure reducing valves at let down station - Slam shut Over-pressure valve at let down station - Low temperature trip downstream of let down station - Redundant let down train and heater	Yes
MHE10	Enclosure	- Construction fault - Material fault - Thermal expansion - Corrosion	- Pipe rupture or leak potential for building/ enclosure to fill will flammable atmosphere - Delayed ignition leading to flash fire or explosion	- Construction works in areas to have permitting and trained and competent operators - NDT testing and hydrotesting of installed pipe - Hold points on material certs for piping and equipment - Painted above ground piping - Flanges are minimised and majority of connections full penetration butt weld. (Pipe wall thickness to exceed design requirements)	Yes
MHE11	Liquid Fuel Storage (Diesel) (2 x 750 kL tanks)	Loss of containment of Diesel from storage tanks due to: - Impact damage - Tank overfills - Tank failure - Pipework failure	- Release of combustible liquid (- ignition leading to tank fire, pool fire. - Environmental pollution if spill not contained and/or not properly cleaned up / disposed.	- Bunding compliant to AS1940 - Fire Protection - Separation distances compliant to AS1940 - Tank overfill protection - Low frequency of diesel offloading (emergency shutdown of gas supply) - Control of ignition sources	Unlikely

Appendix 3

Process Flow Diagram

PROCESS FLOW DIAGRAM

503269-0000-REP-0002 Concept Design Report - Gas Conditioning System

503269-0000-REP-0001 Concept Design Report - Natural Gas Supply Piping and Compression System

Power Station Concept Design Report

Description	Pressure (KPag)	Max Pressure (KPag)	Temperature (oC)	Flow (Sm3/hr)
MHE1	2,500	6,895	15-30	71,000
MHE2	5,500	6,895	15-30	71,000
MHE3	2,500	6,895	15-30	71,000
MHE4	1000	6,895	15-30	71,000
MHE5	15,000	15,300	30-60	71,000
MHE6	15,000	15,300	15-60	71,000
MHE7	15,000	15,300	30-60	71,000
MHE8	1000	6,895	15-30	71,000
MHE9	5,500	6,895	15-30	71,000
MHE10	200	200	15-30	4,734

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CLIENT	REV	DATE	REVISION DETAILS	APPROVED
	A	5/12/2018	AGL - NEWCASTLE POWER STATION - NATURAL GAS SUPPLY AND COMPRESSION UNIT	

SCALE	SIZE
NTS	A1

DRAWN: KS
DESIGNED: KS
REVIEWED: SV
APPROVED
DATE

PROJECT: AGL NEWCASTLE POWER STATION

TITLE: NATURAL GAS SUPPLY, COMPRESSION AND CONDITIONING SKID CONCEPT FLOW DIAGRAM

DRAWING No.	PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
	503269	0000	PFD	PP	0002	A