Boggabri Coal Mine

Mobile Plant Sound Power Survey 2020

Prepared for

Boggabri Coal Pty Limited

Global Acoustics

Noise and Vibration Analysis and Solutions

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Boggabri Coal Mine

Mobile Plant Sound Power Survey 2020

Reference: 19332_R01
Report date: 26 November 2020

Prepared for

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Prepared by

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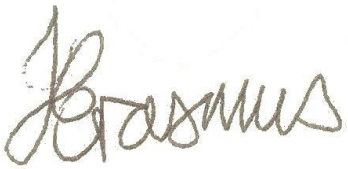

Prepared:	Jonathan Erasmus Consultant	QA Review:	Ryan Bruniges Consultant

Global Acoustics Pty Ltd ~ Environmental noise modelling and impact assessment ~ Sound power testing ~ Noise control advice ~ Noise and vibration monitoring ~ OHS noise monitoring and advice ~ Expert evidence in Land and Environment and Compensation Courts ~ Architectural acoustics ~ Blasting assessments and monitoring ~ Noise management plans (NMP) ~ Sound level meter and noise logger sales and hire

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Appendices

1 INTRODUCTION

This report provides sound power (L_W) data for mobile equipment operating at Boggabri Coal Mine (BCM). An assessment of tonality for each plant item is also provided.

Sound power testing is undertaken over the course of the calendar year. Plant items identified with elevated sound power levels come under additional investigation. This type of monitoring and action is a form of noise control to ensure that equipment noise levels remain at or near modelled levels, assisting in compliance with off site receptor noise limits.

Noise level measurements in this report were taken on 6, 7, and 8 July, and 9 and 19 October 2020.

1.1 Terminology

Some definitions of terminology, which may be used in this report, are provided in Table 1.1.

Table 1.1: TERMINOLOGY & ABBREVIATIONS

Descriptor	Definition
dB	Decibels. For sound pressure level this is 10 times the logarithm to the base 10 of the ratio of the mean-square sound pressure to the square of the reference sound pressure (20 micro-pascals)
dB(A)	Noise level measurement units are decibels (dB). The "A" weighting scale is used to describe human response to noise.
SPL	Sound pressure level (SPL), fluctuations in pressure measured as 10 times a logarithmic scale, the reference pressure being 20 micro-pascals.
L_W	Linear sound power level, expressed in decibels, is the logarithmic ratio of the sound power of a source in watts (W) relative to the sound power reference base of 10-12W
L_{WA}	A-weighted sound power level.
L_{Aeq}	The average A-weighted noise energy during a measurement period, in dB

2 METHODOLOGY

2.1 Test Standards

Test standards referenced in this document include:

- AS 2012.1-1990 'Acoustics – Measurement of airborne noise emitted by earth-moving machinery and agricultural tractors – Stationary test condition – Determination of Compliance With Limits for External Noise';
- AS 2012.2-1990 'Acoustics – Measurement of airborne noise emitted by earth-moving machinery and agricultural tractors – Stationary test condition – Operator's Position';
- AS 1269.1-2005 'Occupational Noise Measurement – Part 1 Measurement and assessment of noise immission and exposure';
- ISO 3744-2010 'Acoustics – Determination of sound power levels and sound energy levels of noise sources using sound pressure – Engineering methods for an essentially free field over a reflecting plane';
- ISO 6393:2008(E) 'Earth-moving machinery – Determination of sound power level – Stationary test conditions'; and
- ISO 6395:2008(E) 'Earth-moving machinery – Determination of sound power level – Dynamic test conditions'.

2.2 Test configuration

2.2.1 Screening Sound Power Methodology

Sound power measurement and calculation of plant to screening sound power methodology (as shown in Table 3.1) conducted using a reduced scope version of Section 2.1 standards.

The reduced scope uses fewer microphone positions than specified in the standards, with only ground positions used. The rationale being to increase mobility of the testing team, provide flexibility in choice of testing location, and to minimise disruption to mining production.

The test is mainly used as a screening tool. A more precise equipment sound power that would result from full adherence to the above standards was not required. A minimum of two test runs were recorded for each plant item with the aim to have less than 1.5 dB difference between results. It is considered that the results are of sufficient accuracy and repeatability for the purpose of this survey.

