

NOISE AND VIBRATION MONITORING REPORT SEPTEMBER 2023

**LIVERPOOL HEALTH AND ACADEMIC
PRECINCT**

LENDLEASE BUILDING PTY LTD



PROPERTY RISK AUSTRALIA



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This report has been prepared with information available at the time of report preparation and within the time and budgetary constraints imposed by the Client. PRA does not accept responsibility for inaccurate or incomplete information provided by the Client or third parties, nor for updates or changes to information made after the preparation of this report.

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DOCUMENT QUALITY CONTROL

Report Title:	Noise and Vibration Monitoring Report - September 2023			
Site Name:	Liverpool Health and Academic Precinct			
Site Address:	Goulburn Street, Liverpool NSW 2170			
Client Name:	Lendlease Construction Pty Ltd			
Job Number:	PRJ-000719			
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1 INTRODUCTION

Property Risk Australia Pty Ltd (PRA) conduct construction noise and vibration monitoring on behalf of Lendlease Construction Pty Ltd (Lendlease, the 'Client') for the redevelopment works at Liverpool Health and Academic Precinct, Goulburn Street, Liverpool NSW 2170 (hereafter the 'site') throughout the duration of main stage 1 and 2 works. The site and redevelopment locations are provided in **Appendix A – Figures 1 and 2**.

1.1 Scope

The objective of the noise and vibration monitoring is to assist with management during the works by providing ongoing unattended noise monitoring to assess compliance against the project Noise Management Levels (NMLs) and real-time vibration monitoring. Noise and vibration alerts are provided to the project team based on real time monitoring at sensitive receivers located at the site's periphery. This report will provide guidance to Lendlease regarding the noise and vibration levels present at Liverpool Hospital during September 2023.

2 GUIDELINES AND STANDARDS

The primary guidelines, specifications, and policy documents relevant to the monitoring include, but are not limited to:

- o NSW DECCW *Interim Construction Noise Guideline (ICNG) 2009*.
- o NSW DEC *Assessing Vibration: A Technical Guideline 2006*.
- o Australian Standard AS 2436:2010 '*Acoustics – Guide to Noise Control on Construction, Maintenance and Demolition Sites*'.
- o British Standard 6472: *Guide to evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)*.
- o British Standard 7385: Part 2 – *Evaluation and measurement of vibration in buildings*.
- o German Standard DIN 4150: *Structural Vibration in Buildings - Effects on Structures*.

3 PROJECT OVERVIEW

3.1 Site Location and Existing Environment

Liverpool Hospital, located 26 kilometres south-west of the Sydney CBD, is part of the South-Western Sydney Local Health District. It is bound by Goulburn Street to the West, Elizabeth Street to the South and Campbell Street to the North and is bisected by the Sydney Trains Main South Railway Line.

The area immediately surrounding the hospital features a variety of usages including Bigge Park to the south, educational institutions such as Liverpool Boys and Girls High Schools to the North and TAFE NSW to the south. A variety of mixed use (B4) and high-density residential properties (R4) are located to the west and whilst general industrial (IN1) activity dominates the east.

The sites regional setting and stages of work are presented in **Appendix A – Figure 1**.

3.2 Summary of Works

The Liverpool Health and Academic Precinct is a \$790 million dollar project to located at Liverpool Hospital. Early works, which included various services and infrastructure upgrades, concluded in August 2021 and are now followed by main stage work which include the following:

- o An integrated cancer centre with inpatient, ambulatory, diagnostic, outpatient, and research facilities.
- o Critical care services including an emergency department, intensive care facilities and specialist care nursery.
- o Maternity and podiatric inpatient and ambulatory facilities.
- o An aged care and rehabilitation centre.
- o Ambulatory care and outpatient clinical services.
- o A new multi-storey carpark.

The work is divided into two stages with the first stage including redevelopment of the hospitals main entrance, maternity services, outpatient and support services and includes the development of a new pathology department and expansion of the pre-existing emergency department. The second stage of works includes construction of the new Integrated Services Building, a new wellness centre and loading dock. Other areas of the hospital are also scheduled to be refurbished throughout the works.

