Field Corriemoillie Ltd

CORRIEMOILLIE BESS

Noise Impact Assessment Report

RP AC 02
NOVEMBER 2024

PUBLIC

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Noise Impact Assessment Report

ACOUSTIC REPORT (FIRST ISSUE) PUBLIC

PROJECT NO. 70124421

OUR REF. NO. RP AC 02

DATE: NOVEMBER 2024

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QUALITY CONTROL

Issue/revision	First issue	Revision 1	Revision 2	Revision 3
Remarks				
Date	11/11/2024			
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Project number	70124421			
Report number	RP AC 02			

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APPENDICES

1 INTRODUCTION

1.1 OVERVIEW

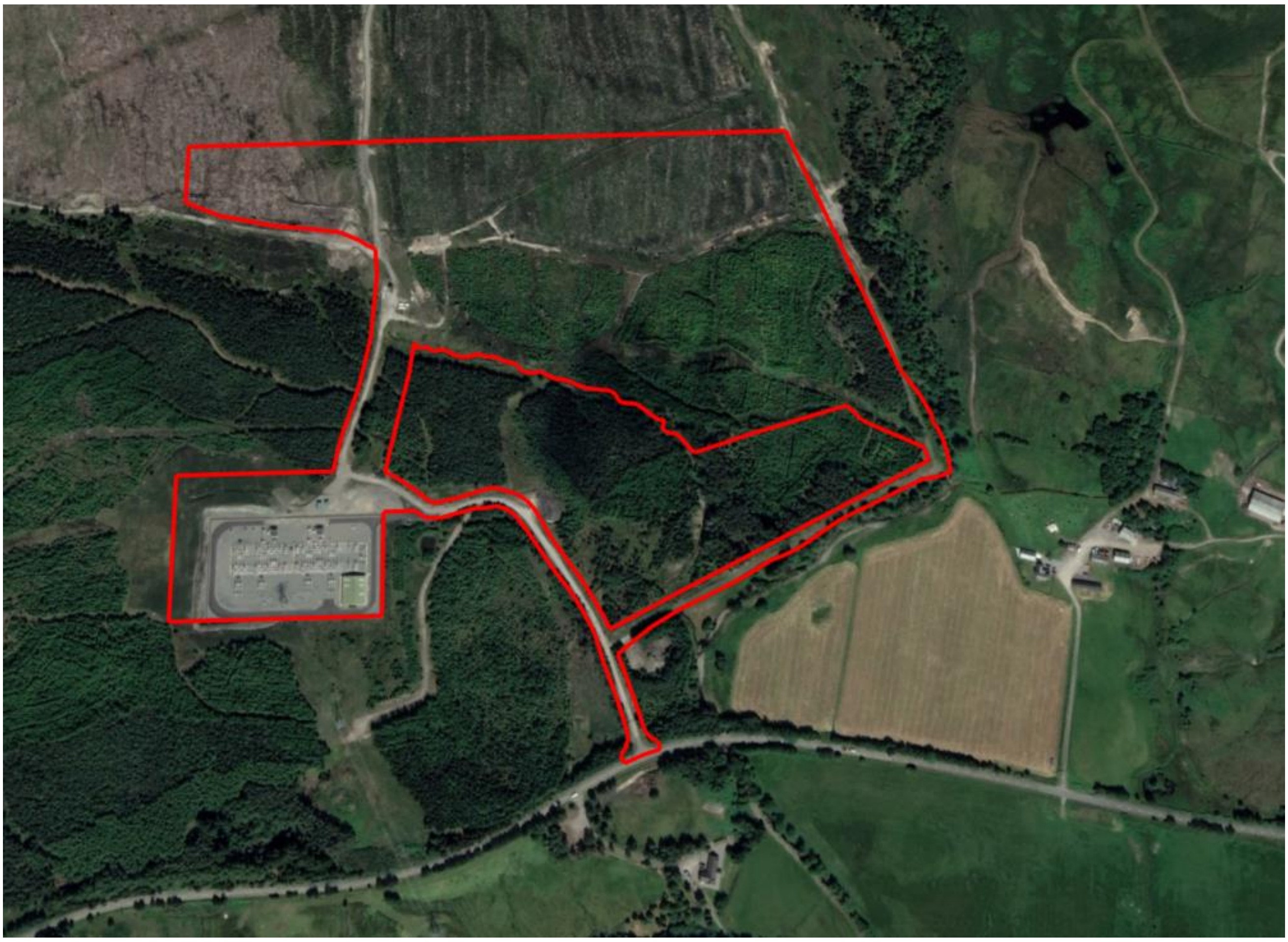
WSP has been appointed by Field Corriemoille Ltd (Field) to undertake a noise assessment to support the planning application for a Battery Energy Storage System (BESS) of up to 200 MW with associated infrastructure (including underground cable route to the existing substation), access and ancillary works (including landscaping and biodiversity enhancement) at Corriemoillie (Land at Garve, Lochluichart, IV23 2PY).

This report is necessarily technical in nature and a glossary is provided in Appendix A to assist the reader. The limitations of the report can be found in Appendix D.

1.2 SITE LOCATION

The site is located within the administrative boundary of The Highland Council (THC), north of the river Luichart and north side of road A832. The surrounding area generally comprises fields, forest, residential properties, and farms. The proposed site currently comprises forest. Figure 1 shows the location of the site .

