atmos CONSULTING

Environmental Impact Assessment Report

Swarclett Wind Farm

Chapter 9: Noise

Swarclett Wind Energy Limited

wind2

June 2024

Contents

Contents

Tables

Figures

Appendices

Glossary of Terms

Term	Definition
The Applicant	Swarclett Wind Energy Limited
The Agent	Wind 2 Limited
Environmental and Planning Consultant	Atmos Consulting Limited
Environmental Impact Assessment	Environmental Impact Assessment (EIA) is a means of carrying out, in a systematic way, an assessment of the likely significant environmental effects from a development.
Environmental Impact Assessment Regulations	The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017 (EIA Regulations)
Environmental Impact Assessment Report	A document reporting the findings of the EIA and produced in accordance with the EIA Regulations
Proposed Development	Swarclett Wind Farm
Proposed Development Footprint	The area within which the Proposed Development will be located.
Proposed Development Site	The full application boundary, ie the red line boundary (Figure 1-1 Site Location).
Study Area	The area of relevance to the noise assessment which is defined by the worst-case predicted downwind 35 dB L_{A90} noise contour

List of Abbreviations

Abbreviation	Description
BESS	Battery Energy Storage System
CEMP	Construction and Environmental Management Plan
dB	Decibel - the unit used to describe sound level (or amplitude). It is an expression of a ratio between two quantities and needs to be accompanied by a descriptor such as L_{Aeq} or L_{A90} (explained below), unless it describes a level difference. 0 dB L_{Aeq} is equivalent to the hearing threshold of a person with typical hearing
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
ETSU-R-97	ETSU-R-97 The Assessment and Rating of Noise from Wind Farms
Immission	A sound immission is received at a receptor location as opposed to a sound emission which would be transmitted (or emitted) from a location
EnvCoW/ECoW	Ecological/Environmental Clerk of Works
IOA	Institute of Acoustics
IOA GPG	Institute of Acoustics A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise.
kWh	Kilowatt-hour
L_{A90}	The A-weighted sound pressure level exceeded for 90% of the time.
$L_{A90,\ 10min}$	The A-weighted sound pressure level exceeded for 90% of the 10-minute measurement period. Used to define the background level here.
L_{Aeq}	The equivalent continuous A-weighted sound pressure level.
$L_{Aeq,\ T}$	This is the A-weighted sound pressure level in decibels of continuous steady sound that within a specified time interval, T, has the same energy

Abbreviation	Description
	as a sound that varies with time. It is used to identify the average sound pressure level over the specified given time.
LW_A	The fundamental measure of sound power. Sound power is the total sound energy radiated by a source per unit time. The subscript 'A' refers to an A-weighted sound power level.
m/s	Meters per second
NTS	Non-Technical Summary
THC	The Highland Council

9 Noise

9.1 Introduction

This chapter considers the potential noise impacts arising from construction and operation of the Proposed Development on noise sensitive receptor locations in the vicinity. Noise sensitive receptor locations in this case are inhabited residential properties.

Noise during the construction phase of the development will arise from construction vehicles accessing the Proposed Development Site and from construction activities within it, including track construction, foundation excavation and pouring and turbine erection.

Noise during the operational phase of the development will arise from the installed wind turbines as they rotate to generate energy and the Battery Energy Storage System (BESS) facility as it charges or discharges.

Construction noise impacts have been assessed with regard to relevant guidance set out in *BS 5228:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites*.

Operational wind turbine noise impacts have been assessed in line with ETSU-R-97, The Assessment and Rating of Noise from Wind Farms, and the associated guidance provided by the Institute of Acoustics (IOA) document, A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise.

Operational noise impacts relating to the BESS facility have been assessed following methodology set out in *BS 4142:201+A12019 Methods for rating and assessing industrial and commercial sound*.

The noise assessment has been undertaken by the Hayes McKenzie Partnership Ltd. The lead author is Seth Roberts, a Principal Consultant at Hayes McKenzie, who has worked in the field of acoustical engineering for over 16 years.

Seth has 13 years of experience in the field of noise from onshore wind farms and has been involved in work on over 50 wind farm projects. Hayes McKenzie Partnership Ltd are sponsor members of the Institute of Acoustics (IOA) and members of the Association of Noise Consultants (ANC).

9.2 Methodology and Approach

9.2.1 Legislation, planning policy and guidance

This section sets out the relevant policy and guidelines that have been taken into consideration in the preparation of the noise assessment.

Planning Policy

The following planning policy has informed the noise assessment methodology:

- Scottish Government 2023, National Planning Framework 4;
- Planning Advice Note PAN1/2011, Planning and Noise

- Scottish Government 2014, Web Based Planning Advice, Onshore Wind Turbines
- The Scottish Government's Technical Advice Note, Assessment of Noise 2011
- Scottish Government On-Shore Wind Policy Statement 2022

Guidance

Cognisance has been taken of the following best practice guidelines / guidance:

- BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites - Noise
- ETSU-R-97 The Assessment and Rating of Noise from Wind Farms
- Institute of Acoustics (IOA), A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise
- BS 4142:2014+A1:2019 Methods for Rating and Assessing Industrial and Commercial Sound

