MORAY WEST
OFFSHORE WINDFARM

Onshore Transmission Infrastructure Environmental Impact Assessment (EIA)

Moray Offshore Windfarm (West) Limited

Chapter 10 Noise and Vibration

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Acronyms	
Acronym	**Expanded Term**
AC	Aberdeenshire Council
BPM	Best Practical Means
BS	British Standard
CRTN	Calculation of Road Traffic Noise
dB(A)	Decibel (A-weighted)
DMRB	Design Manual for Roads and Bridges
EIA	Environmental Impact Assessment
HDD	Horizontal Directional Drilling
Hz	Hertz
IEMA	Institute of Environmental Management and Assessment
kV	Kilovolt
LDP	Local Development Plan
MC	Moray Council
MSR	Mechanically switched capacitor bank reactor
NIA	Noise Impact Assessment
OnTI	Moray West Onshore Transmission Infrastructure
PAB	Planning Application Boundary
PAN	Planning Advice Note
PPV	Peak Particle Velocity
SGT	Super grid transformer
SVR	Static Var compensation reactor
TAN	Technical Advice Note

10 Noise and Vibration

10.1 Introduction

10.1.1.1 This chapter presents the results of the Environmental Impact Assessment (EIA) of the onshore elements of the Moray West Onshore Transmission Infrastructure (OnTI). The specific objectives of this chapter are to identify the likely significant effects of noise and vibration on sensitive receptors as a result of the OnTI.

10.1.1.2 The applicable national, regional and local planning policies relating to noise matters are discussed, together with the relevant legislative context. There then follows a discussion of the spatial, temporal and technical scope of the assessment, including the identification of noise sensitive receptors. Following a description of the assessment methodology, the baseline noise levels in the areas around the proposed location for the OnTI are considered and the potentially significant environmental effects assessed.

10.1.1.3 This chapter is supported by the following Technical Appendices:

- Technical Appendix 10.1: Noise Baseline Report; and
- Technical Appendix 10.2: Prediction and Assessment Methodology.

10.1.1.4 This chapter of the EIA Report has been prepared by Mark Evans MSc MIOA (Member of the Institute of Acoustics), Principal Consultant within the Environmental Assessment department of Wood Environment & Infrastructure Solutions UK Limited (Wood) who has over 10 years' experience in acoustic consultancy. Mark's MSc is Environmental Management and he also holds a Diploma in Acoustics and Noise Control.

10.2 Approach to Assessment

10.2.1 Relevant Terminology

10.2.1.1 Table 10.2.1 provides a list of the technical terms that are included within this chapter. Further terminology relating to noise surveys undertaken to inform the assessment is presented in Appendix 10.1: Noise Baseline Report.

Table 10.2.1: Relevant Terminology

Term	Definition
Ambient sound.	The totally encompassing sound in a given situation at a given time, usually composed of sound from many sources near and far.
Background sound level.	The underlying level of sound over a period, T, and is represented by $L_{A90, T}$.
Decibel (dB).	A measure of sound pressure level in dB, as specified in British Standard (BS) EN 61672-2:2003 Electroacoustics: Sound level meter (SLM).
dB(A).	The A-weighted sound pressure level in dB. An A-weighting is a frequency weighting derived to account for the fact that human response to sound is not equally sensitive to all frequencies.
$L_{A10, T}$.	The A-weighted sound pressure level that is exceeded for 10 % of a given time interval, T, measured using a fast time weighting. It is used to measure road traffic sound levels, normally assessed over the period 06:00-24:00.
$L_{A90, T}$.	The A-weighted sound pressure level that is exceeded for 90 % of a given time interval, T, measuring using a fast time weighting.
$L_{Aeq, T}$.	The A-weighted equivalent continuous sound pressure level measured. It is a notional continuous level that, at a given position and over the defined time period, T, contains

Table 10.2.1: Relevant Terminology	
Term	**Definition**
	the same sound energy as the actual fluctuating sound that occurred at the given position over the same time period, T.
$L_{Amax,T.}$	The maximum recorded sound level within a given time period, T.
Noise.	A term used to describe 'unwanted sound' or any sound that is undesired by the recipient.
Octave Frequency Bands.	A range of frequencies where the upper frequency limit is twice that of the lower frequency limit. For example, the 1000 Hertz (Hz) octave band contains acoustic energy at all frequencies from 707 to 1414 Hz. Subdivided into three parts (third octaves) for more detailed analysis.
Peak particle velocity (PPV).	The PPV is the greatest instantaneous particle velocity during a given time interval.
Rating level, $L_{Ar, T.}$	The specific sound level, plus any adjustments for the characteristic features of the sound, (such as tonality, impulsivity or intermittency).
Sound.	Any pressure variation that the human ear can detect. Depending on the medium, sound extends and affects a greater area (propagates) at different speeds.
Sound level meter.	The instrument used for acoustic (sound that travels through air) measurements. It is commonly a hand-held instrument with a microphone. The diaphragm of the microphone responds to changes in air pressure caused by sound waves.
Sound Power Level (L_w).	The total sound energy radiated by a source per unit of time.
Sound pressure level (L_p).	L_p is the RMS value of the Instantaneous Sound Pressures measured over a specified period of time, measured in dB to a given reference pressure level.
Specific sound level.	An $L_{Aeq,T}$ measurement of a specific sound source at the assessment location of a given time period, T.
Tonal.	A sound which contains one or more distinct tones. In BS 4142:2014 Methods for rating and assessing industrial and commercial sound, a tone can be identified where a frequency band contains more energy and is shown to have a certain level difference over its neighbouring bands. A penalty of up to 6 dB can be applied to a tonal sound dependent on tonal prominence.

