Preliminary Hazard Analysis

Live Fire Training

Jemena NSW Training Facility

Lot 21 DP 270644

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Executive Summary

The NSW Training Facility will provide Jemena with a dedicated and contemporary training facility within which to train (compliance and refresher training) internal staff and field work contractors in undertaking necessary field work associated with installing and maintaining Jemena's Gas Assets. Jemena is a Registered Training Organisation (RTO).

The proposed facility at Pemulwuy will include training room facilities and associated amenities, workshop space and covered and uncovered external training areas. These external areas will provide trainees with real life scenarios of Jemena's gas assets to complement theoretical training undertaken in training rooms. The facility will also involve the installation of a fire pit which provides some trainees with a facility to extinguish gas fires, simulating real life emergencies. This fire pit and live fire training are proposed to be located in an uncovered area within the site. Gas plumbing will be designed to ensure that the fire rigs are isolated from any incoming mains and is operated only when trained staff are present.

The live fire training and rigs, in themselves does not trigger SEPP 33 based on storage quantities as described in "Applying SEPP 33" (NSW DOP, 2011). The events associated with the live fire training and simulation do produce consequences that, without control measures, could have consequences on surrounding land uses.

A hazard analysis (in the form of a Preliminary Hazard Analysis) is used to examine the risk to surrounding land uses associated with the fire pit and live fire training proposed for the Jemena NSW Training facility.

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Findings and Recommendations

Findings

There are three (3) types of fire events simulated at the proposed facility. These events are:

1. Simulation of an underground release where gas is released through a gravel bed and ignited;
2. Simulation where gas is released through a pipe into a small fire pit;
3. Simulation of a jet fire where a release from a hole in a pipe is ignited.

The consequence analysis of the live fire simulations at the proposed Jemena NSW Training Facility revealed the following:

- The consequences of the fire or jet fire produced for the purposes of the training exercises would not produce radiant heat levels above 4.7 kWm^{-2} outside the site boundaries; and
- The risks to the biophysical environment are minimal.

Recommendations

To ensure that that the risks to surrounding land uses from live fire simulations undertaken at Jemena NSW Training are controlled the following recommendations, as shown in Table 1 have been made.

Table: 1 Recommendations

ID	Recommendation
1	Continue to undertake the simulation of a large jet fire only in favourable weather conditions. Establishment of a protocol to ensure this recommendation is undertaken.
2	Lock all gas feed pipe valves at the completion of simulations and training.

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1. Introduction

1.1. Project Background

The Jemena Gas Network distributes natural gas to 1.1 million homes and businesses in Sydney, Newcastle, the Central Coast and Wollongong as well as to over 20 country centres including those in the Central West, Central Tablelands, South Western, Southern Tablelands, Riverina and Southern Highlands regions of New South Wales.

Jemena is proposing the construction of a new training facility at 4 Bellevue Circuit, Pemulwuy, 2145. The site is Lot 21 of DP 270644.

The proposed facility will include training room facilities and associated amenities, workshop space and covered and uncovered external training areas. These external areas will provide trainees with real life scenarios of Jemena's gas assets to complement theoretical training undertaken in training rooms.

The proposed facility will also include live fire training and simulation to allow familiarisation with the hazards associated with gas distribution.

The hazards associated with live fire training and simulations are examined in this Preliminary Hazard Analysis (PHA).

1.2. Objectives

This PHA 's objective is to examine the potential off-site hazards and off-site risks associated with the live fire and fire simulation to be undertaken at the proposed Jemena NSW training facility. The PHA will include the following items:

- Consideration of inherently safe design principles and identification of areas where the facilities can be further enhanced;
- Assessment of the potential off-site risks for live fire training ; and
- Preparing a PHA for the live fire training undertaken at the Jemena NSW Training facility live fire training area using Hazardous Industry Planning Advisory Paper (HIPAP) No. 6, "Hazard Analysis Guidelines.

1.3. Study Scope

This study scope is for the live fire training and fire simulation to be operated by Jemena, at their proposed training site located at 4 Bellevue Circuit, Pemulwuy, 2145.

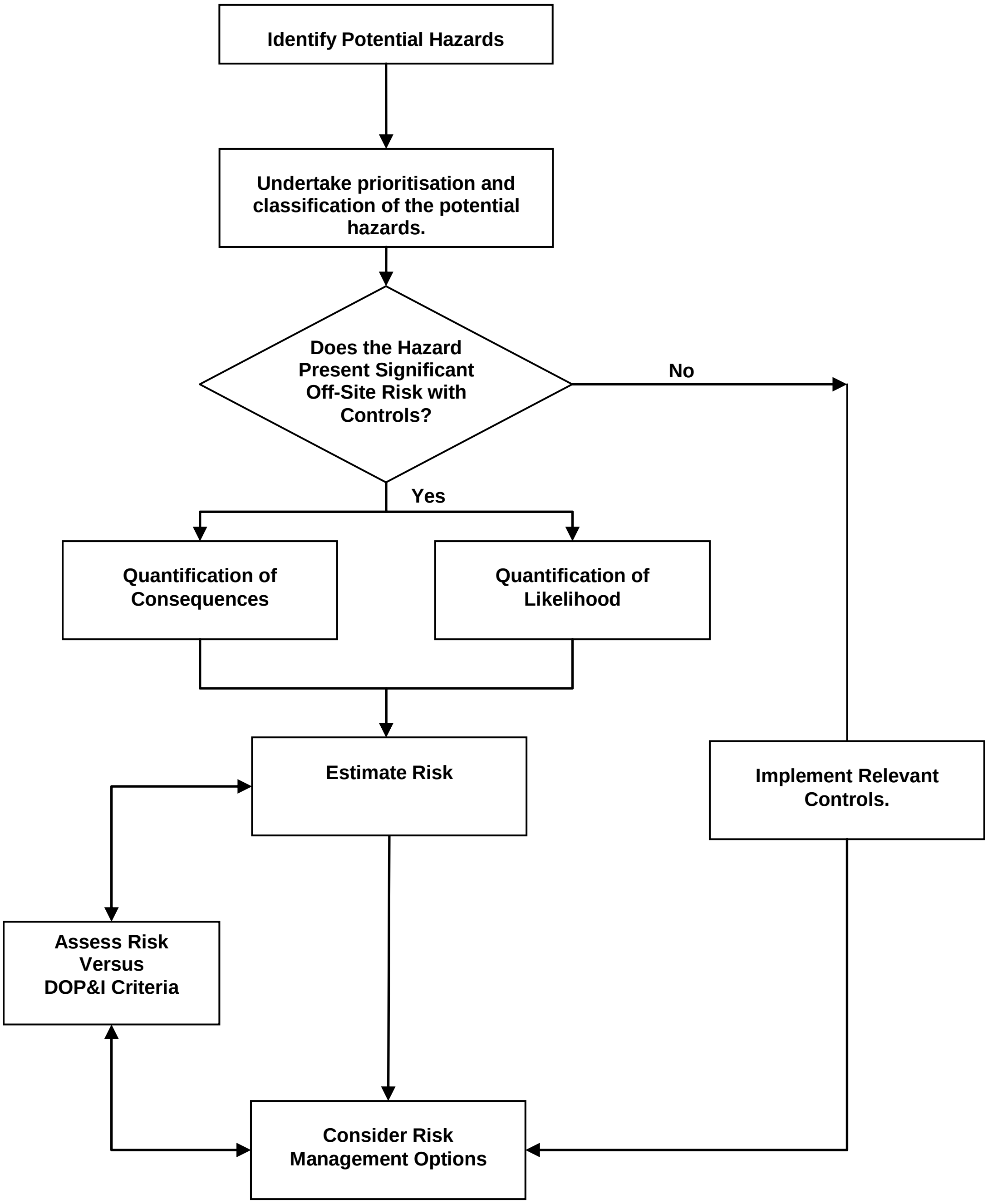
1.4. Methodology

The PHA is developed using the Department of Planning and Infrastructure (DOP&I), *Multi-Level Risk Assessment,* and DOP&I, *Guidelines for Hazard Analysis – HIPAP No.6.*

