Dunmill Battery Energy Storage System

Acoustic Impact Assessment

Ref	05104-6910689

Revision History

Issue	Date	Name	Latest Changes	File Reference
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Contents

1 Introduction

This report contains an assessment of the acoustic impact of the proposed Dunmill Battery Energy Storage System (the 'Proposed Development') in terms of potential operational and construction impacts. Two Members of the Institute of Acoustics have been involved in its production. Details of their experience and qualifications can be found in Appendix A.

An assessment of the sound generated by the equipment to be installed has been undertaken in accordance with British Standard BS 4142:2014+A1:2019 'Methods for Rating and Assessing Industrial and Commercial Sound' [1] and British Standard BS 8233:2014 'Guidance on sound insulation and noise reduction for buildings' [2].

A discussion of the potential impacts resulting from the construction of the Proposed Development has been provided with reference to British Standard BS 5228-1:2009+A1:2014 'Code of Practice for Noise and Vibration Control on Construction and Open Sites - Part 1: Noise' [3].

2 Planning Policy, Guidance & Standards

2.1 Planning Advice Note 1/2011: Planning and Noise

Within Scotland, the treatment of noise is defined in the planning context by 'Planning Advice Note (PAN) 1/2011: Planning and Noise' [4]. This document details the Government's planning policies and how these are expected to be applied. The PAN provides advice on the role of the planning system in helping to prevent and limit the adverse effects of noise, stating that planning policies and decisions should aim to avoid noise giving rise to significant adverse impacts, whilst at the same time mitigating and reducing other adverse impacts on health and quality of life to a minimum.

2.2 Technical Advice Note: Assessment of Noise

The online documentation 'Assessment of Noise: Technical Advice Note (TAN)' [5] provides guidance to assist in the technical evaluation of noise assessments and aims to assist in assessing the significance of impacts associated with various development. The guidance refers to a since superseded version of BS 4142 in terms of assessing the impact of new noise generating development on neighbouring residences (the latest and previous version of which are discussed herein) and provides various matrices as to the significance and sensitivity of residences resulting from the introduction of certain facilities. The document states, at Paragraph 3.20, that '… the Scottish Government consider impacts are normally not significant (in a quantitative sense only) [if] the difference between the rating and background noise levels is less than 5 dB(A), and that usually the threshold of minor significant impacts is when the difference between the rating and background noise levels is at least 5 dB(A); and commonly do not become sufficiently significant to warrant mitigation until the difference between the rating and background noise levels is more than 10 dB(A)'.

2.3 BS 4142 Methods for Rating and Assessing Industrial & Commercial Sound

BS 4142:2014+A1:2019 describes methods for rating and assessing sound of an industrial or commercial nature. Outdoor sound levels are used to assess the likely effects on people who might be inside or outside a residential property via the comparison of the pre-existing background sound levels with the predicted/modelled sound associated with the introduction of a particular development, known as the 'rating' level, which also accounts for any distinguishing characteristics of the emitted sound.

To determine a value for the background sound level at a specific assessment point, a series of measurements are made at a location at, or representative of, a dwelling or receptor of interest. The standard requires that the background sound measurements (dB $L_{A90,\,T}$ – the sound level exceeded for 90% of the time, or the lowest 10 % of sound, for the reference time period, T) should be measured during times when the sound source in question could or will be operating and that the individual measurement intervals should not normally be less than 15-minuites in length. The objective is then to determine a justifiable representative background sound level for time periods of interest via statistical analysis and/or observations of the data set collected. The standard states that the representative background sound level '… should not automatically be assumed to be either the minimum or modal value'.

The 'rating' level is defined as the 'specific' sound level (dB L_{Aeq} – the equivalent continuous sound level) plus any corrections for the presence tones (i.e., whines, whistles, or hums), impulsive character (i.e., banging, crashing, or tapping), intermittency, or other sound characteristics (distinctiveness against the residual acoustic environment) in the sound generated by the source in question. In instances where the sound is unlikely to have a specific character at the assessment location then the rating level can be assumed to equal to the 'specific' sound level. Where corrections are required, a number of decibels are added to the specific sound level to determine the rating level.

The defined representative background sound level(s) and rating level(s) are then compared to determine the possible impact but with consideration of the context in which the industrial or commercial sound source to be introduced presents itself in respect of other sound sources and the existing character of the area. Table 1 provides a summary of expected impacts when comparing background sound levels and rating levels.

Table 1 – BS 4142 Assessment Criteria

Rating Level	BS 4142 Assessment Criteria
Equal to or below background sound level	'…an indication of the specific sound source having a low impact, depending on the context'.
Approximately +5 dB greater than the background sound level	'…an indication of an adverse impact, depending on the context'.
Approximately +10 dB or more greater than the background sound level	'…an indication of a significant adverse impact, depending on the context'.

Further to the above, it may not be appropriate or proportionate to undertake a full assessment in accordance with the BS 4142 standard, particularly when the rating level associated with the new source is particularly low at neighbouring receptors and/or the existing background sound levels are low. The previous version of BS 4142 [6] stated that this version of the standard is not appropriate for use in instances where background

and rating noise levels are very low and that '… background noise levels below about 30 dB and rating levels below about 35 dB are considered to be very low'.

2.4 BS 8233 Guidance on Sound Insulation and Noise Reduction for Buildings

British Standard BS 8233:2014 provides information on the design of buildings to ensure they have internal acoustic environments appropriate to their functions. The standard specifies guideline indoor ambient sound levels for buildings for different activities, locations and times of day and states that it is desirable that these guideline values are not exceeded. Therefore in practice the guidelines specify absolute limits for sound levels in specific environments. The most conservative applicable values specified are those conducive to sleeping or daytime resting in a house bedroom where the internal sound level should not exceed 30 dB $L_{Aeq,\ 8\ hour}$ at night. If a 15 dB reduction is assumed for attenuation through an open window, then a maximum outdoor sound level of 45 dB $L_{Aeq,\ 8\ hour}$ is applicable.

BS 8233:2014 also includes a methodology for assessment to noise rating (NR) values. This is a method for assigning a single-number rating to a noise spectrum. It can be used to specify the maximum acceptable level in each octave band of a frequency spectrum.

2.5 BS 5228 Code of Practice for Noise and Vibration Control on Construction and Open Sites

BS 5228-1:2009+A1:2014 'Code of practice for noise and vibration control on construction and open sites - Part 1: Noise' has been identified as being the appropriate source of guidance on appropriate methods for minimising noise from construction activities and is adopted herein. The document provides guidance on construction noise limits, noise modelling techniques and best practicable measures for the reduction of noise generated during construction activities.

Annex E of BS 5228-1:2009+A1:2014 provides guidance on setting environmental noise targets for construction noise. Several methods of assessing the significance of noise levels are presented with the most applicable being the ABC method. This method sets threshold noise levels for construction noise for specific periods based on the pre-existing ambient noise levels, subject to average lower Category A limiting values of 65, 55 and 45 dB L_{Aeq} for daytime (07:00 - 19:00 weekdays and Saturdays 07:00 – 13:00), evenings and weekends (19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays) and night-time (23:00 – 07:00) periods respectively in instances where existing ambient noise levels are low in relation to these values, which is the case here.

2.6 Consultation with Angus Council

Angus Council have been consulted to ensure that this acoustic assessment meets their requirements. RES and Angus Council agreed the following:

- To undertake a noise impact assessment for the Proposed Development according to BS 4142:2014+A1:2019.

- The measured background sound pressure levels ($L_{Aeq,15\ min}$ dB and $L_{A90,15\ min}$ dB) over a minimum period of 7 days will be used to undertake an acoustic impact assessment in accordance with BS 4142:2014+A1:2019.
- Consideration will be given to Noise Rating Curve NR30 in the daytime and NR20 at night-time, according to the values defined in BS 8233:2014, calculated within the nearest noise sensitive property with windows open.
- Background sound level measurements were proposed in the vicinity of the nearest residential properties, on different sides of the Proposed Development. The four locations to use for unattended background sound measurements were agreed.
- Background sound monitoring will include some manned/attended measurements.
- Meteorological conditions will be recorded and a detailed description of the sound environment will be provided.
- Depending on the level of construction work required, consideration of construction noise will be given in terms of BS 5228-1:2009+A1:2014 'Code of practice for noise and vibration control on construction and open sites'.
- Sound data will be made available upon request and where possible provided in the appendices of the report and that sound predictions are based on manufacturer's data.
- Justification must be given for the use of calculations to predict noise levels and this must be supported with full details of the noise model, any standard it follows, data inputted into the model and any corrections applied (including justification of these corrections).
- Details of measurement uncertainly should also be reported, and any extraneous noise sources should be removed from the measurement data.
- A cumulative assessment will be undertaken considering planning application 23/00754/FULM, located to the southwest of the proposed development and considering the common receptors.

3 Methodology

3.1 Baseline Conditions

In order to complete a BS 4142 assessment of the proposed development, the background sound level at the times when the new sound source is intended to be operational should be measured. The background sound level is defined as the A-weighted sound pressure level that is exceeded for 90 % of the measurement time interval T, or $L_{A90,\,T}$.

Measurements should be made at a location that is representative of the assessment locations, the time interval should be sufficient to obtain a representative value, and the duration should be long enough to reflect the range of background sound levels over the period of interest.

Additional attended measurements should be made near the most relevant residential properties to fully comprehend the acoustic environment at the properties.

Precautions should be taken to minimise the influence on the results from sources of interference. Weather conditions that may affect the measurements should be recorded and an effective wind shield used to minimise wind interference at the microphone.

A statistical analysis, following the example given by BS 4142, should be used to determine an appropriate background sound level for the analysis from the range of results obtained.

3.2 Propagation

A sound propagation model of the Proposed Development and the surroundings has been developed using CadnaA[1] noise modelling software. The ISO 9613-2 [7] propagation model is referenced by BS 4142:2014+A1:2019 as a validated methodology and shall be used to predict the specific sound levels due to the Proposed Development at nearby residential properties, incorporating various assumptions and factors which are considered appropriate for use here:

- The various sound-emitting equipment to be installed as part of the Proposed Development has been modelled as point sources with a height of 1.5 m. The sources are assumed to be operating at their maximum potential output for all time periods as the most conservative basis for the assessment.
- Soft ground conditions have been applied (i.e., a ground factor of 1) as representative of the farmland surrounding the Proposed Development.
- The receptors have been assigned a height of 4 m above ground level.
- Atmospheric attenuation corresponding to a temperature and relative humidity of 10 °C and 70 % respectively, as defined within ISO 9613-1 [8], which represents relatively low levels of sound absorption in the atmosphere.

