Orica Australia Pty Ltd
13-Nov-2013

Noise Impact Assessment

Modification of Project Approval 08_0129

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Client: Orica Australia Pty Ltd

ABN: 24 004 145 868

Prepared by

AECOM Australia Pty Ltd
Level 21, 420 George Street, Sydney NSW 2000, PO Box Q410, QVB Post Office NSW 1230, Australia
T +61 2 8934 0000 F +61 2 8934 0001 www.aecom.com
ABN 20 093 846 925

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Prepared by David Chau

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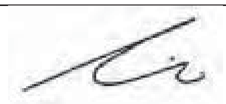
3	13-Nov-2013	Final	Simon Murphy Senior Environmental Planner	

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1.0 Introduction

1.1 Background

Orica Australia Pty Ltd (Orica) has commissioned AECOM Australia Pty Ltd (AECOM) to provide an environmental noise impact assessment for the construction and operation of a nitric acid tank and the construction and operation of three ammonia nitrate flares at its Kooragang Island plant. Kooragang Island is zoned SP1 (Special Activities) under the State Environmental Planning Policy (Major Development) 2005 (SEPP (Major Development)). In accordance with the Environment Protection Authority (EPA) *'NSW Industrial Noise Policy'* (INP) (EPA 2000); this zone is considered to be an industrial setting. The plant has approval to operate 24 hours a day, 7 days a week.

The following activities as part of the expansion and modification are addressed in this report:

- Construction activities including equipment and traffic;
- Operation of a pump associated with the nitric acid tank; and
- Non-routine operation of three ammonia flares located in the ammonia storage, nitrates and ammonia plant areas.

Previous acoustic assessments, associated with the operation of the Orica facility, have been conducted by Atkins Acoustics (Atkins). Atkins' recent noise audit report, detailing the quarterly noise data collected over a 12 month period, has been utilised as the referenced background noise levels in this report. The report is titled 'Orica Australia Pty Ltd Environmental Noise Audit' and referenced as 43.67 19.R3:GA/DT/2013 Rev 00, dated July 2013.

1.2 Scope

The scope of the environmental noise assessment was to:

- Identify potentially affected receivers, both residential and non-residential as a result of the proposed additional nitric acid tank and flaring infrastructure;
- Determine representative background noise levels at affected receivers, using previous unattended noise monitoring data collected between 2011 and 2013;
- Establish noise management levels (NML) for construction activities in accordance with the EPA's '*Interim Construction Noise Guidelines*' (ICNG) (DECC, 2009);
- Establish normal and non-routine operational noise limits in accordance with Orica Ammonium Nitrate Expansion Project '*Specific Environmental Conditions*' within the Project Approval (08_0129) – Schedule 1 (DoP, Dec 2009) and the EPA's *'NSW Industrial Noise Policy'* (INP) (EPA 2000);
- Undertake modelling to determine construction operational and non-routine operational noise impacts at nearby receivers and to determine compliance of proposed activities with the established acoustic requirements; and
- Provide mitigation measures to minimise and manage any exceedances of the acoustic requirements for construction, operational or non-routine operational noise (if required).

Note that due to the large offset distances to sensitive receivers and the proposed construction and operational equipment being used, vibration levels during construction and operation are not expected to impact nearby sensitive receivers, therefore vibration levels have not been assessed in this report.

The modifications to the plant will not generate any additional operational traffic and thus traffic will only be assessed for a construction scenario. Definitions of the acoustic nomenclature used in this report are presented in Appendix A.

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2.0 Existing Environment

2.1 Receivers

The nearest residential receiver (R1) assessed in this assessment is located approximately 800 metres to the east of the industrial site boundary. Sensitive noise receivers were selected to demonstrate the noise contribution due to the Orica ammonia plant modification works. These receivers are presented in Table 1. The locations of these receivers relative to the Orica plant are shown in Figure 1. Receivers R1 and R2 are similar to those assessed previously within the Atkin's acoustic report. Residential receiver R3 has been included in this assessment to represent residential receivers located in the south-western direction, Carrington. Industrial receiver I1 has been included to take into consideration the nearest industrial receiver within the Kooragang Island industrial area.

Table 1 Receiver locations assessed within this report

ID	Address	Type	Distance from site boundary
R1	284 Fullerton Road, Stockton	Residential - Suburban	750 m
R2	218 Fullerton Road, Stockton	Residential - Suburban	730 m
R3	38 Elizabeth Street, Carrington	Residential - Urban	1080 m
I1	39 Heron Road, Kooragang Island	Industrial	Adjacent

Figure 1 Receiver locations assessed within this report

2.2 Ambient and background noise levels

Ambient and background noise levels for nearby receivers are presented below. Background and ambient noise levels for receivers R1, R2 and I1 have been acquired from Atkins' Report. Background and ambient noise levels for receiver R3 have been acquired from a previous assessment performed by Wilkinson Murray (Mayfield Site Port-Related Activities Concept Plan EA, Revision F, July 2010).

Table 2 shows that the ambient noise levels at night for all receivers are equal or lower than day-time levels, and are not too dissimilar from the evening levels. At receiver I3, the night-time level is above the evening noise level by 1 dB.

