Cellarhead BESS – Battery Energy Storage System, Werrington

Noise Impact Assessment for Planning Application

9th August 2022

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Contents

1. Introduction 5
1.1. Overview 5
1.2. Scope and Objectives 5
2. Legislation and Policy Framework 6
2.1. National Policy 6
2.2. Assessment Criteria 9
3. Site Description 11
3.1. Site and Surrounding Area 11
3.2. Proposed Development Overview 12
4. Measurement Methodology 13
4.1. General 13
4.2. Measurement Details 13
4.3. Sound Indices 14
4.4. Summary Results 15
5. Operational Noise Assessment 16
5.1. Noise Modelling 16
5.2. Assessment 20
6. Conclusion 26
7. Appendices 27
7.1. Appendix A – Definition of Terms 28
7.2. Appendix B – Sound Measurement Results 31
7.3. Appendix C – Statistical Analysis 32

Figures

Figure 1: Proposed Development Site, NSRs and Surrounding Area 11

Figure 2: Proposed Development Layout 12

Figure 3: Measurement Position 14

Figure 4: Specific Sound Level Map - Daytime 18

Figure 5: Specific Sound Level Map – Night-time 19

Figure 6: Measured Time History – MP1 31

Figure 7: Statistical Analysis of L_{A90} Background – Daytime - MP1 32

Figure 8: Statistical Analysis of L_{A90} Background – Night-Time – MP1 32

Tables

Table 1: Significance Criteria from NPPG in England: Noise 8

Table 2: Impact Scale for Comparison of Future Noise against Existing Noise 10

Table 3: Inventory of Sound Measurement Equipment 13

Table 4: Measurement Position Description 14

Table 5: Sound Measurement Results 15

Table 6: Sound Source Data 16

Table 7: Predicted Specific Sound Level Summary 19

Table 8: Rating Penalty Assessment 21

Table 9: Measurement Uncertainty Factors 22

Table 10: Calculation Uncertainty Factors 23

Table 11: BS4142 Assessment at NSR1 24

Table 12: Typical Sound Levels found in the Environment 29

1. INTRODUCTION

1.1. Overview

inacoustic has been commissioned to assess the impact of potential noise arising from a proposed Battery Energy Storage System (BESS) facility on Land to the east of Armshead Road, Werrington, Staffordshire Moorlands, ST9 0ND.

This report details the existing background sound climate at the nearest noise-sensitive receptors, as well as the potential sound emissions associated with the Proposed Development.

The assessment considers the potential noise generation from the plant associated with the Proposed Development, with respect to existing sound levels in the area. The assessment methodology contained in British Standard 4142:2014+A1:2019 *Method for rating and assessing industrial and commercial sound* has been used.

Accordingly, the following technical noise assessment has been produced to accompany the Planning Application to Staffordshire Moorlands District Council and is based upon environmental noise measurements undertaken at the site and a subsequent 3-dimensional noise modelling exercise.

This noise assessment is necessarily technical in nature; therefore a glossary of terms is included in Appendix A to assist the reader.

1.2. Scope and Objectives

The scope of the noise assessment can be summarised as follows:

- A sound monitoring survey was undertaken at discrete locations representative of the closest noise-sensitive receptors to the Site;
- A 3-dimensional noise modelling exercise, in order to quantify the potential noise generation of the proposed site uses;
- An assessment of potential noise impacts with respect to the prevailing acoustic conditions at existing off-site receptors; and
- Recommendation of mitigation measures, where necessary, to comply with the requirements of the National Planning Practice Guidance in England: Noise[1].

[1] Department for Communities and Local Government (DCLG), 2019. National Planning Practice Guidance for England: Noise. DCLG England: Noise. DCLG.

2. LEGISLATION AND POLICY FRAMEWORK

The development proposals for the Site are guided by the following policy directives and guidance:

2.1. National Policy

2.1.1. National Planning Policy Framework, 2021

The *National Planning Policy Framework* (NPPF)[2] sets out the Government's planning policies for England. Planning policy requires that applications for planning permission must be determined in accordance with the development plan, unless material considerations indicate otherwise.

The NPPF is also a material consideration in planning decisions. It sets out the Government's requirements for the planning system and how these are expected to be addressed.

Under Section 15; *Conserving and Enhancing the Natural Environment*, in Paragraph 174, the following is stated:

"Planning policies and decisions should contribute to and enhance the natural and local environment by:

e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability".

Paragraph 185 of the document goes on to state:

"Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:

a) mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life;
b) identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason"

Paragraph 185 refers to the Noise Policy Statement for England, which is considered overleaf.

[2] Ministry of Housing, Communities and Local Government (MHCLG), July 2021. National Planning Policy Framework. HMSO. London.

2.1.2. Noise Policy Statement for England, 2010

The underlying principles and aims of existing noise policy documents, legislation and guidance are clarified in *DEFRA: 2010: Noise Policy Statement for England* (NPSE)[3]. The NPSE sets out the *"Long Term Vision"* of Government noise policy as follows:

"Promote good health and good quality of life through the effective management of noise within the context of Government policy on sustainable development".

The NPSE outlines three aims for the effective management and control of environmental, neighbour and neighbourhood noise:

- *"Avoid significant adverse impacts on health and quality of life;*
- *Mitigate and minimise adverse impacts on health and quality of life; and*
- *Where possible, contribute to the improvement of health and quality of life".*

The guidance states that it is not possible to have a single objective noise-based measure that defines *"Significant Observed Adverse Effect Level (SOAEL)"* that is applicable to all sources of noise in all situations and that not having specific SOAEL values in the NPSE provides the necessary policy flexibility until further evidence and suitable guidance is available.

2.1.3. National Planning Practice Guidance in England: Noise, 2019

Further guidance in relation to the NPPF and the NPSE has been published in the *National Planning Practice Guidance in England: Noise* (NPPG Noise)[4], which summarises the noise exposure hierarchy, based on the likely average response. The following three observed effect levels are identified below:

- **Significant Observed Adverse Effect Level**: This is the level of noise exposure above which significant adverse effects on health and quality of life occur;
- **Lowest Observed Adverse Effect Level**: This is the level of noise exposure above which adverse effects on health and quality of life can be detected; and
- **No Observed Adverse Effect Level**: This is the level of noise exposure below which no effect at all on health or quality of life can be detected.

Criteria related to each of these levels are reproduced in Table 1.

[3] Department for Environment, Food and Rural Affairs (DEFRA), 2010. Noise Policy Statement for England. DEFRA.
[4] Department for Communities and Local Government (DCLG), 2019. National Planning Practice Guidance for England: Noise. DCLG.

