
CHAPTER 15 NOISE AND VIBRATION

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15. Noise and Vibration

15.1 Executive Summary

- 15.1.1 This Chapter of the EIA Report evaluates the effects of noise and vibration from the Proposed Development on nearby noise-sensitive receptors (NSRs) (typically residential dwellings) during construction, operation and decommissioning.
- 15.1.2 During construction, noise may result from the use of plant and machinery to carry out construction activities. However, due to the substantial (1.5km) separation distance between any part of the Proposed Development infrastructure and residential dwellings, **no significant effects are likely to occur**. Notwithstanding this, best practice mitigation measures will be adopted to manage noise emissions during construction, including restrictions on construction working hours.
- 15.1.3 The operational assessment has been undertaken in accordance with the recommendations of ETSU-R-97, the method of assessing wind turbine noise recommended by Government guidance and following the current best practice methods described in the Good Practice Guidance, as endorsed by the Scottish Government. Noise modelling of the Proposed Development, in conjunction with the surrounding cumulative developments, indicates compliance with the requirements of ETSU-R-97 at all NSR locations.
- 15.1.4 No significant noise effects are anticipated from the on-site substation given the substantial (approximately 2.5km) separation distance between the substation and nearest NSR.
- 15.1.5 Noise during decommissioning would be of a similar nature to that of construction and will be managed through best practice or other guidance or legislation relevant at the time.

15.2 Introduction

- 15.2.1 This Chapter of the Environmental Impact Assessment Report (EIA Report) assesses whether there are any likely significant effects resulting from Achany Extension Wind Farm (the Proposed Development) on the acoustic environment of the area. This assessment was prepared by a Principal Acoustics Consultant at Arcus Consultancy Services Ltd., with over 11 years' experience in the assessment of wind farm noise and a member of the Institute of Acoustics (MIOA).
- 15.2.2 This Chapter of the EIA Report is supported by the following Technical Appendix documents provided in Volume 4 Technical Appendices:
- Technical Appendix 15.1: Glossary of Terms;
 - Technical Appendix 15.2: Sound Power Levels and Cumulative Noise Levels; and
 - Technical Appendix 15.3: Background Noise Monitoring Results.

15.3 Scope of Assessment

Construction Noise and Vibration

Construction Noise

- 15.3.1 The distance between the Proposed Development and the nearest NSRs (typically residential dwellings) is approximately 1.7km from the closest proposed turbine to the nearest NSR, and 1.5km from the nearest piece of site infrastructure (i.e., access tracks, construction compounds etc.). Based upon previous experience of a large number of similar developments, there is considered to be no reasonable prospect that construction noise levels would exceed the levels specified in The Highland Council (THC) Scoping Opinion (see Table 15.1). Furthermore, construction would not take place outwith the times specified in THC's Scoping Opinion (Table 15.1), which will be committed to through the Development's Construction Environmental Management Plan (CEMP), a draft of which is included in Technical Appendix 3.1.
- 15.3.2 Therefore, rather than assessing the effects of construction noise in terms of noise level, the mitigation measures advocated in BS 5228 (The British Standards Institution, 2009) are to be adopted, which are considered to be Best Practice, and will be included in the CEMP, along with the agreed working hours (see Paragraph 15.8.1 for details). A detailed assessment of construction noise is therefore scoped out of further assessment.

Construction Vibration

- 15.3.3 The nature of works and distances involved in the construction of a wind farm are such that the risk of significant effects relating to ground-borne vibration are very low, and no scoping responses or other consultation responses have expressed concerns about vibration effects during construction. Further guidance on vibration is provided in Paragraph 15.4.35.
- 15.3.4 Given the large separation distances to the closest NSRs (see Paragraph 15.3.1), no significant vibration effects during construction are likely and as such, vibration has been scoped out of further assessment and is not considered in this Chapter. Notwithstanding this, in the event that stone is required to be extracted from borrow pits by blasting, such effects will be managed through a Scheme of Blasting, as described in Paragraph 15.8.2.

Operational Noise and Vibration

Operational Noise

- 15.3.5 Typically, the operational noise assessment process comprises of:
- Identification of potential NSRs, i.e., residential properties and other potentially noise-sensitive locations;
 - If required, measurement of prevailing wind speed dependant background noise levels at nearby properties;
 - Establishment of limits for acceptable levels of wind turbine noise;
 - Prediction of the likely levels of wind turbine noise received at each NSR; and
 - Comparison of the predicted levels with the noise limits.
- 15.3.6 Where the distance between the Proposed Development wind turbines and nearest NSR is such that predicted cumulative noise levels are no greater than the simplified criterion defined in ETSU-R-97 (ESTU, 1996) of 35dB, $L_{A90,10min}$ at wind speeds measured on-site of up to 10m/s, the consideration of background noise is unnecessary. Where the occupants of a dwelling have a financial interest in the Proposed Development (typically by owning part, or all of the land upon which the Proposed Development is situated), the fixed lower limit of 35dB, $L_{A90,10min}$ may be increased to 45dB $L_{A90,10min}$. Further detail on this aspect is provided in Paragraphs 15.4.19 and 15.5.9.
- 15.3.7 No significant noise effects are anticipated from the on-site substation, given the substantial (approximately 2.5km) separation distance between the substation and nearest NSR. Substation noise has therefore been scoped out of further assessment and is not considered in this Chapter.

Low-Frequency Noise and Infrasonic

- 15.3.8 As evidenced by the guidance presented in Paragraph 15.4.25, the level of low-frequency noise and infrasound generated by modern wind turbines is low, and no significant effects are anticipated. A detailed assessment of low-frequency noise and infrasound is therefore scoped out of further assessment.

