Boxted Solar Farm

Acoustic Impact Assessment

Ref	04806-6612352

Revision History

Issue	Date	Name	Latest changes	Document number
01	17/10/2023	Peter Brooks	First Created	04806-6635421

Contents

1 Introduction

This report contains an assessment of the acoustic impact of the proposed Boxted Solar Farm in terms of operational impacts. Two Members of the Institute of Acoustics have been involved in its production. Details of their experience and qualifications can be found in Appendix A.

The scope includes determining the baseline and predicting sound levels due to the proposed development in order to assess the level of impact in accordance with relevant planning guidance.

2 Planning Policy, Guidance & Standards

2.1 National Planning Policy Framework

Within England, the treatment of noise is defined in the planning context by the National Planning Policy Framework (NPPF) [1] which details the Government's planning policies and how these are expected to be applied. The NPPF provides advice on the role of the planning system in helping to prevent and limit the adverse effects of noise, stating that planning policies and decisions should aim to avoid noise giving rise to significant adverse impacts, whilst at the same time mitigating and reducing to a minimum other adverse impacts on health and quality of life. At this point the NPPF refers to the Noise Policy Statement for England (NPSE) [2] which provides guidance on the categorisation of impact levels.

2.2 Noise Policy Statement for England

The Noise Policy Statement for England (NPSE) sets out the long-term vision of Government noise policy: to promote good health and quality of life through effective noise management within the context of sustainable development. In order to balance noise impacts against the economic and social benefits of the activity under consideration, NPSE defines three categories of effect level:

· 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.

· Significant Observed Adverse Effect Level (SOAEL): the level above which effects on health and quality of life become significant.

2.3 National Planning Practice Guidance

National Planning Practice Guidance (NPPG) [3] puts the effect levels defined by NPSE into greater context by explaining how such noise levels might be perceived, providing examples of outcomes based on likely average response, and advising on appropriate actions. These are reproduced in Table 1 below.

Table 1 - Noise Exposure Hierarchy

Response	Examples of Outcomes	Increasing Effect Level	Action
Not present	No Effect	No Observed Effect	No specific measures required
No Observed Effect Level (NOEL)			
Present and not intrusive	Noise can be heard, but does not cause any change in behaviour, attitude or other physiological response. Can slightly affect the acoustic character of the area but not such that there is a change in the quality of life.	No Observed Adverse Effect	No specific measures required
Lowest Observed Adverse Effect Level (LOAEL)			
Present and intrusive	Noise can be heard and causes small changes in behaviour, attitude or other physiological response, e.g., turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a small actual or perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level (SOAEL)			
Present 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 change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Present and very disruptive	Extensive and regular changes in behaviour, attitude or other physiological response and/or an inability to mitigate effect of noise leading to psychological stress, e.g., regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g., auditory and non-auditory.	Unacceptable Adverse Effect	Prevent

2.4 National Policy Statements

In addition to the aforementioned guidance, which is applicable to all forms of environmental noise, specific guidance relating to nationally significant energy infrastructure has been published by the Department of Energy and Climate Change (DECC). Whilst the proposed development is not of a scale that would be deemed nationally significant, the relevant National Policy Statements are informative in that they suggest an assessment methodology that would be considered appropriate for the type of development being proposed.

The Overarching National Policy Statement for Energy (EN-1) [4] outlines the need for new electricity capacity from renewable sources as the country transitions to a low carbon electricity system. However, referring back to the NPSE, EN-1 recognises the potential for energy infrastructure to impact on health and quality of life if it results in excessive noise. It goes on to say that where noise impacts are likely to arise, they should be assessed according to the principles of the relevant British Standards.

Of the examples provided, BS 4142 [5] and BS 8233 [6] relate to operational sound. BS 4142 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. BS 8233 provides guidance on the control of noise for new buildings or those undergoing refurbishment. It does not provide guidance on assessing the effect of changes in external noise levels on occupants of existing buildings.

The National Policy Statement for Electricity Networks Infrastructure (EN-5) [7], relevant to the transmission and distribution parts of the electricity network along with any associated infrastructure, such as substations and converter stations, again points to the appropriateness of BS 4142 in assessing the acoustic impact of such projects. The inverters and transformers deployed as part of the proposed project are examples of infrastructure of this kind.

2.5 Consultation with Babergh and Mid Suffolk District Councils

Babergh and Mid Suffolk District Councils have been consulted to ensure that the acoustic assessment meets their requirements. RES proposed the following assessment methodology:

· To undertake a noise impact assessment for the development according to BS 4142:2014+A1:2019.

· Background sound level measurements were proposed in the vicinity of the nearest residential properties, on different sides of the proposed development. The three locations to use for background sound measurements were agreed.

· The measured sound pressure levels ($L_{Aeq,15\ min}$ dB and $L_{A90,15\ min}$ dB) will be used to undertake an acoustic impact assessment in accordance with BS 4142:2014+A1:2019.

A Planning Officer has confirmed the proposed assessment methodology is acceptable. They suggested to consider the cumulative impacts of nearby solar schemes, however there are no other solar schemes nearby, so cumulative impacts are not applicable to this assessment.

3 Methodology

3.1 Overview

An assessment in accordance with BS 4142:2014+A1:2019 has been undertaken in order to determine the acoustic impact of the proposed development. This approach is consistent with the guidance provided in the National Policy Statements published by DECC for this type of development, as well as with the requirements from Babergh and Mid Suffolk District Councils. BS 4142 lends itself well to an assessment in accordance with NPPF, NPSE and NPPG as it allows the level of impact to be ascertained.

3.2 Baseline Conditions

In order to complete a BS 4142 assessment of the proposal, the background sound level at the times when the new sound source is intended to be operational should be measured. The background sound level is defined as the A-weighted sound pressure level that is exceeded for 90 % of the measurement time interval, or $L_{A90,\,T}$.

Measurements should be made at a location that is representative of the assessment locations, the time interval should be sufficient to obtain a representative value, and the duration should be long enough to reflect the range of background sound levels over the period of interest.

Precautions should be taken to minimise the influence on the results from sources of interference. Weather conditions that may affect the measurements should be recorded and an effective wind shield used to minimise turbulence at the microphone.

A statistical analysis, following the example given by BS 4142, should be used to determine an appropriate background sound level for the analysis from the range of results obtained.

3.3 Propagation

The ISO 9613-2 [8] propagation model shall be used to predict the specific sound levels due to the proposed development at nearby residential properties. The propagation model takes account of sound attenuation due to geometric spreading and atmospheric absorption. The assumed temperature and relative humidity are 10 ˚C and 70 % respectively.

Ground effects are also taken into account by the propagation model, with a ground factor of 1 adopted to reflect the porous ground between the site and the assessment locations. A 1.5 m receiver height shall be used. The effect of surface features such as buildings, trees or solar panels is not included in the model. There is a level of conservatism built into the model as a result of the adoption of these settings.

ISO 9613-2 is a downwind propagation model. Where conditions less favourable to sound propagation occur, such as when the assessment locations are crosswind or upwind of the proposed development, the sound levels would be expected to be less, and the downwind predictions presented here would be regarded as conservative.