TABLE 1: SIGNIFICANCE CRITERIA FROM NPPG IN ENGLAND: NOISE

Perception	Examples of Outcomes	Increasing Effect Level	Action
No Observed Effect Level			
Not Noticeable	No Effect	No Observed Effect	No specific measures required
No Observed Adverse Effect Level			
Noticeable and Not Intrusive	Noise can be heard, but does not cause any change in behaviour, attitude or other physiological response. Can slightly affect the acoustic character of the area but not such that there is a change in the quality of life.	No Observed Adverse Effect	No specific measures required
Lowest Observed Adverse Effect Level			
Noticeable and Intrusive	Noise can be heard and causes small changes in behaviour, attitude or other physiological response, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a small actual or perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level			
Present and Disruptive	The noise causes a material change in behaviour, attitude or other physiological response, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Present and Very Disruptive	Extensive and regular changes in behaviour, attitude or other physiological response and/or an inability to mitigate effect of noise leading to psychological stress, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory.	Unacceptable Adverse Effect	Prevent

2.2. Assessment Criteria

2.2.1. BS4142:2014+A1:2019

BS4142:2014+A1:2019 *Methods for Rating and Assessing Industrial and Commercial Sound* sets out a method to assess the likely effect of sound from factories, industrial premises or fixed installations and sources of an industrial nature in commercial premises, on people who might be inside or outside a dwelling or premises used for residential purposes in the vicinity.

The procedure contained in BS4142:2014+A1:2019 for assessing the effect of sound on residential receptors is to compare the measured or predicted sound level from the source in question, the $L_{Aeq,T}$ *specific sound level*, immediately outside the dwelling with the $L_{A90,T}$ background sound level.

Where the sound contains a tonality, impulsivity, intermittency and other sound characteristics, then a correction depending on the grade of the aforementioned characteristics of the sound is added to the specific sound level to obtain the $L_{Ar,Tr}$ *rating sound level*. The effect of uncertainty in sound measurements, data and calculations should also be considered when necessary.

BS4142:2014+A1:2019 states: *"The significance of sound of an industrial and/or commercial nature 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"*. An estimation of the impact of the specific sound can be obtained by the difference of the rating sound level and the background sound level and considering the following:

- *"Typically, the greater this difference, the greater the magnitude of the impact."*
- *"A difference of around +10dB or more is likely to be an indication of a significant adverse impact, depending on the context."*
- *"A difference of around +5dB is likely to be an indication of an adverse impact, depending on the context."*
- *"The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context."*

During the daytime, the assessment is typically carried out over a reference time period of 1-hour, with a reference period of 15-minutes used for the night-time assessment. The periods associated with day or night, for the purposes of the Standard, are considered to be 07.00 to 23.00 and 23.00 to 07.00, respectively.

2.2.2. Relative Change in Ambient Noise Level

The IEMA Guidelines[5] define 'Noise Impact' as the difference in the acoustic environment before and after the implementation of the proposals, also known as the magnitude of change. In circumstances where a noise environment may be altered by addition or removal of a noise source, considered to be largely anonymous or within the prevailing acoustic character of an area, for example, changes to traffic quantum or patterns, it is normal to consider this relative change in ambient noise level. The assessment, therefore, considers this phenomenon to add context.

The impact scale adopted in this assessment is shown in Table 2 below, which relates to established human responses to noise, in line with '*Table 7-12 Effect Descriptors'* of the IEMA Guidelines and set in the context of NPPG.

TABLE 2: IMPACT SCALE FOR COMPARISON OF FUTURE NOISE AGAINST EXISTING NOISE

Noise Level Change dB(A)	Subjective Response	Significance	NPPG Context
Less than 1.0	No perceptible	Negligible	NOEL
1.0 – 2.9	Barely perceptible	Minor impact	NOAEL
3.0 – 4.9	Noticeable	Moderate impact	LOAEL
5.0 – 9.9	Up to a doubling or halving of loudness	Substantial impact	SOAEL
10.0 or more	More than a doubling or halving of loudness	Major impact	UAEL

The criteria above reflect the key benchmarks that relate to human perception of sound. A change of 3 dB(A) is generally considered to be the smallest change in environmental noise that is perceptible to the human ear. A 10 dB(A) change in noise represents a doubling or halving of the perception of loudness. The difference between the minimum perceptible change and the doubling or halving of the noise level is split to provide greater definition to the assessment of changes in noise level.

It is considered that the criteria specified in Table 2 provide a good indication as to the likely significance of changes in noise levels in this case and can be used to inform the context in which the sound occurs in order to assess the impact of noise from the proposed development.

[5] Institute of Environmental Management & Assessment (IEMA), Version 1.2 (November 2014). Guidelines for Environmental Noise Impact Assessment

3. Site Description

3.1. Site and Surrounding Area

The Proposed Development will be located on Land to the east of Armshead Road, Werrington, Staffordshire Moorlands, ST9 0ND.

The Site is located within the Green Belt and surrounded by agricultural land. The closest Noise-Sensitive Receptors (NSRs) to the site are dwellings to the west and north-west, approximately 250 metres from the site boundary and residential dwellings to the east at approximately 300 metres from the site boundary, along with other dwellings along Armshead Road. The site is approximately 700 metres to the south west of Cellarhead Substation.

The ambient sound environment at the area is influenced by road traffic noise arising from the Armshead Road.

The Proposed Development site, the closest NSRs and the surrounding area can be seen in Figure 1.

Figure 1: Proposed Development Site, NSRs and Surrounding Area



3.2. Proposed Development Overview

BESS is an emissions-free capacity resource that is fast, highly flexible, and always on and ready to provide power services to the grid. It is different from other energy generators as it uses the electrical power grid as a fuel, and can either deliver or withdraw power from the grid depending on what is needed.