The development of the PHA included the following steps:

1. Identifying the potential hazards by evaluating the live fire training undertaken at the proposed Jemena Training site. Identifying each of the hazards and potential sources of loss that are associated with their storage;
2. Undertaking a hazard classification and prioritisation;
3. Estimation of the consequences of major hazardous events were determined quantitatively;
4. Evaluation of the effects of these consequences to determine if their effects would pose an off-site risk;
5. Estimation of the frequency of a hazardous incident occurring; and
6. Evaluation of the risks for the major hazardous incidents against the guidelines in the DOP&I *Risk Criteria from Land Use Safety Planning – HIPAP No.4.*

Figure 1.1 Methodology



2. Site Description

2.1. Jemena Site

The Jemena site is located at 4 Bellevue Circuit, Pemulwuy, 2145. The site is Lot 21 of DP 270644. The site is located in the Greystanes Southern Employment Park (SEP). The SEP is recognised under State Environmental Planning Policy (SEPP), Major Developments 2005

The site will contain training facilities including:

- Training rooms;
- Amenities;
- Workshop space; and
- Covered and uncovered external training areas.

The site layout and location of the fire training and simulation area are shown in Figure 2.1.

2.2. Neighbouring Facilities

The Jemena site has neighbouring facilities. These neighbouring facilities are described in Table 2.1

Table 2.1 Neighbouring Facilities

Direction from Site	Activity
North	Warehousing
East	Data Centre
South	Pharmaceutical Manufacturing Warehousing
West	Warehousing

These neighbouring facilities are consistent with the development of the Greystanes SEP. These neighbouring facilities are consistent with the zoning IN2, Light Industrial.

2.3. Transportation

The operation of the fire fighting training does not in itself require the transportation of dangerous goods to and from the site. The gas used in live fire training

2.4. Security

The perimeter of the site is fenced and after hours security patrols occur.

Figure 2.1 Site Layout

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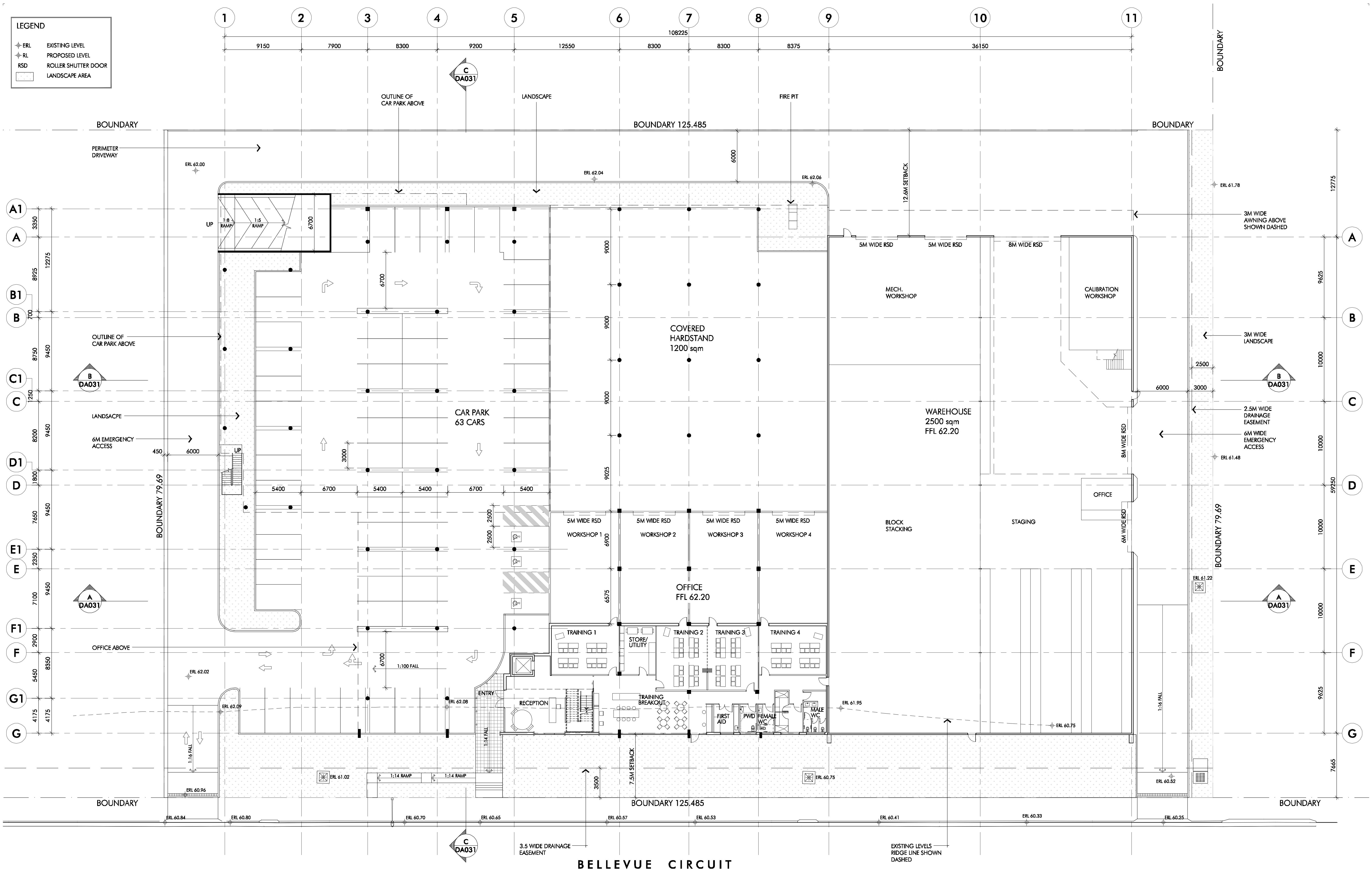
Insert Site Layout



Client

Jemena

Project

Proposed Office and Warehosue

Bellevue Circuit, Greystane, NSW

Issue	Description	Date
P1	PRELIMINARY ISSUE	24/04/14
P2	PRELIMINARY ISSUE	24/04/14
P3	PRELIMINARY ISSUE	28/04/14
P4	PRELIMINARY ISSUE	29/04/14

Title **Ground Floor Plan**

Scale 1:200 @ A1 or 1:400 @ A3

Date April 2014

Number **4441_DA011**

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3. Location

3.1. Site Location

The proposed Jemena site is located at 4 Bellevue Circuit, Pemulwuy, 2145. The site is Lot 21 of DP 270644. The site is located in the Greystanes Southern Employment Park (SEP). The SEP is recognised under State Environmental Planning Policy (SEPP), Major Developments 2005. The location of the Jemena site is shown in Figure 3.1.

Zoning

The land use for the proposed Jemena site is zoned IN2 (Light Industry). The typical objectives of an IN2 zone are**:**

- To provide a wide range of Light industrial, warehouse and related land uses;
- To encourage employment opportunities and support the viability of centres;
- To minimise any adverse effects of industry on other land uses;
- To enable other land uses that provide facilities or services to meet the day to day activities of workers;
- To recognise existing industry and to accommodate new industries that by their nature are compatible with any residential development in the vicinity;
- To enable development that is associated with, ancillary to, or supportive of industry; and
- To encourage new industry that will reinforce the area's economic base.

3.2. Adjacent Land Uses

The adjacent land uses include:

- Light Industrial (IN2);

Figure 3.2 displays the surrounding land uses about the Jemena site.

Sensitive Receptors

Sensitive receptors include:

- Schools;
- Hospitals;
- Childcare; and
- Aged care.

The area surrounding the proposed Jemena Site, for a distance of at least 300 metres, does not contain any sites identified as being sensitive receptors.