10.2.2 Planning Policy and Legislative Context

10.2.2.1 The key national guidance document, which provides guidelines on the assessment of noise in Scotland, is Planning Advice Note (PAN) 1/2011 (Scottish Government, 2011). PAN 1/2011 does not aim to provide a definitive source of guidance on noise issues; however it does set out the range of noise issues that determining authorities need to be aware of in formulating Development Plans and making decisions on planning applications.

10.2.2.2 Paragraph 19 of PAN 1/2011 states "The preparation and consideration of planning applications that raise significant noise issues can be greatly assisted by a Noise Impact Assessment (NIA). Planning authorities can require a NIA either as part of an Environmental Impact Assessment or separately. The need for noise impact assessments is best identified during preapplication discussions. The purpose of a NIA is to demonstrate whether any significant adverse noise impacts are likely to occur and if so, identify what effective measures could reduce, control and mitigate the noise impact. Before a NIA is commissioned, planning authorities and applicants are advised to:

- Agree any potential representative limits of noise and / or the relevant NIA methodology in the context of the proposed development, its location and the surrounding area, and
- Establish criteria for assessing any significant adverse noise impact or predict and describe ambient noise levels (including noise from transport sources) that the proposed development is likely to generate and/or is likely to be subjected to".

10.2.2.3 In relation to 'industrial noise sources', which are relevant to the onshore substation, paragraph 31 of PAN 1/2011 states "Due to its variable character, industrial noise is generally difficult to assess. Since background noise levels vary throughout a 24 hour period it will usually be necessary for Noise Impact Assessments to assess the acceptability of noise levels for separate periods (e.g. day, evening, night and weekend) chosen to suit the hours of operation of the proposed development. Noise that may result from traffic generated by new industrial developments is likely to be a relevant consideration".

10.2.2.4 In relation to 'construction sites' paragraph 32 of PAN 1/2011 states "While planning conditions can be used to limit noise from temporary construction sites, it is most effectively controlled through the Control of Pollution Act 1974 and the Pollution and Prevention Control Act 1999 for relevant installations. Notice can be served in advance of works and site conditions set to control activities".

10.2.2.5 Relevant UK standards and guidance relating to noise, and of potential relevance to the OnTI, are set out in Table 10.2.2.

Table 10.2.2: Planning Policy Context and Guidance

Policy / Legislation	Key Provisions
National Planning Advice	
Planning Advice Note 1/2011: Planning and Noise (2011)	PAN 1/2011 provides general guidance and advice on the role of the planning system in helping to prevent and limit the adverse effects of noise.
Technical Advice Note (TAN): Assessment of Noise (2011)	TAN provides guidance for the assessment of significance in relation to noise effects.
Local Policy and Guidance	
Aberdeenshire Local Development Plan (LDP) (2017)	Identifies noise as an issue with the erosion of rural character and promotes sustainable development including the consideration of noise.
Moray LDP (2015): Policy EP8 Pollution	The Council requires a detailed assessment report to accompany planning applications for developments that may cause significant pollution in terms of noise.
UK Regulations, Standards and Guidance	
HM Government (1974), Control of Pollution Act 1974	The legislation gives the Local Authority powers to serve a notice to the developer requiring the control of site noise under Section 60 of the Act. This may include specific controls to restrict certain activities identified as causing particular problems. Conditions regarding hours of operation would generally be specified and noise and vibration limits at certain locations may be applied in some cases. All requirements must adhere to established guidance and be consistent with best practicable means (BPM) to control noise only as far as is necessary to prevent undue disturbance.

Table 10.2.2: Planning Policy Context and Guidance	
Policy / Legislation	**Key Provisions**
British Standards Institution (2009), BS 5228-1:2009 (+A1: 2014), Code of practice for noise and vibration control on construction and open sites – Part 1 Noise.	Provides a recommended scope for construction and demolition noise assessment. Annex E gives example threshold values for potential significant effects at noise sensitive receptors based upon the results of ambient sound monitoring.
British Standards Institution (2009), BS 5228-2: 2009 (+A1: 2014), Code of practice for noise and vibration control on construction and open sites – Part 2 Vibration.	Provides guidance on the assessment of ground-borne vibration associated with activities such as demolition and construction.
British Standard Institution (2003) BS 7445-1:2003, Description and measurement of environmental noise. Guide to quantities and procedures.	Defines the parameters to be used to describe noise and the basic procedures for measurement.
Highways Agency (2011), Design Manual for Road and Bridges (DMRB) HD 213/11, The Stationary Office Ltd.	Presents a methodology for determining impacts upon noise sensitive receptors from changes in road traffic noise due to road projects.
Department for Transport (1988), Calculation of Road Traffic Noise, Her Majesty's Stationary Office (HMSO).	Provides a calculation methodology for road traffic noise.
British Standards Institute (2014), BS 4142, Method for rating industrial noise affecting mixed residential and industrial areas.	Describes methods for rating and assessing sound of an industrial nature, such as from factories, industrial premises, or fixed installations affecting people who might be inside or outside a dwelling.
International Standards Organization (1996), Acoustics – Attenuation of sound during propagation outdoors – Part 2: general Method of Calculation, International Standard ISO 9613-2: 1996.	Defines a method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at distances from a source.
Institute of Environmental Management and Assessment (IEMA) (2014), Guidelines for Environmental Noise Impact Assessment.	Presents guidelines on how the assessment of noise effects should be presented within the EIA process. The IEMA guidelines cover aspects such as; scoping, baseline, prediction and example definitions of significance criteria.