Amplitude Modulation

- 15.3.9 As evidenced by the guidance presented in Paragraph 15.4.29, the incidence of excess, or 'other' AM occurring at any particular wind farm is low. With the current knowledge, it is not possible to predict whether any particular site is more or less likely to give rise to AM. The guidance contained within the Institute of Acoustics Good Practice Guide (GPG) (IOA, 2013) remains current, which states:

"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."

- 15.3.10 It is therefore not considered necessary to carry out a specific assessment of AM.

Operational Vibration

- 15.3.11 As evidenced by the guidance presented in Paragraph 15.4.35, levels of ground-borne vibration generated by operational wind turbines are very low. The separation distances from NSRs required to ensure no significant effect from airborne noise are such that there can be no potential for any ground-borne vibration effects.

15.3.12 A detailed assessment of construction noise is therefore scoped out of further assessment.

Decommissioning

15.3.13 Noise and vibration effects during the decommissioning of the Proposed Development are likely to be of a similar nature to that during construction, although the duration of decommissioning would likely be shorter than that of construction. Any legislation, guidance or best practice relevant at the time of decommissioning would be complied with. On this basis, no further assessment of decommissioning noise or vibration effects is provided in this Chapter.

Study Area

15.3.14 The Study Area for the operational noise assessment has been determined in accordance with the methodology in Paragraph 15.5.4. The Study Area comprises the area where noise levels from the Proposed Development are predicted to be within 10 dB of those from other relevant wind energy developments, and the predicted cumulative wind farm noise level is greater than 35dB, $L_{A90,10min}$. This is illustrated on Figure 15.1 by the area shaded orange, and by the purple 35dB, $L_{A90,10min}$ contour line. The resulting Study Area is presented in Figure 15.2 for clarity. Further detail is provided in Paragraph 15.6.2.

Consultation Reponses

15.3.15 A summary of consultation responses received during the 2019 and 2020 Scoping exercise are provided in Table 15.1.

Table 15.1: Consultation Responses

Consultee	Type and Date	Summary of Consultation Response	Response / Where Addressed in EIA Report
The Highland Council (THC) Environmental Health Officer (EHO)	Scoping Response 20/05107/SCOP (2020)	The operational noise assessment should be carried out in accordance with ETSU-R-97 and the Good Practice Guide	The operational noise assessment has been undertaken in accordance with the stated guidance, as described in Paragraphs 15.4.12 and 15.4.21.
		Fixed lower noise limits should be 35dB, $L_{A90,10min}$ during the day and 38dB, $L_{A90,10min}$ at night. These limits would apply to cumulative noise levels	The stated limits have been adopted as described in Paragraph 15.5.8.
		The cumulative effect from any other existing, consented or, in some cases, proposed wind turbine developments should be taken into account.	The cumulative noise effects of any relevant existing, consented and/or proposed wind developments in the surrounding area have been considered, as described in Paragraph 15.5.10.
		The noise assessment must take into account predicted and consented levels from such development. The good practice	The cumulative assessment has been undertaken in accordance with the

Consultee	Type and Date	Summary of Consultation Response	Response / Where Addressed in EIA Report
		guide offers guidance on how to deal with cumulative issues.	GPG, and as described in Paragraph 15.5.13.
		The assessment should include a map showing all wind farm developments which may have a cumulative impact and all noise sensitive properties, including any for which a financial involvement is being claimed.	A map has been prepared as requested. See Figure 15.1: Cumulative Noise Contour Plot.
		<p>A table of figures should be included showing:</p> <ul style="list-style-type: none"> • The predicted levels from this development; • The maximum levels based on consented limits from each existing or consented wind farm, if any reduction is made for controlling property or another reason this should be made clear; • The predicted levels from each existing or consented wind farm development and • The cumulative level based on consented and predicted levels. 	<p>Please refer to:</p> <ul style="list-style-type: none"> • Table 15.4: Predicted Operational Noise Levels due to the Proposed Development; • Technical Appendix 15.2: Sound Power Levels and Cumulative Noise Levels; • Technical Appendix 15.2: Sound Power Levels and Cumulative Noise Levels; and • Table 15.5: Predicted Cumulative Operational Noise Levels.
		The assessment should include an outline for a mitigation scheme to be implemented should noise levels from the development be subsequently found to exceed consented levels.	An outline mitigation scheme is presented in Paragraph 15.8.6.
		Background noise surveys should be undertaken in accordance with ETSU and the Good Practice Guide.	The background noise survey was undertaken in accordance with the stated guidance, as presented in Paragraphs 15.6.6 and Technical Appendix 15.3: Background Noise Monitoring Results.
		It is recommended that monitoring be agreed with the Council’s Environmental Health Officer, however it is unlikely they will be able to attend installation.	Monitoring Locations were discussed and agreed with the EHO, as presented in this Table below.
		ETSU states that background noise must not include noise from an existing wind farm. Where a location is already subject to noise from an existing wind turbine development, the GPG provides advice on how to approach this problem. It is advised	Monitoring Locations were discussed and agreed with the EHO, in order to ensure measurements excluded any existing wind turbine

