global environmental solutions

Stratford Coal Pty Ltd

Quarterly Compliance Noise Monitoring

September 2016

Report Number 630.11771-R01

11 January 2017

Stratford Coal Pty Ltd
PO Box 168
GLOUCESTER NSW 2422

Version: v0.2

Stratford Coal Pty Ltd

Quarterly Compliance Noise Monitoring

September 2016

PREPARED BY:

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
10 Kings Road
New Lambton NSW 2305 Australia
(PO Box 447 New Lambton NSW 2305 Australia)
T: +61 2 4037 3200 F: +61 2 4037 3201
newcastleau@slrconsulting.com www.slrconsulting.com

This report has been prepared by SLR Consulting Australia Pty Ltd with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with the Client. Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of Stratford Coal Pty Ltd. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
630.11771-R01-v0.2	11 January 2017	Stephen Kozakiewicz	Yang Liu	Yang Liu

Table of Contents

1 INTRODUCTION 5
1.1 Acoustic Terminology 5
2 SMC NOISE CRITERIA 6
2.1 Project Approval Schedule 3 Environmental Performance Conditions 6
2.2 EPL Noise Limits 8
2.3 Assessment of Low-frequency Emissions 8
3 OPERATIONAL NOISE MONITORING METHODOLOGY 9
3.1 General Requirements 9
3.2 Methodology - Operator Attended Noise Monitoring Locations 9
4 RESULTS 11
4.1 Operator Attended Monitoring – SMC Operational Activity 11
4.1.1 Operator Attended Noise Survey Results – Monitoring Location ‘Atkins’ 11
4.1.2 Operator Attended Noise Survey Results – Monitoring Location ‘Clarke’ 13
4.1.3 Operator Attended Noise Survey Results – Monitoring Location ‘Hall’ 14
4.1.4 Operator Attended Noise Survey Results – Monitoring Location ‘Lowrey’ 16
4.1.5 Operator Attended Noise Survey Results – Monitoring Location ‘Pryce Jones’ 17
4.1.6 Operator Attended Noise Survey Results – Monitoring Location ‘Ellis’ 18
4.1.7 Operator Attended Noise Survey Results – Monitoring Location ‘Van der Drift’ 20
5 PERFORMANCE ASSESSMENT 22
5.1 Operations 22
5.1.1 Assessment of Compliance – Day period 22
5.1.2 Assessment of Compliance – Evening period 22
5.1.3 Assessment of Compliance – Night period 22
5.2 Sleep Disturbance 22
5.3 Low Frequency Noise 23
6 CONCLUSION 23

TABLES

Table 1 Noise Limits for the Nominated Attended Noise Monitoring Locations [dBA re 20 µPa] 8
Table 2 Noise Monitoring Locations 9
Table 3 Operator Attended Noise Survey Results – Atkins 11
Table 4 Attended Noise Survey Results – Clarke 13
Table 5 Attended Noise Survey Results – Hall 15
Table 6 Attended Noise Survey Results – Lowrey 16
Table 7 Attended Noise Survey Results – Pryce Jones 17
Table 8 Attended Noise Survey Results – Ellis 19
Table 9 Attended Noise Survey Results – Van der Drift 20
Table 10 Performance Assessment – Operations 22
Table 11 Performance Assessment – Sleep Disturbance 23

FIGURES

Figure 1 Stratford Mining Complex Attended Noise Monitoring Locations 10

APPENDICES

Table of Contents

Appendix A Acoustic Terminology
Appendix B Measured Ambient Noise Levels

1 INTRODUCTION

Stratford Coal Pty Limited (DCPL), a wholly owned subsidiary of Yancoal Australia Limited (Yancoal), has commissioned SLR Consulting Australia Pty Ltd (SLR) to conduct quarterly noise monitoring for the Stratford Mining Complex (SMC) operations guided by the requirements of the *Stratford Mining Complex Noise Management Plan* (NMP), Project No. GLC-11, Document No. 00389411, dated May 2011. This report presents the results and findings from the operator-attended noise surveys conducted between 26 September and 28 September 2016.

It is understood that the SMC collectively comprises the Stratford Coal Mine (SCM), the Bowens Road North Open Cut (BRNOC) and the associated coal processing and handling facilities. Run-of-mine (ROM) coal from the Duralie Coal Mine (DCM) is transported by rail to the SMC, where it is processed along with ROM coal from the SCM and BRNOC. SMC coal is then loaded and railed on the North Coast Railway to the port of Newcastle.

The objectives of the noise monitoring programme for this operating period were as follows:

- Conduct four rounds of external operator-attended noise measurements at the seven nominated locations listed in NSW Project Approval, representative of receivers in the area surrounding the SMC. The seven nominated external operator-attended noise measurement locations are:
  - Atkins – Off Wenhams Cox Road, Stratford
  - Clarke Gates – Now conducted at Wenhams Cox Road, Stratford
  - Hall – Upper Avon Road
  - Lowrey – Off Crowthers Road, Stratford
  - Pryce Jones – The Bucketts Way, Craven
  - Ellis – Off Wenhams Cox Road, Stratford
  - Van der Drift – Wood Street. Stratford

  Noise monitoring will occur during a day, evening and two consecutive night[1] periods (night survey 1 and night survey 2). The day, evening and night periods being those defined in the NSW Industrial Noise Policy (EPA 2000).
- The operator will quantify and characterise the maximum (L_{Amax}) and the intrusive (L_{Aeq} and L_{Ceq}) noise level contributions from SMC operations over a 15 minute measurement period. In addition, the operator will quantify and characterise the overall levels of ambient noise (i.e. L_{Amax}, L_{A1}, L_{A10}, L_{A50}, L_{A90}, and L_{Aeq}) over the 15 minute measurement interval.
- Assess the noise emissions of SMC and determine compliance with respect to the limits contained in the NMP.

1.1 Acoustic Terminology

The following report uses specialist acoustic terminology. An explanation of common terms is provided in **Appendix A**.

[1] Section 7.2.3 Methodology, of the NMP states that, *'…quarterly night-time monitoring will consist of 2 x 15 minute samples, taken within the 72 hour survey period, for each location, to provide further data to characterise night-time noise from SMC operations.'*

2 SMC NOISE CRITERIA

The figures presented in this Section, provided by SMC, are extracts from the *Stratford Extension Project* (SSD-4966) Development Consent dated 29 May 2015.

2.1 Project Approval Schedule 3 Environmental Performance Conditions

ACQUISITION UPON REQUEST

1. Upon receiving a written request for acquisition from an owner of the land listed in Table 1, the Applicant shall acquire the land in accordance with the procedures in conditions 5-6 of Schedule 4.

Table 1: Land subject to acquisition upon request

Property ID	
40/51/Cr1 – L. Blanch	42 – D. Blanch
Cr7 – Pryce-Jones	Cr 2 – Boorer

Note: To interpret the location referred to in Table 1 see the applicable figure in Appendix 5.

However, the obligation to acquire a property does not apply if the Applicant has a negotiated agreement with the owner/s of the relevant land that sets aside acquisition under the terms of this consent, and the Applicant has advised the Department in writing of the terms of this agreement.

ADDITIONAL MITIGATION UPON REQUEST

2. Upon receiving a written request from the owner of any residence on the land listed in Tables 1 and 2, the Applicant shall implement additional noise mitigation measures (such as double glazing, insulation, and/or air conditioning) at the residence in consultation with the owner. These measures must be reasonable and feasible and directed towards reducing the noise impacts of the development on the residence.

If within 3 months of receiving this request from the owner, the Applicant and the owner cannot agree on the measures to be implemented, or there is a dispute about the implementation of these measures, then either party may refer the matter to the Secretary for resolution.

Table 2: Land subject to additional noise mitigation upon request

Property ID	***Property ID***
31(1) – Isaac	60 – Healy / Greenwood
44 – Cross / Jane	36 – Wallace
37 – Worth	29 – Ward
15(3) – Falla	

Note: To interpret the locations referred to in Table 2 see the applicable figure in Appendix 5.

However, the obligation to implement noise mitigation measures does not apply if the Applicant has a negotiated agreement with the owner/s of the relevant residence or land that sets aside noise mitigation measures under the terms of this consent, and the Applicant has advised the Department in writing of the terms of this agreement.

NOISE

Hours of Operation

3. The Applicant shall comply with the operating hours in Table 3.

Table 3: Operating hours

Activity	Operating Hours
• Open cut mining operations in the Bowens Road North and Roseville West Extension pits • Recovery and transport of CHPP rejects for re-processing • Construction of the noise mitigation bunds on the western side of the Avon North, Roseville West Extension and Stratford East pits	7 am to 6 pm, 7 days per week
• Open cut mining operations in the Avon North and Stratford East pits • Coal processing, loading and dispatch of product coal trains	24 hours a day, 7 days per
• Maintenance activities	week

Noise Criteria

4. The Applicant shall ensure that the noise generated by the development does not exceed the criteria in Table 4 at any residence on privately-owned land.

Table 4: Noise criteria dB(A)

Land	Day $L_{Aeq(15\ min)}$	Evening $L_{Aeq(15\ min)}$	Night $L_{Aeq(15\ min)}$	Night $L_{A1\ (1\ min)}$
40/51/Cr1 – L. Blanch	43	43	43	50
Cr7 – Pryce-Jones	43	43	43	49
42 – D. Blanch	42	42	42	50
Cr 2 – Boorer	41	41	41	49
31(1) – Isaac	40	40	40	48
36 – Wallace	39	39	39	47
44 – Cross / Jane				
60 – Healy / Greenwood	39	39	39	45
37 – Worth	38	38	38	46
29 – Ward	38	38	37	45
23 – Bagnall	37	37	37	45
31(2) – Isaac				
296 – Watson				
297 – Bosma				
298 – Yates	36	36	36	45
15(3) – Falla	39	35	35	45
15(2) – Falla	36	35	35	45
Stratford Village	37	36	35	45
All other privately-owned residences	35	35	35	45

- *To interpret the locations referred to in Table 4 see the applicable figure(s) in Appendix 5.*
- *Stratford village is shown on the figure(s) in Appendix 5.*

Noise generated by the development is to be measured in accordance with the relevant requirements of the *NSW Industrial Noise Policy*. Appendix 6 sets out the meteorological conditions under which these criteria apply and the requirements for evaluating compliance with these criteria.

However, these criteria do not apply if the Applicant has a negotiated agreement with the owner/s of the relevant residence or land to generate higher noise levels, and the Applicant has advised the Department in writing of the terms of this agreement.

2.2 EPL Noise Limits

According to the EPL 5161 Condition L2 and EPL 11745 Condition L2, the site specific noise limits for the seven nominated attended noise monitoring locations are summarised in **Table 1**.

Table 1 Noise Limits for the Nominated Attended Noise Monitoring Locations [dBA re 20 µPa]

Locality	Intrusiveness Criteria $L_{Aeq(15\ min)}$			Modification $L_{A1(1minute)}$ Criterion
	Day	Evening	Night	Night
Atkins	35	35	35	45
Clarke gates[1,2]	37	37	-	-
Hall	35	35	35	45
Lowrey	35	35	35	45
Pryce Jones[3]	43	43	43	49
Ellis/Denyer[2]	35	35	-	-
Van der Drift[2]	35	35	35	45

Note 1: 'Clarke gates' is the alternate location to R. Bagnall, as the owner does not permit monitoring on their property.
Note 2: Owned by Stratford Coal Pty Ltd.
Note 3: Land subject to acquisition upon request.

2.3 Assessment of Low-frequency Emissions

To address the low-frequency noise assessment issues raised in THE 2014 Independent Environmental Audit, as outlined in the VIPAC letter (29N-15-0009-TNT-472681-0, dated 26 February 2015), the following analysis of the operator-attended monitoring data is proposed:

> *…a full L_{Ceq} minus L_{Aeq} spectrum low frequency analysis will be conducted on all noise compliance measurements where the mine noise contribution is deemed to be the dominant noise source. This will be conducted in accordance with the guidance set out in the INP in accordance with the requirements of Development Consent 23-98/99 Schedule 3 Condition 7(a) and Development Consent 39-02-01 Schedule 2 Condition 6.4C(a)(i).*

The low-frequency analysis proposed above shall also serve to meet the *Compliance Monitoring* requirement of Section 5(d) of Appendix 6 *Noise Compliance Assessment* of the Stratford Extension Project Development Consent (SSD-4966, dated 29 May 2015), that states:

> *…the use of an appropriate modifying factor for low frequency noise to be applied during compliance testing at any individual residence if low frequency noise is present (in accordance with the INP) and before comparison with the specified noise levels in the consent.*

A full L_{Ceq} minus L_{Aeq} spectrum low frequency analysis was not conducted on the noise compliance measurements in this round of SMC monitoring as the *'…mine noise contribution...'* was not *'…deemed to be the dominant noise source'* and shall not be addressed further in this report. The results of the operator attended noise measurements presented in **Section 4** of this report.

3 OPERATIONAL NOISE MONITORING METHODOLOGY

3.1 General Requirements

All acoustic instrumentation employed throughout the monitoring programme has been designed to comply with the requirements of AS IEC 61672.1 – 2004 *Electroacoustics—Sound level meters – Specifications*, AS IEC 61672.2-2004, AS IEC 61672.3-2004 and carried current NATA or manufacturer calibration certificates. Instrument calibration was checked before and after each measurement survey, with the variation in calibrated levels not exceeding ±0.5 dBA.

3.2 Methodology - Operator Attended Noise Monitoring Locations

Noise monitoring was conducted in accordance the requirements of the NMP.

Operator attended noise measurements were conducted during the day, evening and two consecutive night-time periods for a minimum of 15 minutes per period at each of the seven nominated noise monitoring locations. The details of the operator-attended mine noise monitoring locations are contained within **Table 2** and shown in **Figure 1**. During the operator attended noise measurements, the character and relative contribution of ambient noise sources and SMC contributions were determined.

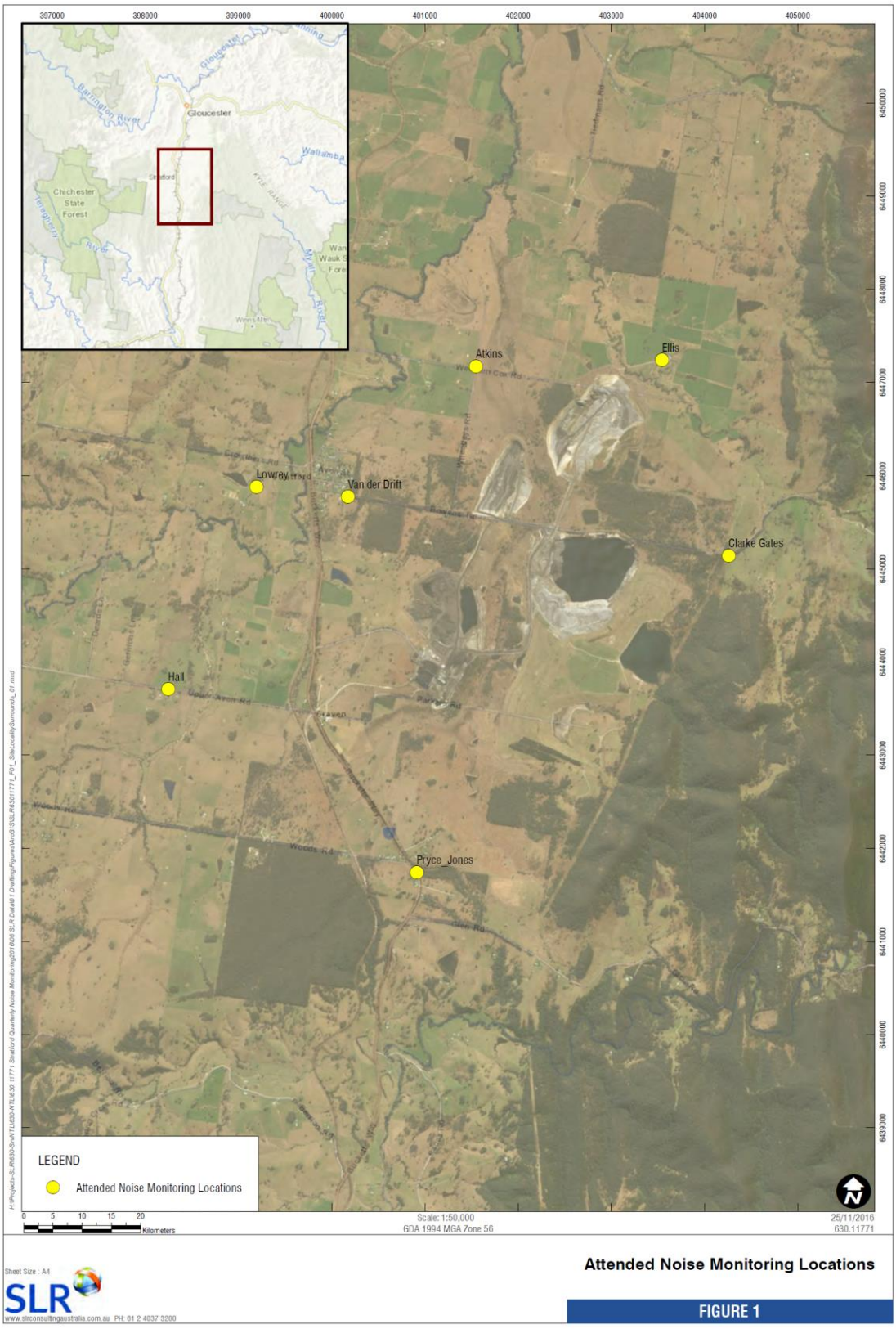
Table 2 Noise Monitoring Locations

Monitoring Location	Receiver Type	Resident / Owner	Monitoring Location - MGA Zone 56	
			Easting (m)	Northing (m)
Atkins	Residence	Atkins	401543	6447162
Clarke gates	Residence	Clarke	404261	6445139
Hall	Residence	Hall	398238	6443704
Lowrey	Residence	Lowrey	399193	6445879
Pryce Jones	Residence	Pryce Jones	400912	6441740
Ellis	Residence	Ellis	403521	6447229
Van der Drift	Residence	Van der Drift	400171	6445775

The objective of the operator attended noise monitoring was to measure the maximum (L_{Amax}) and the $L_{Aeq(15minute)}$ noise level contributions at the nearest potentially affected receptors to determine the noise contribution of mining activities associated with SMC operations over a 15 minute measurement period. In addition, the operator quantifies and characterises the overall levels of ambient noise in the area (ie L_{Amax}, L_{A1}, L_{A10}, L_{A90}, and L_{Aeq}) over the 15 minute measurement interval.