Table 2 Ambient and background noise levels at the assessed receivers

ID	Measurement location	RBL, L_{A90}			Ambient noise levels, L_{AEq}		
		Day	Evening	Night	Day	Evening	Night
R1	284 Fullerton Road (Residential)	50	49	48	65	61	59
R2	218 Fullerton Road (Residential)	47	46	46	58	54	54
R3	38 Elizabeth Street, Carrington	44	43	39	57	54	46
I1	39 Heron Road, Kooragang Island	57	58	59	64	63	64

2.2.1 Attended noise measurements

The Orica nitrate ammonia plant noise contributions to each receiver have been quantified via attended noise measurements. Noise measurements and notes have been partially acquired from Atkins' report (R1,R2 and I1) and recent measurements conducted by AECOM personnel (R3).

During the day-time determining the site contribution was found to be difficult given the myriad of noise sources within such an industrialised area. Atkins (May, 2013) conducted measurements in the night-time to confirm that there was minimal influence from other industrial sources at these locations. The below text has been extracted from the Atkins' report:

> *"Night-time attended noise audits reported for the reference monitoring locations on Kooragang Island (2011) confirmed that there was minimal influence from other industrial sources at those locations. Attended and unattended measurements on Kooragang Island have shown that other than from the immediate noise activities and prevailing winds there is minimal variation between the LA90 and LAeq levels and noise from Orica would be described as steady state".*

Table 3 presents the levels, including the estimated Orica plant site contribution and observations during measurement.

Table 3 Logged Noise Levels, attended noise measurements and observations

ID	Measurement location	Night			Comments
		RBL, L_{A90}	Ambient, L_{Aeq}	Site contribution, L_{Aeq}	
R1	284 Fullerton Road, Stockton	45	54	50	Stockton Beach Surf Ammonia Plant MDEA Pumps and Converter Valves General industrial noise Intermittent passing road traffic
R2	218 Fullerton Road, Stockton	49	53	53	
R3	38 Elizabeth Street, Carrington	39	40	39	Industrial noise in the direction of the Orica plant Passing heavy road traffic
I1	39 Heron Road, Kooragang Island	56	61	56	Ammonia plant Ammonia plant pipe noise (convertor valves) MDEA pumps (500 Hz) Steam pipes

3.0 Noise Limits

3.1 Operational noise limits

The operational noise limits for this project has been established in accordance with the Project Approval issued by the Department of Planning, referenced as 08_0129, dated 1 December 2009.

The specific noise conditions applicable to the Orica plant have been replicated below.

NOISE

Noise Limits

30. The proponent shall ensure that noise levels from the operation of the Project are at least 10 dB(A) below noise levels from Orica's Existing Operations as specified by conditions 31 & 32 below.

Existing Operations – Noise Verification Program

31. Prior to the commencement of construction the Proponent shall prepare and implement an Existing Operations Noise Verification Program to the satisfaction of the Director-General. The Program shall:

- *a) be undertaken by a suitably qualified and experienced person;*
- *b) identify future reference points that will be used to demonstrate compliance;*
- *c) collect new or review existing data, and report on the seasonal background levels for the noise catchment; and*
- *d) confirm the noise levels from Orica's Existing Operations*

Note: Some construction activities may occur under the Project Approval provided that such activity are not undertaken during the monitoring period or that Orica can demonstrate that the activity would not contribute to the background noise level, to the satisfaction of the Director-General.

Noise Management Plan

32. Prior to the commencement of operations of the Project, the Proponent shall prepare and implement a Noise Management Plan in consultation with DECCW and to the satisfaction of the Director-General. The Plan shall:

- *a) be undertaken by a suitably qualified and experienced expert;*
- *b) demonstrate how noise levels from the Project would be managed to ensure noise levels would be 10 dB(A) below noise levels from Orica's Existing Operations (see conditions 30 & 31);*
- *c) include a detailed monitoring program for reporting on ongoing compliance. The monitoring program shall:*
  - *outline the proposed receiver sites at Stockton and sites on Kooragang Island that would be monitored;*
  - *include both attended and unattended noise monitoring;*
  - *verify that actual noise levels from the Project are consistent with the predictions made in the EA; and*
  - *verify that noise levels from the Project are 10 dB(A) below the noise levels identified in condition 31 for Orica's Existing Operations;*
- *d) provide details of any complaints received in the preceding year relating to noise generated by the Project, and action taken to respond to those complaints;*
- *e) detail procedures for implementing additional reasonable and feasible noise mitigation measures for the Project in response to exceedance of limits and/or noise complaints; and*
- *f) be updated annually, unless otherwise agreed to by the Director-General.*

The resultant environmental noise limits have been derived from the night-time attended measurements discussed in Section 2.2 and detailed in Table 4. Considering that the operation of the plant will involve relatively constant noise emissions during the various assessment periods, the night-time noise limits represent the governing noise level and will therefore have been used as the project specific background noise limits. Compliance with the night-time noise limits will ensure compliance with the day and evening noise limits.

A noise limit for the industrial receiver has been based on the acceptable noise level specified within the EPA's INP.