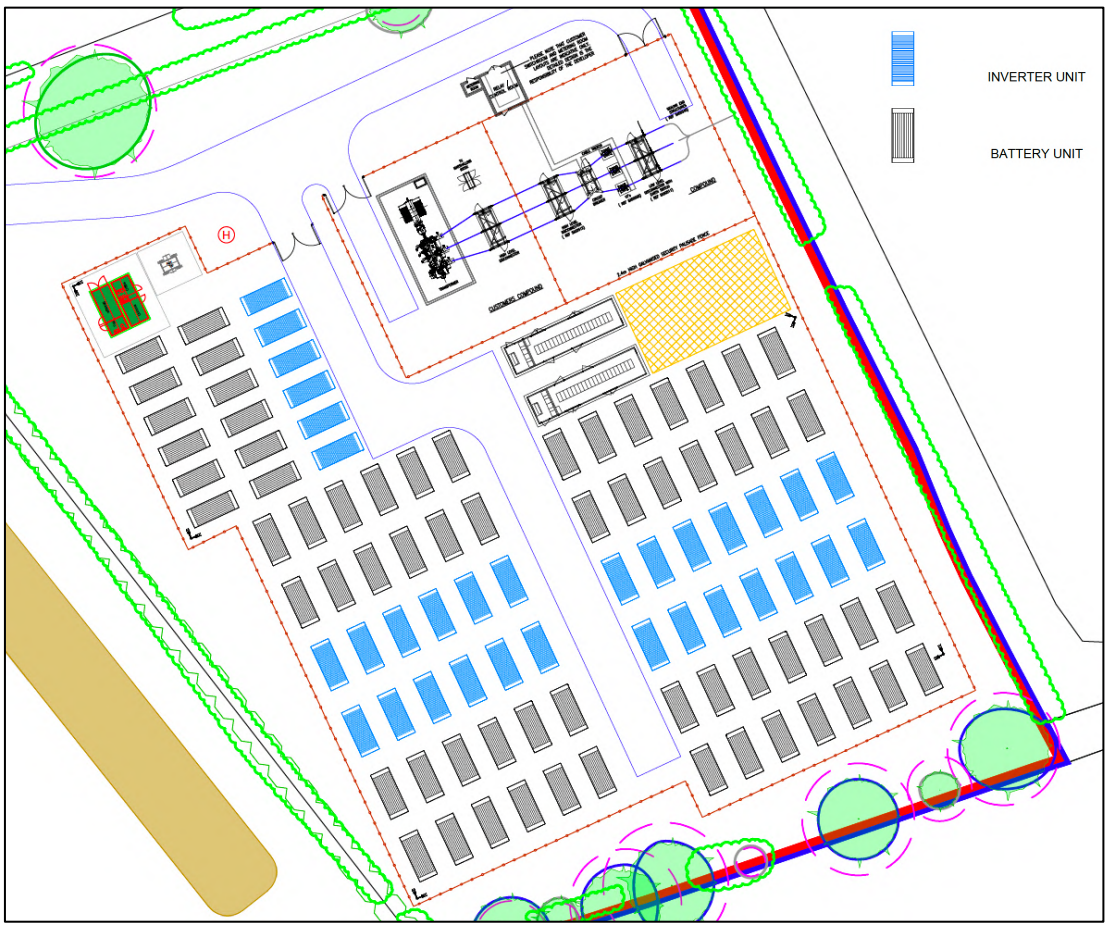
The energy storage process does not inherently have any sound emissions associated with it, however, to ensure the batteries remain at the correct temperature, a series of cooling fans are used. Similarly, the inverter stations used to transform the energy from DC to AC and vice versa are cooled by fans that can generate noise.

Batteries can be charged/discharged over short periods of time with systems operating at full duty. Inversely, they can be charged/discharged over longer periods of time by operating at lower duty. The rest of the time, the systems are on a stand-by mode. Therefore, battery storage developments do not operate continuously at full duty during long periods of time. In addition, cooling fans tend to operate at reduced speed during the night-time when the environmental temperature is lower.

It is proposed that there will be 64 No. containerised battery units and 32 No. inverter/transformer stations on Site. It is assumed that battery units will be served by an integrated cooling system on each side of the container.

An overview of the proposed site layout can be seen below in Figure 2.

FIGURE 2: PROPOSED DEVELOPMENT LAYOUT



4. Measurement Methodology

4.1. General

The prevailing background sound conditions in the area have been determined by an environmental noise survey conducted during both daytime and night-time periods between Wednesday 22nd to Wednesday 29th June 2022.

4.2. Measurement Details

All noise measurements were undertaken by a consultant certified as competent in environmental noise monitoring, and, in accordance with the principles of BS 7445[6].

All acoustic measurement equipment used during the noise survey conformed to Type 1 specification of British Standard 61672[7]. A full inventory of this equipment is shown in Table 3 below.

Table 3: Inventory of Sound Measurement Equipment

Measurement Position	Make, Model & Description	Serial Number	Certificate Number	Calibration Expiry Date
MP1	NTi XL2 Sound Level Meter	A2A-14510-E0	1109696	25/02/2023
	MA220 Microphone	7602		
	Cirrus CR:515 Calibrator	80029	TCRT22/1229	7/05/2023

The sound measurement equipment used during the survey was field calibrated at the start and end of the measurement period. A calibration laboratory has calibrated the field calibrator used within the twelve months preceding the measurements. A drift of less than 0.2 dB in the field calibration was found to have occurred on the sound level meter.

The weather conditions during the survey were variable. When periods of unsuitable weather were noted to occur, that is affected by rain or wind speeds above 5 ms^{-1}, they have been removed from the dataset used to derive the typical background sound level.

[6] British Standard 7445: 2003: Description and measurement of environmental noise. BSI
[7] British Standard 61672: 2013: Electroacoustics. Sound level meters. Part 1 Specifications. BSI.

The microphone was fitted with a protective windshield for the measurements, which is described in Table 4, with an aerial photograph indicating its location shown in Figure 3.

TABLE 4: MEASUREMENT POSITION DESCRIPTION

Measurement Position	Description
MP1	Largely unattended daytime and night-time measurement of sound within the proposed site, representative of the acoustic environment at the closest noise-sensitive receptor to the site. The microphone was located at 1.5 metres above local ground under free-field conditions. The sound environment at the area was influenced by road traffic noise arising from the Armshead Road. Natural sounds such as birdsong and wind-induced vegetation movement did also contribute to the local soundscape.

FIGURE 3: MEASUREMENT POSITION



4.3. Sound Indices

The parameters reported are the average Equivalent Continuous Sound Level, $L_{Aeq,T}$, the statistical index (typical) Background Sound Level, $L_{A90,T}$, as well as the typical Maximum Sound Pressure Level, L_{AFmax}. An explanation of the sound units presented is given in Appendix A.

The measured L_{Aeq}, L_{AFmax}, and L_{AF90} sound levels are presented as time histories in a graph in Appendix B. Furthermore, the statistical distribution of the measured background sound levels to derive the typical representative $L_{A90,T}$ values are presented in a graphical format in Appendix C.

4.4. Summary Results

The summarised results of the environmental sound measurements, during the day and night-time periods, can be seen below in Table 5. Values have been rounded to the nearest whole number.

TABLE 5: SOUND MEASUREMENT RESULTS

Measurement Position	Period	$L_{AF90,T}$ (dB)	$L_{Aeq,T}$ (dB)	L_{AFmax} (dB)
MP1	Day	**32**	49	71
	Night	**25**	43	66

5. Operational Noise Assessment

5.1. Noise Modelling

5.1.1. Source Data

The A-weighted sound power levels associated with the Proposed Development can be seen below in Table 6. At this stage, these are considered robust candidate source noise levels to be achieved by scheme design.