10.2.3 Scope of Assessment

10.2.3.1 The following aspects were scoped into the noise and vibration assessment as presented in the Moray West Onshore Transmission Infrastructure Scoping Report (Moray Offshore Windfarm (West) Limited (Moray West), 2017):

- Temporary construction noise from excavation of the trenches, horizontal directional drilling (HDD) and associated works required for the cable circuits;
- Temporary construction noise and vibration from the construction of the onshore substation;
- Temporary noise from construction traffic associated with construction of the OnTI;
- Permanent operational sound from the onshore substation; and

- Temporary noise from decommissioning of the onshore substation.

10.2.3.2 The following aspects were 'scoped out' as they were considered highly unlikely to result in more than negligible effects:

- Temporary construction vibration from excavation of the trenches required for the cable circuits and associated traffic;
- Vibration effects from operation of the OnTI; and
- Noise and vibration effects from traffic related to operation of the OnTI.

10.2.3.3 In the Scoping Opinion (August 2017), both Moray Council (MC) and Aberdeenshire Council (AC) agreed with the proposed scope. However, MC requested that a degree of attended sound monitoring be undertaken to ensure the assessment team had a more informed understanding of the noise environment. It also requested that further justification be provided where vibration may occur close to residencies.

10.2.3.4 In its response to the Scoping Report, Scottish Water (29 July 2017) requested a degree of assessment and management where vibration might affect its pipelines. It is proposed that this is undertaken during the detail design stage when more is understood regarding the location of the cable circuits.

Consultation

10.2.3.5 Following formal EIA Scoping, further consultation was undertaken to refine the scope. This is set out within Table 10.2.3.

Table 10.2.3: Consultation

Date	Consultee	Issue Raised	Moray West Approach
07/09/2017	MC Environmental Health Officer (EHO)	MC was contacted to refine the sound monitoring method and agree monitoring locations. MC agreed with the proposed monitoring locations, acknowledging that they may change slightly depending on requirements for equipment security. MC requested that the monitoring include a Sunday period at all locations. MC satisfied that attendance onsite during the deployment on monitoring equipment would provide for a sufficient informed understanding of the noise environment. MC queried the additional works that might be required at the existing Blackhillock substation to accommodate the OnTI. It was confirmed that these will be the responsibility of Scottish Hydro Electric Transmission and would not be considered in the EIA.	Sound monitoring undertaken as proposed. Simultaneous measurements at all locations included the Sunday period. Further information is provided in Technical Appendix 10.1: Noise Baseline Report.

10.2.4 Data Gathering

Study Area

10.2.4.1 The initial study area for identifying receptors for the assessment of noise effects was 1 km from the centre of the corridor proposed for the onshore cable circuits and the onshore substation site. Of these identified receptors, the closest to the onshore substation site in each direction were identified as key for the assessment of noise, as presented on Figure 10.2.1. The corridor proposed for the onshore cable circuits includes multiple residential receptors, which have been broadly considered rather than individually as the exact route of the cable circuits within the project boundary is not known.

Desk Study / Field Survey

10.2.4.2 A noise survey was undertaken for seven days between 18 and 25 October 2017 to identify the baseline noise environment at locations representing four noise sensitive receptors surrounding the proposed onshore substation site. Measurements were undertaken in accordance with BS 7445 1:2003 Description and Measurement of Environmental Noise - Part 1: Basic Quantities and Procedures.

10.2.4.3 A desk top review of the noise environment was conducted of the planning application boundary (PAB) and it was concluded that the baseline noise environment would not alter the criteria for the assessment of construction noise in accordance with BS 5228 (discussed further in Section 10.2.5).

10.2.4.4 A desk top review of the vibration environment was conducted of the PAB. No sources of vibration were identified close to vibration sensitive receptors. It was therefore concluded that a baseline vibration survey would not be needed.

10.2.4.5 Further detailed information on the noise survey method is provided in Technical Appendix 10.1: Noise Baseline Report.

Information on the OnTI

10.2.4.6 Assumptions for construction plant equipment, construction schedules, construction traffic flows and onshore substation equipment have been made by Wood in consultation with Moray West, and based on experience of similar developments.

10.2.4.7 The construction of the onshore substation, which is planned to take 100 weeks, has been divided into tasks headed: clearance; excavation; foundations; and installation.

10.2.4.8 Construction of the cable circuits has been considered in terms of clearance, trenching or HDD, cable laying and reinstatement. Cable circuit installation is estimated to take 78 weeks and will occur in spans of 750 metres, with different works being undertaken along the length of each span prior to the next phase commencing. The result of this procedure is that, while noise levels could be elevated as the installation activities pass close to noise sensitive properties or resources, this will be for short periods of time only.

10.2.4.9 For this assessment, it is assumed that the standard hours of construction work will be 07:00 to 19:00, Monday to Friday and 07:00 – 13:00 on Saturdays (no working on Sundays or public holidays), though it is anticipated that HDD might require 24 hour operation dependant on ground conditions. Out of hours HDD operation will be agreed in advance with the local authorities and a Section 61 agreement under the Control of Pollution Act 1974 sought where it is determined that these could result in significant disturbance to residents.