[1] https://www.datakustik.com/

- A 3 m high acoustic fence of suitable mass and density, surrounding the equipment compound, is included in the model. This provides a reduction in the specific sound levels at the receptor locations of 2 - 3 dB $L_{Aeq, Tr}$.
- The topography of the site and surroundings has been included within the model.

The acoustic fence may not be required to be as high as 3 m in practice, as the equipment is expected to have substantially reduced sound emissions compared to those used in this assessment when the equipment is procured, should the site be granted planning consent. The inclusion of the acoustic fence therefore represents a worst-case scenario.

The effect of surface features such as buildings, trees or other objects is not included in the model. There is a level of conservatism built into the model as a result of the adoption of these settings.

ISO 9613-2 is a downwind propagation model. Where conditions less favourable to sound propagation occur, such as when the assessment locations are crosswind or upwind of the proposed development, the sound levels would be expected to be less, and the downwind predictions presented here would be regarded as conservative, i.e., greater than those likely to be experienced in practice.

3.3 Noise Rating

Annex B of BS 8233:2014 states Noise Rating (NR) is a method for assigning a single-number rating to a noise spectrum. BS 8233:2014 provides guidance on the methodology for determining noise rating values in each octave band from unweighted sound pressure levels.

The sound level outdoors is calculated according to the methodology detailed in section 3.2 as an A-weighted sound pressure level spectrum in each octave band. These values have been converted to un-weighted sound pressure levels in each octave band and attenuation values for sound propagation through an open window have been applied. The attenuation values used for sound propagation through an open window have been taken from Table 5-6 (opening size 200k mm^2) of a report produced by Napier University for the Department of Environment, Food and Rural Affairs [9].

The resulting internal un-weighted sound pressure level in each octave band is compared to the NR curve values to obtain an NR rating.

3.4 Construction

BS 5228-1:2009+A1:2014 provides various means of predicting construction noise levels from a wide selection of plant and supplies a range of generic plant source noise levels for this purpose. However, a detailed construction plan for the Proposed Development is not yet available and specific construction noise predictions have not been undertaken as a result.

A discursive assessment as to the generic construction impacts associated with developments of this kind in respect of noise and vibration is provided in Section 5.7.

4 Background Sound Environment

4.1 Details of the Survey

Baseline sound levels were determined in a survey undertaken between 2nd November 2023 and 13th November 2023. Unattended survey locations are shown on the map in Figure 1 (Appendix B.1).

The sound level meters are certified as meeting either BS 7580-1:1997 [10] or IEC 61672-1:2013 [11] Class 1 precision standards. The microphone was approximately 1.2 m above ground level and an outdoor wind shield supplied by the manufacturer was used.

The sound level meters were placed away from reflective surfaces as shown in the photos in Appendix C. The equipment was field calibrated at the start and end of the survey. Maximum detected drift was 0.2 dB, which is appropriate. All the sound level meters had been subject to laboratory calibration traceable to national standards within the previous 24 months and the sound calibrator had been subject to laboratory calibration traceable to national standards within the previous 12 months, with the calibration dates and references provided in Table 2 and Table 6.

Table 2 - Instrumentation Records for Unattended Measurements

	Meter 1	Meter 2	Meter 3	Meter 4
Type	Rion NL-52	Rion NL-31	Rion NL-52	Rion NL-31
Serial No.	00610207	00983380	00721031	00952273
Calibration Certificate No.	UCRT22/1196	UCRT23/1071	UCRT23/2232	UCRT23/1083
Date of Issue	08/02/2022	16/01/2023	18/09/2023	17/01/2023
Microphone Serial No.	02549	315831	21981	315828
Preamp Serial No.	10201	28713	22137	171125
Sound Calibrator Type	Rion NC-74	Rion NC-74	Rion NC-74	Rion NC-74
Calibrator Serial No.	34315132	34315132	34315132	34315132
Calibrator Cert. No.	UCRT23/2386	UCRT23/2386	UCRT23/2386	UCRT23/2386
Date of Issue	23/10/23	23/10/23	23/10/23	23/10/23

During the survey at location 1 the background acoustic environment was dominated by traffic from the A road and from a nearby stream. At location 2 the background acoustic environment was comprised of wildlife, minor hum from an electricity transmission line and distant traffic sounds. At location 3 the dominant sound source was distant traffic noise, occasional cars passing on the adjacent road and trees rustling. The acoustic environment at location 4 was principally the traffic from the A road and bird sounds.

Weather conditions during the survey were overcast with low wind speeds and the temperature ranged between -1°C and 12°C. There was some rain during the survey, therefore measurement data during those periods of rain has been excluded from the data analysis.

4.2 Survey Results

Time histories recorded during the survey at each location are shown in Appendix B.2. The average residual sound levels ($L_{Aeq, 15mins}$) measured during day and night-time at each location are shown in Table 3.

In accordance with BS 4142:2014+A1:2019 representative background sound levels need to be determined from statistical analysis of measured L_{A90} levels. Histograms of measured background sound levels are shown in Appendix B.3, and derived representative background sound levels are shown in Table 3.

Table 3 - Survey Results

Survey location	Residual Sound Level, $L_{Aeq, 15 min}$, dB		Background Sound Level, $L_{A90, 15 min}$, dB	
	Daytime (07:00-23:00)	Night-time (23:00-07:00)	Daytime (07:00-23:00)	Night-time (23:00-07:00)
1	64	55	44	34
2	50	40	41	31
3	47	38	37	29
4	77	64	45	33

This report presents an assessment for the 25 closest residential properties to the site which may be affected.

The residential properties used for the assessment are shown in Figure 15 (Appendix B.4). The house ID numbers, coordinates, as well as representative measured acoustic data for each house are presented in Table 4. The coordinate system used is the British National Grid (EPSG 27700).

Table 4 - Residential Properties and Baseline Levels

House ID	X/m	Y/m	Day Background Sound Level / L_{A90} dB	Night Background Sound Level / L_{A90} dB	Day Residual Sound Level / L_{Aeq} dB	Night Residual Sound Level / L_{Aeq} dB
H02	366605	759840	37	29	47	38
H06	366692	759965	37	29	47	38
H12	365610	759310	45	33	77	64
H13	365394	759191	45	33	77	64
H16	365440	759017	41	31	50	40
H17	366430	758675	37	29	47	38
H18	366848	759070	41	31	50	40
H20	366827	759055	41	31	50	40
H24	365567	759106	41	31	50	40
H38	366953	759174	41	31	50	40
H39	366939	759169	41	31	50	40
H40	366291	758589	37	29	47	38
H42	366329	758606	37	29	47	38
H45	366411	758616	37	29	47	38

House ID	X/m	Y/m	Day Background Sound Level / L_{A90} dB	Night Background Sound Level / L_{A90} dB	Day Residual Sound Level / L_{Aeq} dB	Night Residual Sound Level / L_{Aeq} dB
H46	366311	758598	37	29	47	38
H47	367026	759869	37	29	47	38
H48	366745	759288	44	34	64	55
H52	365508	759270	45	33	77	64
H53	365437	759245	45	33	77	64
H63	367228	759465	44	34	64	55
H67	366516	758686	37	29	47	38
H70	367073	759214	41	31	50	40
H79	366835	759061	41	31	50	40
H80	366477	758763	37	29	47	38
H82	367023	759369	44	34	64	55

4.3 Attended Measurements

Attended measurements were made at three locations near two of the closest residential properties to the site. The attended measurements were carried out on 2nd November 2023, over 15-minute periods. Dominant sound sources occurring during the measurements were noted.

At each location the microphone was positioned approximately 1.2 m above the ground level and more than 5 m from the facades of the existing buildings. Details of the equipment used, and the sound indices measured are provided in Table 5. Locations of the attended monitoring can be seen in Figure 2 (Appendix B.1).

Table 5 - Instrumentation Records for Attended Measurements

	Meter 1	Meter 2
Type	Rion NL-52	Rion NL-31
Serial No.	00197726	00983380
Calibration Certificate No.	UCRT23/1469	UCRT23/1071
Date of Issue	03/04/2023	16/01/2023
Microphone Serial No.	14675	315831
Preamp Serial No.	87935	28713
Sound Calibrator Type	Rion NC-74	Rion NC-74
Calibrator Serial No.	34315132	34315132
Calibrator Cert. No.	UCRT23/2386	UCRT23/2386
Date of Issue	23/10/23	23/10/23

Sound levels and key sound sources recorded during the attended measurements are summarised in Table 6.

Table 6 - Attended Measurement Data

Attended Survey Location	Start Time	Sound Pressure Levels, dB(A)			Sound Sources
		$L_{Aeq,}$ 15 min	$L_{AFmax,}$ 15 min	$L_{A90,}$ 15 min	
A1	12:00	64	77	47	Main sound source was traffic on the main road (traffic count:92). Secondary sound sources included sound from the stream, bird song and cars splashing through puddles.
A1	12.18	63	80	49	Main sound source was traffic on the main road (traffic count:79). Secondary sound sources included construction noise such as humming and drilling, sound from the stream, and bird song.
A2	12.45	50	60	44	Main sound source is distant traffic from the main road. Secondary sources included local traffic (2 vehicle pass-bys), rustling of leaves, minor hum from the electricity transmission line and birdsong.
A3	12.30	52	74	48	Main sound source is distant traffic from the main road. Secondary sources included local traffic (4 vehicles pass-bys), rustling of leaves, minor hum from the electricity transmission line, birdsong, and distant aircraft fly-by.

5 Assessment

5.1 Sound Generating Equipment

The predominant sources of sound to be introduced as part of the Proposed Development are the 32 battery storage enclosures, 16 PCS inverters and 8 PCS medium voltage (MV) transformers. All equipment is assumed to be operating at all times.

The sound power level data for representative equipment to be installed as part of the Proposed Development are provided in Table 7. The overall levels correspond to the maximum sound emission for each of the equipment as provided by the equipment manufacturer. The propagation modelling therefore represents a conservative scenario and actual sound levels would be expected to be lower when the site is not operating at maximum capacity.