3.4 Assessment

Once the specific sound levels due to the proposed new sound source have been predicted the rating level of the sound can be calculated, it is this which is compared to the existing background sound level to determine the level of impact. The rating level is obtained by adding any penalties due to character that may be applicable to the predicted specific sound level.

Table 2 details how the difference between the rating level and background sound level is used to come to a judgement about the level of impact under BS 4142, although it is noted that any assessment is context specific. These criteria relate well with the categories defined by NPSE: with the background sound level representing the NOEL, 5 dB above background representing the LOAEL and 10 dB above background the SOAEL.

Table 2 – BS 4142 Assessment Criteria

Rating Level	BS 4142 Assessment
Below background	Indicates low impact, depending on the context
<5 dB above background	Indicates minor impact, depending on the context
≥5 dB above background	Indicates adverse impact, depending on the context
≥10 dB above background	Indicates significant adverse impact, depending on the context

Depending upon the diurnal variation in the background sound level, and the times when the proposed new sound source is scheduled to operate, it may be appropriate to undertake separate assessments for certain times of day, e.g. day and night.

4 Baseline Data

4.1 Details of the Survey

Baseline sound levels were determined in a survey undertaken between 16th August 2023 and 21st August 2023. The survey locations are shown on the map in Figure 1 (Appendix B).

Three Rion NL-52 sound level meters were used. The meters are certified as meeting IEC 61672-1:2002 [9] Class 1 precision standards. The microphone was approximately 1.2 m above ground level and an outdoor wind shield supplied by the manufacturer was used.

The sound level meters were placed away from reflective surfaces as shown in the photos in Appendix C. The equipment was field calibrated at the start and end of the campaign. Maximum detected drift was 0.1 dB, which is appropriate. All instrumentation had been subject to laboratory calibration traceable to national standards within the previous 12 months, with the calibration dates and references provided in Table 3.

Table 3 - Instrumentation Records

	Meter 1	Meter 2	Meter 3
Type	Rion NL-52	Rion NL-52	Rion NL-52
Serial No.	01198675	00231668	01121402
Calibration Certificate No.	UCRT23/1172	UCRT23/1001	UCRT22/2282
Date of Issue	08/02/2023	24/01/2023	27/10/2022
Microphone Serial No.	21911	04713	04419
Preamp Serial No.	22092	21612	21446
Calibrator type	Rion NC-74	Rion NC-74	Rion NC-74
Calibrator Serial No.	35015343	35015343	35015343
Calibrator Cert. No.	UCRT23/1015	UCRT23/1015	UCRT23/1015

During the survey at location 1 the background acoustic environment was dominated by nearby farm sounds and distant traffic. At location 2 the background acoustic environment was comprised of dogs barking, distant road noise and bird sound. At location 3 the dominant sound source was birds and occasional vehicles passing by.

Weather conditions during the survey were dry with low wind speeds and the temperature ranged between 13°C and 29°C. There was some rain on 18th August during the survey, therefore measurement data during that period has been excluded from the data analysis.

4.2 Survey Results

Time histories recorded during the survey at each location are shown in Appendix B.2. The average residual sound levels ($L_{Aeq,\ 15mins}$) measured during day and night-time at each location are shown in Table 4.

In accordance with BS 4142:2014+A1:2019 representative background sound levels need to be determined from statistical analysis of measured L_{A90} levels. Histograms of measured background sound levels are shown in Appendix B.3, and derived representative background sound levels are shown in Table 4.

Table 4 - Survey Results

Survey location	Residual Sound Level, $L_{Aeq,\ 15\ min}$, dB		Background Sound Level, $L_{A90,\ 15\ min}$, dB	
	Daytime (07:00-23:00)	Night-time (23:00-07:00)	Daytime (07:00-23:00)	Night-time (23:00-07:00)
1	39	27	30	20
2	46	33	34	20
3	40	28	31	20

The background sound levels representative of the houses located to the north of the site were measured at position 1. Levels measured at position 2 are considered to be representative of houses to the east of the site near the river Glem. Measurement location 3 represents the houses that are closest to the south of the site.

This report presents an assessment for the 24 closest residential properties to the site which may be affected.

The residential properties used for the assessment are shown in Figure 11 in Appendix B.4. The house numbers, coordinates, as well as representative measured acoustic data for each house are presented in Table 5. The coordinate system used is the British National Grid (EPSG 27700).

Table 5 - Baseline Data

House ID	X/m	Y/m	Day Background Sound Level / L_{A90} dB	Night Background Sound Level / L_{A90} dB	Day Residual Sound Level / L_{Aeq} dB	Night Residual Sound Level / L_{Aeq} dB
H1	582647	251316	34	20	46	33
H4	582701	251582	34	20	46	33
H5	582830	251182	34	20	46	33
H6	582618	251987	30	20	39	27
H7	581401	251912	30	20	39	27
H9	581542	252001	30	20	39	27
H13	582422	250782	31	20	40	28
H14	582767	250582	31	20	40	28
H15	580957	250502	31	20	40	28
H16	582388	250408	31	20	40	28
H18	581656	250362	31	20	40	28
H19	582664	251124	34	20	46	33
H22	582717	251275	34	20	46	33
H23	581153	251684	30	20	39	27
H25	582695	251301	34	20	46	33
H30	580760	250393	31	20	40	28
H31	582636	250749	34	20	46	33
H33	582344	251891	30	20	39	27
H36	582446	250446	31	20	40	28
H38	582094	251286	30	20	39	27
H41	581284	251834	30	20	39	27
H49	582752	251215	34	20	46	33
H53	582611	251339	34	20	46	33
H54	582871	251151	34	20	46	33

5 Assessment

5.1 Equipment Generating Sound

The main sources of sound within the proposed development are the 6 inverters, with a corresponding 5 MVA transformer next to each inverter. There is no grid transformer located in the substation for the site. Located adjacent to each inverter are 2 battery storage containers, with 12 battery storage containers on the site in total. All equipment is assumed to be operating at all times.

Acoustic emission data for the proposed equipment is detailed in Table 6. The data corresponds to the maximum acoustic emission for each device as advised by the manufacturer. Predictions based on this data therefore represents the worst case, when the site is operating at maximum capacity.

Table 6 - Acoustic Emission Data

Equipment	Sound Power Level, dB(A)
Inverter	93
5 MVA Transformer	79
Battery Storage Container	82

5.2 Acoustic Feature Correction

In accordance with BS 4142:2014+A1:2019 penalties can be applied to the predicted specific sound level to achieve the rating level at each receptor. The penalties can be applied for “attention catching features” such as tonality, impulsivity, intermittency, and other distinguishable characteristics.

The cumulative impact of sound from all the equipment on nearby receivers has been assessed in third octaves in accordance with the objective method provided in Annex C of BS 4142:2014+A1:2019. Results of this assessment show that at all considered receptors the sound generated by the proposed equipment will not contain tones.