10.2.4.10 The assumed onshore substation equipment is set out in Table 10.2.4, with further detail provided in Appendix 10.2: Prediction and Assessment Methodology.

Table 10.2.4: Onshore Substation Plant			
Plant	**Number**	**Height**	**Sound Power Level (dBA)**
Shunt reactor.	4	4.5	91
Shunt reactor cooler.	4	7.5	84
Super grid transformer (SGT).	2	5.5	90
SGT cooler.	4	9.5	75
Mechanically switched capacitor bank (MSR) reactor.	2	6	78
Static Var compensation (SVC) reactor.	2	5.5	78
SVC coolers.	2	2.8	80
400 kilovolt (kV) filter.	2	5	91
220 kV filter.	4	4.5	91

10.2.4.11 The exact location of equipment within the onshore substation site will not be determined until the detailed design stage. The assessment is based on indicative locations to inform a consideration of likely effects and identify potential mitigation measures. Differences in equipment location may alter mitigation requirements. However, the final locations will be informed by the requirements of protecting amenity at the nearest residences. Any changes to mitigation will be considered comparable to that within this chapter (i.e. sound level reductions required might change, but the type of mitigation would be similar).

10.2.4.12 Further details of the OnTI information used within the assessment are presented in Technical Appendix 10.2: Prediction and Assessment Methodology.

Predictions of Noise and Vibration

10.2.4.13 Noise from construction of the onshore substation has been quantified using the prediction methodology within BS 5228-1 incorporated within a spreadsheet calculation tool. Predictions have been undertaken of noise at the closest noise sensitive receptors for each different phase of works.

10.2.4.14 Installation of the cable circuits and joint bays will result in temporary noise disturbance as activities pass noise sensitive receptors. At this stage, an exact route for the cable circuits it is not known and as such neither is the distance of the works to noise sensitive receptors. A qualitative assessment has therefore been undertaken informed by a simple spreadsheet calculation of worst case noise levels from construction activities using BS 5228-1 sound level data.

10.2.4.15 For the purposes of assessment only, candidate locations of the HDD positions have been proposed. Dependent on ground conditions, HDD work could potentially be undertaken at night. For this activity, a more detailed assessment has been undertaken based on spreadsheet calculations using BS 5228-1 sound level data.

10.2.4.16 Construction traffic noise has been predicted at a standard 10 m from each road with and without construction traffic to enable the potential increase in road traffic noise resulting from construction of the OnTI to be predicted. Construction predictions have been undertaken using a spreadsheet calculation tool incorporating methodology within the Calculation of Road Traffic Noise (CRTN).

10.2.4.17 Vibration predictions from potential piling at the onshore substation site (assumed as a worst-case scenario) and HDD activities (as per the MC Scoping Opinion) are based upon empirical data and calculations within BS 5228-2.

10.2.4.18 The noise from operation of the onshore substation has been modelled using LimA computer noise modelling software, based on the inputs in Table 10.2.4, incorporating calculation methodology within ISO 9613-2: 1996 Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation. As a worst case, all plant equipment has been initially modelled as unenclosed.

10.2.4.19 Further details of the prediction methodology used within the assessment are presented in Technical Appendix 10.2: Prediction and Assessment Methodology.

10.2.5 Evaluation of Effects

10.2.5.1 The magnitude of impact of noise is based upon the assessment of change in the environment; with different metrics and procedures dependant on the aspect considered. The magnitude of vibration impact is based on predicted absolute noise levels. The significance of effect is assessed on the basis of impact magnitude and the sensitivity of receptors that may be affected, drawing on professional judgement including experience of similar developments. Levels of magnitude and sensitivity are based upon British Standards and other guidance as referred to within TAN. The pertinent sections of these documents are detailed in Technical Appendix 10.2: Prediction and Assessment Methodology.

Sensitivity of Receptor

10.2.5.2 Table 10.2.5 presents the definition of receptor / resource sensitivity for the purposes of assessing effect significance.

Table 10.2.5: Sensitivity of Receptor / Resource*

Sensitivity	Description	Examples
Low	Receptors where distraction or disturbance from noise is minimal.	• Buildings not occupied during working hours. • Factories and working environments with existing high noise levels. • Sports grounds when spectator noise is a normal part of the event. • Night clubs.
Medium	Receptors moderately sensitive to noise, where it may cause some distraction or disturbance.	• Offices. • Bars / cafes / restaurants where external noise may be intrusive. • Sports grounds when spectator noise is not a normal part of the event and where quiet conditions are necessary (e.g. tennis, golf and bowls).
High	Receptors where people or operations are particularly susceptible to noise.	• Residential, including private gardens where appropriate. • Quiet outdoor areas used for recreation. • Conference facilities. • Theatres / auditoria / studios. • Schools during the daytime. • Hospitals / residential care homes. • Places of worship.

*Replicated from TAN Table 2.1.

Magnitude of Impact

10.2.5.3 Table 10.2.6 presents the definition of impact magnitude for a variety of noise and vibration aspects for the purposes of assessing effect significance.

