parkerjones acoustics

Cleator Battery Storage Facility

Woodend, Cleator, Cumbria (CA22 2TA)

Noise Impact Assessment

13th November 2025

First Issue

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Revision History

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Executive Summary and Conclusions

ParkerJones Acoustics Limited (PJA) has been appointed to assess the noise implications of a proposed augmentation of the existing approved battery storage facility at Woodend Farm, Woodend, Cleator Moor, Cumbria, CA22 2TA.

The proposals involve installing updated battery and electrical equipment broadly within the footprint of the existing BESS. The site was originally approved under application 4/16/2263/0F1, with a later augmentation approved in 2022 (4/22/2335/0F1) but not implemented. This new application represents a revised form of that extension, retaining the established site layout and bunding while incorporating new-generation equipment.

This assessment has evaluated the noise emissions associated with the proposed augmentation, comparing the predicted levels from the new plant against those reported in the previously approved 2022 RES assessment (Ref: 04989-3775755), which underpinned planning approval 4/22/2335/0F1 and therefore provides the appropriate benchmark for determining acceptability.

Noise modelling has been undertaken using a worst-case scenario in which all items of plant are assumed to operate simultaneously at full output. The predicted specific sound levels at nearby residential receptors indicate that the proposed augmentation should not increase noise emissions relative to those previously accepted by the Local Planning Authority. At NSR 1 and NSR 2, the predicted levels are the same as those reported in the RES assessment (39 dB and 33 dB respectively), while at NSR 3 the predicted level reduces from 33 dB to 25 dB. These results demonstrate that the revised plant layout and equipment specification should not give rise to any worsening of noise impact and, at some locations, may offer an improvement.

As the RES assessment was accepted by the Local Planning Authority on the basis of compliance with WHO guideline values, and the predicted levels in this assessment are equal or lower at all receptors, the proposed augmentation would continue to meet the same criteria.

These conclusions are based on the plant layout shown in Section 2.0 / Figure 2.2 and the plant quantities and specifications set out in Section 4.2, which include the integrated rooftop silencers incorporated into the battery containers, the Noise Relief Covers applied to the MV Stations, and the assumed orientation of the units with their noisiest façades directed inward toward the existing compound rather than outward toward residential properties.

Contents

1.0 Introduction

ParkerJones Acoustics Limited (PJA) has been instructed to undertake a Noise Impact Assessment (NIA) in relation to the augmentation of the existing approved battery storage facility ('the proposed development') at Woodend Farm, Woodend, Cleator Moor, Cumbria, CA22 2TA ('the site'), assessing the potential noise impact on nearby residential dwellings.

The proposed development involves the installation of additional battery and generation equipment adjacent to the footprint of the existing Battery Energy Storage System (BESS). The site was originally approved under planning application 4/16/2263/0F1, with a further augmentation approved in 2022 under application 4/22/2335/0F1. However, the 2022 extension was never implemented. This new application therefore represents a revised form of that augmentation, utilising new generation equipment while retaining the previously approved site layout principles, including the established earth bunds, perimeter fencing, and overall site boundaries.

The purpose of this assessment is to:

- Determine whether the proposed development would result in any increase in overall site noise emissions compared with the levels predicted in the previously approved 2022 scheme, using a direct comparison between the predicted sound levels from this augmentation and those reported in the 2022 RES noise assessment (ref: 04989-3775755), which was accepted by the Environmental Health Officer (EHO) at the time.

- Identify whether any additional noise mitigation is required to ensure the resulting noise emissions remain consistent with, or no greater than, the levels previously accepted by the Local Planning Authority as part of the 2022 approval.

While every effort has been made to ensure that this report is accessible to readers without specialist knowledge of acoustics, some sections are necessarily technical. A glossary of acoustic terminology and concepts is provided in Appendix A.

2.0 Site and Development Description

The site is located at Woodend Farm, Woodend, Cleator Moor, Cumbria, CA22 2TA, as shown in Figure 2.1. It comprises an operational Battery Energy Storage System (BESS) situated within a parcel of previously developed land, enclosed by earth bunds approximately 4 m in height, with perimeter security fencing and gated access from the adjoining track.

An extension to the BESS was approved in 2022, although this was not implemented, and the site currently operates in its original form.

The current proposals relate to a new augmentation of the operational BESS, introducing additional battery and electrical plant within and adjacent to the footprint of the existing installation. No existing equipment is being removed or altered; the proposals consist solely of adding new plant. The new equipment includes:

- 6 no. Sungrow ST5015UX-4H-LN battery storage containers, each incorporating an integrated rooftop silencer above the cooling fan exhausts;
- 3 no. Sungrow MVS5140-LS MV Stations, each fitted with a 'Noise Relief Cover' designed to reduce airborne emissions from internal components.

The proposed layout is illustrated in Figure 2.2. The overall site configuration, boundaries, and earth bunding remain unchanged, with the new plant positioned broadly in the area previously identified for development in the unimplemented 2022 extension.

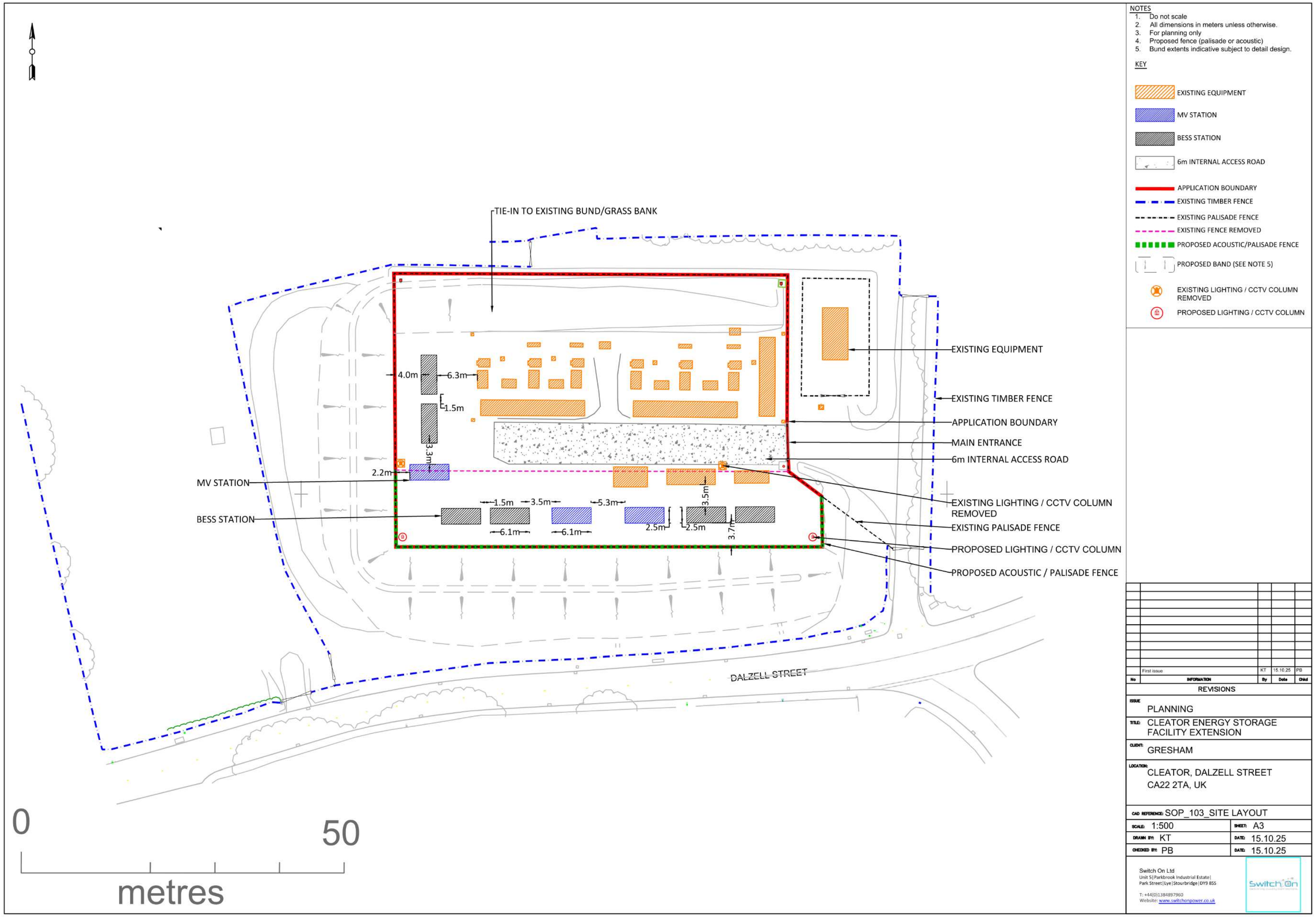
The new battery containers and MV Stations each have a "noisier" side associated with their ventilation systems. To minimise noise toward nearby homes, these louder sides would face inwards, toward the existing plant within the compound, rather than outward toward residential properties. A more detailed explanation of the plant orientation and the supporting manufacturer data is provided in Section 4.2.

