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Dyno Nobel Asia Pacific Limited

Moranbah Ammonium Nitrate Project

Greenhouse Assessment

August 2006

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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1. Introduction

GHD have been commissioned by Dyno Nobel Asia Pacific Limited (DN), as part of an Environmental impact Statement (EIS) to estimate the emissions of greenhouse gases due to ongoing operation of the Proposed Moranbah Ammonium Nitrate (AN) plant (the project). There are a number of gases that have been shown to have the potential to enhance the natural greenhouse effect of the earth's atmosphere (global warming potential or GWP). GWP varies greatly between greenhouse gases, and is normally given in terms of carbon dioxide equivalent (CO_2-e). The GWP of common greenhouse gases (GHG) over a 100 year time horizon is given in Table 1.

Table 1 Global Warming Potentials for Various Greenhouse Gases

Greenhouse Gas	GWP (CO2-e)
Carbon dioxide	1
Methane	21
Nitrous Oxide	310
hydrofluorocarbons (HFCs)	150 - 11700
perfluorocarbons (PFCs)	6500 - 9200
sulphur hexafluoride (SF_6)	23900

1.1 Scope

This assessment estimates the ongoing operational emissions of the proposed ammonium nitrate plant (the project), including transportation of raw materials and products. A comparison between expected transportation emissions from this site and those that would be expected for continued supply of AN from the Moura plant has been undertaken. Typical construction phase emissions sources and mitigation measures that should be considered for the construction phase have been summarised in Table 2.

2. Construction Emissions Profile

Greenhouse gas emissions during the construction of the project have not been considered in detail in this assessment, although preliminary estimates indicate that a peak load would be 0.52 MW during the construction phase. Average energy use during the construction phase of 0.2 MW has been estimated, based on maximum staff numbers and staffing profile for construction workforce that was used for the traffic impact assessment. It has been assumed that construction will take place over 22 months, and will be undertaken over two shifts, with a total of 16 hours work per day, 6 days per week.

This approach gives total energy use of 1525 MWh, equating to GHG emissions of approximately 1,760 tonnes CO_2-e during the construction phase using standard emissions factors for Queensland.

Transport of workers will predominantly be from the adjacent construction camp by bus, with a minor contribution from light vehicle transport from Moranbah. As was assumed in the traffic impact assessment, it has been assumed in this assessment that personnel transportation will comprise 16 bus trips and 18 car trips per day for 475 days of construction. A conservative distance of 3 km per trip has been used in this calculation. This approach gives GHG emissions of approximately 26 tonnes CO_2-e during the construction phase, which can be considered insignificant. Note that in this assessment, conservation means likely to be overestimating emissions, rather than underestimating.

Transportation of construction materials and plant has been assumed, based on data contained within the traffic impact study, to average 4 two-way trips per day, although the distance of travel is not known. If half of the trips were local (distance 10 km each way) and the remainder were to transport materials from Gladstone (a distance of 520 km), which is likely to be a conservative estimate, this would give emissions for diesel vehicles of approximately 790 tonnes CO_2-e during the construction phase.

Other construction phase emissions will be due to the operation of heavy plant such as excavators, cranes, generators, etc. While the type and number of items had not been defined at this stage of design, operation of diesel equipment are expected to result in approximately 3 tonnes CO_2-e per kL fuel used, based on emissions factors contained in the Australian Greenhouse Office Factors and Methods Workbook, December 2005.

Typical measures used to mitigate these emissions are described in Table 2.

Table 2 Typical Construction phase emissions and mitigation measures

Emissions source	Typical Emissions mitigation measures
Transportation Fuel Consumption	
Transportation of construction materials to the site and waste materials from the site	◗ Schedule deliveries of construction materials and/or disposal of waste materials to minimise length and number of trips required, by ensuring full loads and sourcing materials locally where practicable.
Transportation of workers to/from the site	◗ Carpooling and buses will be used to transport workers to the site; ◗ Ensure that the construction camp is located as close as practicable to the construction site.
Use of vehicles onsite during construction	◗ Ensure that vehicles are maintained and operated according to manufacturers instructions to maximise efficiency; ◗ Program works to minimise double handling and materials transfer; ◗ Ensure that vehicles are turned off when not in use; ◗ Where possible, select vehicles and equipment that are efficient (eg avoid using older, less energy efficient vehicles); ◗ Where possible, dispose of wastes to local disposal facilities.
Electricity Use	
Use of electrical equipment during construction	◗ Ensure that equipment is appropriately sized for the task; ◗ Turn electrical equipment off when not in use; ◗ Where practicable, purchase electricity from a renewable or lower emissions source; ◗ Ensure that equipment is well maintained.
Other Emissions	
Wastewater treatment emissions	◗ The sewage/wastewater treatment system should be designed and operated in such a way as to minimise methane emissions.
Land Clearance activities – reduction in carbon sequestration	◗ Identify options for replacement of any trees cleared in the construction phase. These plantings can include plantations, boundary plantings, or other plantings, including plantings at a separate site.

