Statement of Environmental Effects

Proposed S4.55 Modifications to Timber Manufacturing Facility

Borg Panels

124 Lowes Mount Road, Oberon NSW

Borg Panels Pty Ltd

8th August 2019

Revision History

Rev No.	Revision Date	Author / Position	Details	Authorised	
				Name / Position	Signature
0	08/11/2018	Victor Bendevski Environmental and Regulatory Compliance	Draft		
1		Planning and Environmental Officer			
00	8/8/2019		Final	Victor Bendevski Environment and Compliance	

Table of Contents

1 Introduction

1.1 Background

On 29 May 2017 Development Consent SSD 7016 was granted by the Minister for Planning to construct a Particle Board manufacturing facility, modify the existing Medium Density Fibreboard (MDF) manufacturing facility and undertake general site works (the Project) at the existing Borg Panels timber manufacturing facility located on 124 Lowes Mount Road, Oberon. The Project area is known as Lot 1 DP 1085563, Lot 2 DP 1085563, Lot 31 DP1230464, Lot 24 DP 1148073 and Lot 1 DP1228591.

This Statement of Environmental Effects (SEE) has been prepared for modifications to the timber manufacturing facility, approved by Development Consent SSD 7016, including:

- Installation of Electricity generating gas turbine, complete with total thermal loss recovery system ancillary to the particle board drier.
- Installation of a new high-pressure gas pipe as an ancillary to the turbine and the site, within the project boundary;
- Rationalisation of and changes to particleboard plant ancillary equipment & layout, improving site efficiency, reducing emissions and reducing noise impacts.
- Extension of service road north to provide alternative access to ponds and dams during construction and operation.

This SEE addresses the matters referred to in Section 4.15 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

1.2 Existing Development

Borg Panels operates an existing MDF manufacturing facility in Oberon, NSW. This facility manufactures a range of Customwood MDF products including:

- Standard MDF;
- Moisture Resistant MDF;
- E0 (Low Formaldehyde Emitting) MDF;
- Ultraprime MDF Mouldings;
- Decorative Laminated MDF and Particle Board; and
- Treated paper for the lamination of MDF and Particle Board.

The facility consists of an MDF manufacturing plant, mouldings plant, paper treatment process, decorative finishing and MDF press.

The approved maximum output of the facility is 380,000m^3 of MDF board per calendar year.

1.3 Approved Development

The Project comprised the expansion of the Existing Development to include construction and operation of a particleboard facility, and alterations and additions to the Existing Development, including:

- Construction of a dedicated particle board manufacturing line, which includes:
    - Production of chips from fresh round wood;
    - Production of chips and flakes from waste wood;
    - Production of flakes from fresh produced chip;
    - Wood drying process;
    - Sorting and cleaning of dried chip;
    - Addition of resins and chemicals;
    - Forming, pre-pressing, and thickness pressing of chip;
    - Cutting, cooling and stacking; and
    - Final sanding and processing of finished product.
- Expansion and modernisation of the existing MDF and laminating operations, largely located within existing structures on site to include provision of additional infrastructure and value add to existing products.

1.4 Proposed S4.55 Modifications to Approved Development

The proposed modifications to the approved particleboard manufacturing facilities are shown in the accompanying S4.55 Drawing Package and include:

- Installation of electricity generating gas turbine, complete with total thermal loss recovery system ancillary to the particle board drier.
- Installation of a new high-pressure gas pipe as an ancillary to the turbine and site, within the project boundary;
- Rationalisation of and changes to particleboard plant ancillary equipment & layout, improving site efficiency, reducing emissions and reducing noise impacts. Including rationalisation of dust transport and dust extraction systems and further noise attenuation on equipment. This information along with other components of this modification were used to update the site operational noise model (Global Acoustics) which allowed the removal of the acoustic barrier that was required to meet site noise criteria as part of MOD 1 to SSD 7016 consent approved on the 20th November 2018. The detail pertaining to the changes made to equipment and location is outlined in section 5.4 of this report.
- Extension of service road north to provide alternative access to ponds and dams during construction and operation.

The proposed modification is classified as a 1A modification under section 4.55 of the Environmental, Planning and Assesment Act. The development will have minimal environmental impact given that the changes are considered minor in nature and are contained within the approved development area. The changes will allow the Timber Manufacturing Facility to operate more efficiently and will reduce overall impacts. The modification is substantially the same and is consistent with the prevailing legislation as outlined in this statement.

A detailed description of the proposed modifications is provided in **Section 4** of this SEE.

1.5 Project Justification

The existing reconstituted panel operations at the site, including the approved SSD7016 expansion that have been completed consume a large amount of energy to produce particle board. The operations have high fossil fuel energy demand, which translates into increased costs depending on energy prices. Borg is undertaking a number of energy efficiency projects to decrease the amount of base electricity and gas used on the site. These projects include solar panels, potential for increased recovered wood to be used in product drying furnaces, replacement of motors with high efficiency type, cogeneration, installation and of variable speed drives and the proposed gas turbine.

During the initial plant design, it was anticipated that the site would have high energy demands, particularly for gas. Therefore, the Particleboard dryer is heated by a combination gas/dust burner, dust is produced on site with natural gas supplied via a pipeline, both are used in combustion processes. It is now confirmed that when using entirely virgin wood that the moisture content is at its maximum and therefore the energy required to remove the water from the wood is very high, up to 50MW. This is resulting in a shortage of renewable fuel (dust) and increasing gas consumption which is very costly and does not align with the Borg environmental policy.

Gas fired turbines are not the most electrically efficient devices, but they produce large amounts of hot air which make its ideal for the particleboard process as large quantities of hot air are required to dry the flake prior to processing. Turbines are also able to vary in output quite easily and have a large range of efficient operation which further supports their use in the particleboard flake drying process, as temperature modulation is also a necessary characteristic.

Gas turbines have been and are continued to be used throughout the country and the world for electricity generation and heat recovery. They are used because of their flexibility, safety and reliability. The proposed gas turbine, SOLAR Centaur 50, will generate 4 Mega Watts of electricity, with all of the thermal losses, up to 10 Mega Watts being available via the exhaust gases which will be utilised to direct heat the particleboard dryer. The proposed turbine and drum dryer process connection enables a greater than 90% recovery of input energy, see SOLAR Fuel Performance curve.

Furthermore, installation of Electricity generating devices on site enables Borg to curtail electrical energy consumption as requested by the regulator/provider and allows the site to operate effectively and safely even in times of power outages. It will also allow the existing electricity network infrastructure to remain effective for a longer period of time. The remaining changes as part of the proposed modification will provide efficiency to the panels site by reducing on-site conflicts regarding movement and flow of traffic.

1.6 Capital Investment Value

The proposed modification has a capital investment value of $2.72 Million.

1.7 Consultation

Consultation regarding the proposed installation of the high-pressure gas line and co-generation plant has been undertaken with stakeholders including Australian Pipeline Authority (high pressurise gas supplier), Essential Energy and Oberon Council. All parties raised no objection to the proposed modification. Borgs has entered into a contract with APA for the supply of pressurised gas to the site for the purpose of energy generation. Details of these discussions are attached In Appendix E.

1.8 Structure of the SEE

This SEE details the proposed S4.55 modifications and assesses the environmental impacts of those modifications, as follows:

- **Section 2** – Site Description
- **Section 3** – Planning Matters
- **Section 4** – Proposed S4.55 Modifications
- **Section 5** – Environmental Impact Assessment
- **Section 6** – Conclusion

2 Site Description

2.1 Location and Context

2.1.1 Regional Overview

The Oberon LGA covers an area of 3,626km² and lies approximately 195 kilometres to the west of Sydney in the NSW Central Tablelands. Refer **Figure 1**.

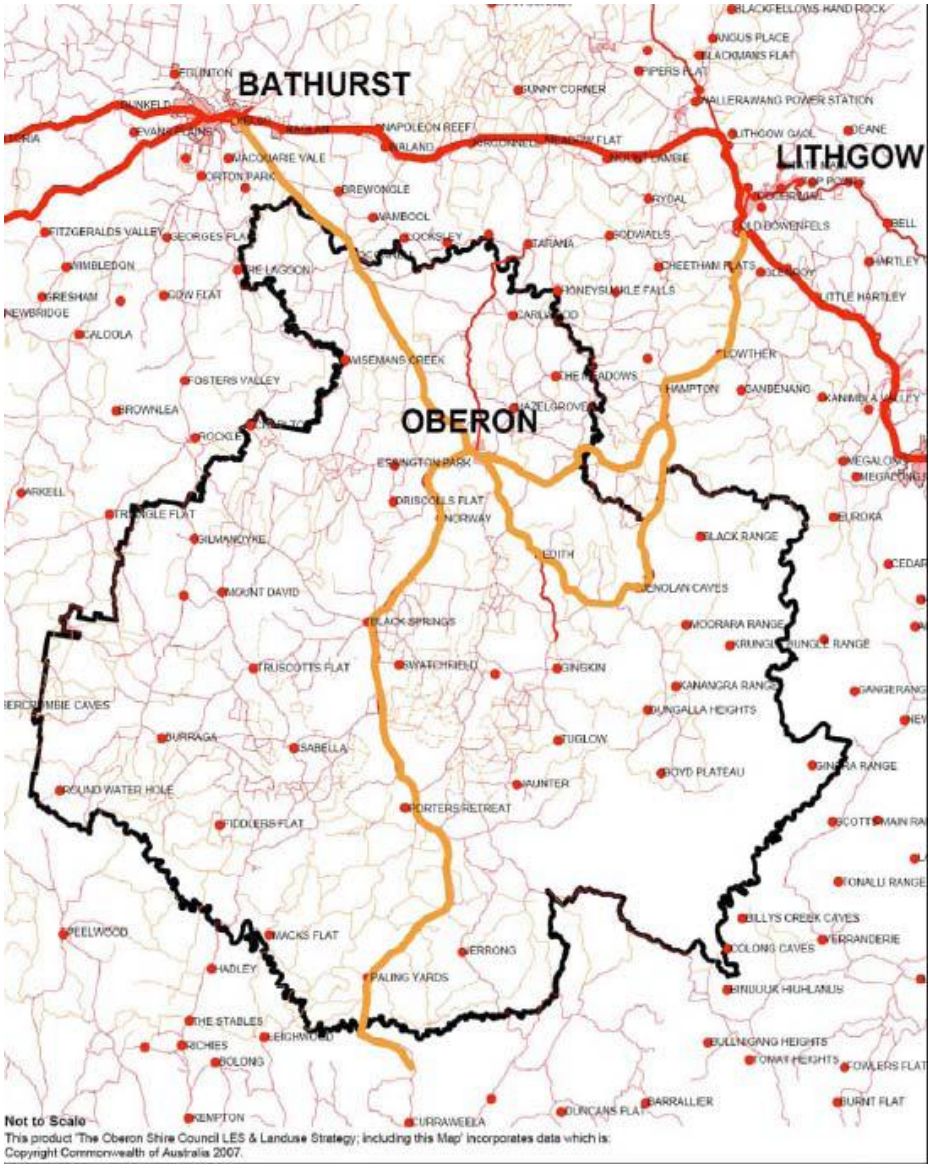

Figure 1 Site Context

The LGA boarders the City of Lithgow to the north, Blue Mountains to the east, Wollondilly to the south-east, Goulburn/Mulwaree and Upper Lachlan to the south and Bathurst Regional to the south-west.

The LGA has a population of 5,270 with much of the population living in the Oberon township (being 2,459 people). In addition to the main settlement of Oberon there are a number of small villages (including Black Springs, Burraga and Mt David) as well as rural localities.

The primary industries within the LGA are agriculture (including sheep and beef farming, as well as plantation timber growing) and industries associated with logging, sawmilling and timber dressing along with the manufacture of wood products.

The subject land is located on the northern outskirts of Oberon, to the east of Lowes Mount Road. The Borg operations are part of the wider Oberon Timber Complex, with facilities operated by several separate companies, which generally involve timber product manufacture. The approved Project area is shown in **Figure 2**.

Figure 2- Project Area

2.1.2 Surrounding Land Use

The Project is located within an existing industrial zoned area. Industrial zoned land adjoins the Project to the south and west. Rural zoned land adjoins the site to the north and east. Refer **Figure 3**.

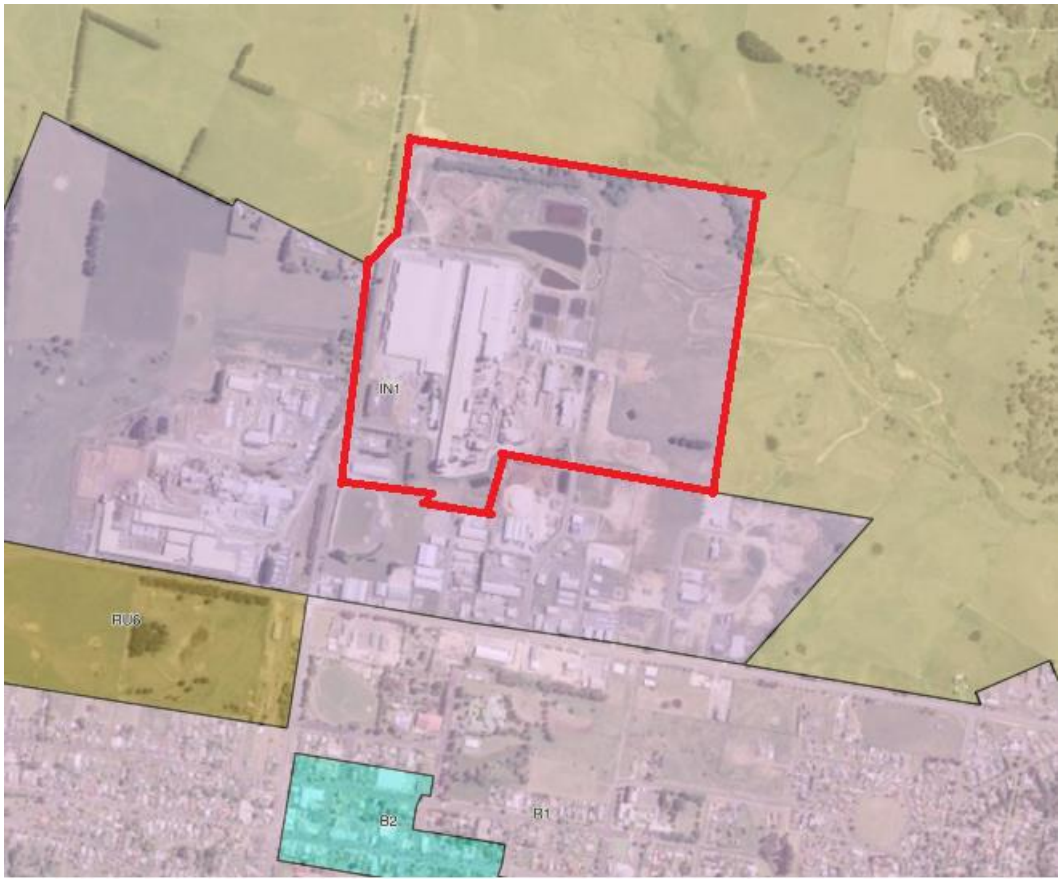

Figure 3 - Zoning Context

2.1.3 Site Description

The Project area is known as Lot 1 DP 1085563, Lot 2 DP 1085563, Lot 31 DP1230464, Lot 24 DP 1148073 and Lot 1 DP1228591. All land is under the ownership of Borg Panels.

2.2 History

After commencing the manufacture of thermo laminated vinyl doors in Charmhaven in the early 1990's, Borg has established itself as a leading Australian manufacturer of melamine panels and components for all joinery applications.

Borg manufactures a range of joinery materials including Polytec Doors (primarily for kitchen and bathroom use), white melamine panels, decorative melamine board products, shelving components, and Createc. With a commitment to Australian manufacturing, Borg focuses much of its activities on manufacturing plants throughout the East Coast (including a world class manufacturing plant at Charmhaven, the Oberon complex and a 45,000m2 manufacturing and distribution centre at Somersby).

Experiencing significant growth over the past two decades, Borg has continued to invest in leading edge, world class machinery across its manufacturing sites. Ensuring the production of the highest quality product in the most cost-effective manufacturing processes is integral to Borg's intent of delivering superior value to its customers.

In March 2010, Borg acquired the former Carter Holt Harvey Oberon Medium Density Fibreboard (MDF) facility at Oberon and a few months later, acquired the associated JeldWen door skin factory located adjoining the MDF plant.

Since that time Borg have improved and modernised the existing plant through modifications to the original DA 27/95.

Application was made to DP&E in April 2015 to construct and operate a particleboard facility and make alterations and additions to the existing MDF facility. This application also sought to remove the Borg Panels operations from DA27/95 (that applies to the OTC) and consolidate all Borg operations under a new single development consent.

Project approval (Development Consent SSD 7016) was granted by the Minister for Planning on 29 May 2017 to construct a Particle Board manufacturing facility, modify the existing Medium Density Fibreboard (MDF) manufacturing facility and undertake general site works (the Project).

3 Planning Matters

This section deals with the proposal's consistency with the various statutory and non-statutory provisions. It also addresses the relevant matters for consideration under Section 4.15(1) of the *Environmental Planning and Assessment Act 1979*.

3.1 Commonwealth Matters

3.1.1 Environment Protection and Biodiversity Conservation Act 1999

Ecological studies undertaken as part of the EIS (The Design Partnership, June 2016) for the Project determined the site has limited biodiversity value and the Project did not trigger any Matters of National Environmental Significance. Therefore, no referral was required. The proposed S4.55 modifications are within the assessed Project footprint and will not affect ecology.

3.2 State Matters

3.2.1 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) and the *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation) provide the framework for development and environmental assessment in NSW.

As stated in the EP&A Act, the project is classified as State Significant Development (SSD) pursuant to Part 4 Section 89C of the EP&A Act, if it is declared as SSD by a State Environmental Planning Policy or declared SSD by order of the Minister for Planning in the Government Gazette.

The Project was classified as State Significant Development (SSD) as set out in Clause 4 of Schedule 1 of State Environmental Planning Policy (State and Regional Development) (2011) (SEPPSRD).

Development Consent SSD 7016 was granted by the Minister for Planning on 29 May 2017 to construct the Particle Board manufacturing facility, modify the existing Medium Density Fibreboard (MDF) manufacturing facility and undertake general site works (the Project) at the existing Borg Panels facility located on 124 Lowes Mount Road, Oberon.

During construction of the Project, a number of minor modifications have been identified to improve the operation of the project. Application is made to modify Development Consent SSD 7016 as described in **Section 4**, and summarised as follows:

- Installation of electricity generating gas turbine, complete with total thermal loss recovery system ancillary to the particle board drier.
- Installation of a new high-pressure gas pipe as an ancillary to the turbine and site, within the project boundary;
- Rationalisation of and changes to particleboard plant ancillary equipment & layout, improving site efficiency, reducing emissions and reducing noise impacts. Including rationalisation of dust transport and dust extraction systems and further noise attenuation on equipment. This information along with other components of this modification were used to update the site operational noise model (Global Acoustics) which allowed the removal of the acoustic barrier that was required to meet site

noise criteria as part of MOD 1 to SSD 7016 consent approved on the 20th November 2018.

- Extension of service road north to provide alternative access to ponds and dams during construction and operation.

These proposed modifications are predominantly to improve the operability of the site and reduce the potential impacts of the project on the surrounding environment. The modifications are sought under *S4.55 (2) Modifications involving minimal environmental impact* of the EP&A Act. This SEE demonstrates the proposed modifications are of minimal environmental impact, and that the development to which the consent as modified relates is substantially the same development as the development for which the consent was originally granted.

Section 4.15(1) of the EP&A Act sets out the matters for consideration. These are shown in **Table 1.**

Table 1 – Section 79C Matters for Consideration

(1) Matters for consideration—general **In determining a development application, a consent authority is to take into consideration such of the following matters as are of relevance to the development the subject of the development application:**	
(a) (i) any environmental planning instrument, and	**Section 3**
(ii) any proposed instrument that is or has been the subject of public consultation under this Act and that has been notified to the consent authority (unless the Secretary has notified the consent authority that the making of the proposed instrument has been deferred indefinitely or has not been approved), and	No proposed instrument is applicable to this application.
(iii) any development control plan, and	Development Controls Plans do not apply to State Significant Development. However, consideration of the Oberon Council Industrial DCP was undertaken in the EIS (The Design Partnership, June 2016) for the Project. The proposed modifications are substantially the same as the approved Project.
(iiia) any planning agreement that has been entered into under section 93F, or any draft planning agreement that a developer has offered to enter into under section 93F, and	No Planning Agreement has been entered into under Section 93F.
(iv) the regulations (to the extent that they prescribe matters for the purposes of this paragraph), and	**Section 3**
(v) any coastal zone management plan (within the meaning of the Coastal Protection Act 1979),	No Coastal Management Plans apply.
(b) the likely impacts of that development, including environmental impacts on both the natural and built environments, and social and economic impacts in the locality,	**Section 5**

(1) Matters for consideration—general **In determining a development application, a consent authority is to take into consideration such of the following matters as are of relevance to the development the subject of the development application:**	
(c) the suitability of the site for the development,	The site is already developed for the purposes of timber manufacturing with an approved particleboard plant under construction. The proposed modifications are substantially the same as the approved Project.
(d) any submissions made in accordance with this Act or the regulations,	Any submissions made in accordance with the Act or the regulations will be addressed following any exhibition period.
(e) the public interest.	The Project is in the public interest as it minimises the current impacts from the development (in regard to both air and noise pollution) whilst increasing regional employment. The proposed modifications are substantially the same as the approved Project.

3.3.2 Environmental Planning and Assessment Regulation 2000

Schedule 3 of the *Environmental Planning and Assessment Regulation 2000* sets out the criteria for designated development.

The Project was classified as a Wood Processing Facility, and approved to manufacture 380,000m^3 of MDF board per year and 500,000m^3 of particleboard per year. On this basis the Project is designated development.

3.3 State Environmental Planning Policies

3.3.1 State Environmental Planning Policy (State and Regional Development) 2011

The Project is 'State Significant Development' in accordance with Division 4.1 of Part 4 of the EP&A Act, as it is triggered as a timber processing facility under Clause 4, Schedule 1 of State Environmental Planning Policy (State and Regional Development) 2011. Specifically, the following provision triggers the proposal as State Significant Development:

Development that has a capital investment value of more than $30 million for any of the following purposes:

a) milling plants, sawmills, log processing works, wood-chipping or particle board manufacture

3.3.2 State Environmental Planning Policy 33 – Offensive and Hazardous Development

State Environmental Planning Policy 33 –Hazardous and Offensive Development (SEPP 33), clause 12 outlines that a Preliminary Hazard Analysis screening test must be undertaken to determine the risk of the proposal.

A potentially hazardous industry is defined within SEPP 33 as a development for the purpose of any industry which, if the development were to operate without employing any measures to reduce or minimise its impact, would pose a significant risk to human health, life or property, or to the biophysical environment.

An assessment of the Project in accordance with Hazardous and Offensive Development – Applying SEPP 33 was undertaken during preparation of the EIS (Sherpa Consulting May 2016) for the Project and concluded that the Project is not offensive or hazardous.

Further assessment of the gas pipe, gas turbine and associated equipment has been carried out as part of the current engineering design in the form of a Preliminary Hazard Analysis, conducted by Planager. This assessment is contained within Appendix A.

3.4 Local Matters

3.4.1 Oberon Local Environmental Plan

The Project is located within the Oberon Council Local Government Area. As a result, the provisions of the Oberon Local Environmental Plan 2013 (LEP) need to be considered as part of this SEE.

The subject land is zoned IN1 – General Industrial (**Figure 3**). The proposed development is consistent with the objectives of the zone as set out under the provisions of the LEP.

The Project was designed to minimise adverse impacts on other land uses. The Project will also assist in ensuring the economic viability of the site, ensuring the continuation of employment for the local community and having obvious flow on effects in terms of economic benefits to local settlements (including the Oberon town itself as well as surrounding areas).

The Project as approved meets the definition of heavy industry as a permitted use within the zoning and is identified as being part of the Oberon Timber Complex. This Section 4.55 Modification does not alter the use.

The Oberon Timber Complex has certain protections in the Oberon LEP. Clause 6.6 of the Oberon LEP notes requirements for land located within an industrial buffer zone, as shown on the Industrial Buffer Map in the OLEP 2013 (**Figure 4**). The objectives of Clause 6.6 Development within a Designated Buffer Area of the OLEP 2013 are:

a) to protect the operational environment of industries operating within the Oberon Timber Complex,

b) to control development near the Oberon Timber Complex and waste disposal facilities to minimise land use conflict.

Before granting development consent to development on land to which this clause applies, the consent authority must consider the following:

a) the impact that any noise, odour or other emissions associated with existing land uses may have on the development,

b) any proposed measures incorporated into the development that limit the impact of such noise and other emissions associated with the existing land use,

c) any opportunities to relocate the development outside the land to which this clause applies,

d) whether the development is likely to adversely affect the operational environment of any existing development on the land to which this clause applies.

Figure 4-Indicative Location of the Project Relative to the Industrial Buffer Zone

In this instance, it is noted that the Project is located within the Industrial Buffer area, as illustrated above. However, the Project is part of the Oberon Timber Complex, rather than being development that may be affected by the ongoing operations of the Oberon Timber Complex.

Despite the above, it is important to note that mitigation measures have been put in place to minimise the impacts of the development on adjoining land uses, such as installation of appropriate noise reducing technology and buildings, air emissions reduction technologies, and the like.

The proposed S4.55 modifications are predominantly to reduce impacts and improve long term operability of the Project.

3.4.2 Oberon Development Control Plan

Clause 11 of SEPP SSD states:

Development control plans (whether made before or after the commencement of this Policy) do not apply to:

a. State significant development, or

b. development for which a relevant council is the consent authority under section 89D (2) of the Act.

As a result, no DCPs are relevant to the Project or proposed S4.55 modification. However, the Oberon Council DCP Part D – Commercial and Industrial Development was considered during assessment of the Project (The Design Partnership, June 2016). The proposed S4.55 Modifications are substantially the same development as the development for which the consent was originally granted.

3.5 Environment Protection Licence

Environment Protection Licence 3035 (EPL 3035) authorises the carrying out of the scheduled activities chemical production and wood or timber milling or processing at the Borg Panels facility in accordance with the requirements of the licence.

The proposed S4.55 modifications are predominantly to reduce impacts and improve long-term operability of the Project.

4 Proposed S4.55 Modifications

The proposed modifications to the approved particleboard and medium density fibreboard manufacturing facilities are shown in the accompanying S4.55 Drawing Package and include:

- Installation and operation of a standalone package- GT 50 Solar Turbines electricity-generating package, complete with heat recovery system for thermal loses. The turbine will be used to generate 4 Mega Watts of Electricity, furthermore up to 10 Mega Watts of thermal loses, via the turbine exhaust system, will be utilised to direct heat the particleboard dryer.
- Installation and operation of a new high-pressure natural gas pipe within the project boundary as an ancillary to the turbine and the site gas requirements. Running parallel to Lowes Mount Road underground within the Borg boundary allows Borg to provide the necessary natural gas supply to operate the turbine at optimum efficiency.
- Rationalisation of and changes to location of particleboard project ancillary equipment, reducing noise impacts. Including rationalisation of dust transport and dust extraction systems and further noise attenuation on equipment. This information along with other components of this modification were used to update the site operational noise model (Global Acoustics) which allowed the removal of the acoustic barrier that was required to meet site noise criteria as part of MOD 1 to SSD 7016 consent approved on the 20th November 2018. Further detailed changes are outlined in section 5.4.
- Extension of service road north to provide alternative access to existing ponds and dams during construction and operation of the facility.

5 Environmental Impact Assessment

5.1 Traffic and Transport

To inform the assessment of the original Project as unmodified, a Traffic Impact Assessment Report (SMEC, 06 May 2016) and subsequent Response to Request for Further Information (SMEC, 21 Sep 2016) was prepared to review the impacts of the Project, both during construction and for the ongoing operation. This assessment looked at both truck and light vehicle movements at the current facility, the anticipated levels of traffic generated during construction, and the estimated heavy vehicle movements post-construction, during the operation of the facility. The findings concluded that the existing road network can absorb the probable increase in traffic without any significant compromise.

This proposed S4.55 modification will result in negligible changes to the traffic movement of the project. The proposed modifications are not expected to create any change to operational traffic generation or timing of traffic movements.

Construction traffic noise would be managed as detailed in **Section 5.4**.

5.2 Air Quality

To inform the assessment of the original Project as unmodified, Todoroski Air Sciences (16 February 2017) prepared an Air Quality Impact Assessment Report for the Project. The report provided an assessment of the potential air quality impacts associated with the existing operations and proposed expansion of the facility.

The assessment concluded in-stack emission concentration limits are below the applicable POEO Clean Air regulation limits for the existing operations and would remain so post construction of the Project. The results indicate that the Project is unlikely to lead to any exceedance of any criteria at any residential receptor at any time.

Overall, the study found that the Project would not lead to any unacceptable or harmful pollutant levels off-site.

The proposed S4.55 modification proposes no change to predicted air quality impacts resulting from operation of the proposed modifications. The proposed modifications will introduce another piece of plant onto the project site (Gas Turbine), it will reduce reliance on the approved plant (particle board dryer burner), both plants items combust natural gas to generate hot air/gas and both meet the Group 6 requirements of the POEO Clean Air Regulation. The quantity of energy required for drying wood flakes does not change significantly and therefore the inputs and predicted impacts of the air dispersion modelling undertaken for the development remain (Todoroski Air Sciences, 16 Feb 2017).

The rationalisation of equipment includes reduction in the quantity of material blowers throughout the particleboard manufacturing plant, reducing the need for dust filters. This in turn reduces the quantity of particulate pollutants emitted into the atmosphere and reduces the amount of electrical energy required to transport these materials.

Specifically, the following changes have been made that will improve and decrease potential impacts on air quality;

- Reject mat blowers are to be enclosed in concrete building, reducing particle release
- Enclosure of drier fans reducing particle release

- Removal of three particle transport blowers reducing potential for particle release

Overall the changes to the positioning of the equipment is minor, with minimal environmental impact, as outlined in the original air quality report prepared by Todoroski Air Sciences (16 February 2017).

5.3 Hazard and Risk

To inform the assessment of the original Project as unmodified, a Preliminary Hazard Analysis (PHA) was undertaken by Sherpa Consulting to assess the potential risk of the Project in accordance with the *Applying SEPP 33 Hazardous and Offensive Industry Development Application Guidelines* (DP&E, 1994). This assessment concluded that the site operations do not constitute a hazardous or offensive industry.

Pre-construction hazard studies have also been prepared and approved by DP&E for the Project, including:

- **Fire Safety Study** covering the relevant aspects of the Department's *Hazardous Industry Planning Advisory Paper No. 2, 'Fire Safety Study Guidelines'* and the NSW Government's '*Best Practice Guidelines for Contaminated Water Retention and Treatment Systems*'. During preparation of the study consultation was undertaken with FRNSW, and their requirements have been addressed in the final assessment.
- **Hazard and Operability Study (HAZOP)** for the Project, chaired by a qualified person, independent of the Development. This study was consistent with the Department's *Hazardous Industry Planning Advisory Paper No. 8, 'HAZOP Guidelines'*.
- **Final Hazard Analysis** of the Project, consistent with the Department's *Hazardous Industry Planning Advisory Paper No. 6, 'Hazard Analysis'*.
- **Construction Safety Study** for the Development, consistent with the Department's *Hazardous Industry Planning Advisory Paper No. 7, 'Construction Safety'*. This study identified and addressed the potential hazards arising from the interactions with the existing facility during construction.

The proposed S4.55 modifications include installation and operation of Gas turbine, high-pressure natural gas pipe and pressure reduction station. Even though the gas turbine is designed as a standalone system with specific integrated controls around safety, reliability of the gas pipe requires consideration, specifically around long-term operation and management. Whilst not applicable to this application the gas pipe and pressure reduction station has been designed according to AS4041 with elements of AS2885 being adopted to ensure the installation operates effectively for the proposed life time.

Contract Engineering companies Furnace Engineering (Fe-gas) and OSD Limited have developed detailed engineering for the gas services required. OSD was contracted to develop the pipeline engineering, the design information is contained in the following reports

- OSD-Basis of Design- 2079-EM-BOD-001. **Appendix C**
- OSD-Safety Management Study Report- 2079-EL-REP-001 **Appendix D**

According to the standards and the hazard studies conducted as part of the design phase, hazards identified were:

Thirty-three actions were recorded in an action list as part of the workshop study for the construction and operational management of the gas pipe at the Borg site (details are

available in **Appendix D**). Some of these have been considered and mitigated sufficiently during the workshop, other issues/actions require further consideration as the project continues.

Five External Interference threats were identified as predominant credible and capable scenarios that would result in a release of gas large enough to create a risk.

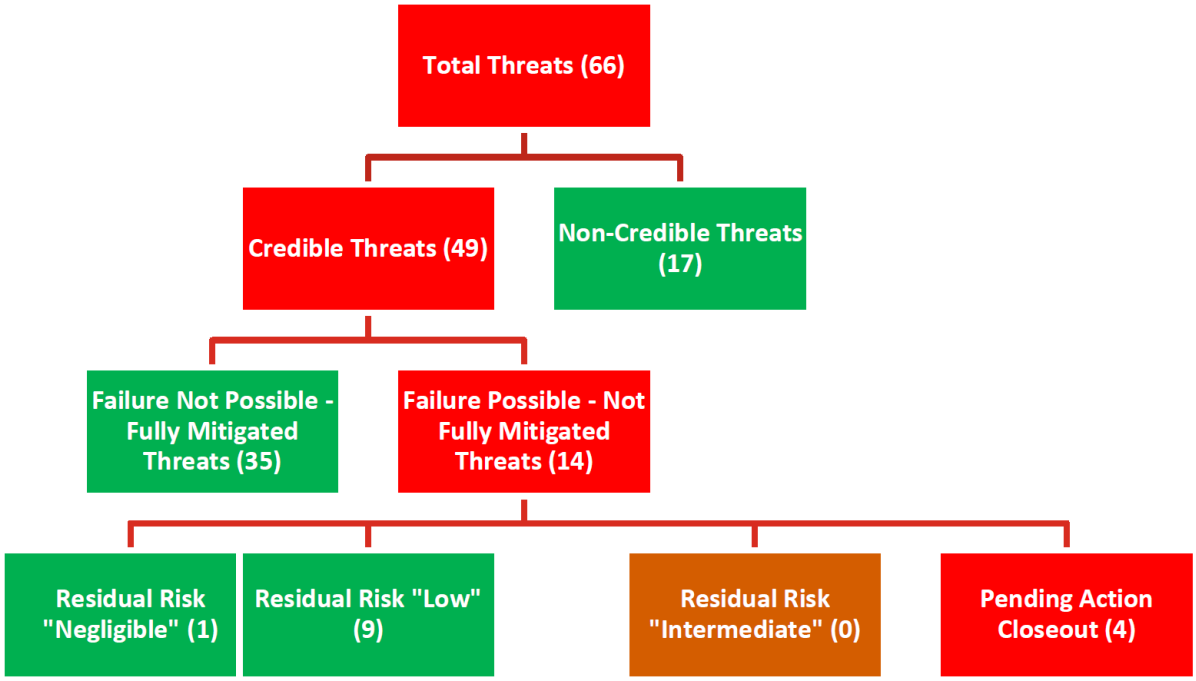

Figure 5- Threat and Risk Summary

The resistance to penetration was calculated in accordance with the guidelines provided in appendix M of AS 2885.1. The full calculations are provided in document 2079-02-CAL-001. Table 6 summarises the results of these calculations.

Table 6: Penetration Resistance (B factor = 1.3)

	Excavator Size (tonnes) and Failure Mode								
	5	10	15	20	25	30	35	40	55
General Purpose Teeth (GPT)	No Puncture. Dent / Gouge.								
Twin Point Tiger Teeth (TPPT)	No Puncture. Dent/Gouge.			Leak / Puncture					
Single Point Penetration Tooth (SPPT)	No Punct. Dent/ Gouge	Leak / Puncture							
Single Point of Tiger Tooth (SPTT)		Leak / Puncture							

However, the study concluded that this risk was mitigated sufficiently by the utilising physical and procedural control, which included increased wall thickness pipe and increasing trench

depth, utilising corrosion control systems, installation of below & above ground pipeline markers and development of pipe management plans, which are integrated into the site operational plan. Whilst not required, the standard for engineering and design AS 2885 has been adopted to guide the process. The risk mitigation proposed is well understood, documented and utilised around the world to protect flammable gas and liquid transfer pipes.

Fe-Gas, a division of Furnace engineering was contracted to engineer and supply the pressure reduction system. The system incorporates regulators, safety valves, process heaters, heat exchangers and some electrical controls to ensure safe and reliable integration into the site systems.

The turbine exhaust will be diverted into the approved particle board dryer system to recover the all the energy available within it for drying of wood chips. Engineering personnel have assessed this, and its findings will be implemented as part of the design and operation of the plant.

As the turbine requires of 2000-3400kPaG for operation consideration was given to the gas pipeline pressure and location of equipment adopted for this project, the following scenarios were considered:

- Installation of a gas compressor to raise current site gas pressure
- Location of the pressure let down nearer to the APA compound.
- Reduced pipe pressure traversing the site.

A gas compressor was considered during the early design engineering, this involves a purchasing a purpose-built rotary screw compressor. Gas compressors are generally used where high-pressure gas is not available, thus it was chosen not to proceed with this option primarily due to:

- High Initial purchase price, near to $1m AUD
- High energy consumption, 300kW
- High Maintenance costs.
- Availability of high-pressure pipe gas.

Furthermore, SOLAR Turbines advised that nearly all turbines installed in Oceania operate on supplied high pressure gas, including a facility is western Sydney capable of producing 125MW of Electrical Energy.

The installation of the Pressure Let down regulator set was considered close to the APA compound at the North of the site. The turbine requires gas which is heated above its hydrocarbon dew point, for the northern installation scenario to operate effectively a standalone water bath heater would also be required in that location increasing the cost and complexity of the project install. This will still require gas at high pressure to be piped across the site

The use of a compressor to raise the pressure (2-3000kpaG) required for the turbine operation the investment cost is still quite high and does not reduce the risk sufficiently far enough to rationalise the alternative location and is not an environmentally sustainable solution considering the site availability of suitable gas. The northern location also requires two pipes to be installed over a great distance, the turbine and the site supply pipe increasing the project capital and operational cost whilst not reducing the risk far enough to further support the location.

The location close to the particleboard plant at the southern end of the site was chosen because it offered a cleared area for site gas service connection and the turbine location, it

offered the opportunity to use waste hot water from the particleboard WESP to heat gas, is closer to other site consumers and was located closer to areas of the site which have operational staff moving around 24hrs per day 7 days per week. The pressure let down skid will be located in a protected compound as required by the standards.

A preliminary hazard analysis consistent with the requirements of HIPAP No:6 was conducted by Planager as proposed in this modification. The assessment covered the Connection to the APA pipeline, gas pipe with the Borg boundary, pressure let down station and the gas pipe connected to the turbine located adjacent to the particleboard dryer.

The results of the assessment show that the levels of risks to public safety associated with the proposed development are within the most stringent accepted risk criteria for land use planning as per the NSW DP&E guidelines in their HIPAP4 and HIPAP6.
In NSW, land use safety is determined based on risk, and in risk terms the proposed development is acceptable in the proposed location because the likelihoods of major incidents associated with natural gas pipeline are very low.
The incremental increase in individual injury and fatality risk, the risk of propagation to/from neighbouring industrial activity and in societal risk in the area associated with the proposed development is very low to negligible and is well within the tolerable limits set in HIPAP4.
The results are summarised in the table below:

Figure 6- Adherence to risk criteria

Risk criteria	Results	Impact on development
Sensitive development criterion - 0.5 pmpy risk	Risk level contained within the site boundary with a very small excursion near the APA Group connection. No sensitive development in this location.	Development is acceptable in this location
Residential development criterion - 1 pmpy risk	Risk level contained within the site boundary. No residential development in this location.	Development is acceptable in this location
Commercial development criterion - 5 pmpy risk	Risk level never reached for this development.	Development is acceptable in this location
Active open space criterion - 10 pmpy risk	Risk level never reached for this development	Development is acceptable in this location
Neighbouring industrial development criterion - 50 pmpy risk	Risk level never reached for this development	Development is acceptable in this location

Risk criteria	Results	Impact on development
Injury risk - 50 pmpy	Injury risk at any location associated with the development is calculated to be about 50 pmpy. The risk of injury at the development is below the maximum risk criterion. The injury risk at the nearest residential development is negligible.	Development is acceptable in this location
Propagation risk - 50 pmpy	Propagation risk at any location of the development is calculated to be about 1.7 pmpy. The injury risk at the nearest neighbouring industrial development is 0.8 pmpy, well below the maximum criterion of 50 pmpy. The risk of propagation at the development is below the maximum risk criterion.	Development is acceptable in this location
Societal risk	Negligible impact on the overall societal risk in the area	Development is acceptable in this location
Risk of propagation to / from neighbouring industrial area including Borg facility, APA Group gas connection and adjacent Woodchem MHF	The risk of propagation from the development onto the neighbouring Woodchem MHF is negligible. The separation distance of 300 metres from the nearest placard chemical storage and the separation distance to locations with dust explosion hazard combined with explosion venting design (located well above ground and relieving 45^{o} upwards) makes the risk of propagation to/from the development highly unlikely. The proposed development does not significantly impact the overall risk in this area. There is a remote possibility of an incident at the APA Group facility impacting the small (few metre) above ground piping in this area – however, construction to Codes and Standards for such pipe connections is generally deemed as sufficient to manage this risk. The below ground pipeline is protected by a 1200mm ground cover, with no other adjacent high-pressure pipeline – propagation from external areas to this pipeline is of very low / negligible risk.	Development is acceptable in this location

The maximum risk at the pipeline is 0.3 pmpy, i.e. less that the lowest risk criterion of 0.5 pmpy specified by the NSW DP&E for sensitive development, and therefore not shown on the figure above. The maximum incremental individual risk of fatality from the proposed development at the western boundary of the site is 0.8 pmpy. The maximum incremental risk from the proposed development at the northern boundary of the site is 1.8 pmpy. The maximum risk criteria at neighbouring land use is not exceeded.

Figure 7- Individual fatality risk contours

There is negligible impact on the eastern and southern boundary from this development. There is negligible impact from the proposed development at the nearest residential at around 600 metres (m) south of the site.

Further hazard and risk studies for the Project as approved, incorporating the modifications of this application, are required pre-commissioning, pre-start up and poststart-up of the plant. Recommendations/requirements of these studies will be implemented into the Site Operational Management Plan.

The findings and outcomes of the hazard and risk studies are valid provided that the proposed development will be operated and maintained in accordance with good practice, at or below design rates, and tested / inspected / maintained as required; personnel trained and competent; Permit To Work system implemented; changes to plant and procedures managed; and emergency response plans and procedures updated to incorporate the proposed new development.

5.4 Noise and Vibration

Global Acoustics prepared an acoustic assessment for the proposed S 4.55 1A modifications described within this SEE. The report is included as **Appendix B**

Acoustics implications associated with the proposed modifications include:

- As the Gas turbine is designed as a standalone package unit, it is contained within an enclosure. Its noise impacts are therefore well understood and documented. Equipment specific Sound power information was available and was utilised during the noise modelling validation, included in **Appendix B**
- Reduction in quantity of operating items of plant resulted in an overall reduction in noise emanating from the site
- Shielding to the south of the site outside of the project boundary in the form of buildings which were previously omitted from the site noise model were now included. Location of onsite equipment & buildings were also updated in the site noise model based on as built information now available
- Removal of the noise wall as previously detailed at the re orientated materials handling building in MOD1 of SDD 7016

The site noise model was updated to incorporate the changes proposed within this modification. A minor 1 dB decrease is predicted for the night period during noise enhancing meteorological conditions for receiver R09 (Albion Street), due to increased shielding for sources located directly north of the original structure.

Specifically, the assessment looked at the impacts of the following changes that have been made on site during construction, many of which are minor;

- Minor change to extent of materials handling building
- Minor changes to flaker building extent
- Height of silos updated
- Enclosure of drier fans
- Reduction of number of mills within the mill building from three to two, enclosure of said mills and minor change to extent of building
- Enclosure of reject mat blowers
- Dust silo blower location revised
- Three material blowers removed
- Dust filter locations revised, minor change to positioning
- Three dust filters removed
- As per recommendations in the acoustic report the barrier proposed in MOD 1 is now removed, as the barrier is no longer required as noise sources are being acoustically treated at the source, hence enclosure of some machinery.

Many of the proposed changes are minor, with original positioning of blowers, and dust filters not shown on original developed model due to the dynamic nature of installation and adaptation to determine best positioning on site. There are minor changes to the extent of the buildings as shown on the submitted plans. As has been outlined in the updated noise assessment, the proposed changes decrease the noise impact off-site, and improve environmental outcomes.

The proposed co-generation plant was included in the updated modelling. The primary noise source is the SOLAR power generation turbine package; a ‘Centaur 50’ unit is proposed. All noise generating equipment other than the air intake is to be housed within an acoustic enclosure of dimensions 9.7 x 2.6 x 2.5m. The enclosure is to have a maximum sound pressure level (SPL) of 85 dB(A) at 1m. Sound power for the enclosure was calculated from data provided in Table 10 of the SOLAR Turbines noise brochure for the 'Centaur 50' unit. The air intake is to be located on top of the turbine enclosure and will include an acoustic silencer. Sound power for the air intake was calculated using data in Table 5 of the SOLAR Turbines noise brochure for the 'Centaur 50' unit. Air filter and air inlet silencer insertion losses were sourced from Tables 16 and 18 of the SOLAR Turbines noise brochure. The exhaust is to be ducted back into the main plant, resulting in negligible noise emission during normal operation. An emergency stack is to be installed; however, it is only to be used in emergencies, during which time the main plant would not operate.

Based on the above conducted modelling in can be concluded that proposed modifications to the Borg Panels Oberon timber manufacturing facility should not materially change from those predicted for the Modification 1 SEE, and it can be considered substantially the same development, as no increase to site noise emission is predicted.

Construction noise associated with the proposed modifications shall be managed in accordance with the approved Construction Noise Management Plan.

5.5 Soil

As identified in the EIS (The Design Partnership, June 2016) prepared to inform the assessment of the original Project as unmodified, the facility is located on existing industrial zoned land and has been used for industrial land uses for a significant period of time.

Prior to construction of the proposed modifications, the Erosion and Sediment Control Plans for the Project will be updated to incorporate control measures for the modifications, and those measures are to be implemented.

On completion of construction, disturbed areas will be stabilised with vegetation or hard surfaces, the surface water management system will be stabilised/vegetated in accordance with the design drawings.

During operation of the Project, all surfaces are to remain stabilised. Where maintenance works require soil disturbance, the area is to be revegetated or reinstated as soon as practicable following completion of the works.

5.6 Water

Assessment of the Project as unmodified, included a Water Cycle Impact Assessment that was prepared by The Sustainability Workshop (12 May 2016) to review the impacts on both surface and ground water. The existing site stormwater system accepts stormwater from other parts of the Oberon Timber Complex and processes this water before discharge. This ensures that contaminants are significantly reduced.

As part of the Project, an extensive upgrade to the existing stormwater management system was approved, which included additional retention and catchment basins. This design ensured that stormwater and any liquids from a potential event can be adequately retained on site prior to treatment, reuse or disposal. This significantly reduced the potential impacts on the surrounding environment in an emergency event.

Additional information was also provided in the Response to Submissions (Sustainability Workshop, 12 Sep 2016) to further clarify information provided in the Water Cycle Impact Assessment.

The modification proposed as part of this application only proposes minor changes to the positioning of channels and swales to improve site efficiency and usability. Changes to the stormwater system will therefore have limited impacts to the operation of the project.

5.7 Waste

Any additional construction waste generated by the proposed modifications would be managed in accordance with the approved Construction Environmental Management Plan (Borg Construction, 31 May 2017) for the Project.

The proposed modifications are predominantly to building design, with process connections remaining functionally the same. Therefore, it is not expected that operation of the modified development will create any change to waste generated.

5.8 Greenhouse Gas Emissions

To inform the assessment of the original Project as unmodified, Northmore Gordon (29 April 2016) undertook a Greenhouse Gas Assessment for the Project. The assessment considered relevant national and state policy and guidelines for GHG emissions and assessment. In addition, the GHG assessment followed the accounting standards for the GHG Protocol. Emissions were reported in terms of standardised carbon dioxide equivalent (CO_2-e) values, which account for a number of GHGs.

Whilst the proposed modification includes changes to the equipment located within the project boundary it does replace/offset equipment with like quality products and incorporates Co-generation as part of the site ongoing operation, therefore GHG emissions would most likely remain neutral for the overall project.

5.9 Visual Impacts

To inform the assessment of the original Project as unmodified, a Visual Impact Assessment (The Design Partnership, 19 May 2016) was prepared. This report found there are significant existing visual impacts on the area from the operations and infrastructure of the Oberon Timber Complex, including the Borg Panels site as well as other facilities in the Complex not associated with the Project.

The Project is located within a highly industrialised context. The wider Oberon Timber Complex has been an integral part of Oberon for many years. As such, the existing infrastructure has been a visible part of the Oberon skyline for many years. Large industrial buildings and chimneys are one of the key visual features.

The S4.55 modification does not fundamentally change the building or equipment layout therefore no changes to the visual impacts as approved are anticipated. The turbine and its ancillaries stand 6 meters high, this is relatively small in comparison to the wood processing

plant (the Project). Furthermore, they are located behind a fence that follows the boundary around the perimeter of the site.

The gas pipe and pressure reduction will be located on site parallel to Lowes Mount Road, the pipe is predominantly run underground. The pressure let down is performed above ground, secured in a protective compound, occupies less than 20m2 and will be located in the area adjacent to Lowes Mount Road, near Gate 4.

These alterations and additions will have negligible impact on the visual amenity of the locale, given the approved existing visual impacts in the area from the operations and infrastructure of the Borg panels site.

5.10 Social and Economic

Assessment of social and economic impacts during preparation of the EIS (The Design Partnership, June 2016) prepared for the original Project as unmodified, found the development to have positive impacts on local employment levels and resultant positive social impacts.

The proposed S4.55 modifications is not expected to create any change to the findings of the Environmental Impact Statement prepared for the original approved project.

5.11 Ecology

A Biodiversity Assessment (Peak Land Management, May 2016) was prepared to inform the assessment of the original Project as unmodified. This report concluded that the Project site is severely disturbed, with most native vegetation under and around the existing facility being cleared, and exotics or planted species occurring around the northern, western and parts of the eastern sides of the site.

The proposed S4.55 modification includes:

- Installation of Electricity generating gas turbine, complete with total thermal loss recovery system ancillary to the particle board drier.
- Installation of a new high-pressure gas pipe as an ancillary to the turbine and site, within the project boundary;
- Rationalisation of and changes to particleboard plant ancillary equipment layout, improving site efficiency, reducing emissions and reducing noise impacts.

Although Apple Box – Yellow Box Dry Grassy Woodland of the SE Highlands Bioregion is recorded on the eastern parts of the site, the proposed S4.55 modifications do not impact the area of this Endangered Ecological Community (EEC).

These proposed modifications are anticipated to have no impact to ecological matters, as they will be carried out in areas of the site that have already been developed.

5.12 Indigenous Heritage

To inform the assessment of the original Project as unmodified, an assessment of indigenous heritage matters was undertaken as part of the EIS (The Design Partnership, June 2016).

Four artefacts have previously been recorded on the site in a 1986 archaeological survey carried out by Brayshaw and Associates prior to the construction of the Borg Panels MDF manufacturing plant. The Brayshaw and Associates report concluded that:

> *In view of the disturbance sustained to the area, the apparent sparseness of the artefacts, and the clay deposit which would make excavation and accurate provenance extremely difficult, excavation of the area is not appropriate.*

This EIS concluded that given the scatted nature of artefacts identified during the previous study carried out, the soil type and general topography of the site and the conclusions of that report, no further studies are considered to be necessary.

However, if any indigenous artefacts are uncovered during earthworks, then work will be stopped, and a suitable representative from the indigenous community contacted. Works would only recommence when an appropriate and approved management strategy has been agreed to by all of the relevant stakeholders.

It is recommended that the Aboriginal and European Heritage Management and Mitigation Measures outlined in the approved Construction Environmental Management Plan (Borg Construction, 31 May 2017) for the Project be adopted for the proposed modifications. The CEMP includes an unexpected finds protocol for heritage items.

5.13 European Heritage

To inform the assessment of the original Project as unmodified, an assessment of European heritage matters was undertaken as part of the EIS (The Design Partnership, June 2016). No heritage items were located within close proximity to the Project, the closest being the Oberon Station Precinct, which is approximately 500m from the site.

The EIS concluded, given the distance from the site of the items of European heritage, no mitigation measures are considered to be necessary. Existing Oberon Timber Complex activities (not part of the Borg Panels operations) are located on a lot adjoining these items, and although the Project brings the Borg activities closer to the heritage item there is still significant physical separation.

It is recommended that the Aboriginal and European Heritage Management and Mitigation Measures outlined in the approved Construction Environmental Management Plan (Borg Construction, 31 May 2017) for the Project be adopted for the proposed modifications. The CEMP includes an unexpected finds protocol for heritage items.

5.14 Cumulative Impacts

The proposed S4.55 modifications will have minimal impact on the immediate area and surrounding environment when compared to the approved Project as unmodified. Primarily due to the fact that the changes are minor and are well understood and controlled.

With the mitigation and management measures proposed in this SEE, it is considered that the potential impacts of the proposed S4.55 modification will have minimal environmental impact.

6 Conclusion

The assessment of potential environmental impacts of the proposed S4.55 modification concludes the proposed modifications to the approved development are ancillary to the

development and are of minimal environmental impact. Furthermore, the modified development remains substantially the same as the development for which the consent was originally granted. Based on this information we request the Department assesses this application as a Section 4.55 (1A) Application, as defined in the *Environmental Planning and Assessment Act 1979*.

Appendices

Appendix A- Preliminary Hazard Analysis of the Natural Gas Pipeline and Turbine

PRELIMINARY HAZARD ANALYSIS OF THE NATURAL GAS PIPELINE AND TURBINE AT BORG TIMBER PANEL MANUFACTURING FACILITY IN OBERON NSW

Prepared for: Borg Manufacturing

Document Number: 01-B519-02

Revision 0

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5 August 2019

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Preliminary Hazard Analysis of the Natural Gas Pipeline and Turbine at Borg Timber Panel Manufacturing Facility in Oberon NSW

Disclaimer

This report was prepared by Planager Pty Ltd (Planager) as an account of work for Borg Manufacturing. The material in it reflects Planager's best judgement in the light of the information available to it at the time of preparation. However, as Planager cannot control the conditions under which this report may be used, Planager and its related corporations will not be responsible for damages of any nature resulting from use of or reliance upon this report. Planager's responsibility for advice given is subject to the terms of engagement with Borg Manufacturing.

Rev	Date	Description	Prepared By	Checked By	Authorised By
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B	04/07/2019	Final draft	Karin Nilsson	Anne Lewis	Karin Nilsson
0	05/07/2019	Final Report	Karin Nilsson	-	Karin Nilsson

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

EXECUTIVE SUMMARY

Introduction

Borg Manufacturing are proposing to install a high pressure natural gas connection and turbine at their Oberon site in NSW, to produce electricity and utilise waste exhaust heat required for their particleboard manufacturing processes. The natural gas will be provided via an (Borg owned and operated) underground pipeline from the existing APA Group branch from the Sydney to Moomba pipeline.