Figure 3.1 Site Location

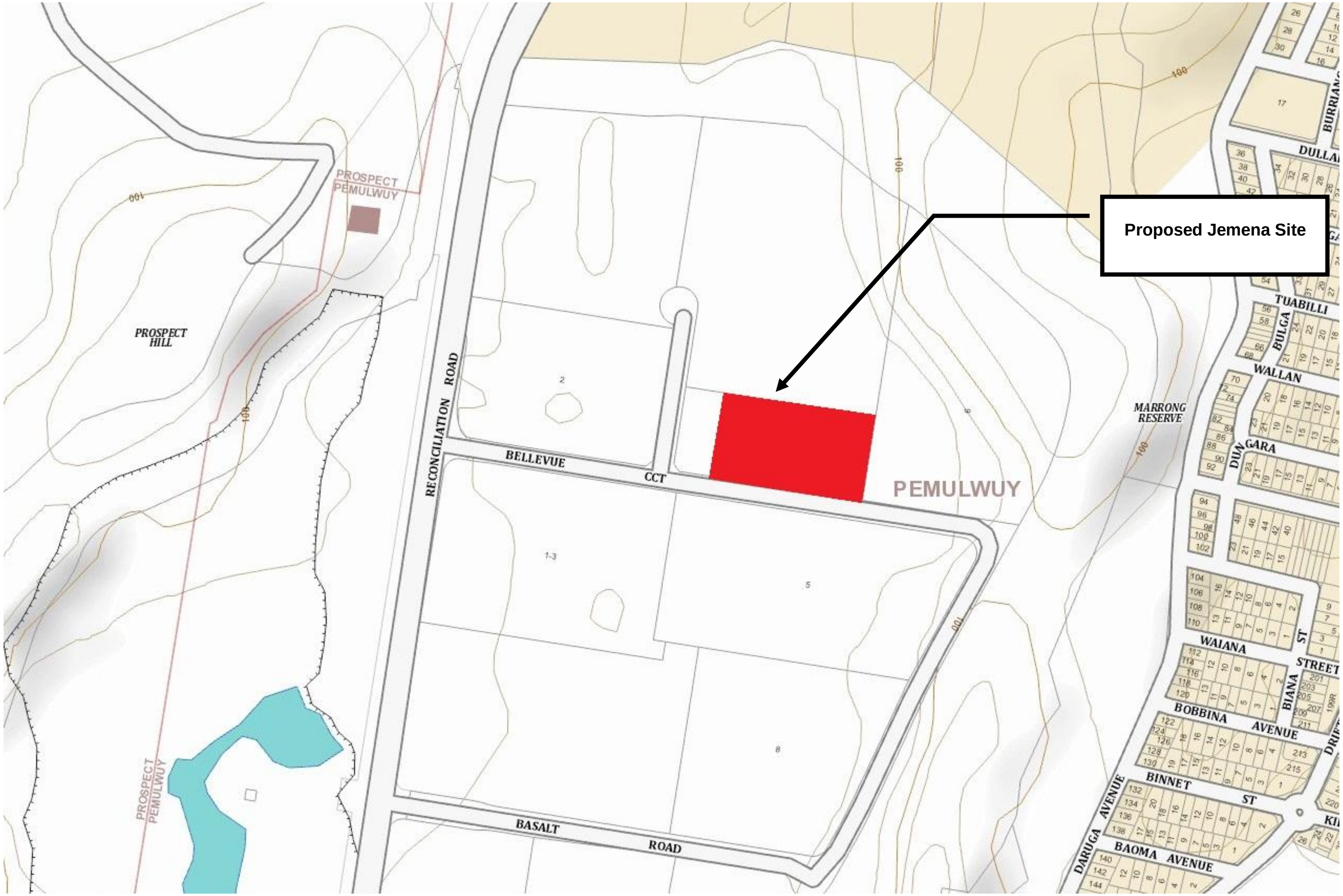
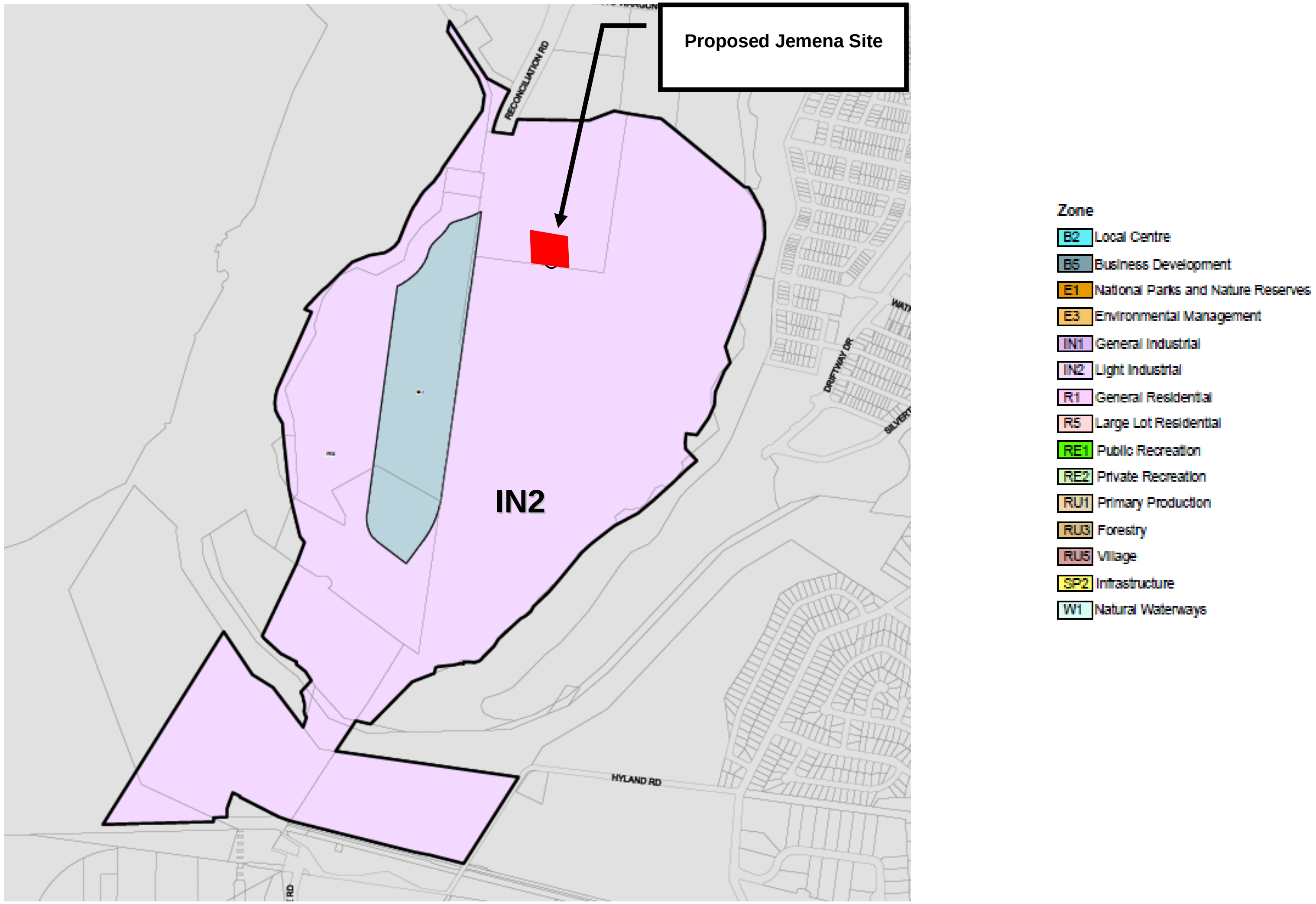


Figure 3.2 Surrounding Land Uses



4. Process

4.1. General Description

The Jemena NSW training facility proposes to provide live fire training. This live fire training involves the ignition on natural gas exiting a pipe. There are three (3) types of fire simulated.

