



Land at Fendyke Farm off Old Fendyke, Sutton St James

Noise Impact Assessment for Planning Application

14th October 2024

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1. INTRODUCTION

1.1. Overview

inacoustic has been commissioned to assess the potential impact of sound associated with the proposed installation and operation of a grid connected solar farm (the 'Proposed Development') on land at Fendyke Farm off Old Fendyke, Sutton St James (the 'Site').

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

The assessment considers the potential sound 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*¹' has been used.

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

This 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 assessment can be summarised as follows:

- A sound monitoring survey was undertaken at discrete locations representative of the closest NSRs receptors to the Site;
- A 3-dimensional sound modelling exercise, in order to quantify the potential sound generation of the Proposed Development;
- An assessment of potential sound impacts with respect to the prevailing acoustic conditions at the nearest NSRs; and
- Recommendation of mitigation measures, where necessary, to comply with the requirements of the National Planning Practice Guidance in England: Noise².

¹ British Standard 4142:2014+A1:2019. Method for rating and assessing industrial and commercial sound. BSI.

² 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

National Planning Policy Framework, 2023

The *National Planning Policy Framework* (NPPF)³ sets out the UK 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 180, 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 191 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 191 refers to the Noise Policy Statement for England, which is considered overleaf.

³ Department for Levelling Up, Housing & Communities (DLUHC), December 2023. National Planning Policy Framework. HMSO. London.

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)⁴. 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.

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)⁵, 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.

⁴ Department for Environment, Food and Rural Affairs (DEFRA), 2010. Noise Policy Statement for England. DEFRA.

⁵ 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. Local Policy

The following Local Planning Policy has been identified relevant to noise and pertinent to this assessment:

South East Lincolnshire Local Plan 2011-36

Policy 2: Development Management

“Proposals requiring planning permission for development will be permitted provided that sustainable development considerations are met, specifically in relation to:

6. impact upon neighbouring land uses by reason of noise, odour, disturbance or visual intrusion”

Policy 30: Pollution

“Development proposals will not be permitted where, taking account of any proposed mitigation measures, they would lead to unacceptable adverse impacts upon:

5. noise including vibration

Suitable mitigation measures will be provided, if required. Proposals will be refused if impacts cannot be suitably mitigated or avoided”

Policy 31: Climate Change and Renewable and Low Carbon Energy

“B. Renewable Energy

With the exception of Wind Energy the development of renewable energy facilities, associated infrastructure and the integration of decentralised technologies on existing or proposed structures will be permitted provided, individually, or cumulatively, there would be no significant harm to:

2. residential amenity in respect of: noise, fumes, odour, vibration, shadow flicker, sunlight reflection, broadcast interference, traffic”

2.3. Assessment Criteria

BS 4142:2014+A1:2019

BS 4142:2014+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 BS 4142:2014+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.

BS 4142:2014+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.

Relative Change in Ambient Noise Level

The IEMA Guidelines⁶ 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.

⁶ 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 at Fendyke Farm off Old Fendyke, Sutton St James.

The Site is surrounded by agricultural land. The ambient sound environment at the area is primarily influenced by road traffic noise from the surrounding roads and noise from vegetation and wildlife.

The location of the Site and surrounding area with reference to the nearest NSRs can be seen below in Figure 1.

FIGURE 1: PROPOSED DEVELOPMENT SITE, SURROUNDING AREA AND NSRs



4. BASELINE SOUND SURVEY

4.1. Overview

The prevailing acoustic conditions in the area have been determined by an environmental sound survey conducted during both daytime and night-time periods between Thursday 23rd June 2024 and Thursday 30th June 2024.

Background sound levels were measured at three locations (MP1-MP3), considered to be representative of the acoustic environment at the nearest NSRs.

4.2. Measurement Details

All sound measurements were undertaken by a consultant certified as competent in environmental sound monitoring, and, in accordance with the principles of British Standard 7445:2003 '*Description and measurement of environmental noise*'⁷.

All sound measurement equipment used during the survey conformed to Type 1 specification of British Standard 61672:2013 '*Electroacoustics. Sound level meters*'⁸. A full inventory of this equipment is shown in Table 3 below.

TABLE 3: INVENTORY OF SOUND MEASUREMENT EQUIPMENT

Position	Make, Model & Description	Serial Number	Calibration Certificate Number	Calibration Due Date
MP1	Brüel & Kjær 2238 Sound Level Meter	2756961	1137607	19/12/2024
	Brüel & Kjær ZC 0030 Preamplifier	-		
	Brüel & Kjær 4188 Microphone	2407240		
MP2	Brüel & Kjær 2238 Sound Level Meter	2328256	1157793	14/02/2026
	Brüel & Kjær ZC 0030 Preamplifier	-		
	Brüel & Kjær 4188 Microphone	171603		
MP3	Brüel & Kjær 2238 Sound Level Meter	2812839	1138715	17/01/2025
	Brüel & Kjær ZC 0030 Preamplifier	-		
	Brüel & Kjær 4188 Microphone	1794946		
All	Rion NC-74 Acoustic Calibrator	34984020	1131148	10/08/2024

⁷ British Standard 7445: 2003: Description and measurement of environmental noise. BSI

⁸ British Standard 61672: 2013: Electroacoustics. Sound level meters. Part 1 Specifications. BSI.

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 meters.

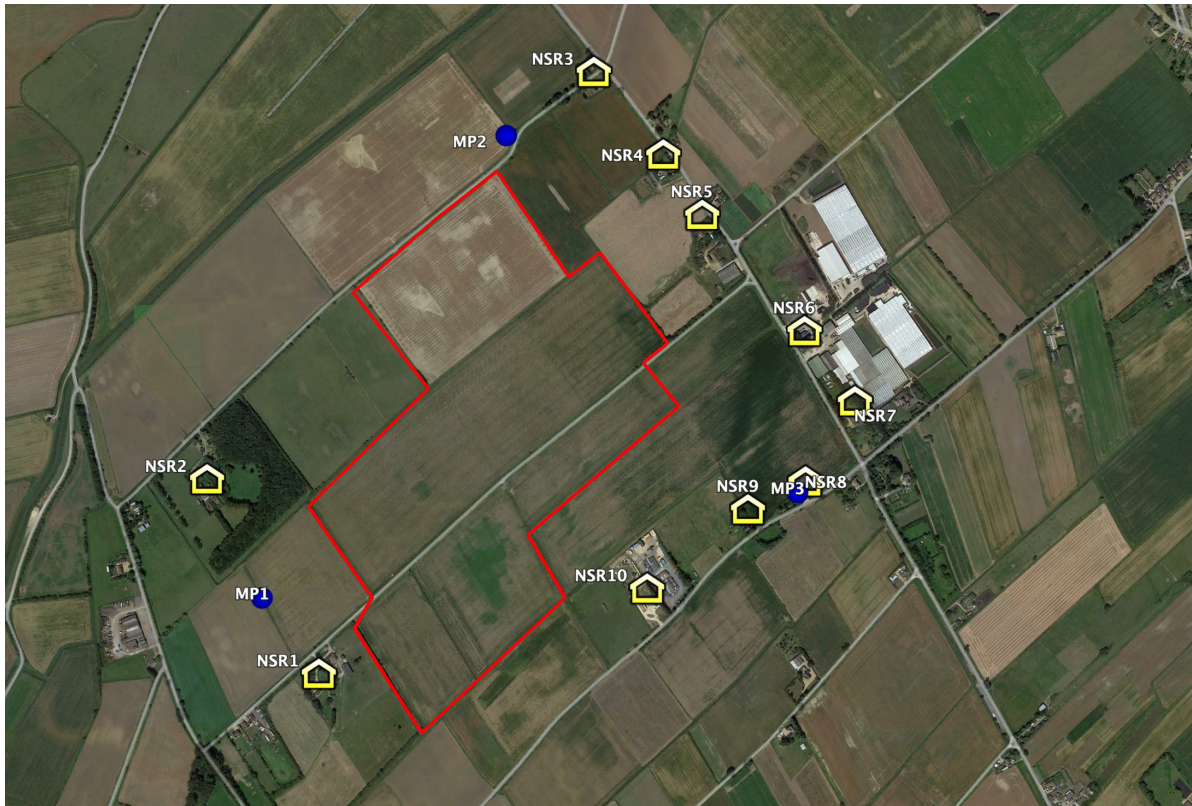
The weather conditions during the survey were conducive to environmental sound measurement; it being predominantly dry, with low wind speeds ($<5\text{ms}^{-1}$). When periods of inclement weather occurred, they have been removed from the dataset used to derive the typical ambient and background sound levels. The microphones were fitted with protective windshields for the measurements.