The NSW Department of Planning & Environment (NSW DP&E) have identified a need for a Preliminary Hazard Analysis (PHA), consistent with the NSW DP&E Hazardous Industry Planning Advisory Paper No.6 (HIPAP6)*, Hazard analysis* and with the risk levels to comply with the criteria for land use planning in HIPAP No.4 *Risk criteria for land use planning*.

Planager Pty Ltd has been engaged by Borg Manufacturing to undertake the PHA for the development, with the results resented in this report.

Results

The results of the assessment show that the levels of risks to public safety associated with the proposed development are within the most stringent accepted risk criteria for land use planning as per the NSW DP&E guidelines in their HIPAP4 and HIPAP6.

In NSW, land use safety is determined based on risk, and in risk terms the proposed development is acceptable in the proposed location because the likelihoods of major incidents associated with natural gas pipeline are very low.

The incremental increase in individual injury and fatality risk, the risk of propagation to/from neighbouring industrial activity and in societal risk in the area associated with

the proposed development is very low to negligible and is well within the tolerable limits set in HIPAP4.

The results are summarised in the table below:

Table E1 – Adherence to Risk Criteria

Risk criteria	Results	Impact on development
Sensitive development criterion - 0.5 pmpy risk	Risk level contained within the site boundary with a very small excursion near the APA Group connection. No sensitive development in this location.	Development is acceptable in this location
Residential development criterion - 1 pmpy risk	Risk level contained within the site boundary. No residential development in this location.	Development is acceptable in this location
Commercial development criterion - 5 pmpy risk	Risk level never reached for this development.	Development is acceptable in this location
Active open space criterion - 10 pmpy risk	Risk level never reached for this development	Development is acceptable in this location
Neighbouring industrial development criterion - 50 pmpy risk	Risk level never reached for this development	Development is acceptable in this location

Risk criteria	Results	Impact on development
Injury risk - 50 pmpy	Injury risk at any location associated with the development is calculated to be about 50 pmpy. The risk of injury at the development is below the maximum risk criterion. The injury risk at the nearest residential development is negligible.	Development is acceptable in this location
Propagation risk - 50 pmpy	Propagation risk at any location of the development is calculated to be about 1.7 pmpy. The injury risk at the nearest neighbouring industrial development is 0.8 pmpy, well below the maximum criterion of 50 pmpy. The risk of propagation at the development is below the maximum risk criterion.	Development is acceptable in this location
Societal risk	Negligible impact on the overall societal risk in the area	Development is acceptable in this location
Risk of propagation to / from neighbouring industrial area including Borg facility, APA Group gas connection and adjacent Woodchem MHF	The risk of propagation from the development onto the neighbouring Woodchem MHF is negligible. The separation distance of 300 metres from the nearest placard chemical storage and the separation distance to locations with dust explosion hazard combined with explosion venting design (located well above ground and relieving 45^{o} upwards) makes the risk of propagation to/from the development highly unlikely. The proposed development does not significantly impact the overall risk in this area.	Development is acceptable in this location

Risk criteria	Results	Impact on development
	There is a remote possibility of an incident at the APA Group facility impacting the small (few metre) above ground piping in this area – however, construction to Codes and Standards for such pipe connections is generally deemed as sufficient to manage this risk. The below ground pipeline is protected by a 1200mm ground cover, with no other adjacent high pressure pipeline – propagation from external areas to this pipeline is of very low / negligible risk.	

These results are valid provided that the proposed development will be operated and maintained in accordance with good practice, at or below design rates, and tested / inspected / maintained as required; personnel trained and competent; Permit To Work system implemented; changes to plant and procedures managed; and emergency procedures updated to incorporate the proposed new development.

Recommendations

1. The assumptions listed in Section 1.3 in this report form the basis for the present risk study and must be implemented for the results to be valid.
2. It is recommended that Borg investigate providing an automatic / remote activated closure at the inlet valve at the APA Group tie-in point on detection of a major incident on downstream pipe and equipment.
3. It is further recommended that a pipeline management plan (PMP) be developed, which includes the requirements for integrity management for the proposed pipeline and associated valve stations and gas treatment skid (refer AS 2885 for Pipeline Management Plan and Integrity Management Plan requirements which should be used as a basis for this Plan).

GLOSSARY

ADG	Australian Dangerous Goods
API	American Petroleum Institute
AS	Australian Standard
DG	Dangerous Goods
DN	Nominal Diameter
DP&E	(NSW) Department of Planning and Environment
HIPAP	Hazardous Industry Planning Advisory Paper
MAOP	Maximum Allowable Operating Pressure
MDF	Medium Density Fibreboard
MHF	Major Hazard Facility
MPa	Mega Pascal
NSW	New South Wales
PG	Packing Group
PHA	Preliminary Hazard Analysis
SDS	Safety Data Sheet

REPORT

1 INTRODUCTION

1.1 BACKGROUND

Borg Manufacturing (Borg) produces a range of Reconstituted Wood product products at a timber manufacturing and processing facility located on Lot 26 DP 1200697 on Lowes Mount Road in Oberon, NSW.

Borg Manufacturing are proposing to install a high pressure natural gas connection and turbine at their Oberon site in NSW, to produce electricity required for their manufacturing processes. The connection will be provided via an existing APA owned and operated branch from the Sydney to Moomba natural gas pipeline which is located outside of the north western end of the site, via the Borg custody transfer point. The proposed connection and associated piping and infrastructure are referred to as *the proposed development* in the present report.

The NSW Department of Planning & Environment (NSW DP&E) have identified a need for a Preliminary Hazard Analysis (PHA), covering all aspects of the proposed development, consistent with the NSW DP&E *Hazardous Industry Planning Advisory Paper No.6, 'Hazard Analysis'* (Ref 1), and with the risk levels to be compared with the criteria for land use planning in HIPAP4 *Risk criteria for land use planning* (Ref 2).

Planager Pty Ltd (Planager) has been engaged by Borg Manufacturing to undertake the PHA for the development, with the results resented in this report.

1.2 AIM AND SCOPE

1.2.1 Overall objective

The overall objective of this risk assessment is to demonstrate that the risk to land uses adjacent to Borg's manufacturing site in Oberon from the proposed development does not exceed the criteria for land use safety, as specified by the NSW DP&E (HIPAP 4, Ref 2).

1.2.2 Aim

The aim of this PHA is to:

- Identify the hazards associated with the proposed development, as developed on the existing site, including potential external hazards;
- Determine the potential for off-site impacts;
- Estimate the incremental risk from the proposed development and it's impact on cumulative risk levels from the overall Borg facility to surrounding land uses and demonstrate that the proposed modification will not increase the risk of the area to unacceptable levels;
- Comment on any risk impact to / at the neighbouring major hazard facility from the development and the overall modified Borg facility;
- Demonstrate that the proposed modification will comply with the criteria set out in the NSW DP&E's HIPAP4 (Ref 2);
- Identify opportunities for cost effective risk reduction, and make recommendations as appropriate.

1.2.3 Facilities covered in the risk assessment

The following facilities are covered in the present PHA:

- Connection at the custody transfer point at the outlet of the APA Group metering station, within Borg's site;
- High pressure pipeline, delivering natural gas from the custody transfer point to the gas treatment skid;
- Gas treatment, including filter, heater and pressure reduction station prior to delivery to the turbine;
- Pipeline delivering gas from the gas treatment skid to the turbine located on the Borg site,

The connection to the existing low pressure gas network, delivering gas for use in the existing engines and other factory supply, is outside of the present scope as the pressure is very low (130kPa(g)) and the risk associated with such gas pipelines is managed through design and operation in accordance with applicable Codes and Standards (refer Section 2.3.2).

1.2.4 Types of risks reviewed

As per the requirements in the NSW DP&E HIPAP 6 (Ref 1), the types of risks considered in this PHA are:

- Risk of human injury or fatality;
- Risk of propagation damage to neighbouring facility, including at the neighbouring MHF;
- Risk of damage to the natural environment.

The PHA assesses the potential for damage to life and limb arising directly from the major hazards aspects of the above mentioned processes, i.e. as initiated by a release of potentially hazardous materials by determining the acute risks associated with the material, i.e. fire, explosion and acute response to exposure. This approach is consistent with the requirements for PHA as per the NSW DP&E's approach for hazard and risk analysis (HIPAP6, Ref 1).

Elements from the Safety Management Study which was conducted for the high pressure pipeline as per the requirements in the Australian Standard AS2885.1, *Pipelines – Gas and Liquid Petroleum*, Part 1 (Ref 3) were used as a basis for the present assessment.

There is no acute environmental damage potential from the burning of natural gas in air and hence this aspect is not covered in the PHA.

The natural gas processed and handled is a simple asphyxiant and has no toxic properties. Combustion products of natural gas are water, carbon dioxide (and possibly carbon monoxide under very adverse conditions[1]).

Operational hazards associated with any confined space entry are best handled through the use of permit to work or other safety management system, which form part of management practices at Borg, and are outside the scope of the present risk assessment.

Hence, the risk associated with proposed facilities is restricted to the acute risk of human injury or fatality resulting from the fire and explosion hazards associated with the potentially hazardous material used and produced.

[1] Carbon monoxide would form during combustion in the present of insufficient air. As the plants which form part of the scope of this study are all out in the open it is considered non-credible that carbon monoxide would cause a hazard to people in the vicinity of a fire associated with the CSM.

1.2.5 Outside the scope of this study

In line with the requirements by the NSW DP&E for the assessment of hazards and risks of a PHA (HIPAP4 and HIPAP6, Refs 2), the following are outside of the scope of the present risk assessment:

- Safety Management Study Assessment for the risks to the integrity of the pipeline as per AS2885.1 (Ref 4) has been conducted separately to the present assessment to comply with the requirements under the Pipelines Regulation and Code;
- Fatality or injury risks for personnel involved with the construction of the new infrastructure in the study area and/or personnel who damage any existing infrastructure or involved with ongoing maintenance of the infrastructure;
- Any possible effects from exposure to any possible contaminated land associated with construction or maintenance activities
- Assessment of low level/continuous emissions such as small fugitive emissions form valve packing etc.

1.3 MAJOR ASSUMPTIONS AND CONSTRAINTS

The PHA is conducted with the following major assumptions:

- The proposed development will be under competent management;
- All personnel required to work with high pressure natural gas will be trained in their safe use and handling, and to be provided with all the relevant safety equipment;
- Emergency procedures will be updated to incorporate the proposed new development and personnel will be trained to respond to emergencies associated with the proposed development;
- The development will be operated and maintained in accordance with good practice;
- All persons on the premises are provided with appropriate personal protective equipment (PPE) suitable for use with the specific hazardous substances. The

required PPE will be reviewed if personnel are required to work with high pressure natural gas;

- The proposed development will be operated by experienced, competent and qualified workers;
- A Permit to Work system (including Hot Work Permit for any work that could provide an ignition source) is in use on site to control work;
- The proposed development will be operated at or below design rates;
- Faulty controls will be replaced;
- The proposed development will be inspected and maintained in good working order, including scheduled testing of shutdown valves, trips and alarms, and relief devices.
- Changes to the proposed development will be investigated using Control of Change process and will not be considered in the PHA;
- A malfunction of a final control element (e.g. pressure regulator, instrument or valve) includes all elements of the control loop, i.e. process connection failure, instrument failure, logic solver etc.);
- The proposed development and associated equipment, including critical control functions such as Pressure Safety Valves and control loops, will be tested regularly and maintained in good working order. PSVs will be inspected and tested in accordance with Code requirements.
- Pressure vessels and pressure piping will be inspected in accordance with Code requirements.

2 DESCRIPTION OF THE FACILITY AND PROTECTIVE SYSTEMS

2.1 LOCATION

The proposed development will be constructed on Borg's existing site located at 124 Lowes Mount Road, approximately 46 kilometres (km) south-east of Bathurst and 195 km west of Sydney in the NSW Central Tablelands (see Figure 1).

The site is located approximately 1.5 km north of the Oberon town centre and the closest residential receiver is around 600 metres (m) south of the site.

The site is situated within an existing industrial area and is surrounded by (see Figure 2):

- parcels of vacant land to the north and west of the site;
- the Boral sawmill, Structaflor particle board facility and Highland Pine Products to the south-west of the site;
- the Oberon Rugby Leagues Football Club, Australian Native Landscapes facility and a number of light industries to the south;
- a vacant land parcel to the east (currently owned by the Applicant); and
- the Woodchem resin manufacturing facility (Woodchem facility), located adjacent to the MDF facility's, on the eastern boundary. The Woodchem facility is classified as a Major Hazard Facility (MHF) under the definition in the Work Health and Safety Regulation (2017).

2.2 DESCRIPTION OF THE EXISTING PLANT

Borg Manufacturing operates an MDF & Particleboard facility on the eastern side of Lowes Mount Road (*the facility*).

Reconstituted wood products (namely particleboard and MDF) are made from processed wood mixed with resins. The facility produces a number of Reconstituted Wood products with varying thicknesses, dimensions and moisture and thermal properties. In addition, the facility also produces primed door skins and treated paper for laminating MDF and particle board.

The facility consists of three production lines – one for MDF thick board and one for MDF thin board and particleboard.

The MDF production lines share debarking, chipping and stockpiling facilities. The existing MDF production process is described as follows:

- logs are brought to site and are debarked and fed into a chipper to form woodchips;
- woodchips are heated with steam, grounded into wood fibres and mixed with resin;
- mixed fibre and resin are blown through a gas fired hot air stream which dries the material into a dried mix;
- the dried mix is transferred onto a conveyor which is passed through a continuous press where it is gradually reduced to the required size. The application of heat and pressure also cures the resin to form MDF; and
- the product is cut, trimmed and sanded, and stored on-site in a warehouse prior to distribution.

Whilst not dissimilar particle board production process can be broken down into the following steps.

- Production of chips from fresh round wood, debarking and chipping.
- Production of chips and flakes from waste wood

- Production of flakes from fresh produced chip.
- Wood Drying process to ensure a suitable moisture content is achieved.
- Sorting and Cleaning of dried flake to ensure it is placed into the correct layers of final product.
- Addition of Resin and Chemicals
- Forming, Pre-Pressing and thickness Pressing of chip.
- Cutting, Cooling and Stacking
- Final sanding and processing of finished product.

2.3 DESCRIPTION OF THE PROPOSED DEVELOPMENT

The proposed development consists of the following:

- Connection at APA Group's custody transfer point via short (12metre) above ground pipe including a shutdown valve, on the northern side of the site;
- A 512 metres long pipeline (100mm nominal diameter, underground), from the APA Group pipeline custody transfer point, through to the above ground gas treatment and pressure regulating skid located at the South western area of the site;
- Gas treatment, including:
    - Coalescing gas filter to remove any particulates;
    - Metering device for billing purposes;
    - A Heat exchanger which heat the gas up prior to pressure reduction;
    - Gas regulators to reduce the pressure of gas to the required pressures for the turbine;
    - Emergency shut down valve
    - Associated new connecting pipework (about 10 metres above ground).

- A 58 metres long underground pipeline and 12 metre long above ground pipeline connecting the pressure regulation skid to the turbine.

The concept layout of the proposed development is shown in Figure 1.

Images from the site model is shown in Figure 2.

Figure 1 – Pipeline run

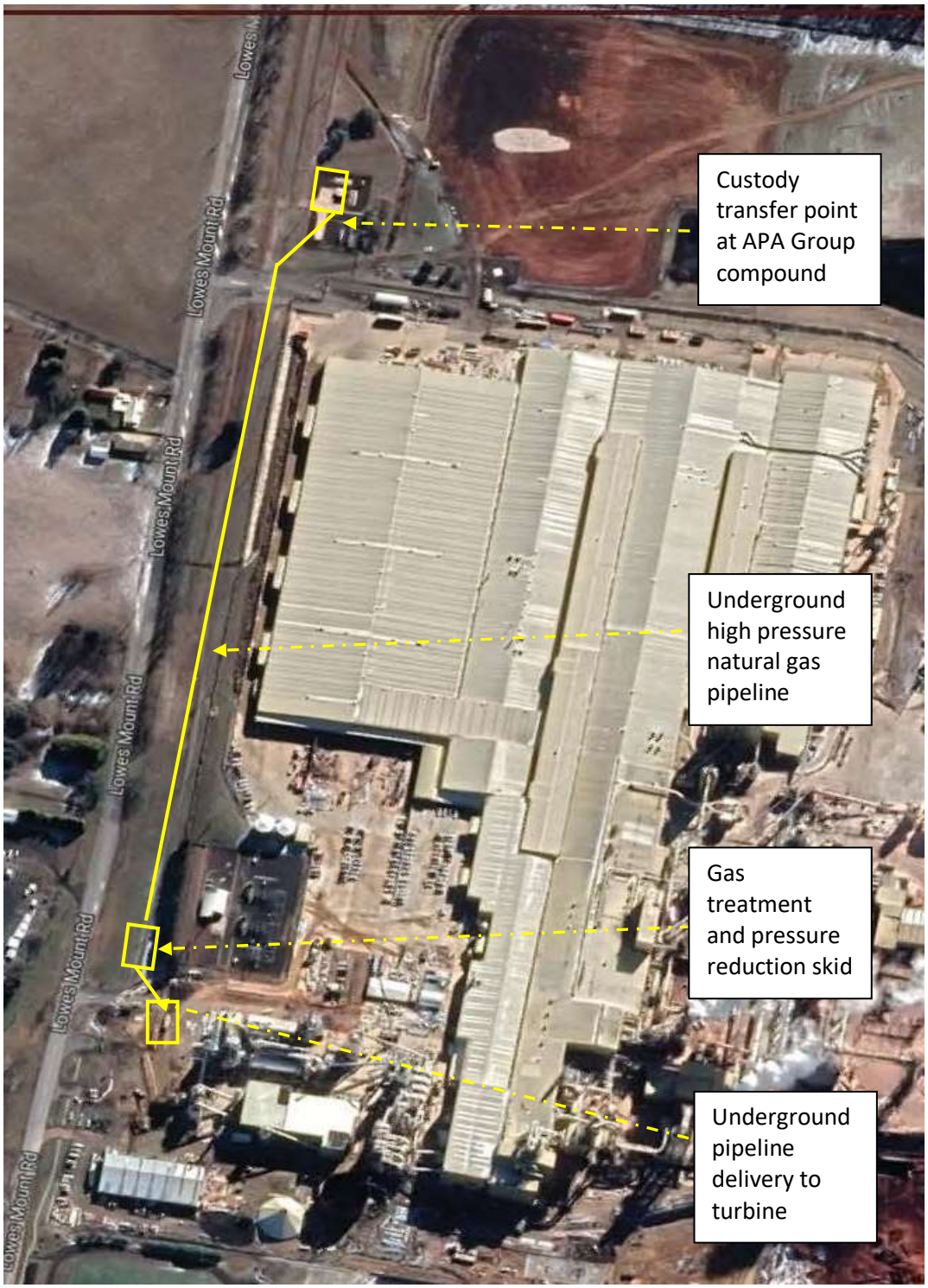
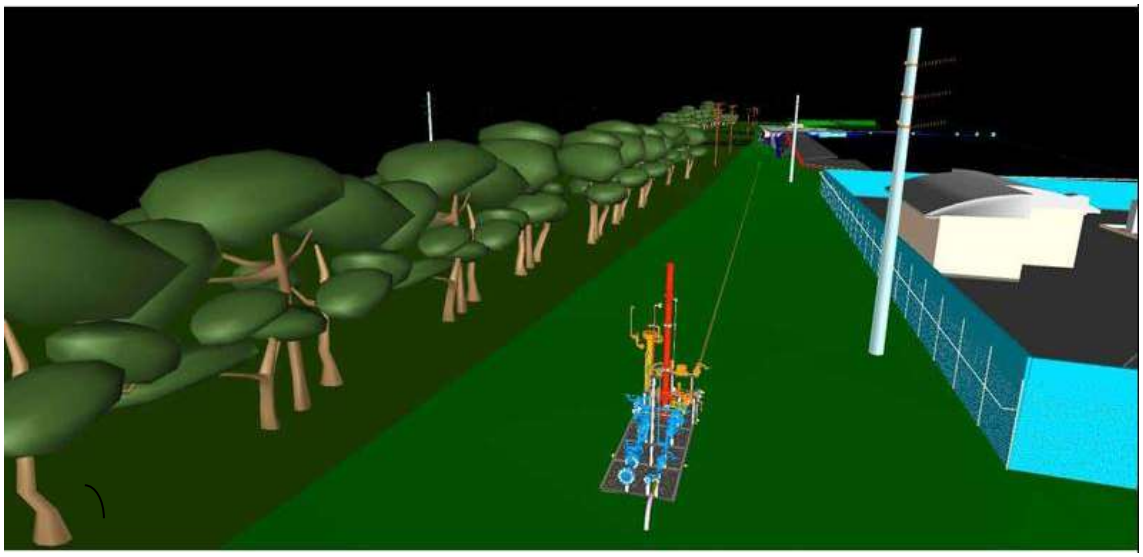
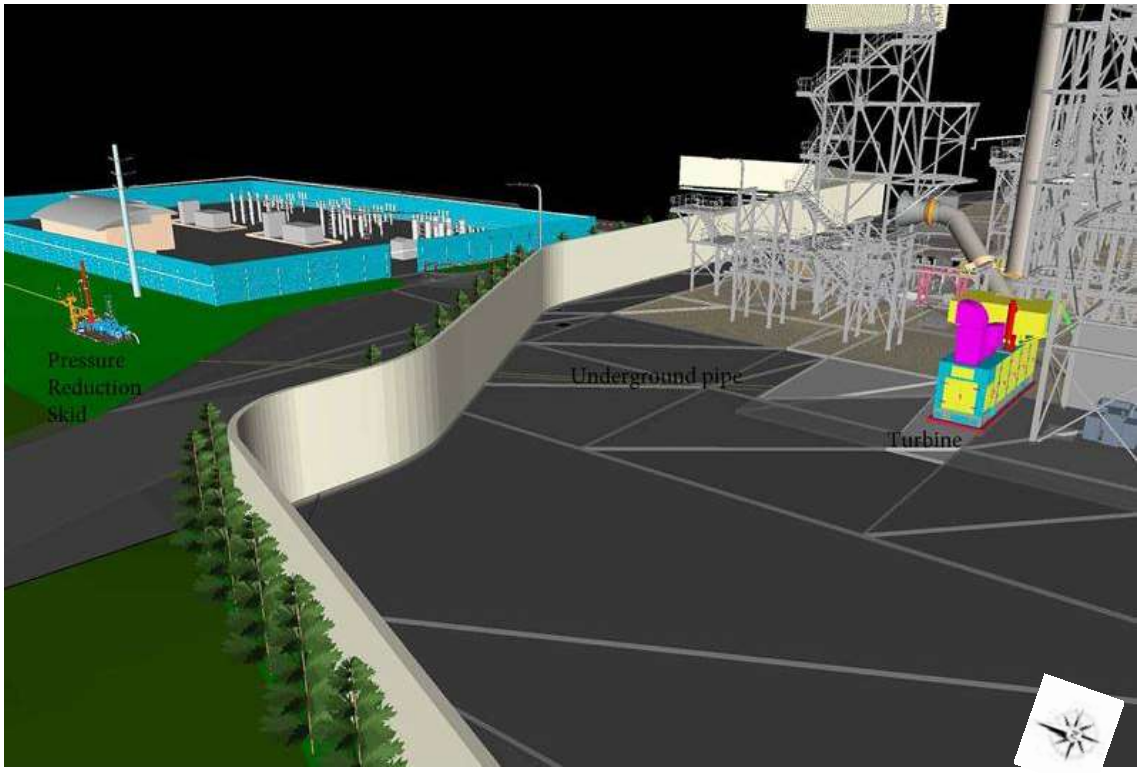


Figure 2 – Site model

Gas treatment and pressure reduction skid, looking north towards APA Group custody transfer point



Pressure reduction skid and underground pipeline to the turbine



2.3.1 Design and construction

Natural gas is supplied from the APA Group trunk main into an existing (APA Group operated and maintained) compound located outside of the site boundaries. The APA Group compound is surrounded by a security fence and is locked and closed at all times except for when accessed by APA Group operators / maintenance personnel.

The new high pressure pipeline will be connected at the APA Group custody transfer point, at Eastern boundary adjoining the Borg property, run above ground for about 12 metres before dipping underground for delivery to the (above ground) gas treatment and pressure reduction station located 500m south of the APA compound and then run underground for delivery to the turbine. The pressure reduction skid is located within the Borg site at the Southernmost entry along Lowes Mount road, it will be located within a fenced compound area.

The pipe at the custody transfer point, the high pressure pipeline and the gas treatment and pressure reduction station will run within Borg's property.

Details of the proposed development are presented in Table 1 below. This risk assessment assumes that the natural gas pipeline and all associated equipment and vessels are pressurised and operational 100% of the time.

Table 1 – Design details, proposed development

Pipeline design Code – high pressure (below ground) pipeline	-	AS 2885.1 : 2012 (Ref 5)
Interconnect gas piping for above ground piping	-	AS 4041 (Ref 5)
Pipeline specification	-	API Spec 5L 45th Edition (Note 1) (Ref 6)
Material transported	-	Natural gas (compressed gas Class 2.1)
Pipeline material	-	API 5L X52 (Ref 6)
Pipe coating:	-	3LPE (specification: CSA Z245.21; FBE Layer), (Ref 6)

Corrosion protection	-	Galvanic anode cathodic protection (CP) system, with flange insulating kits (FIKs) at each end to electrically isolate the buried section from the above ground facilities (Ref 5)
Diameter(a)	mm	114.3 mm / DN100 Ref 6)
Wall thickness(a)	mm	6.02 mm (Ref 6)
Pipeline Length (approx.)	m	500
Primary Location Classification	-	Residential (T1) (Ref 6)
Secondary Location Classification	-	Industrial (I) (Ref 6)
Measurement length (4.7 kW/m^2 thermal radiation)	m	90 (Ref 6)
Temperature Design Assume in QRA	^{o}C	(Ref 7) -10 to 55 23 (turbine supply)
Pressure upstream regulator Design MAOP Normal operating Assumed in QRA	MPa(g)	(Ref 7) 9.93 10.5 8.5 (Gas Cond Skid Drwg B2970/500 Rev A) 9.93
Pressure downstr. HP regul.: PRV PSV Turbine receipt Assumed in QRA	MPa(g)	(Ref 5) 3.0 (pressure regulating valve set-point) 3.45 (pressure safety valve) 1.6 – 3.4 3.45
Pressure downstr. LP regul.: Engine receipt Factory receipt	MPa	(Ref 5) 0.6 – 0.8 0.1 – 0.2
Flow rate (nominal)	Sm^3/hr Kg/hr	4,135 (Ref 5) 3,303

Maximum Excavator Impact Weight	Tonnes	25 (as maximum credible excavator impact weight, with tiger teeth, Refs 6, 7)
Nearest valve stations for pipeline isolation	-	ESD (Borg operated) at custody transfer point and onsite
Inspections	-	TBC, before commissioning
Control measures for third party intervention	-	Protective concrete slab on either side of road and at the gate at site boundary
Usage assumed in QRA	%	100
Depth of burial u-ground:	mm	1200
System Design Life	-	40 years (Ref 5)
Fatigue	-	Max allowable P-fluctuation of two pressure cycles / day is 10.55 MPa, which corresponds to two shutdowns and start-ups per day. As this is not a credible scenario, pipeline fatigue will not be an issue. Fatigue design at pipeline crossings satisfies the requirements of API RP 1102 (Ref 5)

2.3.2 Applicable codes and standards

The interconnect gas piping is covered by the scope of AS 4041 - Pressure Piping. AS 4041 Clause 1.1 stipulates that the standard is intended to apply to "piping within boundaries of chemical manufacturing or processing installations, petroleum refineries, petrochemical plant, gas process plant, refinery tank farms, terminals and bulk handling plants." Therefore, since the pipework will be constructed within the Borg property boundary, the gas connection can be designed to AS 4041 (Ref 5).

AS 4041 deals primarily with aboveground piping. For buried piping, AS 4041 makes reference to AS 2885 for guidance. As such, this design will take into account the appropriate requirements of AS 2885 for the buried piping.

Some of the major applicable Codes and Standards for the proposed development are listed in in Table 2 below (for a full set, refer to the Basis of Design in Ref 5).

Table 2 – Codes and standards

Standard / Code	Tile
API Spec 5L- 45th Ed, Errata 1	Specification for Line Pipe
AS 2885.0 – 2008(+A1)	Pipelines – Gas and Liquid Petroleum Part 0: General Requirements, incorporating Amendment no. 1 in 2012
AS 2885.1 – 2012	Pipelines – Gas and Liquid Petroleum Part 1: Design and Construction
AS 2832.1	Cathodic Protection of Metals: Pipes and Cables
AS 3862	External Fusion-Bonded Epoxy Coating for Steel Pipes
AS 4100	Process Piping

2.3.3 Reference documentation

The proposed development is evaluated and described in the following reference documentation:

Table 3 – Reference documentation

Reference No.	Title/Description
2079-02-EL-PLN-001	Fracture Control Plan
2079-02-EL-CAL-001	AS 2885 Calculation Suite
2079-02-EM-CAL-003	AS 4041 Piping Calculations
8840-001-dsb	Eclipse Consulting Engineers, Design Summary Brief
2079-02-EM-BOD-001	Basis of Design
2079-02-EL-DAT-001	Data sheet Borg HP Gas Connection DN100 Coated Line Pipe
FEGAS	Filtration skid bill of material
2079-EL-REP-001	Safety Management Study
2079-EE-CAL-001	LFI/EPR Hazard Assessment

2.3.4 Regulatory requirement

The Basis of Design (Ref 5) concludes that, given that this gas connection will be wholly within the boundaries of Borg property, Borg's proposed connection need not be classified as a pipeline.

2.3.5 Safety management

General

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

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

If an installation which has significantly below average safety software in place is assessed using the generic frequencies, it is likely that the risk will be underestimated. Conversely, if a plant is significantly above average, the risk will probably be overestimated. However, it is extremely difficult to quantify the effect of software on plant safety. Incorporating safety software as a means of mitigation has the potential to significantly reduce the frequency of incidents and also their consequences if rigorously developed and applied. The risk could also be underestimated if safety software is factored into the risk assessment but is not properly implemented in practice. Practical issues also arise when attempting to factor safety software into the risk assessment – applying a factor to the overall risk results could easily be misleading

as in practice it may be the failure of one aspect of the safety software that causes the accident, while all other aspects are managed exemplarily.

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

Safety Management System Implemented On Site

Borg Manufacturing have a commitment to workplace health and safety and have numerous policies and procedures to achieve a safe workplace.

The operation of the existing facility is continually monitored and controlled from a central control room via a supervisory control and data acquisition (SCADA) system. There are 3 control rooms at site, all gas pipe data will be displayed on these screens.

An incident reporting and response system is established, providing 24 hour coverage.

The new development will comply with the applicable codes and statutory requirements (Ref 5). Special precautions are observed as required by the site conditions, in particular, standards and requirement on the handling of pressurised, flammable gases.

2.4 SECURITY

- Security fence; locked gates and/or manned boom gates;
- Security patrols and reviews.
- Process monitoring (loss of supply)

The APA Group and the Borg compounds at the custody point are surrounded by a security fence and is locked and closed at all times except for when accessed by APA Group / Borg personnel.

2.5 MANNING

Site has approximately 250 employees, 150 during the day and 100 overnight.

2.6 LIGHTNING PROTECTION

The proposed development will be designed to comply with AS 2885 *Lightning Protection*.

If required, additional protection may be provided to monitor the effects of electrical interference from external sources including stray currents, power transmission structures and lightning strikes (Ref 5).

2.7 ELECTRICAL HAZARDS ON PIPELINE

A potential cause of electrical hazard on buried pipelines is Low Frequency Induction (LFI) due to nearby power transmission and distribution lines such as the high voltage (HV) powerline located in the vicinity of the proposed pipeline. An assessment of electrical hazards on the pipeline was conducted by OSD in accordance with the requirements of AS4853 Electrical hazards on metallic pipelines, as reported in the *LFI/EPR Hazard Assessment*.

The assessments considered the impacts from the overhead power line via LFI and the Electron Paramagnetic Resonance (EPR) caused by power transmission faults near the pipeline easement.

Input data was supplied by Essential Energy, including HV powerline phase current under load condition and under fault condition and HV powerline conductor height.

The assessment concluded that the impressed voltage at the pipeline from the distribution power lines is considered low to negligible in both fault conditions and during continuous (normal) conditions and that therefore no equipment damage is expected from impressed voltages due to LFI.

Further, no exposed contact point were identified which could create hazardous touch and step potentials for humans or live stock during operations or by the public.

Impressed voltage levels were however found to exceed the maximum touch voltage (of 110 V / 95 V detailed in AS/NZS 4853), and the LFI/EPR assessment therefore recommended:

- the use of appropriate safety footwear (e.g. gumboots) in conjunction with equipotential bonding between metallic trench support framework, reinforcing mesh on ground and pipeline while conducting construction and maintenance activities. Installation of PCR (polarisation cell replacements) across the FIKs to discharge the unwanted impressed voltages via earth.

The recommendations from LFI/EPR Hazard Assessment report and as specified in other design and development documents are to be included in the project and design specifications and the ongoing management and maintenance of such items will be included in the Pipeline Management Plan (which is to include an Integrity Management Plan), refer Recommendation 3 of the present report.

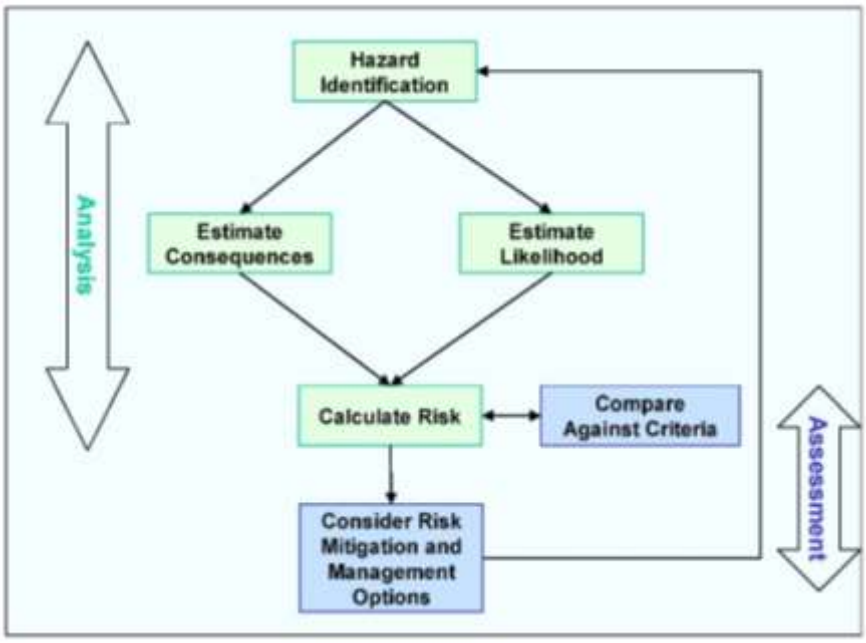
2.8 EARTHQUAKE

Earthquake hazards on the pipeline are managed through design to Code requirements AS 1170.4 – *Structural Design Actions, Part 4: Earthquake Actions in Australia* (assessed using importance level 2 at an annual probability of exceedance of 1/500 years).

3 METHODOLOGY

The assessment has been carried as per the NSW DP&E's *Guidelines for Hazard Analysis* No 6 and *Risk Criteria for Land Use Planning* No 4 (Refs 1 and 2). An outline of the process is conceptually depicted in Figure 3 below.

Figure 3 – Risk assessment process



The six stages in risk assessment are as follows:

Hazard Identification

Including a review of potential hazards associated with all dangerous and hazardous material to be produced, used and handled at the proposed development. The hazard identification includes a comprehensive identification of possible causes of potential incidents and their consequences to public safety and the environment, as well as an outline of the operational and organisational safety controls required to mitigate the likelihood of the hazardous events from occurring.

The tasks involved include a review of all relevant data and information received to highlight specific areas of potential concern and points of discussion, including drafting up of a hazard identification word diagram (HAZID), as presented in Appendix 1.

For this study, the initial hazard identification has been based on the site and layouts, including pipeline routing, flow diagrams, material properties and proposed operating and control strategies of plants and facilities, as well as the Safety Management Study which was conducted for the high pressure pipeline (Ref 6).

Quantitative Consequence and Effect Analysis

The consequences of identified hazards are assessed using current techniques for risk assessment. Well established and recognised correlations between exposure and effect on people are used to calculate impacts.

Consequence calculations were undertaken using the Netherlands Organisation for Applied Scientific Research (*TNO*) consequence modelling software program *Effects®* (version 10.0.3) and risk modelling software package *Riskcurves®* (version 7.6).

The TNO software tools are internationally recognised by industry and government authorities and the consequence models used within the packages are well known and are fully documented in *The Yellow Book* (TNO, Ref 8).

The values of interest for radiant heat (NSW DP&E, HIPAP10 and HAZAN Course notes) are shown in Table 4 and Table 5.

Table 4 - Radiant Heat Impact

Radiant Heat Level (kW/m^2)	Physical Effect (effect depends on exposure duration)
1.2	Received from the sun at noon in summer
2.1	Minimum level required to cause pain after 1 minute
4.7	Pain in 15 to 20 seconds, 1st degree burns in 30 seconds. Injury (second degree burns) to person who cannot escape or seek shelter after 30s exposure.

Radiant Heat Level (kW/m^2)	Physical Effect (effect depends on exposure duration)
12.6	High chance of injury; 30% chance of fatality for extended exposure. Melting of plastics (cable insulation). 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	Fatality on continuous exposure. 10% chance of fatality on 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	25% chance of fatality on instantaneous exposure. Cellulosic material will pilot ignite within one minute's exposure
60	Fatality on instantaneous exposure.

Table 5 – Explosion Overpressure Impact

Overpressure (kPa)	Physical Effect
0.3	Loud noise
1.0	Threshold for breakage of glass.
3.5	Minimal effect in the open. Minor injury from window breakage in building. No fatality, very low probability of injury
7.0	Glass fragments fly with enough force to cause injury. Probability of injury is 10%. No fatality. Damage to internal partitions and joinery of conventional buildings, but can be repaired.
14	1% chance of ear drum rupture. Houses uninhabitable and badly cracked
21	10% chance of ear drum rupture. 20% chance of fatality to person in building. Reinforced structures distort, storage tanks fail

Overpressure (kPa)	Physical Effect
35	50% chance of fatality for a person within a conventional building and 15% chance of fatality for a person in the open. House uninhabitable. Heavy machinery damaged. Significant damage to plant. Houses uninhabitable, rail wagons & plant items overturned.
70	100% chance of fatality for a person within a building or in the open. 100% loss of plant.

The potential for injury or property damage from a fire is determined by the intensity of the heat radiation emitted by the fire and the duration of exposure to this heat radiation. The potential for injury or property damage from an explosion is determined by the intensity of the explosion overpressure.

The impact of explosion overpressure on humans takes two forms, namely (1) for a person in the open, there could be organ damage (e.g. ear drum rupture or lung rupture), that may be considered to constitute serious harm; and (2) the person could be hit by a flying missile, caused by the explosion, and this can lead to serious injury or even fatality.

In assessing the effects of radiant heat, it is generally assumed that if a person is subjected to 4.7 kW/m^2 of radiant heat and they can take cover within approximately 20 seconds then no serious injury, and hence fatality, is not expected. However, exposure to a radiant heat level of 12.6 kW/m^2 can result in fatality for some people for limited exposure durations. Given that this radiant heat level is reached for the larger spills, appropriate emergency response actions are required to minimise the potential for harm to people. This should include moving people away from such releases to a safe distance. Exposure of structures to heat radiations of 23kW/m^2 may cause thermal stress to structural steel.

The dominant effect in a flash fire is direct engulfment by flame within the combusting cloud. To estimate the magnitude of the flammable gas cloud, the furthest distance from the release location with a concentration equal or above the lower flammability limit (LFL) is estimated using a dispersion model.

Quantitative Likelihood Analysis

For incidents with significant effects (heat radiation, explosion overpressure), whether on people, property or the biophysical environment, the incident frequencies are estimated.

In a QRA, the likelihood of each hazardous event is determined using a probabilistic approach to the failure of infrastructure such as pipelines, with exponential notation (e.g. 1.0 x 10^{-6} per year) normally used because the likelihood of a hazardous event is usually a low number (i.e. much less than 1 per year).

When using historical data to forecast the likelihood of a future event, it is important to ensure any specific conditions that existed at the time of the historical event are taken into account. For very low frequency events (i.e. where historical occurrences are very rare), it might not be possible to estimate the likelihood values directly from the historical data and other techniques such as fault tree analysis may be required.

Quantitative Risk Analysis

The frequency and consequence analysis results are combined in order to generate risk results. The risk for each incident is calculated according to the generic formulae

Risk = Consequence x Frequency

The combination of the probability of an outcome (such as injury or death) with the likelihood of an event produces the *risk* of the event. In order to assess the merit of the proposed development, it is necessary to calculate the risk at a number of locations so that the overall impact can be assessed. Total risk is obtained by adding together the results from the risk calculations for each incident, i.e. the total risk is the sum of the individual risk calculated for each scenario. The results are presented as curves representing iso-risk contours.

If required, depending on the population potentially exposed, information on this population is included in the calculations (for so called *societal risk* calculations). The

risk results are then assessed against the guidelines adopted by the NSW DP&E (Ref 2).

Risk is presented in the following three forms:

- *Individual Fatality Risk*, i.e. the likelihood (or frequency) of fatality to notional individuals at locations around the site, as a result of any of the postulated incidents. The units for individual risk are probability (of fatality) per million per year (pmpy).

- *Injury and Propagation Risk*, i.e. the likelihood of injury or propagation to individuals at locations around the site as a result of the same scenarios used to calculate individual fatality risk (above). The units for injury and irritation risk are probability (of injury/propagation) per million per year (pmpy).

- *Societal Risk* takes into account the number of people exposed to the potential incident scenarios. Whereas individual risk is concerned with the risk of fatality to a (notional) person at a particular location (person most at risk), societal risk considers the likelihood of actual fatalities among any of the people exposed to the hazard, i.e. the incident scenario occurring in time and space with a human population.

Risk Assessment

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

Risk Reduction

Where possible, risk reduction measures are recommended.

3.1 RISK CRITERIA

3.1.1 Individual risk criteria

The individual fatality risk is the probability of fatality to a person or a facility at a particular point. It is assumed that the person will be at the point of interest 24 hours per day for the whole year. By convention in NSW, no mitigation is allowed, i.e. any possible evasive action that could be taken by a person exposed to a hazardous event, e.g. by walking away from heat radiation from a fire.

The NSW DP&E uses a set of guidelines on acceptable levels or individual risk which are in line with the criteria used elsewhere in the world (HIPAP4, Ref 2).

The criteria for maximum tolerable individual risk from a new development are shown in the tables below, showing the maximum risk criteria for individual risk of fatality, injury and propagation of an incident and for societal risk of fatality.

Table 6 – Criteria for Tolerable Individual Risk of Fatality

Land Use	Maximum Tolerable Risk (pmpy)
Hospitals, Schools, etc.	0.5
Residential areas, hotels, etc.	1
Offices, retail centres, etc.	5
Open space, recreation areas etc.	10
Neighbouring industrial areas	50

Table 7 – Criteria for Tolerable Individual Risk of Injury

Land Use	Harmful exposure level	Maximum Tolerable Risk (pmpy)
Residential areas, hotels, etc.	4.7 kW/m^2 7 kPa	50

Table 8 – Criteria for Tolerable Individual Risk of Propagation

Land Use	Harmful exposure level	Maximum Tolerable Risk (pmpy)
Adjacent potentially hazardous installation, land zoned to accommodate such installations, or nearest public building	23 kW/m^2 14 kPa	50

Table 9 – Interim Criteria for Acceptable and Unacceptable Societal Risk

Number of fatalities (N) [-]	Acceptable limit of N or more fatalities per year	Unacceptable limit of N or more fatalities per year
1	3×10^{-5}	3×10^{-3}
10	1×10^{-6}	1×10^{-4}
100	3×10^{-8}	3×10^{-6}
1000	1×10^{-9}	1×10^{-7}

Two societal risk criteria are used, defining acceptable and unacceptable levels of risk due to a particular activity. The criteria in Table 9 above are represented on the societal risk (f-N) curve as two parallel lines. Three zones are thus defined:

- Above the unacceptable/intolerable limit the societal risk is not acceptable whatever the perceived benefits of the development.
- The area between the unacceptable and the acceptable limits is known as the ALARP (*As Low As Reasonably Practicable*) region. Risk reduction may be required for potential incidents in this area.
- Below the acceptable limit, the societal risk level is negligible regardless of the perceived value of the activity.

4 RESULTS

The following sections summarise the results of the PHA conducted for the proposed development, following the requirements by the NSW DP&E in their guideline documents HIPAP4 and HIPAP6 (Refs 1 and 2).

4.1 HAZARD IDENTIFICATION

4.1.1 Potentially hazardous material

The only hazardous material associated with the proposed development is high pressure natural gas, with the identified hazardous properties associate with the gas in Table 10.

Natural gas is composed predominantly of methane gas (about 91-97%), with low concentration of ethane (1-5%); propane (0.4%); carbon dioxide (CO_2, 0.7-3%) and nitrogen (0.7-1.2%), and may include some quantities of propane and butane, pentane and other hydrocarbons. The chemical methane (C1) is used to represent natural gas in this QRA – the properties of methane are also presented. Further discussions below.

Table 10 – Materials properties

Material name	DG Class	UN No / HAZCHEM Code	Boiling Point (°C)	Flash Point (°C)	Flammability limits in air (%)	Relative density (air=1)
Natural gas	*2.1*	*1971 / 2SE*	-162	-218 (typically)	5 – 15 (typically)	0.615 (typically)
Gas used in QRA: methane	*2.1*	*1971 / 2SE*	*-161*	-218	*4.4 - 17*	0.6

Notes:
DG3: Flammable liquid
SDS for methane from Air Liquids; SDS for natural gas from AGL
Relative density of the gas is for atmospheric conditions
Data for natural gas are indicative only and composition may change slightly

Natural gas is a buoyant, flammable gas which is lighter than air (relative density of 0.615). On release in the open the non-ignited gas tends to disperse rapidly at altitude. If release in an enclosed area the gas may accumulate and, if ignited at the right flammable concentrations, a flash fire is possible, or even an explosion under worst case conditions. These hazards are well known and understood, and plant layout is such that accumulation is highly improbably. Ignition at the point of release is however more likely for the pressurised gas, in which case the gas would burn as a jet (or torch) flame.

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

Combustion of natural gas materials would produce carbon dioxide (and possibly some carbon monoxide).

The fire will essentially be free of soot.

Locally, the uncontrolled release of compressed gas at high pressure may be hazardous to personnel. These hazards, while of importance for people working in close proximity, do not have implications beyond the immediate location of the release unless the released gas is ignited. Therefore, the risk associated with release of non-ignited compressed gas does not form part of the scope of the present risk assessment. This potential risk would however need to be closely managed through job safety analysis (JSA) and/or other risk assessment practices used by management and operators of the facility (in accordance with NSW Workplace Health and Safety Act and its associated regulations (Ref 6).

4.1.2 Potential hazardous incidents

The main hazard associated with the proposed development are related to a leak of natural gas which is a flammable gas held under pressure.

This would generally only have the potential to cause injury or damage if there was ignition, which resulted in a fire or explosion incident. The factors involved are:

- Failure must occur causing a release. There are several possible causes of failure, with the main ones being corrosion and damage to the equipment due to physical interaction;
- The released material must come into contact with a source of ignition. In some cases this may be heat or sparks generated by mechanical damage while in others, the possible ignition source could include non-flame proof equipment, vehicles, or flames some distance from the release;
- Depending on the release conditions, including the mass of material involved and how rapidly it is ignited, the results may be a localised fire (for example a so called jet fire), a flash fire or an explosion of the vapour cloud formed through the release.
- Finally, for there to be a risk, people must be present within the harmful range (consequence distance) of the fire or explosion. How close the people are will determine whether any injuries or fatalities result.

A total of 14 hazards were reviewed in terms of their potential consequences and likelihoods, as listed in Table 11 below.

Table 11 - Summary of Identified Hazards

Number	Hazardous Event Potential
1-5	Release of flammable gas from a generic leak in pipes, heat exchanger tubing, valves and fittings into the atmosphere (various causes)
6	Release of gas due to propagation from neighbouring plant
7	Explosion / flash within piping

Number	Hazardous Event Potential
8	Malicious damage/ unauthorised operation
9	Flooding / rain water resulting in process upsets
10	Lightning strike
11	Bush fire causes damage to site
12	Differential settlement of pipework and/or equipment
13	Aircraft crash
14	Electrical hazards on underground pipeline from overhead power line and from adjacent railroad

These potential significant incidents are summarised in the Hazard Identification Word Diagram following (Table 12). The diagram presents the causes and consequences of the events, together with major preventative and protective features that are proposed.

Table 12 – Hazard Identification Word Diagram

Control of ignition sources in Section 4.1.9 below

Hazardous Event	Causes and failure modes identified	Proposed Prevention and Mitigation Control Measures	Carried over to the QRA
Release of flammable gas into the atmosphere from the underground high pressure pipeline	Third party activity; Mechanical failure; Corrosion; Natural event (earthquake etc.)	Pipeline buried for full length (1200mm); Coating and wall thickness; Corrosion protection system monitoring; Flange insulating kits (FIKs) at each end of the pipeline to electrically isolate the buried section from the above ground facilities. Physical inspection, Signposting along pipeline to AS2885 requirements; Marker tape; Concrete slabs at road crossings; Thick walled pipe; Natural gas is a clean hydrocarbon lowering the risk of internal corrosion 24/7 monitoring of process conditions (pressures, flow rates) from site control room. Ability to close isolation valves from remote location (site based SCADA and APA Group SCADA). Pipe and equipment installed in open, naturally ventilated area in the open. Accumulation of gases unlikely. Pipeline designed to AS 1170.4 – Structural Design Actions, Part 4: Earthquake Actions in Australia.	YES – part of generic failure database
Release of flammable gas from a generic leak in pipes, heat exchanger tubing, valves and fittings at above ground plant and equipment	Corrosion (external or internal); flange or valve leak; failure to maintain, failure to use in-spec material	Cathodic protection system and clean hydrocarbon – low risk of internal corrosion. Dry gas filters remove corrosive particulates. Routine inspections for ext. corrosion. Below ground piping is coated. Testing of valves. Hazardous area classification. Heater shell designed for tube rupture and safe vent to atmosphere. Automatic and remote plant isolation using a system of shut down valves (refer #1 above). Emergency response plan and procedures. Fire services intervention as required. Pipe and equipment installed in open, naturally ventilated area in the open. Accumulation of gases unlikely.	YES – part of generic failure database

Hazardous Event	Causes and failure modes identified	Proposed Prevention and Mitigation Control Measures	Carried over to the QRA
Release of flammable gas due to failure during design or construction	Design, material and/or construction defects	Competency of contractors. Quality control procedures. Safety factors in Code. Hydrostatic proof testing to the requirements of AS4041 and not exceeding 15.3 MPa(g). NDT of 100% welds. Coating Inspection: 100% holiday detection during coating of the pipe and DCVG survey over the length of the pipeline.	YES – part of generic failure database
Release of flammable gas due to impact	Mechanical damage from external impact e.g. vehicle impact at exposed pipe; dropped object from crane; etc.	Site layout minimises vehicle impacts. Bollards installed near road/equipment boundaries; Designated road access. Permits, inductions, training. Lifting plans and procedures (including requirement to isolate equipment if lift is necessary).	YES – part of generic failure database
Release of gas due to over-pressurisation	Operation / control systems error causes over-pressurisation	Prevention of overpressure (OP) through control logic, trips and automatic closure of isolation valve, pressure safety reliefs. Pipes withstand considerable overpressure by being thick walled, welded (100% weld NDT and hydrotesting for proof).	YES – part of generic failure database

Hazardous Event	Causes and failure modes identified	Proposed Prevention and Mitigation Control Measures	Carried over to the QRA
Release of gas due to propagation from neighbouring plant	Propagation damage from incident at neighbouring facility e.g. projectiles from incident explosive decompression; thermal radiation	Below ground pipeline is protected by 1200mm ground cover and is unlikely to be affected. Above ground piping wall thickness. Separation distances to neighbouring land use, including to the Woodchem MHF facility exceed several hundred meters	YES – part of generic failure database
Explosion / flash within piping	Failure of maintenance activities during shut-down creates ingress of air into natural gas piping; subsequent start-up without adequate purging along with construction debris may create spark	Piping normally operated at a positive pressure, preventing ingress of air - this scenario is theoretically possible during start-up, shut-down and maintenance operations; Prevention of ingress of air is considered throughout the design and operation of the facility. Start-up, shut-down and maintenance procedures. Permits to Work	NO – unlikely threat to neighbouring land use
Malicious damage/ unauthorised operation	Sabotage / vandalism.	Security fence, locked gates, intruder alarms. Security patrols and reviews. Process monitoring (loss of supply) The Borg and APA Group compounds at the custody points are surrounded by security fences and are locked and closed at all times except for when accessed by APA Group/Borg personnel.	YES – part of generic failure database

Hazardous Event	Causes and failure modes identified	Proposed Prevention and Mitigation Control Measures	Carried over to the QRA
Flooding / rain water resulting in process upsets	Heavy rains	Site unlikely to flood. Site drainage/ stormwater management. Buoyance control at the underground pipeline to ensure that it will not be subjected to displacement as a result of short or long term inundation at its full depth of cover or reduced depth of cover. Routine inspection of plant and ground cover.	NO
Lightning strike	Lightning causes failure pipeline / equipment	Plant and equipment designed to AS1768 requirements. Flange insulating kits (FIK) at each end (at transition between above and below ground pipes) to electrically isolate the buried section from the above ground facilities. Requirements for managing the safety risk to people in contact with metallic pipelines is specified in AS/NZS4853. Automatic and remote plant isolation using a system of shut down valves. Fire services intervention as required.	YES – part of generic failure database
Bush / brush fire causes damage to site	Bush / brush fire in the area	The site is gravelled and kept clear. General bush / brush fire mitigating measures by local fire services	YES – part of generic failure database
Differential settlement of pipework and/or equipment	Ground movement, subsidence	No seismic fault line crossings and unstable land have been identified along the pipeline (Ref 5). Safety factors in design (max 0.8 below ground; 0.67 above ground; 0.72 road crossings). Design with adequate foundations. Site technicians would notice support lift-offs. Automatic and remote plant isolation using a system of shut down valves. Emergency response plans. Fire services intervention as required.	YES – part of generic failure database

Hazardous Event	Causes and failure modes identified	Proposed Prevention and Mitigation Control Measures	Carried over to the QRA
Aircraft crash (e.g. patrol helicopter) results in process upsets, potential damage to process / storage facilities resulting in hazardous releases.	Aircraft crash	General aircraft safety regulations make air crashes highly unlikely. Relatively small foot print of development makes it unlikely to be hit even in case of a crash.	YES – part of generic failure database
Electrical hazards on underground pipeline from overhead power line and from adjacent railroad	Earth Potential Rise (EPR) Low Frequency Induction (LFI)	Low to negligible impressed voltage at the pipeline from the distribution power lines in both fault conditions and during continuous (normal) conditions resulting in very low to negligible risk of equipment damage is expected from impressed voltages due to LFI. Negligible risk of hazardous touch and step potentials for humans or livestock during operations or by the public due to no identified exposed contact points in public areas. Construction Management Plan and Pipeline Management Plan (including integrity management plan) and are to specify the use of appropriate safety footwear (e.g. gumboots) in conjunction with equipotential bonding between metallic trench support framework, reinforcing mesh on ground and pipeline while conducting construction and maintenance activities. Also, PCR (polarisation cell replacements) will be installed across the FIKs to discharge the unwanted impressed voltages via earth.	YES – part of generic failure database

4.1.3 Prevention of mechanical failure

The main physical controls and safeguards are:

- The plant and pipeline is designed to stringent Australian Standards as per Table 2 and as described in the Basis of Safety document in Ref 5.
- Non-destructive testing of welds during construction (including acceptance criteria Tier 1; 100% NDT testing of the mainline butt welds, Ref 5);
- Preventative maintenance on all valves and equipment associated with the proposed development, including regular inspection of site equipment;
- Stringent requirements for material and fabrication inspection prior to fabrication of pipe and coating inspection (100% holiday detection and factory and DCVG for full length of pipeline at construction);
- Hydrostatic testing of installation prior to commissioning (100%).

