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CALTEX REFINERY, KURNELL

CONSTRUCTION NOISE & VIBRATION

ASSESSMENT OF JET FUEL PIPELINE

TE992-02F02 (REV 4) CN&V ASSESSMENT.DOC

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Prepared for:

Caltex Australia Petroleum Pty Ltd

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25 1982-2007 ACOUSTIC ENGINEERING EXCELLENCE

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1 INTRODUCTION

1.1 Background Information

Renzo Tonin & Associates were engaged to undertake a desktop environmental noise and vibration assessment associated with the construction of the jet fuel pipeline from the Caltex refinery at Kurnell to the Banksmeadow Terminal in Banksmeadow. More specifically, this report quantifies the noise and vibration impact from construction activity associated with the jet fuel pipeline and assesses the potential impact on neighbouring premises close to the site.

The issues addressed in this study include noise and vibration emissions during construction of the pipeline and identifies sensitive locations to assess potential noise and vibration impacts against noise and vibration criteria stipulated by the NSW Department of Environment, Climate Change and Water (DECCW).

The existing ambient noise environment was previously measured at locations near the proposed construction site at Kurnell and has been used for the establishment of construction noise criteria for nearby affected residential receivers in Kurnell. Construction noise emissions from the jet fuel pipeline were then calculated at the potentially most affected neighbouring premises at Kurnell and Banksmeadow during the construction works of the project.

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001

1.2 Study Area

This study concentrates on two areas associated with the proposed jet fuel pipeline:

Kurnell

The proposed construction in Kurnell will include the area along Road 7 located on the north western side of the Caltex refinery and along the pipeline easement from Road 7 through to and including the refinery wharf at Kurnell.

Banksmeadow

The proposed construction in Banksmeadow will include a small area on the northern side of the Banksmeadow Terminal.

Specifically, this study investigates construction noise and vibration impacts at sensitive receivers near these study areas.

An assessment of construction noise impacts was completed at the nearest affected sensitive receivers. For the purpose of construction noise assessment the nearest and potentially worst affected sensitive receivers were identified as follows:

Kurnell

- **Receiver R1 – 44-64 Cook Street (Industrial Premises)**
  Industrial premises adjacent to the Caltex refinery to the west and sharing a common boundary. Potentially impacted by construction noise from within the refinery and along the pipeline easement.

- **Receiver R2 – 30D Cook Street (Residential)**
  Residential property adjacent to the Caltex refinery to the west and sharing a common boundary. Potentially impacted by construction noise from within the refinery and along the pipeline easement.

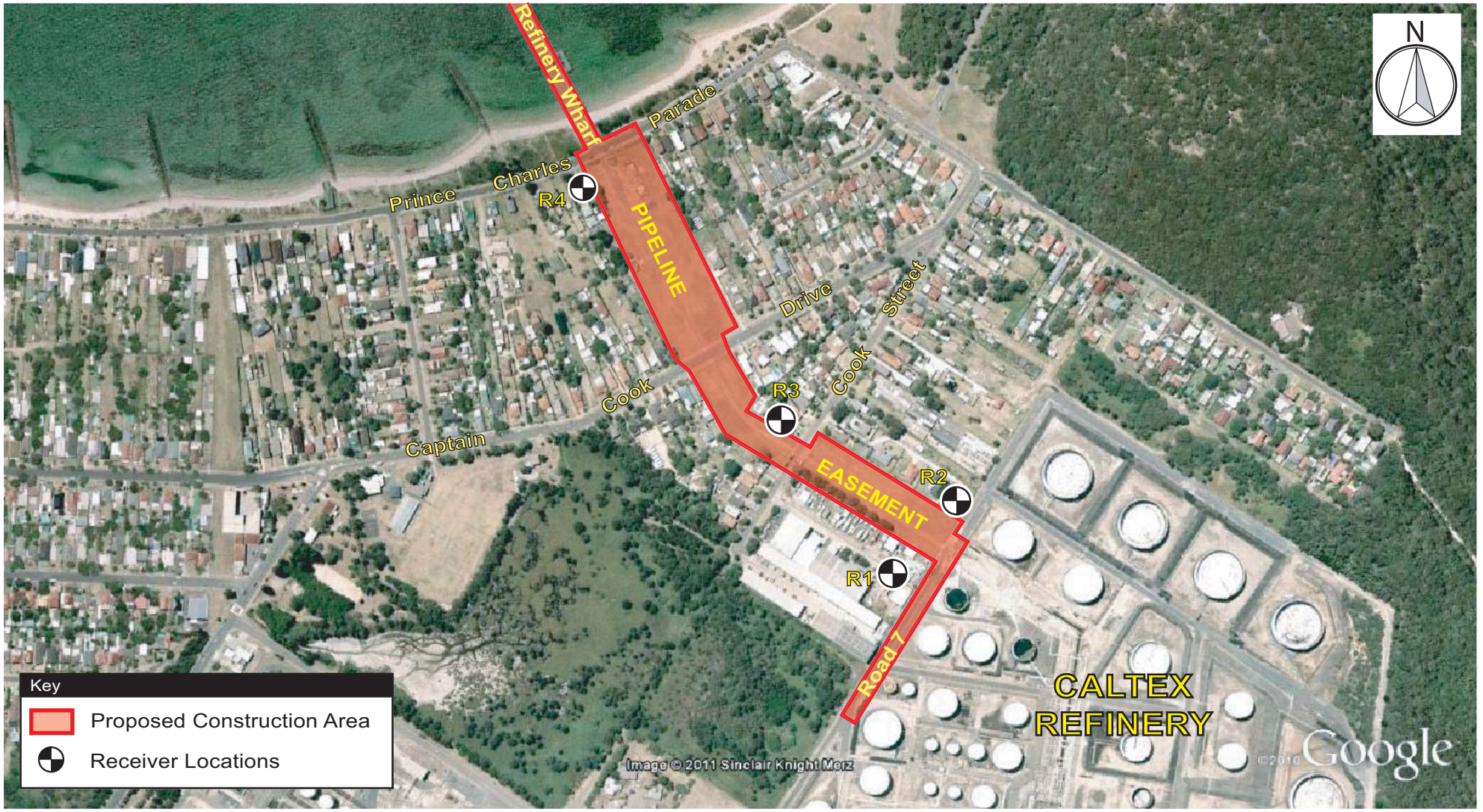
- **Receiver R3 – 21 Cook Street (Residential)**
  Residential property west of the refinery and potentially impacted by construction noise along the pipeline easement.