Table 7 - Overall Sound Power Levels, dB L_{WA}

Equipment & ID	Sound Power Level, dB L_{WA}
Battery Storage Enclosure (BESS)	83
PCS Inverter (INV)	93
PCS MV Transformer (TRA)	79

The data is further supplemented by the sound power level in octave bands, as provided in Table 8. This information is based on a combination of manufacturer data and RES's experience of typical equipment.

Table 8 - Octave Band Sound Power Levels, dB L_{WA}

ID	Overall, dB L_{WA}	Octave Band Centre Frequency, Hz							
		63	125	250	500	1k	2k	4k	8k
BESS	83	67	71	75	77	77	75	71	69
INV	93	67	77	88	85	86	84	81	75
TRA	79	44	66	74	77	67	60	54	52

5.2 Acoustic Feature Correction

In accordance with BS 4142:2014+A1:2019 penalties can be applied to the predicted specific sound level to achieve the rating level at each receptor. The penalties can be applied for "attention catching features" such as tonality, impulsivity, intermittency and other distinguishable characteristics.

The impact of sound from the operation of all the equipment on nearby receivers has been assessed in third octaves in accordance with the objective method provided in Annex C of BS 4142:2014+A1:2019. Results of this assessment show that at all considered receptors the sound generated by the proposed equipment will not contain tones.

The sound generated by the proposed equipment is not expected to be intermittent or impulsive, due to the equipment operating consistently. Changes to sound pressure levels due to load changes will be gradual and

will not result in attention catching characteristics. There are no other specific sound feature characteristics expected to be present which would be readily distinctive against the residual acoustic environment.

As a result, the rating level is equal to the specific sound level.

5.3 Acoustic Impact

The potential impact is described as 'negligible' if the rating level is more than 10 dB below the background noise level; 'low' if less than or equal to the background noise level; 'minor' if not more than 5 dB above; 'moderate' if not more than 10 dB above and 'major' if more than 10 dB above.

The assessment indicates that the predicted noise impact from the Proposed Development at the nearest neighbouring residences is negligible-to-low for daytime periods and low-to-minor for night-time periods, with the minor impact predicted to occur at residences towards the east and south of the site. This level would be considered not significant in terms of the guidance provided within the Technical Advice Note (TAN) detailed at Section 2.2, as outlined by the Scottish Government.

Predicted rating levels at nearby properties are detailed in Table 9 for day and night-time periods respectively. As the assessment is undertaken with all equipment operating at all times, the day and night-time rating levels are equal.

The rating level is then compared to the background sound levels from Table 4 to give an initial estimate of the potential impact at each location and results of this are also shown in Table 9. An illustrative sound footprint for the proposed development showing the predicted specific sound level during the day and night is provided in Figure 15 (Appendix B.4). The predicted maximum rating level ($L_{Ar, Tr}$) at any house is 37 dB.

Table 9 - BS 4142 Assessment Results

House ID	Rating Level, dB $L_{Ar, Tr}$		Rating vs Background, dB		Potential Impact	
	Daytime (07:00-23:00)	Night-time (23:00-07:00)	Daytime (07:00-23:00)	Night-time (23:00-07:00)	Daytime (07:00-23:00)	Night-time (23:00-07:00)
H02	24	24	-13	-5	Negligible	Low
H06	24	24	-13	-5	Negligible	Low
H12	27	27	-18	-6	Negligible	Low
H13	25	25	-20	-8	Negligible	Low
H16	25	25	-16	-6	Negligible	Low
H17	32	32	-5	3	Low	Minor
H18	34	34	-7	3	Low	Minor
H20	34	34	-7	3	Low	Minor
H24	27	27	-14	-4	Negligible	Low
H38	32	32	-9	1	Low	Minor
H39	32	32	-9	1	Low	Minor
H40	30	30	-7	1	Low	Minor
H42	30	30	-7	1	Low	Minor

House ID	Rating Level, dB $L_{Ar, Tr}$		Rating vs Background, dB		Potential Impact	
	Daytime (07:00-23:00)	Night-time (23:00-07:00)	Daytime (07:00-23:00)	Night-time (23:00-07:00)	Daytime (07:00-23:00)	Night-time (23:00-07:00)
H45	31	31	-6	2	Low	Minor
H46	30	30	-7	1	Low	Minor
H47	26	26	-11	-3	Negligible	Low
H48	37	37	-7	3	Low	Minor
H52	26	26	-19	-7	Negligible	Low
H53	25	25	-20	-8	Negligible	Low
H63	27	27	-17	-7	Negligible	Low
H67	32	32	-5	3	Low	Minor
H70	30	30	-11	-1	Negligible	Low
H79	34	34	-7	3	Low	Minor
H80	33	33	-4	4	Low	Minor
H82	31	31	-13	-3	Negligible	Low

Overall, based on the noise modelling assumptions and assessment results presented, the sound emitted by the Proposed Development can be considered not significant in terms of technical advice provided by the Scottish Government.

BS 4142 recognizes the importance of the context in which a sound occurs. It states that the impact depends upon both the margin by which the rating level of the specific sound source exceeds the background sound level and the context in which the sound occurs.

BS 4142 states that absolute levels may be more relevant than the margin by which the rating level exceeds the background sound level in circumstances where the background sound levels and rating levels are low. The previous version of BS 4142 (1997 version) provides numerical values for this and states that "background noise levels below about 30 dB and rating levels below about 35 dB are considered to be very low". The representative background sound level at most houses is around 30 dB at night and the rating levels at all but one house are below 35 dB. Therefore in accordance with BS 4142 an assessment against absolute limits is more relevant during night time.

An assessment against an outdoor sound level of 45 dB $L_{Aeq, 8\ hour}$ (as detailed in section 2.4) shows that the Proposed Development meets this absolute limit at all properties during the night-time. In addition the noise rating assessment in section 5.4 below is also against absolute limits.

The wording for a suggested planning condition that would restrict noise/sound associated with the introduction of the Proposed Development, should the site gain planning consent, is provided in Appendix D.

5.4 Noise Rating Assessment

Following the methodology as detailed in section 3.3, the resulting internal un-weighted sound pressure levels in each octave band at H48 (the nearest property to the Proposed Development) are compared to NR curve values for NR20 during night-time (23:00 - 07:00) and NR30 during daytime (07:00-23:00) hours. The site is assumed to be operating at all times so rating levels for day and night-time are the same.

Table 10 - Noise Rating Levels at H48

Octave band Centre Frequency, Hz	63	125	250	500	1000	2000	4000	8000
Outdoor Level Spectrum, dB(A)	21	25	30	32	32	28	18	-7
Outdoor Level Spectrum, dB(Z)	47	41	39	35	32	27	17	-6
Open Window Sound Attenuation, dB(Z)	20	14	14	16	14	17	19	19
Indoor Level Spectrum, dB(Z)	27	27	25	19	18	9	-2	-25
NR20 Values, dB(Z)	51	39	31	24	20	17	14	13
NR30 Values, dB(Z)	59	48	40	34	30	27	25	23
Resulting Noise Rating Value (NR)	0	6	14	15	18	13	4	0

Table 10 shows that the internal level spectrum is below the NR20 and NR30 values. The highest noise rating value is NR18, therefore noise rating NR20 is met during the night-time and NR30 is met during the day. These results are displayed graphically in Figure 16 (Appendix B.5).

As H48 is the nearest property to the Proposed Development, the NR20 and NR30 values will also be met at all other properties.

5.5 Cumulative Assessment

5.5.1 Cumulative Site Considered

A planning application has been submitted for the construction and operation of a battery energy storage system (reference 23/00754/FULM) which is located approximately 700 m to the south west of the Proposed Development. A noise impact assessment report for that development [12] has been submitted as part of the planning application for that development.

5.5.2 Sound Levels for the Cumulative Site in Isolation

Rating Levels (as defined in BS 4142:2014+A1:2019) are stated in the noise impact assessment report (Table 6.3 and Table 6.4) for the cumulative site in isolation. Three properties are considered in the report, NSR1 – NSR3, which correspond to properties H16, H24 and H40 as defined in Table 4 above. The rating levels for the cumulative site in isolation are detailed in Table 11 below.

Table 11 - Rating Levels for the Cumulative Site in Isolation

Cumulative Site Receptor Name	House ID	Rating Level, dB $L_{Ar, Tr}$	
		Daytime	Night-time
NSR1	H16	17	17
NSR2	H24	23	23
NSR3	H40	23	23

5.5.3 Cumulative Acoustic Impact

A cumulative assessment has been undertaken to determine the combined acoustic impact of the Proposed Development and the cumulative site whilst operating together.

There are three common receptors which can be considered using the information provided for the cumulative site, H16, H24 and H40. A cumulative rating level is calculated by adding the predicted rating levels from both developments at each of the three common receptors, as defined in Table 9 and Table 11 above. The cumulative rating level is then compared with the derived background sound levels as defined in Table 4 above. Table 12 details the results of the cumulative assessment.

Table 12 - BS 4142 Cumulative Assessment Results

House ID	Cumulative Rating Level, dB $L_{Ar, Tr}$		Cumulative Rating vs Background, dB		Potential Impact	
	Daytime (07:00-23:00)	Night-time (23:00-07:00)	Daytime (07:00-23:00)	Night-time (23:00-07:00)	Daytime (07:00-23:00)	Night-time (23:00-07:00)
H16	26	26	-15	-5	Negligible	Low
H24	28	28	-13	-3	Negligible	Low
H40	31	31	-6	2	Low	Minor

Again considering the context, in accordance with BS 4142 an assessment against absolute limits is more relevant during night time. An assessment considering an outdoor sound level of 45 dB $L_{Aeq, 8\ hour}$ (as detailed in section 2.4) shows that the Proposed Development and the cumulative site meets this cumulative absolute limit at all properties considered in the cumulative assessment during the night-time.

5.6 Uncertainty

The instrumentation used for the survey measurements is of class 1 specification, precautions were taken to minimize the influence on the measurements from sources of interference and the metrological conditions were suitable to obtain accurate results.