Table 4 Project specific noise limits for assessment receivers

ID	Assessment receiver address	Noise limits, $L_{Aeq,\ 15\ minute}$
		Night
R1	284 Fullerton Road (Residential)	40
R2	218 Fullerton Road (Residential)	43
R3	38 Elizabeth Street, Carrington	29
I1	39 Heron Road, Kooragang Island	70

3.2 Sleep disturbance criteria

The INP has recently been updated with application notes which discuss sleep disturbance and its objective assessment.

To minimise the risk of sleep disturbance as a result of industrial type operations during the night-time period, the INP application notes recommend that the $L_{A1(1\ minute)}$ noise level outside a bedroom window should not exceed the L_{A90} background noise level by more than 15 dB(A) during the night-time period (10.00 pm to 7.00 am). The EPA considers it appropriate to use this metric as a screening criterion to assess the likelihood of sleep disturbance. If this screening criterion is found to be exceeded then a more detailed analysis must be undertaken and include the extent that the maximum noise level exceeds the background noise level and the number of times this is likely to happen during the night-time period.

The EPA's Interim Construction Noise Guideline (ICNG) and Industrial Noise Policy (INP) recommend reference to the EPA's '*NSW Road Noise Policy*' (RNP) (DECCW, 2011) some guidance in assessing the potential for sleep disturbance.

The RNP contains an assessment of sleep disturbance which represents EPA's advice on the subject of sleep disturbance due to noise events. Section 5.4 of RNP concludes, having considered the results of four research papers by *Pearson et al (1995)*, *Bullen et al (1996)*, *Griefahn (1992)* and *Finegold et al (1994),* with the statement, *'Maximum internal noise levels below 50 - 55 dB(A) are unlikely to cause awakening reactions'*. Therefore, given that an open window provides 10 dB(A) noise attenuation from outside to inside, external noise levels of 60 - 65 dB(A) are unlikely to result in awakening reactions.

Based on the measured background noise levels during the night, the sleep disturbance screening level and awakening reaction for the nearest residential receivers are presented in Table 5.

Table 5 Night-time sleep disturbance criteria

Location	RBL $L_{A90\ (15\ min)}$ dB(A)	Sleep disturbance criteria $L_{A1\ (1\ minute)}$ dB(A)	
		Screening level	Awakening reaction
R1	48	63	60 - 65
R2	46	61	60 - 65
R3	39	54	60 - 65

The night-time noise emissions from the plant would generally be associated with relatively constant pumping activities. Therefore no significant peak noise events would be expected. Compliance with the operational noise limits will ensure compliance with the sleep disturbance criteria.

3.3 Maintenance and non-routine flare operational noise limits

The proposed flares may operate in an non-routine mode, that is, as a safety component when high gas pressures pose a risk to the integrity of the systems. During an event resulting in a non-routine release of ammonia, flares will activate. Three flare systems have been assessed in this noise impact assessment.

The utilisation of the ammonia flares is characterised by events which occur at low frequency, can have crucial consequences if not activated and may emit higher noise levels. There are no noise limits for non-routine operation specified within Orica plant's EPL.

The frequencies and durations of operations are presented in Table 6 which will form a basis to justify appropriate non-routine operation noise limits. These values are justified with incident report data from Incitec Pivot Limited, who currently has a similar flare proposal under consideration with the Department of Planning and Infrastructure.

Table 6 Duration and frequency of each flare

Designation	A	B	C
System description	**Nitrates**	**Storage**	**Ammonia**
Duration	5 minutes	Extended period of time depending on the circumstance	5 minutes
Frequency of event	1/2 years	1/10 years	1/2 years

Flare A and C may operate at a higher frequency to Flare B, however, they have a significantly lower duration. Therefore, two noise limits have been set which cater for the differing durations – one which caters for short-term noise (Flares A and C) and another which caters for continuous long-term noise (Flare B).

For each flare, there will also be the base (constant) noise and impulsive noise sources. These are expanded on in the section 5.1. To cater for the varying types of noise occurring from these flares, the following noise limits have been determined:

- Short-term noise (Flare A and C)
- Long-term noise (Flare B)

3.3.1 Short-term noise limits *(Flare A and C)*

The short-term noise limits for each period and receiver type are shown in Table 7. Due to the short-term nature of Flares A and C, the noise limits have been set higher than the long-term criteria.

The industrial receiver noise limits have been based off the recommended maximum noise level for this type of receiver as specified in Table 2.1 of the INP. The short-term noise limits for each period and receiver type are shown in Table 7.

Table 7 Short-term criteria, $L_{Aeq,\ 15minute}$ dB(A)

Receiver type	Noise limits short-term, $L_{Aeq,\ 15minute}$ dB(A)		
	Day	Evening	Night
Residential	RBL + 20	RBL + 10	RBL + 10
Industrial	75	75	75

3.3.2 Long-term noise limit (Flare B)

The long-term noise limits are more stringent than the short-term noise limits. The long-term noise limits for each period and receiver type are shown in Table 8.