The broadband sound generated by the proposed equipment is not expected to be intermittent or impulsive, due to the equipment operating consistently. Changes to sound pressure levels due to load changes will be gradual and will not result in attention catching characteristics.

As a result, the rating level will be equal to the specific sound level.

5.3 Predicted Acoustic Impact

Predicted rating levels at nearby properties are detailed in Table 7 for day and night-time periods respectively. As the assessment is undertaken with all equipment operating at all times, the day and night-time rating levels are equal.

The rating level is then compared to the background sound levels from Table 5 to give the potential impact at each location, results of this are also shown in Table 7. An illustrative sound footprint for the proposed development showing the predicted specific sound level during the day and night is

provided in Figure 11 in Appendix B.4. The predicted maximum rating level ($L_{Ar, Tr}$) at any house is 33 dB.

Table 7 - BS 4142 Assessment Results

House ID	Rating Level, dB $L_{Ar, Tr}$		Rating vs Background, dB		Potential Impact	
	Daytime (07:00-23:00)	Night-time (23:00-07:00)	Daytime (07:00-23:00)	Night-time (23:00-07:00)	Daytime (07:00-23:00)	Night-time (23:00-07:00)
H1	28	28	-6	8	Low	Adverse
H4	23	23	-11	3	Low	Minor
H5	26	26	-8	6	Low	Adverse
H6	19	19	-11	-1	Low	Low
H7	19	19	-11	-1	Low	Low
H9	19	19	-11	-1	Low	Low
H13	33	33	2	13	Minor	Significant adverse
H14	25	25	-6	5	Low	Adverse
H15	18	18	-13	-2	Low	Low
H16	23	23	-8	3	Low	Minor
H18	24	24	-7	4	Low	Minor
H19	30	30	-4	10	Low	Significant adverse
H22	27	27	-7	7	Low	Adverse
H23	20	20	-10	0	Low	Low
H25	27	27	-7	7	Low	Adverse
H30	16	16	-15	-4	Low	Low
H31	28	28	-6	8	Low	Adverse
H33	21	21	-9	1	Low	Minor
H36	24	24	-7	4	Low	Minor
H38	32	32	2	12	Minor	Significant adverse
H41	19	19	-11	-1	Low	Low
H49	27	27	-7	7	Low	Adverse
H53	28	28	-6	8	Low	Adverse
H54	25	25	-9	5	Low	Adverse

Whilst rating levels over the threshold for when adverse impacts may start to occur are predicted at some properties during night-time periods, BS 4142 states that absolute levels may be more relevant than the margin of the rating level above background sound level in circumstances where the background sound levels and rating levels are low, as is the case at this site. This suggests that an assessment based on absolute levels is more appropriate given the low background levels and rating levels, and the Guidelines for Community Noise produced by the World Health Organisation (WHO) [10] along with BS 8233:2014 are suggested as providing appropriate assessment criteria.

The WHO Guidelines for Community Noise recommend sound levels intended to minimise health impacts in specific environments. At dwellings the Guidelines for Community Noise recommend that outside sound level should not exceed 45 dB L_{Aeq} so that people may sleep with the windows open and not be disturbed. During the daytime the outside sound level should not exceed 50 dB L_{Aeq} to protect the majority of people from being moderately annoyed.

The predicted specific sound levels due to the proposed development from Table 7 are added to the residual sound levels from Table 5 to determine the total ambient sound level at each house for the day and night-time periods. The total ambient sound levels during the daytime and night-time periods are compared to the WHO target value in Table 8 (day) and Table 9 (night).

Table 8 - WHO Assessment Results - Day

House ID	Ambient Sound Level, dB L_{Aeq}	Limit, dB L_{Aeq}	Margin, dB
H1	46	50	-4
H4	46	50	-4
H5	46	50	-4
H6	39	50	-11
H7	39	50	-11
H9	39	50	-11
H13	41	50	-9
H14	40	50	-10
H15	40	50	-10
H16	40	50	-10
H18	40	50	-10
H19	46	50	-4
H22	46	50	-4
H23	39	50	-11
H25	46	50	-4
H30	40	50	-10
H31	46	50	-4
H33	39	50	-11
H36	40	50	-10
H38	40	50	-10
H41	39	50	-11
H49	46	50	-4
H53	46	50	-4
H54	46	50	-4

Table 9 - WHO Assessment Results - Night

House ID	Ambient Sound Level, dB L_{Aeq}	Limit, dB L_{Aeq}	Margin, dB
H1	34	45	-11
H4	33	45	-12
H5	34	45	-11
H6	28	45	-17
H7	28	45	-17
H9	28	45	-17
H13	34	45	-11
H14	30	45	-15
H15	28	45	-17
H16	29	45	-16
H18	30	45	-15
H19	35	45	-10
H22	34	45	-11
H23	28	45	-17
H25	34	45	-11
H30	28	45	-17
H31	34	45	-11
H33	28	45	-17
H36	29	45	-16
H38	33	45	-12
H41	28	45	-17
H49	34	45	-11
H53	34	45	-11
H54	34	45	-11

BS 8233 provides indoor ambient noise levels for dwellings for different activities, locations and times of day and states that it is desirable that these guideline values are not exceeded. The most conservative values specified are those conducive to sleeping or daytime resting in a bedroom where the internal noise level should not exceed 35 dB $L_{Aeq,16\ hour}$ during the day and 30 dB $L_{Aeq,8\ hour}$ at night. If a 15 dB(A) reduction is assumed for attenuation through an open window, then these limits are consistent with the outdoor limits specified by the WHO Community Noise Guidelines such that they are met by the same margins as shown in Table 10 (day) and Table 11 (night).

Table 10 - BS 8233 Assessment Results - Day

House ID	Indoor Sound Level, dB L_{Aeq}	Limit, dB L_{Aeq}	Margin, dB
H1	31	35	-4
H4	31	35	-4
H5	31	35	-4
H6	24	35	-11
H7	24	35	-11
H9	24	35	-11
H13	26	35	-9
H14	25	35	-10
H15	25	35	-10
H16	25	35	-10
H18	25	35	-10
H19	31	35	-4
H22	31	35	-4
H23	24	35	-11
H25	31	35	-4
H30	25	35	-10
H31	31	35	-4
H33	24	35	-11
H36	25	35	-10
H38	25	35	-10
H41	24	35	-11
H49	31	35	-4
H53	31	35	-4
H54	31	35	-4

Table 11 – BS 8233 Assessment Results - Night

House ID	Indoor Sound Level, dB L_{Aeq}	Limit, dB L_{Aeq}	Margin, dB
H1	19	30	-11
H4	18	30	-12
H5	19	30	-11
H6	13	30	-17
H7	13	30	-17
H9	13	30	-17
H13	19	30	-11
H14	15	30	-15
H15	13	30	-17
H16	14	30	-16
H18	15	30	-15
H19	20	30	-10
H22	19	30	-11
H23	13	30	-17
H25	19	30	-11
H30	13	30	-17
H31	19	30	-11
H33	13	30	-17
H36	14	30	-16
H38	18	30	-12
H41	13	30	-17
H49	19	30	-11
H53	19	30	-11
H54	19	30	-11

A level of conservatism has been built into the assessment to compensate for the potential impact of uncertainty. The predicted specific sound levels presented in this assessment, and the sound footprint shown in Figure 11 reflects this. The amenity of nearby residents can be protected by the imposition of a planning condition relating to sound. A suggested appropriate form of wording for such a condition is provided in Appendix D.