Figure 1 – The proposed site and surroundings

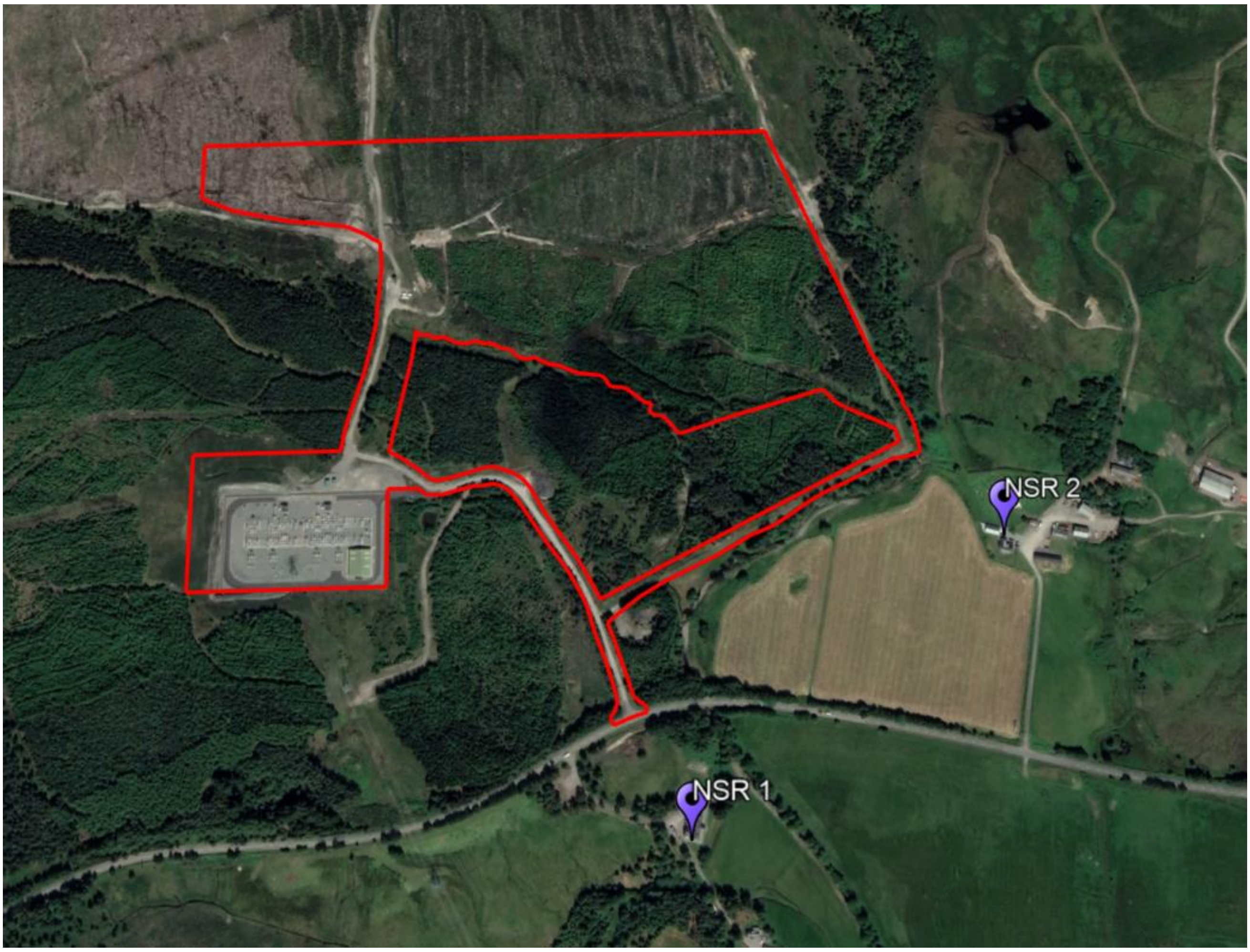


The nearest noise sensitive properties to the site are indicated in Figure 2 and identified in Table 1. They include a residential property to the south-east, on the north of A832; and a residential property to the south, south of A832.

Table 1 – Noise sensitive receptors

Receptors	Coordinates (British National Grid)	
	X (Easting)	Y (Easting)
NSR 1 (Glenview, Corriemoillie)	235150.72	863605.82
NSR 2 (Corriemoillie Farm)	235449.52	863844.09

Figure 2 – Locations of noise sensitive receptors



2 TECHNICAL GUIDANCE

2.1 LOCAL AUTHORITY REQUIREMENTS

WSP has consulted with THC who have stated the proposed site should demonstrate it will meet the following criteria:

- The noise when measured and/or calculated as an LZeq,5min in the 100 Hz one third octave frequency band must not exceed 30 dB, at the curtilage of any noise sensitive premises; and
- The Rating Level must not exceed the current background noise levels at the curtilage of noise sensitive premises. The Rating Level should be calculated in accordance with BS 4142:2014+A1:2019: Methods for rating and assessing industrial and commercial sound.

They have also stated that:

"*NR20 might be used as a design standard where there is no garden or other external amenity at the noise sensitive receptor, or where background levels are very high (> 40 dB). However, I understand that the existing background sound level in the vicinity of the site is relatively low.*

I would advise that there would not be any relaxation of the above noise standards for any properties with a financial involvement with the development.

Finally, the expectation is that the noise assessments are based on 100% operational capacity unless there is something from the manufacturer which demonstrates that a lower capacity and lower sound power level would be appropriate. Ideally, it would be useful if the units can be physically restricted to whatever lower capacity is adopted."

WSP has suggested to THC to update the limit of 30 dB $L_{Zeq,5min}$ in the 100 Hz one third octave band frequency such that:

The L_{Zeq} 100 Hz must not exceed a level of 5 dB below the measured $L_{Zeq,5min}$ 100 Hz as it would still provide assurance to local authority that the resulting noise levels would not be tonal and there would be no significant change in the prevailing conditions for the 100 Hz band.

WSP has also consulted whether the proposed broadband limit of a rating level not greater than the background noise level can be updated such that it also accounts for context as required by BS 4142 as follows:

The absolute noise levels will be taken into account as a contextual consideration in accordance with BS 4142.

THC's response stated:

"In respect to the limit of 30dB L_{Zeq} 100Hz, provided that it can be demonstrate the BESS does not have any significant tonal element at 100Hz, our Service would accept with your suggested criteria of "The L_{Zeq} 100Hz must not exceed a level of 5dB below the measured $L_{Zeq,5mins}$ 100Hz"

In respect to the broadband criteria, I appreciate that this is quite an onerous standard, but it is the criteria our Service applies to all BESS. Whilst BS4142 does allow for context to be considered and for the consideration of a fixed limit for areas of very low background, it does not state how initial estimate of impact should be adjusted when background and rating levels are low. Our Service would not agree to the suggested criteria of "Rating Level must not exceed the current background noise levels or must be less than 35dB $L_{Ar,Tr}$"

However, as the BS 4142 assessment will consider contextual matters, our Service will take this into consideration and may agree noise level above background noise level, if it is considered appropriate in the circumstances."

2.2 BRITISH STANDARD 4142:2014+A1:2019 'METHOD FOR RATING AND ASSESSING INDUSTRIAL AND COMMERCIAL SOUND' (BS 4142)

BS 4142:2014+A1:2019[1] provides methods for rating and assessing sound arising from commercial sources, including external plant and on-site vehicle movements, and unloading, at residential receptors. It uses a relative assessment approach whereby the predicted commercial sound level (suitably penalised for annoyance character if appropriate) is compared with the prevailing background sound level. A summary of the BS 4142 approach is set out as follows:

- Establish the specific sound level of the source(s).
- Measure the representative background sound level.
- Correct the specific sound level for on-time and interferences if necessary.
- Rate the specific sound level to account for distinguishing characteristics.
- Estimate the impact by subtracting the background sound level from the rating level.
- Consider the initial impact estimate in the context of the sound and its environs.

The representative background sound level should be established from data measured at the receptor locations.