4.1.4 Prevention of third party damage

Prevention of failure from third party intervention through:

- Depth of burial, signposting and marker tape (underground sections of the pipeline);
- Protection using concrete slab at either side of road at road crossings;
- Bollards or other physical protection at above ground sections of the pipe (on-site); correct. Furthermore the pipe is located in an area which has not any site traffic.
- Thick walled and well supported pipe

4.1.5 Prevention of corrosion

Prevention of corrosion through:

- Buried pipeline and pipes are coated; above ground pipeline and pipes are painted;
- Buried pipeline is provided with cathodic protection (with regular inspection and monitoring);
- Flange insulating kits (FIKs) at each end of the pipeline to electrically isolate the buried section from the above ground facilities, including regular FIK inspections;
- Thick wall pipe;
- Natural gas is a clean hydrocarbon lowering the risk of internal corrosion;
- Dry filtering of inlet gas stream removes corrosive particulates;
- Corrosion inhibitor in water circuit at heater.

4.1.6 Prevention of over pressure

Overpressure control through:

- Pressure monitoring with alarms and remote (manually) activated shut-down valves;
- Automatic pressure trip at the inlet of the skid on high-high pressure;
- Heater shell is designed for tube rupture and safe vent to atmosphere.
- Pipe will be designed to withstand considerable overpressure by being thick walled, welded and hydrotested.

4.1.7 Protection from electrical hazards on underground pipeline

Protection from electrical hazards on underground pipeline from overhead power line and from adjacent railroad through as discussed in Section 2.7.

4.1.8 Protection from propagation to and from neighbouring industrial facility

Protection from propagation to/from neighbouring industrial facility, including the neighbouring Woodchem MHF:

- Below ground pipeline is protected by 1200mm ground cover and is unlikely to be affected by a major incident at neighbouring or adjacent facility including fire, explosion. No high pressure gas pipelines buried in the same location.
- Incident at APA Group compound may propagate to adjacent above ground Borg-operated piping. This is prevented through pipe layout, very short pipe, and design to stringent Australian Standard requirements;
- Separation distances to neighbouring land use, including to the Woodchem MHF by several hundred metres. Risk from the proposed development at the neighbouring MHF is negligible.
- Nearest placarded area on the Borg site is 300 metres from the gas treatment site– the risk of propagation from/to this area is highly unlikely.
- The pressure reduction skid and the majority of pipe and equipment is located well outside of the influence zone for potential dust explosion at silos (refer Dangerous Goods Layout Plan in Appendix 3), with the turbine and some above ground piping and valving located within the zone. However, venting from a potential dust explosion is directed upwards and well away from any ground level equipment and the risk at the turbine and associated above ground piping is very low.

4.1.9 Control of ignition sources

Ignition sources are minimised as follows:

- Design of site and equipment as per Hazardous Area requirements;

- Earthing of all equipment to an earth grid;
- All electrical equipment has surge diverters for protection of the control system;
- Permit to Work requirements (including Hot Work permit);
- No smoking or naked flames allowed on site, and no spark ignition vehicles allowed in designated hazardous areas; Smoking in designated areas only.
- Fenced off area with warning signs as per Australian Standards requirements.

4.1.10 Plant isolation

Should a loss of containment or a threat of a leak occur, the pipeline can be isolated as follows:

- Isolation valve can be actuated remotely (manually) from the Control Room to isolate the facility from the pipeline to which it is connected. It is also possible for the APA Group to isolate the pipeline at the APA Group compound from their SCADA.
- Automatic Emergency Shut Down at the emergency shutdown valve (ESD) located at Borg's compound adjacent to the connection to the APA Group custody point in case of the following:
    - (high high) pressure trip at the inlet of the pressure reduction skid;
    - high differential pressure across the filter (suggesting a blockage of the filter);
    - burst disk activation on the heat exchanger (indicating gas leaking from tube of heat exchanger into the shell);
    - (low low) gas temperature exiting heat exchanger;

- activation of any of the E-Stops mounted on the main and control skids and/or additional E-stop input for use by Borg for downstream/other issues. The valve can also be actuated remotely from the Control Room. The ESD is to be installed to activate in a fail safe manner.

4.1.11 Prevention of flooding risk

Flooding in this area is regarded as a low risk scenario from a land use planning point of view.

Site drainage and stormwater management applies, as does routine inspection of plant and ground cover and inspection after unusual event.

Buoyance control at the underground pipeline to ensure it will not be subjected to displacement as a result of short or long term inundation at its full depth of cover or reduced depth of cover.

4.1.12 Road transportation risk management

Not applicable for the proposed development.

4.1.13 Procedural / software controls

The following procedural and software controls are in place:

- The pipeline and associated equipment are protected from high and low temperatures and high pressure by safety shutdown valves;
- The pipeline and associated equipment are protected from high pressure by PSVs and bursting disk;
- Hazardous area compliance – the facilities shall be classified for explosive gas in accordance with AS/NZ 60079.10 in accordance with AS61241.10 \;
- Instrumentation shall be NZ/Ex or IEC Ex approved for installation within the particular hazardous area defined for its location. A hazardous area

dossier shall be completed in accordance with the requirements as AS3000 – *Electrical Wiring Rules.*

4.2 CONSEQUENCES AND EFFECTS ANALYSIS

A set of representative incident scenarios was determined, based on the current design of the proposed new development, applicable codes and standards, and engineering practice.

These scenarios include a range of the hazardous events that have some potential to occur. In general, these events can be divided into the following categories:

- Moderate releases (punctures), characterised by a hole equivalent to 10% of the cross sectional surface area of the pipe diameter;
- Large releases (ruptures), characterised by a hole with a diameter equal to the pipe diameter or, for vessels and certain process equipment, a hole with a diameter equal to the diameter of the largest attached pipe;
- Minor failure of a vessel, characterised by a hole of 10mm equivalent diameter;
- Massive failure of a vessel, characterised by a release over 10 minutes of the full contents of the vessel;
- Catastrophic failure of a vessel, characterised by an instantaneous release of its contents.

Consequence analysis was undertaken using the TNO (the Netherlands Organisation for Applied Scientific Research) consequence modelling software program *Effects®* (version 8.0). The models within *Effects®* are well known and are fully documented in the TNO Yellow Book (Ref 8). The TNO tools are internationally recognised by industry and government authorities.

Essentially, an appropriate release rate equation is selected based on the release situation and initial state of the material. The atmospheric dispersion model for lighter-than-air releases is used to model dispersion behaviour for natural gas.

Further detail is provided in Appendix 1.

4.3 LIKELIHOOD ANALYSIS

Leak data for below ground pipeline is sourced from the UK Health and Safety Executive (UK HSE, Ref 10) and ignition probabilities are based on the OGP (Ref 12).

Leak data for above ground pipes and equipment and ignition probabilities are based on the TNO Purple Book (Ref 9).

A summary of major assumptions is provided in Appendix 2.

4.4 RISK ANALYSIS

4.4.1 Individual Risk of Fatality

Individual fatality risk contours for the proposed development is shown in Figure 5. The maximum risk at the pipeline is 0.3 pmpy, i.e. less that the lowest risk criterion of 0.5 pmpy specified by the NSW DP&E for sensitive development, and therefore not shown on the figure below.

Figure 4 – Individual fatality risk contours

Note: The risk at the connecting pipeline is less than the HIPAP4 criteria of 0.5x 10^{-6} per year specified above and therefore not shown in Figure 4.

The maximum incremental individual risk of fatality from the proposed development at the western boundary of the site is 0.8 pmpy. The maximum incremental risk from the proposed development at the northern boundary of the site is 1.8 pmpy. The maximum risk criteria at neighbouring land use is not exceeded.

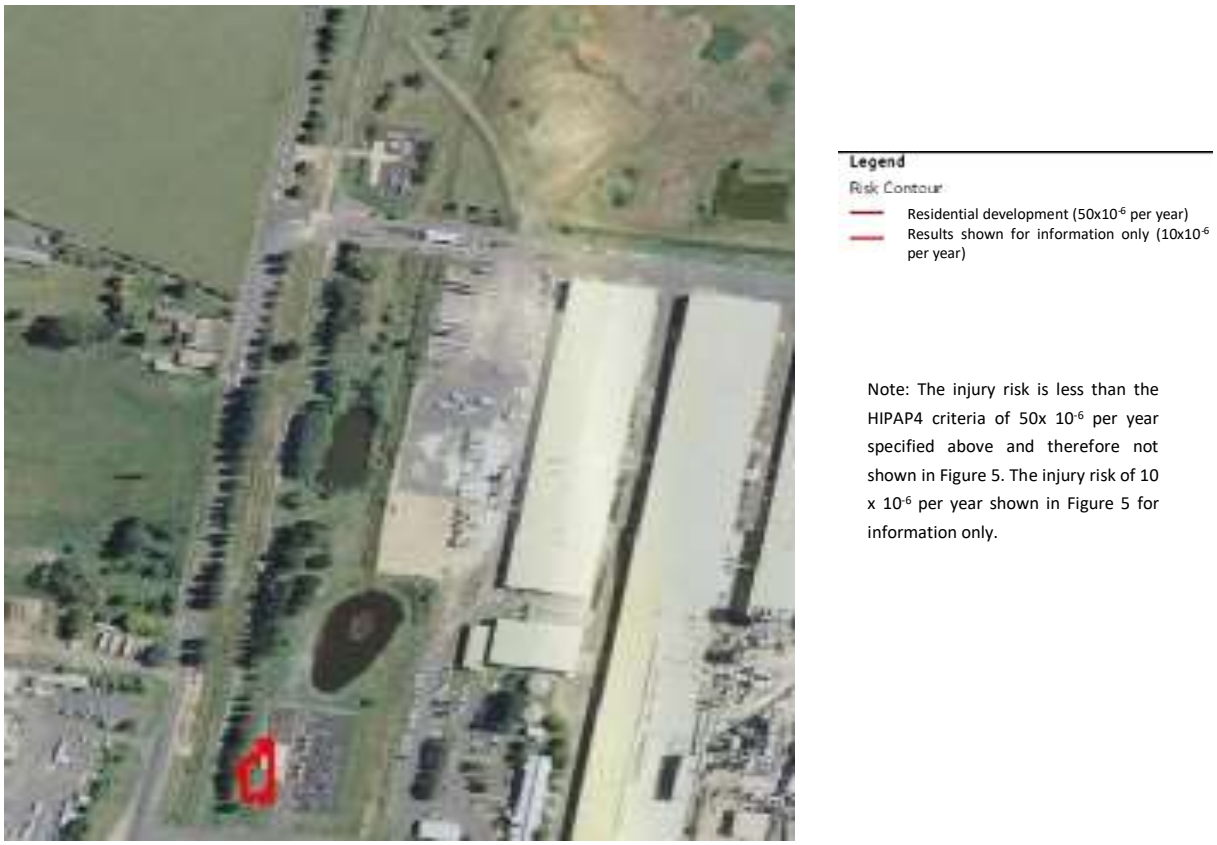
There is negligible impact on the eastern and southern boundary from this development. There is negligible impact from the proposed development at the nearest residential at around 600 metres (m) south of the site.

4.4.2 Risk of injury

Injury risk contours for the proposed development is shown in

Figure 5. The maximum injury risk at the proposed development is 10 pmpy, shown in the figure above for information only. The risk criterion of 50 pmpy is never reached for this development.

Figure 5 – Injury risk contours



Note: The injury risk is less than the HIPAP4 criteria of 50x 10^{-6} per year specified above and therefore not shown in Figure 5. The injury risk of 10 x 10^{-6} per year shown in Figure 5 for information only.

4.4.3 Risk of propagation

Propagation risk contours for the proposed development is shown in Figure 6. The maximum propagation risk at the proposed development is 1.7 pmpy, shown

in the figure above for information only. The risk of propagation at the nearest industrial development (APA Group connection) is 0.8 pmpy. The risk criterion of 50 pmpy is never reached for this development.

Figure 6 – Propagation risk contours

Note: The propagation risk is less than the HIPAP4 criteria of 50x 10^{-6} per year specified above and therefore not shown in Figure 6. The propagation risk of 1 x 10^{-6} per year shown in Figure 6 for information only.

4.4.4 Societal risk

There is negligible increase in the societal risk levels from this development.

5 Summary of Findings

5.1 Fires

- Incidents associated with high pressure natural gas pipelines are extremely rare in Australia due to the stringent requirements in the management of risk, as per the Pipelines Act and associated Regulations and Standard.

- While rare, the predominant risk from the HP pipeline and the associated pipes, vessels and connections is associated with a leak and a jet fire;
- Major fire scenarios at the proposed development have the potential to affect the site based facilities;
- Major fire scenarios are unlikely to affect the neighbouring land use, for example:
    - The individual fatality risk at the closest residential development is 0.08 pmpy which is well below the risk criterion for residential areas of 1 pmpy. There are no sensitive, commercial or active open space developments located within these applicable risk contours. The individual fatality risk at the closest industrial area, the APA Group compound, is 4.3 pmpy which is well below the risk criterion for industrial areas of 50 pmpy.
    - There is negligible injury risk at the closest residential area, well below the injury risk criterion for residential areas of 50 pmpy. The maximum injury risk associated with the proposed development is 10 pmpy.
    - The propagation risk at the closest industrial area, the APA Group compound, is 0.8 pmpy which is well below the risk criterion for industrial areas of 50 pmpy. There is negligible propagation risk from the proposed development to the neighbouring Woodchem MHF.

5.2 VAPOUR CLOUD EXPLOSIONS

Vapour cloud explosions are considered extremely rare events for the types of facility, materials and quantities associated with the proposed development. The computer modelling carried out for the worst case scenarios under most of the worst case credible wind weather conditions found very little flammable vapours in the vapour cloud and a vapour cloud explosion is highly unlikely.

Some extreme scenarios may result in vapour clouds that may explode if an ignition source was present, have been included in this QRA.

5.3 ADHERENCE TO RISK CRITERIA

The NSW DP&E uses a *risk-based* methodology as the basis of a framework for locational guidance for developments of potentially hazardous industry.

In a risk based approach the likelihoods of major incidents are combined with the potential consequences to determine the risk of exposure.

The resulting risk is compared with the risk criteria defined by the NSW DP&E (Ref 2).

Even though the proposed development is located close to the western and northern site boundary, its contribution to the total risk in the area is very low. This is in line with current understanding of the risk associated with natural gas pipelines which travel through towns, cities and open fields and paddocks.

A summary is provided in Table 13 of the risk results compared against the risk criteria for land use planning.

Table 13 – Adherence to Risk Criteria

Risk criteria	Results	Impact on development
Sensitive development criterion - 0.5 pmpy risk	Risk level contained within the site boundary with a very small excursion near the APA Group connection. No sensitive development in this location.	Development is acceptable in this location
Residential development criterion - 1 pmpy risk	Risk level contained within the site boundary. No residential development in this location.	Development is acceptable in this location
Commercial development criterion - 5 pmpy risk	Risk level never reached for this development	Development is acceptable in this location

Risk criteria	Results	Impact on development
Active open space criterion - 10 pmpy risk	Risk level never reached for this development	Development is acceptable in this location
Neighbouring industrial development criterion - 50 pmpy risk	Risk level never reached for this development	Development is acceptable in this location
Injury risk - 50 pmpy	The incremental injury risk at any location of the development is calculated to be about 50 pmpy. The injury risk at the nearest residential development is negligible. The risk of injury at the development is below the maximum risk criterion.	Development is acceptable in this location
Propagation risk - 50 pmpy	The incremental injury risk at any location of the development is calculated to be about 1.7 pmpy. The injury risk at the nearest neighbouring industrial development is 0.8 pmpy. The risk of propagation at the development is below the maximum risk criterion.	Development is acceptable in this location
Societal risk	Negligible impact on the overall societal risk the area	Development is acceptable in this location
Risk of propagation to and from the neighbouring industrial area including Borg facility and adjacent Woodchem MHF	The risk of propagation from the development on the neighbouring MHF is negligible. The below ground pipeline is protected by a 1200mm ground cover, with	Development is acceptable in this location

Risk criteria	Results	Impact on development
	no other adjacent high pressure pipeline. The separation distance of 300 metres from the nearest placarded chemical storage and the separation distance to locations with dust explosion hazard combined with explosion venting design (well above ground and pressure and dust relieved 45^{o} upwards) makes the risk of propagation to/from the development highly unlikely. The proposed development does not significantly impact the overall risk in this area.	

6 FINAL CONCLUSION AND RECOMMENDATION

The levels of risks to public safety associated with the proposed development comply with the most stringent accepted safety and risk criteria for land use planning as per the NSW DP&E guidelines in their HIPAP4 and HIPAP6 (Refs 1, 2).

In NSW, land use safety is determined based on risk, and in risk terms the proposed development is acceptable in the proposed location because the likelihoods of major incidents associated with natural gas pipeline are very low.

The incremental increase in societal risk in the area associated with the proposed development is negligible and is well within the tolerable zone for the full range.

Recommendations:

1. The assumptions listed in Section 1.3 in this report form the basis for the present risk study and must be implemented for the results to be valid.

2. It is recommended that Borg investigate providing an automatic / remote activated closure at the inlet valve at the APA Group tie-in point on detection of a major incident on downstream pipe and equipment. .

3. It is further recommended that a pipeline management plan (PMP) be developed, which includes the requirements for integrity management for the proposed pipeline and associated valve stations and gas treatment skid (refer AS 2885 for Pipeline Management Plan and Integrity Management Plan requirements).

Appendix 1

Consequence Calculations

Preliminary Hazard Analysis of the Natural Gas Pipeline

and Turbine at Borg Timber Panel Manufacturing Facility

in Oberon NSW

Appendix 1 – Consequence Calculations

A1.1 Summary of the major assumptions

A summary of the major assumptions made in the risk analysis relating to the consequence assessment is provided in Table A1.1 below:

Table A1.1 – Summary, Major Assumptions for the Consequence Assessment

Item	Assumptions, data used and reference
Conditions inside the pipeline	As per Table 1 in Section 2.2. For high pressure pipeline: • Pressure: 9.93MPa(g) • Temperature: 10°C
Release rates and duration	Release rates assumed to be constant for all hole sizes up until their shut-down. Duration of a release of flammable liquid is assumed to last for 1800 seconds at which point they are assumed to be shut-down (e.g. in a fire scenario). Releases were modelled at the MAOP.
Hole sizes for loss of containment scenarios of below ground pipeline – equivalent diameter	As per UK HSE data, Ref 10: • Pinhole: ≤25mm equivalent diameter, modelled as 25mm • Small hole: > 25 mm to ≤ 75 mm, modelled as 50mm • Large hole: > 75 mm to ≤ 110 mm, modelled as 100mm • Rupture: modelled as 356mm; full pumping rate plus backflow from downstream pipe
Hole sizes for loss of containment scenarios of above ground pipes and equipment	As per TNO (Ref 11) for pipes 75mm to 150mm NB: *Pipes* • Small hole: from ≤25mm equivalent diameter to 10% surface rea of cross section of pipe, up to max 50mm • Rupture: from > 50 mm to ruptures, modelled as full cross sectional area of pipe *Pressure vessels (process)* • Continuous release of the complete inventory in 10 min at a constant rate of release • Continuous release from a hole with an effective diameter of 10 mm • Instantaneous release of the complete inventory *Heat exchanger (hazardous substance inside tubes; design pressure outer shell is less than pressure of hazardous substance and protected by pressure relief)* • Rupture, 10 pipes (taken as rupture all pipes)

Item	Assumptions, data used and reference
	• Rupture, 1 pipe • Leak - outflow from a leak with an effective diameter of 10% of the nominal diameter, with a maximum of 50 mm *PRV failure:* pressure relief opens in error
Release model used (*Effects®*)	Gas release from long pipeline (Wilson model), Ref 8
Trips and alarms - instrumented	Base case: No credit taken for any automatic valve closure of shutdown valve in case of loss of containment. Risk reduced case: Risk reduction assessed in case of automatic closure of shutdown valve on detection of e.g. pressure dip. Only assumed to pick up rupture scenarios as leak may not result in sufficient pressure dip and gas detectors do not tend to be reliable out in the open
Orientation of gas jet	50% vertical; 50% horizontal (PRV opens: 100% vertical)
Outcome of ignition from puncture and rupture events and possible outcome from release	Size hole / Possible outcome of ignition: Jet fire / Flash fire / VCE Pinhole: X / Not credible Small hole: X / X / X Large hole: X / X / X Rupture: X / X / X
Consequence criteria, people and property	NSW DP&E HIPAP4 and 6 (Refs 1 and 2) and TNO Purple Book (Ref 11)
Escape and shelter	No escape assumed by personnel / persons on site in case of a major hazardous incident. Buildings are not assumed to provide any shelter from heat radiation or explosion overpressure.

Further discussion is provided below:

A1.2 Hole sizes and release rate

Representative hole diameters are selected to align with the leak frequency data (UK HSE for underground pipelines and TNO Purple Book for above ground pipes, vessels and heat exchanger). The representative hole diameter/s in each hole size category are selected based on a review of the available historical data (Refer to Section 4.2).

Release rates are calculated using TNO's software tool Effect® incorporating data relating to the material, pipeline diameter, hole size, overpressure, and temperature of the material.

A1.3 Release orientation

A release from a pipe or vessel may occur in any direction, including down.

The direction of a releases depend on the failure mode, with releases from the top of the pipelines being the predominant mode of release in cases of third party damage. As a conservative assumption, the direction of failures is taken as 100% horizontal.

The software tools used for this QRA (Effects® and Riskcurves®) do not permit entry of a release height of less than 0 metres which would be the case for underground pipelines. Hence, the release from the pipeline is assumed to occur at ground level rather than at the actual depth.

A1.4 Duration of the release

Harmful effects from fires and explosions would occur very quickly if they arise, and steady-state is set in rapidly, within minutes of the start of the release.

Hence, the duration of a release of flammable material is not as critical as it would be if there were toxic materials in the pipeline.

The duration of the release is set at the maximum time of ½ hour (1,800 seconds) as per the limitations of the software. Any longer time would not increase the risk as a steady state release and/or fire scenario would have been established at this time.

Release rates are assumed to remain constant for all hole sizes up until their shut-down.

A1.5 Jet Fire

Ignition of a pressurised release of flammable gas burn as a jet fire.

The potential for fatality due to exposure to heat radiation from a jet fire (including direct exposure to the burning liquid) was included in the QRA.

Heat radiation from jet fires are calculated using TNO's software Effects® (Yellow Book, Ref 8).

A1.6 Dispersion

The mass in a flammable vapour cloud relates to the amount of gas in the cloud that is at a concentration higher than the Lower Explosive Limit (LEL). This depends on a number of factors, including wind speed and the roughness of the ground surface under the cloud.

The TNO software model (Effects®) uses *roughness length* which is an artificial length-scale relating wind speed over the surface and surface roughness. A set of *roughness length descriptions* in the model enables the user to determine the appropriate roughness length for the location under analysis.

The roughness description which most closely describes the area where the site is located is *Low crops; occasional large obstacles.*

Wind weather data from Borg's internal meteorological station, period 1/7/17 to 21/6/2019.

A1.7 Flash Fire

Combustion of an unconfined vapour cloud of flammable gas will usually progress at low velocities and will not generate a significant explosion overpressure, and a delayed ignition of the vapour cloud will result in a flash fire, which has the potential to cause injuries or fatalities for individuals within the ignited cloud.

A flash fire is included in the QRA as a potential outcome for the larger releases.

The potential for fatality due to direct exposure to a flash fire was included in the QRA.

Dispersion of flammable gas is calculated using TNO's software Effects® (Yellow Book Chapter 5.13 *Concentration*, Ref 8).

A1.8 Vapour cloud explosion

A high degree of confinement and congestion is required to produce high flame speeds (i.e. > 100 m/s) in a flammable gas cloud.

If a leak of flammable gas enters a confined space, then a confined explosion may occur if it is ignited.

This is only possible for the largest of releases.

Overpressure effects from VCEs are calculated using TNO's software Effects® (Yellow Book CPR14E 3rd Edition - Chapter 5: Vapour cloud explosions, Ref 8) using the Multi Energy Model and setting the degree of confinement to 6.

The potential for fatality due to exposure to the overpressure from an explosion was included in the QRA.

A1.9 Ingress into underground locations

Due to the buoyancy of the gas, this is not considered a credible outcome from a release.

A1.10 Parts count table and loss of containment scenarios

No	EQUIPMENT	EQUIPMENT	LENGTH metres	TRIP	PRESSURE (BAR)	DIAM PIPE (MM)	DIAM HOLE (MM)	TNO EQ. DIAM (MM)	DURATION INITIAL RELEASE (SECONDS)
1	Outlet from APA compound into Borg receiving station	Above-gr	12	NO	9.93E+01	100	100	100	1800
2			12	NO	9.93E+01	100	32	32	1800
3		Below-gr	512	NO	9.93E+01	100	100	100	1800
4			512	NO	9.93E+01	100	100	100	1800
5			512	NO	9.93E+01	100	50	50	1800
6			512	NO	9.93E+01	100	25	25	1800
7	Filter FIL-001 to Heater HEX-0201	Above-gr	0.6	NO	9.93E+01	50	50	50	1800
8			0.6	NO	9.93E+01	50	16	16	1800
9	Outlet heater to high pressure regulators PRV-0301/0302	Above-gr	1.2	NO	9.93E+01	50	50	50	1800
10			1.2	NO	9.93E+01	50	16	16	1800

No	EQUIPMENT	EQUIPMENT	LENGTH metres	TRIP	PRESSURE (BAR)	DIAM PIPE (MM)	DIAM HOLE (MM)	TNO EQ. DIAM (MM)	DURATION INITIAL RELEASE (SECONDS)
11	Outlet from P-302 to turbine	Below-gr	58	NO	3.45E+01	50[2]	50	50	1800
12			58	NO	3.45E+01	50[2]	50	50	1800
13			58	NO	3.45E+01	50[2]	50	50	1800
14			58	NO	3.45E+01	50[2]	25	25	1800
15	Outlet from P-302 to turbine	Above-gr	12	NO	3.45E+01	50[2]	50	50	1800
16			12	NO	3.45E+01	50[2]	16	16	1800
17	New filter FIL-001 (Vertical Coalescing Filter)	Above-gr	-	NO	9.93E+01	-	300	300	1800
18			-	NO	9.93E+01	-	10	10	1800
19			-	NO	9.93E+01	-	10	10	1800
20	New heater HEX-0201 (Vertical Heat Exchanger)	Above-gr	-	NO	9.93E+01	-	300	300	1800
21			-	NO	9.93E+01	-	10	10	1800
22			-	NO	9.93E+01	-	10	10	1800
23			-	NO	9.93E+01	-	10	10	1800
24	Pressure relief valve (PRV-0401)	Above-gr	-	NO	3.45E+01	-	50	50	1800

A1.11 Results of consequence calculations (Effects®)

No	INITIAL LEAK RATE (KG/S) EFFECT®	CLOUD		HEAT RADIATION, JET FIRE (HORIZONTAL)			DIMENSIONS OF FLAMMABLE CLOUD, D4		DIMENSIONS OF FLAMMABLE CLOUD, F2	
		D4 (KG)	F2 (KG)	22 kW/m²	12.5 kW/m²	4.7 kW/m²	Length (METRES)	Width (METRES)	Length (METRES)	Width (METRES)
1	81.09	3851	35179	30	35	40	318.6	19.9	1483.2	38.3
2	1.25	4.8	38	26	32	35	26.0	2.1	104.4	3.5
3	81.09	3851	35179	30	35	40	318.6	19.9	1483.2	38.3
4	81.09	3851	35179	30	35	40	318.6	19.9	1483.2	38.3
5	1.71	8	64	28	34	38	31.3	2.5	127.2	4.2
6	0.93	3	24	22	29	34	21.7	1.8	86.4	3.0
7	19.98	409	3560	14.5	15.0	17.0	137.3	9.3	608.4	17.2
8	0.26	0.4	2.9	14.0	14.5	16.5	10.0	0.9	38.0	1.4
9	19.98	409	3560	9.0	9.5	10.5	137.3	9.3	608.4	17.2
10	0.26	0.4	2.9	9.0	9.5	10.5	10.0	0.9	38.0	1.4
11	6.94	75	632	9.0	9.5	10.5	72.8	5.3	310.5	9.4

[2] The pipe itself is 100mm diam but the connections are 50mm, restricting the maximum flow from a leak

No	INITIAL LEAK RATE (KG/S) EFFECT®	CLOUD		HEAT RADIATION, JET FIRE (HORIZONTAL)			DIMENSIONS OF FLAMMABLE CLOUD, D4		DIMENSIONS OF FLAMMABLE CLOUD, F2	
		D4 (KG)	F2 (KG)	22 kW/m²	12.5 kW/m²	4.7 kW/m²	Length (METRES)	Width (METRES)	Length (METRES)	Width (METRES)
12	6.94	75	632	9.0	9.5	10.5	72.8	5.3	310.5	9.4
13	6.94	75	632	9.0	9.5	10.5	72.8	5.3	310.5	9.4
14	0.14	0.1	1.0	9.0	9.5	10.5	6.9	0.6	25.7	1.0
15	6.94	75	632	9.0	9.5	10.5	72.8	5.3	310.5	9.4
16	0.114	0.1	0.8	9.0	9.5	10.5	6.2	0.6	22.7	0.9
17	1664.80	1537	1535	-	-	-	69.6	24.8	63.8	19.9
18	0.67	2	14	14.5	15.0	17.0	17.8	1.5	70.2	2.5
19	0.67	2	14	14.5	15.0	17.0	17.8	1.5	70.2	2.5
20	1664.80	1537	1535				69.6	24.8	63.8	22.2
21	0.67	2	14	14.5	15.0	17.0	17.8	1.5	70.2	2.5
22	0.67	2	14	14.5	15.0	17.0	17.8	1.5	70.2	2.5
23	0.67	2	14	14.5	15.0	17.0	17.8	1.5	70.2	2.5
24	10.44	145	1232	-	-	-	93.0	6.6	402.9	11.9

Appendix 2

Likelihood Calculation

Preliminary Hazard Analysis of the Natural Gas Pipeline and Turbine at Borg Timber Panel Manufacturing Facility in Oberon NSW

Appendix 2 – Likelihood Calculations

A2.1 Summary of major assumptions

A summary of major assumptions made for the likelihood assessment is provided in Table A2.1 below.

Table A2.1 – Major Assumptions for the Likelihood Assessment

Item	Assumptions & Data		
Leak data for below ground pipeline	UK HSE (UK HSE, Ref 10):		
	Size hole		Leak Frequency (/ km / yr)
	Pinhole		5.40E-05
	Small Hole		2.70E-05
	Large Hole		2.20E-05
	Rupture		8.80E-06
Leak data for above ground pipes and equipment	TNO Purple Book (Ref 11):		
	Pipe diam (mm)	Size hole	Leak Frequency (/ m / yr)
	<75	Leak (10% up to 50mm)	5.0E-6
		Rupture	1.0E-6
	75 – 150	Leak (10% up to 50mm)	2.0E-6
		Rupture	0.3E-6
	>150	Leak (10% up to 50mm)	0.5E-6
		Rupture	0.1E-6
	Note: In the TNO methodology, failures of flanges are assumed to be included in the failure frequency of the pipeline; for that reason, the minimum length of a pipe is set at 10 metres.		
	Pressure vessel		Leak Frequency (/ yr)
	Instantaneous release of the complete inventory		0.5E-6
	Continuous release of the complete inventory in 10 min at a constant rate of release		0.5E-6
	Continuous release from a hole with an effective diameter of 10 mm		10.0E-6

Item	Assumptions & Data		
Continued - Leak data for above ground pipes and equipment	Heat exchanger (hazardous subst. inside tubes; shell requires pressure relief)		Leak Frequency (/ yr)
	Instantaneous release of the complete inventory		1.0E-5
	Continuous release of the complete inventory in 10 min at a constant rate of release		10.0E-6
	Continuous release from a hole with an effective diameter of 10 mm		10,000E-6
	PRV		Leak Frequency (/ yr)
	Fully opens in error		20E-6
Ignition probabilities for below ground pipelines	Based on OGP (Ref 12), Scenario 1		
	Release Rate, continuous source (kg/s)		Total ignition
	≤10		0.0198
	≥10-20		0.0311
	≥20-50		0.0563
	>50		0.0700
Split between immediate versus delayed ignition	The total ignition probability was split 50:50 for immediate ignition : delayed ignition		
Ignition probabilities for above ground facility – immediate ignition	Based on TNO's Purple Book (Ref 11):		
	Release Rate, continuous source (kg/s)	Mass released instantaneous source (kg)	On-plant low reactivity, immediate ignition
	≤10	<1,000	0.02
	≥10-100	1,000-10,000	0.04
	≥100	10,000	0.09
Delayed ignition	Size release		[-]
	Small vapour cloud		0.1
	Medium vapour cloud		0.22
	Massive vapour cloud		0.33
	Based TNO Purple Book (Ref 11), defining potential ignition sources and then applying a factor to account for the effectiveness (and strength) of the ignition source		
Split between flash vs vapour cloud explosion (VCE) in case of delayed ignition	Assumes a split of 60 : 40 for flash fire : VCE (TNO, Ref 11)		
Risk reduction from concrete block over pipeline and marker tape	90%		

Item	Assumptions & Data
Probability of damage from one buried pipeline to another	Not considered as a credible scenario in this QRA with no other high pressure pipeline in the vicinity

Further discussion below.

A2.2 Leak frequency

Underground pipeline

The database from UK HSE (Ref 10) was used as the most up-to-date and comprehensive data relevant to this QRA. It includes data in period between 1950 to 2010, but only the most recent 22 years of historical incident data was analysed in this QRA to ensure a consistent pipeline population and to remove the older incident data, which may not be as representative of current practice. Incident data for pipelines carrying products at elevated temperatures was excluded from the analysis.

It includes the data for four hole size categories (pinhole, small hole, large hole and rupture), four failure mode categories (mechanical failure, corrosion, ground movement / other and third party activity), and in some cases for varying pipe diameters and / or wall thicknesses. Material specific leak frequency data is also reported.

Note that the leak frequency data reported in the UK HSE database and adopted in this QRA (analysed as above), is slightly more conservative than the NSW performance data (1.1E-4 per km per year vz 0.82E-4 per km per year).

On-site data

The frequency of each postulated equipment failure was determined using the data in Section 4.3.

The frequencies used for fixed plant are those in the database documented in the *Purple Book* by the Dutch TNO (Ref 11) and which is a worldwide recognised source of reference for QRAs of potentially hazardous industry.

Parts count

The part count and including operating conditions, are included in Appendix 1 (paragraph A1.10).

A2.3 Ignition Probability

Underground pipeline

The 2010 *Risk Assessment Data Directory* by IOGP on *Ignition probabilities,* was used to determine the probability of an ignition following a release of flammable gas. This is the most recent publication of ignition probabilities, with data sourced from the mathematical functions drawn from the UKOOA look-up correlations (Ref 12). It refers to the *Purple Book* by TNO (Ref 11) and the publication entitled *Classification of Hazardous Locations* by Cox, Lees and Ang (Ref 13). As such it appears to be particularly robust and most applicable to this QRA.

Scenario a, applicable for onshore cross-country pipelines running through industrial or urban areas, was used.

The probability increases as a function of the size of the release. For the smallest releases the ignition probability may be less than 4%, increasing to 13% for large releases.

The values presented relate to *total* ignition probability, which can be considered as the sum of the probabilities of immediate ignition and delayed ignition, where:

- Immediate ignition can be considered as the situation where the fluid ignites immediately on release through auto-ignition or because the incident which causes the release also provided an ignition source.
- Delayed ignition is the result of the build-up of a flammable vapour cloud which is ignited by a source remote from the release point. It is assumed to result in flash fires, and also to burn back to the source of the leak resulting in a jet fire and/or a pool fire.

The probability of the delayed ignition of a formed flammable vapour cloud, for on-plant incidents is split 50 : 50.

The outcome from a delayed ignition may be a flash fire, with very little overpressure effects, or a VCE, with the predominant effect being overpressure. The split between a flash fire and a VCE depends a number of factors, including the reactivity of the material (natural gas is considered to be *low reactivity*, Ref 11), the amount of vapours in the cloud, and the degree of confinement. The probability of an explosion is virtually zero for a natural gas leak out in the open. However, as a conservative assumption and as per the methodology in the TNO Purple Book, the probability of an explosion is taken as 40% of the total delayed ignition case, with flash fires accounting for the other 60% of cases.

The results of the likelihood assessment are presented below, listing the leak frequencies and the frequency of the resulting flammable events for each one of the scenarios included in the QRA.

A2.4 Likelihood calculations

No	EQUIPMENT	EQUIPMENT	LEAK FREQ. (/YR)	JET FIRE FREQ. (/YR)	FLASH FREQ. (/YR)	EXPLOSION FREQ. (/YR)	JET FIRE FREQ. (/KM/YR)	FLASH FREQ. (/KM/YR)	EXPLOSION FREQ. (/KM/YR)
1	Outlet from APA compound into Borg receiving station	Above-gr	3.60E-06	3.24E-07	7.13E-07	4.75E-07			
2			2.40E-05	4.80E-07	2.40E-06	0.00E+00			
3		Below-gr	4.51E-06				3.08E-07	1.85E-07	1.23E-07
4			1.13E-05				7.70E-07	4.62E-07	3.08E-07
5			1.38E-05				2.67E-07	2.67E-07	0.00E+00
6			2.76E-05				5.35E-07	5.35E-07	0.00E+00
7	Filter FIL-001 to Heater HEX-0201	Above-gr	6.00E-07	2.40E-08	7.92E-08	5.28E-08			
8			3.00E-06	6.00E-08	3.00E-07	0.00E+00			
9	Outlet heater to high pressure regulators PRV-0301/0302	Above-gr	1.20E-06	4.80E-08	1.58E-07	1.06E-07			
10			6.00E-06	1.20E-07	6.00E-07	0.00E+00			
11	Outlet from P-302 to turbine	Below-gr	5.10E-07				3.08E-07	1.85E-07	1.23E-07
12			1.28E-06				7.70E-07	4.62E-07	3.08E-07
13			1.57E-06				2.67E-07	2.67E-07	3.78E-07
14			3.13E-06				5.35E-07	5.35E-07	0.00E+00

No	EQUIPMENT	EQUIPMENT	LEAK FREQ. (/YR)	JET FIRE FREQ. (/YR)	FLASH FREQ. (/YR)	EXPLOSION FREQ. (/YR)	JET FIRE FREQ. (/KM/YR)	FLASH FREQ. (/KM/YR)	EXPLOSION FREQ. (/KM/YR)
15	Outlet from P-302 to turbine	Above-gr	1.20E-05	4.80E-07	1.58E-06	1.06E-06	2.97E-09	2.97E-09	0.00E+00
16			6.00E-05	1.20E-06	6.00E-06	0.00E+00	1.98E-08	1.98E-08	0.00E+00
17	New filter FIL-001 (Vertical Coalescing Filter)	Above-gr	5.00E-06	2.00E-07	6.60E-07	4.40E-07			
18			5.00E-06	1.00E-07	5.00E-07	0.00E+00			
19			1.00E-04	2.00E-06	1.00E-05	0.00E+00			
20	New heater HEX-0201 (Vertical Heat Exchanger)	Above-gr	1.00E-05	4.00E-07	1.32E-06	8.80E-07			
21			1.00E-06	2.00E-08	1.00E-07	0.00E+00			
22			1.00E-05						
23			1.00E-02						
24	Pressure relief valve (PRV-0401)	Above-gr	2.00E-05						

Appendix 3

Dangerous Goods Layout Plan

Preliminary Hazard Analysis of the Natural Gas Pipeline and Turbine at Borg Timber Panel Manufacturing Facility in Oberon NSW

Appendix 3 – Dangerous Goods Layout Plan

7 REFERENCES

1 State of New South Wales through the Department of Planning, Hazardous Industry Planning Advisory Paper No 6: *Hazard analysis*, January 2011

2 State of New South Wales through the Department of Planning, Hazardous Industry Planning Advisory Paper No. 4: *Risk Criteria for Land Use Planning*; NSW Government, Sydney, 2011

3 Australian Standard AS2885.1, *Pipelines – Gas and liquid petroleum*, Part 1: Design and Construction, Standards Australia.

4 AS2885-2012 *Pipelines – Gas and liquid petroleum*, Standards Australia, Suite of Codes

5 Basis of Design, HP Gas Connection Project, Document No. 2079-02-EM-BOD-001, OSD Pty Ltd, 11 September 2018

6 Safety Management Study Report, 2079-EL-REP-001

7 *Fracture Control Plan,* 2079-02-EL-PLN-001

8 Yellow Book, *Methods for the Calculation of the Physical Effects of the Escape of Dangerous Material*, CPR 14E, Parts 1& 2, Committee for the Prevention of Disasters, TNO, 3rd edition 2n revised printout 2005

9 Purple Book, Guidelines for quantitative risk assessment, Committee for the Prevention of Disasters, TNO (Ministerie van VROM Ministerie van Verkeer en Waterstaat), December 2005

10 Health and Safety Laboratory. *Update of pipeline failure rates for land use planning assessments*. UK Health and Safety Executive, 2015. RR1035

11 Purple Book, Guidelines for quantitative risk assessment, Committee for the Prevention of Disasters, TNO (Ministerie van VROM Ministerie van Verkeer en Waterstaat), December 2005

12 *Ignition Probability Review, Model Development and Look-Up Correlations*, Research Report published by the Energy Institute, January 2006.

13 Cox, Lees and Ang, *Classification of Hazardous Locations*, Rugby: Institution of Chemical Engineers, 1991

Appendix B – Global Acoustics S4.55 Modifications Assessment

Global Acoustics

Noise and Vibration Analysis and Solutions

19 March 2019

Borg Manufacturing Pty Ltd
2 Wella Way
Somersby NSW 2250
Attention: Victor Bendevski

Dear Victor,

Regarding: Borg Panels Oberon, S96(1A) modification to Development Consent SSD 7016

1 INTRODUCTION

On 29 May 2017 Development Consent SSD 7016 was granted by the Minister for Planning to construct a Particle Board manufacturing facility, modify the existing Medium Density Fibreboard (MDF) manufacturing facility and undertake general site works (the Project) at the existing Borg Panels timber manufacturing facility located on 124 Lowes Mount Road, Oberon.

On 20 November 2018, a modification to the development consent was approved (Modification 1) to incorporate design changes to the approved particle board facility and alterations and additions to other existing structures at the facility.

Borg are preparing another Statement of Environmental Effects (SEE) for a second modification to the development consent (Modification 2) to incorporate further design changes to the approved particle board facility, alterations and additions to other existing structures at the facility, and, addition of new plant.

This letter provides acoustics advice regarding proposed site modifications associated with Modification 2.

Key elements of Modification 2 that relate to noise include:

1. Modification 1 included a requirement for an acoustic barrier to be installed adjacent to the material handling building in the south end of the site. Borg propose to remove the requirement for the barrier though provision of further attenuation at the source for key plant items;

2. Changes to the location, orientation, construction materials and noise emission data associated with some plant associated with the approved particle board facility resulting from further detailed design; and

3. Co-generation plant is proposed to be added to the site.

Plans illustrating proposed changes are included as Attachment A.

2 NOISE MODEL UPDATES

The site noise model developed for the Modification 1 SEE was revised and updated to reflect proposed changes associated with Modification 2. Model updates are outlined in the following points:

1. The materials handling building extents were updated;
2. The flaker building extents were updated;
3. The height of the silos was updated;
4. The 4800 drier fans were modelled within a 200mm core filled concrete block enclosure with concrete lid and a roller door on the north facade;
5. The conidur mill building extents were updated. The mills were modelled within a 200mm core filled concrete block enclosure with concrete lid and a roller door on the north facade. The number of mills within the building was reduced from three to two;
6. The reject mat blowers (item 7365) are to be enclosed in a concrete building. The location was revised and sound power was reduced to reflect updated emission data;
7. Sound power for the saws and forming blower (item 8941) was reduced to reflect updated emission data);
8. The dust silo blower (item 3550) location was revised. Sound power was reduced to reflect updated emission data;
9. Blowers 5400, 5520, 5370 and 5385 were removed;
10. The dust filter (item 8940) location was revised. Sound power was reduced to reflect updated emission data;
11. The dust filter (item 8930) location was revised. Sound power was reduced to reflect updated emission data;
12. The dust filter (item 8910) location was revised. Sound power was reduced to reflect updated emission data;
13. Dust filters 5155, 2205, and 5510 were removed;
14. Off site buildings located south of the Borg facility that were not included in previous models were added;

15. The barrier included in the Modification 1 model in the southern end of the site was omitted. This barrier is no longer required due to noise sources that were previously afforded shielding by the barrier now being acoustically treated at the source. Treatment at the source is considered to be a more effective method of noise control than providing mitigation along the propagation path; and

16. Co-generation plant was included in the model at coordinates Easting 764805, Northing 6268016 (MGA). The primary noise source is a Solar Turbines power generation turbine; a 'Centaur 50' unit is proposed. Borg advised all noise generating equipment other than the air intake is to be housed within an acoustic enclosure of dimensions 9.7 x 2.6 x 2.5m. The enclosure is to have a maximum sound pressure level (SPL) of 85 dB(A) at 1m. Sound power for the enclosure was calculated from data provided in Table 10 of the Solar Turbines noise brochure for the 'Centaur 50' unit. The air intake is to be located on top of the turbine enclosure, and will include an acoustic silencer. Sound power for the air intake was calculated using data in Table 5 of the Solar Turbines noise brochure for the 'Centaur 50' unit. Air filter and air inlet silencer insertion losses were sourced from Tables 16 and 18 of the Solar Turbines noise brochure. The exhaust is to be ducted back into the main plant, resulting in negligible noise emission during normal operation. An emergency stack is to be be installed; however it is only to be used in emergencies, during which time the main plant would not operate.

Table 2.1 presents sound power levels for plant that has changed since the previous assessment. The Solar Turbines noise brochure is included as Attachment B.

Table 2.1: SOUND POWER, $L_{Aeq,15MINUTE}$ dB

ID	Description	Linear	A-weighted
PF3550	Pneumatic extraction	96	87
PF5501	Mill building south facade	89	74
PF5502	Mill building north facade	89	74
PF5503	Mill building east facade	94	79
PF5504	Mill building west facade	94	79
PF5506	Mill building roof	95	81
PF5505	Mill building roller door	104	102
PF7365	HP blower reject to fines building	99	90
PF8910	Extraction forming line filter	99	90
PF8930	Extraction forming line filter	99	90
PF8940	Bag house filter extraction saw granulates	99	90
PF8941	Pneumatic extraction	89	80
PF4800_S	Drier fans enclosure south facade	62	49
PF4800_E	Drier fans enclosure east facade	63	50
PF4800_W	Drier fans enclosure west facade	63	50
PF4800_RD	Drier fans enclosure roller door	90	76

ID	Description	Linear	A-weighted
PF4800_R	Drier fans enclosure roof	63	50
Turbine_air	Turbine air intake	112	99
Turbine_enc	Turbine enclosure	109	102

3 MODEL PREDICTIONS

Table 3.1 presents model predictions for the updated model for prevailing meteorological conditions. Source inclusions per time period are consistent with the Modification 1 model, with modifications as described above.

Table 3.1: MODEL PREDICTIONS, $L_{Aeq,15MINUTE}$ dB

		Criteria	Prediction			
Receptor ID	**Location**	**D/E/N**	**Day 1**	**Day 2**	**Evening**	**Night**
R01	32 O'Connell Road	55/50/45	45	38	38	37
R02	6 Herborn Street	55/50/45	50	42	42	41
R03	Oberon High School	55/50/45	53	44	44	43
R04	10 Tasman Street	55/50/45	48	38	38	40
R05	127 Hazelgrove Road	55/50/45	45	35	35	39
R06	26 Cunyngham Street	55/50/45	51	43	43	42
R07	131 Hazelgrove Road	55/50/45	45	36	36	40
R08	2 Herborn Street	55/50/45	50	43	43	41
R09	Albion Street	55/50/45	**56**	47	47	45
R10	Caravan Park	55/50/45	53	45	45	44

Compliance with project approval criteria is predicted for all time periods with the exception of a minor 1 dB exceedance at R09 during the day period if a mobile chipper is operational. This is consistent with outcomes of EIS modelling. The development consent includes conditions restricting operation of mobile chippers during certain meteorological conditions which should prevent exceedance of noise criteria due to mobile chippers.

For the night period, a 1 dB reduction is predicted for receptors R01, R02, R03 and R08 relative to the Modification 1 model. No change is predicted for other receptors.

For the day (Day 2 scenario) and evening periods, a 1 dB reduction is predicted for receptors R01, R02, R03, R06 and R10 relative to the Modification 1 model. No change is predicted for receptors R04, R05, R07, R08 or R09.

In overall terms, a reduction in site noise emissions is predicted to result from proposed modifications relative to the Modification 1 SEE assessment.

4 CONCLUSION

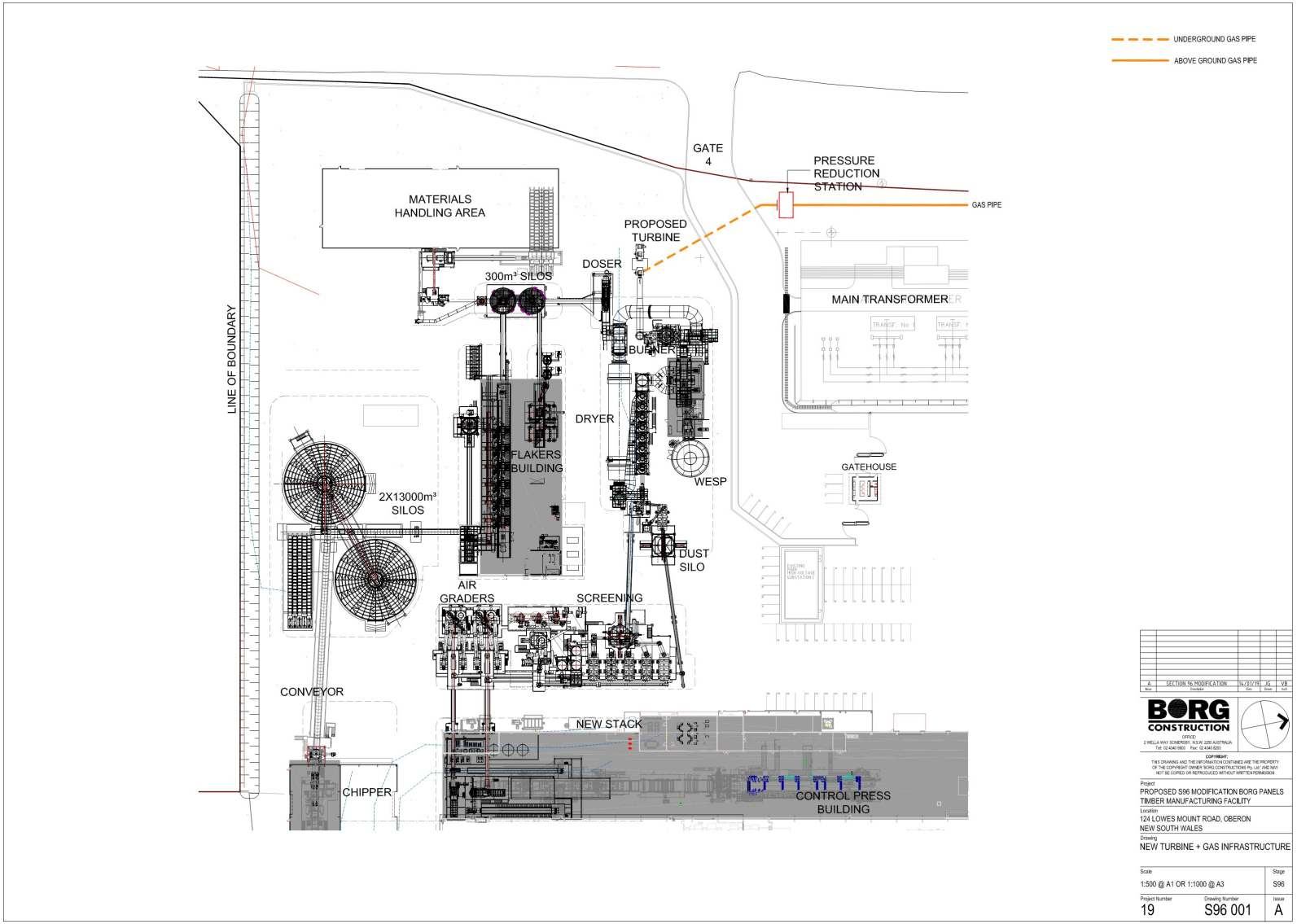
Based on the above it is my opinion that proposed modifications to the Borg Panels Oberon timber manufacturing facility should not materially change from those predicted for the Modification 1 SEE, and it can be considered substantially the same development, as no increase to site noise emission is predicted.

I trust this information meets your requirements. If you have any questions or need further details please contact me.

Prepared: Jeremy Welbourne
Consultant

QA review: Tony Welbourne
Director

Attachment A



Global Acoustics Pty Ltd | PO Box 3115 | Thornton NSW 2322
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ABN 94 094 985 734

Attachment B

Solar® Turbines

A Caterpillar Company

NOISE PREDICTION

Guidelines for Industrial Gas Turbines

PERFORMANCE

Introduction

This document provides information for predicting the noise levels from a site at a receiver a specified distance from the gas turbine installation. Site conditions, including piping, topography, equipment arrangement, reflective surfaces, meteorology, ground cover, and other noise sources, will affect the noise levels measured at the receiver. These conditions must be accounted for in the noise analysis of an installation. Because the consideration of these conditions requires expertise in the field of noise control engineering, detailed treatment of a site analysis is beyond the scope of this document.

This document uses atmospheric absorption, distance spreading, directivity, and noise source combination to demonstrate the procedure for performing a site noise analysis. Often, only these four factors are needed for the analysis. Since the other site conditions mentioned above are not considered in the procedure demonstrated herein, actual noise levels may exceed predicted levels.

Solar can provide a detailed noise analysis and report for use in environmental impact statements or for submittal to state or local authorities. To perform this analysis, site drawings, a description of the area, an equipment list, and the noise criteria, if specified, are needed.