Table 8 Long-term criteria, $L_{Aeq\ 15min}$ dB(A)

Receiver Type	Criteria Long-term, $L_{Aeq\ 15min}$ dB(A)		
	Day	Evening	Night
Residential	RBL + 10	RBL + 5	RBL + 5

Receiver Type	Criteria Long-term, $L_{Aeq\ 15min}$ dB(A)		
	Day	Evening	Night
Industrial	75	75	75

3.3.3 Summary of the non-routine noise limits

The night-time noise limits have been selected for assessment as they represent the most stringent noise compliance levels of the three categories and thus if the predicted noise levels complies with these night-time noise limits then by default they will satisfy the evening and day noise limits for all residential receivers.

A summary of the night-time non-routine noise limits is presented in Table 9.

Table 9 Night-time non-routine assessment noise limits

Location	Night-time RBL $L_{A90\ (15\ min)}$ dB(A)	Night-time noise limits, $L_{Aeq\ 15min}$ dB(A)	
		Short-term RBL + 10	Long-term RBL + 5
R1	48	58	53
R2	46	56	51
R3	39	49	44

Table 10 Industrial receiver non-routine noise limits

Receiver Type	Non-routine noise limits, long and short-term, $L_{Aeq\ 15\ minutes}$ dB(A)		
	Day	Evening	Night
Industrial	75	75	75

3.4 Construction noise management levels

The ICNG aims to manage noise from construction works regulated by the EPA.

The Guideline seeks to promote a clear understanding of ways to identify and minimise noise generated during construction. The guideline focuses on applying all 'reasonable and feasible' work practices to minimise construction noise impacts. Depending on the extent of impact and the scale of the works, managing noise impacts may involve community engagement.

The ICNG defines what is considered to be feasible and reasonable as follows:

Feasible

> *A work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements.*

Reasonable

> *Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure.*

The ICNG recommends that a quantitative assessment is carried out for all *'major construction projects that are typically subject to the EIA process'*. A quantitative assessment, based on a likely 'reasonable' worst case construction scenario, has been carried out for the development.

Predicted noise levels at nearby noise sensitive receivers (residential and industrial premises) are compared to the management levels provided in Section 4 of the ICNG. Where an exceedance of the noise management levels (NMLs) is predicted the ICNG advises that the proponent should apply all feasible and reasonable work practises to minimise the noise impact.

NMLs for residential receivers are derived using the information in Table 11 (excerpt from Table 2 of the ICNG).

Table 11 Noise management levels at residences

Time of day	Management level $L_{Aeq\ (15min)}$*	How to apply
Construction hours: *Monday to Friday 8 am to 5 pm* *Saturday 8 am to 1 pm* *No work on Sundays or public holidays*	*Noise affected* *RBL + 10 dB*	- The noise affected level represents the point above which there may be some community reaction to noise. - Where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. - The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected *75 dB(A)*	- The highly noise affected level represents the point above which there may be strong community reaction to noise. - Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: • times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences

Time of day	Management level $L_{Aeq\ (15min)}$*	How to apply
		• if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times. The community's preference on these matters will need to be gauged through community consultation.
Outside recommended standard hours	*Noise affected RBL + 5 dB*	- A strong justification would typically be required for works outside the recommended standard hours. - The proponent should apply all feasible and reasonable work practices to meet the noise affected level. - Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. - For guidance on negotiating agreements see section 7.2.2 (ICNG).

Table 12 Construction noise management levels – Residential receivers

Residential receiver	Recommended standard hours RBL dB(A)	Recommended standard hours NML, $L_{Aeq,\ 15min}$ dB(A)
R1	50	60
R2	47	57
R3	44	54
Residential receiver	**Outside recommended hours RBL dB(A)**	**Outside recommended standard hours NML, $L_{Aeq,\ 15min}$ dB(A)**
R1	48	43
R2	46	51
R3	39	44

The proposed development will occur within close proximity to industrial premises. The NML for these receivers, as defined in the ICNG, are presented in Table 13.

Table 13 Noise at land uses (other than residences) using quantitative assessment

Land use	NML, $L_{Aeq,15min}$ (applies when properties are being used)
Industrial premises	External noise level 75 dB(A)

3.5 Construction Traffic Noise Criteria

The EPA's Interim Construction Noise Guideline (ICNG) does not provide direct reference to an appropriate criterion to assess the noise arising from construction traffic on public roads.

Given the relative short duration of most construction activities and taking into consideration the recently released EPA's Road Noise Policy (RNP) which provides guidance when assessing relative increases in criteria, namely:

'*In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person'.*

Thus, the criterion applied to traffic movements on public roads generated during the construction phase of the project is an increase in existing road traffic noise of no more than 2 dB(A). This criteria is similar to the one applied for operational traffic generated noise.

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4.0 Normal Operational Assessment

4.1 Operational noise sources

The potential noise sources during the operational scenario of the nitric acid tank are associated with the nitric acid tank transfer pump and the NOx Scrubber recirculation pump. As the pumps are to be designed so that noise generated during normal operation does not exceed a maximum noise level of 82 dB(A) at 1 metre, corresponding to the site's OH&S protective hearing area requirement. The derived total sound power of the two pumps is shown in Table 14. The installed pumps must have an overall sound power level that is equal or less than this sound power level and not contain any annoying noise characteristics as described in the INP (i.e. tonality, low frequency, etc.) to remain consistent with the conclusions within this report. The pumps are expected to operate 24 hours a day, 7 days a week.