4 CONSTRUCTION NOISE MONITORING

4.1 Unattended Noise Monitoring

Two (2) NATA-calibrated unattended noise monitoring systems were deployed at Liverpool Hospital to conduct noise monitoring throughout September 2023. Noise monitoring was performed using ARL NGARA 4G Class 1 sound level meters which were field calibrated using handheld Pulsar model 105 field calibrators prior to monitoring. Monitoring was continuous, taking place during day, evening, and night periods with a trigger point set at the project noise management levels to capture exceedances which sends alerts to the client. Each of the relevant NATA calibration certificates can be found in **Appendix C**.

The monitors were placed at locations representative of the ambient noise experienced by the hospital occupants and neighbouring sensitive receivers in accordance with the NSW DECCW *Interim Construction Noise Guidelines (ICNG)* and AS 2436:2010.

4.2 Noise Management Levels

Background noise monitoring was undertaken by Acoustic Logic in June 2018 (EIS ref.: *Appendix A SSD Acoustic Assessment 4_kh*) to establish rating background levels (RBLs) for the site. The RBLs were used to calculate the Noise Management Levels (NMLs) for the site (**Table 1**) in accordance with the ICNG.

Table 1: Unattended Noise Monitor Locations and Rating Background Levels

Monitor Number	Receiver	Noise Management Levels, $L_{Aeq, 15min}$ (dB)		
		Day (7am – 6pm)	Evening (6pm -10pm)	Night (10pm – 7am)
N1	External, Goulburn Residential Balcony	52	47	44
N2	Internal, level 1, Audiology Storeroom	45		

4.3 Unattended Noise Monitoring Results

Table 2 contains a summary of the noise data by comparing the percentage of noise readings during construction that exceed the NMLs by various amounts. **Appendix B** contains a full list of the noise readings for the month.

Table 2: Summary of Unattended Noise Monitoring During Construction Hours

Criterion	Exceedance	N1: 55-59 Goulburn Street, Balcony	N2: Level 1, Audiology NUM Office
Noise Affected NML <i>L_{Aeq, 15min} (dB)</i>	≤0 dB	0.1%	81.2%
	>0 and ≤5 dB	50.3%	15.5%
	>5 and ≤10 dB	43.8%	2.9%
	>10 and ≤15 dB	3.9%	0.1%
	>15 and ≤20 dB	1.0%	0.0%
	>20 dB	0.9%	0.3%
Highly Noise Affected NML, <i>L_{Aeq, 15min} (dB)</i>	Exceedance	0.6%	0.2%

4.4 Noise Discussion

Noise levels at location N1 (residential property opposite the site on Goulburn Road) exceeded the Highly Noise Affected NML during operational hours on two occasions:

- Thursday 7th September 2023 at 13:45-14:30hrs; and
- Tuesday 19th September 2023 at 15:30hrs.

Noise levels were rarely (0.1%) below the Noise Affected NML at any time within and outside the site’s operating hours. This indicates that noise from other sources, most notably from road traffic on Goulburn Road, is a significant influence and likely attributable to many of exceedances during operating hours. Noise levels during operating hours did not exceed the Noise Affected NML by more than 10 dB most (94.2%) of the time compared to 77.0% outside of operating hours. This further indicates that there is a significant level of background noise in the area surrounding the site.

Noise levels at location N2 (Audiology) did not exceed the Noise Affected NML for over three-quarters of the time (81.2%) during operating hours. Noise levels during operating hours did not exceed the Noise Affected NML by more than 10 dB almost all of the time (99.6%).

There were exceedances above the Highly Noise Affected NML during operational hours on two occasions:

- Wednesday 20th September 2023 at 17:00hrs; and
- Thursday 21st September 2023 at 12:15hrs.

5 VIBRATION MONITORING

5.1 Vibration Criteria

Condition C20 of the Planning approval (SSD 10389) states that vibration caused by construction must be limited to the criteria contained within the latest version of German standard *DIN 4150-3 Vibrations in buildings - Part 3: Effects on structures*. That standard provides recommendations for vibration levels below which cosmetic or structural damage is unlikely. Vibration criteria are specified in terms of Peak Particle Velocity (PPV) in various frequency ranges for different types of building construction. The criteria apply to vibration in the building foundations.

Vibration criteria to assess human response are specified within the EPA guidelines *Assessing Vibration: A Technical Guideline* (2006). The guideline is based on British Standard *BS 6472:1992 Evaluation of human exposure to vibration in buildings (1-80 Hz)*. That standard evaluates the probability of adverse comment from occupants of various buildings usages in terms of Vibration Dose Value (VDV). VDV is a root-mean-quad average of frequency-weighted vibration acceleration on the floor(s) of the building.

