

## 11 Acoustic & Vibration Assessment

### 11.1 Introduction

- 11.1.1 This chapter considers the likely significant noise effects associated with the construction, operation and decommissioning of the Proposed Development on residents of nearby properties. The specific objectives of the chapter are to:
- describe the current baseline;
  - describe the assessment methodology and significance criteria used in completing the impact assessment;
  - describe the potential effects, including direct, indirect and cumulative effects;
  - describe the mitigation measures proposed to address the likely significant effects; and
  - assess the residual effects remaining following the implementation of mitigation measures.
- 11.1.2 This assessment has been undertaken by RES, with three in-house Members of the Institute of Acoustics (MIOA) involved in its production. RES has undertaken acoustic impact assessments in every single one of its UK wind farm development applications since 2000 and has also reported to several local planning authorities on operational wind energy projects, and various other renewable energy developments, including taking measurements on newly constructed wind farms to ensure compliance with planning conditions, investigating sources of complaint and determining relevant remedial action where necessary.
- 11.1.3 Additionally, RES has been project coordinator for several Joule projects (DGXII European Commission funded projects in the field of Research and Technological Development in non-nuclear energy); led European research into wind turbine noise; was involved in producing the guideline ‘The Assessment and Rating of Noise from Wind Farms’ ETSU for the DTI in 1996; acted as peer reviewer for the ‘Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise’ (IOA GPG), and contributed to works conducted via RenewableUK work on Amplitude Modulation (AM).
- 11.1.4 A list of relevant publications in which RES have been involved is provided in **Technical Appendix 11.1: Renewable Energy Systems (RES) Publications.**

- 11.1.5 This chapter is supported by the following Technical Appendices and Figures:
- **Technical Appendix 11.1: Renewable Energy Systems (RES) Publications;**
  - **Technical Appendix 11.2: Issues Scoped Out;**
  - **Technical Appendix 11.3: BESS Acoustic Assessment;**
  - **Technical Appendix 11.4: Assessment Charts;**
  - **Technical Appendix 11.5: Suggested Planning Conditions;**
  - **Figure 11.1: Predicted Sound Footprint;** and
  - **Figure 11.2: Predicted Battery Energy Storage System Sound Footprint.**

11.1.6 The relevant Figures and Technical Appendices are referenced in the text where necessary.

### 11.2 Legislation, Policy and Guidance

#### Operation

- 11.2.1 In the context of other sources of environmental noise, the noise levels produced by wind turbines are generally low and have greater dependence upon wind speed. The combination of these two factors mean that a degree of masking would often be provided by background noise.
- 11.2.2 As described by Scottish Government Planning Advice for Onshore Wind Turbines<sup>1</sup>:
- “Technically, there are two quite distinct types of noise sources within a wind turbine - the mechanical noise produced by the gearbox, generator and other parts of the drive train; and the aerodynamic noise produced by the passage of the blades through the air. There has been significant reduction in the mechanical noise generated by wind turbines through improved turbine design.”*
- 11.2.3 Within Scotland, noise is defined within the planning context by ‘Planning Advice Note 1/2011: Planning and Noise’<sup>2</sup>. This Planning Advice Note provides advice on the role of the planning system in helping to prevent and limit the adverse effects of noise. The Planning Advice Note 1/2011 states that:
- “Good acoustical design and siting of turbines is essential to minimise the potential to generate noise.”*

<sup>1</sup> ‘Onshore wind turbines: planning advice’, Scottish Government, May 2014. Available at: <https://www.gov.scot/publications/onshore-wind-turbines-planning-advice/>

<sup>2</sup> ‘Planning Advice Note 1/2011: Planning and Noise’, Scottish Government, March 2011. Available at: <https://www.gov.scot/publications/planning-advice-note-1-2011-planning-noise/>

- 11.2.4 Planning Advice Note 1/2011 refers to the use of the Department of Trade and Industry's 'The Assessment and Rating of Noise from Wind Farms' (ETSU-R-97), noting that further guidance is provided in the web-based planning advice on renewable technologies for onshore wind turbines<sup>5</sup>. In relation to noise from wind farms the web-based renewables advice states:
- "The Report, 'The Assessment and Rating of Noise from Wind Farms' describes a framework for the measurement of wind farm noise, which should be followed by applicants and consultees, and used by planning authorities to assess and rate noise from wind energy developments, until such time as an update is available."*
- 11.2.5 It is therefore considered that the use of ETSU-R-97, as criteria for assessment of wind farm noise, fulfils the requirements of Planning Advice Note 1/2011.
- 11.2.6 The methodology described in ETSU-R-97 was developed by a working group comprised of a cross-section of interested persons including, amongst others, environmental health officers, wind farm operators, and independent acoustic experts.
- 11.2.7 ETSU-R-97 makes it clear from the outset that any noise restrictions placed on a wind farm must balance the environmental impact of the wind farm against the national and global benefits that arise through the development of renewable energy resources. The principle of balancing development needs against the protection of amenity may be considered common to any type of noise control guidance.
- 11.2.8 The basic aim of ETSU-R-97, in arriving at the recommendations contained within the report, is the intention to provide:
- "Indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable restrictions on wind farm development or adding unduly to the costs and administrative burdens on wind farm developers or local authorities."*
- 11.2.9 An article published in the Institute of Acoustics (IOA) Bulletin Vol. 34 No. 2, March/April 2009<sup>3</sup>, recommends a methodology for addressing issues not made explicit by, or outside the scope of, ETSU-R-97, such as in relation to wind shear or noise propagation modelling. Whilst this article does not represent formal legislation or guidance it was authored by a group of independent acousticians experienced in wind farm noise issues who have undertaken work on behalf of wind farm developers, local planning authorities and third parties and as such is a good indicator of best practice techniques.
- 11.2.10 A Good Practice Guide (GPG) to the application of ETSU-R-97 for the assessment and rating of wind turbine noise<sup>3</sup>, issued by the Institute of Acoustics in May 2013 and endorsed by the Scottish Government, along with the governments in England, Northern Ireland and Wales, provides guidance on all aspects of the use of ETSU-R-97 and reaffirms the recommendations of the Acoustics Bulletin article with regard to propagation modelling and wind shear. The assessment presented herein adopts the recommendations of the GPG.
- 11.2.11 Supplementary guidance notes were published by the IOA in July and September 2014, and these provide further details on specific areas of the IOA GPG<sup>4</sup>. The assessment presented herein adopts the recommendations made within these supplementary guidance notes.
- 11.2.12 ETSU-R-97 has been applied at the vast majority of wind farms currently operating in the UK and provides a robust basis for assessing the noise impact of a wind farm when used in accordance with the IOA GPG. It is the only relevant guidance referenced in Scottish Planning Policy (2014) for rating and assessing operational wind farm noise. Based on planning policy and guidance, as outlined above, a wind farm which can operate within noise limits derived according to ETSU-R-97 shall be considered acceptable. This approach has been agreed with The Highland Council (THC).
- Construction & Decommissioning**
- 11.2.13 The Control of Pollution Act 1974 provides information on the need for ensuring that the best practicable means are employed to minimise noise<sup>5</sup>.