Consultee	Type and Date	Summary of Consultation Response	Response / Where Addressed in EIA Report
		that the developer consults the environmental health officer at an early stage to discuss the proposed methodology.	noise survey, details are presented in Paragraph 15.6.6
		Planning conditions are not used to control construction noise as similar powers are available under the Control of Pollution Act 1974. A construction noise assessment will be required where it is proposed to carry out work outwith the hours Monday to Friday 8 AM to 7 PM and Saturday 8 AM to 1 PM, or where noise levels during the above periods are likely to exceed 75dB, $L_{Aeq,1hr}$ for short terms works or 55dB $L_{Aeq,1hr}$ for long-term works. If an assessment is submitted, it should be carried out in accordance with BS5228.	A detailed assessment of construction noise has been scoped out of this assessment in agreement with the EHO and as presented in Paragraph 15.3.1. Proposed working hours were agreed in further consultation with the EHO, as detailed later in this Table.
		The developer should employ the best practicable means to reduce the impact from construction activities. Attention should be given to construction traffic and reversing alarms.	Best practicable means will be adopted as presented in Paragraph 15.8.1.
		At this time, the Good Practice guide does not provide definitive Planning guidance on the subject of Amplitude Modulation. That being the case, any complaints linked to amplitude modulation would be investigated in terms of the Statutory Nuisance provisions of the Environmental Protection Act 1990	This is agreed. Further detail is provided in Paragraph 15.4.29.
		When assessing the cumulative impact from more than one wind farm, consideration must be given to any increase in exposure time. Regardless of whether cumulative levels can meet relevant criteria, if a noise sensitive property subsequently becomes affected by wind turbine noise from more than one direction this could result in a significant loss of respite.	As requested, consideration has been given to exposure time, as discussed in Paragraph 15.7.6
THC EHO	Email providing details of proposed assessment methodology (July 2020)	No response received initially. This was followed up in April 2021, to which the EHO responded, confirming acceptance of the proposed methodology, including background noise monitoring locations and cumulative developments requiring consideration. Confirmed Glencassley Castle as the preferred background noise monitoring location, when compared to March Cottage.	The agreed methodology has been followed throughout this Chapter. Background noise monitoring was undertaken at the preferred locations, as presented in Paragraph 15.6.6.
THC EHO	Email regarding construction	As the Development's proposed working hours are slightly greater than those	The proposed working hours were discussed

Consultee	Type and Date	Summary of Consultation Response	Response / Where Addressed in EIA Report
	working hours (May 2021)	suggested in THC’s Scoping Response, further consultation was undertaken.	and agreed. Proposed working hours are detailed in Paragraph 15.8.1

15.4 Legislation, Policy and Guidance

Legislation

15.4.1 The following legislation documents are of particular relevance to the assessment:

- The Control of Pollution Act 1974 (CoPA 1974) (UK Government, 1974); and
- The Environmental Protection Act 1990 (EPA 1990) (UK Government, 1990).

The Control of Pollution Act 1974

15.4.2 The Control of Pollution Act 1974 (CoPA 1974) provides Local Authorities with powers to control noise and vibration from construction sites.

15.4.3 Section 60 of the CoPA 1974 enables a Local Authority to serve a notice to persons carrying out construction work of its requirements for the control of site noise. This may specify plant or machinery that is or is not to be used; the hours during which construction work may be carried out; the level of noise or vibration that may be emitted; and provide for changes in circumstances. Appeal procedures are available.

15.4.4 Section 61 of the CoPA 1974 allows for those carrying out construction work to apply to the Local Authority in advance for consent to carry out the works. This is not mandatory, but is often advantageous for the developer, as once consent is issued, the Local Authority is no longer able to take action under Section 60 of CoPA 1974 or Section 80 of the EPA 1990, provided the works are carried out in accordance with the Section 61 consent. It does not, however, prevent nuisance action under Section 82 of the EPA 1990. The Application is expected to give as much detail as possible about the works to be carried out, the methods to be used, and the measures that will be taken to minimise noise and vibration.

The Environmental Protection Act 1990

15.4.5 The Environmental Protection Act 1990 (EPA 1990) specifies mandatory powers available to Local Authorities in respect of any noise that either constitutes or is likely to cause a statutory nuisance, which is also defined in CoPA 1974. A duty is imposed on Local Authorities to carry out inspections to identify statutory nuisances, and to serve abatement notices against these. Procedures are also specified with regards to complaints from persons affected by a statutory nuisance.

Policy and Guidance

15.4.6 The following key policy and guidance has been considered in carrying out this assessment.

Construction Noise

15.4.7 Guidance relevant to the effects of noise and vibration during construction and decommissioning is provided by BS 5228:2009+A1:2014. This standard:

- Is published in two parts: Part 1 - Noise and Part 2 - Vibration. The points below relate mainly to Part 1, however, the recommendations of Part 2 in terms of vibration are broadly very similar;
- Refers to the need for the protection against noise and vibration of persons living and working in the vicinity of, and those working on construction and open sites;
- Recommends procedures for noise and vibration control in respect of construction operations;
- Stresses the importance of community relations, and states that early establishment and maintenance of these relations throughout site operations will go some way towards allaying any concerns;
- Provides recommendations regarding the supervision, planning, preparation and execution of works, emphasising the need to consider noise at every stage of the operation;
- Describes methods of controlling noise at source and its spread; and
- Includes a discussion of noise control targets, and example criteria for the assessment of the significance of noise effects.

Operational Noise

15.4.8 Guidance relevant to the effects of noise during operation is provided in the following guidance and information sources:

- The Scottish Government's web-based planning information on onshore wind turbines (Scottish Government, 2014);
- Planning Advice Note 1/2011 (PAN 1/2011): Planning and Noise (Scottish Government, 2011);
- ETSU-R-97: The Assessment and Rating of Noise from Wind Farms (ESTU, 1996); and
- A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (IOA, 2013).