Table 6: Sound Source Data

Plant	Quantity	Sound Power Level per unit, L_{wA} (dB)
Inverter Unit (with sound attenuation)	32	75 (Day – Full Duty) 62 (Night – Reduced Duty)
Battery Cooling System	128	77 (Day – Full Duty) 70 (Night – Reduced Duty)
Auxiliary Transformer	1	71
Substation/Transformer	1	82

These input parameters are intended to determine the likely sources of noise impact and whether attenuation is likely to be required, such that acoustic feasibility is demonstrated for the purposes of planning consideration.

5.1.2. Calculation Process

Calculations were carried out using Cadna/A, which undertakes its calculations in accordance with guidance given in ISO9613-1:1993 and ISO9613-2:1996.

5.1.3. Model Assumptions

Given that the land between proposed development and nearest receptors is largely soft, the ground factor has been set to 1, within the calculation software, with 2 orders of reflection. Full octave frequency spectra have been used in the calculations. It has been assumed that all processes will occur simultaneously, representing a worst-case scenario.

In order to accurately model the land surrounding the development, an AutoCAD DXF drawing was produced, which was based on data provided by the Ordnance Survey, along with associated topographic contours sourced from Defra.

5.1.4. Mitigation by Design

In order to reduce the potential noise impact of the Proposed Development, an iterative assessment of suitable noise mitigation techniques has been undertaken. The following mitigations have been considered in the noise model and subsequent assessment of residual effects.

Table 6 shows the maximum sound power level required to achieve compliance at the worst affected receptors. To achieve this the inverters should be housed within an acoustic enclosure with suitably attenuated air inlet and outlet, capable of reducing the total sound power level to those presented in Table 6. M&E engineers should make allowances for the necessary pressure loss introduced by the proposed mitigations.

These mitigation measures have been incorporated into the calculations taken forward for assessment of residual effects.

5.1.5. Specific Sound Level Map

The sound map showing the specific sound level emissions from the Proposed Development can be seen in Figure 4 and Figure 5 for daytime and night-time periods respectively.

FIGURE 4: SPECIFIC SOUND LEVEL MAP - DAYTIME

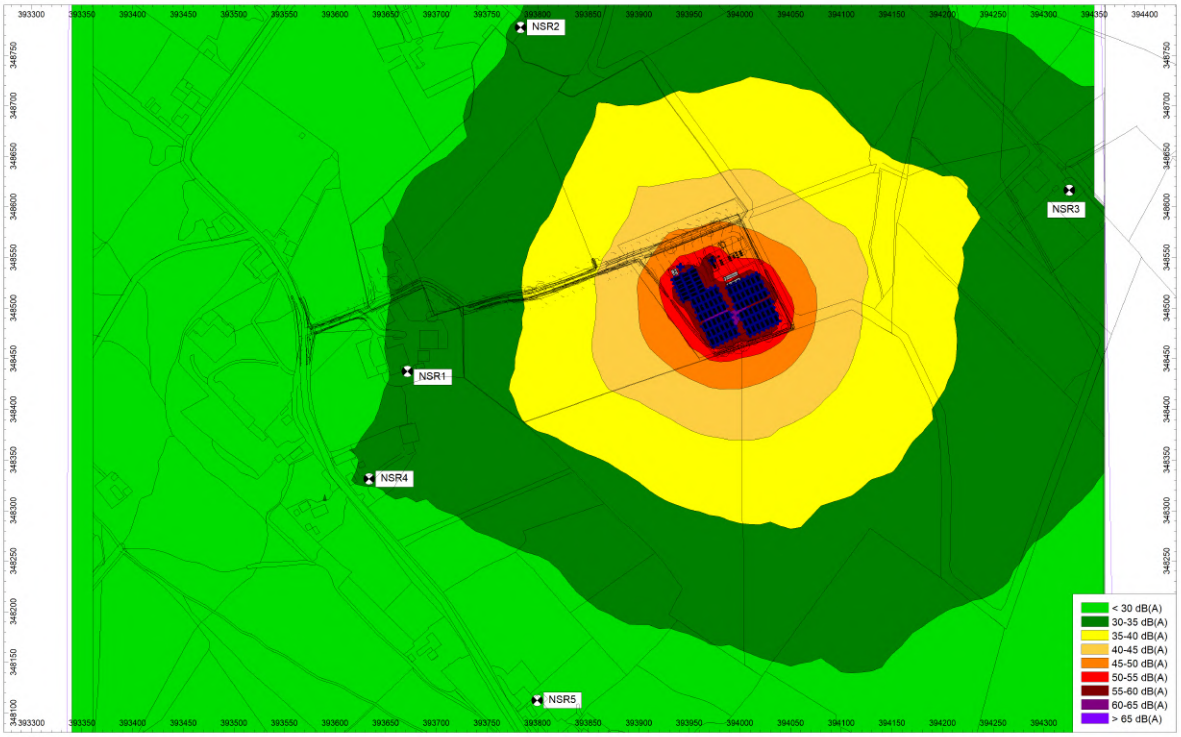
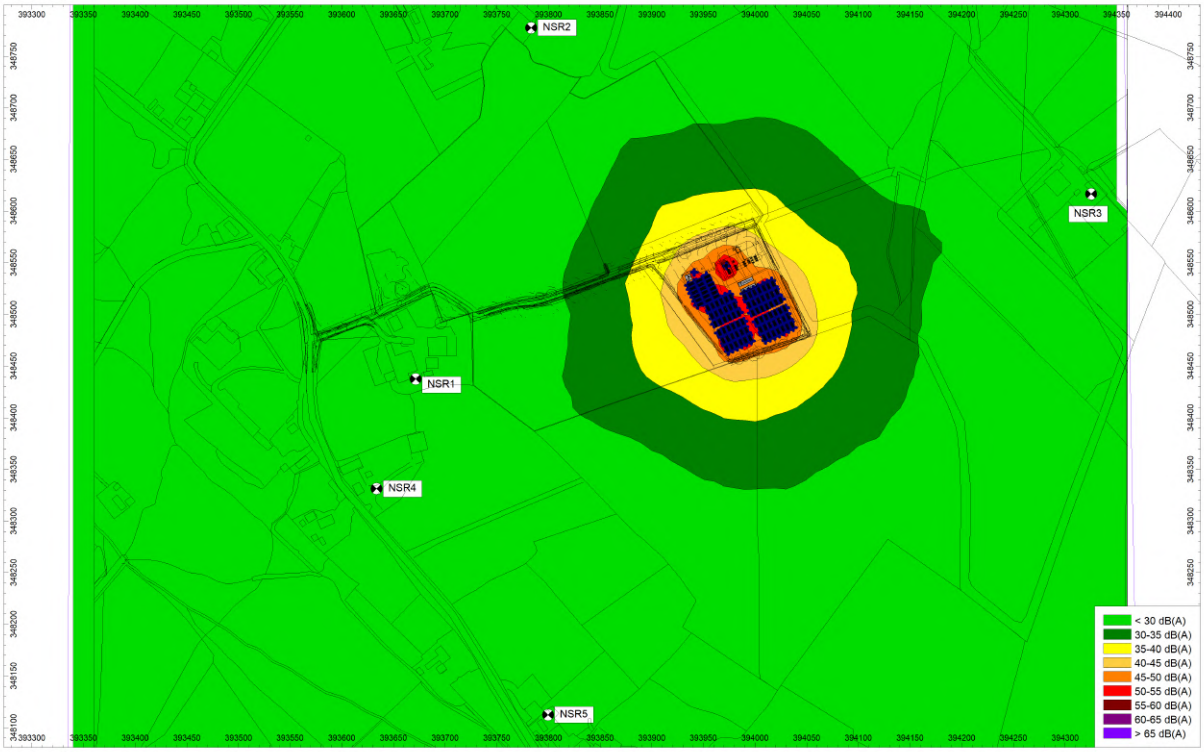


