Machaire Battery Storage Project

Acoustic Assessment

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Contents

Revision History

Issue	Date	Name	Latest Changes	File References
01	26/02/2025	Mike Craven	Finalised	05511-9673425
02	05/03/2025	Mike Craven	Minor Updates	05511-9674052

1 Introduction

This report provides an acoustic assessment of the proposed Machaire Battery Storage Project, referred to as 'the Proposed Development' herein, in terms of operational impacts. Two Members of the Institute of Acoustics have been involved in its production and details of their experience and qualifications can be found in **Appendix A**.

An assessment of the sound generated by the equipment to be installed as part of the Proposed Development has been undertaken in accordance with BS 4142:2014+A1:2019 'Methods for Rating and Assessing Industrial & Commercial Sound' and with reference to guidance from World Health Organisation (WHO).

2 Planning Policy, Guidance & Standards

2.1 Noise Policy Statement for Northern Ireland (NPSNI)

The Noise Policy Statement for Northern Ireland (NPSNI) [1] sets out the long-term vision of Government noise policy which is to: *"1. Avoid or mitigate significant adverse impacts on health and quality of life; 2. Mitigate and minimise adverse impacts on heath and quality of life; and 3. Where possible, contribute to the improvement of health and quality of life."*. In order to weigh noise impacts against the economic and social benefits of the activity under consideration, the NPSNI defines three categories of effect levels:

- No Observed Effect Level (NOEL) - noise levels below this have no detectable effect on health and quality of life.
- Lowest Observed Adverse Effect Level (LOAEL) - the level above which adverse effects on health and quality of life can be detected; and,
- Significant Observed Adverse Effect Level - the level above which effects on health and quality of life become significant.

2.2 Strategic Planning Policy Statement for Northern Ireland (SPPS)

The SPPS for Northern Ireland [2] provides current policy regarding planning matters, referencing the NPSNI discussed above for further information. The document references noise throughout in respect of development that could generate noise and the positioning of new residential development near to existing noise generating facilities. Specific guidance is provided within Annex A of the document where it is stated that planning authorities *'… should seek to reach balanced decisions that consider noise issues alongside other relevant material considerations, including the wider benefits of the particular proposal'*.

2.3 Planning Policy Statement 18 (PPS18) - Renewable Energy

Planning Policy Statement 18 - Renewable Energy [3] *"… sets out the* [Department of Environments] *planning policy for development that generates energy from renewable resources and that requires the submission*

of a planning application". The document points to the Best Practice Guidance to PPS18 for further information.

2.4 Best Practice Guidance to PPS18 - Renewable Energy

The introduction to the current Best Practice Guidance to PPS 18 [4], as amended in 2019, states that the *"… guidance contained in Best Practice Guidance to PPS 18 - Renewable Energy will continue to have effect (where relevant) unless and until such guidance is updated, revised or replaced by new Departmental guidance on this planning issue"*. The guidance details the potential impacts associated with a variety of renewable energy development, with noise impacts from wind energy development being considered in some detail and the assessment methodology detailed within BS 4142:2014+A1:2019 (as discussed in **Section 2.5**) being referenced in respect of noise associated with planned biomass facilities. There is no suggested assessment methodology for determining impacts associated with battery energy storage facilities, however, based on experience, the BS 4142:2014+A1:2019 assessment methodology would also apply in this respect.

2.5 BS 4142 Methods for Rating and Assessing Industrial & Commercial Sound

BS 4142:2014+A1:2019 [5] describes methods for rating and assessing sound of an industrial or commercial nature. Outdoor sound levels are used to assess the likely effects on people who might be inside or outside a residential property via the comparison of the pre-existing background sound levels with the predicted/modelled sound associated with the introduction of a particular development, known as the 'rating' level, which also accounts for any distinguishing characteristics of the emitted sound.

To determine a value for the background sound level at a specific assessment point, a series of measurements are made at a location at, or representative of, a dwelling or receptor of interest. The standard requires that that the background sound measurements (dB $L_{A90,\,T}$ – the sound level exceeded for 90% of the time, or the lowest 10 % of sound, for the reference time period, T) should be measured during times when the sound source in question could or will be operating and that the individual measurement intervals should not normally be less than 15-minutes in length. The objective is then to determine a justifiable representative background sound level for time periods of interest via statistical analysis and/or observations of the data set collected. The standard states that the representative background sound level *"… should not automatically be assumed to be either the minimum or modal value"*.

The 'rating' level (dB L_{Ar}) is defined as the 'specific' sound level (dB L_{Aeq} – the average sound level) plus any adjustment for the characteristic features of the sound generated by the source in question. In instances where the source is unlikely to have a specific character at the assessment location then the 'rating' level can be assumed to equal to the 'specific' sound level. Where tones are present a correction of 2 to 6 dB can be added to the 'specific' sound level to determine the 'rating' level and further adjustments may be added where the source has other applicable characteristics.

The defined representative background sound level(s) and rating level(s) are then compared to determine the possible impact but with consideration of the context in which the industrial or commercial sound source to be introduced presents itself in respect of other sound sources and the existing character of the area. **Table 1** provides a summary of expected impacts when comparing background and rating levels.

Table 1 – BS 4142 Assessment Criteria

Rating Level	BS 4142 Assessment Criteria
Equal to or below background	*"…an indication of the specific sound source having a low impact, depending on the context".*
Approximately +5 dB greater than the background sound level	*"…an indication of an adverse impact, depending on the context".*
Approximately +10 dB or more greater than the background sound level	*"…an indication of a significant adverse impact, depending on the context".*

Further to the above, it may not be appropriate or proportionate to undertake a full assessment in accordance with the BS 4142 standard, particularly when the sound level associated with the new source is particularly low at neighbouring receptors and/or is expected to be much lower than the existing background sound levels. The previous version of BS 4142 [6] stated that this version of the standard is not appropriate for use in instances where background and rating levels are very low and that *"… background noise levels below about 30 dB and rating levels below about 35 dB are considered to be very low".*

2.6 World Health Organisation (WHO)

The WHO document Guidelines for Community Noise [7] provides guideline values for overall desirable internal and external noise levels for a variety of situations which are intended to minimise health impacts for certain environments.

The guidelines state that overall internal night-time sound levels should not be above 30 dB L_{Aeq} within bedrooms such that people may sleep with minimal disturbance while the windows are open and it is stated that this corresponds to an external night-time noise level of 45 dB L_{Aeq}, when assuming a 15 dB attenuation in sound levels externally to internally. Furthermore, the guidance recommends that daytime external levels should not exceed 50 dB L_{Aeq} to protect the majority of people from being moderately annoyed.

The Night Noise Guidelines for Europe [8] are described as complementary to the Guidelines for Community Noise and recommend a limit of 40 dB L_{night}, outside. This is a yearly average night-time sound level which could potentially be exceeded on some nights of the year such that it is not necessarily inconsistent with the Guidelines for Community Noise if the sound levels do not exceed 45 dB L_{Aeq} on those nights. However, on this basis, it is considered that a minimum limiting level of 40 dB L_{Ar} would be more than sufficient to protect the night-time and daytime amenity of local residents.

The WHO Environmental Noise Guidelines for the European Region [9] was published in 2018 and provides *"… recommendations for protecting human health from exposure to environmental noise originating from various sources: transportation (road traffic, railway and aircraft) noise, wind turbine noise and leisure noise"* and make a series of strong or conditional noise exposure recommendations for each based on the weight of evidence available at the time the report was being drafted. The document does not consider noise from industrial sources as the specific features of these sources are usually very localised and vary between different kinds of development.

2.7 NANR45 Procedure for the Assessment of Low Frequency Noise Complaints

NANR45 - Procedure for the Assessment of Low Frequency Noise Complaints [10] provides a generalised procedure and aid as to the investigation and assessment of low frequency noise (LFN) for instances where complaints occur. The procedure contains generic internal noise criteria, over a range of 1/3 octave bands, which can be referenced when determining whether a LFN issue exists. The values are intended as a guide and are not intended to be used as any fixed criteria for planning purposes or otherwise. However, they have been referenced here to provide context as to the potential sound levels resulting from the introduction of the Proposed Development in the low frequency range. The values are provided in **Table 2** for reference with the corresponding A-weighted levels also shown.

Table 2 - NANR45 Internal Low Frequency Noise Criteria

ID	Centre of 1/3 Octave Band, Hz												
	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
Linear, dB L_{eq}	92	87	83	74	64	56	49	43	42	40	38	36	34
A-Weighted, dB L_{Aeq}	22	23	27	24	19	17	15	13	16	18	19	20	21

2.8 Local Guidance & Consultation

Causeway Coast and Glens Borough Council do not have any specific planning guidance in relation to operational sound from new sound generating development. However, the Environmental Health Department were contacted to present and agree the extent of the acoustic assessment, as provided in this report. This included reference to the BS 4142 assessment methodology as being appropriate for use; the scope out of any assessment of cumulative operational sound impacts with other development in the area; and, the agreement of suitable measurement locations at or near to properties neighbouring the Proposed Development.