The Scottish Government's web-based Planning Information on Onshore Wind Turbines and PAN 1/2011

15.4.9 The Scottish Government's web-based information provides advice to local authorities on the planning issues associated with wind farm development. With respect to noise from wind farms, it recommends the use of ETSU-R-97: The Assessment and Rating of Noise from Wind Farms and the Institute of Acoustics' Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise.

15.4.10 It goes on to refer to PAN 1/2011 as providing advice on the role of the planning system in helping to prevent and limit the adverse effects of noise, and states that the associated Technical Advice Note provides guidance which may assist in the technical evaluation of noise assessment.

15.4.11 PAN 1/2011 promotes the principles of good acoustic design and the appropriate location of new potentially noisy development. The associated Technical Advice Note offers advice on the assessment of noise impact and includes details of the legislation, technical standards and codes of practice appropriate to specific noise issues. Appendix 1 of the Technical Advice Note: Assessment of Noise, describes the use of ETSU-R-97 in the assessment of wind turbine noise.

ETSU-R-97

- 15.4.12 ETSU-R-97 provides a framework for the assessment and rating of noise from wind turbine installations. It is the de facto standard for wind farm developments in the UK, and the methodology has therefore been adopted for the present assessment.
- 15.4.13 Both background noise and noise from wind turbines typically vary with wind speed. According to ETSU-R-97, wind farm noise assessments should therefore consider the site-specific relationship between wind speed and background noise, along with the particular noise emission characteristics of the proposed wind turbines.
- 15.4.14 ETSU-R-97 specifies the use of the $L_{A90,10min}$ descriptor for both background and wind turbine noise. Therefore, unless otherwise specified, all references to noise levels within this Chapter relate to this descriptor. Similarly, all wind speeds referred to, relate to a height of 10 metres (m) Above Ground Level (AGL) at the location of the Proposed Development, standardised in accordance with current good practice guidance.
- 15.4.15 The document recommends the application of external noise limits at the nearest noise sensitive properties, to protect outside amenity and prevent sleep disturbance inside dwellings. These limits take the form of a 5dB margin above the prevailing background noise level, except where background noise levels are lower than certain thresholds, where fixed lower limits apply. Separate limits apply for quiet daytime and night-time periods, as outlined below. The limits apply to the cumulative effects of all wind turbines that affect a particular location.
- 15.4.16 During daytime, the guidance specifies limits designed to protect the amenity of residents whilst within the external amenity areas of their properties. The limits are based on the prevailing background noise level for 'quiet daytime' periods, defined in ETSU-R-97 as:
- 18:00 – 23:00 every day;
 - 13:00 – 18:00 on Saturday; and
 - 07:00 – 18:00 on Sundays.
- 15.4.17 ETSU-R-97 recommends that the fixed lower noise limit for daytime should be set within the range 35 to 40dB, $L_{A90,10min}$, with choice of value dependent on the following factors:
- The number of dwellings in the neighbourhood of the Proposed Development;
 - The effect of the noise limits on the number of kilo Watt hours (kWh) generated; and
 - The duration and level of exposure.
- 15.4.18 Different standards apply at night, where potential sleep disturbance is the primary concern rather than the requirement to protect outdoor amenity. Night-time is considered to be all periods between 23:00 and 07:00. A limit of 43dB(A) is recommended at night at wind speeds or locations where the prevailing wind speed related night-time background noise level is lower than 38dB(A). At other times, the limit of 5dB above the prevailing wind speed-related background noise level applies. The value of night-time fixed lower limit was selected in order to ensure that internal noise levels remained below those considered to have the potential to cause sleep disturbance, taking account of the attenuation of noise when passing from outdoors to indoors, and making allowance for the presence of open windows.

- 15.4.19 A 'simplified criterion' is also described which is applicable where there are large separation distances between the proposed turbines and nearest NSRs. In such cases, a fixed limit of 35dB, $L_{A90,10min}$ applies, without reference to background noise levels.
- 15.4.20 Where the occupier of the property has a financial interest in the Proposed Development, ETSU-R-97 states that the fixed lower noise limit for both daytime and night-time can be increased to 45dB(A).

The Institute of Acoustics (IOA) Good Practice Guide

- 15.4.21 The Good Practice Guide (GPG) was published by IOA in May 2013 and has been endorsed by the Scottish Government as current industry good practice. The GPG is supported by a suite of six Supplementary Guidance Notes, published in 2014. The guide presents current good practice in the application of ETSU-R-97 assessment methodology for wind turbine developments at the various stages of the assessment process. The recommendations provided in the GPG been followed throughout this assessment.
- 15.4.22 The GPG provides advice on the assessment of cumulative noise impact, detailing several possible cumulative scenarios and recommended approaches. Advice is also provided regarding the geographical scope of a cumulative noise assessment, to determine the area within which a cumulative noise assessment is necessary.
- 15.4.23 Where a new noise source is introduced to a given scenario with a noise level which is predicted to be 10dB or more below the existing level, the increase in the total noise level is negligible. On this basis, the extents of a cumulative noise assessment can be determined. Paragraph 5.1.4 of the GPG states:

"If the proposed wind farm produces noise levels within 10 dB of any existing wind farm(s) at the same receptor location, then a cumulative noise impact assessment is necessary".

- 15.4.24 As noted in ETSU-R-97, noise from existing wind turbines should not form part of the background noise level from which noise limits for new wind energy developments are derived.