6 Conclusion

An assessment of the acoustic impact of the proposed Boxted Solar Farm has been undertaken in accordance with BS 4142:2014+A1:2019.

During the daytime at all properties the predicted impact is low or minor. No adverse impacts are predicted to occur during the daytime.

Whilst the margin by which the rating level exceeds the background sound level is close to the threshold for when adverse impacts may start to occur at some properties during night-time periods, such an assessment is considered overly conservative in the context of the low background sound levels and rating levels at this site. BS 4142 states that assessments against absolute limits may be more appropriate in this situation. An assessment against absolute limits, in line with WHO guidance and BS 8233, demonstrates that such limits are met at all properties considered in the assessment. Therefore no adverse impacts are predicted to occur during the night-time.

7 References

[1] Department for Levelling Up, Housing and Communities, National Planning Policy Framework, 2023.

[2] Department for Environment, Food and Rural Affairs, Noise Policy Statement for England (NPSE), 2010.

[3] Department for Communities and Local Government, National Planning Practice Guidance, Noise, 2019.

[4] Department of Energy and Climate Change, Overarching National Policy Statement for Energy (EN-1), 2011.

[5] The British Standards Institution, Methods for rating and assessing industrial and commercial sound, BS 4142:2014+A1:2019, 2014 (Amended 2019).

[6] The British Standards Institution, Guidance on sound insulation and noise reduction for buildings, BS 8233:2014, 2014.

[7] Department of Energy and Climate Change, National Policy Statement for Electricity Networks Infrastructure (EN-5), 2011.

[8] International Organisation for Standardisation, Acoustics - Attenuation of Sound During Propagation Outdoors, Part 2: General Method of Calculation, 1996.

[9] International Organisation for Standardisation, Electroacoustics – Sound level Meters – Part 1: Specifications, IEC 61672-1:2002

[10] World Health Organisation, Guidelines for Community Noise, 1999.

Appendix A – Experience & Qualifications

Author:

Name	Peter Brooks
Experience	Acoustics Team Lead, Renewable Energy Systems, 2023-Present Senior Acoustic Analyst, Renewable Energy Systems, 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

Checker/Approver:

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Experience	Head of Specialist Services/Senior Technical Manager, Renewable Energy Systems, 2000-Present Technical Analyst/Senior Technical Analyst, Renewable Energy Systems, 1990-2000 Foreign Exchange Researcher, Mechanical Engineering Laboratory, Tsukuba, Japan, 1989-1990 Research Associate, Energy Research Unit, Rutherford Appleton Laboratory, 1986-1989
Qualifications	MIOA, Member of the Institute of Acoustics MInstP, Member of the Institute of Physics PhD, The Potential of Combined Heat & Power, Wind Power & Load Management for Cost Reduction in Small Electricity Supply Systems, Department of Applied Physics, University of Strathclyde BSc Physics, University of Durham