Simulation 1: Underground Leak

The pipe is laid under a bed of gravel. The pipe has a number of holes in it that allow natural gas to escape through the gravel bed. This natural gas is ignited producing a low burning flame over the gravel area. This fire scenario is used for live fire training and is fought with carbon dioxide extinguishers

Simulation 2: Small Fire

The gas pipe opening is enclosed in a small bricked walled area and the pipe is directed at an angle. It is desired to produce a small semi-vertical flame that can be used to give live fire training. This fire scenario is used for live fire training and is fought with carbon dioxide extinguishers.

The impact of the released gas with the pipe and enclosure walls will result in the spreading of the flame.

Figure 4.1 Small Jet fire Rig

The frequency of use of the live fire training facilities is shown in section 4.2.

Simulation 3: Jet Fire

The gas pipe has a hole cut into the pipe to allow for the release of natural gas. This gas is ignited producing a jet fire. The exercise is undertaken for observation only and no fire fighting is attempted. The flame is only ignited for some seconds before the gas supply is isolated.

Figure 4.2 Large Jet Fire Rig

4.2. Frequency of Use

Frequency of Use (Live Fire Training)

Type of training	Use (per annum)
Induction Training	12
Compliance Training	30
Industry Demonstrations	20
3rd party Training	24

As the table reveals the live fire testing facility would be anticipated to be used 86 times per year. This is better described as one (1) to two (2) times a week.

4.3. Material Properties

The live fire training will be undertaken with natural gas as a source of fuel. This gas will be at between 35 kPa_g to 110 kPa_g for small fire simulation and up to 210 kPa_g for Jet fire simulation. For the purposes of this study the material properties will be taken as pure methane. The physical properties of methane are described in Table 4.1.

Table 4.1 Methane Physical Properties

Molecular weight (g/mol)	17
Relative density of the gas (atmospheric temp. and pressure)	0.6
Heat of combustion (MJ/kg)	50
Flammable range (vol. % in air)	5 to 15
Ratio of specific heats (C_p/C_v)	1.31
Flash point	-218°C

5. Hazard Identification

Hazard Identification involves the identification of all possible conditions that could lead to a hazardous event. This hazard identification indentifies the initiation of the hazardous event, the potential causes leading to that hazardous event and the consequence of that hazardous event. The consequences of the hazardous event can include:

- Harm to individuals;
- Damage to properties and surrounding lands uses and
- Damage to the biophysical environment,

This hazard identification use a word table for the capturing of the hazardous event. The hazard identification results are shown in Table 5.1.

The hazard identification undertaken in Table 5.1 identified potentially hazardous events associated with the live fire fighting and fire simulations undertaken at the proposed Jemena NSW Training site.

Table 5.1Hazard Identification

Hazard ID	Activity and DG Class	Event	Causes	Possible Consequences	Controls
1	Fire fighting Training	Ignition of a natural gas release producing a jet fire. This event is desired for training purposes.	Activity undertaken for training purposes.	Flame impingement on surrounding buildings or other equipment using in an escalation of the event. Injury to personnel undertaking the training activity	Separation from other activities, buildings and other activities. Remote isolation is provided to isolate the flow of natural gas. Protocol and procedures for undertaking the fire fighting training activity. Experience fire fighting personnel leading the training exercise. Provision of PPE suitable for the training exercise.
2	Fire fighting Training	Ignition of a natural gas release producing a jet fire. This event is desired for training purposes	Activity undertaken for training purposes.	Radiant Heat surrounding buildings or other equipment using in an escalation of the event. Injury to personnel undertaking the training activity. Radiant heat experienced at surround land uses.	Separation from other activities, buildings and other activities. Remote isolation is provided to isolate the flow of natural gas. Protocol and procedures for undertaking the fire fighting training activity. Experience fire fighting personnel leading the training exercise. Provision of PPE suitable for the training exercise.
3	Fire fighting Training	Ignition of a natural gas release producing a jet fire. This event is desired for training purposes	Activity undertaken for training purposes.	Combustion products of the ignition of natural gas affect surrounding land uses. Generation of contaminated fire fighting water.	Natural gas is a relatively clean burning gaseous fuel. The process is not expected to generate large volumes of smoke, Nox or Sox CO_2 fire extinguisher training is the primary training given. The use of water is limited to emergency events and is not part of regular training.

6. Consequence Analysis

6.1. Simulated Fires

6.1.1. Underground Leak

The pipe is laid under a bed of gravel. The pipe has a number of holes in it that allow natural gas to escape through the gravel bed. This natural gas is ignited producing a low burning flame over the gravel area. The radiant heat produced by this fire will be localised around the gravel bed. In this PHA, no consequence analysis is undertaken as the fire simulations in section 6.1.2and 0 will have significantly greater consequences than the underground leak simulation.

6.1.2. Small Fire

The ignition of the natural gas from the pipe work will result in the production of a jet fire like fire event. This jet fire allows for live fire fighting training.

The small fire is within a enclosed pit and this will disperse flames and reduce the effective flame length. The evaluation of the radiant heat from this fire event is undertaken as a jet fire. The calculation is shown in Appendix B.

Table 6.1 Small Fire

Line Pressure (kPa$_g$)	**Flame Length** Metres	**Distance to 4.7 kWm^{-2}** Metres
70	2.2	2.7

As revealed by Table 6.1 the distances to 4.7 kWm^{-2} are located close to the source fire, and do not extend off-site.

6.1.3. Large Jet fire

A jet fire is a turbulent diffusion flame resulting from the combustion of a fuel continuously released with some significant momentum in a particular direction or directions. Jet fires can arise from releases of gaseous material. The properties of jet fires depend on the fuel composition, release conditions, release rate, release geometry, direction and ambient wind conditions.

The production of the large jet fire is only undertaken in favourable wind condition to prevent the jet fire from distorting downwind. This fire simulation is not approached and is for observation only. The evaluation of the radiant heat from this fire event is undertaken as a jet fire. The calculation is shown in Appendix B.

Table 6.2 Large Jet Fire

Line Pressure (kPa$_g$)	**Flame Length** Metres	**Distance to 4.7 kWm^{-2}** Metres
210	4.7	6.0

The dimensions and results shown in Table 6.2 are conservative. The release is from a sharp edged square orifice and rates of release would be expected to be lower. The distances to 4.7 kWm^{-2} are located close to the source fire, and do not extend off-site.

6.2. Biophysical Consequences

Jemena will implement controls to minimise the occurrence of releases into the environment. The combustion of the natural gas does not produce large volumes of soot, black smoke or un-combusted materials. The fire is clean burning. There will be minimal effects to the atmospheric environment.

The live fire fighting uses of carbon dioxide portable extinguishers. The use of water is not undertaken. The carbon dioxide will quickly disperse into the atmosphere. It is considered unlikely that the live fire training and fire pits will have any effects on waterways in the surround areas.

7. Estimation of the Likelihood of Hazardous Events

In section 6 the consequences of the live fire training exercises were examined. The radiant heat level of 4.7 kWm^{-2} was found to be contained within the site boundaries. The consequences are below the criteria required for the examination of risks to surrounding land uses and no detailed examination of the likelihood of the hazardous event is undertaken.

The frequency of use of the live fire training facility is described in section 4.1.

8. Risk Assessment

8.1. Risk Assessment

The risk assessment is the process of evaluating the combination consequence of the potentially hazardous event and the likelihood of that event.

8.2. Comparison with Criteria

The DOP&I (found in HIPAP No.4) risk criteria for surrounding land uses is a risk based criteria. This criteria is examined in Table 8.1

8.2.1. Findings

The consequences associated with live fire training at Jemena NSW training facility were examined in section 6 . These consequences were found to have small consequence distances and did not have consequences of concern, based on the risk criteria, extending to surrounding land uses.

