A specialist energy consultancy

Noise Impact Assessment

Neilston Greener Grid Park
Section 36 Application

Statkraft UK Limited

15957-019-R0
20 August 2024

COMMERCIAL IN CONFIDENCE

Statkraft

Quality Assurance

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Document Control

Revision	Status	Prepared by	Checked by	Approved by	Date
D1	DRAFT	JS	RL	RL	21/06/2024
D2	DRAFT	JS	RL	RL	03/07/2024
R0	FINAL ISSUE	JS	BP	BP	20/08/2024

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1 Introduction

1.1 Overview

TNEI has been commissioned by Statkraft UK Limited (Statkraft) to undertake a Noise Impact Assessment (NIA) to support the Section 36 planning application for a Battery Energy Storage System (BESS) development (the Proposed Development).

The Proposed Development is to be located opposite the existing Neilston National Grid Substation, adjacent to the B775, at approximate Ordnance Survey coordinates 245060, 659853.

Statkraft already have two consents on the development site, both of which are currently under construction. These are for a High Voltage (HV) Yard and a 'Greener Grid Park' (GGP), which contains a 50 MW BESS. TNEI have already undertaken Noise Impact Assessments (NIAs) for both of the developments, including the discharge of operational noise related planning conditions.

The Proposed Development accounts for the Phase 1 works currently under construction on site. This NIA presents the cumulative operational noise levels for the operation of both the consented HV compound and the first 50MW of BESS.

The aims of this NIA are to:

- Identify the dominant sound sources associated with the operation of the Proposed Development;
- Calculate the likely levels of operational noise at the nearest noise sensitive receptors to determine the cumulative noise impacts associated with the operation of the Proposed Development and the already consented developments; and,
- Indicate any requirements for mitigation measures, if required, to provide sufficient levels of protection for nearby receptors.

All work undertaken to produce this report has been carried out by members of the TNEI Environment and Engineering Team, all of whom are affiliated with the Institute of Acoustics (IOA). Specifically, the following members of staff have been involved in the project:

- Ewan Watson – Associate Member Institute of Acoustics (AMIOA), IOA PG Dip Acoustics & Noise Control: **Noise Propagation Modelling**
- Jim Singleton - Member Institute of Acoustics (MIOA), IOA PG Dip Acoustics & Noise Control: **Reporting and Assessment**
- Ryan Llewellyn, MRTPI **Quality Assurance**

1.2 Nomenclature

Please note the following terms and definitions, which are used throughout this report;

- **Emission** refers to the noise level emitted from a noise source, expressed as either a sound power level or a sound pressure level;
- **Immission** refers to the sound pressure level received at a specific location from a noise source;
- **SWL** indicates the sound power level in decibels (dB);
- **SPL** indicates the sound pressure level in decibels (dB);
- **NML** (Noise Monitoring Location) refers to any location where noise levels have been measured;

- **NSRs** (Noise Sensitive Receptors) are all identified receptors which are sensitive to noise; and;
- **NAL** (Noise Assessment Location) refers to any location where the immission levels are calculated and assessed.

In the interests of clarity, a Glossary of Terms is also provided as Appendix A of this report.

All figures referenced within the report can be found in Appendix D.

Unless otherwise stated, all noise levels refer to free field levels i.e. noise levels without influence from any nearby reflective surfaces.

All grid coordinates refer to the Ordnance Survey grid using Eastings and Northings

2 Description of Development

2.1 Summary of Consented and Proposed Development

The consented GGP uses the same red line boundary as the Proposed Development. It includes a 50 MW BESS, which takes up a small amount of the available development space. The 50 MW BESS is currently under construction and was previously consented through Planning Appeal reference PPA-350-2047.

The consented HV Yard consists of a single HV transformer, a small earthing transformer and a small auxiliary transformer. It is located adjacent to the GGP and is also currently under construction and was consented through planning application ref 23/0224/PP.

The Proposed Development is described as follows;

Formation of an up to 750MW Battery Storage Facility, comprising up to 88 battery storage container blocks and associated infrastructure, storage containers, welfare, diesel generators, CCTV and lighting columns and associated access, internal access roads, hard and soft landscaping, SuDS Basin, perimeter fence and underground grid connection cable.

The footprint of the Proposed Development fits within the already consented GGP. The described 750 MW BESS includes the already consented 50 MW BESS that is currently under construction.

2.2 Planning History

2.2.1 Greener Grid Park

The previously consented GGP has the following noise related planning condition (Planning Condition 1);

"Prior to the commencement of development on site, the developer shall submit a noise assessment, including proposed noise limits, for the written approval of the planning authority. The background noise level shall be determined during the most sensitive times of the day/night when the development will be operational. In addition, the LAmax level should not exceed 60 dB during night time periods at the façade of any nearby property. The measurements and assessment should be made in accordance with BS4142:2014+A1:2019 'Methods for rating industrial and commercial sound'. The facility shall thereafter operate in accordance with the noise assessment as approved by the planning authority".

The condition was discharged on 11 August 2023 (ref. 21/0034/PP) through the submission of TNEI NIA report '*15628-47-R1*'[1]. The Summary section of that report is reproduced here;

"In order to discharge Planning Condition 1 of Appeal Decision Notice for PPA-350-2047 for the Neilston Greener Grid Park, TNEI has;

- *Identified the nearest Noise Sensitive Receptor to the Development*
- *Quantified the Background Sound Level at the receptor;*
- *Proposed a set of noise level limits; and,*
- *Produced a Noise Impact Assessment that demonstrates;*

    a) the noise limits will not be exceeded; and,

    b) no adverse noise impacts are anticipated.

[1] 15628-47-R1 *For Discharge of Planning Condition 1 (Noise), Neilston Greener Grid Park*: 31 March 2023

Planning Condition 1 includes a requirement for the Development not to exceed a noise limit of 60 dB LAmax, however, this report presents an explanation as to why that specific noise limit is not appropriate for the consented Development.

With due regard to the above, the proposed noise limits are 41 dB $L_{Aeq(1\ hour)}$ during the daytime and 35 dB $L_{Aeq(15\ mins)}$ during the night-time. These limits to apply externally at the closest residential receptor, namely Sergeant Law Farm.

Accordingly, TNEI consider that the requirements of Condition 1 can now be discharged and request that the Local Planning Authority confirm this in writing to TNEI."

-

The noise level limits detailed above were derived to incorporate some headroom for future development, and in this regard the NIA report stated;

"With due regards to the BS 4142 assessment, including the measured background sound level, the following noise level limits are proposed;

- *During the daytime (07:00 – 23:00) the Rating Level will not exceed 41 dB LAeq(1 hour) externally at Sergeant Law Farm; and,*
- *During the night-time (23:00 – 07:00) the Rating Level will not exceed 36 dB LAeq(15 mins) externally at Sergeant Law Farm.*

This effectively sets a noise limit of 0 dB above the background sound level, which allows some additional headroom (up to 5 dB in a BS 4142 context) should any additional development be proposed in the future. This provides flexibility for any future development, whilst affording the nearest receptor appropriate levels of protection against noise."