Modelling of the sound propagation from the Proposed Development has been undertaken on a highly conservative basis, assuming all equipment is operating simultaneously at maximum output. The equipment cooling systems are likely to be speed / thermostat-controlled (operating on/off independently); as such combined sound emissions during typical operation are therefore likely to be lower than those presented. In

addition the sound propagation modelling is assuming downwind conditions. Where conditions less favourable to sound propagation occur, such as when the assessment locations are crosswind or upwind of the proposed development, the specific sound levels would be expected to be lower than those presented in this assessment.

Therefore, the uncertainties inherent in this assessment will not have a significant effect on the outcome of the assessment.

5.7 Construction

Construction noise is discussed with reference to the 'ABC Method' daytime, evening/weekend, and night-time limits of 65, 55 and 45 dB L_{Aeq} respectively, for instances where existing ambient noise levels are relatively low, which is the case here.

The construction of battery storage facilities is typically undertaken in phases starting with the formation of access tracks such that the main site construction activities can begin, following with the installation of security fencing; the introduction of a concrete base and the subsequent construction of the battery storage and ancillary equipment; installation of transmission connection and installation of any necessary ecological and landscape mitigation measures.

The main activities which have the potential to generate noise and vibration are the formation of the access tracks, concrete works and landscaping when occurring relatively close to neighbouring residences. The other activities either occur at distances which are very unlikely to result in noise levels that would breach typical construction noise limits or involve relatively light construction methods/techniques that would equally result in comparably low temporary levels of noise and vibration.

Additional traffic movements generated during the construction process, along existing local roads, and access tracks, also have the potential to have sporadic noise impacts at residences adjacent to these. However, this essentially only tends to result in a minor increase in the average noise levels from existing roads, with the most noticeable noise effects resulting from the sporadic and increased number of HGV pass-bys at residences along the access routes and with resulting levels for individual events being similar to that created by existing HGV movements. In the case of the use of the introduced access tracks, overall levels are highly unlikely to breach typical overall construction noise limits.

Where relatively intense construction activities are to be undertaken near neighbouring residences, particularly during the construction of the site access routes and trenching, specific attention to potential for enhanced mitigation measures to reduce the level of noise and vibration from these activities will be considered.

For all activities, measures will be taken to reduce noise levels with due regard to practicality and cost as per the concept of 'best practicable means' as defined for example in Section 72 of the Control of Pollution Act 1974 [13], which BS 5228-1 makes refence to. BS 5228-1 states that community relations are important in minimising the likelihood of complaints and therefore liaison with the local authority and members of the public will take place to ensure that residents are informed of the intended activities. Non-acoustic factors which influence the likelihood of complaints, such as mud on roads and dust generation, shall also be controlled.

Activities that have the potential to generate significant noise levels will occur during normal working hours (07:00-19:00 weekdays and Saturdays 07:00–13:00) with less intensive activities potentially occurring outside these hours depending on the location and sensitivity of the works.

The following construction noise mitigation measures will be implemented where appropriate and proportionate:

- Consideration shall be given to noise and vibration emissions when selecting or modifying the plant and equipment to be used on site, with quieter variants given preference;
- All plant and equipment should be used in accordance with manufacturers' instructions, maintained in good working order and fitted with the appropriate silencers, mufflers, or acoustic covers where applicable;
- Where noise generated from a specific activity is expected to be directional steps should be taken to orientate the equipment such that sound is directed away from any noise sensitive areas;
- Stationary noise sources shall be sited as far away as reasonably possible from residential properties and consideration given as to whether it is necessary to install acoustic barriers to provide screening;
- The movement of vehicles to and from the site shall be controlled and employees instructed to ensure compliance with the noise control measures adopted;
- Reducing the number of construction activities occurring simultaneously;
- Restricting activities being performed within a certain distance of noise sensitive locations; and,
- Reducing construction traffic.

Any strategy that would reasonably be expected to reduce the level of construction noise and vibration by the desired amount will be considered.

6 Conclusions

An acoustic impact assessment of the proposed Dunmill Battery Energy Storage System has been undertaken. The results show that the impact resulting from the operation of the site will not be significant in the context of relevant assessment criteria (i.e., BS 4142 and BS 8233) and can be considered insignificant in terms of technical advice provided by the Scottish Government.

Noise resulting from the construction of the site is unlikely to exceed typical noise limits at neighbouring dwellings and is therefore unlikely to be significant. However, appropriate noise reduction measures via the use of 'best practicable means' will be implemented to mitigate noise levels in any case.

7 References

[1] British Standards Institution (2019) BS 4142:2014+A1:2019 Methods for Rating and Assessing Industrial and Commercial Sound

[2] British Standards Institution (2014) BS 8233:2014 Guidance on Sound Insulation and Noise Reduction for Buildings

[3] British Standards Institution (2014) BS 5228-1:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites - Part 1: Noise

[4] Scottish Government (March 2011) Planning Advice Notice 1/2011: Planning and Noise

[5] Scottish Government (March 2011) Assessment of Noise: Technical Advice Note

[6] British Standards Institution (1997) BS 4142:1997 Rating Industrial Noise Affecting Mixed Residential and Industrial Areas

[7] International Organisation for Standardisation (1996) ISO 9613-2:1996 Acoustics - Attenuation of Sound During Propagation Outdoors - Part 2: General Method of Calculation

[8] International Organisation for Standardisation (1993) ISO 9613-1:1993 Acoustics - Attenuation of sound during propagation outdoors - Part 1: Calculation of the Absorption of Sound by the Atmosphere

[9] The Building Performance Centre, Napier University (2007) NANR116: 'Open/closed window research' Sound Insulation Through Ventilated Domestic Windows

[10] British Standards Institution (1997) BS 7580-1:1997 Specification for the verification of sound level meters - Comprehensive procedure

[11] International Electrotechnical Commission (2013) IEC 61672-1:2013 Electroacoustics - Sound level meters - Part 1: Specifications

[12] Dragonfly Consulting (August 2023) Noise Impact Assessment DC4271-NR1v2. Submitted to Angus Council as part of planning application 23/00754/FULM.

[13] Her Majesty's Stationery Office (July 1974) The Control of Pollution Act (CoPA)

Appendix A – Experience & Qualifications

Table A.1 - Author

Name	Peter Brooks
Experience	Acoustics Team Lead, Renewable Energy Systems, 2023-Present Senior Acoustic Analyst, Renewable Energy Systems, 2022-2023 Acoustic Consultant, Arcus Consultancy Services, 2021-2022 Director, 343 Acoustics, 2019-2021 Lead Acoustic Engineer, Tymphany, 2017-2019 Research and Development Engineer, SEAS Fabrikker, 2014-2017 Acoustic Engineer, Premium Sound Solutions, 2011-2013
Qualifications	MIOA, Member of the Institute of Acoustics PGCert Environmental Acoustics, University of Salford BSc (Hons) Audio Technology, University of Salford

Table A.2 - Checker & Approver

Name	Dr Jeremy Bass
Experience	Head of Specialist Services/Senior Technical Manager, Renewable Energy Systems, 2000-Present Technical Analyst/Senior Technical Analyst, Renewable Energy Systems, 1990-2000 Foreign Exchange Researcher, Mechanical Engineering Laboratory, Tsukuba, Japan, 1989-1990 Research Associate, Energy Research Unit, Rutherford Appleton Laboratory, 1986-1989
Qualifications	MIOA, Member of the Institute of Acoustics MInstP, Member of the Institute of Physics PhD, The Potential of Combined Heat & Power, Wind Power & Load Management for Cost Reduction in Small Electricity Supply Systems, Department of Applied Physics, University of Strathclyde BSc Physics, University of Durham