Low-Frequency Noise and Infrasound Studies

- 15.4.25 A study, published in 2006 by acoustic consultants Hayes McKenzie on the behalf of the Department of Trade and Industry (DTI), investigated low frequency noise from wind farms (Hayes McKenzie, 2006). This study concluded that there is no evidence of health effects arising from infrasound or low frequency noise generated by wind turbines, but that complaints attributed to low frequency noise were possibly due to a phenomenon known as Amplitude Modulation (AM).
- 15.4.26 Further, in February 2013, the Environmental Protection Authority of South Australia published the results of a study into infrasound levels near wind farms (Environment Protection Authority, 2013). This study measured infrasound levels at urban locations, rural locations with wind turbines close by, and rural locations with no wind turbines in the vicinity. It found that infrasound levels near wind farms are comparable to levels away from wind farms in both urban and rural locations. Infrasound levels were also measured during organised shut downs of the wind farms; the results showed that there was no noticeable difference in infrasound levels whether the turbines were active or inactive.
- 15.4.27 Bowdler *et al.* (2009) concludes that:

"...there is no robust evidence that low frequency noise (including 'infrasound') or ground-borne vibration from wind farms generally has adverse effects on wind farm neighbours."

- 15.4.28 It is therefore not considered necessary to carry out a specific assessment of infrasound and low-frequency noise.

Research Into Amplitude Modulation

- 15.4.29 A study was carried out on behalf of the Department for Business, Enterprise and Regulatory Reform (BERR) by the University of Salford, which investigated the incidence of noise complaints associated with wind farms and whether these were associated with AM (University of Salford, 2007). This report defined AM as aerodynamic noise from wind turbines with a greater degree of fluctuation than normal at blade passing frequency (occasionally referred to elsewhere as 'other AM' (OAM)). Its aims were to ascertain the prevalence of AM on UK wind farm sites, to try to gain a better understanding of the likely causes, and to establish whether further research into AM is required.
- 15.4.30 The study concluded that AM has occurred at only a small number of wind farms in the UK (4 of 133), and only for between 7% and 15% of the time. It also states that, at the time of writing, the causes of AM were not well understood and that prediction of the effect was not currently possible.
- 15.4.31 This research was updated in 2013 by an in-depth study undertaken by Renewable UK, which identified that many of the previously suggested causes of AM have little or no association to the occurrence of AM in practice (Renewable UK, 2013). The generation of AM is based upon the interaction of several factors, the combination and contributions of which are unique to each site. With the current knowledge, it is not possible to predict whether any particular site is more or less likely to give rise to AM, and the incidence of AM occurring at any particular site remains low, as identified in the University of Salford study.
- 15.4.32 In 2016, the IOA proposed a measurement technique to quantify the level of AM present in any particular sample of wind farm noise (Institute of Acoustics, 2016). This technique is supported by the Department of Business, Energy & Industrial Strategy (BEIS, formerly the Department of Energy & Climate Change) who have published guidance, which follows on from the conclusions of the IOA study in order to define an appropriate assessment method for AM, including a penalty scheme and an outline planning condition (BEIS, 2016). Notwithstanding this, the suggested outline planning condition is as yet unvalidated, remains in a draft form and would require site-specific legal advice on its appropriateness to a specific development.

- 15.4.33 Section 7.2.1 of the GPG therefore remains current, stating:

"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".

- 15.4.34 It is therefore not considered necessary to carry out a specific assessment of AM.

Vibration

- 15.4.35 Research undertaken by Snow found that levels of ground-borne vibration 100 m from the nearest wind turbine were significantly below criteria for 'critical working areas' given by British Standard BS 6472:1992 Evaluation of human exposure to vibration in buildings

(1 Hz to 80 Hz) and were lower than limits specified for residential premises by an even greater margin (Snow, 1997).

15.4.36 Ground-borne vibration from wind turbines can be detected using sophisticated instruments several kilometres (km) from a wind farm site, as reported by Keele University (Keele University, 2005). This report clearly shows that, although detectable using highly sensitive instruments, the magnitude of the vibration is orders of magnitude below the human level of perception and does not pose any risk to human health.

15.4.37 It is therefore not considered necessary to carry out a specific assessment of vibration.

15.5 Methodology

Design Parameters

15.5.1 The GPG notes that most sites at planning stage will not have selected a preferred turbine, therefore a representative candidate turbine should be selected to provide appropriate noise levels. Once noise levels have been predicted at the potentially affected properties, compliance with noise limits can be assessed and design advice provided if compliance with the limits is considered unlikely.

15.5.2 The Enercon E-126 4.0MW turbine with a hub height of 86m and equipped with Trailing Edge Serrations has been identified as the worst-case option of those models likely to be used on site, and has therefore been selected as the candidate turbine for this assessment. The manufacturer’s data excludes any margin for uncertainty, and as such an additional 2dB has been included in the sound power levels in this assessment, as detailed in Table 15.2.

Table 15.2: Manufacturer’s Noise Emission Data – Enercon E-126 4.0 MW, 86 m Hub Height

	Standardised 10 m Wind Speed, m/s								
	4	5	6	7	8	9	10	11	12
	Sound Power Level, dB(A)								
Sound Power Level, dB, LWA, inc. 2dB allowance for uncertainty	95.6	101.3	105.4	107.2	107.9	108.1	108.1	108.1	108.1

15.5.3 The octave-band frequency spectrum equivalent to the maximum sound power level (including 2dB allowance for uncertainty) is detailed in Table 15.3.

