Boggabri Coal Mine

Mobile Plant Sound Power Survey

2021

Prepared for

Boggabri Coal Pty Limited

Global Acoustics

Noise and Vibration Analysis and Solutions

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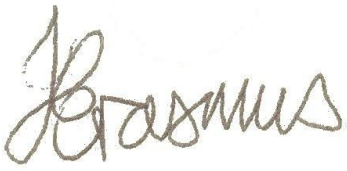

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1 INTRODUCTION

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 13 September 2021.

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 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.

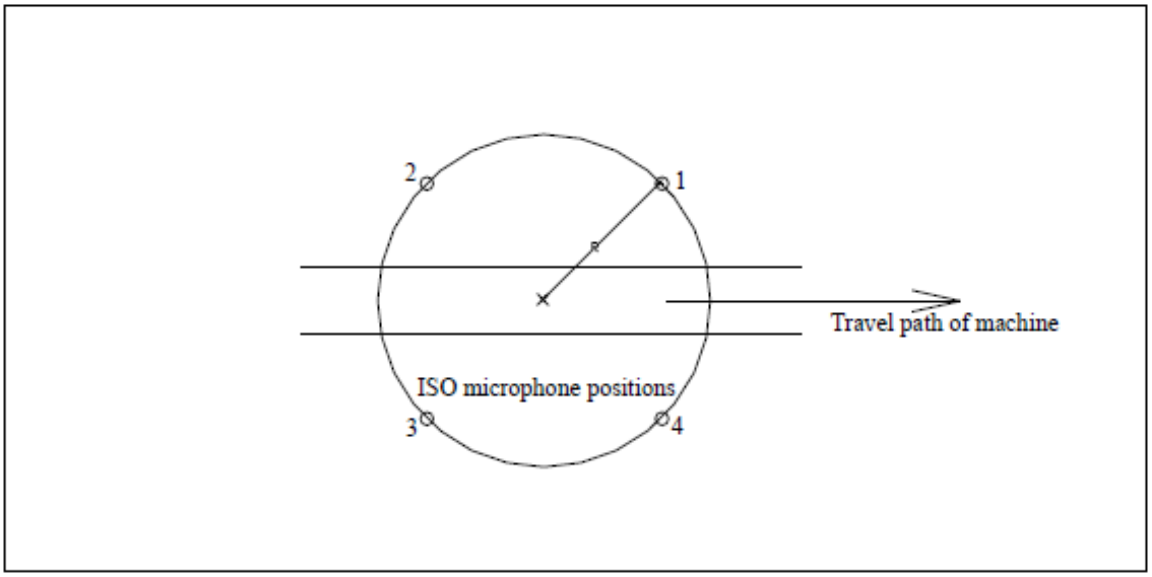

Figure 1 Sound Power Microphone Positions

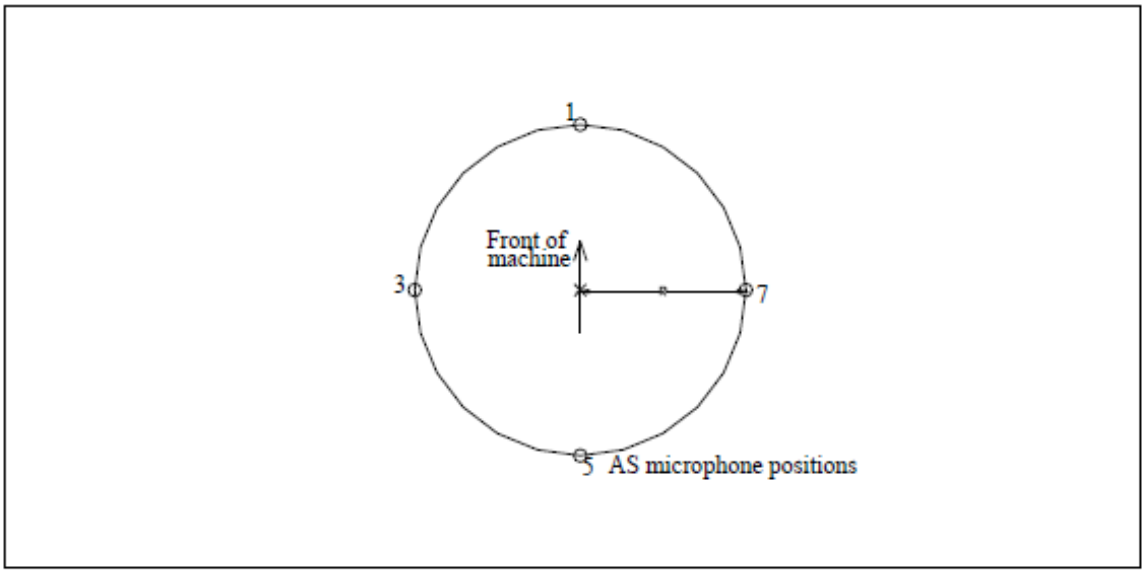

Figure 2 Alternate Stationary Sound Power Microphone Positions

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	14/04/2022
Rion NC74 sound level calibrator	50941314	17/06/2021