Gas turbine specifications can have noise criteria that apply to the near field, far field, or both. These criteria must be considered separately because near-field noise data cannot be used to reliably predict far-field noise levels.

Unsilenced noise data for the *Saturn*®, *Centaur*®, *Mercury*™, *Taurus*™, *Mars*® and *Titan*™ gas turbines are found in Section 4, “Noise Data.” This section also explains the procedure for selecting combustion air inlet silencers, exhaust silencers, and lube oil coolers.

Octave band sound pressure levels and A-weighted sound levels at 1 m (3 ft) from the base skid of the gas turbine and driven equipment are included for use in predicting workplace sound levels.

If the driven equipment is unenclosed and a gearbox is used, the gearbox must be enclosed. Gearboxes are significant noise sources that are often quoted at 85 dBA measured 1 m (3 ft) from the gearbox at no load conditions. When the gearbox is under load, however, the sound level 1 m (3 ft) from the gearbox can exceed 95 dBA.

ACOUSTICAL ENCLOSURE

Solar’s acoustical enclosure is designed to maximize noise reduction. The A-weighted sound level of Solar’s acoustically enclosed gas turbines (except for the *Saturn*) at full-load operation, when installed in a free field, is estimated to meet an average of 85 dBA at 1 m (3 ft) from the enclosure and at 1.5 m (5 ft) above the bottom of the skid. This sound level is measured at points spaced typically 1.5 to 3.0 m (5 to 10 ft) apart on each side of the enclosure and at one position on each end of the enclosure on the longitudinal axis. The enclosed *Saturn* gas turbine has a design A-weighted sound level of 90 dBA.

For enclosed *Mars* and *Titan* gas turbine packages, acoustical lagging is required for the combustion air inlet ducting. Solar can provide this lagging, which for the *Mars* gas turbine must extend from the top of the enclosure to the inlet air cleaner or for the *Titan* gas turbine must extend from the top of the enclosure through the flex duct.

Again, the estimated sound level is exclusive of other site conditions. Additionally, if there is a gap between the bottom of the skid and the housekeeping pad, deck or ground, this gap must be sealed with a non-hardening caulk.

When enclosed packages are installed on elevated mounts, such as gimbals or anti-vibration mounts, the gap between the skid bottom and the deck is typically about 305 to 355 mm (12 to 14 in.), which is too large to seal by caulking. Sound emission from the skid bottom will increase the sound level adjacent to the package. For example, and the average sound level from an 85 dBA package will be increased 3 to 4 dBA. For elevated installations, the 85 dBA average sound level can be obtained only through the use of skirts that extend from the bottom of the skid to the deck.

SPECIAL NOISE CONTROL COMPONENTS

When noise criteria cannot be met with the use of standard components, Solar can supply special oil coolers, combustion air inlet and exhaust silencers, and enclosures. Contact Solar’s Mechanical Package Design department for information about the recommended material and installation for acoustical lagging, special noise control components, and other noise requirements.

Contents

Illustrations

Tables

Conversion Chart

ABBREVIATIONS

abs	Absolute
ata	atmosphere absolute
Btu	British thermal unit
Btu/h	British thermal units/hour
cfm	cubic feet/minute
cm	centimeter
cm^2	square centimeter
cm^3	cubic centimeter
cu ft	cubic feet
°C	degrees Celsius
°F	degrees Fahrenheit
fps	feet per second
ft/s	feet/second
ft-lb	foot-pound
$ft\text{-}lb_f/lb_m$	foot-pound force/pound mass
gal.	gallon
hp	horsepower
in.	inch
in. Hg	inches of mercury
in. H_2O	inches of water
kcal	kilocalorie
kg	kilogram
kJ	kilojoule
kPa	kilopascal
ksi	1000 pounds/square inch
kW	kilowatt
L	liter
m	meter
mm	millimeter
MMSCFD	millions of standard* cubic feet/day
MPa	megapascal
mph	miles per hour
m^2	square meter
m^3	cubic meter
m^3/min	cubic meters/minute
N	Newton
N/m^2	Pascal
nm^3/h	normal** cubic meters/hour
psi	pounds/square inch
psia	pounds/square inch absolute
psig	pounds/square inch gauge
scf	standard* cubic foot
scfd	standard* cubic feet/day
scfm	standard* cubic feet/minute
sm^3/h	standard*** cubic meters/hour
sq	square

* "standard" = 60°F, 14.7 psia
** "normal" = 0°C, 1.01325 x 10^5 Pascals
*** "standard" = 15°C, 760 mm Hg

CONVERSION FACTORS

To Convert from Old English	To S.I. Metric	Multiply by	To Old Metric	Multiply by
Btu	kJ	1.0551	kcal	0.252
Btu/h	W	0.2931	kcal/h	0.252
Btu/scf	kJ/nm^3	39.3694	$kcal/nm^3$	9.382
cfm	m^3/min	0.028317	m^3/min	0.028317
cfm	m^3/s	0.00047195	m^3/s	0.00047195
cu ft	m^3	0.028317	m^3	0.028317
°F	°C	(°F-32) 5/9	°C	(°F-32) 5/9
°F (Interval)	°C (Interval)	5/9	°C (Interval)	5/9
ft	m	0.3048	m	0.3048
$ft\text{-}lb_f/lb_m$	kJ/kg	0.0029891	kJ/kg	0.002989
ft/s	m/s	0.3048	m/s	0.3048
gal. (U.S.)	L	3.7854	L	3.7854
hp	kW	0.7457	kW	0.7457
in.	mm	25.400	cm	2.540
in. Hg	kPa	3.3769	cm Hg	2.540
in. H_2O	kPa	0.2488	cm H_2O	2.540
kcal	kJ	4.1868		
lb	kg	0.4536	kg	0.4536
lb/cu ft	kg/m^3	16.0185	kg/m^3	16.0185
lb/sq ft	kg/m^2	4.882428	kg/m^2	4.882428
lb_f	N	4.448222		
lb_f-in.	Nm	0.1129848		
MMSCFD	nm^3/min	18.62	nm^3/h	1117
mph	km/h	1.6093	km/h	1.6093
psi	kPa	6.8948	kg/cm^2	0.070
psia	kPa (a)	6.8948	bars abs	0.068948
psig	kPa (g)	6.8948	ata	0.070
scfm	nm^3/min	0.0268	nm^3/h	1.61
sq in.	mm^2	645.16	cm^2	6.4516
sq ft	m^2	0.0929	m^2	0.0929
yd	m	0.914	m	0.914

To Convert from Old Metric	To S.I. Metric	Multiply by		
atm	kPa	101.325		
bar	kPa	100.0		
cm	mm	10		
cm Hg	kPa	1.3332		
cm H_2O	kPa	0.09807		
kcal/h	W	1.16279		
kg/cm^2	kPa	98.0665		
nm^3/h	nm^3/min	0.0167		

1 Noise Criteria

1.1 COMMUNITY NOISE CRITERIA

Noise specifications, as they apply to gas turbine installations, are generally based on local, state, or federal criteria in the United States, and on local, county, or provincial criteria in other countries. In the United States, they are generally based on A-weighted sound levels or on day/night average sound levels (Ldn), although some ordinances include octave band sound pressure level criteria. Two common criteria are an A-weighted sound level of 45 dBA and an Ldn of 55 dBA (which is also an A-weighted criterion). However, other ordinances based on ambient sound levels and which state, in effect, that the ambient sound level cannot be increased, can be much more stringent. Ambient A-weighted sound levels in rural areas are often measured as low as 40 dBA and can be as low as 30 dBA. A summary of A-weighted daytime and nighttime sound levels in U.S. cities is given in Figure 1 (Beranek, 1988).

However, emergency equipment, such as standby electrical generator sets, are generally allowed to operate at higher noise levels, typically as much as 10 dBA above the maximum allowed for continuously operated noise sources.

1.2 FEDERAL ENERGY REGULATORY COMMISSION CRITERIA

The Federal Energy Regulatory Commission (FERC) currently requires that all new compressor stations under its jurisdiction meet an Ldn of 55 dBA at the nearest noise sensitive area. This criterion is applied to the new compressor station or to the additional gas turbine at an existing station.

If the gas turbine is being added to a station with existing horsepower, FERC may also request a field noise survey of the existing station. The noise survey will provide noise data that FERC will use to assess the impact of the additional horsepower on the existing noise levels. FERC may also examine its records on the existing station to determine if noise complaints have been lodged against the station by residents. If there have been complaints, FERC may require the applicant to conduct an assessment to determine the practicality of remedial noise treatment for the existing station.

If the gas turbine being installed is a replacement for existing horsepower, a noise analysis is not required if there is no net increase in station horsepower.

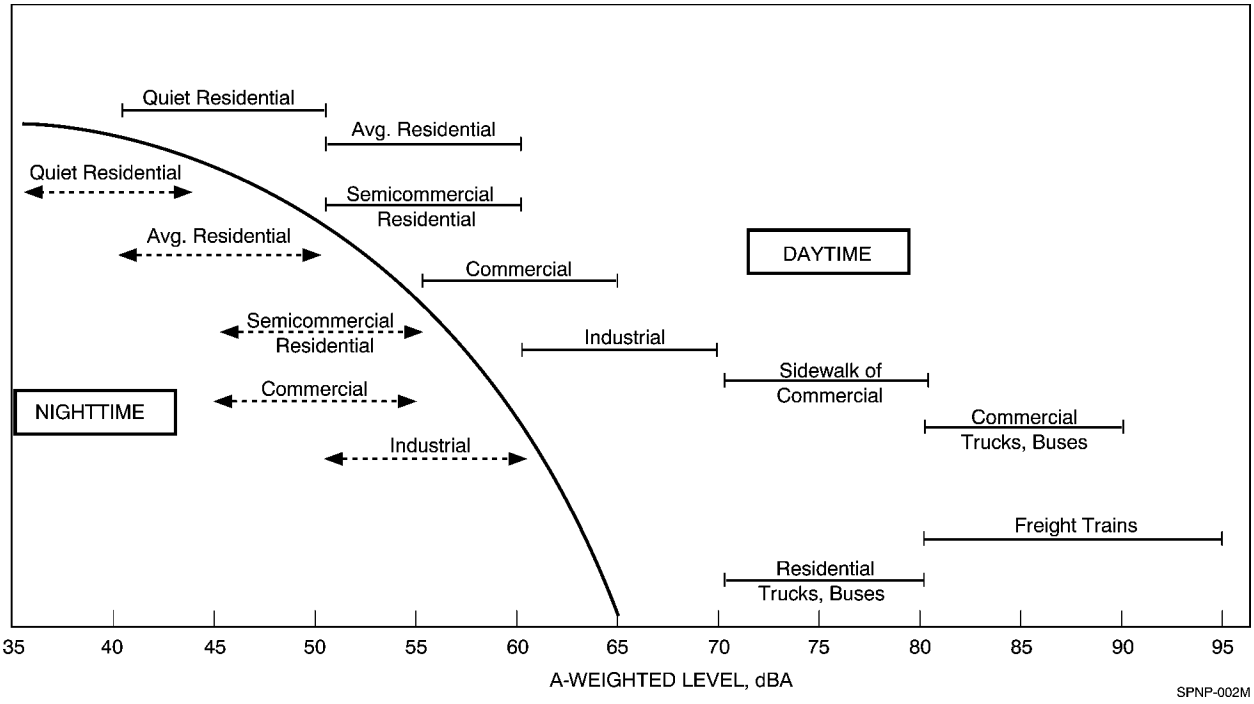


Figure 1. A-Weighted Day/Night Sound Levels in U.S. Cities

1.3 NEAR-FIELD CRITERIA

Near-field noise criteria are typically specified for a distance of 1 m (3 ft) from the noise source, for example, from the enclosure surface. 85 dBA is usually specified in the belief that an enclosure meeting this criterion will comply with the 8-hour personnel exposure action level of 85 dBA specified in most noise standards. Often, however, specifications for an estimated 85 dBA sound level at 1 m (3 ft) from the enclosure do not consider the room effect or the presence of other noise sources in the room, including other gas turbine packages. Therefore, the sound level in the gas turbine room could exceed 85 dBA, even if the enclosed package by itself meets an 85 dBA criterion at 1 m (3 ft) in a free field.

The employer has a clear advantage if the sound level in the gas turbine room is maintained below 85 dBA since no one working in the room will be exposed to an 8-hour exposure level above 85 dBA and the compliance measures required for exposure levels exceeding this value will not be triggered. However, the benefit of specifying an estimated 85 dBA sound level at 1 m (3 ft) from the enclosure may not be realized since:

- Specifications for 85 dBA at 1 m (3 ft) from the enclosure are often written in the belief that these are maximum exposures allowed by the standard.
- Sound level in the gas turbine room could be above 85 dBA even if the standard 85 dBA acoustical enclosure is used.
- Employees do not normally spend their entire 8-hour workday in the gas turbine room.

Enclosures meeting requirements for a sound level not exceeding 85 dBA at any measurement location 1 m (3 ft) from the enclosure and 1.5 m (5 ft) high are available, but these enclosures are more expensive than the standard enclosure since they require tighter construction and a skirt to cover the base rail. Tighter construction significantly reduces maintenance access to the gas turbine package. The skirt extends from the top of the skid to the ground.

For enclosures meeting 80 dBA and lower, an offskid enclosure is required. Offskid enclosures can be supplied as close fitting, meaning the clearance between the enclosure panels and the base rail is 51 or 76 mm (2 or 3 in.). Alternatively, the enclosure can be 1 m (3 ft) wider than the base rail in order to provide a walk-around space inside. The wider enclosure significantly increases the space occupied by the gas turbine package since it adds as much as 1.8 m (6 ft) to the length and width of the standard package.

1.4 NEAR-FIELD CRITERIA IN OUTDOOR INSTALLATIONS

When the gas turbine package will be installed outdoors, the selection of the inlet and exhaust silencers will not affect the near-field sound levels: at 1 m (3 ft) from the enclosure. This is because the noise limiting source is the enclosure. Improving the inlet and exhaust silencers beyond the insertion loss values of the lowest performing standard silencers will not decrease the average sound level from the gas turbine package.

2 Noise Sources

Noise sources typical of a gas turbine installation are the gas turbine combustion air inlet and exhaust, the gas turbine casing (including gas turbine and gearbox), and driven equipment. Other noise sources often include cooling towers, fuel gas compressor skids, fuel gas coolers, lube oil coolers, transformers, blow-down vents, and process piping.

If the gas turbine is installed in a building, casing and driven equipment noise becomes an aspect of noise transmitted through the building walls. Noise from building ventilation systems must also be considered.

All of these noise sources must be added and compared with the noise criteria. Noise control systems must be designed to prevent the site sound level from exceeding the criteria.

2.1 VIBRATION ISOLATION

Structure-borne vibrations from a gas turbine are generally at frequencies above building resonances. Exceptions exist for driven equipment having rotating or reciprocating frequencies below 60 Hz. Vibration isolation may be necessary to reduce the transmission of vibration from the driven equipment to the building structure. For example, a gas turbine driving an 1800-rpm electric generator will produce a 30-Hz driving force. Whether vibration isolation is required will depend upon where the gas turbine generator set is located within the building. Generally, vibration isolation is recommended for above-grade installation in buildings.

For vibration isolation, elastomeric pads are generally used, although springs can be used by those who prefer them. For installation on the upper or top floors of a building or on offshore platforms, the need for vibration isolation should be considered and rejected only if analysis demonstrates that vibration isolation is not necessary.

2.2 OCTAVE BAND PREFERRED FREQUENCIES AND FREQUENCY BANDS

Octave bands are used to describe the noise from noise sources. They are commonly used in specifications and ordinances to define maximally accepted noise levels. The frequency range employed is 22 Hz to 11,314 Hz in nine octave bands.

Table 1 describes these octave band center frequencies and the upper and lower cutoff frequencies for each octave band. The cutoff frequencies have been calculated from ANSI S1.11-1986 (R1998).

2.3 WEIGHTED SOUND LEVELS

A sound level meter equipped with a frequency weighting filter can give a single number reading from the selected weighting network. The three most common weighted networks are A, B, and C, although the A-weighting network is by far the most frequently used. The frequency response characteristics of each of these weighted networks are shown in Figure 2, which is produced from frequency weightings in ANSI S1.4-1983 (R1997).

The A, B, and C weighting networks approximate the response of the human ear's equal loudness perception of pure tones relative to a reference sound pressure level at 1000 Hz. The human ear is less sensitive to lower frequency sounds at lower sound levels, but as the sound levels increase, this sensitivity is less pronounced, which accounts for the development of the three weighting networks. However, because using a single number is an easy way to rate noise and because the A-weighting has a high correlation with other noise rating methods, it is the most widely accepted way to rate human response to noise. It is used internationally in noise standards and regulations.

Table 1. Frequencies and Frequency Bands

	Octave Band Center Frequency, Hz								
	31.5	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Frequency Range, Hz	22 to 45	45 to 89	89 to 177	177 to 354	354 to 707	707 to 1414	1414 to 2828	2828 to 5657	5657 to 11,314

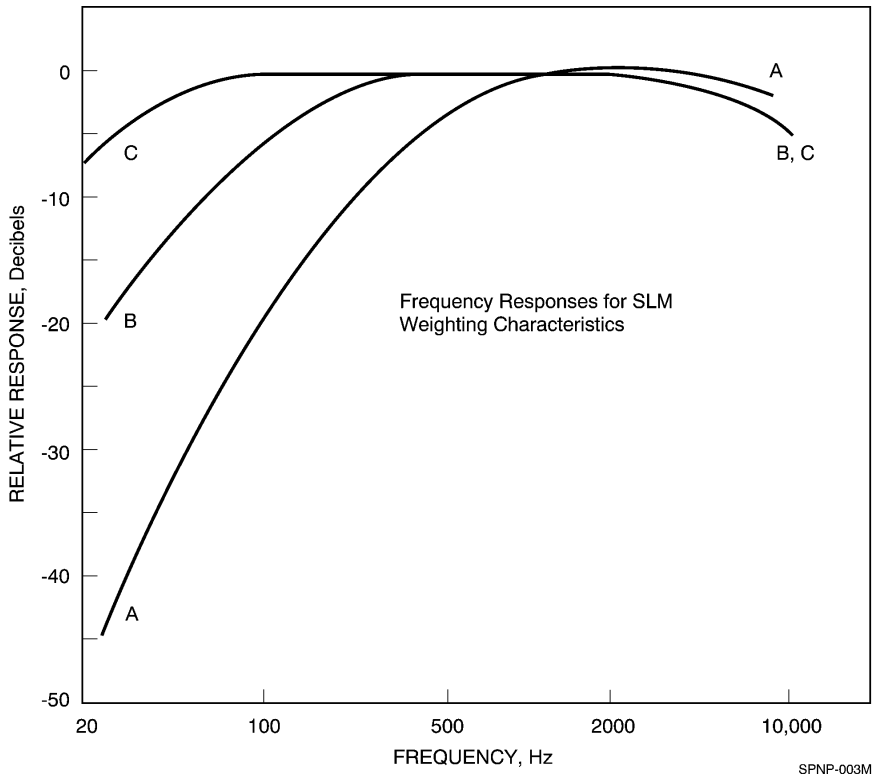


Figure 2. Sound Level Meter-Weighted Frequency Response Characteristics

A sound level meter having the A, B, and C weighting networks can be used to estimate the frequency distribution. If the sound level is relatively the same when measured on all three networks, the source noise is probably primarily above 600 Hz. If the C-weighted sound level is several dBA higher than the A and B networks, low frequency sound (below 600 Hz) predominates.

Typical A-weighted sound levels of various noise sources are shown in Figure 3 (Peterson, 1980).

2.4 COMMUNITY RESPONSE TO NOISE

Individuals respond differently to noise and the range of response can be quite large. Noise that is intrusive and annoying to some may not be bothersome to others. The response of an individual to noise depends on several factors, some of which are given below. These factors, taken from Peterson (1980) are also discussed in EPA (1974), Pollack (1952) and Schultz (1972).

1. The magnitude of the noise level and its spectral shape.
2. The variation of the noise level with time.
3. The time of day. People are more sensitive to nighttime than to daytime noise.
4. The time of year. During cold weather, doors and windows are shut, so homes are better insulated from external noise sources.
5. Previous exposure. People apparently are conditioned by their previous exposure to noise.
6. Pure tones. Noise with pure tone components are apparently more objectionable than noise without pure tone components.
7. Impulsive noise.
8. Community acceptance. Apparently, a community's tolerance of an intruding noise is increased if the community accepts the function of the noise producer as very necessary.
9. Socio-economic status.

There are numerous documents (guidelines, ordinances, and standards), dealing with community noise. Among the currently pertinent are the HUD Environmental Criteria and Standards, the Model Community Noise Control Ordinance, the EPA Noise Guidelines, and the ANSI S12.9-1998 Standard.

These documents are more applicable to city and residential areas than to rural areas.

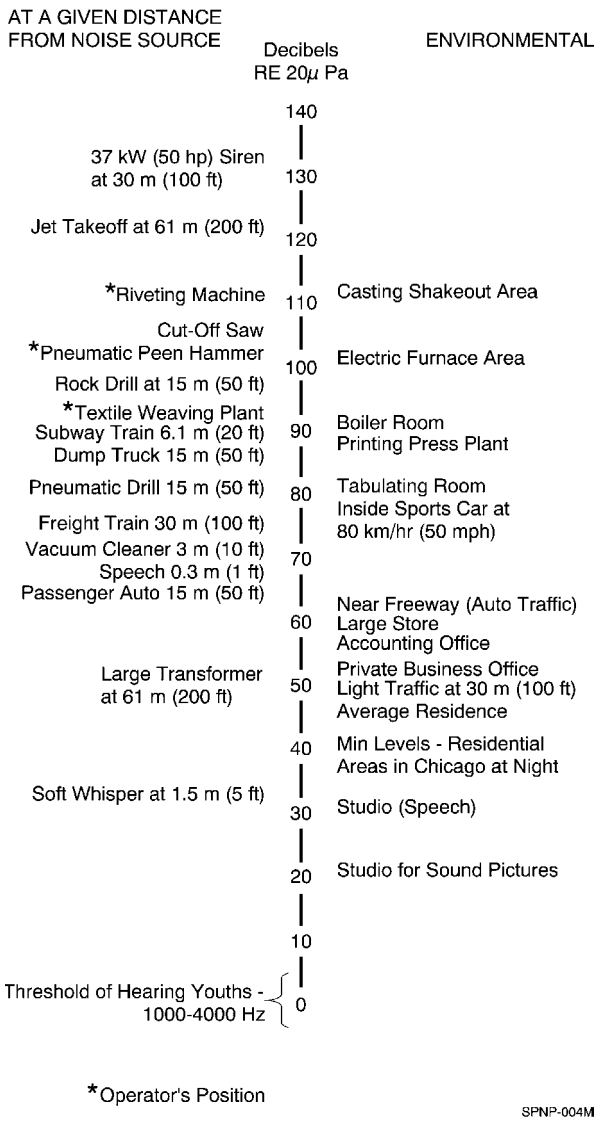


Figure 3. Typical A-Weighted Sound Levels of Representative Noise Sources

3 Physical Properties of Sound

The physical properties of sound discussed in this section will be limited to:

- Spreading of the sound wave with distance
- Temperature inversion
- Atmospheric absorption
- Directivity effects
- Combining sound levels

3.1 DISTANCE SPREADING

In the far field of a noise source, the sound level decreases in accordance with the "inverse square rule." The decrease in the sound level with distance is taken as 6 dBA for each doubling of the distance from the noise source. This can be calculated using Eq. 1:

Note: to use this equation, R_1 must be in the far field. Do not use this equation with 1 m (3 ft) data; use 15 m (50 ft) data.

Equation (1)

$$Lp_2 = Lp_1 - 20 \log_{10} [R_2 / R_1], \text{ dBA}$$

where:

- Lp_2 = Sound level at the new location
- Lp_1 = Sound level at the initial location
- R_2 = Distance from the noise source to the new location
- R_1 = Distance from the noise source to the initial location

3.2 TEMPERATURE INVERSION

A temperature inversion occurs when the temperature of the air increases, instead of decreasing, with elevation. During this condition, the sound wave suffers repeated reflections between the ground and the thermal layer, and the pressure of the sound wave does not decrease in proportion to the inverse of the distance squared, as it propagates in the far field.

Unfortunately, there are no procedures that can easily be used to predict the effects of a temperature inversion and wind effects usually predominate over thermal inversions (Electric Power Plant, 1983). For these two reasons and because inversions are considered upset conditions that occur infrequently, designing for them does not justify the considerable additional expense.

3.3 ATMOSPHERIC ABSORPTION

The absorption of acoustic energy by the atmosphere decreases the sound level as the sound propagates from the noise source. This decrease in sound level caused by atmospheric absorption is added to the sound level decrease that occurs with distance. Figure 4 combines distance spreading and atmospheric absorption to show the decrease in sound level with increasing distance from a noise source. Eq. 1 now takes the form:

Note: to use this equation, R_1 must be in the far field. Do not use this equation with 1 m (3 ft) data; use 15 m (50 ft) data.

Equation (2)

$$Lp_2 = Lp_1 - 20 \log_{10} [R_2/R_1] - \alpha [R_2-R_1], \text{ dBA}$$

where:

- α = Atmospheric absorption in dBA/unit distance calculated in accordance with ANSI Standard S1.26-1995 for 100% relative humidity and an ambient temperature of 20°C (68°F).
- Lp_2 = Sound level at the new location
- Lp_1 = Sound level at the initial location
- R_2 = Distance from the noise source to the new location
- R_1 = Distance from the noise source to the initial location

3.4 DIRECTIVITY EFFECTS

Directivity effects as discussed in this document are applied to stack openings. Sound from the outlet of an exhaust stack is greater in front of the stack opening than at the side. As shown in Figure 5, while a position in front of the stack opening is at zero degrees to the direction of flow, at the side, the position could be 45, 60, 90, or 135 degrees. The directivity effect is affected by both frequency and the area of the stack opening. The higher the frequency and the larger the stack opening, the greater the effect.

Because of variabilities in the results of measurements of stack directivity, Table 2 (AGA, 1969) is offered as an average of those effects.

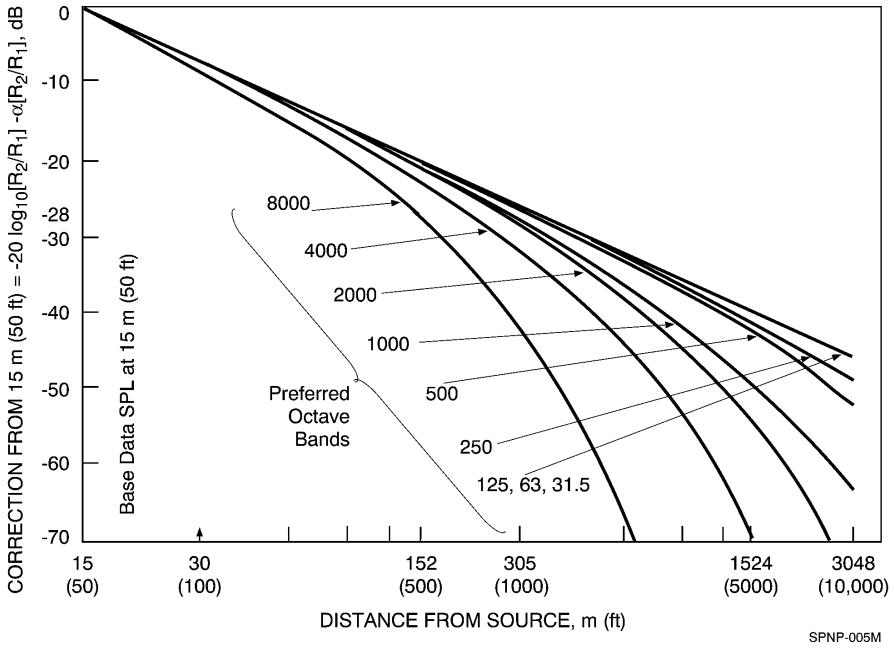


Figure 4. Corrections of Octave Band Sound Pressure Levels for Distance

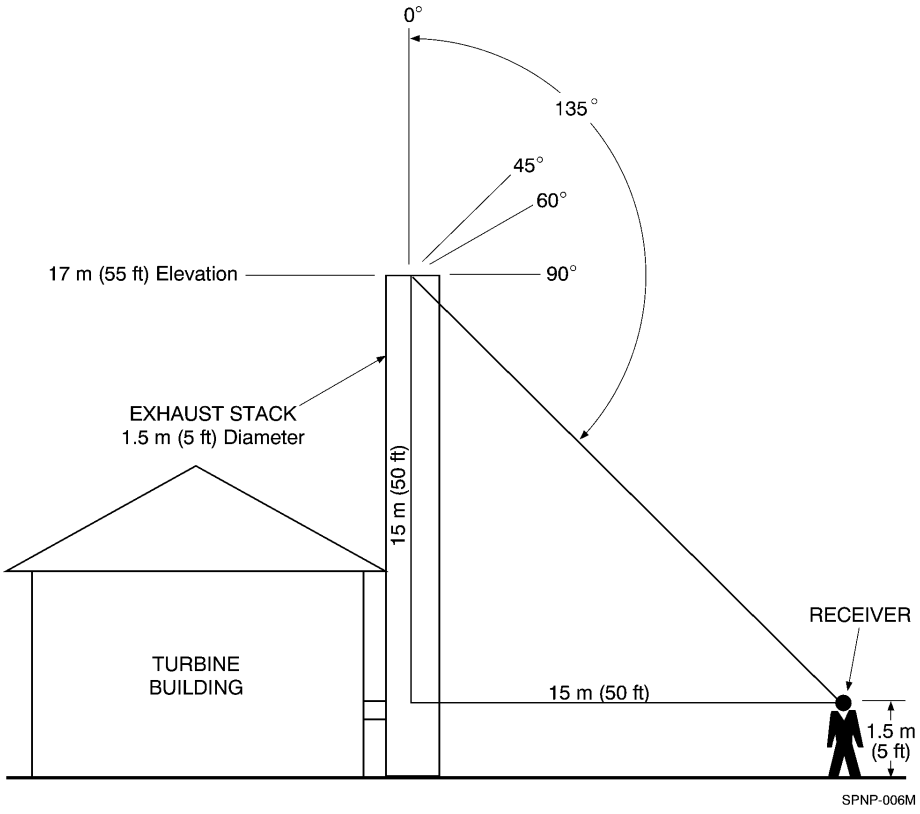


Figure 5. Exhaust Stack Directivity

Table 2. Stack Directivity

Duct Diameter >3 m (10 ft)									
	Octave Band Center Frequency, Hz								
Degree	**31.5***	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
0	6	8	8	8	9	9	10	10	10
45	4	5	5	5	6	6	7	7	7
60	1	2	2	2	1	1	-1	-1	-1
90	-2	-3	-3	-3	-9	-9	-14	-14	-14
135	-3	-4	-4	-4	-11	-11	-18	-18	-18
Duct Diameter 1 m (3 ft) ≤D ≤3 m (10 ft)									
	Octave Band Center Frequency, Hz								
Degree	**31.5***	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
0	3	4	4	4	5	5	6	6	6
45	1	2	2	2	3	3	4	4	4
60	0	0	0	0	-1	-1	-2	-2	-2
90	-1	-2	-2	-2	-4	-4	-8	-8	-8
135	-2	-3	-3	-3	-7	-7	-12	-12	-12

* 31.5 Hz values are estimated. AGA (1969) does not include this octave band.

Example: What is the directivity effect in the 8000-Hz octave band at a measurement position 15 m (50 ft) from the centerline of a 17 m (55 ft) high exhaust stack? The exhaust stack diameter is 1.5 m (5 ft). Referring to Figure 5, the angle from the vertical is 135 degrees. From Table 2 the directivity effect is -12 dBA for 135 degrees. However, the sound from the exhaust of the gas turbine is given for 90 degrees. The directivity for 90 degrees is -8 dBA. Therefore, the directivity effect for this example is the difference between 90 and 135 degrees (Figure 6):

Equation (3)
Directivity Effect = (-12) - (-8) = -4, dBA

Assuming an exhaust sound pressure level (SPL) at 15 m (50 ft) of 67 dBA and an exhaust silencer insertion loss of -17 dBA, the correct 8000-Hz octave band SPL at the observer is:

Exhaust SPL at 15 m (50 ft)	67 dBA
Exhaust silencer insertion loss	-17 dBA
Directivity Effect 135 degrees vs 90 degrees	-4 dBA
SPL at the receiver	46 dBA

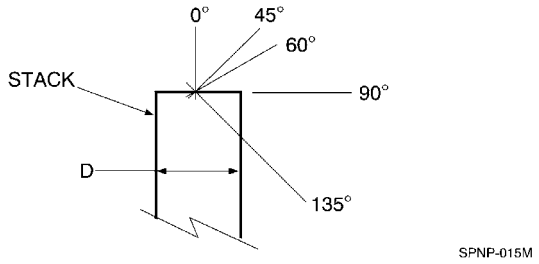


Figure 6. Stack Directivity Example

The footnote in the reference (Table 34, AGA 1969) allows the values in the 90 degrees and 135 degrees columns to be increased by 50% for an air intake opening.

3.5 COMBINING SOUND LEVELS

Sound levels are combined when calculating:

- Sound level from two or more sources
- Sound level from a noise source and the ambient sound level
- Overall sound pressure level or sound power level from octave band levels

- A-weighted sound level from an A-weighted octave band spectrum

Levels are combined logarithmically, not arithmetically. Thus, two noise sources each producing 90 dBA combine to produce 93 dBA, not 180. Sound levels from multiple sources can be calculated with Eq. 4. Alternatively, the procedure described in Examples 1 and 2 using Figure 7 (Harris, 1979) can be used. L_1 is the higher of the two.

Equation (4)

$$Lp_T = 10\log_{10}\left(\sum_i^n 10^{(Lp_i/10)}\right), dB$$

where: n = Number of sources
Lp_i = Sound level of ith source
Lp_T = Sum of all sound sources

The left scale shows the number of decibels to be added to the higher level L_1 to obtain the levels of the combination of L_1 and L_2. Assume two noise sources of equal amplitude. The right scale of the chart shows the difference between the two noise sources is 0 dBA. On the left side, read 3 dBA, the number of decibels to be added to the louder noise source L_1. In this example, because the two noise sources are equal, it does not matter which one is designated L_1.

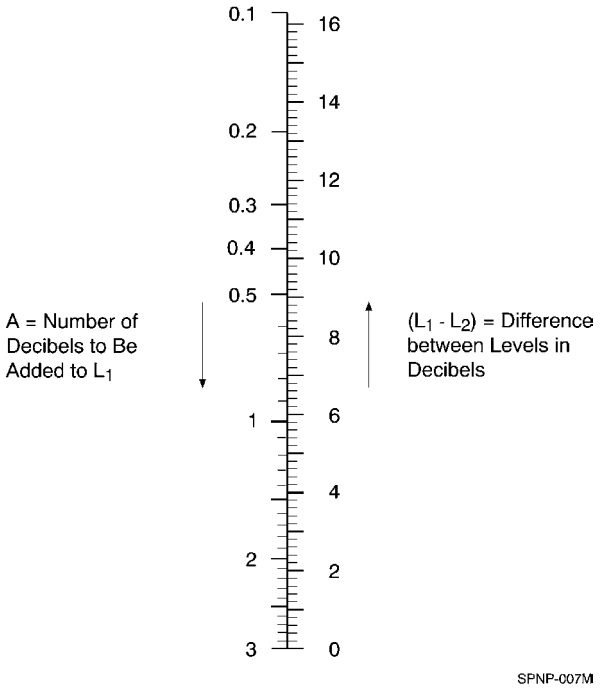


Figure 7. Combining Two Sound Levels, L_1 and L_2

Example 1. Assume three noise sources, each contributing the sound levels of: Source 1, 85 dBA; Source 2, 86 dBA; and Source 3, 92 dBA.

Referring to Figure 7, the difference between 85 and 86 dBA is 1 dBA. Therefore, add 2.5 dBA to the higher number, 86 dBA, to get 88.5 dBA. Then, take the difference between 92 dBA and 88.5 dBA, which is 3.5 dBA. From Figure 7, add 1.6 dBA to the higher number, 92 dBA, to get 93.6 dBA as follows:

86 - 85 = 1 (from Figure 7, difference is 2.5 dBA)
86 + 2.5 = 88.5
92 - 88.5 = 3.5 (from Figure 7, difference is 1.6 dBA)
92 + 1.6 = 93.6 (round to 94)

In the operation to combine sound levels, it is acceptable to use tenths of a dBA. After calculating the combined sound levels, round off the result to the nearest dBA. This is depicted graphically in Figure 8:

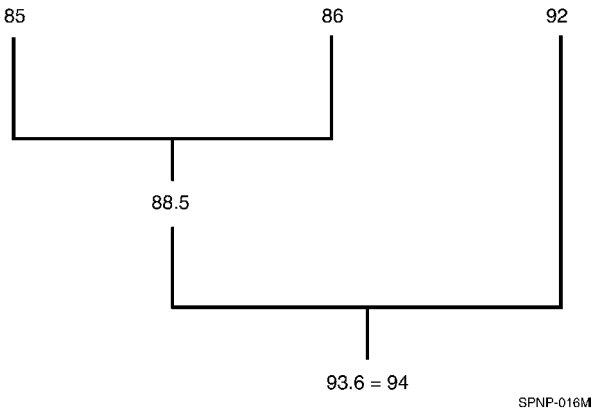


Figure 8. Example of Combining Sound Levels

Because of the approximate nature of noise analyses, it is pointless to present results calculated to the tenth of a dBA.

Example 2. Assume that the octave band sound pressure levels have been calculated for the inlet and exhaust at a receiver and, now, must be summed to calculate the A-weighted sound level (Table 3).

First, the A-weighting correction must be made to each octave band using Table 4 and then summed to get the A-weighted sound level, 52 dBA.

Table 3. Example of Summing Octave Band Sound Pressure Levels

Sound Level	Octave Band Center Frequency, Hz									
	31.5	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dBA**
Inlet/Exhaust, dBA	72	69	60	51	43	37	36	35	49	--
A-Weighted Corrections, dBA (from Table 4)	-39	-26	-16	-9	-3	0	+1	+1	-1	--
A-Weighted dBA	33	43	44	42	40	37	37	36	48	52

Table 4. A-Weighted Octave Band Corrections

Sound Level	Octave Band Center Frequency, Hz								
	31.5	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
A-Weighted Corrections, dBA	-39	-26	-16	-9	-3	0	+1	+1	-1

To sum the A-weighted octave band sound pressure levels, use Figure 7 to obtain the differences between noise levels, adding the difference to the higher noise level, and proceed through all of the octave bands until the summation is complete, as depicted in Figure 9. Again, round off the combined sound level (51.8) to the nearest dBA (52 dBA).

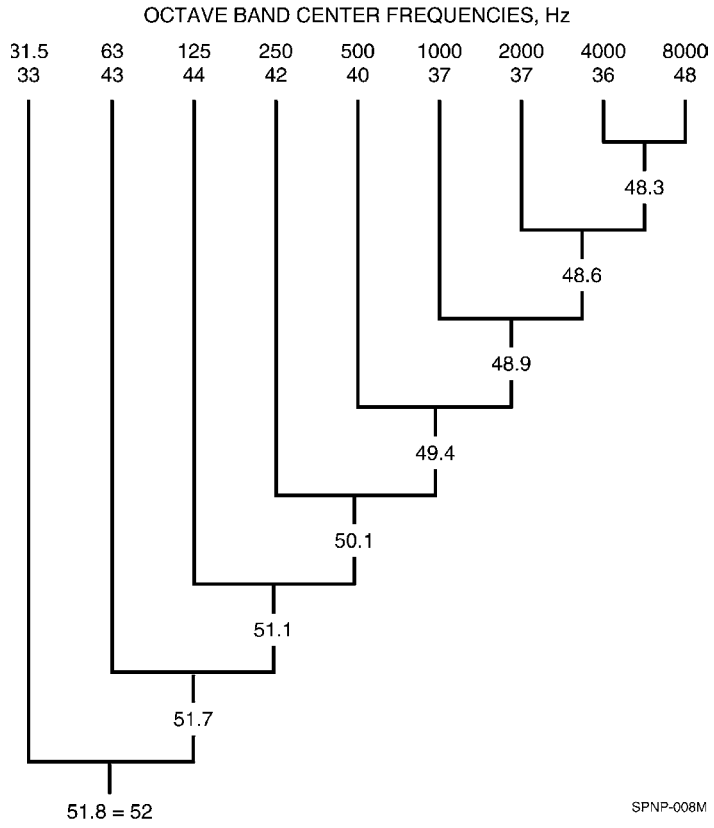


Figure 9. Combining Sound Levels

4 Noise Data

The noise levels of Solar's gas turbines are given in Tables 5 through 14. The exhaust measurement position (Figure 10) is 90 degrees from the exhaust stack centerline on the plane of the outlet flange. The air inlet measurement position (Figure 11) is on the centerline of the inlet duct flange. Noise levels for both unenclosed and enclosed packages apply at 1 m (3 ft) from the skid and 1.5 m (5 ft) above the bottom of the skid (Figure 12), and are based on free-field conditions. Because these are averaged levels, the noise level at some locations around the skid (or enclosure) will be higher, and at some locations lower, than the average noise level. Table 15 gives the octave band insertion losses for the combustion air inlet cleaners. Table 16 gives lube oil cooler noise levels at 15 m (50 ft). Tables 17 through 20 give octave band insertion losses for standard inlet and exhaust silencers. Sound pressure levels are referenced to 20 μPa (2×10^{-5} N/m^2).

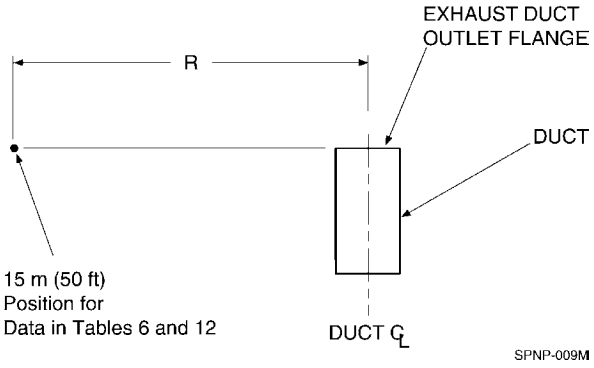


Figure 10. Exhaust Measurement Position

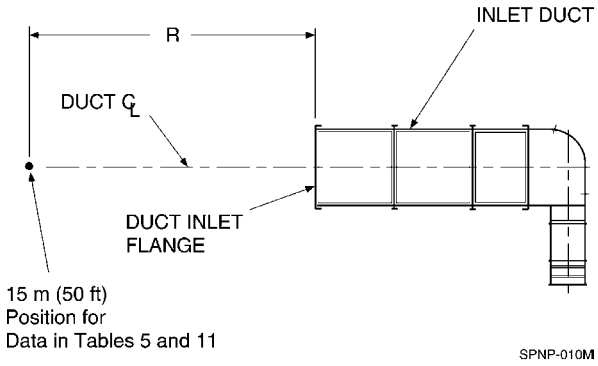


Figure 11. Inlet Measurement Position

All product noise data are exclusive of the contribution from the lube oil cooer.

Tables 5 through 10 apply to gas turbines operating at full load. Noise levels from two-shaft *SoLoNOx*™ gas turbines can be higher when operating at less than full load, and the part-load noise levels are given in Tables 11 through 14. Octave band sound pressure levels do not change uniformly with changes in load; i.e., the sound pressure level change in any octave band can be more, or less, than the change in other octave bands. Because of this, the part-load octave band sound pressure levels given in Tables 11 through 14 are the highest sound pressure levels expected for those octave bands, regardless of the gas turbine's load conditions. The A-weighted sound levels in Tables 11 through 14 are calculated from the octave band sound pressure levels.

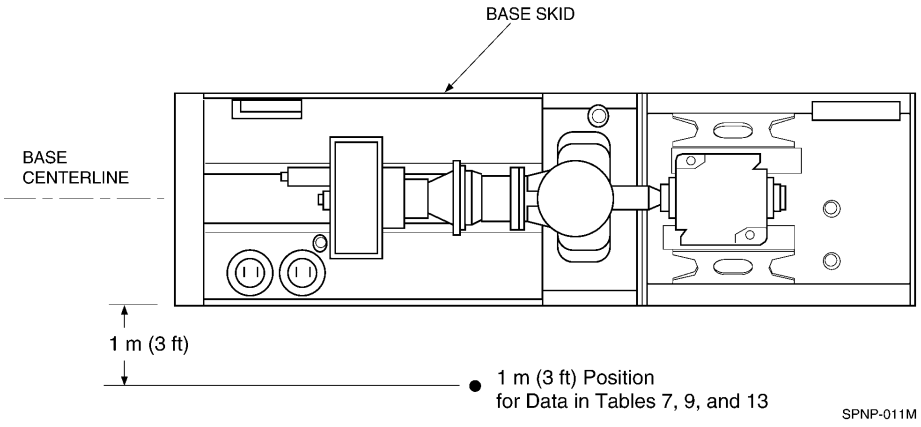


Figure 12. Casing Measurement Position

A description of each table follows:

Table 5 – Unsilenced octave band sound pressure levels and A-weighted sound levels at 15 m (50 ft) from the combustion air inlet for full-load operation.

Table 6 – Unsilenced octave band sound pressure levels and A-weighted sound levels at 15 m (50 ft) from the combustion exhaust for full-load operation. Using ISO 10494, unsilenced sound power levels were obtained for the exhaust of the *Centaur* 40, *Centaur* 50, and *Taurus* 60 gas turbines using a 1.22 m (4 ft) diameter stack, and on the *Taurus* 70 using a 1.32 m (4 ft-4 in.) diameter stack. *Mars* and *Titan* exhaust sound power levels are calculated using an algorithm calibrated from noise measurements made on the *Centaur* 40, *Centaur* 50 and *Taurus* 60 gas turbines and verified with the *Taurus* 70 gas turbine. The exhaust duct diameter for the *Mars* and *Titan* gas turbines is 1.52 m (5 ft). The octave band sound pressure levels in the table were obtained by extrapolating the sound power levels to 15 m (50 ft) using hemispherical divergence. The sound levels given in this table are at the 95% upper confidence limit.

Table 7 – Averaged octave band sound pressure levels and A-weighted sound levels at 1 m (3 ft) from the base skid and at 1.5 m (5 ft) above the skid bottom for an unenclosed package operating at full load.

Table 8 – Averaged octave band sound pressure levels and A-weighted sound levels at 15 m (50 ft) from the base skid and at 1.5 m (5 ft) high for an unenclosed package operating at full load. The sound levels in this table are calculated from the sound levels in Table 7, using the algorithm described in Section 6, “Source Sound Power Levels.”

Table 9 – Averaged octave band sound pressure levels and A-weighted sound levels at 1 m (3 ft) from the base skid and at 1.5 m (5 ft) above the skid bottom for an enclosed package operating at full load.

Table 10 – Averaged octave band sound pressure levels and A-weighted sound levels at 15 m (50 ft) from the enclosure and at 1.5 m (5 ft) high for an enclosed package operating at full load. The sound levels in this table are calculated from the sound levels in Table 8, using the algorithm described in Section 6, “Source Sound Power Levels.”

Table 11 – Unsilenced octave band sound pressure levels and A-weighted sound levels at 15 m (50 ft) from the combustion air inlet for less than full-load operation. This affects the *Taurus*, *Mars* and *Titan* two-shaft gas turbines only.

Table 12 – Unsilenced octave band sound pressure levels and A-weighted sound levels at 15 m (50 ft) from the combustion exhaust for less than full-load operation. This affects the *Taurus*, *Mars* and *Titan* two-shaft gas turbines only.

Table 13 – Averaged octave band sound pressure levels and A-weighted sound levels at 15 m (50 ft) from the base skid for an unenclosed package operating at part load. This affects the *Taurus*, *Mars* and *Titan* two-shaft gas turbines only.

Table 14 – Averaged octave band sound pressure levels and A-weighted sound levels at 1 m (3 ft) from the base skid for an unenclosed package operating at part load. The sound levels in this table are calculated from the sound levels in Table 13, using the algorithm described in Section 6, “Source Sound Power Levels.” This affects the *Taurus*, *Mars* and *Titan* two-shaft gas turbines only.

Table 15 – Although the lube oil coolers are defined as 90 or 100 dBA sound power level, the noise data in this table are given as octave band sound pressure levels and A-weighted sound levels at 15 m (50 ft). The 90 dBA sound power level oil cooler is a special cooler; the 100 dBA sound power level cooler is the standard oil cooler.

Table 16 – Combustion air filter insertion losses.

Table 17 – Combustion air inlet silencer insertion losses for Oil & Gas applications.

Table 18 – Combustion air inlet silencer insertion losses for Power Generation applications.

Table 19 – Combustion exhaust silencer insertion losses for Oil & Gas applications.

Table 20 – Combustion exhaust silencer insertion losses for Power Generation applications.

Tables 17 through 20 include Solar’s standard silencers. Special silencers designed to meet more stringent insertion loss requirements are available.

Table 5. Sound Pressure Levels – Unsilenced Combustion Air Inlet at 15 m (50 ft), Full Load

Model	Octave Band Center Frequency, Hz									
	31.5	63	125	250	500	1000	2000	4000	8000	dBA
Saturn 10	70	72	74	78	82	89	91	95	106	106
Saturn 20	72	74	76	80	84	91	93	97	108	108
Centaur 40	75	81	87	88	89	91	94	117	109	118
Centaur 50	75	81	87	88	89	91	94	118	110	119
Mercury 50	74	80	86	87	88	90	93	116	108	117
Taurus 60	76	82	88	89	90	92	95	120	112	121
Taurus 70	79	85	91	92	93	95	98	126	118	127
Mars 90	81	87	93	94	95	97	100	125	117	126
Mars 100	81	87	93	94	95	97	100	129	121	130
Titan 130	82	88	94	95	96	98	101	131	123	132

Sound pressure levels (Re 20 μPa) for *SoLoNOx* and conventional gas turbine packages

Table 6. Sound Pressure Levels – Unsilenced Combustion Exhaust at 15 m (50 ft), Full Load

Model	Octave Band Center Frequency, Hz									
	31.5	63	125	250	500	1000	2000	4000	8000	dBA
Saturn 10	93	93	92	91	89	88	84	80	69	92
Saturn 20	94	94	93	92	90	89	85	81	70	93
Centaur 40	84	92	88	90	89	88	81	72	66	91
Centaur 50	86	88	88	87	94	88	82	70	61	93
Mercury 50	63	75	71	69	75	65	54	41	32	73
Taurus 60	88	91	88	91	95	87	80	72	64	94
Taurus 70	91	94	91	95	97	93	87	80	67	98
Mars 90	91	95	93	96	100	95	87	77	67	100
Mars 100	91	95	93	96	100	95	87	77	67	100
Titan 130	92	96	94	97	101	96	88	78	68	101

Sound pressure levels (Re 20 μPa) for *SoLoNOx* and conventional gas turbine packages

Table 7. Sound Pressure Levels – Unenclosed Package at 1 m (3 ft), Full Load

Model	Octave Band Center Frequency, Hz									
	31.5	63	125	250	500	1000	2000	4000	8000	dBA
Saturn 10	85	90	91	94	94	90	90	91	93	98
Saturn 20	86	91	92	95	95	91	91	92	94	99
Centaur 40	94	94	97	99	99	94	92	91	92	101
Centaur 50	94	94	97	99	99	94	92	91	92	101
Mercury 50	79	81	84	88	84	84	86	90	83	94
Taurus 60	94	94	97	99	99	94	92	91	92	101
Taurus 70	94	94	97	99	99	94	102	100	95	106
Mars 90	87	86	92	92	95	93	102	100	95	106
Mars 100	87	86	92	92	95	93	102	100	95	106
Titan 130	93	92	100	97	94	90	91	103	96	105

Package average sound pressure levels (Re 20 μPa) for *SoLoNOx* and conventional gas turbine packages

Table 8. Sound Pressure Levels – Unenclosed Package at 15 m (50 ft), Full Load

Model	Octave Band Center Frequency, Hz									
	31.5	63	125	250	500	1000	2000	4000	8000	dBA
Saturn 10	71	76	77	80	80	76	76	77	79	84
Saturn 20	72	77	78	81	81	77	77	78	80	85
Centaur 40	81	81	84	86	86	81	79	78	79	88
Centaur 50	81	81	84	86	86	81	79	78	79	88
Mercury 50	67	69	72	76	72	72	74	78	71	82
Taurus 60	81	81	84	86	86	81	79	78	79	88
Taurus 70	82	82	85	87	87	82	90	88	83	94
Mars 90	75	74	80	80	83	81	90	88	83	94
Mars 100	75	74	80	80	83	81	90	88	83	94
Titan 130	82	81	89	86	83	79	80	92	85	94

Package average sound pressure levels (Re 20 μPa) for *SoLoNOx* and conventional gas turbine packages

Table 9. Sound Pressure Levels – Enclosed Package at 1 m (3 ft), Full Load

Model	Octave Band Center Frequency, Hz									
	31.5	63	125	250	500	1000	2000	4000	8000	dBA
Saturn 10	84	83	86	82	80	76	75	89	76	90
Saturn 20	84	83	86	82	80	76	75	89	76	90
Centaur 40	84	86	86	88	83	78	74	76	71	85
Centaur 50	85	86	84	85	81	77	73	72	64	83
Mercury 50	86	87	84	83	78	76	70	74	68	82
Taurus 60	85	78	79	80	81	77	77	73	66	83
Taurus 70	96	89	86	83	81	80	78	75	70	85
Mars 90	96	89	86	83	81	80	78	75	70	85
Mars 100	96	89	86	83	81	80	78	75	70	85
Titan 130	96	89	86	83	81	80	78	75	70	85

Package average sound pressure levels (Re 20 μPa) for *SoLoNOx* and conventional gas turbine packages
For enclosed *Mars* and *Titan* gas turbine packages, acoustical lagging is required for the combustion air inlet ducting.

Table 10. Sound Pressure Levels – Enclosed Package at 15 m (50 ft), Full Load

Model	Octave Band Center Frequency, Hz									
	31.5	63	125	250	500	1000	2000	4000	8000	dBA
Saturn 10	70	69	72	68	66	62	61	75	62	76
Saturn 20	70	69	72	68	66	62	61	75	62	76
Centaur 40	71	73	73	75	70	65	61	63	58	72
Centaur 50	72	73	71	72	68	64	60	59	51	70
Mercury 50	73	74	72	73	69	65	61	60	52	71
Taurus 60	72	65	66	67	68	64	64	60	53	70
Taurus 70	84	77	74	71	69	68	66	63	58	73
Mars 90	84	77	74	71	69	68	66	63	58	73
Mars 100	84	77	74	71	69	68	66	63	58	73
Titan 130	85	78	75	72	70	69	67	64	59	74

Package average sound pressure levels (Re 20 μPa) for *SoLoNOx* and conventional gas turbine packages
For enclosed *Mars* and *Titan* gas turbine packages, acoustical lagging is required for the combustion air inlet ducting.