9.2.2 Consultation

Table 9-1: Consultation

Consultee	Summary of Consultee Response	Where addressed within this Report
The Highland Council (THC) Preapplication Advice for Major Developments dated 3rd November 2021	The document sets out that operational and construction noise assessments would be required. Methodology set out in ETSU-R-97 and BS5228 are referred to and recommended. Additionally, the Highlands Council policy of lowering the ETSU-R-97 night limit to 38dB LA90 or up to 5dB above background noise is set out.	The operational and construction noise impact assessments have been carried out in line with the recommended guidance.
THC Scoping Response dated 28th March 2022	The scoping response document sets out advice that is broadly similar to the recommendations provided in the Preapplication Advice. With regards to construction noise, the scoping response details the likely requirements for a noise management plan for regulating noise under Section 60 of the Control of Pollution Act 1974.	An Outline Construction Management Plan (OCEMP) is included in Technical Appendix 15-1 of this ES
THC Letter proposing noise measurement locations dated 9th March 2023	THC confirmed on 20th March 2023 that they had read the letter and agreed to the proposed measurement locations.	The operational noise impact assessment has been carried out in line with the assessment methodology set out in Preapplication advice and the scoping response. As part of this methodology, baseline noise measurement locations have been confirmed as suitable by THC. Details are included within Technical Appendix 9-1 Baseline Noise Measurements.

9.2.3 Potential Effects Scoped Out

The following potential effects have been scoped out of the assessment.

Tonal Noise

ETSU-R-97 specifies that, in line with other noise guidance, a penalty should be added to measured or predicted wind turbine noise levels if there is tonal noise above a certain level which is audible at residential properties.

In this assessment, it has been assumed that there would be no tonal noise associated with the operation of the wind farm which would give rise to such a penalty, as most modern turbines operate without significant tonal noise.

It is anticipated that a penalty would be included in an appropriately worded planning condition such that a tonal penalty would need to be added to measured noise levels, where required, before comparing them with the noise limits. Warranty agreements with turbine suppliers ensure that any such penalties will not occur in practice.

Low Frequency and Infrasound

Low frequency sound is typically defined as sound in the audible hearing frequency range of 20 Hz up to about 200 Hz. Noise from wind turbines is not inherently low-frequency and it is typically broad-band in nature, and close to a wind turbine the dominant frequencies are usually in the 250 to 2000 Hz range.

As the distance from a wind farm increases, the noise level decreases as a result of the spreading out of the sound energy and also due to air absorption which increases with increasing frequency.

This means that, although the energy across the whole frequency range is reduced, higher frequencies are reduced to a greater extent than lower frequencies with the effect that as distance from the site increases the ratio of low to high frequencies also increases.

This effect may be observed with road traffic noise or natural sources, such as the sea, where higher frequency components are diminished relative to lower frequency components at increasing distances.

At such distances, however, the overall noise level is so low, such that overall noise levels are well below noise levels produced by everyday household activities and any bias in the frequency spectrum can usually be considered to be insignificant due to the relatively quiet nature of the sound.

Work carried out in 2006 by Hayes McKenzie for the UK Department of Trade and Industry (DTI, 2006) to investigate the extent of low frequency and infrasonic noise from three UK wind farms concluded that;

> "*the common cause of complaints associated with noise at all three wind farms is not associated with low frequency noise, but is the audible modulation of the aerodynamic noise, especially at night*".

It is therefore considered that low frequency noise can be scoped out of the assessment.

Infra-sound is noise occurring at frequencies below that at which sound is normally audible, i.e. at less than about 20 Hz, due to the significantly reduced sensitivity of the ear at such frequencies. In this frequency range, for sound to be perceptible, it has to be at very high amplitude, which is not the case for wind turbine noise.

In November 2016 a study into low frequency and infrasound was published by the State Office for the Environment, Measurement and Nature Conservation of the Federal State of Baden-Wuerttemberg (Landesanstalt für Umwelt, Messungen und Naturschutz Baden-Württemberg, 2016) that contained a comprehensive review of low frequency and infrasound from wind turbines, and evaluated such noise in relation to other sources. The results state that;

> "*the infrasound level in the vicinity of wind turbines is – at distances between 120m and 300 m – well below the threshold of what humans perceive*" and that "*at a distance of 700 m from the wind turbines, it was observed by means of measurements that when the turbine is switched on, the measured infrasound level did not increase or only increased to a limited extent. The infrasound was generated mainly by the wind and not by the turbines*".

The report concludes that;

> *"Infrasound is caused by a large number of different natural and technical sources. It is an everyday part of our environment that can be found everywhere. Wind turbines make no considerable contribution to it. The infrasound level generated by them lie clearly below the limits of human perception. There is no scientifically proven evidence of adverse effects in this level range".*

It is therefore considered that infrasound can be scoped out of the assessment.

Amplitude Modulation

The variation in noise level associated with wind turbine operation, at the rate at which turbine blades pass any fixed point of their rotation (the blade passing frequency), is often referred to as blade swish or Amplitude/Aerodynamic Modulation (AM). This effect is identified within ETSU-R-97 where it is envisaged that

> "*… modulation of blade noise may result in variation of the overall A-Weighted noise level by as much as 3 dB(A) (peak to trough) when measured close to a wind turbine…*"

and that at distances further from the turbine where there are;

> "*… more than two hard, reflective surfaces, then the increase in modulation depth may be as much as 6 dB(A) (peak to trough)*".

There have been instances where level of AM rates are higher than this, which results in the noise being perceived as more intrusive (in the same way as tonal content makes the noise more intrusive).

The Department of Energy & Climate Change commissioned a Wind Turbine AM Review report that was published in two phases: Phase 1 in September 2015 and Phase 2 in October 2016 (although the Phase 2 report is dated August 2016).