Operator attended noise measurements were conducted using a one-third octave integrating Brüel & Kjær Type 2250L sound level meter (s/n 3004635).

Figure 1 Stratford Mining Complex Attended Noise Monitoring Locations



4 RESULTS

4.1 Operator Attended Monitoring – SMC Operational Activity

Operator attended noise measurements were conducted during a day, evening and two consecutive night periods (night survey 1 and night survey 2) commencing on Monday 26 September 2016 and ending Tuesday 27 September 2016. Results of the operator attended noise surveys are provided in **Table 3** to **Table 9**, respectively.

A summary of the results for the attended noise monitoring are displayed graphically in **Appendix B**. Charts of the noise surveys show L_{Amax}, L_{Aeq}, and $L_{Aeq(12.5Hz-1.25kHz)}$ and where required shaded bands represent periods containing the audible SMC noise contribution.

Ambient noise levels presented include all noise sources such as transport (roads, rail and aircraft), fauna (insects, frogs, birds, and bats), farm animals (cows, bulls), the natural environment (wind, wind in trees), domestic noises, other industrial operations as well as SMC noise emissions.

Weather data during the monitoring period has been obtained from the weather station located on the SMC site. Where this data was not available meteorological conditions have been estimated based on observed conditions during the monitoring period.

The tables provide the following information:

- Date and start time, operator and equipment details.
- Monitoring location.
- Wind velocity (m/s) and temperature (ºC) at the measurement location.
- Typical maximum (L_{Amax}) and contributed $L_{Aeq(15minute)}$ noise levels.

4.1.1 Operator Attended Noise Survey Results – Monitoring Location 'Atkins'

Results of the operator attended noise surveys at 'Atkins' (Atkins) are provided in **Table 3**. Monitoring location Atkins represents residential receptors located to the north of the site.

Table 3 Operator Attended Noise Survey Results – Atkins

Period	Date/Start Time/ Weather	Primary Noise Descriptor (dBA re 20 μPa)					Description of Noise Emissions and Typical Maximum Noise Levels (dBA)
		LAmax	**LA1**	**LA10**	**LA90**	**LAeq <1.25 Hz**	
Day	26/9/2016 16:20 22°C 2.9 – 3.0 m/s S - SSW	53	50	41	35	39	*Site related noise events:* **SMC: Intermittently barely audible low frequency noise from mobile plant (Dozer) activity** **Calculated contribution $L_{Aeq(15minute)}$ <10 dBA** Dozer (<250 Hz) 18 to 27 *Other noise events:* Insects/Frogs 35 to 38 Bird calls 33 to 49 Cows 36 to 37 Dogs barking 46 Wind/trees < 45 Road traffic noise 24 to 53

Period	Date/Start Time/ Weather	Primary Noise Descriptor (dBA re 20 μPa)					Description of Noise Emissions and Typical Maximum Noise Levels (dBA)
		LAmax	LA1	LA10	LA90	LAeq <1.25 Hz	
Evening	26/9/2016 19:21 13°C 1.4 – 1.6 m/s W	65	54	46	40	45	*Site related noise events:* **SMC: Inaudible** *Other noise events:* Insects/Frogs 40 to 48 Aircraft 23 to 55 Road traffic noise 22 to 65 Dogs 22 to 27
Night Survey 1	26/9/2016 23:01 14°C 1.4 - 2.9 m/s W	52	40	35	26	32	*Site related noise events:* **SMC: Inaudible** *Other noise events:* Insects/Frogs 29 to 44 Wind / Trees 28 to 52 Dogs barking 33 to 36 Road traffic noise < 30 Aircraft < 40
Night Survey 2	27/9/2016 22:11 12°C 1.1 – 2.1 m/s SW	59	52	40	23	39	*Site related noise events:* **SMC: Inaudible** *Other noise events:* Insects/Frogs 22 to 35 Wind / Trees <40 Dogs barking 31 to 37 Road traffic noise < 30 Aircraft 24 to 59 Bull ≤35 Distant road traffic < 25

SMC operations were intermittently barely audible during the day period operator attended noise survey at this location. SMC operations were inaudible during the evening and both night period noise surveys at this location.

The ambient noise environment at the monitoring location during the day period was dominated by insect and frog noise, birds and vehicle noise. Other contributory noise sources included farm animal noise (cows and dogs), wind noise as well as the SMC noise contribution. The SMC $L_{Aeq(15minute)}$ noise contribution was estimated to be less than <10 dBA during the daytime period. The major site noise contributor identified during the survey was intermittent dozer activity.

The ambient noise environment at the monitoring location during the evening period was dominated insects and frog noise, aircraft flyover noise and road traffic noise. Other contributory noise sources included barking dogs.

The ambient noise environment at the monitoring location during the first of the night period surveys was dominated by insects and frog noise and wind noise. Other contributory noise sources included dogs barking, an aircraft flyover, and distant road traffic noise.

The ambient noise environment at the monitoring location during the second of the night period surveys was dominated by aircraft noise, insects and frog noise and wind noise. Other contributory noise sources included dogs barking, bulls and distant road traffic noise.

4.1.2 Operator Attended Noise Survey Results – Monitoring Location 'Clarke'

Results of the operator attended noise surveys at 'Clarke' (Clarke) are provided in **Table 4**. Monitoring location Clarke represents residential receptors located to the east of the site.

Table 4 Attended Noise Survey Results – Clarke

Period	Date/Start Time/ Weather	Primary Noise Descriptor (dBA re 20 μPa)					Description of Noise Emissions and Typical Maximum Noise Levels (dBA)
		LAmax	LA1	LA10	LA90	LAeq <1.25 Hz	
Day	26/9/2016 15:25 22°C 1.6 – 2.0 m/s S - SSE	63	51	41	30	39	*Site related noise events:* **SMC: Inaudible** *Other noise events:* Insects 29 to 32 Bird calls 35 to 63 Aircraft 26 to 30 Wind/trees 30 to 54 Road Traffic 22 to 24
Evening	26/9/2016 18:27 18°C 0.0 - 0.8 m/s SE - SSE	59	39	37	35	36	*Site related noise events:* **SMC: Barely audible low frequency continuum and impact** **Calculated contribution LAeq(15minute) <21 dBA** Haul trucks (<500 Hz) 19 to 27 Impact 32 *Other noise events:* Insects/Frogs 34 to 37 Birds 37 to 59 Wind in trees 33 to 37 Aircraft 20 to 36 Train 25 to 26 Train Horn 29
Night Survey 1	26/9/2016 22:31 15°C 0.0 - 0.5 m/s W	40	35	33	30	31	*Site related noise events:* **SMC: Barely audible low frequency continuum** **Calculated contribution LAeq(15minute) 13 dBA** **LA1(1minute) 22 dBA** Low frequency continuum (<630 Hz) 17 to 22 *Other noise events:* Insects/Frogs 30 to 33 Birds 34 to 35 Wind / Trees 30 to 31 Aircraft 32 to 40

Period	Date/Start Time/ Weather	Primary Noise Descriptor (dBA re 20 μPa)					Description of Noise Emissions and Typical Maximum Noise Levels (dBA)
		LAmax	LA1	LA10	LA90	LAeq <1.25 Hz	
Night Survey 2	27/9/2016 23:03 14°C 0.0 – 1.1 m/s ESE - SE	52	39	30	19	28	*Site related noise events:* **SMC: Inaudible** *Other noise events:* Insects/Frogs 19 to 22 Birds 21 to 39 Animals in scrub 28 to 52 Dogs barking 30 to 39 Wind / Trees 26 to 42 Aircraft 32 to 40

SMC operations were inaudible during both the day and the second night period noise surveys at this location. SMC operations were audible during the evening period and the first night period operator attended noise surveys at this location.

The ambient noise environment at the monitoring location during the day period was dominated by birds, insect noise, winds and tree movements. Other contributory noise sources included an aircraft flyover noise and distant road traffic noise. The SMC $L_{Aeq(15minute)}$ noise contribution was estimated to be 21 dBA during the daytime period. The site noise contributor identified during the survey was low frequency mechanical plant continuous noise and impacts.

The ambient noise environment at the monitoring location during the evening period was dominated by insects, frogs and birds. Other contributory noise sources included trees in the wind, aircraft flyovers and train noise.

The ambient noise environment at the monitoring location during the first of the night period surveys was dominated by insect and frog noise, wind in the trees. Other contributory noise sources included and aircraft flyover, SMC contribution and birds. The SMC $L_{Aeq(15minute)}$ noise contribution was estimated to be 13 dBA during the night-time period. The site noise contributor identified during the survey was low frequency mechanical plant continuous noise. During the night-time noise monitoring survey the SMC operational noise resulted in a $L_{A1(1minute)}$ noise level of 22 dBA.

The ambient noise environment at the monitoring location during the second of the night period surveys was dominated by insect and frog noise, wind in the trees and animal sounds and activity.

4.1.3 Operator Attended Noise Survey Results – Monitoring Location 'Hall'

Results of the operator attended noise surveys at 'Hall' (Hall) are provided in **Table 5**. Monitoring location Hall represents residential receptors located to the southwest of the site.

Table 5 Attended Noise Survey Results – Hall

Period	Date/Start Time/ Weather	Primary Noise Descriptor (dBA re 20 μPa)					Description of Noise Emissions and Typical Maximum Noise Levels (dBA)
		LAmax	LA1	LA10	LA90	LAeq <1.25 Hz	
Day	26/9/2016 17:43 20°C 1.8 – 2.0 m/s SE - SSE	56	45	39	36	38	*Site related noise events:* **SMC: Inaudible** *Other noise events:* Insects 36 to 39 Farm activity 10 to 56 Birds 36 to 56 Aircraft 21 to 29 Horses/Cows 38 to 43
Evening	26/9/2016 21:25 17°C 0.5 – 4.0 m/s WSW - W	49	43	40	33	37	*Site related noise events:* **SMC: Inaudible** *Other noise events:* Insects / Frogs 32 to 43 Wind 32 to 49 Horse 39 to 53
Night Survey 1	27/9/2016 00:29 15°C 0.5 – 1.5 m/s WNW	45	36	29	22	27	*Site related noise events:* **SMC: Inaudible** *Other noise events:* Wind 29 to 30 Electricity transformer <15 Insects/Frogs 22 to 45 Dogs ≤36 Cows/Bulls < 36 Birds <36
Night Survey 2	28/9/2016 00:30 13°C 0.5 - 2.8 m/s SSW to WSW	56	47	40	21	36	*Site related noise events:* **SMC: Inaudible** *Other noise events:* Wind 26 to 56 Electricity transformer 10 to 12 Insects/Frogs 20 to 22 Dogs 31 to 32 Road traffic noise < 30 Aircraft 20 to 35

SMC operations were inaudible during the day, evening and night period noise surveys at this location.

The ambient noise environment at the monitoring location during the day period was dominated by birds, insects and farm activity noise. Other contributory noise sources included farm animals and aircraft flyover noise.

The ambient noise environment at the monitoring location during the evening period was dominated wind noise, trees in the wind and insects and frog noise. Other contributory noise sources included the farm animal noise (horses).

The ambient noise environment at the monitoring location during the first of the night period surveys was dominated by insects and frog noise, wind noise and the continuous electricity transformer noise. Other contributory noise sources included birds, dogs and farm animals (cows/bulls).

The ambient noise environment at the monitoring location during the second of the night period surveys was dominated by aircraft noise, wind noise, insects and frog noise and the continuous electricity transformer noise. Other contributory noise sources included dogs and distant road traffic noise.

4.1.4 Operator Attended Noise Survey Results – Monitoring Location 'Lowrey'

Results of the operator attended noise surveys at 'Lowrey' (Lowrey) are provided in **Table 6**. Lowrey represents residential receptors located to the west of the site and west of Bucketts Way.

Table 6 Attended Noise Survey Results – Lowrey

Period	Date/Start Time/ Weather	Primary Noise Descriptor (dBA re 20 μPa)					Description of Noise Emissions and Typical Maximum Noise Levels (dBA)
		LAmax	LA1	LA10	LA90	LAeq <1.25 Hz	
Day	26/9/2016 17:12 19°C 2.2 – 2.8 m/s SSE	68	50	44	40	43	*Site related noise events:* **SMC: Barely audible intermittent low frequency noise and impacts.** **Calculated contribution LAeq(15minute) <10 dBA** Low frequency noise (≤ 500 Hz) 24 to 32 Impacts 27 to 34 *Other noise events:* Insects 33 to 43 Birds 42 to 68 Road Traffic noise 43 to 44 Farm activity noise 44 to 68 Cows 44 to 49
Evening	26/9/2016 20:20 16°C 1.6 – 4.6 m/s WSW	52	48	45	39	42	*Site related noise events:* **SMC: Inaudible** *Other noise events:* Insects/Frogs 41 to 49 Road traffic noise 35 to 49 Cows 43 Wind/trees 43 to 52
Night Survey 1	26/9/2016 23:31 14°C 0.0 - 2.1 m/s WNW	51	48	45	31	40	*Site related noise events:* **SMC: Inaudible** *Other noise events:* Insects/Frogs 29 to 49 Road traffic noise < 30 Wind / Trees 30 to 51
Night Survey 2	27/9/2016 23:59 13°C 0.6 m/s WSW	41	35	31	25	29	*Site related noise events:* **SMC: Inaudible** *Other noise events:* Insects/Frogs 27 to 33 Dogs barking <31 Cows 29 to 36 Bull 35 to 41 Water flow 25 to 33 Aircraft 12 to 21

SMC operations were inaudible during the day and both night survey periods at this location. SMC operations were audible during the day period operator attended noise survey at this location.

The ambient noise environment at the monitoring location during the day period was dominated by insects, birds, road traffic noise and farm animal activity noise. Other contributory noise sources included cows and the SMC noise contribution. The SMC $L_{Aeq(15minute)}$ noise contribution was estimated to be <10 dBA during the daytime period resulting from intermittent low frequency noise and site impacts.

The ambient noise environment at the monitoring location during the evening period was dominated by insects and frogs noise as well as wind noise. Other contributory noise sources included road traffic noise and cows.

The ambient noise environment at the monitoring location during the first of the night period surveys was dominated by wind noise and insects and frogs. Other contributory noise sources included road traffic noise.

The ambient noise environment at the monitoring location during the second of the night period surveys was dominated by noise from insects and frogs, on-farm water flow, bulls and cows. Other contributory noise sources included aircraft noise and dogs barking.

4.1.5 Operator Attended Noise Survey Results – Monitoring Location 'Pryce Jones'

Results of the operator attended noise surveys at 'Pryce Jones' (Pryce Jones) are provided in **Table 7**. Pryce Jones represents residential receptors located in Craven to the south of the site.