- **Receiver R4 – 48 Prince Charles Parade (Residential)**
  Residential property south of the refinery wharf and potentially impacted by construction noise along the pipeline easement and the wharf.

Banksmeadow

- **Receiver R5 – EGL Eagle Global Logistics (Industrial / Commercial Premises)**
  Industrial and commercial premises to the north of the Banksmeadow Terminal, across Botany Road. Potentially impacted by noise from construction activities on the northern side or the Banksmeadow Terminal. For a conservative assessment, this receiver will be assessed as a commercial type receiver.

Detailed maps showing the study areas and the receiver locations are shown in Figure 1 and Figure 2.



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Title : Figure 1 - Kurnell Site,Surrounds & Reciever Locations

Date : 01/07/11

Scale: NTS

Project : Caltex Jet Fuel Pumps

Ref: TE992-02P01 (rev 1)

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Title : Figure 2 - Banksmeadow Terminal Site,Surrounds & Reciever Location

Date : 12/04/11

Scale: NTS

Project : Caltex Jet Fuel Pumps

Ref: TE992-02P02 (rev 0)

2 EXISTING NOISE ENVIRONMENT

Background noise varies over the course of any 24 hour period, typically from a minimum at 3am in the morning to a maximum during morning and afternoon traffic peak hours. Therefore, the NSW 'Industrial Noise Policy' (INP) requires that the level of background and ambient noise be assessed separately for the daytime, evening and night-time periods. The INP defines these periods as follows:

- **Day** is defined as 7:00am to 6:00pm, Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays.
- **Evening** is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays.
- **Night** is defined as 10:00pm to 7:00am, Monday to Saturday and 10:00pm to 8:00am Sundays & Public Holidays.

To determine background L_{90} noise levels used for the construction noise assessment, previous long-term unattended noise monitoring carried out between 27th April and 4th May 2006 at the following locations were obtained:

- **Location M1 – 15 Cook Street, Kurnell**
  Noise monitoring undertaken in the rear yard. Noise environment is considered to be representative of residences potentially impacted by the proposed construction activities.

The results of the background noise measurements are presented in Table 2.1 below.

Table 2.1 – Previously Monitored Background (L_{90}) Noise Levels, dB(A)

Noise Monitoring Location	L_{90} Background Noise Levels		
	Day	Evening	Night
Location M1 – 15 Cook Street	41	43	39

3 CONSTRUCTION NOISE ASSESSMENT

3.1 Construction Noise Criteria

3.1.1 Interim Construction Noise Guideline

Chapter 171 of the NSW *Environmental Noise Control Manual* (ENCM, Environment Protection Authority 1994) provides guidelines for assessing noise generated during the construction phase. However, the Department of Environment, Climate Change and Water (DECCW – formerly DECC) has recently released its *NSW Interim Construction Noise Guideline* (ICNG). This document is the DECCW's standard policy for assessing construction noise. This new guideline supersedes Chapter 171 of the ENCM.

The key components of the guideline that could be incorporated into this assessment include:

1. Use of L_{Aeq} as the descriptor for measuring and assessing construction noise.

   In recent years NSW noise policies including DECCW's NSW Industrial Noise Policy (INP) and the NSW Environmental Criteria for Road Traffic Noise (ECRTN) have moved to the primary use of L_{Aeq} over any other descriptor. As an energy average, L_{Aeq} provides ease of use when measuring or calculating noise levels since a full statistical analysis is not required as when using, for example, the L_{A10} descriptor.

   Consistent with the ICNG we recommend the use of L_{Aeq} as the key descriptor for measuring and assessing construction noise.

2. Application of reasonable and feasible noise mitigation measures

   As stated in the ICNG, a noise mitigation measure is feasible if it is capable of being put into practice, and is practical to build given the project constraints.

   Selecting reasonable mitigation measures from those that are feasible involves making a judgement to determine whether the overall noise benefit outweighs the overall social, economic and environmental effects.

3. Quantitative and qualitative assessment

   The ICNG provides two methods for assessment of construction noise, being either a quantitative or a qualitative assessment.

   A quantitative assessment is recommended for major construction projects of significant duration, and involves the measurement and prediction of noise levels, and assessment against set criteria.

   A qualitative assessment is recommended for small projects with a duration of less than three weeks and focuses on minimising noise disturbance through the implementation of reasonable and feasible work practices, and community notification.

It is anticipated that construction works proposed for the jet fuel pipeline will occur for more than three weeks; therefore, a quantitative assessment is carried out herein, consistent with the ICNG's requirements.