The specific sound level is rated using the following penalties:

- Tonality up to 6 dB
- Impulsivity up to 9 dB
- Other sound characteristics up to 3 dB
- Intermittency 3 dB

An initial estimate of the impact of the specific sound is obtained by subtracting the measured background sound level from the rating level as described in section 11 of BS 4142. The results of this comparison are assessed based on the following:

- Typically, the greater the difference, the greater the magnitude of the impact.
- A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.
- A difference of around +5 dB 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.

[1] BS 4142:2014 +A1:2019 *Methods for rating and assessing industrial and commercial sound*, British Standards Institute

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.

All pertinent contextual factors should then be considered, and these include:

- The absolute level of the sound.
- The character and level of the residual sound compared to the character and level of the specific sound.
- The sensitivity of the receptor and whether dwellings or other premises used for residential purposes will already incorporate design measures that secure good internal and/or outdoor acoustic conditions.

3 ENVIRONMENTAL SOUND SURVEY

3.1 METHODOLOGY

To determine the existing environmental sound levels at the site, a baseline survey was undertaken between approximately 11:00 Wednesday 8th and 12:00 Wednesday 15th May 2024.

During the survey, consecutive 1-second measurements were sampled and recorded, to allow post-processing L_{Aeq}, $L_{Amax,Fast}$ and L_{A90} parameters for any required period.

3.2 WEATHER

At the time of installation, there was no rain, cloud cover was 30%, the temperature was 14°C and wind speed was between 0 and 2.7 m/s. At collection, conditions were dry, cloud cover was 10%, temperature was 20°C, and the wind was still.

A weather station was installed to obtain weather data throughout the entire survey. The conditions were considered to be suitable for obtaining representative sound level measurements.

3.3 MEASUREMENT POSITIONS

A sound level meter was installed at measurement position 1 (MP1), on the path leading to the residential property, on the south side of the A832. This position was selected to be representative of the sound levels occurring at the closest property to the south of site. The microphone was installed on a tripod at a height of 1.6 m, in free-field conditions.

A second sound level meter was installed at MP2, in the south-east part of the site. This location was selected to be representative of the background sound levels experienced at existing receptors to the south-east. The sound level meter was installed at a height of approx. 1.6 m so that the microphone was above an existing fence, in free-field conditions.

Figure 3 shows the locations of the monitoring positions.

Figure 3 – Locations of noise monitoring locations

3.4 EXISTING SOUND ENVIRONMENT

Road traffic noise from the A832 was noted to be the dominant source at MP1. In addition, there was noise from occasional vehicle/tractor pass-bys on a local access road, birdsong and rustling of foliage. Rail noise was also occasionally audible.

Sound at MP2 was dominated by road traffic noise from A832. Birdsong and rustling of foliage were also audible throughout the attendance. Distant noise from the substation can be heard when wind was still.

3.5 EQUIPMENT

The monitoring was completed using the type 1 specification sound level monitoring equipment detailed in Table 3.

Table 3 – Sound level monitoring equipment

Location	Equipment	Make and Model	Serial Number	Calibration Due Date
MP1 – Duo 2	Sound Level Meter	01dB-Stell Duo	10618	
	Pre-amplifier	01dB-Stell PRE 22	10627	

	Microphone	G.R.A.S Type 40CD Condenser	331635	03 December 2025
	Calibrator	01dB Cal 21	34924047	13 December 2024
MP2 – Rion B	Sound Level Meter	Rion NL52	00320637	10 January 2026
	Pre-amplifier	H25	10645	
	Microphone	UC59	05708	
	Calibrator	Rion NC-74	34851881	23 August 2024

3.6 MEASUREMENT RESULTS

Table 4 below, summarises the sound level measurement results from the survey that are relevant to the noise impact assessment. The full survey results are presented in Appendix B. The background $L_{A90,T}$ sound levels presented in Table 4 below have been determined from the most commonly occurring measured background sound levels in the applicable period.

Table 4 – Summary of survey results

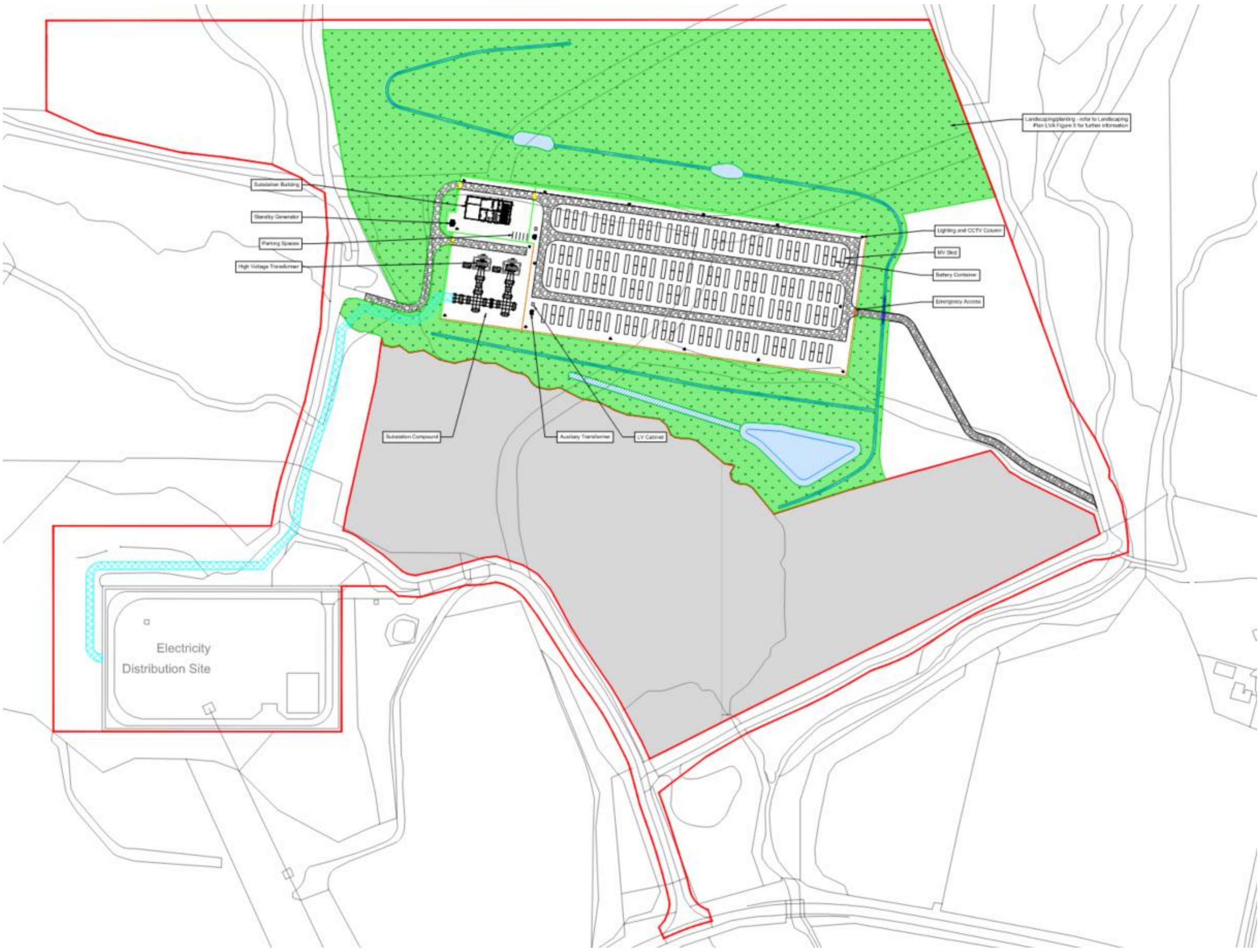
Location	Ambient, daytime	Ambient, night-time	Background, daytime	Background, night-time
MP1	48 dB $L_{Aeq,16hr}$	50 dB $L_{Aeq,8hr}$	36 dB $L_{A90,1hr}$	29 dB $L_{A90,15min}$
MP2	57 dB $L_{Aeq,16hr}$	40 dB $L_{Aeq,8hr}$	34 dB $L_{A90,1hr}$	28 dB $L_{A90,15min}$