Table 14 Pump sound power level

Equipment	Sum of A-weighted Overall, dB(A)
Tank transfer pump and NOx recirculation pump	90

Figure 2 Location of pump relative to receivers

4.2 Modelling

The operational noise levels were predicted using an implementation of the CONCAWE algorithms in the SoundPLAN (V7.1) noise propagation software.

The noise model takes into account significant noise source sound level emissions and locations, receiver locations, and noise attenuation due to geometrical spreading, air absorption, ground absorption and the effects of the worst-case weather conditions. Screening due to buildings and ground topography were not included within this model adding conservatism to the assessment.

The noise model was based on the proposed location of the plant and the sound power levels detailed in Table 14.

4.3 Adverse meteorological conditions

Certain meteorological conditions may increase noise levels by focusing sound-wave propagation paths at a single point. Such refraction of sound waves will occur during temperature inversions and where there is a slight breeze with wind direction from the source to receiver. The INP details a method for assessing the increase in noise levels caused by temperature inversions.

Wind velocity of 2 m/s is modelled in the direction of source to receiver for all source and receiver locations. This represents a conservative assessment since it is not possible for the wind to be travelling in multiple directions at the same time. The effect of F-class temperature inversions have also been applied within this assessment.

4.4 Operational assessment results

The proposed nitric acid pumps may operate 24 hours per day, 7 days a week, with similar capacity during the day, evening and night-time periods. The night-time noise limits are the most stringent and therefore the assessment has been undertaken against the night-time noise limits.

The results as shown in Table 15 demonstrate compliance against the established criteria.

Table 15 Normal Operation Assessment Results

ID	Location	Type	Noise limit, $L_{Aeq,(15 minute)}$, dB(A)	Predicted noise level $L_{Aeq,15 minute}$, dB(A)		Exceedance, dB(A)	
				Neutral Met*	Adverse Met*	Neutral Met*	Adverse Met*
Night Period							
R1	284 Fullerton Road, Stockton	Residential	40	23	30	-	-
R2	218 Fullerton Road, Stockton	Residential	43	24	30	-	-
R3	38 Elizabeth Street, Carrington	Residential	29	21	28	-	-
I1	39 Heron Road, Kooragang Island	Industrial	70	38	40	-	-

**Meteorology*

5.0 Operation and Maintenance of Ammonia Flares

5.1 Ammonia Flare operational noise sources

In the event that the flares become operational, gas flares will activate to burn gas and relieve pressure build up.

Flare noise derives from four sources:

i) Sonic discharge from the relief valve referred along the header and emanating from the stack;

ii) The vent gas exit velocity at the stack;

iii) Combustion noise from the reaction between the vent gas and oxygen; and

iv) The use of high pressure steam or compressed air to aid combustion efficiency

In the case of ammonia flares there is no steam or air assistance required, leaving the main contributors to noise the first three items listed above.

The noise will be dominated by the sonic discharge at the relief valve (i) and in this respect, will be equivalent to the noise currently experienced on-site when relief valves discharge directly to atmosphere, with the larger relief valves venting to the Ammonia Plant Vent stack. The diversion of ammonia relief valve to a flare system will neither increase nor significantly decrease this existing noise level associated with pressure relief events.

The flare exit velocity (ii) is kept below 20 m/sec which is less than 5% of the speed of sound. There will be some noise associated with this velocity albeit considerably lower than what would be observed from near sonic designed flares, typical with many hydrocarbon processes.

When compared with a typical hydrocarbon, the combustion noise (iv) from ammonia is low. The noise from the reaction is a function of the vent gas lower heating value which, for ammonia is 14.1 MJ/m3 versus 35.6 MJ/m3 for methane.

Estimates for the expected sound power level (SWL) from the discharge point are summarised in Table 16. When flaring vent gas originating from other than relief valves the combustion noise dominates the sound power level emitted.

It is unlikely for the three flares to be activated simultaneously. Therefore, the flares have been modelled to activate at individual times and thus the flares have been assessed operating individually. Further, each of the three flare systems operate independently of one another, and thus triggering one does not lend itself to increase the chances of another being triggered.

Table 16 Different sound sources from flares and their sound power levels

Designation	A	B	C
System Description	Nitrates	Storage	Ammonia
Capacity, t/h	10	4	56
Pressure Release Valve, Lw_A dB(A)	138	133	145
Vent Exit, Lw_A dB(A)	78	75	86
Combustion, Lw_A dB(A)	123	119	133
Frequency	1/2 years	1/10 years	1/2 years
Duration	5 minutes	Extended period of time depending on the circumstance	5 minutes

The pressure release valve has been assumed to activate once per minute within the duration of activation, each pressure relief event will sound for approximately 2 seconds.

The locations of these flares are shown in Figure 3.

Figure 3 Location of flares and assessment receivers

5.2 Operational assessment results

$L_{Aeq\ 15\ minutes}$ noise levels due to operation of the three ammonia flares are presented in Table 17. The levels shown are due to all three sources operating individually.

A 5 dB penalty, in accordance with the INP, was arithmetically added to the final predicted noise levels due to the impulsive (sudden and short-lived) nature of the pressure relief valve.