Typical test areas showing microphone positions are presented in Figure 1 and Figure 2. The majority of tests for mobile plant were undertaken using a dynamic test only, where the plant item passes through the test area shown in Figure 1 under full power on level ground. The measurement is commenced and

completed when the plant item (centre of) passes between microphone positions 2 & 3 and 1&4 respectively. In some cases, stationary tests were conducted for dozers, wheel dozers, and loaders in order to determine engine noise in the absence of track noise and reverse alarms.

Haul trucks, water carts, service carts, front end loaders, graders and dozers were all tested on a flat test area at high idle using the test area shown in Figure 1. Drills were tested in-situ during normal operations using the test area shown in Figure 2. Excavator testing involved measurement at one or more locations at a known distance whilst normal truck loading operations were undertaken. This method provides the most convenient means to test diggers as it presents minimal disruption to production. Excavator testing was performed using some of the positions in Figure 2 (microphone positions being dependant on the excavator immediate working environment).

A more detailed test methodology document can be provided upon request.

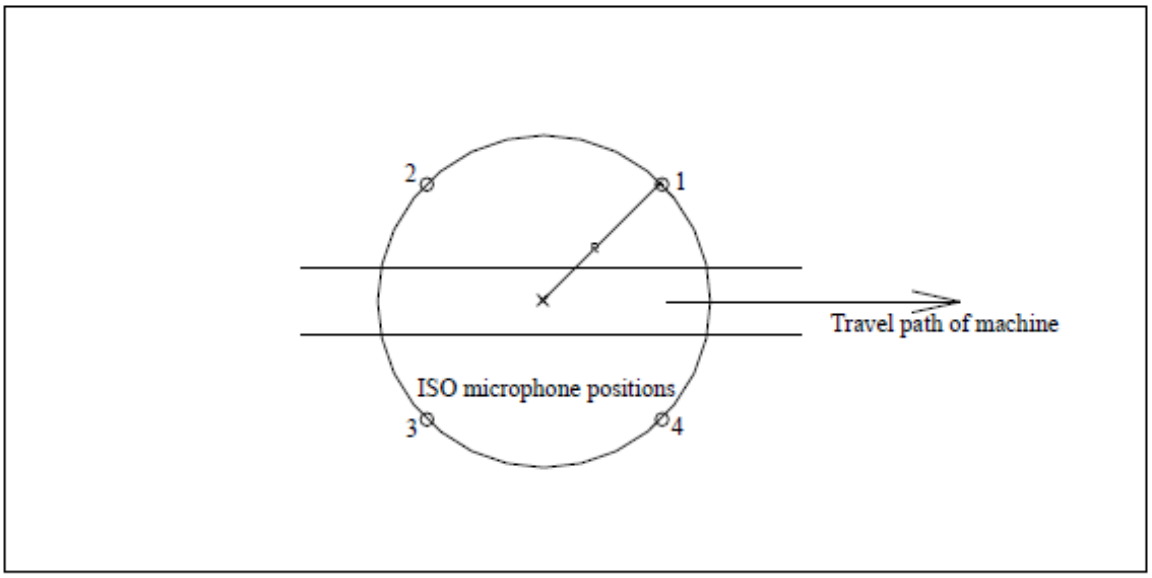

Figure 1 Sound Power Microphone Positions

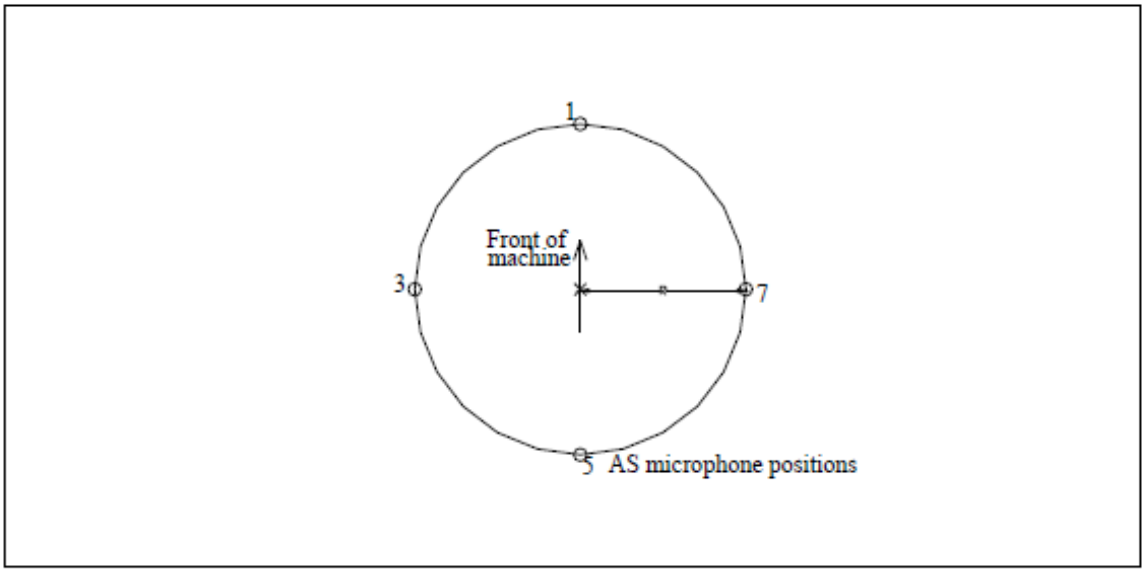

Figure 2 Alternate Stationary Sound Power Microphone Positions

2.3 Equipment Used

Equipment used to measure and record noise levels are listed in Table 2.1. Calibration certificates are provided in Appendix A.

Table 2.1: SOUND LEVEL MEASUREMENT EQUIPMENT

Model	Serial Number	Calibration Due Date
SVAN 958 noise and vibration analyser	20880	22/01/2021
SVAN 958A noise and vibration analyser	69814	23/05/2021
Rion NC74 sound level calibrator	50941314	17/06/2021
Rion NC74 sound level calibrator	34172616	22/01/2021

2.4 Weather Conditions

Weather conditions at the time of testing are presented in Table 2.2.

Table 2.2: ATMOSPHERIC CONDITIONS

Date	Temperature (°C)	Wind Speed (m/s)	Barometric Pressure (hPa)	Relative Humidity (%)
06/07/2020	17	0 – 2	1027	45
07/07/2020	13	0 – 1	1028	54
08/07/2020	22	2 – 3	1029	71
09/10/2020	16	1	1018	47
19/10/2020	16	1	1014	64

2.5 Criteria

Sound power results in this report have been assessed against sound powers used in modelling for the Continuation of Boggabri Coal Mine Environmental Assessment (EA) (Hansen Bailey, 2010), as advised by Boggabri Coal Mine. Dozers have been assessed against the specified limits for 1st gear operation only.