4 NOISE IMPACT ASSESSMENT

4.1 SITE LAYOUT

The site layout is shown in Figure 4 based on drawing BTGBCOR01 – Corriemoillie Site Plan dated 241024.

Figure 4 – Corriemoillie proposed site layout



4.2 NOISE SOURCES

Details of the site and equipment have been provided by Field. The development plan includes the following noise sources:

- 128 DC skid BESS containers
- 64 AC skid twin inverters and transformer units (PCS)
- 2 HV grid transformers

Noise modelling is based on candidate plant typical for the size and class of the Proposed Development. It should be noted that final plant specifications may vary during the tendering process. Where possible, noise modelling data is shown within Appendix E, however, where data cannot be published due to confidentiality reasons, Field would be happy to discuss this data in more detail with THC, if required.

The third-octave band sound power levels of these sources have been provided by the manufacturer, and are presented in Table 5. In addition to the source noise data supplied, which has been measured in a controlled test environment, a modelling recommendation document has been provided by the Supplier (as included within Appendix E) that states the recommended operational parameters for use within the noise propagation model. These recommendations are based upon operational data obtained from a 2-hour battery scheme located within the UK.

Field has designed the site to be ‘oversized’ in order to be capable of delivering a short-term inertial response service to the grid, thus requiring the Proposed Development to have more PCS units than would normally be required in order to deliver the maximum power which is permitted by its grid connection management.

Typically, the supplier recommends the use of 40% or 50% rated power data to model the PCS, as these output powers were found to keep the C rates below 0.25C around 95% of the time during the daytime and about 96.5% of the time during night-time. However, this data is prescribed for situations where the PCS units are expected to operate as they would for a typical, non-oversized site. In the case of this site, because it is oversized, the PCS units of each skid will be operating at a reduced rating and as such, the noise model assumes the 30% rated power data to model the PCS.

In addition to this, it should be noted that the noise data provided is from measurements undertaken for a single PCS unit (i.e. one PCS per MV transformer), not a twin skid as is the proposed candidate. As such, the supplier has recommended that 3 dB is added to the overall sound power level value to account for this increase. The resulting one-third octave band sound power level data used to model the PCS units equates to a broadband value of 81 dBA (as opposed to the 78 dBA data shown within Table 5).

Table 5 – Sound power levels for proposed plant

Frequency (Hz)	Sound Power Level, dB L_{wA}		
	DC container	AC inverter	HV Grid Transformer
50	N/A[1]	58	64
63	N/A[1]	60	48
80	N/A[1]	61	55
100	48	64	72
125	54	63	69
160	58	63	78
200	64	66	74
250	59	65	77
315	65	67	80
400	67	65	77
500	68	67	77
630	67	66	79

800	68	68	79
1000	67	72	77
1250	67	65	75
1600	67	64	72
2000	67	61	70
2500	67	58	69
3150	66	57	68
4000	64	58	67
5000	62	52	65
6300	60	51	62
8000	52	56	60
10000	47	51	58
Total Sound Power Level, dB L_{wA}	78	78	88

[1] No data available.

4.3 NOISE MODEL

A 3D noise model of the Corriemoillie site and the surrounding area has been produced using the CadnaA noise prediction software (version 2024 MR1 (build: 205.5427), which implements the ISO 9613-2:2024 calculation methodology to predict the effects on noise propagation of geometric spreading, topography, screening, meteorological conditions, and information provided regarding the sources of noise.

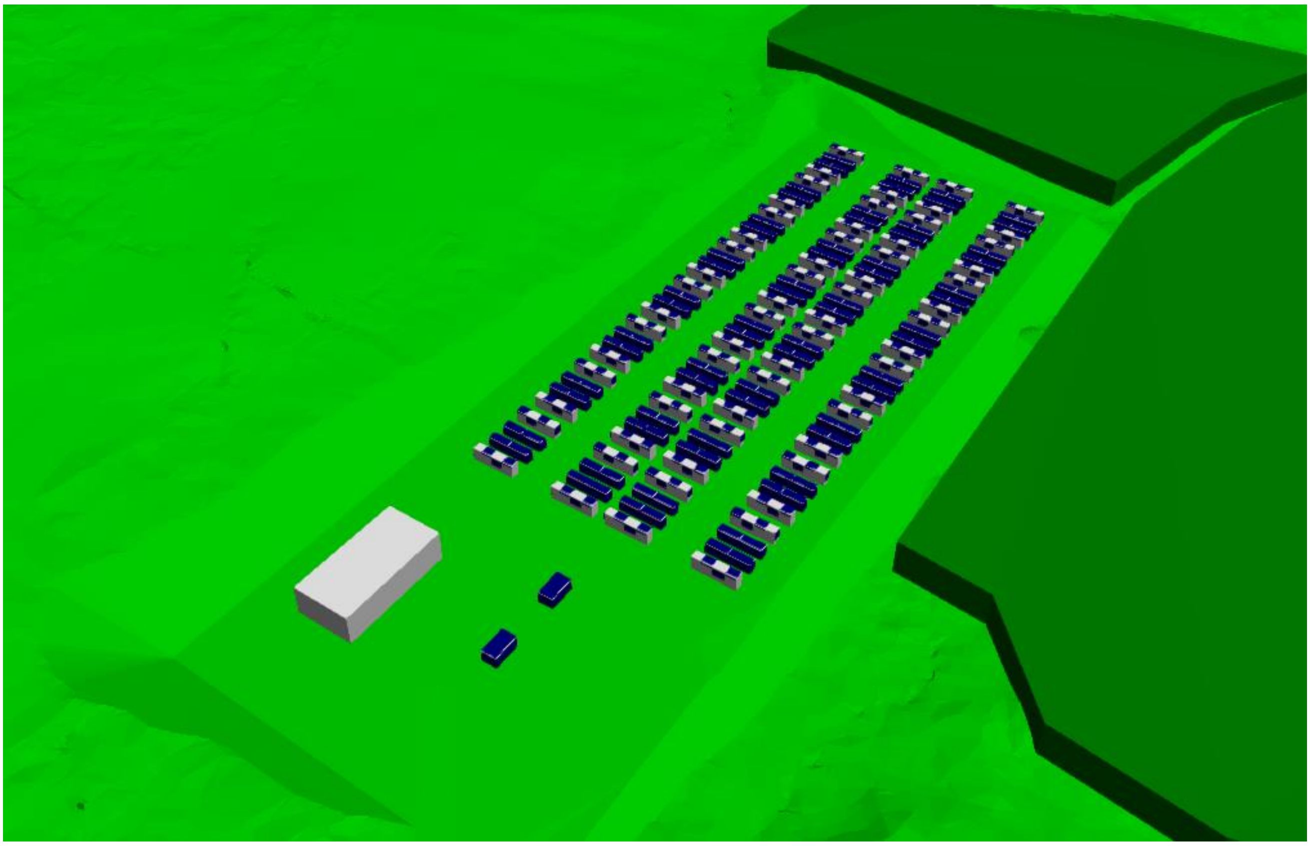
A 5 m noise barrier is included in the model around the southern and south-eastern boundary of the site.