For consistency with the 2022 RES Acoustic Impact Assessment, the same noise-sensitive receptors (NSRs) have been adopted in this assessment. Their model coordinates (replicated directly from the RES report) are:

- NSR 1 (H1) – X: 301076, Y: 512966.
- NSR 2 (H2) – X: 300974, Y: 512947.
- NSR 3 (H3) – X: 301292, Y: 513060.

Figure 2.1 – Aerial view of the site and surrounding area

Figure 2.2 – Proposed site layout



3.0 Planning Background and Relevant Guidelines

3.1 Planning History

The Cleator Battery Energy Storage Facility was originally approved under planning application 4/16/2263/0F1, permitting the development of a battery storage installation and associated infrastructure at Woodend Farm, Woodend, Cleator Moor. The approved layout established the current site boundary and the earth bund formation that remains in place.

However, the original planning application documents for the 2016 approval are not available on the public planning portal, and it has not been possible to verify whether any noise-related assessment or specific operational noise limits were submitted or imposed as part of that permission. A later assessment in 2022 (referenced below) stated that *"the existing scheme is assumed to be operating up to its conditioned limit of 35 dB L_{Aeq} at the nearest property"*, although no such planning condition is explicitly referenced or available to review.

A subsequent planning application, 4/22/2335/0F1, was submitted in 2022 for an extension/augmentation to the existing BESS. This application was supported by an Acoustic Impact Assessment prepared by RES (June 2022, report ref: 04989-3775755). As noted above, the RES report adopted an assumed existing noise level of 35 dB L_{Aeq} at the nearest residential receptor from the existing plant, and assessed the cumulative impact of the proposed new equipment against WHO guideline values (i.e. typically ≤50 dB L_{Aeq} during the day and ≤40–45 dB at night).

The Environmental Health Officer raised no objection to the proposal. The planning officer's delegated report stated:
"Following liaison with the applicant's acoustic consultant, it is considered that predicted noise levels for the development would not present a noise problem to residents."

The application was subsequently approved on 15th December 2022, and no specific planning noise condition or numerical noise limit was imposed.

Although fully approved, the 2022 extension was never implemented, and the site therefore remains in its original operational form associated with the 2016 permission.

3.2 World Health Organisation (WHO) Environmental Noise Guidelines

The World Health Organisation (WHO) has published a series of documents providing guidance on environmental noise and its potential health impacts. The Guidelines for Community Noise recommend that outdoor sound levels at residential properties should not exceed 45 dB L_{Aeq} at night, allowing people to sleep with windows open without being disturbed. During the daytime, the guidelines recommend that sound levels should not exceed 50 dB L_{Aeq} to protect the majority of people from being moderately annoyed.

The WHO has also published the Night Noise Guidelines, intended to complement the Guidelines for Community Noise. These recommend an outdoor nighttime limit of 40 dB L_{night}, expressed as a yearly average. As this metric represents an annualised value, it may be exceeded on some nights without conflicting with the Guidelines for Community Noise, provided that outdoor levels do not exceed 45 dB L_{Aeq} on those nights.

In line with the approach taken in the 2022 RES assessment, the predicted sound levels from the proposed development are therefore assessed against the WHO guideline values. Assuming a typical 15 dB attenuation through a partially open window, the outdoor WHO limits correspond to indoor levels of approximately 35 dB L_{Aeq} during the day and 30 dB L_{Aeq} at night, which are consistent with the internal noise criteria presented in BS 8233:2014 for dwellings used for sleeping or daytime resting.

4.0 Assessment

4.1 Previous Noise Assessment

A previous Noise Impact Assessment was undertaken by RES in support of the unimplemented 2022 extension (RES, June 2022; ref: 04989-3775755). The assessment modelled the noise emissions from the additional plant proposed at that time and evaluated the resulting cumulative sound levels at nearby residential receptors.

The RES assessment appeared to use 3D noise map modelling in accordance with ISO 9613-2, with propagation parameters and modelling assumptions set out in Section 3.1 of their report. Noise emissions from the extension plant were predicted using manufacturer data and the proposed layout (presented in Section 4 of the RES report).

These predicted plant noise levels were then added to an assumed existing BESS noise level. The RES report states that an existing BESS noise level of 35 dB L_{Aeq} was assumed at the nearest residential receptor (H1). However, the cumulative results presented in their Tables 4 and 5 suggest that lower existing noise contributions were applied at the more distant receptors (H2 and H3), including during the nighttime scenario, which explains why some of the cumulative values reported for those receptors fall below 35 dB. The RES report does not specify what existing levels were assumed at each receptor, nor the basis for any adjustments between daytime and nighttime periods, and therefore the exact cumulative calculation cannot be verified from the information provided.

The assessment considered separate daytime and nighttime scenarios, reflecting RES's assumption that plant noise emissions would reduce at night due to lower ambient temperatures and reduced cooling demand.

The predicted noise levels reported by RES (Tables 4 and 5 of the RES report) are summarised below:

Daytime cumulative levels:

- H1: Extension plant predicted at 43 dB → cumulative level 43 dB
- H2: Extension plant predicted at 36 dB → cumulative level 38 dB
- H3: Extension plant predicted at 36 dB → cumulative level 37 dB

Nighttime cumulative levels:

- H1: Extension plant predicted at 39 dB → cumulative level 40 dB
- H2: Extension plant predicted at 33 dB → cumulative level 35 dB
- H3: Extension plant predicted at 33 dB → cumulative level 34 dB

The resulting cumulative levels were compared against the relevant WHO guideline values, including the 50 dB L_{Aeq} daytime guideline, the 45 dB L_{Aeq} nighttime guideline, and the WHO Night Noise Guideline of 40 dB.

RES concluded that all receptors were compliant with WHO guideline values. In particular, the predicted cumulative nighttime level at H1 reached, but did not exceed, the WHO Night Noise Guideline value of 40 dB, while all daytime levels met the WHO daytime limit by a margin of at least 7 dB.

4.2 Proposed Plant / Source Noise Levels

The new plant forming the proposed augmentation, and expected to be the principal noise-emitting equipment, comprises:

- 6 no. Sungrow ST5015UX-4H-LN battery storage containers, each incorporating an integrated rooftop silencer above the cooling fan exhausts; and
- 3 no. Sungrow MVS5140-LS MV Stations, each fitted with a 'Noise Relief Cover' designed to reduce airborne emissions from internal components.

The noise emissions from the new plant have been modelled based on the manufacturer's noise testing reports provided to PJA by the client. Separate noise models have first been conducted to effectively replicate the set-up and results of these tests and therefore fine-tune how each BESS Container and MV Station is represented in the noise model, in order to ensure it is accurate. Further information on this process is provided in Appendix C.1 and C.2.

The noise emission data supplied by the manufacturer indicate that each item of plant has identifiable "noisiest" façades associated with ventilation intakes, exhausts, and cooling assemblies. The orientation of these façades can materially influence the resulting noise levels at nearby receptors. Accordingly, the noise model incorporates the following orientation assumptions:

- Sungrow MVS5140-LS MV Stations (Appendix C.1) - The test data indicate that the rear of each MV Station is the noisiest elevation. The model therefore assumes that the rear faces inwards toward the interior of the compound.
- Sungrow ST5015UX-4H-LN Battery Containers (Appendix C.2) - The test data show that the front of each battery container is the highest noise-emitting side. The model therefore assumes that the front faces inwards toward the interior of the compound.

As a worst-case, it is necessary to assess a worst-case 1-hour daytime period, and a worst-case 15-minute nighttime period. Thus, it is assumed that this worst-case scenario could involve all plant operating simultaneously during either period, at maximum capacity, and the results presented hereafter reflect this worst-case noise output.

In practice, the 'discharge' process is when noise emissions are at their maximum, with the cooling systems to all of the plant operating at a much higher capacity (and thus noisier level) during discharge compared to the majority of the day/night when energy is being drawn/stored. The discharge hours would be dictated by the demands of the National Grid, but would likely occur between around 07:30 and 20:30 rather than overnight, not for this whole period, but typically for up to 2 hours at a time.