Management Levels

Table 3.1 below (reproduced from Table 2 of the ICNG) sets out the noise management levels and how they are to be applied for residential receivers. The guidelines intend to provide respite for residents exposed to excessive construction noise outside the recommended standard hours whilst allowing construction during the recommended standard hours without undue constraints.

In Table 3.1 below, the rating background level (RBL) is used when determining the management level. The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours).

Table 3.1 – Noise at Residences Using Quantitative Assessment

Time of Day	Management Level $L_{Aeq\ (15\ min)}$*	How to Apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10dB(A)	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 75dB(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: 1. 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) 2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5dB(A)	• 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 5dB(A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see section 7.2.2 of the *NSW Interim Construction Noise Guideline*.

** Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.*

The measured background noise levels at the monitoring location (M1) were considered to be representative of the RBL for residences potentially impacted upon by construction works associated with the jet fuel pipeline. Therefore, measured background noise levels are suitable for setting construction noise criteria, consistent with a conservative assessment. Based on the background noise levels measured and the construction work proposed for the day time period only, the construction noise criteria for the day period are summarised below.

Table 3.2 – Summary of Construction Noise Management Levels

Receiver	Time of Day	Base Management Level $L_{Aeq(15min)}$
Receiver R2 – 30D Cook St	During recommended standard hours (day period)	41 + 10 = **51**
Receiver R3 – 21 Cook St		
Receiver R4 – 48 Prince Charles Pde		

Industrial and Commercial Premises

Industrial and commercial premises located near the proposed Kurnell and Banksmeadow construction sites may potentially be impacted by construction noise. Therefore, in accordance with Section 4.1.3 of the ICNG, industrial and commercial properties should be assessed for construction noise impacts. The noise management levels presented in the ICNG for industrial and commercial premises are reproduced in Table 3.3 below.

Table 3.3 – Noise at Commercial Premises Using Quantitative Assessment

Type of Premises	Management level, $L_{Aeq\ (15\ min)}$
Industrial (Receiver R1)	External noise level = 75 dB(A)
Commercial (Receiver R5)	External noise level = 70 dB(A)

3.2 Construction Noise Sources

The following table lists construction plant and equipment that are considered to be noisy and likely to be used for the construction activities associated with the jet fuel pipeline at Kurnell and Banksmeadow. It is noted that the list does not include quieter plant and equipment that are expected to not contribute to noise impacts to the nearby sensitive receivers.

Table 3.4 – Typical Construction Equipment & Sound Pressure Levels, dB(A)

Plant Item	Plant Description	L_{Aeq} Sound Pressure Levels @ 1m
	Equipment used at Caltex Refinery	
1	Mobile Crane (50 tonne)	85
2	Bevelling Machine (electric)	95
4	Hand Held Grinders	105
3	De-watering Equipment	57
5	Tip Truck	75
6	Power Generator / Welder - Shindaiwa	58
7	Backhoe – Robelco 13T	75

Plant Item	Plant Description	L_{Aeq} Sound Pressure Levels @ 1m
8	Bobcat	90
	Equipment used along Pipeline Easement	
9	Mobile Crane	85
10	Bevelling Machine (electric)	95
11	Hand Held Grinders	105
12	De-watering Equipment	57
13	Tip Truck	75
14	Power Generator / Welder - Shindaiwa	58
15	Backhoe – Robelco 13T	75
16	Bobcat	90
	Equipment used on Wharf	
17	Mobile Crane	85
18	Hand Held Grinders	105
19	Power Generator / Welder - Shindaiwa	58
	Equipment used at Banksmeadow Terminal	
20	Mobile Crane	85
21	Bevelling Machine (electric)	95
22	Hand Held Grinders	105
23	Tip Truck	75
24	Concrete Pump	90
25	Power Generator / Welder - Shindaiwa	58
26	Backhoe – Robelco 13T	75
27	Bobcat	90

Note: Only plant and equipment items that are expected to contribute to noise impacts to nearby sensitive receivers have been included in this table

The sound power levels for the majority of plant items presented in the above table are based on Table A1 of Australian Standard 2436 - 2010 "Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites"; information from past projects; information from the client and manufacturers; and information held in our library files.

3.3 Predicted Construction Noise

Table 3.5 presents predicted external construction noise levels at the nominated receiver locations for each individual plant item, where the item is operating at the closest point to the receiver location. Due to the close proximity of the works and the nature of the topography, it was assumed that there were no intervening structures between construction activity and the nearest affected receivers.

As mentioned previously, Receivers R1 and R2 will be impacted by construction activities within the Caltex refinery site and the pipeline easement, Receiver R3 is only impacted by construction activities along the pipeline easement, Receiver R4 is impacted by construction

activities along the pipeline easement and the wharf and Receiver R5 is only impacted by construction activities within the Banksmeadow Terminal.