Table 17 Maintenance and non-routine operational assessment results

ID	Type	Noise limits $L_{Aeq,15\ minute,}$ dB(A)	Predicted Noise Level $L_{Aeq,15\ minute,}$ dB(A)		Exceedance, dB(A)	
			Neutral Met*	Adverse Met*	Neutral Met*	Adverse Met*
Flare A						
R1	Residential	58	53	57	-	-
R2	Residential	56	54	59	-	3
R3	Residential	49	45	50	-	1
I1	Industrial	75	58	61	-	-
Flare B						
R1	Residential	53	49	54	-	1
R2	Residential	51	49	54	-	3
R3	Residential	44	44	49	-	5
I1	Industrial	75	71	73	-	-
Flare C						
R1	Residential	58	57	62	-	4
R2	Residential	56	57	62	1	6
R3	Residential	49	51	55	2	6
I1	Industrial	75	80	81	5	6
Cumulative Impact						
R1	Residential	58	59	64	1	6
R2	Residential	56	59	64	3	8
R3	Residential	49	53	57	4	8
I1	Industrial	75	81	82	6	7

5.2.1 Sleep disturbance assessment

A sleep disturbance assessment was conducted to predict the impact of impulsive noise sources.

Table 18 Sleep disturbance results

ID	Type	Criteria $L_{A1,1min}$ dB(A)	Predicted noise Level $L_{A1,1min}$ dB(A)		Exceedance, dB(A)	
			Neutral Met*	Adverse Met*	Neutral Met*	Adverse Met*
Flare A						
R1	Residential	65	66	70	1	5
R2	Residential	65	67	72	2	7
R3	Residential	65	58	63	-	-
Flare B						
R1	Residential	65	57	62	-	-
R2	Residential	65	57	62	-	-
R3	Residential	65	52	57	-	-
Flare C						
R1	Residential	65	70	75	5	10

ID	Type	Criteria $L_{A1,1min}$ dB(A)	Predicted noise Level $L_{A1,1min}$ dB(A)		Exceedance, dB(A)	
R2	Residential	65	70	75	5	10
R3	Residential	65	64	68	-	3

5.2.2 Discussion

The modelling results show that the night-time operation of the three flares will generally comply with the noise limits. This is a conservative comparison as the flares have the equal potential to operate during the day and evening to the night. Also it is highly unlikely that multiple flares would be operation at the same time.

Flare A

- Noise levels are expected to comply during both neutral wind and adverse weather conditions with R1 and R2 experiencing minor 1 dB(A) and 3 dB(A) exceedances respectively.

Flare B

- Flare B, with an operational duration ranging from a few seconds to several weeks, complies with the noise limits for all receivers during neutral weather conditions.
- R1 and R2 may exceed by 1-3 dB(A) during adverse weather conditions. A level of 2 dB(A) is considered barely perceptible to the human ear and therefore is considered marginally acceptable.
- R3 may exceed by 5 dB(A) during adverse weather conditions. The predicted noise level is 49 dB(A) during these adverse weather conditions, which will result in an approximate internal noise level of 39 dB(A) with windows open and 29 dB(A) with windows closed. These levels are within the acceptable ranges of noise level for bedrooms located near major roadways, according to '*Australian Standard 2107:2001 – Recommended design noise levels for internal noise levels and reverberation times for building interiors'*.

Flare C

- During neutral weather conditions noise levels experienced by the industrial receiver are likely to exceed by 5 dB(A) and residential receivers R2 and R3 are likely to exceed by 1 dB(A) and 2dB(A) respectively. These exceedances at R2 and R3 would be barely perceptible to the human ear.
- During adverse weather conditions, receivers R1 exceeds by 4 dB(A) and R2, R3 and I1 exceed by 6 dB(A).
- It should be noted that the flare C will only operate for a period of 5 minutes, and thus the receiver will only experience the L_{Aeq} quoted for no more than a single 15 minute period.
- The non-routine use of the flare is expected to occur once in every 2 years
- It should also be noted that these noise levels were assessed against a night time RBL. The non-routine flare systems have the equal potential to activate within the day, evening or night.

Cumulative Impact

- These noise levels demonstrate the highly unlikely worst case scenario with all flares being activated simultaneously
- The noise impact of all three flares at the same time are 1-2 dB(A) higher than that of the Flare C activated by itself, for both neutral and adverse weather conditions
- These noise levels will only be experienced by the receivers for a period less than 15 mins – after this period of 15 mins, Flare A and C will cease operation and the remaining noise contribution of the flares will be solely due to Flare B. Flare B has been shown to be generally compliant with the noise criteria.
- The likelihood of this occurrence is extremely low considering the frequency of operation and duration at which the flares are activated

Sleep disturbance

- The sleep disturbance assessment reveals that the criterion will be triggered due to flares A and C. Both flares will operate for a period of 5 minutes each, expected to be every 2 years.
- Flare A only exceeds the criteria during neutral weather conditions by 2 dB(A), which is a minor exceedance.

- It should also be noted that these noise levels were assessed against a night time RBL. The non-routine flare systems have the equal potential to activate within the day, evening or night.
- Flare B, which operates for a significantly longer period of time, is not expected to trigger awakening reactions and thus disturb the sleep of receivers indoors.