Table 8.1 Risk Criteria

Description/Risk Criteria	Criteria	Results	Risk Criteria
Fatality risk to sensitive uses, including hospitals, schools, aged care	0.5×10^{-6} per year	The consequences of the live fire training do not produce significant risks for surrounding land uses.	**YES**
Fatality risk to residential areas and hotels	1×10^{-6} per year	The consequences of the live fire training do not produce significant risks for surrounding land uses.	**YES**
Fatality risk to commercial areas, including offices, retail centres and entertainment centres	5×10^{-6} per year	The consequences of the live fire training do not produce significant risks for surrounding land uses.	**YES**
Fatality risk to sporting complexes and active open spaces	10×10^{-6} per year	The consequences of the live fire training do not produce significant risks for surrounding land uses.	**YES**
Fatality risk contained to within the boundary of an industrial site	50×10^{-6} per year	The consequences of the live fire training do not produce significant risks for surrounding land uses.	**YES**
Injury risk–incident heat flux radiation at residential areas should not exceed 4.7 kW/m^2 at frequencies of more than 50 chances in a million per year or incident explosion overpressure at residential areas should not exceed 7kPa at frequencies of more than 50 chances in a million per year	50×10^{-6} per year	Residential area are not impacted on by radiant heat at or above 4.7 kW/m^2	**YES**
Toxic exposure-toxic concentrations in residential areas which would be seriously injurious to sensitive members of the community following a relatively short period of exposure	10×10^{-6} per year	The burning of natural gas will not be seriously injurious to sensitive members of the community	**YES**
Toxic exposure-toxic concentrations in residential areas which should cause irritation to eyes or throat, coughing or other acute physiological responses in sensitive members of the community	50×10^{-6} per year	The burning of natural gas will not cause irritation to eyes or throat, coughing or other acute physiological responses to sensitive members of the community	**YES**
Propagation due to Fire and Explosion exceed radiant heat levels of 23kW/m^2 or explosion overpressures of 14kPa in adjacent industrial facilities	50×10^{-6} per year	radiant heat levels of 23kW/m^2 or explosion overpressures of 14kPa are do not occur at adjacent industrial facilities	**YES**

9. Conclusion

9.1. Project Description

The NSW Training Facility will provide Jemena with a dedicated and contemporary training facility within which to train (compliance and refresher training) internal staff and field work contractors in undertaking necessary field work associated with installing and maintaining Jemena's Gas Assets. Jemena is a Registered Training Organisation (RTO).

The proposed facility at Pemulwuy will include training room facilities and associated amenities, workshop space and covered and uncovered external training areas. These external areas will provide trainees with real life scenarios of Jemena's gas assets to complement theoretical training undertaken in training rooms.

The facility will also undertake live fire training that provides some trainees with a facility to extinguish gas fires, simulating real life emergencies. Gas plumbing will be designed to ensure that the fire simulation rigs are isolated from any incoming mains and is operated only when trained staff are present. There are three (3) types of fire events simulated at the facility. These events are:

1. Simulation of an underground release where gas is released through a gravel bed and ignited;
2. Simulation of an gas release where gas is released through a pipe into a small fire pit;
3. Simulation of a jet fire where a release from a hole in a pipe is ignited.

9.2. Findings

The consequence analysis of the live fire simulations at the proposed Jemena NSW Training facility revealed the following:

- The consequences of a jet fire produced for the purposes of the training exercise would not produce radiant heat levels above 4.7 kWm^{-2} outside the site boundaries; and
- The risks to the biophysical environment are minimal.

9.3. Recommendations

To ensure that that the risks to surrounding land uses from live fire simulations undertaken at Jemena NSW Training are controlled the following recommendations, as shown in Table 9.1 have been made.

Table 9.1 Recommendations

ID	Recommendation
1	Continue to undertake the simulation of a large jet fire only in favourable weather conditions. Establishment of a protocol to ensure this recommendation is undertaken.
2	Lock all gas feed pipe valves at the completion of simulations and training.

10. Glossary and Abbreviations

DOP	NSW Department of Planning (Now DOP&I)
DOP&I	NSW Department of Planning and Infrastructure
HIPAP	Hazardous Industry Planning Advisory Paper
kWm^{-2}	Kilowatts per square meter
PHA	Preliminary Hazard Analysis
PPE	Personal Protective Equipment
SEPP 33	State environmental Planning Policy No. 33

11. References

1	AIChE, CCPS, "Guidelines for Chemical Process Quantitative Risk Analysis (GCPQRA)", 2nd Edition. 2000
2	AIChE, CCPS, "Guidelines for Chemical Reactivity Evaluation and Application to Process Design", Centre for Chemical Process Safety, American Institute of Chemical Engineers, New York. 1995
3	AIChE, CCPS, "Guidelines for Hazard Evaluation Procedures", USA, 2nd edition. 1992
4	Lees, F.P., "Loss Prevention in the Process Industries", Vol.2, Edition 2, Butterworth- Heinemann, Oxford, 1996.
5	NFPA (National Fire Protection Association), "The SFPE Handbook of Fire Protection Engineering"
6	NSW Department of Planning, 2011, Hazardous Industry Planning Advisory Paper No. 4 - Risk Criteria for Land Use Planning
7	NSW Department of Planning, 2011, Hazardous Industry Planning Advisory Paper No. 6 - Guidelines for Hazard Analysis
8	TNO, 2005, CPR 14E - Methods for the Calculation of Physical Effects (Yellow Book), 3rd Edition
9	TNO, CPR 16E - Methods for the Determination of Possible Damage (Green Book), 1st Edition. 1992,
10	TNO, VROM, Guidelines for Quantitative Risk Assessment (Purple book), CPR18E, 3rd Edition.

Appendix A. Risk in Context

Risk in Context

The following table is published in HIPAP No.4 and provide useful background information on the risks of various types of activity. The tables provide a context against which some of the suggested numerical risk criteria can be compared and demonstrate the significant degree of conservatism in the criteria when compared against risks from normal daily activities.

Table. A.1 Risk in Context

Chances of fatality per million person years	
Voluntary Risks (average to those who take the risk)	
Smoking (20 cigarettes/day)	
▪ all effects	5,000
▪ all cancers	2,000
▪ lung cancers 1000	1,000
Drinking alcohol (average for all drinkers)	
▪ all effects	380
▪ alcoholism and alcoholic cirrhosis	115
Swimming	50
Playing rugby football	30
Owning firearms	30
Transportation Risks (average to travellers)	
Travelling by motor vehicle	145
Travelling by train	30
Travelling by aeroplane	10
Risks Averaged over the Whole Population	
Cancers from all causes	
- Total	1,800
- Lung	380
Air pollution from burning coal to generate electricity	0.07-380
Accidents in the home	110
Accidental falls	60
Pedestrians being struck by motor vehicles	35
Homicide	20
Accidental poisoning total	18
Venomous animals and plants	0.1
Fires and accidental burns	10
Electrocution (non-industrial)	3
Falling objects	3
Therapeutic use of drugs	2
Cataclysmic storms and storm floods	.2
Lightning strikes	.1
Meteorite strikes	.001

Heat Radiation

The following table is published in HIPAP No.6 and provide useful background information on the risks of various types of activity and the consequences of individual exposure to heat radiation.

Table. A.2 Heat Radiation Effects

Heat Flux (kW/m^2)	Effect of Heat Flux
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)
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
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

Appendix B. Consequences of Hazardous Events

Jet Fire Mode

Release Rates

A single phase gas flow escaping from a hole where

$$\frac{P_a}{P_1} > \left(\frac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma-1}}$$

can be found by the equation

$$G_v = 0.8A\sqrt{2\,\rho_v\,\Delta P}$$

G_v	Mass flow rate (kgs^{-1})
A	Cross-section area of leak path (m2)
ΔP	Pressure Differential
ρ_v	Density of gas (kg/m3)
γ	Ratio of specific heats

A single phase gas flow escaping from a hole where

$$\frac{P_a}{P_1} < \left(\frac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma-1}}$$

can be found by the equation

$$= 0.8AP\sqrt{\left(\frac{M\gamma}{z\,RT_1}\right)\left(\frac{2}{\gamma+1}\right)^{\frac{\gamma+1}{\gamma-1}}}$$

G_v	Mass flow rate (kgs^{-1})
A	Cross-section area of leak path (m2)
P_a	Atmospheric Pressure (Pa)
P_1	Upstream absolute Pressure (Pa)
γ	Ratio of specific heats
M	Molecular Weight
R	Gas Constant (J/k mol K
z	Compressibility factor of Gas