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)	Relative Humidity (%)
13/09/2021	17	0 – 3	42

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.

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: 2021 SOUND POWER LEVELS

Plant ID	Make/Model	Test Level	Test Type	Test Date	Result dB	Result dB(A)	Limit dB	Limit dB(A)	Exceedance dB	Exceedance dB (A)	Tonal Hz
Excavators / Loaders											
EX123	Caterpillar 6060	Screen	Dynamic	2021-09-13	131	118	130	120	1	Nil	No
EX129	Liebherr R9400	Screen	Dynamic	2021-09-13	130	115	130	120	Nil	Nil	No
EX255	Caterpillar 6060	Screen	Dynamic	2021-09-13	130	123	130	120	0	3	No
EX256	Caterpillar 6060	Screen	Dynamic	2021-09-13	128	118	130	120	Nil	Nil	No
WL188	Komatsu WA1200-3	Screen	Dynamic, Forward	2021-09-13	125	117	126	117	Nil	Nil	No
WL190	Komatsu WA600	Screen	Dynamic, Forward	2021-09-13	123	111	126	117	Nil	Nil	No
Graders											
GR060	Caterpillar 16M	Screen	Dynamic, 1st Gear Forward	2021-09-13	114	105	126	115	Nil	Nil	No
GR063	Caterpillar 24M	Screen	Dynamic, 1st Gear Forward	2021-09-13	116	107	126	115	Nil	Nil	100
Trucks											
DT178	Komatsu HD1500-7	Screen	Dynamic, Forward	2021-09-13	125	118	126	117	Nil	1	No
DT180	Komatsu HD1500-7	Screen	Dynamic, Forward	2021-09-13	124	117	126	117	Nil	Nil	No
DT181	Komatsu HD1500-7	Screen	Dynamic, Forward	2021-09-13	121	116	126	117	Nil	Nil	No
DT265	Komatsu 930-E	Screen	Dynamic, Forward	2021-09-13	129	117	126	117	3	Nil	No
DT304	Hitachi EH3500ACII	Screen	Dynamic, Forward	2021-09-13	131	117	126	117	5	Nil	No
DT306	Hitachi EH3500ACII	Screen	Dynamic, Forward	2021-09-13	130	117	126	117	4	Nil	No
DT307	Hitachi EH3500ACII	Screen	Dynamic, Forward	2021-09-13	130	118	126	117	4	1	No
DT308	Hitachi EH3500ACII	Screen	Dynamic, Forward	2021-09-13	130	120	126	117	4	3	No
DT751	Komatsu 930-E	Screen	Dynamic, Forward	2021-09-13	134	124	126	117	8	7	No