Phase 1 of the report sets out the approach and methodology to the review and research, and the Phase 2 report includes a literature review, research into human response to AM, and recommends how excessive AM might be controlled through the use of a planning condition.

The report includes recommendations on how AM should be addressed when quantified according to the recommendations of a separate Institute of Acoustics (IOA) working group document, A Method for Rating Amplitude Modulation in Wind Turbine Noise (August 2016).

The AM Review reports recommend a two-tier approach whereby the first tier seeks a reduction in the depth and/or occurrence of AM with a rating level (according to the IOA Amplitude Modulation Working Group method) ≥3 dB. Whether remedial action is required depends on the prevalence of any complaints, and how often AM rating levels ≥3 dB occur.

The second tier is that if AM is deemed to be a significant issue, and if nothing can be done to reduce the level of AM, then a penalty scheme is proposed whereby a penalty ranging from 3 dB (for a rating level of 3 dB) up to a maximum of 5 dB (for a rating level of 10 dB and above) could be added to the measured turbine noise level before measured levels are compared with the relevant noise limits.

It should be noted that most wind farms operate without significant AM, and that it is not possible to predict the likely occurrence of AM.

At the time of writing there has been no official response to those recommendations from the IOA Noise Working Group or endorsement from any Scottish Government Minister or Department. The IOA GPG, states that "*the evidence in relation to "Excess" or "other" Amplitude Modulation (AM) is still developing. At the time of writing, current practice is not to assign a planning condition to deal with AM*", although it is possible to control such noise with an appropriately worded planning condition if necessary.

9.2.4 Assessment Methodology

This chapter considers the effects of noise associated with the construction, operation and decommissioning of the Proposed Development on neighbouring noise sensitive receptors. It should be noted that operational noise for the Proposed Development will be generated by two separate elements which fall into different categories for noise assessment, wind turbine noise and electrical plant noise associated with the BESS facility.

Construction Noise

A detailed assessment of construction noise from all construction activities has been deemed unnecessary due to the relatively large distance between items of plant and residential receptors but predictions have been carried out for the activity occurring closest to residential properties.

Predictions have been carried out using source data detailed in BS 5228-1:2009+A1:2014 according to prediction methodology set out in ISO 9613-2 and this is detailed further in Technical Appendix 9-2 Noise Prediction Methodology (EIAR Volume 3).

Construction activities within the Proposed Development site boundary that could give rise to the greatest levels of noise are listed below:

- Track construction has the potential to pass closest to residential properties; and
- Blasting, if required, will generate the highest levels of noise at the source.

The nearest noise sensitive receptors to the proposed locations of these construction activities are:

- For track construction, Durran Mains, within approximately 450 m of the nearest potential track location; and
- For blasting, it is understood that the application does not include the use of any existing or creation of any new borrow pits on the site (where blasting could potentially occur). It is understood that the Applicant intends to import all aggregate from external suppliers and blasting is therefore not expected at the site.

BS 5228-1:2009 + A1:2014 provides example criteria for the assessment of the significance of construction noise effects and a method for the prediction of noise levels from construction activities. Two example methods are provided for assessing significance.

The first is based on the use of criteria defined in Department of the Environment Advisory Leaflet (AL) 72, Noise Control On Building Sites (DoE, 1976), which sets a fixed limit of 70 dB(A) in rural suburban and urban areas away from main roads and traffic. Noise levels are generally taken as façade L_{Aeq} values with free-field levels taken to be 3 dB lower giving an equivalent noise criterion of 67 dB L_{Aeq}.

The second is based on noise change but applies minimum criteria of 45, 55 and 65 dB L_{Aeq} for night-time (23:00-07:00), evening and weekends (19:00-23:00 weekdays, 13:00-23:00 Saturdays and 07:00-23:00 Sundays), and daytime (07:00-19:00) including Saturdays (07:00-13:00) respectively.

These limits are applicable irrespective of existing baseline noise levels, and where construction activities have a duration of one month or more. It should be noted that the time period to which each limit applies also defines the time averaging period for the calculated L_{Aeq}.

Standard best practice measures to minimise noise during construction will be implemented in accordance with a detailed Construction Environmental Management Plan (CEMP), which can be secured by means of an appropriately worded planning condition.

A simplified daytime construction noise limit of 65 dB L_{Aeq} during normal working hours will be applied in accordance with the second method from BS5228-1:2009 +A1 2014 discussed above.

Guidance on air over-pressure as a consequence of any blasting associated with borrow pit activities is provided within Annex I to the Standard (BS 5228-1). Guidance with respect to vibration induced from blasting is also provided within BS 5228_2 together with additional advice for air over-pressure (BS5228_2 Annex G).

It is not possible to accurately predict vibration or air-overpressure and the focus within the standard is on managing the potential effects during the construction process.

Any potential noise issues associated with the movement of construction vehicles to and from the Proposed Development Site would be sufficiently dealt with within the Construction Traffic Management Plan (CTMP) where considered necessary.

Wind Turbine Noise

The approach to assessing operational wind turbine noise effects has been carried out in line with the recommendations of ETSU-R-97 The Assessment and Rating of Noise from

Wind Farms (ETSU-R-97) and the Institute of Acoustics, A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (IOA GPG) as referred to in National Planning policy identified above. The assessment methodology includes the following stages:

- Baseline noise survey conducted at noise sensitive receptors around the Proposed Development and correlated with standardised 10 m height wind speeds measured concurrently on site.
- Plots of baseline L_{A90} noise levels against standardised 10 m height wind speed are used to derive prevailing daytime and night-time background noise curves for a range of wind speeds up to 12 m/s.
- Derived prevailing background noise curves are used to define daytime and night-time noise limits calculated in accordance with ETSU-R-97 and THC scoping response.
- Predicted noise levels are calculated / modelled using ISO 9613-2 methodology implemented using proprietary noise modelling software.
- Noise contour plots are produced showing predicted L_{A90} at a height of 4 m above ground level assuming downwind conditions in all directions (not possible in practice but represents worst-case for all receptor locations).
- Worst-case downwind predicted noise levels are compared to the noise limits.