Table 3 contains vibration criteria adopted for the project. These are in terms of vibration velocity (PPV) and are from *Appendix C* of the EPA guidelines.

Table 3: Project Vibration Criteria

Place	Period	Preferred Value, PPV (mm/s)	Maximum Value, PPV (mm/s)
Critical Working Areas (e.g., hospital operating theatres, precision laboratories)	Day or Night-Time	0.14	0.28

For additional context, **Table 4** reproduces suggestions of expected community reactions to various levels of construction vibration from British Standard *BS 5228-2:2009*.

Table 4: Guidance on the Effects of Ground Vibration Levels (BS 5228-2:2009, Annex B)

Peak Vibration Level (mm/s)	Likely Stakeholder Response
0.14	Barely perceptible to all but the most sensitive situations for construction related environmental vibration.
0.3	Barely perceptible in residential settings.
1.0	Strong likelihood for a complaint – it is recommended warning is given before work commences.
10	Vibration is intolerable for any more than a very brief exposure period.

5.2 Unattended Vibration Monitoring

One (1) NATA calibrated unattended vibration monitor was deployed within the Liverpool Hospital oncology bunker to conduct building vibration monitoring. Vibration monitoring was performed using a Profound Vibra+, which log Peak Particle Velocity (PPV). **Appendix C** contains copies of the NATA calibration certificate.

During September 2023, there were no vibration monitoring results due to a battery power supply issue and hospital restrictions that prevented the relocation of vibration monitor to a suitable location



with access to mains power. A replacement vibration monitor is scheduled for installation in October 2023.

5.3 Vibration Results

No results are available for the monitoring period of 1 September 2023 to 30 September 2023.



APPENDIX A FIGURES



Title:	Site Location and Regional Context
Project ID:	PRJ-000719
Project Location:	Liverpool Health and Academic Precinct Elizabeth and Goulburn Street, Liverpool NSW 2170
Figure Number:	01
Client:	Lendlease Construction Pty Ltd
Map Scale:	1:8,000
CRS:	GDA2020 / MGA zone 56
Source:	SixMaps
Prepared By:	Brendon Phan
Reviewed By:	Scott Bamford
Date:	05/07/2023
Revision:	V1

Legend

- Site Boundary
- Buildings**
- Scheduled for Demolition
- Hospital Structure
- Sensitive Receptor
- Demolished
- Critical Infection Control Zones

All extents and locations are approximate.