Table 3.5 – Predicted L_{eq} Construction Noise Levels, dB(A)

Plant Item	Plant Description	Receiver Locations				
		R1	R2	R3	R4	R5
	Criteria	*75*	*51*	*51*	*51*	*70*
	Equipment used at Caltex Refinery					
1	Mobile Crane (50 tonne)	65	**52**	-	-	-
2	Bevelling Machine (electric)	75	**62**	-	-	-
3	Hand Held Grinders	**85**	**72**	-	-	-
4	De-watering Equipment	37	24	-	-	-
5	Tip Truck	55	42	-	-	-
6	Power Generator / Welder - Shindaiwa	38	25	-	-	-
7	Backhoe – Robelco 13T	55	42	-	-	-
8	Bobcat	70	**57**	-	-	-
	Equipment used along Pipeline Easement					
9	Mobile Crane	61	**54**	**60**	**65**	-
10	Bevelling Machine (electric)	71	**64**	**70**	**75**	-
11	Hand Held Grinders	**81**	**74**	**80**	**85**	-
12	De-watering Equipment	33	26	32	37	-
13	Tip Truck	51	44	50	**55**	-
14	Power Generator / Welder - Shindaiwa	34	27	33	38	-
15	Backhoe – Robelco 13T	51	44	50	**55**	-
16	Bobcat	66	**59**	**65**	**70**	-
	Equipment used on Wharf					
17	Mobile Crane	-	-	-	48	-
18	Hand Held Grinders	-	-	-	**68**	-
19	Power Generator / Welder - Shindaiwa	-	-	-	21	-
	Equipment used at Banksmeadow Terminal					
20	Mobile Crane	-	-	-	-	47
21	Bevelling Machine (electric)	-	-	-	-	57
22	Hand Held Grinders	-	-	-	-	67
23	Tip Truck	-	-	-	-	37
24	Concrete Pump	-	-	-	-	52
25	Power Generator / Welder - Shindaiwa	-	-	-	-	20
26	Backhoe – Robelco 13T	-	-	-	-	37
27	Bobcat	-	-	-	-	52

Notes: 1. Predicted noise levels based on plant item operating at the closest point to the receiver location
*2. **Bold** font indicates exceedances*

Noise levels at any receptors resulting from construction would depend on the location of the receptor with respect to the area of construction, shielding from intervening topography and structures (eg. boundary fences) and the type and duration of construction being undertaken. Furthermore, noise levels at receivers will vary significantly over the total construction program due to the transient nature and range of plant and equipment that could be used.

Based on the construction noise levels predicted above, the construction noise criteria may be exceeded at the nearest sensitive receiver locations in Kurnell by the crane, bevelling machine, grinder, tip truck, backhoe and/or the bobcat when operating near the nominated receiver locations. Construction noise from construction activities within the Banksmeadow Terminal will comply with the noise criteria at Receiver R5. It is noted that noise levels could exceed those shown if two or more items of plant are operating concurrently in close proximity. However, Caltex will be committed to operate no more than three items of plant in close proximity at any one time.

Therefore, a reasonable and feasible approach towards noise management measures will be required to reduce noise levels as much as possible to manage the impact from construction noise as result of construction activities associated with the jet fuel pipeline at Kurnell. Such measures will include the construction of acoustic enclosures around hand held and portable equipment (eg. grinders and bevelling machines) to reduce noise impacts at nearby receiver locations.

It should be noted that the construction works are progressive along Road 7 and the pipeline easement. These works will be divided into four distinct sections:

- Road 7 to gate 5 (adjacent to Receiver R2);
- Gate 5 to Cook Street;
- Cook Street to Captain Cook Drive; and
- Captain Cook Drive to Prince Charles Parade.

It is expected that each section will take approximately five to six weeks to complete and concurrent work in each section is not planned.

Construction works on the wharf will commence at the same time as the works for Road 7 to Gate 5. The wharf works will conclude during the Cook Street to Captain Cook Drive works. Construction works on the wharf will start at the landward end and progress away from shore. As mentioned previously, Receiver R4 will be impacted by both activities along the pipeline easement and activities on the wharf; however, there are not expected to be any cumulative impacts to Receiver R4 from works in the easement and on the wharf as the wharf works will be either completed or far enough from any residential receivers so as to not overlap with any works within the pipeline easement between Captain Cook Drive and Prince Charles Parade.

4 CONSTRUCTION VIBRATION ASSESSMENT

4.1 Construction Vibration Criteria

Disturbance to Buildings Occupants

For disturbance to human occupants of buildings, we refer to DECCW's 'Assessing Vibration; a technical guideline', published in February 2006. This document provides criteria which are based on the British Standard BS 6472-1992, *'Evaluation of human exposure to vibration in buildings (1-80Hz)'*.

Vibration sources are defined as C*ontinuous, Impulsive or Intermittent.* Section 2 of the technical guideline defines each type of vibration as follows:

> '***Continuous*** *vibration continues uninterrupted for a defined period (usually throughout the day-time and/or night-time).*
>
> ***Impulsive*** *vibration is a rapid build up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds.*
>
> ***Intermittent*** *vibration can be defined as interrupted periods of continuous or repeated periods of impulsive vibration that varies significantly in magnitude'.*

The criteria are to be applied to a single weighted root mean square (rms) acceleration source level in each orthogonal axis. Section 2.3 of the guideline states:

> *'Evidence from research suggests that there are summation effects for vibrations at different frequencies. Therefore, for evaluation of vibration in relation to annoyance and comfort, overall weighted rms acceleration values of the vibration in each orthogonal axis are preferred (BS 6472).'*

Preferred and maximum values for continuous and impulsive vibration are defined in Table 2.2 of the guideline and are reproduced below. It is noted that only values applicable to residential, industrial (workshop) and commercial (offices) receivers have been reproduced.