<sup>3</sup> 'Prediction and Assessment of Wind Turbine Noise', Bowdler et al, Acoustics Bulletin Vol 34 No 2 March/April 2009

<sup>4</sup> 'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise - Supplementary Guidance Notes', Institute of Acoustics, July & September 2014. Available at <https://www.ioa.org.uk/publications/wind-turbine-noise>

<sup>5</sup> 'Control of Pollution Act', published by Her Majesty's Stationary Office, July 1974. Available at: <https://www.legislation.gov.uk/ukpga/1974/40>

- 11.2.14 Specifically in relation to Environmental Impact Assessments and planning, however, the web-based Scottish Government technical advice on construction noise assessment in ‘Appendix 1: Legislative Background, Technical Standards and Codes of Practice’<sup>6</sup> states that
- the 2009 version of BS 5228 ‘Code of practice for noise and vibration control on construction and open sites - Part 1: Noise’<sup>7</sup> is applicable.
- 11.2.15 Given that BS 5228-1:2009 is identified as being the appropriate source of guidance on appropriate methods for minimising noise from construction activities, it is adopted herein.
- 11.2.16 BS 5228-2:2009 ‘Code of practice for noise and vibration control on construction and open sites - Part 2: Vibration’<sup>8</sup>, provides a method for predicting vibration levels which has been adopted in this assessment.
- 11.2.17 BS 6472-2:2008 ‘Guide to evaluation of human exposure to vibration in buildings - Part 2: Blast-induced vibration’<sup>9</sup> has been used to set criteria for satisfactory magnitudes of vibration at nearby residential properties to ensure compliance with respect to human response.

### 11.3 Consultation

- 11.3.1 The Environmental Health Department at THC was consulted prior to this assessment being undertaken. It was agreed that, there would be no requirement for a background noise survey as an initial cumulative assessment, indicated that predicted levels would be below 35 dBA at all considered residential properties. Additionally, it was stated that there is the potential for background noise levels to be affected by the presence of the existing turbines.

- 11.3.2 The scoping response for the Proposed Development indicated that the assessment should consider consented levels as well as predicted levels from cumulative sites. It was discussed in this instance that the approach of assessing to consented levels would be overly conservative as predicted levels are so far below the limits for each scheme. The existing operational Glen Kyllachy wind farm together with Farr wind farm have noise limits that are derived in accordance with ETSU-R-97, incorporating the suggested limit modifications proposed by the Environmental Health Officer (EHO) and the results of background noise measurements made in the area. As a result, it was proposed that these limits could be applied in a cumulative sense to determine the overall acceptability of the combined operation of the sites for planning purposes. If the limits were adopted in this way, even if the existing and planned cumulative wind farms considered here had resultant levels 3dB higher than assumed here, the overall requirements of ETSU-R-97 would be met. This methodology was agreed with THC.
- 11.3.3 It was also discussed that, some of the cumulative sites under consideration do not have consented limits. Further to this, it was stated that the considered cumulative sites are already built or under construction and the source noise levels for the installed turbines are well known and well defined (i.e. no ambiguity as to what could be installed if the some of the sites were at the planned/consented stage of development). Additionally, the IOA GPG assumptions regarding uncertainty (2 dB) were considered appropriate given the aforementioned.

- 11.3.4 Details of the consultation undertaken are outlined in **Table 11.1**.

**Table 11.1: Consultation**

Consultee	Date of Consultation	Type	Nature and Purpose of Consultation
The Highland Council	19 February 2024	Scoping Report	Environmental Impact Assessment (EIA) Scoping report detailing proposed approach to the acoustic assessment for the Proposed Development.
The Highland Council	1 May 2024	Scoping Opinion	Response from Highland Council Environmental Health Department with regards to the EIA Scoping report outlining the required assessment methodology for the acoustic assessment. The following was proposed by a representative of THC:  The target sound levels for the wind farm are either a simplified standard of 35dB L <sub>A90</sub> at standardised 10m height wind speeds up to 10m/s or a composite standard of

<sup>6</sup> ‘Assessment of noise: technical advice note’, Scottish Government, March 2011. Available at: <http://www.gov.scot/publications/technical-advice-note-assessment-noise/>

<sup>7</sup> ‘Code of Practice for Noise and vibration control on construction and open sites - Part 1: Noise’, British Standards Institution, BS 5228-1:2009

<sup>8</sup> ‘Code of Practice for Noise and vibration control on construction and open sites - Part 2: Vibration’, British Standards Institution, BS 5228-2:2009

<sup>9</sup> ‘Guide to evaluation of human exposure to vibration in buildings. Blast-induced vibration’, BS 6472-2:2008

Consultee	Date of Consultation	Type	Nature and Purpose of Consultation
			<p>35dB <math>L_{A90}</math> (daytime) and 38dB <math>L_{A90}</math> (night-time) fixed limit or up to 5dB above the respective background noise levels at up to 12m/s, whichever is the greater. Furthermore, the suggested limits should apply to cumulative turbine noise levels, that the assessment should take into account the potential consented levels from such developments and that consideration should be given to any increase in exposure to wind turbine sound.</p> <p>In respect of sound generated by sub-station or battery storage site(s), the EHO requested that sound levels should not exceed 30dB <math>L_{Zeq, 5min}</math>, in the 100 Hz one third octave frequency and that the rating level, calculated in accordance with BS 4142: 2014+A1:2019, should not be above the current background noise levels at noise sensitive premises.</p>
The Highland Council	27 June 2024	Email	<p>'Planned Acoustic Assessment at the Proposed Clune Wind Farm' report (04707-7990135) sent to the EHO, detailing the proposed assessment methodology.</p> <p>A simplified 35dB <math>L_{A90}</math> (daytime) and 38dB <math>L_{A90}</math> (night-time) limit for Clune Wind Farm operating alone was proposed as it is considered that this would protect the amenity of neighbouring residents sufficiently.</p> <p>No strict requirement for a background noise survey as an initial cumulative assessment indicated that predicted levels would be below 35dB(A) at all considered residential properties neighbouring the site when taking into account wind direction effects.</p> <p>A BS 4142 or an assessment based on a fixed noise level limit will be undertaken for the Battery Energy Storage System (BESS), depending on the appropriateness of the relevant guidance.</p> <p>It was proposed that specific construction noise predictions would not be undertaken and only a discursive assessment would be provided.</p>
The Highland Council	1 July 2024	Email	<p>Response received from EHO. Confirmed general agreement with the proposed assessment methodology. The response also stated that since the maximum cumulative levels were all below 35dB <math>L_{A90}</math>, it was agreed that a baseline survey could be scoped out of the assessment and that the 35dB <math>L_{A90}</math> simplified ETSU limit could be applied to cumulative levels as a basis of planning acceptability, with appropriate apportioned condition limits being applied to the Proposed Development.</p>