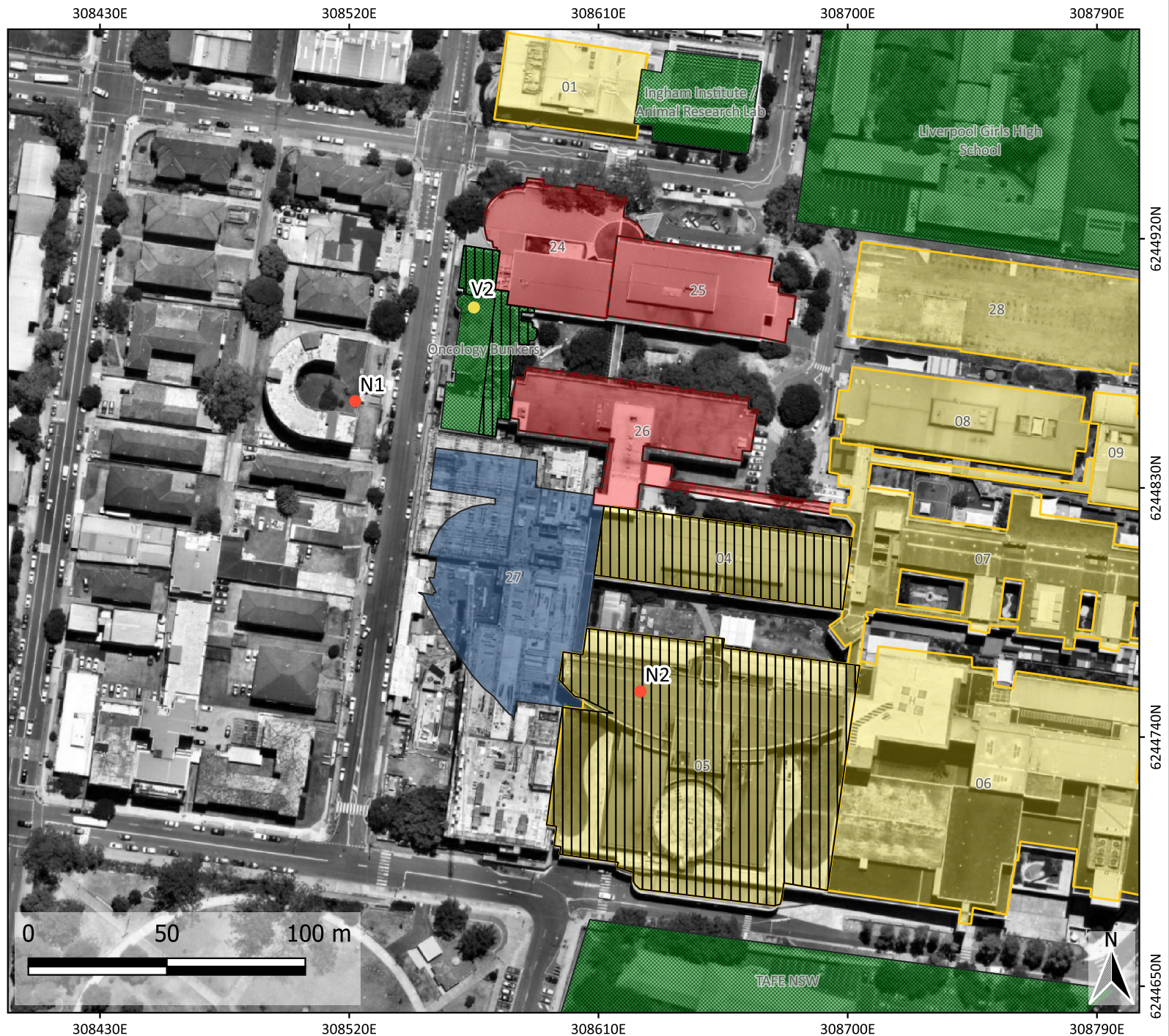


Title:	Noise and Vibration Monitoring Locations
Project ID:	PRJ-000719
Project Location:	Elizabeth & Goulburn Street, Liverpool, NSW 2170
Project Description:	Environmental Noise and Vibration Monitoring at Liverpool Health and Academic Precinct Site
Figure Number:	02
Client:	Lendlease Construction Pty Ltd
Map Scale:	1:2,000
CRS:	GDA2020 / MGA zone 56
Source:	Nearmap (18 Jan 2023)
Prepared By:	Brendon Phan
Reviewed By:	Scott Bamford
Date:	04/07/2023
Revision:	V1

Legend

- Buildings**
- Scheduled for Demolition
 - Hospital Structure
 - Sensitive Receptor
 - Demolished
 - Critical Infection Control Zones
- Environmental Monitors**
- Ground Vibration Monitor
 - Noise Logger

All extents and locations are approximate.