The ETSU-R-97 noise limits apply to cumulative noise from all wind turbine development, and therefore neighbouring wind turbine developments should be considered alongside the Proposed Development. The only neighbouring wind turbine development at the time of submission either in planning, consented or operational is another proposed 2 wind turbine scheme at Red Moss.

The assessment is based on the Proposed Development as described in Chapter 3 Description of Development (EIAR Volume 2) and assumes the installation of 2 turbines up to 149.9 m tip height. For the purposes of the EIAR and this noise assessment use of a Nordex N133 4.8 MW candidate turbine with the inclusion of Serrated Trailing Edges (STE's) has been assumed.

It should be noted that the actual turbine selection will depend on a number of factors that will be taken into account during the procurement process, post consent and it cannot be guaranteed that this candidate turbine would be installed on the Proposed Development Site.

The adjacent proposed development at Red Moss includes a similar description in the scoping report which assumes the installation of 2 turbines up to 150 m tip height. For the purposes of the EIAR and this noise assessment use of the same N133 4.8 MW candidate turbine has been assumed for the Red Moss Turbines.

Operational noise predictions have been carried out for a candidate wind turbine under consideration for the Proposed Development in line with the methodology set out in the IOA GPG (IOA 2013). Full details of the prediction methodology are set out in Technical Appendix 9-2 Noise Prediction Methodology (EIAR Volume 3), and the main assumptions are described below:

- Receiver height of 4 m;
- Ground effect ground coefficient G=0.5;
- Atmospheric attenuation corresponding to a temperature of 10°C and a relative humidity of 70%;

- Topographical barriers and concave ground profile corrections have been applied according to the IOA GPG (IOA 2013);
- A margin of plus 2 dB has been added to manufacturer's sound power level data to account for uncertainty.

The source noise levels for the candidate turbine assumed for the Proposed Development are set out at Table 9-2. The candidate N133 4.8-STE turbine used for the purposes of the predictions is assumed to have a hub height of 83 m.

The octave band noise data taken from the manufacturer's technical specification document are also set out at Table 9-2 and have been normalised to the overall sound power level at each integer wind speed. Note that above 7 m/s standardised 10 m height wind speed (12 m/s at hub height) the source noise levels in the manufacturer's documentation are indicated not to increase.

Table 9-2: Candidate Turbine Octave Band Sound Power Level (dB L_{WA})

Standardised 10 m height wind speed	Octave band centre frequency (Hz)								Broadband
	63	125	250	500	1000	2000	4000	8000	
3	76.7	83.7	87.5	88.4	88.9	87.6	83.3	74.1	95.0
4	77.9	84.9	88.7	89.6	90.1	88.8	84.5	75.3	96.2
5	83.4	90.4	94.2	95.1	95.6	94.3	90.0	80.8	101.7
6	87.6	94.6	98.4	99.3	99.8	98.5	94.2	85.0	105.9
7	88.3	95.3	99.1	100.0	100.4	99.2	94.9	85.7	106.5
8	88.2	95.2	99.0	99.9	100.4	99.1	94.8	85.6	106.5
9	88.2	95.2	99.0	99.9	100.4	99.1	94.8	85.6	106.5
10	88.2	95.2	99.0	99.9	100.4	99.1	94.8	85.6	106.5
11	88.2	95.2	99.0	99.9	100.4	99.1	94.8	85.6	106.5
12	88.2	95.2	99.0	99.9	100.4	99.1	94.8	85.6	106.5

BESS Facility Electrical Plant Noise

BS 4142:2014 + A1 2019 is generally aimed at industrial or commercial sound sources and is therefore entirely appropriate for assessing sound immissions from the proposed electrical plant to be installed as part of the proposed BESS facility.

Specific sound levels, due to all items of plant operating simultaneously, under downwind propagation conditions, arriving at neighbouring residential properties have been calculated through noise predictions according to ISO 9613-2, as referred to in BS 4142:2014 + A1 2019 and described in Technical Appendix 9-2, Noise Prediction Methodology (EIAR Volume 3).

The BS 4142:2014 + A1 2019 assessment methodology describes an initial test for determining the impact based on the difference between the existing background sound level (without the sound source), measured using the L_{A90} measurement index, and the sound immission level of the source at a receiver location (known as the specific sound level), measured or predicted using the L_{Aeq} index.

If the specific sound level exhibits an identifiable character such as tonality or impulsiveness, then a variable penalty of up to 6 dB or 9 dB respectively is added to give the 'rating level'.

The difference between the background sound level and the rating level (rating minus background) is then used as an initial assessment of the impact as described in **Table 9-3** below.