## 11.4 Methodology

### Scope of Assessment

#### Operation

- 11.4.1 To ensure adequate assessment of the potential impacts of the operational noise from the Proposed Development, the following steps have been taken, in accordance with relevant guidance detailed above:
- The baseline noise conditions at each of the nearest residential properties to the Proposed Development have been established by way of representative background noise surveys;
  - The noise levels at the nearest residential properties from the operation of the Proposed Development have been predicted using a sound propagation model considering: the locations of the wind turbines; the intervening terrain; and the likely noise emission characteristics of the wind turbines;
  - The acoustic assessment criteria have been derived appropriately; and
  - The evaluation of the acoustic impact has been undertaken by comparing the predicted noise levels with the assessment criteria. Significant effects would be identified if the predicted noise levels exceed limits derived in accordance with ETSU-R-97. Significant effects would not be expected should the predicted noise levels be less than the ETSU-R-97 limits.
- 11.4.2 Aerodynamic and mechanical noise are scoped into the operational noise assessment. The focus of the assessment of operational noise presented here is based on the most relevant type of noise emission for modern wind turbines - aerodynamic noise, which is broadband in nature. Mechanical noise, which can be tonal in nature, is also considered albeit less relevant to modern wind turbines whose improved design has led to significant reductions in mechanical noise. Implicitly incorporated within this assessment is the normal character of the noise associated with wind turbines (commonly referred to as 'blade swish') and consideration of a range of noise frequencies, including low frequencies.

- 11.4.3 Low frequency content of the noise from wind farms shall be considered through the use of octave band specific noise emission and propagation modelling, however it is considered that specific and targeted assessment on low frequency content of noise emissions from the Proposed Development is unjustified. Details for scoping out low frequency noise from the operational noise assessment, as well as infrasound, sleep disturbance, vibration, amplitude modulation and wind turbine syndrome can be found in **Technical Appendix 11.2**.
- 11.4.4 Health effects are scoped out of the assessment. However, a summary of the findings of a comprehensive study into wind turbine noise and associated health effects can be found in **Technical Appendix 11.2** with justification on why no additional assessment of health effects has been undertaken for this project.
- 11.4.5 An acoustic assessment considering the operation of the proposed BESS, including consideration of the cumulative impact with the proposed wind turbines, is scoped in and can be found in **Technical Appendix 11.3**.

#### **Construction & Decommissioning**

- 11.4.6 The construction of turbines, ancillary electrical equipment, compounds and the corresponding access tracks typically occurs at large distances from neighbouring residences. The resultant noise and vibration, which would be temporary in nature, is only very rarely cause for concern in terms of the potential for disturbing the inhabitants of neighbouring residences. Whilst the noise associated with the construction of these aspects may well be audible to people residing in the area, the levels would be below established noise limits and planning requirements in this respect. Nevertheless, typical mitigation measures, including the use of ‘best practicable means’<sup>10</sup> would be incorporated into the construction practices for the Proposed Development with a view to reducing noise and vibration levels where possible and practical. As a result, this aspect is discussed in generalised terms with reference to standard noise limiting requirements; typical working practices; hours of work; and standard mitigation measures in this respect. A detailed assessment has not been undertaken and a similar rationale can be applied for noise and vibration impacts associated with decommissioning of the Proposed Development.

- 11.4.7 Construction relating to the provision of access to the site, including the upgrade of local roads and their use thereof, may well occur at locations near to residences. As a result, and in instances where this is likely to occur, consideration of enhanced mitigation measures which would be reasonably possible to implement, have been discussed. In any event, typical noise limiting requirements would apply and the contractor undertaking the works would be responsible for potential issues and taking appropriate and reasonable steps to address these should they occur. As a result, this aspect is also discussed in generalised terms and a detailed assessment has not been undertaken as this would require a detailed construction plan to provide confidence in the results, which is not available at this time. However, certain details as to construction practices would be provided within a Construction Environmental Management Plan (CEMP), with reference to potential noise and vibration impacts, where necessary. An outline CEMP is provided in **Technical Appendix 3.1**.
- 11.4.8 Noise and vibration associated with the movement of additional vehicles, including heavy goods vehicles (HGVs) along local roads and access routes may well be noticeable to residents adjacent to these. However, this would essentially only result in a minor increase in the average noise levels from existing roads, with the most noticeable noise and perceptible vibration effects resulting from the sporadic and increased number of HGV pass-bys at residences along the access routes, with resulting levels for individual events being similar to that created by existing HGV movements.
- 11.4.9 Whilst noise would also arise during decommissioning of the Proposed Development (through turbine deconstruction and breaking of the exposed part of the concrete bases) this is not discussed separately as noise levels resulting from it are expected to be lower than those during construction due to the number and type of activities involved. The impact of decommissioning can therefore be considered in light of the conclusions of the construction noise assessment.

#### **Baseline Characterisation**

- 11.4.10 The study area is limited to properties located within approximately 4.5km of the Proposed Development and dwellings directly adjacent to access tracks and delivery routes.