APPENDIX B RESULTS

Overall Performance for Project

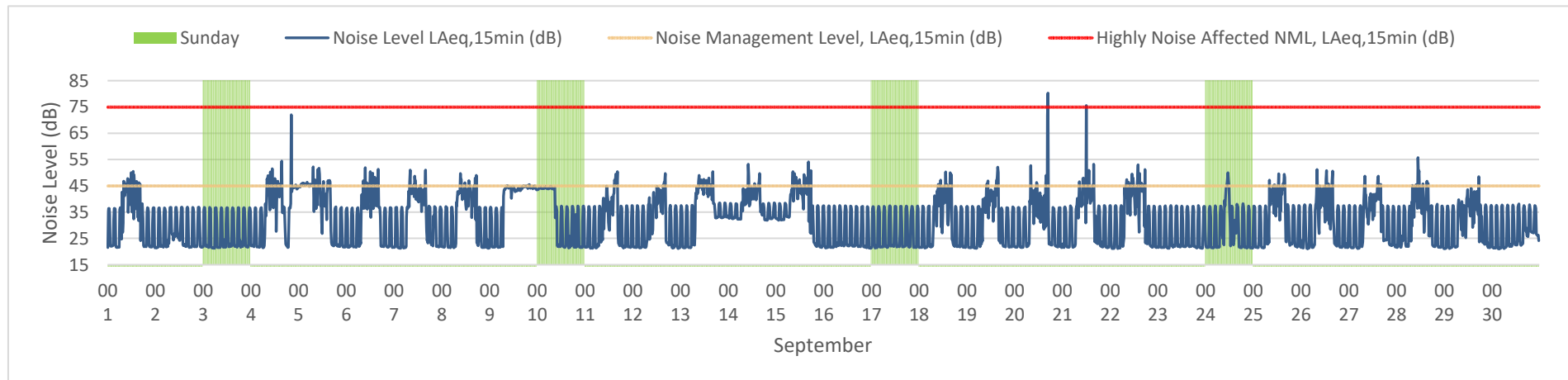
Percentages of period

	Within approved operating hours	Outside approved operating hours	Combined
Highly Noise Affected NML, LAeq,15min (dB)			
Exceedance	0.4%	0%	0.2%
Non-exceedance	99.6%	100%	99.8%
Noise Affected NML, LAeq,15min (dB)			
<=0 dB	65.6%	99.2%	87.5%
>0 and <=05 dB	12.9%	0.3%	4.7%
>05 and <=10 dB	8.9%	0.2%	3.2%
>10 and <=15 dB	8.0%	0.1%	2.9%
>15 and <=20 dB	3.4%	0.1%	1.2%
>20 dB	1.2%	0.1%	0.5%

Performance During September, 2023

Percentages of period

	Within approved operating hours	Outside approved operating hours	Combined
Highly Noise Affected NML, LAeq,15min (dB)			
Exceedance	0.2%	0%	0.1%
Non-exceedance	99.8%	100%	99.9%
Noise Affected NML, LAeq,15min (dB)			
<=0 dB	81.2%	98.5%	92.3%
>0 and <=05 dB	15.5%	1.5%	6.5%
>05 and <=10 dB	2.9%	0.0%	1.0%
>10 and <=15 dB	0.1%	0.0%	0.0%
>15 and <=20 dB	0.0%	0.0%	0.0%
>20 dB	0.3%	0.1%	0.1%