Table 10.2.6: Magnitude of Impact

Magnitude	Site Construction Noise	Site Construction Vibration	Construction Traffic Noise	Operational Noise
High	Exceeds BS 5228 threshold values* for one month or more or trigger levels** by more than nine days in a 15 day period by 10 dB.	X ≥ 10 mm/s Peak Particle Velocity (PPV)	Increase in traffic noise***, x ≥ 5 dB $L_{A10,\ 18\ h}$	Plant noise rating level ($L_{Ar,\ T}$) difference with Background ($L_{A90,T}$), x ≥ 10 dB
Moderate	Exceeds BS 5228 threshold values for one month or more or trigger levels by more than 9 days in a 15 day period by 1 to 9 dB.	5 ≤ x < 10 mm/s PPV	3 ≤ x < 5 dB $L_{A10,\ 18\ h}$	5 ≤ x < 10 dB
Low	Exceeds BS 5228 threshold values or trigger levels by less than temporal criteria of significance.	1 ≤ x < 5 mm/s PPV	1 ≤ x < 3 dB $L_{A10,\ 18\ h}$	0 ≤ x < 5 dB
Negligible	Is within < 10 dB below BS 5228 threshold values or trigger levels.	0.3 ≤ x < 1 mm/s PPV	0 < x < 1 dB $L_{A10,\ 18\ h}$	-10 ≤ x < 0 dB
No Change	Is more than 10 dB below BS 5228 threshold values or trigger levels.	< 0.3 mm/s PPV	= 0 dB $L_{A10,\ 18\ h}$	x ≤ -10 dB

*65 dB day, 07:00 – 23:00 Monday to Friday, 07:00 – 13:00 Saturday. 45 dB night-time 23:00-07:00. Assumes evening work would also necessitate night-time work, which would be the constraining time period.

**75 dB daytime, 55 dB night-time.

*** Change in $L_{A10,\ 18\ h}$, construction noise + baseline noise minus baseline noise in isolation.

10.2.5.4 As per guidance within TAN, once a quantitative impact magnitude has been identified, this result Is filtered through a qualitative assessment, which could change the magnitude based on numbers of receptors affected or the context of change. An example of this qualification would be if the onshore substation noise was 5 dB above the background noise level at a residence, but was not considered a moderate impact due to the absolute noise level being very low (approximately considered to be 30-35 dB).

Significance of Effect

10.2.5.5 Once impact magnitude has been identified, this is cross referenced with the sensitivity of the receptor as presented in Table 10.2.7. The significance of effect is then qualified with professional judgment taking into account factors such as duration and scale etc. major or moderate effects are deemed as significant in EIA terms and prompt an analysis of additional mitigation requirements.

Table 10.2.7: Significance of Effect Matrix			
Magnitude of Impact	**Level of Significance to Sensitivity of Receptor / Resource**		
	Low	**Moderate**	**High**
No Change	Neutral	Neutral	Neutral
Negligible	Negligible	Negligible / Minor	Minor
Low	Negligible / Minor	Minor	Minor / Moderate
Moderate	Minor	Minor / Moderate	Moderate / Major
High	Minor / Moderate	Moderate / Major	Major

10.3 Baseline Conditions

10.3.1.1 The noise environment in and around the PAB is rural with agricultural use dominating. Noise sources include road and rail traffic, agricultural machinery and activities, and the sea when close to the coast. Noise sensitive receptors generally consist of residential dwellings interspersed throughout the PAB and surrounds. There are no other constraining receptors within the study area (agricultural buildings are considered non-sensitive). Residences along the proposed cable corridor are not specifically identified due to the uncertainty of the exact routing of the cable circuits. The following residences, all four of which are located within Moray and are presented in Figure 10.2.1, have been identified for the onshore substation construction and operation assessment:

- NSR1: Marypark (represented by noise monitoring at North Whitley);
- NSR2: Newtack Farm;
- NSR3: Mains of Pitlurg; and
- NSR4: Whitehillock.

10.3.1.2 As identified within the PAN examples for sensitivity (Table 10.2.5), these residences are considered of high sensitivity.

10.3.1.3 There are two Sites of Special Scientific Interest (SSSI's) within the PAB. It is considered that the features of these sites will not be susceptible to noise or vibration effects as they are of geological or botanical interest. There is the potential for short-term disturbance to wildlife during construction work; this is considered within Chapter 6: Ecology and Nature Conservation.

10.3.1.4 Table 10.3.1 provides a summary of the pertinent data for identifying the baseline and informing criteria. A full set of data is presented in Technical Appendix 10.1: Noise Baseline Report.

Table 10.3.1: Baseline Data					
Ref.	**Monitoring Location (Receptor, if Different)**	**$L_{Aeq, T}$ (dB)**		**$L_{A90, T}$ (dB) Average**	
		Daytime	**Night-time**	**Daytime**	**Night-time**
NSR1	North Whitley (Marypark)	53	49	47	30
NSR2	Newtack Farm	50	46	42	31
NSR3	Mains of Pitlurg	46	44	36	27
NSR4	Whitehillock	48	43	39	26

10.3.1.5 The $L_{Aeq, T}$ results show that BS 5228 threshold cut-off values would be appropriate to use within the construction assessment (i.e. measured baseline levels are below the lower cut-off thresholds). The $L_{A90, T}$ levels have been used in the assessment of onshore substation noise as representing the background noise level at residences. It is noted that the background noise levels are very low and this is taken into account in terms of the context of the noise from the onshore substation. No current industrial continuous noise was noted at the monitoring locations.

10.3.2 Future Baseline

10.3.2.1 Other than the 'natural' growth of road traffic resulting in a potential slight increase in background noise levels, no other notable changes in environmental noise at the receptor locations are anticipated.

10.3.3 Data Limitations

10.3.3.1 The week of data is considered representative of normal baseline conditions when noise from the OnTI will be most audible (dry, low winds) and no events were encountered that required the isolation or removal of data. It is however acknowledged that the data do not represent all conditions throughout the year given the limited duration of surveys.