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<sup>10</sup> Environmental Protection Act 1990, Part III. <https://www.legislation.gov.uk/ukpga/1990/43/part/III/view=extent>

## Operation

- 11.4.11 Similar to other standards of assessments of noise impacts (most notably BS 4142<sup>11</sup>, which ETSU-R-97 identifies as forming the basis of its recommendations), the ETSU-R-97 methodology requires the comparison of predicted noise levels due to turbine emissions (which vary with hub height wind speed) with noise limits based upon the noise levels already existing under those same conditions (i.e. the baseline conditions).
- 11.4.12 Since background noise levels depend upon wind speed, as indeed do wind turbine noise emissions, it is important when making reference measurements to put them in that context. Thus, the assessment of background noise levels requires the measurement of not only noise levels, but concurrent wind conditions, covering a representative range of wind speeds. These wind measurements are made at the site rather than at the residential properties, since it is this wind speed that would subsequently govern the Proposed Development's noise generation. Often the residential properties themselves will be sheltered from the wind and may consequently have relatively low background noise levels.
- 11.4.13 To establish the baseline conditions, sound level meters and associated apparatus are set-up to record the required acoustic information at a selection of the nearest residential properties geographically spread around the Proposed Development and which are likely to be representative of other residential properties in the locale.
- 11.4.14 Wind speed and direction are recorded as 10-minute averages for the same period as for the noise measurements and are synchronised with the acoustic data to allow correlations to be established. The wind speed that is adopted for use is the same wind speed as that which drives the turbine noise levels.
- 11.4.15 Prior to establishing the baseline conditions the acoustic data is filtered as follows:
- For each background noise measurement location, the measured noise data is divided into two sets, as specified by ETSU-R-97 and shown in **Table 11.2**:

**Table 11.2: Definition of Time-of-Day Periods**

Time of Day	Definition
Quiet daytime	08:00 - 23:00 every day 13:00 - 18:00 Saturday 07:00 - 18:00 Sunday
Night-time	23:00 - 07:00 every day

- Rainfall affected data is systematically removed from the acoustic data set. To facilitate this, a rain gauge is deployed to record 10-minute rainfall data and identify potentially affected noise data. Both the 10-minute period containing the bucket tip and the preceding 10-minute period are removed from the dataset as recommended in the IOA GPG to account for the time it takes for the rain gauge tipping bucket to fill.
- Periods of measured background noise data thought to be affected by extraneous, i.e. non-typical, noise sources are identified and removed from the data set. Whilst some 'extraneous' data may actually be real, it tends to bias any trend lines upwards, so its removal is adopted as a conservative measure.
- In practice this means close inspection of the measured background noise levels, comparison with concurrent data measured at nearby locations and consideration of both directional and temporal variation.

### Construction & Decommissioning

- 11.4.16 Baseline background and ambient levels of noise and vibration area are consistent with that of a rural environment, as discussed elsewhere within this Chapter. No formal quantification of current levels has been supplied as this is not considered relevant to the overall construction and decommissioning noise and vibration discussion.

<sup>11</sup> 'Method for Rating Industrial Noise affecting Mixed Residential and Industrial Areas', British Standards Institution, 1997

## Significance Criteria

### Operation

- 11.4.17 Sound is measured in decibels (dB) which is a measure of the sound pressure level, i.e. the magnitude of the pressure variations in the air. Measurements of environmental noise are usually made in dB(A) which includes a correction for the sensitivity of the human ear.
- 11.4.18 ETSU-R-97 seeks to protect the internal and external amenity of wind farm neighbours by defining acceptable limits for operational noise from wind turbines. The test applied to operational noise is whether or not the noise levels produced by the combined operation of the wind turbines at nearby residential properties lie below noise limits derived in accordance with ETSU-R-97.
- 11.4.19 Whilst ETSU-R-97 presents a comprehensive and detailed assessment methodology for wind farm noise, it also provides a simplified methodology based on including certain conditions:
- “if the noise is limited to an  $L_{A90,10min}$  of 35dB(A) up to wind speeds of 10m/s at 10m height, then these conditions alone would offer sufficient protection of amenity, and background noise surveys would be unnecessary”.*
- 11.4.20 In the detailed methodology, ETSU-R-97 states that different limits should be applied during daytime and night-time periods. The daytime limits, derived from the background noise levels measured during quiet daytime periods, are intended to preserve outdoor amenity, while the night-time limits are intended to prevent sleep disturbance. The general principle is that the noise limits should be based on existing background noise levels, except for very low background noise levels, in which case a fixed limit may be applied. The suggested limits are given in **Table 11.3**, where  $L_B$  is the background  $L_{A90,10min}$  and is a function of wind speed. During daytime periods and at low background noise levels, a lower fixed limit of 35-40dB  $L_{A90}$  is applicable. The exact value is dependent upon a number of factors: the number of nearby dwellings, the effect of the noise limits on energy produced, and the duration and level of exposure.

**Table 11.3: Permissible Noise Level Criteria**

Time of Day	Definition
Quiet daytime	35-40 dB $L_{A90}$ for $L_B$ less than 30-35dB $L_B + 5dB$ , for $L_B$ greater than 30-35dB
Night-time	43 dB $L_{A90}$ for $L_B$ less than 38dB $L_B + 5dB$ , for $L_B$ greater than 38dB

- 11.4.21 It should be noted that a higher noise level is permissible during the night than during the day as it is assumed that residents would be indoors. The night-time criterion is derived from sleep disturbance criterion referred to in ETSU-R-97, with an allowance of 10 dB for attenuation through an open window.
- 11.4.22 Further to the above, the absolute lower noise limits may be increased up to 45dB  $L_{A90}$  for both daytime and night-time periods if the occupant of a property has a financial involvement in the proposed wind farm.
- 11.4.23 THC have further requested that target operational sound levels are either a simplified standard of 35dB  $L_{A90}$  for standardised 10m height wind speeds up to  $10m.s^{-1}$  or a composite standard of 35dB  $L_{A90}$  (daytime) and 38dB  $L_{A90}$  (night-time), or up to 5dB above background noise levels for standardised 10m height wind speeds up to  $12m.s^{-1}$ , whichever is the greater (see **Section 11.3**). Whilst these limits represent a departure from the typical requirements of ETSU-R-97, they have been adopted here as a conservative basis of assessment.
- 11.4.24 The wind speeds at which the acoustic impact are considered are for standardised 10m height wind speeds of 3 to  $12m.s^{-1}$ . Below these wind speeds, the turbines will not be operating or be at ‘cut-in’, where rotational speeds will be such that the resultant noise impact is very low and no significant impacts would be expected. Above these wind speeds, as stated in ETSU-R-97, reliable measurements of background and turbine noise are difficult to make. However, if a wind farm meets the noise criteria at the wind speeds of 3 to  $12m.s^{-1}$ , it is very unlikely that it would cause any greater loss of amenity at higher wind speeds due to increasing background noise levels masking wind farm generated noise.
- 11.4.25 It is important to note that, since reactions to noise are subjective, it is not possible to guarantee that a given development would not result in any adverse comment with regard to noise as the response to any given noise will vary from person to person. Consequently, standards and guidance that relate to environmental noise are typically presented in terms of criteria that would be expected to be considered acceptable by the majority of the population.
- 11.4.26 Where turbine levels are predicted to be above the modified ETSU-R-97 noise limits specified in paragraph 11.4.23, these would be considered significant, and if below, not significant.