Table 11. Sound Pressure Levels – Unsilenced Combustion Inlet at 15 m (50 ft), Less than Full Load

Model	Octave Band Center Frequency, Hz									
	31.5	63	125	250	500	1000	2000	4000	8000	dBA
Taurus 60	78	83	93	95	95	98	103	133	116	134
Taurus 70	81	86	96	98	98	101	106	139	122	140
Mars 90	81	87	94	94	95	98	101	135	126	136
Mars 100	81	87	94	94	95	98	101	135	126	136
Titan 130	82	88	95	95	96	99	102	137	129	138

Sound pressure levels (Re 20 μPa) for *Taurus*, *Mars* and *Titan* two-shaft gas turbine packages only

Table 12. Sound Pressure Levels – Unsilenced Combustion Exhaust at 15 m (50 ft), Less than Full Load

Model	Octave Band Center Frequency, Hz									
	31.5	63	125	250	500	1000	2000	4000	8000	dBA
Taurus 60	89	91	88	91	98	93	82	73	64	97
Taurus 70	96	98	96	98	102	107	106	95	80	111
Mars 90	92	95	93	96	102	101	89	78	67	103
Mars 100	92	95	93	96	102	101	89	78	67	103
Titan 130	93	96	94	97	104	102	90	79	68	105

Sound pressure levels (Re 20 μPa) for *Taurus*, *Mars* and *Titan* two-shaft gas turbine packages only

Table 13. Sound Pressure Levels – Unenclosed Package at 1 m (3 ft), Less than Full Load

Model	Octave Band Center Frequency, Hz									
	31.5	63	125	250	500	1000	2000	4000	8000	dBA
Taurus 60	98	92	95	100	109	98	92	90	95	107
Taurus 70	91	91	100	100	104	102	110	104	101	113
Mars 90	84	83	95	93	100	100	110	104	101	113
Mars 100	84	83	95	93	100	100	110	104	101	113
Titan 130	84	83	95	93	100	100	110	104	101	113

Sound pressure levels (Re 20 μPa) for *Taurus*, *Mars* and *Titan* two-shaft gas turbine packages only

Table 14. Sound Pressure Levels – Unenclosed Package at 15 m (50 ft), Less than Full Load

Model	Octave Band Center Frequency, Hz									
	31.5	63	125	250	500	1000	2000	4000	8000	dBA
Taurus 60	85	79	82	87	96	85	79	77	82	94
Taurus 70	72	71	83	81	88	88	98	92	89	101
Mars 90	72	71	83	81	88	88	98	92	89	101
Mars 100	72	71	83	81	88	88	98	92	89	101
Titan 130	73	72	84	82	89	89	99	93	90	102

Sound pressure levels (Re 20 μPa) for *Taurus*, *Mars* and *Titan* two-shaft gas turbine packages only

Table 15. Sound Pressure Levels – Lube Oil Cooler at 15 m (50 ft)

Lube Oil Cooler, Sound Power Level	Octave Band Center Frequency, Hz									
	31.5	63	125	250	500	1000	2000	4000	8000	dBA
90 dBA (special)	63	70	67	60	55	52	48	44	39	58
100 dBA (standard)	73	80	77	70	65	62	58	54	49	68

Table 16. Combustion Air Inlet Air Filter Insertion Losses

Air Filter	Octave Band Center Frequency, Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
Pulse Cleaning, Up-Draft, dBA	2	4	8	9	13	26	27	27	33
Pulse Cleaning, Cross-Flow, dBA	0	3	5	7	12	9	18	17	24
Barrier, dBA	0	2	3	4	4	5	8	3	18
Marine, dBA	0	1	2	1	2	5	6	9	8

Table 17. Inlet Silencer Insertion Losses for Oil & Gas Applications

Model	Octave Band Center Frequency, Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
Saturn	0	1	2	3	15	25	48	55	37
Centaur & Taurus 60	1	2	3	4	17	32	46	47	31
Taurus 70	1	2	4	6	22	43	47	55	52
Mars	2	4	7	16	40	50	51	55	55
Titan	3	7	13	23	40	54	57	59	48

Table 18. Inlet Silencer Insertion Losses for Power Generation Applications

Model	Octave Band Center Frequency, Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
Saturn	0	1	2	3	15	25	48	55	37
Centaur & Taurus 60	1	2	3	4	18	38	46	54	50
Taurus 70	1	3	7	11	20	40	55	53	41
Mars	3	6	15	24	35	55	55	55	45
Titan	0	1	5	8	27	48	55	61	60

Table 19. Exhaust Silencer Insertion Losses for Oil & Gas Applications

Model	Octave Band Center Frequency, Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
Saturn	0	1	4	8	13	19	17	14	8
Centaur & Taurus 60	1	2	6	12	17	21	19	14	10
Centaur & Taurus 60 (floor standing)	2	4	9	19	26	29	23	20	13
Taurus 70	2	4	8	16	22	26	22	19	12
Taurus 70 (floor standing)	2	5	11	22	30	36	34	29	13
Mars (1.5 m (5 ft) long)	1	3	6	11	16	18	19	19	17
Mars (3 m (10 ft) long)	3	5	10	19	28	34	34	33	22
Titan	1	6	10	20	35	38	36	24	16

Table 20. Exhaust Silencer Insertion Losses for Power Generation Applications

Model	Octave Band Center Frequency, Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
Saturn (floor standing)	3	5	11	19	22	28	26	17	14
Centaur & Taurus 60	1	2	6	12	17	21	19	14	10
Centaur & Taurus 60 (floor standing)	2	4	9	19	26	29	23	20	13
Taurus 70	2	5	10	16	21	26	26	24	17
Taurus 70 (floor standing)	2	5	11	22	30	36	34	29	13
Mars	1	3	6	11	16	18	19	19	17
Titan	1	6	10	20	35	38	36	24	16

5 Sample Calculations

Calculate the octave band sound pressure levels and the A-weighted sound level from the combustion air inlet and exhaust and the oil cooler of a *Centaur* 40 gas turbine compressor set at a receiver 152 m (500 ft) from the site. The exhaust stack is 12.2 m (40 ft) high. Assume that the ground elevation at the receiver is the same as the site (see Figure 13). Because the receiver height above ground is 1.5 m (5 ft) (by convention), subtract the 1.5-m (5-ft) receiver height from the 12.2-m (40-ft) stack height to get 10.7 m (35 ft). Now, calculate the angle from the top of the exhaust stack to the receiver:

Equation (5)

$\theta = \tan^{-1}$ (10.7 m/152 m) = 4 degrees

$\theta = \tan^{-1}$ (35 ft/500 ft) = 4 degrees

Checking the directivity of the exhaust stack in Figure 5, 94 degrees compared with 90 degrees is insignificant, so a directivity correction will not be made.

Site data will be filled in on the Noise Analysis Form (Figure 14). From Table 5, enter the octave band sound pressure levels for the *Centaur* 40 gas turbine inlet in Line 1 of the Noise Analysis Example (Figure 15). Next, enter the octave band insertion losses for an inlet filter from Table 16 in Line 2. For this example, the pulse cleaning up-draft type has been selected. Then, enter the octave band insertion losses for an inlet silencer from Table 17 (*Centaur* and *Taurus* 60) in Line 3. Select the distance attenuation from Figure 4 for 152 m (500 ft). Enter the distance attenuation values in Line 4. Subtract the air filter and inlet silencer insertion losses and the distance attenuation from the inlet noise levels in Line 1, and enter the results in Line 5.

Now, repeat the procedure for the exhaust. Using the exhaust octave band sound pressure levels from Table 6 for the *Centaur* 40 gas turbine, enter the exhaust sound levels in Line 6. Enter the insertion losses for the exhaust silencer from Table 19 (*Centaur* and *Taurus* 60) in Line 7. Enter the distance attenuation (the same as previously determined for the inlet) in Line 8. Subtract the exhaust silencer insertion losses and the distance attenuation from the exhaust noise levels in Line 6, and enter the results in Line 9.

Next, enter the lube oil cooler sound pressure levels from Table 15 in Line 10. For this example, the 100 dBA sound power level cooler has been selected. Enter the distance attenuation in Line 11 (it is the same for the inlet and exhaust systems). Subtract the distance attenuation in Line 11 from the oil cooler sound levels in Line 10, and enter the result in Line 12.

Finally, combine the sound levels in Lines 5, 9 and 12 by logarithmically summing the octave band sound pressure levels in these three lines. This can be accomplished by using Figures 7 and 9 and following the procedure described in Section 3.5, “Combining Sound Levels.” Enter the combined octave band sound pressure levels in Line 13.

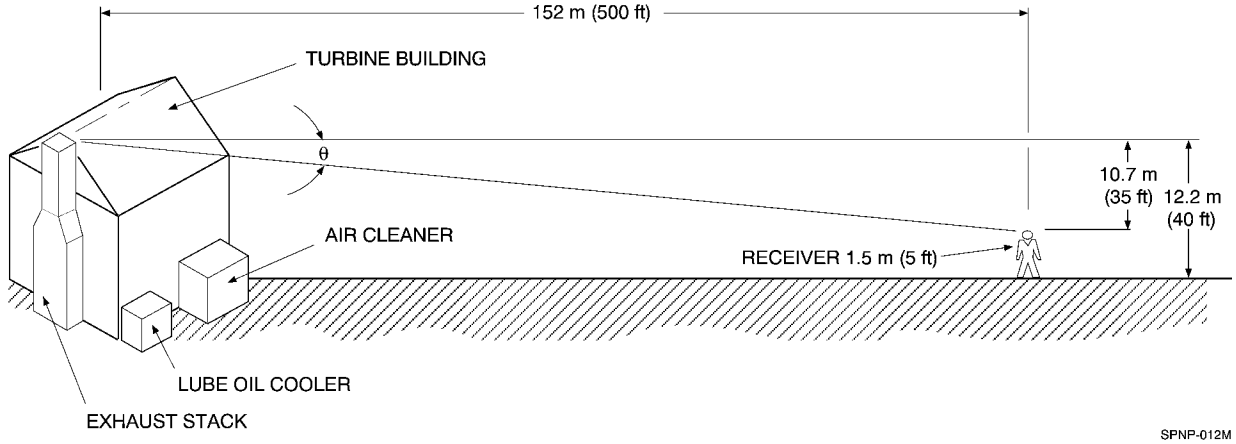


Figure 13. Site Example

Customer:								Date:			
Subject:								Project No.:			
Engineer:											
		Octave Band Center Frequency, Hz									
Line	Source	31.5	63	125	250	500	1000	2000	4000	8000	dBA
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											

Figure 14. Noise Analysis Form

Customer: Super Pipelines, Inc.											**Date:** 10 October 2003
Subject: *Centaur* 40 Inlet, Exhaust and Oil Cooler @152 m (500 ft)											**Project No.:** 12345
Engineer: Solar Turbines Incorporated											
		Octave Band Center Frequency, Hz									
Line	**Source**	**31.5**	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dBA***
1	Inlet Lp @15 m (50 ft), dBA (Table 5)	75	81	87	88	89	91	94	117	109	118
2	Pulse Cleaning Up-Draft Air Filter, dBA (Table 16)	-2	-4	-8	-9	-13	-26	-27	-27	-33	--
3	Inlet Silencer, dBA (Table 17)	-1	-2	-3	-4	-17	-32	-46	-47	-31	--
4	Adjust to 152 m (500 ft), dBA (Figure 4)	-20	-20	-20	-20	-20	-21	-21	-23	-28	--
5	Net Inlet Lp @152 m (500 ft), dBA (add lines 1 to 4)	52	55	56	55	39	12	0	20	17	48
6	Exhaust Lp @15 m (50 ft), dBA (Table 6)	84	92	88	90	89	88	81	72	66	91
7	Exhaust Silencer (Table 19)	-1	-2	-6	-12	-17	-21	-19	-14	-10	--
8	Adjust to 152 m (500 ft), dBA (Figure 4)	-20	-20	-20	-20	-20	-21	-21	-23	-28	--
9	Net Exhaust Lp @152 m (500 ft) (add lines 6 to 8)	63	70	62	58	52	46	41	35	28	55
10	100 dBA Oil Cooler Lp @15 m (50 ft) (Table 16)	73	80	77	70	65	62	58	54	49	68
11	Adjust to 152 m (500 ft), dBA (Figure 4)	-20	-20	-20	-20	-20	-21	-21	-23	-28	--
12	Net Cooler Lp @152 m (500 ft) (subtract line 11 from line 10)	53	60	57	50	45	41	37	31	21	48
13	Sum of Sources, dBA (add lines 5, 9 and 12)	64	71	64	60	53	47	42	37	29	56
14	3 Gas Turbines (Eq. 6)	5	5	5	5	5	5	5	5	5	--
15	Net, 3 Gas Turbines (add lines 13 and 14)	69	76	69	65	58	52	47	42	34	61
16	Octave Band A-Weighted Correction (Table 4)	-39	-26	-16	-9	-3	0	1	1	-1	--
17	A-Weighted Sound Level (subtract line 16 from line 15)	30	50	53	56	55	52	48	43	33	61

* To calculate an A-weighted sound level from an octave band sound pressure level, subtract the octave band A-weighted correction in Table 4 from the octave band sound pressure level, then add the resulting A-weighted octave band sound pressure level using Figure 9.

Figure 15. Noise Analysis Example

If there is more than one gas turbine package, the multiple package sound pressure levels can be increased by using Figure 7 or Eq. 5. In this example, three gas turbine packages are assumed, and the increase over one package is 5 dBA. Enter 5 dBA for each octave band in Line 14. Add Line 13 and Line 14 and enter the result in Line 15. Line 15 represents the octave band sound pressure levels for three gas turbine packages.

Finally, in Line 16, enter the A-weighted octave band sound pressure level corrections from Table 4. Subtract the A-weighted corrections in Line 16 from Line 15 and enter the result in Line 17. These are the A-weighted octave band sound pressure levels. Using the procedure described in Section 3.5, "Combining Sound Levels," logarithmically sum these A-weighted octave band sound pressure levels in Line 17 to get the A-weighted sound level and enter this value into the "dBA" column of Line 17.

It is recommended that the A-weighted sound level of each sound source (inlet, exhaust, and lube oil cooler) be calculated and entered in the "dBA" column for that source. The procedure is the same as the one described above for Lines 16 and 17. Having an A-weighted sound level for each source allows the evaluator to identify the sound source contributing the highest A-weighted sound level. If the calculated sound level of the sum of the three sources is too high, the sound source contributing the highest sound level to this sum can be reduced first. In the example, the exhaust A-weighted sound level (55 dBA) is the loudest source. If the exhaust silencer is replaced with a silencer that results in a 48 dBA exhaust sound level, the sum of the three sources would be reduced from 56 to 53 dBA. Likewise, the A-weighted sound level of the three gas turbines would be reduced from 61 to 58 dBA.

5.1 MORE THAN ONE GAS TURBINE

There may be more than one gas turbine at a site. If there are three, for example, Eq. 5 and the procedure described below can be used to incrementally increase the noise level from one gas turbine to three:

Equation (6)

$Lp_N = 10 \log_{10} N$, dBA

where:

Lp_N = Increase in noise level produced by N number of identical noise sources (gas turbines)

N = Number of noise sources (gas turbines)

For three gas turbines, $Lp_N = Lp_3 = 5$ dBA. In the example in Figure 15, the increase in noise level for three gas turbines (Line 14) has been calculated logarithmically, but the increase has been added algebraically to the sum of the sources (Line 13) to get the noise level of three gas turbines (Line 15).

5.2 CALCULATING THE DAY-NIGHT SOUND LEVEL (Ldn)

If the day/night sound level is desired, calculate it using Eq. 7:

Equation (7)

$$Ldn = 10\log_{10}\left[\frac{1}{24}\left(\sum_{i=1}^{15} 10^{(La_i/10)} + \sum_{i=16}^{24} 10^{((La_i+10)/10)}\right)\right], dB$$

where: L_A = A-weighted sound level

The first term in the equation is summed over 15 hours using the calculated A-weighted sound level. The second term is summed over 9 hours using the A-weighted sound level plus 10 dBA. The 15-hour summation represents the time from 7 a.m. to 10 p.m. The 9-hour summation represents the time from midnight to 7 a.m. plus the time from 10 p.m. to midnight. This is because the day/night sound level is calculated for one day, a 24-hour period from midnight to midnight, with the nighttime hours (midnight to 7 a.m. and 10 p.m. to midnight) weighted by adding 10 dBA to them.

From Line 17 in Figure 15, the A-weighted sound level is 61 dBA. Using Eq. 7, the day/night sound level is calculated to be 67.4 dBA, rounded to 67 dBA.

6 Source Sound Power Levels

Although unsilenced sound pressure levels from the inlet, exhaust and casing of the gas turbine package are given in this document, customers sometimes request source sound power levels instead. Source sound power levels are properly determined from sound pressure levels, or sound intensity levels, that have been measured in accordance with a test standard specifically intended for use in calculating sound power levels. With the exception of the exhaust sound data, the sound pressure levels in this document were not measured with the intent of using them to calculate source sound power levels. Sound power levels calculated as described in this section for the casing and combustion air inlet will not be as accurate as levels obtained from the test procedures described in appropriate standards.

When source sound power levels are requested, they are calculated from the sound pressure levels in Tables 5, 6, 11 and 12, using Eq. 8, and in Tables 7, 9 and 13 using Eq. 9:

Equation (8)

$$Lw = Lp + 20 \log_{10} R + K, \text{ dBA}$$

where:

Lw = Sound power level

Lp = Sound pressure level from Table 5 or 11 (inlet) and Table 6 or 12 (exhaust)

R = 15 m (50 ft)

K = -8 dBA for R in meters
(+2.4 dBA for R in feet)

Calculating the casing sound power level for the unenclosed package or for the enclosed package requires knowledge of the package dimensions (length, width and height). The calculation uses the following procedure:

1. Add 2.0 m to the length and width. For enclosed packages, add 1.0 m to the height. For unenclosed packages, assume the package is enclosed and add 1.0 m to the equivalent enclosed package height.
2. Calculate the surface area (S) of a parallelepiped created with these larger dimensions (Figure 16).
3. Calculate the package sound power level using Eq. 9:

Equation (9)

$$Lw = Lp + 10 \log_{10} S, \text{ dBA}$$

where:

Lw = Sound power level

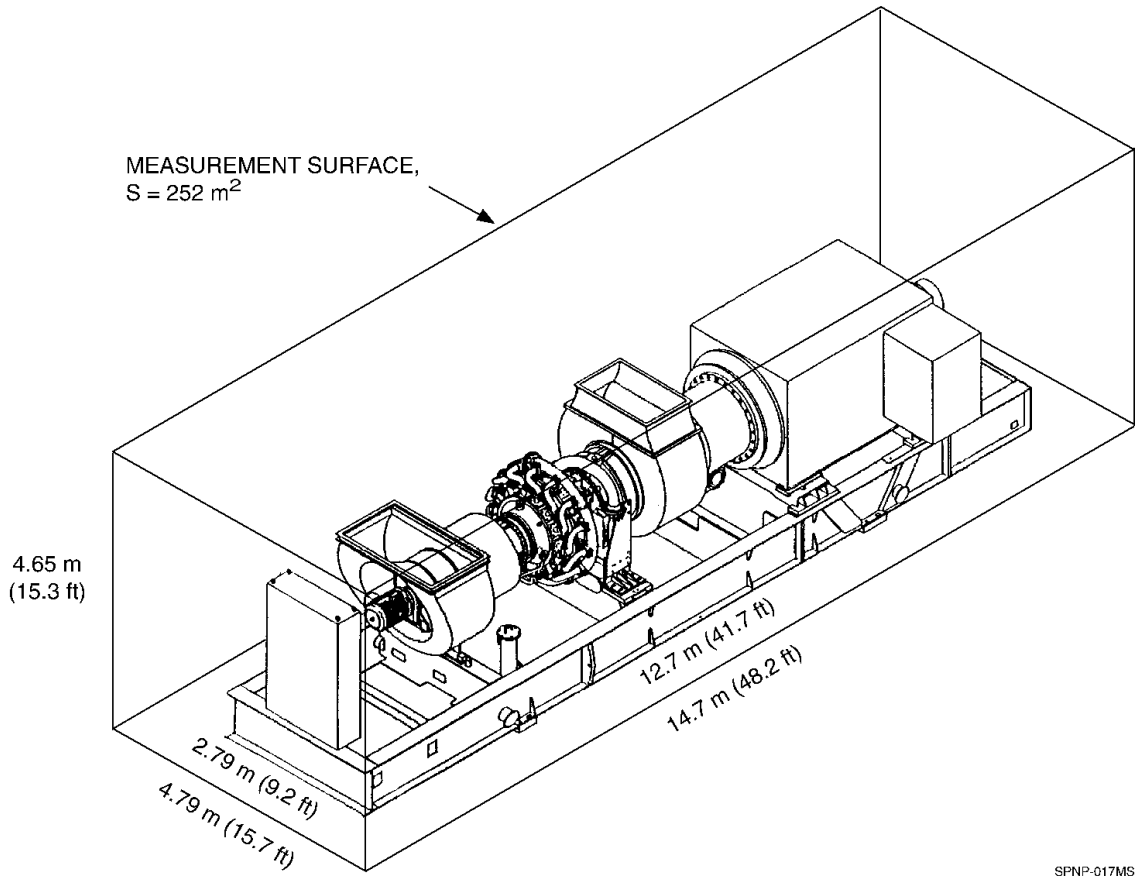
Lp = Sound pressure level from Table 7, 8, 13 or 14 (unenclosed) or from Table 9 or 10 (enclosed)

S = Parallelepiped area in square meters

The exhaust sound pressure levels in Tables 6 and 12 are calculated from sound power levels obtained from sound measurements taken in accordance with ISO Standard 10494 and extrapolated to 15 m (50 ft) using hemispherical divergence. Therefore, sound power levels calculated from the data in Tables 6 and 12 using Eq. 8 and R = 15 m (50 ft) are the sound power levels obtained from the procedure defined in ISO Standard 10494 (1993).

The inlet sound pressure levels were measured at 15 m (50 ft) from the inlet duct flange, on the duct centerline, as shown in Figure 11. This measurement position is the location from which the inlet sound power levels are calculated: R = 15 m (50 ft).

The casing sound pressure levels were measured from positions around the base skid and averaged to obtain the values in the data tables. The location from which the casing sound power levels are calculated is shown in Figure 12. Note that directivity effects are not included in the calculation of the source sound power levels described above. Directivity effects are not included in the averaging of the casing sound pressure levels given in the data tables and there is no advantage gained by considering the directivity effects when calculating the casing sound power levels. For the inlet and exhaust noise, directivity effects should be employed when the noise receiver is not in line with the noise source and the measurement position, as shown in Figures 10 and 11. To calculate the directivity effect for the inlet or exhaust sources, use Figure 5 and follow Example 1 under Section 3.4, “Directivity Effects.”



(Measurement surface extends 1.0 m (3 ft) from base skid and
1.0 m (3 ft) above equivalent height of enclosed package.)

Figure 16. Power Generation Package with Sound Measurement Surface

7 Appendix

7.1 OCCUPATIONAL NOISE EXPOSURE STANDARDS

The workplace noise standards in most countries specify an 8-hour exposure limit of 85 dBA, although some have a 90 dBA limit. In these standards, the 8-hour exposure limit above which engineering or administrative controls must be applied is also 85 to 90 dBA. Some countries apply an 8-hour exposure limit of 80 dBA while utilizing an 85 dBA 8-hour exposure limit for the application of engineering and administrative controls. Discussed below are three workplace noise standards: The United States Occupational Noise Exposure Standard and the European Union's Council Directives 86/188/EEC and 2003/10/EC. Please refer to these for a complete explanation of the their requirements.

These standards apply to the sound levels in the workplace. They do not establish limits for the sound levels from machinery or other equipment. It is popularly assumed that a requirement for machinery to meet the OSHA or the EU standards means that workplace sound levels from the machinery will not exceed 85 dBA. However, the sound level in the workplace is a function of the workplace environment and the number and sound levels of the other machines in the workplace. Workplace sound levels equal to or greater than 85 dBA can be in compliance with these standards, if the provisions of the standards are met.

7.1.1 United States Occupational Noise Exposure Standard

The U.S. Department of Labor Occupational Safety and Health Administration (OSHA) Noise Exposure Standard of May 29, 1971 established a standard for noise exposure in the workplace. This standard was amended on March 8, 1983 with the addition of the Hearing Conservation Amendment, which described conditions and requirements for hearing conservation programs and lowered the 8-hour exposure action level from a sound level exceeding 90 dBA to a sound level equal to or greater than 85 dBA. This standard is known as the OSHA standard.

OSHA Standard

The OSHA standard requires protection against the effects of noise exposure when the sound levels exceed those shown in Table 21 (Table G-16 from the standard), when measured on the A scale of a sound level meter at slow response. The standard also allows determination of the A-weighted sound level from octave bands and it defines a procedure for this.

Table 21 defines permissible exposure levels. When these exposure levels are exceeded, the standard requires employers to implement feasible administrative or engineering controls. If these controls do not reduce the sound levels within the levels of Table 21, the employer must provide personal protective equipment to employees and employees must wear them to reduce the exposure levels to the levels in the table.

Table 21. Permissible Noise Exposures

Duration per Day, hours	Sound Level, dBA slow response
8	90
6	92
4	95
3	97
2	100
1½	102
1	105
½	110
¼ or less	115

When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. If the sum of the following fractions: $C_1/T_1 + C_2/T_2 + \ldots + C_n/T_n$ exceeds unity, then the mixed exposure should be considered to exceed the limit value. C_n indicates the total time of exposure permitted at that level and T_n indicates the total time of exposure permitted at that level.

Exposure to impulsive or impact noise should not exceed 140 dBA sound pressure level.

Hearing Conservation Program

The hearing conservation program is intended to minimize employee hearing loss from exposure to noise. The amendment to the OSHA standard requires implementation of a hearing conservation program when an employee's noise exposure equals or exceeds an 8-hour time-weighted

average A-weighted sound level of 85 dBA measured on the sound level instrument's slow response scale. The hearing conservation program is composed of:

1. Monitoring of the workplace noise levels
2. Notifying employees of the results of noise monitoring
3. Providing an opportunity for employees or their representatives to observe the noise measurements
4. Establishing and maintaining an audiometric testing program
5. Providing hearing protectors to employees
6. Maintaining a training program to inform employees of the effects of noise on hearing, the purpose of hearing protectors, including their use, fitting, care, and selection
7. Access to information and training materials
8. Maintaining accurate records of employee exposure measurements and employee audiometric test results

7.1.2 Council Directive 86/188/EEC

This directive of May 12, 1986 specifies two action levels: 85 and 90 dBA. Instantaneous C-weighted peak sound level limits also apply, but are not discussed here.

Employers are required to evaluate workplace noise levels and worker noise exposures to identify the persons and locations where the provisions of the directive apply.

Where daily personal exposure is likely to exceed 85 dBA, information and training relative to the risks of this exposure must be provided to workers and their representatives, and they must also be informed of the measures taken in accordance with the requirements of the directive. Additionally, hearing protectors must be made available.

If it is not practicable to reduce a worker's daily personal exposure level below 85 dBA, the worker "shall be able to have his hearing checked by a doctor."

If a worker's daily personal noise exposure exceeds 90 dBA, technical and/or organizational measures must be employed to reduce the exposure as much as practicable. Hearing protectors must be used, and workers and their representatives must be informed of the excess exposure level and the measures taken to reduce it. Access to areas where this exposure could occur must be limited, and signs must be posted to define the area.

7.1.3 Council Directive 2003/10/EC

Council Directive 86/188/EEC was repealed with the publication of Council Directive 2003/10/EC in the Official Journal of the European Union on February 15, 2003. The Member States of the EU have until February 15, 2006 to implement their own laws or regulations needed to comply with it. Until a Member State has implemented this directive, Council Directive 86/188/EEC remains in force.

Council Directive 2003/10/EC specifies an 8-hour exposure limit value of 87 dBA, an upper exposure action value of 85 dBA, and a lower exposure action level of 80 dBA. These are 8-hour time-weighted average values. Instantaneous C-weighted peak sound level limits also apply, but are not discussed here.

Employers are required to assess and, if necessary, measure the sound levels to which workers are exposed.

The 8-hour exposure limit value, 87 dBA, is the absolute maximum level an individual can be exposed to. However, if an individual is exposed to a sound level high enough to result in an 8-hour exposure level greater than 87 dBA, hearing protection devices (HPs) can be used to reduce the 8-hour exposure level to 87 dBA. HPs cannot be used to reduce the 8-hour exposure level to the 8-hour upper action value of 85 dBA. Therefore, in an environment that would expose personnel not using HPs to an 8-hour exposure level above 87 dBA, personnel using HPs are deemed to be exposed to an 8-hour exposure level of 87 dBA, even though the use of HPs reduces the 8-hour exposure to a level well below 87 dBA. Consequently, "technical and/or organisational measures" must be employed to reduce the 8-hour exposure level from 87 dBA to 85 dBA.

If the exposure level equals or exceeds the upper exposure action value, HPs must be worn. If the exposure level exceeds the upper exposure action level, technical or organizational measures must be employed to reduce the exposure and the worker "shall have the right to have his/her hearing checked."

If a worker's exposure level exceeds the lower exposure action value, HPs must be made available and audiometric testing shall be made available to the individual, where a risk to health is indicated.

Workers whose exposure levels equal or exceed the lower exposure action value shall re-

ceive information and training relative to the risks of the exposure.

Weekly noise exposure levels may be used instead of daily noise exposure levels in some circumstances.

7.2 ACOUSTICAL TERMINOLOGY

Acoustical terms used in this document are defined in this section. Most of these definitions are described fully by Harris (1979) and ANSI S1.1-1994.

A-Weighted Sound Level. Weighted sound pressure level obtained by the use of metering characteristics and the A-weighting specified in American National Standard Sound Level Meters for Measurement of Noise and Other Sounds (ANSI S1.4-1983, 1997).

Day/Night Sound Level (Ldn). The 24-hour, time averaged, A-weighted sound level obtained by adding 10 dBA to the sound levels from 10 p.m. to 7 a.m.

Decibel. A unit of level denoting the ratio between two quantities that are proportional to power; the number of decibels corresponding to this ratio is 10 times the logarithm to the base 10 of this ratio.

Far Field. The part of the sound field in which the sound pressure level decreases by 6 dBA for each doubling of distance from the source.

Free Field. A field in a homogeneous, isotropic medium free from boundaries.

Near Field. The part of the sound field that lies between the noise source and the far field. In this region, the sound pressure level does **not** decrease by 6 dBA for each doubling of distance from the source.

Noise. Unwanted sound.

Octave Band. An interval between two sounds having a frequency ratio of two.

Octave Band Sound Pressure Level. The band pressure level in decibels for a frequency band corresponding to a specified octave.

Receiver. A person (or persons) or equipment affected by noise.

Sound. An oscillation in pressure in an elastic medium, which is capable of producing the sensation of hearing. Also, the sensation of hearing caused by a pressure oscillation.

Sound Intensity Level (Li). In decibels, 10 times the logarithm to the base 10 of a given intensity to a reference intensity. The reference intensity is 10^{-12} watt/in.^{2}).

Sound Pressure Level (Lp). In decibels, 20 times the logarithm to the base 10 of the ratio of the pressure of the sound to a reference pressure. The reference pressure is 20 μPa (2 x 10^{-5} N/m^2).

Sound Power Level (Lw). In decibels, 10 times the logarithm to the base 10 of the ratio of a given power to a reference power. The reference power is 10^{-12} watt.

7.3 REFERENCES

AGA Catalog No. S20069, 1969, “Noise Control for Reciprocating and Turbine Engines Driven by Natural Gas and Liquid Fuel,” American Gas Association, December 1969, Table 34.

ANSI S1.1-1994, “Acoustical Terminology.”

ANSI S1.4-1983 (R1997), “Specification for Sound Level Meters.”

ANSI S1.11-1986 (R1998), “Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters.”

ANSI S1.26-1995, “Method for the Calculation of the Absorption of Sound by the Atmosphere.”

ANSI S12.9-1998/Part 5, “Quantities and Procedures for Description of Environmental Sound – Part 5: Sound Level Descriptors for Determination of Compatible Land Use.”

Beranek, L.L., ed., 1988, **Noise and Vibration Control**, Institute of Noise Control Engineering, Figure 18, p. 605.

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Appendix C – OSD-Basis of Design

Borg Manufacturing

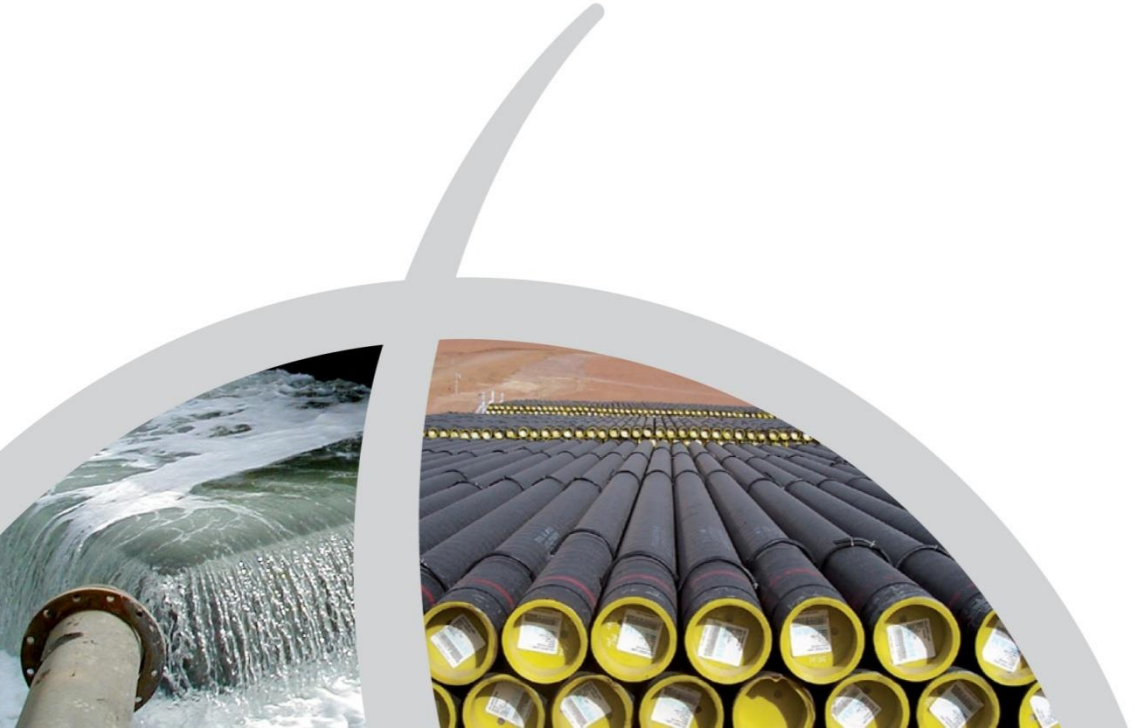
Basis of Design

HP Gas Connection Project

11 September 2018

Document No. 2079-02-EM-BOD-001

Revision 0



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Rev	Status	Prepared by	Checked by	Approved by (OSD)	Approved by (BORG)	Date
0	Issued for Use	NBM	SOT	AJB		11/09/2018

Contents

Appendices

Tables

Figures

1 Introduction

1.1 Overview

Borg Manufacturing (Borg) engaged OSD Pty Ltd (OSD) to design a high-pressure gas connection for their manufacturing plant located at Lowes Mount Road, Oberon NSW. The gas connection will tie into an APA custody transfer point and connect into a proposed pressure reduction station. The pipeline will run within Borg's property.

1.2 Scope

This document provides the basis of design of the gas connection, inclusive of both above ground and below ground infrastructure, between the following battery limits;

- From and including the FIK downstream of the metering skid at the APA site;
- To and including the FIK upstream of the heater at the pressure reduction station.

Figure 1 below, illustrates a preliminary representation of the gas interconnect scope.

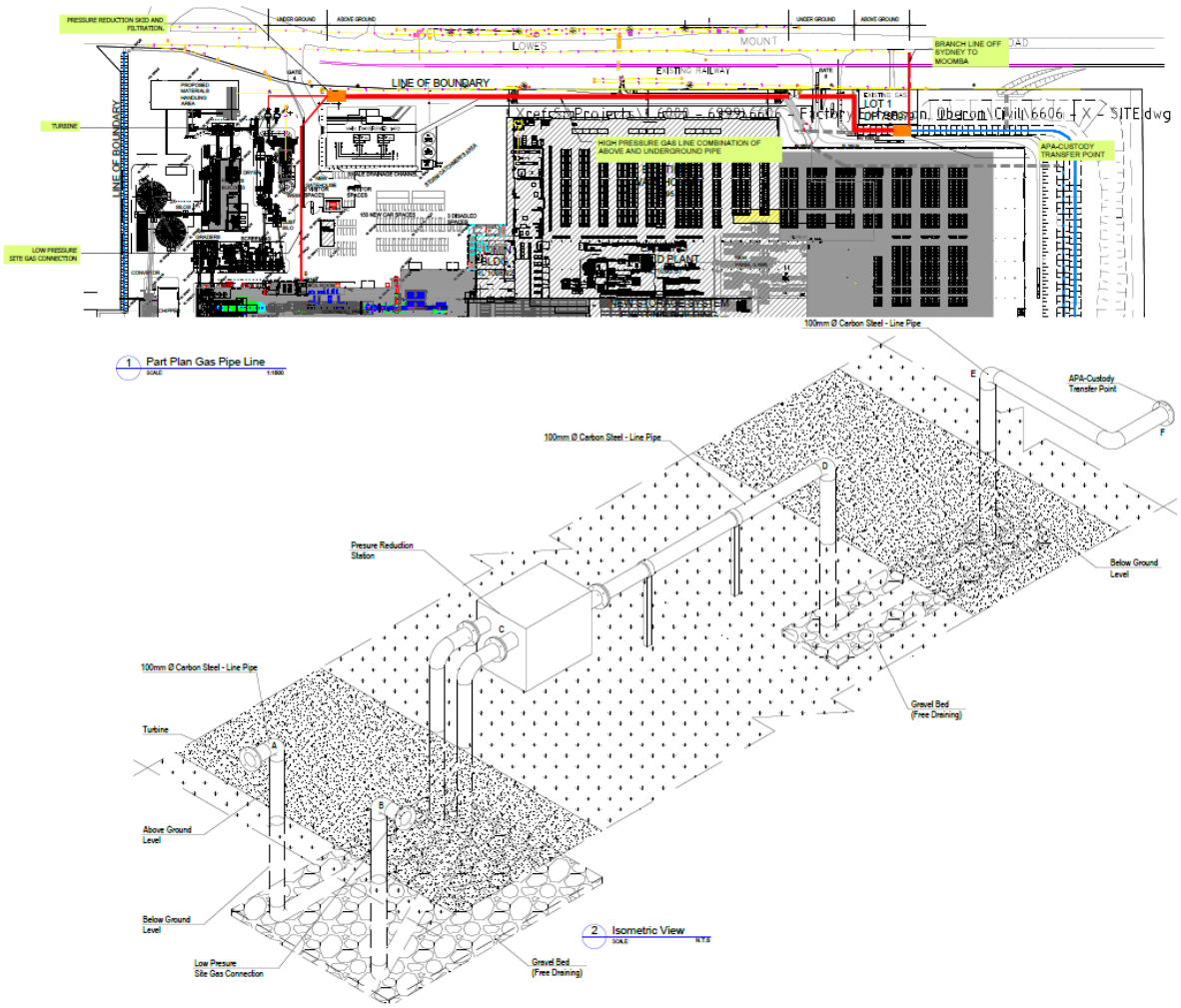


Figure 1: Preliminary Scope of Gas Connection

The scope of this Basis of Design is to define the design requirements applicable to the high-pressure gas connection to achieve compliance to the mandatory standards and legislation.

1.3 Terms and Abbreviations

The following definitions apply throughout this document:

Table 1: Terms and Abbreviations

Term	Definition
APA	APA Group
API	American Petroleum Institute
AS	Australian Standard
ASME	American Society of Mechanical Engineers
BOD	Basic of Design
CP	Cathodic Protection
DCVG	Direct Current Voltage Gradient
FBE	Fusion Bonded Epoxy
MAOP	Maximum Allowable Operating Pressure
MIC	Microbiological Induced Corrosion
NSW	New South Wales
OSD	OSD Pty Ltd
PCM	Pipeline Current Mapping
PRS	Pressure Reduction Station

1.4 Standards, Acts and Regulations

The latest editions of the following standards, acts and regulations are applicable throughout this document:

Table 2: Standards, Acts and Regulations

Document No.	Description
API 5L	Specification for Line Pipe
AS 1170.2	Structural Design Actions - Wind Actions
AS 1170.4	Structural Design Actions - Earthquake Actions in Australia
AS 1554	Structural steel welding - Welding of steel structures
AS 1768	Lightning Protection
AS 2832.1	Cathodic Protection of Metals: Pipes and Cables
AS 2885.1	Pipeline – Gas and Liquid Petroleum: Design and Construction

Document No.	Description
AS 3000	Electrical Installations (Australian/New Zealand Wiring Rules)
AS 3600	Concrete Structures
AS 3862	External Fusion-Bonded Epoxy Coating for Steel Pipes
AS 4100	Steel Structures
AS 4041	Process Piping
AS IEC 61882	Hazard and Operability Studies

The order of precedence shall be as follows:

1. Regulatory, Statutory and Legislative Requirements
2. Australian Standards
3. Industry Standards

1.5 Other Reference Documents

The following resources are referred to throughout this document:

Table 3: Other Reference Documents

Reference No.	Title/Description
2079-02-EL-PLN-001	Fracture Control Plan
2079-02-EL-CAL-001	AS 2885 Calculation Suite
2079-02-EM-CAL-003	AS 4041 Piping Calculations
8840-001-dsb	Eclipse Consulting Engineers, Design Summary Brief

2 Regulatory Requirements

NSW Pipelines Act 1967 Section 5 (1) (c) states that nothing in the Act requires a person to hold a licence if it is "*constructed or to be constructed on land used for residential, business, commercial or industrial purposes, designed for use solely for the residential, business, commercial or industrial purposes carried out on that land and situated wholly within the boundaries of that land"*.

Therefore, given that this gas connection will be wholly within the boundaries of Borg property, Borg's proposed connection need not be classified as a pipeline.

The interconnect gas piping is covered by the scope of AS 4041 - Pressure Piping. AS 4041 Clause 1.1 stipulates that the standard is intended to apply to "*piping within boundaries of chemical manufacturing or processing installations, petroleum refineries, petrochemical plant, gas process plant, refinery tank farms, terminals and bulk handling plants."* Therefore, since the pipework will be constructed within the Borg property boundary, the gas connection can be designed to AS 4041.

AS 4041 deals primarily with aboveground piping. For buried piping, AS 4041 makes reference to AS 2885 for guidance. As such, this design will take into account the appropriate requirements of AS 2885 for the buried piping.

3 Climatic Conditions

The following climatic conditions apply for the gas connection:

Table 4: Applicable Climatic Conditions for Oberon, NSW

Parameter	Value	Source
Ambient Design Temperature (Process Design)	-10 to 40 °C	8840-001-dsb
Maximum Surface Temperature of Metal Exposed to Direct Sun	70 °C	Assumed, typical
1 m Below Surface Temperature	15 to 35 °C	Assumed, typical
Site Elevation	1100 m AHD	8840-001-dsb

4 Gas Composition

The fluid being conveyed is natural gas; the gas composition is based on the indicative composition provided by APA (refer to Appendix B):

Table 5: Gas Composition

Gas Component	Mole Percent (%)		
	Low Methane (Average from 20/09/17 to 02/02/18)	High Methane (Average from 18/04/18 to 05/09/18)	2-Year Average (20/09/18 to 05/09/18)
Methane*	90.8907	96.805	92.894
Ethane	4.800	0.850	3.740
Propane	0.380	0.370	0.380
I-Butane	0.0803	0.042	0.063
N-Butane	0.090	0.044	0.070
I-Pentane	0.033	0.005	0.021
N-Pentane	0.023	0.005	0.016
C6+	0.031	0.005	0.020
Nitrogen	0.798	1.181	0.882
Carbon Dioxide	2.874	0.693	1.914
TOTAL*	100.000	100.000	100.000

* Methane compositions slightly adjusted from data provided to ensure totals are 100%.

5 Process Design

The basis for process design of this scope is obtained from the following resources:

- Gas Flow Diagram by Borg Construction, per **2018 PRS Schematic.pdf**
- General Schematic by Furnace Engineering, per **OSPS schematic.pdf**, per Appendix A
- Oberon Pressure Reduction Skid datasheet, per **Borg Project information_Engineering Jan 2017.pdf**
- APA responses to OSD queries, per Appendix B.

Gas transmitted through the pipeline will be used as turbine, engine and factory supplies. The following table summarises pertinent information on process design for the pipeline based on the above resources:

Parameter	Value
APA Supply	
• Maximum Flowrate	4150 Sm^3/hr or 3303 kg/hr
• Pressure	8000 to 8500 kPag
• MAOP	9930 kPag
• Operating Temperature	0 to 55 °C
Turbine Receipt	
• Nominal Flowrate	50 GJ/hr
• Pressure	1600 to 3400 kPag
• Nominal Temperature	28°C
Engine Receipt	
• Nominal Flowrate	40 GJ/hr
• Pressure	600 to 800 kPag
• Nominal Temperature	28°C
Factory Receipt	
• Nominal Flowrate	70 GJ/hr
• Pressure	100 to 200 kPag
• Nominal Temperature	20°C

6 Pipeline Design

Key design parameters for the pipeline are listed in Table 6, below.

Table 6: Key Pipeline Design Parameters

Parameter	Value
System Design Life	40 years
Pipeline Diameter	DN100
Line Pipe Fabrication	HFW

Parameter	Value
Line Pipe Material	API 5L X52
Corrosion Allowance	0.0 mm
Other Allowances	0.0 mm
Mill Tolerance	0.0 mm
MAOP = Design Pressure	9.93 MPag
Minimum Design Temperature	-10 °C
Minimum Operating Temperature	0 °C
Normal Operating Temperature	25 °C
Maximum Operating Temperature	55 °C
Maximum Design Temperature (Below Ground)	55 °C
Maximum Design Temperature (Above Ground) - Solar Radiation	70 °C
Design Factor (Below Ground, Maximum)	0.8
Design Factor (Above Ground, Maximum)	0.67
Design Factor (Road Crossings, Maximum)	0.72

6.1 Odorant

Gas transported through the gas connection is odorised upstream by APA and no odorant injection facilities are required for this project.

6.2 Corrosion

Internal corrosion protection is not required as the sales gas from APA is dry gas.

External corrosion protection is provided by a three layer polyethylene coating (3LPE), with a field applied heat shrinkable sleeves or a similar material.

A galvanic anode cathodic protection (CP) system shall be applied to the pipeline, with flange insulating kits (FIKs) at each end to electrically isolate the buried section from the above ground facilities. The cathodic protection system shall be in accordance with AS 2832.1, as illustrated in the Cathodic Protection Schematic Diagram (2079-02-EL-SCD-001).

If required, additional protection may be provided to monitor the effects of electrical interference from external sources including stray currents, power transmission structures and lightning strikes.

6.3 Microbiologically Induced Corrosion

Microbiologically induced corrosion (MIC) assessment is not required as gas supplied by APA is sales gas quality.

6.4 Fatigue

The impact of fatigue on the pipeline was assessed in accordance with Appendix N of AS 2885.1 for the below ground pipework and documented in AS 2885 calculation (2079-02-EL-CAL-001). The assessment concluded that the maximum allowable pressure fluctuation of two pressure cycles per day is 10.55 MPa, which corresponds to two shutdowns and startups per day. As this is not a credible scenario, pipeline fatigue will not be an issue.

Fatigue design at pipeline crossings satisfies the requirements of API RP 1102.

6.5 Stress and Strain

The pipeline shall be designed such that the stresses and strains imposed upon it are within the limits set by AS 4041 and AS 2885.

6.6 Vibration

Acoustically Induced Vibration (AIV) energy generation occurs immediately downstream of high flow rate and high differential pressure flow restriction devices. Flow Induced Vibration (FIV) may be driven by high flow velocities in small diameter piping system. Susceptibility of the pipeline to AIV and FIV fatigue failure does not require evaluation as there is no such connection on the pipeline.

6.7 Crossings

The design of buried crossings complies with AS 2885.1 per the following typical crossing drawings applicable for this pipeline:

- 2079-02-EM-DTL-003: Road Crossing (Open Cut) Standard Drawing
- 2079-02-EM-DTL-004: Foreign Service Crossing Standard Drawing

All crossings shall be open cut. The location(s) of crossing(s) will be shown on the pipeline alignment sheet.

6.8 Buoyancy Control (Submerged and Inundated Land)

The pipeline shall be designed and constructed to ensure that it is not be subjected to displacement from its installed location as a result of short or long term inundation at its full depth of cover or reduced depth of cover.

6.9 Bends

Changes in direction are achieved, in order of preference, by roped bends, cold field bends or induction bends.

- Induction bends have a bend radius of 5D.
- Cold field bends have a bend radius of 40D from a maximum bend angle per diameter length of 1.5°.

6.10 Welding

The pipeline shall be constructed from welded joints in accordance with AS 2885.2.

6.11 Fittings

Fittings used for the fabrication of pipeline assemblies connected to the main run of the pipeline are "high test" fittings complying with either MSS SP 75 or MSS SP 92. The fitting strength is matched to the pipeline material strength.

Fittings not connected to the main run of the pipeline are either fabricated from either high tensile or standard materials.

The design of fittings shall minimise the requirements for transition pieces to be installed in between pipes and fittings of different grades and thicknesses.

6.12 Depth of Cover

The pipeline will be installed with a nominal depth of cover of 1200 mm which is in excess of AS 2885.1 Table 5.5.2. The depth of cover changes along the pipeline will be documented in the alignment sheets.

6.13 Warning Signs

Pipeline marker signs will be installed along the pipeline route. These will be designed and installed in accordance with AS 2885.1 for the buried section. Markers will be double sided and will be installed with a maximum spacing as indicated in Table 4.4.1 of AS 2885.1, which is 100 m for this pipeline.

Where the pipeline crosses minor features such as tracks, signs will be installed as required by the feature, having regard to the proximity of adjacent signs and the utilisation of the feature.

6.14 Marker Tape

Pipeline marker tape shall be installed 300 mm above the pipeline for the entire pipeline route. Pipeline marker tape installation is as per Trench Details Standard Drawing (2079-02-EM-DTL-002).

6.15 Safety Studies

Following safety studies will be completed for this pipeline:

- HAZOP
- Safety Management Study based on AS2885.1 methodology

6.16 Acceptance Testing

Line pipe material and associated components will be subjected to destructive and non-destructive tests to demonstrate their fitness for purpose. The minimum standard is the requirements of AS 2885 and the referenced codes or design specific codes. Each acceptance test shall be documented, approved, and included in the project deliverables.

6.16.1 Weld Examination

Pipeline girth welds shall comply with the requirements of AS 2885.2, acceptance criteria Tier 1.

100% of the mainline butt welds shall be subjected to non-destructive radiography examination or ultrasonic testing.

Inspection of pipeline facilities piping shall comply with the requirements specified in the facilities pipe specifications, or the requirements of an approved shop welding standard which meets the requirements of AS 2885 inspection criteria.

6.16.2 Coating Inspection

All mill applied external coatings shall be subjected to 100% holiday detection at the coating plant, and immediately prior to installation (lowering into the trench). The test shall be performed at the appropriate voltage as specified by the relevant Standard or the manufacturer's recommendation.

After pipeline installation, the coating integrity shall be assessed by conducting a DCVG survey over the length of the pipeline. Identified defects of the agreed size range shall be excavated and repaired.

6.16.3 Hydrostatic Testing

Hydrostatic testing of the pipeline shall be carried out in accordance with the requirements of AS4041 and not exceeding 15.3 MPag.

On completion of testing and dewatering, the pipeline shall be cleaned to remove all debris and dust to a level of less than 50 microns, and dried to a water dew point of -20 °C.

7 Route and Environmental Conditions

7.1 Location Classification

Pipeline location classification was designated in accordance with AS 2885.1, based on a review of the pipeline route.

The primary location classification is Residential (T1) for the entire length of the pipeline. As such, the entire pipeline is designated as a high consequence area and the requirements for no rupture and a limited energy discharge rate shall apply, as per sections 4.7.2 and 4.7.3 of AS 2885.1.

7.2 Excavator Threats

The pipeline has been designed such that the penetration resistance required by the location classification is achievable for the largest size excavator threat which can be credibly expected to be operated along the pipeline route.

The largest size excavator threat in the vicinity of the pipeline is assumed to be a 25T excavator equipped with tiger teeth.

Penetration resistance calculations have been performed with a B factor of 1.3 due to the high consequence area.

7.3 Normal Conditions

Under normal conditions, the pipeline shall be fully restrained by installing the pipeline in an excavated, backfilled and compacted trench.

7.4 Unstable Soil Conditions

The pipeline route has been selected to avoid, where practicable, land identified as unstable, either as a result of landslip or settlement. No seismic fault line crossings and unstable land have been identified along the pipeline.

7.5 Foreign Services

Where required, the pipeline will be installed below other existing services. Clearance between the pipe utility shall meet the minimum requirements of AS 2885 and the service owners' requirements. The minimum depth of cover requirement shall be maintained at all existing service crossings.

Marker tape shall be placed above the foreign service, in line with the pipeline, and also between the foreign service and the pipeline along the entire easement. Refer to Section 6.14 for details on marker tape.

Standard requirements of foreign crossings are detailed in the Foreign Services Crossing Standard Drawing (2079-02-EM-DTL-004).

The location(s) of foreign crossing(s) are to be shown on the pipeline alignment sheet.

7.6 Erosion

Sampling and testing of soil for erosion potential shall be conducted along the route and appropriate design controls implemented.

7.7 Acidic and Sodic Soils

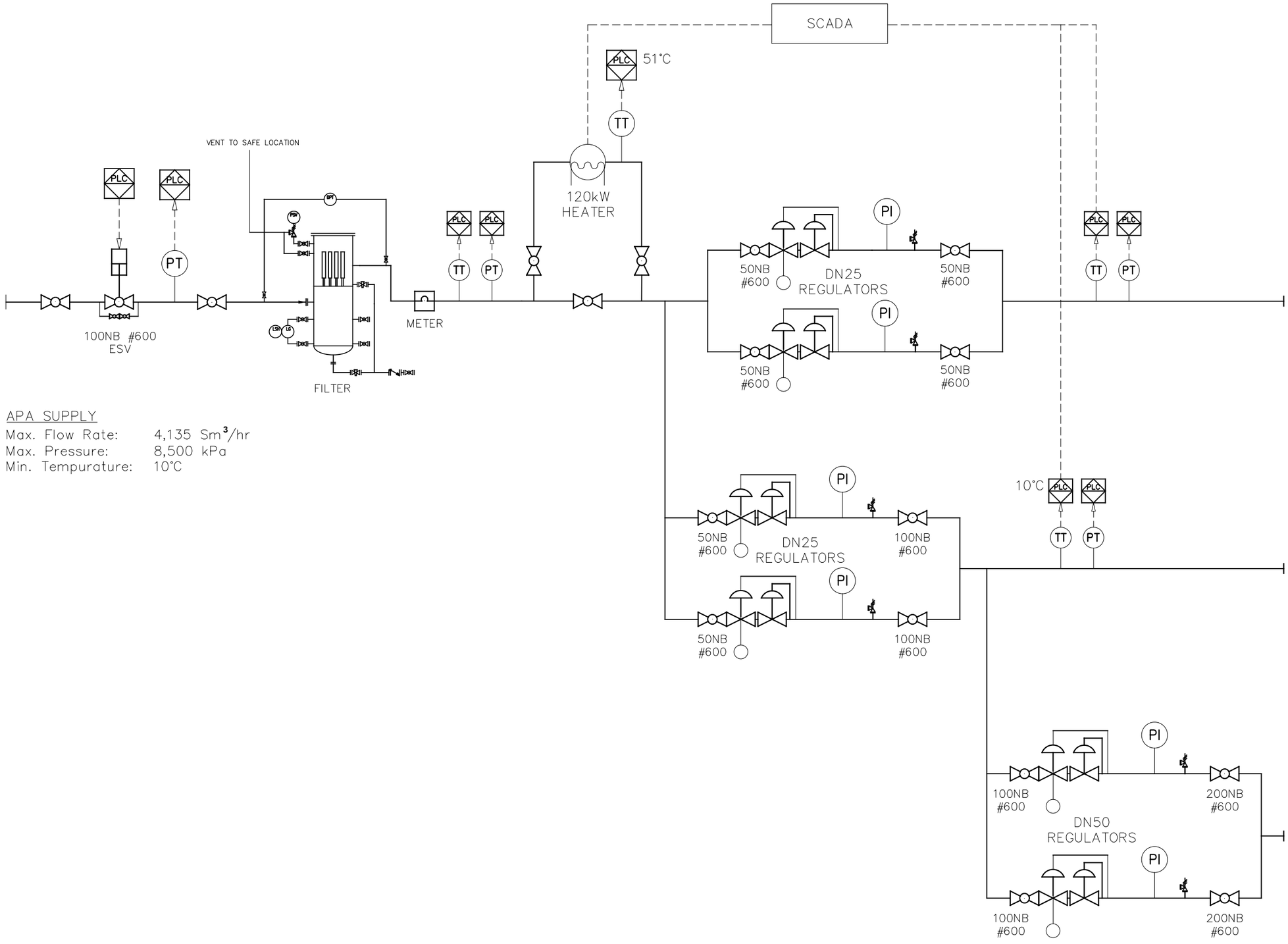
Sampling or testing for acidic and sodic soils shall be carried out to assess the potential threat to both buried concrete and steel.