Accordingly, this NIA will consider the available headroom that can be allocated to the Proposed Development.

Planning Condition 1 was formally discharged on 11th August 2023, as detailed within the confirmation letter issued by the Council.

2.2.2 High Voltage Yard

An NIA report was submitted as part of the Neilston GGP Cable Route and High Voltage (HV) Yard Minor Planning Application[2]. The predictions indicated that the noise level from the HV yard at the closest receptor to the HV Yard (and the Proposed Development) was 18 dBA. This is significantly below the noise level attributable to the GGP (35 dBA) and as such would not contribute at all to the cumulative noise level at the receptor.[3]

The HV Yard was consented on the 30th of November 2023.

[2] 15628-46-D0 *Environmental Noise Impact Assessment. Neilston GGP Cable Route and High Voltage (HV) Yard Minor Planning Application:* 28 April 2023

[3] Due to the logarithmic nature of the way noise levels add together, when two noise sources have a difference of more than 12 dB, there is no increase in overall noise level. In this case the HV Yard is 17 dB below the Greener Grid Park noise level and as such the HV Yard will not contribute to the cumulative noise level.

2.3 Proposed Development

The Proposed Development adds an additional 700 MW of BESS to the GGP. This would introduce new sound sources to the local area and the primary sound sources considered within the assessment (including the already consented BESS) are as follows:

- Battery Cubes (1772 of);
- Inverter/Medium Voltage Transformer Skids (150 of); and,
- HV Transformers (2 of).

The sound level output of any additional infrastructure e.g. switch gear, control rooms etc. is considered to be insignificant in comparison to the sound sources detailed above. Accordingly, no other items of plant have been considered within the assessment.

2.4 Study Area

Noise Sensitive Receptors (NSRs) are properties that are sensitive to noise and, therefore, require protection from nearby noise sources. The study area for the assessment of environmental noise is usually defined through the identification of the closest NSRs to the development.

Only one NSR (Sergeant Law Farm) has been identified within proximity of the site, approximately 485 m to the south east of the closest sound sources.

The assessment of noise considers the dwelling at Sergeant Law Farm only, on the assumption that if sound levels at the closest receptor are within defined limits, then sound levels at NSRs at greater distances from the Proposed Development should also be within acceptable levels.

Figure 1 (Appendix D) details the study area and the closest NSR considered within the assessment.

3 Assessment Methodology

3.1 Assessment Method

A number of standards and guidelines are available for the assessment of environmental noise from proposed new developments or activities. Typically, assessments are based on a comparison of likely noise levels against either 'context' based limits or a set of fixed limits.

Context based limits are set relative to the existing noise environment and may also consider the characteristics of the noise source(s), whilst fixed limits are usually set regardless of the existing noise environment or type of noise source(s). The NIA report used to discharge Planning Condition 1 of the consented GGP was based on a BS 4142 assessment, which is a context based assessment.

3.1.1 BS 4142:2014+A1:2019

The BS 4142:2014 *'Methods for Rating and Assessing Industrial and Commercial Sound'* [3] form of assessment is based on the predicted or measured levels of an assessed sound source compared to the measured background sound levels without the specific sound source present and uses, *"outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident".*

The assessment is undertaken in two parts; an initial assessment is made by subtracting the measured background sound level from a calculated or measured 'Rating Level'. The second part of the assessment then considers the context in which the Rating Level occurs, which enables the final qualitative assessment to be undertaken.

BS 4142 uses the following definitions:

Ambient Sound: Totally encompassing sound in a given situation at a given time, usually composed of sound from many sources, both near and far. Described using the metric, $L_{Aeq\ (t)}$.

Specific Sound Level: Equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, *Tr*. Described using the metric $L_{Aeq\ (t)}$. Also referred to in this report as the *Immission Level*.

Residual Sound Level: Equivalent continuous A-weighted sound pressure level of the residual sound without the specific sound source(s) present at the assessment location over a given time interval, *T*. Described using the metric $L_{Aeq\ (t)}$.

Background Sound Level: A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval, *T*, measured using time weighting *F* and quoted to the nearest whole number of decibels. Described using the metric $L_{A90\ (t)}$.

Rating Level: The Specific Sound Level adjusted for the characteristics of the sound. The Rating Level is calculated by adding a penalty or penalties (if required) to the Specific Sound Level when the sound source contains audible characteristics such as tonal, impulsive or intermittent components. Described using the metric, $L_{Aeq\ (t)}$.

3.2 Calculation Method

3.2.1 Noise Propagation Model (ISO 9613-2:2024)

To predict the noise immission levels attributable to the Proposed Development a noise propagation model was created using the propriety noise modelling software CadnaA. Within the software, complex models can be produced to simulate the propagation of noise according to a range of international calculation standards.

For this assessment noise propagation was calculated in accordance with ISO9613 '*Acoustics – Attenuation of sound during propagation outdoors* ((ISO), International Organization for Standardization) using the following input parameters;

- Temperature is assumed to be 10°C and relative humidity as 70%;
- A ground attenuation factor of 1 (soft ground) has been used except for specific areas of developed ground (including the Proposed Development area and the existing substation, which have been modelled with a ground attenuation factor of 0 (hard ground); and
- Receiver heights have been set to 4 m.

3.2.2 Uncertainties and Limitations

The noise propagation model is designed to give a good approximation of the specific sound level and the contribution of each individual sound source; however, it is expected that measured levels are unlikely to be matched exactly with modelled values and the following limitations in the model should be considered:

- In accordance with ISO 9613, all assessment locations are modelled as downwind of all sound sources and propagation calculations are based on a moderate ground-based temperature inversion, such as commonly occurs at night. These conditions are favourable to noise propagation;
- The predicted barrier attenuation provided by local topography, embankments, walls, buildings, and other structures in the intervening ground between source and receiver can only be approximated and not all barrier attenuation will have been accounted for; and,
- The model assumes all sound sources are operating continuously, simultaneously and at maximum noise output.

Due to the limitations detailed above it should be noted that predicted noise levels are likely to be slightly higher than actual noise levels for the majority of the time.

4 Baseline Sound Level Monitoring

In order to inform the BS 4142 assessment to discharge the GGP planning conditions, a baseline sound level survey was undertaken at Sergeant Law Farm between the 18th and 25th of January 2023. Full details of the survey are included in that report (TNEI 15628-47-R1), however, relevant extracts (noise data, analysis charts, calibration certificates etc.) are included within Appendix B of this report for ease.

Error! Reference source not found. details the representative background sound level $L_{A90\ (15mins)}$, which was determined after considering the distribution of data for each measurement period (07:00-23:00 daytime and 23:00-07:00 night-time).

Table 4-1: Representative Background Sound Level, dB LA90, Derived Through Statistical Analysis

NML	Daytime $LA90_{(15mins)}$	Night-time $LA90_{(15mins)}$
NML01	41	36

5 Operational Noise Impacts

5.1 Modelling of Individual Sound Sources

The noise model considers the sound sources detailed within Section 2. The following paragraphs describe how each sound source has been incorporated into the noise model.