### Construction & Decommissioning

- 11.4.27 Construction noise is discussed with reference to Annex E of BS 5228-1:2009, which provides guidance on setting environmental noise targets. Several methods of assessing the significance of noise levels are presented in Annex E and the most applicable to the construction of the Proposed Development is the ABC method.
- 11.4.28 The ABC method sets threshold noise levels for construction noise for specific periods based on the pre-existing ambient noise levels, subject to average lower Category A limiting values of 65, 55 and 45dB  $L_{Aeq}$  for daytime (07:00 - 19:00 weekdays and Saturdays 07:00 - 13:00), evenings and weekends (19:00 - 23:00 weekdays, 13:00 - 23:00 Saturdays and 07:00 - 23:00 Sundays) and night-time (23:00 - 07:00) periods respectively, for instances where existing ambient noise levels are relatively low, which is the case here.
- 11.4.29 BS 5228-2:2009 provides guidance on the assessment of vibration due to blasting. A scaled distance graph is shown in Figure E.1 within Annex E of the guidance which provides an indication of likely vibration magnitudes at various distances. This Figure can be used to determine the level of vibration which would not be expected to be exceeded in 95 % of blasts for a given distance and charge size.
- 11.4.30 BS 6472-2:2008 details the maximum satisfactory magnitudes for vibration measured on a firm surface outside buildings with respect to human response. For up to three blast vibration events per day, the generally accepted maximum satisfactory magnitude at residential premises during daytime periods (08:00 - 18:00 Monday to Friday and 08:00 - 13:00 on Saturdays), is a peak particle velocity (ppv) of 6.0 to 10.0  $mms^{-1}$ . In practice, the lower satisfactory magnitude should be used with the higher magnitude being justified on a case-by-case basis.
- 11.4.31 Where it is considered that the levels of construction noise and vibration, including that from blasting, can meet the relevant limits for each aspect or that appropriate controls or mitigation can be put in place, the resultant impact is considered not significant.

### Modelling Noise Propagation

#### Operation

- 11.4.32 Whilst there are several sound propagation models available, the ISO 9613 Part 2 model has been used<sup>12</sup>, this being identified as most appropriate for use in such rural sites<sup>13</sup>. The specific interpretation of the ISO 9613 Part 2 propagation methodology recommended in the aforementioned IOA Bulletin and the subsequent IOA GPG has been employed.
- 11.4.33 To conduct noise predictions, it is assumed that:
- the turbines at the Proposed Development are identical;
  - the wind turbines radiate noise at the power specified in this report;
  - each wind turbine can be modelled as a point source at hub-height; and
  - each residential property is assigned a reference height to simulate the presence of an observer.
- 11.4.34 The sound propagation model takes account of attenuation due to geometric spreading and atmospheric absorption. The assumed temperature and relative humidity are 10 °C and 70% respectively, as recommended in the IOA Bulletin and IOA GPG. Ground effects are also taken into account by the propagation model with a ground factor of 0.5 and a receiver height of 4m used as recommended in the IOA Bulletin and IOA GPG.
- 11.4.35 The barrier attenuations predicted by ISO 9613 Part 2 have been shown to be significantly greater than those measured in practice under downwind conditions<sup>13</sup>. Therefore, barrier attenuation according to the ISO 9613 Part 2 method has been discounted. In lieu of this, where there is no direct line of sight between the residential property in question and any part of the wind turbine, 2dB attenuation has been assumed as recommended in the IOA Bulletin and the IOA GPG.
- 11.4.36 Verification studies have also shown that ISO 9613 Part 2 tends to slightly underestimate noise levels at nearby dwellings in certain exceptional cases, notably in a valley type environment where the ground drops off between source and receiver. In these instances, an addition of 3dB has been applied to the resulting overall A-weighted noise level as recommended by the IOA GPG.

<sup>12</sup> 'Acoustics - Attenuation of Sound During Propagation Outdoors, Part 2: General Method of Calculation', International Organisation for Standardisation, ISO 9613-2:1996

<sup>13</sup> 'A Critical Appraisal of Wind Farm Noise Propagation', ETSU Report W/13/00385/REP, January 2000



11.4.37 To generate the ground cross sections between each turbine and each dwelling necessary for reliable propagation modelling, ground contours at 5m intervals for the area of interest have been generated from 50m grid resolution digital terrain data.

11.4.38 Additionally, rather than making a conservative assumption that properties are always downwind of the wind farm, a more detailed assessment, which incorporates the effects of wind direction has been undertaken. This accounts for the fact that noise levels at a property will be less when the property is crosswind or upwind of the development. The directional attenuation factors applied, as shown in **Table 11.4**, are consistent with the recommendations of the IOA GPG, with reductions in noise of around 2dB when a receiver is crosswind, and up to 10dB when a receiver is upwind of a particular turbine. The IOA GPG also states that upwind reductions in noise level will only come into play gradually at distances of between 5 and 10 tip heights. As a result, these attenuation factors applied have been adjusted by the distance between the source and receiver accordingly.

**Table 11.4: Directional Attenuation**

Direction offset from downwind (°)	0	30	60	90	120	150	180	210	240	270	300	330
Directional attenuation factor (dB)	0	0	0	2	6.7	9.3	10	9.3	6.7	2	0	0

11.4.39 The predicted noise levels are calculated as  $L_{Aeq}$  noise levels and changed to the  $L_{A90}$  descriptor (to allow comparisons to be made) by subtraction of 2dB, as specified by ETSU-R-97.

11.4.40 It has been shown by measurement-based verification studies that the ISO 9613 Part 2 model tends to slightly overestimate noise levels at nearby dwellings<sup>14</sup>. Examples of conservative assumptions informing the conservative model are as follows.

- Although, in reality, the ground is predominantly porous (acoustically absorptive) it has been modelled as ‘mixed’, i.e. a combination of hard and porous, corresponding to a ground absorption coefficient of 0.5 as recommended by the IOA Bulletin and IOA GPG.
- Receiver heights are modelled at 4m above local ground level, which equates roughly to first floor window level, as recommended by the IOA Bulletin and IOA

GPG. This results in a predicted noise level anything up to 2dB higher than at the typical human ear height of 1.2m - 1.8m.

- Trees and other non-terrain shielding effects have not been considered.
- An allowance for measurement uncertainty has been included in the sound power levels for the presented candidate turbine.

11.4.41 The locations of the turbines which make up the Proposed Development, and four neighbouring developments - Dunmaglass Wind Farm (operational), Glen Kyllachy Wind Farm (operational), Farr Wind Farm (operational) and Aberarder Wind Farm (under construction) are provided in **Table 11.5**. The co-ordinates for these cumulative sites are taken from publicly available information.