The measurement positions are described in Table 4, with an aerial photograph indicating their locations shown in Figure 3.

TABLE 4: MEASUREMENT POSITION DESCRIPTIONS

Measurement Position	Measurement Description
MP1	Largely unattended daytime and night-time measurement of sound under free-field conditions, at a height of 1.5 metres above local ground level, located to the west of the Site boundary. The sound environment at this location was influenced by intermittent road traffic noise from New Fen Dyke Road. This position was opposite a working deer farm; however, no associated sound was audible during deployment and collection of the equipment. This measurement position is considered representative of NSR1 and NSR2.
MP2	Largely unattended daytime and night-time measurement of sound under free-field conditions, at a height of 1.5 metres above local ground level, located to the north of the Site boundary. The sound environment at this location was influenced by wildlife noise as this was a quiet area. Very little road traffic noise was audible. This measurement position is considered representative of NSR3, NSR4 and NSR5.
MP3	Largely unattended daytime and night-time measurement of sound under free-field conditions, at a height of 1.5 metres above local ground level, located to the east of the Site boundary. The sound environment at this location was influenced by infrequent, intermittent road traffic noise. General wildlife and birdsong were also audible. This measurement position is considered representative of NSR6, NSR7, NSR8 and NSR9.

FIGURE 3: MEASUREMENT POSITIONS



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 and the typical Maximum Sound Pressure Level, L_{AFmax} . An explanation of the sound units presented is given in Appendix A.

For clarity, it is noted that the background sound level ($L_{A90,T}$) is an underlying level of sound over a period, T , and might in part be an indication of relative quietness at a given location. It does not reflect the occurrence of transient and/or higher sound level events and is generally governed by continuous or semi-continuous sounds.

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: SUMMARY OF SOUND MEASUREMENT RESULTS

Measurement Position	Period	L _{Aeq,T} (dB)	L _{AF90,T} (dB)	L _{AFmax} (dB)
MP1	Daytime (07:00-23:00)	50	30	72
	Night-time (23:00-07:00)	43	25	65
MP2	Daytime (07:00-23:00)	48	28	65
	Night-time (23:00-07:00)	40	25	60
MP3	Daytime (07:00-23:00)	51	34	69
	Night-time (23:00-07:00)	43	26	62

5. OPERATIONAL SOUND ASSESSMENT

5.1. Sound Propagation Modelling

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 sound levels to be achieved by scheme design. The sound generated by the tracking motors for the individual panels has not been incorporated into the model, as it is deemed to be negligible.

TABLE 6: SOUND SOURCE DATA

Plant	Quantity	Sound Power Level per unit, L_{WA} (dB)* - Daytime	Sound Power Level per unit, L_{WA} (dB)* - Night-time
Solar Inverter	5	88	84
Auxiliary Transformer	1	71	71
BESS Compound Battery Cooling System	6	76	76
BESS Compound Inverter	3	88	84
BESS Compound Transformer	2	71	71

** Some suppliers provide their data in terms of Sound Pressure Level (SPL) at a given distance rather than Sound Power Level (SWL/Lw). However, SPL depends on i) the environment the measurements are taken in, ii) the dimensions and shape of the plant and iii) the distance from the source to the measurement position, etc. SWL is a more objective metric for noise assessments, as it represents the total sound energy radiated by a sound source and can therefore being used in the noise modelling to predict the SPL at any distance, under various environmental conditions. Thus, our noise specifications are provided primarily as derived SWL to enable a transparent and robust comparison between different suppliers.*

Confirmation from the selected plant manufacturers that the above sound levels can be achieved should always be sought prior to plant procurement.

It is noted that some cooling systems may perform at lower duty during the night, when ambient temperature is lower, if provided with variable fan speed. This assessment assumes that the inverter units operate a nominal fan speed during the daytime period and 60% fan duty during the night-time.

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.

Calculation Process

Calculations were carried out using Cadna/A, which undertakes its calculations in accordance with guidance given in ISO9613⁹, which considers a worst-case downwind propagation to all NSRs.

Modelling Data Assumptions

Given that the land between proposed development and nearest NSRs 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, although this is an unlikely occurrence as all of the units are independent of each other and usually operate as per demand and for a short period of time.