Details of the settings used in the model are summarised as follows:

- Default ground absorption: G=0.8 (acoustically absorbent).
- Three orders of reflection (buildings are reflective).
- ISO 9613 (2024) propagation model.
- Topography data was included in the model.
- Offsite receptor locations derived from satellite imagery.
- Receptors have heights of 4.0 m.
- Predicted levels are free field.
- Heights of buildings are assumed to be 6 meters.
- Sound power level data are based on information received by Field, as summarised above.

A screenshot of the model is shown in Figure 5 for reference. Noise plots are presented in Appendix C.

Figure 5 – Screenshot of noise model



The DC batteries were assumed to operate at 30% fan speed. The AC inverters have been modelled operating at 30%, based on the manufacturer's data.

4.4 RESULTS

Specific sound levels from the BESS have been calculated at the nearest noise sensitive receptors shown in Table 2 using the noise model. The results presented in Table 6 below are compared against the background sound levels to provide an initial estimate of the impact in accordance with BS4142 Clause 11. Noise prediction results are presented with and without the noise barrier on the southern and south-eastern boundaries of the site.

Table 6 – Noise Model results

Receptor	Description	Predicted sound level, dB $L_{Aeq,T}$	
		Without noise barrier	With 5 m noise barrier
NSR 1	Predicted dB(A)	31	29
	dB above night L_{A90}	+2	0
NSR 2	Predicted dB(A)	26	23
	dB above night L_{A90}	-2	-5

4.5 DISCUSSION

4.5.1 BS 4142 RATING CORRECTIONS

From the currently available third-octave data for the proposed plant, it is unlikely that there are any tonal characteristics. Based on experience, it is likely that any tonality would be related to the fan speed. Not all fans will operate at the same speed at the same time, so different fan speeds will therefore blur any tonality, and make it less perceptible.

BESS equipment is very unlikely to have any impulsive characteristics, as all moving parts are related to airflow and are therefore rotational.

The nature of modern plant inherently leads to varying or intermittent operation in order that the plant can respond to changes in temperature efficiently. However, these changes are usually small variations as opposed to dramatic changes from ‘fully off’ to ‘full load’ and are therefore unlikely to draw attention. Furthermore, any rating correction applied for intermittent or varying operation is normally offset by the changes to the plants’ on-time. As such, it is not considered appropriate to apply any correction for intermittent operation.

On this basis, no rating corrections have been applied and the specific sound levels are considered to be the rating levels.

4.5.2 BS 4142 INITIAL ASSESSMENT RESULTS

The results of the initial estimate presented in Table 6 demonstrates that the rating levels do not exceed the background sound level when the inverters run at 30% speed and a 5 metre high acoustic barrier is included along the southern and south-eastern boundary of the site.

The initial estimate of the BS 4142 assessment presented above has confirmed that the proposed BESS equipment in Table 5 is likely to meet the aspirations indicated by THC of rating level not exceeding background sound levels.

4.5.3 BS 4142 CONTEXTUAL CONSIDERATIONS

It is understood that THC would seek to place a noise condition that would require the $L_{Zeq,5min}$ in the 100 Hz third-octave band frequency to not exceed 30 dB at the curtilage of any noise sensitive premises.

Field has also recently discussed with THC regarding another of their BESS developments just outside of Inverness (Knocknagael) and have a previously agreed position that an alternate approach is acceptable to demonstrate no tonal characteristics were expected.

According to Annex C of BS 4142 *‘Objective method for assessing the audibility of tones in sound: One-third octave method’,* the level difference to identify a tone in the low-frequency one-third octave bands (25 Hz to 125 Hz) is 15 dB. Sound power levels for the proposed equipment shown in Table 5 demonstrate that there are no tonal features, as defined in Annex C of BS 4142.

Our predicted levels at the receptors, in accordance with the sound levels at source in Table 5, demonstrate that the proposed development does not expect to produce tonal characteristics at 100 Hz in accordance with Annex C of BS 4142.

The survey results in Table 7 also illustrate that the measured prevailing third-octave band sound level L_{Zeq} at 100 Hz is already 5 dB above the required criterion at NSR1 and 7 dB above at NSR2.

Table 7 – Sound levels at the measurement locations at 100 Hz L_{Zeq}

Location	Daytime dB (L_{Zeq})	Night-time dB (L_{Zeq})
NSR1	44	35
NSR2	50	37

WSP understands that a similar noise limit has been set in the past by THC due to concerns regarding tonality in the 100 Hz band for electrical plant, most specifically for transformers from substations. However in this context, where there are no tonal features at the source, this could be unduly restrictive and is not considered appropriate for a BESS development.

The predicted 100 Hz third-octave band levels are lower than the prevailing ambient sound levels in the same band. On the basis that the sources are not expected to be tonal, this is considered to support a finding of a low impact and therefore should provide adequate protection to residents.

5 CONCLUSION

WSP have been appointed by Field to undertake a noise assessment to support the planning application for a 200 MW BESS at Corriemoillie (Land at Garve, Lochluichart, IV23 2PY).

A sound level survey has been carried out to determine the existing ambient and background sound levels at locations that are representative of the nearest noise sensitive receptors. The survey took place between approximately 11:00 Wednesday 8th and 12:00 Wednesday 15th May 2024.