3. Operational Emissions Profile

Electricity and GHG emissions were calculated using the Australian Greenhouse Office Emission Calculator Tool 2006, which uses emission factors that are consistent with the *AGO Factors and Methods Workbook*, December 2005. It calculates the total emissions (made up of Scope 1 + Scope 2 + Scope 3, formerly known as 'full fuel cycle' or 'direct and indirect emissions'). The emission factors used to calculate total emissions also apply to transport energy. The spreadsheet used to calculate emissions is given in Appendix A.

3.1 Transportation of Raw Materials

The primary feedstock to the plant is the coal seam methane fed to the reformer, which is essentially methane (over 97% methane) and less than 1% CO_2. This resource of almost a pure methane feedstock as the ideal process feed for efficient ammonia production. Use of this material minimises environmental impact (minimum treatment and minimum waste) prior to use and is also energy efficient. Many ammonia plants are LPG/CNG feedstock, which requires processing prior to use.

Coal seam gas is a local resource, which minimises the environmental impact from extraction and transport (energy/facilities) prior to use. The degassing and capture of gas in the coal prior to its mining prevents its release to the atmosphere thereby reducing fugitive methane emissions directly to atmosphere. The coal seam methane is supplied from a local source, minimising transport emissions.

Other raw materials to be used at the site will include sulphuric acid, sodium hydroxide, corrosion inhibitor, dispersion agent, biocide used for water treatment, and oxygen scavenger. The most likely source of these materials is Gladstone, a distance of approximately 520 km from Moranbah. Emissions associated with the transportation of raw materials is expected to be insignificant compared to those associated with transportation of products.

3.2 Transportation of Products

Based on vehicle movements given in the transport section of the EIS, an estimated 4308 B-triple loads of prill will leave the site per year. Based on the Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2003 – Energy (Transport), a diesel consumption rate of 0.4 L/km has been used in this calculation.

The calculation indicated that emissions due to the transportation of products to the various final destinations would total approximately 2100 tonnes CO_2 equivalent per year, a reduction of approximately 3,690 tonnes CO_2-e, or around 60% from the current situation, where AN is supplied from a plant located at Moura.

3.3 Electricity Use

3.3.1 Energy use calculated using standard emissions factors

It is expected that electricity used at the proposed plant will be sourced from a natural gas fired power generation facility adjacent to the plant and supplemented if required from the grid. It is expected that average electricity use will be 11 MW based on 330,000 tonnes per year of AN, equivalent to 264 kWh/tonne of AN produced. The maximum facility generating capacity is 15 MW based on 350,000 tonnes per year of AN, equivalent to 360 kWh/tonne of AN produced.

Using this approach, the average emissions due to electricity use at the site if connected to the grid would be 107,000 tonnes CO_2-e per year (145,500 tonnes CO_2-e per year at the maximum 15 MW capacity) based on standard electricity emission factors for Queensland.

3.3.2 Energy use emissions based on data for onsite power station

Dyno Nobel Asia Pacific Limited expects that electricity for use at the site will be provided by a combined cycle gas-fired power station adjacent to the proposed AN plant. This power generation facility will be fired by coal seam gas sources locally. This coal seam gas comprises 97% methane and 3% carbon dioxide.

It has been estimated that combined cycle gas fired power generation facilities can generate electricity at 550 kg CO_2-e per MWh, compared to approximately 900 kg CO_2-e per MWh for a best practice black coal power station. For the 92,400 MWh per year (maximum 126,000 MWh per year) used at the proposed AN plant, this gives greenhouse gas emissions of approximately 51,000 tonnes CO_2-e per year (maximum 63,300 tonnes), a saving of over 56,000 tonnes CO_2-e per year (maximum 76,000 tonnes) over using power from the grid.