Table 15.3: Manufacturer’s Noise Emission Data – Enercon E-126 4.0 MW, 86 m Hub Height

	Octave-band Centre Frequency, f, Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
	Sound Power Level, dB, L _{WA}								
Sound Power Level, dB, LWA, Scaled to 108.1dB(A)	79.7	91.3	97.2	100.2	102.4	102.4	100.4	92.9	76.2

Noise Prediction Methodology

- 15.5.4 Noise predictions have been made using SoundPLAN software (v8.1), which implements the ISO 9613-2 methodology (ISO, 1996) and takes account of the specific data and parameters recommended in the GPG, as summarised below:
- The turbine sound power levels should be stated and these should include an appropriate allowance for measurement uncertainty. If the data provided contains no allowance for measurement uncertainty, or uncertainties are not stated, an additional 2dB should be included;
 - Atmospheric absorption should be calculated based on conditions of 10°C and 70% relative humidity;
 - The ground factor assumed should be $G=0.5$ (mixed ground) except in urban areas or where noise propagates across large bodies of water, where $G=0$ (hard ground) should be assumed;
 - A receiver height of 4.0m should be assumed;
 - Barrier attenuation should be limited to 2dB where there is no line of sight from the NSR.
 - An additional 3dB should be added to noise immission levels at properties located across a valley or with heavily concave ground between the NSR location and the wind turbine(s)¹; and
 - The predicted noise levels ($L_{Aeq,t}$) should be converted to the required $L_{A90,10min}$ by subtracting 2dB.
- 15.5.5 ISO 9613-2 provides a prediction of noise levels likely to occur under worst-case conditions; those favourable to the propagation of sound, i.e., down-wind or under a moderate, ground-based temperature inversion as often occurs at night (often referred to as stable atmospheric conditions). The specific measures recommended in the GPG have been shown to provide good correlation with levels of wind turbine noise measured at operational wind farms (Bullmore et al., 2009).

Selection of Fixed Lower Limits

- 15.5.6 As discussed at Paragraph 15.4.5, the noise limits described in ETSU-R-97 are a combination of a 5dB margin above the prevailing wind speed-dependent background noise level and fixed lower limits, applicable where background noise levels are low. These limits apply to cumulative effects.
- 15.5.7 For night-time periods (23:00 – 07:00), a fixed lower limit of 38dB, L_{A90} has been applied, as requested by THC.
- 15.5.8 For daytime periods, the fixed lower portion of the noise limit is defined in ETSU-R-97 as a value within the range 35 to 40dB, $L_{A90,10min}$. For the purposes of this assessment, and as requested by THC, the most stringent ETSU-R-97 daytime fixed lower limit of 35dB, $L_{A90,10min}$ has been applied to both noise due to the Proposed Development, and cumulative noise effects.
- 15.5.9 The occupants of the properties known as Glenrossal House and Glencassley Castle (see Figure 15.1), are owners of the land upon which the Proposed Development is situated.

¹ Equation to determine concave ground as presented in Section 4.3.9 of the GPG.

As such, these properties are considered to have a financial interest in the Proposed Development and are therefore subject to the increased ETSU-R-97 fixed lower limit of 45dB $L_{A90,10min}$ for both daytime and night-time periods.

Cumulative Assessment Methodology

- 15.5.10 ETSU-R-97 states that the assessment should take account of the effect of noise from all existing consented or, in some cases, proposed wind turbines² that may affect a particular NSR / area. In order to facilitate this, a screening exercise was conducted to identify any wind turbines either operational, consented, or part of a current planning application, located within 10km of the Proposed Development wind turbines. Potential cumulative noise effects are typically restricted to turbines within 5km; as such, a 10km search ensures that all potential developments are identified and considered for inclusion where necessary.
- 15.5.11 Following the screening exercise, the following cumulative developments were identified for assessment, and agreed with the EHO:
- Achany Wind Farm (operational); and
 - Rosehall Wind Farm (operational).
- 15.5.12 As noted in the GPG, when assessing cumulative noise levels, consideration should be given to the noise limits applicable to each development.
- 15.5.13 Where there is no reasonable prospect of a cumulative development producing noise levels up to its consented (or proposed) limits, the GPG recommends that predicted noise levels should be used along with an additional safety margin. This approach prevents the sterilisation of an area in which existing wind turbine noise levels are substantially lower than the ETSU-R-97 limits, enabling further appropriate development to be considered.
- 15.5.14 In such instances, an additional safety margin of 2dB has been applied to the noise emissions of that development, on top of the required addition for uncertainty (typically a further 2dB).
- 15.5.15 Details of the noise emission data for each cumulative development is presented in Technical Appendix 15.2, detailing the required adjustments in each instance.

Significance Criteria

- 15.5.16 The acceptable limits for wind turbine operational noise are clearly defined in ETSU-R-97, the methodology for assessment of wind turbine noise recommended by Government guidance. Therefore, this assessment determines whether the calculated immission levels at nearby NSRs lie below the noise limits derived in accordance with ETSU-R-97. Where the noise immission levels at NSRs are shown to be below derived noise limits, the impact is considered to be not significant in terms of the EIA Regulations.

15.6 Baseline

Noise-Sensitive Receptors

- 15.6.1 Potential NSRs have been identified using Ordnance Survey (OS) MasterMap AddressBase, a database which combines the locations of buildings and other features

² Clarified in the GPG to mean those which are the subject of a valid planning application.

from large-scale digital mapping with the Royal Mail's address database, along with aerial photography. Potential NSR locations were verified via site visits.

