Our Reference: NA230258

Your Reference: NA230258 Wyong Hospital Consent Memo Rev2

16/02/2024

NSW Health infrastructure

Re: NA230258 Wyong Hospital Consent Memo – Construction Noise and Vibration

Introduction

ACOR Consultants Pty Ltd (ACOR) have been engaged by NSW Health Infrastructure to provide acoustic and vibration consulting services for the proposed refurbishment of the Wyong Hospital to accommodate a World Class End of Life Facility. ACOR have been engaged to undertake an acoustic and vibration assessment of the proposed refurbishment and provide design recommendations to achieve relevant acoustic and vibration requirements.

Project Description

It is understood that the existing Wyong Hospital Education Centre will be refurbished to cater a 12 Bed World-Class End of Life Facility (Figure 1). The single storey development will broadly comprise of the scope elements set out below:

- 12 Bed Rooms
- Lounge
- Dining
- Laundry
- Interview & Meeting Rooms
- Offices
- Storage
- Hydraulic & Plant Rooms

Figure 1: Site Plan

Regulations, Standards, and Guidelines

The following regulations, standards, and guidelines have been referred to in relation to the noise and vibration impact assessment performed:

- NSW EPA Noise Policy for Industry 2017 (NPI).
- NSW Health – Engineering Services Guidelines 2022
- NSW EPA Noise Guide for Local Government (NGLG).
- NSW EPA Approved Methods for the Measurement and Analysis of Environmental Noise in NSW.
- NSW DEC Assessing Vibration: A Technical Guideline (2006)
- NSW RMS Construction Noise and Vibration Guideline – August 2016
- EPA NSW Interim Construction Noise Guidelines (ICNG) 2009.
- BS ISO 14837-1:2005 Mechanical vibration – Ground-borne noise and vibration arising from rail systems – Part 1: General guidance.
- BS ISO 2631-1:1997 Mechanical vibration and shock – Evaluation of human exposure to whole-body vibration Part 1: General Requirements.
- ISO 2631-2:2003(E) Mechanical vibration and shock – Evaluation of human exposure to whole-body vibration – Part 2: Vibration in buildings (1 Hz to 80 Hz).
- NSW Health – Engineering Services Guidelines 2022

Reference Documents

Table 1 below shows the documents referred to during the assessment.

Table 1 Reference documents

Document Name	Drawing No.	Revision	Discipline	Prepared By	Project No.	Date
WORD CLASS END OF LIFE PROGRAM WYONG HOSPITAL	WCP-BVN-DRW-ARC-WYO- 11B-0000001	-	Architecture	BVN	-	-

NSW EPA Noise Policy for Industry 2017

Industrial noise can have a significant effect on noise-sensitive receivers (see below). Both the increase in noise level above background levels, as well as the absolute level of noise are important factors in how a community will respond to noise from industrial sources. The project “noise trigger level” established in the NPI addresses each of these components of noise impact. The following subsections show the process of determining the project noise trigger level in accordance with the NPI.

Noise Sensitive Receivers

The project site is located at Wyong Hospital, 664 Pacific Highway Hamlyn Terrace NSW 2259. The nearest noise sensitive receivers are residential dwellings to the to the north, west and east, with the existing development encircling the project site. Figure 2 below shows the project site and the noise sensitive receivers.

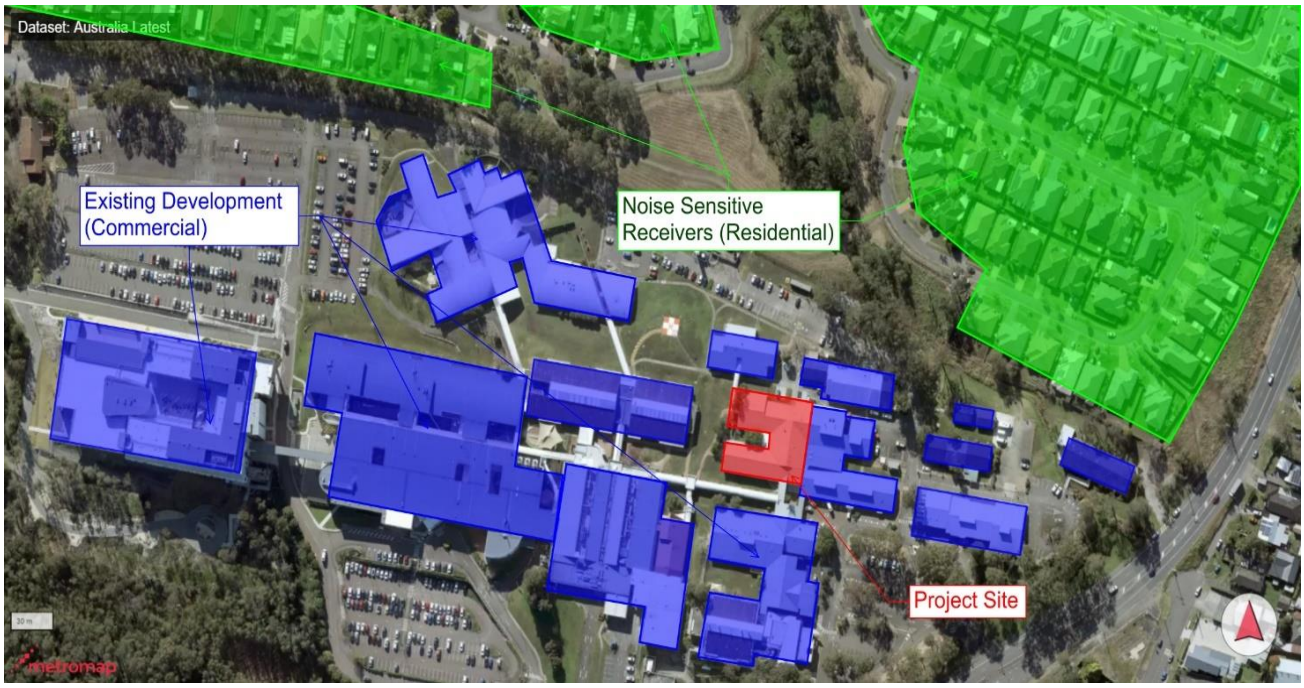

Figure 2 Satellite image showing project site and noise sensitive receivers (Metromap © 2023)

Noise sensitive receivers are listed below in Table 2.

Table 2 Noise sensitive receivers

Noise Sensitive Receiver	**Direction from Project Site**
Residents along Yellow Rose Terrace	North east
Residents along Skyhawk Avenue	North & north west
Existing Wyong Public Hospital	Encircling the Project site.

Project Intrusiveness Noise Level

The intrusiveness of an industrial noise source may generally be considered acceptable if the level of noise from the source ($L_{Aeq,15min}$) does not exceed the RBL by more than 5 dB, when beyond a minimum threshold (35 dB(A) for the day, 30 dB(A) for the evening and night). This intrusiveness noise level seeks to limit the degree of change a new noise source introduces to an existing environment. The outcome of this approach aims to ensure that the intrusiveness noise level is being met for at least 90% of the time-periods over which annoyance reactions can occur (taken to be periods of 15 minutes). Project intrusiveness noise level is defined as follows:

Project intrusiveness noise level ($L_{Aeq,15min}$) = RBL + 5 dB

Based on the measured RBL presented in *NA230258 AC Wyong Hospital Rev3* and the NPI, the project intrusiveness noise levels are established in Table 3.

Table 3 Project intrusiveness noise levels

	Rating Background Level RBL, dB(A)			**Project Intrusiveness Noise Levels, $L_{Aeq,15min}$ dB(A)**		
	Day	Evening	Night	Day	Evening	Night
At Residential Location	50	30*	30*	55	35	35
At Hospital Buildings (Commercial Buildings)	50	50	50	55	55	55
*This is based on NPI recommended assumed RBLs, the measured levels are affected by operation of mechanical plant equipment and fans.						

Project Amenity Noise Level

To limit continuing increases in noise levels from application of the intrusiveness level alone, the ambient noise level within an area from all industrial noise sources combined should remain below the recommended amenity noise levels specified in Table 2.2 of the NPI, where feasible and reasonable. The recommended amenity noise levels will protect against noise impacts such as speech interference, community annoyance and some sleep disturbance.

The recommended amenity noise levels (Table 2.2 of the NPI) represent the objective for total industrial noise at a receiver location, whereas the project amenity noise level represents the objective for noise from a single industrial development at a receiver location. To ensure that industrial noise levels (existing plus new) remain within the recommended amenity noise levels for an area, a project amenity noise level applies for each new source of industrial noise as follows:

Project amenity noise level $L_{Aeq,15min}$ = Recommended amenity noise level – 5 dB(A) + 3 dB(A)

The recommended amenity noise level should be established from Table 2.2 of the NPI based on the noise sensitive receivers' category, determined based on Table 2.3 of the NPI.

As the NPI states, the approach of deriving the project amenity noise level from the recommended amenity noise level minus 5 dB is based on a receiver not being impacted by more than three to four individual industrial noise sources. To standardise the time periods for the intrusiveness and amenity noise levels, NPI assumes that the Amenity $L_{Aeq,15min}$ will be taken to be equal to the $L_{Aeq,period}$ + 3 decibels (dB).

Considering that the residential noise sensitive receivers are located in an R2 Low Density Residential Zone (Suburban Residential), the NPI recommended Amenity Noise Level and Project Amenity Noise Level for this project are presented in Table 4 below.

Table 4 Project amenity noise levels

Noise Sensitive Receiver	**Recommended Amenity Noise Level, LAeq dB(A)**			**Project Amenity Noise Levels, LAeq,15min dB(A)**		
	Day	**Evening**	**Night**	**Day**	**Evening**	**Night**
Residents along Yellow Rose Terrace	55	45	40	53	43	38
Residents along Skyhawk Avenue	55	45	40	53	43	38
Wyong Hospital (External)	50			48		

Project Noise Trigger Level

The project noise trigger level is the lower (that is, the more stringent) value of the project intrusiveness noise level and the project amenity noise level determined in accordance with the NPI. The project intrusiveness noise level aims to protect against significant changes in noise levels, whilst the project amenity noise level seeks to protect against cumulative noise impacts from industry and maintain amenity for particular land uses. Applying the most stringent requirement as the project noise trigger level ensures that both intrusive noise is limited, and amenity is protected and that no single industry can unacceptably change the noise level of an area. It is noted that Intrusive noise levels are only applied to residential receivers (residences). For other receiver types identified in Table 2.2 of the NPI, only the amenity levels apply. The project noise trigger levels for this project are established in accordance with the NPI and are shown below in Table 5.

Table 5 Project noise trigger levels

Noise Sensitive Receiver	Project Intrusiveness Noise Level, $L_{Aeq,15min}$ dB(A)			Project Amenity Noise Level, $L_{Aeq,15min}$ dB(A)			Project Noise Trigger Level, $L_{Aeq,15min}$ dB(A)		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
Residents along Yellow Rose Terrace	55	35	35	53	43	38	53	35	35
Residents along Skyhawk Avenue	55	35	35	53	43	38	53	35	35
Wyong Hospital	55			48			48		

Correction for Modifying Factors

Where a noise source contains certain characteristics, such as tonality, intermittency, irregularity or dominant low-frequency content, a correction should be applied as per the NPI, to the measured or predicted noise levels at the receiver before comparison with the project noise trigger levels. The maximum correction of 10 dB(A) to be applied to the predicted or the measured level where two or more modifying factors are present. NPI recommended correction factors (Table C1 of the NPI) are shown in Table 6.