2.6 Tonality

The NPfI states that a noise is determined to be tonal when the level of an individual one-third octave band exceeds the level of the adjacent bands on both sides by:

- 5 dB or more if the centre frequency of the band containing the tone is above 400Hz;

- 8 dB or more if the centre frequency of the band containing the tone is 160 Hz to 400 Hz inclusive;
- 15 dB or more if the centre frequency of the band containing the tone is below 160 Hz.

Tonal plant is listed in Table 3.1.

3 Overall Sound Power Results

Overall A-weighted sound power levels determined from measured SPL are shown in Table 3.1. Overall sound power screening results which exceeded the relevant criterion by 2 dB or less are considered minor and not significant enough to require additional investigation. Overall sound power screening results which exceeded the relevant criterion by 3 dB or more are considered significant and require additional investigation. Any difference in screening results for the same plant between consecutive years of +3 dB or more would also trigger a more detailed analysis of results (third octave band results analysis) and potentially follow-up machine inspection and/or additional testing.

This approach has been developed in consideration of a number of uncertainty factors and has been adopted and approved by the Department of Planning and Environment (DPE) in other annual noise testing regimes of mobile plant in NSW. These factors include, but are not limited to:

- As described in the Methodology section of this report, the acceptable repeatability for screening is up to 1.5 dB between measured results;
- Due to the mobile nature of screening testing, additional variables such as other mobile plant operating nearby, hard-packed and/or uneven testing surfaces, varying skill of operators, and certain modes of operations being undertaken during testing (in the case of excavators and drills) can result in measured noise levels that are slightly higher than they would be under full scope noise testing;

Single and one-third-octave graphs for equipment tested can be useful in identifying noise sources or differences between like machines. These graphs have not been included in this report but are available upon request.

Note that overall linear sound power levels are a better indicator of low frequency noise content of plant than overall A-weighted sound power levels. Low frequency noise can propagate further than high frequency noise, and so can indicate items with higher potential for off-site noise impacts.