The Environmental Health Officer (EHO) dealing with the Proposed Development also requested that some consideration of the potential for low frequency sound generated by the Proposed Development is also provided.

3 Baseline Environment

A survey of the existing background and ambient sound levels was undertaken at three locations considered representative of the environment at properties neighbouring the Proposed Development (L1, L2 & L3), as agreed with the EHO. The monitoring locations are marked in **Figure 1 - Section 5**.

Sound level meters (SLMs) were installed at the identified measurement locations between 25th September and 1st October 2024 with the equipment setup to collect average residual (dB L_{Aeq}) and background (dB L_{A90}) sound levels in consecutive 15-minute intervals along with various other statistical parameters throughout the week-long survey period.

The equipment was housed with appropriate outdoor protections and uprated microphone wind shields. The microphones were placed at a height approximately 1.3 m above the ground, in free-field conditions and the equipment was field calibrated at the start of the survey and checked at the end, with the drift in calibration level being well within normal tolerances.

A meteorological station was located beside Location 2 (L2) which obtained wind speed and precipitation information throughout the survey period for the same time intervals such that the data collected from the sound level meters may be readily filtered to remove any data considered to be affected by adverse weather conditions and/or the sound associated with the pattering of rain on the measurement equipment and its surroundings.

The measurement setup at each survey locations are shown in **Appendix B** of this report.

The current sound environment at properties surrounding the site typically consists of occasional traffic along local roads, birdsong, sound from farm machinery, wind in the trees and foliage, farm stock, the pattering of rain, localised human activities and aircraft overhead.

The sound level meters used for the measurement campaign, corresponding serial numbers and calibration records are shown in **Table 3**.

Table 3 - Instrumentation Records

Location	L1	L2	L3
Type	RION NL-52	RION NL-52	RION NL-52
Serial No.	00721031	00732144	00610207
Calibration Certificate No.	UCRT23/2232	UCRT24/1272	UCRT24/1086
Date of Issue	18/09/2023	19/02/2024	17/01/2024
Microphone Serial No.	21981	05336	24815
Preamp Serial No.	22137	32172	10201
Calibrator Type		NC-74	
Calibrator Serial No.		34315132	
Calibrator Certificate No.		UCRT23/2386	
Date of Issue		23/10/2023	

The data sets were filtered to remove periods where measured wind speeds were above 5 $m.s^{-1}$ and where any precipitation was detected during any 15-minute measurement period.

The adopted background (dB L_{A90}) and residual (dB L_{Aeq}) sound levels have been determined from statistical analysis and observations of the remaining filtered data sets collected during daytime (07:00 – 23:00) and night-time (23:00 – 07:00) periods respectively for all measurement locations. The median value of the filtered data sets has been used as a reasonable basis of assessment.

Figures showing the collected data sets and background and ambient/residual sound analysis are provided within **Appendix C** of this report. The results are summarised in **Table 4**.

Table 4 - Existing Background & Residual Sound Levels

ID	Co-ordinates (ITM, EPSG 2157)		Background Sound Level, dB L_{A90}		Residual Sound Level, dB L_{Aeq}	
	Easting	Northing	Daytime	Night-time	Daytime	Night-time
L1	296916	414757	37	32	42	35
L2	297233	414417	37	29	42	34
L3	296837	414219	40	28	48	39

A list of locations considered representative of residences located closest to the Proposed Development is provided in **Table 5** as also shown in **Figure 1, Section 5.**

Table 5 - Assessment Locations

ID	Co-ordinates (ITM, EPSG 2157)		ID	Co-ordinates (ITM, EPSG 2157)	
	Easting	Northing		Easting	Northing
H1	296877	414778	H4	296583	414367
H2	297250	414406	H5	297025	414741
H3	296801	414184	H6	296816	414758

4 Predictions

A model of the battery storage facilities, including the site surroundings has been developed using CadnaA[1] sound modelling software. The ISO 9613-2 [11] sound propagation/prediction methodology has been employed to predict the specific sound levels resulting from the development at nearby residential properties, incorporating various assumptions and factors which are considered appropriate for use here:

- The various plant to be installed as part of the development has been modelled as point sources with a height of 2 m and these sources are assumed to be operating at their near maximum potential output for all time periods as a conservative basis of assessment;
- Soft ground conditions have been assumed (i.e. G=1) as representative of the farmland surrounding the Proposed Development. The ISO 9613-2 standard allows for a range of ground conditions to be applied, from porous ground conditions (G=1), which includes surfaces suitable for the growth of vegetation (i.e. farmland), to hard ground (G=0), such as paving, water and concrete;
- The receptors have been assigned a height of 1.5 m;
- Atmospheric attenuation corresponding to a temperature and relative humidity of 10 ˚C and 70 % respectively, as defined within ISO 9613-1 [12], which represents relatively low levels of sound absorption in the atmosphere;

[1] https://www.datakustik.com/

- The topography of the site and surroundings has been included within the model; and,
- A 4 m high barrier of suitable mass and density surrounding the battery storage facility and substation as an 'embedded' mitigation measure.

Furthermore, ISO 9613-2 is a downwind propagation model. Where conditions less favourable to sound propagation occur, such as when the assessment locations are upwind of the Proposed Development, the levels would be expected to be less and the downwind predictions presented as part of this report would be regarded as conservative, i.e. greater than those likely to be experienced in practice.

The predominant sources of sound to be introduced as part of the Proposed Development are the inverters/power conversion system (PCS) units, attached transformers, battery storage containers and substation transformer(s).

The site has been designed on an iterative basis with a view to minimising, as far as practicably possible, the projected operational sound levels with due regard to the relative sensitivity of neighbouring premises and all other site constraints.

The assumed sound power data for the equipment to be installed as part of the Proposed Development are provided at **Table 6**. The overall levels correspond to the maximum expected sound output for each of the respective plant that will be available at the time of potential procurement/installation, should the site be granted planning consent, and as advised by candidate manufacturers.

Table 6 - Overall Sound Power Levels, dB L_{WA}

Equipment & ID	Sound Power Level, dB L_{WA}
Battery Energy Storage System (BESS)	68
Power Conversion System (PCS)	80
Transformer (TRA)	76
Substation (SUB)	90

The source data is further supplemented by the level of sound in octave and 1/3 octave bands, as provided at **Tables 7 & 8**. This information is based on a combination of expected manufacturers data and RES experience of similar plant.

Table 7 - Octave Band Sound Power Levels, dB L_{WA}

ID	Overall, dB L_{WA}	Centre of Octave Band (A-Weighted), Hz							
		63	125	250	500	1k	2k	4k	8k
PCS	80	55	65	75	73	73	72	69	63
BESS	68	56	60	61	61	63	58	48	41
TRA	76	41	62	70	74	64	57	51	49
SUB	90	55	77	85	88	78	71	65	64

The combination of assumptions detailed above are considered to provide a conservative prediction/modelling basis overall. The results of the predictions at the various residences surrounding the Proposed Development are shown in **Section 5**.

Table 8 - 1/3 Octave Band Sound Power Levels, dB L_{WA}

ID	Centre of 1/3 Octave Band (A-Weighted), Hz											
	50	63	80	100	125	160	200	250	315	400	500	630
PCS	47	49	52	55	59	62	69	72	69	66	69	68
BESS	47	53	53	53	56	56	54	56	57	55	57	57
TRA	28	35	39	62	45	44	67	55	68	72	67	65
SUB	43	50	54	77	60	59	81	69	82	86	82	79
ID	**800**	**1k**	**1.25k**	**1.6k**	**2k**	**2.5k**	**3.15k**	**4k**	**5k**	**6.3k**	**8k**	**10k**
PCS	68	69	68	68	67	66	65	64	63	61	57	54
BESS	59	59	57	56	52	49	46	43	40	37	37	31
TRA	59	59	59	53	52	51	48	44	45	46	43	42
SUB	73	74	74	68	66	65	62	59	60	61	58	57

The sound emitted by the various equipment to be introduced as part of the Proposed Development can occasionally have distinctive tonal character (i.e. a whine, whistle or hum). Under the subjective method described in BS 4142, a correction of 2 dB has been applied to account for this feature. However, the assessed specific and rating sound levels detailed in **Section 5** are particularly low and potential tonal character in the sound emitted from the various plant may well be masked by existing sources of sound in the area.

A warranty and/or guarantee will be sought from the manufacturers of the equipment to be installed as part of the Proposed Development that limits the potential for a tonal character to be present in the sound generated. This will allow for appropriate recourse with the manufacturer in the instance that tones (in the low frequency region or otherwise) be present in practice, should the site become operational.