11.4.42 The locations of the nearest residential properties to the turbines have been determined by inspection of relevant maps, address databases and via site visits. More residential properties may have been identified but have not been considered critical to this acoustic assessment and/or may be adequately represented by another residential property. The locations considered are listed in **Table 11.6** and are also shown in **Figure 11.1**.

**Table 11.5: Turbine Locations**

Turbine ID	OSGB Co-Ordinates		Turbine ID	OSGB Co-Ordinates	
	X (m)	Y (m)		X (m)	Y (m)
<b>Clune Wind Farm</b>			T8	264388	820359
T1	281637	820368	T9	264871	820815
T2	281329	819817	T10	265003	821367
T3	280657	820041	T11	263981	820494
T4	281085	820446	T12	264584	821345
T5	281319	821288	<b>Farr Wind Farm</b>		
T6	280690	821229	T1	271842	829305
T7	280433	820723	T2	271981	829099
T8	280008	820187	T3	271263	829102
T9	279489	820440	T4	271510	828910
T10	279942	821007	T5	272058	830020
T11	280292	821670	T6	273093	830117
T12	279901	822081	T7	272485	830324
T13	279739	821537	T8	272533	830079

<sup>14</sup> ‘Development of a Wind Farm Propagation Model’, J H Bass, A J Bulmore, E Sloth, JOR3-CT95-0051, May 1998

Turbine ID	OSGB Co-Ordinates		Turbine ID	OSGB Co-Ordinates	
	X (m)	Y (m)		X (m)	Y (m)
T14	278962	820720	T9	272084	828863
T15	278430	820902	T10	272236	828662
T16	279293	821181	T11	272689	829886
T17	279210	822098	T12	272462	828475
T18	279151	822661	T13	272985	828560
T19	278898	821624	T14	272847	828824
T20	278331	821549	T15	272421	829360
T21	277848	821218	T16	272202	829807
T22	277853	822135	T17	272300	829591
T23	278643	822217	T18	273110	828343
T24	278201	822574	T19	273186	829813
T25	277293	822166	T20	273200	829573
T26	276906	821701	T21	273382	828806
<b>Dunmaglass Wind Farm</b>			T22	274184	828986
T1	262759	818644	T23	274223	828747
T2	262545	818377	T24	273968	828011
T3	262756	818051	T25	274373	828545
T4	263193	818980	T26	273789	828208
T5	262518	820006	T27	273293	828127
T6	262789	820505	T28	273469	827931
T7	263024	820263	T29	273289	829073
T8	262849	819789	T30	273231	829321
T9	263312	820069	T31	273692	829371
T10	263696	819859	T32	274254	829546
T11	263193	819615	T33	274613	829251
T12	262559	819369	T34	274819	829035
T13	262868	819166	T35	274228	829312
T14	262332	819079	T36	274658	829481
T15	262274	818733	T37	273660	829825
T16	263519	819435	T38	273471	828622
T17	263697	818757	T39	273764	829114
T18	264079	818553	T40	273662	829622
T19	264470	818369	<b>Glen Kyllachy Wind Farm</b>		

Turbine ID	OSGB Co-Ordinates		Turbine ID	OSGB Co-Ordinates	
	X (m)	Y (m)		X (m)	Y (m)
T20	264752	818655	T1	271156	828474
T21	265166	818921	T2	272007	828164
T22	265504	819180	T3	272555	827739
T23	265560	819594	T4	271827	827631
T24	265204	819852	T5	273817	827530
T25	264781	819601	T6	274480	827768
T26	264776	819167	T7	275287	827602
T27	265226	819358	T8	275706	827032
T28	264463	819328	T9	271293	828207
T29	264359	818857	T10	271726	828366
T30	264040	819063	T11	272252	827912
T31	264151	819557	T12	271603	827876
T32	264169	819901	T13	272159	827458
T33	264552	819813	T14	274156	827386
<b>Aberarder Wind Farm</b>			T15	275042	827883
T1	265849	820594	T16	275547	827299
T2	265645	820179	T17	275136	827234
T3	265254	820288	T18	274826	827501
T4	265736	821012	T19	274429	827176
T5	264832	820371	T20	275201	826910
T6	265297	820771			
T7	265433	821279			

Table 11.6: Property Locations

Property ID	Property Name	OSGB Co-Ordinates	
		X (m)	Y (m)
H1	Daltomich	274209	821336
H2	Insharn	284315	822230
H3	Banchoruan	275175	822475
H4	The Old Post Office	274866	822995
H5	Culrain	274920	823042
H6	The Bungalow	274920	823042
H7	Dorran Bungalow	275360	823366

Property ID	Property Name	OSGB Co-Ordinates	
		X (m)	Y (m)
H8	Dalmigavie House	275414	823416
H9	Wester Garbole	275109	823421
H10	Slochd Cottages	284787	823795
H11	2 Slochd Railway Cottages	284792	823795
H12	4 Slochd Railway Cottages	284803	823795
H13	3 Slochd Railway Cottages	284798	823796
H14	Slochd Mhor Lodge	284785	823802
H15	Glen Kyllachy Lodge	275316	823885
H16	Norwood	275626	824127
H17	Doneen	284543	824163
H18	Ryna Clask	284523	824195
H19	Garbole	275623	824224
H20	Asgard	275666	824219
H21	Easter Strathnoon	277844	824295
H22	Iarr Tigh	277160	824354
H23	The Old Schoolhouse West	276851	824387
H24	Old Schoolhouse East	276867	824392
H25	Keepers House	276598	824416
H26	Wester Achintoul Lodge	278211	824929
H27	Easter Achintoul	278359	825095
H28	Ghillie's Cottage	278330	825106
H29	Knockandhu Farm	278845	825181
H30	Wagtail House	278891	825197
H31	Clune Farmhouse	279347	825703
H32	Old Clune Lodge	279417	825768
H33	Clune Lodge	279825	825865
H34	The Press	280770	826174
H35	Balnagordonach	280984	826724
H36	Drumbain Steading	281022	827039
H37	Drumbain Cottage	281057	827044
H38	Property At Caggan	282006	816666

Property ID	Property Name	OSGB Co-Ordinates	
		X (m)	Y (m)
H39	Red Bothy	280567	816229
H40	Easter Woodend	279388	826364
H41	Corrievorrie	277304	824768
H42	Kyllachy House	278624	825925
H43	Woodend	279124	826217
H44	Ardachy Consented	277821	825138