The facility may also not necessarily charge batteries to full capacity (to preserve battery life) and thus could generally operate at around a 50% charging capacity.

The main source of noise is from the cooling systems, which may not need to run at 100% capacity in British weather conditions or may only need to run at this capacity on the hottest days of the year, or at peak operation. This may mean the cooling systems operate at a lower capacity for much of the year, and overnight (when temperatures are typically cooler compared to the daytime). Noise data for 'tick-over' conditions when the site is drawing/storing energy is not available at this stage, but from observations at an operational BESS facility, is thought to be much lower.

4.3 Predicted Plant Noise Levels at Receptors

The noise predictions in this report have been made using a noise model which has been constructed using the CadnaA® software package, a commonly used 3-D noise mapping software that implements a wide range of national and international standards, guidelines and calculation algorithms, including those set out in ISO 9613-2:1996. A full explanation of the noise modelling is provided in Appendix D, along with images and noise maps/results from the model.

The model has been configured to reflect the proposed plant layout shown in Figure 2.2, and the plant items and sound emission data described in Section 4.2 and Appendix C. All relevant residential properties in the surrounding area have been included as receptors, including those corresponding to the NSR locations identified in Figure 2.1.

Importantly, the model includes only the new plant forming the proposed augmentation. Noise emissions from the existing BESS installation have not been included, as the purpose of this section is to quantify the contribution from the new plant in isolation. This approach also avoids reliance on the cumulative methodology used in the 2022 RES assessment, the basis of which is not fully clear: although RES referred to an existing BESS noise level of 35 dB L_{Aeq} at the nearest receptor, the resulting cumulative levels imply lower existing contributions at NSRs 2 and 3, including at night, yet these assumed values were not stated.

In contrast to the RES assessment, which assumed a reduced nighttime operating mode for the cooling systems, PJA has adopted a worst-case scenario applicable at any time, with all new plant items assumed to operate simultaneously at full capacity. As such, no reduced nighttime noise output has been applied.

Predicted specific sound levels at typical ground-floor (1.5 m) and first-floor (4.5 m) window heights are presented in Figures D.2 and D.3, shown as coloured noise contours. Façade receptor points have been positioned 1 m from the façades, incorporating façade reflection as a reasonable worst-case.

A direct comparison (below) has then been made between PJA's predicted specific levels and the augmentation-related levels reported in the 2022 RES assessment. As noted above, PJA assumes a worst-case scenario that full-capacity operation could occur overnight, making the comparison on a nighttime basis appropriate. This demonstrates that:

- NSR 1: RES predicted a specific noise level of 39 dB, and PJA predicts the same level of 39 dB, indicating no change at the nearest receptor.
- NSR 2: RES predicted 33 dB, and PJA likewise predicts 33 dB, again indicating no change.
- NSR 3: RES predicted 33 dB, whereas PJA predicts a lower level of 25 dB, an 8 dB decrease

Overall, the proposed augmentation results in equal or lower noise emissions than those predicted for the previously approved 2022 extension.

4.4 Conclusions

This assessment has evaluated the noise emissions associated with the proposed augmentation of the Cleator Battery Energy Storage Facility, comparing the predicted noise levels from the proposed plant against those reported in the previously approved 2022 RES assessment (Ref: 04989-3775755), which underpinned planning approval 4/22/2335/0F1 and therefore provides the appropriate benchmark for determining acceptability.

Noise modelling has been undertaken using a worst-case scenario in which all items of plant are assumed to operate simultaneously at full output. The predicted specific sound levels at nearby residential receptors indicate that the proposed augmentation should not increase noise emissions relative to those previously accepted by the Local Planning Authority. At NSR 1 and NSR 2, the predicted levels are the same as those reported in the RES assessment (39 dB and 33 dB respectively), while at NSR 3 the predicted level reduces from 33 dB to 25 dB. These results demonstrate that the revised plant layout and equipment specification should not give rise to any worsening of noise impact and, at some locations, may offer an improvement.

As the RES assessment was accepted by the Local Planning Authority on the basis of compliance with WHO guideline values, and the predicted levels in this assessment are equal or lower at all receptors, the proposed augmentation would continue to meet the same criteria.

These conclusions are based on the plant layout shown in Section 2.0 / Figure 2.2 and the plant quantities and specifications set out in Section 4.2, which include the integrated rooftop silencers incorporated into the battery containers, the Noise Relief Covers applied to the MV Stations, and the assumed orientation of the units with their noisiest façades directed inward toward the existing compound rather than outward toward residential properties.

Appendix A – Acoustic Terminology and Concepts

A.1 – Glossary

Table A.1 – Glossary of acoustic terminology

Term	Description
dB (decibel)	The scale on which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio of the root-mean-square pressure of the sound and a reference pressure (2x10-5 Pa).
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.
Frequency	Sound can occur over a range of frequencies extending from the very low, such as the rumble of thunder, up to the very high such as the crash of cymbals. Sound is generally described over the frequency range from 63Hz to 4000Hz (4kHz). This is roughly equal to the range of frequencies on a piano.
$L_{Aeq,T}$	L_{Aeq} is defined as the notional steady sound level which, over a stated period of time, would contain the same amount of acoustical energy as the A-weighted fluctuating sound measured over that period. This parameter is typically considered as a good representation of the 'average' overall noise level. It is referred to technically as the A-weighted equivalent continuous sound level and is a dB(A) as defined above.
$L_{A90,T}$	The A-weighted noise level that is exceeded for 90% of the measurement period T. This parameter is often considered as the 'average minimum level'.
$L_{A10,T}$	The A-weighted noise level that is exceeded for 10% of the measurement period T. This parameter is often considered as the 'average maximum level';
$L_{AFmax,T}$	The maximum A-weighted noise level during the measurement period T.

A.2 – Subjective Changes in Noise Level

Table A.2 – Subjective loudness from an increase or decrease in sound pressure level

Change in sound pressure level	Relative change in sound power energy (multiplier)		Change in apparent subjective loudness (for mid-frequency range)
	Decrease	Increase	
3 dB	1/2	2	'Just perceptible'
5 dB	1/3	3	'Clearly noticeable'
10 dB	1/10	10	'Half or twice as loud'
20 dB	1/100	100	'Much quieter, or louder'

Appendix B – Relevant Planning Policies and Guidelines

B.1 – National Planning Policy Framework (NPPF)

The National Planning Policy Framework (NPPF) sets out the Government's planning policies for England and how these are expected to be applied. The NPPF provides a framework within which local people and their council can produce their own distinctive local and neighbourhood plans. With explicit reference to noise, the NPPF states that *"Planning policies and decisions should contribute to and enhance the natural and local environment by … preventing new and existing development from contributing to, being put at unacceptable risk from … noise pollution"*.

B.2 - Noise Policy Statement for England (NPSE)

The NPPF refers to the Noise Policy Statement for England (NPSE), which applies to most forms of noise including environmental noise. The NPSE sets out the long-term vision of Government policy which is to *"Promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development."*. It aims that *"Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:*

- *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 use of the terms *"significant adverse"* and *"adverse"* are key phrases within the NPSE. The guidance establishes the concept of how the level of adverse effect on health and quality of life can be referenced including:

- NOEL – No Observed Effect Level - This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.
- LOAEL – Lowest Observed Adverse Effect Level - This is the level above which *adverse* effects on health and quality of life can be detected.
- SOAEL – Significant Observed Adverse Effect Level - This is the level above which *significant adverse* effects on health and quality of life occur.

Under the first aim of the NPSE ("avoid significant adverse impacts on health and quality of life"), an impact in line with SOAEL should be avoided. Under the second aim ("mitigate and minimise adverse impacts on health and quality of life"), where the impact lies somewhere between LOAEL and SOAEL, requiring that all reasonable steps are taken to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development, but <u>does not</u> mean that such adverse effects cannot occur.

B.3 - Planning Practice Guidance on Noise (PPG-N)

The Planning Practice Guidance on Noise (PPG-N) is part of a suite of web-based guidance which is intended to support the implementation of the policies in the NPPF and the NPSE.

It aids in expanding on the definitions form the NPSE of NOEL, LOAEL and SOAEL, by linking these terms to 'examples of outcomes', i.e., changes in behaviour and/or attitude to noise. The table below summarises the guidance from PPG-N in this regard.