- 15.6.2 In order to identify the area (and thereby the NSRs) requiring a cumulative assessment, a screening tool has been developed. This involves calculating noise grids for both the Proposed Development and the identified cumulative sites (See Paragraph 15.5.11). The difference between the grid values is then calculated to identify the area in which the difference in noise levels is less than 10dB, in line with the requirements of the GPG. The cumulative screening figure was produced at a wind speed of 10 m/s to align with the maximum wind speed applicable under ETSU-R-97 'simplified assessment' criterion.
- 15.6.3 As stated in Paragraph 15.3.9, the area where the cumulative level is both greater than 35dB(A), and the difference between the Proposed Development and the cumulative developments is less than 10dB, defines the area with the potential for cumulative noise effects ('the Study Area').
- 15.6.4 Figure 15.2 presents the results of this screening exercise. As shown on the figure, only one NSR has been identified within the Study Area (Glenrossal House).
- 15.6.5 As discussed in paragraph 15.5.9, the occupants of this property are owners of the land upon which parts of the Proposed Development are situated. As such, and along with Glencassley Castle, this property is subject to the increased ETSU-R-97 fixed lower limit for financial involvement of 45dB $L_{A90,10min}$ for both daytime and night-time periods.

Survey Details

- 15.6.6 Baseline noise measurements were carried out at two locations (Badintaggart and Glencassley Castle) between the 16 July 2020 and 11 September 2020. The survey was carried out as agreed with the EHO, in accordance with the method specified in ETSU-R-97 and following GPG advice.
- 15.6.7 Background noise monitoring was undertaken on the basis of the Proposed Development's working layout of June 2020. However, since this early stage, the Proposed Development has evolved through the design iteration process. As discussed in Paragraph 15.7.2, the Proposed Development (including cumulative effects) is compliant with the ETSU-R-97 'simplified assessment' methodology, thereby negating the requirement for consideration of background noise levels. Notwithstanding this, the background noise data has been analysed in accordance with the GPG and presented in Technical Appendix 15.3 in the interest of completeness.

15.7 Potential Effects

Operational Noise

- 15.7.1 Table 15.4 details the predicted noise immission levels due to the Proposed Development at closest residential dwelling (Glencassley Castle), and at the only dwelling identified within the Study Area (Glenrossal House). Noise levels have been calculated following the methodology described in Paragraph 15.5.4 and using the noise emission data presented in Paragraph 15.5.2.

Table 15.4: Predicted Operational Noise Levels Due to the Proposed Development

Noise Sensitive Receptor	Standardised 10 m Wind Speed, m/s								
	4	5	6	7	8	9	10	11	12
	Predicted Noise Level, dB, LA _{90,10min}								
Glencassley Castle (244106, 907625)	14.8	20.3	26.0	30.1	31.9	32.6	32.8	32.8	32.8
Glenrossal House (246654, 904337)	9.9	15.4	21.1	25.2	27.0	27.7	27.9	27.9	27.9

15.7.2 Table 15.4 shows that for the Proposed Development in isolation, predicted noise levels are below the ETSU-R-97 simplified assessment criterion (35dB, LA_{90,10min}). As such, all other NSRs would also comply.

Cumulative Operational Noise Effects

15.7.3 Table 15.5 details the predicted cumulative noise immission levels due to the operation of the Proposed Development in conjunction with Achany and Rosehall Wind Farms. Cumulative Operational Noise levels have been calculated using the noise emission data presented in Technical Appendix 15.2.

Table 15.5: Predicted Cumulative Operational Noise Levels

Noise Sensitive Receptor	Standardised 10 m Wind Speed, m/s								
	4	5	6	7	8	9	10	11	12
	Predicted Noise Level, dB, LA _{90,10min}								
Glencassley Castle (244106, 907625)	22.7	27.0	30.6	32.5	33.1	33.4	33.5	33.6	33.8
Glenrossal House (246654, 904337)	29.4	30.6	32.2	34.1	34.4	35.1	35.8	36.6	37.5

15.7.4 As Tables 15.5 shows, predicted cumulative operational noise levels are below the applicable fixed lower limits at the assessed NSRs (45dB, LA_{90,10min}).

15.7.5 On the basis of the above, the operational noise produced by the Proposed Development is anticipated to be compliant with the ETSU-R-97 and therefore **not significant** in terms of the EIA Regulations.

Noise Exposure Time by Wind Direction

15.7.6 As requested by THC, and whilst not specifically required under ETSU-R-97 methodology, consideration has been given to the exposure of NSRs to wind turbine noise under various wind directions due to the Proposed Development, relative to the existing cumulative scenario (i.e., the developments detailed in Paragraph 15.5.11).

15.7.7 As Figure 15.1 shows, based upon the relative location of the assessed wind turbines (both of the Development and cumulative) and NSRs, the majority of NSRs are expected to experience wind turbine noise primarily from either the Proposed Development in isolation, or from the Proposed Development in combination with the existing operational developments. As such, there is a negligible increase in exposure due to cumulative effects at these NSRs. The only potential exception is Glenrossal House as this dwelling is located between the Proposed Development and the cumulative

developments considered in this assessment. However, the occupants of Glenrossal House are financially involved in the Proposed Development and **no significant effects** are therefore anticipated due to an increase in exposure to wind turbine noise at this location.

- 15.7.8 All NSRs, including Glenrossal House, are located to the south-west of the Proposed Development and the operational Achany and Rosehall Wind Farms. As such, these NSRs would experience worst-case wind turbine noise levels under north-easterly wind directions, which is expected to be a relatively rare occurrence given the prevailing wind direction at this location is predominantly westerly and south-easterly. Under prevailing wind directions and based upon the GPG, cumulative wind turbine noise levels will be up to 10dB lower than presented in this Chapter.