Radiant Heat

The incident heat flux a point source method was used. This uses the equation:

$$q = \frac{Xr\;Q\;cos\theta}{4\pi R^2}$$

q	Incident heat flux received (kWm^{-2})
Xr	Fraction of heat radiated
Q	Heat of Combustion (kW)
θ	Angle of Incident between centre of release and receptor
R	Distance from centre (m)

Small Fire

The modelling parameters and key assumption are listed in Table. B.1

Table. B.1 Small fire (70kPag)

Scenario Ref	B1
Scenario Description	Jet Release of Natural Gas Ignited
Release	15mm hole
Model	Simplified Gas release ICI Point Source Model
Model parameters	A Based on a diameter of hole of 15mm P_a 101,300 Pa P_1 171,300 Pa Xr 0.2 θ 0 degrees (in line)
Assumptions	Modelled as Methane. No allowance has been made for wind tilt The point source method does not allow for geometric factors Flame length is calculated by the following formula $\boldsymbol{L = 1.555Q^{0.467}}$ The gas and flame impact on surround walls and would not be expected to reach the length described in the formula.
Comments	

Jet Fire Modelling

Data:

Modelled gas	Methane	
Heat of combustion of gas	50000	kJ/kg
Hole Diameter	15	mm
Upstream Pressure	171300	Pa
Atmospheric Pressure	101300	Pa
Ambient temperature:	298	K
Ratio of specific Heats	1.31	
Molecular weight	17.000	g. moles
Compressibility factor	0.990	
Receptor distance from Jet fire	2.69	m
Radiation efficiency for point source model:	0.2	
Gas desity	0.8823	kJ/m3

Calculated Results:

Cross section leak path	0.00018	m^2
P_a/P_1	0.59	
Specific Heat	0.54	
Mass Release Rate (chocked flow)	0.043	kg/s
Mass Release Rate (unchocked flow)	**0.050**	**kg/s**
Mass burning rate:	2133.06	kW

Flame Length

Flame Length	2.22	m

Point Source Model:

Transmissity	1.00	
Height adjustment	0.00	m

Thermal flux at receptor (Point source):	**4.70**	**kW/m^2**

Jet Fire

The modelling parameters and key assumption are listed in Table. B.1

Table. B.2 Jet fire (210kPag)

Scenario Ref	B1
Scenario Description	Jet Release of Natural Gas Ignited
Release	25mm hole
Model	Simplified Gas release ICI Point Source Model
Model parameters	A Based on a diameter of hole of 25mm P_a 101,300 Pa P_1 311,300 Pa Xr 0.2 θ 0 degrees (in line)
Assumptions	Modelled as Methane. No allowance has been made for wind tilt The point source method does not allow for geometric factors Flame length is calculated by the following formula $\boldsymbol{L = 1.555Q^{0.467}}$ The gas and flame impact on surround walls and would not be expected to reach the length described in the formula.
Comments	Flow rate may be mall than those calculated here as the hole is a sharp edged orifice. Gas pressure is evaluated at the highest pressure available.

Jet Fire Modelling

Data:

Modelled gas	Methane	
Heat of combustion of gas	50000	kJ/kg
Hole Diameter	25	mm
Upstream Pressure	311300	Pa
Atmospheric Pressure	101300	Pa
Ambient temperature:	298	K
Ratio of specific Heats	1.31	
Molecular weight	17.000	g. moles
Compressibility factor	0.990	
Receptor distance from Jet fire	6.04	m
Radiation efficiency for point source model:	0.2	
Gas desity	0.8823	kJ/m3

Calculated Results:

Cross section leak path	0.00049	m^2
P_a/P_1	0.33	
Specific Heat	0.54	
Mass Release Rate (chocked flow)	**0.215**	**kg/s**
Mass Release Rate (unchocked flow)	0.239	kg/s
Mass burning rate:	10767.68	kW

Flame Length

Flame Length	4.73	m

Point Source Model:

Transmissity	1.00	
Height adjustment	0.00	m

Thermal flux at receptor (Point source):	**4.70**	**kW/m^2**

Appendix C. Site Details

Additional Site Details

This section contains the following information.

1. LEP map

NSW GOVERNMENT
Department of Planning

State Environmental Planning Policy (Major Projects) 2005 (Amendment No 22)

Greystanes Southern Employment Lands Site -
Land Zoning Map

Subject Land

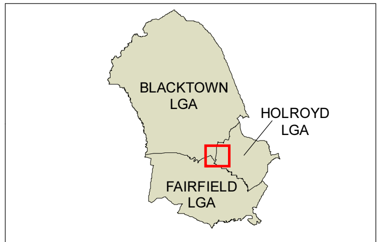
Zone

B7 Business Park

IN2 Light Industrial

Cadastre

Cadastre 19/09/08 © Dept of Lands

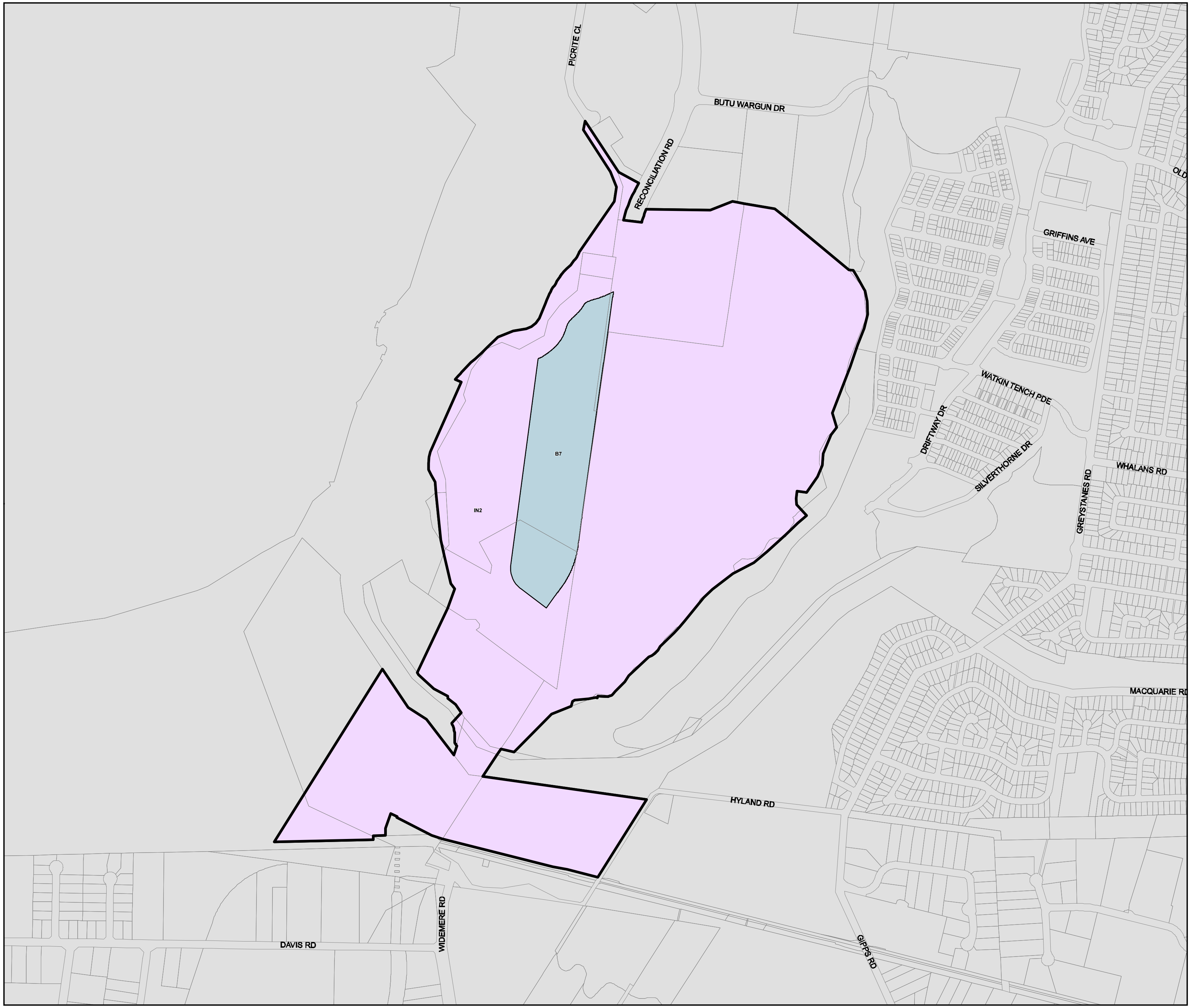


Projection: GDA 1994
Zone 56

0 100 200 Metres

Scale: 1:10,000 @ A3

Map Identification Number
SEPP_MP_GEL_LZN_001_20080922



Appendix D. MSDS

MSDS

This section contains SDSs for the following:

1. Natural Gas.

Section 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME
AGL Natural Gas

SYNONYMS
"high methane", "natural gas NG"

PROPER SHIPPING NAME
METHANE, COMPRESSED or NATURAL GAS, COMPRESSED with high methane content

PRODUCT USE
Commercial heating and cooking gas fuel, fuel for vehicles. Fractionated and used as base raw material for the manufacture of many chemicals ammonia, acetylene. etc.

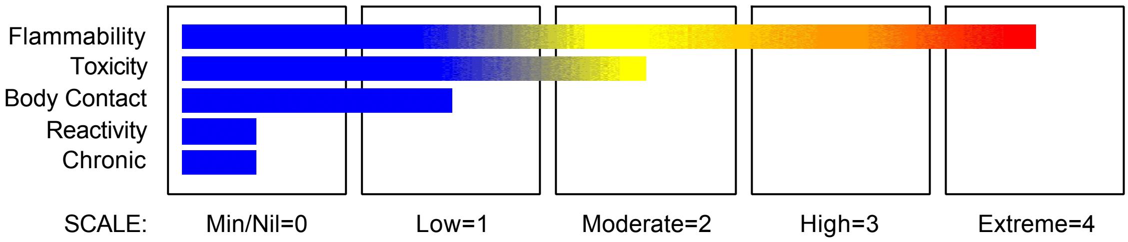
SUPPLIER

Company: AGL Energy Limited	Company: AGL Energy Limited
Address:	Address:
Locked Bag 1837	Level 22, 101 Miller Street
St. Leonards	North Sydney
NSW, 2065	NSW, 2060
Australia	Australia
	Telephone: +61 2 9921 2999
	Emergency Tel:**000**

Section 2 - HAZARDS IDENTIFICATION

STATEMENT OF HAZARDOUS NATURE
DANGEROUS GOODS. NON-HAZARDOUS SUBSTANCE. According to NOHSC Criteria, and ADG Code.

CHEMWATCH HAZARD RATINGS



RISK
■ Extremely flammable.
■ Risk of explosion if heated under confinement.
■ Inhalation may produce health damage*.
■ May produce discomfort of the eyes*.
■ Vapours potentially cause drowsiness and dizziness*.
* (limited evidence).

SAFETY
• Keep away from sources of ignition. No smoking.
• Do not breathe gas/fumes/vapour/spray.
• Avoid contact with skin.
• Avoid contact with eyes.
• Wear eye/face protection.
• Use only in well ventilated areas.
• Keep container in a well ventilated place.

continued...

• Keep container tightly closed.
• In case of contact with eyes, rinse with plenty of water and contact Doctor or Poisons Information Centre.
• This material and its container must be disposed of as hazardous waste.

Section 3 - COMPOSITION / INFORMATION ON INGREDIENTS

NAME	CAS RN	%
natural gas	8006-14-2	100

Section 4 - FIRST AID MEASURES

SWALLOWED

■ Not considered a normal route of entry.

EYE

• If product comes in contact with eyes remove the patient from gas source or contaminated area.
• Take the patient to the nearest eye wash, shower or other source of clean water.
• Open the eyelid(s) wide to allow the material to evaporate.
• Gently rinse the affected eye(s) with clean, cool water for at least 15 minutes. Have the patient lie or sit down and tilt the head back. Hold the eyelid(s) open and pour water slowly over the eyeball(s) at the inner corners, letting the water run out of the outer corners.

SKIN

• Generally not applicable.

INHALED

• Following exposure to gas, remove the patient from the gas source or contaminated area.
• NOTE: Personal Protective Equipment (PPE), including positive pressure self-contained breathing apparatus may be required to assure the safety of the rescuer.
• Prostheses such as false teeth, which may block the airway, should be removed, where possible, prior to initiating first aid procedures.
• If the patient is not breathing spontaneously, administer rescue breathing.

NOTES TO PHYSICIAN

Treat symptomatically.

Section 5 - FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA

■ DO NOT EXTINGUISH BURNING GAS UNLESS LEAK CAN BE STOPPED SAFELY:
OTHERWISE: LEAVE GAS TO BURN.
FOR SMALL FIRE:
• Dry chemical, CO_2 or water spray to extinguish gas (only if absolutely necessary and safe to do so).
• DO NOT use water jets.
FOR LARGE FIRE:
• Cool cylinder by direct flooding quantities of water onto upper surface until well after fire is out.
• DO NOT direct water at source of leak or venting safety devices as icing may occur.

FIRE FIGHTING

■ --
GENERAL

• Alert Fire Brigade and tell them location and nature of hazard.
• May be violently or explosively reactive.
• Wear breathing apparatus plus protective gloves.
• Consider evacuation.

continued...

FIRE/EXPLOSION HAZARD

- HIGHLY FLAMMABLE: will be easily ignited by heat, sparks or flames.
- Will form explosive mixtures with air
- Fire exposed containers may vent contents through pressure relief valves thereby increasing fire intensity and/ or vapour concentration.
- Vapours may travel to source of ignition and flash back.

On combustion, emits toxic fumes of: carbon monoxide (CO), carbon dioxide (CO_2).

FIRE INCOMPATIBILITY

- Explosion hazard may follow contact with incompatible materials.

HAZCHEM

2SE

Section 6 - ACCIDENTAL RELEASE MEASURES

MINOR SPILLS

- Avoid breathing vapour and any contact with liquid or gas. Protective equipment including respirator should be used.
- DO NOT enter confined spaces where gas may have accumulated.
- Shut off all sources of possible ignition and increase ventilation.
- Clear area of personnel.

MAJOR SPILLS

- Clear area of all unprotected personnel and move upwind.
- Alert Emergency Authority and advise them of the location and nature of hazard.
- May be violently or explosively reactive.
- Wear full body clothing with breathing apparatus.

Personal Protective Equipment advice is contained in Section 8 of the MSDS.

Section 7 - HANDLING AND STORAGE

PROCEDURE FOR HANDLING

- Consider use in closed pressurised systems, fitted with temperature, pressure and safety relief valves which are vented for safe dispersal.
- The tubing network design connecting gas cylinders to the delivery system should include appropriate pressure indicators and vacuum or suction lines.
- Fully-welded types of pressure gauges, where the bourdon tube sensing element is welded to the gauge body, are recommended.
- Before connecting gas cylinders, ensure manifold is mechanically secure and does not containing another gas. Before disconnecting gas cylinder, isolate supply line segment proximal to cylinder, remove trapped gas in supply line with aid of vacuum pump.
- Avoid generation of static electricity. Earth all lines and equipment.
- DO NOT transfer gas from one cylinder to another.

SUITABLE CONTAINER

- Cylinder:
- Ensure the use of equipment rated for cylinder pressure.
- Ensure the use of compatible materials of construction.
- Valve protection cap to be in place until cylinder is secured, connected.
- Check that containers are clearly labelled.
- Packaging as recommended by manufacturer.

STORAGE INCOMPATIBILITY

Segregate from oxygen gas, oxidising agents.