Table 6 Modifying factor corrections for noise characteristics

Factors	Corrections[1]	Notes
Tonal Noise	5 dB[2,3]	[1.] Corrections to be added to the measured or predicted levels, except in the case of duration where the adjustment is to be made to the criterion. [2.] Where a source emits tonal and low-frequency noise, only one 5-dB correction should be applied if the tone is in the low-frequency range, that is, at or below 160 Hz. [3.] Where narrow-band analysis using the reference method is required, as outlined in column 5, the correction will be determined by the ISO1996-2:2007 standard
Low-Frequency Noise	2 or 5 dB[2]	
Intermittent Noise	5 dB	
Duration	0 to 20 dB(A)	
Maximum Adjustment	Maximum correction of 10 dB(A)[2] (excluding duration correction).	

As per the NPI, correction for duration is applied where a single-event noise is continuous for a period of less than two and a half hours in any assessment period. The allowable exceedance of the $L_{Aeq,15min}$ equivalent noise criterion is provided in Table C3 of the NPI for the duration of the event. This adjustment is designed to account for unusual and one-off events and does not apply to regular and/or routine high-noise level events. The adjustments for duration are to be applied to the criterion.

Sleep Disturbance Criteria

The potential for sleep disturbance from maximum noise level events from premises during the night-time period needs to be considered. NPI recommends, where the subject development/premises night-time noise levels at a residential location exceed:

- LAeq,15min 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or
- LAFmax 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater,

that a detailed maximum noise level event assessment should be undertaken. The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the rating background noise level, and the number of times this happens during the night-time period. Based on the NPI, the sleep disturbance criteria for the proposed development are determined as shown in Table 7.

Table 7 Sleep disturbance criteria

Noise Sensitive Receiver	Rating Background Level (RBL) at Night, L_{A90} dB(A)	NPI Recommended Sleep Disturbance Criteria, dB(A)	
		$L_{Aeq,15min}$ (40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater)	L_{AFmax} (52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater)
Residents along Yellow Rose Terrace	30	40	52
Residents along Skyhawk Avenue	30	40	52
Wyong Hospital (commercial)	50	55	65

In addition to the above, NSW Road Noise Policy (RNP) noted that the research on sleep disturbance to date concluded that:

Maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep

One or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly.

Helicopter Noise Intrusion Criteria

NSW Health – Engineering Services Guidelines 2022 stipulates that Helicopter operations can exhibit similar noise characteristics to fixed wing aircraft pass-bys and generate high levels of short period steady noise levels hovering or idling. However, emergency medical helicopter operations differ from fixed wing aircraft as:

They can occur at any time of day or night

They are generally much less frequent than fixed wing aircraft operations near a typical airport

They are directly associated with the hospital facility

Please refer to the information below relating to the number of historical helicopter movements per year. note Wyong is a retrieval only hospital and do not drop offs.

2022

Jan - 2

Feb -2

March - 3

April - 4

May - 5

June - 2

July - 6

August - 0

Sept - 0

October - 1

Nov - 0

Dec - 2

2023

Jan - 4

Feb -0

March - 4

April - 1

May - 1

June - 4

July - 0

August - 3

Sept - 3

In 2022, there were approximately 0.48 helicopter movements per week, and in 2023, there were approximately 0.38 helicopter movements per week. This frequency of helicopter movements is assumed to continue throughout the lifecycle of the development. Table 8**Error! Reference source not found.** below outlines the internal noise level criteria that should be considered with respect to the new redevelopment.

Table 8 Helicopter noise intrusion criteria

Room	**NSW Health Recommended Internal Noise Levels, L_{Amax} dB(A)**
Private Offices, Meeting Rooms	70
Open Plan Office	75
Corridors and Lobbies, Reception and Waiting areas	80
ICU Wards, Patient rooms, Bed Wards or sensitive spaces	68
Consulting rooms, Interview and Counselling Rooms	65

Construction Noise

The Interim Construction Noise Guideline (ICNG) (DECC, 2009) guideline recommends standard hours for construction activities as Monday to Friday: 7am to 6pm, Saturday: 8am to 1pm and no work on Sundays or public holidays. These hours are not mandatory and the ICNG acknowledges that the following activities have justification to be undertaken outside the recommended standard construction hours assuming that all reasonable and feasible mitigation measures are implemented to minimise the impacts to the surrounding sensitive land uses:

- the delivery of oversized plant or structures that police or other authorities determine to require special arrangements to transport along public roads
- emergency work to avoid the loss of life or damage to property, or to prevent environmental harm
- works where a proponent demonstrates and justifies a need to operate outside the recommended standard construction hours
- works which maintain noise levels at sensitive receivers to below the noise management levels outside of the recommended standard construction hours.
- Construction noise management levels at sensitive residential receivers are provided in Table 9. The construction noise management levels during recommended standard hours represent a noise level that, if exceeded, would require management measures including:
- reasonable and feasible work practices

- contact with the residences to inform them of the nature or works to be carried out, the expected noise levels and durations and contact details.

The management measures are aimed at reducing noise impacts at the residential receivers. However, it may not be reasonable and feasible to reduce noise levels to below the noise affected management level. The noise affected construction noise management levels during recommended standard hours is not intended as a noise limit but rather a level where noise management is required and as such should not be included as a noise limit in the environmental protection license.

Table 9 Residential construction noise management levels, dBA

Time of day	Noise Management level, $L_{Aeq\ (15\ min)}$	Application Notes
Recommended standard hours	Noise affected: RBL + 10 dBA	The noise affected level represents the point above which there may be some community reaction to noise. a) where the predicted or measured LAeq(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 b) 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 dBA	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: c) times identified by the community when they are less sensitive to noise (such as before and after school, or mid-morning or mid-afternoon for works near residences) d) 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 + 5 dBA	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 measures have been applied and noise is more than 5 dBA above the noise affected level, the proponent should negotiate with the community.

Noise management levels for other sensitive land uses are provided in Table 10 and only apply when the properties are in use.

Table 10: Noise management levels for other sensitive land uses

Land Use	Noise management, $L_{Aeq\ (15\ minutes)}$
Commercial premises	70 dBA (external)

A summary of the construction noise management levels are provided in Table 11

Table 11: Proposal construction noise management levels, dBA

Receiver type	Construction noise management levels, $L_{Aeq(15\ min)}$				
	Standard construction hours		Outside standard construction hours		
	Noise affected	Highly noise affected	Day	Evening	Night
Residents along Yellow Rose Terrace	60	75	55	35	35
Residents along Skyhawk Avenue	60	75	55	35	35
Commercial	70	-	-	-	-

Protection of the Environment Operations (POEO) Act 1997

The POEO Act 1997 aims to protect, restore and enhance the quality of the noise environment in New South Wales. 'Offensive noise' in the Act is defined as noise:

> *(a) that, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances—*
>
> *(i) is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or*
>
> *(ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or*
>
> *(b) that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances, prescribed by the regulations.*

For control of noise from Air Conditioners, Pumps and Heat Pump Water Heaters, the Act defines the following in regards to its use on residential premises:

> *A person is guilty of an offence if -*
>
> *(a) the person causes or permits an air conditioner / pump to be used on residential premises in such a manner that it emits noise that can be heard within any room in any other residential premises (that is not a garage, storage area, bathroom, laundry, toilet or pantry) whether or not any door or window to that room is open -*
>
> *(i) before 8 am or after 10 pm on any Saturday, Sunday or public holiday, or*
>
> *(ii) before 7 am or after 10 pm on any other day,*

Building Vibration Criteria

Human response to floor motion is a complex phenomenon. There are wide variations in vibration tolerance of humans and accordingly the acceptance criteria for human comfort are difficult to define and quantify.

Acceptable values of human exposure to vibration are primarily dependent on the activity taking place in the occupied space (e.g., office, meeting rooms, residential etc.) and the character of vibration (e.g., continuous or intermittent). In addition, specific values are dependent upon social and cultural factors, psychological attitudes, expected interference with privacy, and ultimately the individual's perceptibility.

Vibration transfer within a building has the potential to adversely affect the occupants. The building structure must be designed to achieve appropriate levels of vibration to minimise such adverse effects.

The concept of using base curves to assess human comfort has been adopted from Australian Standard 2670.2:1990. NB - Please note that this standard was superseded by AS ISO 2631.2:2014, however, it is accepted practice within the Australian market to adopt the multiplying factors as presented in Table 2 Appendix A (2670.2:1990) for building vibration from human comfort.

A base curve marks the threshold of human perception and is defined in one-third octave bands from 1 Hz to 80 Hz. Vibration levels below the base curves typically do not result in adverse comments or complaints from occupants. The vibration criteria for different occupancy types are obtained by multiplying the base curve by a factor. Multiplying factors for different occupation types on the recommendations in AS 2670.2:1990 are listed in Table 12.

Table 12 Multiplying factors for satisfactory magnitudes of building vibration

Room Type	**Multiplying Factor**	
	Continuous or Intermittent Vibration	**Transient Vibration excitation with several occurrences per day**
Critical working areas (for example some hospital operating-theatres, some precision laboratories)	1.0	1.0
Boardroom/conference, open plan and private offices	4.0	60 to 128
Engineering, Workshop, co-working and collaborative spaces, Plant rooms	8.0	90 to 128

The ASHRAE curves include workshop, office, residential, operating room and VC curves for sensitive equipment.. Velocity vibration criteria curves (RMS) defined in one-third octave frequency bands (CPB) range 1 to 80 Hz are shown in Table 13.

Table 13 Human Comfort and Equipment Vibration Criteria from Continuous Vibration

Location	**Assessment Period**	**1 to 80Hz Curve mm/s**
Office Areas, Consulting, examination, treatment, procedures, interview, counselling	Day – or Night time	0.406
Hospital operating theatres rooms and critical work areas	Day – or Night time	0.102
Single bed ward (including Mental Health, Parent Accommodation), Multiple bed ward, General intensive care wards, Neonatal or paediatric ICUs, and the like	Day – or Night time	0.140

Guidelines for human comfort with respect to vibration within a building are also provided by NSW Environmental Noise Management – Assessing Vibration: a technical guide (February 2006). This technical guideline provides acceptable RMS acceleration and velocity for continuous, impulsive and intermittent vibration. Velocity and acceleration limits are presented in Table 14.

Table 14 Velocity and acceleration criteria for exposure to continuous and impulsive vibration

Location	**Assessment Period**	**RMS velocity (mm/s)**		**RMS acceleration (m/s^2)**		**Peak velocity (mm/s)**	
Continuous Vibration							
	Preferred		Maximum	Preferred	Maximum	Preferred	Maximum
Offices	Day – or Night time	0.40	0.80	0.020	0.040	0.56	1.1
Critical Areas, include hospital operating theatres and precision	Day – or Night time	0.10	0.20	0.0050	0.010	0.14	0.28

Location	Assessment Period	RMS velocity (mm/s)		RMS acceleration (m/s^2)		Peak velocity (mm/s)	
laboratories where sensitive operations are occurring							
Impulsive Vibration							
Offices	Day – or Night time	13	26	0.64	1.28	18.0	36.0
Critical Areas, include hospital operating theatres and precision laboratories where sensitive operations are occurring	Day – or Night time	0.10	0.2	0.0050	0.010	0.14	0.28

Vibration Dose Values (VDV)

The vibration dose value (VDV) is fully described in British Standard BS 6472:2008 Guide to Evaluation of human exposure to vibration in buildings – Part 1: Vibration sources other than blasting.