All sound sources are assumed to be operating continually and with a constant sound level output.

5.1.1 Fluence Battery Cubes

The model assumes that 1772 Fluence battery cubes will be installed. The cubes will be arranged in 'cores', typically as 2 rows of 5 units (10 cubes per core).

The client has provided a noise measurement report for the BESS cubes. An extract of the report detailing measured octave band, C-weighted, sound pressure levels (SPL) is included in Appendix C.

A number of measurement positions are reported, and the SPL measured at a distance of 9-feet (measurement position SD.F.9) has been used within the noise model. The equivalent octave-band A-weighted Sound Power Level (SWL) is detailed in **Error! Reference source not found.**.

Table 5-1: Octave Band, SWL dBA used to model the Fluence BESS Cubes

Frequency (Hz)									dBA
31.5	63	125	250	500	1000	2000	4000	8000	
46	50	73	71	72	76	75	76	68	82

5.1.2 Inverter/Transformer Units

Pairs of Cores will be connected into a single inverter/transformer unit, known as a Power Conversion System (PCS). The noise model considers 150 of, SMA SC4600-UP PCS units. TNEI hold data for multiple variants of this unit but for the purpose of this assessment, noise level data has been used for a 4600 kVA 2350 V DC UON Modulation Trafotek Coil unit operating at 100% fan load and without a silencer fitted. This represents the loudest of the models available, however, the actual unit that is installed may have a lower noise output.

The noise data has been provided to TNEI from SMA under a Non-Disclosure Agreement and as such the spectral data cannot be provided in this report, however, we can report that the broadband SWL is modelled at 94.3 dB(A). TNEI would be happy to discuss this data in more detail with the Local Planning Authority, if required.

5.2 Calculated Immission Levels

Noise immission levels have been calculated at a Noise Assessment location (NAL) set on the side of the residential property facing the Proposed Development. The NAL is detailed in Table 5-2 and shown on Figure 2 in Appendix D.

Table 5-2: Noise Assessment Location

Noise Assessment Location			
NAL ID	**NAL Descriptor**	**Eastings**	**Northings**
NAL01	Sergeant Law Farm	24516	65931

The immission level (Specific Sound Level) is calculated assuming all plant is operating continuously and concurrently at maximum operating capacities. The level is detailed in Table 5-3 as dB $L_{Aeq(t)}$. No time period (*t*) is specified as the model assumes that noise levels would not fluctuate and would remain the same for both daytime and night-time periods.

A contour plot detailing the noise propagation from the proposed development is included as Figure 2 in Appendix D.

Table 5-3: Predicted Immission Levels (Specific Sound Level), dB $L_{Aeq(t)}$

Noise Assessment Location	Specific Sound Level
NAL ID	**dB $LA_{eq(t)}$**
NAL01	39

6 Noise Impact Assessment

6.1 Qualitative Assessment

BS 4142 describes a qualitative assessment methodology, which considers the predicted immission levels, the character of the sound, the existing sound environment, and the context of the development.

To assess the immission levels in accordance with BS 4142, the Specific Sound Level must be converted into a Rating Level. The Rating Level allows for character corrections to be added to account for particular characteristics of the sound that may be perceived as more annoying. In particular the Rating Level considers tonality, impulsivity and intermittency of the sound, as well other sound characteristics that are neither tonal, impulsive, or intermittent, but are otherwise readily distinctive against the residual acoustic environment.

6.1.1 Tonality

With regards to tonality, BS 4142 states:

"For sound ranging from not tonal to prominently tonal the Joint Nordic Method gives a correction of between 0 dB and +6 dB for tonality. Subjectively, this can be converted to a penalty of 2 dB for a tone which is just perceptible at the noise receptor, 4 dB where it is clearly perceptible and 6 dB where it is highly perceptible."

Consideration of the predicted one third octave levels at the closest receptors indicates that tonality may be present in the 630 Hz 1/3 octave band, which is generated from the operation of the BESS cube cooling systems. It should be noted, however, that the noise model assumes all cubes will be operating with maximum cooling at all times, whereas in reality not all cubes will function concurrently and not all cube cooling systems will be operating at 100% capacity.

With due regard to the predicted levels and considering these in context with the likely operating scenarios and the existing baseline noise levels, it is expected that tonality may be "just perceptible" at the receptor some of the time. As such, a tonal character correction of +2 dB has been applied.

6.1.2 Impulsivity

With regards to impulsivity, BS4142 states:

"A correction of up to +9dB can be applied for sound that is highly impulsive, considering both the rapidity of the change in sound level and the overall change in sound level. Subjectively this can be converted to a penalty of 3dB for impulsivity which is just perceptible at the noise receptor, 6dB where it is clearly perceptible, and 9dB where it is highly perceptible."

Impulsivity is not considered to be a relevant sound characteristic of a BESS as when operational, the noise level will be predictable and consistent.

6.1.3 Intermittency

The intermittency of the sound source needs to be considered when it has identifiable on/off conditions. With regards to intermittency, BS4142 states:

"If the intermittency is readily distinctive against the residual acoustic environment, a penalty of 3 dB can be applied."

As with impulsivity, intermittency is not considered to be a relevant sound characteristic in this case. Once operational, noise levels may fluctuate by a small amount over long periods of time, but no step changes in noise level are anticipated.

6.1.4 Calculation of the Rating Level

With due regard to the above, a 2dB character correction is required. Therefore, the BS 4142 Rating Level at NAL01 is 41 dBA i.e. the Specific Sound Level +2 dB.

6.1.5 Assessment of the Impacts

Section 11 of BS 4142 requires that the assessment considers the context in which the sound occurs, and as such there is no definitive pass/fail element to the standard. However, as a starting point the standard states:

"Obtain an initial estimate of the impact of the specific sound by subtracting the measured background sound level from the rating level, and consider the following…

a) Typically, the greater this difference, the greater the magnitude of the impact.

b) A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.

c) A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.

d) 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."

Table 6-1 presents a comparison of the Rating Levels to the daytime and night-time background sound levels.

Table 6-1: Margin Above / Below (+/-) Background Sound Level, dB

Noise Assessment	Daytime and Night-time		
	Rating Level, dBA	Representative Background Sound Level, dBA	Margin Above/Below (+/-) Background Sound Level, dB
NAL01 Day	41	41	0
NAL01 Night	41	36	+5

During the daytime the Rating Level does not exceed the background sound level, which is "*an indication of the specific sound source having a low impact, depending on the context."*

During the night-time the Rating Level is 5 dB above the background sound level, which is *"an indication of an adverse impact, depending on the context."*

The context in which the assessment is made is as follows;

- The noise model assumes all plant is operating concurrently, however not all cooling units will necessarily be required to operate at the same time and as such, overall noise levels are likely to be lower than predicted.