Overall Performance for Project

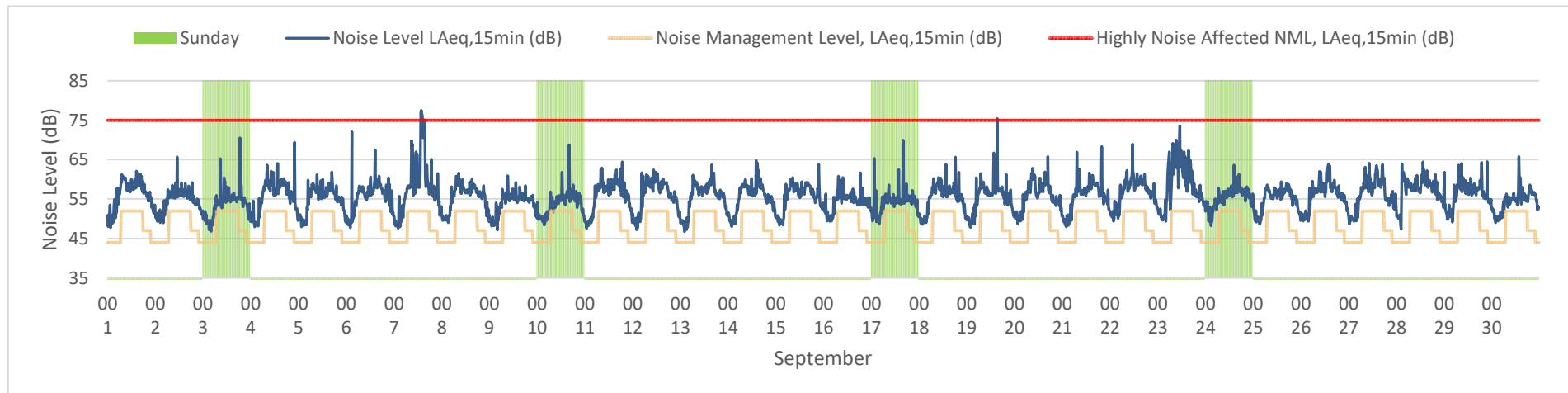
Percentages of period

	Within approved operating hours	Outside approved operating hours	Combined
Highly Noise Affected NML, LAeq,15min (dB)			
Exceedance	0.1%	0%	0.1%
Non-exceedance	99.9%	100%	99.9%
Noise Affected NML, LAeq,15min (dB)			
<=0 dB	0.3%	0.7%	0.5%
>0 and <=05 dB	26.3%	19.4%	21.7%
>05 and <=10 dB	53.7%	58.9%	57.2%
>10 and <=15 dB	17.5%	19.1%	18.6%
>15 and <=20 dB	2.0%	1.5%	1.7%
>20 dB	0.3%	0.4%	0.3%

Performance During September, 2023

Percentages of period

	Within approved operating hours	Outside approved operating hours	Combined
Highly Noise Affected NML, LAeq,15min (dB)			
Exceedance	0.6%	0%	0.2%
Non-exceedance	99.4%	100%	99.8%
Noise Affected NML, LAeq,15min (dB)			
<=0 dB	0.1%	0.3%	0.2%
>0 and <=05 dB	50.3%	18.4%	29.8%
>05 and <=10 dB	43.8%	58.3%	53.2%
>10 and <=15 dB	3.9%	20.8%	14.8%
>15 and <=20 dB	1.0%	1.8%	1.5%
>20 dB	0.9%	0.4%	0.6%





APPENDIX C CALIBRATION CERTIFICATES



Sound Level Meter IEC 61672-3:2013 Calibration Test Report

Calibration Number C23097

Client Details Tech Rentals Pty Ltd
18 Joseph Street
Blackburn North VIC 3130


Equipment Tested/ Model Number : ARL Ngara
Instrument Serial Number : 87823E
Microphone Serial Number : 323017
Pre-amplifier Serial Number : 28675
Firmware Version : 12.6

Pre-Test Atmospheric Conditions
Ambient Temperature : 26°C
Relative Humidity : 51.9%
Barometric Pressure : 100.65kPa

Post-Test Atmospheric Conditions
Ambient Temperature : 23.8°C
Relative Humidity : 41%
Barometric Pressure : 101.48kPa

Calibration Technician : Shaheen Boaz
Calibration Date : 10 May 2023

Secondary Check: Rhys Gravelle
Report Issue Date : 11 May 2023

Approved Signatory : 

Ken Williams

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
12: Acoustical Sig. tests of a frequency weighting	Pass	17: Level linearity incl. the level range control	N/A
13: Electrical Sig. tests of frequency weightings	Pass	18: Toneburst response	Pass
14: Frequency and time weightings at 1 kHz	Pass	19: C Weighted Peak Sound Level	N/A
15: Long Term Stability	Pass	20: Overload Indication	Pass
16: Level linearity on the reference level range	Pass	21: High Level Stability	Pass

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed.

However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1:2013 because evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2013 and because the periodic tests of IEC 61672-3:2013 cover only a limited subset of the specifications in IEC 61672-1:2013.

Uncertainties of Measurement -			
Acoustic Tests		Environmental Conditions	
125Hz	±0.13dB	Temperature	±0.1°C
1kHz	±0.13dB	Relative Humidity	±1.9%
8kHz	±0.14dB	Barometric Pressure	±0.014 kPa
Electrical Tests	±0.13dB		

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.

This report applies only to the item tested and shall only be reproduced in full, unless approved in writing by Acoustic Research Labs.

Acoustic Research Labs Pty Ltd is NATA Accredited Laboratory Number 14172.
Accredited for compliance with ISO/IEC 17025 - Calibration.

The results of the tests, calibrations and/or measurements included in this document are traceable to SI units.

NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration and inspection reports.





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Sound Calibrator

IEC 60942:2017

Calibration Certificate

Calibration Number C23098

Client Details Tech Rentals Pty Ltd
18 Joseph Street
Blackburn North VIC 3130

Equipment Tested/ Model Number : Pulsar Model 105
Instrument Serial Number : 99013

Atmospheric Conditions

Ambient Temperature : 23.7°C
Relative Humidity : 46.8%
Barometric Pressure : 100.33kPa

Calibration Technician : Shaheen Boaz
Calibration Date : 27 Mar 2023
Secondary Check: Rhys Gravelle
Report Issue Date : 11 May 2023

Approved Signatory :  Ken Williams

Characteristic Tested	Result
Generated Sound Pressure Level	Pass
Frequency Generated	Pass
Total Distortion	Pass

Nominal Level	Nominal Frequency	Measured Level	Measured Frequency
94	1000	94.03	1000.30

The sound calibrator has been shown to conform to the class 1 requirements for periodic testing, described in Annex B of IEC 60942:2017 for the sound pressure level(s) and frequency(ies) stated, for the environmental conditions under which the tests were performed..