Table 3.1: 2020 SOUND POWER LEVELS

Plant No	Make/Model	Test Level	Test Type	Test Date	Results dB	Results dB(A)	Limit dB	Limit dB(A)	Exceedance dB	Exceedance dB(A)	Comments	Tonal Hz
Excavators/Loaders												
EX127	Komatsu PC450LC-8	Screen	Stationary	2020-07-07	116	106	130	120	Nil	Nil		500Hz
EX128	Komatsu PC300LC	Screen	Stationary	2020-07-07	109	98	130	120	Nil	Nil		
EX255	Caterpillar 6060	Screen	Dynamic	2020-07-07	128	119	130	120	Nil	Nil		
EX256	Caterpillar 6060	Screen	Dynamic	2020-07-08	128	116	130	120	Nil	Nil		
EX258	Hitachi EX1900-6	Screen	Stationary	2020-07-07	125	115	130	120	Nil	Nil		
WL03	Caterpillar 992K	Screen	Stationary	2020-07-07	122	109	126	117	Nil	Nil		
Trucks												
DT178	Komatsu HD1500-7	Screen	Dynamic, Forward	2020-07-06	126	119	126	117	Nil	2		
DT180	Komatsu HD1500-7	Screen	Dynamic, Forward	2020-07-06	127	119	126	117	1	2		
DT181	Komatsu HD1500-7	Screen	Dynamic, Forward	2020-07-06	125	118	126	117	Nil	1		
DT267	Komatsu 930E	Screen	Dynamic, Forward	2020-07-06	127	116	126	117	1	Nil		
DT755	Komatsu 930E	Screen	Dynamic, Forward	2020-07-06	131	119	126	117	5	2		
DT279	Komatsu 730E	Screen	Dynamic, Forward	2020-07-06	125	114	126	117	Nil	Nil		
DT281	Komatsu 730E	Screen	Dynamic, Forward	2020-07-06	126	113	126	117	Nil	Nil		
DT282	Komatsu 730E	Screen	Dynamic, Forward	2020-07-06	126	114	126	117	Nil	Nil		
DT285	Komatsu 730E	Screen	Dynamic, Forward	2020-07-06	127	113	126	117	1	Nil		
DT288	Komatsu 730E	Screen	Dynamic, Forward	2020-07-06	126	114	126	117	Nil	Nil		
DT289	Komatsu 730E	Screen	Dynamic, Forward	2020-07-06	124	113	126	117	Nil	Nil		

Plant No	Make/Model	Test Level	Test Type	Test Date	Results dB	Results dB(A)	Limit dB	Limit dB(A)	Exceedance dB	Exceedance dB(A)	Comments	Tonal Hz
DT290	Komatsu 730E	Screen	Dynamic, Forward	2020-07-06	125	113	126	117	Nil	Nil		
DT304	Hitachi EH3500ACII	Screen	Dynamic, Forward	2020-07-06	130	118	126	117	4	1		
DT305	Hitachi EH3500ACII	Screen	Dynamic, Forward	2020-07-06	129	115	126	117	3	Nil		
Dozers												
TD02	Komatsu D475A	Screen	1st Gear Forward	2020-07-07	118	110	126	116	Nil	Nil		
TD02	Komatsu D475A	Screen	1st Gear Reverse	2020-07-07	119	111	126	116	Nil	Nil		
TD02	Komatsu D475A	Screen	Stationary	2020-07-07	116	104	126	116	Nil	Nil		
TD074	Komatsu D475	Screen	1st Gear Forward	2020-10-19	117	107	126	116	Nil	Nil		
TD074	Komatsu D475A	Screen	1st Gear Reverse	2020-10-19	118	110	126	116	Nil	Nil		
TD074	Komatsu D475A	Screen	Stationary	2020-10-19	116	103	126	116	Nil	Nil		
TD075	Komatsu 375A-6	Screen	1st Gear Forward	2020-07-07	116	109	126	116	Nil	Nil		
TD075	Komatsu 375A-6	Screen	1st Gear Reverse	2020-07-07	117	112	126	116	Nil	Nil		
TD075	Komatsu 375A-6	Screen	Stationary	2020-07-07	115	105	126	116	Nil	Nil		
TD076	Komatsu 375A-6	Screen	1st Gear Forward	2020-07-07	115	108	126	116	Nil	Nil		
TD076	Komatsu 375A-6	Screen	1st Gear Reverse	2020-07-07	117	109	126	116	Nil	Nil		
TD076	Komatsu 375A-6	Screen	Stationary	2020-07-07	112	105	126	116	Nil	Nil		
TD079	Komatsu D475A	Screen	1st Gear Forward	2020-07-08	120	117	126	116	Nil	1		3150
TD079	Komatsu D475A	Screen	1st Gear Reverse	2020-07-08	121	119	126	116	Nil	3		3150
TD079	Komatsu D475A	Screen	Stationary	2020-07-08	115	106	126	116	Nil	Nil		
TD08	Caterpillar D10T	Screen	1st Gear Forward	2020-07-07	122	113	126	116	Nil	Nil		