- Similarly, the noise model assumes all cooling plant is operating at maximum noise level output, however, this will only occur when ambient temperatures are high, or the equipment is under full load. For much of the time cooling equipment will be operating at lower capacities and overall sound output will be reduced.
- The predicted levels assume the receptor is downwind of all sound sources, however, the prevailing wind in this locale is a South Westerly i.e. coming from the south west and blowing towards the north east, whilst the receptor is located to the south east of the Proposed Development. As such, for much of the time the wind will be blowing away from the receptor, rather than towards it.

With due consideration of the context, which indicates that the noise level predictions are likely to be higher than what will occur in reality, the conclusion of the BS 4142 assessment is that that the Proposed Development is not expected to have an adverse impact in terms of noise.

7 Summary

An up to 750 MW BESS development is proposed within the red line boundary of the Neilston Greener Grid Park (GGP). The GGP already includes a 50 MW BESS, so the Noise Impact Assessment considers an additional 700 MW of BESS plant on top of the previously predicted 50 MW BESS noise levels.

A noise propagation model has been produced assuming all plant is operating concurrently and continuously and with all associated cooling plant operating at 100% capacity. In reality this will not occur; not all cubes will be operating at the same time and varying levels of cooling requirements will be needed depending on operational status.

There is only one residential receptor close to the Proposed Development and the predicted noise levels at that receptor are 2 dB below the daytime background sound levels and 3 dB above the night-time background sound levels. A +2 dB character correction has been added for tonality, however, which may be just perceptible under certain conditions, so the BS 4142 Rating Level is equal to the daytime background sound level and 5 dB above the night-time background sound level.

The BS 4142 assessment has considered the difference between the Rating Level and the background sound level, as well as the context of the development, and concluded that the Proposed Development is not expected to have an adverse impact in terms of noise.

8 References

(ISO), International Organization for Standardization. *Acoustics — Attenuation of sound during propagation outdoors. Part 2: Engineering method for the prediction of sound pressure levels outdoors*. Geneva: (ISO), International Organization for Standardization, 2024.

British Standards Institute. *Methods for Rating and Assessing Industrial and Commercial Sound*. UK: BSI, 2014.

Appendix A – Glossary of Terms

Attenuation: the reduction in level of a sound between the source and a receiver due to any combination of effects including: distance, atmospheric absorption, acoustic screening, the presence of a building façade, etc.

Background Sound Level: the sound level rarely fallen below in any given location over any given time period, often classed according to daytime, evening or night-time periods. The LA90 indices (see below) are typically used to represent the background sound level.

Broadband Noise: noise with components over a wide range of frequencies.

Decibel (dB): the ratio between the quietest audible sound and the loudest tolerable sound is a million to one in terms of the change in sound pressure. A logarithmic scale is used in sound level measurements because of this wide range. The scale used is the decibel (dB) scale which extends from 0 to 140 decibels (dB) corresponding to the intensity of the sound level.

dB(A): the ear has the ability to recognise a particular sound depending on its pitch or frequency. Microphones cannot differentiate sound in the same way as the ear, and to counter this weakness the sound measuring instrument applies a correction to correspond more closely to the frequency response of the human ear. The correction factor is called 'A Weighting' and the resulting measurements are written as dB(A). The dB(A) weighting is internationally accepted and has been found to correspond well with people's subjective reaction to sound levels and noise. Some typical subjective changes in sound levels are:

- a change of 3dB(A) is just perceptible;
- a change of 5dB(A) is clearly perceptible; and
- a change of 10dB(A) is twice (or half) as loud.

Directivity: the property of a sound source that causes more sound to be radiated in one direction than another.

Emission: the sound energy emitted by a sound source (e.g. a wind turbine).

Frequency: the pitch of a sound in Hz or kHz. See Hertz.

Ground Effects: the modification of sound at a receiver location due to the interaction of the sound waves with the ground along its propagation path from source to receiver. Described using the term 'G', and ranges between 0 (hard ground), 0.5 (mixed ground) and 1 (soft ground).

Hertz (Hz): sound frequency refers to how quickly the air vibrates, or how close the sound waves are to each other (in cycles per second, or Hertz (Hz)).

Immission: the sound pressure level detected at a given location (e.g. the nearest dwelling).

Noise: unwanted sound.

Lw: is the sound power level. It is a measure of the total sound energy radiated by a sound source and is used to calculate sound levels at a distant location. The *LWA* is the A-weighted sound power level.

Leq: is the equivalent continuous sound level, and is the sound level of a steady sound with the same energy as a fluctuating sound over the same period. It is possible to consider this level as the ambient noise encompassing all noise at a given time. The LAeq, T is the A-weighted equivalent continuous sound level over a given time period (T).

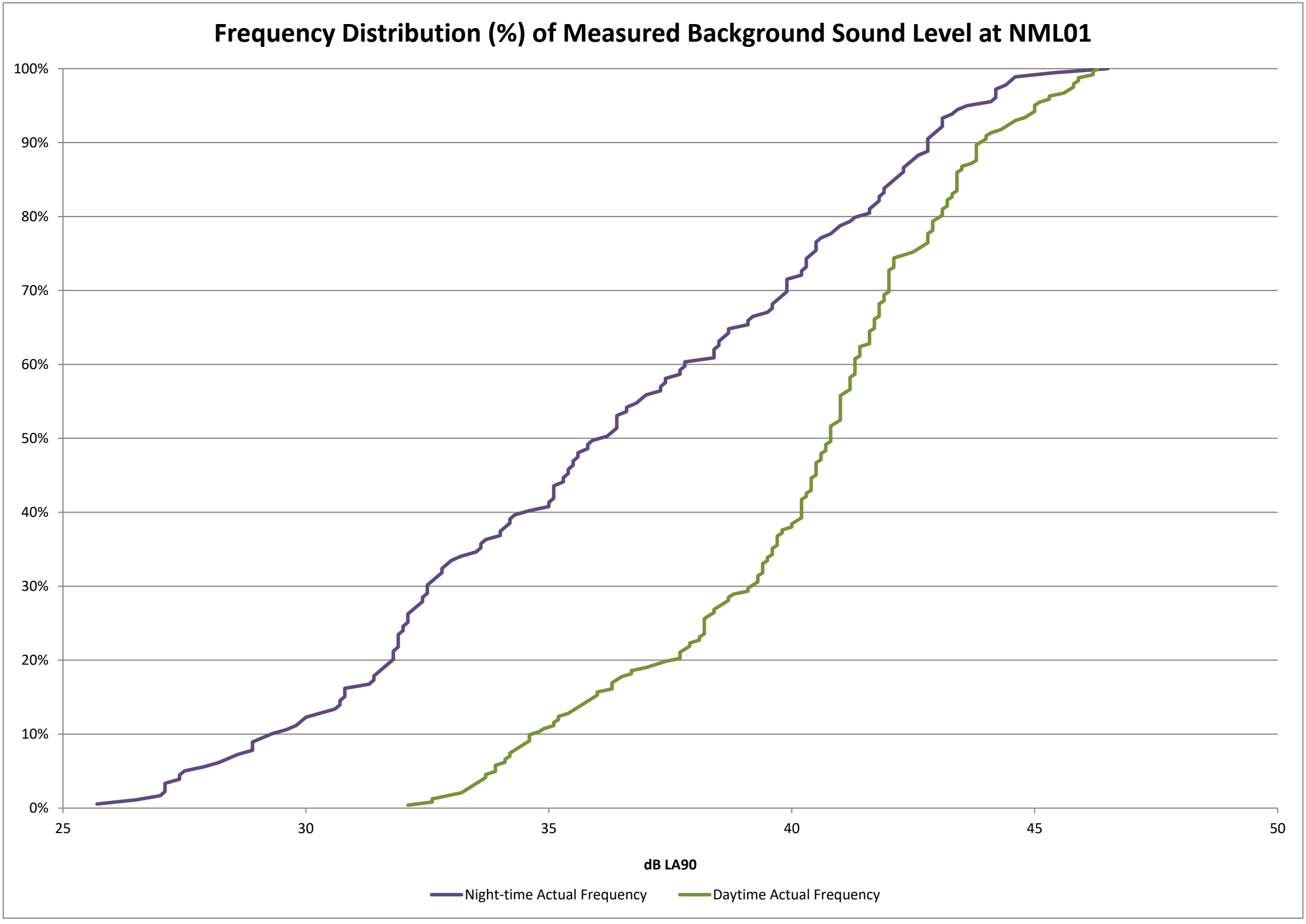
L90: index represents the sound level exceeded for 90 percent of the measurement period and is used to indicate quieter times during the measurement period. It is often used to measure the background sound level. The LA90,10min is the A-weighted background sound level over a ten-minute measurement sample.