7.8 Electrical Hazards on Pipeline

Electrical hazards on the pipeline, Earth Potential Rise (EPR) and Low Frequency Induction (LFI), effects on the pipeline are expected as the pipeline parallels an overhead powerline. The assessment of electrical hazards on the pipeline shall be completed in accordance with the requirements of AS 4853.

AS 4853 requires provides a 3-level design process; it is expected that the pipeline design as-is will not comply with a conservative Level 1 assessment. At minimum, a Level 2 assessment shall be conducted for this pipeline.

Appendix A
Process Schematic



APA SUPPLY

Max. Flow Rate:	4,135 Sm^3/hr
Max. Pressure:	8,500 kPa
Min. Tempurature:	10°C

TURBINE SUPPLY

Max. Flow Rate:	1,297 Sm^3/hr
Nom. Pressure:	3,000 kPa
Tempurature:	23°C
Connection:	DN50 CL300

ENGINE SUPPLY

Max. Flow Rate:	1,038 Sm^3/hr
Nom. Pressure:	700 kPa
Tempurature:	12°C
Connection:	DN100 CL150

FACTORY SUPPLY

Max. Flow Rate:	1,800 Sm^3/hr
Nom. Pressure:	150 kPa
Tempurature:	8°C
Connection:	DN200 CL150

REVISIONS NO.	DESCRIPTION	REV. BY	DATE	APPR. BY
A	ORIGINAL RELEASE – PRELIMINARY	M.A.	12/12/17	

GENERAL NOTES

FURNACE ENGINEERING PTY.LTD
A.B.N. 63 006 276 786

A1

THIRD ANG. PROJ
AUST STD AS1100

AUTOCAD 2007

CAD FILE No.

DESIGNED:
DRAWN:
DATE:
CHECKED:
APPROVED:
SCALE:

TITLE: GENERAL SCHEMATIC

FOR INFORMATION ONLY

CLIENT
Doc. No.

DRG. NO.

SHT. NO. 1/1

REV

Appendix B
APA Responses to OSD Queries

Norzaki Mizan

From: Soheil Taherian
Sent: Thursday, 6 September 2018 8:31 AM
To: Norzaki Mizan
Subject: FW: 2079 - TQ from the APA phone meeting

FYI.

Regards,

Soheil Taherian
Supervising Pipeline Engineer, CPEng

Level 2, 349 Coronation Drive, Milton QLD 4064
Tel +61 7 3377 4156 **Mob** +61 421 084 997 **www.OSDlimited.com**

From: Stephen Sizer <sizers@borgs.com.au>
Sent: Wednesday, 5 September 2018 2:28 PM
To: Andrew Bailey <Andrew.Bailey@osdlimited.com>; Soheil Taherian <Soheil.Taherian@osdlimited.com>
Subject: FW: 2079 - TQ from the APA phone meeting

Hi Andrew,

Please see APA's response to your TQ below in red.

Thank you,

Steve

Stephen Sizer
Energy Manager

m:0488 423 247
e:sizers@borgs.com.au | w:www.borgs.com.au
a:2 Wella Way Somersby NSW 2250

From: Fleming, Sean <Sean.Fleming@apa.com.au>
Sent: Wednesday, 5 September 2018 1:00 PM
To: Stephen Sizer <sizers@borgs.com.au>
Cc: Stephan, Edward <Edward.Stephan@apa.com.au>
Subject: RE: 2079 - TQ from the APA phone meeting

Hi Stephen

Indicative responses to your queries below.

1. Typical gas composition, as well as extremities for lean and rich gas.

Date based on 2 years of hourly average. Average is the overall average for the 2 years. Ammonia requires lab test and APA have not been testing this.

- Rich is the average from 20/9/17 to 2/2/18
- Lean is the average from the period 18/4/18 to now

	rich avg	lean avg	2 yr avg
Methane	91	97	93
Ethane	4.8	0.85	3.74
Propane	0.38	0.37	0.38
I-Butane	0.0803	0.042	0.063
N-Butane	0.090	0.044	0.070
I-Pentane	0.033	0.005	0.021
N-Pentane	0.023	0.005	0.016
C6	0.031	0.005	0.020
Nitrogen	0.798	1.181	0.882
Carbon Dioxide	2.874	0.693	1.914

2. Confirmation on whether the gas is odorised.

Yes, gas is odorised.

3. Tie-in connection details at APA's compound – please also provide relevant P&IDs and GA drawings.

APA can't provide any P&IDs or GAs drawings until we have executed the CNFA and we can generate required updates (current drawings on file are incorrect).

4. Minimum and maximum operating temperature of the main line.

0-55 degrees C

5. MAOP of the main line.

9,930kPa.

Appendix D- OSD-Safety Management Study Report- 17/7/2018

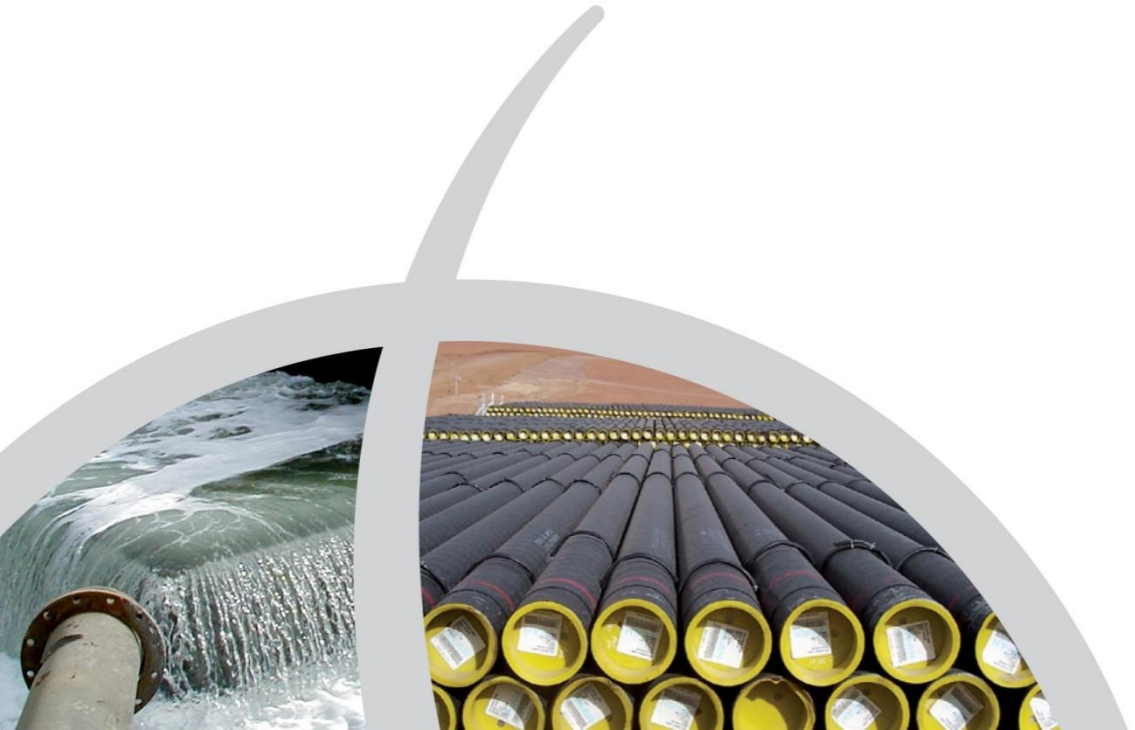
Borg Manufacturing

Safety Management Study Report

HP Gas Connection Project

19 July 2018

Document No. 2079-EL-REP-001
Revision A



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Limitations Statement

This report has been prepared on behalf of and for the exclusive use of the Client, and is subject to and issued in connection with the provisions of the agreement between OSD Pty Ltd and the Client. OSD Pty Ltd accepts no liability or responsibility whatsoever for or in respect of any use of or reliance upon this report by any third party.

The findings, observations and conclusions expressed by OSD Pty Ltd in this report are not, and should not be considered, an opinion concerning the viability of the proposed project. No warranty or guarantee, whether express or implied, is made with respect to the data reported or to the findings, observations and conclusions expressed in this report. Further, such data, findings, observations and conclusions are based solely upon previous experience and information supplied by the Client in existence at the time of the investigation.

Approval Status

Rev	Status	Prepared by	Checked by	Approved by	Date
A	Issued for Review	MJ	ST	AB	17/07/2018

Amendments

Rev	Status	Amendments	Date

Executive Summary

Borg Manufacturing (Borg) plan to construct a high-pressure gas connection for their manufacturing plant located on Lowes Mount Road, Oberon NSW.

This report documents the preparation for and the outcome of the 'detailed design' Safety Management Study (SMS) performed on June 12, 2018 for this project.

The purpose of the SMS was to identify and assess threats to the pipeline, and to subsequently apply control measures to either eliminate or control these threats to acceptable levels of risk.

There was insufficient information to assess four of the identified threats for which appropriate actions have been nominated to ensure that these are addressed in subsequent phases of the project.

Thirty-five identified threats were considered to be either completely mitigated by the current design, or by planned actions which were recorded during the workshop.

Fourteen threats were identified which were considered to be either unmitigated or only partially mitigated by the current design and planned actions, and these threats were subsequently risk assessed. All of these threats were found to be within acceptable levels of risk as per the definitions of AS2885, or additional actions were assigned such that the residual risk was reduced to acceptable levels.

A total of 33 actions were recorded during the workshop which can be found in appendix C.

A summary of the outcome of the threat and risk assessment is outlined by Figure 1.

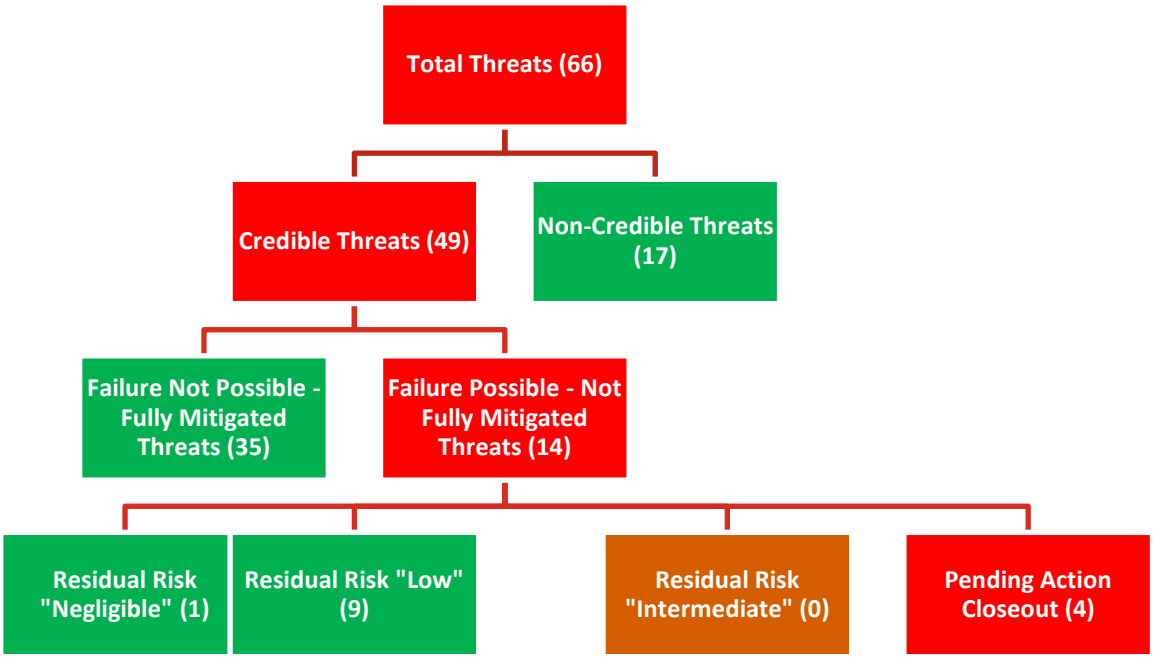


Figure 1: Threat and Risk Summary

Contents

Appendices

Tables

Figures

1 Introduction

Borg Manufacturing (Borg) plan to construct a high-pressure gas connection for their manufacturing plant located on Lowes Mount Road, Oberon NSW.

The connection will be provided via an APA owned and operated branch from the Sydney to Moomba pipeline. The Borg connection will tie into an APA custody transfer point located adjacent to the Borg facility. Within the facility, the connection will contain pressure reduction stations and a combination of above and below ground pipeline runs to deliver gas to manufacturing equipment.

1.1 Purpose

This report documents the preparation for and the outcome of the 'detailed design' Safety Management Study (SMS) performed for the Borg gas pipeline.

The purpose of the SMS was to identify and assess threats to the pipeline, and to subsequently apply control measures to either eliminate or control these threats to acceptable levels of risk.

It is intended that this report is used to fulfil the requirements of a preliminary hazard analysis (PHA) to support the development application for a potentially hazardous industry, as required by the State Environmental Planning Policy No. 33 (SEPP 33) under the Environmental and Planning and Assessment Act 1979.

1.2 Workshop Details

To validate the study relevant personnel conducted a one-day workshop on June 12, 2018 at the OSD office located in Brisbane. The workshop participants are listed Table 1. The signed attendance sheet for the workshop is provided in Appendix A.

Table 1: Workshop Participants

Name	Company	Position
Stephen Sizer	Borg Manufacturing	Energy Manager
Andrew Bailey	OSD Limited	Project Engineer
Kieran Carrigan	OSD Limited	Process Engineer
Michael Jones	OSD Limited	Pipeline Engineer
Soheil Taherian	OSD Limited	Workshop Facilitator

1.3 SMS Database

The pipeline SMS database (Appendix B) is the primary record of this study. It is expected that this database remains a live document that is updated as additional information becomes available or as changes are made, and during the 'Pre-construction review' and 'Pre-commissioning review' activities. The SMS database is to remain a live document during operation and should be updated during operational reviews that are required to be conducted as a result of any of the following triggers:

a) At intervals not exceeding five years.

b) At any review for changed operating conditions.

c) At any review for extension of design life.

d) As may be required by AS 2885.3.

e) At any other time that new or changed threats occur.

f) At any time when there is a change in the state of knowledge affecting the safety of the pipeline.

1.4 Definitions

Table 2 defines key terms that are used throughout the safety management process.

Table 2: Definitions

Term/ Abbreviation	Definition
ALARP	"As Low as Reasonably Practicable". A risk associated with a threat is deemed ALARP if the threat is controlled, or the residual risk is assessed to be low or negligible, or the residual risk is assessed to be intermediate and is formally demonstrated to be ALARP. ALARP means the cost of further risk reduction measures is grossly disproportionate to the benefit gained from the reduced risk that would result.
Common Threats	Threats that occur at similar locations along the pipeline and which can therefore be treated by a standard design solution for that location type (e.g. road crossings).
Controlled or Controlled threat	Where sufficient measures have been applied to a threat so that the possibility of a failure event due to that threat has been removed for all practical purposes at that location.
Critical Defect Length	Length of a through wall axial flaw that, if exceeded, will grow rapidly and result in pipeline rupture. When the flaw is smaller than this length, the pipeline will leak rather than rupture.
Encroachment	Work by third parties within the pipeline corridor, or activities in close proximity that could affect the pipeline (e.g. blasting, earthworks).
Failure	The occurrence of one or more of the following conditions: (a) Any loss of containment. (b) Supply is restricted. (c) Maximum allowable operating pressure is reduced. (d) Immediate repair is required in order to maintain safe operation.
Failure scenario	Combination of a threat, a failure mode and a consequence. A threat may result in several failure modes (eg. rupture, leak), and each failure mode may have several consequences.
High Consequence Area	A location where pipeline rupture can be expected to result in multiple fatalities or significant environmental damage, including as a minimum location classes T1 (Residential), T2 (High Density), I (Industrial), and S (Sensitive).
Land use change	Comprises any change outside the pipeline corridor but within the measurement length, such that there is either a change in location class, or an increase in the likelihood or consequences of failure even without change in location class.
Location Class	The classification of an area according to its general geographic and demographic characteristics, reflecting both the threats to the pipeline from the land usage and the consequences for the population should the pipeline suffer a loss of containment
Maximum Allowable Operating Pressure (MAOP)	The maximum pressure at which a pipeline system or section of a pipeline system may be operated, following pressure testing in accordance with the AS(/NZS) 2885 series or after an MAOP review performed in accordance with AS 2885.3
Measurement Length	Radius of the 4.7 kW/m^2 radiation contour for an ignited rupture, calculated in accordance with AS/NZS AS 2885.1, applied at all locations along the pipeline. Measurement length is used in the determination of location class regardless of whether rupture is a credible failure mode.
Non-credible threat	A threat for which the frequency of occurrence is so low that it does not exist for any practical purpose at that location. The credibility or otherwise of a threat is a characteristic of the threat itself and is assessed independently of any protective measures that may be applied to mitigate it. A non-credible threat is not the same as a credible threat that has been controlled.

Non-location specific threat	Threats that can occur anywhere along the pipeline (e.g. corrosion).
one-call services	Service which provides a single point of contact for information on the buried utility services of multiple asset owners. E.g. Dial Before You Dig (DBYD).
Protection measures – Physical	Measures for protection of a pipeline that prevent external interference from causing failure, either by physically preventing contact with the pipe or by providing adequate resistance to penetration in the pipe itself.
Protection measures - Procedural	Measures for protection of a pipeline that minimize the likelihood of human activities with potential to damage the pipeline.
Rupture	Failure of the pipe such that the cylinder has opened to a size equivalent to its diameter.
SMS Safety Management Study or process	The process that identifies threats to the pipeline system and applies controls to them, and (if necessary) undertakes assessment and treatment of any risks to ensure that residual risk is reduced to an acceptable level.
Specified minimum yield strength (SMYS)	Minimum yield stress for a pipe material that is specified in the manufacturing standard with which the pipe or fittings used in the pipeline conforms.
Station	Facility that controls and/or measures pipeline fluids, including compressor and pump stations, pressure regulation and metering facilities. Other facilities that involve frequent operational activity may also be designated stations. In addition to piping and equipment, a station includes other infrastructure such as control facilities, power supply, and security fencing.
Threat	Any activity or condition that can adversely affect the pipeline if not adequately controlled.

1.5 Legislative Requirements

Within the state of New South Wales pipelines conveying hydrocarbons are regulated by the *Pipelines Act 1967*, however not all pipelines are required to be licensed under the act.

One such exemption is for pipelines constructed on land used for industrial purposes, designed for use solely for the industrial purposes carried out on that land and situated wholly within the boundaries of that land.

The interconnect gas pipeline and piping will be situated within Borg's property boundary and is intended for use solely for Borg's industrial purposes; as such the pipeline is not required to be licenced under the Pipeline Act.

The design standard under which the interconnect piping system is being designed to is AS 4041 - Pressure Piping, which is intended to apply to "*piping within boundaries of chemical manufacturing or processing installations, petroleum refineries, petrochemical plant, gas process plant, refinery tank farms, terminals and bulk handling plants.*"

Primarily dealing with above ground piping, AS 4041 refers to AS 2885 for guidance applicable to buried piping. The AS 2885 series of standards establishes requirements for the safe design, construction, inspection, testing, operation and maintenance of a land or a submarine pipeline, and is additionally the standard to which pipelines licensed under the *Pipelines Act* are required to comply with. It is therefore appropriate to apply this standard to the buried pipeline component of the interconnect piping system.

Management of safety is a fundamental principle underlying the AS 2885 series of standards. To achieve this the standard specifies a safety management study process. This document is a record of the application of that process to the Borg pipeline and piping system.

1.6 Scope

AS2885 requires that a safety management study is undertaken during the following project phases:

1. Preliminary design and approval
2. Detailed design
3. Pre-construction review
4. Pre-commissioning review

Typically, the preliminary design and approval safety management study is performed during the feasibility phase to guide high level aspects of the design such as route selection, and to deliver sufficient information to stakeholders involved in the regulatory approvals process about the risks involved in the project. This is appropriate for long pipelines which traverse public and / or third-party land and which typically encounter a variety of different threat types along its route, and where there are legislative requirements for the pipeline to be licensed.

As this is a short, unlicensed pipeline which is expected to be entirely contained within the property boundary of the Borg facility, and as the design is sufficiently advanced, the workshop performed was a detailed design study. No preliminary design and approval study was performed for this pipeline.

The scope of the assessment, indicated by Figure 1, was from the APA custody transfer point through to the individual equipment gas connections. The study considered the metering station at the beginning of the line, the pipeline, and the pressure regulating station at the end of the line. Process safety threats are not included in the scope of this assessment; these shall be assessed by a separate Hazard and Operability (HAZOP) study.

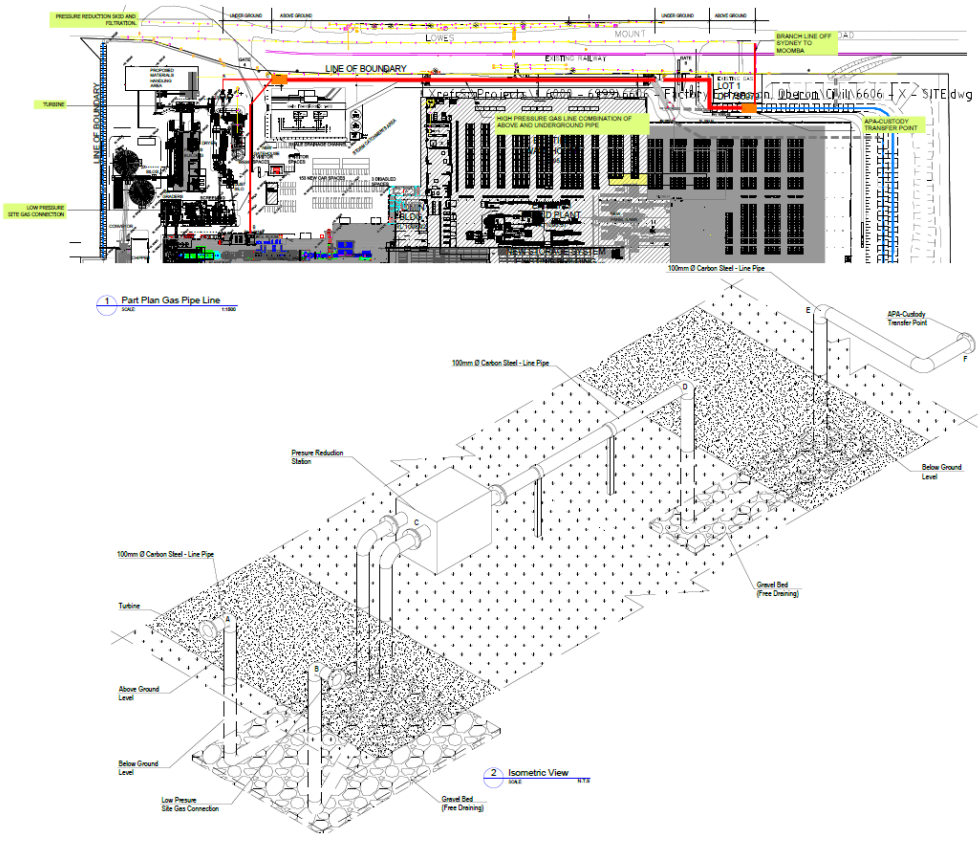


Figure 2: SMS Scope

2 Reference Documents

2.1 Pipeline Design Documents

The documentation listed in Table 3 reflects the design of the pipeline at the time of the Safety Management Study workshop. The workshop was based on the information contained in these documents.

Table 3: Pipeline Design Documents

Document Number	Revision	Dated	Document Title
2079-EL-TOR-001	A	11/06/2018	Safety Management Study Terms of Reference
2079-EM-BOD-001	A	Note 1	Basis of Design
2079-02-CAL-001	A	23/05/2018	AS2885 Calculations
2079-02-EL-CAL-002	A	25/05/2018	Galvanic Anode Cathodic Protection Calculations
2079-02-EL-DAT-001	A	22/05/2018	Line Pipe Datasheet
2079-02-EM-CAL-003	A	01/06/2018	AS 4041 Piping Calculations
2079-02-EM-CAL-0001	A	10/05/2018	Line Size Calculation

Note 1: At the time of the workshop the Basis of Design was a live document yet to be formally issued.

2.2 Standards

Table 4 details the relevant standards for the design, construction and operation of the pipeline and cathodic protection system.

Table 4: Standards

Document Title	Reference
Pipelines—Gas and liquid petroleum. Part 1: Design and construction	AS 2885.1-2012
Pipelines—Gas and liquid petroleum. Part 3: Operation and Maintenance	AS 2885.3-2012
Cathodic Protection of metals – pipes and cables	AS 2832.1-2015
Pressure Piping	AS 4041-2006

3 Safety Management Study Methodology

The Safety Management Study was carried out in accordance with the requirements of AS 2885.1. The process is outlined in Figure 3, replicated from AS 2885.1 Figure 2.3.1.

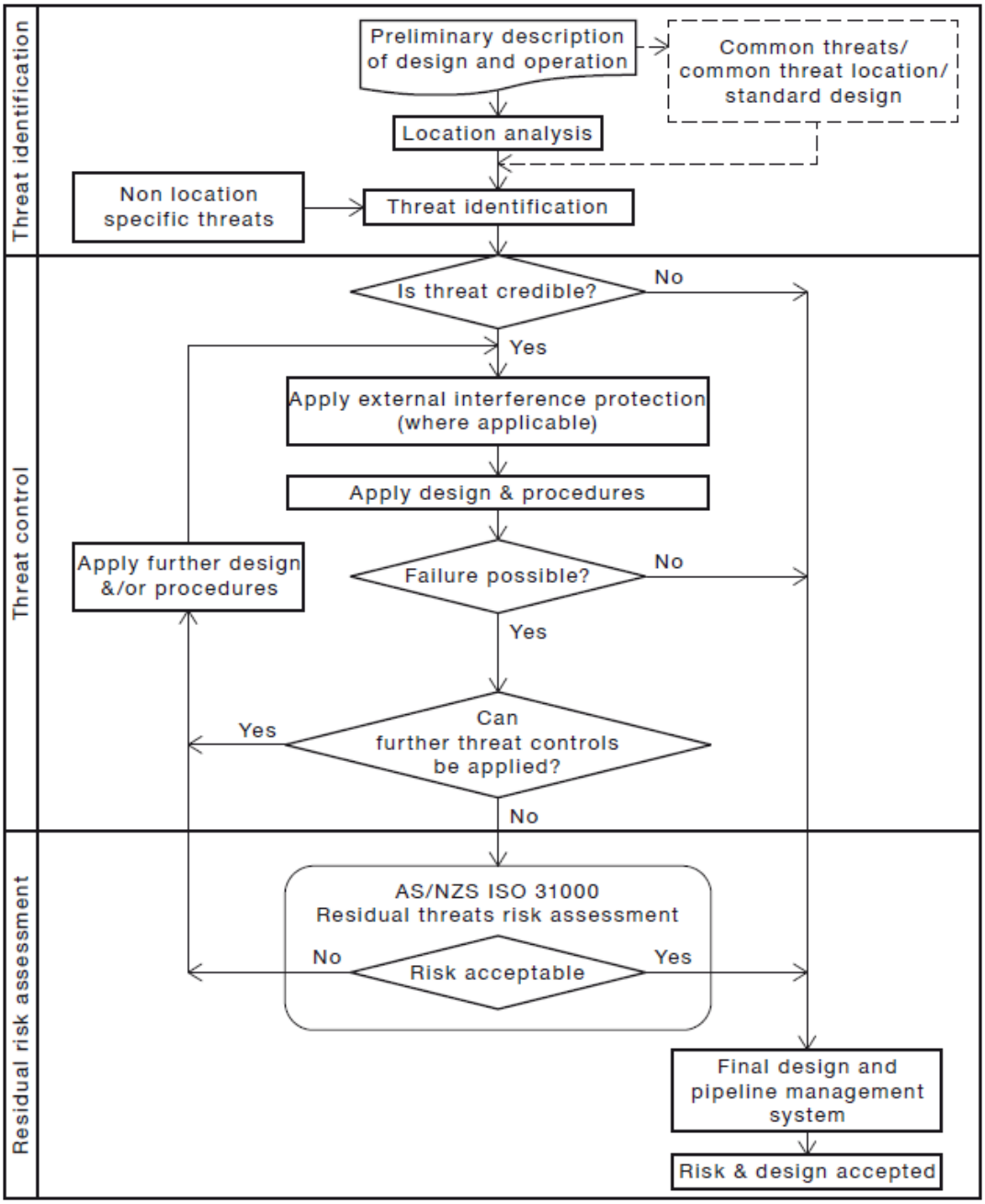


Figure 3: Safety Management Process

3.1 Location Analysis

Location analysis is a structured assessment of the land use through which the pipeline passes. It serves two main purposes in the risk assessment process:

- Systematically identify the land use and features along the route, providing important information on the activities and events which potentially pose a threat to the pipeline integrity.
- Provides important information on the nature and sensitivity of the land and population which are potentially threatened by the loss of pipeline integrity.

Section 4.1 provides details of the location analysis performed for this pipeline.

3.2 Threat Identification

A register outlining potential threats to the integrity of the pipeline and stations was populated. The threat identification process strived to identify all threats with the potential to damage the pipeline and cause:

- Interruption to service;
- Release of fluid or gas from the pipeline network;
- Harm to the pipeline operators, the public or the environment.

All threats assessed during the workshop were categorised as either location specific or as non-location specific 'repetitive' threats. Non-location specific threats are those which can occur anywhere along the pipeline (e.g corrosion). The threats considered were broadly categorised to fall under one of the following guide words:

- External interference;
- Corrosion;
- Natural events;
- Operations and maintenance;
- Design defects;
- Material defects;
- Construction defects;
- Intentional damage.

The safety management study did not consider process safety threats; these are to be assessed via a separate hazard and operability study (HAZOP).

For each threat, an assessment was made as to whether the threat is both credible and capable of causing a failure of the asset. A failure of the asset is constituted by one or more of the following conditions:

1. Containment is lost
2. Supply is restricted
3. The maximum allowable operating pressure must be immediately reduced to maintain safe operation

4. Immediate repair is required to maintain safe operation

Credible threats not capable of causing a failure of the asset required no further consideration and for such threats no further action was taken.

Where it was determined that a credible threat is capable of causing a failure, the frequency and severity of such an event occurring was assessed and a resulting risk was assigned to the threat. This was a qualitative risk assessment conducted in accordance with AS/NZS ISO 31000, using the mandatory risk matrix presented in appendix F of AS2885.1 (Figure 7).

The severity classes used are for the assessment are defined in Table F2 (Figure 4).

TABLE F2

SEVERITY CLASSES

	Severity class				
	Catastrophic	**Major**	**Severe**	**Minor**	**Trivial**
Dimension	**Measures of severity**				
People	Multiple fatalities result	Few fatalities; several people with life-threatening injuries	Injury or illness requiring hospital treatment	Injuries requiring first aid treatment	Minimal impact on health and safety
Supply	Long-term interruption of supply	Prolonged interruption; long-term restriction of supply	Short-term interruption; prolonged restriction of supply	Short-term interruption; restriction of supply but shortfall met from other sources	No impact; no restriction of pipeline supply
Environment (see Note)	Effects widespread; viability of ecosystems or species affected; permanent major changes	Major off-site impact; long-term severe effects; rectification difficult	Localized (<1 ha) and short-term (<2 y) effects, easily rectified	Effect very localized (<0.1 ha) and very short-term (weeks), minimal rectification	No effect; minor on-site effects rectified rapidly with negligible residual effect

NOTE: Significant environmental consequences may occur in locations that are relatively small and isolated.

Figure 4: AS 2885.1-2012 Table F2 – Severity Classes

The frequency classes used for the assessment are defined in Table F3 (Figure 5).

TABLE F3

FREQUENCY CLASSES

Frequency class	Frequency description
Frequent	Expected to occur once per year or more
Occasional	May occur occasionally in the life of the pipeline
Unlikely	Unlikely to occur within the life of the pipeline, but possible
Remote	Not anticipated for this pipeline at this location
Hypothetical	Theoretically possible but has never occurred on a similar pipeline

Figure 5: AS 2885.1-2012 Table F3 – Frequency Classes

TABLE F4

RISK MATRIX

	Catastrophic	Major	Severe	Minor	Trivial
Frequent	Extreme	Extreme	High	Intermediate	Low
Occasional	Extreme	High	Intermediate	Low	Low
Unlikely	High	High	Intermediate	Low	Negligible
Remote	High	Intermediate	Low	Negligible	Negligible
Hypothetical	Intermediate	Low	Negligible	Negligible	Negligible

Figure 6: AS 2885.1-2012 Table F4 – Risk Matrix

Where the risk level resulting from a threat was assessed to be 'intermediate' or higher, additional controls were considered such that the threat was no longer capable of causing a failure of the asset, or such that the residual risk resulting from the threat was reduced. In some cases it may not be possible or practicable to reduce the risk below the 'intermediate' level; any risks re-assessed to be 'intermediate' following the process of assigning additional controls must be subjected to an ALARP assessment.

No risk above the level of 'intermediate' is permitted; additional controls or a complete removal of the threat must take place until the resulting risk is assessed to be 'intermediate' or lower.

Figure 5 details the risk treatment actions required for each level of risk ranking.

TABLE F5

RISK TREATMENT ACTIONS

Risk rank	Required action
Extreme	Modify the threat, the frequency or the consequences so that the risk rank is reduced to 'intermediate' or lower For an in-service pipeline the risk shall be reduced immediately
High	Modify the threat, the frequency or the consequences so that the risk rank is reduced to Intermediate or lower For an in-service pipeline the risk shall be reduced as soon as possible, typically within a timescale of not more than a few weeks
Intermediate	Repeat threat identification and risk evaluation processes to verify and, where possible, quantify the risk estimation; determine the accuracy and uncertainty of the estimation. Where the risk rank is confirmed to be 'intermediate', if possible modify the threat, the frequency or the consequence to reduce the risk rank to 'low' or 'negligible' Where the risk rank cannot be reduced to 'low' or 'negligible', action shall be taken to— (a) remove threats, reduce frequencies and/or reduce severity of consequences to the extent practicable; and (b) demonstrate ALARP For an in-service pipeline, the reduction to 'low' or 'negligible' or demonstration of ALARP shall be completed as soon as possible; typically within a timescale of not more than a few months
Low	Determine the management plan for the threat to prevent occurrence and to monitor changes that could affect the classification
Negligible	Review at the next review interval

Figure 7: AS 2885.1-2012 Table F5 – Risk Treatment Actions

4 Pipeline Design Summary

Table 5 provides a summary of the pipeline design.

Table 5: Pipeline Design Summary

Parameter	Value
Measurement Length	90 m
Pipeline Length (approx.)	400 m
Nominal Diameter	DN100
Pipe Material Grade	API 5L X52 PSL2
Specified Minimum Yield Strength (SMYS)	360 MPa
Pipe Fabrication	Seamless
Nominal Wall Thickness	6.02 mm (STD Schedule)
Maximum Allowable Operating Pressure (MAOP)	9.93 MPag
Min. depth of cover	1200 mm
Hoop stress at MAOP	108 MPa
Hoop stress as % of SMYS	30%
Critical Defect Length	129 mm
Buoyancy Ratio	> 1.2 (pipe is negatively buoyant)
Maximum Energy Release Rate (Rupture)	2 GJ/s
Coating	Dual Layer Fusion Bonded Epoxy
Cathodic Protection	Magnesium Anode
Gas Quality	Clean, dry

4.1 Location Classification

The pipeline will be located adjacent to Lowes Mount Road in Oberon, NSW. A railway line is located between the pipeline and the road, however Borg representatives advised in the workshop that the railway line is no longer operational.

Figure 1 displays the proposed pipeline centreline and the extent of the 90m measurement length. Other than the Borg facility itself, contained within the measurement length are two residential properties, a section of Lowes Mount Road, and a small section of a neighbouring industrial / commercial facility (Highland Pine Products).

The workshop agreed that the primary location classification shall be designated as *Residential* (T1). Although there are only two residential properties currently within the measurement length, Lowes Mount Road leads into the town of Oberon, approximately 800m south of the Borg facility. Additionally, the Oberon Rugby League Football Club is located approximately 150 – 200m south of the facility on Lowes Mount Road, and it could be reasonably expected that members of the public gather there on a frequent basis. The road is therefore considered to be a road which serves the residential community and a T1 location classification is appropriate.

The secondary location classification was assessed to be *Industrial* (I) primarily due to the Borg facility itself.

4.1.1 Special Provisions for High Consequence Areas

Both residential and industrial locations are considered by AS2885.1 to be high consequence areas, and the special provisions for high consequence areas described by section 4.7 of AS2885.1 must be met by the design of the pipeline. These are:

1. The pipeline shall be designed such that rupture is not a credible failure mode. This is to be achieved by either one of the following methods:
    a) The hoop stress shall not exceed 30% of SMYS.
    b) The largest equivalent defect length produced by the threats identified in that location shall be determined. The hoop stress at MAOP shall be selected such that the critical defect length is not less than 150% of the axial length of the largest equivalent defect.
2. The maximum energy release rate from the largest credible ignited release scenario shall not exceed 10 GJ/s.

The pipeline meets the no-rupture criteria as the hoop stress at the MAOP is not greater than 30% of the SMYS (it is 29.9%).

The energy release rate from an ignited release is a function of the pipeline diameter, pressure, gas composition, and the physical size of the opening from which the hydrocarbon is released. For this pipeline the energy release rate from an ignited full-bore rupture is approximately 2 GJ/s (refer 2079-02-CAL-001). The maximum energy release rate requirement is therefore within the required limit for all credible release scenarios. This is discussed further in section 5.2.

Figure 8: Pipeline Measurement Length

5 Study Outcomes

5.1 Summary

A total of eleven threats to the pipeline were identified which are not completely mitigated by the pipeline design or by other protection measures. These threats were risk assessed and in all cases except one, the risk was assessed to be either 'low' or 'negligible'.

Threat ID. 3 was initially assessed to be intermediate, and was subsequently reassessed to be 'low' following the implementation of a risk treatment action. This threat is discussed in further detail in section 5.2.2.

A total of 33 actions were recorded during the workshop; the majority of which are actions to confirm or ensure that nominated controls and mitigation measures are implemented during later phases of the project. Appendix C provides details of all actions recorded and individual action close-out sheets have been provided to facilitate action tracking. The action close-out sheets are to be completed once the actions have been performed.

5.2 External Interference Threats

External interference is typically recognised in the pipeline industry as one of the highest risk threats to pipelines, however as this pipeline will be located on Borg's property it is expected that external interference will not pose a significant threat and that Borg will have control over activities taking place near the pipeline.

Twelve external interference threats were considered for the pipeline, of which five were assessed to be both credible and capable of causing a failure of the pipeline.

The following sections discuss these threats in greater detail.

5.2.1 Excavation Threats and Penetration Resistance (Threat ID 1 and 2)

Threat Numbers 1 and 2 relate to third and first party excavation, respectively. The pipeline's resistance to penetration by excavators is a key input for the assessment of these threats.

The resistance to penetration was calculated in accordance with the guidelines provided in appendix M of AS 2885.1. The full calculations are provided in document 2079-02-CAL-001. Table 6 summarises the results of these calculations.

Table 6: Penetration Resistance (B factor = 1.3)

<table>
<tr><th rowspan="2">Excavator Tooth Type</th><th colspan="9">Excavator Size (tonnes) and Failure Mode</th></tr>
<tr><th>5</th><th>10</th><th>15</th><th>20</th><th>25</th><th>30</th><th>35</th><th>40</th><th>55</th></tr>
<tr><td>General Purpose Teeth (GPT)</td><td colspan="9">No Puncture. Dent / Gouge.</td></tr>
<tr><td>Twin Point Tiger Teeth (TPPT)</td><td colspan="3">No Puncture. Dent/Gouge.</td><td colspan="6">Leak / Puncture</td></tr>
<tr><td>Single Point Penetration Tooth (SPPT)</td><td rowspan="2">No Punct. Dent/ Gouge</td><td colspan="8">Leak / Puncture</td></tr>
<tr><td>Single Point of Tiger Tooth (SPTT)</td><td colspan="8">Leak / Puncture</td></tr>
</table>

The 'B factor' used in the calculations is a multipurpose parameter that combines into a single value the bucket force multiplier, empirical experience and a safety factor. Due to the designation of the pipeline location as a high consequence area a B factor of 1.3 was used for these calculations, as per the recommendations of AS 2885.1. In practice, a B factor of 1.3 represents aggressive excavator operation, as the theoretical bucket force that an excavator could apply to the pipe is multiplied by 1.3.

> *Note: if a B factor of 0.75 was used the calculations show that 15 tonne (and below) excavators would not penetrate the pipe. A factor of 0.75 is indicative of careful excavation operation, with the force being applied by the bucket three quarters of the available force. This is provided for information purposes only; however it indicates that another potential risk mitigation Borg could take would be to limit the size of excavator allowed on site to 15 tonnes, in particular if using single point teeth.*

As the full bore rupture energy release rate for the pipeline is 2 GJ/s, it follows that the energy release rate from any puncture due to an excavator strike would be less than 2 GJ/s (if ignited). The pipeline therefore meets the AS 2885.1 energy release rate requirement for the Industrial and Residential location classifications (< 10 GJ/s) for any credible excavator strike.

The calculations show that even under aggressive excavator operation a general purpose tooth is incapable of penetrating the pipe, to the point of it not being a credible threat (assuming good pipe condition, i.e no corrosion). Note however that a dent of gouge may still be produced potentially necessitating pipeline repair to maintain safe operation.

Single point teeth present the greatest risk to the pipeline, with excavators as small 10 tonnes potentially being able to penetrate the pipe if equipped with single point teeth and operated with significant force. It was therefore recommended that Borg consider imposing restrictions on the excavator tooth types allowed to be used in the vicinity of the pipeline, and that if possible single point teeth and tiger teeth are prohibited from use (action number 2).

The risk was assessed assuming that such restrictions are not in place and that pipe penetration may occur. For both threats (first and third party excavation) the risk was assessed to be 'low'. This resulted from a 'remote' likelihood assessment combined with a potential 'severe' consequence (possible injury requiring medical treatment if the leak ignited resulting in a jet fire). The 'remote' likelihood was driven by the following factors:

- The excavation would have to reach the depth of the pipeline which is buried at 1200mm; this is deeper than the typical depth of other services likely to be installed on site such as communication cables.
- Pipeline penetration would have to occur; this requires striking the pipe directly with sufficient force and with single point teeth. A strike on the pipe would require failure of the procedural controls listed in Table 7.
- The probability of ignition of the resulting leak is estimated to be of the order of 5 - 10%.

Table 7: External Interference Protection

Physical Controls	Procedural Controls
Wall thickness – The pipeline wall thickness provides complete protection against general purpose teeth and **partial protection** against single point teeth.	Marker signs every 50m – these notify excavator operators that there is a pipeline in the area
Separation – The pipeline will be buried at 1200mm which is typically deeper than the depth of other services such as communications cables and water services. **It is recognised that this is only a partial control and that some excavation threats may reach the pipeline depth.**	Marker tape will be installed 300mm above the pipeline; if this is spotted by an excavator operator during excavation they will be aware that there is a gas pipeline below. Typically this is a last line of defence.
Separation – If possible move fence such that the pipeline is 100% inside the fence line and third party services are outside the fence line (action no. 1).	Short pipeline on manned site 24/7 – this allows personnel to see any excavation activities taking place and if necessary intervene.
	Borg site procedures / permits (Note action no. 1 – "Develop management process for supervising known activities near pipeline" and "Create information pack and distribute to third party service operators near pipeline - to inform people of the pipeline location and risks.")
	Registration of pipeline with Dial Before You Dig (DBYD) – action no. 1.

Although a recommendation was made to prohibit the use of single point teeth, it is noted that their use is not necessarily precluded should they be required (given the 'low' risk ranking associated with this threat).

Borg site procedures / permits have been listed as a procedural control; for Borg's reference some typical procedures implemented for excavation near pipelines include:

- Excavation supervision.
- A requirement to positively locate the pipeline by non-mechanical methods, such as vacuum excavation and /or hand excavation, prior to the use of any mechanical excavation when exposing the pipe or when excavating within 3m of the pipe.

It is recommended that these restrictions are adopted for any excavation near the pipeline to prevent pipe damage requiring repair, regardless of the tooth type used.

5.2.2 Augers (Threat ID 3)

Threat ID 3 relates to the installation of posts or poles for fences or power cable installation. It is generally recognised that short of installing concrete slabs over the pipeline, there is little physical protection that can be provided to protect against such threats, and that the potential size of a release from such a threat can be significant (depending on the size of the machine used).

This threat was deemed to be credible due to the presence of an overhead powerline running parallel to the pipeline, with the separation distance varying from 3 – 7m. Additionally, it is known

that the Borg fence line is to be relocated in the future (to enable the pipeline to be located within the fence line), which could present a threat to the pipeline if not performed carefully.

The size of an auger used for powerline pole installation (or replacement) would be sufficient to produce a large release from the pipeline, up to the size of a full bore rupture[1]. If this were to ignite, the workshop assessed that the severity of the consequences could be 'major', potentially producing a small number of fatalities (the crew operating the machinery). The likelihood of this occurring was assessed to be 'remote', qualitatively meaning that it is not anticipated to occur. The reason it is not anticipated is because an action was nominated prior to the risk assessment for Borg to create an information pack to provide to relevant third parties (i.e. the powerline operator), informing them of the location of the pipeline and the requirements for working near the pipeline (action no. 3). Specifically, it was noted that a minimum separation requirement of 3m would be imposed.

Given these severity and likelihood assessments, the resulting risk ranking for auger threats was 'intermediate'. As such an additional risk treatment action was nominated (action no. 4) to relocate the fence line prior to the introduction of gas into the pipeline, and if possible to relocate the fence such that it separates the pipeline from third party services, including the powerlines. Given this action the likelihood of the event occurring would be expected to be reduced to 'hypothetical', resulting in a revised risk ranking of 'low'.

5.2.3 Horizontal Directional Drilling (HDD) (Threat ID 4)

It was assessed in the workshop that a large HDD would not be used in the area, but that a mini-HDD could be used (mini HDDs are commonly used for the installation of buried cables).

A mini-HDD running parallel to the pipeline would not be expected to penetrate the pipe however a gouge could be produced leading to coating damage and accelerated corrosion. This would typically be noticed prior to a loss of containment through monitoring of the cathodic protection system and the consequence was assessed to be 'severe' (short term supply interruption). The likelihood of a HDD being used on the Borg property and the HDD striking the pipe was considered to be remote, resulting in a 'low' risk assessment. No action was recorded for this threat.

5.2.4 Vehicle Impacts to Above Ground Facilities (Threat ID 5)

The final external interference threat capable of causing failure was a vehicle impact to the above ground facilities. Due to the distance of the facilities from Lowes Mount Road (35 – 40m), the presence of trees lining the road, and all facilities being fenced, it was assessed that the distance and barriers would reduce any impact speed such that the consequences would be 'minor'. Additionally, the distance and barriers make the likelihood of such an event occurring 'remote', resulting in a negligible risk ranking. No action was recorded for this threat.

5.3 Corrosion

Corrosion threats are in all cases mitigated by the design of the pipeline and facilities and no risk assessments were required. A number of actions have been nominated to ensure that planned design mitigations are implemented in the later phases of the project.

[1] Note that although the pipeline is designated as a "no rupture" line, a release from an opening equivalent in size to the pipe diameter is considered to be a rupture. The "no rupture" design for this pipeline means that there would be insufficient energy to drive a sub-critical defect to the critical size, resulting in a rupture. An opening that is greater than the critical size to begin with would be considered a rupture, such as that which could be produced by a sufficiently sized auger.

External corrosion and pipeline coating condition is monitored during operation of the pipeline through annual cathodic protection surveys and Direct Current Voltage Gradient surveys (DCVG). As it is unknown who will produce and/or perform the operating and maintenance procedures for the pipeline at this stage, an action has been nominated to for Borg to ensure that these activities are performed and that their requirement is included in the Pipeline Integrity Management Plan. The Pipeline Integrity Management Plan is a key document of the Pipeline Management System. For Borg's reference, full details of these requirements can be found in AS2885.3.

As there are no significant corrosion risks, they are not individually discussed in this report. Refer to the threat register and action close out sheets for further details on these threats.

5.4 Natural Events

Natural events include threats such as earthquakes, wind, cyclones and lightning strikes. In all cases natural events are mitigated by the pipeline and facility design.

As a third party is designing the above ground piping facilities, an action has been nominated for Borg to ensure that these are designed to AS1170.2 and that their suitability for natural event loading is demonstrated by stress analysis.

To protect against the threat of ground movement from trench instability (threat ID no. 21) an action has been nominated for Borg to ensure that the construction specification has requirements for adequate compaction following backfilling the pipeline. This has been assigned to Borg as it is unknown at this stage who will produce the construction specification.

The only natural event threat which was assessed to be not completely mitigated by the design and was subsequently risk assessed was the threat of a lightning striking the pipeline, resulting in a pinhole leak (threat ID 24). This threat was assessed to be a 'low' risk and no action was taken.

As there are no significant natural event threats, refer to the threat register and action close out sheets for further information.

5.5 Operation and Maintenance

Operation and maintenance threats are mitigated both by design and by operating and maintenance procedures. A number of these threats are process threats which are to be assessed during the HAZOP; actions have therefore been nominated for Borg to ensure that these are considered during the HAZOP.

Where a threat is to be mitigated by an operation or maintenance procedure, an action has been nominated for Borg to ensure that these procedures are developed.

The threat of inadequate operation and maintenance procedures, or actions contrary to the procedures, was the only threat required to be taken to a risk assessment (threat ID 36). This was assessed to be a 'low' risk threat and no further action was assigned.

As there are no significant operation and maintenance threats, refer to the threat register and action close out sheets for further information.

5.6 Design, Material or Construction Defects

The workshop considered a range of design, material and construction defect threats. These threats were all considered to be completely mitigated by existing controls or planned controls and as such no risk assessments were required.

Actions have been nominated for Borg to ensure that the planned controls are implemented.

Refer to the threat register and action close out sheets for further information.

5.7 Intentional Damage

The threat of intentional damage to the above ground facilities was considered however as all facilities are fenced and the site is manned the risk was assessed to be low and no additional actions were nominated.

Refer to the threat register for further details.

5.8 Other

A total of four credible threats were categorised as 'other' during the workshop.

Three of these threats are related:

- Threat ID 61: Induced voltages (often termed Low Frequency Induction - LFI), arising from parallel electricity transmission lines
- Threat ID 62: Fault voltages from nearby transmission towers (often termed Earth Potential Rise - EPR)
- Threat ID 63: LFI / EPR during construction

These threats will be mitigated by the design and hence did not require risk assessment during the workshop; however additional information is required to ensure that these threats are mitigated appropriately. Actions have therefore been nominated for OSD to obtain this information and close out the assessment.

The final 'other' credible threat was:

- Threat ID 65: Drainage culvert collapse during pipeline construction or after construction

This threat relates to the existing drainage culvert located on the Borg property, which runs parallel to a section of the pipeline with a horizontal separation of 1m from the top of bank and 4.9m from the toe of bank, and such that the invert of the culvert is below the pipeline burial depth.

Appendix A
Attendance Register

SAFETY MANAGEMENT STUDY
ATTENDANCE SHEET

Client	Borg Manufacturing	**Chair**	Soheil Taherian	**Document No.**	2079-EL-REG-001
Project Number	2079	**Scribe**	Michael Jones	**Document Rev.**	A
Project	HP Gas Pipeline Project	**Attendees**	Refer to attendance register	**Document Date**	12/06/2018
Description	Safety Management Study	**Meeting Location**	Level 2, 349 Coronation Drive, Milton, QLD 4064	**Meeting Date**	12/05/2018

First Name	Last Name	Company	Title	Email	Sign for Attendance		
					Day 1	Day 2	Day 3
MICHAEL	JONES	OSD	SCRIBE/ PIPELINE ENG.				
Stephen	Sizer	Borg	Energy Manager	sizerS@borgs.com.au			
KIERAN	CARRIGAN	OSD	PROCESS ENG				
ANDREW	BAILEY	OSD	Project Engineer				
SOHEIL	TAHERIAN	OSD	LEAD PIPELINE ENG. (FACILITATOR).				