Table B.1 – Noise exposure hierarchy based on the likely average response – adapted from PPG-N

Perception	Examples of outcomes	Increasing effect level	Action
NOEL - No Observed Effect Level [1]			
Not noticeable	No Effect	No Observed Effect	No specific measures required
Noticeable and not intrusive	Noise can be heard but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.	No Observed Adverse Effect	No specific measures required
LOAEL - Lowest Observed Adverse Effect Level			
Noticeable and intrusive	Noise can be heard and causes small changes in behaviour and/or attitude, e.g., turning up the 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 perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
SOAEL - Significant Observed Adverse Effect Level			
Noticeable and disruptive	The noise causes a material change in behaviour and/or attitude, 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 a change in the acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Noticeable and very disruptive	Extensive and regular changes in behaviour and/or an inability to mitigate the effect of noise leading to psychological stress or physiological effects, e.g., regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g., auditory and non-auditory	Unacceptable Adverse Effect	Prevent
[1] This line is an assumption of the adverse effect level and is not explicitly referenced by PPG-N, though this appears to be a safe assumption.			

Appendix C – Proposed Plant

C.1 – New MV Stations

C.1.1 – Manufacturer Data

Figure C.2 overleaf presents extracts of the results from the sound pressure level measurements of a Sungrow MVS5140-LS unit (dimensions 6026mm x 2858mm x 2435mm), conducted by Sungrow Power Supply Co. Ltd in November 2023.

The tests were conducted in an outdoor location, with hard reflective ground, and no other reflectors within at least 10m. Sound pressure levels were measured at a 1m distance away at various points along each of the sides and top. Figure C.1 shows this setup.

The calculated sound power levels are shown in Figure C.3.

The MVS5140-LS-US that was under test consists of an MV transformer, an SCC (with LV busbar), and a container. The results presented herein are for the unit fitted with a 'Noise Relief Cover'.

It is seen from the test report that the predominant noise-emitting element from the MV Station is the rear vertical side, located presumably closest to where the necessary cooling/ventilation equipment is.

Figure C.1 – MV Station test environment

Figure C.2 – Measured sound pressure levels around the MV Station – taken from the manufacturer's test report

Tab. 3 Max. Sound Pressure Level of Each Surface (dBA) @ 1m

Working Conditions	Front	Right	Back	Left	Top	Expanded Uncertainty U/dB
Running at full power	54.8	50.6*	66.1	59.3	57.5	2.4

Note: "*" indicates that the background noise does not meet the standard ISO11201 but satisfies ISO11202. The value represents the upper limit of the sound pressure level under this condition (The difference between the average sound pressure level of the overall product and the background noise sound pressure level is less than 3 dBA. According to ISO11202, the correction value is set to -3 dBA).

Tab. 5 Sound Pressure Rate Levels Under 1/3 Octave

	Front	Right	Back	Left	Top
1/3 Octave (Hz)	**Sound Pressure Level , dBA**				
25	12.3	9.5	14.2	11.5	10.2
31.5	17.9	15.0	21.9	19.5	17.3
40	20.4	20.0	26.1	23.0	19.9
50	25.5	27.0	36.0	30.2	27.4
63	30.0	31.1	35.6	34.6	27.2
80	32.6	33.2	41.1	38.4	31.5
100	33.1	31.7	46.4	36.9	36.5
125	39.0	36.6	50.9	41.3	40.6
160	43.0	38.1	54.1	43.9	46.1
200	43.5	38.0	53.9	46.2	47.7
250	44.0	37.2	52.7	44.7	47.4
315	44.0	38.3	54.0	48.1	46.8
400	44.3	40.4	58.9	50.1	46.9
500	45.6	38.9	52.3	50.7	45.1
630	43.6	39.4	52.0	51.0	46.3
800	44.2	40.3	53.8	48.1	46.5
1000	43.1	39.4	54.2	47.2	45.7
1250	42.9	39.8	56.0	46.9	46.2
1600	41.8	39.3	54.7	46.9	44.7
2000	40.3	38.1	53.1	45.2	45.2
2500	38.9	36.2	53.3	44.6	43.2
3150	36.0	34.3	50.5	42.0	39.7
4000	32.7	31.3	48.5	39.1	35.8
5000	28.7	27.4	45.7	36.1	31.9
6300	24.0	21.4	40.5	30.6	26.7
8000	18.4	15.6	40.7	27.4	22.4
10000	12.8	8.1	35.1	23.1	18.1
12500	8.0	3.4	31.1	18.7	12.9
16000	4.1	1.2	27.7	12.8	8.6
20000	0.1	-1.5	20.2	5.5	1.6

Note: The bolded frequency values represent the center frequency of the octave.

Figure C.3 – Determined sound power levels produced by the MV Station – taken from the manufacturer's test report

Tab. 2 Sound Power Level Test Results

Working Conditions	Sound Power Level /dBA	Expanded Uncertainty U/dB
Running at full power	79.3	2.4

Note: The sound power level of the MV transformer is 63.8 dBA, which has a negligible impact on the overall sound power level test results and can be disregarded.

Tab. 4 Sound Power Levels Under 1/3 Octave

1/3 Octave (Hz)	Sound power level , dBA	1/3 Octave (Hz)	Sound power level , dBA	1/3 Octave (Hz)	Sound power level , dBA
25	33.3	**250**	67.4	2500	65.7
31.5	38.7	315	68.2	3150	62.7
40	43.2	400	70.3	**4000**	60.0
50	52.1	**500**	67.0	5000	57.4
63	52.7	630	67.4	6300	51.8
80	56.3	800	67.7	**8000**	48.5
100	60.0	**1000**	67.4	10000	43.6
125	64.7	1250	67.9	12500	39.2
160	67.8	1600	67.6	**16000**	34.6
200	67.5	**2000**	66.8	20000	28.2

Note: The bolded frequency values represent the center frequency of the octave.

C.1.2 – Noise Modelling

PJA has attempted to repeat the outdoor sound pressure level tests conducted by the manufacturer in order to effectively calibrate the model and ensure a high level of accuracy. The proprietary software CadnaA® has been used to do so, a 3-D noise mapping package that implements a wide range of national and international standards.

The MV Station has been modelled using the correct dimensions, with receptors placed 1m from the centre of each surface, at similar assumed heights to the measurement positions in the tests. The noise emissions have been modelled as a series of vertical area sources to reflect each individual vent and solid panel, with a horizontal area source representing the roof. For simplicity, the station has been modelled as a solid/flat cuboid (i.e. like a shipping container, as the geometry of the station seen in Figure C.1 is too complicated/unknown to represent in full detail). This is considered more accurate than simply modelling the whole station as a single point source, given the differing noise contributions from each element and therefore the overall directivity of noise propagation from the MV Station.

A base sound power level spectrum has been set based upon that in Figure C.3 (noting that this spectrum is with the A-weighting corrections applied, which has been accounted for in the modelling).