Appendix B – Figures

B.1 Background Sound Monitoring Locations

Figure 1 - Background Sound Monitoring Locations

B.2 Measured Time Histories

Figure 2 - Time History of Measurements Taken at Location 1

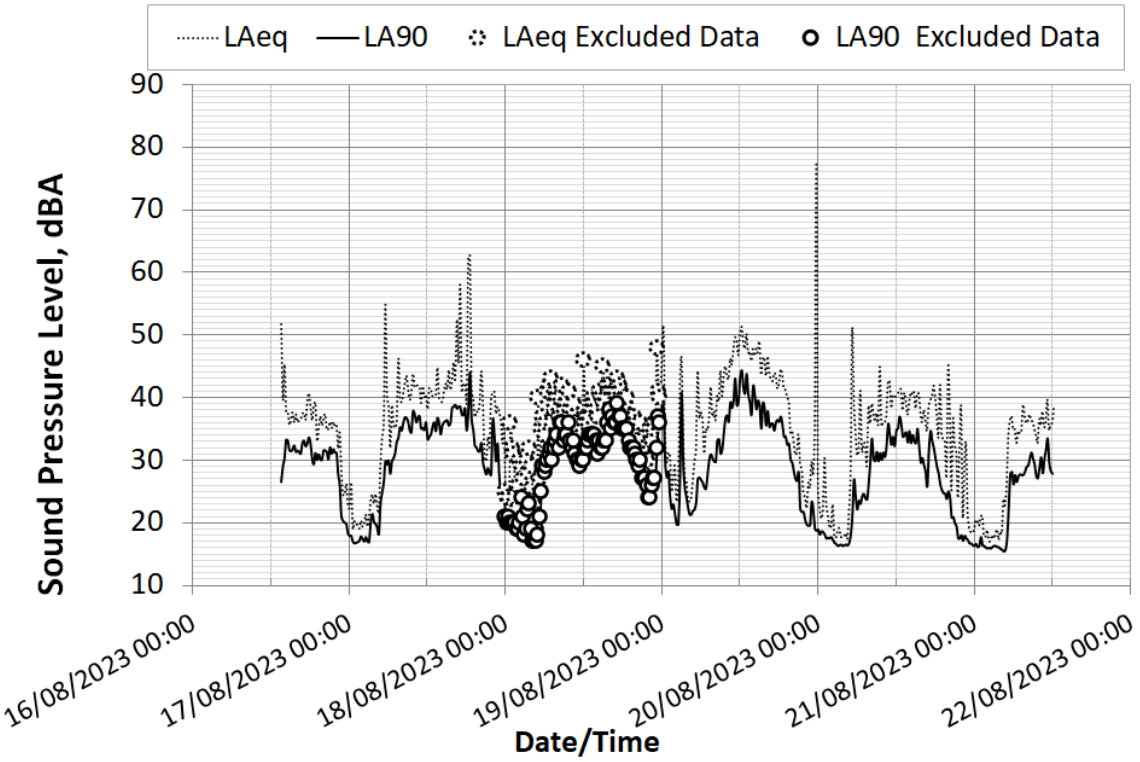


Figure 3 - Time History of Measurements Taken at Location 2

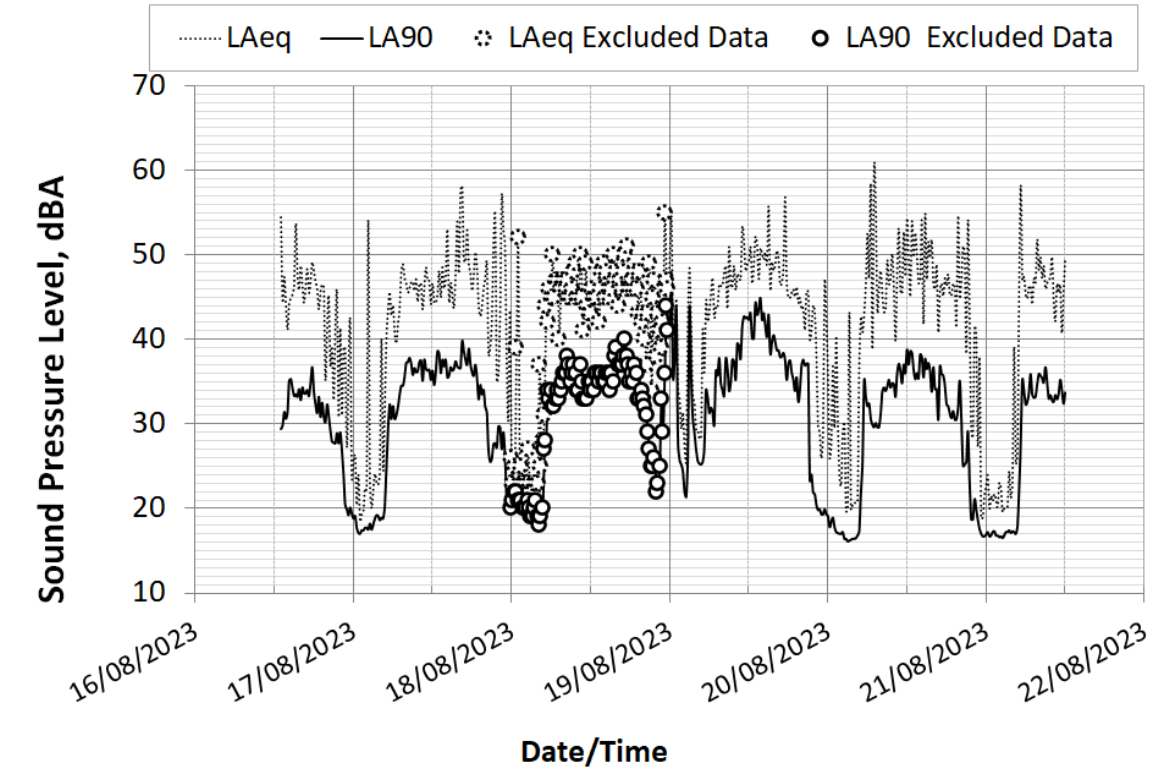
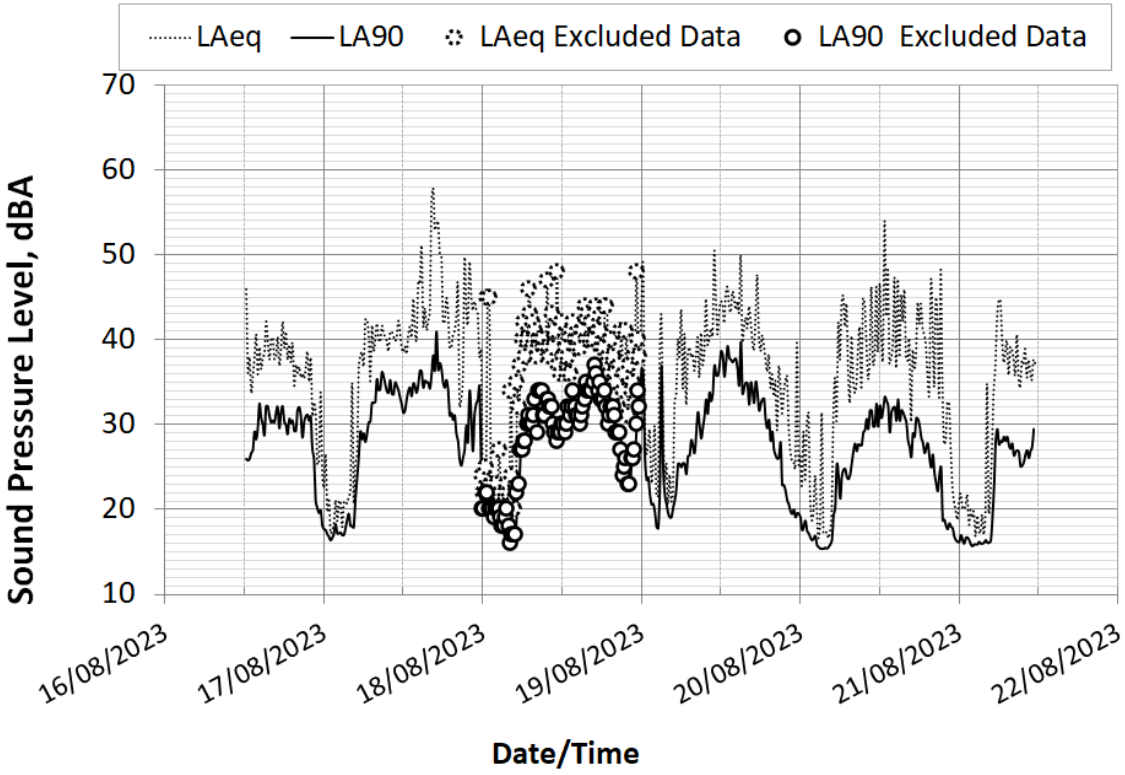


Figure 4 - Time History of Measurements Taken at Location 3



B.3 Histograms of background sound levels

B.3.1 Monitoring position 1

Figure 5 - Histogram of Daytime $L_{A90,\ 15\ Min}$, dB, Measured During Daytime at Measurement Position 1