The results of the sound level survey and the requirements of The Highland Council have been used to assess the likely noise impacts arising from the proposed 200 MW BESS.

Noise levels from the proposed development have been calculated at the nearest noise sensitive receptors using a 3D noise model. A noise assessment has been undertaken in accordance with BS 4142, having an initial estimate and placing this into context.

The noise levels predicted at the nearest noise sensitive receptors demonstrate that the criterion set out by THC can be achieved with a 5 m high acoustic barrier around the southern and south-eastern boundary of the site.

A second criterion proposed by THC relates to the sound level in the 100 Hz one-third octave band. However, it has been shown that this is not necessary for this development as the proposed plant does not exhibit tonal sound characteristics, and the existing sound levels are already higher than the criterion.

Based on the sound levels predicted and the context in which the sound would occur, this assessment demonstrates that noise from the proposed BESS will have a low impact at receptors.

It is therefore concluded that there are no noise considerations which would preclude against determination in favour of the application. However, it is anticipated that pre-development conditions would be agreed in relation to operational noise.

Appendix A

GLOSSARY OF ACOUSTIC TERMINOLOGY

NOISE

Noise is defined as unwanted sound. Human ears are able to respond to sound in the frequency range 20 Hz (deep bass) to 20,000 Hz (high treble) and over the audible range of 0 dB (the threshold of perception) to 140 dB (the threshold of pain). The ear does not respond equally to different frequencies of the same magnitude but is more responsive to mid-frequencies than to lower or higher frequencies. To quantify noise in a manner that approximates the response of the human ear, a weighting mechanism is used. This reduces the importance of lower and higher frequencies, in a similar manner to the human ear.

Furthermore, the perception of noise may be determined by a number of other factors, which may not necessarily be acoustic. In general, the impact of noise depends upon its level, the margin by which it exceeds the background level, its character and its variation over a given period of time. In some cases, the time of day and other acoustic features such as tonality or impulsiveness may be important, as may the disposition of the affected individual. Any assessment of noise should give due consideration to all of these factors when assessing the significance of a noise source.

The most widely used weighting mechanism that best corresponds to the response of the human ear is the 'A'-weighting scale. This is widely used for environmental noise measurement, and the levels are denoted as dB(A) or LAeq, LA90 etc, according to the parameter being measured.

The decibel scale is logarithmic rather than linear, and hence a 3 dB increase in sound level represents a doubling of the sound energy present. Judgement of sound is subjective, but as a general guide a 10 dB(A) increase can be taken to represent a doubling of loudness, whilst an increase in the order of 3 dB(A) is generally regarded as the minimum difference needed to perceive a change under normal listening conditions.

An indication of the range of sound levels commonly found in the environment is given in the following table:

Sound Level	Location
0 dB(A)	Threshold of hearing
20 to 30 dB(A)	Quiet bedroom at night
30 to 40dB(A)	Living room during the day
40 to 50 dB(A)	Typical office
50 to 60 dB(A)	Inside a car
60 to 70 dB(A)	Typical high street
70 to 90 dB(A)	Inside factory

Acoustic Terminology

dB (decibel)	The scale on which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the root-mean-square pressure of the sound field and a reference pressure (2x10-5Pa).
dB(A)	A-weighted decibel. This is a measure of the overall level of sound across the audible spectrum with a frequency weighting (i.e. 'A' - weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.
$L_{Aeq,T}$	L_{Aeq} is defined as the notional steady sound level which, over a stated period of time (T), would contain the same amount of acoustical energy as the A - weighted fluctuating sound measured over that period.
L_{Amax}	L_{Amax} is the maximum A - weighted sound pressure level recorded over the period stated. L_{Amax} is sometimes used in assessing environmental noise where occasional loud noises occur, 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}	If a non-steady noise is to be described it is necessary to know both its level and the degree of fluctuation. The L_n indices are used for this purpose, and the term refers to the level exceeded for n% of the time. Hence L_{90} is the level exceeded for 90% of the time.
Free-field Level	A sound field determined at a point away from reflective surfaces other than the ground with no significant contributions due to sound from other reflective surfaces. Generally as measured outside and away from buildings.
Background Sound	A sound field that represents a typical ambient sound level in a given location, free from any unusual sonic events, measured as an L_{90}. Background sound is usually the sound level against which the severity of the impact relating an intrusive noise is measured.

Appendix B

SURVEY RESULTS

Public

TIME HISTORY

Location MP1

Day results (07:00 – 23:00)

Date	Ambient, dB $L_{Aeq,T}$	Maximum, dB L_{AFmax}	Background, dB $L_{A90,T}$
08/05/2024	49	64	41
09/05/2024	51	66	39
10/05/2024	51	65	35
11/05/2024	48	71	36
12/05/2024	46	68	36
13/05/2024	46	68	34
14/05/2024	44	65	34
15/05/2024	46	70	36
Average	48	68	36
Range	33 - 61	52 - 88	20 - 48

Night Values – 23:00 – 07:00

Date	Ambient, dB $L_{Aeq,T}$	Maximum, dB L_{AFmax}	Background, dB $L_{A90,T}$
08/05/2024	-	-	-
09/05/2024	49	67	36
10/05/2024	44	58	25
11/05/2024	49	63	26
12/05/2024	52	59	26
13/05/2024	50	67	32
14/05/2024	50	65	28
15/05/2024	50	61	27
Average	50	63	29
Range	21 - 60	38 - 93	19 - 45

Location 2 – MP2

Day Values – 07:00 – 23:00

Date	Ambient, dB $L_{Aeq,T}$	Maximum, dB L_{AFmax}	Background, dB $L_{A90,T}$
08/05/2024	47	61	37
09/05/2024	48	61	36
10/05/2024	65	64	34
11/05/2024	56	63	35
12/05/2024	45	60	34
13/05/2024	45	60	33
14/05/2024	45	60	33
15/05/2024	50	61	34
Average	57	61	35
Range	27 - 83	46 - 102	21 - 47