Plant ID	Make/Model	Test Level	Test Type	Test Date	Result dB	Result dB(A)	Limit dB	Limit dB(A)	Exceedance dB	Exceedance dB (A)	Tonal Hz
DT752	Komatsu 930-E	Screen	Dynamic, Forward	2021-09-13	132	123	126	117	6	6	No
DT754	Komatsu 930-E	Screen	Dynamic, Forward	2021-09-13	128	121	126	117	2	4	No
DT755	Komatsu 930-E	Screen	Dynamic, Forward	2021-09-13	135	125	126	117	9	8	No
DT757	Komatsu 930-E	Screen	Dynamic, Forward	2021-09-13	130	121	126	117	4	4	No
DT291	Komatsu 930-E	Screen	Dynamic, Forward	2021-09-13	129	117	126	117	3	Nil	No
DT292	Komatsu 930-E	Screen	Dynamic, Forward	2021-09-13	129	118	126	117	3	1	No
Water Carts											
WC031	Komatsu HD785-7	Screen	Dynamic, Forward	2021-09-13	127	118	128	117	Nil	1	No
Service Carts											
TK828	Caterpillar 775G	Screen	Dynamic, 1st Gear Forward	2021-09-13	123	116	128	117	Nil	Nil	No
Dozers											
TD082	Komatsu D475A-5EO	Screen	Dynamic, 1st Gear Forward	2021-09-13	118	110	126	116	Nil	Nil	No
TD082	Komatsu D475A-5EO	Screen	Dynamic, 1st Gear Reverse	2021-09-13	119	111	126	116	Nil	Nil	No
TD082	Komatsu D475A-5EO	Screen	Stationary	2021-09-13	118	105	126	116	Nil	Nil	No
TD083	Komatsu D475A-5EO	Screen	Dynamic, 1st Gear Forward	2021-09-13	120	113	126	116	Nil	Nil	No
TD083	Komatsu D475A-5EO	Screen	Dynamic, 1st Gear Reverse	2021-09-13	121	114	126	116	Nil	Nil	No
TD083	Komatsu D475A-5EO	Screen	Stationary	2021-09-13	117	105	126	116	Nil	Nil	No
TD084	Komatsu D475A-5EO	Screen	Dynamic, 1st Gear Forward	2021-09-13	119	111	126	116	Nil	Nil	No
TD084	Komatsu D475A-5EO	Screen	Dynamic, 1st Gear Reverse	2021-09-13	121	115	126	116	Nil	Nil	No
TD084	Komatsu D475A-5EO	Screen	Stationary	2021-09-13	115	103	126	116	Nil	Nil	No
TD085	Komatsu D475A-5EO	Screen	Dynamic, 1st Gear Forward	2021-09-13	121	111	126	116	Nil	Nil	No
TD085	Komatsu D475A-5EO	Screen	Dynamic, 1st Gear Reverse	2021-09-13	121	112	126	116	Nil	Nil	No

Plant ID	Make/Model	Test Level	Test Type	Test Date	Result dB	Result dB(A)	Limit dB	Limit dB(A)	Exceedance dB	Exceedance dB (A)	Tonal Hz
TD085	Komatsu D475A-5EO	Screen	Stationary	2021-09-13	119	107	126	116	Nil	Nil	No
TD086	Komatsu D475A-5EO	Screen	Dynamic, 1st Gear Forward	2021-09-13	121	112	126	116	Nil	Nil	No
TD086	Komatsu D475A-5EO	Screen	Dynamic, 1st Gear Reverse	2021-09-13	122	115	126	116	Nil	Nil	No
TD086	Komatsu D475A-5EO	Screen	Stationary	2021-09-13	120	106	126	116	Nil	Nil	No
TD093	Komatsu 375A-6	Screen	Dynamic, 1st Gear Forward	2021-09-13	121	118	126	116	Nil	Nil	No
TD093	Komatsu 375A-6	Screen	Dynamic, 1st Gear Reverse	2021-09-13	120	115	126	116	Nil	Nil	No
TD093	Komatsu 375A-6	Screen	Stationary	2021-09-13	113	106	126	116	Nil	Nil	No

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:

- Caterpillar 6060 excavator 255 exceeded the A-weighted target by 3 dB;
- Komatsu 930E-4 rear-dump trucks 265, 751, 752, 754, 755, 757, 291, and 292 exceeded A-weighted or linear targets by 3 or more dB; and
- Hitachi EH3500ACII rear-dump trucks 304, 306, 307, and 308 exceeded A-weighted or linear targets by 3 or more dB.

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
Unit 36/14 Loyalty Rd
North Rocks NSW AUSTRALIA 2151
Ph: +61 2 9484 0800 A.B.N. 65 160 399 119
www.acousticresearch.com.au

Sound Level Meter
IEC 61672-3.2013

Calibration Certificate

Calibration Number C20218

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 :	16894
Pre-amplifier Serial Number :	24298

Pre-Test Atmospheric Conditions		Post-Test Atmospheric Conditions	
Ambient Temperature :	23.5°C	**Ambient Temperature :**	24.6°C
Relative Humidity :	47.3%	**Relative Humidity :**	46.6%
Barometric Pressure :	101.2kPa	**Barometric Pressure :**	101.1kPa

Calibration Technician : Lucky Jaiswal **Secondary Check:** Max Moore
Calibration Date : 14 Apr 2020 **Report Issue Date :** 17 Apr 2020

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 -

Acoustic Tests		Environmental Conditions	
125Hz	*±0.13dB*	*Temperature*	*±0.2°C*
1kHz	*±0.13dB*	*Relative Humidity*	*±2.4%*
8kHz	*±0.14dB*	*Barometric Pressure*	*±0.015kPa*
Electrical Tests	*±0.10dB*		

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 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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