Table 4.1 – Preferred and maximum weighted rms values for continuous and impulsive vibration acceleration (m/s^2) 1-80Hz

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x & y-axis	z-axis	x & y-axis
Continuous vibration					
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices	Day- or night-time	0.020	0.014	0.040	0.028

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x & y-axis	z-axis	x & y-axis
Workshops	Day- or night-time	0.04	0.029	0.080	0.058
Impulsive vibration					
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices	Day- or night-time	0.64	0.46	1.28	0.92
Workshops	Day- or night-time	0.64	0.46	1.28	0.92

Notes: 1. Daytime is 7.00 am to 10.00 pm and night-time is 10.00pm to 7.00 am

Intermittent vibration is to be assessed using vibration dose values (VDVs). The VDV method is a fourth power approach which is more sensitive to peaks in the acceleration waveform and makes corrections to the criteria based on the duration of the source's operation. The VDV can be calculated using the overall weighted rms acceleration of the vibrating source in each orthogonal axis and the total period during which the vibration may occur. Weighting curves are provided in each orthogonal axis in the guideline. Preferred and maximum VDV values for residential, industrial (workshop) and commercial (offices) receivers are defined in Table 2.4 of the guideline and are reproduced below.

Table 4.2 – Acceptable vibration dose values for intermittent vibration ($m/s^{1.75}$)

Location	Daytime [1]		Night-time [1]	
	Preferred values	Maximum values	Preferred values	Maximum values
Residences	0.20	0.40	0.13	0.26
Offices	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes: 1. Daytime is 7.00 am to 10.00 pm and night-time is 10.00pm to 7.00 am

Structural Damage to Buildings

Currently there exists no Australian Standard for assessment of structural building damage caused by vibrational energy. Therefore, reference is made to both the British and German standards below which are relevant to the assessment of structural damage.

British Standard

British Standard 7385: Part 2 "Evaluation and measurement of vibration in buildings", can be used as a guide to assess the likelihood of building damage from ground vibration. BS7385 suggests levels at which 'cosmetic', 'minor' and 'major' categories of damage might occur.

BS7385 recommends that the peak particle velocity is used to quantify vibration and specifies damage criteria for frequencies within the range 4Hz to 250Hz, which is the range usually encountered in buildings. At frequencies below 4Hz, a maximum displacement value is recommended. The levels from the standard are given below in Table 4.3.

Table 4.3 – BS 7385 Structural Damage Criteria

Group	Type of Structure	Peak component particle velocity, mm/s		
		4Hz to 15Hz	15Hz to 40Hz	40Hz and above
1	Reinforced or framed structures. Industrial and heavy commercial buildings		50	
2	Un-reinforced or light framed structures. Residential or light commercial type buildings	15 to 20	20 to 50	50

The peak vibration limits set for minimal risk of 'cosmetic' damage are: 15mm/s for un-reinforced or light framed structures, for example residential or light commercial buildings (Group 2; increasing as the frequency content of the vibration increases) and 50mm/s for reinforced or framed structures, for example industrial and heavy commercial buildings (Group 1; constant across all frequencies). 'Minor' damage is considered possible at vibration magnitudes which are twice those given and 'major' damage to a building structure may occur at levels greater than four times those values.

These values relate to transient vibrations and to low rise buildings. Continuous vibration can give rise to dynamic magnifications due to resonances and may need to be reduced by up to 50%.

The levels set by this standard are considered 'safe limits' up to which no damage due to vibration effects has been observed for certain particular types of buildings. Damage comprises minor non-structural effects such as hairline cracks on drywall surfaces, hairline cracks in mortar joints and cement render, enlargement of existing cracks and separation of partitions or intermediate walls from load bearing walls.

This standard states that it considers sources of vibration including blasting, demolition, piling, ground treatments, compaction, construction equipment, tunnelling, road and rail traffic and industrial machinery.

As stated in the standard, it sets guide values for building vibration based on the lowest levels above which damage has been credibly demonstrated. That is, it gives guidance on the levels of vibration above which building structures could be damaged.

German Standard

The German standard DIN 4150 - Part 3 - "Structural vibration in buildings - Effects on Structures", also provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration. This standard too, presents recommended maximum limits over a range of frequencies measured in any direction at the foundation or in the plane of the uppermost floor.

The minimum 'safe limit' of vibration at low frequencies for commercial and industrial buildings is 20mm/s. For dwellings it is 5mm/s and for particularly sensitive structures (eg historical with preservation orders etc), it is 3mm/s. These limits increase as the frequency content of

the vibration increases. These values are presented in Table 4.4 below and are generally recognised to be conservative.

Table 4.4 – DIN 4150-3 Structural Damage Criteria

Group	Type of Structure	Vibration Velocity, mm/s			
		At Foundation at Frequency of			Plane of Floor Uppermost Storey
		Less than 10Hz	10Hz to 50Hz	50Hz to 100Hz	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Group 1 or 2 and have intrinsic value (eg buildings under a preservation order)	3	3 to 8	8 to 10	8

4.2 Construction Vibration Sources

Typical vibration levels from construction equipment most likely to cause significant vibration are summarised below. The information was sourced from a variety of reference materials available in the Renzo Tonin & Associates library.

Table 4.5 – Typical Ground Vibration Generated by Construction Plant

Activity	Typical ground vibration
Backhoe / Bulldozer	Typical ground vibration from backhoes and bulldozers range from 1mm/s to 2mm/s at distances of approximately 5m and at distances greater than 20m, vibration levels are usually below 0.2mm/s.
Truck traffic	Typical vibration from heavy trucks passing over normal (smooth) road surfaces generate relatively low vibration levels in the range of 0.01 - 0.2mm/s at the footings of buildings located 10 - 20m from a roadway. Very large surface irregularities can cause levels up to five to ten times higher. In general, ground vibration from trucks is usually imperceptible in nearby buildings. The rattling of windows and other loose fittings that is sometimes reported is more likely to be caused by airborne acoustic excitation from very low frequency (infrasonic) noise radiated by truck exhausts and truck bodies. While this may cause concern to the occupants, the phenomenon is no different from the rattling caused by wind or people walking or jumping on the floor and fears of structural damage or even accelerated ageing are usually unfounded.