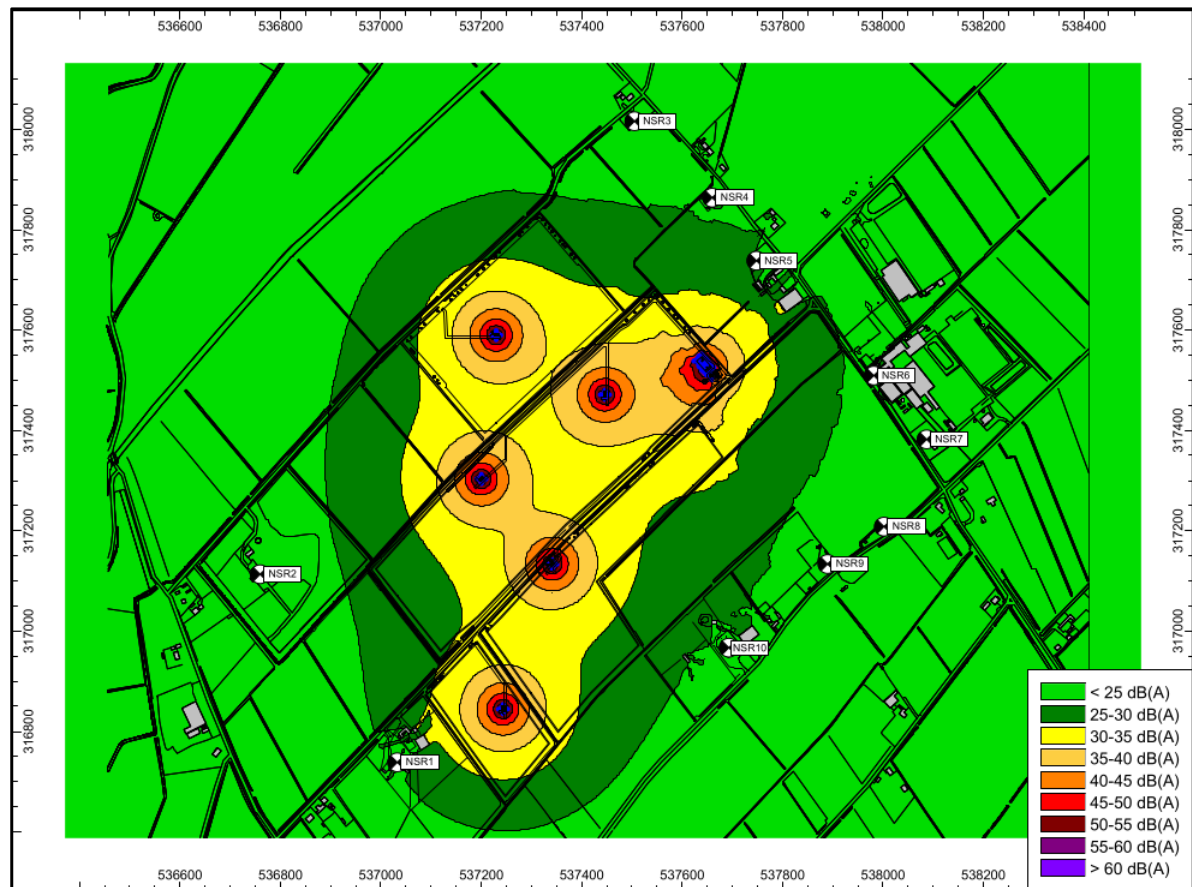
In order to accurately model the land surrounding the development, an AutoCAD DXF drawing was produced, which was based on data provided by the Ordnance Survey, along with associated LIDAR Composite DTM topographic contours sourced from the Defra Data Services Platform.

⁹ *ISO 9613-1:1993 and ISO 9613-2:1996: Acoustics - Attenuation of sound during propagation outdoors. Part 1: Calculation of the absorption of sound by the atmosphere and Part 2: General method of calculation*

Specific Sound Level Maps

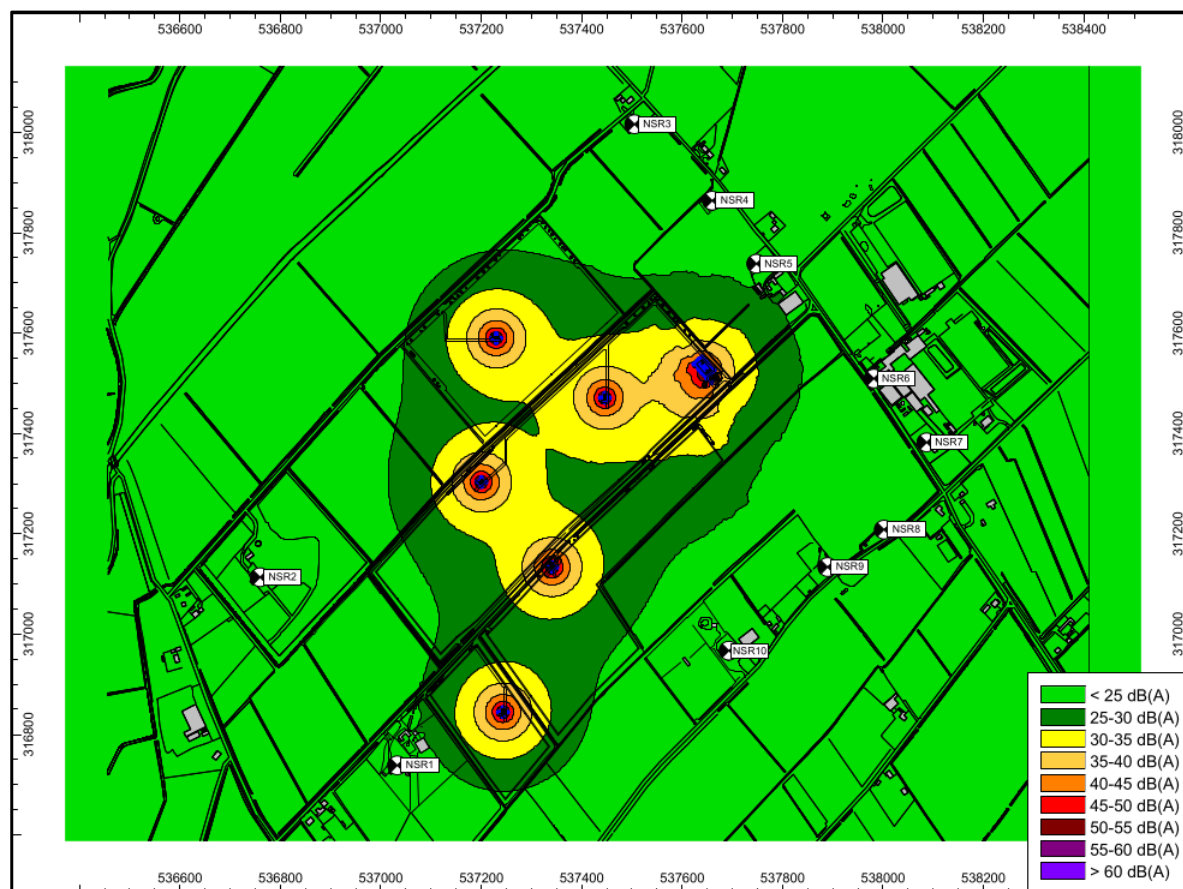
The sound map at 4m above ground, showing the specific sound level emissions from the Proposed Development during the daytime period can be seen in Figure 5.

FIGURE 5: SPECIFIC SOUND LEVEL MAP - DAYTIME



The sound map at 4m above ground, showing the specific sound level emissions from the Proposed Development during the night-time period can be seen in Figure 6.

FIGURE 6: SPECIFIC SOUND LEVEL MAP – NIGHT-TIME



Specific Sound Level Summary

A summary of the predicted specific sound levels at the closest NSRs during the daytime period, based on the sound map shown in Figure 5 can be seen below in Table 7.

TABLE 7: PREDICTED SPECIFIC SOUND LEVEL SUMMARY - DAYTIME

Receptors	Specific Sound Level (dB)
NSR1	26
NSR2	22
NSR3	21
NSR4	22
NSR5	26
NSR6	23
NSR7	21
NSR8	22
NSR9	23
NSR10	24

A summary of the predicted specific sound levels at the closest NSRs during the night-time period, based on the sound map shown in Figure 6 can be seen below in Table 8.