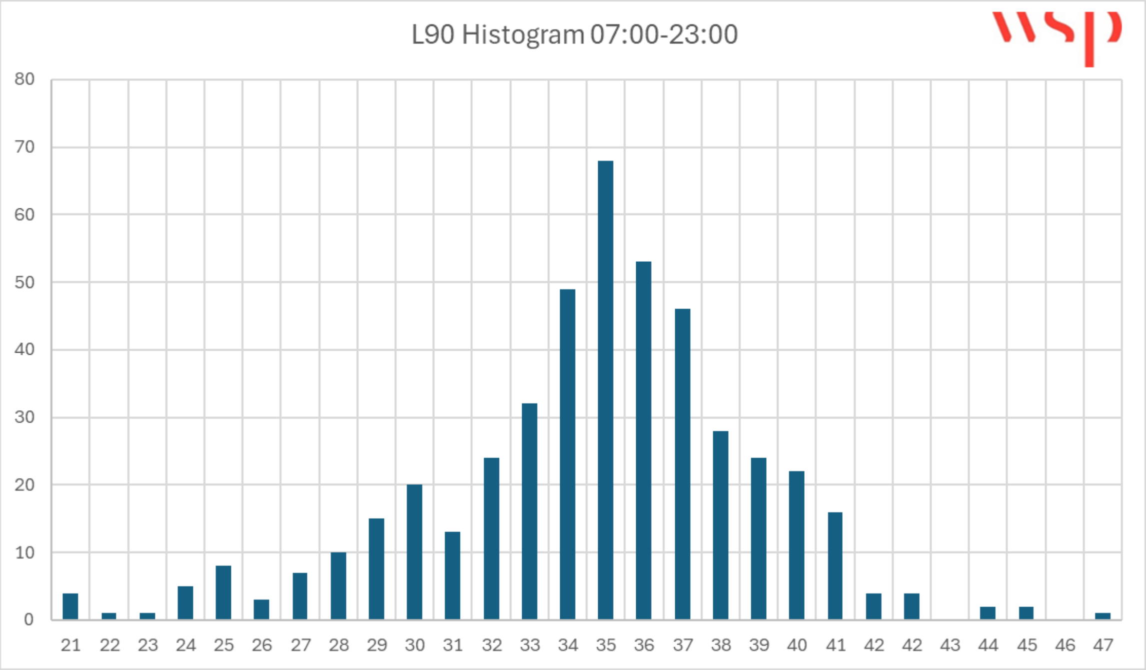
Night Values – 23:00 – 07:00

Date	Ambient, dB $L_{Aeq,T}$	Maximum, dB L_{AFmax}	Background, dB $L_{A90,T}$
08/05/2024	39	54	30
09/05/2024	43	57	32
10/05/2024	39	51	26
11/05/2024	40	53	26
12/05/2024	37	53	26
13/05/2024	39	51	32
14/05/2024	37	51	27
15/05/2024	38	48	27
Average	40	52	28
Range	21 - 50	29 - 72	20 - 41