Table 7 Attended Noise Survey Results – Pryce Jones

Period	Date/Start Time/ Weather	Primary Noise Descriptor (dBA re 20 μPa)					Description of Noise Emissions and Typical Maximum Noise Levels (dBA)
		LAmax	LA1	LA10	LA90	LAeq <1.25 Hz	
Day	27/9/2016 17:35 19°C 7.1 – 7.6 m/s SW - WSW	81	74	61	40	61	*Site related noise events:* **SMC: Inaudible** *Other noise events:* Road traffic 66 to 81 Birds 39 to 58 Domestic noises 47 Aircraft 39 to 49 Wind / Trees 40 to 61
Evening	26/9/2016 20:52 17 - 18°C 0.6 – 1.8 m/s SSW	82	65	52	44	56	*Site related noise events:* **SMC: Inaudible** *Other noise events:* Insects/Frogs 42 to 43 Road traffic (Bucketts Way) 49 to 82 Wind/Trees 48 to 51 Dogs 43
Night Survey 1	27/9/2016 00:56 15°C 0.0 - 1.0 m/s NE - E	56	41	36	28	34	*Site related noise events:* **SMC: Inaudible** *Other noise events:* Aircraft 45 to 46 Insects/Frogs 27 to 36 Wind/wind in trees 28 to 36 *Operator noise (ignore) 56*

Period	Date/Start Time/ Weather	Primary Noise Descriptor (dBA re 20 μPa)					Description of Noise Emissions and Typical Maximum Noise Levels (dBA)
		LAmax	LA1	LA10	LA90	LAeq <1.25 Hz	
Night Survey 2	28/9/2016 00:58 13°C 0.0 – 0.5 m/s E	79	61	38	27	52	*Site related noise events:* **SMC: Inaudible** *Other noise events:* Insects/Frogs 28 to 29 Wind/wind in trees 21 to 36 Road traffic 33 to 79 Horse 39 to 43 Birds 28 to 30

SMC operations were inaudible during the day, evening and both night period noise surveys at this location.

The ambient noise environment at the monitoring location during the day period was dominated by road traffic noise, wind in trees and bird noise. Other sources included aircraft flyover noise and domestic noises.

The ambient noise environment at the monitoring location during the evening period was dominated by The Bucketts Way road traffic noise, trees in the wind and insects. Other sources included barking dogs.

The ambient noise environment at the monitoring location during the first of the night period surveys was dominated by insect noise and wind noise. Other contributory noise sources included an aircraft flyover.

The ambient noise environment at the monitoring location during the second of the night period surveys was dominated by road traffic noise, insect noise and wind noise. Other contributory noise sources included an horse and birds.

4.1.6 Operator Attended Noise Survey Results – Monitoring Location 'Ellis'

Results of the operator attended noise surveys at 'Ellis' (Ellis) are provided in **Table 8**. Ellis represents residential receptors located northeast of the site.

Table 8 Attended Noise Survey Results – Ellis

Period	Date/Start Time/ Weather	Primary Noise Descriptor (dBA re 20 μPa)					Description of Noise Emissions and Typical Maximum Noise Levels (dBA)
		LAmax	LA1	LA10	LA90	LAeq <1.25 Hz	
Day	26/9/2016 15:53 22°C 3.0 – 3.3 m/s SE - SSW	57	52	47	40	44	*Site related noise events:* **SMC: Inaudible** *Other noise events:* Cows 40 to 57 Dogs barking 45 to 53 Birds 40 to 50 Farm noise (Mechanical plant) 38 to 41 Farm noise (Impacts) 43 to 50 Farm noise (vehicle) 42 to 47 Wind /Trees < 40 Aircraft 42 to 43
Evening	26/9/2016 18:54 16°C 0.8 – 1.2 m/s ENE	71	63	58	40	53	*Site related noise events:* **SMC: Inaudible** *Other noise events:* Dogs 42 to 71 Insects/Frogs < 40 Farm noise (Mechanical plant) 38 to 41 Cows 25 to 52 Aircraft 27 to 49 Train 27 to 49
Night Survey 1	26/9/2016 22:05 16°C 0.0 – 0.5 m/s W	43	36	34	30	32	*Site related noise events:* **SMC: Inaudible** *Other noise events:* Insects/Frogs 30 to 33 Wind / Trees 26 to 34 Cows 23 to 43 Road traffic noise < 30 Farm noise (impacts) 34 to 52
Night Survey 2	27/9/2016 22:37 14°C 1.3 – 1.8 m/s ESE	65	54	31	26	39	*Site related noise events:* **SMC: Inaudible** *Other noise events:* Insects/Frogs < 33 Wind / Trees 26 to 29 Cows 29 to 42 Bulls 48 to 59 Dogs 29 to 65 Road traffic noise < 30 Farm activity 39 to 41

SMC operations were inaudible during day, evening and both night period noise surveys at this location.

The ambient noise environment at the monitoring location during the day period was dominated by continuous noise from the farm mechanical plant, dogs, cows and birds. Other sources included farm vehicle noise, aircraft flyover noise, noise from the wind induced movement of the trees.

The ambient noise environment at the monitoring location during the evening period was dominated by barking dogs, insect noise and continuous farm mechanical plant noise. Other sources included an aircraft flyover, a train passby and cows.

The ambient noise environment at the monitoring location during the first night period survey was dominated by insects and frog noise, wind and noise from cows. Other contributory noise sources included intermittent farm impacts and distant road traffic noise.

The ambient noise environment at the monitoring location during the second night period survey was dominated by dogs activity and barking, bulls, insects and frog noise. Other contributory noise sources included wind noise, intermittent farm impacts, cows and distant road traffic noise.

4.1.7 Operator Attended Noise Survey Results – Monitoring Location 'Van der Drift'

Results of the operator attended noise surveys at 'Van der Drift' (van der Drift) are provided in **Table 9**. Van der Drift represents residential receptors located in Stratford to the west of the site.

Table 9 Attended Noise Survey Results – Van der Drift

Period	Date/Start Time/ Weather	Primary Noise Descriptor (dBA re 20 μPa)					Description of Noise Emissions and Typical Maximum Noise Levels (dBA)
		LAmax	LA1	LA10	LA90	LAeq <1.25 Hz	
Day	26/9/2016 16:47 22°C 2.8 m/s SSE	60	44	43	39	41	*Site related noise events:* **SMC: Audible intermittent mobile plant (Dozer) activity and impacts.** **Calculated contribution LAeq(15minute) 24 dBA** Mobile plant activity (≤ 250 Hz) 28 to 51 Impacts 33 to 40 *Other noise events:* Road traffic (Bucketts Way) 31 to 51 Dogs barking 39 to 46 Birds 33 to 60 Domestic noises 37 to 45 Train horn 43 to 46 Insects 36 to 41
Evening	26/9/2016 19:51 13°C 0.6 – 3.2 m/s E - SSE	53	50	47	42	44	*Site related noise events:* **SMC: Barely audible low frequency mechanical plant noise** **Calculated contribution LAeq(15minute) <20 dBA** Low frequency noise 29 to 32 *Other noise events:* Insects/Frogs 46 to 47 Road traffic 45 to 53 Dogs 43 to 51 Aircraft 35 to 38 Trees in the wind 47 to 48

Period	Date/Start Time/ Weather	Primary Noise Descriptor (dBA re 20 μPa)					Description of Noise Emissions and Typical Maximum Noise Levels (dBA)
		LAmax	LA1	LA10	LA90	LAeq <1.25 Hz	
Night Survey 1	27/9/2016 00:08 14°C 0.6 – 1.8 m/s W	55	46	36	31	36	*Site related noise events:* **SMC: Inaudible** *Other noise events:* Road traffic (Bucketts Way) 38 to 55 Farm noise (mechanical plant) < 20 Insects/Frogs 30 to 33 Wind/wind in trees 33 to 34
Night Survey 2	27/9/2016 23:32 11°C 1.2 – 1.5 m/s NNE	51	42	36	22	32	*Site related noise events:* **SMC: Inaudible** *Other noise events:* Dogs barking 33 to 51 Road traffic (Bucketts Way) < 36 Domestics mechanical plant < 10 Insects/Frogs 23 to 26 Birds 24 to 39 Wind/wind in trees <30

SMC operations were intermittently audible during the day and evening period operator attended noise surveys at this location. SMC operations were inaudible during both the night period noise surveys at this location.

The ambient noise environment at the monitoring location during the day period was dominated by noise from dogs and birds, insect noise and road traffic noise. Other sources included train horns, domestic noises and the SMC noise contribution resulting from the low frequency noise component of mobile plant activity and impact noise. The SMC $L_{Aeq(15minute)}$ noise contribution was estimated to be **24 dBA** during the evening period resulting from dozer operations and site impact noise.

The ambient noise environment at the monitoring location during the evening period was dominated by The Bucketts Way road traffic noise, insect noise and dogs. Other sources included continuous the SMC noise contribution, trees in the wind, and an aircraft flyover. The SMC $L_{Aeq(15minute)}$ noise contribution was estimated to be **<20 dBA** during the evening period resulting from low frequency site emitted noise.

The ambient noise environment at the monitoring location during the first of the night period surveys was dominated by insect noise and wind noise as well as The Bucketts Way road traffic noise. Other contributory noise sources included continuous low frequency mechanical plant noise from an adjoining farm.

The ambient noise environment at the monitoring location during the second of the night period surveys was dominated by dogs barking, birds and insect noise. Other contributory noise sources included wind noise, road traffic noise and continuous low frequency mechanical plant noise from a nearby residence.

5 PERFORMANCE ASSESSMENT

5.1 Operations

Results of the operator attended noise measurements compared with the relevant noise criteria contained in the SMC Development Consent are given in **Table 10**.

Table 10 Performance Assessment – Operations

Location	Estimated SMC $L_{Aeq(15minute)}$ Contribution dBA				Noise Criteria $L_{Aeq(15minute)}$ dBA				Compliance			
	Day	Eve	Night Survey 1	Night Survey 2	Day	Eve	Night Survey 1	Night Survey 2	Day	Eve	Night Survey 1	Night Survey 2
Atkins	<10	I/A[1]	I/A	I/A	35	35	35	35	Yes	Yes	Yes	Yes
Clarke[2]	I/A	21	13	I/A	37	37	-	-	Yes	Yes	Yes	Yes
Hall	I/A	I/A	I/A	I/A	35	35	35	35	Yes	Yes	Yes	Yes
Lowrey	<10	I/A	I/A	I/A	35	35	35	35	Yes	Yes	Yes	Yes
Pryce Jones	I/A	I/A	I/A	I/A	43	43	43	43	Yes	Yes	Yes	Yes
Ellis[2]	I/A	I/A	I/A	I/A	35	35	-	-	Yes	Yes	Yes	Yes
Van der Drift[2]	21	<20	I/A	I/A	35	35	35	45	Yes	Yes	Yes	Yes

Note: 1: I/A = Inaudible.

Note 2: Owned by Stratford Coal Pty Ltd.

5.1.1 Assessment of Compliance – Day period

Results presented in **Table 10** indicate that SMC operations during the operator attended noise monitoring at all locations were compliant with the day period Development Consent conditions.

5.1.2 Assessment of Compliance – Evening period

Results presented in **Table 10** indicate that compliance with the Development Consent conditions was achieved at all attended noise monitoring locations during the evening period.

5.1.3 Assessment of Compliance – Night period

Results presented in **Table 10** indicate that compliance with the consent conditions was achieved at all attended noise monitoring locations during both of the two consecutive night period surveys undertaken.

5.2 Sleep Disturbance

Results of the night period sleep disturbance measurements compared with the relevant noise criteria contained in the Development Consent are given in **Table 11**.

Table 11 Performance Assessment – Sleep Disturbance

Location	SMC $L_{A1(1minute)}$ Contribution	Noise Criteria $L_{A1(1minute)}$	Compliance
Atkins	I/A[1]	45	Yes
Clarke gates	22	-	Yes
Hall	I/A	45	Yes
Lowrey	I/A	45	Yes
Pryce Jones	I/A	49	Yes
Ellis	I/A	-	Yes
Van der Drift	I/A	45	Yes

Note: 1. I/A = Inaudible.

Table 11 indicates that compliance with the relevant sleep disturbance noise criteria was achieved at all of the noise monitoring locations during the night-time noise monitoring period.

5.3 Low Frequency Noise

The Stratford Extension Project EIS indicates there is no known dominant low-frequency content relating to noise emissions from the existing Stratford Mining Complex.

6 CONCLUSION

SLR was engaged by *Stratford Coal Pty Limited* (DCPL) to conduct quarterly noise monitoring for the Stratford Mining Complex (SMC) operations guided by the requirements of the *Stratford Mining Complex Noise Management Plan* (NMP), Project No. GLC-11, Document No. 00389411, dated May 2011.

Operator-attended noise monitoring conducted at seven locations between 26 September and 28 September 2016 in order to determine the noise performance of the SMC operations against the Development Consent conditions, has resulted in the following per period assessment of compliance:

- Compliance with the relevant noise criteria was achieved at all noise monitoring locations during the day period.

- Compliance with the relevant noise criteria was achieved at all noise monitoring locations during the evening period.

- Compliance with the relevant noise criteria was achieved at all noise monitoring locations during both of the two consecutive night period surveys undertaken.

A full L_{Ceq} minus L_{Aeq} spectrum low frequency analysis of the operational noise contribution was not conducted on the noise compliance measurements for this round of SMC monitoring as the *'…mine noise contribution...'* was not *'…deemed to be the dominant noise source.'*

Based on the measured SMC noise contribution, compliance with the relevant sleep disturbance noise criteria was achieved at all noise monitoring locations during both of the two consecutive night-time noise monitoring periods.

ACOUSTIC TERMINOLOGY

1 Sound Level or Noise Level

The terms 'sound' and 'noise' are almost interchangeable, except that in common usage 'noise' is often used to refer to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure capable of evoking the sense of hearing. The human ear responds to changes in sound pressure over a very wide range. The loudest sound pressure to which the human ear responds is ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or LP are commonly used to represent Sound Pressure Level. The symbol LA represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2×10^{-5} Pa.

2 'A' Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an 'A-weighting' filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4000 Hz), and less sensitive at lower and higher frequencies. Thus, the level of a sound in dBA is a good measure of the loudness of that sound. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dBA or 2 dBA in the level of a sound is difficult for most people to detect, whilst a 3 dBA to 5 dBA change corresponds to a small but noticeable change in loudness. A 10 dBA change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels

Sound Pressure Level (dB)	Typical Source	Subjective Evaluatio
130	Threshold of pain	Intolerable
120	Heavy rock concert	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 m	Very noisy
90	Construction site with pneumatic hammering	
80	Kerbside of busy street	Loud
70	Loud radio or television	
60	Department store	Moderate to quiet
50	General Office	
40	Inside private office	Quiet to very quiet
30	Inside bedroom	
20	Recording studio	Almost silent

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as 'linear', and the units are expressed as dB(lin) or dB.

3 Sound Power Level

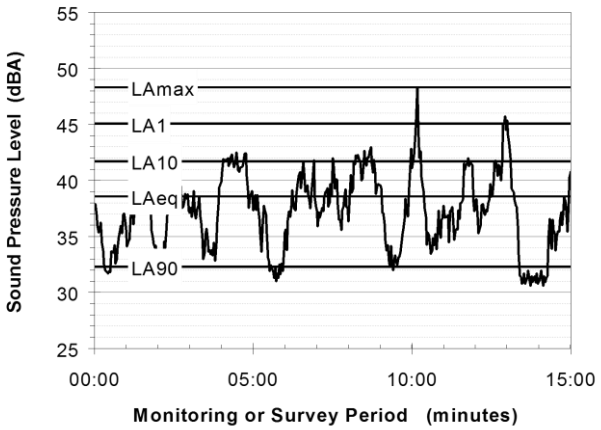
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or LW, or by the reference unit 10^{-12} W.

The relationship between Sound Power and Sound Pressure may be likened to an electric radiator, which is characterised by a power rating, but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4 Statistical Noise Levels

Sounds that vary in level over time, such as transportation noise and most community noise, are commonly described in terms of the statistical exceedance levels L_{AN}, where L_{AN} is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the L_{A1} is the noise level exceeded for 1% of the time, L_{A10} the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

L_{A1} The noise level exceeded for 1% of the 15 minute interval.

L_{A10} The noise level exceed for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.

L_{A90} The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.

L_{Aeq} The A-weighted equivalent noise level (basically the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

When dealing with numerous days of statistical noise data, it is sometimes necessary to define the typical noise levels at a given monitoring location for a particular time of day. A standardised method is available for determining these representative levels.

This method produces a level representing the 'repeatable minimum' L_{A90} noise level over the daytime and night-time measurement periods, as required by the EPA. In addition the method produces mean or 'average' levels representative of the other descriptors (L_{Aeq}, L_{A10}, etc).

5 Tonality

Tonal noise contains one or more prominent tones (ie distinct frequency components), and is normally regarded as more offensive than 'broad band' noise.

6 Impulsiveness

An impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.