Table 15 below presents the vibration criteria for human comfort, in terms of preferred and maximum vibration dose values as described in BS 6472 and also provided by NSW Environmental Noise Management – Assessing Vibration: a technical guide (February 2006). The VDV level can be directly related to vibration discomfort experienced by a person. VDV accumulates the vibration energy received over the daytime and night-time periods.

Table 15 Maximum vibration dose values for intermittent vibration

Place	Vibration Dose Values (m/s$^{1.75}$)			
	Daytime (7am – 10pm)		Night-time (10pm – 7am)	
	Preferred	Maximum	Preferred	Maximum
Critical Areas, hospital operating theatres and precision laboratories where operations are occurring	0.10	0.20	0.10	0.20
Offices	0.40	0.80	0.40	0.80
AAAC Guideline for Healthcare Facilities: Single bed ward (including Mental Health, Parent Accommodation), Multiple bed ward, General intensive care wards, Neonatal or paediatric ICUs, and the like	-	0.20	-	0.10
AAAC Guideline for Healthcare Facilities: Consulting, examination, treatment, procedures, interview, counselling etc.	-	0.40	-	0.40
AAAC Guideline for Healthcare Facilities: Boardroom/conference, open plan and private offices, etc.	-	0.80	-	0.80

Sound Insulation of Building Façade

Noise intrusion to the building from the external environment has the potential to affect the acoustic amenity within the working environment. Figure 1 below shows the locality plan for the proposed buildings and its surroundings.

The main external noise sources that have been identified in the vicinity of the building are listed below:

- Mechanical Plant/Equipment serving adjacent buildings
- Road traffic from surrounding roads, predominately along Pacific Highway
- Helicopter take-off and landing

To determine the noise levels due to each of the sources listed above and quantify the likely impact that the noise would have on the building, attended noise measurements were conducted in the vicinity of the proposed site. Helicopter noise readings have been taken in previous assessments and corrections for distance have been applied for this project.

Table 22 below presents a summary of the noise measurements that were performed at the site, including a description of the events that took place at the locations of the measurements.

Table 16 External Noise Measurement Results

Location	Measured Noise Level	Description of Noise Events
Helicopter measurement locations at the external façade	87 dB(A) L_{Aeq} 93 dB(A) L_{Amax}	Helicopter Take-off
North facing facade	60 dB(A) L_{Aeq} 63 dB(A) L_{Amax}	Noise Impacts from adjacent chillers
South & east facing facade	47 dB(A) L_{Aeq} 70 dB(A) L_{Amax}	Ambient Noise Levels (Mech Plant from surroundings + Traffic Noise)

To achieve the internal noise level specifications for the building, the following preliminary design recommendations are provided:

External Glazing

The building façade will be designed to control external noise intrusion to meet internal noise levels in accordance with Australian Standards and guidelines. This section documents the external glazing recommendations to achieve the nominated internal noise criteria.

The recommendations are separated into design options considering the proposed design and further recommendations to reduce project cost impacts. Table 23 presents the specification of the minimum glass for the external façade.

Table 17 Façade Glazing

Room	Glazing Construction	Rw
North Facing Facade		
Bedroom, Dining	Double Glazed Unit comprising of: ▪ 6mm glass ▪ 16mm air space ▪ 8.5mm glass	41
All Other Areas		
Meeting/Staff Rooms, Reception, Dining, Storage, Bedrooms	Double Glazed Unit comprising of: ▪ 6mm glass ▪ 12mm air space ▪ 6mm glass	33
	Single Glazed Unit comprising of: ▪ 8.38mm laminated glass	34

Please note that the above glazing should achieve acoustic requirements based on accredited laboratory testing, including global and frequency requirements. An alternative glazing construction that meets the sound insulation performance may be able to be used; however, it would need to be reviewed by the acoustic engineer.

External Walls

This section documents the external wall recommendations to achieve the nominated internal noise criteria.

Table 18 Façade Wall Types

Room	R_w Rating	Example Façade Construction
North Facing Facade		
Bedroom, toilets, Meeting/Staff Rooms, Reception, Dining, Storage, Comms	Rw 47 - 50	▪ Cemitel Sheet or Weatherboard Cladding ▪ 1x16mm Fire/Moisture Rated Plasterboard (minimum 13 kg/m^2) ▪ 90mm steel studs at maximum 600mm centres ▪ 75mm Gold Batts R1.5 Insulation within cavity ▪ 1x16mm Fire Rated Plasterboard (minimum 13 kg/m^2) Per CSR 5168 or equivalent
		▪ Masonry/Blockwork Wall ▪ Minimum 40mm cavity ▪ Minimum 70mm steel studs at maximum 600mm centres ▪ 75mm Gold Batts R1.5 Insulation within cavity ▪ 1x10mm GYPROCK Plus plasterboard (or equivalent) Per CSR 5403 or equivalent
All Other Areas		
Bedrooms/Toilets	Rw 47 - 50	▪ Cemitel Sheet or Weatherboard Cladding ▪ 1x16mm Fire/Moisture Rated Plasterboard (minimum 13 kg/m^2) ▪ 90mm steel studs at maximum 600mm centres ▪ 75mm Gold Batts R1.5 Insulation within cavity ▪ 1x16mm Fire Rated Plasterboard (minimum 13 kg/m^2) Per CSR 5168 or equivalent
		▪ Masonry/Blockwork Wall ▪ Minimum 40mm cavity ▪ Minimum 70mm steel studs at maximum 600mm centres ▪ 75mm Gold Batts R1.5 Insulation within cavity ▪ 1x10mm GYPROCK Plus plasterboard (or equivalent) Per CSR 5403 or equivalent
Meeting/Staff Rooms, Reception, Dining, Storage, Comms	Rw 45	▪ Cemitel cladding system ▪ Minimum 70mm steel studs at maximum 600mm centres ▪ 75mm Gold Batts R1.5 Insulation within cavity ▪ 1x10mm GYPROCK Plus plasterboard (or equivalent) ▪ Per CSR 5302 or equivalent
		▪ Masonry/Blockwork Wall ▪ Minimum 40mm cavity ▪ Minimum 70mm steel studs at maximum 600mm centres ▪ 75mm Gold Batts R1.5 Insulation within cavity ▪ 1x10mm GYPROCK Plus plasterboard (or equivalent)

Room	R_w Rating	Example Façade Construction
		Per CSR 5403 or equivalent
Plant Room	Rw 55	▪ Cemitel Express Panel, Barestone or equivalent ▪ 15mm top hat ▪ 2x16mm Fyrcheck MR Plasterboard (minimum 13 kg/m^2) ▪ 90mm steel studs at maximum 600mm centres ▪ 75mm Gold Batts R1.5 Insulation within cavity ▪ 2x16mm Fyrcheck MR Plasterboard (minimum 13 kg/m^2) Per CSR 5349 or equivalent
		▪ Masonry/Blockwork Wall ▪ Minimum 40mm cavity ▪ Minimum 70mm steel studs at maximum 600mm centres ▪ 75mm Gold Batts R1.5 Insulation within cavity ▪ 1x10mm GYPROCK Plus plasterboard (or equivalent) Per CSR 5403 or equivalent

External Doors

This section documents the external wall recommendations to achieve the nominated internal noise criteria.

Table 19 Examples of door assemblies

Room	Rw Rating	Door Type	Door Seals
North Facing Facade			
Bedroom, Dining	Rw 34	▪ AWS 731 Thermally Broken Sliding Door – 8.5mm HUSH/10mm air gap/6.5mm Hush	▪ As per manufacturer's specification
All Other Areas			
Plantroom	Rw 47	▪ Pyropanel proprietary 48mm thick Timber Acoustic Door	▪ Acoustic doors rated no less than R_w47based on laboratory test. Doors are supplied as a set including door, frame, hardware and seals. Example of suitable door would be Pyropanel AS-Special-A4
Comms	Rw 34	▪ 50mm thick single solid core timber door	▪ Frame: RP 10 ▪ Bottom: RP 70 ▪ Threshold plate: RP 96/ RP66
Bedroom, Corridor, Reception, Dinng	Rw 30	▪ 10.38mm laminated glass Single – glass	▪ Frame: RP 10 ▪ Bottom: RP 70 ▪ Threshold plate: RP 96/ RP66
		▪ 44mm solid core timber door	▪ Frame: RP 120 ▪ Bottom: RP 38 ▪ Threshold plate: RP 96/ RP66
		▪ Double doors – 38mm solid core timber	▪ Frame: RP 10 ▪ Bottom: RP38Si ▪ Meeting stile: 2 x RP 16Si astragal seal

Roof system

The roof system must address the need to control external noise sources, such as road traffic and helicopter noise The selected and installed construction systems must comply with all the requirements listed in Table 30 below.

Table 20 Acoustic performance requirements

	Octave Band Centre Frequency						
	63Hz	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**
Min. airborne sound insulation in sound reduction index (Rw) dB	16	29	44	55	63	58	57

Roof constructions

Example metal roof constructions that are predicted to achieve these requirements are provided in Table 25.

Table 21 Example roof constructions

Room	**Roof system**	**Additional considerations**
All areas except Lounge	Option 1: ▪ 1 x 0.6 mm Custom Orb (0.55mm) metal roof ▪ Steel C-Joist and resilient rail parallel with timber trusses ▪ Cavity Width 200 mm ▪ 75 mm Ecowool 32kg/m³ insulation within cavity ▪ 13mm flush plasterboard (8.5 kg/m^2) ▪ Steel furring channel ▪ 2 x 13 mm CSR Gyprock 13mm Soundchek plasterboard (13 kg/m^2)	Insulation can be rated to provide thermal and acoustic performance. Additional acoustic treatment to underside of ceiling required for reverberation control within relevant spaces.
Lounge or Breakout Area	Option 2: ▪ 1 x 0.6 mm Custom Orb (0.55mm) metal roof ▪ Steel C-Joist and resilient rail ▪ Cavity Width 200 mm ▪ 75 mm Eco wool 32kg/m³ insulation within cavity ▪ 2 x 13 mm CSR Gyprock Soundchek plasterboard (13 kg/m^2)	

A schematic diagram of the above roof construction is shown in Figure **Error! No text of specified style in document.**.3. The location of the above recommended roof constructions are shown in Figure 5.5.

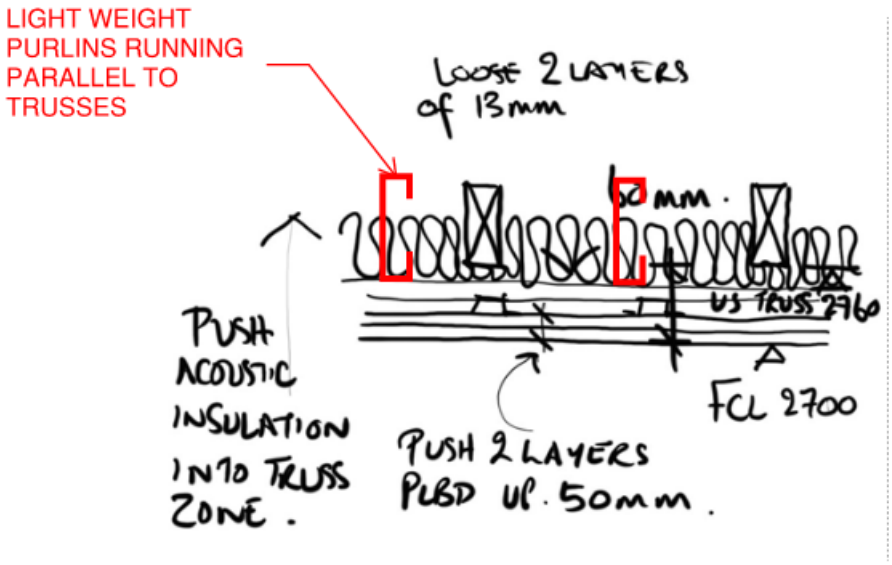

Figure **Error! No text of specified style in document.**.3: Schematic diagram of the roof construction (Option 1)

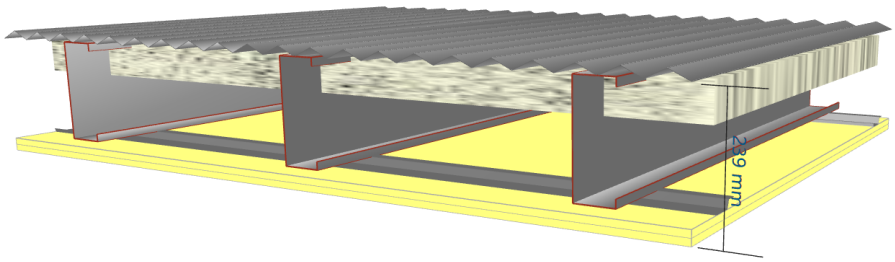

Figure **Error! No text of specified style in document.**.4: Schematic diagram of the roof construction (Option 2)

Figure **Error! No text of specified style in document.**.5: Locations of recommended roof construction

Alternative constructions can be selected but must be approved by the Acoustic Engineer or supplier. Final roof construction is to be reviewed and accepted the client.