Appendix B – Figures

B.1 Background Sound Monitoring Locations

Figure 1 – Unattended Background Sound Monitoring Locations

Figure 2 – Attended Background Sound Monitoring Locations

B.2 Measured Time Histories of Unattended Measurements

Figure 3 - Time History of Measurements Taken at Location 1

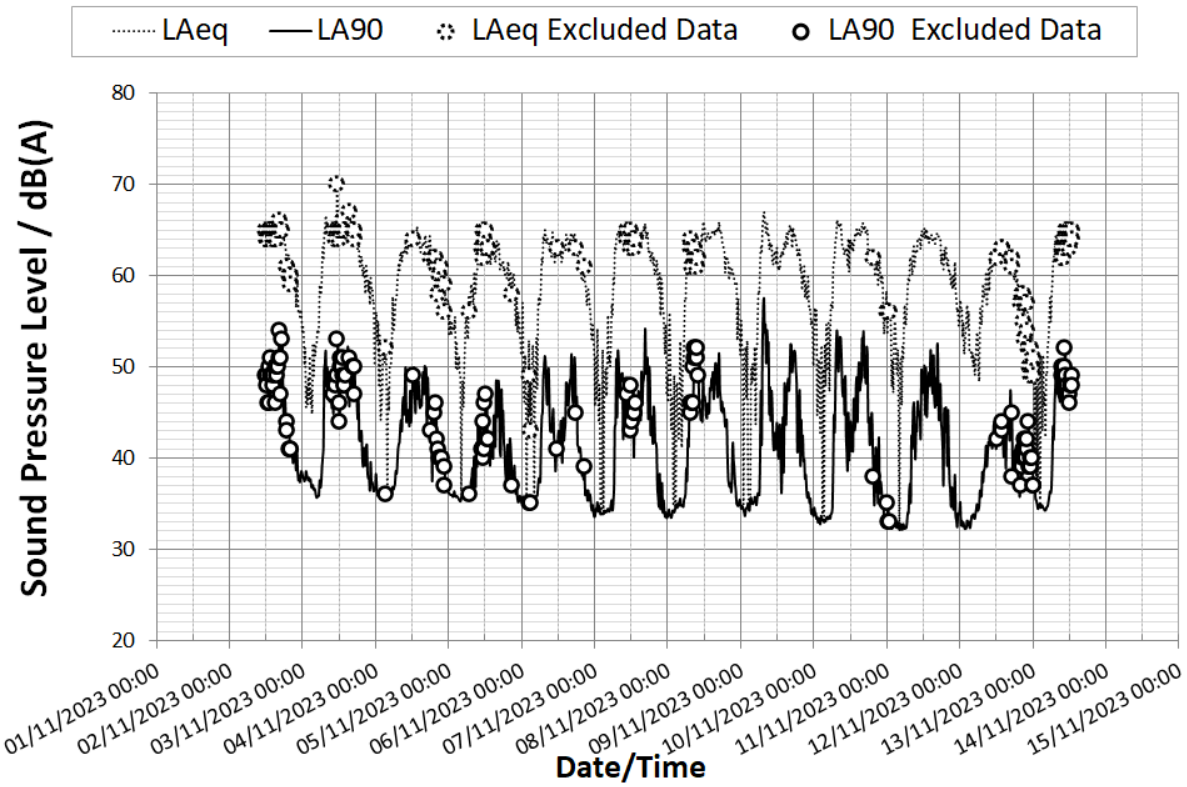


Figure 4 - Time History of Measurements Taken at Location 2

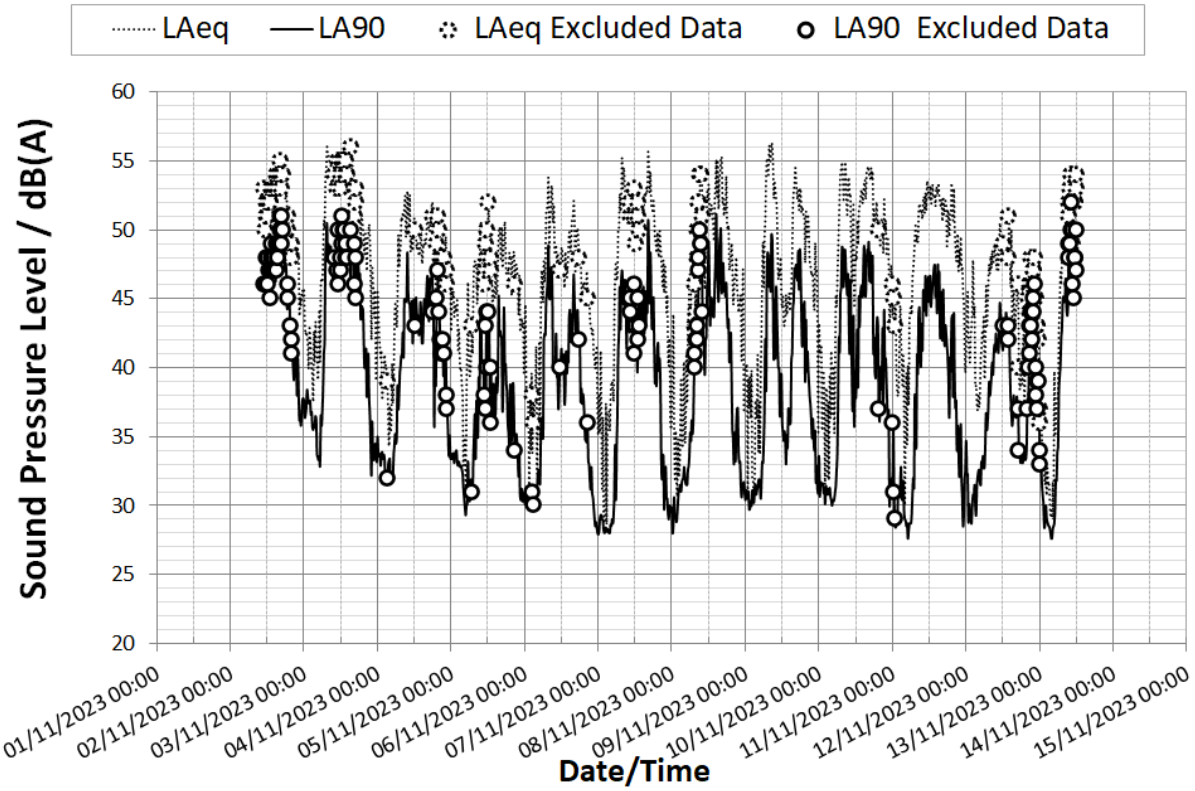


Figure 5 - Time History of Measurements Taken at Location 3

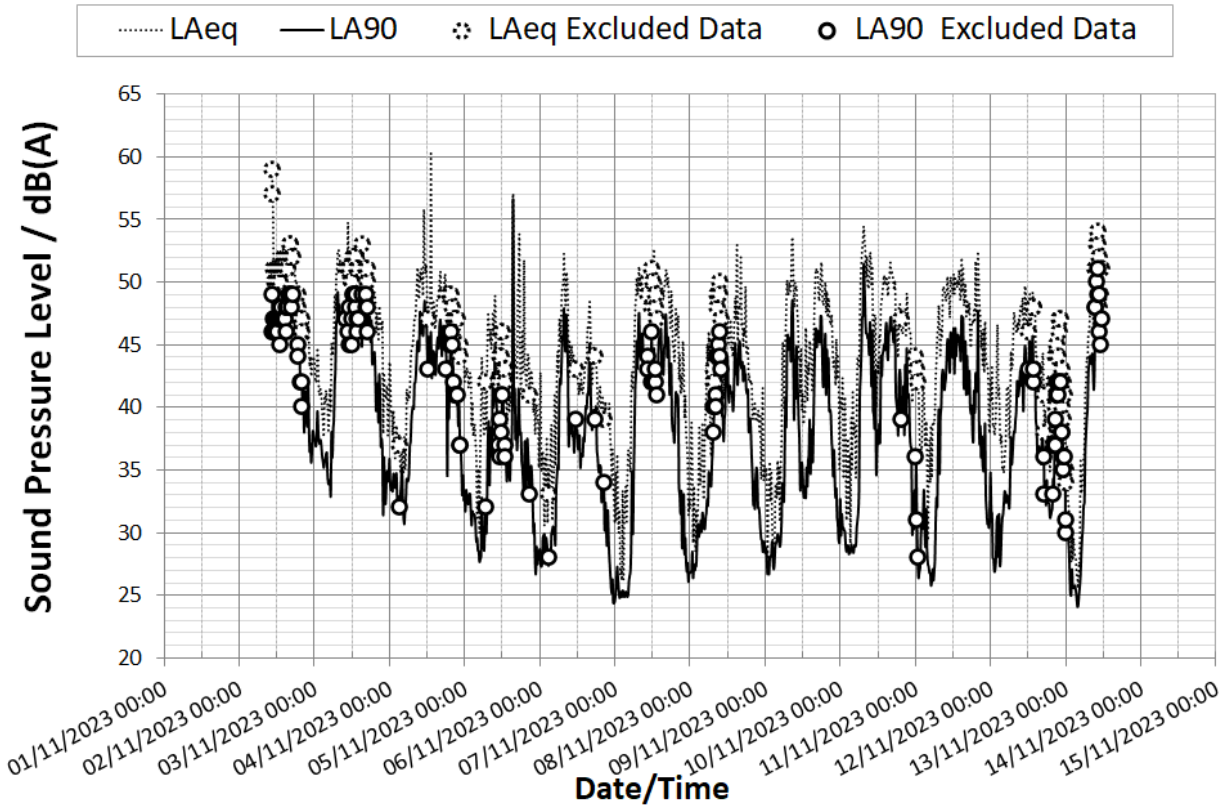
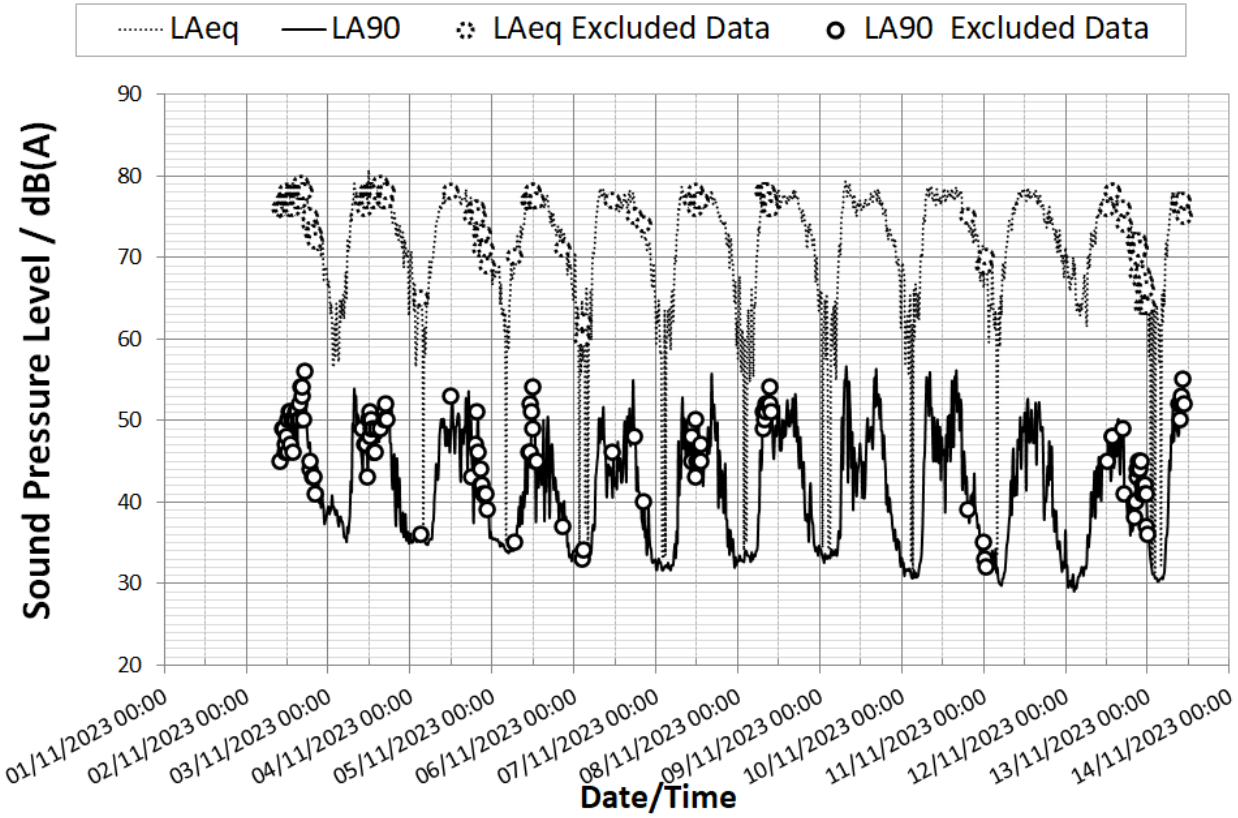