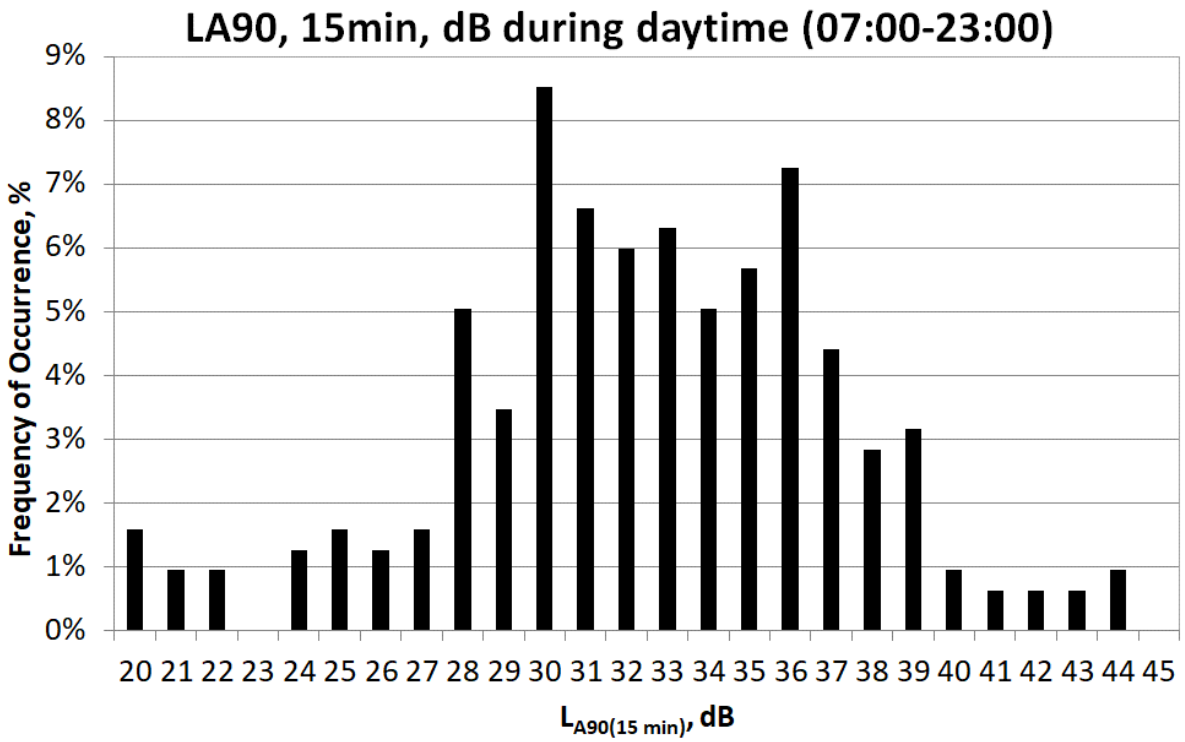
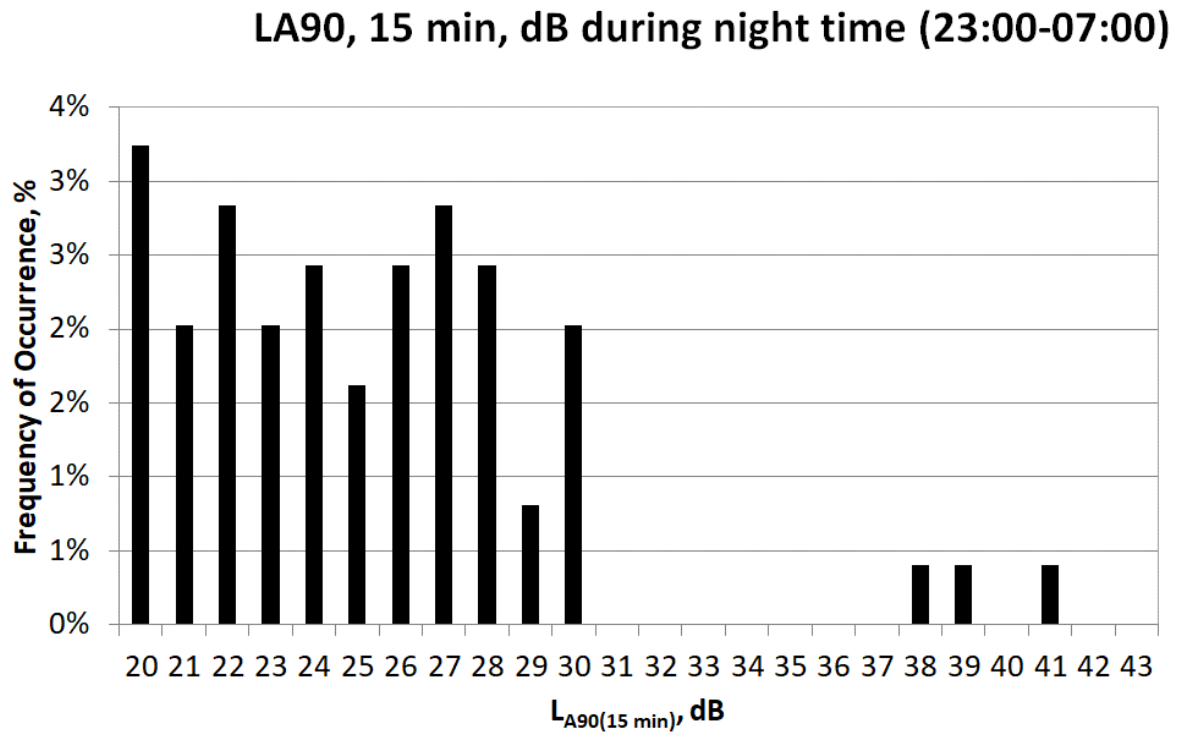


Figure 6 - Histogram of Night Time $L_{A90,\ 15\ Min}$, dB, Measured During Night Time at Measurement Position 1



B.3.2 Monitoring position 2

Figure 7 - Histogram of Daytime $L_{A90,\ 15\ Min}$, dB, Measured During Daytime at Measurement Position 2