5 Assessment

The predicted specific sound and corresponding rating levels (i.e. including for a 2 dB penalty for tonal character) at the properties located nearest to the Proposed Development are shown in **Table 9**. The rating level is compared to the background sound levels detailed in **Section 3**, which are applied to each of the assessment locations for which the nearest existing sound level information is available, to provide the associated impact.

The impact is described as 'negligible' if the rating level is 10 dB or more below the determined background sound level; 'low' if the rating level is less than or equal to the background sound level; 'minor' if not more than 5 dB above; 'moderate' if not more than 10 dB above and major if more than 10 dB above. These criteria compare to the categories defined by the NPSNI, with rating levels less than or equal to background sound level plus 5 dB representing the NOEL, greater than 5 dB above background representing the LOAEL and greater than 10 dB above background the SOAEL.

An illustrative sound footprint for the proposed development showing the predicted specific sound level (dB L_{Aeq}) is provided in **Figure 1**. The background sound survey locations are marked in red.

Figure 1 - Specific Sound Level Contour Plot, dB L_{Aeq}

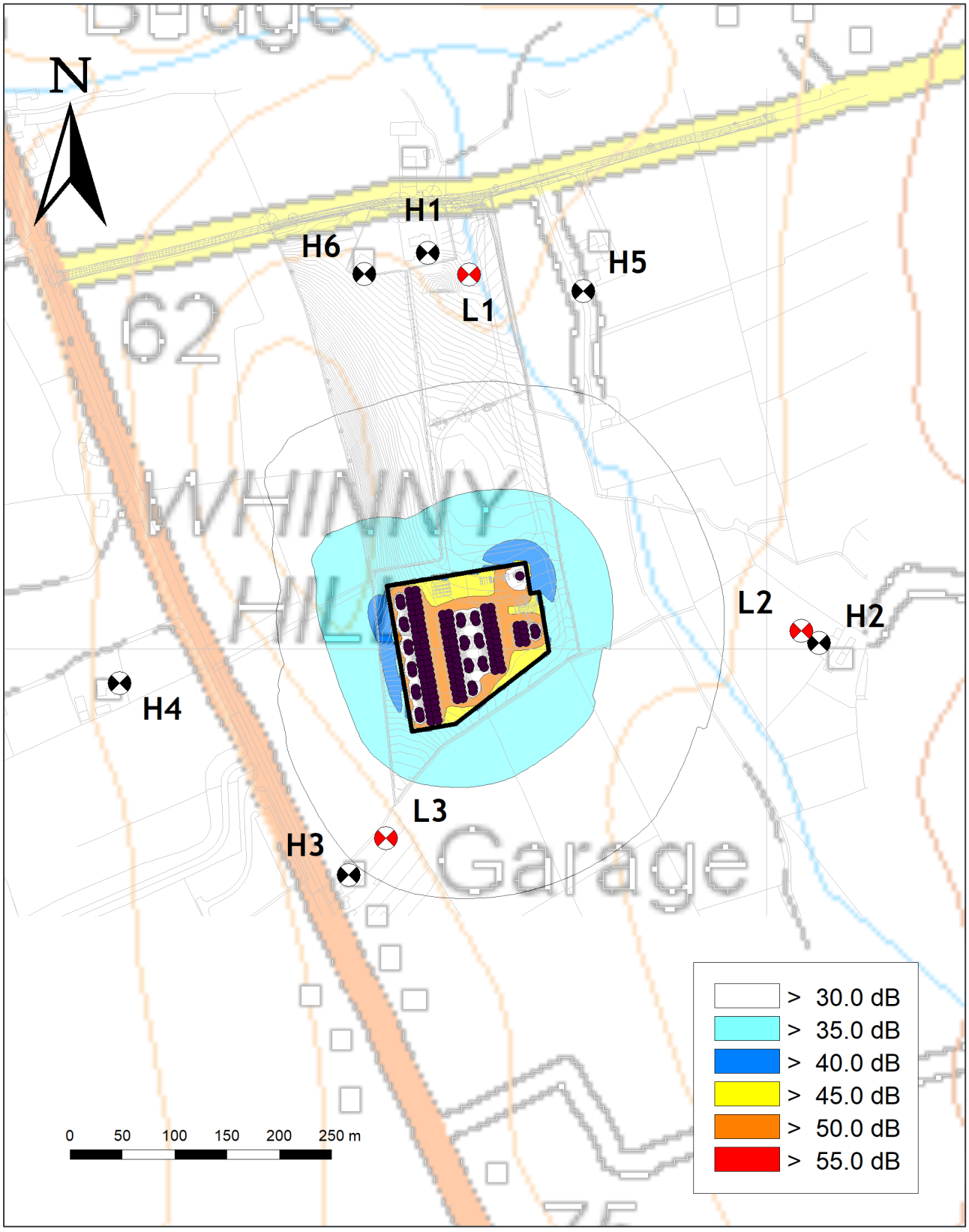


Table 9 - BS 4142 Assessment

House ID	Specific Level, dB L_{Aeq}	Rating Level, dB L_{Ar}	Background Level, dB L_{A90}	L_{Ar} - L_{A90}, dB	Potential Impact
			Daytime		
H1	26	28	37	-9	Low
H2	27	29	37	-8	Low
H3	30	32	40	-8	Low
H4	22	24	40	-16	Negligible
H5	27	29	37	-8	Low
H6	26	28	37	-9	Low
			Night-time		
H1	26	28	32	-4	Low
H2	27	29	29	0	Low
H3	30	32	28	4	Minor
H4	22	24	28	-4	Low
H5	27	29	32	-3	Low
H6	26	28	32	-4	Low

The assessment indicates that the predicted sound impact from the Proposed Development at the nearest neighbouring properties is negligible-to-low for daytime periods and low-to-minor during night-time periods. The predicted rating levels are also low to the point at which the 1997 version of the BS 4142 standard suggests that it is not appropriate for use (see **Section 2.5**). Furthermore, the generalised levels to minimise health effects, as set out within WHO guidance (see **Section 2.6**), would not be exceeded unless existing levels are already at or above the suggested thresholds.

Table 10 shows the predicted one third octave band sound levels externally to each of the assessment locations. These levels are all below the DEFRA NANR45 LFN criteria (see **Section 2.7**) even when considering that the criteria is intended to be applied internally. Actual internal sound levels due to the introduction of the Proposed Development will be substantially (>10 dB) less, well below levels which would be considered problematic under normal circumstances.

Overall, based on the modelling assumptions and assessment results, the level of sound emitted by the Proposed Development can be considered negligible-to-minor according to criteria derived with reference to BS 4142, low in the context of WHO guideline values and well below the NANR45 internal low frequency noise criteria.

The wording for a suggested planning condition that would restrict sound associated with the introduction of the Proposed Development, should the site gain planning consent, is provided in **Appendix D**.

Table 10 - Predicted 1/3 Octave Band Levels, dB L_{Aeq}

ID	Centre of 1/3 Octave Band (A-Weighted), Hz											
	50	63	80	100	125	160	200	250	315	400	500	630
H1	1	6	7	13	11	12	11	11	12	19	17	15
H2	2	7	8	14	12	13	12	12	13	20	18	16
H3	5	11	11	16	15	16	15	16	15	22	20	19
H4	1	6	6	10	9	10	12	13	12	14	12	10
H5	1	7	7	14	11	12	12	11	13	20	18	16
H6	1	7	7	13	11	12	11	11	12	20	17	16
ID	**800**	**1k**	**1.25k**	**1.6k**	**2k**	**2.5k**	**3.15k**	**4k**	**5k**	**6.3k**	**8k**	**10k**
H1	15	16	14	13	10	7	3	-3	-10	-23	-41	-66
H2	17	17	16	15	12	10	6	1	-6	-18	-35	-58
H3	19	20	18	16	14	11	8	3	-2	-11	-24	-41
H4	8	8	6	4	1	-3	-8	-13	-20	-32	-48	-68
H5	16	17	15	14	11	9	5	-1	-8	-20	-37	-61
H6	16	16	15	13	10	8	3	-3	-10	-22	-40	-65

6 Conclusions

An acoustic assessment of the proposed Machaire Battery Storage Project has been undertaken. The results show that sound levels resulting from the operation of the site will generally be negligible-to-minor or low in the context of relevant assessment criteria (i.e. in relation to BS 4142 and WHO guideline levels respectively) which corresponds to the lowest observed effect level (LOAEL) in terms of the NPSNI.