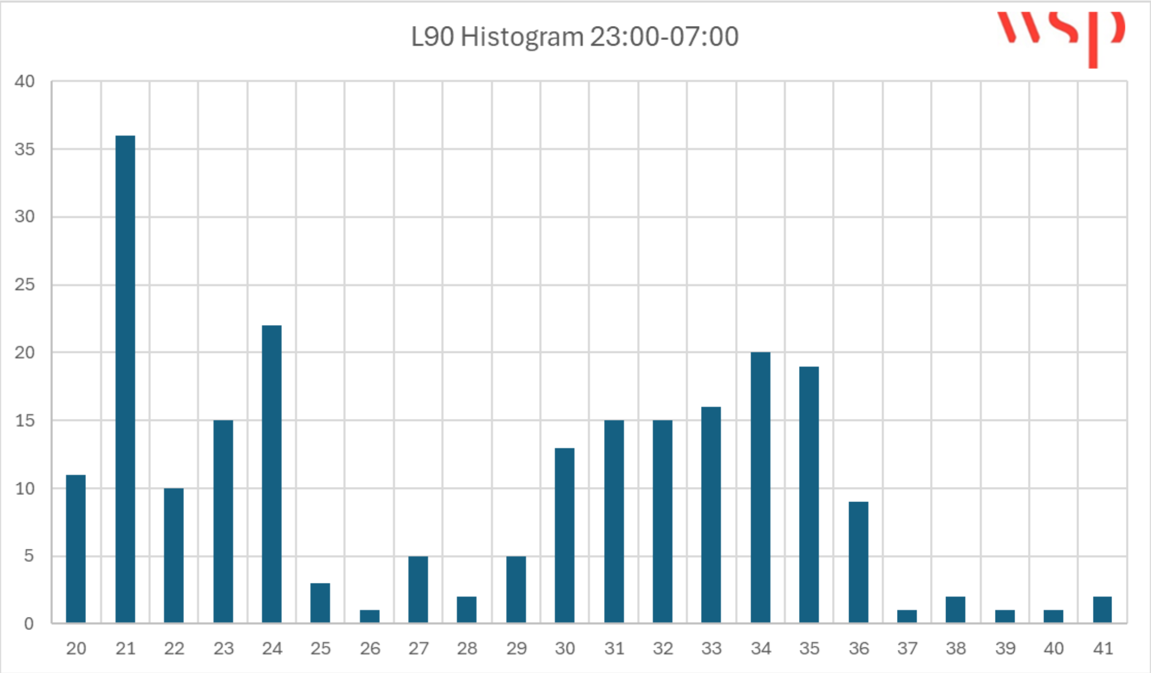
HISTOGRAMS

Location 1 – MP1

MP1 – L_{90} Day Values

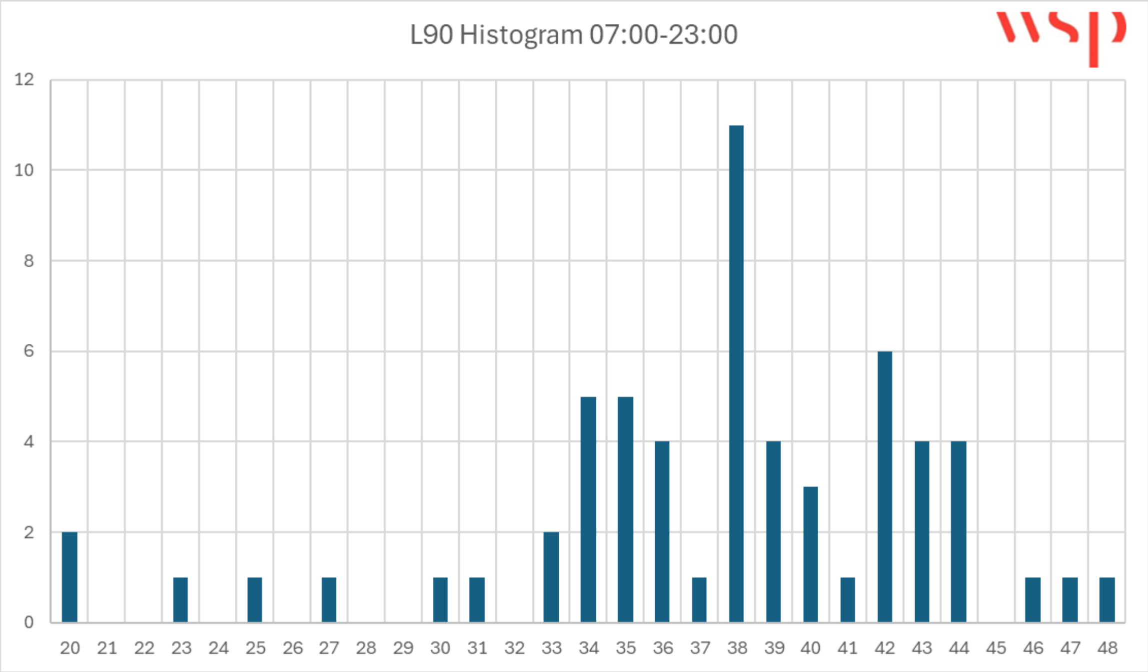


MP1 – L_{90} Night Values

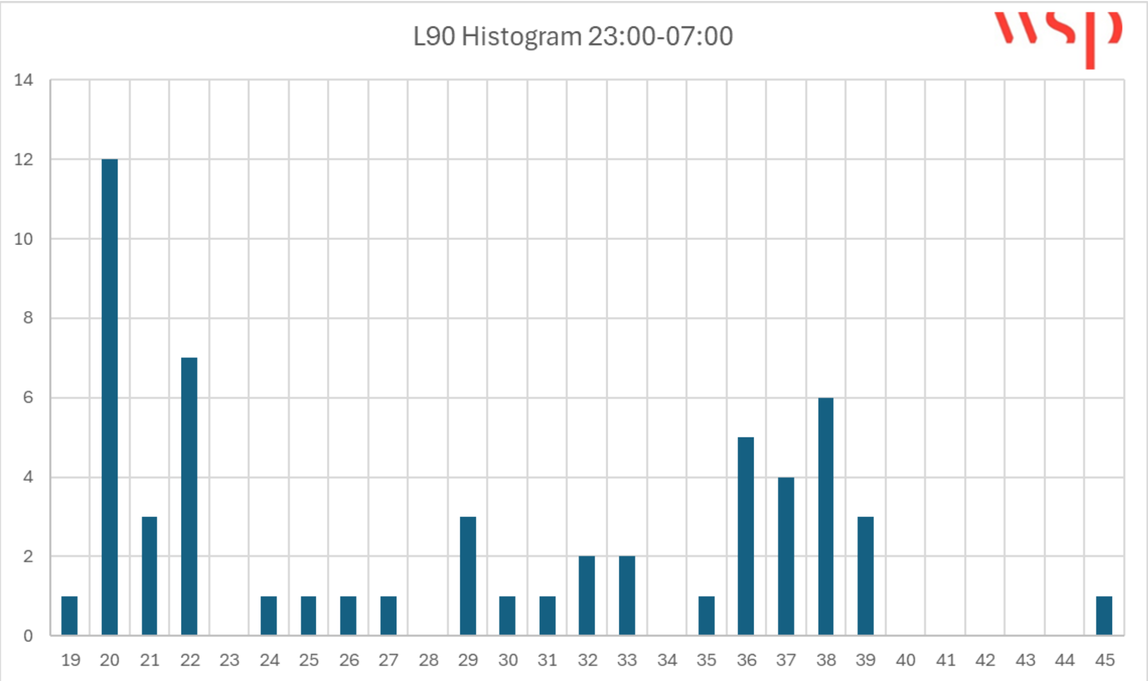


Location 2 – MP2

MP2 – L_{90} Day Values



MP2 – L_{90} Night Values



Appendix C

NOISE PLOTS

Noise predictions at 30% inverter speed without acoustic barrier

Noise predictions at 30% inverter speed with 5 m high acoustic barrier

Appendix D

LIMITATIONS TO THIS REPORT

Appendix E

SUPPLIER MODELLING RECOMMENDATIONS

DC System

The only noise source on the DC skids is the chiller in each cabinet. The matrix of Table 1 shows the C rates that can be covered by this chiller over a range of cooling loads and ambient temperatures.

The cooling loads are referred to in our DC noise test report, which provides measurements taken under cooling loads ranging from 10% to 100% of rated cooling load, at 10% intervals.

Table 1 C rates that can be covered by the DC chiller over a range of cooling loads and ambient temperatures.

	Ambient Temperature / °C						
Percentage of Max Cooling Load	5	10	15	20	25	35	45
30%							
40%							
50%							
60%							
70%							
80%							
90%							
100%							

Can cover 0.25C
Can cover 0.33C
Can cover 0.5C

We have conducted analysis of six months of 10-minute resolution data from a 50 MW / 100 MWh BESS operating in the UK market (so a nominal maximum C rate of 0.5C). Covering the period 22/06/2023 to 18/12/2023, this data represents both summer and winter. Table 2 shows the results of this analysis in terms of the proportion of time that C rate was below 0.33C, considering both charging and discharging.

Table 2 Percentage of times during which C rate was below 0.33C during six months of operation.

Scenario	**Proportion of All Times**
<0.33C anytime	97.5%
<0.33C during day (07:00-23:00)	98.2%
<0.33C during night (23:00-07:00)	99.3%

Evidently, C rates were below 0.33C more than 97% of the time. From Table 1 it is clear that this can be covered by a 40% cooling load at all temperatures up to and including 45 °C, and can be covered by a 30% cooling load at temperatures up to and including 25 °C. Temperatures in the UK rarely exceed 25 °C, particularly at night.

Therefore, **for 0.5C systems in the UK, we believe that is reasonable to use the noise test data for 30% DC system cooling load.**

AC System

Each AC skid contains two bi-directional inverters (known as power conversion systems, or PCSs) and one transformer, all of which generate noise. Our AC skid noise test report contains measurements made at 10% intervals of output power, where 100% represents the system operating at rated power.

Table 3 shows the proportion of times that C rates were below 0.2C and 0.25C during the six months of operation data referred to previously. These correspond to AC skid operating levels of 40% and 50% respectively.

Table 3 Percentage of times during which C rate was below 0.2C and 0.25C during six months of operation.

Scenario	Percentage of Rated Power	Proportion of All Times
<0.2C anytime	<40%	87.7%
<0.2C during day	<40%	91.2%
<0.2C during night	<40%	96.5%
<0.25C anytime	<50%	92.9%
<0.25C during day	<50%	94.9%
<0.25C during night	<50%	98.0%

As highlighted in Table 3 in green, it is found that daytime C rates are below 0.25C around 95% of the time and night-time C rates are below 0.2C about 96.5% of the time.

Therefore, **we believe that it is reasonable to use the noise test data for 50% AC output power to represent daytime operation and the noise test data for 40% AC output power to represent night-time operation.**

Note: It is important to recognise that our AC skid noise test measurements were made on an AC single skid, which contains one PCS and one step-up transformer, however at some sites we recommend our AC twinskid product, which contains two PCSs and one larger step-up transformer. In our analysis to date we have modelled a twinskid by doubling the sound power levels of a single skid.

Twinskid testing with a lower-noise fan option for the PCS will be conducted in the coming months.

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