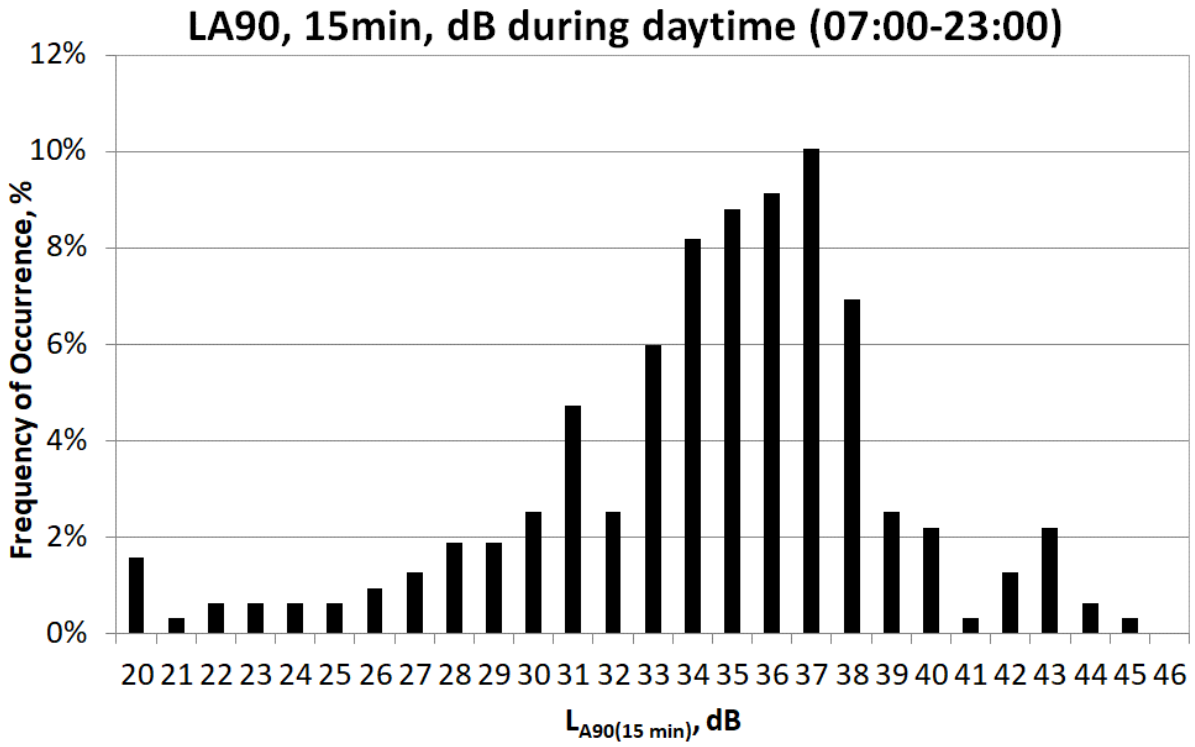
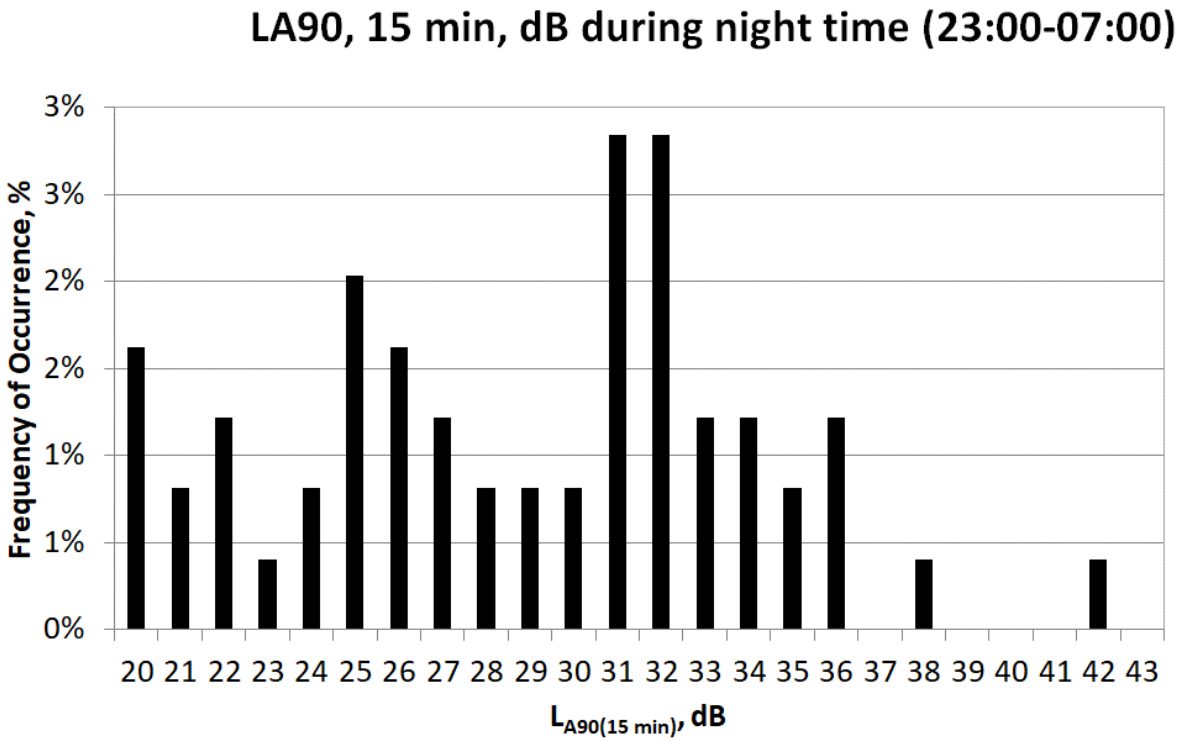


Figure 8 - Histogram of Night Time $L_{A90,\ 15\ Min}$, dB, Measured During Night Time at Measurement Position 2



B.3.3 Monitoring Position 3

Figure 9 - Histogram of Daytime $L_{A90,\ 15\ Min}$, dB, Measured During Daytime at Measurement Position 3