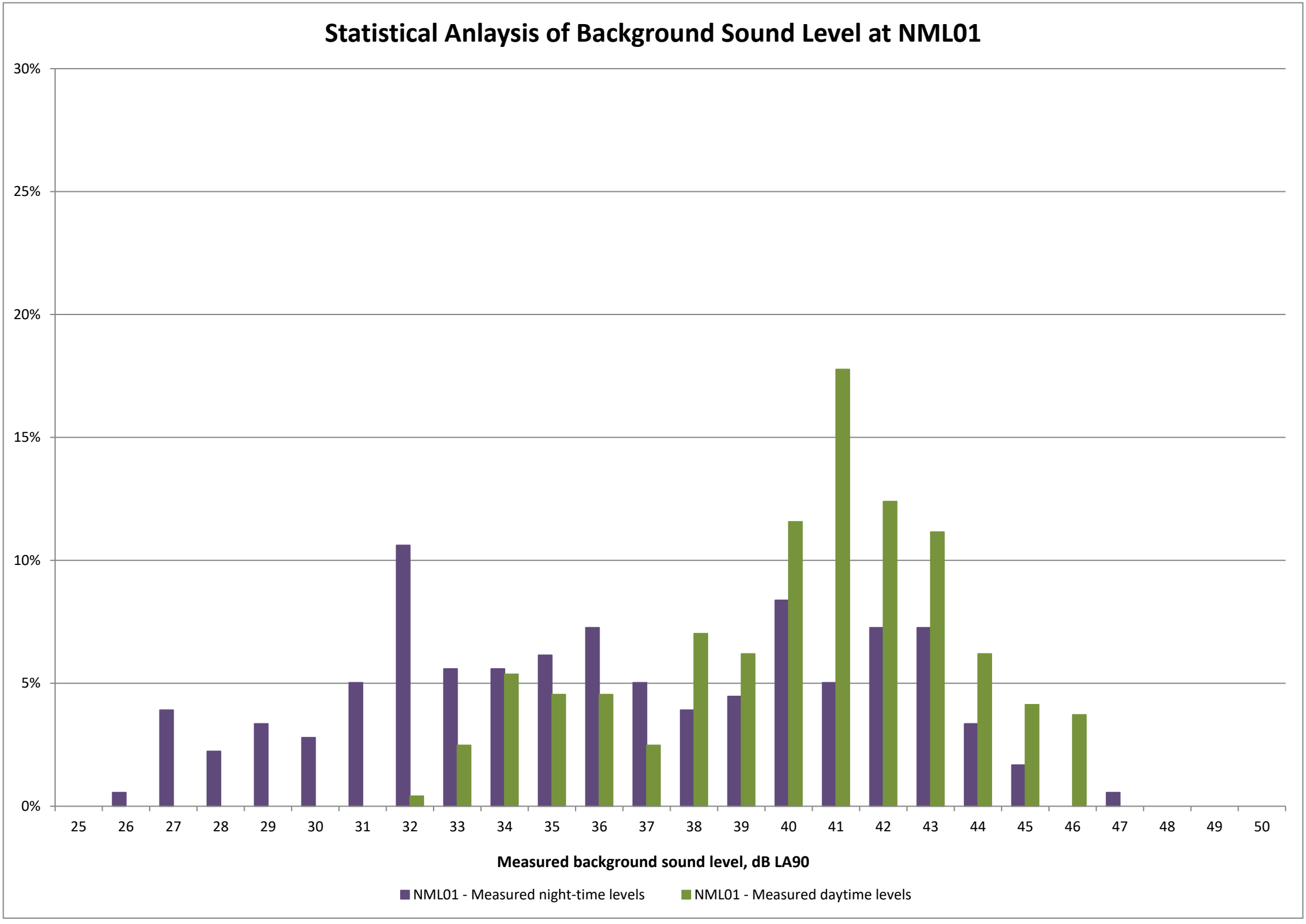
Sound Level Meter: an instrument for measuring sound pressure level.

Sound Pressure Level: a measure of the sound pressure at a point, in decibels.

Tonal Noise: noise which covers a very restricted range of frequencies (e.g. a range of ≤20 Hz). This noise is subjectively more annoying than broadband noise.

Appendix B – Baseline Survey Data


Frequency Distribution (%) of Measured Background Sound Level at NML01
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
25
30
35
40
45
50
dB LA90
Night-time Actual Frequency
Daytime Actual Frequency


Statistical Anlaysis of Background Sound Level at NML01
30%
25%
20%
15%
10%
5%
0%
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
Measured background sound level, dB LA90
NML01 - Measured night-time levels
NML01 - Measured daytime levels

Noise Monitoring Location

North Facing

East Facing

South Facing

West Facing

CERTIFICATE OF CALIBRATION

ISSUED BY **Cirrus Research plc**

DATE OF ISSUE **13 October 2022** CERTIFICATE NUMBER **181509**

Cirrus Research plc
Acoustic House
Bridlington Road
Hunmanby
North Yorkshire
YO14 0PH
United Kingdom

Approved signatory
M.Berry
Electronically signed:
M.BERRY

Sound Level Meter : IEC 61672-3:2013

Instrument information

Manufacturer:	Cirrus Research plc	Notes:
Model:	CR:171B	
Serial number:	G078524	
Class:	1	
Firmware version:	3.2.3197	

Test summary

Date of calibration: 13 October 2022

The calibration was performed respecting the requirements of ISO/IEC 17025:2017.
Periodic tests were performed in accordance with procedures from IEC 61672-3:2013.