Plant No	Make/Model	Test Level	Test Type	Test Date	Results dB	Results dB(A)	Limit dB	Limit dB(A)	Exceedance dB	Exceedance dB(A)	Comments	Tonal Hz
TD08	Caterpillar D10T	Screen	1st Gear Reverse	2020-07-07	123	115	126	116	Nil	Nil		
TD08	Caterpillar D10T	Screen	Stationary	2020-07-07	120	110	126	116	Nil	Nil		
TD081	Komatsu D475A	Screen	1st Gear Forward	2020-10-09	119	111	126	116	Nil	Nil		
TD081	Komatsu D475A	Screen	1st Gear Reverse	2020-10-09	120	114	126	116	Nil	Nil		
TD081	Komatsu D475A	Screen	Stationary	2020-10-09	116	104	126	116	Nil	Nil		
TD09	Caterpillar D10T	Screen	1st Gear Forward	2020-07-07	122	112	126	116	Nil	Nil		
TD09	Caterpillar D10T	Screen	1st Gear Reverse	2020-07-07	122	116	126	116	Nil	Nil		
TD09	Caterpillar D10T	Screen	Stationary	2020-07-07	120	108	126	116	Nil	Nil		
Water Trucks												
WC041	Komatsu 730E	Screen	Dynamic, Forward	2020-07-06	124	116	128	117	Nil	Nil		
WC043	Komatsu 730E	Screen	Dynamic, Forward	2020-07-06	127	115	128	117	Nil	Nil		
WC042	Komatsu 730E	Screen	Dynamic, Forward	2020-07-06	124	113	128	117	Nil	Nil		
Service Trucks												
TK828	Caterpillar 775G	Screen	1st Gear Forward	2020-07-06	122	114	NA	NA	NA	NA		
TK829	Caterpillar 775G	Screen	1st Gear Forward	2020-07-06	124	115	NA	NA	NA	NA		
Drills												
DR650	ReichDrill C700D	Screen	Stationary	2020-07-07	126	115	129	117	Nil	Nil		
DR655	ReichDrill C700D	Screen	Stationary	2020-07-07	126	116	129	117	Nil	Nil		

4 SUMMARY

This report provides sound power (L_W) data for mobile equipment operating at Boggabri Coal Mine (BCM).

Results in Table 3.1 show that:

- Hitachi EH3500ACII trucks 304 and 305 exceeded the linear target by 4 dB and 3 dB respectively;
- Komatsu 930-E truck 755 exceeded the A-weighted target by 5 dB;
- Komatsu D475A TD79 exceeded the A-weighted target by 3 dB during the 1st gear reverse test and was noted as tonal in the 1/3 octave band during the dynamic tests;

Global Acoustics recommend that any plant with a sound power level change between test periods of greater than 2 dB and/or an exceedance of a sound power limit by more than 2 dB, be initially inspected for damaged or missing sound attenuation, further action to be determined from the outcomes of said inspection.

We trust this information is per your requirements. Please contact us if you require further details or advice.