10.4 Embedded Mitigation

10.4.1.1 The relevant construction documentation prepared for the OnTI will include a section on noise and vibration management incorporating best practice measures. These best practice measures are considered qualitatively when assessing impact magnitude and determining effects.

10.4.1.2 It is standard practice that design measures (e.g. bunds or enclosure) are applied to onshore substation equipment. However, for the purposes of the assessment, such measures have not been considered as embedded mitigation as the form they will take will not be confirmed until the detailed design stage, and their design may be modified specifically to increase noise mitigation.

10.5 Assessment of Potential Effects

10.5.1 Potential Construction Noise Effects

10.5.1.1 Table 10.5.1 presents the results of the noise predictions from construction of the onshore substation.

Table 10.5.1: Noise Predictions from Onshore Substation Construction				
Ref.	**Predicted Noise Levels Per Phase ($L_{Aeq,T}$ dB)**			
	Clearance	**Excavation**	**Foundations**	**Installation**
NSR1 - Marypark	41	38	45	35
NSR2 - Newtrack	49	46	51	43
NSR3 - Mains of Pitlurg	42	40	45	36
NSR4 - Whitehillock	54	51	57	51

10.5.1.2 The results show that noise from construction of the onshore substation is below the BS 5228 daytime threshold at all receptors. The noise impact from the construction of the onshore substation is therefore considered to be of **negligible magnitude**. Assuming a **high sensitivity** receptor, there will be **minor effects** at most. It is therefore concluded that noise relating to the construction of the onshore substation will be **not significant**.

10.5.1.3 It is not possible at this stage to predict noise at residences from trenching of the cable circuits (including junctions, but excluding HDD, which is considered below) as the exact route has not been established. If the working width is close to residences (within 10 m to 20 m), noise from the loudest plant equipment could exceed BS 5228 criteria for significance. However, based on the schedule of works, it is predicted that these elevated noise levels will not last for a duration of more than nine days in any 15 day period. At most, the noise impact as a result of the trenching of the cable circuits will be of **low magnitude**. Assuming a **high sensitivity** receptor, due to the temporary nature of this impact there will be **minor effects**. It is therefore concluded that noise relating to the construction of the substation will be **not significant**.

10.5.1.4 HDD works have been considered separately from cable circuit trenching due to their potential longer duration at any one location and the possibility they may occur during night-time periods (though works are currently anticipated to be during daytime only). While approximate locations for HDD have been identified, the locations for launch and receiving pits are not yet known. As such, a distance at which these sites will result in an exceedance of BS 5228 criteria have been predicted based on daytime and night-time works as presented in Table 10.5.2

Table 10.5.2: Distances from HDD Sites to Meet BS 5228 Criteria				
Works	**Distance (m) in Order to Meet Various BS 5228 Criteria ($L_{Aeq,T}$ dB)**			
	Night-time Criteria for Work ≥1 month	**Night-time Criteria for Work 10 days x < 1 month**	**Daytime Criteria for Work ≥1 month**	**Daytime Criteria for Work 10 days x < 1 month**
Launch Pit	377	150	60	24
Receiving Pit	136	54	21	9

10.5.1.5 Based on the indicative locations for HDD, Table 10.5.3 presents the potential worst case impacts without mitigation dependent on duration and the time of works.

Table 10.5.3: Likelihood of HDD Potential Impacts without Mitigation

Locations	Likelihood of Exceeding BS 5228 Criteria at The Nearest Residences to Indicative HDD Sites			
	Night-time Criteria for Work ≥1 month	Night-time Criteria for Work 10 days x < 1 month	Daytime Criteria for Work ≥1 month	Daytime Criteria for Work 10 days x < 1 month
Landfall	Likely	Possible	Unlikely	Unlikely
A98 Crossing	Likely	Possible	Unlikely	Unlikely
A95 Crossing	Likely	Possible	Unlikely	Unlikely
River Isla and Railway line	Possible	Unlikely	Unlikely	Unlikely
A96 Crossing	Likely	Possible	Unlikely	Unlikely
Pitlurg Wood	Likely	Possible	Unlikely	Unlikely

10.5.1.6 Based on the approach above, if HDD works are undertaken at night and if those works are to take place in close proximity to high sensitivity receptors, it is possible that, without mitigation, BS 5228 criteria will be exceeded at HDD locations, with the exception of the River Isla and railway line crossing, resulting in an impact of **moderate magnitude**. Assuming a **high sensitivity** receptor, based on the temporary nature of the impact there will be **moderate effects**. If this work is undertaken at night in close proximity to a high sensitivity receptor, effects associated with HDD works will be **significant**. During the daytime, noise levels are largely unlikely to result in exceedances of BS 5228 criteria without mitigation, resulting in an impact of **negligible magnitude**. Assuming a **high sensitivity** receptor, this will result in a **minor effect** at most, that is considered to be **not significant**.

10.5.1.7 Table 10.5.4 presents the results of the traffic noise assessment comparing traffic flows during construction (total flows including future non-construction traffic levels) and future non-construction traffic.