The sound level meter submitted for testing successfully completed the class 1 periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed.

However, no general statement or conclusion can be made about conformance of the sound level meter to the full specifications of IEC 61672-1:2013 because (a) evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to determine that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013 or correction data for acoustical test of frequency weighting were not provided in the Instruction Manual and (b) because the periodic tests of IEC 61672-3:2013 cover only a limited subset of the specifications in IEC 61672-1:2013.

Notes

CERTIFICATE OF CALIBRATION

Environmental conditions

The following conditions were recorded at the time of the test:

Before	Pressure:	100.90 kPa	Temperature:	21.1 °C	Humidity:	49.1 %
After	Pressure:	100.84 kPa	Temperature:	21.3 °C	Humidity:	49.9 %

Test equipment

Equipment	Manufacturer	Model	Serial number
Signal Generator	TTi	TGA1241	257309
Attenuator	Cirrus Research	ZE:952	78135
Environmental Monitor	Comet	T7510	16966334

Additional instrument information

Instruction manual:

Reference level range: Single range

Pattern approval: No

Source of pattern approval: -

Preamplifier

Model: MV:200F

Serial number: 5935F

Microphone

Model: MK:224

Serial number: 212180B

Test results summary

Test	Result
Toneburst response	Complies
Electrical noise-floor	Complies
Linearity	Complies
Electrical Frequency weightings	Complies
Frequency and time weightings at 1 kHz	Complies
C-weighted peak	Complies
Overload indication	Complies
High level stability	Complies
Long-term stability	Complies
Acoustic Frequency weightings	Complies

CERTIFICATE OF CALIBRATION

ISSUED BY **Cirrus Research plc**

DATE OF ISSUE **13 October 2022** CERTIFICATE NUMBER **181508**

Cirrus Research plc
Acoustic House
Bridlington Road
Hunmanby
North Yorkshire
YO14 0PH
United Kingdom

Approved signatory
M.Berry
Electronically signed:

M.BERRY

Outdoor Kit Calibration Information

Instrument information

Manufacturer:	Cirrus Research plc
Model:	CK:675
Preamp Model	MK:172
Microphone Serial Number	2015
Primary Calibration Certificate Number	181508

Summary

Date of calibration: 13 October 2022

The calibration was performed respecting the requirements of ISO/IEC 17025:2017.
This information is in addition to the primary calibration certificate for the sound level meter. The calibration certificate number is shown above and should be used in conjunction with this additional information.

The sound level meter detailed above has been calibrated to the published test and calibration data as detailed in the instrument handbook, using the techniques recommended in the standards to which the instrument has been designed.

All calibration procedures were carried out by substituting the microphone capsule with a suitable electrical signal, apart from the final acoustic calibration.

The microphone capsule was calibrated using an electrostatic calibration system to produce the frequency response and a reference acoustic source for the final sensitivity testing.

In addition to the calibration of the complete sound level meter in its standard configuration, (instrument, MV:200 series preamplifier and microphone capsule), the sound level meter and microphone capsule were tested with the MK:172 preamplifier in place of the MV:200 series.

The sound level meter, G078524 , has been tested with Outdoor Microphone/Preamplifier Type MK:172 Serial Number 2015 and conforms to the requirements of the standards stated in the instrument user manual.

CERTIFICATE OF CALIBRATION

ISSUED BY **Cirrus Research plc**

DATE OF ISSUE **13 October 2022** CERTIFICATE NUMBER **181510**

Cirrus Research plc
Acoustic House
Bridlington Road
Hunmanby
North Yorkshire
YO14 0PH
United Kingdom

Approved signatory
M.Berry
Electronically signed:
M.BERRY

Sound Calibrator : IEC 60942:2003

Instrument information

Manufacturer: Cirrus Research plc

Model: CR:515

Serial number: 78218

Class: 1

Notes:

Test summary

Date of calibration: 13 October 2022

The sound calibrator detailed above has been calibrated to the published data as described in the operating manual and in the half-inch configuration. The procedures and techniques used are as described in IEC60942_2003 Annex B – Periodic Tests and three determinations of the sound pressure level, frequency and total distortion were made.

The sound pressure level was measured using a WS2F condenser microphone type MK:224 manufactured by Cirrus Research plc.

The results have been corrected to the reference pressure of 101.33 kPa using the manufacturer's data.

As public evidence was available, from a testing organisation responsible for approving the results of pattern evaluation tests, to demonstrate that the model of sound calibrator fully conformed to the requirements for pattern evaluation described in Annex A of IEC 60942:2003, the sound calibrator tested is considered to conform to all the Class 1 requirements of IEC 60942:2003.

The manufacturer's product information indicates that this model of sound calibrator has been formally pattern approved to IEC60942_2003 Annex A to Class 1. This has been confirmed by Laboratoire National d'Essais (LNE), PhysikalischTechnische Bundesanstalt (PTB) and APPLUS (APPLUS).

Notes:

CERTIFICATE OF CALIBRATION

Environmental conditions

The following conditions were recorded at the time of the test:

Pressure: 100.71 kPa
Temperature: 22.8 °C
Humidity: 41.9 %

Test equipment

Equipment	Manufacturer	Model	Serial number
Distortion Meter	Keithley	2015	1063074
Acoustic Calibrator	Bruel and Kjaer	4231	2610257
Environmental Monitor	Comet	T7510	21962628

Initial Results

	Expected	Sample 1	Sample 2	Sample 3	Average	Deviation	Tolerance	Uncertainty
Level (dB)	94.00	93.96	93.95	93.89	**93.93**	-0.07	±0.40	0.11 dB
Distortion (%)	< 3.00	0.20	0.28	0.63	**0.37**	0.37	+3.00	0.13 %
Frequency (Hz)	1000.0	1000.3	1000.3	1000.3	**1000.3**	0.3	±10.0	0.1 Hz

The measured quantities or deviations (as applicable), extended by the expanded combined uncertainty of measurement, must not exceed the corresponding tolerance.

Adjusted Results

	Expected	Sample 1	Sample 2	Sample 3	Average	Deviation	Tolerance	Uncertainty
Level (dB)	94.00	94.00	93.97	93.97	**93.98**	-0.02	±0.40	0.11 dB
Distortion (%)	< 3.00	0.26	0.18	0.39	**0.28**	0.28	+3.00	0.13 %
Frequency (Hz)	1000.0	1000.3	1000.3	1000.3	**1000.3**	0.3	±10.0	0.1 Hz

End of results

CERTIFICATE OF CALIBRATION

ISSUED BY **Cirrus Research plc**

DATE OF ISSUE **13 October 2022** CERTIFICATE NUMBER **181511**

Cirrus Research plc
Acoustic House
Bridlington Road
Hunmanby
North Yorkshire
YO14 0PH
United Kingdom

Test engineer:
D.Swalwell
Electronically signed:

Microphone

Microphone capsule

Manufacturer: Cirrus Research plc

Model: MK:224

Serial Number: 212180B

Calibration procedure

Date of calibration: 06 October 2022

Open circuit: 49.1 mV/Pa

Sensitivity at 1 kHz: -26.2 dB rel 1 V/Pa

The microphone capsule detailed above has been calibrated to the published data as described in the operating manual of the associated sound level meter (where applicable).