Figure 6 - Time History of Measurements Taken at Location 4



B.3 Histograms of Background Sound Levels from Unattended Measurements

B.3.1 Monitoring Position 1

Figure 7 - Histogram of Daytime $L_{A90,\ 15\ Min}$, dB, Measured at Measurement Position 1

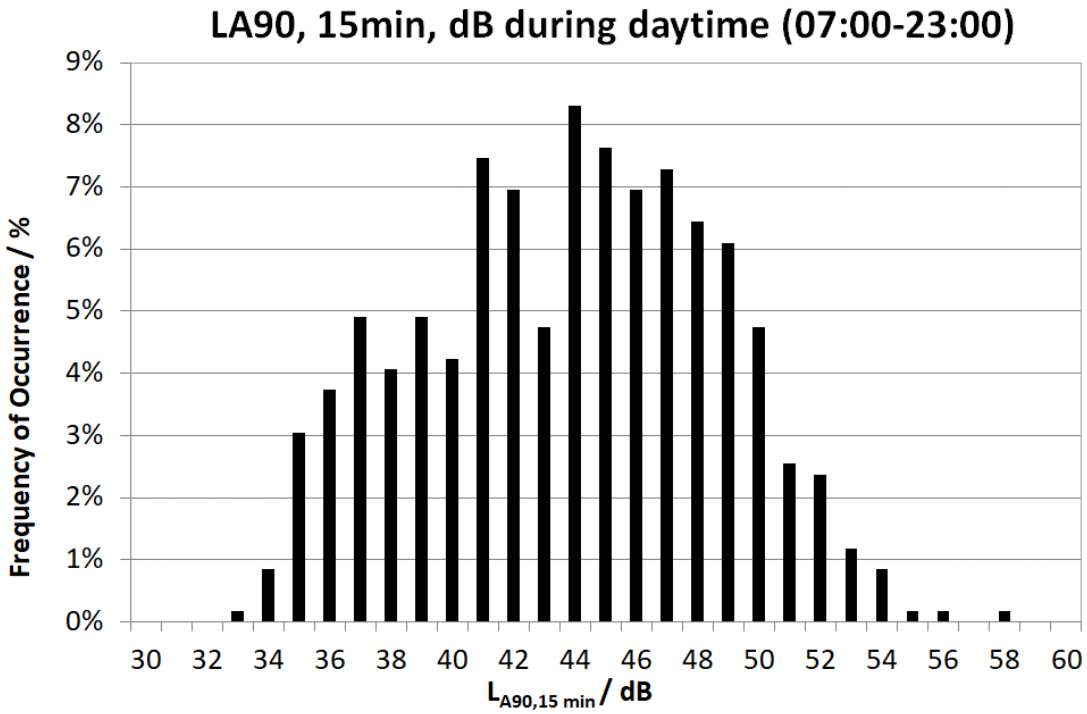
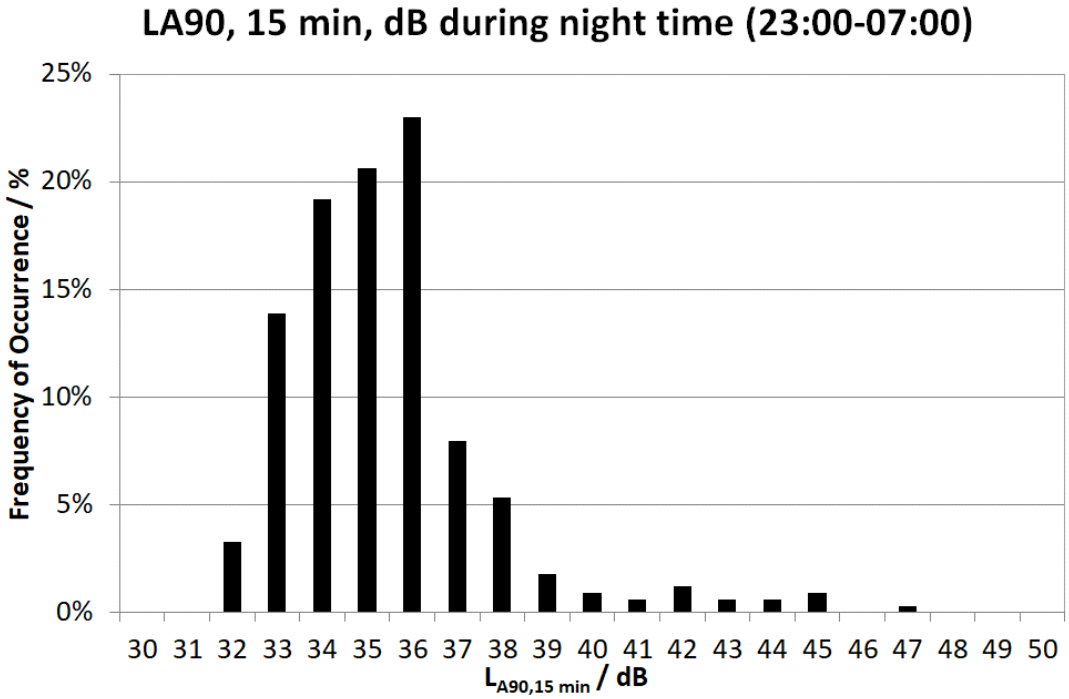


Figure 8 - Histogram of Night-time $L_{A90,\ 15\ Min}$, dB, Measured at Measurement Position 1



B.3.2 Monitoring Position 2

Figure 9 - Histogram of Daytime $L_{A90,\ 15\ Min}$, dB, Measured at Measurement Position 2

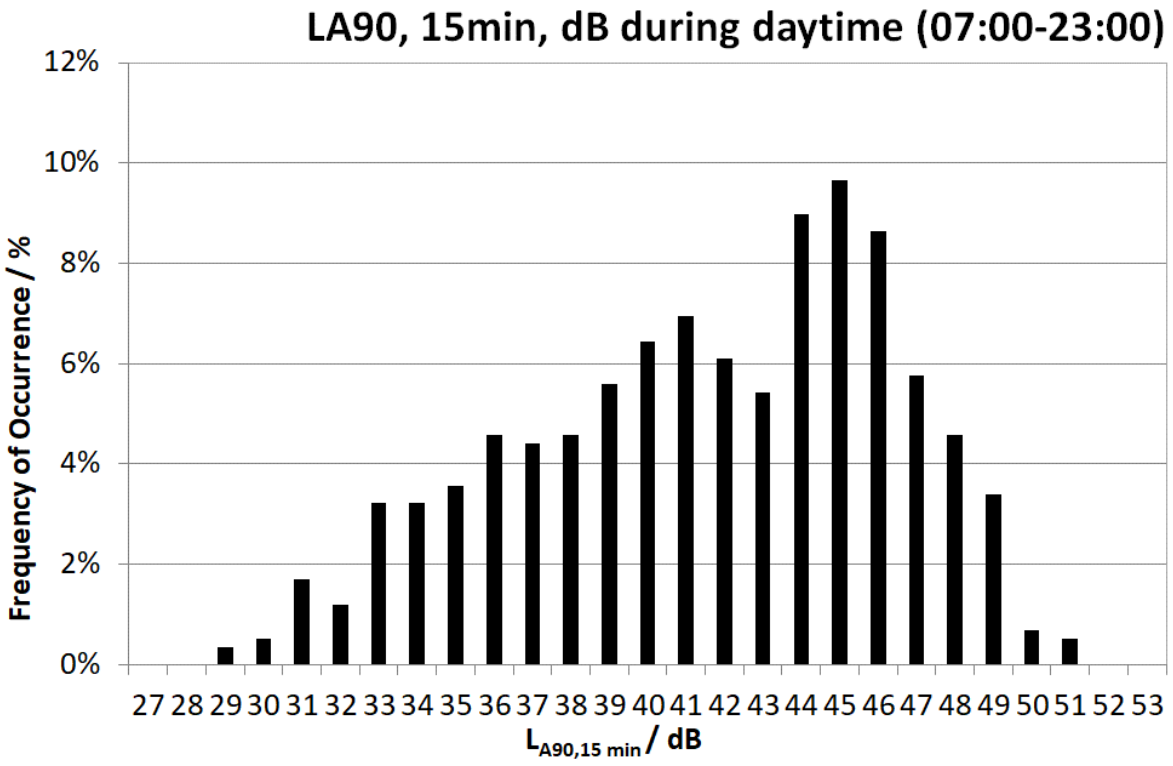
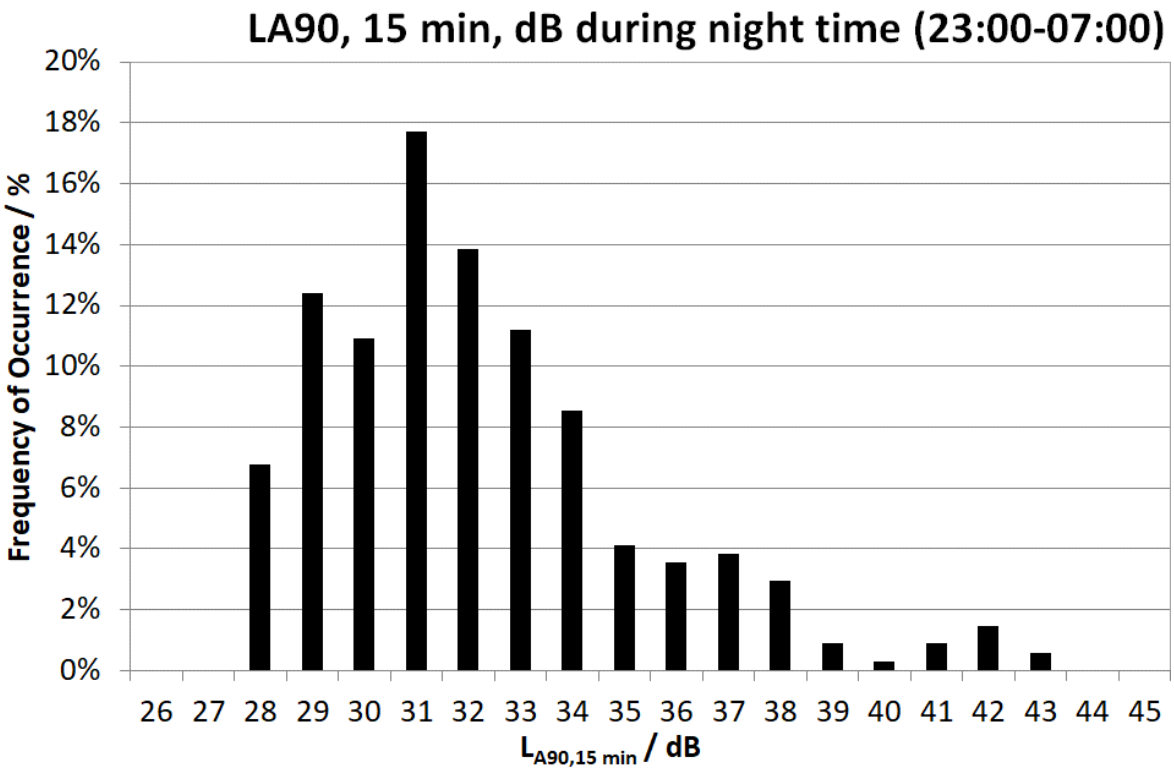