7 References

[1] Department of the Environment (September 2014) Noise Policy Statement for Northern Ireland

[2] Department of the Environment (September 2015) Strategic Planning Policy Statement for Northern Ireland (SPPS)

[3] Department of the Environment (August 2009) Planning Policy Statement 18 - Renewable Energy

[4] Department for Infrastructure (August 2009) Best Practice Guidance to PPS 18 - Renewable Energy

[5] British Standards Institution (2019) BS 4142:2014+A1:2019 Methods for Rating and Assessing Industrial and Commercial Sound

[6] British Standards Institution (1997) BS 4142:1997 Rating Industrial Noise Affecting Mixed Residential and Industrial Areas

[7] World Health Organisation (2000) Guidelines for Community Noise

[8] World Health Organisation (2009) Night Noise Guidelines for Europe

[9] World Health Organisation (2018) Environmental Noise Guidelines for the European Region

[10] University of Salford (February 2011) NANR45 - Procedure for the Assessment of Low Frequency Noise Complaints

[11] International Organisation for Standardisation (December 1996) ISO 9613-2:1996 Acoustics - Attenuation of Sound During Propagation Outdoors - Part 2: General Method of Calculation

[12] International Organisation for Standardisation (June 1993) ISO 9613-1:1993 Acoustics - Attenuation of Sound During Propagation Outdoors - Part 1: Calculation of the Absorption of Sound by the Atmosphere

Appendix A – Experience & Qualifications

Table A.1 - Author

Name	Mike Craven
Experience	Senior Acoustic Specialist, Renewable Energy Systems (RES), 2023-Present Principal Acoustic Consultant, Hayes McKenzie Partnership Limited (HMPL), 2019-2022 Senior Acoustic Consultant, HMPL, 2013-2019 Acoustic Consultant, HMPL, 2011-2013 Acoustic Consultant, URS/Scott Wilson, 2008-2011 Acoustic Consultant, HMPL, 2004-2008
Qualifications	MIOA, Member of the Institute of Acoustics BSc Audio Technology, University of Salford

Table A.2 - Checker

Name	Peter Brooks
Experience	Acoustic Lead, Renewable Energy Systems (RES), 2023-Present Senior Acoustic Analyst, RES, 2022-2023 Acoustic Consultant, Arcus Consultancy Services, 2021-2022 Director, 343 Acoustics, 2019-2021 Lead Acoustic Engineer, Tymphany, 2017-2019 Research and Development Engineer, SEAS Fabrikker, 2014-2017 Acoustic Engineer, Premium Sound Solutions, 2011-2013
Qualifications	MIOA, Member of the Institute of Acoustics PgCert Environmental Acoustics, University of Salford BSc (Hons) Audio Technology, University of Salford

Table A.3 - Approver

Name	Karen Anne Hutton
Experience	Technical Director, Renewable Energy Systems (RES), 2023-Present Head of Repowering & Life Extension, RES, 2019-2023 Head of Innovation & Optimisation, RES, 2018-2019 Transformation Manager, RES, 2016-2018 Initiatives Manager, RES, 2015-2016 Prospecting & Development Data Manager, RES, 2012-2015 Technical Manager, RES, 2009-2012 Senior Wind Analyst, RES, 2007-2009 Wind Analyst, RES, 2001-2007
Qualifications	MEng Civil Engineering, Heriot-Watt University