3.4 Stationary Fossil Fuel Use

It is proposed that coal seam gas, comprising approximately 97% methane will be used to produce ammonia, using the following chemical reactions:

$$CH_4(g) + H_2O(g) \rightarrow CO(g) + 3H_2(g)$$
$$CO(g) + H_2O(g) \rightarrow CO_2(g) + H_2(g)$$
$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$$

Design flowsheets show that the consumption of coal seam gas to produce the rated plant flow of 454 tonnes per day of ammonia is 11,930 kg/hr, containing 11497 kg/h methane and 364 kg/h carbon dioxide. Upon combustion this produces 34,088 kg/hr CO_2, which is equivalent to 286,000 tonnes per annum of CO_2-e. These values include the gas required for the air heater, the auxiliary boiler and the flare pilots, as well as the synthesis gas. No other significant sources of greenhouse gas emission due to stationary fuel use during plant operation are expected to be significant.

3.5 Waste Treatment

While there may be a small wastewater treatment facility at the site, emissions associated with this are expected to be insignificant compared to other greenhouse gas emissions. To give an indication of the magnitude of emissions, for a staff of 75 personnel working 40 hours per week, it is likely that methane emissions from wastewater treatment are likely to be less than 1 tonne CO_2-e per year. It is not expected that there will be other significant sources of methane from wastewater treatment at the site.

3.6 Summary of Emissions Estimates

Total annual emissions of greenhouse gases from operation of the plant is expected to be approximately 430,000 tonnes CO_2-e per year (maximum of 469,000 tonnes), including both energy-related emissions and direct emissions from the process. This is considered to be minor, approximately 0.08% of national emissions, and approximately 0.27% (maximum 0.3%) of Queensland's annual emissions.

The most recent publicly available data for National and State greenhouse gas emissions is from 2004. Australia's total greenhouse gas emissions in 2004 amounted to 564.7 million tonnes CO_2 equivalent. Of this, Queensland emissions were 158.5 million tonnes CO_2 equivalent.

4. Proposed Measures to Minimise/Offset Greenhouse Gas Emissions

A number of opportunities have been implemented or are being considered to minimise GHG emissions from the proposed plant. These include the following:

- Use of fuel gas that is free from sulphur and therefore requires no sulphur removal treatment. This reduces environmental impact - there is no atmospheric sulphur (SO_2) discharge or disposal of sulphur cake required;
- The most significant air pollutants associated with the plant are oxides of nitrogen in the nitric acid and ammonia plant emissions. While the air emissions assessment has assumed that these emissions are nitrogen dioxide, the NO_x contained in the NH_3 and NA plants is shown in plant flow sheets as 25 lb/hr and 10 kg/hr respectively. Well-established catalysts are used to minimise emissions of nitrogen oxides. The activity of the catalysts will be closely monitored to ensure that emission levels are kept to a minimum. Catalysts will be regenerated as required and replaced during the operation of the plant with best available catalysts to improve NO_x reduction. In addition, approximately 9 kg N_2O per tonne of HNO_3 is produced in the nitric acid plant, which is equivalent to 287 kg/hr N_2O (91.84 tonnes CO_2-e per hour). The extent to which the nitrous acid can be minimised is dependent upon the process used, which has not been determined at this time;
- Plants will be operated by DN in accordance with best available practice. Dyno Nobel Asia Pacific Limited is a major supplier and manufacturer of ammonium nitrate prill and emulsion and operates a number of plants in Australia to international standards.

Opportunities to offset greenhouse emissions from the plant construction and operation process (e.g. through planting trees, etc) are currently being considered, to establish the magnitude of the work required to produce a significant impact. An option being considered is tree-planting and landscaping at the Moranbah site.

5. Comparison of Proposed Technologies

Integrated Pollution Prevention and Control (IPPC) 2004 [1]describes best available techniques (BAT) for production of ammonium nitrate and its derivatives. Techniques that can be used to minimise energy use and emissions of greenhouse gases and other emissions include the following:

- Optimise the neutralisation section;
- Minimise fugitive emissions and breathing losses by good maintenance and installation of appropriate equipment;
- Minimise gaseous and particulate emissions by use of appropriate scrubbers;
- Use granulation as a finishing technique in AN production; and
- Reuse water and process steam.

It should be noted that these techniques do not necessarily aim to minimise greenhouse emissions specifically, but aim to minimise overall emissions from the process.

Dyno Nobel Asia Pacific Limited have indicated that the three plants that make up the ammonium nitrate complex will be designed by appropriate specialists, in accordance with appropriate standards. The ammonia plant has been pre-owned and in operation for a number of years at Yazoo City, Mississippi USA and is understood to comply with current standards in the USA. The emulsion plant will be designed by DN, a leading specialist and designer in that field. The design will incorporate a number of heat recovery stages that will assist in minimising energy use and emissions of heat. Catalysts are used to optimise chemical reactions and therefore emissions of byproducts.