Figure 5: Specific Sound Level Map – Night-time



5.1.6. Specific Sound Level Summary

A summary of the predicted specific sound levels at the closest NSRs, based on the sound maps shown in Figure 4 and Figure 5 can be seen below in Table 7.

Table 7: Predicted Specific Sound Level Summary

NSR	Period	Specific Sound Level (dB)
1	Daytime (07:00-23:00)	31
	Night-time (23:00-07:00)	23
2	Daytime (07:00-23:00)	30
	Night-time (23:00-07:00)	23
3	Daytime (07:00-23:00)	32
	Night-time (23:00-07:00)	25
4	Daytime (07:00-23:00)	30
	Night-time (23:00-07:00)	23
5	Daytime (07:00-23:00)	28
	Night-time (23:00-07:00)	20

5.2. Assessment

5.2.1. Rating Penalty Principle

Section 9 of BS4142:2014+A1:2019 describes how the rating sound level should be derived from the specific sound level, by determining a rating penalty. BS4142:2014+A1:2019 states:

"Certain acoustic features can increase the significance of impact over that expected from a basic comparison between the specific sound level and the background sound level. Where such features are present at the assessment location, add a character correction to the specific sound level to obtain the rating level. This can be approached in three ways:

a) subjective method;
b) objective method for tonality;
c) reference method."

Given that the Proposed Development is not operational, the subjective method has been adopted to derive the rating sound level from the specific sound level. This is discussed in Section 9.2 of BS4142:2014+A1:2019, which states:

"Where appropriate, establish a rating penalty for sound based on a subjective assessment of its characteristics. This would also be appropriate where a new source cannot be measured because it is only proposed at that time, but the characteristics of similar sources can subjectively be assessed.

Correct the specific sound level if a tone, impulse or other characteristics occurs, or is expected to be present, for new or modified sound sources."

BS4142:2014+A1:2019 defines four characteristics that should be considered when deriving a rating penalty, namely; tonality; impulsivity; intermittency; and other sound characteristics, which are defined as:

Tonality

A rating penalty of +2 dB is applicable for a tone which is *"just perceptible"*, +4 dB where a tone is *"clearly perceptible"*, and +6 dB where a tone is *"highly perceptible"*.

Impulsivity

A rating penalty of +3 dB is applicable for impulsivity which is *"just perceptible"*, +6 dB where it is *"clearly perceptible"*, and +9 dB where it is *"highly perceptible"*.

Intermittency

BS4142:2014+A1:2019 states that when the *"specific sound has identifiable on/off conditions, the specific sound level ought to be representative of the time period of length equal to the reference time interval which contains the greatest total amount of on time … if the intermittency is readily distinctive against the residual acoustic environment, a penalty of +3 dB can be applied."*

Other Sound Characteristics

BS4142:2014+A1:2019 states that where *"the specific sound features characteristics that are neither tonal nor impulsive, though otherwise are readily distance against the residual acoustic environment, a penalty of +3 dB can be applied."*

5.2.2. Rating Penalty Assessment

Considering the content of Section 5.2.1, an assessment of the various sound sources associated with the Proposed Development, in terms of whether any rating penalties are applicable, has been detailed in Table 8 below.

TABLE 8: RATING PENALTY ASSESSMENT

Source	Tonality	Impulsivity	Intermittency	Other Sound Characteristics	Discussion
Battery Energy Storage Plant	0 dB	0 dB	0 dB	0 dB	The cooling systems do normally operate continuously during the majority of the charging/discharging periods. They might switch on/off, but not simultaneously, during cool down periods when they are less noisy, and therefore the intermittency is not expected to be readily noticeable at the receptor locations. A potential mid-low frequency bias might exist at source, but due to distance to receptors, the residual acoustic environment will mask any significant tones or low frequency characteristics

In summary, a no rating penalty has been included in the assessment.

5.2.3. Uncertainty

BS4142:2014+A1:2019 requires that the level of uncertainty in the measured data and associated calculations is considered in the assessment. The Standard recommends that steps should be taken to reduce the level of uncertainty.

Measurement Uncertainty

BS4142:2014+A1:2019 states that measurement uncertainty depends on a number of factors, including the following, which are applicable to the Proposed Development:

"
...
b) the complexity and level of variability of the residual acoustic environment;
...
d) the location(s) selected for taking the measurements;
...
g) the measurement time intervals;
h) the range of times when the measurements have been taken;
i) the range of suitable weather conditions during which measurements have been taken;
...
k) the level of rounding of each measurement recorded; and
l) the instrumentation used."

Each of the measurement uncertainty factors outlined above have been considered and discussed in Table 9 below.

TABLE 9: MEASUREMENT UNCERTAINTY FACTORS

Measurement Uncertainty Factor Reference	Level of Uncertainty	Discussion
b)	0 dB	Residual acoustic environment is relatively constant, hence no correction for a complex residual acoustic environment.
d)	0 dB	Measuring at a location representative of the closest receptors to the site has enabled the determination of robust background sound levels.
g)	0 dB	Measurement time intervals were set in accordance with BS4142:2014+A1:2019, hence no further correction needs to be made.
h)	0 dB	Measurements were undertaken over a continuous 7-day period, including midweek and weekend periods.
i)	1 dB	Periods of high wind or precipitation were removed from the data set used to derive the typical background sound levels.
k)	0 dB	Measured values were rounded to 0.1 dB, therefore rounding would not have had a significant impact on the overall typical background sound levels.
l)	0 dB	The acoustic measurement equipment accorded with Type 1 specification of British Standard 61672, and were deployed with appropriate wind shields.