Appendix B – Measurement Locations

Figure B.1 – Measurement Location 1

Figure B.2 – Measurement Location 2

Figure B.3 – Measurement Location 3

Appendix C – Survey Data & Analysis

Figure C.1 - Location 1 - Time Series

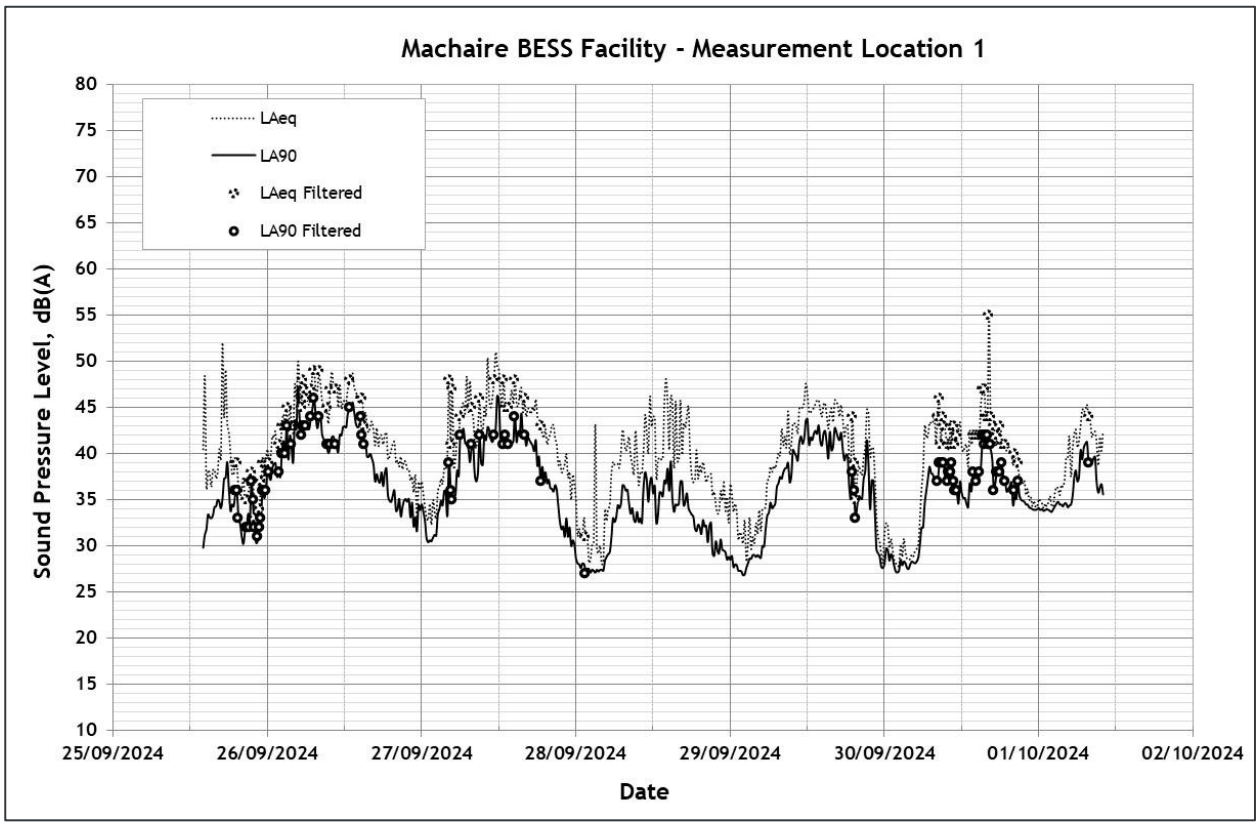


Figure C.2 - Location 1 Data Analysis - All Data

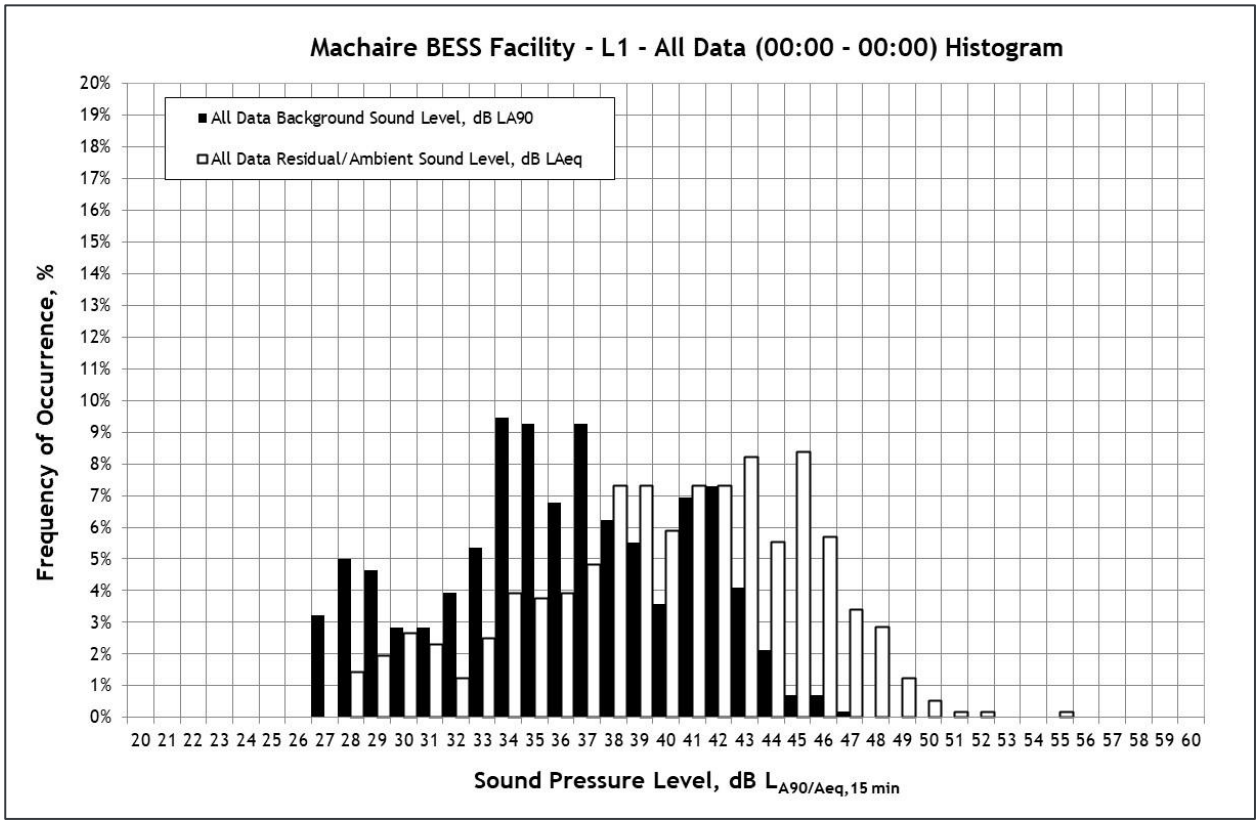


Figure C.3 - Location 1 Data Analysis - Daytime