Benchmarking data is not widely available in the public domain in relation to energy use and greenhouse gas emissions associated with good practice in production of AN or other similar productions. The Australian Greenhouse Office's Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2003: Industrial Processes includes a methodology for calculation of emissions from production of ammonia and nitric acid, however emissions factors are stated in that document as being confidential. The most appropriate source of possible benchmarking data available for use in this assessment was IPPC (2004). This document gave the following energy requirements for production of ammonia, nitric acid and ammonium nitrate:

[1] Integrated Pollution Prevention and Control, Draft Reference Document on Best Available Techniques in the Large Volume Inorganic Chemicals, Ammonia, Acids and Fertilizers Industries, 2004

Table 3 Summary of Typical Emissions from NH_3, HNO_3 and Ammonium Nitrate production

Emission Source	Ammonia production	Nitric acid production	Ammonium nitrate
Energy	Up to 39 – 42 GJ (HHV)/tonne in partial oxidation plants, including imported power and/or auxiliary steam for driving the machinery.	Typically a net exporter of energy to the order of 1.6 GJ/tonne HNO_3.	25-60 kWh/tonne of solid product, with up to 70 kWh additional to retrofit existing facilities; 5 kWh/tonne of liquid product (solution)
Carbon dioxide	2-2.6 kg CO_2/kg NH_3 dependent upon the feedstock C/H ratio in partial oxidation of residual oils		
Other		N_2O: 580 – 6860 mg N_2O/m^3 tail gas	

This information indicates that emissions from the proposed operation are within the range associated with current good practice for production of ammonium nitrate.

6. Proposed Monitoring, Measurement and Auditing

It is proposed that, in order to monitor and minimise greenhouse gas emissions from the plant, DN will:

- Maintain an inventory of greenhouse gas emissions for the project once construction starts, by monitoring the use of electricity, liquid and gaseous fuels and other direct and indirect emissions;
- Publicly report greenhouse emissions and progress on greenhouse mitigation measures; and
- Obtain and maintain membership of the Commonwealth Government Greenhouse Challenge Program.

7. Conclusions

The main sources of greenhouse emissions associated with the operation of the site include emissions of carbon dioxide from the production of ammonia, electricity use, transportation of products and nitrous oxide from the production of nitric acid. Emissions associated with fugitive emissions of carbon dioxide, methane and nitrous oxide are expected to be insignificant, although there is potential for emission of any or all of these compounds from site operations.

This preliminary assessment indicates that emissions of greenhouse gas directly attributable to the operation of this plant are likely to be approximately 430,000 tonnes CO_2 equivalent per year (maximum 469,000 tonnes). The 469,000 tonnes CO_2 equivalent per year of greenhouse gases allows for 145,000 (electricity), 38,000 (natural gas) and 286,000 (fugitive emissions). Refer to the details in Appendix A. Emissions of 430,000 tonnes CO_2 equivalent per year is approximately 0.08% of Australia's annual emissions (based on data for 2004), and approximately 0.27% (maximum 0.3% for 469,000 tonnes) of Queensland's annual emissions.