- 11.4.43 The candidate turbine model for the Proposed Development is the Vestas V162 7.2MW, with a hub-height of 119m and serrated trailing edge (STE) blade modifications. The turbine model at the operational Dunmaglass Wind Farm site is the Siemens SWT 101 3 MW with a hub height of 68.5m, the turbine model at the operational Glen Kyllachy Wind Farm site is the Nordex N80 2.5MW with a hub-height of 70m, the turbine model at the operational Farr Wind Farm site is the Siemens 2.3MW / Bonus B82 with a hub-height of 60m, and the turbine model at the under construction Aberarder Wind Farm site is the Vestas V117 4.3MW with a hub-height of 71m.
- 11.4.44 The acoustic emission data for the turbines at each of the cumulative sites used in the analysis, are taken from the information supporting the various planning applications for each development. The turbines installed at each site have been confirmed through data available on THC Open Map Data for Wind Turbines<sup>15</sup>.
- 11.4.45 Acoustic emission data from the manufacturer's general specification for each of the machines discussed above are used in the analysis and have been identified as typically warranted. However, no independent test reports are currently available to indicate whether any margin for uncertainty has been incorporated into the levels. As a result, 2dB has been added to the specified levels for all turbine models as a conservative measure and as recommended by the IOA GPG.

<sup>15</sup> Wind Turbines | Highland Council Open Map Data (arcgis.com). [https://maphighland.opendata.arcgis.com/datasets/fdad9392071a477087c9e0cb4184b5d4\\_0/about](https://maphighland.opendata.arcgis.com/datasets/fdad9392071a477087c9e0cb4184b5d4_0/about)

11.4.46 **Table 11.7** shows the overall sound power levels over a range of standardised 10m height wind speeds for the turbine models considered as part of the isolative and cumulative assessments provided herein. **Table 11.8** shows the octave band noise levels corresponding to the maximum noise output for each respective turbine model, as also based on manufacturer's specifications, as provided separately, and including for the relevant uncertainty.

**Table 11.7: Sound Power Levels, dB L<sub>WA</sub>, including 2dB uncertainty**

Turbine	Standardised 10m Height Wind Speed, ms <sup>-1</sup>									
	3	4	5	6	7	8	9	10	11	12
V162 7.2MW	96.0	97.2	101.3	105.2	106.5	106.8	107.1	107.4	107.5	107.5
SWT 101 3MW	97.1	97.1	101.3	106.5	108.7	109.8	110.0	110.0	110.0	110.0
N80 2.5MW	94.5	98.2	100.8	102.8	103.6	104.1	104.6	104.9	105.0	105.0
B82 2.3MW	104.7	104.7	104.7	104.7	105.4	106.8	108.5	109.2	109.2	109.2
V117 4.3MW	94.9	97.5	101.6	105.3	107.6	108.0	108.0	108.0	108.0	108.0

**Table 11.8: Octave Band Sound Power Levels, dB L<sub>WA</sub>**

Turbine	Overall, dB L <sub>WA</sub>	Standardised 10m Height Wind Speed, ms <sup>-1</sup>							
		63	125	250	500	1k	2k	4k	8k
V162 7.2MW	107.5	87.4	95.0	99.8	101.9	101.1	97.6	91.3	82.2
SWT 101 3MW	110.0	84.8	96.7	103.4	106.7	103.4	95.5	84.6	81.3
N80 2.5MW	105.0	90.9	97.5	98.3	96.1	95.8	94.9	91.3	83.4
B82 2.3MW	109.2	90.4	97.7	97.7	99.6	99.6	100.8	99.2	91.7
V117 4.3MW	108.0	88.4	95.5	100.2	102.5	102.4	99.8	94.9	87.5

11.4.47 The turbine models are assumed not to have any tonal noise output that would attract a penalty at neighbouring residences as per the requirements of ETSU-R-97. Nevertheless, a warranty or guarantee would be obtained from the manufacturer which limits the level of tonal noise associated with the operation of the individual turbines (or the site as a whole), should the site be granted planning consent, and a finalised turbine model is procured. This would also help to provide appropriate recourse with the turbine manufacturer should a tonal character be present in the noise generated by the site.

### Construction & Decommissioning

11.4.48 BS 5228 provides various means of predicting construction noise and vibration levels from various plant and supplies a wide range of generic plant source noise levels for this purpose. However, as discussed earlier, the construction of the Proposed Development is not expected to have any significant impacts given the distance of the turbines from neighbouring properties and the generic nature of the works. As a result, specific construction noise predictions have not been undertaken and only a discursive assessment is provided.

## 11.5 Baseline

### Operation

- 11.5.1 The Proposed Development is located approximately 25km south-east of Inverness. The general noise character is typical of a rural environment with noise from farm machinery, sheep, cattle, and birds, with the occasional overhead aircraft and noise associated with traffic movements along local roads and the A9 approximately 4km to the east/north-east of the Proposed Development.
- 11.5.2 The Environmental Statement (ES) for the neighbouring operational Glen Kyllachy Wind Farm (Planning Reference 13/02441/FUL) contains the results of background noise monitoring undertaken in support of the planning application for the development. A survey was undertaken at eight locations neighbouring the site and the collected data was reviewed and analysed in accordance with ETSU-R-97 and the IOA GPG. Two of the survey locations (Easter Woodend and Asgard) are positioned between the Glen Kyllachy Wind Farm and the Proposed Development and are representative of the properties considered in this assessment. The derived background noise levels for the two survey locations are taken from Table 4, Table 5 and Figures E1, E2, E7 & E8 of the Glen Kyllachy ES, and are shown in **Table 11.9**. The corresponding overall modified ETSU-R-97 limits are taken from the Decision Notice for Glen Kyllachy (Highland Council Reference No.:18/05083/S42) and are shown in **Table 11.10**.
- 11.5.3 The various levels referred to in paragraph 11.5.2 have been accepted by representatives of THC in their consideration of two or more neighbouring consented and operational developments and are considered appropriate for use here as a result.