TABLE 8: PREDICTED SPECIFIC SOUND LEVEL SUMMARY - NIGHT-TIME

Receptors	Specific Sound Level (dB)
NSR1	23
NSR2	18
NSR3	18
NSR4	18
NSR5	23
NSR6	21
NSR7	18
NSR8	19
NSR9	20
NSR10	21

5.2. Assessment

Rating Penalty Principle

Section 9 of BS 4142:2014+A1:2019 describes how the rating sound level should be derived from the specific sound level, by determining a rating penalty. BS 4142:2014+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 BS 4142:2014+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.”

BS 4142:2014+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

BS 4142:2014+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

BS 4142:2014+A1:2019 states that where *“the specific sound features characteristics that are neither tonal nor impulsive, though otherwise are readily distinctive against the residual acoustic environment, a penalty of +3 dB can be applied.”*

Rating Penalty Assessment

Considering the content of Section O, 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 9 below.

TABLE 9: RATING PENALTY ASSESSMENT

Sound Characteristic	Penalty	Discussion
Tonality	0 dB	The primary source of sound generation from Solar PV projects is the fans serving the inverters and battery cooling systems, that typically generate aerodynamic broadband sound, which should be achieved by design. As such no rating penalty correction should be applied for Tonality.
Impulsivity	0 dB	Inverters and battery cooling systems operate continuously without the audibility or prominence of sudden sounds. As such, no rating penalty correction should be applied for Impulsivity.
Intermittency	0 dB	Inverters and battery cooling systems operate continuously for longer than 100% of the BS 4142 reference time interval (1 hour during the day and 15 minutes during the night). The cooling system will then gradually switch off during the cool down period. As clarified by the Association of Noise Consultants (ANC) Technical Note on BS 4142:2014+A1:2019, dated March 2020, if a source is considered to be ON for 100% of the reference time interval, an Intermittency correction should not, therefore, be applied.
Other Sound Characteristics	0 dB	Solar PV and BESS systems do not have acoustic features present such as a whine, hiss, screech, non-tonal hum, rattle or rasp that can attract attention. By its electrical nature, HV Transformers will typically emit a distinct 100Hz tone at source that can be identified as a ‘hum’. However, the sound from the transformers is much lower than from the cumulative sound of all inverters and batteries themselves. As such, no rating penalty correction should be applied for ‘Other Sound Characteristics’.

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

Uncertainty

BS 4142:2014+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

BS 4142:2014+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 10 below.

TABLE 10: 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 positions representative of the closest affected receptors to the Site has enabled the determination of robust background sound levels.
g)	0 dB	Measurement time intervals were set in accordance with BS 4142:2014+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)	0 dB	No periods of significant wind or precipitation were noted.
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, no uncertainty budget has been considered in the assessment, to account for measurement uncertainty.

Calculation Uncertainty

BS 4142:2014+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 11 below.

TABLE 11: CALCULATION UNCERTAINTY FACTORS

Calculation Uncertainty Factor Reference	Level of Uncertainty	Discussion
b)	0 dB	Sound source levels are based on robust candidate plant data, to be achieved by the design.
c)	0 dB	Calculations were undertaken in accordance with ISO 9613-2, which is considered a “ <i>validated method</i> ” by BS 4142:2014+A1:2019.
d)	0 dB	The real situation has not been simplified for the purposes of this assessment.
e)	±2 dB	ISO 9613-2 indicates that there is a ±3 dB accuracy to the prediction method, therefore, an uncertainty factor of ±2 dB is considered appropriate and proportional, given the separation distances involved.

In summary, an uncertainty budget of ±2 dB has been considered in the assessment, to account for calculation uncertainty.

The overall uncertainty is considered to be sufficiently 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.

BS 4142:2014+A1:2019 Assessment

The rating level, as calculated from the predicted specific sound level, has been assessed in accordance with BS 4142:2014+A1:2019, at the closest NSRs, and can be seen in Table 12 and Table 13 for the daytime and night-time respectively.

TABLE 12: BS 4142:2014+A1:2019 ASSESSMENT – DAYTIME (07:00-23:00)

Receptors	Specific Sound Level (dB)	Rating Penalty (dB)	Rating Sound Level (dB)	Daytime Background Sound Level (dB)	Excess of Rating over Background Sound Level (dB)
NSR1	26	0	26	30	-4
NSR2	22	0	22	30	-8
NSR3	21	0	21	28	-7
NSR4	22	0	22	28	-6
NSR5	26	0	26	28	-2
NSR6	23	0	23	34	-11
NSR7	21	0	21	34	-13
NSR8	22	0	22	34	-12
NSR9	23	0	23	34	-11
NSR10	24	0	24	34	-10

TABLE 13: BS 4142:2014+A1:2019 ASSESSMENT – NIGHT-TIME (23:00-07:00)

Receptors	Specific Sound Level (dB)	Rating Penalty (dB)	Rating Sound Level (dB)	Night-time Background Sound Level (dB)	Excess of Rating over Background Sound Level (dB)
NSR1	23	0	23	25	-2
NSR2	18	0	18	25	-7
NSR3	18	0	18	25	-7
NSR4	18	0	18	25	-7
NSR5	23	0	23	25	-2
NSR6	21	0	21	26	-5
NSR7	18	0	18	26	-8
NSR8	19	0	19	26	-7
NSR9	20	0	20	26	-6
NSR10	21	0	21	26	-5

It can be seen that the Proposed Development is predicted to have rating levels that do not exceed the prevailing background sound level at the nearest NSRs, which in BS 4142:2014+A1:2019 terms represent a 'Low Impact', depending on the context, which is discussed below.

Discussion on Context

The results set out in Table 12 and Table 13 identify that the operation of the scheme, as proposed, can occur without affecting the amenity of the closest NSRs to the site during the daytime and night-time on the basis of a worst-case operational scenario.

BS 4142:2014+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, with all batteries charging/discharging at the same time and downwind noise propagation to all NSRs. At night, when cooling demand is lower, inverters and battery unit fans may operate at lower duty if the system is provided with variable fan speed. Reduced duty during the night-time has been considered for the inverter units only.

In addition to this, BS 4142:2014+A1:2019 states that '*for a given difference between the rating level and the background sound level, the magnitude of the overall impact might be greater for an acoustic environment where the residual sound level is high than for an acoustic environment where the residual sound level is low*'. It follows on to say that '*where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night*'.

In this case, both background sound levels and rating levels are low at the assessment locations. The predicted specific levels presented in Table 7 and Table 8 demonstrate that indoor ambient noise levels would be well below the BS 8233:2014 criteria of 30 dB(A) for bedrooms at night, when considering a 10-15 dB sound reduction for a partially open window for ventilation. This ensures that the internal amenity of the closest NSRs would not be compromised by noise.

On this basis, there is no adverse or significant impact and the Proposed Development is therefore, in accordance with the relevant National and Local Planning Policies.