Table 9-3: BS4142 Initial Assessment Criteria

Difference	Assessment
Around +10 dB or more	Indication of a significant adverse impact
Around +5 dB	Indication of an adverse impact
<0 dB	Indication of a low impact

The standard notes, however, that this is only an initial estimate and the assessment should take cognisance of context, as described in the following quote taken from section 11 of BS 4142:2014 + A1 2019:

> *"Where the initial estimate of the impact needs to be modified due to the context, take all pertinent factors into consideration, including the following.*
>
> *1) The absolute level of sound. For a given difference between the rating level and the background sound level, the magnitude of the overall impact might be greater for an acoustic environment where the residual sound level is high than for an acoustic environment where the residual sound level is low. Where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night."*

Background sound levels have been measured at Hoy which is considered representative of the closest noise sensitive location (to the BESS facility) Durran Mains, as part of an unattended noise survey.

The measurement location was chosen to be in the resident's garden to the rear (north) of the property, which was partially sheltered from the wind blowing from the south during the installation. It was set up in an area that would be used for rest and recreation and positioned at least 2.5 m from a low garden wall to the west and approximately 5 m from the façade of the house.

Hayes McKenzie consider that background sound levels below 35 dB L_{A90} are low and that for background sound levels below 30 dB L_{A90}, the initial comparison between background sound and rating level becomes less important.

In the context of low background sound levels, section 11 of BS 4142:2014 + A1:2019 states that 'absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background' as noted above.

For representative daytime background sound levels between 30 and 45 dB L_{A90}, it is considered that a threshold criterion of rating level no higher than 5 dB above background sound level is suitably conservative for identifying potential adverse impacts.

For representative night-time background sound levels below 30 dB L_{A90}, it is considered that comparison of external rating levels against background sound levels is no longer appropriate and absolute predicted sound levels within bedrooms are more relevant.

It is considered that an internal rating level criterion of no higher than 30 dB(A) within bedrooms is a suitable threshold for determining the onset of potential adverse impact from the Proposed Development during the night.

The Proposed BESS facility could be charging or discharging at any time of the day or night, and therefore, both the day and night reference time intervals specified in BS 4142:2014 + A1:2019 are relevant for this assessment.

It should be noted that the inverters assumed for the battery storage are PCS units housed in containers with cooling fans and that the speed of these fans determines the noise output.

The maximum noise level for the PCS unit cooling fans is only likely to occur if the ambient outside temperature is in the range of 40 - 50 °C and generally, for sites in the UK, the cooling fans would be operating at slower speeds with a lower noise output.

For the purposes of the noise assessment the PCS units are modelled as operating at 70% fan speed which would only be required for ambient outside temperatures of 30 °C and slower fan speeds (and hence lower noise levels) could be expected for temperatures below this.

In practice, temperatures as high as 30 °C are very unlikely to occur most of the time and the fans are likely to be running at slower speeds or switched off altogether, particularly at night when temperatures would never get this high at the Proposed Development Site. Accordingly, the likely operational sound levels would be expected to be lower than those that have been modelled.

9.2.5 Significance Criteria

If the relevant noise limits, identified above, are met then the construction and operational noise impact for the purposes of this assessment are considered to be not significant. These noise limits are summarised again below.

For the purposes of the construction noise assessment, airborne noise from track construction will be considered significant if it has the potential to exceed 65 dB L_{Aeq} over a 12-hour working day. It is not possible to assess the significance of vibration or air-over-pressure related to blasting at borrow pits and this will be managed during the construction phase.

Operational wind farm noise will be considered significant if it exceeds the relevant ETSU-R-97 noise limits for daytime and night-time hours (as adjusted and confirmed in THC scoping response). During the day this is the greater of either 35 dB or 5 dB above prevailing background sound levels.

During the night this is the greater of either 38 dB or 5 dB above prevailing background sound levels. If a property is financially involved with a development the ETSU-R-97 limits are increased to the greater of 45 dB or 5 dB above background for the day and night periods.

The prevailing background sound levels are derived through noise measurements correlated with wind speed resulting in noise limits set at integer wind speeds. Methodology and results of the baseline noise survey are detailed within Technical Appendix 9-1 which includes derived background noise levels and the resulting limits detailed in Table 9-1-3 and Table 9-1-4 respectively.

9.3 Baseline Conditions

9.3.1 ETSU-R-97 Baseline

The results of the baseline noise measurements, processed according to ETSU-R-97 methodology (as presented in Technical Appendix 9-1) are summarised at **Table 9-4**.

Table 9-4: Baseline Noise Measurement Results (dB L_{A90})

Location	Time Period	Standardised 10 m height wind speed (m/s)[1]										
		2	3	4	5	6	7	8	9	10	11	12
Hoy	Night-time	23	24	26	28	31	33	36	40	42	45	47
	Quiet Day	29	29	30	32	34	38	41	45	49	52	55
Oakwood	Night-time	21	22	23	25	27	29	31	33	35	38	40
	Quiet Day	24	25	26	27	29	32	34	37	41	44	48
Lower Bowertower	Night-time	22	23	24	26	29	31	34	37	40	43	45
	Quiet Day	25	26	27	30	32	36	39	43	46	50	52

9.3.2 BS4142 Baseline

Statistical analyses of the background sound level results measured at Hoy are detailed within Technical Appendix 9-1 for daytime and night-time hours separately. It should be noted that this location is considered to be representative of Durran Mains, which is the closest residential property to the BESS Facility.

Representative values for the background sound levels to be used in the BS 4142 assessment must be derived by taking into account frequency distribution plots of the background sound measurements.

Review of the distribution plots (included at Technical Appendix 9-1) indicates that the most commonly occurring background sound levels are **30 dB L_{A90}** and **18 dB L_{A90}** for daytime and night-time respectively. It should also be noted that very similar results can be obtained by taking an arithmetic average of the daytime background sound levels.