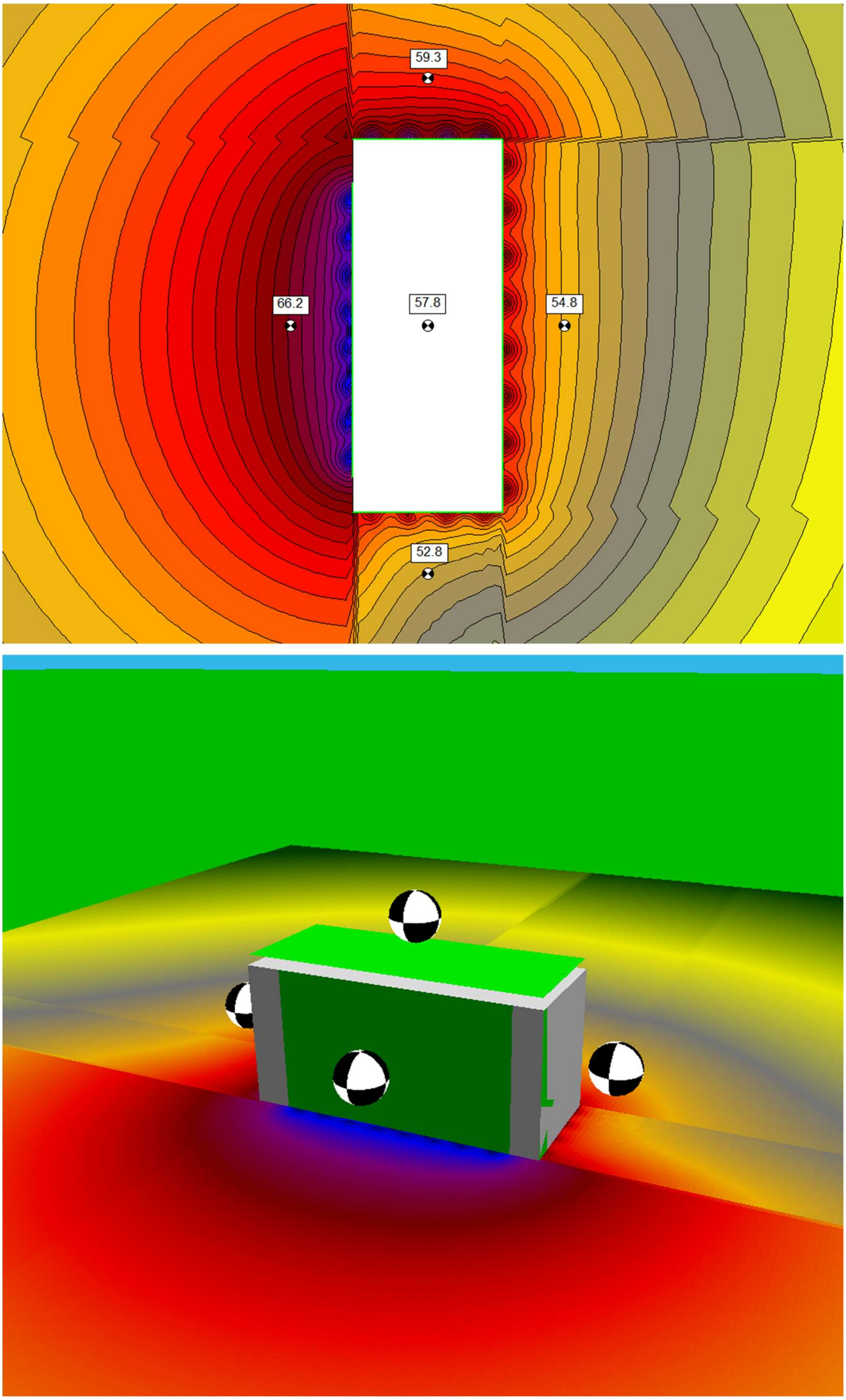
Each area source has then been adjusted by trial and error to adjust this spectrum to as closely match the average sound pressure levels recorded at each side (Figure C.2), to reflect the estimated noise contribution from each element (recognising that for example, the noise contribution from the element at the 'rear' of the unit is much higher than all other sides).

The source sound power levels have been adjusted so that the values at each receptor point are within 0.5 dB(A) of the values from the manufacturers' test – albeit with the exception of the 'right' side, which PJA have modelled as 2.2 dB(A) louder than the manufacturer's claim).

The model has been conducted in the free field with the exception of the floor which has been modelled as a hard, sound reflective surface. No other objects are included in this model (it is modelled in isolation to 'calibrate' the noise emissions from the MV Station, before being input into the model of the site).

Images from the noise modelling are shown in Figure C.4.

Figure C.4 – Noise modelling of a single MV Station under test conditions



C.2 – New Battery Containers

C.2.1 – Manufacturer Data

The figure below provides information on the dimensions and elevations of the battery cell (a Sungrow ST5015UX-4H-LN unit) which has been used to represent the noise emissions from the proposed battery container, taken from the manufacturers' brochure (https://us.sungrowpower.com/productDetail/2635/energy-storage-systems-powertitan-20-st5015ux-2h-us-st5015ux-4h-us). An additional 1m has been added to the battery height to account for the top fitted silencer (given that the extract from the ventilation system is atop the unit, directed upwards), making the container a total height of 3.9m.

Figures C.7 and C.8 overleaf present extracts of the results from the sound pressure level and sound power testing of (what appears to be the battery cell in Figure C.5) conducted by Sungrow Power Supply Co., Ltd.

The tests appear to have been conducted in an outdoor location with a hard reflective floor, away from other reflective surfaces, measuring the sound pressure level in 1/3 octave bands at 1m the centre point of all 4 sides of the container assumed approximately 1.5m above ground level, and 1m above the roof, that is, a total of 5 positions. In addition, sound power level testing was conducted with a total of 37 measurement positions enveloping the unit, at distances of 1.5m. Diagrams/photographs demonstrating this are shown in Figure C.6.

Figure C.5 – Battery cell container dimensions

Product name	ST5015UX-2H-US	ST5015UX-4H-US
DC side		
Cell type	LFP 3.2 V / 314 Ah	
Battery configuration	416S12P	
Nominal capacity	5015 kWh	
Nominal voltage range	1123.2 V ~ 1497.6 V	
AC side		
Nominal AC power	210 kVA * 12	210 kVA * 6
AC current distortion rate	< 3 % (Nominal Power)	
DC component	< 0.5 %	
Nominal AC voltage	690 V	
AC voltage range	607 V ~ 759 V	
Termination (LV)	352 A * 3 Phase * 6	352 A * 3 Phase * 3
Power factor	> 0.99 (Nominal Power)	
Adjustable range of reactive power	- 100 % ~ 100 %	
Nominal frequency	60 Hz	
Isolation method	Transformerless	
System parameter		
Dimension (W * H * D)	6058 mm * 2896 mm * 2438 mm 238.5'' * 114.0'' * 96.0''	
Weight	42500 kg / 93696.5 lbs	42000 kg / 92594.0 lbs
Degree of protection	Type 3S	
Anti-corrosion degree	C4	
Operation temperature range	- 30 ℃ ~ 50 ℃ (> 45 ℃ Derating) -22 °F ~ 122 °F (> 113 °F Derating)	
Operation humidity range	0 % ~ 100 %	
Max. operation altitude	3000 m / 9842.5 ft	
Temperature control method	Intelligent Liquid Cooling	
Fire suppression system	Default: NFPA 68 compliance vent panel, smoke and heat, detectors, Mini FACP Optional: Sprinkler, sound beacon, NFPA 69, compliance ventilation system, Flammable gas detector	
Communication	Ethernet	
Standard	UL 9540A, NFPA 855, NFPA 68, NFPA 69 (optional) IEEE 1547, UL 1973, UL 1741SB, UL 9540	

Figure C.6 – Test positions and photographs – taken from the manufacturer's test report

2.1 Test Environment

(1) Installation conditions: Open ground without reflecting planes.

(2) Ambient temperature:20℃

(3) Ambient humidity: 50%RH

(4) Positions of sound level microphones：

Sensor location in sound power level test (test distance d=1.5m, number of measuring points N=37).

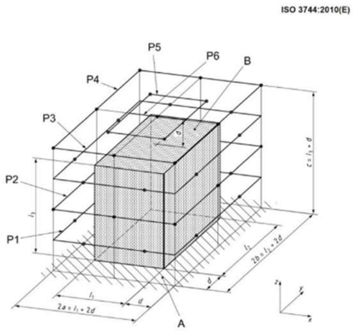


Fig. 1 Positions of Sound Power Level Microphones

Sensor location in sound pressure level test (test distance d=1m, noise on the front, rear, left, right, and top of the product are tested).

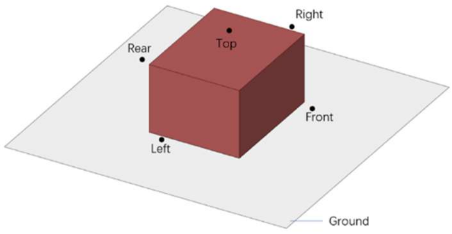


Fig. 2 Positions of Sound Pressure Level Microphones

(5) On-site test environment：

Fig. 3 Test Environment

(6) Background noise: 58.7 dBA

Figure C.7 – Measured sound pressure levels around the BESS Container – taken from the manufacturer's test report

Tab. 4 Maximum Sound Pressure Level Test Results of Positions 1m Away from the Surface

Working Conditions	Front/dBA	Right/dBA	Rear/dBA	Left/dBA	Top/dBA	Extended Measurement Uncertainty U/dB
0.25C_45℃ Ambient Temperature_100% Power	62.5	60.2*	55.8*	50.6*	69.9	2.4
0.25C_45℃ Ambient Temperature_80% Power	62.5	60.2*	55.8*	50.6*	69.9	
0.25C_45℃ Ambient Temperature_50% Power	59.8*	60.2*	51.4*	49.4*	59.8	
0.25C_35℃ Ambient Temperature_100% Power	59.7*	60.0*	52.1*	49.4*	62.0	

5

Tab. 20 Sound Pressure Level 1/3-Octave Spectrum(0.25C_35℃_100% Power)