Appendix A

Emissions Estimation Spreadsheet

Site/Activity A Acitivity/Site name: **Dyno Nobel Moranbah**

Select state: QLD

Emissions inventory							
Fuel/process	**Consumption units**	**Unit**	**Basic units**	**factors**		**kg CO_2-e**	**Tonnes CO_2-e**
Electricity	110,000	MJ	30,555.56 kWh	1.155	kg CO_2-e/kWh	35292	35.3
Natural Gas (non-transport)	6	PJ	550,000.00 GJ	68.8	kg CO_2-e/GJ	37840000	37,840.0
LPG - (non-transport)		t	0.00 t	3.3	t CO2/t	0	0.0
Industrial Diesel Oil		kL	0.00 kL	3.1	t CO2/kL	0	0.0
Petroleum Products Transport							
Petrol/Gasoline		kL	0.00 kL	3	t CO2/kL	0	0.0
Automotive Diesel Oil		kL	0.00 kL	3	t CO2/kL	0	0.0
LPG - transport		kL	0.00 kL	1.8	t CO2/kL	0	0.0
Natural Gas/CNG LDV		m3	0.00 m^3	2.7	kg CO_2/m^3	0	0.0
Natural Gas/CNG HDV		m3	0.00 m^3	2.6	kg CO_2/m^3	0	0.0
Marine/Industrial Diesel Fuel		kL	0.00 kL	3.1	t CO2/kL	0	0.0
Aviation Gasoline		kL	0.00 kL	2.6	t CO2/kL	0	0.0
Aviation Turbine		kL	0.00 kL	2.9	t CO2/kL	0	0.0
Waste							
Co-mingled		t	0.00 t	0.9	t CO2-e/t	0	0.0
Paper and paper board		t	0.00 t	2.5	t CO2-e/t	0	0.0
Textiles (excluding synthetics)		t	0.00 t	1.5	t CO2-e/t	0	0.0
Wood/straw		t	0.00 t	2.7	t CO2-e/t	0	0.0
Garden		t	0.00 t	1.1	t CO2-e/t	0	0.0
Food/Garden		t	0.00 t	0.9	t CO2-e/t	0	0.0
Medical		t	0.00 t	0.3	t CO2-e/t	0	0.0
Concrete/metal/plastic/glass		t	0.00 t	0.0	t CO2-e/t	0	0.0
Synthetic gases							
SF_6		t	0.00 t	23,900	t CO2-e/t	0	0.0
HFCs		t	0.00 t		t CO2-e/t	0	0.0
Fugitive emissions							
CH4		t	0.00 t	21	t CO2-e/t	0	0.0
CO2		t	0.00 t	1	t CO2-e/t	0	0.0
Other							
Other		<UNIT>	<UNIT>		t CO2-e/unit	0	0.0
Other		<UNIT>	<UNIT>		t CO2-e/unit	0	0.0
Other		<UNIT>	<UNIT>		t CO2-e/unit	0	0.0
Gross Emissions							**37,875.3**
Offsets (should be entered as negative figures)							
Gross Offsets							**0.0**
Net Emissions							**37,875.3**

Site/Activity B Acitivity/Site name: **Dyno Nobel Moranbah**

Select state: QLD

Emissions inventory

Fuel/process	Consumption units	Unit	Basic units	factors	kg CO_2-e	Tonnes CO_2-e
Electricity	1,381	MWh	1,381,120.00 kWh	1.155 kg CO_2-e/kWh	1595194	1595.2
Natural Gas (non transport)		GJ	0.00 GJ	68.8 kg CO_2-e/GJ	0	0.0
LPG - (non-transport)		t	0.00 t	3.3 t CO2/t	0	0.0
Industrial Diesel Oil		kL	0.00 kL	3.1 t CO2/kL	0	0.0
Petroleum Products Transport						
Petrol/Gasoline	2	kL	2.32 kL	3 t CO2/kL	6966	7.0
Automotive Diesel Oil	244	kL	244.25 kL	3 t CO2/kL	732741	732.7
LPG - transport		kL	0.00 kL	1.8 t CO2/kL	0	0.0
Natural Gas/CNG LDV		m3	0.00 m^3	2.7 kg CO_2/m^3	0	0.0
Natural Gas/CNG HDV		m3	0.00 m^3	2.6 kg CO_2/m^3	0	0.0
Marine/Industrial diesel fuel		kL	0.00 kL	3.1 t CO2/kL	0	0.0
Aviation Gasoline		kL	0.00 kL	2.6 t CO2/kL	0	0.0
Aviation Turbine		kL	0.00 kL	2.9 t CO2/kL	0	0.0
Waste						
Co-mingled		t	0.00 t	0.9 t CO2-e/t	0	0.0
Paper and paper board		t	0.00 t	2.5 t CO2-e/t	0	0.0
Textiles (excluding synthetics)		t	0.00 t	1.5 t CO2-e/t	0	0.0
Wood/straw		t	0.00 t	2.7 t CO2-e/t	0	0.0
Garden		t	0.00 t	1.1 t CO2-e/t	0	0.0
Food/Garden		t	0.00 t	0.9 t CO2-e/t	0	0.0
Medical		t	0.00 t	0.3 t CO2-e/t	0	0.0
Concrete/metal/plastic/glass		t	0.00 t	0.0 t CO2-e/t	0	0.0
Synthetic gases						
SF_6		t	0.00 t	23,900 t CO2-e/t	0	0.0

HFC's		t	0.00 t	t CO2-e/t	0	0.0
Fugitive emissions						
CH4		t	0.00 t	21 t CO2-e/t	0	0.0
CO2		t	0.00 t	1 t CO2-e/t	0	0.0
Other						
Other		<UNIT>	<UNIT>	t CO2-e/unit		0.0
Other		<UNIT>	<UNIT>	t CO2-e/unit		0.0
Other		<UNIT>	<UNIT>	t CO2-e/unit		0.0
Gross Emissions						**2334.9**
Offsets (should be entered as negative figures)						
Gross Offsets						**0.0**
Net Emissions						**2334.9**

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