6. CONCLUSION

inacoustic has been commissioned to assess the potential impact of sound associated with the proposed installation and operation of a grid connected solar farm on land at Fendyke Farm off Old Fendyke, Sutton St James.

This assessment details the existing background sound climate at the nearest NSRs, as well as the potential sound emissions associated with the Proposed Development, and has been produced to accompany the Planning Application to South Holland District Council.

The assessment methodology contained in BS 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 levels that are below the measured background sound level in the area, thus giving rise to a 'Low Impact'.

Consequently, the assessment demonstrates that the Proposed Development will give rise to noise impacts that would be categorised as *No Observed Adverse Effect Level (NOAEL)* within the PPGNoise 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, National and Local 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 sound, 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 14: 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 sound levels would result in an increase of 3 dB(A) in the sound level from a single source.

A change of 3 dB(A) is generally regarded as the smallest change in broadband continuous sound 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 sound represents a subjective doubling of loudness.

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

For levels of sound 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, road 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 sound level in the absence of discrete events. An alternative way of assessing the time varying sound 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 sound measurement should be specified. For example, BS 4142:2014+A1:2019 specifies background sound measurement periods of 1 hour during the daytime and 15 minutes during the night-time. The sound levels are commonly symbolised as $L_{A90,1\text{hour}}$ dB and $L_{A90,15\text{mins}}$ dB. The sound measurement should be recorded using a 'FAST' time response equivalent to 0.125 ms.