The frequency response was measured using an electrostatic actuator in accordance with BS EN 61094-6:2005 with the free-field response derived via standard correction data traceable to a National Measurement Institute.

The absolute sensitivity at 1 kHz was measured using an acoustic calibrator conforming to IEC 60942:2003 Class 1.

Environmental conditions

Pressure: 101.20 kPa

Temperature: 20.0 °C

Humidity: 44.0 %

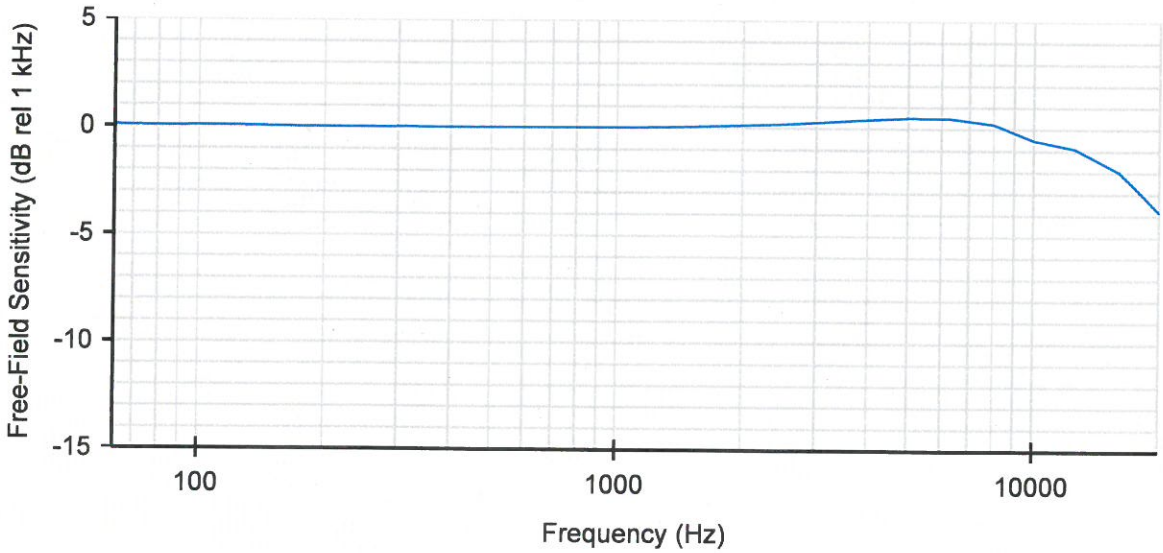
CERTIFICATE OF CALIBRATION

Certificate Number: **181511**

Free-Field Frequency Response : Tabular

Frequency (Hz)	Free-Field Sensitivity (dB rel 1 kHz)	Actuator Response (dB)
63	**0.06**	**-0.14**
80	0.04	-0.05
100	0.05	-0.01
125	**0.05**	**0.03**
160	0.02	0.03
200	0.00	0.03
250	**0.00**	**0.03**
315	0.02	0.02
400	0.01	0.02
500	**0.00**	**0.01**
630	0.00	0.01
800	0.00	-0.01
1 000	**0.00**	**-0.02**
1 250	0.02	-0.03
1 600	0.07	-0.05
2 000	**0.12**	**-0.10**
2 500	0.19	-0.15
3 150	0.29	-0.28
4 000	**0.40**	**-0.49**
5 000	0.49	-0.86
6 300	0.49	-1.58
8 000	**0.21**	**-2.95**
10 000	-0.53	-5.16
12 500	-0.91	-7.42
16 000	**-1.97**	**-9.92**
20 000	-3.86	-12.98

Free-Field Frequency Response : Graphical



Appendix C – Noise Source Data

Extract of larger report TNEI Edit

1661-0027-RPT-001
Revision 0

Fluence Cube Vibration and Noise Data Collection Report

Short and Long Duration Liquid-Cooled Cubes

Prepared for: Fluence Energy

Preparer:	Colby Zarger	E-signed by: Colby Zarger on 2021-01-31 16:35:20
Checker:	Thomas King	E-signed by: Thomas King on 2021-01-31 17:58:25
Reviewer: (Section 5.0)	Robert Ashworth	E-signed by: Robert Ashworth on 2021-01-31 20:24:36
Reviewer: (All but Section 5.0)	Thomas King	E-signed by: Thomas King on 2021-01-31 17:58:53
Approver:	Thomas King	E-signed by: Thomas King on 2021-01-31 20:41:02

QA Statement of Compliance

This document has been prepared, reviewed, and approved in accordance with the Quality Assurance requirements of the MPR Standard Quality Program.

Created: 2021-01-31 16:35:20
Project-Task No. 16612101-0027

MPR Associates, Inc.
320 King St. • Alexandria, VA 22314
(703) 519-0200 • www.mpr.com