Specific Tests	Uncertainties of Measurement -	
	Environmental Conditions	
Generated SPL	±0.10dB	Temperature ±0.1°C
Frequency	±0.07%	Relative Humidity ±1.9%
Distortion	±0.20%	Barometric Pressure ±0.014kPa

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.



This calibration certificate is to be read in conjunction with the calibration test report.

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Sound Level Meter
IEC 61672-3:2013
Calibration Certificate
Calibration Number C22711

Client Details	Tech Rentals Pty Ltd 18 Joseph Street Blackburn North VIC 3130
-----------------------	--

Equipment Tested/ Model Number :	ARL Ngara
Instrument Serial Number :	878241
Microphone Serial Number :	21998
Pre-amplifier Serial Number :	28700
Firmware Version :	12.6

Pre-Test Atmospheric Conditions	Post-Test Atmospheric Conditions
Ambient Temperature : 22.4°C	Ambient Temperature : 23°C
Relative Humidity : 48.7%	Relative Humidity : 52.6%
Barometric Pressure : 101.17kPa	Barometric Pressure : 101.15kPa

Calibration Technician : Lucky Jaiswal	Secondary Check: Rhys Gravelle
Calibration Date : 9 Nov 2022	Report Issue Date : 14 Nov 2022

Approved Signatory :  Ken Williams

Clause and Characteristic Tested	Result	Clause and Characteristic Tested	Result
12: Acoustical Sig. tests of a frequency weighting	Pass	17: Level linearity incl. the level range control	N/A
13: Electrical Sig. tests of frequency weightings	Pass	18: Toneburst response	Pass
14: Frequency and time weightings at 1 kHz	Pass	19: C Weighted Peak Sound Level	N/A
15: Long Term Stability	Pass	20: Overload Indication	Pass
16: Level linearity on the reference level range	Pass	21: High Level Stability	Pass

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed.

However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1:2013 because evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2013 and because the periodic tests of IEC 61672-3:2013 cover only a limited subset of the specifications in IEC 61672-1:2013.

Uncertainties of Measurement -			
Acoustic Tests		Environmental Conditions	
125Hz	±0.13dB	Temperature	±0.1°C
1kHz	±0.13dB	Relative Humidity	±1.9%
8kHz	±0.14dB	Barometric Pressure	±0.014kPa
Electrical Tests	±0.13dB		

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.



This calibration certificate is to be read in conjunction with the calibration test report.

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Sound Calibrator

IEC 60942:2017

Calibration Certificate

Calibration Number C22722

Client Details Tech Rentals Pty Ltd
18 Joseph Street
Blackburn North VIC 3130

Equipment Tested/ Model Number : Pulsar Model 105
Instrument Serial Number : 99001

Atmospheric Conditions

Ambient Temperature : 24.6°C
Relative Humidity : 47.3%
Barometric Pressure : 100.9kPa

Calibration Technician : Lucky Jaiswal
Calibration Date : 09 Nov 2022
Secondary Check: Dylan Selge
Report Issue Date : 10 Nov 2022

Approved Signatory : 

Ken Williams

Characteristic Tested	Result
Generated Sound Pressure Level	Pass
Frequency Generated	Pass
Total Distortion	Pass

Nominal Level	Nominal Frequency	Measured Level	Measured Frequency
94	1000	94.06	1000.30

The sound calibrator has been shown to conform to the class 1 requirements for periodic testing, described in Annex B of IEC 60942:2017 for the sound pressure level(s) and frequency(ies) stated, for the environmental conditions under which the tests were performed..

Uncertainties of Measurement -

Specific Tests	Environmental Conditions
Generated SPL	Temperature
Frequency	Relative Humidity
Distortion	Barometric Pressure

All uncertainties are derived at the 95% confidence level with a coverage factor of 2.



This calibration certificate is to be read in conjunction with the calibration test report.

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