7.2. Appendix B – Sound Measurement Results

FIGURE 7: MEASURED TIME HISTORY – MP1

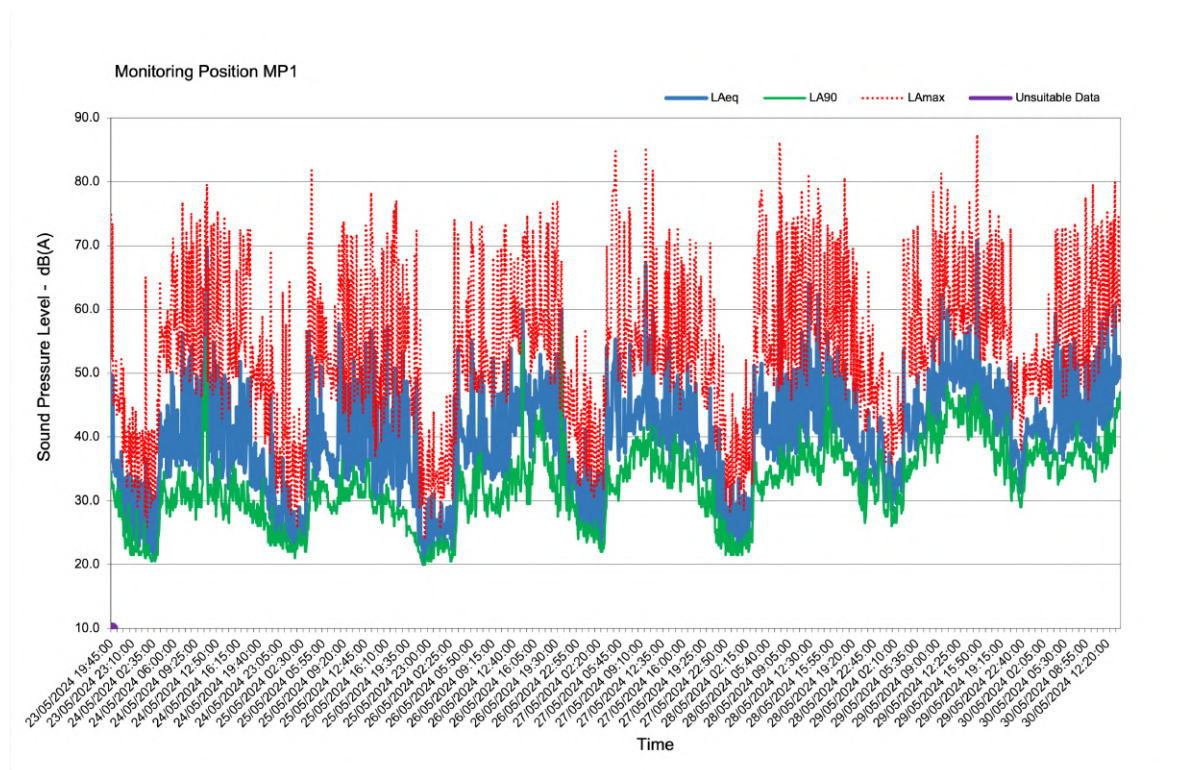


FIGURE 8: MEASURED TIME HISTORY – MP2

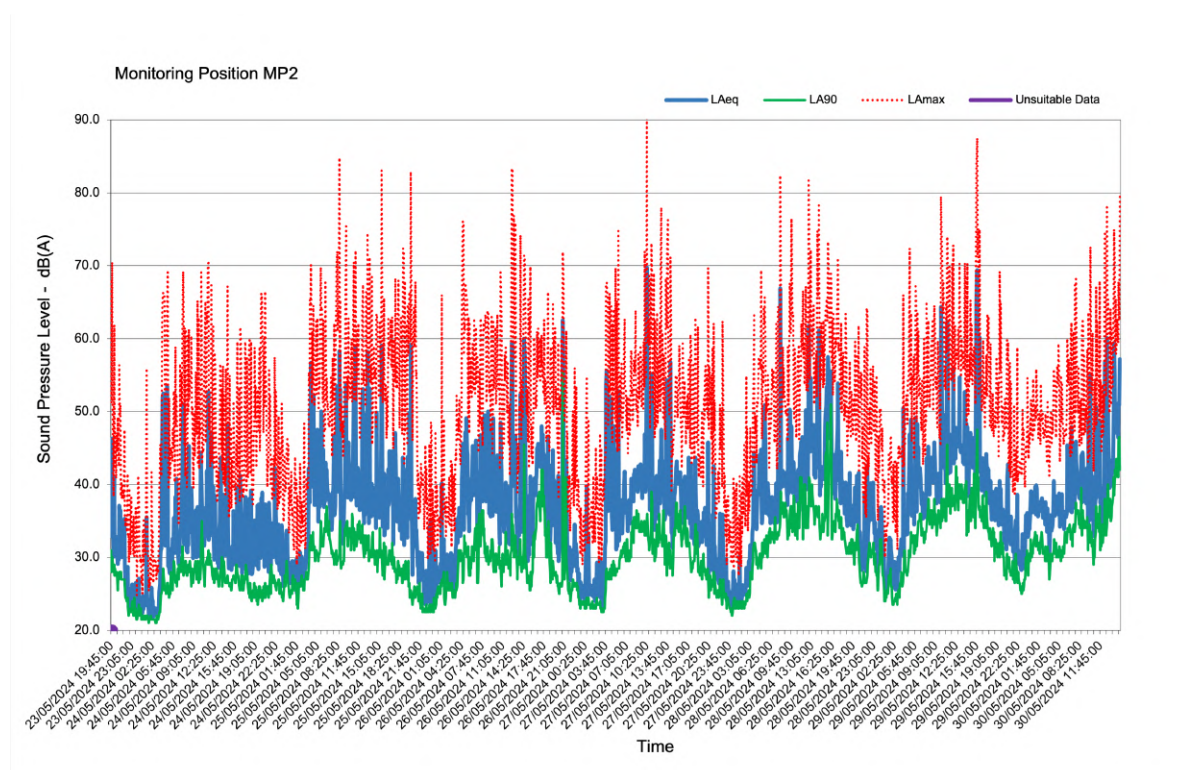
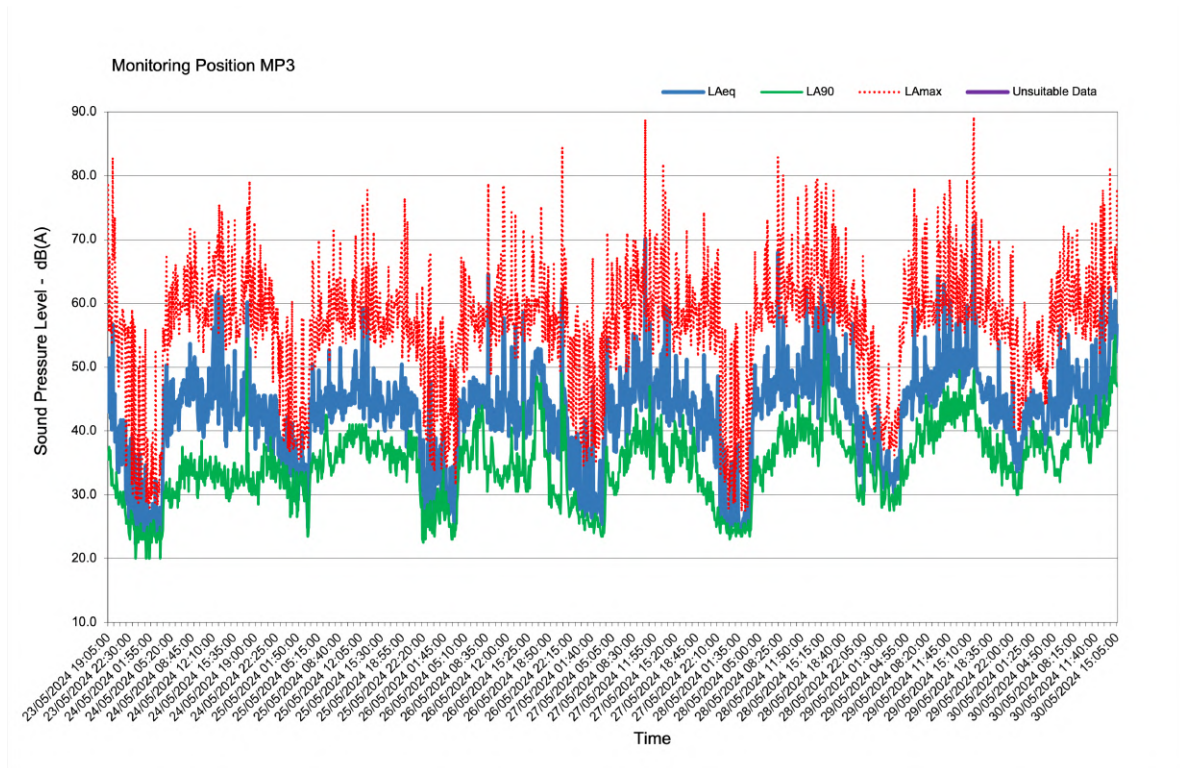