7 Frequency Analysis

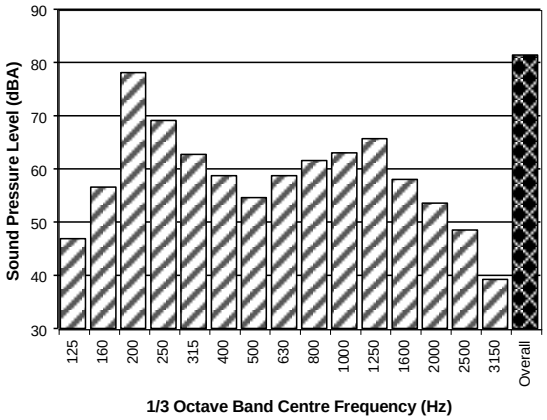
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal. This analysis was traditionally carried out using analogue electronic filters, but is now normally carried out using Fast Fourier Transform (FFT) analysers.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (3 bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

The following figure shows a 1/3 octave band frequency analysis where the noise is dominated by the 200 Hz band. Note that the indicated level of each individual band is less than the overall level, which is the logarithmic sum of the bands.



8 Vibration

Vibration may be defined as cyclic or transient motion. This motion can be measured in terms of its displacement, velocity or acceleration. Most assessments of human response to vibration or the risk of damage to buildings use measurements of vibration velocity. These may be expressed in terms of 'peak' velocity or 'rms' velocity.

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as 'peak particle velocity', or PPV. The latter incorporates 'root mean squared' averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements. Where triaxial measurements are used, the axes are commonly designated vertical, longitudinal (aligned toward the source) and transverse.

The common units for velocity are millimetres per second (mm/s). As with noise, decibel units can also be used, in which case the reference level should always be stated. A vibration level V, expressed in mm/s can be converted to decibels by the formula 20 log (V/Vo), where Vo is the reference level (10^{-9} m/s). Care is required in this regard, as other reference levels may be used by some organizations.

9 Human Perception of Vibration

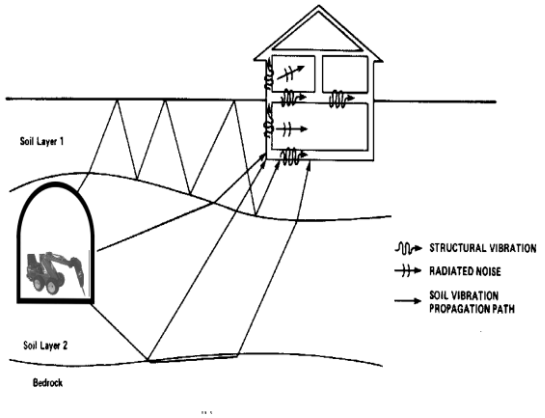
People are able to 'feel' vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as 'normal' in a car, bus or train is considerably higher than what is perceived as 'normal' in a shop, office or dwelling.

10 Ground-borne Noise, Structure-borne Noise and Regenerated Noise

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed 'structure-borne noise', 'ground-borne noise' or 'regenerated noise'. This noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

Typical sources of ground-borne or structure-borne noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

The following figure presents the various paths by which vibration and ground-borne noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.



The term 'regenerated noise' is also used in other instances where energy is converted to noise away from the primary source. One example would be a fan blowing air through a discharge grill. The fan is the energy source and primary noise source. Additional noise may be created by the aerodynamic effect of the discharge grill in the airstream. This secondary noise is referred to as regenerated noise.

OPERATOR ATTENDED NOISE SURVEY CHARTS

Figure B1 – Day Period – Atkins Operator Attended Noise Survey Results

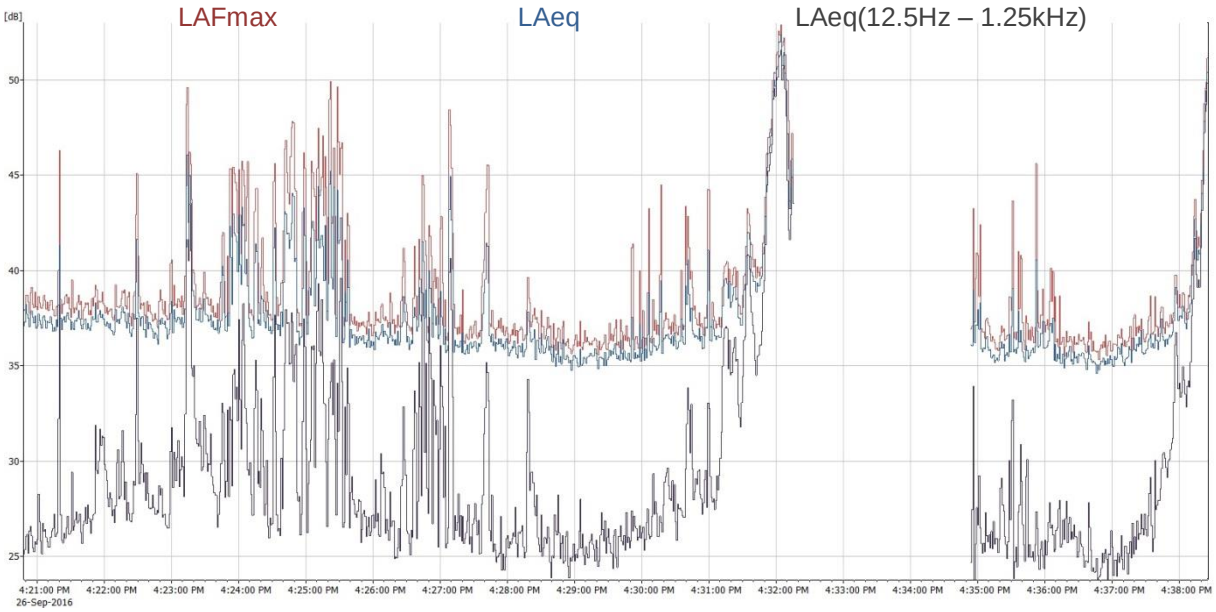


Figure B2 – Day Period – Atkins Operator Attended Noise Survey Results [Shaded bands represent periods containing audible SMC noise contribution]

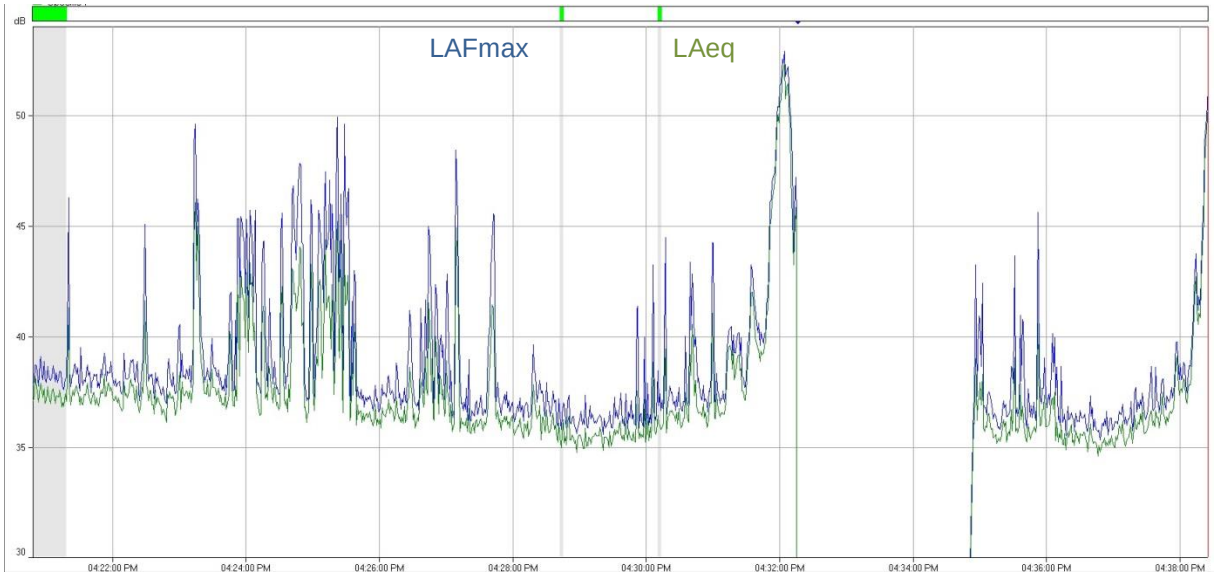


Figure B3 – Day Period – Clarke gates Operator Attended Noise Survey Results

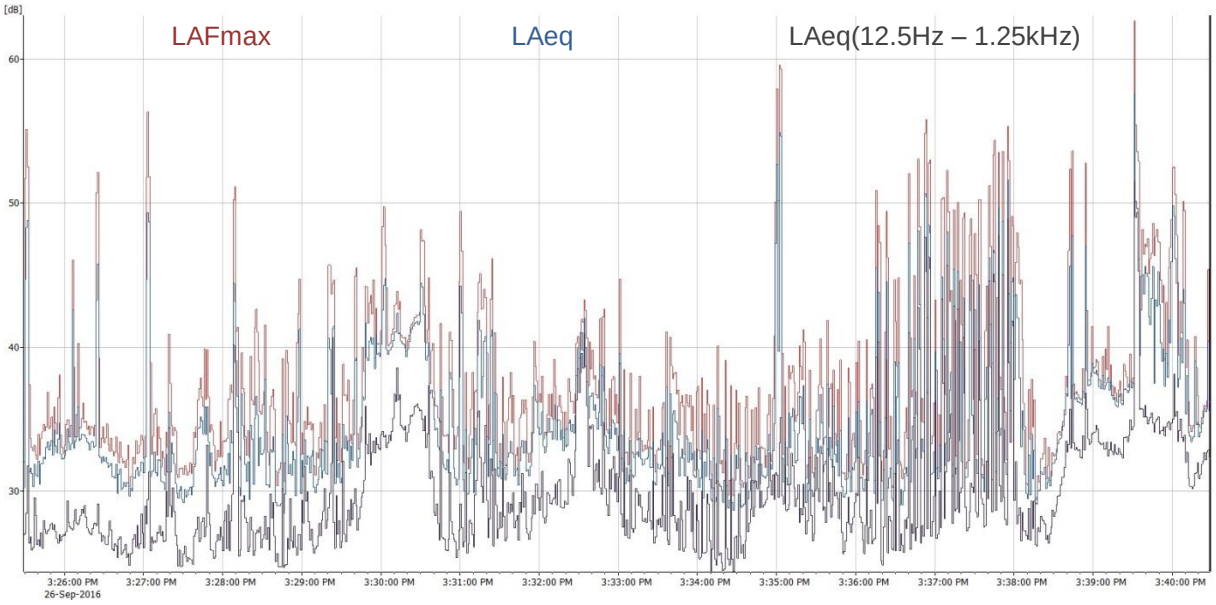


Figure B4 – Day Period – Hall Operator Attended Noise Survey Results

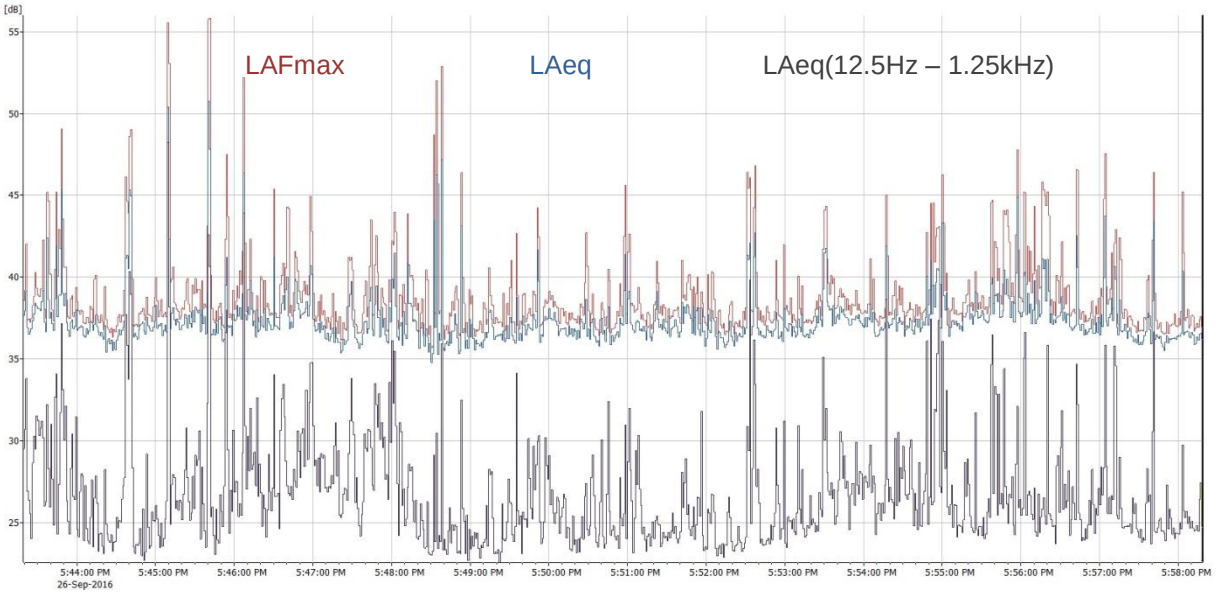


Figure B5 – Day Period – Lowrey Operator Attended Noise Survey Results

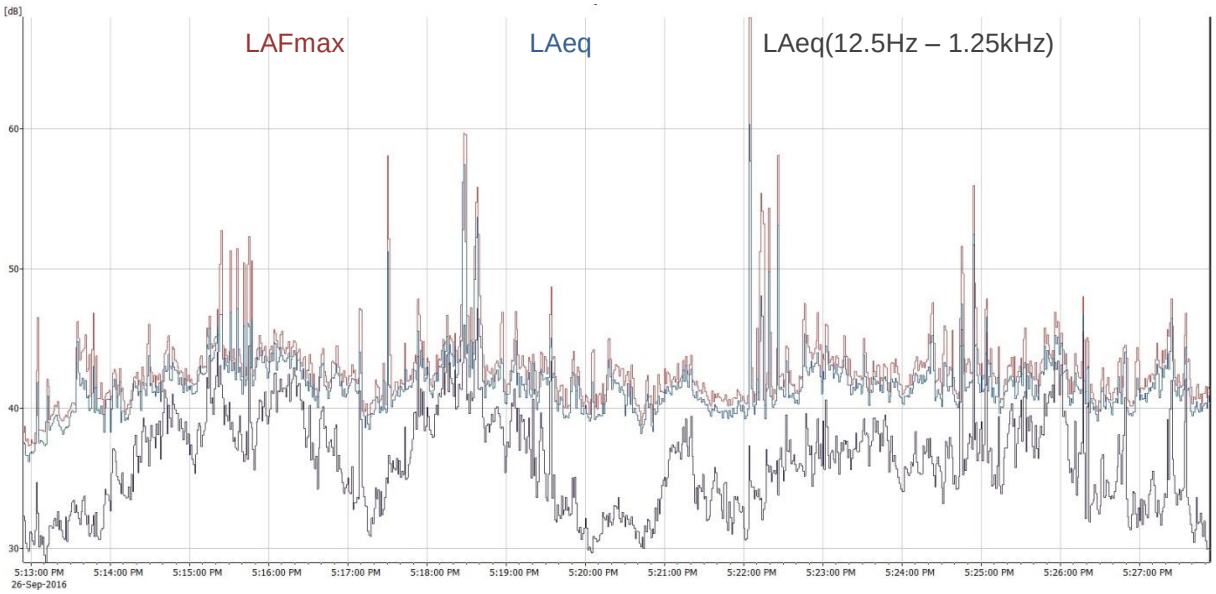


Figure B6 – Day Period – Lowrey Operator Attended Noise Survey Results [Shaded bands represent periods containing audible SMC noise contribution]