Wall to ceiling/roof junctions must be appropriately detailed based on manufacturers specification to not reduce the sound insulation performance due to noise flanking. Junction detailing will be coordinated and reviewed during the documentation phase, including detailing for acoustically rated walls to underside of the roof system.

The building will need to provide appropriate acoustic isolation between adjoining spaces to maintain acoustic privacy and minimise intrusiveness. This section of the report details acoustic specifications for internal walls and floors.

General Detailing

In order to maintain the required sound insulation performance, the following advice is provided with regards to the installation of partitions:

- All horizontal and vertical joints between boards shall be filled and taped. All acoustically rated walls shall be well sealed and airtight including at all perimeter junctions.
- Where door or window frames are built into the wall, a non-hardening resilient acoustic sealant shall be used to seal all joints between the wall and frame.
- For doors and glazed screens with a sound insulation rating above R_w 40, the vertical and horizontal sections of the frame shall be fully packed with acoustic insulation with a density of at least 32 kg/m³.
- Head details shall be designed to take up relative movements, live load variations and drying shrinkage.
- All acoustic partitions, floors and ceilings will require acoustic penetration details. Wall partitions rated R_w 55 or higher should not be penetrated by ventilation, electrical or piped services (including cable trays).
- Penetrations in the stud partitions and plasterboard dry lining walls shall be smooth and even, and finished 20mm to 30 mm from the service penetration to allow the penetration to be sealed effectively. The penetrations shall not be oversized.
- Acoustic compressible (neoprene) seal: Material must provide a density of at least 75 kg/m3 and when installed the density must not alter by more than ±8kg/m3.
- Standard partition junctions shall be constructed as per the appropriate manufacturer's detailing (e.g. Knauf Technical Manual, CSR Gyprock Red Book, USG Boral Systems+ Manual, etc) unless superseded by details within the architectural plans approved by Acor.
- Acoustic/fire sealant is to be adopted to ensure the sealing of any air gaps and possible discontinuities within the construction. This must be non-hardening resilient acoustic sealant.

Construction Noise and Vibration Assessment and Recommended Mitigation Measures

It is understood that the project is currently at the concept/feasibility design stage and there is no contractor engaged or any construction plan developed, therefore assessment of construction noise and vibration would be preliminary at this stage.

The noise emissions from construction have been assessed at the surrounding potentially affected receivers during the standard construction hours. A quantitative assessment has been undertaken with consideration to the ICNG.

Construction activities would generally be carried out during the recommended standard construction working hours. Early morning oversized deliveries may be required on occasion for some of the construction works and may occur outside the recommended construction hours. No work would be intended on Sundays or public holidays.

Construction traffic movements would primarily be associated with the transportation of construction machinery and equipment to the proposal site and the transportation of material.

Plant and equipment needed for the proposal would be determined during the construction planning phase. Other equipment may be used however it is anticipated that they would produce similar noise emissions.

The magnitude of off-site noise impact associated with construction will be dependent upon a number of factors:

- The intensity and location of construction activities.
- The type of equipment used.
- Existing background noise levels.
- Intervening terrain and structures.
- The prevailing weather conditions.

Construction machinery would likely move about the study area altering noise impacts with respect to individual receivers. During any given period, the machinery items to be used in the study area would operate at maximum sound power levels for only brief stages. At other times, the machinery may produce lower sound levels while carrying out activities not requiring full power. It is highly unlikely that all construction equipment would be operating at their maximum sound power levels at any one time and certain types of construction machinery would be present in the study area for only brief periods during construction. Therefore, noise predictions are considered conservative.

Table 22: Highest allowable noise levels for construction equipment

Activity	**Description of Activity**	**Plant/Equipment**	**L_{Aeq} SWL**	**L_{Aeq} at 7m**
Mobilisation & Site Establishment	Installing construction boundary hoardings/ fences and traffic barriers	Truck (medium rigid)	103	78
		Road truck	108	83
		Scissor Lift	98	73
		Franna crane	98	73
Bulk earthworks	Formation of road alignment. Excavation of soil and rock, hammering/rock breaking, drilling, loading, haulage, compaction of fill areas, grading	Bulldozer D9	116	91
		Scraper 651	110	85
		Excavator (tracked) 35t	110	85
		As above + hydraulic hammer	122	97
		Grader	113	88
		Dump truck	110	85
		Compactor	106	81
		Roller (large pad foot)	109	84
		Water cart	107	82
Activity	Description of Activity	Plant/Equipment	L_{Aeq} SWL	L_{Aeq} at 7m
Mobilisation & Site Establishment	Installing construction boundary hoardings/ fences and traffic barriers	Truck (medium rigid)	103	78
		Road truck	108	83
		Scissor Lift	98	73
		Franna crane	98	73
Bulk earthworks	Formation of road alignment. Excavation of soil and rock, hammering/rock breaking, drilling, loading, haulage, compaction of fill areas, grading	Bulldozer D9	116	91
		Scraper 651	110	85
		Excavator (tracked) 35t	110	85
		As above + hydraulic hammer	122	97
		Grader	113	88

Activity	Description of Activity	Plant/Equipment	L_{Aeq} SWL	L_{Aeq} at 7m
		Dump truck	110	85
		Compactor	106	81
		Roller (large pad foot)	109	84
		Water cart	107	82

Airborne Construction Noise Impacts

The equipment noise levels were distance attenuated from the site and the noise levels are shown Table 23. Propagation calculations take into account sound intensity losses due to hemispherical spreading, with additional minor losses such as atmospheric absorption, directivity, ground absorption and shielding ignored in the calculations. No construction equipment have been planned at this stage, therefore noise assessment from the following construction equipment is for preliminary planning only.

Table 23: Construction plant and equipment noise levels at distance

Plant and equipment	Noise level at distance							
	25m	50m	100m	150m	200m	300m	400m	500m
Truck (medium rigid)	64	58	52	48	46	42	40	38
Road truck	69	63	57	53	51	47	45	43
Scissor Lift	59	53	47	43	41	37	35	33
Franna crane	59	53	47	43	41	37	35	33
Bulldozer D9	77	71	65	61	59	55	53	51
Scraper 651	71	65	59	55	53	49	47	45
Excavator (tracked) 35t	71	65	59	55	53	49	47	45
As above + hydraulic hammer	83	77	71	67	65	61	59	57
Grader	74	68	62	58	56	52	50	48
Dump truck	71	65	59	55	53	49	47	45
Compactor	67	61	55	51	49	45	43	41
Roller (large pad foot)	70	64	58	54	52	48	46	44
Water cart	68	62	56	52	50	46	44	42

Note: There are some exceedances to the 70 dB(A) CNML during standard construction hours for commercial receivers (surrounding buildings within the hospital). The noise levels would further reduce by 10 to 20 dB(A) at the nearby residential receivers due to noise barrier effect from nearby buildings.

Where the predicted L_{Aeq} (15 minute) noise level is greater than the noise affected level all feasible and reasonable work practices should be applied, however, it is unlikely that mitigation measures would reduce the predicted noise levels below the management levels. The magnitudes of construction noise levels are dependent on the duration of construction, the type of equipment, location of activities, the surrounding environment's background noise levels and the weather conditions during construction. The predicted noise levels are generally conservative as the construction noise model predicts the worse-case 15 minute scenario and these levels may not represent the actual noise emission experienced by the community throughout the entire construction period.

The residential noise management level of 60 dBA during standard construction hours is predicted to be exceeded at residences located within 100 m of the construction works at some stage during construction.

The highly noise affected level of 75 dBA is not predicted to be exceeded at any residential receiver as no residential receiver would be located within 25 m of the works.

Mitigation measures to manage noise impacts have been recommended and are provided further in the report.

Sleep Disturbance

All construction activity is expected to occur during recommended standard hours therefore sleep disturbance impacts at the neighbouring residential receivers are not expected.

Construction traffic impacts

The application notes1 for the Road Noise Policy state that "for existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level as a result of the development should be limited to 2 dB above that of the noise level without the development. This limit applies wherever the noise level without the development is within 2 dB of, or exceeds, the relevant day or night noise assessment criterion." This is also considered to be applicable for construction noise therefore if road traffic noise increases from construction is within 2 dB(A) of current levels then the objectives on the Road Noise Policy are achieved.

A significant increase in traffic volumes would be needed in order to increase road traffic noise by 2 dB(A) (a doubling in traffic corresponds to an approximate 3 dB(A) increase). Construction work would generate light and heavy vehicle movements associated with employees, deliveries, transportation of machinery, materials and equipment to work sites.

The increase in vehicle movements would be limited to the period of construction. Noise level increases due to construction traffic would not be significant when compared with the existing vehicle numbers in the study area.

Construction vibration impacts

As a guide, minimum working distances from sensitive receivers for typical items of vibration intensive plant are listed in Table 24. The minimum distances are quoted for both "cosmetic" damage (refer BS 7385) and human comfort (refer OH&E's Assessing Vibration - a technical guideline). The minimum working distances for cosmetic damage must be complied with at all times, unless otherwise approved by Roads and Maritime or under the environmental license as relevant. DIN 4150 has criteria of particular reference for heritage structures.

Table 24 Recommended buffer distance for control of construction vibration

Plant Item	Rating/ /Description	Minimum working distance	
		Cosmetic damage (BS 7385)	Human response (OH&E Vibration guideline)
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	5m	15 to 20m
	< 100 kN (Typically 2-4 tonnes)	6m	20m
	< 200 kN (Typically 4-6 tonnes)	12m	40m
	< 300 kN (Typically 7-13 tonnes)	15m	100m
	> 300 kN (Typically 13-18 tonnes)	20m	100m
	> 300 kN (> 18 tonnes)	25m	100m
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2m	7m

Plant Item	Rating/ /Description	Minimum working distance	
		Cosmetic damage (BS 7385)	Human response (OH&E Vibration guideline)
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	7m	23m
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22m	73m
Vibratory Pile Driver	Sheet piles	2m to 20m	20m
Pile Boring	≤ 800 mm	2m (nominal)	4m
Jackhammer	Hand held	1m (nominal)	2m

The minimum working distances are indicative and will vary depending on the particular item of plant and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions. Vibration monitoring is recommended to confirm the minimum working distances at specific sites.