In summary, an uncertainty budget of 1 dB has been considered in the assessment, to account for measurement uncertainty.

Calculation Uncertainty

BS4142:2014+A1:2019 states that calculation uncertainty depends on a number of factors, including the following, which are applicable to the Proposed Development:

"

...

b) uncertainty in the operation or sound emission characteristics of the specific sound source and any assumed sound power levels;
c) uncertainty in the calculation method;
d) simplifying the real situation to "fit" the model (user influence on modelling); and
e) error in the calculation process."

Each of the calculation uncertainty factors outlined above have been considered and discussed in Table 10 below.

TABLE 10: CALCULATION UNCERTAINTY FACTORS

Calculation Uncertainty Factor Reference	Level of Uncertainty	Discussion
b)	0 dB	Sound source levels are based on robust candidate plant data and suitable mitigations, to be achieved by the design.
c)	0 dB	Calculations were undertaken in accordance with ISO 9613-2, which is considered a *"validated method"* by BS4142:2014+A1:2019.
d)	0 dB	The real situation has not been simplified for the purposes of this assessment.
e)	±1 dB	ISO 9613-2 indicates that there is a ±3 dB accuracy to the prediction method, therefore, an uncertainty factor of ±1 dB is considered appropriate and proportional, given the separation distances involved.

In summary, an uncertainty budget of ±1 dB has been considered in the assessment, to account for calculation uncertainty.

The overall uncertainty is considered to be small enough that it would not affect the conclusions of the assessment. It is also noted that because the assessment considers a worst-case scenario, such as downwind sound propagation (which in reality cannot happen at all NSRs at the same time) the relevance of the uncertainty is further reduced.

5.2.4. BS4142:2014+A1:2019 Assessment

The rating sound level, as calculated from the predicted specific sound level, has been assessed in accordance with BS4142:2014+A1:2019, at the closest NSRs.

The BS4142:2014+A1:2019 assessment at all NSRs, during the day and night-time periods, can be seen in Table 11.

TABLE 11: BS4142 ASSESSMENT AT NSR1

NSR	Period	Rating Sound Level (dB)	Background Sound Level (dB)	Excess of Rating over Daytime Background Sound Level (dB)
1	Daytime	31	32	-1
	Night-time	23	25	-2
2	Daytime	30	32	-2
	Night-time	23	25	-2
3	Daytime	32	32	0
	Night-time	25	25	0
4	Daytime	30	32	-2
	Night-time	23	25	-2
5	Daytime	28	32	-4
	Night-time	20	25	-5

It can be seen that the Proposed Development, once mitigated, is predicted to not exceed the prevailing background sound levels in the area, thus having a 'Low Impact' at the closest NSRs depending on the context, which is discussed below.

5.2.5. Discussion on Context

The results set out in Table 11 identify that the operation of the scheme, as proposed, can occur without affecting the amenity of the closest residential receptors to the site, on the basis of a worst-case operational scenario.

BS4142:2014+A1:2019, however, recognises the importance of the context in which a sound occurs when assessing impacts.

It is noted that the assessment considers a worst-case scenario, such as all plant operating simultaneously under 'Deep Cycling' mode during the day, where the batteries are working at their maximum output and inverters and battery cooling fans operate at full duty. In reality, 'Deep Cycling' typically occurs during limited periods of the day only.

Commercially, 'Deep Cycling' is not a normal practice during the night, and the operator has confirmed that there is no foreseeable case when the fans should operate at night due to a requirement for 'Deep Cycling'. At night, batteries typically operate in a 'Shallow Cycling' mode

where there is hardly ever any need for fan use. In any case, this assessment considers a worst-case approach of fans operating at lower duty during the night.

Long-term source noise measurements undertaken at a comparable operational development has confirmed that noise levels associated with plant operating at full duty tends to occur during short periods of the daytime only, with the majority of the daytime and night-time periods presenting significantly lower noise emission levels.

The effect of the Proposed Development on the relative change in ambient noise levels at the nearest residential receptors should also be considered as part of the context. The large differential between the predicted specific sound levels at the closest NSRs as presented in Table 7, when compared to the measured ambient $L_{Aeq,T}$ levels in the area as presented in Table 5, would ensure that no increase in the prevailing ambient sound level would occur as a result of the operation of the proposed scheme.

As part of the wider context and benefits of the proposed scheme, it is also important to note the role that these type of energy developments fulfil, in working towards achieving the 'Net Zero Strategy: Build Back Greener' from the Department for Business, Energy & Industrial Strategy, which sets out policies and proposals for decarbonising all sectors of the UK economy to meet the net zero target by 2050.

6. CONCLUSION

inacoustic has been commissioned to assess the impact of potential noise arising from a proposed Battery Energy Storage System (BESS) facility on Land to the east of Armshead Road, Werrington, Staffordshire Moorlands, ST9 0ND.

This technical noise assessment has been produced to accompany a Planning Application to Staffordshire Moorlands District Council and is based upon environmental noise measurements undertaken at the site and a subsequent 3-dimensional noise modelling exercise.

The assessment considers the potential noise generation from the plant associated with the Proposed Development, with respect to existing sound levels in the area, including mitigation measures presented in Section 5.1.4.

The assessment methodology contained in British Standard 4142: 2014+A1:2019 *Method for rating and assessing industrial and commercial sound* has been used in conjunction with supplementary acoustic guidance.

The assessment identifies that the Proposed Development will give rise to rating sound levels that do not exceed the measured background sound level in the area, thus giving rise to a 'Low Impact'.

The assessment also identifies that no significant change in ambient sound level at the identified receptor locations will be engendered as a result of the Proposed Development in its proposed and assessed form and that the amenity of residential receptors a will not be compromised.

Consequently, the assessment demonstrates that the Proposed Development will give rise to noise impacts that would be within the range of NOAEL of the NPPG England guidance.

For ease of reference, the definition of *No Observed Adverse Effect Level* in PPGNoise is reproduced below:

"Noise can be heard, but does not cause any change in behaviour, attitude or other physiological response. Can slightly affect the acoustic character of the area but not such that there is a change in the quality of life."

Since the Proposed Development conforms to British Standard and National Planning Policy requirements, it is recommended that noise should not be a considered constraint to the approval of this Planning Application, providing that the plant is constructed and operated in accordance with the acoustic assumptions and recommendations set out within this report.