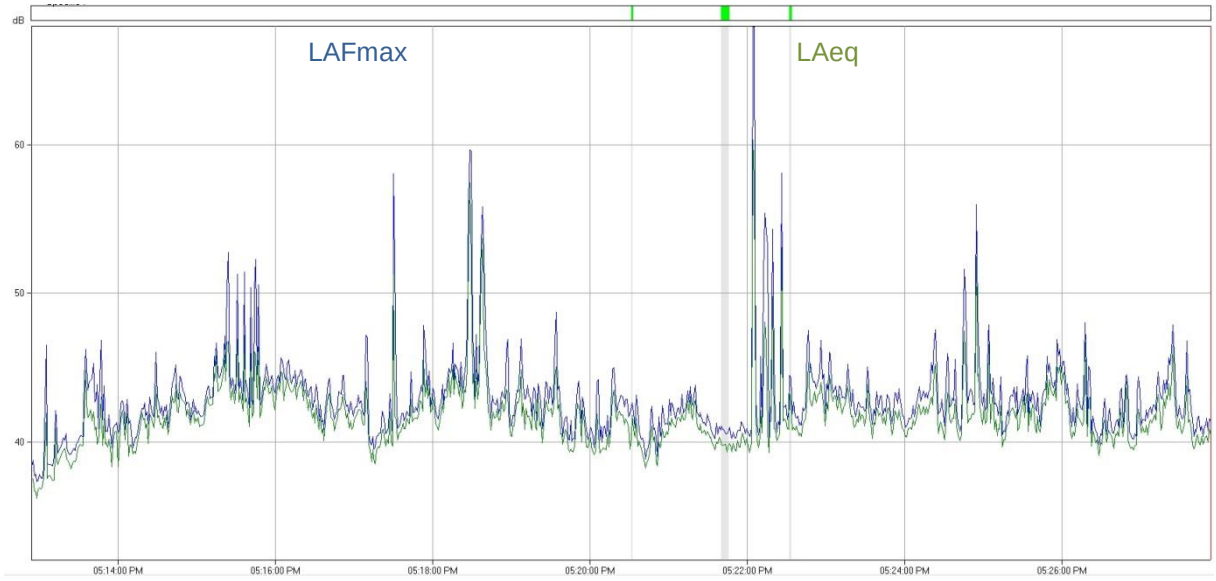


Figure B7 – Day Period – Pryce Jones Operator Attended Noise Survey Results

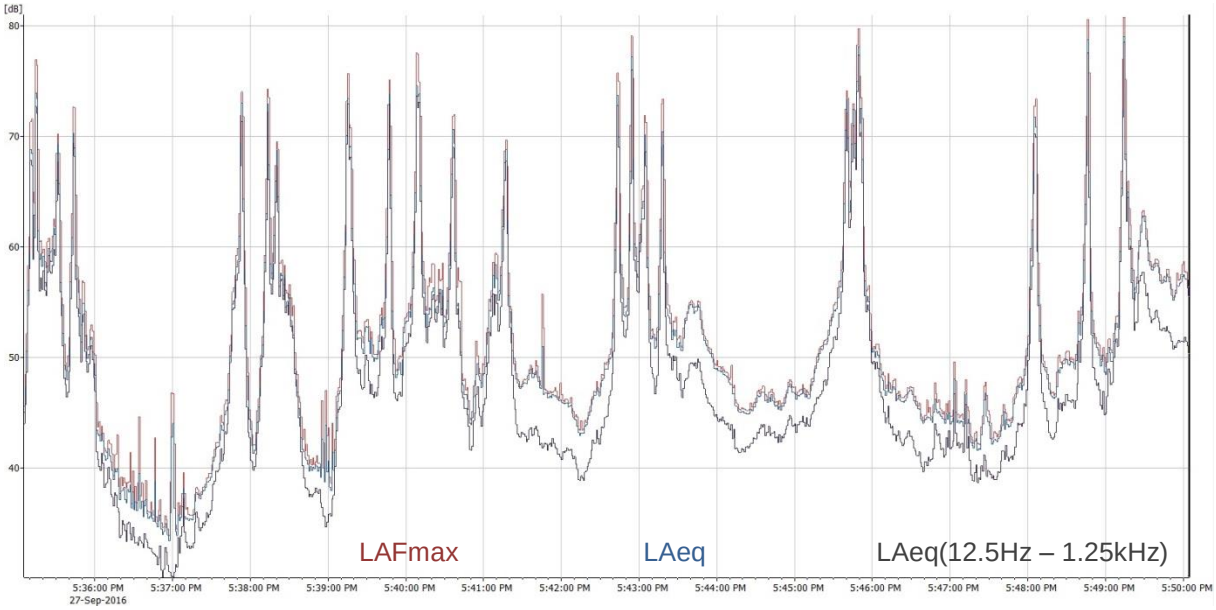


Figure B8 – Day Period – Ellis Operator Attended Noise Survey Results

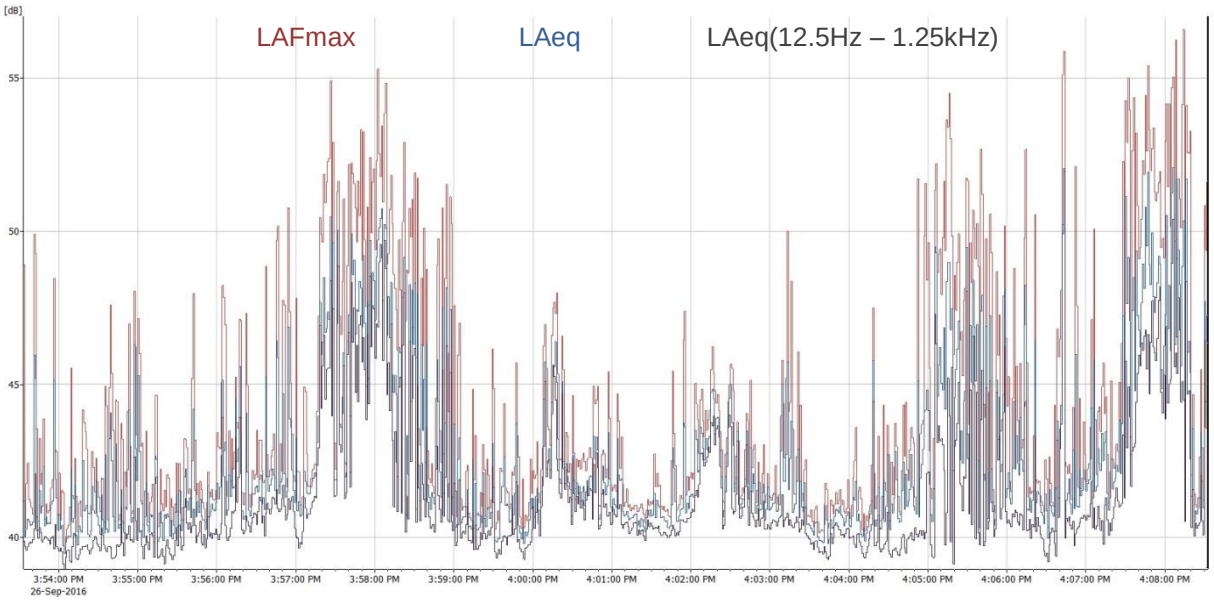


Figure B9 – Day Period – Van der Drift Operator Attended Noise Survey Results

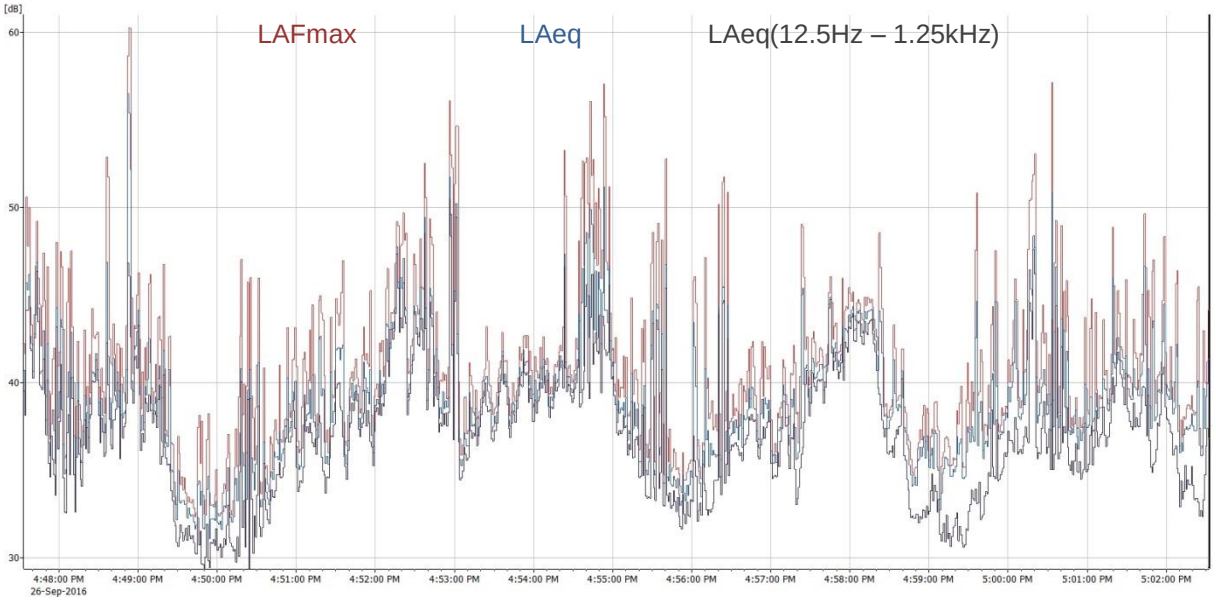


Figure B10 – Day Period – Van der Drift Operator Attended Noise Survey Results [Shaded bands represent periods containing audible SMC noise contribution]

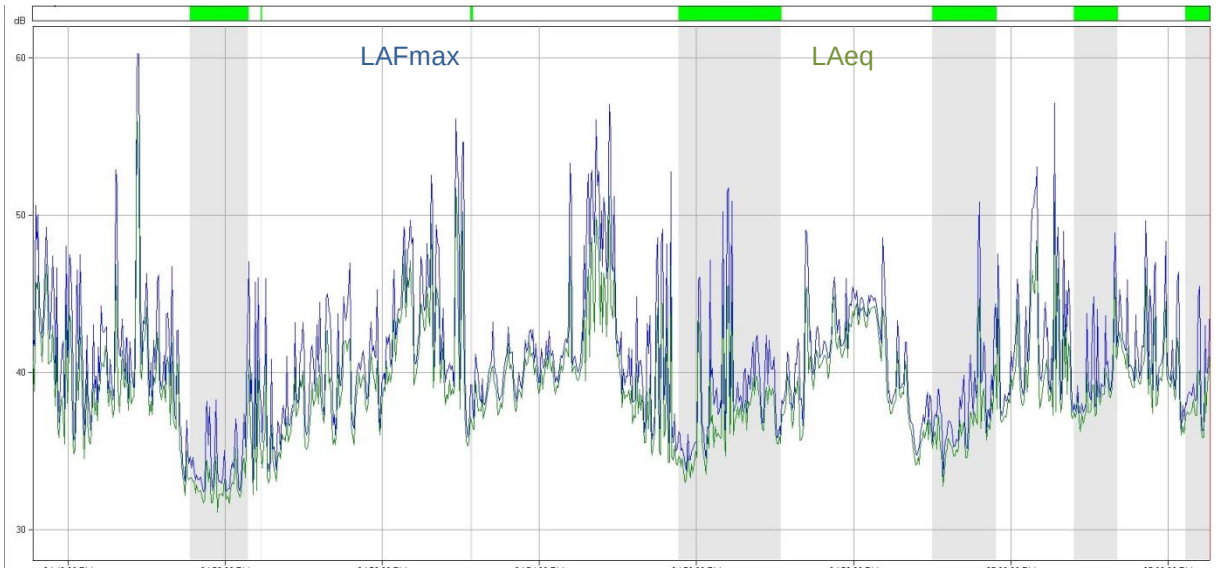


Figure B11 – Evening Period – Atkins Operator Attended Noise Survey Results

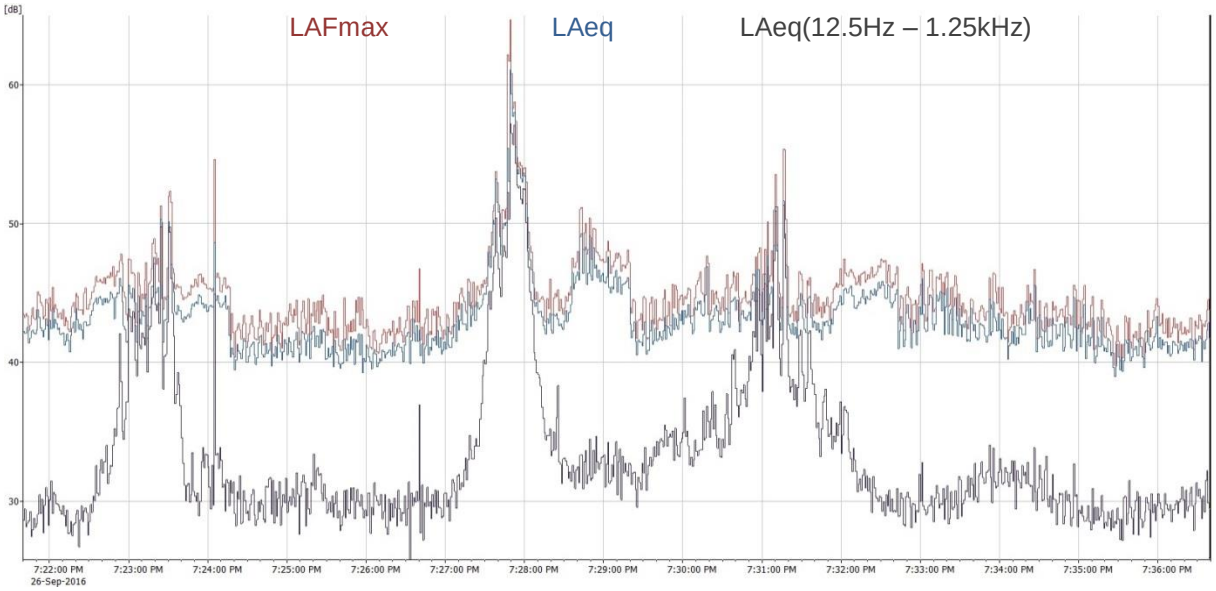


Figure B12 – Evening Period – Clarke Operator Attended Noise Survey Results

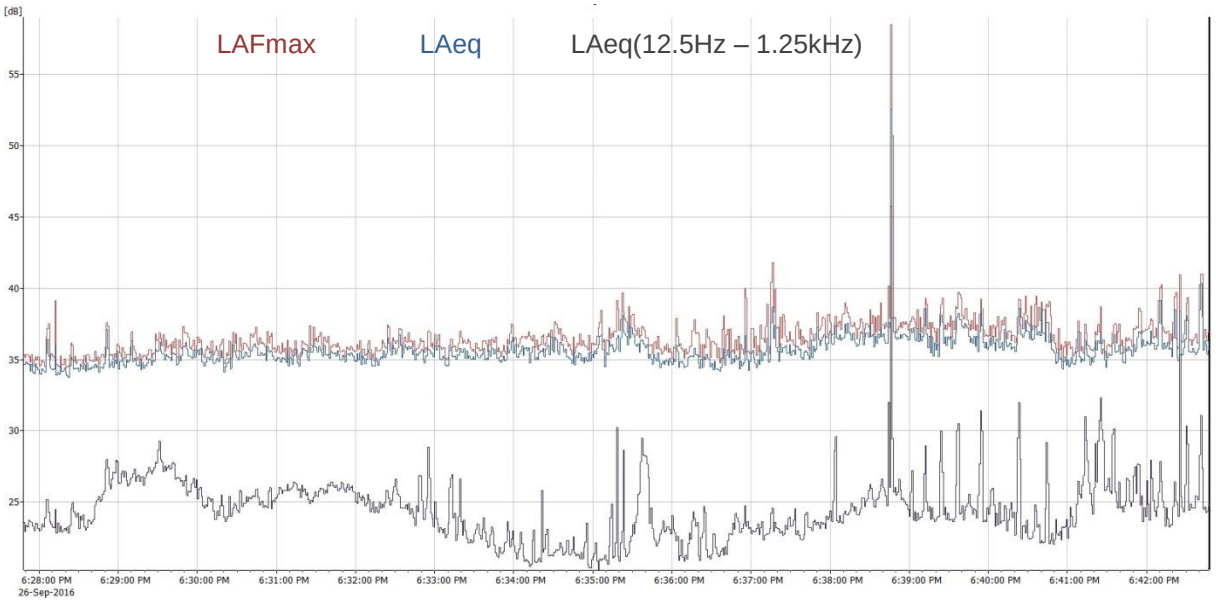


Figure B13 – Evening Period – Clarke Operator Attended Noise Survey Results [Shaded bands represent periods containing audible SMC noise contribution]