Appendix B
Threat Register

THREAT IDENTIFICATION						LOCATION			EXISTING CONTROLS			ADDITIONAL CONTROLS (ACTION ITEM)				RISK ASSESSMENT					RISK TREATMENT								
ID	Category	Description	Consequence	Threat Credible?	If no, why?	Primary Location Class	Secondary Location Class	Location	Physical Controls	Procedural and/or Design Controls	Failure Possible?	Additional Controls	Action By	Due Date	Failure Possible?	Severity	Severity Notes	Frequency	Frequency Notes	Risk Ranking	Risk Treatment / Action	Action By	Due Date	Revised Severity	Severity Notes	Revised Frequency	Frequency Notes	Revised Risk Ranking	ALARP Yes/No
1	External Interference	Third Party Excavation - Such as construction or maintenance of roads or buried services	Damage to pipeline causing loss of containment with or without ignition	Yes		T1	I	Borg Facility	Wall Thickness	Marker signs Marker tape Short pipeline on 24/7 manned site - ability to spot activity near the pipeline	Yes	Create information pack and distribute to third party service operators near pipeline - to inform people of the pipeline location and risks. Develop management process for supervising known activities near pipeline (eg excavation). Register pipeline with One-call service (DBYD). All of the above should be documented in the pipeline integrity management plan If possible move fence such that the pipeline is 100% inside the fence line and third party services are outside the fence line.	Borg	Prior to commissioning	Yes	Severe	Possible injury requireing medical treatment (assuming jet fire) Pipeline is no rupture	Remote	GP teeth are most likely to be used and cant penetrate. Scenario would require aggressive excavation with single point tooth and ignition. Pipe at 1200mm cover which is deeper than typical other service depth. Operator must disregard or not see marker signs and tape.	Low									
2	External Interference	First Party Excavation - Such as for maintenance of buried services or installation of new services	Damage to pipeline causing loss of containment with or without ignition	Yes		T1	I	Borg Facility	Wall Thickness	Borg site procedures / permits Alignment sheets / site plans Marker signs Marker tape	Yes	Recommend only allowing general purpose teeth to be used near pipeline (if adopted add to permit to work system)	Borg	Prior to commissioning	Yes	Severe	Possible injury requireing medical treatment (assuming jet fire) Pipeline is no rupture	Remote	Less likely than the above case but not hypothetical	Low									
3	External Interference	Installation of posts or poles for fences or power cable installation (Augers)	Damage to pipeline causing loss of containment with or without ignition	Yes		T1	I	Borg Facility	Nil	Marker signs Short pipeline on 24/7 manned site - ability to spot activity near the pipeline DBYD Third Party liaison	Yes	Include minimum separation requirements (3m) in information pack for third parties.	Borg	Prior to commissioning	Yes	Major	Larger size release, up to full bore. Assuming ignition resulting in few fatailties (at least the auger operator)	Remote	Fence and power lines are near the pipeline	Intermediate	Fence posts to be relocated prior to introducing gas to pipeline. There is an earlier recommendation to put fence between pipeline and third party services which would add mitigation to this threat if practicable (threat ID 1)	Borg	Prior to Constructio n	Major	Larger size release, up to full bore. Assuming ignition resulting in few fatailties (at least the auger operator)	Hypothetica l	Many layers of protection must fail	Low	
4	External Interference	Horizontal directional drilling	Pipeline damage leading to loss of containment	Yes		T1	I	Borg Facility	Wall thickness	Marker signs Short pipeline on 24/7 manned site - ability to spot activity near the pipeline DBYD Third Party liaison	Yes	No actions				Severe	At worst mini HDD is expected in the area. Potential dent or gouge leading to coating damage and accelerated corrosion.	Remote	HDD alone is unlikely therefore HDD + damage is an order less	Low									
5	External Interference	Land development - grading, cropping, irrigation, forestry etc.		No	Pipeline located on Borg controlled property. No farming activities.	T1	I	Borg Facility				No actions																	
6	External Interference	Ploughing		No	Pipeline located on Borg controlled property. No farming activities.	T1	I	Borg Facility				No actions																	
7	External Interference	Deep Ripping		No	Pipeline located on Borg controlled property. No farming activities.	T1	I	Borg Facility				No actions																	
8	External Interference	Impacts by vehicles to above ground infrastructure	Loss of containment with ignition	Yes		T1	I	Borg Facility	Above ground infrastructure fenced. APA facility approximately 35 - 40m from road and trees line road. Borg facility inside fenceline and similar distance from road with trees lining road.		Yes	No actions				Minor	Distance from road and barriers will reduce impact speed, driver injury possible, fatality not expected.	Remote	Distance from road is significant, vehicle would have to be travelling at extreme speed	Negligible									
9	External Interference	Bogged vehicles or plant over the pipeline		No	Pipeline located on Borg controlled property	T1	I	Borg Facility				No actions																	
10	External Interference	Vehicles crossing the pipeline at areas other than road crossings		No	Pipeline located on Borg controlled property. No reason to cross pipeline.	T1	I	Borg Facility				No actions																	
11	External Interference	Excessive external loads from backfill or traffic	Pipe deformation (ovality) Loss of containment (fatigue)	Yes		T1	I	Borg Facility	Wall thickness (low stress pipeline - load required to cause fatigue is not credible, also insufficient frequency)	Signage Site procedures	No	No actions																	
12	External Interference	Blasting		No	Pipeline located on Borg controlled property. No reason for blasting near pipeline.	T1	I	Borg Facility				No actions																	
13	External Interference	Other?		No	None identified	T1	I	Borg Facility				No actions																	
14	Corrosion	External corrosion/erosion of pipe due to environmental factors, such as salinity, type of soil and moisture content, and the abrasive action of sand and soil particles.	Loss of wall thickness, leading to reduction of MAOP and/or loss of containment.	Yes		T1	I	Borg Facility	2FBE coating and field joint coating. Cathodic protection (CP). A/G pipe to be painted	Direct current voltage gradient (DCVG) survey. Annual CP survey.	No	Ensure that pipeline integrity management plan (PIMP) contains requirements to perform the procedural controls	Borg	Prior to commissioning	No														
15	Corrosion	Internal corrosion due to contaminants, e.g. chlorides, hydrogen sulphide, carbon dioxide, water	Loss of wall thickness, leading to reduction of MAOP and/or loss of containment.	Yes		T1	I	Borg Facility	Nil. Wall thickness in excess of pressure requirement, but then the no-rupture property may be lost.	Sales gas quality (dry). Upstream filter.	No	No actions																	

THREAT IDENTIFICATION						LOCATION			EXISTING CONTROLS			ADDITIONAL CONTROLS (ACTION ITEM)				RISK ASSESSMENT					RISK TREATMENT								
ID	Category	Description	Consequence	Threat Credible?	If no, why?	Primary Location Class	Secondary Location Class	Location	Physical Controls	Procedural and/or Design Controls	Failure Possible?	Additional Controls	Action By	Due Date	Failure Possible?	Severity	Severity Notes	Frequency	Frequency Notes	Risk Ranking	Risk Treatment / Action	Action By	Due Date	Revised Severity	Severity Notes	Revised Frequency	Frequency Notes	Revised Risk Ranking	ALARP Yes/No
16	Corrosion	Internal erosion caused by the abrasive action of solids/ sand	Loss of wall thickness, leading to reduction of MAOP and/or loss of containment.	Yes		T1	I	Borg Facility	Velocity insufficient to cause erosion	Sales gas quality (dry). Upstream filter.	No	No actions																	
17	Corrosion	Environmentally assisted cracking (SCC - Stress Corrosion Cracking)	Eventual loss of containment	Yes		T1	I	Borg Facility	2FBE coating Low stress pipeline		No	Perform SCC assessment	OSD	With SMS Report	No														
18	Corrosion	Bacterial Corrosion	Loss of wall thickness, leading to reduction of MAOP and/or loss of containment.	Yes		T1	I	Borg Facility		Hydrotest water treated with biocide. Cleaning and drying during commissioning.	No	Confirm that hydrotest water will be treated with biocide and sufficient cleaning/drying will be performed on the pipeline during commisisoning. This shall be captured in the Construction SOW.	Borg	Prior to construction	No													
19	Corrosion	CP interference from other nearby services	External corrosion leading to loss of conatinment	Yes		T1	I	Borg Facility		CP monitoring (includes interference checks)	No	Ensure PIMP has requirements for CP monitoring including interference checks.	Borg	Prior to commissioning	No														
20	Natural Events	Earthquake	Pipe deformation with possible loss of containment	Yes		T1	I	Borg Facility			Yes	Designers to investigate and ammend design if required	OSD	During detailed design	No														
21	Natural Events	Ground movement, due to trench instability	Loss of containment with or without ignition	Yes		T1	I	Borg Facility			Yes	Construction specification to address compaction requirements (100% compaction is suggested)	Borg	Prior to construction	No														
22	Natural Events	Wind and cyclone	Damage to above ground facilities leading to loss of containment.	Yes		T1	I	Borg Facility			Yes	Wall thickness and piping arrangement (to be demonstrated by stress analysis). Design to AS1170.2	Borg	Prior to construction	No														
23	Natural Events	Bushfires		Yes		T1	I	Borg Facility		Site clearing	No	No actions																	
24	Natural Events	Lightning	Damage to pipeline, causing pinhole leak	Yes		T1	I	Borg Facility	Depth of cover. Surge diverters and earthing	Nil	Yes	No actions			Yes	Severe	Direct lightning strike may result in pinhole leak. Short-term interruption of supply for remediation.	Remote	The pipeline is less susceptible to direct strikes compared to all other facilities and services in the area.	**Low**									
25	Natural Events	Lightning	Injury/fatality on people working in a different location along the pipeline.	Yes		T1	I	Borg Facility		Surge diverters and earthing	No	Borg policies to prohibit working in a storm	Borg	Prior to commissioning	No														
26	Natural Events	Floods, leading to erosion or impact damage	Damage to above ground facilities leading to loss of containment.	Yes		T1	I	Borg Facility		A/G facilities fenced - debris will hit fence	No	Drainage culvert to be maintained and inspected on a regular basis.	Borg	Prior to commissioning	No														
27	Natural Events	Inundation, leading to flotation	Overstress of pipe causing eventual loss of containment.	Yes		T1	I	Borg Facility	Depth of cover Wall thickness Pipe is not buoyant	Manned site - ability to remediate pipe before failure	No	No actions																	
28	Natural Events	Erosion of cover or support	Reduction in external interference protection	Yes		T1	I	Borg Facility	Depth of cover Earlier action recemmended 100% compaction to be included in construction spec	Manned site - ability to see and remediate erosion	No	No actions																	
29	Natural Events	Other?		No	None identified	T1	I	Borg Facility				No actions																	
30	Operations and Maintenance	Exceeding MAOP	Overstress of pipe causing eventual loss of containment.	Yes		T1	I	Borg Facility			Yes	Confirm that Sydney to Moomba pipeline MAOP does not exceed MAOP of this pipeline. HAZOP to be performed for pressure let down stations.	Borg	HAZOP	No													
31	Operations and Maintenance	Incorrect operation of pigging		No	Pipeline not intended to be pigged and can not be pigged without installing launcher / receiver. Risk assesment would be performed prior to any pigging if planned	T1	I	Borg Facility				No actions																	
32	Operations and Maintenance	Incorrect valve operating sequence.	Overstress of pipe causing eventual loss of containment.	Yes		T1	I	Borg Facility	Two independent layers of overpressure protection		No	To be considered in HAZOP for stations, including consideration of pressurisation / depressurisation leading to temperatures in brittle range	Borg	HAZOP															
33	Operations and Maintenance	Incorrect operation of control and protective equipment	Incorrect settings on XSV causing overpressure of pipeline.	Yes		T1	I	Borg Facility		Low stress pipeline	No	Appropriate operating procedures to be developed for pipeline and all new equipment associated with the project	Borg	Prior to commissioning															
34	Operations and Maintenance	Bypass of logic, control or protection equipment	Overstress of pipe causing eventual loss of containment.	Yes		T1	I	Borg Facility			Yes	To be considered in HAZOP	Borg	HAZOP	No														
35	Operations and Maintenance	Fatigue from pressure cycling for which the pipeline is not designed		No	Pressure cycles required to cause failure outside of credible range	T1	I	Borg Facility				No actions																	

THREAT IDENTIFICATION						LOCATION			EXISTING CONTROLS			ADDITIONAL CONTROLS (ACTION ITEM)				RISK ASSESSMENT					RISK TREATMENT								
ID	Category	Description	Consequence	Threat Credible?	If no, why?	Primary Location Class	Secondary Location Class	Location	Physical Controls	Procedural and/or Design Controls	Failure Possible?	Additional Controls	Action By	Due Date	Failure Possible?	Severity	Severity Notes	Frequency	Frequency Notes	Risk Ranking	Risk Treatment / Action	Action By	Due Date	Revised Severity	Severity Notes	Revised Frequency	Frequency Notes	Revised Risk Ranking	ALARP Yes/No
36	Operations and Maintenance	Inadequate or incomplete maintenance procedures leading to equipment failure, or actions contrary to procedures	Potential personnel injury	Yes		T1	I	Borg Facility			Yes	Maintenance procedures to be developed. Training to be provided for personnel. Training management to be included in pipeline management system. Consider outsourcing operation and maintenance to experienced parties.	Borg	Prior to commissioning	Yes	Minor	Pipeline failure not credible, personal injury possible.	Unlikely	Operators will occasionally disregard procedures which may result in minor injury. Frequency of severe injury will drop to remote, resulting in the same risk ranking.	Low										
37	Operations and Maintenance	Inaccurate test equipment, leading to incorrect control and safety equipment settings	Overpressure of piping and equipment downstream of pressure let down station	Yes		T1	I	Borg Facility			Yes	Confirm PSV testing procedure exists. If not, develop one.	Borg	Prior to commissioning	No														
38	Operations and Maintenance	Other?		No	None identified	T1	I	Borg Facility				No actions																	
39	Design Defects	Failure to specify the correct material, component and equipment characteristics.	Overstress of pipe causing eventual loss of containment.	Yes		T1	I	Borg Facility	Pressure testing prior to commissioning	Review of engineering deliverables by competent engineers	No	Ensure pressurisation / depressurisation study is performed to ensure materials are suitable for expected temperatures and pressures	Borg	Prior to procurement	No													
40	Design Defects	Incorrect design or engineering analysis of the pipeline and associated piping. (different entities designing pipeline and stations)	Overstress of pipe causing eventual loss of containment.	Yes		T1	I	Borg Facility	Pressure testing prior to commissioning	Review of engineering deliverables by competent engineers	No	Ensure HAZOP covers the entire system including interface issues.	Borg	HAZOP	No													
41	Design Defects	Failure to define the correct range of operating conditions, leading to incorrect settings on control or protective devices, or unacceptable pressures, temperatures and loads.	Overstress of pipe causing eventual loss of containment.	Yes		T1	I	Borg Facility	Nil	Review of engineering deliverables by competent engineers. HAZOP study.	No	Ensure HAZOP covers the entire system including interface issues. Confirm MAOP of sydney to moomba pipeline.	Borg	HAZOP	No													
42	Design Defects	Failure of design configuration and equipment features to allow for safe operations and maintenance.	Inability to operate and maintain, leading to pipeline shutdown.	Yes		T1	I	Borg Facility	Nil	Review of engineering deliverables by competent engineers	No	Ensure HAZOP covers the entire system including interface issues. Confirm MAOP of sydney to moomba pipeline.	Borg	HAZOP	No													
43	Design Defects	Other?		No	None identified	T1	I	Borg Facility				No actions																	
44	Material Defects	Incorrectly identified components	Overstress of pipe causing eventual loss of containment - due to understrength pipe.	Yes		T1	I	Borg Facility	Hydrostatic testing	Material receipt and traceablity procedures	No	No actions																
45	Material Defects	Incorrect specification, supply, handling, storage, installation or testing which allow faults to remain undetected, or which damage the item and render its operation inadequate	Overstress of pipe causing eventual loss of containment.	Yes		T1	I	Borg Facility	Hydrostatic testing. 100% NDE on field welds.	Construction specification. Construction QA/QC. Construction supervision.	No	Ensure TBE is completed before placing order for linepipe	Borg	Prior to procurement	No													
46	Material Defects	Under-strength pipe	Overstress of pipe causing eventual loss of containment.	Yes		T1	I	Borg Facility	Hydrostatic testing		No	Review of mill certificates	Borg	Prior to construction	No													
47	Material Defects	Manufacturing defect	Overstress of pipe causing eventual loss of containment.	Yes		T1	I	Borg Facility	Hydrostatic testing	Purchase of material from reputable suppliers with QA/QC certified vendors.	No	No actions																
48	Material Defects	Lack of adequate inspection and test procedures to confirm the acceptability of material and equipment	Overstress of pipe causing eventual loss of containment.	Yes		T1	I	Borg Facility	Hydrostatic testing	Purchase of material from reputable suppliers with QA/QC certified vendors.	No	No actions																
49	Material Defects	Other?		No	None identified	T1	I	Borg Facility				No actions																	
50	Construction Defects	Undetected or unreported damage to the pipe, coating or equipment	Pipeline damage including dents, coating damage, etc. Resulting in pitting corrosion and release of hydrocarbon.	Yes		T1	I	Borg Facility	Hydrostatic testing. Cathodic protection.	Construction QA/QC. Holiday testing. DCVG	No	Construction specification to include controls listed. Construction to be supervised by competent and experienced supervisor.	Borg	Prior to construction	No													
51	Construction Defects	Undetected critical weld defects	Low strength joints and release of hydrocarbon.	Yes		T1	I	Borg Facility	PQT. NDE. Hydrostatic testing	Qualified welders and welding procedures	No	Construction specification to include these requirements.	Borg	Prior to construction	No													
52	Construction Defects	Failure to install the specified materials or equipment	Loss of containment	Yes		T1	I	Borg Facility	Hydrostatic testing. NDE.	Construction specification. Construction QA/QC. Only 1 pipe spec for whole of buried pipeline	No	No actions																
53	Construction Defects	Failure to install the pipeline in the specified location		Yes		T1	I	Borg Facility			Yes	Ensure construction spec details survey requirements to survey property boundary and pipeline is constructed inside property boundary	Borg	Prior to construction	No													
54	Construction Defects	Inadequate testing for defects prior to commissioning. Eg. incorrect test pressure	Loss of containment	Yes		T1	I	Borg Facility	Nil	Construction specification. Construction QA/QC.	No	No actions																
55	Construction Defects	Failure during hydrostest	personnel injury	yes		T1	I	Borg Facility		Construction spec. Hydro test plan.	Yes	Exclusion zone to be maintained during hydrotest.	Borg	During Hydrotest	No													
56	Intentional Damage	Sabotage	Damage leading to loss of containment	Yes		T1	I	Borg Facility	Fenced site.	Manned and controlled site.	Yes	No actions			Yes	Severe	Possible injury	Remote	Not expected to occur	Low								

THREAT IDENTIFICATION						LOCATION			EXISTING CONTROLS			ADDITIONAL CONTROLS (ACTION ITEM)				RISK ASSESSMENT					RISK TREATMENT								
ID	Category	Description	Consequence	Threat Credible?	If no, why?	Primary Location Class	Secondary Location Class	Location	Physical Controls	Procedural and/or Design Controls	Failure Possible?	Additional Controls	Action By	Due Date	Failure Possible?	Severity	Severity Notes	Frequency	Frequency Notes	Risk Ranking	Risk Treatment / Action	Action By	Due Date	Revised Severity	Severity Notes	Revised Frequency	Frequency Notes	Revised Risk Ranking	ALARP Yes/No
57	Intentional Damage	Terrorism		No	None identified	T1	I	Borg Facility				No actions																	
58	Intentional Damage	Malicious damage	Damage leading to loss of containment	Yes		T1	I	Borg Facility	Fenced site.	Manned and controlled site.	Yes	No actions			Yes	Severe	Possible injury	Remote	Not expected to occur	Low									
59	Intentional Damage	Other?		No	None identified	T1	I	Borg Facility				No actions																	
60	Other	Seismic survey, resulting in blast or equivalent external pressure loads.		No	Not expected in this location	T1	I	Borg Facility				No actions																	
61	Other	Induced voltages, arising from parallel electricity transmission lines	Induced voltage on pipeline is a danger to people. Coating damage. Negative effect on CP performance.	Yes		T1	I	Borg Facility		PCR is included in the design to protect people from electric shock when touching A/G equipment	Yes	Level 2 LFI / EPR assessment is to be performed. OSD to raise TQ to request required information. OSD to finalise CP design based on results of assessment.	OSD	During detailed design														
62	Other	Fault voltages from nearby transmission towers	Danger to people. Coating damage. Negative effect on CP performance.	Yes		T1	I	Borg Facility			Yes	Level 2 LFI / EPR assessment is to be performed. OSD to raise TQ to request required information. OSD to finalise CP design based on results of assessment.	OSD	During detailed design														
63	Other	Mine subsidence		No	No nearby mine site	T1	I	Borg Facility				No actions																	
64	Others	LFI / EPR during construction	Danger to people.	Yes		T1	I	Borg Facility			Yes	If level 2 assessment shows there is a risk, the construction contractor needs to be made aware of the risk. Risk to be documented in construction specification. Construction contractor to mitigate risk.	OSD	Prior to construction														
65	Others	Drainage culvert collapse during pipeline construction or after construction	Danger to people.	Yes		T1	I	Borg Facility			Yes	Recommended that Borg consult with civil engineer to ensure pipeline construction does not introduce risk to the culvert wall	Borg	Prior to construction														

Appendix C
Actions

SAFETY MANAGEMENT STUDY
ACTION LIST

Client	Borg Manufacturing	**Chair**	Soheil Taherian	**Document No.**	2079-EL-REG-001
Project Number	2079	**Scribe**	Michael Jones	**Document Rev.**	A
Project	HP Gas Pipeline Project	**Attendees**	Refer to attendance register	**Document Date**	12/06/2018
Description	Safety Management Study	**Meeting Location**	Level 2, 349 Coronation Drive, Milton, QLD 4064	**Meeting Date**	12/05/2018

Action No.	Threat ID No.	Threat Category	Threat Description	Threat Consequences	Action	Responsible	Due Date
1	1	External Interference	Third Party Excavation - Such as construction or maintenance of roads or buried services	Damage to pipeline causing loss of containment with or without ignition	Create information pack and distribute to third party service operators near pipeline - to inform people of the pipeline location and risks. Develop management process for supervising known activities near pipeline (eg excavation). Register pipeline with One-call service (DBYD). All of the above should be documented in the pipeline integrity management plan If possible move fence such that the pipeline is 100% inside the fence line and third party services are outside the fence line.	Borg	Prior to commissioning
2	2	External Interference	First Party Excavation - Such as for maintenance of buried services or installation of new services	Damage to pipeline causing loss of containment with or without ignition	Recommend only allowing general purpose teeth to be used near pipeline (if adopted add to permit to work system)	Borg	Prior to commissioning
3	3	External Interference	Installation of posts or poles for fences or power cable installation (Augers)	Damage to pipeline causing loss of containment with or without ignition	Include minimum separation requirements (3m) in information pack for third parties.	Borg	Prior to commissioning
4	3	External Interference	Installation of posts or poles for fences or power cable installation (Augers)	Damage to pipeline causing loss of containment with or without ignition	Fence posts to be relocated prior to introducing gas to pipeline. There is an earlier recommendation to put fence between pipeline and third party services which would add mitigation to this threat if practicable (threat ID 1)	Borg	Prior to Construction
5	14	Corrosion	External corrosion/erosion of pipe due to environmental factors, such as salinity, type of soil and moisture content, and the abrasive action of sand and soil particles.	Loss of wall thickness, leading to reduction of MAOP and/or loss of containment.	Ensure that pipeline integrity management plan (PIMP) contains requirements to perform the procedural controls	Borg	Prior to commissioning
6	17	Corrosion	Environmentally assisted cracking (SCC - Stress Corrosion Cracking)	Eventual loss of containment	Perform SCC assessment	OSD	With SMS Report
7	18	Corrosion	Bacterial Corrosion	Loss of wall thickness, leading to reduction of MAOP and/or loss of containment.	Confirm that hydrotest water will be treated with biocide and sufficient cleaning/drying will be performed on the pipeline during commisisoning. This shall be captured in the Construction SOW.	Borg	Prior to construction
8	19	Corrosion	CP interference from other nearby services	External corrosion leading to loss of conatinment	Ensure PIMP has requirements for CP monitoring including interference checks.	Borg	Prior to commissioning
9	20	Natural Events	Earthquake	Pipe deformation with possible loss of containment	Designers to investigate and ammend design if required	OSD	During detailed design
10	21	Natural Events	Ground movement, due to trench instability	Loss of containment with or without ignition	Construction specification to address compaction requirements (100% compaction is suggested)	Borg	Prior to construction
11	22	Natural Events	Wind and cyclone	Damage to above ground facilities leading to loss of containment.	Wall thickness and piping arrangement (to be demonstrated by stress analysis). Design to AS1170.2	Borg	Prior to construction
12	25	Natural Events	Lightning	Injury/fatality on people working in a different location along the pipeline.	Borg policies to prohibit working in a storm	Borg	Prior to commissioning
13	26	Natural Events	Floods, leading to erosion or impact damage	Damage to above ground facilities leading to loss of containment.	Drainage culvert to be maintained and inspected on a regular basis.	Borg	Prior to commissioning
14	30	Operations and Maintenance	Exceeding MAOP	Overstress of pipe causing eventual loss of containment.	Confirm that Sydney to Moomba pipeline MAOP does not exceed MAOP of this pipeline. HAZOP to be performed for pressure let down stations.	Borg	HAZOP
15	32	Operations and Maintenance	Incorrect valve operating sequence.	Overstress of pipe causing eventual loss of containment.	To be considered in HAZOP for stations, including consideration of pressurisation / depressurisation leading to temperatures in brittle range	Borg	HAZOP
16	33	Operations and Maintenance	Incorrect operation of control and protective equipment	Incorrect settings on XSV causing overpressure of pipeline.	Appropriate operating procedures to be developed for pipeline and all new equipment associated with the project	Borg	Prior to commissioning
17	34	Operations and Maintenance	Bypass of logic, control or protection equipment	Overstress of pipe causing eventual loss of containment.	To be considered in HAZOP	Borg	HAZOP
18	36	Operations and Maintenance	Inadequate or incomplete maintenance procedures leading to equipment failure, or actions contrary to procedures	Potential personnel injury	Maintenance procedures to be developed. Training to be provided for personnel. Training management to be included in pipeline management system. Consider outsourcing operation and maintenance to experienced parties.	Borg	Prior to commissioning
19	37	Operations and Maintenance	Inaccurate test equipment, leading to incorrect control and safety equipment settings	Overpressure of piping and equipment downstream of pressure let down station	Confirm PSV testing procedure exists. If not, develop one.	Borg	Prior to commissioning
20	39	Design Defects	Failure to specify the correct material, component and equipment characteristics.	Overstress of pipe causing eventual loss of containment.	Ensure pressurisation / depressurisation study is performed to ensure materials are suitable for expected temperatures and pressures	Borg	Prior to procurement
21	40	Design Defects	Incorrect design or engineering analysis of the pipeline and associated piping. (different entities designing pipeline and stations)	Overstress of pipe causing eventual loss of containment.	Ensure HAZOP covers the entire system including interface issues.	Borg	HAZOP
22	41	Design Defects	Failure to define the correct range of operating conditions, leading to incorrect settings on control or protective devices, or unacceptable pressures, temperatures and loads.	Overstress of pipe causing eventual loss of containment.	Ensure HAZOP covers the entire system including interface issues. Confirm MAOP of sydney to moomba pipeline.	Borg	HAZOP

23	42	Design Defects	Failure of design configuration and equipment features to allow for safe operations and maintenance.	Inability to operate and maintain, leading to pipeline shutdown.	Ensure HAZOP covers the entire system including interface issues. Confirm MAOP of sydney to moomba pipeline.	Borg	HAZOP
24	45	Material Defects	Incorrect specification, supply, handling, storage, installation or testing which allow faults to remain undetected, or which damage the item and render its operation inadequate	Overstress of pipe causing eventual loss of containment.	Ensure TBE is completed before placing order for linepipe	Borg	Prior to procurement
25	46	Material Defects	Under-strength pipe	Overstress of pipe causing eventual loss of containment.	Review of mill certificates	Borg	Prior to construction
26	50	Construction Defects	Undetected or unreported damage to the pipe, coating or equipment	Pipeline damage including dents, coating damage, etc. Resulting in pitting corrosion and release of hydrocarbon.	Construction specification to include controls listed. Construction to be supervised by competent and experienced supervisor.	Borg	Prior to construction
27	51	Construction Defects	Undetected critical weld defects	Low strength joints and release of hydrocarbon.	Construction specification to include these requirements.	Borg	Prior to construction
28	53	Construction Defects	Failure to install the pipeline in the specified location		Ensure construction spec details survey requirements to survey property boundary and pipeline is constructed inside property boundary	Borg	Prior to construction
29	55	Construction Defects	Failure during hydrostest	personnel injury	Exclusion zone to be maintained during hydrotest.	Borg	During Hydrotest
30	61	Other	Induced voltages, arising from parallel electricity transmission lines	Induced voltage on pipeline is a danger to people. Coating damage. Negative effect on CP performance.	Level 2 LFI / EPR assessment is to be performed. OSD to raise TQ to request required information. OSD to finalise CP design based on results of assessment.	OSD	During detailed design
31	62	Other	Fault voltages from nearby transmission towers	Danger to people. Coating damage. Negative effect on CP performance.	Level 2 LFI / EPR assessment is to be performed. OSD to raise TQ to request required information. OSD to finalise CP design based on results of assessment.	OSD	During detailed design
32	64	Others	LFI / EPR during construction	Danger to people.	If level 2 assessment shows there is a risk, the construction contractor needs to be made aware of the risk. Risk to be documented in construction specification. Construction contractor to mitigate risk.	OSD	Prior to construction
33	65	Others	Drainage culvert collapse during pipeline construction or after construction	Danger to people.	Recommended that Borg consult with civil engineer to ensure pipeline construction does not introduce risk to the culvert wall	Borg	Prior to construction

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	1
Project No.	2079	**Threat ID No.**	1
Project Name	HP Gas Pipeline Project		

Threat Category

External Interference

Threat Description

Third Party Excavation - Such as construction or maintenance of roads or buried services

Threat Consequences

Damage to pipeline causing loss of containment with or without ignition

Action

Create information pack and distribute to third party service operators near pipeline - to inform people of the pipeline location and risks. Develop management process for supervising known activities near pipeline (eg excavation).
Register pipeline with One-call service (DBYD).
All of the above should be documented in the pipeline integrity management plan
If possible move fence such that the pipeline is 100% inside the fence line and third party services are outside the fence line.

Action Assigned To	Borg	**Action Due Date**	Prior to commissioning

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	2
Project No.	2079	**Threat ID No.**	2
Project Name	HP Gas Pipeline Project		

Threat Category

External Interference

Threat Description

First Party Excavation - Such as for maintenance of buried services or installation of new services

Threat Consequences

Damage to pipeline causing loss of containment with or without ignition

Action

Recommend only allowing general purpose teeth to be used near pipeline (if adopted add to permit to work system)

Action Assigned To	Borg	**Action Due Date**	Prior to commissioning

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	3
Project No.	2079	**Threat ID No.**	3
Project Name	HP Gas Pipeline Project		

Threat Category

External Interference

Threat Description

Installation of posts or poles for fences or power cable installation (Augers)

Threat Consequences

Damage to pipeline causing loss of containment with or without ignition

Action

Include minimum separation requirements (3m) in information pack for third parties.

Action Assigned To	Borg	**Action Due Date**	Prior to commissioning

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	4
Project No.	2079	**Threat ID No.**	3
Project Name	HP Gas Pipeline Project		

Threat Category

External Interference

Threat Description

Installation of posts or poles for fences or power cable installation (Augers)

Threat Consequences

Damage to pipeline causing loss of containment with or without ignition

Action

Fence posts to be relocated prior to introducing gas to pipeline.
There is an earlier recommendation to put fence between pipeline and third party services which would add mitigation to this threat if practicable (threat ID 1)

Action Assigned To	Borg	**Action Due Date**	Prior to Construction

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	5
Project No.	2079	**Threat ID No.**	14
Project Name	HP Gas Pipeline Project		

Threat Category

Corrosion

Threat Description

External corrosion/erosion of pipe due to environmental factors, such as salinity, type of soil and moisture content, and the abrasive action of sand and soil particles.

Threat Consequences

Loss of wall thickness, leading to reduction of MAOP and/or loss of containment.

Action

Ensure that pipeline integrity management plan (PIMP) contains requirements to perform the procedural controls

Action Assigned To	Borg	**Action Due Date**	Prior to commissioning

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	6
Project No.	2079	**Threat ID No.**	17
Project Name	HP Gas Pipeline Project		

Threat Category

Corrosion

Threat Description

Environmentally assisted cracking (SCC - Stress Corrosion Cracking)

Threat Consequences

Eventual loss of containment

Action

Perform SCC assessment

Action Assigned To	OSD	**Action Due Date**	With SMS Report

Closeout Details

An assessment was carried out as per "Pipeline Research Committee International (PRCI) PR-3-9403 - Protocol to prioritize sites for high pH stress corrosion cracking on gas pipelines." When using conservative assumptions the susceptibility of the design to high pH stress corrosion cracking was rated as 'Low', and no design mitigations are required.

This assessment is documented in 2079-EL-CAL-003.

Closed Out By	Michael Jones	**Signed**		**Date**	25-Jun-18
Approved by	Soheil Taherian	**Signed**		**Date**	25-Jun-18

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	7
Project No.	2079	**Threat ID No.**	18
Project Name	HP Gas Pipeline Project		

Threat Category

Corrosion

Threat Description

Bacterial Corrosion

Threat Consequences

Loss of wall thickness, leading to reduction of MAOP and/or loss of containment.

Action

Confirm that hydrotest water will be treated with biocide and sufficient cleaning/drying will be performed on the pipeline during commisisoning. This shall be captured in the Construction SOW.

Action Assigned To	Borg	**Action Due Date**	Prior to construction

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	8
Project No.	2079	**Threat ID No.**	19
Project Name	HP Gas Pipeline Project		

Threat Category

Corrosion

Threat Description

CP interference from other nearby services

Threat Consequences

External corrosion leading to loss of conatinment

Action

Ensure PIMP has requirements for CP monitoring including interference checks.

Action Assigned To	Borg	**Action Due Date**	Prior to commissioning

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	9
Project No.	2079	**Threat ID No.**	20
Project Name	HP Gas Pipeline Project		

Threat Category

Natural Events

Threat Description

Earthquake

Threat Consequences

Pipe deformation with possible loss of containment

Action

Designers to investigate and ammend design if required

Action Assigned To	OSD	**Action Due Date**	During detailed design

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	10
Project No.	2079	**Threat ID No.**	21
Project Name	HP Gas Pipeline Project		

Threat Category

Natural Events

Threat Description

Ground movement, due to trench instability

Threat Consequences

Loss of containment with or without ignition

Action

Construction specification to address compaction requirements (100% compaction is suggested)

Action Assigned To	Borg	**Action Due Date**	Prior to construction

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	11
Project No.	2079	**Threat ID No.**	22
Project Name	HP Gas Pipeline Project		

Threat Category

Natural Events

Threat Description

Wind and cyclone

Threat Consequences

Damage to above ground facilities leading to loss of containment.

Action

Wall thickness and piping arrangement (to be demonstrated by stress analysis).
Design to AS1170.2

Action Assigned To	Borg	**Action Due Date**	Prior to construction

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	12
Project No.	2079	**Threat ID No.**	25
Project Name	HP Gas Pipeline Project		

Threat Category

Natural Events

Threat Description

Lightning

Threat Consequences

Injury/fatality on people working in a different location along the pipeline.

Action

Borg policies to prohibit working in a storm

Action Assigned To	Borg	**Action Due Date**	Prior to commissioning

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	13
Project No.	2079	**Threat ID No.**	26
Project Name	HP Gas Pipeline Project		

Threat Category

Natural Events

Threat Description

Floods, leading to erosion or impact damage

Threat Consequences

Damage to above ground facilities leading to loss of containment.

Action

Drainage culvert to be maintained and inspected on a regular basis.

Action Assigned To	Borg	**Action Due Date**	Prior to commissioning

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	14
Project No.	2079	**Threat ID No.**	30
Project Name	HP Gas Pipeline Project		

Threat Category

Operations and Maintenance

Threat Description

Exceeding MAOP

Threat Consequences

Overstress of pipe causing eventual loss of containment.

Action

Confirm that Sydney to Moomba pipeline MAOP does not exceed MAOP of this pipeline.
HAZOP to be performed for pressure let down stations.

Action Assigned To	Borg	**Action Due Date**	HAZOP

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	15
Project No.	2079	**Threat ID No.**	32
Project Name	HP Gas Pipeline Project		

Threat Category

Operations and Maintenance

Threat Description

Incorrect valve operating sequence.

Threat Consequences

Overstress of pipe causing eventual loss of containment.

Action

To be considered in HAZOP for stations, including consideration of pressurisation / depressurisation leading to temperatures in brittle range

Action Assigned To	Borg	**Action Due Date**	HAZOP

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	16
Project No.	2079	**Threat ID No.**	33
Project Name	HP Gas Pipeline Project		

Threat Category

Operations and Maintenance

Threat Description

Incorrect operation of control and protective equipment

Threat Consequences

Incorrect settings on XSV causing overpressure of pipeline.

Action

Appropriate operating procedures to be developed for pipeline and all new equipment associated with the project

Action Assigned To	Borg	**Action Due Date**	Prior to commissioning

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	17
Project No.	2079	**Threat ID No.**	34
Project Name	HP Gas Pipeline Project		

Threat Category

Operations and Maintenance

Threat Description

Bypass of logic, control or protection equipment

Threat Consequences

Overstress of pipe causing eventual loss of containment.

Action

To be considered in HAZOP

Action Assigned To	Borg	**Action Due Date**	HAZOP

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	18
Project No.	2079	**Threat ID No.**	36
Project Name	HP Gas Pipeline Project		

Threat Category

Operations and Maintenance

Threat Description

Inadequate or incomplete maintenance procedures leading to equipment failure, or actions contrary to procedures

Threat Consequences

Potential personnel injury

Action

Maintenance procedures to be developed.
Training to be provided for personnel.
Training management to be included in pipeline management system.
Consider outsourcing operation and maintenance to experienced parties.

Action Assigned To	Borg	**Action Due Date**	Prior to commissioning

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	19
Project No.	2079	**Threat ID No.**	37
Project Name	HP Gas Pipeline Project		

Threat Category

Operations and Maintenance

Threat Description

Inaccurate test equipment, leading to incorrect control and safety equipment settings

Threat Consequences

Overpressure of piping and equipment downstream of pressure let down station

Action

Confirm PSV testing procedure exists. If not, develop one.

Action Assigned To	Borg	**Action Due Date**	Prior to commissioning

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	20
Project No.	2079	**Threat ID No.**	39
Project Name	HP Gas Pipeline Project		

Threat Category

Design Defects

Threat Description

Failure to specify the correct material, component and equipment characteristics.

Threat Consequences

Overstress of pipe causing eventual loss of containment.

Action

Ensure pressurisation / depressurisation study is performed to ensure materials are suitable for expected temperatures and pressures

Action Assigned To	Borg	**Action Due Date**	Prior to procurement

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	21
Project No.	2079	**Threat ID No.**	40
Project Name	HP Gas Pipeline Project		

Threat Category

Design Defects

Threat Description

Incorrect design or engineering analysis of the pipeline and associated piping. (different entities designing pipeline and stations)

Threat Consequences

Overstress of pipe causing eventual loss of containment.

Action

Ensure HAZOP covers the entire system including interface issues.

Action Assigned To	Borg	**Action Due Date**	HAZOP

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	22
Project No.	2079	**Threat ID No.**	41
Project Name	HP Gas Pipeline Project		

Threat Category

Design Defects

Threat Description

Failure to define the correct range of operating conditions, leading to incorrect settings on control or protective devices, or unacceptable pressures, temperatures and loads.

Threat Consequences

Overstress of pipe causing eventual loss of containment.

Action

Ensure HAZOP covers the entire system including interface issues.
Confirm MAOP of sydney to moomba pipeline.

Action Assigned To	Borg	**Action Due Date**	HAZOP

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	23
Project No.	2079	**Threat ID No.**	42
Project Name	HP Gas Pipeline Project		

Threat Category

Design Defects

Threat Description

Failure of design configuration and equipment features to allow for safe operations
and maintenance.

Threat Consequences

Inability to operate and maintain, leading to pipeline shutdown.

Action

Ensure HAZOP covers the entire system including interface issues.
Confirm MAOP of sydney to moomba pipeline.

Action Assigned To	Borg	**Action Due Date**	HAZOP

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	24
Project No.	2079	**Threat ID No.**	45
Project Name	HP Gas Pipeline Project		

Threat Category

Material Defects

Threat Description

Incorrect specification, supply, handling, storage, installation or testing which allow faults to remain undetected, or which damage the item and render its operation inadequate

Threat Consequences

Overstress of pipe causing eventual loss of containment.

Action

Ensure TBE is completed before placing order for linepipe

Action Assigned To	Borg	**Action Due Date**	Prior to procurement

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	25
Project No.	2079	**Threat ID No.**	46
Project Name	HP Gas Pipeline Project		

Threat Category

Material Defects

Threat Description

Under-strength pipe

Threat Consequences

Overstress of pipe causing eventual loss of containment.

Action

Review of mill certificates

Action Assigned To	Borg	**Action Due Date**	Prior to construction

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	26
Project No.	2079	**Threat ID No.**	50
Project Name	HP Gas Pipeline Project		

Threat Category

Construction Defects

Threat Description

Undetected or unreported damage to the pipe, coating or equipment

Threat Consequences

Pipeline damage including dents, coating damage, etc. Resulting in pitting corrosion and release of hydrocarbon.

Action

Construction specification to include controls listed.
Construction to be supervised by competent and experienced supervisor.

Action Assigned To	Borg	**Action Due Date**	Prior to construction

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	27
Project No.	2079	**Threat ID No.**	51
Project Name	HP Gas Pipeline Project		

Threat Category

Construction Defects

Threat Description

Undetected critical weld defects

Threat Consequences

Low strength joints and release of hydrocarbon.

Action

Construction specification to include these requirements.

Action Assigned To	Borg	**Action Due Date**	Prior to construction

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	28
Project No.	2079	**Threat ID No.**	53
Project Name	HP Gas Pipeline Project		

Threat Category

Construction Defects

Threat Description

Failure to install the pipeline in the specified location

Threat Consequences

0

Action

Ensure construction spec details survey requirements to survey property boundary and pipeline is constructed inside property boundary

Action Assigned To	Borg	**Action Due Date**	Prior to construction

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	29
Project No.	2079	**Threat ID No.**	55
Project Name	HP Gas Pipeline Project		

Threat Category

Construction Defects

Threat Description

Failure during hydrostest

Threat Consequences

personnel injury

Action

Exclusion zone to be maintained during hydrotest.

Action Assigned To	Borg	**Action Due Date**	During Hydrotest

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	30
Project No.	2079	**Threat ID No.**	61
Project Name	HP Gas Pipeline Project		

Threat Category

Other

Threat Description

Induced voltages, arising from parallel electricity transmission lines

Threat Consequences

Induced voltage on pipeline is a danger to people.
Coating damage.
Negative effect on CP performance.

Action

Level 2 LFI / EPR assessment is to be performed. OSD to raise TQ to request required information. OSD to finalise CP design based on results of assessment.

Action Assigned To	OSD	**Action Due Date**	During detailed design

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	31
Project No.	2079	**Threat ID No.**	62
Project Name	HP Gas Pipeline Project		

Threat Category

Other

Threat Description

Fault voltages from nearby transmission towers

Threat Consequences

Danger to people.
Coating damage.
Negative effect on CP performance.

Action

Level 2 LFI / EPR assessment is to be performed. OSD to raise TQ to request required information. OSD to finalise CP design based on results of assessment.

Action Assigned To	OSD	**Action Due Date**	During detailed design

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	32
Project No.	2079	**Threat ID No.**	64
Project Name	HP Gas Pipeline Project		

Threat Category

Others

Threat Description

LFI / EPR during construction

Threat Consequences

Danger to people.

Action

If level 2 assessment shows there is a risk, the construction contractor needs to be made aware of the risk. Risk to be documented in construction specification. Construction contractor to mitigate risk.

Action Assigned To	OSD	**Action Due Date**	Prior to construction

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

AS2885 SAFETY MANAGEMENT STUDY ACTION SHEET

SMS Date	12/05/2018	**Action No.**	33
Project No.	2079	**Threat ID No.**	65
Project Name	HP Gas Pipeline Project		

Threat Category

Others

Threat Description

Drainage culvert collapse during pipeline construction or after construction

Threat Consequences

Danger to people.

Action

Recommended that Borg consult with civil engineer to ensure pipeline construction does not introduce risk to the culvert wall

Action Assigned To	Borg	**Action Due Date**	Prior to construction

Closeout Details

Closed Out By		**Signed**		**Date**	
Approved by		**Signed**		**Date**	

Notes

Appendix E- Consultation

Connection and New Facility Agreement

Borg Oberon Meter Station – Moomba Sydney Pipeline

Date

This agreement is dated on the date it is signed by the last party to do so.

Parties

APA	East Australian Pipeline Pty Limited
ABN	33 064 629 009
Address for service	Level 25, 580 George Street, Sydney NSW 2000
Facsimile	+612 9693 0093
APA's Representative	Yoko Kosugi
Email	Company.Secretary@apa.com.au CC: Yoko.Kosugi@apa.com.au and Commercial.Contracts@apa.com.au
Service User	Borg Manufacturing Pty Limited
ABN	31 003 246 357
Address for service	124 Lowes Mount Road, Oberon NSW 2787
Address for invoices	2 Wella Way, Somersby NSW 2250
Service User's Representative	Victor Bendevski
Email	bendevskiv@borgs.com.au

Details

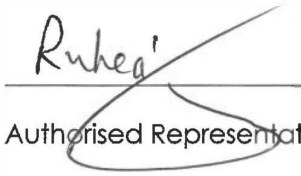
APA Meter Station	Oberon Meter Station (located at the end of the Oberon Lateral off the Young Lithgow Pipeline) owned and operated by APA
Jurisdiction	New South Wales
Service User Site	The land identified in the drawing at Schedule 2 on Lot 31, DP 1230464.
APA Site	The land identified in the drawing at Schedule 2 on Lot 1, DP 78979.
APA Pipeline	Moomba Sydney Pipeline
New Facility	The following plant and equipment (owned and operated by APA): • excavation and footing upgrades within the APA Meter Station to allow for New Facility; • installation of a new above ground 3" offtake, from an existing 3" bypass pipeline in the APA Meter Station facility to the boundary fence of the APA Meter Station at the proposed Connection Point; • metering equipment with series proving capability (no series prove meter included) and associated instrumentation and filtration; • installation of new flow computer; and • upgrade to existing APA Meter Station RTU and SCADA upgrade.
Service User Facility	The following plant and equipment (owned and operated by Service User): • all access and approvals required for any works outside of the APA Meter Station; • excavation required downstream of the Connection Point to the Service User Site; • installing new 3" pipeline from the Connection Point (above ground) to the Service User Site; • isolation valve; • remotely actuated shut down valve; • filter; • pressure regulator; and • all other items downstream of the Connection Point.
Commencement Date	Date of execution of this Agreement.
Date for Actual Completion	The date that is nine months after the Date of this agreement, as extended under clause **Error! Reference source not found.** or clause 5.2.
Preliminary Obligations	• Service User providing APA with the Service User Facility preliminary design; and

	• Service User providing APA with the output of HAZOP studies in relation to the Service User Facility.
Preliminary Obligations Date	1 June 2019
End Date	The expiry of the Connection Term, as extended under clause 9.2.
Gas Transportation Agreement	Not applicable
Services	• Construction Services Yes • Connection Services Yes being the services that APA has agreed to provide pursuant to this Agreement
Construction Specifications	See Schedule 3.
Connection Point	The point connecting the Service User Facility to the New Facility which at the Commencement Date is the location marked "Proposed Supply Point to Borg – proposed above ground (TBC)" as shown in the Diagram in Schedule 2.
Connection Specifications	See Schedule 3.
Charges	The following charges payable by Service User to APA in respect of the Services, being: **New Facility Charge** - calculated in accordance with clause 13.2. **Connection Charge** - set out in clause 13.3. These Charges are GST-exclusive.
Margin for Construction Services (clause 13.2)	10%
Termination Payment	Not applicable
Invoice Date	On or before the 10th day of each Month.
Payment Date	The date that is 14 days after the receipt by Service User of APA's valid tax invoice under clause 15.
Non-Financial Default (clause 1.1)	Not applicable
Specified Credit Support (clause 16.1)	A deposit of $#@#%^__ paid by the Service User to APA, to be held by APA during the Construction Term. APA will invoice the deposit in the first invoice issued to Service User during the Construction Term. The deposit will be deducted from the last payment to be made from the Service User to APA pursuant to this Agreement.
Parent Company Guarantee (clause 16.2)	Not Applicable

Guarantor (clause 16.2)	Not Applicable
Liability Cap (clause 18.2)	

EXECUTED as an agreement

Executed by **East Australian Pipeline Pty Limited** by its authorised representative in the presence of:



Authorised Representative Signature

Witness Signature

ROBERT PATON HEAD OF BD.

Print Name **R. A. Wheals**

Print Name and Position

Date 23-4-19

Executed by **Borg Manufacturing Pty Limited** by its authorised representative in the presence of:

Authorised Representative Signature

Witness Signature

Print Name

Print Name and Position

Date

EXECUTED as an agreement

Executed by **East Australian Pipeline Pty Limited** by its authorised representative in the presence of:

Authorised Representative Signature

Witness Signature

ROBERT PATON HEAD OF BD.

Print Name **R. A. Wheals**

Print Name and Position

Date 23-4-19

Executed by **Borg Manufacturing Pty Limited** by its authorised representative in the presence of:

~~Authorised Representative Signature~~

Witness Signature

VICTOR BENDEWSKI - COMPLIANCE

Print Name

3/5/2019

Print Name and Position

Date

ESSENTIAL ENERGY.

From: Neil Searant <Neil.Searant@ampcontrolgroup.com>
Sent: Monday, August 12, 2019 11:26 AM
To: Troy Brien <brient@borgs.com.au>
Cc: Tom Hagan <hagant@crossmuller.com.au>
Subject: RE: Approval for Solar Turbine approval

Troy,
In Andrew Tuckers email, on Friday, 6 July 2018 10:15 AM

Thanks Neil, I now have full approval for all the co-gen and add load so you can proceed with the commissioning.

All the co-gen refers to the LV & HV generation. The add load is the PBP.

Regards

Neil Searant (BEng(Elec))
NSW HV Field Service - Senior Electrical Engineer
21 Old Punt Road, Tomago, NSW 2322
P +61 2 4961 9000 M 0418 688 397 D 02 49139598

ampcontrolgroup.com

-----Original Message-----
From: Troy Brien [mailto:brient@borgs.com.au]
Sent: Monday, 12 August 2019 11:20 AM
To: Neil Searant <Neil.Searant@ampcontrolgroup.com>
Cc: Tom Hagan <hagant@crossmuller.com.au>
Subject: Re: Approval for Solar Turbine approval

Thanks Neil, this is the one I was looking for, though it actually doesn't give us the go ahead for the Turbine. Do you know if the HV generator is ok to commission and sync when we complete our installation.

Regards,

Sent from my iPhone

> On 12 Aug 2019, at 11:07 am, Neil Searant <Neil.Searant@ampcontrolgroup.com> wrote:
>
> Try this one
>
>
> Regards
>
> Neil Searant (BEng(Elec))
> NSW HV Field Service - Senior Electrical Engineer
> 21 Old Punt Road, Tomago, NSW 2322
> P +61 2 4961 9000 M 0418 688 397 D 02 49139598
>
>

> ampcontrolgroup.com
>
>
>
>
> -----Original Message-----
> From: Troy Brien [mailto:brient@borgs.com.au]
> Sent: Monday, 12 August 2019 11:03 AM
> To: Neil Searant <Neil.Searant@ampcontrolgroup.com>
> Cc: Tom Hagan <hagant@crossmuller.com.au>
> Subject: Re: Approval for Solar Turbine approval
>
> Hi Neil, it may have been a follow up email from you to us relating to this email from Andrew Tucker.
>
> Thanks,
>
> Sent from my iPhone
>
> On 12 Aug 2019, at 10:54 am, Neil Searant
<Neil.Searant@ampcontrolgroup.com<mailto:Neil.Searant@ampcontrolgroup.com>> wrote:
>
> Troy,
> Is this the email you are after?
>
>
> Regards
> <image001.jpg>
>
> Neil Searant (BEng(Elec))
> NSW HV Field Service - Senior Electrical Engineer
> 21 Old Punt Road, Tomago, NSW 2322
> P +61 2 4961 9000 M 0418 688 397 D 02 49139598
>
>
> ampcontrolgroup.com<https://www.ampcontrolgroup.com/>
>
>
<image002.jpg><https://au.linkedin.com/company/ampcontrol> <image003.jpg><https://www.youtub
e.com/user/ampcontrol>
>
>
>
> From: Troy Brien [mailto:brient@borgs.com.au]
> Sent: Monday, 12 August 2019 10:51 AM
> To: Neil Searant
<Neil.Searant@ampcontrolgroup.com<mailto:Neil.Searant@ampcontrolgroup.com>>
> Cc: Tom Hagan <hagant@crossmuller.com.au<mailto:hagant@crossmuller.com.au>>
> Subject: RE: Approval for Solar Turbine approval
>
> Hi Neil,
> It looks like I had the wrong email. I'm after the email that Andrew Tucker sent you with approval of
the connection, commissioning and running of the PB site, LV and HV generators.
>
> Thanks,
>
> [Borg Panels]
>
> Troy Brien
> Electrical Team Leader
> p:02 6339 6272 | m:0438 396 252

> e:brient@borgs.com.au<mailto:brient@borgs.com.au> | w:www.borgs.com.au
> a:2 Lowes Mount Road Oberon NSW 2787
>
>
> From: Neil Searant
<Neil.Searant@ampcontrolgroup.com<mailto:Neil.Searant@ampcontrolgroup.com>>
> Sent: Monday, 12 August 2019 10:39 AM
> To: Troy Brien <brient@borgs.com.au<mailto:brient@borgs.com.au>>
> Cc: Tom Hagan <hagant@crossmuller.com.au<mailto:hagant@crossmuller.com.au>>
> Subject: RE: Approval for Solar Turbine approval
>
> Troy,
> The attached is the email from below. Let me know if this is what you are looking for.
>
>
> Regards
> <image001.jpg>
>
> Neil Searant (BEng(Elec))
> NSW HV Field Service - Senior Electrical Engineer
> 21 Old Punt Road, Tomago, NSW 2322
> P +61 2 4961 9000 M 0418 688 397 D 02 49139598
>
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> ampcontrolgroup.com<https://www.ampcontrolgroup.com/>
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<image002.jpg><https://au.linkedin.com/company/ampcontrol> <image003.jpg><https://www.youtub
e.com/user/ampcontrol>
>
>
>
> From: Troy Brien [mailto:brient@borgs.com.au]
> Sent: Monday, 12 August 2019 9:23 AM
> To: Neil Searant
<Neil.Searant@ampcontrolgroup.com<mailto:Neil.Searant@ampcontrolgroup.com>>
> Cc: Tom Hagan <hagant@crossmuller.com.au<mailto:hagant@crossmuller.com.au>>
> Subject: Approval for Solar Turbine approval
>
> Hi Neil,
> I'm after the email that you previously sent to us that has the approval for the connection of the
Solar turbine to our HV network. Can you please resend as I'm having trouble opening the archives.
>
> Thanks,
>
> <image006.jpg>
>
> [Borg Panels]
>
> Troy Brien
> Electrical Team Leader
> p:02 6339 6272 | m:0438 396 252
> e:brient@borgs.com.au<mailto:brient@borgs.com.au> | w:www.borgs.com.au
> a:2 Lowes Mount Road Oberon NSW 2787
>
>
> _____
> "The Borg Group of Companies respects the privacy of individuals and strives to comply with all
areas of the Privacy Act. This email, and any attachment(s) to it, may contain privileged or confidential
information and is for use only by the intended recipient. If you are not the intended recipient, you may

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> _____
> <mime-attachment>
> <mime-attachment>

ESSENTIAL ENERGY- EASEMENT ENCROACHMENT

Hi Fiona,
Please find attached information request.
The application is for an underground gas pipeline that is required to be constructed within the easement.