Operational aspects of some receivers may be highly sensitive to noise and vibration over and above typical noise and vibration allowances based on annoyance and human comfort. For highly sensitive receivers (eg, high technology facilities with sensitive equipment, recording studios and cinemas), specific assessment is required to ensure satisfactory operation of the facility and determine if any mitigation or management measures are required to minimise the potential impacts. Some guidance where building contents contain sensitive equipment may be found in these additional references:

- Australian Standard 2834-1995 Computer Accommodation, Chapter 2.9 Vibration, p16
- Gordon CG Generic Vibration Criteria for Vibration Sensitive Equipment Proceedings of International Society for Optical Engineering (SPIE), Vol. 1619, San Jose, CA, November 4-6, 1991, pp. 71-85
- ASHRAE Applications Handbook (SI) 2003, Chapter 47 Sound and Vibration Control, pp47.39-47.40
- ISO 8569 1996 Measurement & Evaluation of Shock & Vibration Effects on Sensitive Equipment in buildings

In relation to human comfort (response), the minimum working distances in Table 24 relate to continuous vibration. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are allowed (see OEH's Assessing Vibration: a technical guideline). Where the predicted vibration levels exceed the human comfort objectives, procedures are to be followed in order to mitigate the potential impacts at sensitive receivers.

If the predicted ground-borne vibration levels exceed the cosmetic damage objectives, a different construction method with lower source vibration levels must be used where feasible and reasonable otherwise construction works should not proceed unless attended vibration measurements are undertaken at the commencement of the works. If there is any risk of exceedance of the cosmetic damage objective, a permanent vibration monitoring system should be installed, to warn plant operators (via flashing light, audible alarm, SMS, etc) when vibration levels are approaching the cosmetic damage objective.

Mitigation Measures

The following standard actions and mitigation measures should be implemented, where applicable.

Table 25 Standard Mitigation Measures (Source NSW RMS Construction Noise and Vibration Guideline

Action Required	Applies to	Details
Management		
Implement community consultation or notification measures	Airborne noise. Ground-borne noise & vibration.	Notification detailing work activities, dates and hours, impacts and mitigation measures, indication of work schedule over the night time period, any operational noise benefits from the works (where applicable) and contact telephone number. Notification should be a minimum of 7 calendar days prior to the start of works. For projects other than maintenance works more advanced consultation or notification may be required. Please contact Roads and Maritime Communication and Stakeholder Engagement for guidance. Website (If required) Contact telephone number for community Email distribution list (if required) Community drop in session (if required by approval conditions).
Site inductions	Airborne noise. Ground-borne noise & vibration.	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: all project specific and relevant standard noise and vibration mitigation measures relevant licence and approval conditions permissible hours of work any limitations on high noise generating activities location of nearest sensitive receivers construction employee parking areas designated loading/unloading areas and procedures site opening/closing times (including deliveries) environmental incident procedures.
Behavioural practices	Airborne noise	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors.
Attended vibration measurements	Ground-borne vibration	Where required attended vibration measurements should be undertaken at the commencement of vibration generating activities to confirm that vibration levels are within the acceptable range to prevent cosmetic building damage.
Source Control		
Construction hours and scheduling.	Airborne noise.	Where feasible and reasonable, construction should be carried out during the standard daytime

Action Required	Applies to	Details
	Ground-borne noise & vibration.	working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods.
Construction respite period during normal hours and out-of-hours work	Ground-borne noise & vibration. Airborne noise.	
Equipment selection.	Airborne noise. Ground-borne noise & vibration	Use quieter and less vibration emitting construction methods where feasible and reasonable. For example, when piling is required, bored piles rather than impact-driven piles will minimise noise and vibration impacts. Similarly, diaphragm wall construction techniques, in lieu of sheet piling, will have significant noise and vibration benefits. Ensure plant including the silencer is well maintained.
Plant noise levels.	Airborne-noise.	The noise levels of plant and equipment must have lower sound power level and should be assessed by the acoustic consultant to ensure that the noise emission levels are within the criteria.
Use and siting of plant.	Airborne-noise.	The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down. Noise-emitting plant to be directed away from sensitive receivers. Only have necessary equipment on site.
Plan worksites and activities to minimise noise and vibration.	Airborne noise. Ground-borne vibration.	Locate compounds away from sensitive receivers and discourage access from local roads. Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site. Where additional activities or plant may only result in a marginal noise increase and speed up works, consider limiting duration of impact by concentrating noisy activities at one location and move to another as quickly as possible. Very noise activities should be scheduled for normal working hours. If the work can not be undertaken during the day, it should be completed before 11:00pm. Where practicable, work should be scheduled to avoid major student examination periods when students are studying for examinations such as before or during Higher School Certificate and at the end of higher education semesters.

Action Required	Applies to	Details
		If programmed night work is postponed the work should be re-programmed and the approaches in this guideline apply again.
Reduced equipment power	Airborne noise. Ground-borne vibration.	Use only the necessary size and power
Non-tonal and ambient sensitive reversing alarms	Airborne noise.	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work. Consider the use of ambient sensitive alarms that adjust output relative to the ambient noise level.
Minimise disturbance arising from delivery of goods to construction sites.	Airborne noise.	Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers. Select site access points and roads as far as possible away from sensitive receivers. Dedicated loading/unloading areas to be shielded if close to sensitive receivers. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible. Avoid or minimise these out of hours movements where possible.
Path Control		
Shield stationary noise sources such as pumps, compressors, fans etc.	Airborne noise.	Stationary noise sources should be enclosed or shielded where feasible and reasonable whilst ensuring that the occupational health and safety of workers is maintained.
Shield sensitive receivers from noisy activities.	Airborne noise.	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.

The above standard mitigation measures should be considered during the planning stage, which should be further reviewed and updated when the appropriate construction methodology are known. Additional mitigation measures may be required, some examples are provided below.

Operational Noise Assessment

ACOR Acoustics will review and provide comprehensive recommendations for the building services to achieve the requirements through the design phases when Mechanical documentation will be provided. The following sections provide our general design considerations to be included in the building services design.

Mechanical services are expected to be finalised in further stages of the design and are not available at the time of writing.

General

Small gaps and cracks, or incorrect corner detailing and setting of walls can significantly compromise the acoustic rating of the partitions. It is vital to understand that workmanship must be excellent. All gaps and cracks must be sealed with a resilient, non-hardening mastic that can withstand any movement likely throughout the life of the

rooms. Generally, a polyurethane mastic or fire mastic that allows for minimum 15% joint movement will be acceptable. The top, bottom and sides of all plasterboard walls, as well as all services penetrations must be fully mastic sealed and inspected, prior to any finishing detailing (skirting, architraves and the like) being provided.

P50 shadow line edging and the like can compromise the acoustic rating of the partitions and it is recommended that such edging not be used unless a suitable detail is provided to minimise leakage.

Door seals are to be installed and adjusted correctly to minimise noise leakage. The manufacturer's instructions for best acoustic practice installation should be followed.

Wall penetration details assume the duct is above an acoustic ceiling or below a data floor. If the duct is exposed within the space, additional treatment may be required and will be determined on an individual basis.

Architectural documentation should show mastic sealing at the base and the head of the of Dw 40 (>Rw45) walls, so this is not missed by the contractor. For the acoustic integrity of building elements to be maintained, all gaps and interfaces along the junctions and joints of linings must be sealed with an appropriate acoustic grade sealant. Penetrations for mechanical or electrical services must be properly blocked and sealed around the ductwork/cabling to ensure the intended acoustic rating of the partition is retained.

Appropriate acoustic caulking products include:

Bostik Firemastic

Bostik Seal-n-flex 1

Pyropanel Multiflex

Boral Fyreflex

Sika Sikaflex-11 FC

Waste Pipes, Vent Pipes for Hydraulics Services and Stormwater Pipes

Following recommendations should be adopted where services and/or waste pipes pass through adjacent to any occupied space:

Service/waste pipe should be lagged with minimum 5kg/m2 flexible acoustic barrier bonded with minimum 25mm thick de-coupling convoluted open cell foam. Example of recommended acoustic lagging would be Pyrotek Soundlag 4525C or Thermotic NuWrap 5.

Suspended ceiling should comprise of a minimum one layer of 13mm thick standard plasterboard (8.5 kg/m2) or one layer of 9mm fibre cement board. However, Ceiling requirement would be derived from the floor-ceiling assembly design.

Minimum 75mm, 14kg/m3 acoustic insulation should be laid over the suspended ceiling.

Services must not be chased into concrete, masonry, plasterboard elements.

Vent pipes for hydraulics services (i.e., air moves through these pipes) – acoustic lagging (Pyrotek Soundlag 4525C) is required only for acoustic walls adjacent to teaching rooms, meeting rooms, private office or similar. Partition should be discontinuous or, alternatively, the pipes must be decoupled from the steel structure and plasterboard.

Service Riser

It is recommended that all service/waste pipe in the service riser should be lagged with minimum 5kg/m^2 flexible acoustic barrier bonded with minimum 25mm thick de-coupling convoluted open cell foam. An example of recommended acoustic lagging would be Pyrotek Soundlag 4525C or Thermotic NuWrap 5. Recommended acoustic treatments for the service risers are provided below.

Table 26 Recommendations for services

Location	Acoustic Rating	Recommended Construction
Services adjacent to Habitable area	R_w+C_{tr} 40	A lightweight shaft wall system comprising of the following: Side 1: No lining. This is the riser/shaft side. Frame: 102mm (BMT 0.5mm) C-H Stud at 600mm centre. Between Studs: 1 x 25mm Shaft Liner Panel installed in C-H stud. Cavity Insulation: Install 75mm, 14kg/m^3 acoustic insulation in the cavity between Shaft liner and Side 2. Side 2: 1 x 16mm fire-rated plasterboard (surface mass 12.5kg/m^2).

Electrical Services

All holes for electrical services must be cut or drilled, not punched. Once a cable is passed through an acoustically rated wall, seal the gap around the cable with a resilient, non-hardening mastic. Power points, data outlets and the like must not be installed back-to-back. The minimum offset shall be 300 mm, as shown in Figure 6.6.

Skirting ducts may only pass into the room through the sound lock. If there are any other skirting ducts present, they must be removed so that they do not compromise the acoustic rating of the as-built partition.

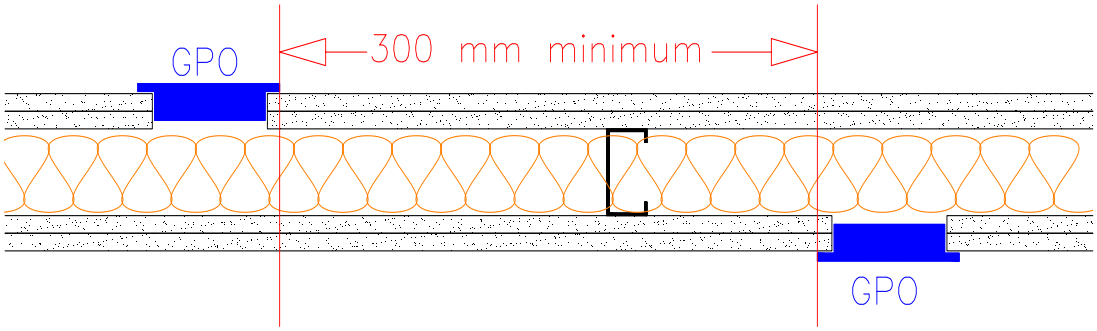

Figure **Error! No text of specified style in document.**.6 Power Point Offset

It is recommended to use Acoustic GPO (R_w 45) in the acoustic rated wall.