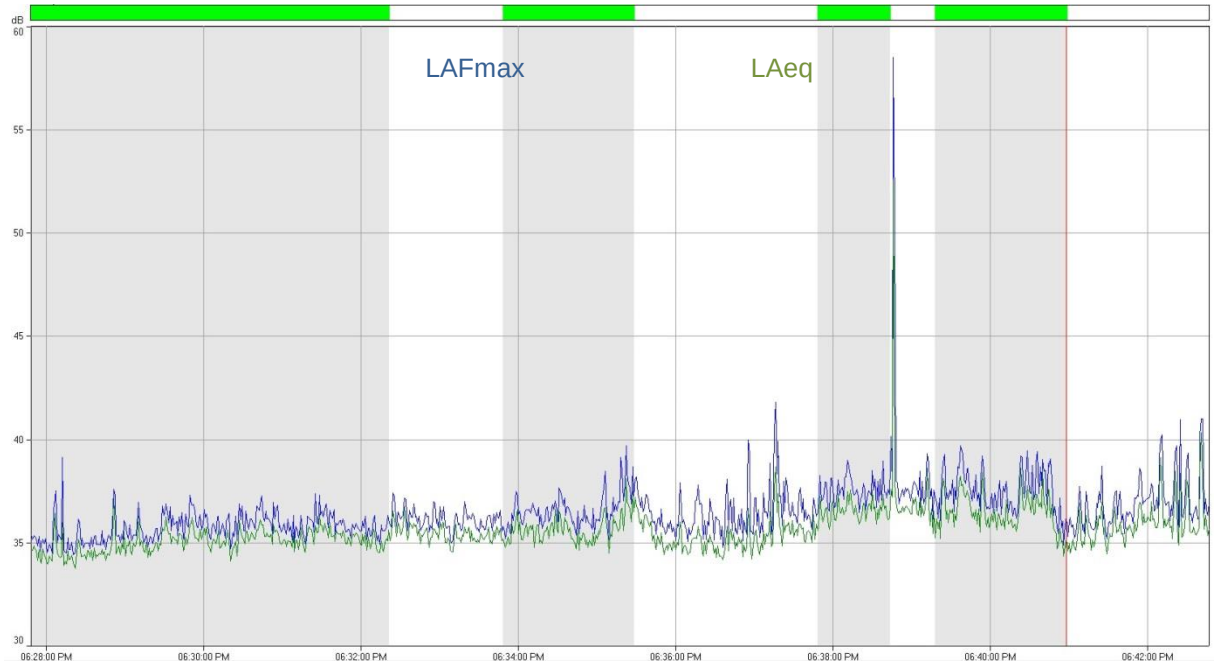


Figure B14 – Evening Period – Hall Operator Attended Noise Survey Results

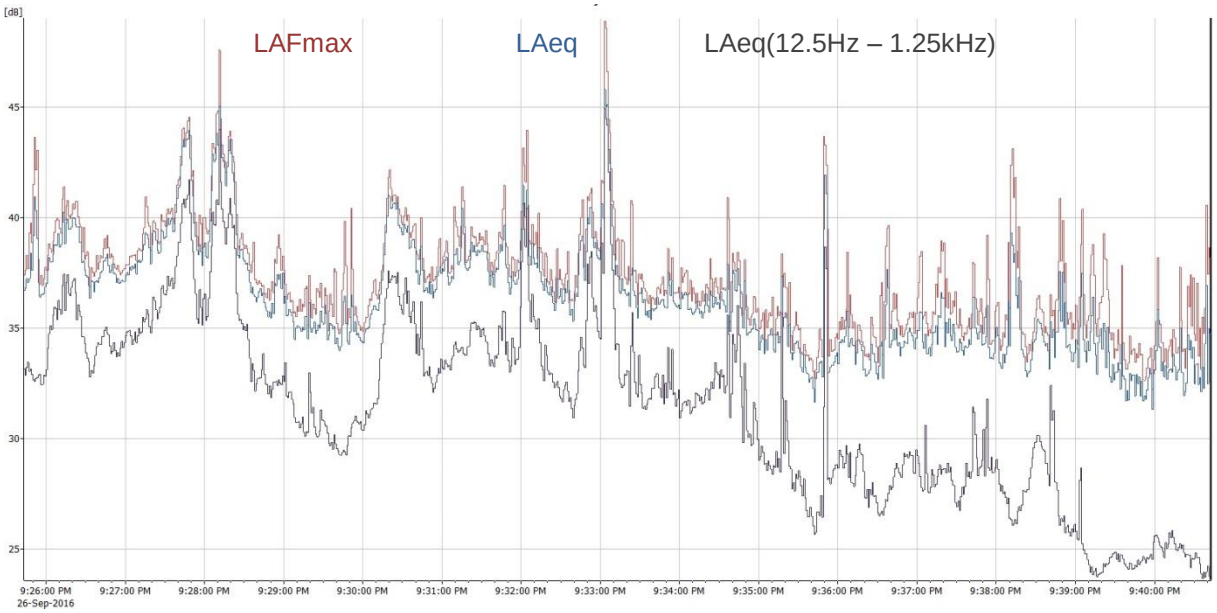


Figure B15 – Evening Period – Lowrey Operator Attended Noise Survey Results

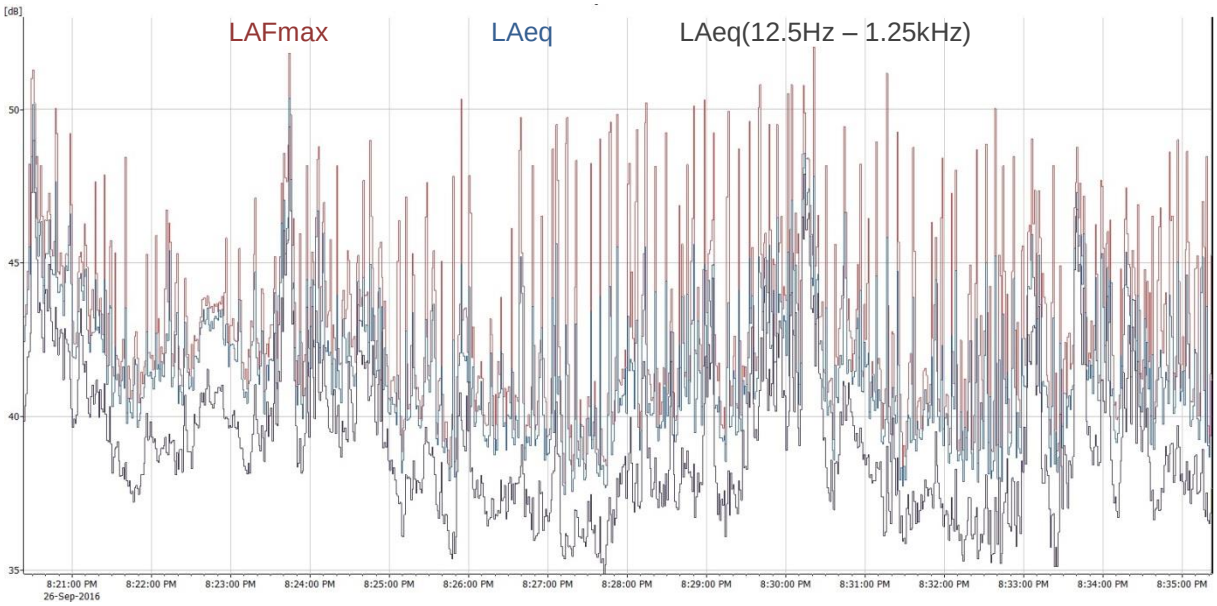


Figure B16 – Evening Period – Pryce Jones Operator Attended Noise Survey Results

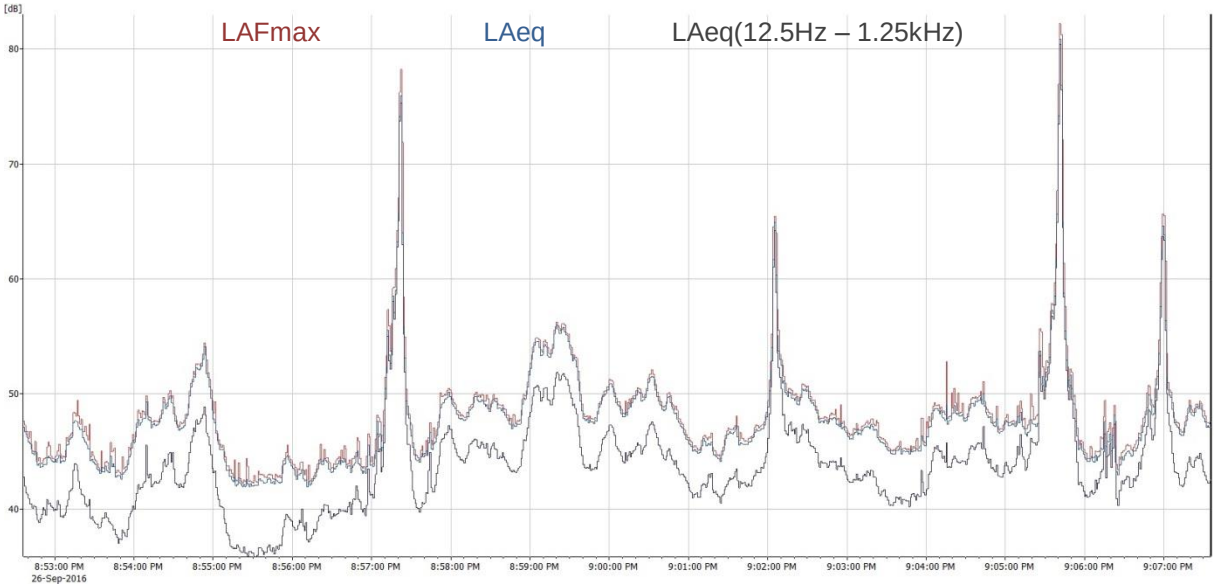


Figure B17 – Evening Period – Ellis Operator Attended Noise Survey Results

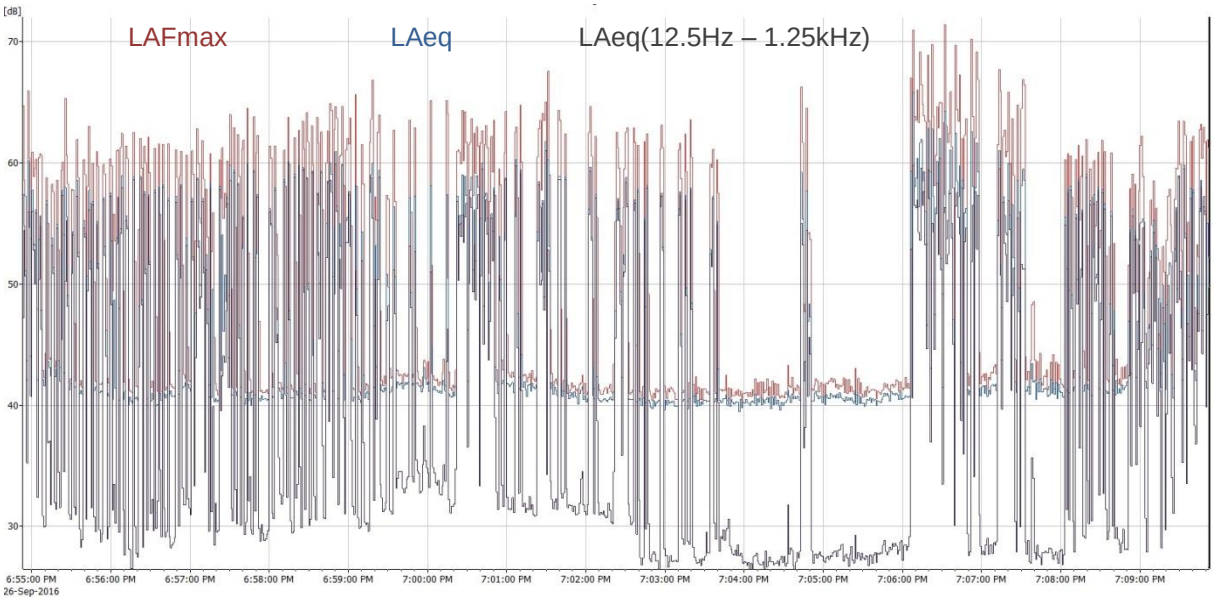


Figure B18 – Evening Period – Van der Drift Operator Attended Noise Survey Results

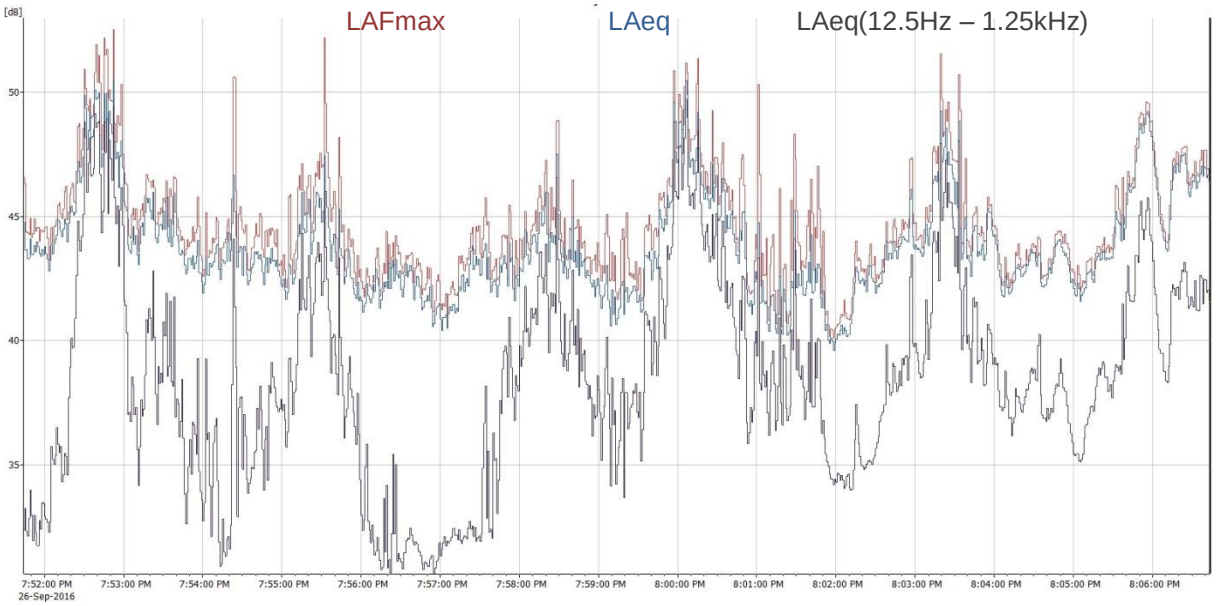


Figure B19 – Evening Period – Van der Drift Operator Attended Noise Survey Results [Shaded band represent periods containing audible SMC noise contribution]