Regards

Victor Bendevski
Borg - Environmental and Regulatory Compliance

2 Wella Way Somersby NSW 2250
m 0410 327 635 p 02 4340 9827

-----Original Message-----
From: Nick Bessant <Nicholas.Bessant@crossmuller.com.au>
Sent: Wednesday, 27 March 2019 10:17 AM
To: Victor Bendevski <bendevskiv@borgs.com.au>
Subject: FW: Emailing: HV UG Crossing 2079-02-EL-ALP-001_0.pdf - Request to Encroach

Hi Victor,

See below

Nick Bessant
Crossmuller - Electrical Project Supervisor

2 Wella Way Somersby NSW 2250
m 0412 724 689 p 02 4340 9820

-----Original Message-----
From: ConveyancingTeam <
Sent: Tuesday, 26 March 2019 3:54 PM
To: Nick Bessant <Nicholas.Bessant@crossmuller.com.au>

Subject: RE: Emailing: HV UG Crossing 2079-02-EL-ALP-001_0.pdf - Request to Encroach

Dear Nick,

Further to your below email.

To assist Essential Energy in considering your request, would you please complete the attached form and also provide:

. Copy of the title search;
. Copy of the Deposited Plan showing the registered easement; . Copy of the terms of easement or dealing creating the easement; . A plan showing Essential Energy's electrical infrastructure in relation to your improvements including distances from the electrical infrastructure; . Information as to the structure or thing to encroach; . Nature of structure or thing including height, materials, purpose, whether power is to be connected.

Easements are primarily obtained or created to ensure the safety of persons living, working or playing near electricity infrastructure. They are also created to ensure electricity network operators can gain ready access to install, operate, maintain and replace, upgrade and renew infrastructure.

It is essential that persons be prevented from carrying out any activity close to electrical infrastructure which may create a public safety risk or affect the safe operation of the electrical network. It is for this reason that approval from Essential Energy should be obtained prior to any works being undertaken within an easement area.

I look forward to receipt of the above documents.

Should you require any clarification, please do not hesitate to contact me.

Regards

Fiona Duncan
Conveyancing Officer
Legal & Conveyancing
Governance & Corporate Services

T: 02 6589 8773 (Ext 88773) | fiona.duncan@essentialenergy.com.au
PO Box 5730 Port Macquarie NSW 2444 | essentialenergy.com.au General enquiries: 13 23 91 | Supply interruptions (24hr): 13 20 80
Follow us

-----Original Message-----
From: Nick Bessant <Nicholas.Bessant@crossmuller.com.au>
Sent: Wednesday, 20 March 2019 7:13 AM
To: ConveyancingTeam <conveyancingteam@essentialenergy.com.au>
Subject: FW: Emailing: HV UG Crossing 2079-02-EL-ALP-001_0.pdf

Hi Conveyancing Team,

Are you able to see the below correspondence from Victor and the attached drawing in regards to crossing an easement at our Borg manufacturing plant at Oberon.

Nick Bessant
Crossmuller - Electrical Project Supervisor

2 Wella Way Somersby NSW 2250
m 0412 724 689 p 02 4340 9820

-----Original Message-----
From: Andrew Tucker <andrew.tucker@essentialenergy.com.au>
Sent: Tuesday, 19 March 2019 2:18 PM
To: Nick Bessant <Nicholas.Bessant@crossmuller.com.au>
Cc: Victor Bendevski <bendevskiv@borgs.com.au>
Subject: RE: Emailing: HV UG Crossing 2079-02-EL-ALP-001_0.pdf

Hi Nick, send all the details to conveyancingteam@essentialenergy.com.au , they will respond and have someone from the encroachment team contact you.

Kind regards,

Andrew Tucker
Major Connections Case Manager

T: 02 6883 4411 | Ext 64411 andrew.tucker@essentialenergy.com.au
PO Box 5730 Port Macquarie NSW 2444 | essentialenergy.com.au General enquiries: 13 23 91 | Supply interruptions (24hr): 13 20 80 Follow us

-----Original Message-----
From: Nick Bessant <Nicholas.Bessant@crossmuller.com.au>
Sent: Monday, 18 March 2019 10:02 AM
To: Andrew Tucker <andrew.tucker@essentialenergy.com.au>
Cc: Victor Bendevski <bendevskiv@borgs.com.au>
Subject: FW: Emailing: HV UG Crossing 2079-02-EL-ALP-001_0.pdf

Hi Andrew,

Are you able to advise on the below email from Victor or let me know who to contact to ask the question.

I have gone on the essential website to see if I can find any info on HV easements but could find any.

Nick Bessant
Crossmuller - Electrical Project Supervisor

2 Wella Way Somersby NSW 2250
m 0412 724 689 p 02 4340 9820

-----Original Message-----
From: Victor Bendevski <bendevskiv@borgs.com.au>
Sent: Monday, 18 March 2019 9:29 AM
To: Nick Bessant <Nicholas.Bessant@crossmuller.com.au>
Cc: Tom Hagan <Tom.Hagan@crossmuller.com.au>
Subject: Emailing: HV UG Crossing 2079-02-EL-ALP-001_0.pdf

Nick,
See attached PDF. I have marked the area where we want to install underground and operate a gas pipe line and pressure let down station within the electricity easement.
I think it's better to get this discussion out of the way now rather than later on.

Can you please include me on all correspondence.

Regards
Victor

Environmental and Regulatory Compliance
p:02 4340 9827 | m:0410 327 635
e:bendevskiv@borgs.com.au | w:www.Borgs.com.au
a:2 Wella Way Somersby NSW 2250

Your message is ready to be sent with the following file or link attachments:

HV UG Crossing 2079-02-EL-ALP-001_0.pdf

OBERON COUNCIL

Hi Victor

Council has reviewed your proposed modification for the installation of a high pressure gas pipeline within your boundary parallel Lowes Mount Road.

No objections are raised by Council in relation to the proposed installation, given that it is generally to contained within your property.

Regards

Shane Wilson
Planning & Development Director

02 6329 8122 Direct
0408 220 702 Mobile
shane.wilson@oberon.nsw.gov.au
www.oberon.nsw.gov.au

-----Original Message-----
From: Victor Bendevski [mailto:bendevskiv@borgs.com.au]
Sent: Tuesday, 23 July 2019 11:49 AM
To: Shane Wilson
Subject: Proposed modification

Shane,
Borg are proposing a new modification to the Panels site which includes the installation of gas turbine electricity generator to assist the new particleboard site. This also involves the installation of a high pressure gas pipeline along our boundary parallel Lowes Mount road.
Attached is a drawing which will give you a general outline.
We have undertaken initial discussions with planning and completed various report to support its ability to operate with limited risk to the public and will lodge formally shortly.
Feel free to give me a call and discuss if required.

Regards

Victor

Your message is ready to be sent with the following file or link attachments:

S96-02

Note: To protect against computer viruses, e-mail programs may prevent sending or receiving certain types of file attachments. Check your e-mail security settings to determine how attachments are handled.

Appendix F – Submitted Drawings

APA GAS SUPPLY		FILTER VESSEL FIL-003		HEAT EXCHANGER HEX-003		TURBINE SUPPLY		ENGINE SUPPLY		FACTORY SUPPLY		WATER SUPPLY	
Max Flow Rate:	4135 Sm3/hr	Max Flow Rate:	??? Sm3/hr	Max Flow Rate:	4135 Sm3/hr	Max Flow Rate:	1292 Sm3/hr	Max Flow Rate:	1034 Sm3/hr	Max Flow Rate:	1809 Sm3/hr	Flow Rate:	100 L/min
Max Pressure:	9930 kPag	Nom. Pressure:	??? kPa	Max Pressure:	9930 kPa	Nom. Pressure:	3000 kPag	Nom. Pressure:	100 kPag	Nom. Pressure:	100 kPag	Max. Pressure:	500 kPag
Nom. Pressure:	8500 kPag	Temperature :	?°C	Temperature :	80°C	Temperature :	23°C	Temperature :	8°C	Temperature :	8°C	Nom. Pressure:	150 kPag
Min Pressure:	1750 kPag					Min. Pressure Supply @ TP01:	3300kPag					Min. Pressure:	100 kPag
												Supply. Temp:	80°C
												Return Temp:	60°C

OFF SKID

BORG AIR SUPPLY
APA GAS SUPPLY
HOT WATER SUPPLY
HOT WATER RETURN
TURBINE SUPPLY
ENGINE SUPPLY
FACTORY SUPPLY
VENT
VENT TO SAFE LOCATION
ATM (RAIN COWL)
5 WAY VALVE
SV-0101
NV-0101
ZA 0102
ZIOC 0102
ZSC 0102
ZSO 0102
PIT 0101
PDIT 0101
55 kPa AH 02
50 kPa AH 01
1 kPa AL 01
BV-0101
BV-0102
BV-0103
BV-0104
50-G-CS6-01
FIL - 001
NC BV-0105
OP - 0101
NV-0103
LS 01
LS 0101
LAH 002
50-G-CS6-02
BV-0201
FI 002
FT-0201
TIT 0201
TW 0201
PIT 0201
NV-0201
HEX - 201
TT 0202
TW 0202
BV-0202
BV-0203
BV-0204
BV-0205
BV-0206
BV-0207
50-G-CS6-03
NC BV-0301
PRV-0301
PRV-0302
NV-0301
PRV SET @ 3000kPag
OPSO SET @ 3900kPag
ACCELERATING SET @ 3180kPag
MONITOR SET @ 3090kPag
ZA 0301
ZIO 0301
ESD
ZSO 0301
NC BV-0209
OP - 0102
BV-0901
BV-1201
UV 001
TWV-1501
25-W-CU1-15
25-W-CU1-14
25-W-CU1-13
25-W-CU1-09
25-W-CU1-12
NV-0901
PIT 0901
PI 1601
TIA 003
TW 0901
TIT 0901
TI 003
FIT 0901
FI 003
05
06
PI 0301
PI 0401
NV-0401
PSV-0401 SP:3450kPag
PIT 0501
NV-0501
TW 0501
TT 0501
TC 003
DCS SP
OP SP DF
PI 0801
PSV-0701 SP:130kPag
PI 0701
NV-0701
TIT 0801
TW 0801
PIT 0801
NV-0801
150/100
PI 0601
NV-0601
PRV-0601
PRV-0602
50-G-CS6-04
50-G-CS6-05
50-G-CS6-06
150-G-CS1-07
150-G-CS1-08
BV-0208
NC BV-0601
BV-0401
BV-0701
PRV SET @ 100kPag
OPSO SET @ 150kPag
ACCELERATING SET @ 120kPag
MONITOR SET @ 110kPag
50/25
25/50
50/150
150/100

NOT FOR MANUFACTURE - PRELIMINARY ONLY

NO.	DESCRIPTION	REV. BY	DATE	APPR. BY
A	ORIGINAL RELEASE - NOT FOR MANUFACTURE	C.H.	8 OCT 18	J.B.

REVISIONS

NOTES:
1. ELECTRICAL PLC CONNECTIONS TBC IN DETAILED DESIGN

FURNACE ENGINEERING PTY.LTD
A.B.N. 63 006 276 786

A1

DESIGNED:	
DRAWN:	D.B.
DATE:	8/10/2018
CHECKED:	A.M.
APPROVED:	C.L.
SCALE:	NTS

TITLE: GAS CONDITIONING SKID P&ID

CLIENT:

AUTOCAD 2007

CAD FILE No.: B2970 500 A

DRG. NO.: B2970/500

SHT. NO.: 1/2

REV: A

LINE NUMBERING

AAA - BB - CCC - DD

- AAA — NOMINAL LINE SIZE (mm)
- BB — SERVICE CODE
- CCC — PIPING SPECIFICATION
- DD — UNIQUE IDENTIFIER

SERVICE CODES

CI	CORROSION INHIBITOR
DI	DIESEL
W	WATER
DFG	FUEL GAS
G	GAS (METERING STATION ONLY)
GL	GLYCOIL
HY	HYDRAULIC OIL
IG	INSTRUMENT GAS
LO	LUBE OIL
NG	NITROGEN
SS	STORMWATER SYSTEM
SW	SERVICE WATER
V	VENT
WD	WASTE OIL
WW	WASTE WATER

PIPE SPECIFICATION CS 1

- MATERIAL
- PIPING CLASS

MATERIAL

CS	CARBON STEEL
SS	STAINLESS STEEL
CU	COPPER

PIPING CLASS

1	ANSI CLASS 150
3	ANSI CLASS 300
6	ANSI CLASS 600

PIPELINE EQUIPMENT

	FLEXIBLE PIPE/HOSE
	BELLOWS
	EXPANSION JOINT
	REDUCER
	FLANGED CONNECTION
	BLANK FLANGE
	END CAP (BUTT WELD)
	END CAP (SCREWED)
	UNION
	PLUG
	HOSE CONNECTION
	QUICK CONNECTOR (WITHOUT CHECKS)
	QUICK CONNECTOR (WITH CHECKS)
	AIR PURGING DEVICE
	STRAINER,Y-TYPE.
	STRAINER,FILTER (GENERAL SYMBOL)
	SEPARATOR (GENERAL SYMBOL)
	TRAP (GENERAL SYMBOL)
F R L	COMBINATION FILTER, REGULATOR,LUBRICATOR
FG	FLOW SIGHT GLASS
	DRAIN OR TUNDISH
	SILENCER
	MIXER
	ORIFICE PLATE

SIGNAL(INSTRUMENT) LINE SYMBOLS

	INSTRUMENT AIR (PNEUMATIC SIGNAL)
	INSTRUMENT LIQUID (HYDRAULIC SIGNAL)
	ELECTRIC
	INSTRUMENT CAPILLIARY TUBING(FILLED SYSTEM)
	ELECTROMAGNETIC OR SONIC (WITHOUT WIRING OR TUBING)
	MODBUS
F.E / CUSTOMER	TERMINATION POINT

PIPELINE SYMBOLS

	PRIMARY PROCESS
	SECONDARY PROCESS
	UNDERGROUND
EXISTING	EXISTING
FUTURE	FUTURE
X MM	INSULATED
X MM E	TRACED LINE
	JACKETED
	EXISTING TO BE REMOVED
	CHANGE IN SPECIFICATION
	CROSSING PIPE NOT CONNECTED
	CROSSING PIPE CONNECTED
	TEE

INSTRUMENTS ON PIPING

X/X	CONTROL ROOM MOUNTED INSTRUMENT
X/X	LOCALLY MOUNTED INSTRUMENT
	LOCAL PANEL MOUNTED INSTRUMENT
	CONTROL ROOM MOUNTED NORMALLY INACCESSIBLE
X/X	PRIMARY DCS DISPLAY
	SECONDARY DCS DISPLAY
	SHARED DISPLAY (NOT ACCESSIBLE TO OPERATOR)
X	PRIMARY CONTROL/DISPLAY BY PLC
	FIELD MOUNTED PLC
	SECONDARY DISPLAY BY PLC
I X/X	GENERAL INTERLOCK
L 1	LOGIC WITH ALLOCATED PLC
OR	OR-GATE
S	SAFETY INTERLOCK LOGIC

VALVES

NO VO-001	VALVE GENERAL-NORMALLY OPEN (GENERAL SYMBOL)
NC VC-001	VALVE - NORMALLY CLOSED (GENERAL SYMBOL)
GV-001	GATE VALVE
GLV-001	GLOBE VALVE
BV-001	BALL VALVE
BUV-001	BUTTERFLY VALVE
PV-001	PLUG VALVE (COCK)
NV-001	NEEDLE VALVE
TWV-001	THREE WAY VALVE
DV-001	DIAPHRAGM VALVE
AV-001	ANGLE VALVE (GENERAL SYMBOL)
SV-001	SAFETY/RELIEF VALVE (PRESSURE OR VACUUM)
PSV-001	SAFETY/RELIEF VALVE
	BURST DISC
CV-001	CHECK/NON RETURN VALVE
RV-001	REDUCING VALVE
AV-001	AUTO DRAIN VALVE

GAS SERVICE SPECIALTY VALVES

	ADJUSTABLE PORT VALVE
LO	LIMITING ORIFICE BUTTERFLY VALVE
LO	LIMITING ORIFICE VALVE
MO	METERING ORIFICE VALVE

MECHANICAL EQUIPMENT

	PUMP (GENERAL SYMBOL)
	COMPRESSOR
	HEAT EXCHANGER
	OPEN OR VENTED RESERVOIR
	PRESSURIZED RESERVOIR
	RECEIVER

VALVE CONTROL AND REGULATION COMPONENTS

MV-001	MANUALLY OPERATED (GENERAL SYMBOL)
QOV-001	QUICK OPENING
SV-001	SPRING
DV-001	DIAPHRAGM
PIV-001	PISTON
ELV-001	ELECTRIC MOTOR
SV-001	SOLENOID
FV-001	FLOAT
WV-001	WEIGHT
PRV-001 / PRV-001	SELF ACTUATED REGULATING VALVE
PAV-001	PILOT ACTUATED REGULATING VALVE
ARV-001	ATMOSPHERIC REGULATOR (ZERO GOVERNOR)

AIR HANDLING EQUIPMENT

F	FAN (GENERAL SYMBOL)
F	CENTRIFUGAL FAN
AF	AIR FILTER
SIL	SILENCER
D	DAMPER (SINGLE BLADE)
MD	DAMPER (MULTI-BLADE)
	DUCT (GENERAL SYMBOL)
	THERMAL INSULATION
FL	FLEXIBLE
FD	FLEXIBLE DUCTWORK

REVISIONS NO.	DESCRIPTION	REV. BY	DATE	APPR. BY
A	ORIGINAL RELEASE - NOT FOR MANUFACTURE	C.H.	8 OCT 18	J.B.

NOTES:
1. ELECTRICAL PLC CONNECTIONS TBC IN DETAILED DESIGN

NOT FOR MANUFACTURE - PRELIMINARY ONLY

FURNACE ENGINEERING PTY.LTD
A.B.N. 63 006 276 786

A1

DESIGNED:	
DRAWN:	C.H.
DATE:	8/10/2018
CHECKED:	A.M.
APPROVED:	C.L.
SCALE:	NTS

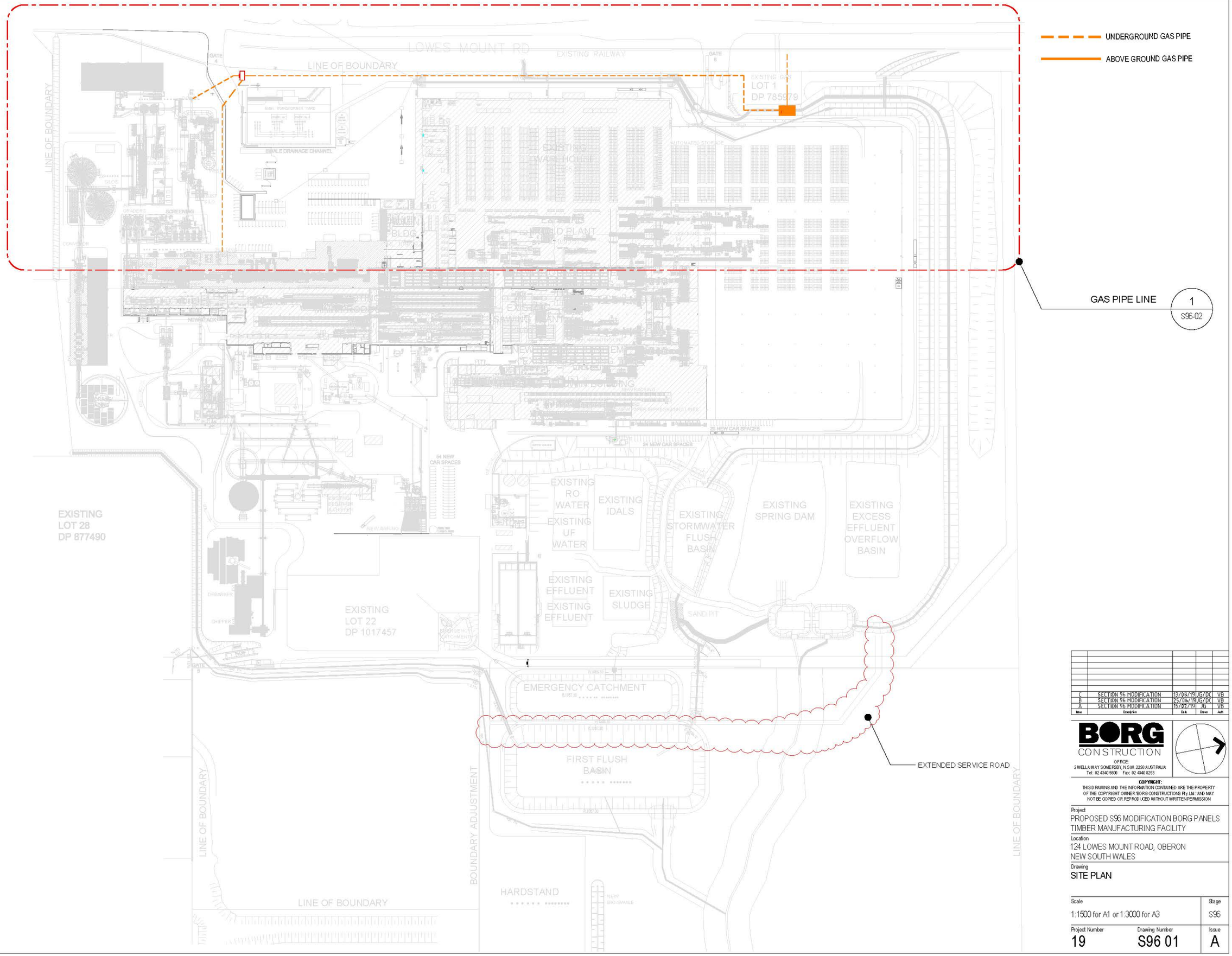
TITLE: GAS CONDITIONING SKID P&ID

CLIENT:

AUTOCAD 2007

CAD FILE No. B2970 500 A

DRG. NO. B2970/500 | SHT. NO. 2/2 | REV A



Issue	Description	Date	Drawn	Auth
C	SECTION 96 MODIFICATION	13/08/19	JG/DL	VB
B	SECTION 96 MODIFICATION	25/06/19	JG/DL	VB
A	SECTION 96 MODIFICATION	15/02/19	JG	VB

BORG CONSTRUCTION
OFFICE
2 WELLA WAY SOMERSBY, N.S.W. 2250 AUSTRALIA
Tel: 02 4340 9800 Fax: 02 4340 8293

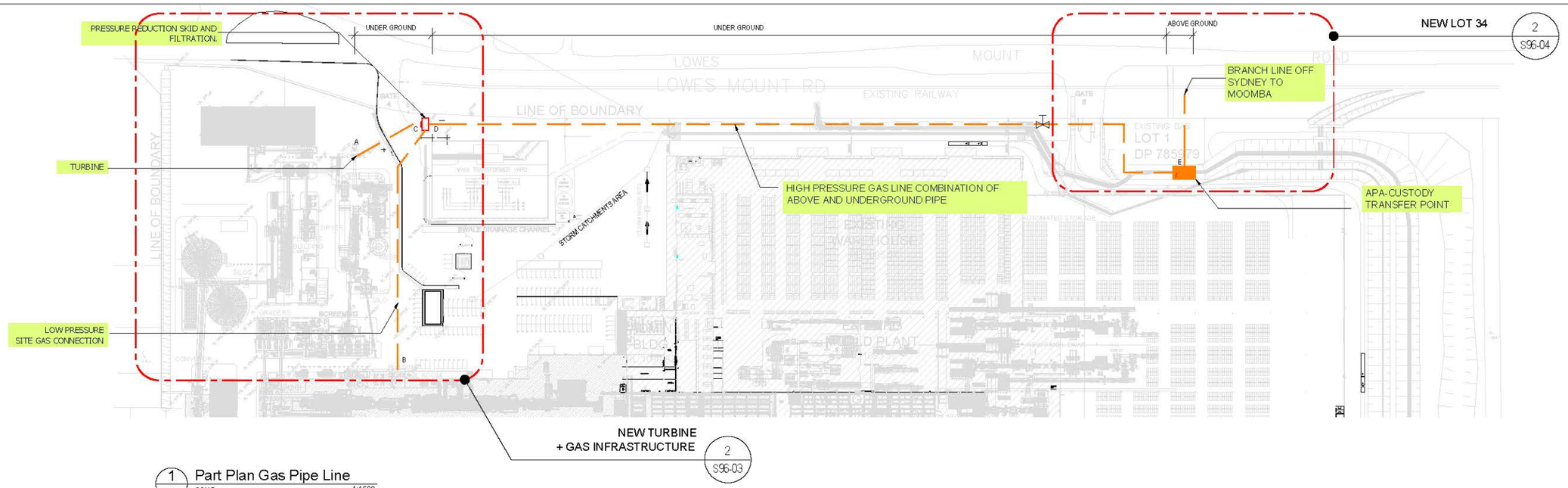
Project
PROPOSED S96 MODIFICATION BORG PANELS TIMBER MANUFACTURING FACILITY

Location
124 LOWES MOUNT ROAD, OBERON
NEW SOUTH WALES

Drawing
SITE PLAN

Scale	Stage
1:1500 for A1 or 1:3000 for A3	S96

Project Number	Drawing Number	Issue
19	S96 01	A



1 Part Plan Gas Pipe Line
SCALE: 1:1500

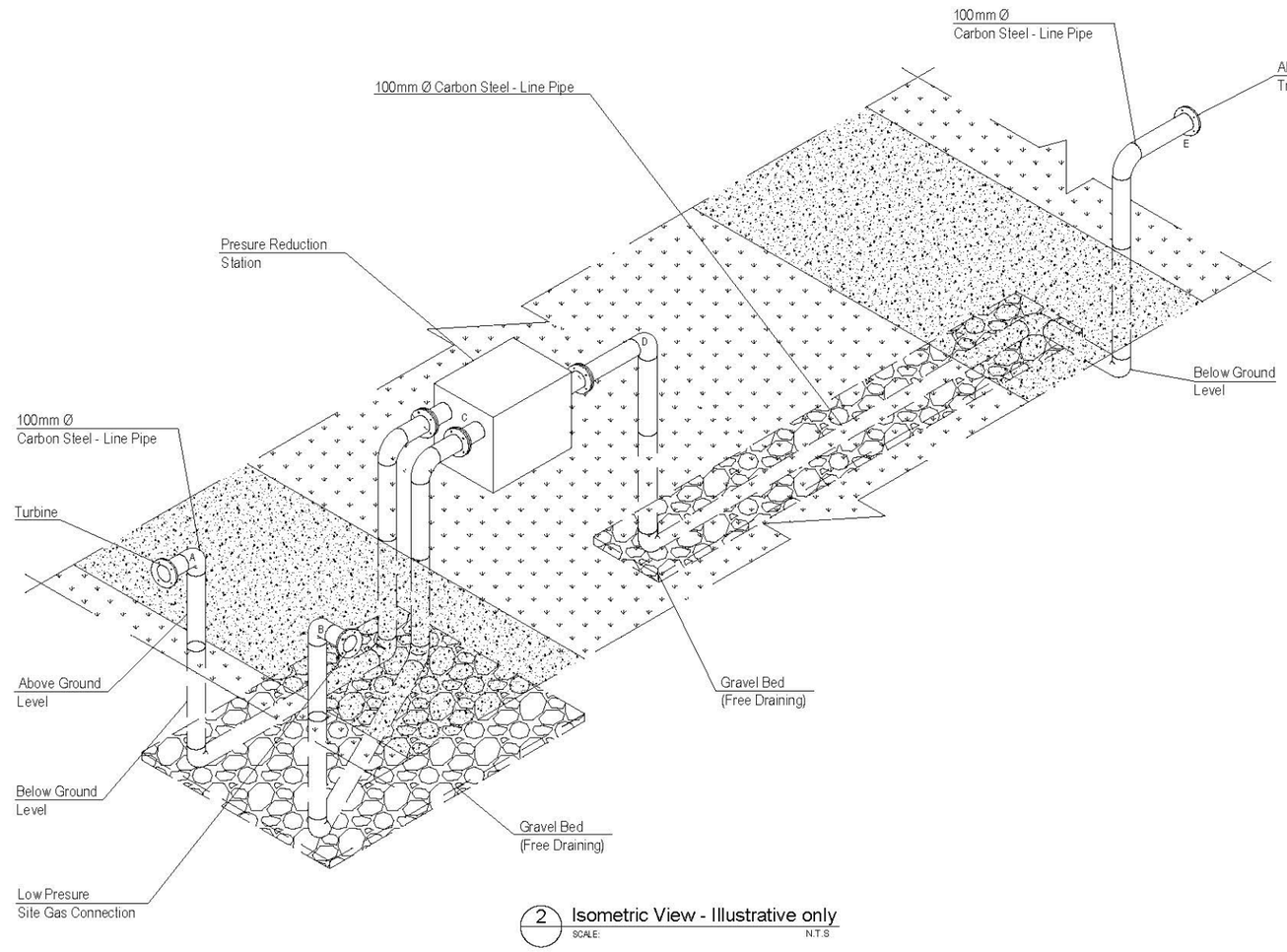
NOTE:

LOT BOUNDARIES FOR CONSOLIDATION ARE NOT SHOWN ON THIS PLAN (FOR CLARITY) - REFER DA 04 CONSOLIDATION PLAN FOR DETAIL

REFER TO KEY PLAN FOR REFERENCES TO DOCUMENTATION OF NEW WORKS

LEGEND:

- VALVE
- ISOLATION VALVE
- UNDERGROUND GAS PIPE
- ABOVE GROUND GAS PIPE



2 Isometric View - Illustrative only
SCALE: N.T.S

0 10 20 30 40 50 70 90m

Issue	Description	Date	Drawn	Auth
C	SECTION 96 MODIFICATION	13/08/19	JG/DC	VB
B	SECTION 96 MODIFICATION	25/06/19	JG/DC	VB
A	SECTION 96 MODIFICATION	02/02/18	TG	VB

BORG CONSTRUCTION

OFFICE:
2 WELLA WAY SOMERSBY, NSW. 2250 AUSTRALIA
Tel.: 02 4340 9800 Fax: 02 4340 8293

Project
PROPOSED S96 MODIFICATION BOARD PANELS TIMBER MANUFACTURING FACILITY

Location
124 LOWES MOUNT ROAD, OBERON
NEW SOUTH WALES

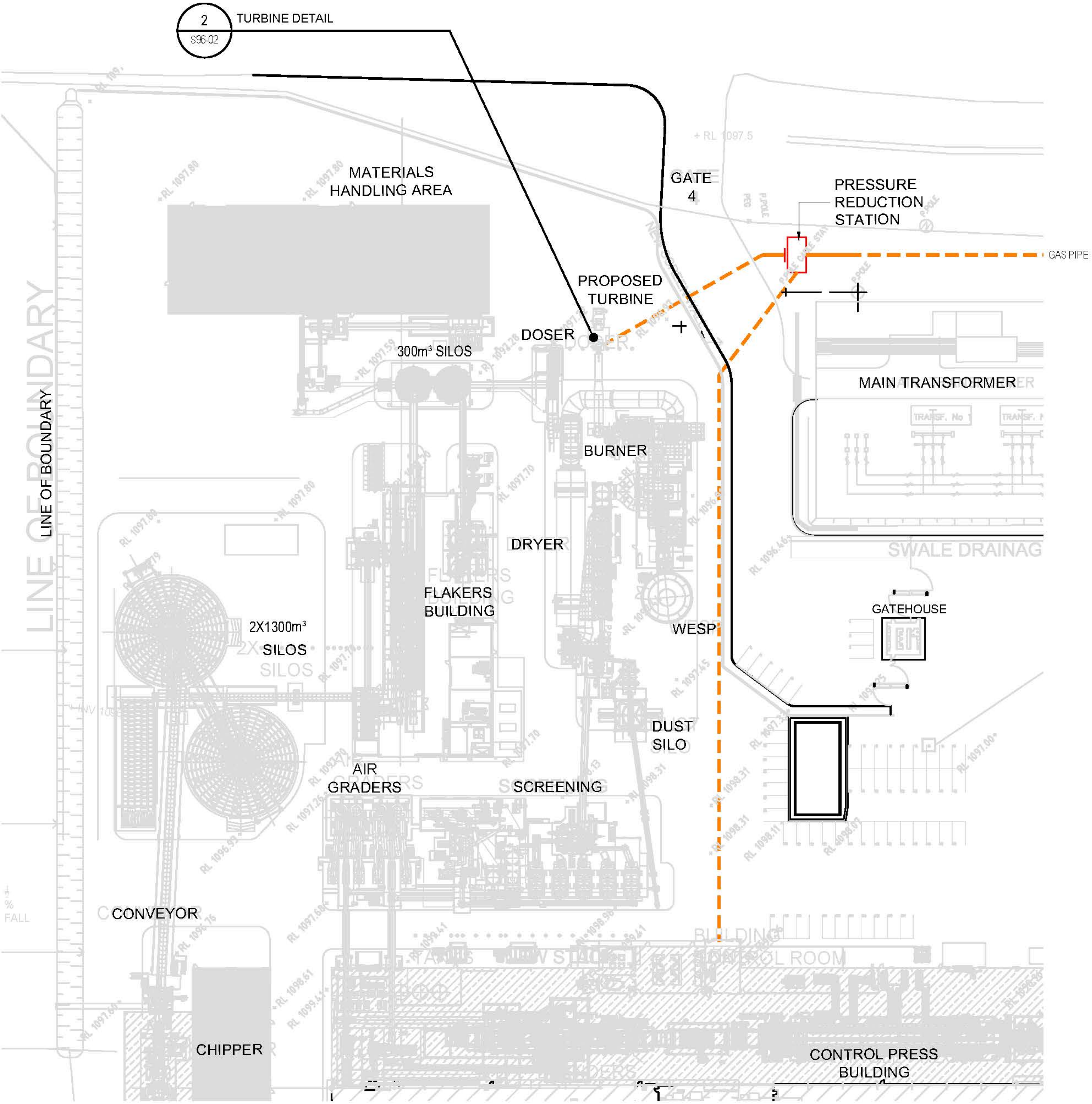
Drawing
GAS PIPE LINE

Scale	Stage
1:1500 for A1 or 1:3000 for A3	S96

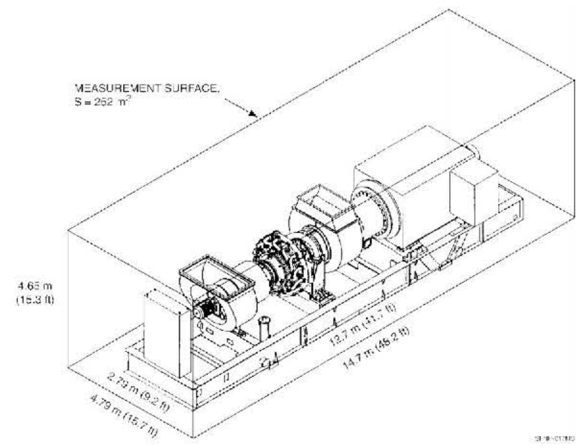
Project Number	Drawing Number	Issue
19	S96 002	A

UNDERGROUND GAS PIPE

ABOVE GROUND GAS PIPE



1 PLAN
SCALE: 1:500



2 TURBINE DETAIL
SCALE: NTS

Issue	Description	Date	Drawn	Auth
C	SECTION 96 MODIFICATION	[illegible]	[illegible]	VB
B	SECTION 96 MODIFICATION	[illegible]	[illegible]	VB
A	SECTION 96 MODIFICATION	[illegible]	[illegible]	VB

BORG CONSTRUCTION
OFFICE:
2 WELLA WAY SOMERSBY, N.S.W. 2250 AUSTRALIA
Tel: 02 4340 9800 Fax: 02 4340 8293

Project
PROPOSED S96 MODIFICATION BORG PANELS TIMBER MANUFACTURING FACILITY

Location
124 LOWES MOUNT ROAD, OBERON
NEW SOUTH WALES

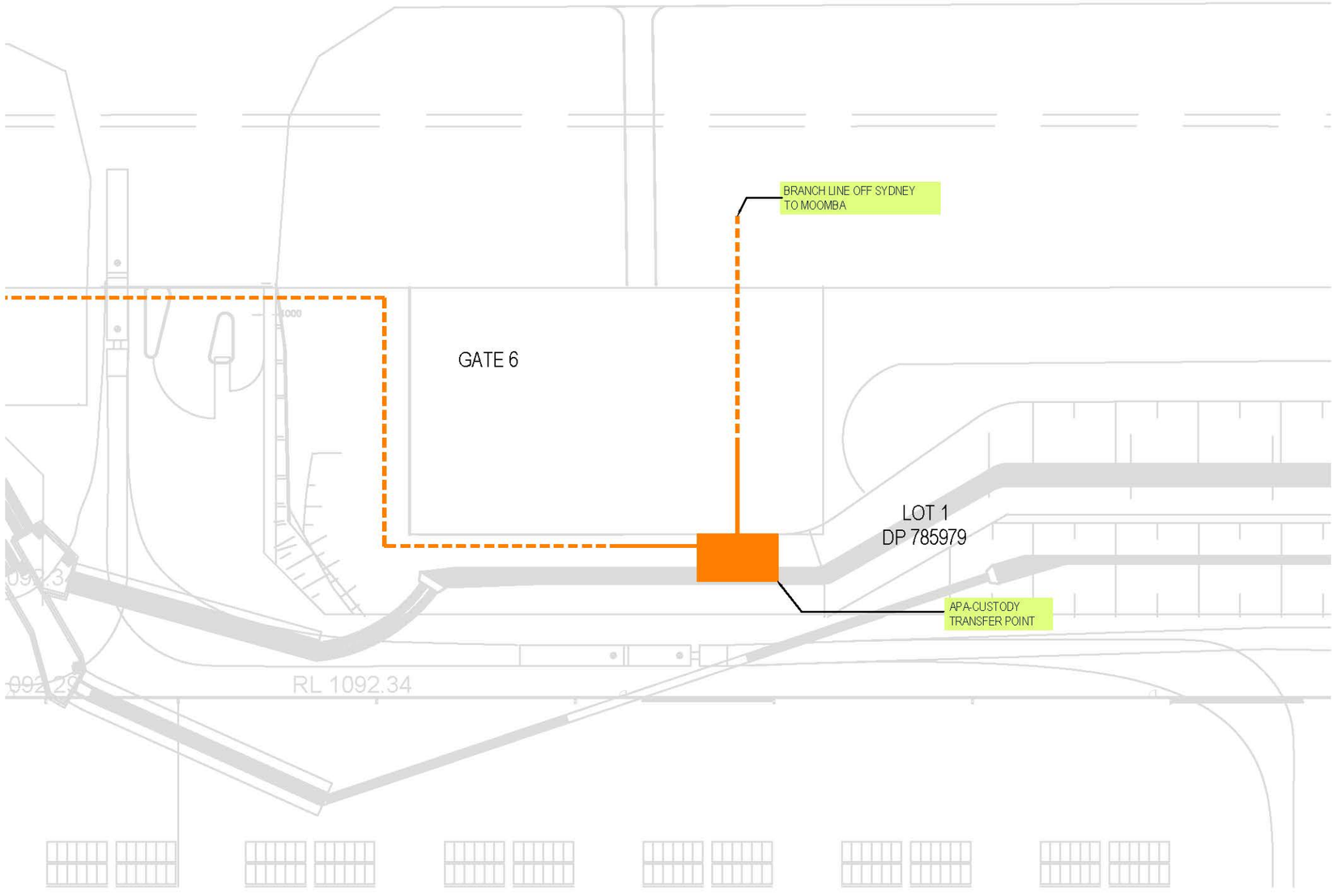
Drawing
NEW TURBINE + GAS INFRASTRUCTURE

Scale	Stage
1:500 @ A1 OR 1:1000 @ A3	S96

Project Number	Drawing Number	Issue
19	S96 03	A

UNDERGROUND GAS PIPE

ABOVE GROUND GAS PIPE



Issue	Description	Date	Drawn	Auth
C	SECTION 96 MODIFICATION	23/01/2020	JK	VB
B	SECTION 96 MODIFICATION	24/10/2019	JK	VB
A	SECTION 96 MODIFICATION	25/7/19	JK	VB

BORG CONSTRUCTION
OFFICE:
2 WELLA WAY SOMERSBY, N.S.W. 2250 AUSTRALIA
Tel: 02 4340 9800 Fax: 02 4340 8293

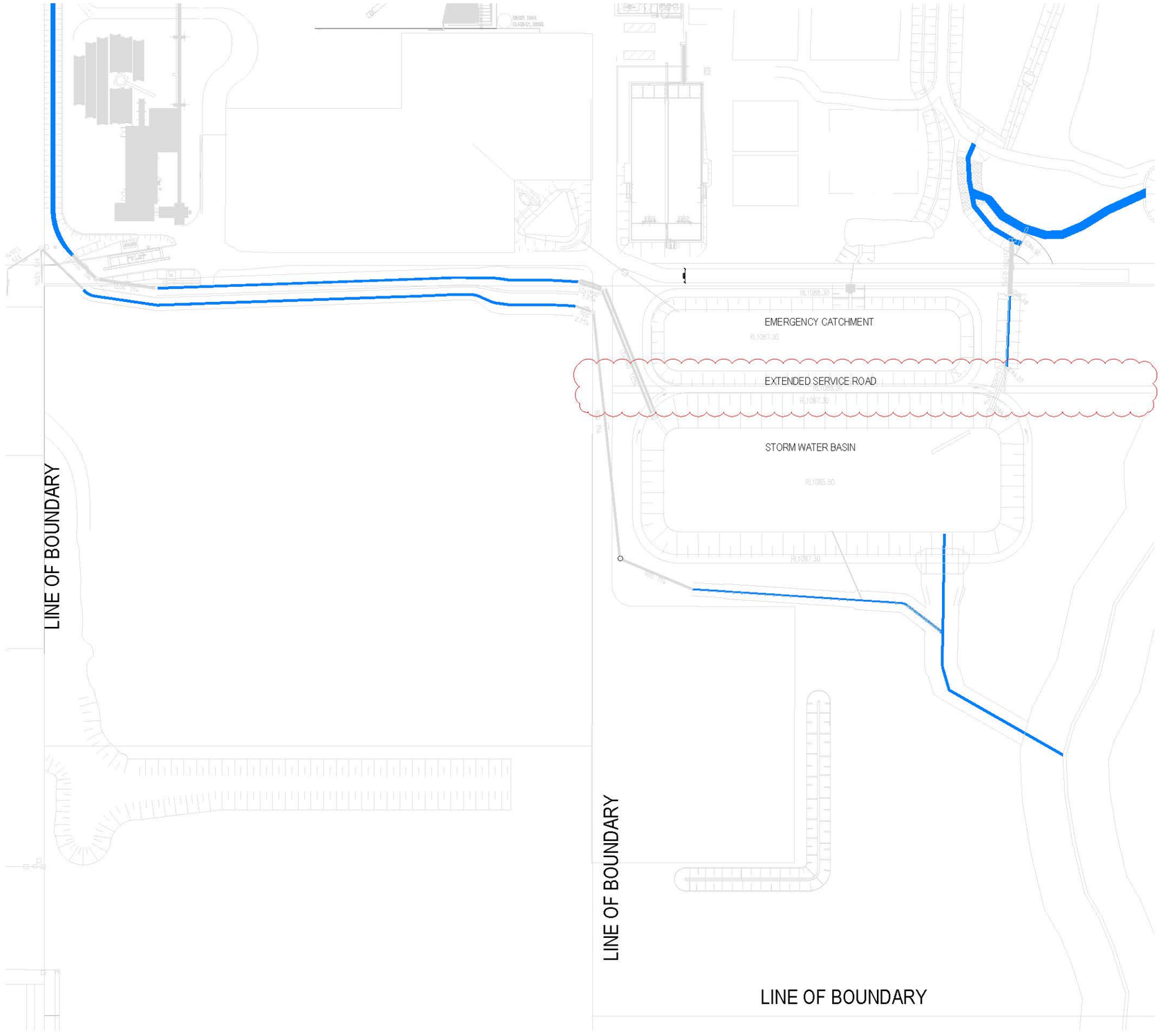
Project
PROPOSED S96 MODIFICATION BORG PANELS TIMBER MANUFACTURING FACILITY

Location
124 LOWES MOUNT ROAD, OBERON
NEW SOUTH WALES

Drawing
GATE 6

Scale	Stage
1:300 @ A1 OR 1:600 @ A3	S96

Project Number	Drawing Number	Issue
19	S96 04	A



Issue	Details	Date	Drawn	Auth
C	SECTION 96 MODIFICATION	08/08/19	JG/DC	VB
B	SECTION 96 MODIFICATION	15/02/19	JG/DC	VB
A	SECTION 96 MODIFICATION	15/02/19	TG	VB

BORG CONSTRUCTION
OFFICE:
2 WELLA WAY SOMERSBY, NSW 2250 AUSTRALIA
Tel: 02 4340 9800 Fax: 02 4340 8293

Project
PROPOSED S96 MODIFICATION BORG PANELS TIMBER MANUFACTURING FACILITY

Location
124 LOWES MOUNT ROAD, OBERON
NEW SOUTH WALES

Drawing
HARDSTAND

Scale	Stage
1:1000 @ A1 OR 1:2000 @ A3	S96

Project Number	Drawing Number	Issue
19	S96 005	A

Appendix G – Solar Turbines Information

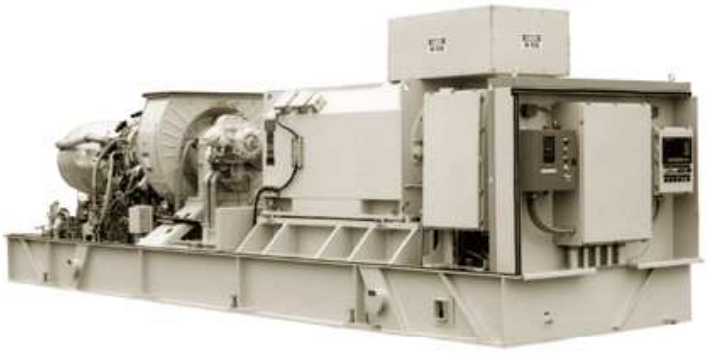
Solar® Turbines

A Caterpillar Company

CENTAUR 50

Gas Turbine Generator Set

Power Generation



General Specifications

***Centaur*® 50 Gas Turbine**

- Industrial, Single-Shaft
- 11 Stage Axial Compressor
  - Variable Inlet Guide Vanes and Stators
  - Pressure Ratio: 10.6:1
  - Inlet Airflow: 41.4 kg/sec (18.8 lb/sec)
  - Vertically Split Case
- Combustion Chamber, Annular-Type
  - 12 Conventional Fuel Injectors or 12 Lean-Premixed, Dry Low Emissions SoLoNOx Injectors
  - Single Torch Ignitor System
- Power Turbine
  - 3-Stage Reaction
  - Clockwise Rotation
- Bearings
  - 3 Radial Journal: Tilt-Pad
  - 1 Thrust, Active: Tilt-Pad
  - 1 Thrust, Inactive: Fixed Tapered Land
- Coatings
  - Compressor: Inorganic Aluminum
  - Turbine and Nozzle Blades: Precious Metal Diffusion Aluminide
- Vibration Transducer Type
  - Proximity Probes, 2 per Radial Bearing/ 2 per Thrust Bearing, horizontal and vertical
  - Velocity Pick-up*

Main Reduction Drive

- Epicyclic Type
  - 1500 or 1800 rpm (50 or 60 Hz)
  - Vibration monitoring: Acceleration Transducer

Generator

- 4 Pole, 3 Phase, 6 Wire, Wye Connected, Synchronous with Permanent Magnet Generator Exciter
- Available Construction Types:
  - Open Drip-Proof Construction
  - CACA/TEAAC (Closed Air, Cooling Air/ Totally Enclosed, Air to Air Cooling)*
  - CACW/TEWAC (Closed Air, Cooling Water/Totally Enclosed, Water to Air Cooling)*
- Sleeve Bearings
- Vibration Monitoring; Velocity Transducers
- Vibration Monitoring; Displacement Transducers*
- NEMA Class F Insulation
- Class F Temperature Rise
- Class B Temperature Rise*
- Continuous Duty Rating Voltages:
  - 3300, 6600, 11 000 (50Hz)
  - 4160, 6900, 12 470, 13 200, 13 800 (60Hz)

Package

- Mechanical Construction
  - Steel Base Frame with Drip Pans
  - 316L Stainless Steel Piping
  - Compression Type Tube Fittings
- Start System
  - Direct Drive AC Motor with VFD Control
- Package Electrical Certification
  - NEC, CSA Class 1, Group D, Div.2
- Fuel System
  - Natural Gas
  - Diesel*
  - Dual (Natural Gas and Diesel)*
  - Low BTU Gas*
- Integrated Lube Oil System
  - Turbine-Driven Lube Pump
  - AC Motor Driven Pre/Post Lube Pump
  - DC Motor Driven Backup Lube Pump
  - Air to Oil Cooler
  - Water to Oil Cooler*
  - Integral Lube Oil Tank
  - Lube Oil Tank Heater
  - Lube Oil Filter
  - Duplex Lube Oil Filter*
  - Oil Tank Vent Separator with Flame Arrestor
- Air Inlet and Exhaust Systems
  - Carbon Steel
  - Stainless Steel*
  - Barrier Type Filters
  - Self-Cleaning Filters
  - Inlet and Exhaust Silencers
  - Inlet Evaporative Cooler*
  - Inlet Chiller Coils*
- Enclosure
  - Complete Package
  - Driver Only*
  - Fire Detection and CO_2 Suppression System
- Turbine Compressor Cleaning Systems
  - On-Crank/On-Line
  - Portable Cleaning Tank*
- Package Power
  - 120VDC Battery/Charger System*
- *Turbotronic*™ 4 On-Skid Gas Turbine and Generator Control System Features
  - Combination Generator Control Module with Load Share, Auto Synchronization, Voltage Control
  - Standard Display with Discrete Event Log, Strip Chart, Historical Trend, Maintenance Screen
  - Vibration and Temperature Monitoring
  - English Display Text and Labels
  - Spanish, Portuguese, German, French or Simplified Chinese Display Text and Labels*
  - Auxiliary and Remote Display/Control Terminals*
  - Turbine Performance Map*
  - KW Import Control*
  - KVAR/Power Factor Control*
  - ControlNet Redundant Media, Ethernet, Data Highway Plus or Modbus RS232C/422/485 Supervisory Interface*
  - Heat Recovery Application Interface*
  - Multi-Unit Applications: Load Shed Control, Import/Export or kW/KVAR Control Panels*
  - *InSight System*™ Equipment Health Management*
  - Printer/Logger*
- Electrical System Options
  - Neutral Grounding Resistor or Transformer*
  - Switchgear and Generator Protective Relay*
  - Motor Control Center with Automatic Transfer Switch*
- Documentation
  - Drawings
  - Quality Control Data Book
  - Inspection and Test Plan
  - Test Reports
  - O&M Manuals
- Factory Testing of Turbine
- Factory Testing of Package Systems
  - Non-Dynamic
  - Dynamic

* Option

Solar® Turbines

A Caterpillar Company

CENTAUR 50

Gas Turbine Generator Set

Power Generation

Performance

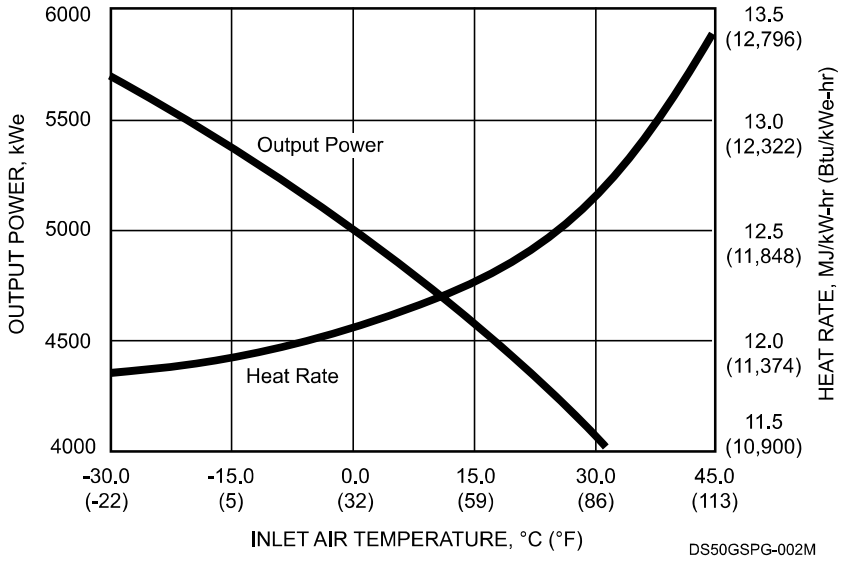
Output Power	4600 kWe
Heat Rate	12 270 kJ/kWe-hr (11,630 Btu/kWe-hr)
Exhaust Flow	68 680 kg/hr (151,410 lb/hr)
Exhaust Temp.	510°C (950°F)

Application Performance

Steam (Unfired)	11.5 tonnes/hr (25,280 lb/hr)
Steam (Fired) 1536°C (2800°F)	50.4 tonnes/hr (111,190 lb/hr)
Chilling (Absorp.)	9890 kW (2810 refrigeration tons)

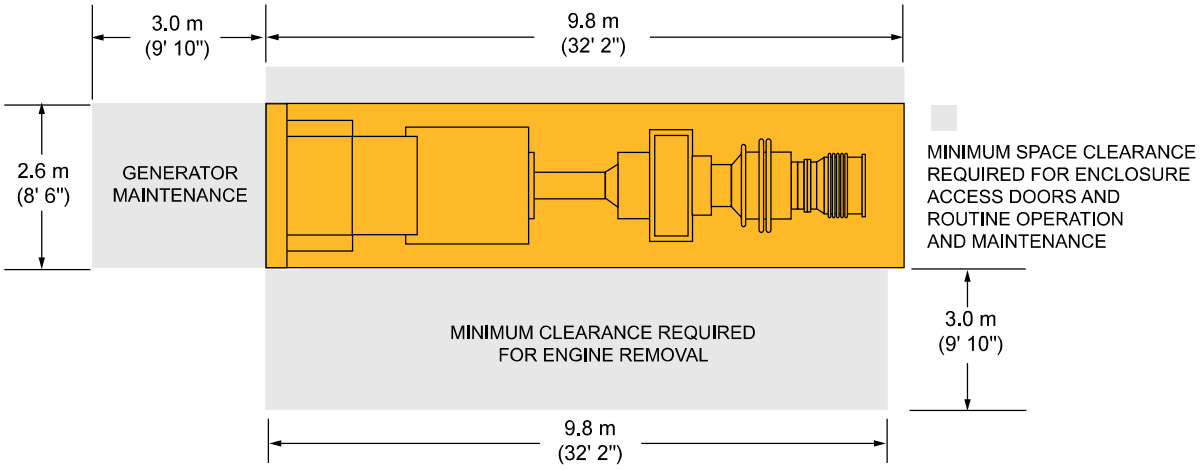
Nominal rating – per ISO
At 15°C (59°F), sea level
No inlet/exhaust losses
Relative humidity 60%
Natural gas fuel with
LHV = 35 MJ/Nm³ (940 Btu/scf)
No accessory losses
Engine efficiency: 29.3%
(measured at generator terminals)

Available Power



DS50GSPG-002M

Enclosure Access and Maintenance Space



DS40,50,60PG-003C

Package Height: 3.2 m (10' 5")
Package Weight: 38 900 kg (85,800 lb)

Solar Turbines Incorporated
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DS50PG/0113/EO

FOR MORE INFORMATION

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ISO-9001 DNV CERTIFICATED FIRM