Extract of larger report TNEI Edit

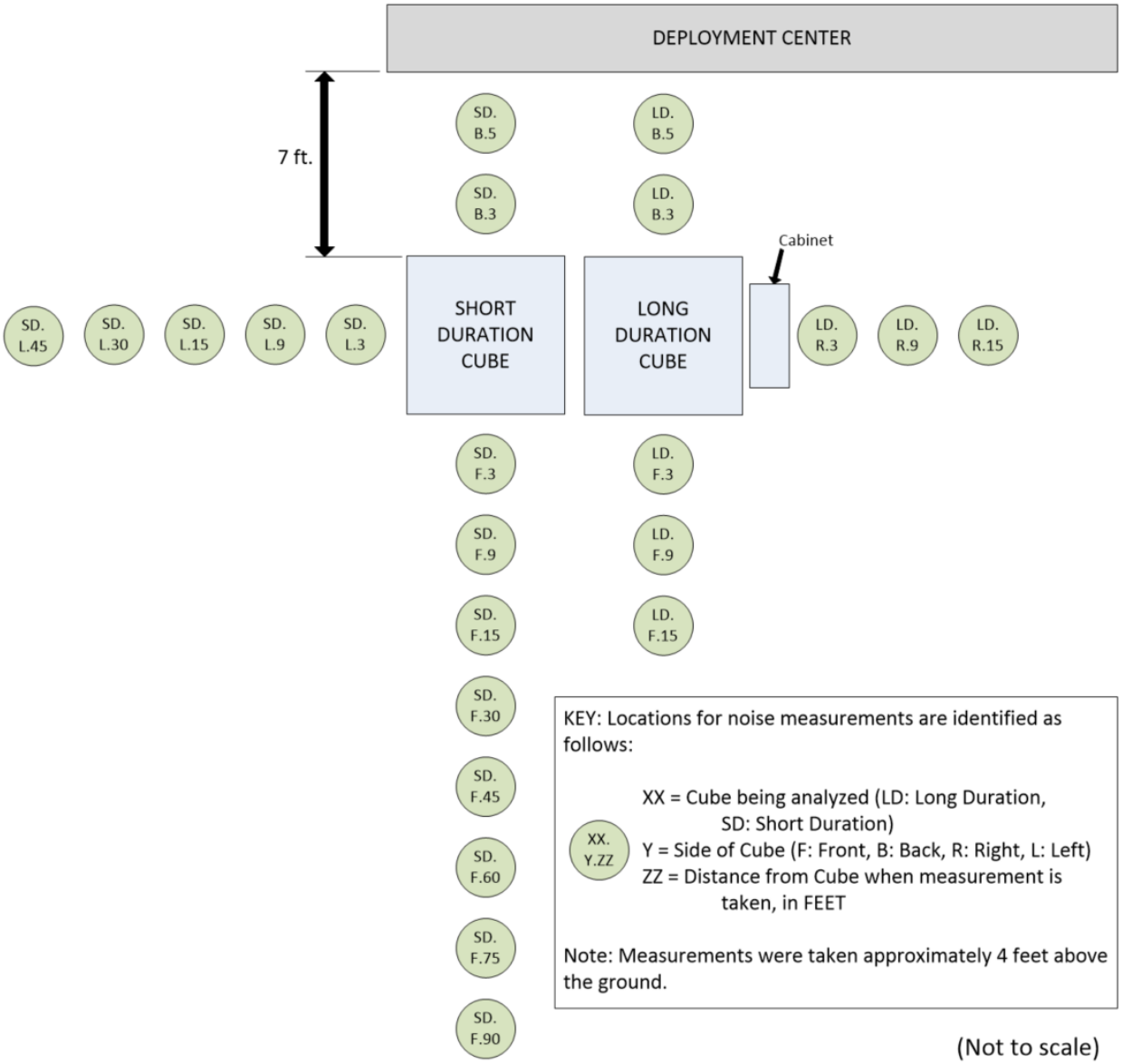


Figure D-1. Sound Measurement Locations

Extract of larger report TNEI Edit

Table D-5. Noise Data, Collected in Evening
Short Duration Cube, Cooling Systems On, Background Noise Subtracted
(measurements are in dB)

Location Index[(1)]	Center Frequency (Hz) [Frequency Band Limits (Hz)]								
	31.5 [22-44]	**63 [44-88]**	**125 [88-176]**	**250 [176-353]**	**500 [353-707]**	**1000 [707-1414]**	**2000 [1414-2825]**	**4000 [2825-5650]**	**8000 [5650-11300]**
SD.F.3	60.3	62.9	74.4	69.9	69.8	65.0	64.7	63.7	55.2
SD.F.9	65.5	58.7	72.6	63.0	58.9	59.1	57.2	57.6	49.4
SD.F.15	54.4	57.4	69.6	60.4	56.6	52.2	52.5	53.5	45.2
SD.F.30	54.8	67.8	64.1	58.5	55.1	52.1	48.1	47.7	40.0
SD.F.45	57.4	67.9	57.7	51.8	46.3	46.2	37.1	45.5	38.7
SD.F.60	60.6	66.5	57.4	51.0	50.1	44.6	46.9	43.5	37.8
SD.F.75	63.6	65.9	61.7	58.3	50.9	45.8	34.3	42.2	37.0
SD.F.90	62.4	58.5	65.3	54.9	50.1	49.1	43.0	39.6	36.2
SD.L.3	65.4	70.3	70.4	62.9	58.8	54.3	51.7	48.9	42.5
SD.L.9	69.0	56.3	70.6	58.0	52.3	51.3	49.4	47.4	41.1
SD.L.15	71.4	69.2	68.8	56.3	51.4	48.7	46.6	45.1	39.3
SD.L.30	65.3	60.3	63.9	53.1	47.1	55.2	42.4	40.1	37.4
SD.L.45	62.6	71.1	62.9	53.5	54.7	33.8	48.4	31.0	36.6
SD.B.3	60.3	69.5	80.8	74.0	71.6	69.1	68.0	65.4	58.0
SD.B.5	63.0	71.4	72.8	71.6	70.9	66.0	65.0	63.0	55.5

Note:
(1) See Figure D-1 for explanation.
(2) Calculation methodology is noted in Section 5.2.

Appendix D – Figures

N

GLENIFFER ROAD

B775

Sergeant Law

SERGEANT LAW ROAD

Metres

0 250 500

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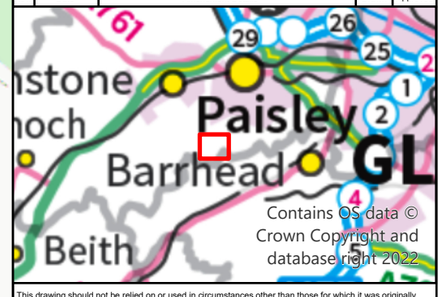
LEGEND

- Section 36 Application Red Line Boundary
- Noise Monitoring Location (NML)
- Noise Sensitive Receptors (NSRs)

Rev.	Date	Amendment Details	Drawn	Approved
0	21/06/2024	FIRST ISSUE	JCM	RL



tnei

Client: Statkraft

Drawing Status: FOR INFORMATION

Project Title: NEILSTON GREENER GRID PARK

Drawing Title: FIGURE 1: NOISE STUDY AREA

Scale:	Original Size:	Spatial Reference:
1:4,500	A3	British National Grid

Drawing Number: 15957-022

LEGEND

- Section 36 Application Red Line Boundary
- Noise Assessment Locations (NALs)
- Modelled Noise Sources
- Modelled Buildings and Structures

Predicted Noise Levels (dBA)

35 - 40	55 - 60
40 - 45	60 - 65
45 - 50	65 - 70
50 - 55	

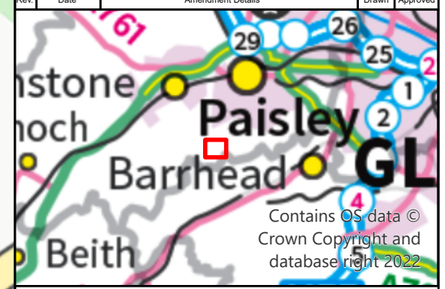
Noise Model details the final plant layout (in accordance with approved non-material variation) overlain on a drawing of the originally consented scheme.

Noise contours modelled in accordance with ISO 9613 Part 2: 2024 at a height of 4 m and displayed on a 10 m by 10 m grid.

All noise sources are assumed to be operating concurrently and continuously.

All levels shown as dB LAeq(t).

Rev.	Date	Amendment Details	Drawn	Approved
0	21/06/2024	FIRST ISSUE	JCM	RL



tnei

Client: Statkraft

Drawing Status: FOR INFORMATION

Project Title: NEILSTON GREENER GRID PARK

Drawing Title: FIGURE 1: NOISE STUDY AREA

Scale:	Original Size:	Spatial Reference:
1:3,250	A3	British National Grid

Drawing Number: 15957-022