FIGURE 9: MEASURED TIME HISTORY – MP3



7.3. Appendix C – Statistical Analysis

FIGURE 10: STATISTICAL ANALYSIS OF L_{A90} BACKGROUND – DAYTIME – MP1

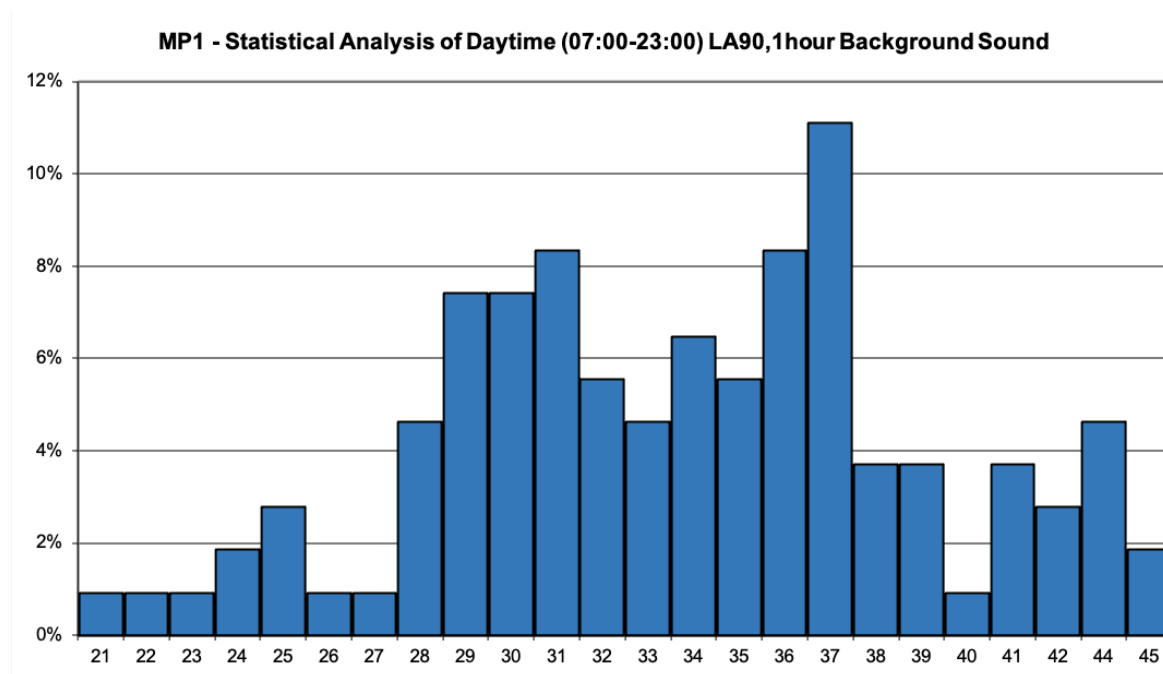


FIGURE 11: STATISTICAL ANALYSIS OF L_{A90} BACKGROUND – NIGHT-TIME – MP1

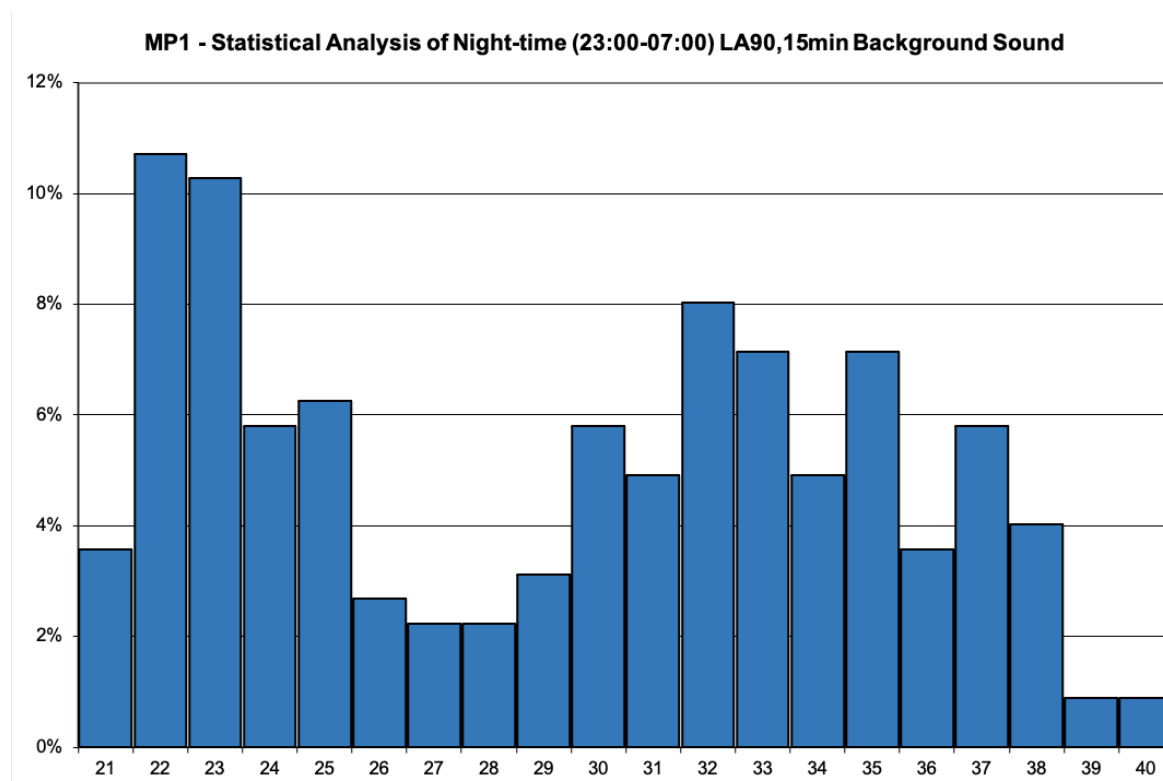


FIGURE 12: STATISTICAL ANALYSIS OF L_{A90} BACKGROUND – DAYTIME – MP2

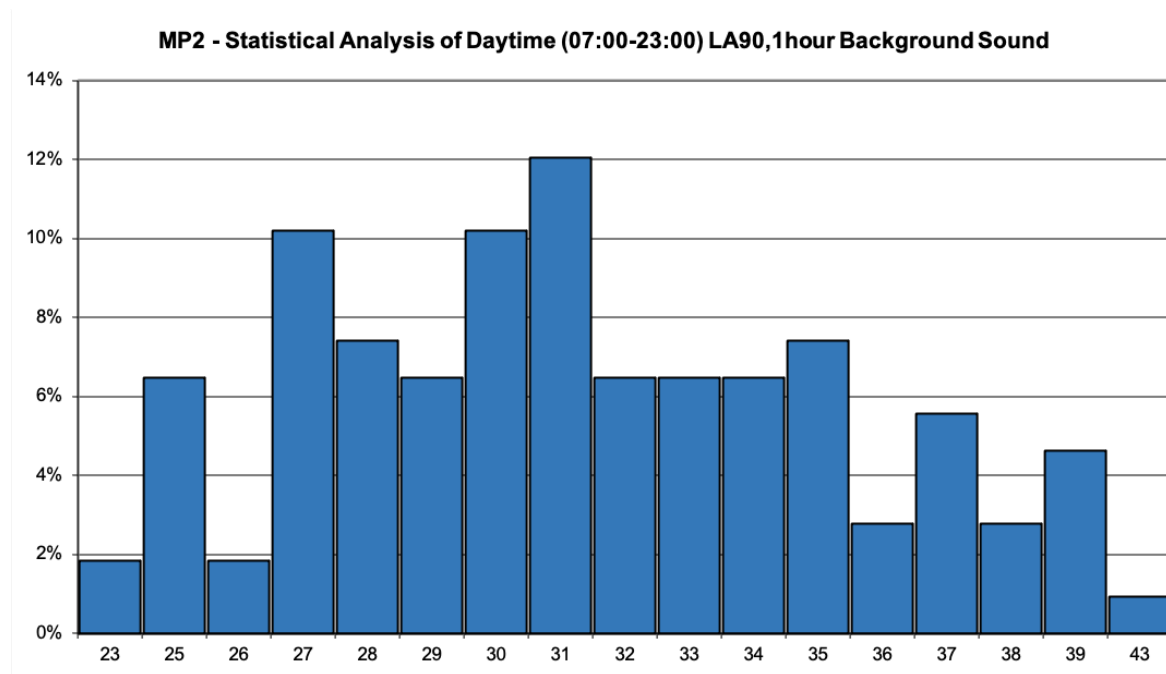