Figure 10 - Histogram of Night-time $L_{A90,\ 15\ Min}$, dB, Measured at Measurement Position 2



B.3.3 Monitoring Position 3

Figure 11 - Histogram of Daytime $L_{A90,\ 15\ Min}$, dB, Measured at Measurement Position 3

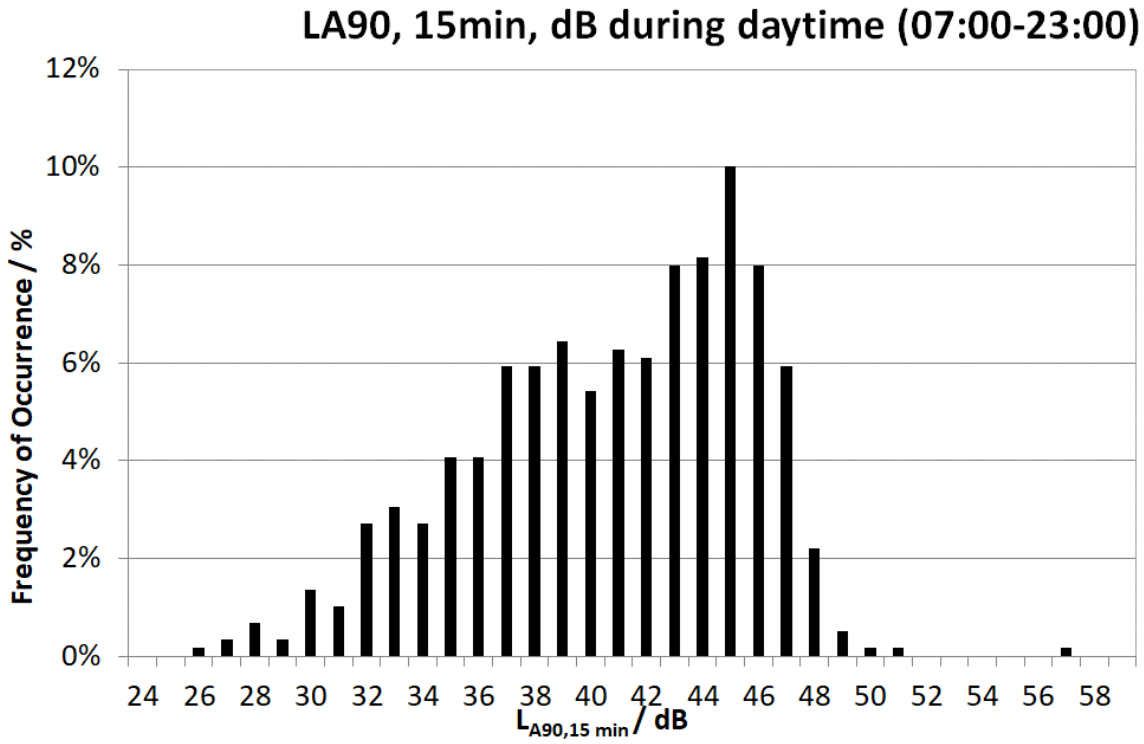
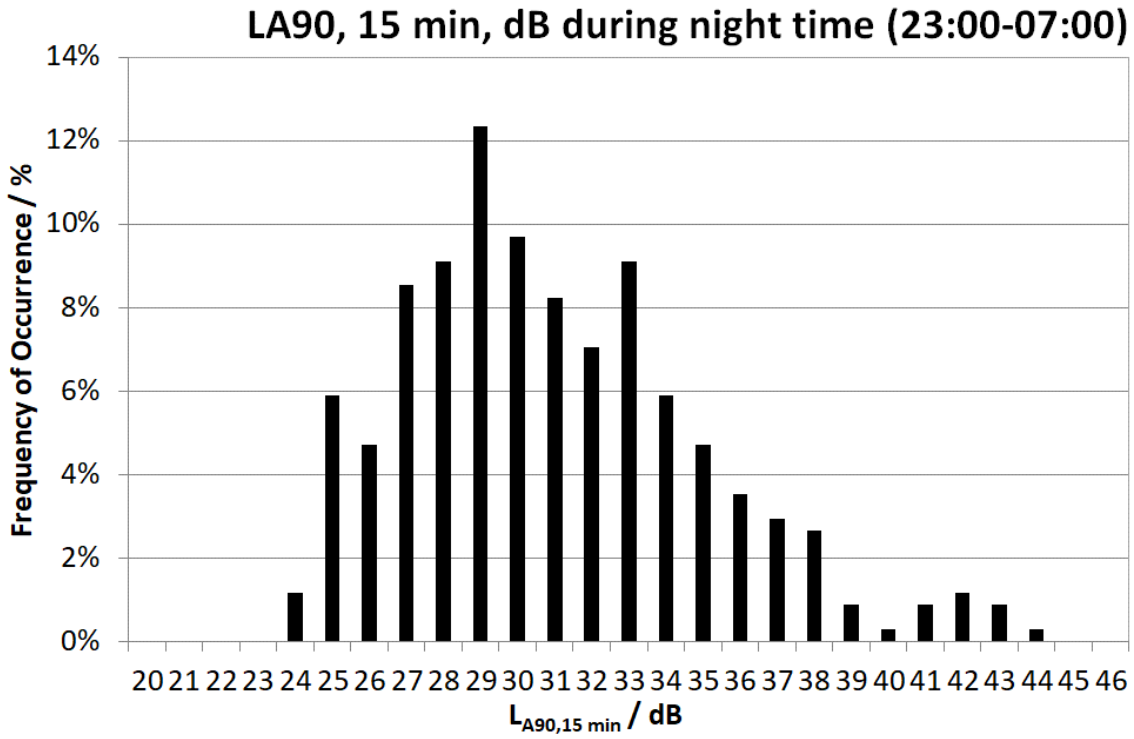


Figure 12 - Histogram of Night-time $L_{A90,\ 15\ Min}$, dB, Measured at Measurement Position 3



B.3.4 Monitoring Position 4

Figure 13 - Histogram of Daytime $L_{A90,\ 15\ Min}$, dB, Measured at Measurement Position 4