Due to the function of the safety ammonia flares and that noise is likely to exceed INP noise criteria over a limited period of time it is recommended that no mitigation measures will be required for the flare system. It should also be noted that Orica has a community consultation hotline which nearby residences should be made aware of, if not already.

The flares will operate at a significantly lower flow rate during maintenance and thus are deemed to comply. Flares should be tested during the day to reduce the noise impact onto nearby receivers.

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6.0 Construction Noise Assessment

6.1 Construction noise sources

The construction noise and vibration assessment has been based on a typical equipment list and phases. The construction of both the ammonia flares and nitric acid tank will be undertaken in compliance with the environmental controls identified in the approved expansion project Construction Environmental Management Plan.

6.2 Construction phases

Two distinct phases of construction have been assumed to occur for the construction of these plant modifications. These phases are defined for each construction site as follows:

- Earthworks and excavation; and
- Construction and installation

The equipment list for these two stages is shown in Table 19.

Construction is assumed to be undertaken from 7 am to 6 pm thus spanning both recommended standard hours and outside of recommended standard working hours. Since the hours are not within 10.00 pm to 7.00 am the impacts of construction activities out-of-hours and on sleep disturbance do not need to be assessed.

Table 19 Activities and plant items used for the installation of the tank and pump

Activity	Plant Items	Qty	Height, m	Unit sound power level, dB(A)
Earthworks and excavations	Flatbed truck with crane	1	1.5	98
	Light delivery vehicles	1	1.5	98
	Cranes	1	1.5	106
	Material and delivery trucks	1	1.5	98
	Excavator (40 tonne)	1	3	105
Construction of tank	Generators	1	0.5	101
	Excavator (40 tonne)	1	3	105
	Mobile crane	1	3	104
	Tower crane	1	3	106
	Concrete mixer	1	3	89
	Concrete truck	1	3	106
	Mobile electric welding sets	1	3	101
	Electric hand tools	1	3	108
	Material and delivery trucks	1	1.5	98

Commissioning works would be carried out following the completion of the main construction phases. Commissioning works would involve running and testing pump systems. Noise generated during commissioning would therefore be similar to operational noise. As described in Section 7.0, there is not expected to be any significant impacts on sensitive receivers from operational noise.

The construction of the nitric acid tank and its associated flare, flare B, may occur simultaneously, however would be staged to minimise impacts.

6.3 Construction noise modelling

The model used for the construction assessment was similar to the model used for the operational scenario. Appropriate sources were used, which are presented in Table 19.

It can be expected that there may be differences between predicted and measured noise levels due to variation in instantaneous operation conditions, plant in operation during the measurement and also the location of the plant equipment. The absence of acoustic shielding from buildings and other civil structures and also ground topology add to the conservativeness of the assessment. The attenuation due to this shielding from these features will serve to reduce the measured levels.

6.4 Construction noise assessment results

Results shown in Table 20 are of the construction noise modelling. It shows that no exceedances are predicted for the construction noise scenarios of the flares or nitric acid tank against the outside of recommended working hours criteria

The cumulative impact of construction works of the nitric acid tank and its associated flare, Flare B, occurring simultaneously has been presented. The results demonstrate that this scenario will still achieve compliance against the established criteria.

Table 20 Construction noise assessment results

Receiver	Noise management level, $L_{Aeq\ (15min)}$, dB(A)	Predicted noise level $L_{Aeq,15min}$, dB(A)	Exceedance, dB(A)
		Neutral weather	Neutral weather
Nitric Acid Tank			
R1	43	37	-
R2	51	38	-
R3	44	36	-
I1	75	55	-
Flare A			
R1	43	41	-
R2	51	43	-
R3	44	34	-
I1	75	46	-
Flare B			
R1	43	38	-
R2	51	38	-
R3	44	33	-
I1	75	60	-
Flare C			
R1	43	39	-
R2	51	39	-
R3	44	32	-
I1	75	61	-
Cumulative Noise Levels of Flare B and Nitric Acid Tank Construction			
R1	43	41	-
R2	51	41	-
R3	44	38	-
I1	75	61	-

6.5 Construction traffic noise assessment

No major earthworks are required for the construction of the nitric acid tank or flares. Daily truck movements, associated with construction works, would be low. This assessment assumed 20 light vehicle and 10 heavy vehicle movements per day during peak construction. The increase in noise level has been assessed conservatively, by assuming that traffic will be consistent 24 hours within a day. Annual average daily traffic (AADT) sourced from the Roads and Maritime Services (RMS). A heavy vehicle percentage of 10% has been assumed for these flows, which is conservative based on AECOM's experience for a highly industrialised area.

As presented in Section 6.5, the criterion applied to traffic movements on public roads generated during the construction phase of the project is an increase in existing road traffic noise of no more than 2 dB(A). Tourle Street and Nelson Bay Road (Stockton Bridge) are the nearest collector roads and as such have been assessed.

Presented in Table 21 are the results of the construction traffic noise assessment.