15.8 Mitigation

Construction Noise

- 15.8.1 Although an assessment of construction noise has been scoped out of assessment due to the distance between the Proposed Development and the nearest NSRs, the following good practice measures will be implemented through the CEMP, in order to manage the effects of noise during construction, and will be required of all contractors:

- Construction activities are anticipated to be between 07.00 and 19.00 hours Mondays to Fridays, and 07:00 to 14:00 hours on Saturdays. No working activities would be planned on Sundays. In the event of works being required outwith these hours, e.g. abnormal load deliveries, commissioning works or emergency mitigation works, the Planning Authority would be notified prior to these works taking place, wherever possible.
- Operation of crushing equipment located within / next to borrow pits will generally be limited to 08:00 to 18:00 hours Monday to Friday and 08:00 to 13:00 on Saturdays, with no operation on Sundays.
- Deliveries of turbine components, plant and materials by HGV to site shall only take place by designated routes and within times agreed with THC;
- The site contractors shall be required to employ the best practicable means of reducing noise emissions from plant, machinery and construction activities, as advocated in BS 5228;
- Non-tonal and / or directional reversing alarms will be used;
- Where necessary and practicable, noise from fixed plant and equipment will be contained within suitable acoustic enclosures or behind acoustic screens;
- All sub-contractors appointed by the principal contractor will be formally and legally obliged, and required through contract, to comply with all environmental noise conditions;
- Where practicable, night-time working will not be carried out. Local residents shall be notified in advance of any night-time construction activities likely to generate significant noise levels, e.g. turbine erection; and
- Any plant and equipment normally required for operation at night (23:00 - 07:00), e.g. generators or dewatering pumps, shall be silenced or suitably shielded to ensure that the night-time lower threshold of 45dB, $L_{Aeq,night}$, as defined in BS5228, shall not be exceeded at the nearest NSRs.

15.8.2 In the event that stone is required to be extracted from borrow pits by blasting, the following process would be employed to ensure that the effects of blasting noise and vibration on nearby properties are adequately controlled:

- Compliance with planning conditions specifying limits to vibration resulting from blasting, restrictions on times of blasting, and a requirement for vibration monitoring;
- Preparation of a Scheme of Blasting, which will be submitted to THC for approval prior to the commencement of any blasting;
- Any blasting on site would only take place between the hours of 10:00 to 16:00 on Monday to Friday inclusive and 10:00 to 12:00 on Saturdays, with no blasting taking place on a Sunday unless otherwise approved in advance in writing by THC; and
- Provision of information on blasting to neighbouring residents.

15.8.3 An outline CEMP is included as Technical Appendix 3.1.

Operational Noise

15.8.4 As no significant effects are anticipated in relation to operational noise from the Proposed Development, no specific mitigation in relation to operational noise is proposed. However, it is recommended that a planning condition is applied in the form of an ETSU-R-97 'simplified assessment' limit, limiting noise due to the Proposed Development at the nearest NSRs to 35dB, $L_{A90,10min}$ at wind speeds at 10m AGL of up to 10m/s.

15.8.5 As previously noted in Paragraph 15.5.9, Glenrossal House and Glencassley Castle are classed as financially involved properties, and are therefore subject to a fixed lower limit of 45dB, $L_{A90,10min}$. However, given that there are NSRs located in close proximity to Glencassley Castle with no financial interest, a limit of 35dB, $L_{A90,10min}$ at the closest NSR's would ensure noise is suitably controlled at all NSRs, whether or not they are financially involved in the Proposed Development.

15.8.6 In addition to the above, THC has requested an outline of mitigation that could be applied in the event that noise levels in practice are found to exceed conditioned levels. Assuming that this was identified through noise monitoring carried out at the request of THC (e.g., following a complaint about wind turbine noise), the following process would be carried out:

- Calculation of the overall reduction in noise emissions required of the Proposed Development as a function of wind speeds and direction;
- Identification of the available reduced noise operating modes and how the turbines' control software can implement these in relation to wind speed, direction and time of day;
- Modelling of noise from the Proposed Development to identify the most efficient combination of reduced noise operating modes that would achieve the required reduction in noise emissions;
- Application of the identified mitigation strategy;
- Follow-up noise monitoring to verify efficacy of mitigation; and
- If necessary, repetition of the above stages until compliance with conditioned noise limits is demonstrated.

Residual Effects

Operational Noise

- 15.8.7 As no specific mitigation is required for operational noise effects, there is no change in the assessment of likely significant effects as assessed in Section 15.7. Residual operational noise effects would therefore be compliant with the ETSU-R-97 and **not significant** in terms of the EIA Regulations, both in isolation, and cumulatively.
- 15.8.8 If operational noise levels in practice are found to exceed conditioned levels, a suitable mitigation strategy would be agreed with THC, as detailed in Paragraph 15.8.6.

15.9 Cumulative Effects

- 15.9.1 Operational cumulative noise effects have been considered as an inherent part of the assessment methodology detailed in this Chapter and have been found to be **not significant**.

15.10 Conclusion

- 15.10.1 An assessment of potential noise effects associated with the Proposed Development has been carried out.
- 15.10.2 Construction noise will be limited in duration and confined to working hours as specified by THC and therefore can be adequately controlled through the application of good practice measures and secured by planning condition. This will ensure that any noise from the Proposed Development site during construction will be adequately controlled.
- 15.10.3 Operational noise has been assessed in accordance with ETSU-R-97 and in line with current best practice. It has been shown that the Proposed Development would comply with the requirements of ETSU-R-97 at all NSR locations and is therefore **not significant** in terms of the EIA Regulations.
- 15.10.4 The cumulative effects of the Proposed Development in conjunction with nearby wind energy developments either operational, consented or the subject of a current planning application were taken into consideration in the above assessment in accordance with ETSU-R-97 and the GPG, and found to be acceptable and therefore **not significant** in terms of the EIA Regulations.
- 15.10.5 Noise during decommissioning is understood to be of a similar nature to that of construction and will be managed through best practice or other guidance and relevant legislation at the time.

15.11 References

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