1/3-Octave (Hz)	Front/dBA	Right/dBA	Rear/dBA	Left/dBA	Top/dBA
25	6.6	9.0	9.2	6.9	26.8
31.5	20.7	16.7	14.8	16.2	28.0
40	21.1	19.3	19.6	14.8	32.5
50	20.6	21.5	19.7	16.7	32.2
63	22.8	23.8	21.6	21.4	35.4
80	36.4	36.8	30.8	31.1	39.0
100	29.7	37.5	32.0	31.0	46.6
125	33.7	39.7	35.0	33.9	48.4
160	35.2	38.9	35.5	32.8	43.8
200	39.4	43.0	38.8	36.0	44.4
250	50.4	47.3	38.6	37.1	46.9
315	40.6	46.5	38.0	35.6	47.4
400	41.7	46.1	40.9	35.5	48.9
500	45.6	49.4	43.4	40.6	51.1
630	46.6	51.2	42.9	39.5	52.3
800	52.0	50.2	42.0	41.9	51.4
1000	55.2	51.1	41.7	39.6	51.7
1250	47.9	50.8	40.2	37.9	51.9
1600	45.3	47.4	39.6	35.4	50.9
2000	44.5	45.8	37.5	34.4	49.4
2500	46.5	47.4	37.4	33.0	48.4
3150	44.4	48.7	38.6	34.0	47.5
4000	39.3	39.4	34.1	28.9	45.9
5000	38.6	36.3	32.9	26.6	45.5
6300	36.3	33.4	32.5	23.8	45.0
8000	33.3	30.9	30.5	20.9	43.6
10000	29.0	24.8	28.0	15.7	42.4
12500	25.1	19.7	23.1	10.8	37.9
16000	19.3	13.9	17.5	8.4	35.4
20000	11.0	6.9	10.3	2.7	27.1

Figure C.8 – Determined sound power levels produced by the BESS Container – taken from the manufacturer's test report

Tab. 3 Sound Power Level Test Result

Working Conditions	Sound Power Level L_{WA} /dBA	Extended Measurement Uncertainty U/dB
0.25C_45℃ Ambient Temperature_100% Power	82.6	
0.25C_45℃ Ambient Temperature_80% Power	82.6	
0.25C_45℃ Ambient Temperature_50% Power	78.9*	
0.25C_35℃ Ambient Temperature_100% Power	79.5*	
0.25C_35℃ Ambient Temperature_80% Power	79.2*	2.4

Tab. 8 Sound Power Level 1/3-Octave Spectrum (0.25C_35℃_100% Power)

1/3-Octave (Hz)	Sound Power Level L_{WA} /dBA
25	34.4
31.5	36.7
40	43.3
50	43.8
63	49.3
80	54.3
100	60.7
125	61.8
160	61.0
200	62.3
250	65.3
315	65.4
400	65.9
500	68.6
630	68.8
800	69.3
1000	70.1
1250	70.5
1600	69.1
2000	68.4
2500	67.2
3150	66.0
4000	62.6
5000	60.1
6300	56.3
8000	53.4
10000	47.7
12500	42.5
16000	38.9
20000	26.2

C.2.2 – Noise Modelling

PJA has attempted to repeat the outdoor sound pressure level tests conducted by the manufacturer in order to effectively calibrate the model and ensure a high level of accuracy. The proprietary software CadnaA® has been used to do so, a 3-D noise mapping package that implements a wide range of national and international standards.

The Battery Container has been modelled using the correct dimensions, with receptors placed 1m from the centre of each surface, at similar assumed heights to the measurement positions in the tests. The noise emissions have been modelled as a series of vertical area sources to reflect each individual vent and solid panel, with a horizontal area source representing the roof.

A base sound power level spectrum has been set based upon that in Figure C.8 (noting that this spectrum is with the A-weighting corrections applied, which has been accounted for in the modelling).

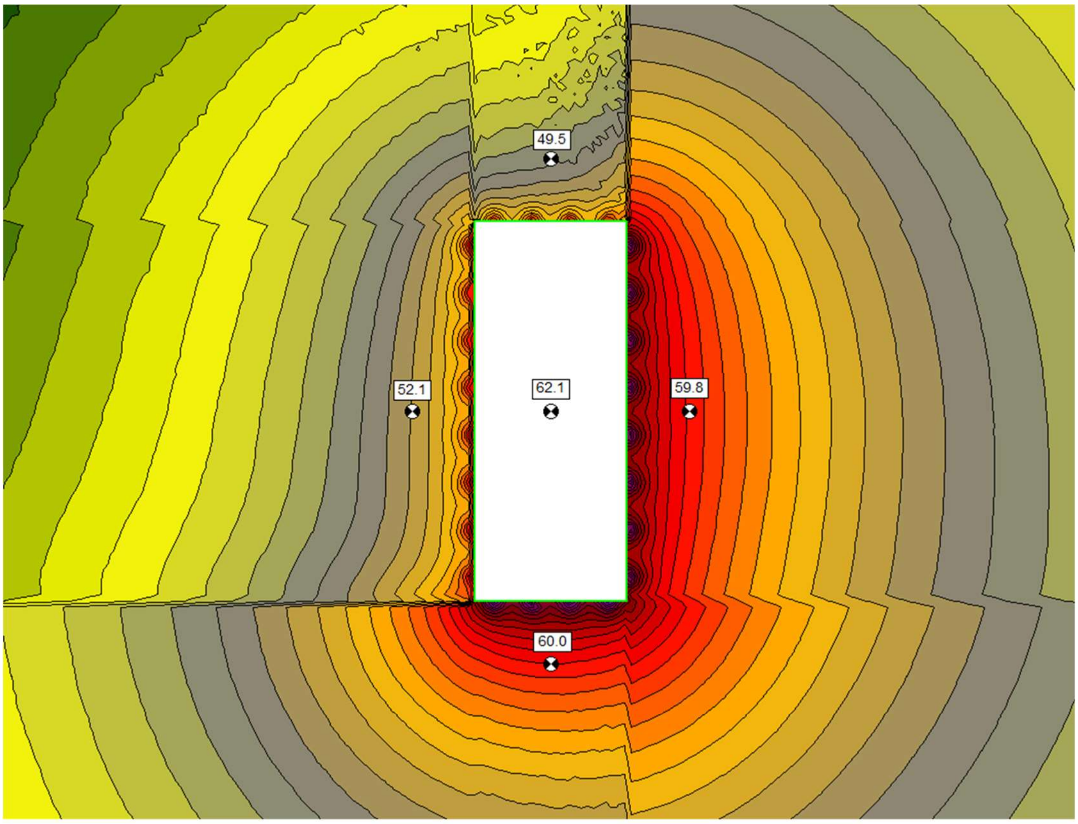
Each area source has then been adjusted by trial and error to adjust this spectrum to as closely match the average sound pressure levels recorded at each side (Figure C.7), to reflect the estimated noise contribution from each element (recognising that for example, the noise contribution from the top, front, and right sides of the unit is much higher than the rear and left sides).