4.3 Safe Working Distances

The relationship between vibration and the probability of causing human annoyance or damage to structures is complex. This complexity is mostly due to the magnitude of the vibration source, the particular ground conditions between the source and receiver, the foundation-to-footing interaction and the large range of structures that exist in terms of design (eg dimensions, materials, type and quality of construction and footing conditions). The intensity,

duration, frequency content and number of occurrences of vibration, are all important aspects in both the annoyances caused and the strains induced in structures.

The pattern of vibration radiation is very different to the pattern of airborne noise radiation, and is very site specific. As a guide, safe working distances to avoid human discomfort for typical items of vibration intensive plant are listed in Table 4.6 below.

Table 4.6 – Recommended safe working distances for vibration intensive plant

Plant Item	Safe Working Distance
Backhoe / Bulldozer[2]	5m
Truck Movements[2]	10m

Notes: 1. Based on Renzo Tonin & Associates project files, databases & library

Vibration levels are unlikely to exceed the criteria for human comfort at all the nearest receivers as all the receivers are at least 10m away which is equal to or more than the recommended minimum safe working distances for each plant item shown in Table 4.6. However, these are indicative distances only and more detailed site specific safe working distances should be determined once vibration emission levels are measured from each plant item prior to the commencement of their regular use on site.

Furthermore, since the above safe working distances were determined based on the requirements for human comfort, safe working distances to avoid structural damage would significantly be lower as the requirements for human comfort are more stringent than those for structural damage.

5 CONSTRUCTION NOISE AND VIBRATION MITIGATION

The following recommendations provide reasonable and feasible in-principle noise control solutions to reduce noise impacts to sensitive receivers in Kurnell. Where actual construction activities differ from those assessed in this report, more detailed design of noise control measures may be required once specific items of plant and construction methods have been chosen and assessed on site.

The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.

Implementation of noise control measures, such as those suggested in Australian Standard 2436-2010 "Guide to Noise Control on Construction, Demolition and Maintenance Sites", are expected to reduce predicted construction noise levels. Reference to Australian Standard 2436-2010, Appendix C, Table C1 suggests possible remedies and alternatives to reduce noise emission levels from typical construction equipment. Table C2 in Appendix C of AS2436-2010 presents typical examples of noise reductions achievable after treatment of various noise sources. Table C3 in Appendix C of AS2436-2010 presents the relative effectiveness of various forms of noise control treatment.

Table 5.1 below presents noise control methods, practical examples and expected noise reductions according to AS2436 and according to Renzo Tonin & Associates' opinion based on experience with past projects.

Table 5.1 – Relative Effectiveness of Various Forms of Noise Control, dB(A)

Noise Control Method	Practical Examples	Typical noise reduction possible in practice		Maximum noise reduction possible in practice	
		AS 2436	Renzo Tonin & Assoc.	AS 2436	Renzo Tonin & Assoc.
Distance	Doubling of distance between source and receiver	6	6	6	6
Noise Control Kits	Residential class mufflers & engine silencing	5 to 10	5 to 10	20	20
Screening	Acoustic barriers such as earth mounds, temporary or permanent noise barriers	5 to 10	5 to 10	15	15
Acoustic Enclosures	Engine casing lagged with acoustic insulation and plywood	15 to 25	10 to 20	50	30
Substitution by alternative process	Use electric motors in preference to diesel or petrol	-	15 to 25	-	40

The Renzo Tonin & Associates' listed noise reductions are conservatively low and should be referred to in preference to those of AS2436, for this assessment.

Table 5.2 below identifies possible noise control measures, which are applicable on the construction plant likely to be used on site.

Table 5.2 – Noise Control Measures for Likely Construction Plant

Plant Description	Screening	Acoustic Enclosures	Silencing	Alternative Process
Mobile Crane (50 tonne)	✔	✔	✔	x
Bevelling Machine (electric)	✔	✔	x	x
Hand Held Grinders	✔	✔	x	x
De-watering Equipment	✔	x	x	x
Tip Trucks	✔	x	✔	x
Power Generator / Welder - Shindaiwa	✔	✔	✔	x
Backhoe – Robelco 13T	✔	x	✔	x
Bobcats	✔	x	✔	x
Concrete Pump	✔	✔	✔	✔

Based on Table 5.1 and Table 5.2 above, the noise impacts after any possible noise control measures are predicted and presented in Table 5.3 below. It should be noted that these are only estimated noise levels and actual noise levels on site after any implementation of noise control measures will need to be confirmed through noise monitoring once construction works are underway.