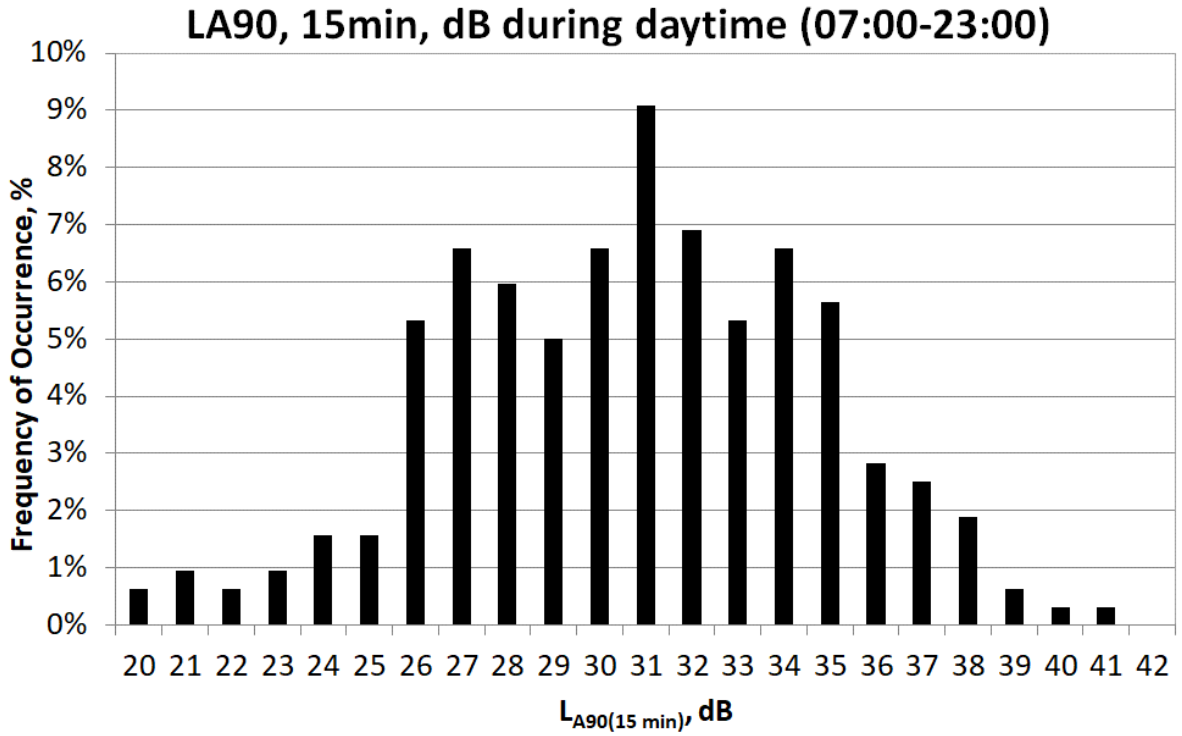
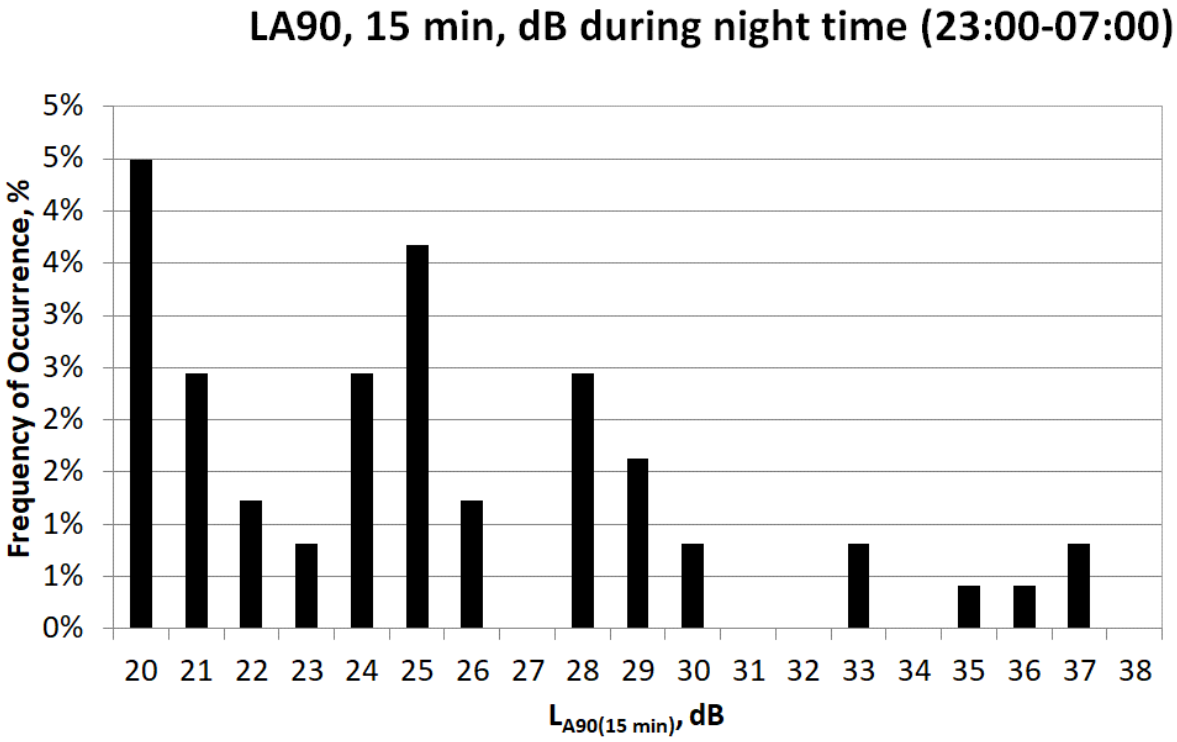
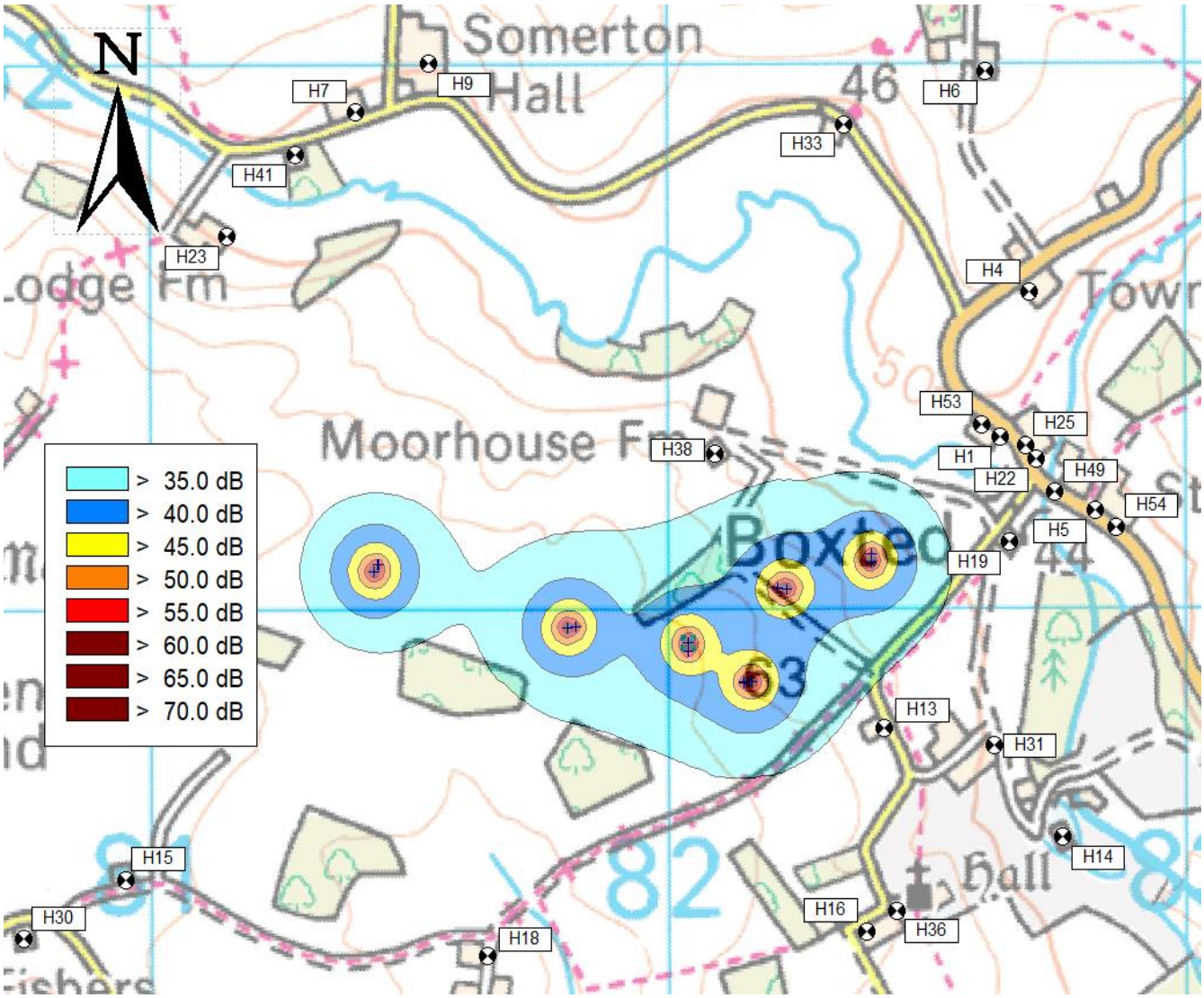


Figure 10 - Histogram of Night Time $L_{A90,\ 15\ Min}$, dB, Measured During Night Time at Measurement Position 3



B.4 Predicted Acoustic Footprint

Figure 11 - Predicted operational acoustic footprint of the site ($L_{Aeq,Tr}$ dB)



Appendix C – Photos

C.1 Background sound survey Positions

Figure 12 - Background Sound Monitor at Location 1

Figure 13 - Background Sound Monitor at Location 2

Figure 14 - Background Sound Monitor at Location 3

Appendix D – Suggested Planning Condition Wording

The facility shall be designed and operated to ensure that the sound level shall not exceed 50 dB L_{Aeq} during the day and 45 dB L_{Aeq} at night outside the nearest residential properties (as identified in RES report 04806-6612352 dated 17/10/2023).