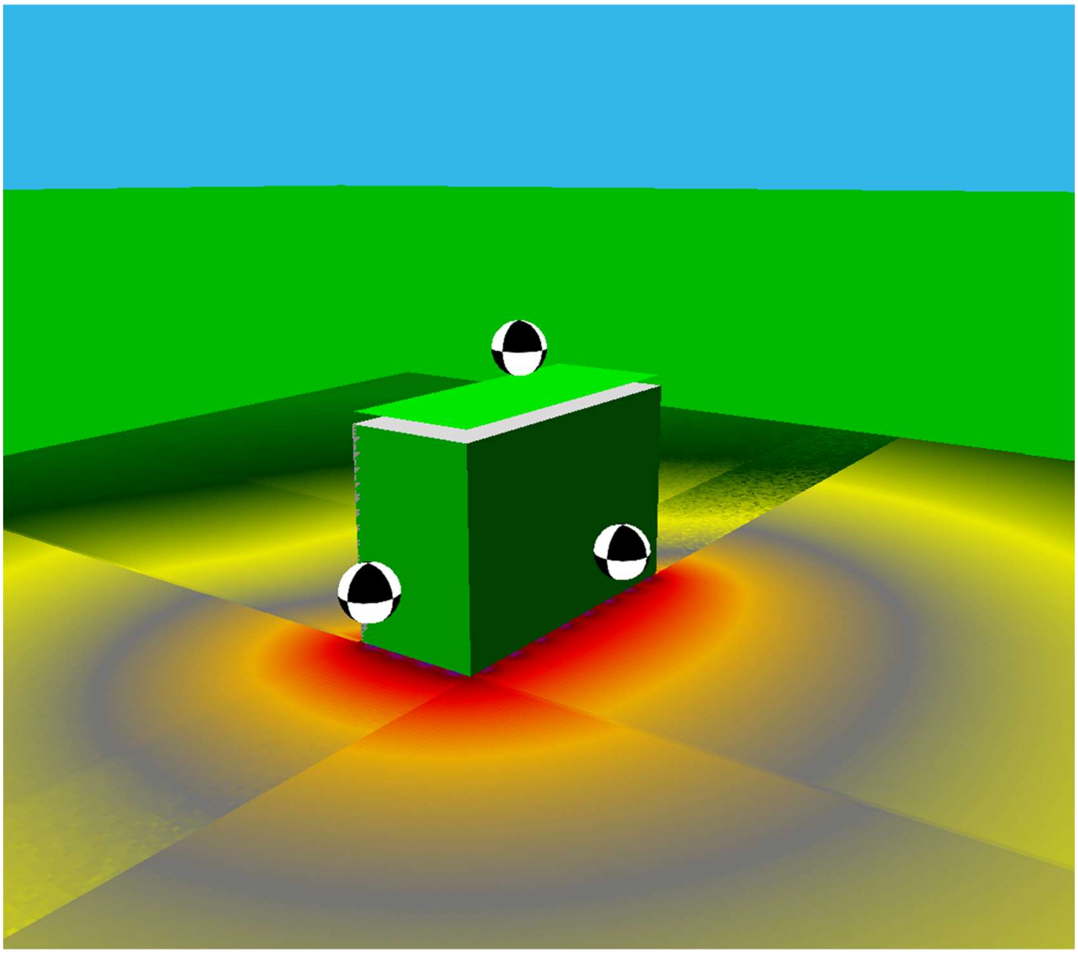
The source sound power levels have been adjusted so that the values at each receptor point are within 1 dB(A) of the values from the manufacturers' test.

The model has been conducted in the free field with the exception of the floor which has been modelled as a hard, sound reflective surface. No other objects are included in this model (it is modelled in isolation to 'calibrate' the noise emissions from the Battery Container, before being input into the model of the site).

Images from the noise modelling are shown in Figure C.9.

Figure C.9 – Noise modelling of a single Battery Container under test conditions





Appendix D – Calculations

The noise predictions within this report have been undertaken using the proprietary software CadnaA® by DataKustik, a 3D noise mapping package that enables detailed noise modelling and assessment in line with various national and international standards, including ISO 9613-2:1996. This software allows for the calculation of noise propagation over complex terrain, incorporating factors such as ground absorption, reflections, and meteorological conditions to provide accurate noise level predictions.

To create a representative model of the site and its surroundings, a combination of geospatial and site-specific data sources has been used. Building and road data have been imported from OpenStreetMap, ensuring that existing structures, roads, and other infrastructure are accounted for. Where OpenStreetMap data was incomplete or lacked sufficient detail, additional structures have been manually drawn based on available site information.

Building heights have been estimated using Google Earth Pro, utilizing the 3D view tool to determine elevation levels at the tops of buildings, roads, and other relevant structures. These heights have been manually inputted into the model to improve accuracy. The scaled site plans, floor plans, and elevations for the proposed development have also been incorporated to ensure the model accurately reflects the spatial arrangement of buildings and plant equipment.

The model assumptions and parameters include:

- Ground absorption factors of 0 for all hard, sound-reflective surfaces (site, roads, tarmacked areas), 1 in greenfield/agricultural land, and 0.5 in the curtilage of residential properties to represent mixed ground conditions.
- A maximum reflection factor of two, assuming buildings and barriers have a 'smooth' reflective façade as a worst-case scenario.
- Façade receptor points have been positioned at 1.5 m (ground floor) and 4.5 m (first floor), located 1 m from the building façade to account for reflection effects.
- Atmospheric sound absorption based on a temperature of 10°C and a humidity level of 70%, in accordance with Table 2 of ISO 9613-2:1996.
- Downwind propagation to represent a worst-case scenario, assuming a wind direction that enhances sound propagation from source to receptor.

The noise model has been used to predict L_{Aeq} noise emissions from the proposed plant sources, ensuring their contributions to the surrounding noise environment are fully considered. Noise levels (L_{eq}) have also been predicted in both 1/1 and 1/3 octave bands. The noise mapping results present the specific noise levels (L_{Aeq}) at the specified receptor heights, with no rating level penalties applied.

Figure D.1 – 3D view of the model setup

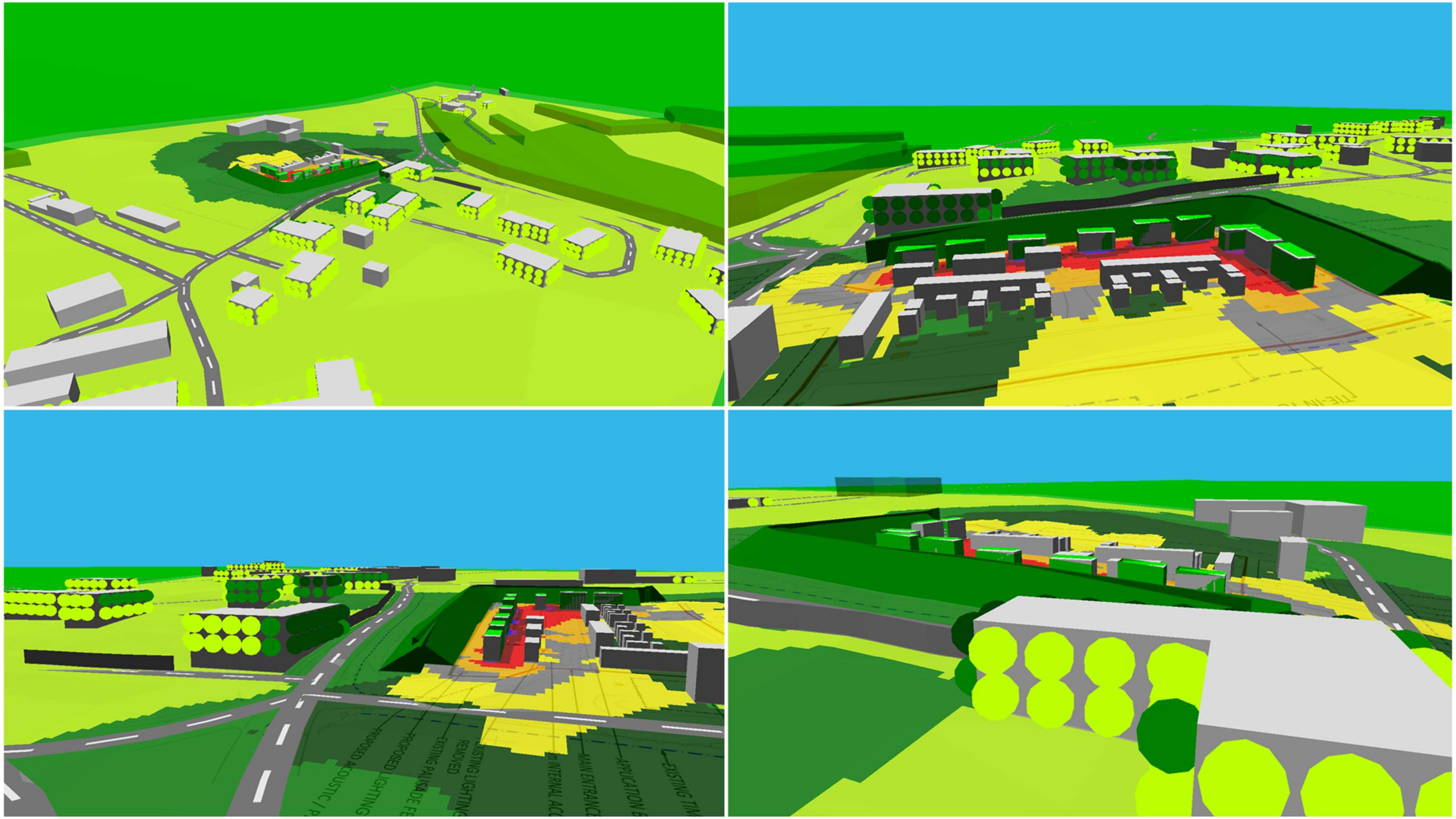


Figure D.2 – Predicted specific noise levels (dB L_{Aeq}) – worst-case with all new augmentation plant operating simultaneously at 100% capacity – ground floor height (1.5m)