Table 5.3 – Predicted Construction Noise Levels After Noise Control Measures, dB(A)

Plant Item	Plant Description	Receiver Locations				
		R1	R2	R3	R4	R5
	Criteria	*75*	*51*	*51*	*51*	*70*
	Equipment used at Caltex Refinery					
1	Mobile Crane (50 tonne)	45	32	-	-	-
2	Bevelling Machine (electric)	45	32	-	-	-
3	Hand Held Grinders	55	42	-	-	-
4	De-watering Equipment	<20	<20	-	-	-
5	Tip Truck	35	22	-	-	-
6	Power Generator / Welder - Shindaiwa	<20	<20	-	-	-
7	Backhoe – Robelco 13T	35	22	-	-	-
8	Bobcat	50	37	-	-	-
	Equipment used along Pipeline Easement					
9	Mobile Crane	41	34	40	45	-
10	Bevelling Machine (electric)	41	34	40	45	-
11	Hand Held Grinders	51	44	50	**55**	-
12	De-watering Equipment	<20	<20	<20	<20	-

Plant Item	Plant Description	Receiver Locations				
		R1	R2	R3	R4	R5
13	Tip Truck	31	24	30	35	-
14	Power Generator / Welder - Shindaiwa	<20	<20	<20	<20	-
15	Backhoe – Robelco 13T	31	24	30	35	-
16	Bobcat	46	39	45	50	-
Equipment used on Wharf						
17	Mobile Crane	-	-	-	28	-
18	Hand Held Grinders	-	-	-	38	-
19	Power Generator / Welder - Shindaiwa	-	-	-	<20	-
Equipment used at Banksmeadow Terminal						
20	Mobile Crane	-	-	-	-	27
21	Bevelling Machine (electric)	-	-	-	-	27
22	Hand Held Grinders	-	-	-	-	37
23	Tip Truck	-	-	-	-	<20
24	Concrete Pump	-	-	-	-	32
25	Power Generator / Welder - Shindaiwa	-	-	-	-	<20
26	Backhoe – Robelco 13T	-	-	-	-	<20
27	Bobcat	-	-	-	-	32

Notes: 1. Noise reductions based on noise control kits, screening and acoustic enclosures, where applicable
*2. **Bold** font indicates exceedances*

From the above table it can be seen that when all reasonable and feasible noise mitigation measures are implemented, noise levels at the receiver locations are estimated to generally comply with the applicable noise criteria. A slight exceedance at Receiver R4 is estimated when hand held grinders are used along the pipeline easement and close to the receiver location. However, the estimated noise level is well below the highly noise affected level of 75dB(A) as described in the ICNG.

To ensure efficient noise attenuation performance is achieved using any of the methods listed in Table 5.1 and Table 5.2, it is recommended acoustic engineers work closely with the construction contractors and carry out preliminary testing prior to commencement of works.

A construction noise and vibration management plan should be implemented to avoid adverse noise and vibration disturbance to affected residences.

Table 5.4 below summarises various techniques for controlling construction noise and vibration.

Table 5.4 – Construction Noise and Vibration Management Options

Construction Noise and Vibration Management Options	
Source controls	
Time constraints	Limit work to daylight hours. Consider implementing respite periods with low noise/vibration-producing construction activities.
Scheduling	Perform noisy work during less sensitive time periods.
Equipment restrictions	Select low-noise plant and equipment as a priority. Ensure equipment has quality mufflers installed.
Emission restrictions	Establish stringent noise emission limits for specified plant and equipment. Implement noise monitoring audit program to ensure equipment remains within specified limits.
Substitute methods	Use quieter and less vibration emitting construction methods where possible.
Limit equipment on site	Only have necessary equipment on site.
Limit activity duration	Where possible, concentrate noisy activities at one location and move to another as quickly as possible. Any equipment not in use for extended periods during construction work should be switched off.
Equipment location	Noisy plant and equipment should be located as far as possible from noise sensitive areas, optimising attenuation effects from topography, natural and purpose built barriers and materials stockpiles.
Site access	Vehicle movements outside construction hours, including loading and unloading operations, should be minimised and avoided where possible.
Equipment maintenance	Ensure equipment is well maintained and fitted with adequately maintained silencers which meet the design specifications.
Reduced equipment power	Use only necessary size and power.
Quieter work practices	For example, implement worksite induction training, educating staff on noise sensitive issues and the need to make as little noise as possible.
Reversing alarms	Consider alternatives, such as manually adjustable or ambient noise sensitive types (“smart” reversing alarms) and closed circuit TV systems. Alternative site management strategies can be developed, in accordance with the Occupational Health and Safety Plan, with the concurrence of the Occupational Health and Safety Officer.
Path controls	
Noise barriers / hoarding	Consider installing temporary construction noise barriers / hoarding. Locate equipment to take advantage of the noise screening provided by existing site features and structures, such as embankments, storage sheds and/or boundary fences.
Enclosures	Enclosures will be utilised around hand held and portable equipment (eg. angle grinders and bevelling machines), wherever possible.
Increased distance	Locate noisy plant as far away from noise-sensitive receptors as possible.
Site access	Select and locate site access roads as far away as possible from noise-sensitive areas.
Receptor controls	
Structural surveys and vibration monitoring	Pre-construction surveys of the structural integrity of vibration sensitive buildings may be warranted (ie. dilapidation reports) At locations where there are high-risk receptors, vibration monitoring should be conducted during the activities which cause vibration.
Temporary relocation	In extreme cases.

Construction Noise and Vibration Management Options	
Consultation	Community consultation, information, participation and complaint responses are essential aspects of all construction noise management programs. They typically involve: • A community information program before construction and/or high risk activities are commenced. This usually involves a leaflet distribution and direct discussions and negotiations with affected residents, explaining the type, time and duration of expected noise emissions. • The involvement of affected residents in the development of acceptable noise management strategies. • A nominated community liaison officer with a contact telephone number. • A complaints hotline. • Timely responses to complaints, providing information on planned actions and progress towards the resolution of concerns.
Noise / Vibration Monitoring	Noise and vibration compliance monitoring for all major equipment and activities on site should be undertaken.