STORAGE REQUIREMENTS

Store in a cool, dry place Store in a flame proof area.
- No smoking, naked lights, heat or ignition sources.

Store in a cool area and away from sunlight Store below 45 deg. C.

continued...

Store in a well-ventilated area Store away from incompatible materials.
• Store in an upright position • Outside or detached storage is preferred.
Protect containers against physical damage.
Rotate all stock to prevent ageing. Use on FIFO (First In-First Out) basis.

Section 8 - EXPOSURE CONTROLS / PERSONAL PROTECTION

EXPOSURE CONTROLS
The following materials had no OELs on our records
• natural gas: CAS:8006- 14- 2

MATERIAL DATA
AGL NATURAL GAS:
Not available

NATURAL GAS:
TLV TWA: 1000 ppm as aliphatic hydrocarbon gases, alkane C1-C4
ES TWA: simple asphyxiant

PERSONAL PROTECTION



EYE
• Safety glasses with side shields; or as required,
• Chemical goggles.
• Contact lenses may pose a special hazard; soft contact lenses may absorb and concentrate irritants. A written policy document, describing the wearing of lens or restrictions on use, should be created for each workplace or task. This should include a review of lens absorption and adsorption for the class of chemicals in use and an account of injury experience. Medical and first-aid personnel should be trained in their removal and suitable equipment should be readily available. In the event of chemical exposure, begin eye irrigation immediately and remove contact lens as soon as practicable. Lens should be removed at the first signs of eye redness or irritation - lens should be removed in a clean environment only after workers have washed hands thoroughly. [CDC NIOSH Current Intelligence Bulletin 59], [AS/NZS 1336 or national equivalent].

HANDS/FEET
• When handling sealed and suitably insulated cylinders wear cloth or leather gloves.

OTHER
• Protective overalls, closely fitted at neck and wrist.
• Eye-wash unit.
IN CONFINED SPACES:
• Non-sparking protective boots
• Static-free clothing.
Operators should be trained in correct use.
Ensure that there is ready access to breathing apparatus.
Ensure ready access to a burns first aid kit.

ENGINEERING CONTROLS
■ Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection.
The basic types of engineering controls are:
Process controls which involve changing the way a job activity or process is done to reduce the risk.
Enclosure and/or isolation of emission source which keeps a selected hazard "physically" away from the worker and ventilation that strategically "adds" and "removes" air in the work environment.

continued...

Section 9 - PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE

Invisible, highly flammable gas which readily forms explosive mixtures in air.
Odourant in the form of tertiary butylmercaptan (TBM) 30% and tetrahydrothiophene (THT) 70% is added to allow detection, recognition.
Gas is less dense than air. Burns with a pale, luminous flame.
Practically insoluble in water. Soluble in alcohol, ether, hydrocarbons
Packed as a gas under pressure. Sudden release of pressure or leakage will result in generation of a large volume of highly flammable / explosive gas.

PHYSICAL PROPERTIES

Gas.
Does not mix with water.
Floats on water.

State	Compressed gas	Molecular Weight	16.04
Melting Range (°C)	- 182	Viscosity	Not available
Boiling Range (°C)	- 162	Solubility in water (g/L)	Immiscible
Flash Point (°C)	- 218	pH (1% solution)	Not applicable.
Decomposition Temp (°C)	Not available	pH (as supplied)	Not applicable
Autoignition Temp (°C)	540	Vapour Pressure (kPa)	Not applicable.
Upper Explosive Limit (%)	15.0	Specific Gravity (water=1)	0.615 (Air = 1)
Lower Explosive Limit (%)	5.0	Relative Vapour Density (air=1)	0.615
Volatile Component (%vol)	100	Evaporation Rate	Not applicable

Section 10 - STABILITY AND REACTIVITY

CONDITIONS CONTRIBUTING TO INSTABILITY

• Presence of incompatible materials • Presence of elevated temperatures.
• Presence of heat source and ignition source.
Product is considered stable under normal handling conditions.
Hazardous polymerisation will not occur.
For incompatible materials - refer to Section 7 - Handling and Storage.

Section 11 - TOXICOLOGICAL INFORMATION

POTENTIAL HEALTH EFFECTS

ACUTE HEALTH EFFECTS

SWALLOWED

■ Not normally a hazard due to physical form of product.

EYE

• Generally not applicable.
Not considered to be a risk because of the extreme volatility of the gas.

SKIN

• Generally not applicable.

INHALED

■ Inhalation of non-toxic gases may cause:
• CNS effects: headache, confusion, dizziness, stupor, seizures and coma;
• respiratory: shortness of breath and rapid breathing;
• cardiovascular: collapse and irregular heart beats;
• gastrointestinal: mucous membrane irritation, nausea and vomiting.
The paraffin gases are practically not harmful at low doses. Higher doses may produce reversible brain and nerve depression and

continued...

irritation.

CHRONIC HEALTH EFFECTS
■ Principal route of occupational exposure to the gas is by inhalation.
Long-term exposure to the product is not thought to produce chronic effects adverse to the health (as classified by EC Directives using animal models); nevertheless exposure by all routes should be minimised as a matter of course.

TOXICITY AND IRRITATION
■ Not available. Refer to individual constituents.

Section 12 - ECOLOGICAL INFORMATION

This material and its container must be disposed of as hazardous waste.

Ecotoxicity

Ingredient	Persistence: Water/Soil	Persistence: Air	Bioaccumulation	Mobility
natural gas	No Data Available	No Data Available	No Data Available	No Data Available

Section 13 - DISPOSAL CONSIDERATIONS

■ Discharge to burning flare.
Ensure damaged or non-returnable cylinders are gas-free before disposal.

Section 14 - TRANSPORTATION INFORMATION

Labels Required: FLAMMABLE GAS

HAZCHEM:
2SE (ADG7)

ADG7:

Class or Division:	2.1	Subsidiary Risk:	None
UN No.:	1971	Packing Group:	None
Special Provision:	None	Limited Quantity:	0
Portable Tanks & Bulk Containers - Instruction:	None	Portable Tanks & Bulk Containers - Special Provision:	None
Packagings & IBCs - Packing Instruction:	P200	Packagings & IBCs - Special Packing Provision:	None

Name and Description: METHANE, COMPRESSED or NATURAL GAS, COMPRESSED with high methane content

Air Transport IATA:

ICAO/IATA Class:	2.1	ICAO/IATA Subrisk:	None
UN/ID Number:	1971	Packing Group:	-
Special provisions:	A1		
Cargo Only Packing Instructions:	200	Maximum Qty/Pack:	150 kg
Passenger and Cargo Packing Instructions:	Forbidden	Passenger and Cargo Maximum Qty/Pack:	Forbidden
Passenger and Cargo Limited Quantity		Passenger and Cargo Limited Quantity	

continued...

Packing Instructions:	Forbidden	Maximum Qty/Pack:	Forbidden

Shipping name:METHANE, COMPRESSED or NATURAL GAS, COMPRESSED with high methane content

Maritime Transport IMDG:

IMDG Class:	2.1	IMDG Subrisk:	None
UN Number:	1971	Packing Group:	None
EMS Number:	F-D,S-U	Special provisions:	None
Limited Quantities:	0		

Shipping name:METHANE, COMPRESSED or NATURAL GAS, COMPRESSED with high methane content

Section 15 - REGULATORY INFORMATION

Indications of Danger:
F+ Extremely flammable

POISONS SCHEDULE
None

REGULATIONS

Regulations for ingredients

natural gas (CAS: 8006-14-2) is found on the following regulatory lists;
"Australia High Volume Industrial Chemical List (HVICL)", "Australia Inventory of Chemical Substances (AICS)", "OECD List of High Production Volume (HPV) Chemicals"

No data for AGL Natural Gas (CW: 65706)

Section 16 - OTHER INFORMATION

■ Classification of the preparation and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.
A list of reference resources used to assist the committee may be found at:
www.chemwatch.net/references.

■ The (M)SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings.

Issue Date: 11-Feb-2013
Print Date: 16-Apr-2013

This is the end of the MSDS.