Global Acoustics Pty Ltd

APPENDIX

A CALIBRATION CERTIFICATES

Acoustic Research Labs Pty Ltd
Level 7 Building 2 423 Pennant Hills Rd
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www.acousticresearch.com.au

Sound Level Meter
IEC 61672-3.2013
Calibration Certificate

Calibration Number C19031

Client Details	Global Acoustics Pty Ltd 12/16 Huntingdale Drive Thornton NSW 2322
Equipment Tested/ Model Number :	SVANTEK 958
Instrument Serial Number :	20880
Microphone Serial Number :	298761
Pre-amplifier Serial Number :	90081

Pre-Test Atmospheric Conditions		Post-Test Atmospheric Conditions	
Ambient Temperature :	22.9°C	**Ambient Temperature :**	24.3°C
Relative Humidity :	53.2%	**Relative Humidity :**	49.9%
Barometric Pressure :	99.39kPa	**Barometric Pressure :**	99.16kPa

Calibration Technician : Lucky Jaiswal
Calibration Date : 22 Jan 2019
Secondary Check: Lewis Boorman
Report Issue Date : 24 Jan 2019
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	*Pass*
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	*Pass*
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.

As public evidence was available, from an independent testing organisation responsible for approving the results of pattern evaluation test performed in accordance with IEC 61672-2:2013, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2013, the sound level meter submitted for testing conforms to the class 1 requirements of IEC 61672-1:2013.

Least Uncertainties of Measurement -

		Environmental Conditions	
Acoustic Tests		*Temperature*	*±0.2°C*
31.5 Hz to 8kHz:	*±0.15dB*	*Relative Humidity*	*±2.4%*
12.5kHz:	*±0.21dB*	*Barometric Pressure*	*±0.015kPa*
16kHz:	*±0.29dB*		
Electrical Tests			
31.5 Hz to 20 kHz	*±0.12dB*		

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.

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 Australian/national standards.

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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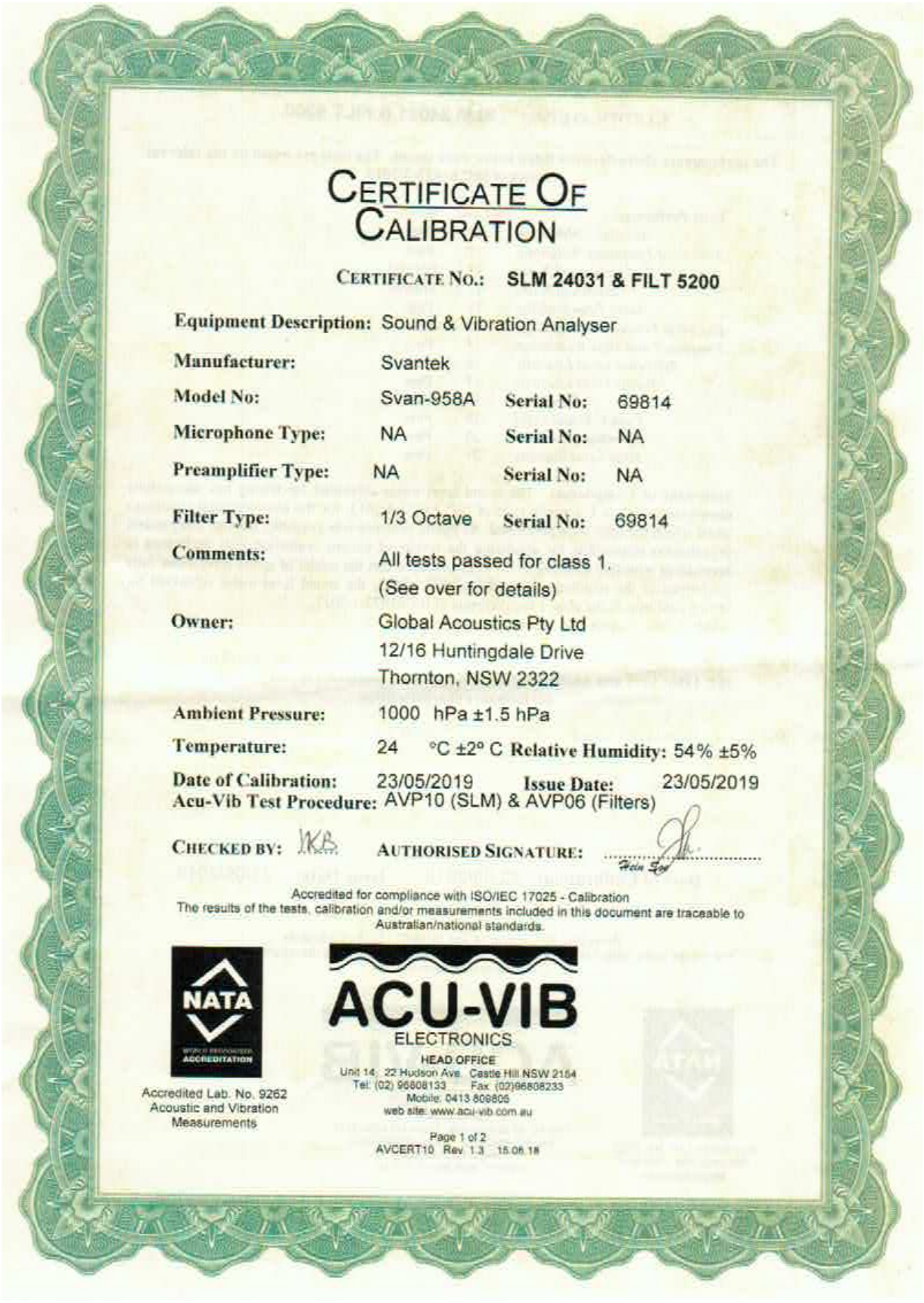

CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 24031 & FILT 5200

Equipment Description:	Sound & Vibration Analyser		
Manufacturer:	Svantek		
Model No:	Svan-958A	**Serial No:**	69814
Microphone Type:	NA	**Serial No:**	NA
Preamplifier Type:	NA	**Serial No:**	NA
Filter Type:	1/3 Octave	**Serial No:**	69814
Comments:	All tests passed for class 1. (See over for details)		
Owner:	Global Acoustics Pty Ltd 12/16 Huntingdale Drive Thornton, NSW 2322		
Ambient Pressure:	1000 hPa ±1.5 hPa		
Temperature:	24 °C ±2° C	**Relative Humidity:**	54% ±5%
Date of Calibration:	23/05/2019	**Issue Date:**	23/05/2019
Acu-Vib Test Procedure:	AVP10 (SLM) & AVP06 (Filters)		

CHECKED BY: JKB **AUTHORISED SIGNATURE:** .....

Accredited for compliance with ISO/IEC 17025 - Calibration
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

NATA ACCREDITATION

Accredited Lab. No. 9262
Acoustic and Vibration Measurements

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AVCERT10 Rev. 1.3 15.05.18

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Sound Calibrator
IEC 60942-2017

Calibration Certificate

Calibration Number C19343

Client Details Global Acoustics Pty Ltd
12/16 Huntingdale Drive
Thorton NSW 2322

Equipment Tested/ Model Number : Rion NC-74
Instrument Serial Number : 50941314

Atmospheric Conditions
Ambient Temperature : 24.2°C
Relative Humidity : 47.4%
Barometric Pressure : 100.85kPa

Calibration Technician : Lucky Jaiswal
Calibration Date : 17 Jun 2019
Secondary Check: Eloise Burrows
Report Issue Date : 17 Jun 2019
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
Measured Output	94.0	1000.0	94.2	1002.89

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.

Least Uncertainties of Measurement -

Specific Tests		Environmental Conditions	
Generated SPL	*±0.11dB*	*Temperature*	*±0.2°C*
Frequency	*±0.01%*	*Relative Humidity*	*±2.4%*
Distortion	*±0.48%*	*Barometric Pressure*	*±0.015kPa*

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

* The tests <1000 kHz are not covered by Acoustic Research Labs Pty Ltd NATA accreditation.

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

Acoustic Research Labs Pty Ltd is NATA Accredited Laboratory Number 14172.
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Sound Calibrator

IEC 60942-2017

Calibration Certificate

Calibration Number C19030

Client Details Global Acoustics Pty Ltd
12/16 Huntingdale Drive
Thornton NSW 2322

Equipment Tested/ Model Number : NC-74
Instrument Serial Number : 34172616

Atmospheric Conditions
Ambient Temperature : 22.9°C
Relative Humidity : 54.2%
Barometric Pressure : 99.46kPa

Calibration Technician : Charlie Neil
Calibration Date : 22 Jan 2019
Secondary Check: Lewis Boorman
Report Issue Date : 24 Jan 2019
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
Measured Output	94.0	1000.0	94.2	1002.33

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.

Least Uncertainties of Measurement :

Specific Tests		Environmental Conditions	
Generated SPL	*±0.11dB*	*Temperature*	*±0.2°C*
Frequency	*±0.01%*	*Relative Humidity*	*±2.4%*
Distortion	*±0.5%*	*Barometric Pressure*	*±0.015kPa*

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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