6 ROAD TRAFFIC NOISE ASSESSMENT

6.1 Road Traffic Noise Criteria

The L_{eq} noise level or the "equivalent continuous noise level" correlates best with the human perception of annoyance associated with traffic noise. The NSW *Environmental Criteria for Road Traffic Noise* (ECRTN) uses the $L_{Aeq(15hr)}$, $L_{Aeq(9hr)}$ and $L_{Aeq(1hr)}$ to assess traffic noise impact. The ECRTN is used to assess the potential traffic noise impact from construction traffic travelling on public roads onto residential receivers only. Construction traffic in Kurnell are likely to travel along Captain Cook Drive, Cook Street and/or Prince Charles Parade, while construction traffic at Banksmeadow are likely to travel along Foreshore Road. Residential receivers are located in Kurnell along the roads where construction traffic are likely to travel along and therefore will be assessed against the ECRTN accordingly. However, there are no residential receivers along Foreshore Road where construction traffic associated with the Banksmeadow Terminal are to travel and therefore, construction traffic associated with the Banksmeadow Terminal travelling along Foreshore Road will not be assessed from herein.

Table 1 in the ECRTN, 'Road Traffic Noise Criteria for Proposed Road or Residential Land Use Developments', divides land use developments into different categories and lists the respective noise criteria for each case. Captain Cook Drive is categorised as a 'collector' road, while Cook Street and Prince Charles Parade are classified as 'local' roads. Therefore, the applicable road traffic noise criteria at residential receivers for the day and night periods are summarised in Table 6.1 below.

Table 6.1 – Applicable Road Traffic Noise Criteria, dB(A)

Type of Development	Day (7am-10pm)	Night (10pm-7am)	Where Criteria are Already Exceeded
8. Land use developments with potential to create additional traffic on collector road	$L_{Aeq(1hr)}$ 60	$L_{Aeq(1hr)}$ 55	Where feasible and reasonable, existing noise levels should be mitigated to meet the noise criteria. Examples of applicable strategies include appropriate location of private access roads; regulating time of use; using clustering; using 'quiet' vehicles; and using barriers and acoustic treatments. In all cases, traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dB
13. Land use developments with potential to create additional traffic on local roads	$L_{Aeq(1hr)}$ 55	$L_{Aeq(1hr)}$ 50	

Note: 1. Table reproduced from Table 1 of ECRTN

Given that construction activities are to only occur during the day time period, only the day period (7.00am to 10.00pm) will be assessed for traffic noise from herein.

6.2 Predicted Road Traffic Noise

As a 'worst case' scenario, it is proposed that there will be up to 20 construction truck movements per day (from 10 construction trucks) plus 20 delivery truck movements per day

(from 10 delivery trucks), resulting in a total of up to 40 truck movements per day servicing the construction sites in Kurnell that may potentially utilise Captain Cook Drive, Cook Street and/or Prince Charles Parade. This will result in a maximum of four (4) truck movements over a one hour period travelling along Captain Cook Drive, Cook Street and/or Prince Charles Parade.

The following predicted road traffic noise levels based on the maximum number of construction related truck movements over a one hour period have been determined for the nearest residences along Captain Cook Drive, Cook Street and Prince Charles Parade.

Table 6.2 – Predicted Traffic Noise Levels from Proposed Construction Trucks, dB(A)

Road	Distance of Nearest Dwelling to Road	$L_{Aeq,\ 1hr}$ Criteria	Traffic Noise Level from Construction Traffic	Complies?
Captain Cook Drive	5m	*60*	56	Yes
Cook Street	9m	*55*	54	Yes
Prince Charles Parade	5m	*55*	55	Yes

From Table 6.2 above, the predicted traffic noise levels at residential receivers along Captain Cook Drive, Cook Street and Prince Charles Parade due to construction traffic from the proposed construction sites at Kurnell, comply with the applicable criteria during the day period.

7 CONCLUSION

A desktop assessment of the construction noise and vibration emissions from the proposed construction of the jet fuel pipeline at the Caltex refinery site in Kurnell and the Banksmeadow Terminal site in Banksmeadow has been undertaken. Specifically, this report aims to minimise noise and vibration impacts during the construction works through a combination of physical noise controls and noise management measures.

Reasonable and feasible in-principle noise and vibration mitigation measures are provided in Section 5 to aid in reducing construction noise and vibration levels at nearby receivers.

Furthermore, noise from construction traffic travelling along public roads were also assessed and were predicted to comply with the applicable criteria stipulated in the ECRTN.

APPENDIX A - GLOSSARY OF ACOUSTIC TERMS

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Adverse Weather — Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).

Ambient Noise — The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.

Assessment Period — The period in a day over which assessments are made.

Assessment Point — A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.

Background Noise — Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the $\mathbf{L_{90}}$ noise level (see below).

Decibel [dB] — The units that sound is measured in. The following are examples of the decibel readings of every day sounds:

0dB The faintest sound we can hear

30dB A quiet library or in a quiet location in the country

45dB Typical office space. Ambience in the city at night

60dB Martin Place at lunch time

70dB The sound of a car passing on the street

80dB Loud music played at home

	90dB The sound of a truck passing on the street
	100dB The sound of a rock band
	115dB Limit of sound permitted in industry
	120dB Deafening
dB(A):	A-weighted decibels The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L_{max}	The maximum sound pressure level measured over a given period.
L_{min}	The minimum sound pressure level measured over a given period.
L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L_{90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L_{90} noise level expressed in units of dB(A).

L_{eq}	The “equivalent noise level” is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound Absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound Level Meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound Pressure Level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound Power Level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.