The arithmetic average for night-time is higher than the modal value but the lower value is considered to be representative of the quietest parts of the night and therefore more conservative. These values have therefore been adopted as the appropriate representative background sound levels for the assessment.

9.3.3 Summary of Sensitive Receptors

Only receptor locations where predicted operational noise levels from the Proposed Development are above 30 dB L_{A90} have been scoped into the assessment. This is defined as the Study Area. The receptor locations included in the assessment are shown at **Table 9-5** and Figure 9-1.

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[1] The standardised 10 m height wind speed is the hub height wind speed corrected to 10 m height using a logarithmic wind shear profile and a ground roughness length of 0.05 m.

One of the receptors is a proposed dwelling in the planning system and this has been labelled with the relevant THC planning reference in the absence of a property name. All other receptors considered in the assessment are occupied residential properties.

Where a receptor is within the Study Area, and is not a measurement location, it has been assigned limits from one of the three baseline measurement locations if one is deemed representative. All other noise sensitive receptors outside the Study Area are unlikely to experience significant noise effects and accordingly are scoped out.

Table 9-5: Noise Sensitive Receptors

Receptor	Grid Reference	Limit Location
Durran Mains	319918, 962747	Hoy (financially involved)
Hoy	321128, 963975	Hoy (financially involved)
Lower Bowertower	322143, 962817	Lower Bowertower
Oakwood	322108, 962424	Oakwood
Lissadel House	322098, 961974	Oakwood
Stonefield Farm	322432, 962101	Oakwood
23/00185/FUL	321936, 962214	Oakwood
Dunnone	322192, 961985	Oakwood
The Croft	322290, 961884	Oakwood

9.4 Assessment of Effects and Mitigation

9.4.1 Construction Effects

Predictions have been made of noise levels at locations representative of the nearest residential properties to the proposed development, using the methods prescribed in BS 5228:2014. It is assumed that all construction works will occur during daytime hours (0700-1900) including Saturdays (0700-1300).

Quasi-Static Track Construction

In carrying out the predictions it has been assumed that all plant involved with track construction is located at the nearest possible point to the closest property. It should be noted that this is unlikely to occur in practice but gives worst-case noise levels.

The plant assumed for Quasi-Static Track Construction along with the assumed octave band sound power levels for each item are detailed in Technical Appendix 9-2 Noise Prediction Methodology.

For the calculations, 50% soft ground attenuation has been used throughout with no topographical barrier attenuation. In practice it is likely that at least some of the plant will be screened from view as there are multiple battery containers arranged in such a way that the closest of these will screen the others from view, but the calculation represents a realistic worst case.

The only noise sensitive location from the list at **Table 9-5** which is close enough to the Proposed Development for potential noise impacts related to track construction is Durran Mains.

The predicted noise levels for Quasi-Static Track Construction at this property are 55 dB L_{Aeq} which is significantly below the 65 dB L_{Aeq} daytime criterion. Durran Mains is the closest property to the Proposed Development such that noise levels and the likely impacts at all other properties would therefore be lower.

Blasting at Borrow Pits

Whilst it is understood that no new borrow pits are proposed as part of the application and the Applicant plans to use existing borrow pits in the area, this noise source may still be of relevance to the CEMP. BS 5228-1:2009 +A1:2014 states, regarding blasting and its potential effect on neighbours to a site, that;

> '*Vibration and air overpressure from blasting operations is a special case and can under some circumstances give rise to concern or even alarm to persons unaccustomed to it. The adoption of good blasting practices will reduce the inherent and associated impulsive noise: prior warning to members of the public, individually if necessary, is important.*'

BS 5228-1:2009 +A1:2014 states that practical measures, including good blast design, that have been found to reduce air overpressure and/or vibration are:

- Ensuring appropriate burden to avoid over or under confinement of the charge;
- Accurate setting out and drilling;
- Appropriate charging;
- Appropriate stemming with appropriate material such as sized gravel or stone chippings;
- Using delay detonation to ensure smaller maximum instantaneous charges (MICs);
- Using decked charges and in-hole delays;
- Blast monitoring to enable adjustment of subsequent charges;
- Designing each blast to maximize its efficiency and reduce the transmission of vibration; and
- Avoiding the use of exposed detonating cord on the surface in order to minimize air overpressure – if detonating cord is to be used in those cases where down-the-hole initiation techniques are not possible, it should be covered with a reasonable thickness of selected overburden.

The above factors should be considered when creating the Construction Environmental Management Plans (CEMPs) for the construction works and a combination of minimising blasting activities and ensuring nearby residents are fully warned should mitigate any adverse impact from these activities which are high in sound and vibration energy but of very short duration.

9.4.2 Operational Effects

Operational noise effects are separated into those relating to operation of the wind turbines and those relating to operation of the BESS facility since differing methodology applies.

Wind Turbines – ETSU-R-97 Assessment

Operational noise impacts relating to the wind turbines have been assessed by comparing predicted operational noise levels with ETSU-R-97 noise limits derived from the baseline noise measurements. The relevant noise limits are set out at **Table 9-6**.

Table 9-6: Derived Noise Limits (dB L_{A90})

Location Name	Limit Period	Standardised 10m height wind speeds (m/s)										
		2	3	4	5	6	7	8	9	10	11	12
Hoy (financially involved)	Night-time	45	45	45	45	45	45	45	45	47	50	52
	Quiet Day	45	45	45	45	45	45	46	50	54	57	60
Oakwood	Night-time	38	38	38	38	38	38	38	38	40	43	45
	Quiet Day	35	35	35	35	35	37	39	42	46	49	53
Lower Bowertower	Night-time	38	38	38	38	38	38	39	42	45	48	50
	Quiet Day	35	35	35	35	37	41	44	48	51	55	57

Operational noise prediction results are presented for all receptors scoped into the assessment.