7. APPENDICES

7.1. Appendix A – Definition of Terms

Sound Pressure	Sound, or sound pressure, is a fluctuation in air pressure over the static ambient pressure.
Sound Pressure Level (Sound Level)	The sound level is the sound pressure relative to a standard reference pressure of 20µPa ($20x10^{-6}$ Pascals) on a decibel scale.
Decibel (dB)	A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s1 and s2 is given by 20 log10 (s1 / s2). The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is 20µPa.
A-weighting, dB(A)	The unit of sound level, weighted according to the A-scale, which takes into account the increased sensitivity of the human ear at some frequencies.
Noise Level Indices	Noise levels usually fluctuate over time, so it is often necessary to consider an average or statistical noise level. This can be done in several ways, so a number of different noise indices have been defined, according to how the averaging or statistics are carried out.
$L_{eq,T}$	A noise level index called the equivalent continuous noise level over the time period T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded.
$L_{max,T}$	A noise level index defined as the maximum noise level during the period T. L_{max} is sometimes used for the assessment of occasional loud noises, which may have little effect on the overall L_{eq} noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
$L_{90,T}$	A noise level index. The noise level exceeded for 90% of the time over the period T. L_{90} can be considered to be the "average minimum" noise level and is often used to describe the background noise.
$L_{10,T}$	A noise level index. The noise level exceeded for 10% of the time over the period T. L_{10} can be considered to be the "average maximum" noise level. Generally used to describe road traffic noise.
Free-Field	Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5m
Facade	At a distance of 1m in front of a large sound reflecting object such as a building façade.
Fast Time Weighting	An averaging time used in sound level meters. Defined in BS 5969.

In order to assist the understanding of acoustic terminology and the relative change in noise, the following background information is provided.

The human ear can detect a very wide range of pressure fluctuations, which are perceived as sound. In order to express these fluctuations in a manageable way, a logarithmic scale called the decibel, or dB scale is used. The decibel scale typically ranges from 0 dB (the threshold of hearing) to over 120 dB. An indication of the range of sound levels commonly found in the environment is given in the following table.

TABLE 12: TYPICAL SOUND LEVELS FOUND IN THE ENVIRONMENT

Sound Level	Location
0dB(A)	Threshold of hearing
20 to 30dB(A)	Quiet bedroom at night
30 to 40dB(A)	Living room during the day
40 to 50dB(A)	Typical office
50 to 60dB(A)	Inside a car
60 to 70dB(A)	Typical high street
70 to 90dB(A)	Inside factory
100 to 110dB(A)	Burglar alarm at 1m away
110 to 130dB(A)	Jet aircraft on take off
140dB(A)	Threshold of Pain

The ear is less sensitive to some frequencies than to others. The A-weighting scale is used to approximate the frequency response of the ear. Levels weighted using this scale are commonly identified by the notation dB(A).

In accordance with logarithmic addition, combining two sources with equal noise levels would result in an increase of 3 dB(A) in the noise level from a single source.

A change of 3 dB(A) is generally regarded as the smallest change in broadband continuous noise which the human ear can detect (although in certain controlled circumstances a change of 1 dB(A) is just perceptible). Therefore, a 2 dB(A) increase would not be normally be perceptible. A 10 dB(A) increase in noise represents a subjective doubling of loudness.

A noise impact on a community is deemed to occur when a new noise is introduced that is out of character with the area, or when a significant increase above the pre-existing ambient noise level occurs.

For levels of noise that vary with time, it is necessary to employ a statistical index that allows for this variation. These statistical indices are expressed as the sound level that is exceeded for a percentage of the time period of interest. In the UK, traffic noise is measured as the L_{A10}, the noise level exceeded for 10% of the measurement period. The L_{A90} is the level exceeded for 90% of the time and has been adopted to represent the background noise level in the absence of discrete events. An alternative way of assessing the time varying noise levels is to use the equivalent continuous sound level, L_{Aeq}.

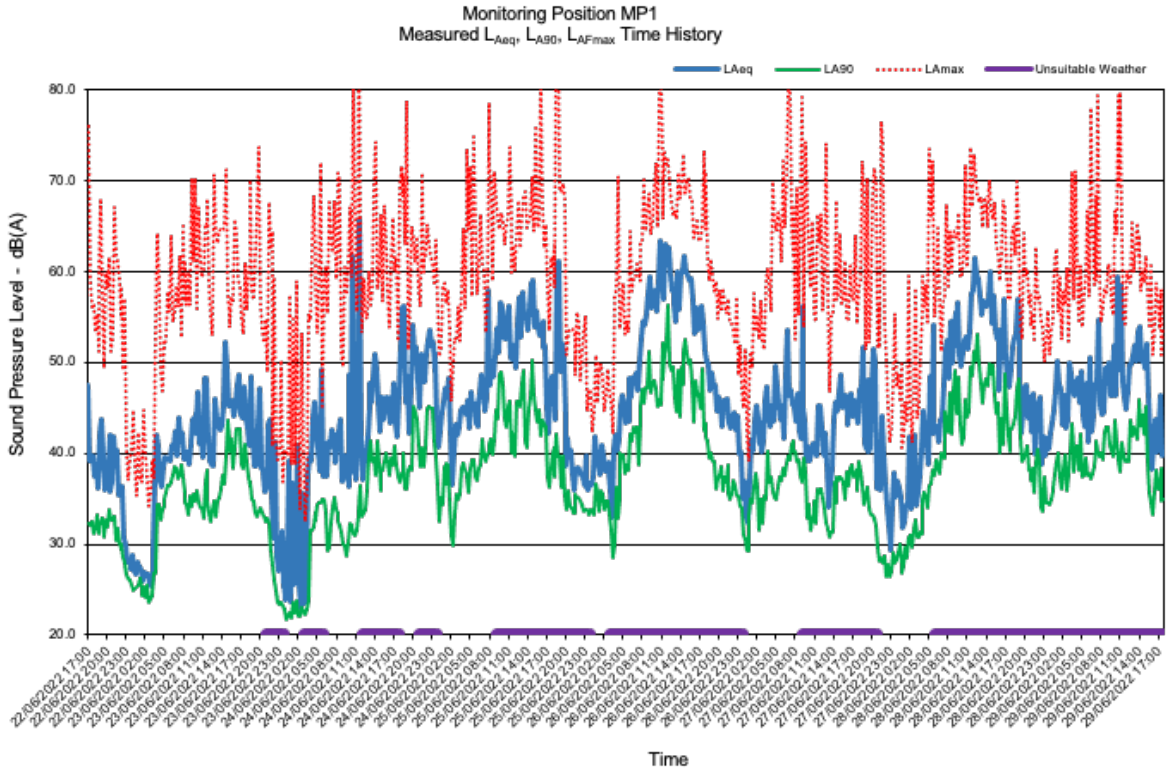
This is a notional steady level that would, over a given period of time, deliver the same sound energy as the actual fluctuating sound.