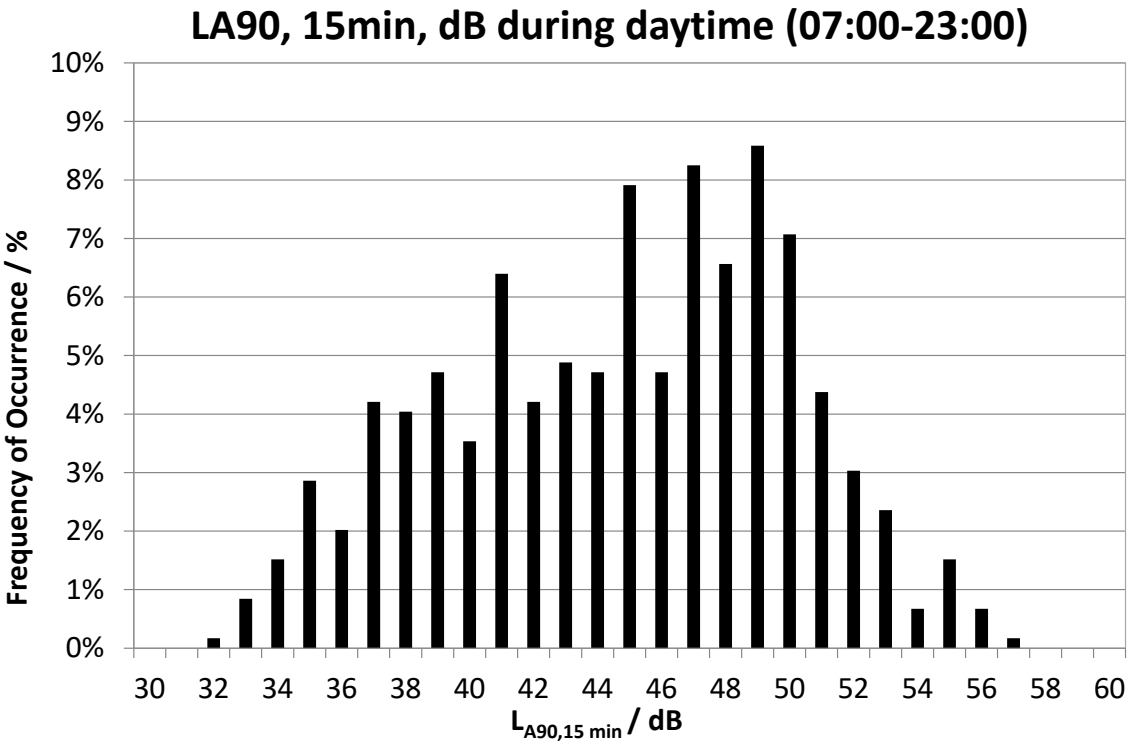
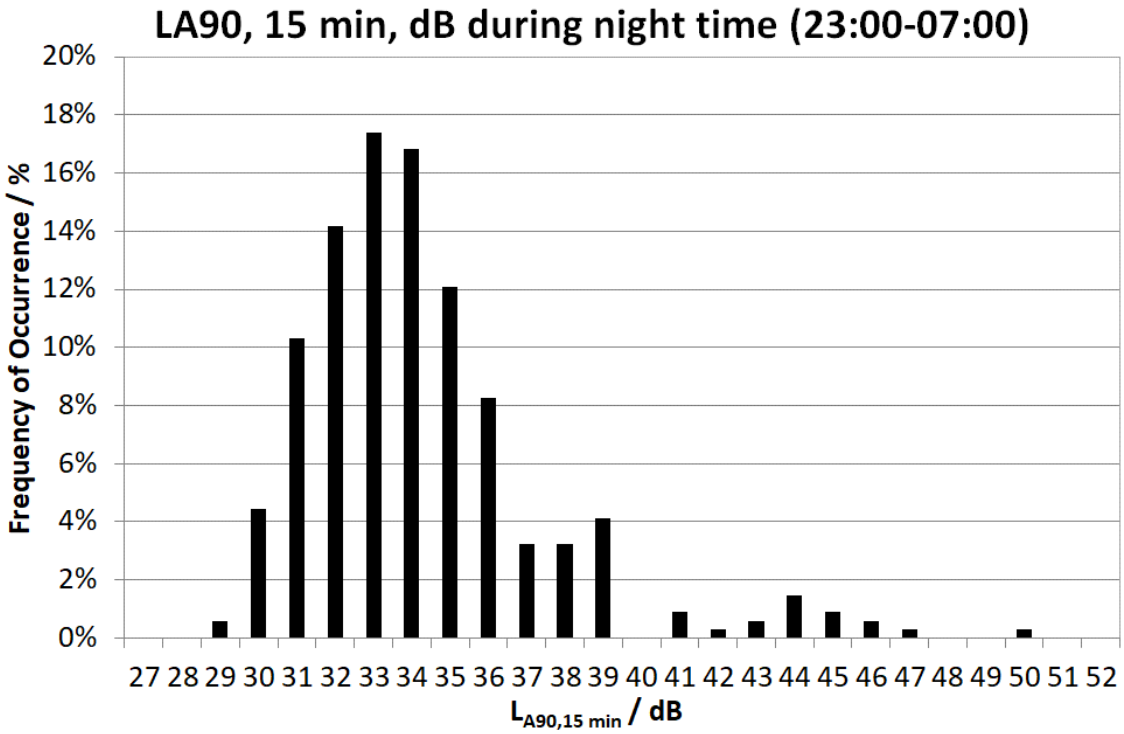
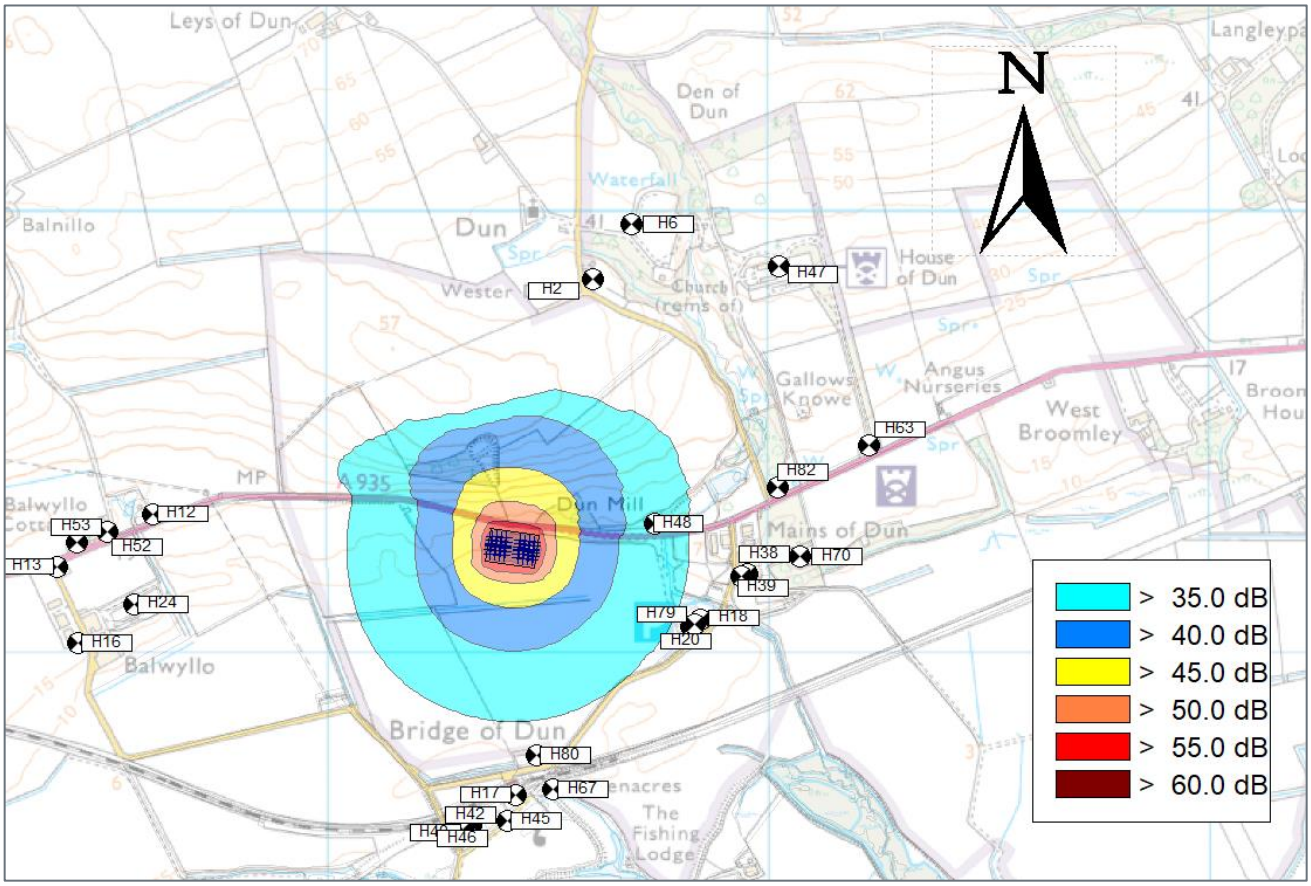


Figure 14 - Histogram of Night-time $L_{A90,\ 15\ Min}$, dB, Measured at Measurement Position 4



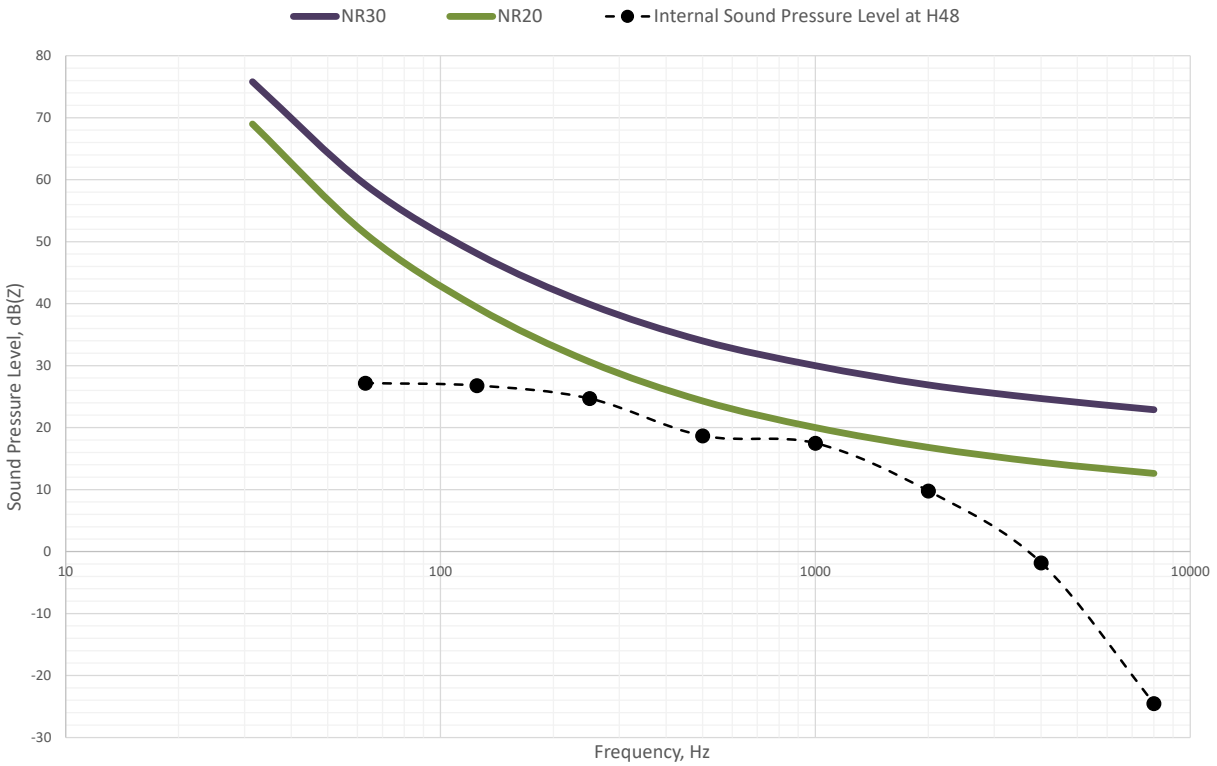
B.4 Predicted Acoustic Footprint

Figure 15 - Predicted operational acoustic footprint of the site (dB $L_{Aeq,Tr}$)



B.5 Noise Rating Curves

Figure 16 – Noise Rating Curves Compared to H48 Level Spectrum, dB(Z)



Appendix C – Photos

C.1 Background Sound Survey Unattended Positions

Figure 17 - Background Sound Monitor at Location 1

Figure 18 - Background Sound Monitor at Location 2

Figure 19 - Background Sound Monitor at Location 3

Figure 20 - Background Sound Monitor at Location 4

Appendix D – Suggested Planning Condition Wording

Dunmill Battery Energy Storage System shall be designed and operated to ensure that the resulting rating level $L_{Ar,Tr}$ external to any neighbouring residential property, determined using the BS 4142:2014+A1:2019 methodology, shall not exceed 37 dB(A) or the background sound level plus 5 dB for both daytime and night-time periods, whichever is the greater.