Hydraulic Services and Mechanical Ductwork Penetrations

All holes for sprinkler pipework must be cut or drilled, not punched. Seal around pipes with a resilient, non-hardening mastic. If the gap is greater than 5 mm, a plasterboard patch is likely to be necessary to reduce this gap. The patch must be screwed and glued using the resilient mastic as shown in Figure 6.7, pending a review by the security consultant as to their requirements.

These details assume the duct is above an acoustic ceiling or below a data floor. If the duct is exposed within the space, additional treatment may be required and will be determined on an individual basis.

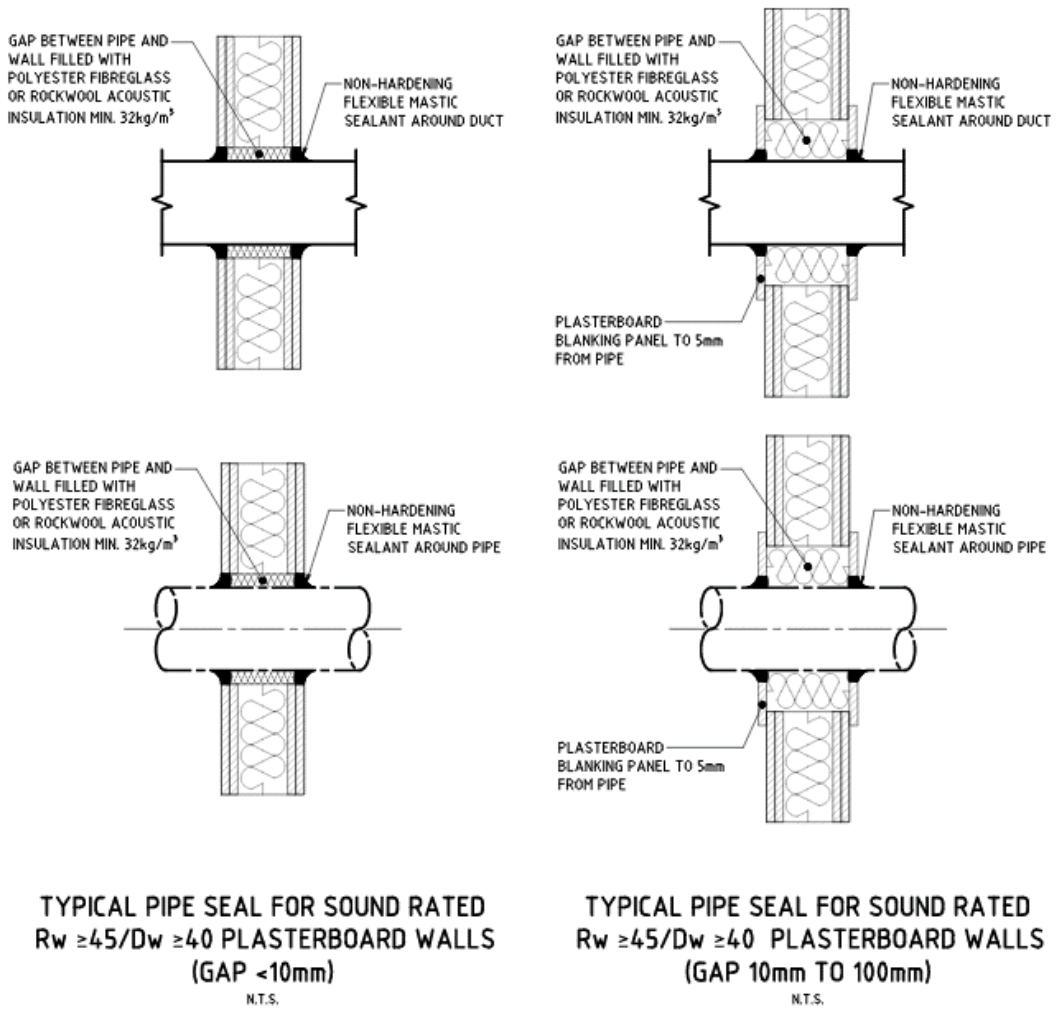

Figure **Error! No text of specified style in document.**.7 Sprinkler Pipe and Duct Penetration of Acoustic Walls

The same method can be used for sealing around mechanical ducts where they pass through acoustically rated walls. Additional metal angles, etc. are not considered necessary unless required for other reasons.

Cable Tray Detailing

Ideally, cable trays should run down the hallway, entering each room above the ceiling. At the doorway. If the cable tray runs down the building above the offices and meeting rooms, the detail shown in Figure 6.8 can be used.

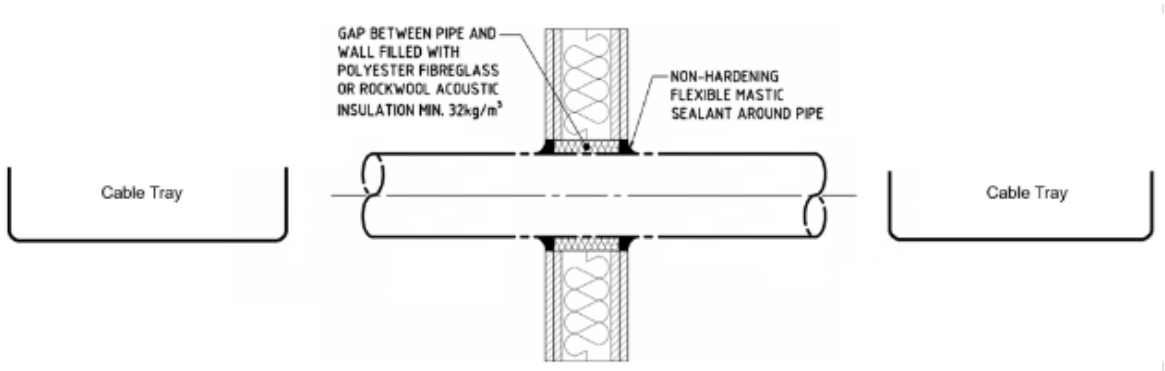

Figure **Error! No text of specified style in document.**.8 Cable Penetration Detailing – Pipe Penetrations

Vibration Isolation

All mechanical services plant, equipment and associated ancillaries, and hydraulic services, should be mounted or supported using vibration isolating elements to minimise the transmission of structure-borne noise throughout the building. This includes all building services, such as ductwork and pipework.

It is recommended that all plant, including but not limited to, outdoor condenser units, outdoor fans and pumps be mounted on vibration mounts that achieve an isolation efficiency of at least 95%. Similarly, all in-ceiling fans and fan coil units will need to be supported using isolated hangers.

There should be a flexible coupling or connection installed between each item of plant, such as a fan, air handling unit or pump, and the associated ductwork and pipework.

Rigid contact between ductwork or pipework and the building structure should be avoided by mounting the duct or pipe such that contact does not occur, or by installing a 6mm thick neoprene strip between the duct or pipe and the building structure for cases where space constraints are an issue.

All pipework should be isolated at support points. Main riser and dropper pipes should be supported from the floor slabs only, and mounting points on lightweight walls between the slabs should not be used. All branch and main riser pipes must be supported by rubber lined clips or vibration-isolated hangers.

Pipework should only be located in dividing walls if the dividing walls are of a discontinuous construction. Pipes in dividing walls should be supported by resilient clamps and only be mounted to the wall leaf adjacent to the room served by the pipe, or the wall leaf adjacent to the least noise sensitive space in the case of common pipework. If a pipe is required to be installed in single framed stud wall, the pipe should be connected to the stud frame using vibration isolating elements, for e.g., rubber lined clips or resilient mounts.

Control of Building Services Noise (Noise Emission to Outdoor)

Compliance with NSW EPA Noise Policy for Industry 2017 is a legislative requirement in the State of New South Wales. The Policy prescribes procedures for determining the statutory environmental noise limits that apply at noise sensitive locations (such as residential areas) due to noise due to commercial, industrial and trade operations.

As the proposed development may include centralised plant located on the roof or in common areas, noise emissions from the proposed development are required to comply with these requirements.

At this preliminary design stage, information regarding mechanical services design is no available. However, this will be reviewed in further stages of the project.

Chiller Noise

In order to minimise the noise impacts from the Chiller adjacent to the north facing bedrooms, it is recommended that an acoustic noise barrier is placed adjacent to the bedrooms. The predictions indicate that an acoustic barrier is required to comply with indoor noise criteria as per Section **Error! Reference source not found.**. The predictions were based on the following outdoor acoustic fence construction:

Acoustic solid barrier

A solid layer with a minimum 15 kg/m^2 surface mass of compressed FC, i.e Cemitel or James Hardie 9mm CFC sheet or equivalent prefabricated material (such as Wallmark EvoWall or equivalent) on framing with no openings/holes. Barrier material is to be reviewed by structural engineer.

Alternative to a solid barrier, PALSUN Polycarbonate 12mm thick, or equivalent transparent barrier can be utilised which would provide a minimum sound insertion loss of R_w 31. There should be no gap between the bottom of the noise barrier and the ground, with the exception for drainage purposes.

Constructed to a minimum 2.7m height and as drawn in the red line in Figure 6.9.

Figure **Error! No text of specified style in document.**.9 Acoustic Noise Barrier

Plant Room Noise

It is understood the following Condenser Units will be housed within the southeastern plant room (Figure 6.10).

Description / Comment	Weighting		Octave Band Centre Frequency, Hz							
	Lin	A	63	125	250	500	1k	2k	4k	8k
A Weighting			-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1
REYQ18BYM9	78	69	69	74	72	68	63	56	52	45
REYQ24YM9	88	75	85	83	78	73	69	63	57	49

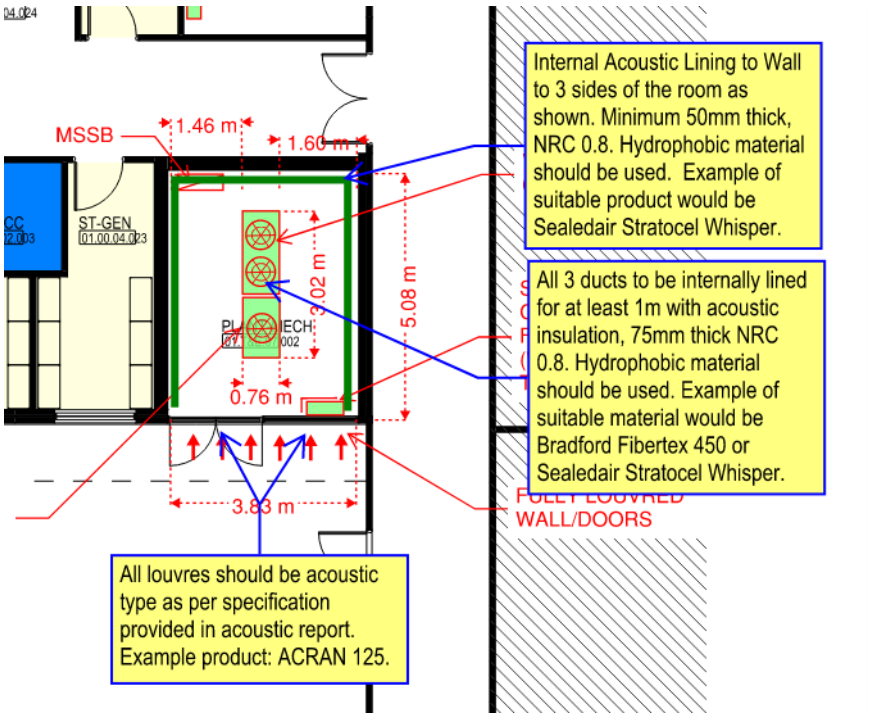

Figure **Error! No text of specified style in document.**.10 South East Plant Room

In order to satisfy the internal noise limits within the development and noise limits at adjacent buildings, the following treatment methodologies should be implemented.