Table 21 Road traffic noise assessment - construction

Street	Situation	Vehicle volume throughout day		Peak hour		Predicted noise level increase, dB(A)
		Light	Heavy	Light	Heavy	
Tourle Street	Existing	19156	2130	798	89	< 1
	Future[1]	19176	2150	818	99	
Nelson Bay Road	Existing	15621	1736	651	72	< 1
	Future[1]	15641	1746	671	82	

Notes:

1 Includes construction traffic.

Figure 4 Collector road locations used for assessment

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7.0 Conclusion

7.1 Operational noise assessment

The operation of the nitric acid tank would create the need for nitric acid to be pumped at any time of the day. The sound power level of the pump was based on a Work Health and Safety (WHS) requirement of 82 dB(A) at 1 metre.

The operation of the pumps were assessed against the noise limits prescribed by the Department of Planning, Project Approval 08_0129. The assessment demonstrated that the noise at all assessed receivers complied against the operational noise limits.

7.2 Operation and maintenance of Ammonia flares

The assessment demonstrates that the on-routine use of the flares generally complies with the noise limits set in section 3.3. Operation of Flare C, which operates for a short period of time, was found to cause an exceedance at one receiver location during neutral weather conditions. Receivers are predicted to exceed by 5 dB(A) during adverse weather conditions. However, due to the infrequent use Flare C, the short duration in operation and the safety function for which the flares serve, these exceedances are deemed to be acceptable.

Flare A was found to comply with the criteria set for all receiver locations and all weather conditions. Flare B complied during neutral weather condition at all receiver location and had marginal exceedances of 1 and 3 dB(A) during adverse weather conditions.

The sleep disturbance assessment revealed that Flare B, which would operate for the long-term, complied at all receiver locations and weather conditions. Flares A and C were found to trigger the sleep disturbance levels, however the length of operation and the frequency at which these flares would be activated were reasoned to be insignificant.

No mitigation measures were recommended to treat the flares, however, it is recommended that community consultation contact lines are broadcasted to nearby and potentially affected receivers.

7.3 Construction noise assessment

Typical construction scenarios have been assessed across two phases: excavation and earthworks, and construction. Typical plant equipment was also assumed for these phases and assessed against the requirements of the ICNG.

The construction noise assessment demonstrated that the noise management levels would be met at all assessed receivers, which included residential and industrial receivers.

7.4 Construction traffic noise assessment

Noise generated from light and heavy construction traffic due to the modification of the plant was assessed. It was found that noise caused by these vehicles will not increase the $L_{Aeq,\ 1\ hour}$ road noise levels by more than 2 dB and hence will comply with the established RNP criteria.

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Appendix A

Acoustic Terminology

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Appendix A Acoustic Terminology

The following is a brief description of acoustic terminology used in this report.

Sound power level	The total sound emitted by a source.
Sound pressure level	The amount of sound at a specified point.
Decibel [dB]	The measurement unit of sound.
A Weighted decibels [dB(A])	The A weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1kHz and 4 kHz) which the human ear is most sensitive to, and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dB(A).
Decibel scale	The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. A 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. A 10 dB increase in the sound pressure level corresponds to a perceived doubling in volume. Examples of decibel levels of common sounds are as follows:
	0dB(A) Threshold of human hearing
	30dB(A) A quiet country park
	40dB(A) Whisper in a library
	50dB(A) Open office space
	70dB(A) Inside a car on a freeway
	80dB(A) Outboard motor
	90dB(A) Heavy truck pass-by
	100dB(A) Jackhammer/Subway train
	110 dB(A) Rock Concert
	115dB(A) Limit of sound permitted in industry
	120dB(A) 747 take off at 250 metres
Frequency [f]	The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high pitched sound and a low frequency to a low pitched sound.
Equivalent continuous sound level [L_{eq}]	The constant sound level which, when occurring over the same period of time, would result in the receiver experiencing the same amount of sound energy.
L_{max}	The maximum sound pressure level measured over the measurement period.
L_{min}	The minimum sound pressure level measured over the measurement period.
L_{10}	The sound pressure level exceeded for 10% of the measurement period. For 10% of the measurement period it was louder than the L_{10}.
L_{90}	The sound pressure level exceeded for 90% of the measurement period. For 90% of the measurement period it was louder than the L_{90}.
Ambient noise	The all-encompassing noise at a point composed of sound from all sources near and far.

Background noise	The underlying level of noise present in the ambient noise when extraneous noise (such as transient traffic and dogs barking) is removed. The L_{90} sound pressure level is used to quantify background noise.
Traffic noise	The total noise resulting from road traffic. The L_{eq} sound pressure level is used to quantify traffic noise.
Day	The period from 0700 to 1800 h Monday to Saturday and 0800 to 1800 h Sundays and Public Holidays.
Evening	The period from 1800 to 2200 h Monday to Sunday and Public Holidays.
Night	The period from 2200 to 0700 h Monday to Saturday and 2200 to 0800 h Sundays and Public Holidays.
Assessment background level [ABL]	The overall background level for each day, evening and night period for **each day** of the noise monitoring.
Rating background level [RBL]	The overall background level for each day, evening and night period for the **entire length** of noise monitoring.

*Definitions of a number of terms have been adapted from Australian Standard AS1633:1985 *"Acoustics – Glossary of terms and related symbols"*, the EPA's NSW Industrial Noise Policy and the EPA's Road Noise Policy.