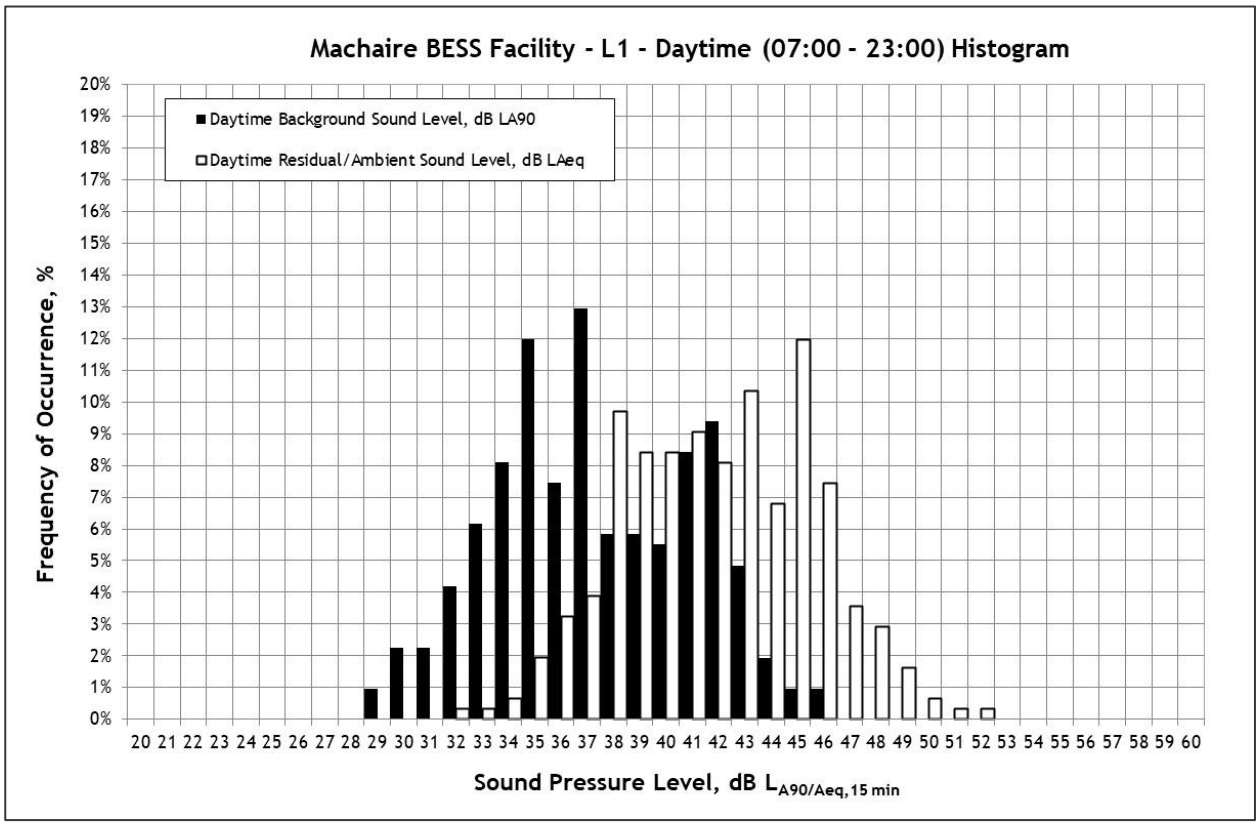


Figure C.4 - Location 1 Data Analysis - Night-time

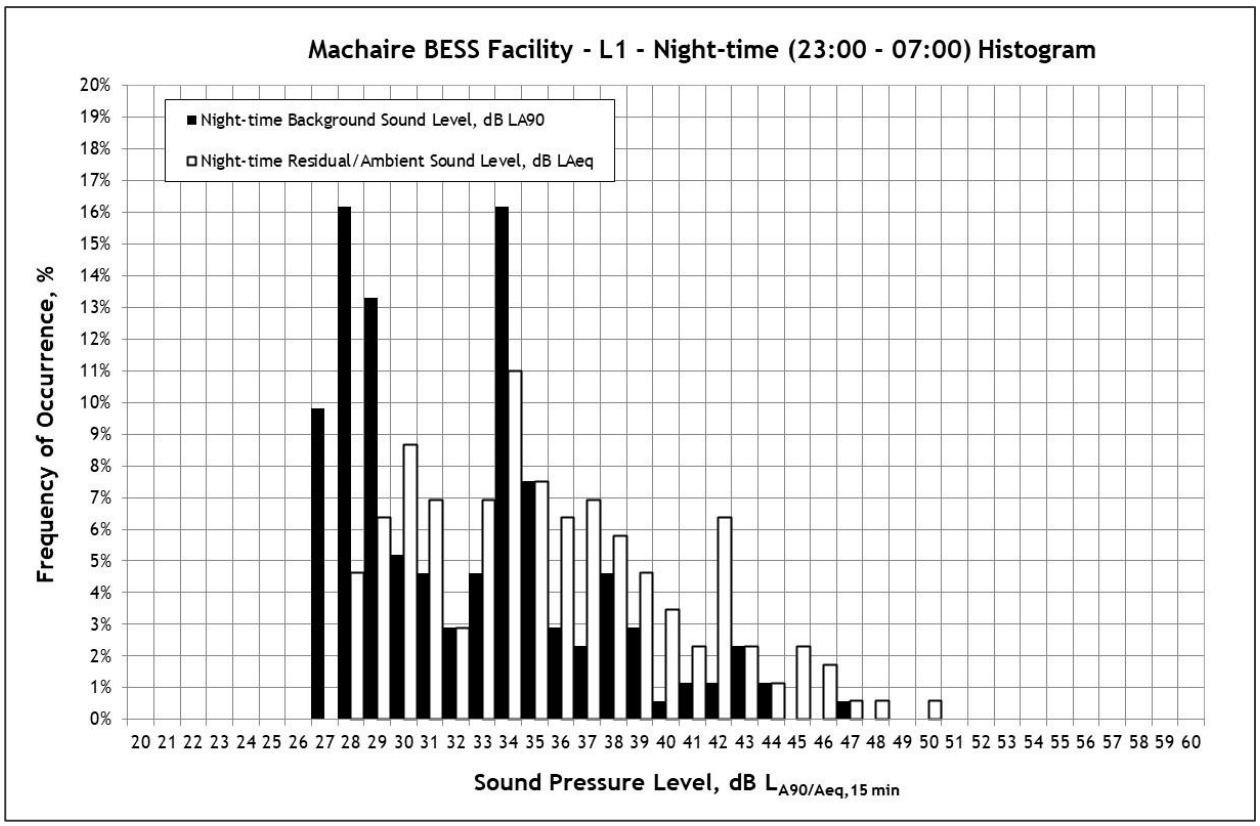


Figure C.5 - Location 2 - Time Series

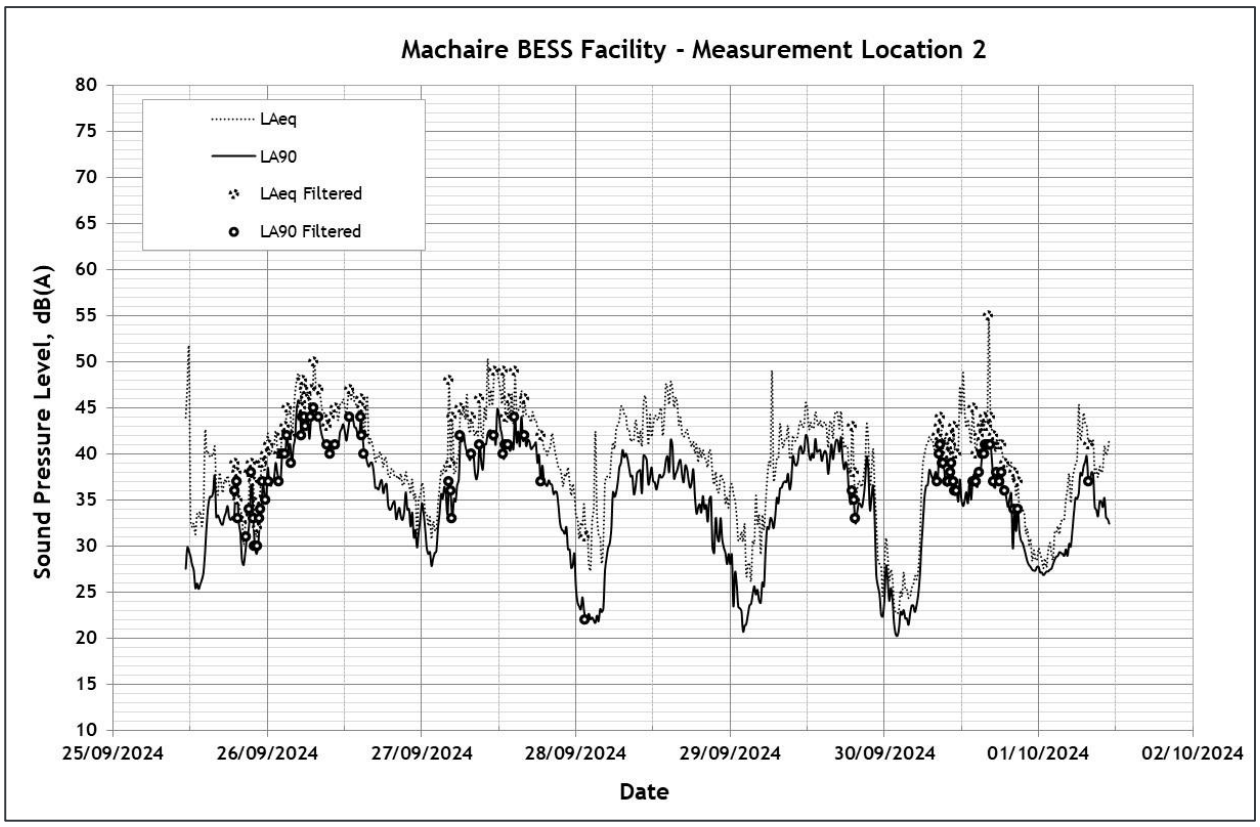


Figure C.6 - Location 2 Data Analysis - All Data

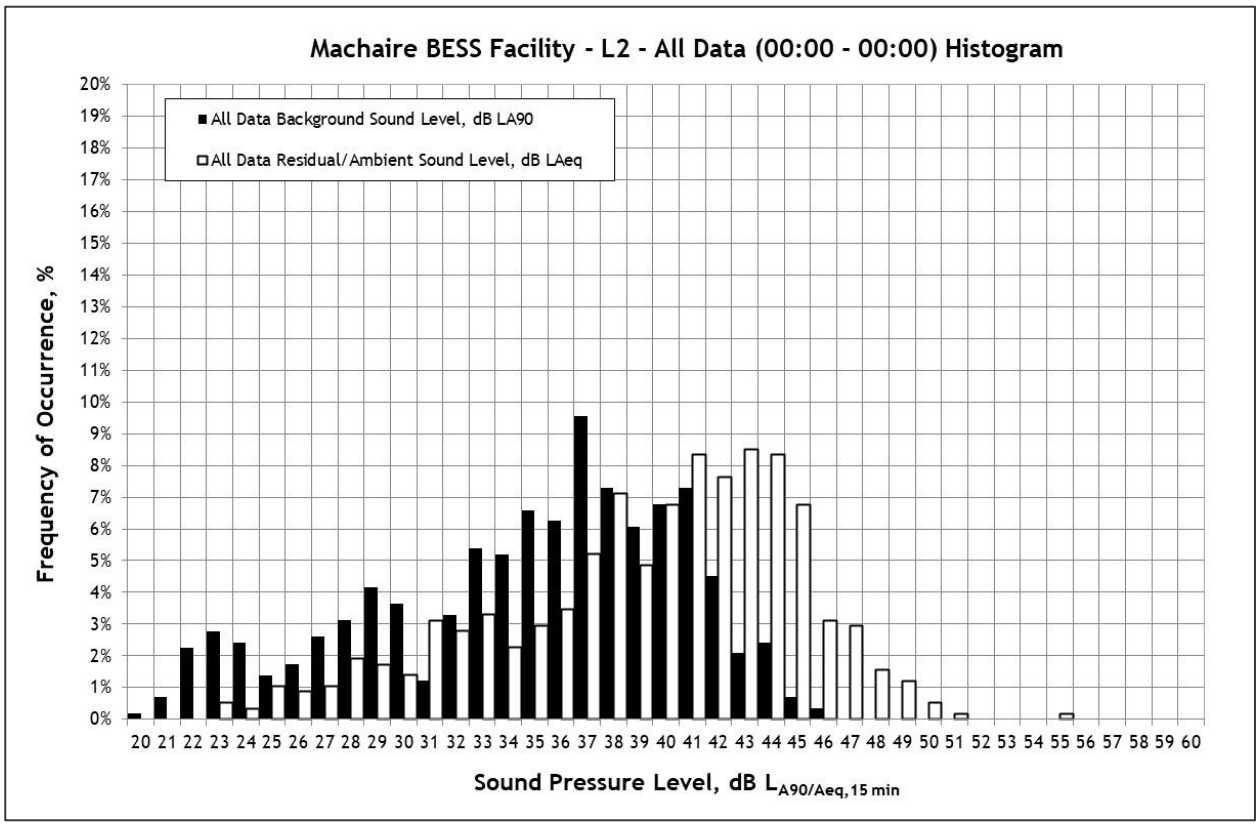


Figure C.7 - Location 2 Data Analysis - Daytime

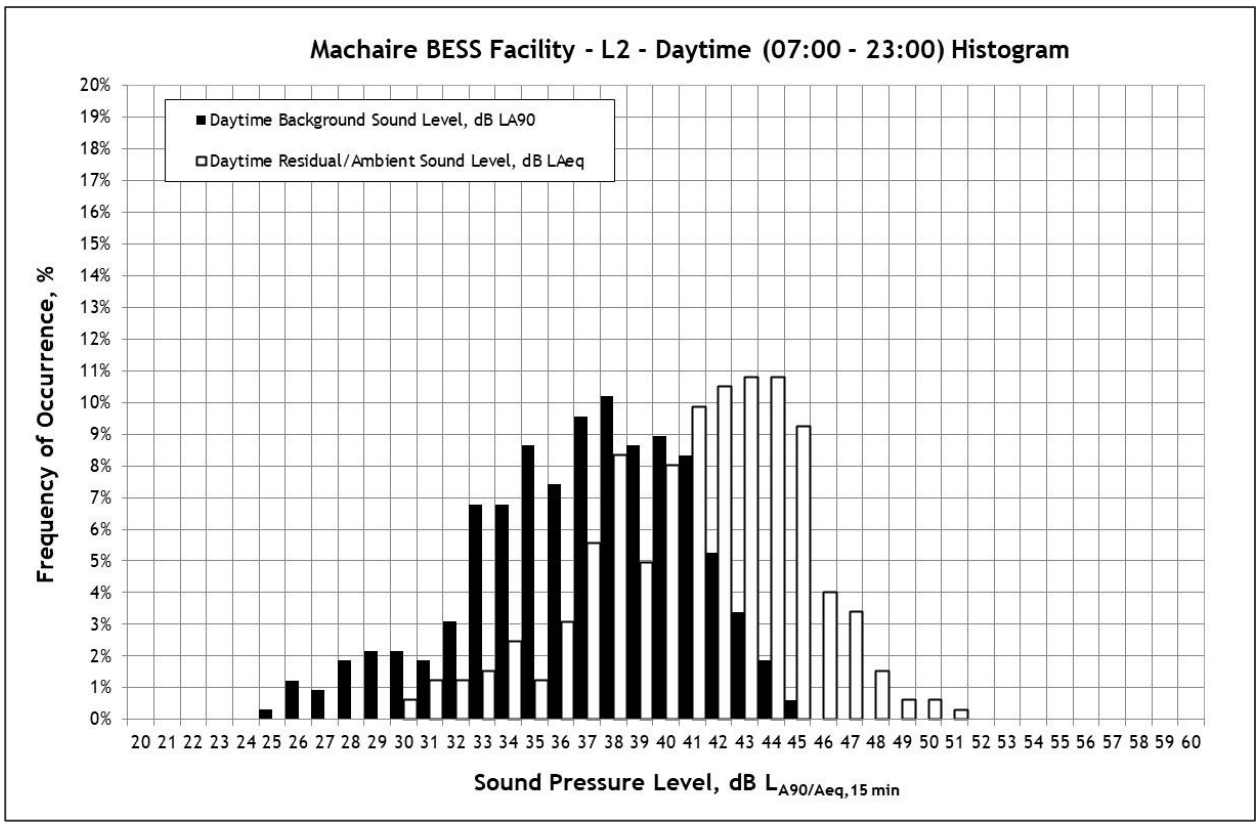