Acoustic Louvre Door

It is recommended that an acoustic louvre is placed at the plant room, as shown in Figure **Error! No text of specified style in document.**.10. The minimum required insertion loss for acoustic louvres are specified in Table 27 below.

Table 27 Acoustic Louvre Minimum Insertion Loss

Type	Octave – Band Centre Frequencies Transmission Loss							
	63	125	250	500	1000	2000	4000	8000
ACRAN acoustic louvre, Series 125 - 125mm depth	4	8	8	10	15	21	21	8

Rooftop Discharge

In addition to the acoustic louvre on the facade, it is recommended that the ductwork connecting the top of the Condenser Units to the rooftop discharge locations (Figure 6.11 in blue) are comprised of 75mm 32 kg/m^3 internal acoustic insulation for a distance of no less than 1 metre. Acoustic insulation should be hydrophobic for exposure to weather. Example of suitable product would be Sealed Air Stratocell Whisper 50mm.

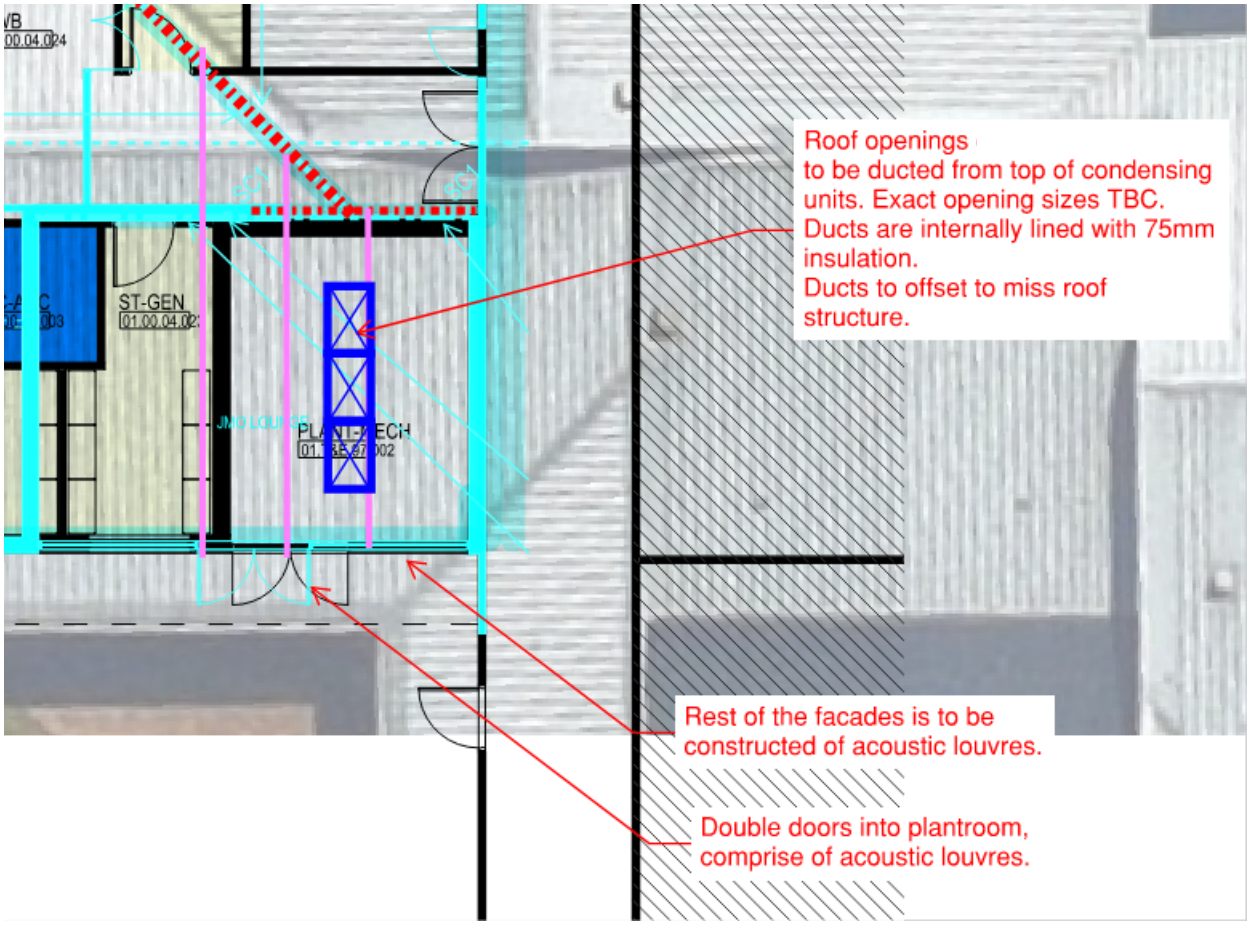

Figure **Error! No text of specified style in document.**.11: Rooftop Discharge

Acoustic Lining to the internal Wall of the Plantroom

Provided there would be a partial or full opening of the roof of the mechanical plant room (other than the 3 ducts), it is recommended that the three side walls of the plantroom are lined to full height of the wall with acoustic absorbing material, 50mm thick, NRC 0.8. This is shown in Figure **Error! No text of specified style in document.**.10. Example of suitable material would be 50mm thick Sealed Air's Stratocell Whisper. This should be checked with fire engineer for suitability of use.

Fan Coil Units

Error! Reference source not found. presents a summary of treatment options to the fan coil units, based on the information provided. Acoustic calculations have been based on units running at 100% capacity.

Table 28 FCU acoustic treatment

Unit	Supply Air	Return Air	Casing Radiated
AC-PCU-1 AC-PCU-2 AC-PCU-3 AC-PCU-4 AC-PCU-5 AC-PCU-6 AC-PCU-7 AC-PCU-8 AC-PCU-9 AC-PCU-10 AC-PCU-11 AC-PCU-12 AC-PCU-16 AC-PCU-21 AC-PCU-22	Minimum 1.5m of rigid ductwork lined with 50mm 32 kg/m^3 glass wool insulation with before first outlet. Minimum 1m acoustic flexible ductwork on all outlets. Insulation must be wrapped with Melinex or equivalent.	Minimum 1.5m of rigid ductwork lined with 50mm 32 kg/m^3 glass wool insulation with one 90 degree lined elbow between fan and first flexible duct inlet. Insulation must be wrapped with Melinex or equivalent.	Minimum 10mm standard (5.7kg/m2) plasterboard or CAC 40 Ceiling Tile finish between FCU and room below.
AC-PCU-17 AC-PCU-18 AC-PCU-19	Minimum 1m of rigid ductwork lined with 50mm 32 kg/m^3 glass wool insulation with before first outlet. Minimum 1m acoustic flexible ductwork on all outlets. Insulation must be wrapped with Melinex or equivalent.	Minimum 1m of rigid ductwork lined with 50mm 32 kg/m^3 glass wool insulation with one 90 degree lined elbow between fan and first flexible duct inlet. Insulation must be wrapped with Melinex or equivalent.	
AC-PCU-20 AC-PCU-14 AC-PCU-15 AC-PCU-13	Minimum 2m of rigid ductwork lined with 50mm 32 kg/m^3 glass wool insulation with before first outlet. Minimum 1m acoustic flexible ductwork on all outlets. Insulation must be wrapped with Melinex or equivalent.	Minimum 2m of rigid ductwork lined with 50mm 32 kg/m^3 glass wool insulation with one 90 degree lined elbow between fan and first flexible duct inlet. Insulation must be wrapped with Melinex or equivalent.	

Notes:

(1) Flexible connections on all supply and return ductwork all fans.

(2) FCU should be mounted/supported on rubber isolator hangers with minimum 12mm static deflection to avoid structure borne noise and excessive vibration experienced inside the building. The ductworks (SA and RA) should be connected to the associated unit via flexible connections (Getzner, Embelton or equivalent).

(3) Acoustic flexible ductwork should not penetrate acoustic full height walls

Fans

Table 29 presents a summary of treatment options to the fans, based on the information provided. Acoustic calculations have been based on units running at 100% capacity.

Table 29 Fans acoustic treatment

Unit	Outlet Air	Intake Air	Casing Radiated
EAF-PCU-2 GEF-PCU-1 GEF-PCU-3	Minimum 1.5m of rigid ductwork lined with 50mm 32 kg/m^3 glass wool insulation with before first outlet. Insulation must be wrapped with Melinex or equivalent.	Minimum 1.5m of rigid ductwork lined with 50mm 32 kg/m^3 glass wool insulation between fan and intake grille must be wrapped with Melinex or equivalent.	Minimum 10mm standard (5.7kg/m2) plasterboard or CAC 40 Ceiling Tile finish between FCU and room below.
EAF-PCU-3 EAF-PCU-1 GEF-PCU-2	Minimum 2m of rigid ductwork lined with 50mm 32 kg/m^3 glass wool insulation with before first outlet. Insulation must be wrapped with Melinex or equivalent.	Minimum 2.5m of rigid ductwork lined with 50mm 32 kg/m^3 glass wool insulation between fan and intake grille must be wrapped with Melinex or equivalent.	
OAF-PCU-1 OAF-PCU-2	Minimum 2.5m of rigid ductwork lined with 50mm 32 kg/m^3 glass wool insulation with before first outlet. Insulation must be wrapped with Melinex or equivalent.	Minimum 2m of rigid ductwork lined with 50mm 32 kg/m^3 glass wool insulation between fan and intake grille must be wrapped with Melinex or equivalent.	
EAF-PCU-4	Minimum 3m of rigid ductwork lined with 50mm 32 kg/m^3 glass wool insulation with before first outlet. Insulation must be wrapped with Melinex or equivalent.	Minimum 2m of rigid ductwork lined with 50mm 32 kg/m^3 glass wool insulation between fan and intake grille must be wrapped with Melinex or equivalent.	

Notes:

(1) Fan should be mounted/supported on rubber isolator hangers with minimum 12mm static deflection to avoid structure borne noise and excessive vibration experienced inside the building. The ductworks (SA and RA) should be connected to the associated unit via flexible connections (Getzner, Embelton or equivalent).

Acoustic flexible ductwork should not penetrate acoustic full height walls.

Conclusion

ACOR Consultants Pty Ltd (ACOR) has undertaken an acoustic review of the proposed World Class End of Life Program, to be located at Wyong. Acoustic design review and recommendations are provided to achieve the relevant acoustic criteria for this project, as per below:

- NSW Noise Policy for Industry (NPI) 2017 and NSW Health – Engineering Services Guidelines 2022.
- NSW EPA Noise Policy for Industry 2017 (NPI).

It is predicted that the proposed development would achieve the relevant noise criteria, provided the design recommendations are implemented.

We trust this information provided in this report meets your requirements. If you have any questions, please do not hesitate to contact ACOR.