The prediction results are presented at **Table 9-7**. It should be noted that the predictions assume that each receptor location is downwind of the Proposed Development to provide a worst-case assessment. Under non-downwind conditions, operational noise levels will be lower. In addition, worst-case downwind noise contours for the maximum operational noise levels from the Proposed Development, as well as the noise sensitive receptor locations, are shown at Figure 9-2 (EIAR Volume 4a).

Table 9-7: Operational Noise Prediction Results (dB L_{A90})

Location	Standardised 10 m height wind speed (m/s)										
	2	3	4	5	6	7	8	9	10	11	12
Durran Mains	-	20	21	26	30	31	31	31	31	31	31
Hoy	-	23	25	30	34	35	35	35	35	35	35
Lower Bowertower	-	24	25	30	35	35	35	35	35	35	35
Oakwood	-	23	24	30	34	35	35	35	35	35	35
Lissadel House	-	21	22	27	31	32	32	32	32	32	32
Stonefield Farm	-	19	20	26	30	30	30	30	30	30	30
23/00185/FUL	-	23	25	30	34	35	35	35	35	35	35
Dunnone	-	20	21	27	31	31	31	31	31	31	31
The Croft	-	19	20	26	30	30	30	30	30	30	30

Predicted noise levels are below the relevant night and day-time noise limits at all noise sensitive receptor locations, which is illustrated by the margins between predicted noise levels and these two limits in **Table 9-8** and **Table 9-9**. Therefore, the operational noise impact of the Proposed Development is determined to be not significant at all receptor locations included in the assessment.

Table 9-8: Margin Between Predicted Operational Noise Level and Derived Night-Time Noise Limits (dB L_{A90})

Location	Standardised 10 m height wind speed (m/s)										
	2	3	4	5	6	7	8	9	10	11	12
Durran Mains	-	25	24	19	15	14	14	14	16	19	21
Hoy	-	22	20	15	11	10	10	10	12	15	17
Lower Bowertower	-	14	13	8	3	3	4	7	10	13	15
Oakwood	-	15	14	8	4	3	3	3	5	8	10
Lissadel House	-	17	16	11	7	6	6	6	8	11	13

Location	Standardised 10 m height wind speed (m/s)										
	2	3	4	5	6	7	8	9	10	11	12
Stonefield Farm	-	19	18	12	8	8	8	8	10	13	15
23/00185/FUL	-	15	13	8	4	3	3	3	5	8	10
Dunnone	-	18	17	11	7	7	7	7	9	12	14
The Croft	-	19	18	12	8	8	8	8	10	13	15

Table 9-9: Margin Between Predicted Operational Noise Level and Derived Day-Time Noise Limits (dB L_{A90})

Location	Standardised 10 m height wind speed (m/s)										
	2	3	4	5	6	7	8	9	10	11	12
Durran Mains	-	25	24	19	15	14	15	19	23	26	29
Hoy	-	22	20	15	11	10	11	15	19	22	25
Lower Bowertower	-	11	10	5	2	6	9	13	16	20	22
Oakwood	-	12	11	5	1	2	4	7	11	14	18
Lissadel House	-	14	13	8	4	5	7	10	14	17	21
Stonefield Farm	-	16	15	9	5	7	9	12	16	19	23
23/00185/FUL	-	12	10	5	1	2	4	7	11	14	18
Dunnone	-	15	14	8	4	6	8	11	15	18	22
The Croft	-	16	15	9	5	7	9	12	16	19	23

BESS Facility – BS 4142 Assessment

In order to assess the level of noise from the proposed BESS facility, initially, the predicted rating level has been compared with the adopted daytime and night-time criteria (discussed at section 9.2.4).

The representative background sound level during the day is 30 dB L_{A90} and therefore the adopted significance criterion is 5 dB above this value and the rating level should not exceed 35 dB. The representative background sound level at night is well below 30 dB L_{A90} and therefore, the adopted significance criterion is an internal rating level of no higher than 30 dB.

When the transformers are operating, tonal noise is likely to be evident at close range and could potentially be audible at the nearest residential locations. However, it should be noted that noise from the transformers is at a significantly lower level than the PCS inverters and would therefore be less likely to be audible.

To account for tonal noise being just audible, a tonal penalty of 2 dB has been added to the predicted specific sound level. There will be no impulsive noise from the BESS facility that requires a character correction, and it is assumed that no other character corrections apply.

Worst-case downwind noise contours showing the predicted rating levels from the BESS facility, as well as the noise sensitive receptor locations, are shown at Figure 9-4 (EIAR Volume 4a).

It can be seen from this figure that the rating level is just below 30 dB at Durran Mains which is 5 dB below the daytime criterion. It is generally accepted that a window partially open for ventilation offers 10 -15 dB of attenuation so an internal level of 15 – 20 dB L_{ATr} could be expected within bedrooms at night which is at least 10 dB below the night time criterion.

All other nearby residential properties in the immediate vicinity of the proposed BESS facility, are more distant than the location assessed such that the predicted noise level and associated likely noise impacts would be lower. Therefore, the noise impact of the proposed BESS facility is determined to be not significant at all receptor locations considered in this assessment.