FIGURE 13: STATISTICAL ANALYSIS OF L_{A90} BACKGROUND – NIGHT-TIME – MP2

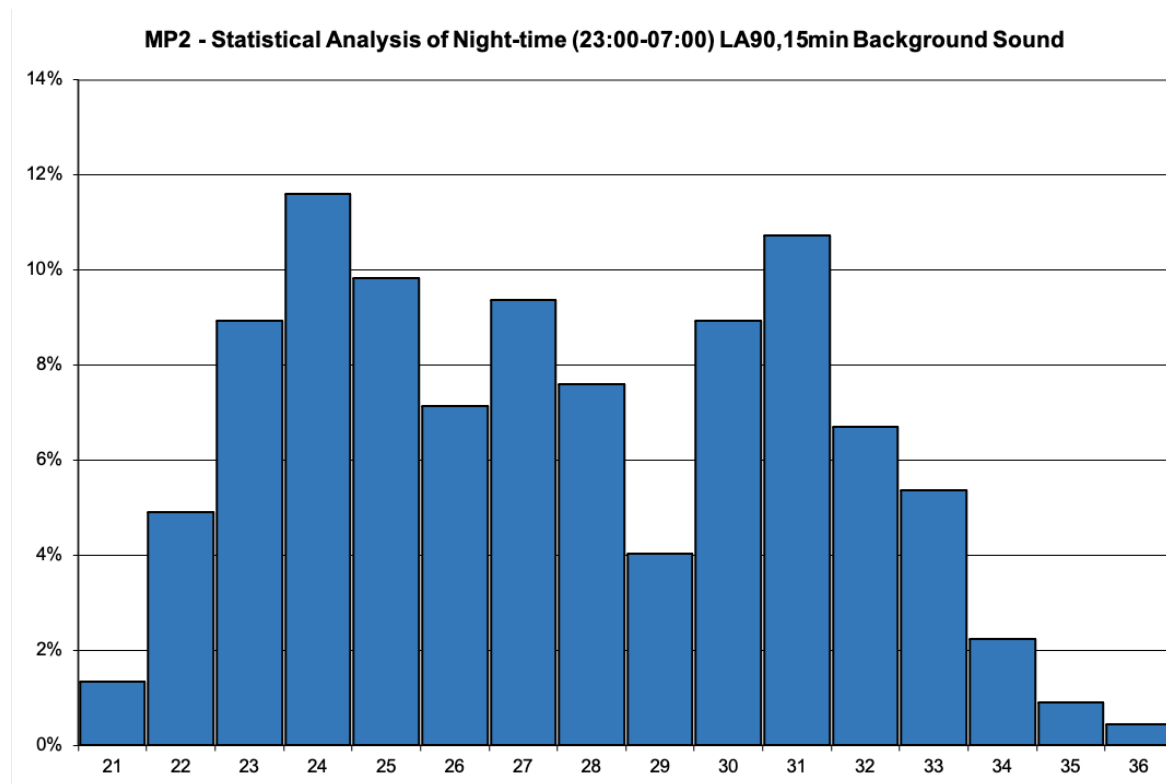


FIGURE 14: STATISTICAL ANALYSIS OF L_{A90} BACKGROUND – DAYTIME – MP3

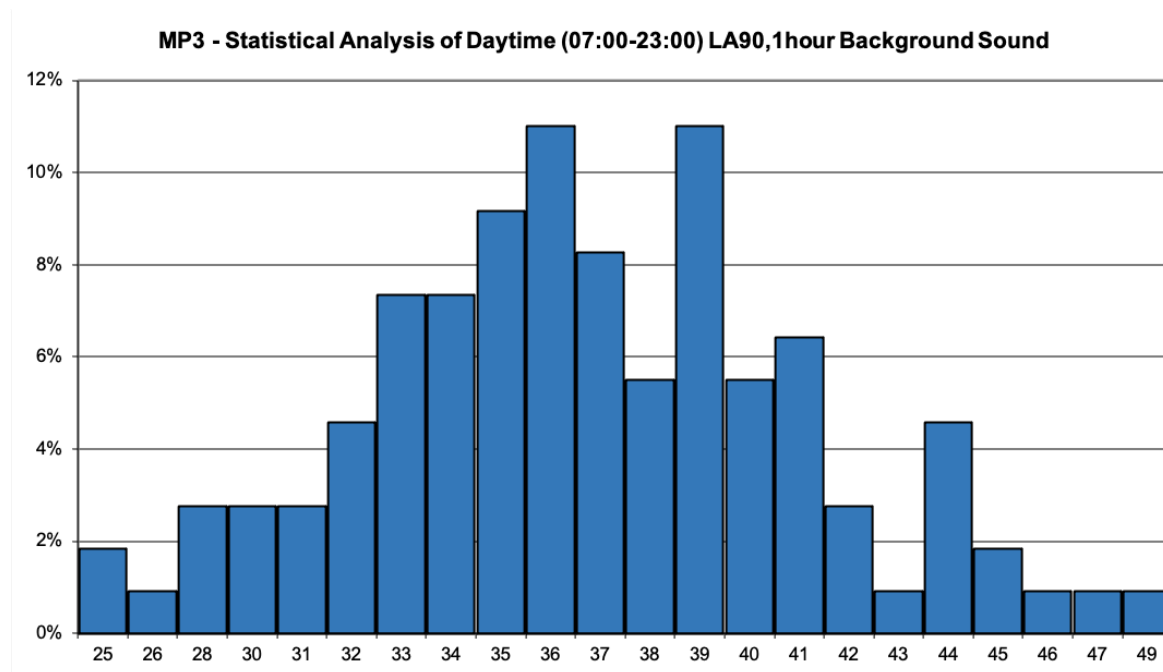
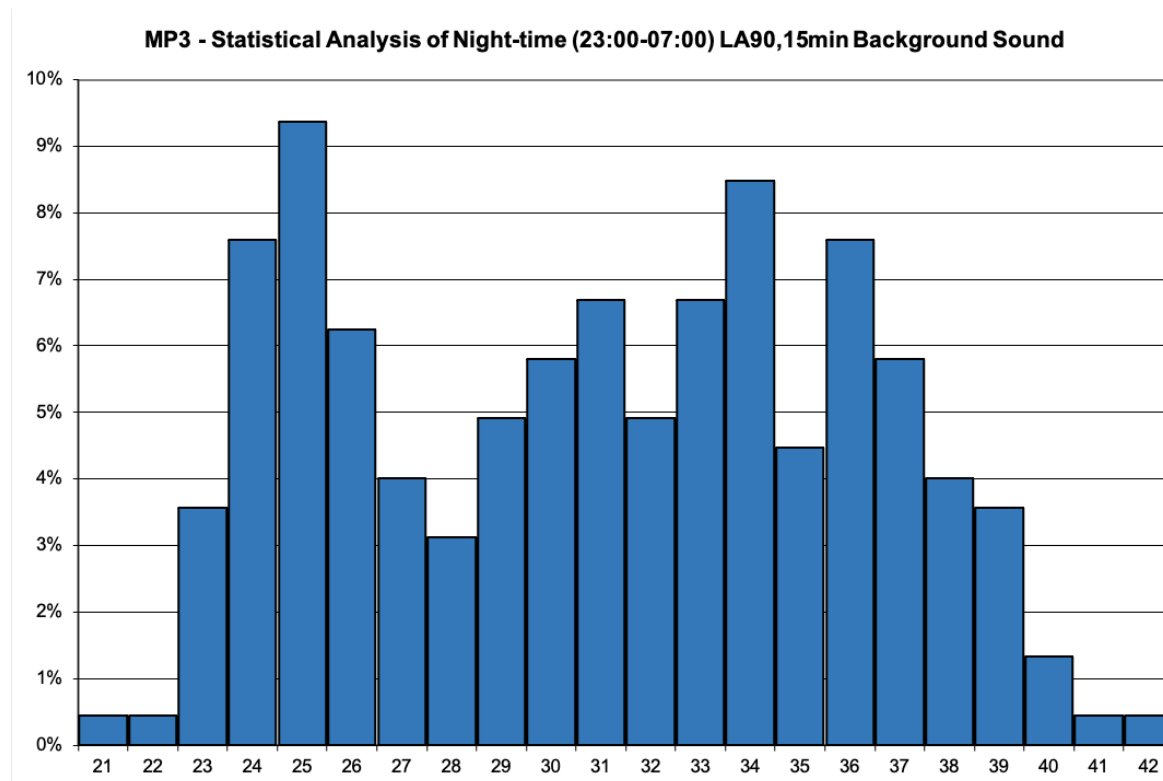


FIGURE 15: STATISTICAL ANALYSIS OF L_{A90} BACKGROUND – NIGHT-TIME – MP3



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