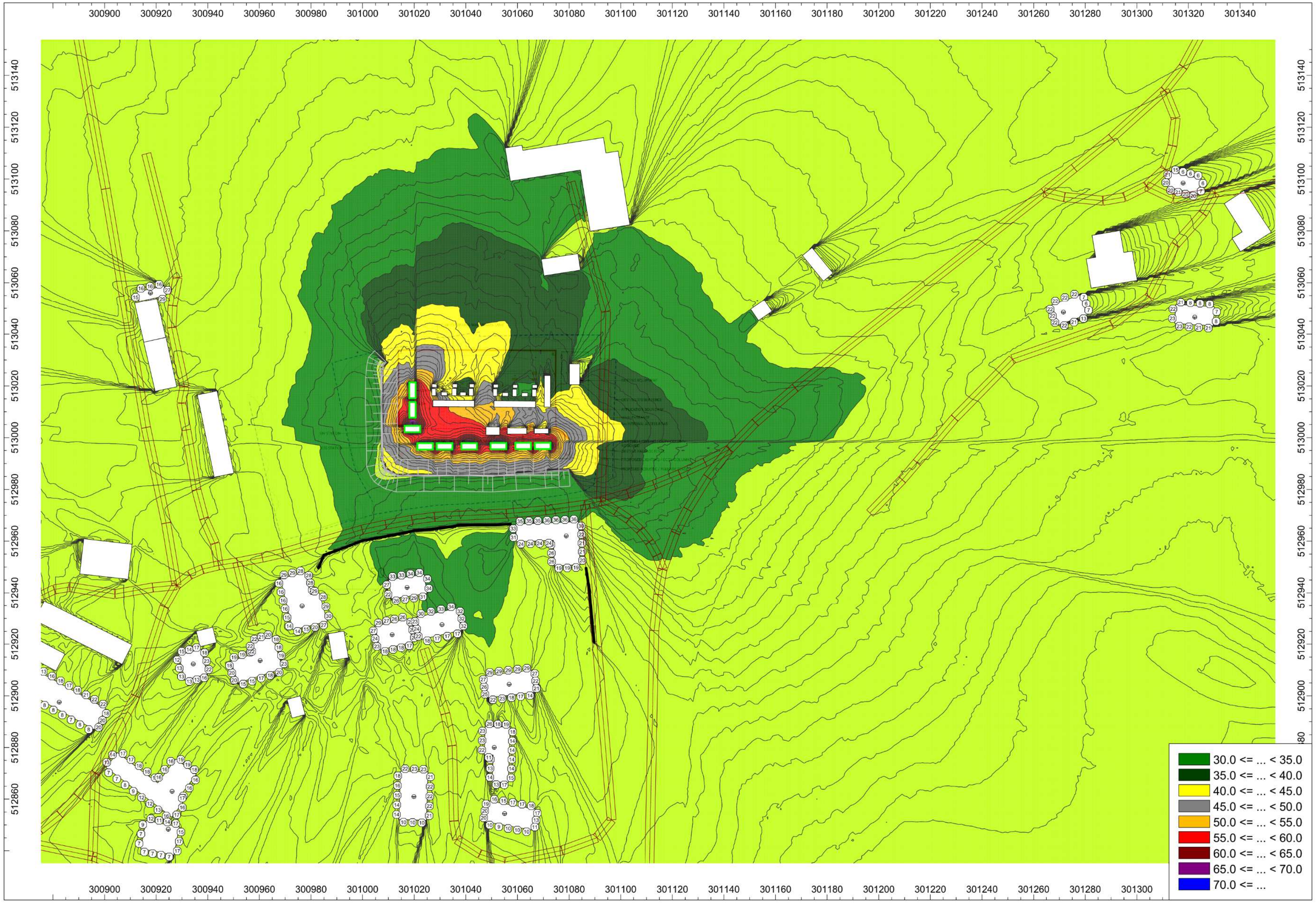
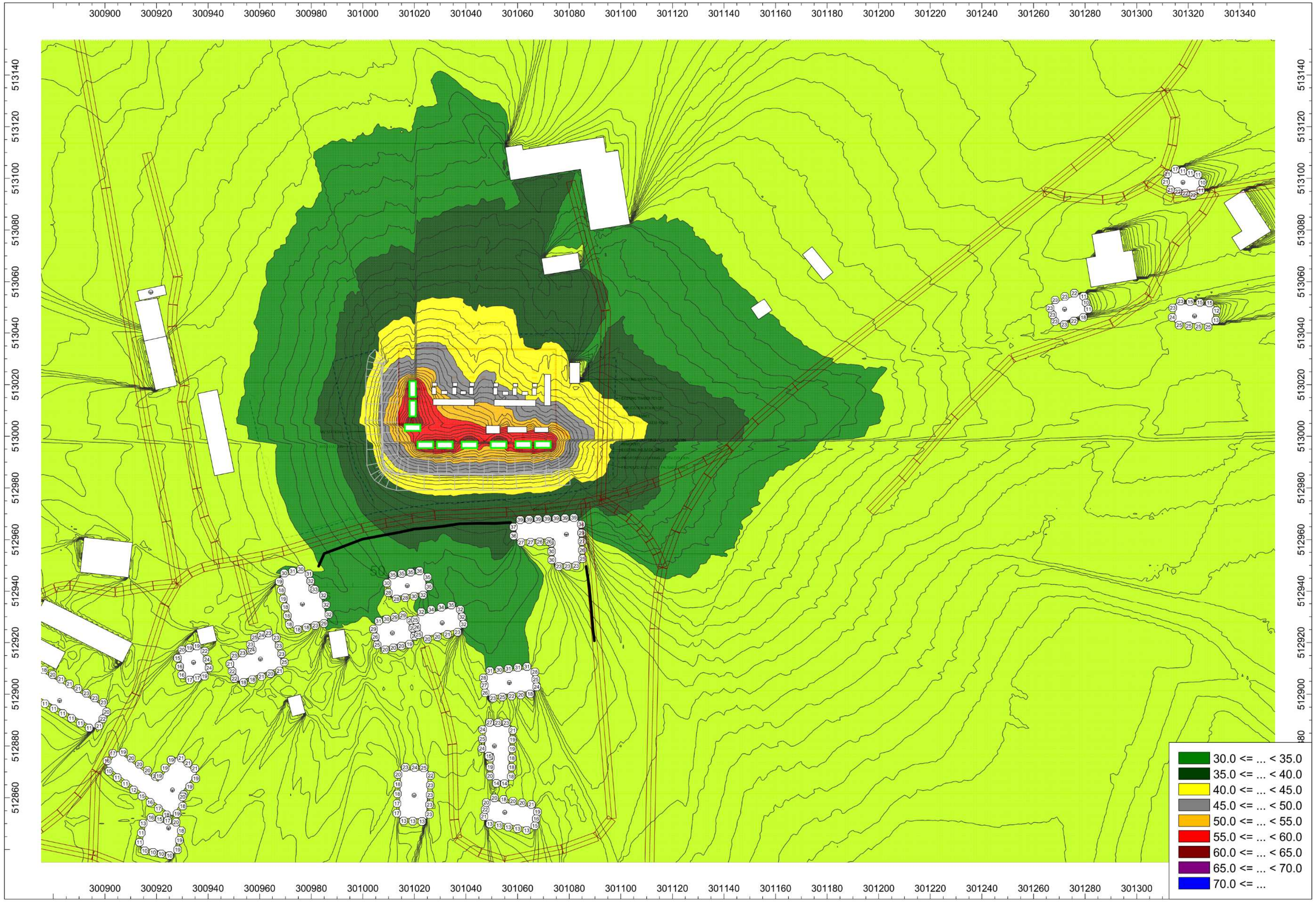


Figure D.3 – Predicted specific noise levels (dB L_{Aeq}) – worst-case with all new augmentation plant operating simultaneously at 100% capacity – 1st floor height (4.5m)



Appendix E - Author Qualifications

This report has been produced by Chris Parker-Jones, the director and primary acoustic consultant at ParkerJones Acoustics. Chris holds the following qualifications:

- MIOA (Member of the Institute of Acoustics)
- BSc in Music Systems Engineering from the University of the West of England – 1st Class
- MSc in Sound and Vibration Studies from the University of Southampton - Distinction

Chris has worked as an acoustic consultant for various companies since July 2011.

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