Table 10.5.4: Traffic Noise Predictions

Road Link	Road Traffic Noise ($L_{A10, 18\ Hour}$), dB		
	Without Construction	With Construction	Difference
A98 south of Buckie	66.9	67.0	0.1
A98 Cullen	62.2	62.3	0.1
B9018 Lintmill	53.1	53.8	0.8
A98 south of Sandend	64.0	64.1	0.1
A98 Portsoy	61.6	61.7	0.1
A9022 East of Longmuir Farm	57.6	58.7	1.1
B9018 northeast of Berryhillock	54.8	55.8	1.0

Table 10.5.4: Traffic Noise Predictions			
Road Link	**Road Traffic Noise ($L_{A10, 18\ Hour}$), dB**		
	Without Construction	**With Construction**	**Difference**
B9018 Grange Crossroads	56.9	57.3	0.5
A95 Drumnagorrach	58.7	59.6	0.9
A95 west of Davoch of Grange	60.8	61.3	0.6
A96 Keith	66.3	66.4	0.2
A96 northwest of Forgie	66.6	66.8	0.2
A95 east of Rosarie	60.3	60.3	0.0
A96 Moss Street northeast of Blackhillock Quarry	66.7	67.0	0.3

10.5.1.8 In a small number of locations, the results of the traffic noise assessment show that noise levels will increase temporarily by up to 1 dB as a result of the construction works. The resultant impact is considered to be of **low magnitude**. Assuming a **high sensitivity** receptor, this will result in a **minor effect** at most, which is considered **not significant**.

10.5.2 Potential Construction Vibration Effects

10.5.2.1 Depending upon ground conditions, there is the potential for hammer piling at the onshore substation site. BS 5229-2 provides empirical data for hammer piling, an example of which is diesel hammer driving metal sheets, which was measured with a PPV of 1.1 mm/s at 30 m and 0.1mm/s at 250 m. Based on the indicative distance of the nearest residence to the boundary of the site being 200 m, assuming a **high sensitivity** receptor, the impact of any potential piling onsite at residences will be of **negligible magnitude**, leading to **minor effects** at most. These are considered to be **not significant**.

10.5.2.2 Using the prediction formula within BS 5228-2, the onset of a low impact from HDD vibration would be 20 m to 60 m from the works site. A vibration impact of moderate magnitude would be predicted between 15 and 20 m from an HDD site. However, it is considered highly unlikely that the drill hole will be closer than 20 m to residential receptors given the likely size of the HDD compound. Based on this, a vibration impact of **low magnitude** is predicted at residences closest to drill sites, being those HDD for the landfall and the A98, dependant on exact locations. Assuming a **high sensitivity** receptor, given the temporary nature of the impact, there will be **minor effects** at most, which are considered **not significant**.

10.5.3 Potential Operational Effects

10.5.3.1 Table 10.5.5 presents the results of an industrial noise assessment based on predicted operational noise from the onshore substation at the nearest residential receptors. The noise contours representing the specific (non-corrected) noise from the onshore substation with indicative equipment locations are presented on Figure 10.5.1. The assessment is based on a worst case operational time during the night. It is anticipated that the transformers at the onshore substation will be tonal, and given the level predicted a rating correction of 4 dB has been applied.

Table 10.5.5: Industrial Noise Assessment				
Residence	**BS4142 Assessment**			
	Background Noise Level ($L_{A90,T}$), DB	**Specific Onshore Substation Noise ($L_{Aeq,T}$), dB**	**Substation Rating Noise Level ($L_{Ar,T}$), dB**	**Difference of Rating Noise Level and Background (dB)**
NSR1 - Marypark	30	41	45	+15
NSR2 - Newtrack	31	46	50	+19
NSR3 - Mains of Pitlurg	27	43	47	+20
NSR4 - Whitehillock	26	37	41	+15

10.5.3.2 Without mitigation, the resultant noise from the onshore substation at all identified residential receptors will result in an impact of **high magnitude**, leading to a **major effect** that will be **significant**.

10.5.4 Potential Decommissioning Effects

10.5.4.1 After the lifetime of the Moray West Offshore Wind Farm (assumed to be up to 50 years), it is possible that the onshore substation may be retained and not decommissioned. However, in accordance with the Scoping Report and Scoping Opinion, the most likely decommissioning scenario for the OnTI is also considered here.

10.5.4.2 It is considered that decommissioning effects will similar to, or less than, those already predicted for the construction phase. Should the OnTI be decommissioned, it is likely that all underground equipment and the onshore substation foundations will remain in-situ, therefore breaking and HDD works will not be required. Above ground equipment at the onshore substation site will be cleared and the site reinstated. Assuming a **high sensitivity** receptor, the impact from decommissioning works will be of **negligible magnitude**. This will result in a **minor effect** that is **not significant**.

10.6 Additional Mitigation and Enhancement Measures

10.6.1.1 No moderate or major effects have been predicted to result from construction of the cable circuits or onshore substation as currently planned during the daytime. Therefore, no further mitigation beyond the embedded best practice measures will be required to minimise noise or vibration levels. However, should longer lengths of HDD be required, with works that need to be undertaken at night in the vicinity of high sensitivity receptors, it is likely that the plant equipment will need to be screened from the nearest residential receptors to avoid significant effects. This will be effective in reducing the impacts at night to below the BS 5228 criteria. A detailed assessment of HDD noise effects will be undertaken at the detailed design and stage once locations and specific plant equipment are known to establish screening requirements, if any.

10.6.1.2 To minimise the noise from the operation of the onshore substation the sound level reductions set out in Table 10.6.1 are proposed. The sound reductions are all considered achievable with appropriate sound enclosures.