To put these quantities into context, where a receiver is predominantly affected by continuous flows of road traffic, a doubling or halving of the flows would result in a just perceptible change of 3 dB, while an increase of more than 25%, or a decrease of more than 20%, in traffic flows represent changes of 1 dB in traffic noise levels (assuming no alteration in the mix of traffic or flow speeds).

Note that the time constant and the period of the noise measurement should be specified. For example, BS 4142 specifies background noise measurement periods of 1 hour during the day and 15 minutes during the night. The noise levels are commonly symbolised as $L_{A90,1hour}$ dB and $L_{A90,15mins}$ dB. The noise measurement should be recorded using a 'FAST' time response equivalent to 0.125 ms.

7.2. Appendix B – Sound Measurement Results

FIGURE 6: MEASURED TIME HISTORY – MP1



7.3. Appendix C – Statistical Analysis

FIGURE 7: STATISTICAL ANALYSIS OF L_{A90} BACKGROUND – DAYTIME - MP1

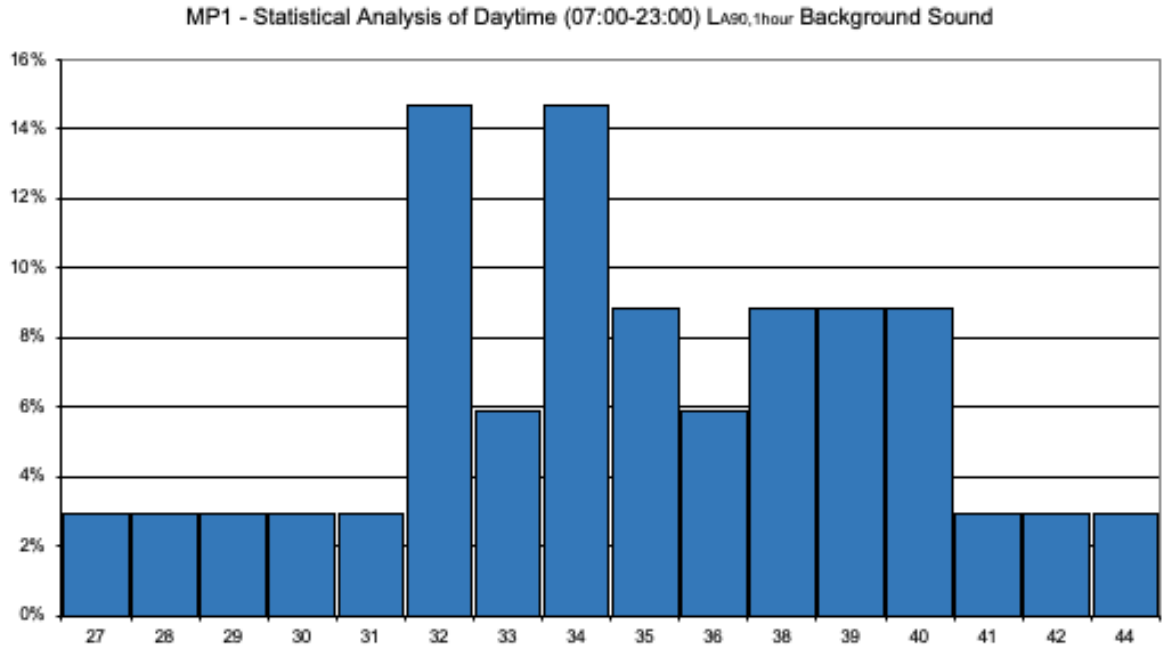
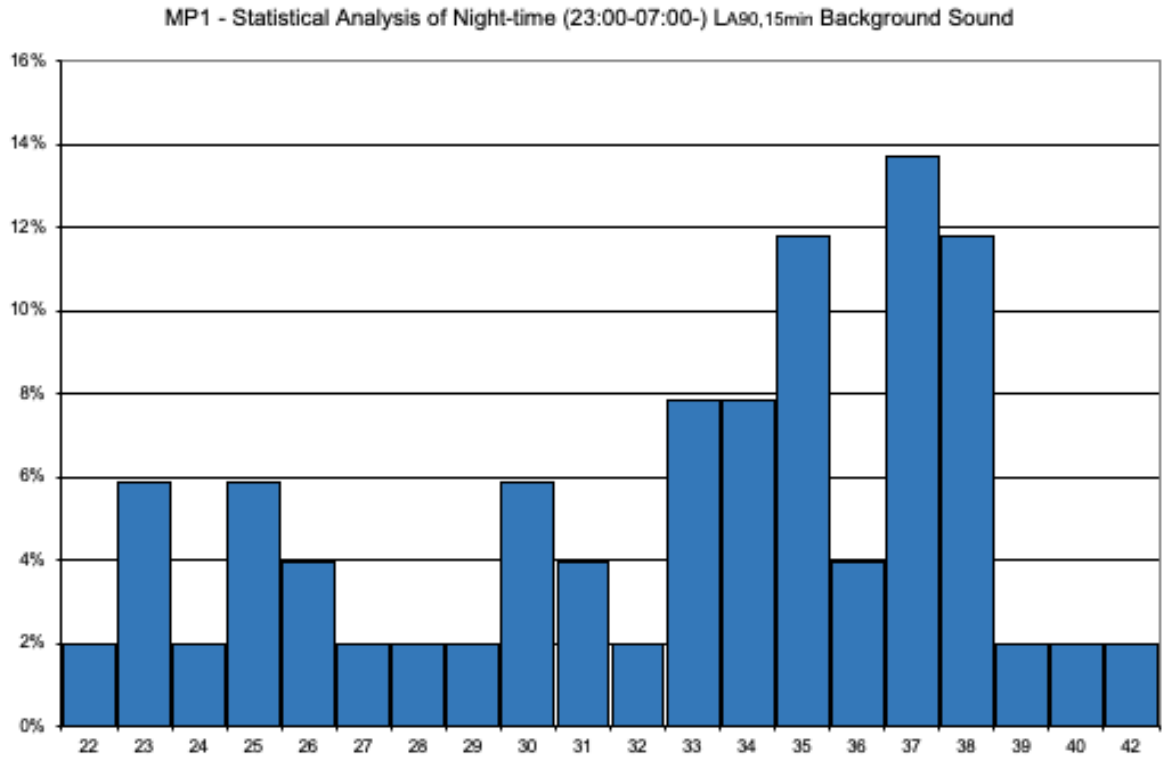


FIGURE 8: STATISTICAL ANALYSIS OF L_{A90} BACKGROUND – NIGHT-TIME – MP1



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