Figure C.8 - Location 2 Data Analysis - Night-time

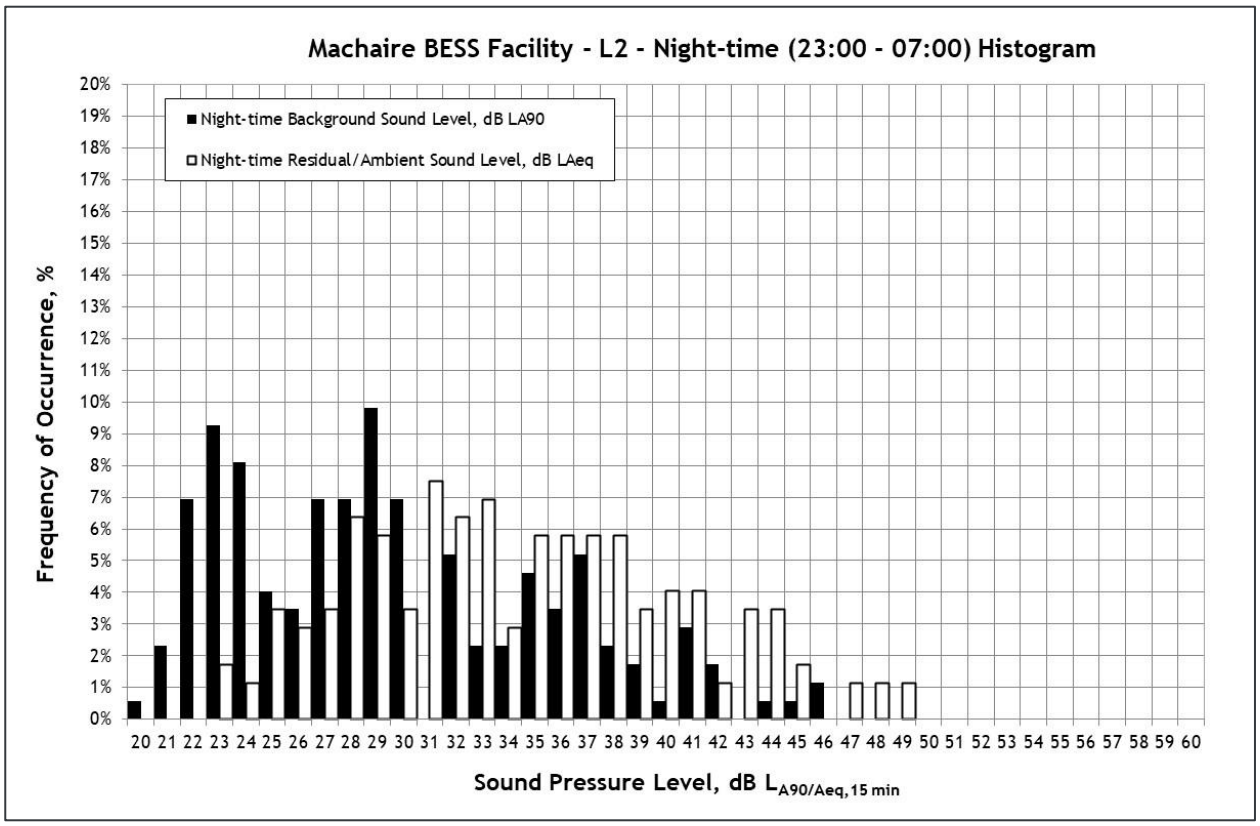


Figure C.9 - Location 3 - Time Series

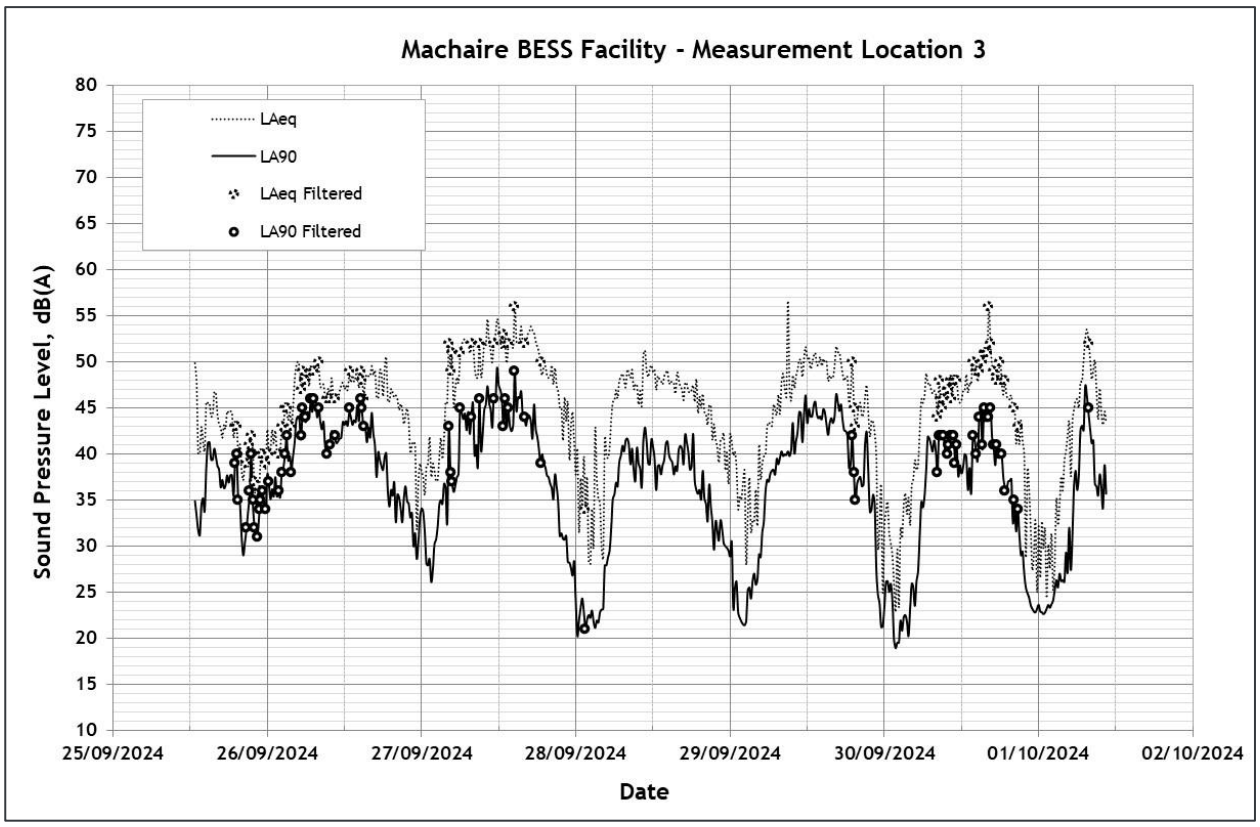


Figure C.10 - Location 3 Data Analysis - All Data

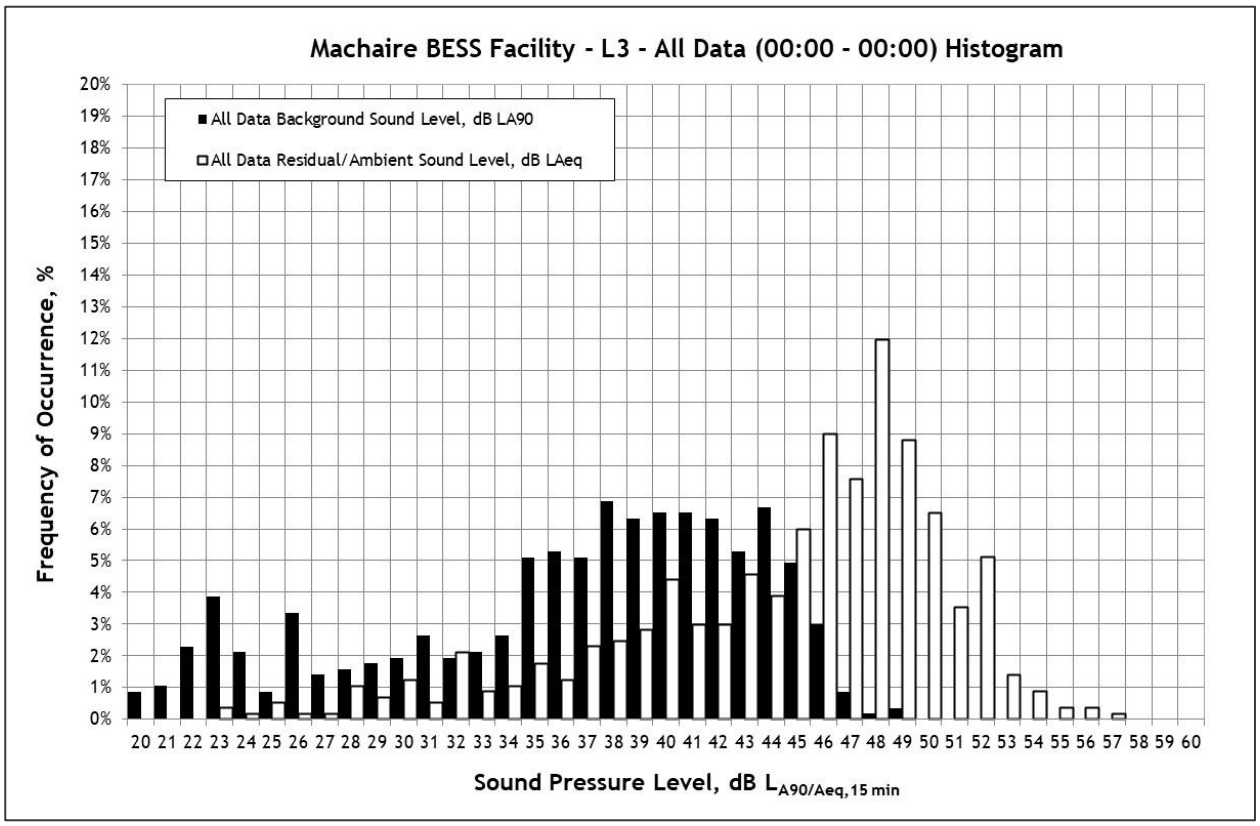


Figure C.11 – Location 3 Data Analysis - Daytime

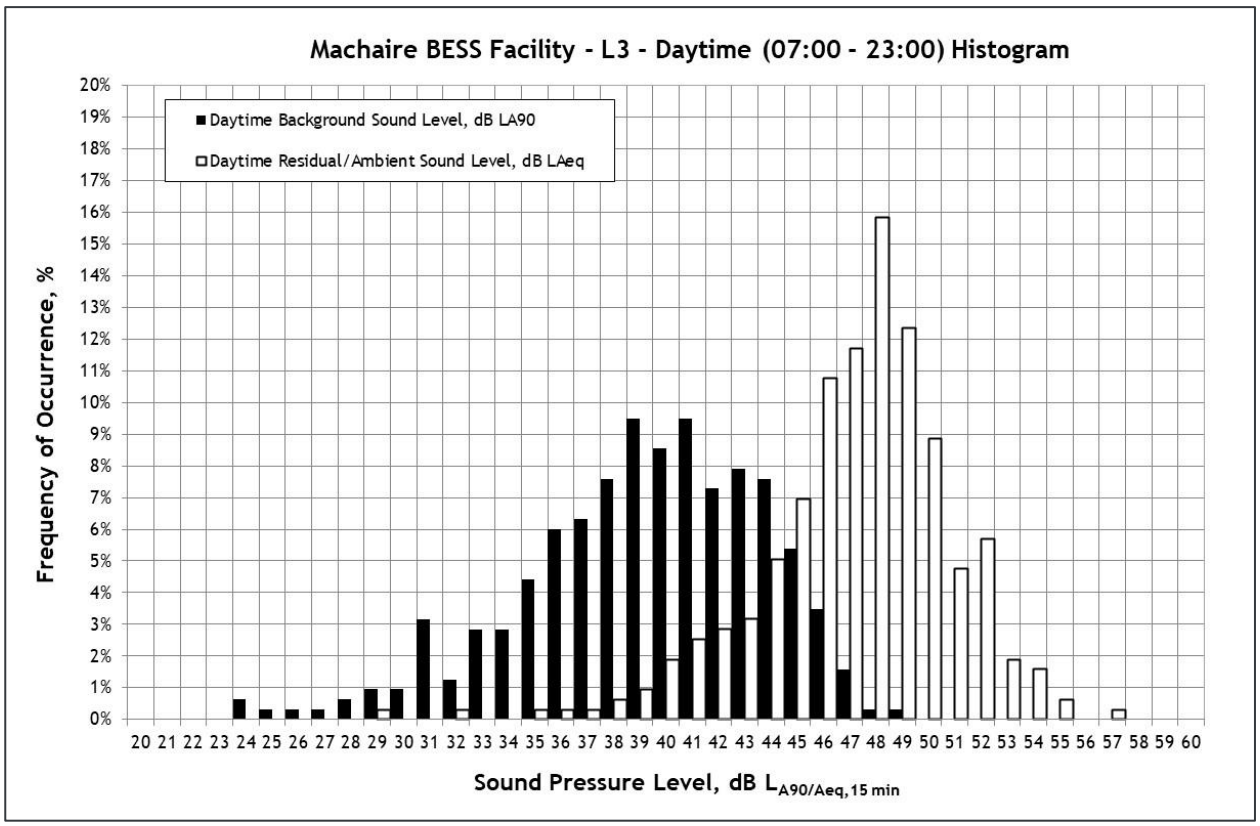
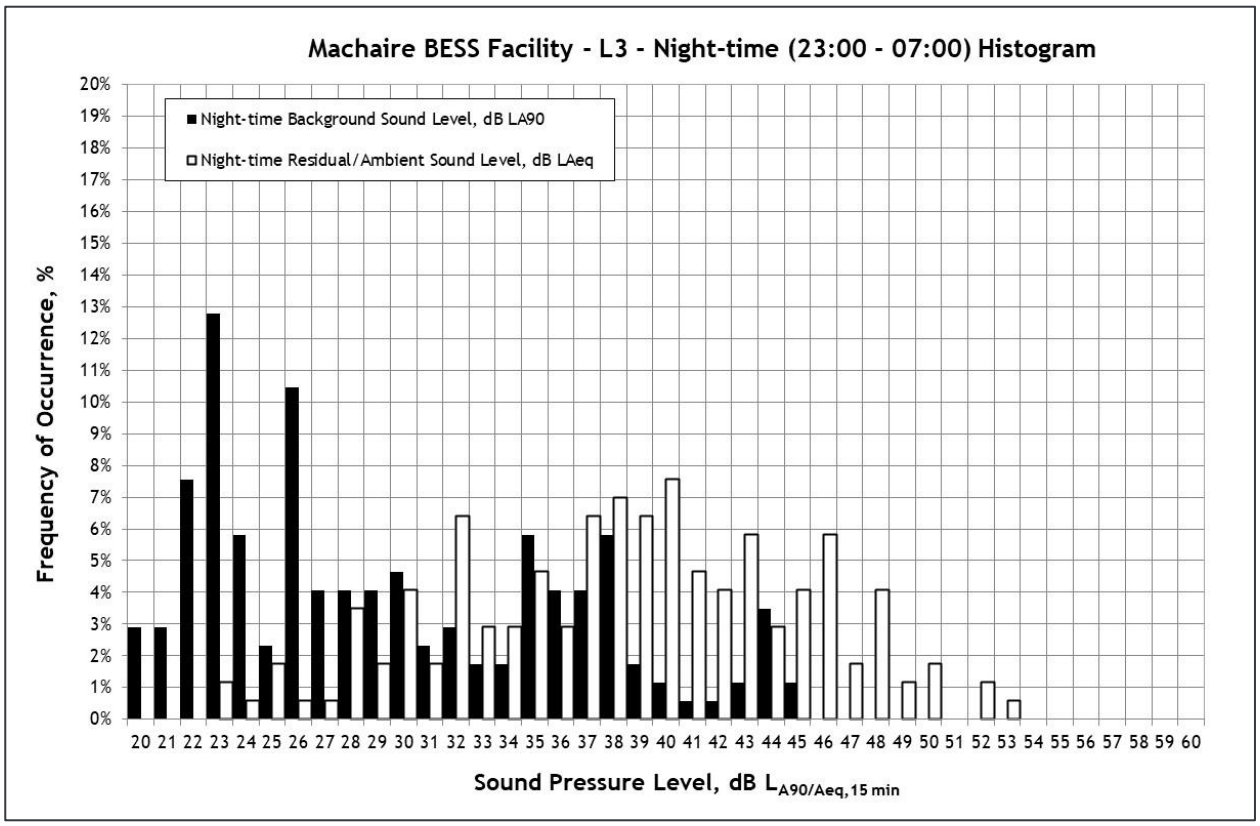


Figure C.12 – Location 3 Data Analysis - Night-time



Appendix D – Suggested Planning Condition Wording

The battery storage project shall be designed and operated to ensure that the rating sound level, determined using the BS 4142:2014 + A1:2019 methodology external to an existing residence, shall not exceed 40 dB L_{Ar} or the background sound level plus 5 dB, whichever is the greater, for both daytime and night-time periods.