Table 10.6.1: Proposed Substation Mitigation		
Substation Equipment	**Sound Level Reduction (dB)**	**Mitigation Form**
Shunt reactor	15	Enclosure.
Shunt reactor cooler	9	Barrier, low noise equipment.
SGT	25	Enclosure.
SGT cooler	0	N/A.
MSR reactor	15	Enclosure.
SVC reactor	15	Enclosure.
SVC coolers	5	Barrier, low noise equipment.
400kV filter	20	Enclosure.
220kV filter	20	Enclosure.

10.7 Residual Effects

10.7.1.1 If night-time HDD works are required, appropriate screening will be installed around the HDD equipment and site layout arranged such that exceedances of the BS 5228 noise level and temporal criteria are avoided. Assuming a **high sensitivity** receptor, the mitigated impact from HDD works will be of **low magnitude.** A **minor effect** will therefore result which will be **not significant**.

10.7.1.2 Table 10.7.1 presents the results of an industrial noise assessment based on predicted operational noise from the mitigated onshore substation at the indicative location. The noise contours representing the specific (non-corrected) noise from the onshore substation are presented in Figure 10.7.1. The assessment is based on a worst case operational time during the night. It is anticipated that the transformers in the onshore substation will be tonal, but the absolute level of noise will be low, and therefore the tone will be less evident than in the unmitigated scenario. As such, a rating correction of 2 dB has been applied.

Table 10.7.1: Industrial Noise Assessment with Mitigation				
Residence	**BS4142 Assessment**			
	Background Noise Level ($L_{A90,T}$), dB	**Specific Substation Noise ($L_{Aeq,T}$), dB**	**Substation Rating Noise Level ($L_{Ar,T}$), dB**	**Difference of Rating Noise Level and Background (dB)**
NSR1 - Marypark	30	24	26	-4
NSR2 - Newtrack	31	29	31	0
NSR3 - Mains of Pitlurg	27	26	28	+1
NSR4 - Whitehillock	26	21	23	-3

10.7.1.3 The results show that with the appropriate additional mitigation proposed, noise from the onshore substation will lead to an impact of **low magnitude** at the nearest **high sensitivity** residential receptor. Based on the very low level of the predicted noise (< 30 dB), at most a **minor effect** will result that is **not significant**.

10.7.1.4 The full assessment is summarised in Table 10.7.2

Table 10.7.2: Summary of Assessment						
Potential Effect	**Nature**	**Probability**	**Sensitivity of Receptor**	**Magnitude of Impact**	**Significance of Effect**	**Rationale**
Construction Phase						
Noise disturbance from onshore substation.	Direct short-term	Unlikely	High	Negligible	Minor (Not Significant)	Temporary noise attenuated with distance from residences.
Noise disturbance from cable circuits.	Direct short-term	Unlikely	High	Low	Minor (Not Significant)	Very temporary noise impact as cable circuit installation passes residences.
Noise disturbance from HDD sites.	Direct short-term	Possible	High	Low	Minor (Not Significant)	Temporary noise impact, with noise attenuated at distance from residences or suitably screened if undertaken at night at sites close to residences.
Noise disturbance from construction traffic.	Direct short-term	Unlikely	High	Low	Minor (Not Significant)	Temporary and very small change in traffic noise levels at residences.
Vibration disturbance from piling and HDD sites.	Direct short-term	Possible	High	Low	Minor (Not Significant)	Piling and drilling works assumed to be at a distance from residences that will not result in disturbance.
Operational Phase						
Noise disturbance from onshore substation.	Direct long-term	Possible	High	Low	Minor (Not Significant)	Mitigation available to be applied to onshore substation equipment such that noise will be approximately at the level of the exiting background noise level.
Decommissioning Phase						
Noise disturbance at the onshore substation site.	Direct short-term	Unlikely	High	Negligible	Minor (Not Significant)	Temporary noise attenuated with distance from residences. Will not include works, such as HDD, that will have the potential for disturbance without mitigation.
Vibration disturbance at the onshore substation site.	Direct short-term	Unlikely	High	Negligible	Minor (Not Significant)	Construction site distance from residences.

10.8 Assessment of Cumulative Effects

10.8.1.1 As noted in Chapter 3: The Environmental Impact Assessment Process, there are two other proposed developments within 5 km of the PAB, the potential effects of which could be significant when considered cumulatively with those of the OnTI. The other proposed developments are Aultmore Wind Energy Project and Lurg Hill Wind Farm.

10.8.1.2 Specific construction timelines for both of these wind energy developments are not known. However, Aultmore Wind Energy Project is consented and its construction is proposed to last 10 months. The planning application for Lurg Hill Wind Farm remains undetermined; it's construction programme is proposed to last seven to eight months and it is preferred that this commences during 2019. It is considered likely that both of these other proposed developments will be constructed prior to the OnTI, the construction of which is proposed to commence in 2022.

10.8.1.3 Depending upon the final route of the onshore cable circuits, should the construction programmes of one, or both of the wind energy developments overlap with that of the OnTI, there will be potential for cumulative noise effects at the nearest NSRs. As construction noise is varied and often intermittent, it is not possible to predict the likely cumulative noise from these other proposed developments. However, due to the temporary nature of cable circuit installation, it is considered unlikely that the associated noise contribution will significantly contribute to construction noise from the other proposed developments.

10.8.1.4 During operation of the OnTI, the onshore substation will be its only noise emitting element. The sites of the other proposed developments are situated close to the PAB, but over 10 km from the onshore substation site. At such a distance, it is considered that neither wind energy development will have significant noise cumulative effects in combination with the OnTI.

10.9 References

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