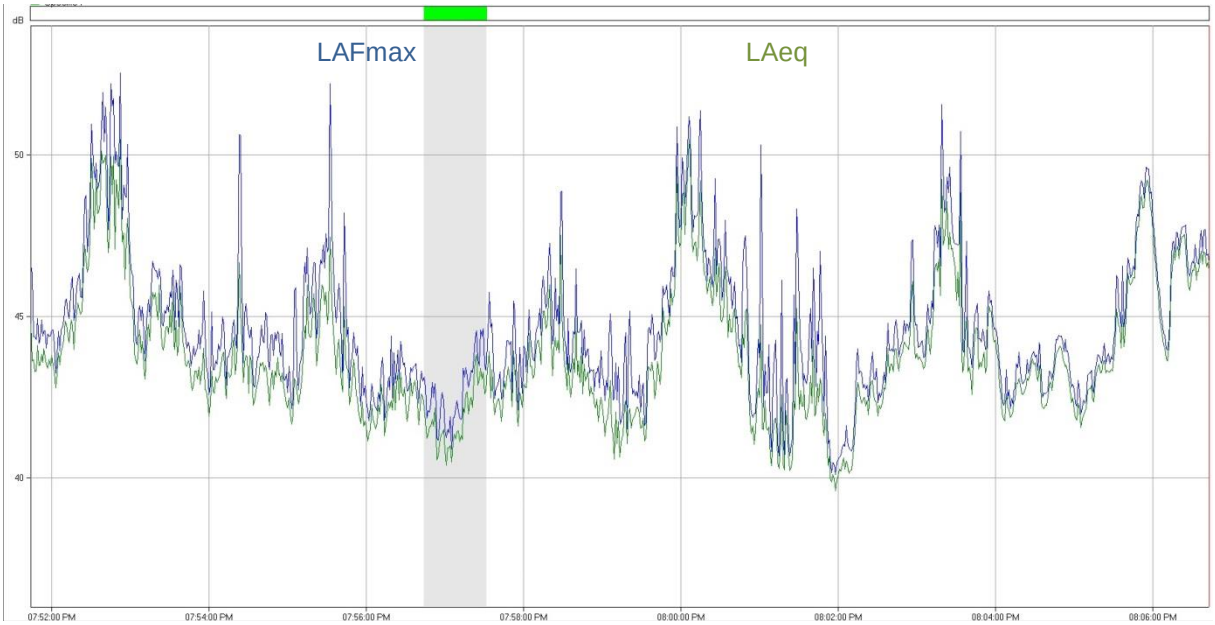


Figure B20 – Night Period 01 – Atkins Operator Attended Noise Survey Results

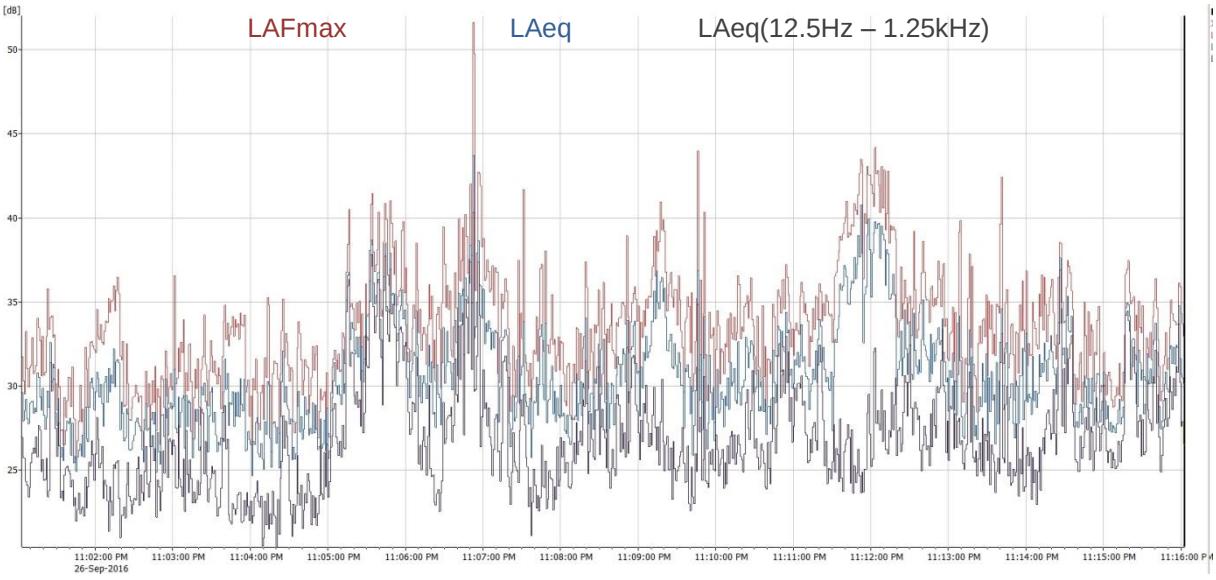


Figure B21 – Night Period 01 – Clarke Operator Attended Noise Survey Results

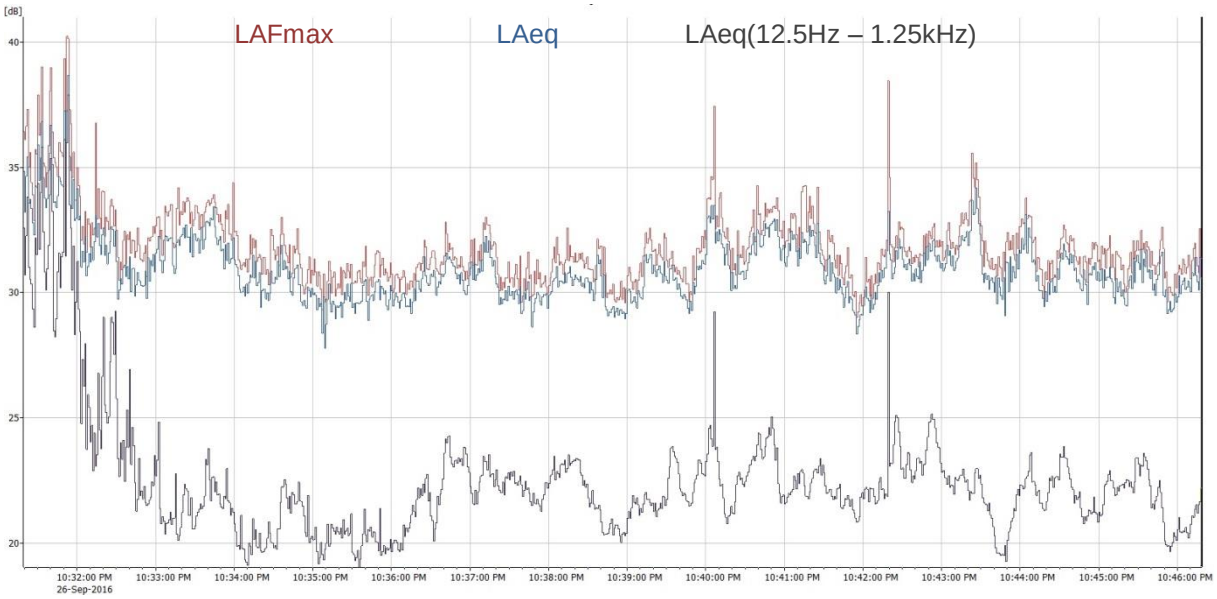


Figure B22 – Night Period 01 – Clarke Operator Attended Noise Survey Results [Shaded bands represent periods containing audible SMC noise contribution]

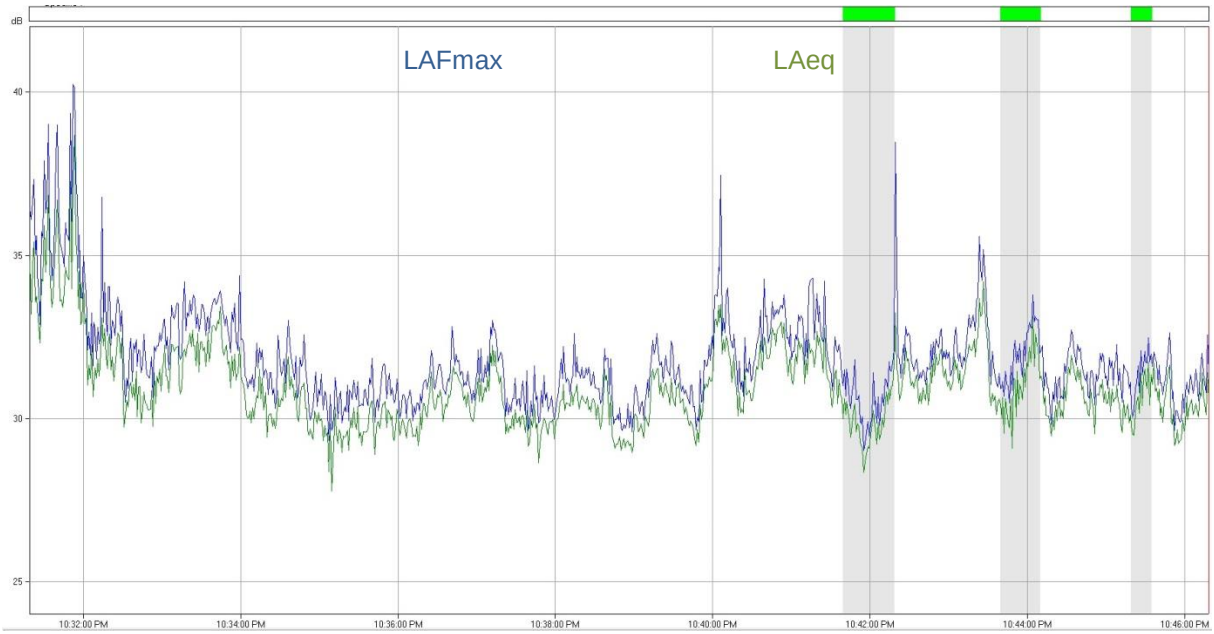


Figure B23 – Night Period 01 – Hall Operator Attended Noise Survey Results

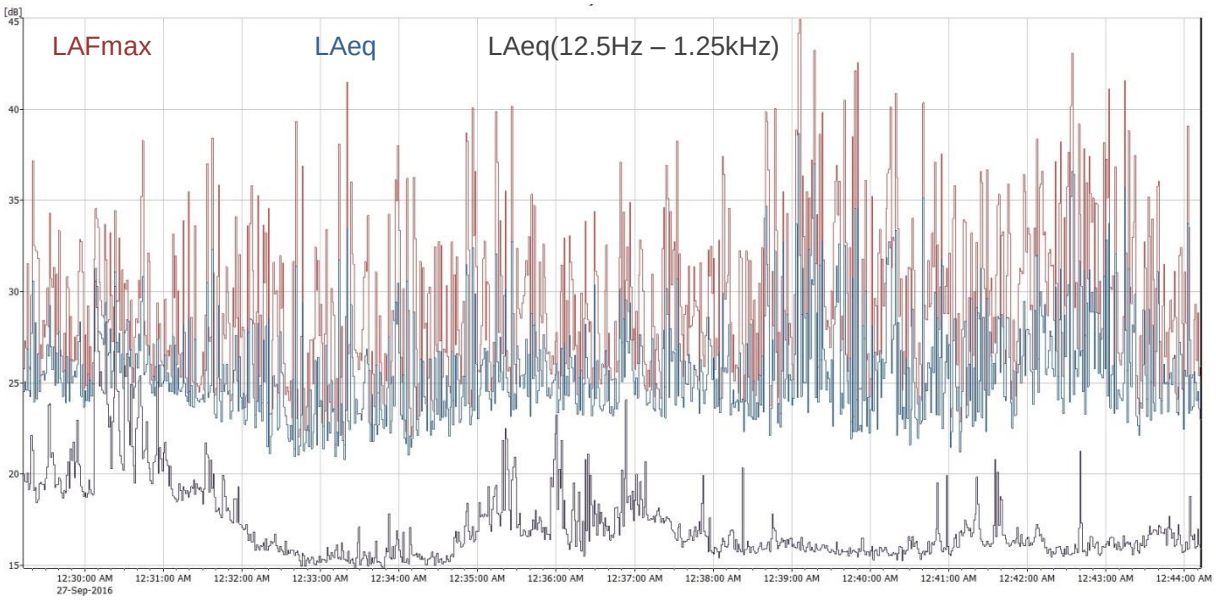


Figure B24 – Night Period 01 – Lowrey Operator Attended Noise Survey Results

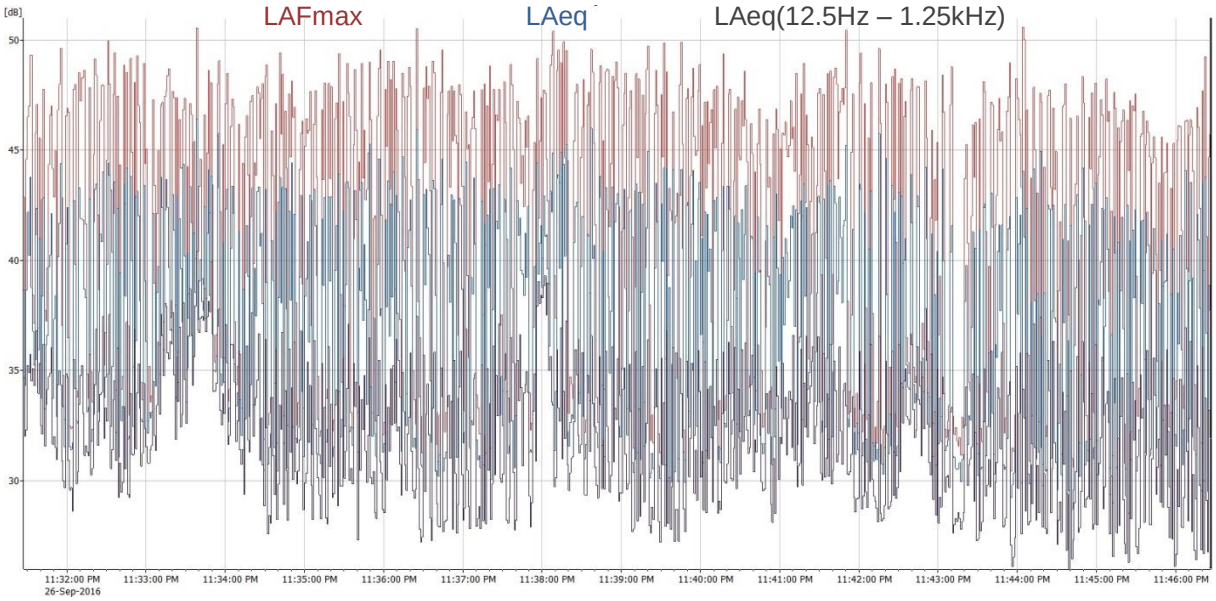


Figure B25 – Night Period 01 – Pryce Jones Operator Attended Noise Survey Results

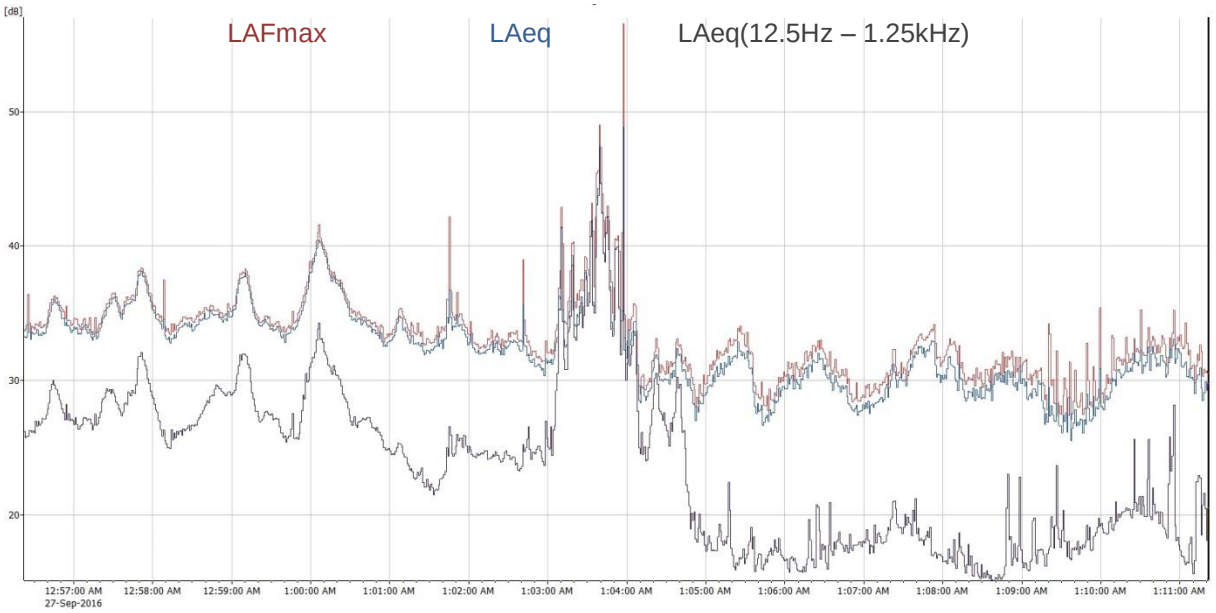


Figure B26 – Night Period 01 – Ellis Operator Attended Noise Survey Results

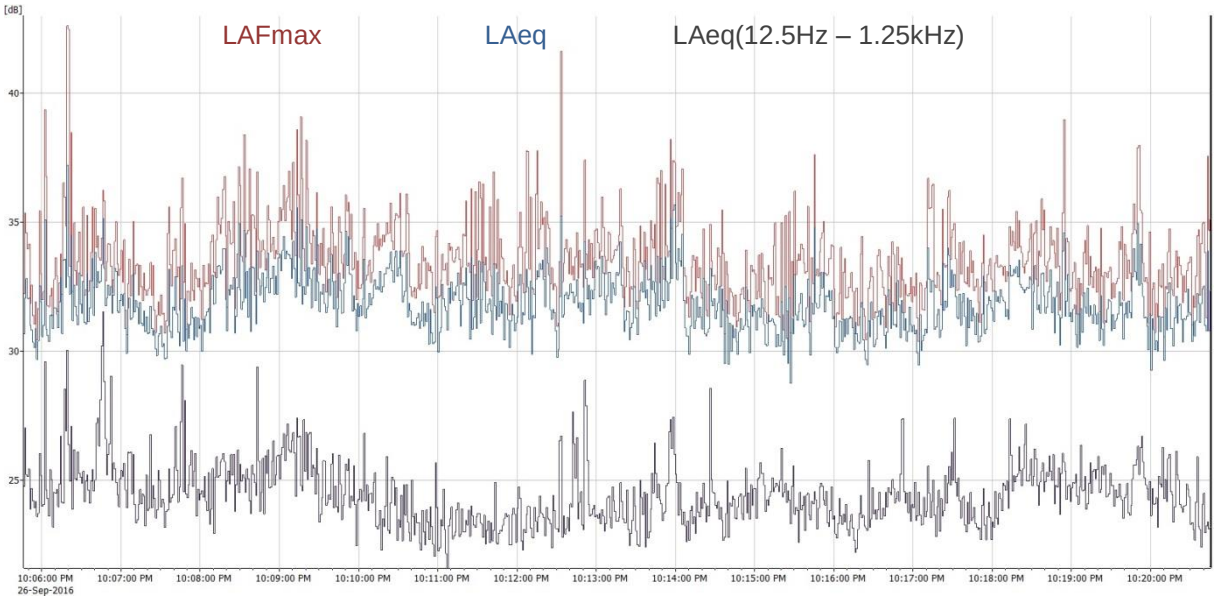


Figure B27 – Night Period 01 – Van der Drift Operator Attended Noise Survey Results