9.4.3 Decommissioning Effects

Noise arising from decommissioning activities will be below the relevant noise limits that apply to noise from construction, and decommissioning operations will be undertaken in line with the relevant standards and limits that apply at the time.

The decommissioning effects will not include track construction and all construction plant will be significantly further from residential receptors than has been assumed for this activity. Therefore, decommissioning effects have not been assessed in detail as these will be less than the effects of construction which have been shown to be not significant.

Therefore, noise effects during decommissioning have been scoped out of further assessment.

9.4.4 Cumulative Effects

Operational noise impacts relating to the combined effect of the Red Moss and Swarclett wind turbines have been assessed by comparing predicted cumulative operational noise levels with the ETSU-R-97 noise limits set out at Table 9-6.

The cumulative prediction results are presented at **Table 9-10**. It should be noted that the predictions assume that each receptor location is downwind of the Proposed Development to provide a worst-case assessment.

Under non-downwind conditions, operational noise levels will be lower. In addition, worst-case downwind noise contours for the maximum operational noise levels from the Proposed Development, as well as the noise sensitive receptor locations, are shown at Figure 9-2 (EIAR Volume 4a).

Table 9-10: Cumulative Operational Noise Prediction Results (dB L_{A90})

Location	Standardised 10 m height wind speed (m/s)										
	2	3	4	5	6	7	8	9	10	11	12
Durran Mains	-	20	21	27	31	32	32	32	32	32	32
Hoy	-	26	27	32	36	37	37	37	37	37	37
Lower Bowertower	-	26	27	33	37	38	38	38	38	38	38
Oakwood	-	24	26	31	35	36	36	36	36	36	36
Lissadel House	-	22	23	29	33	33	33	33	33	33	33
Stonefield Farm	-	21	22	28	32	33	33	33	33	33	33
SW of Oakwood	-	24	26	31	35	36	36	36	36	36	36
Dunnone	-	21	23	28	32	33	33	33	33	33	33
The Croft	-	20	22	27	31	32	32	32	32	32	32

The relevant night and day-time noise limits are met at all noise sensitive receptor locations, which is illustrated by the margins below these two limits in **Table 9-11** and **Table 9-12**. Therefore, based on the assumed turbine selection for Red Moss, the cumulative noise impact of the Proposed Development is considered to be not significant.

Table 9-11: Margin Between Predicted Cumulative Operational Noise Level and Derived Night-Time Noise Limits (dB L_{A90})

Location	Standardised 10 m height wind speed (m/s)										
	2	3	4	5	6	7	8	9	10	11	12
Durran Mains	-	25	24	18	14	13	13	13	15	18	20
Hoy	-	19	18	13	9	8	8	8	10	13	15
Lower Bowertower	-	12	11	5	1	0	1	4	7	10	12
Oakwood	-	14	12	7	3	2	2	2	4	7	9
Lissadel House	-	16	15	9	5	5	5	5	7	10	12
Stonefield Farm	-	17	16	10	6	5	5	5	7	10	12
SW of Oakwood	-	14	12	7	3	2	2	2	4	7	9
Dunnone	-	17	15	10	6	5	5	5	7	10	12
The Croft	-	18	16	11	7	6	6	6	8	11	13

Table 9-12: Margin Between Predicted Cumulative Operational Noise Level and Derived Day-Time Noise Limits (dB L_{A90})

Location	Standardised 10 m height wind speed (m/s)										
	2	3	4	5	6	7	8	9	10	11	12
Durran Mains	-	25	24	18	14	13	14	18	22	25	28
Hoy	-	19	18	13	9	8	9	13	17	20	23
Lower Bowertower	-	9	8	2	0	3	6	10	13	17	19
Oakwood	-	11	9	4	0	1	3	6	10	13	17
Lissadel House	-	13	12	6	2	4	6	9	13	16	20
Stonefield Farm	-	14	13	7	3	4	6	9	13	16	20
SW of Oakwood	-	11	9	4	0	1	3	6	10	13	17
Dunnone	-	14	12	7	3	4	6	9	13	16	20
The Croft	-	15	13	8	4	5	7	10	14	17	21

9.4.5 Mitigation

The Proposed Development is located sufficiently far from receptors such that, acting alone, predicted noise levels associated with its operation are below the limiting requirements of ETSU-R-97, without the need to impose additional mitigation or curtail the operation of the turbines.

When considered cumulatively with the proposed Red Moss turbines, the combined effect meets the ETSU-R-97 noise limits at all locations, without the need to impose additional mitigation or curtail the operation of the turbines .

9.5 Residual Effects and Conclusions

The Proposed Development is located sufficiently far from receptors such that predicted noise levels associated with its construction and operation will meet the limiting requirements of BS 5228-1:2009 + A1 :2014, ETSU-R-97 and BS 4142:2014 + A1:2019 when operating in isolation or cumulatively with the adjacent Red Moss scheme.

The construction, operational and cumulative noise effects associated with the Proposed Development are considered not significant (Table 9-13).

Table 9-13: Summary of Potential Significant Effects of the Proposed Development

Likely Significant Effect	Mitigation Proposed	Means of Implementation	Outcome/Residual Effect
Construction			
No significant effects predicted.	No specific mitigation required.	N/A	Not significant.
Operation			
No significant effects predicted.	No specific mitigation required.	N/A	Not significant.
Cumulative Operation			
No significant effects predicted.	No specific mitigation required.	N/A	Not significant.
Decommissioning			
No significant effects predicted.	No specific mitigation required.	N/A	Not significant.

9.6 References

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