Yours sincerely

ACOR Consultants Pty Ltd

Thomas Lee

Acoustics Engineer

Glossary of Acoustic Terms

A-weighting	Frequency weighting applied to the level in each stated octave band by a specified amount, in order to better represent the response of the human ear. The letter 'A' will follow a descriptor, indicating the value has been 'A' weighted. An 'A' weighted noise level may also be written as dB(A).
Ctr	The spectrum adaptation term Ctr adjustment factor takes account of low frequency noise.
CAC	Ceiling Attenuation Class. The CAC determines how much cross-talk will occur between one room and another through the ceiling cavity where both rooms have the tested ceiling tile. This is an ideal situation, with no wall head leaks and no services penetrations in the ceiling. Therefore, it defines the ideal, best possible result as tested in a laboratory
dB	Decibel. This is the unit measurement of sound.
dBA	A weighted decibel is the most commonly used descriptor. The A weighting is an adjustment to the raw sound level to approximate what the average human ear can hear, which is less sensitive at very low and very high frequencies.
Dw	The Weighted Level Difference as defined in AS/NZS ISO 717.1:2004. This is the single number rating describing the ability of a partition to reduce noise as measured in the field with no standardisation or normalisation.
DnTw	The Weighted standardised level difference as defined in AS/NZS ISO 717.1:2004. This is the single number rating describing the ability of a partition to reduce noise as measured in the field. The higher the DnTw rating, the better is the acoustic performance of the wall or floor.
DnTw + Ctr	DnTw + Ctr is DnTw with the addition of a low frequency sound correction factor Ctr (always a negative number remember). Rw + Ctr is used because of the increase in low frequency sound sources such as surround sound systems, drums or bass guitars, and of course traffic or aircraft noise. Two walls can have the same DnTw rating, but have different resistance to low frequency sound, thus a different DnTw + Ctr.
Lw or SWL	Sound power level. This is the total radiated sound energy.
Lp or SPL	Sound pressure level. This is the measurable sound level at a given distance from an item.
Lmax	The RMS maximum noise level of a measurement
L10	90th percentile sound level of a measurement. Often called the average maximum noise level
Leq	The energy average noise level of a measurement.
L90	10th percentile sound level of a measurement. Often called the average background noise level
Leq(T)	The time (T) equivalent energy noise level. The time interval is often in blocks of 10 or 15 minutes for short term measurements, or hours for long-term measurements. Common increments for long term measurements are 1 hour, day, night, 18 hours and 24 hours.
Leq(8h)	The 8 hour equivalent energy noise level. Primarily used for occupational noise assessments
LCpeak	The C weighted peak noise level. Primarily used for occupational noise assessments
Ln,w	The Weighted Normalized Impact Sound Pressure Level. This is a single number rating describing the impact sound performance of a floor ceiling assembly as measured in a laboratory. Assessed in accordance with AS/NZS ISO 717.2. The lower the Ln,w rating, the better is the impact sound isolation performance of a floor-ceiling assembly
L'n'Tw	The weighted standardized impact sound pressure level. This is a single number rating describing the impact sound performance of a floor ceiling assembly as measured in a filed. Assessed in accordance with AS/NZS ISO 717.2. The lower the L'nT,w rating, the better is the impact sound isolation performance of a floor-ceiling assembly

Rw	The Weighted Sound Reduction Index. This is the single number rating describing the ability of a building element to reduce noise as measured in a laboratory. Assessed in accordance with AS/NZS ISO 717.1. The higher the Rw rating, the better is the acoustic performance of the wall or floor.
Rw + Ctr	Rw + Ctr is Rw with the addition of a low frequency sound correction factor Ctr (always a negative number remember). Rw + Ctr is used because of the increase in low frequency sound sources such as surround sound systems, drums or bass guitars, and of course traffic or aircraft noise. Two walls can have the same Rw rating, but have different resistance to low frequency sound, thus a different Rw + Ctr.
A-weighting	Frequency weighting applied to the level in each stated octave band by a specified amount, in order to better represent the response of the human ear. The letter 'A' will follow a descriptor, indicating the value has been 'A' weighted. An 'A' weighted noise level may also be written as dB(A).
Ctr	The spectrum adaptation term Ctr adjustment factor takes account of low frequency noise.
CAC	Ceiling Attenuation Class. The CAC determines how much cross-talk will occur between one room and another through the ceiling cavity where both rooms have the tested ceiling tile. This is an ideal situation, with no wall head leaks and no services penetrations in the ceiling. Therefore, it defines the ideal, best possible result as tested in a laboratory
dB	Decibel. This is the unit measurement of sound.
dBA	A weighted decibel is the most commonly used descriptor. The A weighting is an adjustment to the raw sound level to approximate what the average human ear can hear, which is less sensitive at very low and very high frequencies.
Dw	The Weighted Level Difference as defined in AS/NZS ISO 717.1:2004. This is the single number rating describing the ability of a partition to reduce noise as measured in the field with no standardisation or normalisation.
DnTw	The Weighted standardised level difference as defined in AS/NZS ISO 717.1:2004. This is the single number rating describing the ability of a partition to reduce noise as measured in the field. The higher the DnTw rating, the better is the acoustic performance of the wall or floor.
DnTw + Ctr	DnTw + Ctr is DnTw with the addition of a low frequency sound correction factor Ctr (always a negative number remember). Rw + Ctr is used because of the increase in low frequency sound sources such as surround sound systems, drums or bass guitars, and of course traffic or aircraft noise. Two walls can have the same DnTw rating, but have different resistance to low frequency sound, thus a different DnTw + Ctr.
Lw or SWL	Sound power level. This is the total radiated sound energy.
Lp or SPL	Sound pressure level. This is the measurable sound level at a given distance from an item.
Lmax	The RMS maximum noise level of a measurement
L10	90th percentile sound level of a measurement. Often called the average maximum noise level
Leq	The energy average noise level of a measurement.
L90	10th percentile sound level of a measurement. Often called the average background noise level
Leq(T)	The time (T) equivalent energy noise level. The time interval is often in blocks of 10 or 15 minutes for short term measurements, or hours for long-term measurements. Common increments for long term measurements are 1 hour, day, night, 18 hours and 24 hours.
Leq(8h)	The 8 hour equivalent energy noise level. Primarily used for occupational noise assessments
LCpeak	The C weighted peak noise level. Primarily used for occupational noise assessments
Ln,w	The Weighted Normalized Impact Sound Pressure Level. This is a single number rating describing the impact sound performance of a floor ceiling assembly as measured in a laboratory. Assessed in accordance with AS/NZS ISO 717.2. The lower the Ln,w rating, the better is the impact sound isolation performance of a floor-ceiling assembly

L'n'Tw	The weighted standardized impact sound pressure level. This is a single number rating describing the impact sound performance of a floor ceiling assembly as measured in a filed. Assessed in accordance with AS/NZS ISO 717.2. The lower the L'nT,w rating, the better is the impact sound isolation performance of a floor-ceiling assembly
Rw	The Weighted Sound Reduction Index. This is the single number rating describing the ability of a building element to reduce noise as measured in a laboratory. Assessed in accordance with AS/NZS ISO 717.1. The higher the Rw rating, the better is the acoustic performance of the wall or floor.
Rw + Ctr	Rw + Ctr is Rw with the addition of a low frequency sound correction factor Ctr (always a negative number remember). Rw + Ctr is used because of the increase in low frequency sound sources such as surround sound systems, drums or bass guitars, and of course traffic or aircraft noise. Two walls can have the same Rw rating, but have different resistance to low frequency sound, thus a different Rw + Ctr.

officeAddress
officePostalAddress
T officeTelephone

Additional Mitigation Measures

For calculated noise levels the tables show additional measures to be implemented for each receiver depending on how far above the background noise level or NML the impact is. These measures are most appropriate for shorter term works. For distance-based assessments the distances where additional mitigation measures should be implemented are identified by cross referencing the Mitigation Levels in

Table 30: Triggers for Additional Mitigation Measures - Airborne Noise (Source: NSW RMS Construction Noise and Vibration Guideline)

Predicted airborne $L_{Aeq(15min)}$ noise level at receiver			Additional mitigation measures	
Perception	dB(A) above RBL	dB(A) above NML	type[1]:	Mitigation Levels[2]:
All hours				
75dBA or greater			N, V, PC, RO	HA
Standard Hours: Mon - Fri (7am – 6pm), Sat (8am – 1pm), Sun/Pub Hol (Nil)				
Noticeable	5 to 10	0	-	NML
Clearly Audible	10 to 20	< 10	-	NML
Moderately intrusive	20 to 30	10 to 20	N, V	NML+10
Highly intrusive	> 30	> 20	N, V	NML+20
OOHW Period 1: Mon – Fri (6pm – 10pm), Sat (7am – 8am & 1pm – 10pm), Sun/Pub Hol (8am – 6pm)				
Noticeable	5 to 10	< 5	-	NML
Clearly Audible	10 to 20	5 to 15	N, R1, DR	NML+5
Moderately intrusive	20 to 30	15 to 25	V, N, R1, DR	NML+15
Highly intrusive	> 30	> 25	V, IB, N, R1, DR, PC, SN	NML+25
OOHW Period 2: Mon – Fri (10pm – 7am), Sat (10pm – 8am), Sun/Pub Hol (6pm – 7am)				
Noticeable	5 to 10	< 5	N	NML
Clearly Audible	10 to 20	5 to 15	V, N, R2, DR	NML+5
Moderately intrusive	20 to 30	15 to 25	V, IB, N, PC, SN, R2, DR	NML+15
Highly intrusive	> 30	> 25	AA, V, IB, N, PC, SN, R2, DR	NML+25

Where;

- AA = Alternative Accommodation R1 = Respite Period 1
- V = Verification PC = Phone calls
- IB = Individual briefings SN = Specific notifications
- N = Notification
- R2 = Respite Period 2
- DR = Duration Respite
- Perception = relates to level above RBL
- NML = Noise Management Level
- HA = Highly Affected (> 75 dB(A) - applies to residences only)

During long term works or at fixed sites the additional mitigation measures above may become less effective. In these situations at-receiver noise mitigation may be considered where feasible and reasonable if options for at source noise mitigation and management measures have been exhausted.

At receiver mitigation may include temporary window and door screens, temporary localised shielding or permanent forms of mitigation.

Feasible and reasonable considerations for providing at-receiver treatments should include:

- time of day of the noise increase and exceedance of criteria
- time of use of affected receivers
- how many decibels the noise levels are to increase
- how long the mitigation will provide benefit to the receiver during the project
- optimal design of acoustic sheds and noise barriers/hoardings

Mitigation – Ground borne Noise

Table 31: Triggers for Additional Mitigation Measures - Vibration

Predicted ground-borne $L_{Aeq(15min)}$ noise level at receiver		Additional mitigation measures	
perception	dB(A) above GB NML	type[1]:	apply to[2]:
Standard Hours: Mon - Fri (7am – 6pm), Sat (8am – 1pm), Sun/Pub Hol (Nil)			
N/A	Vibration only applicable during standard hours		
OOHW Period 1: Mon – Fri (6pm – 10pm), Sat (7am – 8am & 1pm – 10pm), Sun/Pub Hol (8am – 6pm)			
Clearly Audible	< 10	N	All
Moderately intrusive	10 to 20	V, N, R1, DR SN	All
Highly intrusive	> 20	V, IB, N, PC, SN, R1, DR	All
OOHW Period 2: Mon – Fri (10pm – 7am), Sat (10pm – 8am), Sun/Pub Hol (6pm – 7am)			
Clearly Audible	< 10	V, N, SN	All
Moderately intrusive	10 to 20	AA, V, IB, N, PC, RP, SN, R2, DR	All
Highly intrusive	> 20	AA, V, IB, N, PC, RP, SN, R2, DR	All

Notes:

- 1 AA = Alternative accommodation
- RO = Project specific respite offer
- V = Validation of predicted noise levels
- PC = Phone calls
- IB = Individual briefings SN = Specific notifications
- N = Notification drops
- 2 All affected receivers