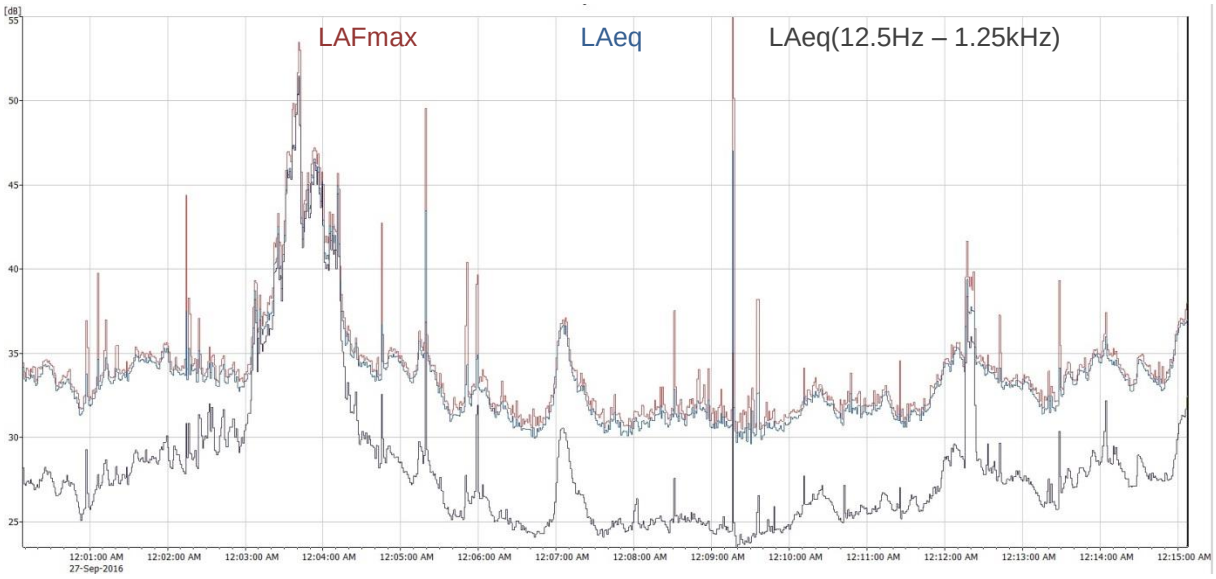


Figure B28 – Night Period 02 – Atkins Operator Attended Noise Survey Results

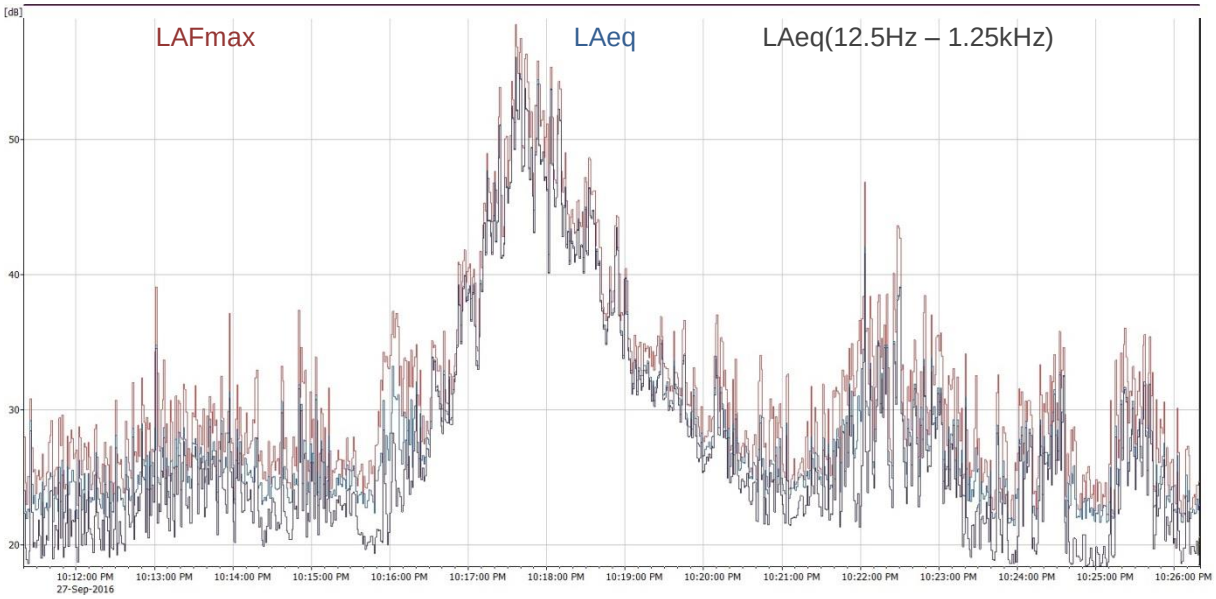


Figure B29 – Night Period 02 – Clarke Operator Attended Noise Survey Results

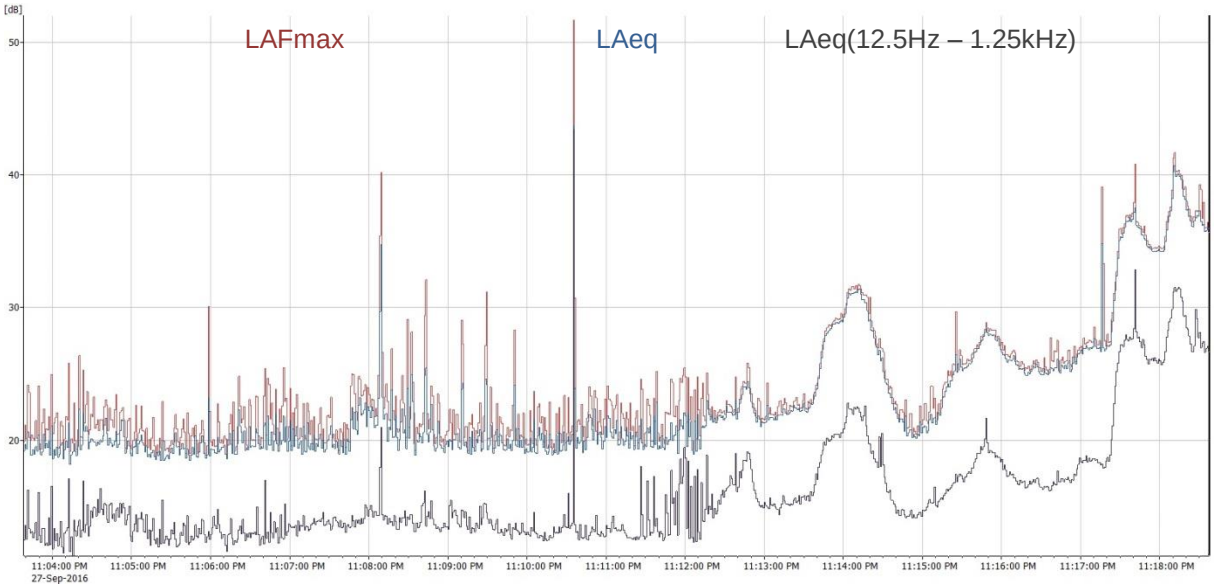


Figure B30 – Night Period 02 – Hall Operator Attended Noise Survey Results

Figure B31 – Night Period 02 – Lowrey Operator Attended Noise Survey Results

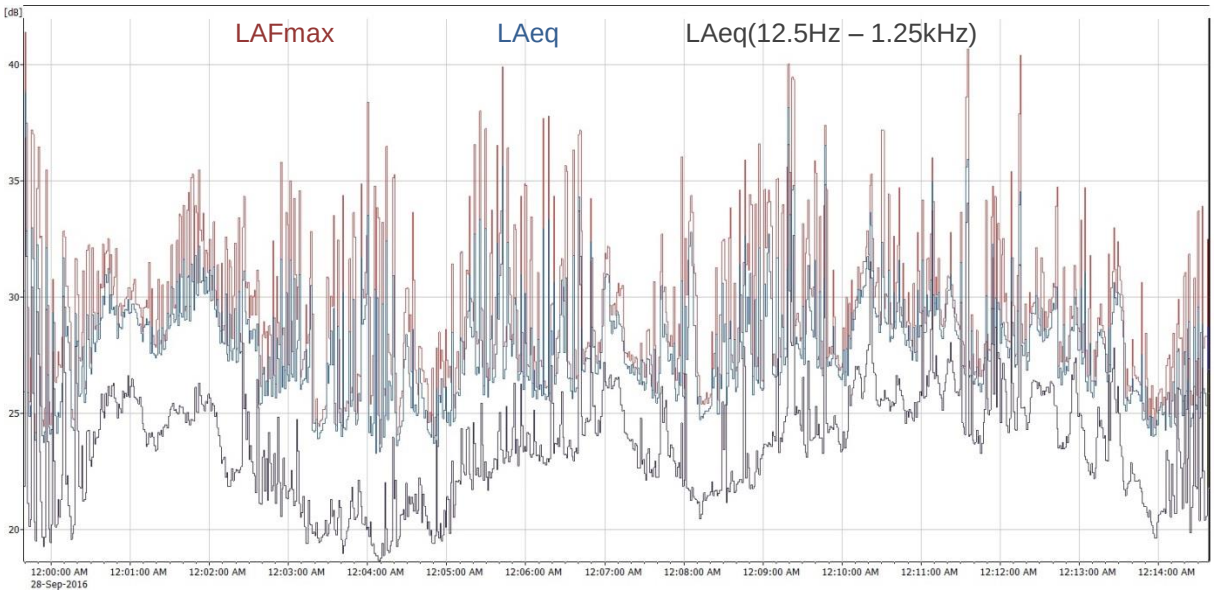


Figure B32 – Night Period 02 – Pryce Jones Operator Attended Noise Survey Results

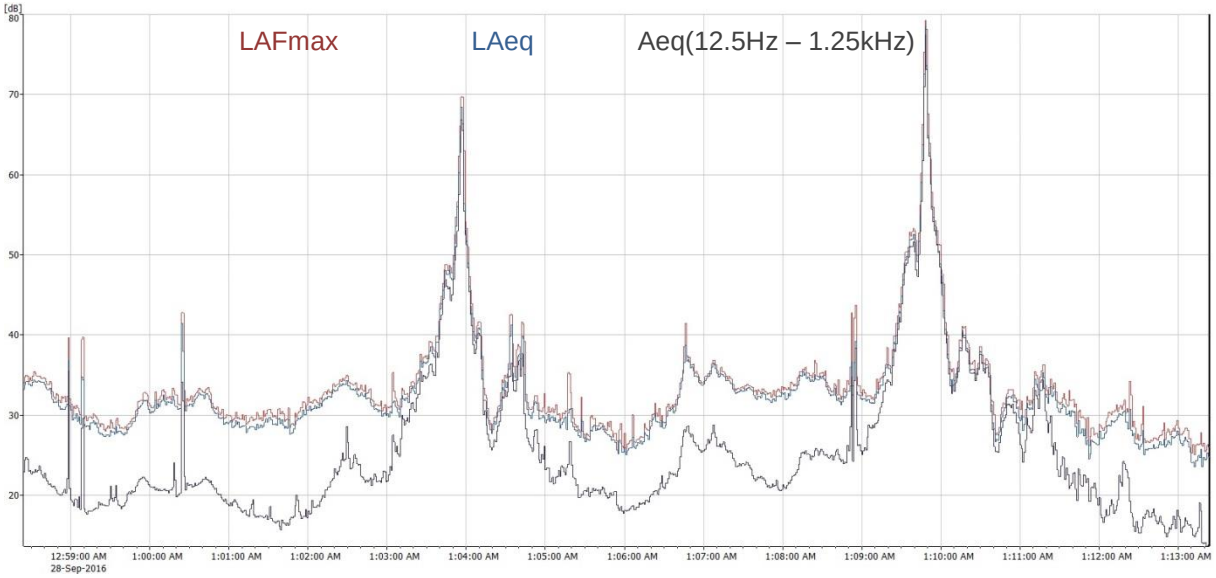


Figure B33 – Night Period 02 – Ellis Operator Attended Noise Survey Results

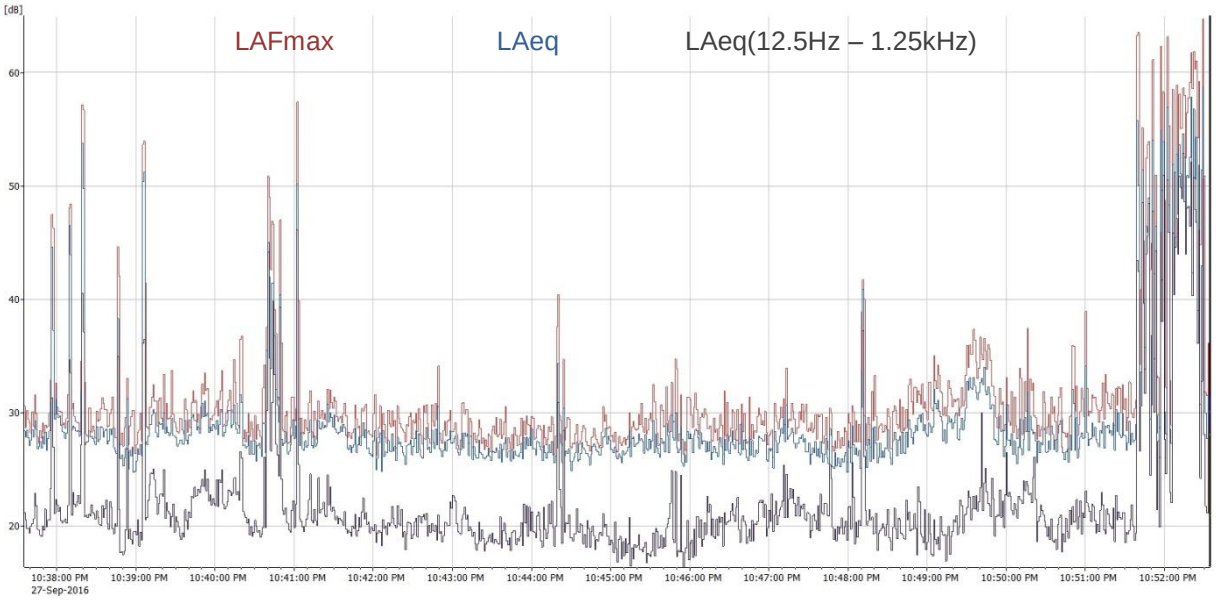
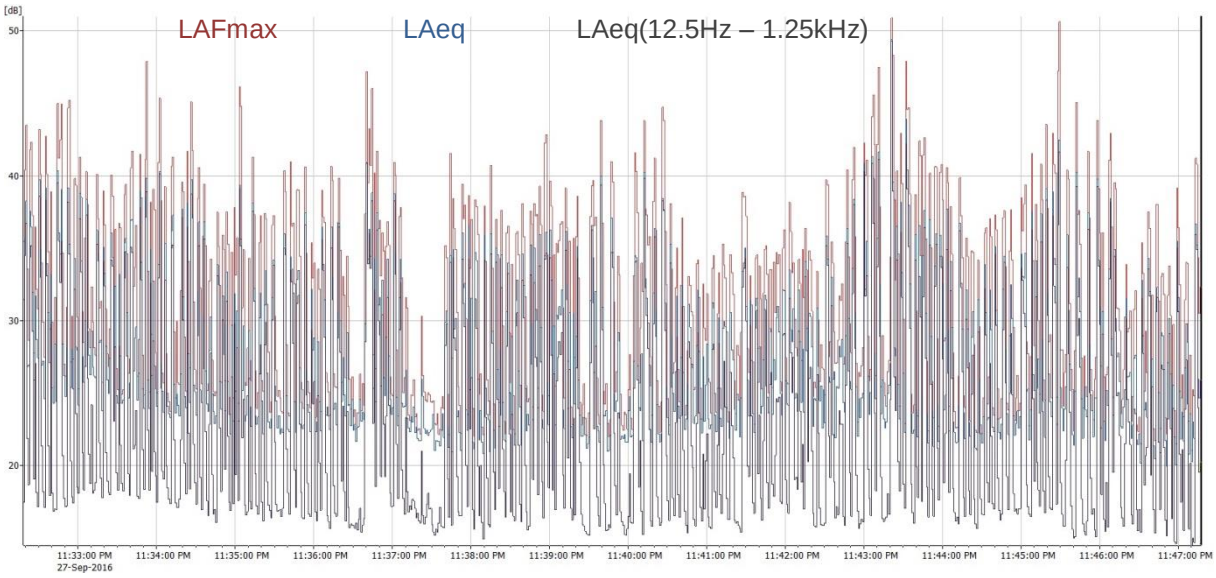



Figure B34 – Night Period 02 – Van der Drift Operator Attended Noise Survey Results