**Table 11.9 - Average (Best-Fit) Background Sound Levels, dB LA90**

Location	Standardised 10m Height Wind Speed, m s <sup>-1</sup>							
	4	5	6	7	8	9	10	11
Quiet Daytime								
Asgard	31.5	31.4	31.8	32.5	33.5	34.8	36.2	36.9
Easter Woodend	26.0	27.7	30.0	32.4	34.7	36.6	37.6	37.8
Night-time								
Asgard	31.0	31.1	31.4	31.9	32.5	33.4	34.4	34.4
Easter Woodend	23.0	24.3	26.5	29.4	32.5	35.2	36.6	36.6

**Table 11.10 - Operational Noise Limits, dB LA90**

Location	Standardised 10m Height Wind Speed, m s <sup>-1</sup>									
	3	4	5	6	7	8	9	10	11	12
Daytime										
Asgard	36.4	36.4	36.4	36.8	37.5	38.5	39.8	41.2	41.9	41.9
Easter Woodend	35.0	35.0	35.0	35.0	37.4	39.7	41.6	42.6	42.8	42.8
Night-time										
Asgard	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.4	39.4	39.4
Easter Woodend	38.0	38.0	38.0	38.0	38.0	38.0	40.2	41.6	41.6	41.6

11.5.4 The derived noise limits are assigned to each of the assessment locations identified in **Table 11.11** based on the relative proximity of the monitoring location to the assessment locations. Where there is ambiguity in this respect, the noise limits are applied on a basis that is considered conservative.

**Table 11.11: Application of Noise Limits**

Property ID	OSGB Co-Ordinates		Applied Noise Limit
	X (m)	Y (m)	
H1	274209	821336	Asgard
H2	284315	822230	Asgard
H3	275175	822475	Asgard
H4	274866	822995	Asgard
H5	274920	823042	Asgard
H6	274920	823042	Asgard
H7	275360	823366	Asgard
H8	275414	823416	Asgard
H9	275109	823421	Asgard
H10	284787	823795	Asgard

Property ID	OSGB Co-Ordinates		Applied Noise Limit
	X (m)	Y (m)	
H11	284792	823795	Asgard
H12	284803	823795	Asgard
H13	284798	823796	Asgard
H14	284785	823802	Asgard
H15	275316	823885	Asgard
H16	275626	824127	Asgard
H17	284543	824163	Asgard
H18	284523	824195	Asgard
H19	275623	824224	Asgard
H20	275666	824219	Asgard
H21	277844	824295	Easter Woodend
H22	277160	824354	Easter Woodend
H23	276851	824387	Easter Woodend
H24	276867	824392	Easter Woodend
H25	276598	824416	Easter Woodend
H26	278211	824929	Easter Woodend
H27	278359	825095	Easter Woodend
H28	278330	825106	Easter Woodend
H29	278845	825181	Easter Woodend
H30	278891	825197	Easter Woodend
H31	279347	825703	Easter Woodend
H32	279417	825768	Easter Woodend
H33	279825	825865	Easter Woodend
H34	280770	826174	Easter Woodend
H35	280984	826724	Easter Woodend
H36	281022	827039	Easter Woodend
H37	281057	827044	Easter Woodend
H38	282006	816666	Easter Woodend
H39	280567	816229	Easter Woodend
H40	279388	826364	Easter Woodend
H41	277304	824768	Easter Woodend
H42	278624	825925	Easter Woodend
H43	279124	826217	Easter Woodend
H44	277821	825138	Easter Woodend

11.5.5 Table 11.12 shows the corresponding daytime and night-time noise limits at the residential assessment locations considered here. These limits are intended to apply to the cumulative impact of operational noise from the Proposed Development and the other existing, planned, or permitted development near the site to determine whether the combined operation of the sites would be acceptable under current planning guidance. THC have specified that target noise levels are either a simplified standard of 35dB L<sub>A90</sub> at wind speeds up to 10m.s<sup>-1</sup> or a composite standard of 35dB L<sub>A90</sub> (daytime) and 38dB L<sub>A90</sub> (night-time) or up to 5dB above background noise levels at up to 12m.s<sup>-1</sup>.

Table 11.12: Overall Noise Limits, dB L<sub>A90</sub>

Property ID	Standardised 10m height Wind Speed, m.s <sup>-1</sup>									
	3	4	5	6	7	8	9	10	11	12
Daytime										
H1	36.4	36.4	36.4	36.8	37.5	38.5	39.8	41.2	41.9	41.9
H2	36.4	36.4	36.4	36.8	37.5	38.5	39.8	41.2	41.9	41.9
H3	36.4	36.4	36.4	36.8	37.5	38.5	39.8	41.2	41.9	41.9
H4	36.4	36.4	36.4	36.8	37.5	38.5	39.8	41.2	41.9	41.9
H5	36.4	36.4	36.4	36.8	37.5	38.5	39.8	41.2	41.9	41.9
H6	36.4	36.4	36.4	36.8	37.5	38.5	39.8	41.2	41.9	41.9
H7	36.4	36.4	36.4	36.8	37.5	38.5	39.8	41.2	41.9	41.9
H8	36.4	36.4	36.4	36.8	37.5	38.5	39.8	41.2	41.9	41.9
H9	36.4	36.4	36.4	36.8	37.5	38.5	39.8	41.2	41.9	41.9
H10	36.4	36.4	36.4	36.8	37.5	38.5	39.8	41.2	41.9	41.9
H11	36.4	36.4	36.4	36.8	37.5	38.5	39.8	41.2	41.9	41.9
H12	36.4	36.4	36.4	36.8	37.5	38.5	39.8	41.2	41.9	41.9
H13	36.4	36.4	36.4	36.8	37.5	38.5	39.8	41.2	41.9	41.9
H14	36.4	36.4	36.4	36.8	37.5	38.5	39.8	41.2	41.9	41.9
H15	36.4	36.4	36.4	36.8	37.5	38.5	39.8	41.2	41.9	41.9
H16	36.4	36.4	36.4	36.8	37.5	38.5	39.8	41.2	41.9	41.9
H17	36.4	36.4	36.4	36.8	37.5	38.5	39.8	41.2	41.9	41.9
H18	36.4	36.4	36.4	36.8	37.5	38.5	39.8	41.2	41.9	41.9
H19	36.4	36.4	36.4	36.8	37.5	38.5	39.8	41.2	41.9	41.9
H20	36.4	36.4	36.4	36.8	37.5	38.5	39.8	41.2	41.9	41.9
H21	35.0	35.0	35.0	35.0	37.4	39.7	41.6	42.6	42.8	42.8
H22	35.0	35.0	35.0	35.0	37.4	39.7	41.6	42.6	42.8	42.8

Property ID	Standardised 10m height Wind Speed, m.s <sup>-1</sup>									
	3	4	5	6	7	8	9	10	11	12
H23	35.0	35.0	35.0	35.0	37.4	39.7	41.6	42.6	42.8	42.8
H24	35.0	35.0	35.0	35.0	37.4	39.7	41.6	42.6	42.8	42.8
H25	35.0	35.0	35.0	35.0	37.4	39.7	41.6	42.6	42.8	42.8
H26	35.0	35.0	35.0	35.0	37.4	39.7	41.6	42.6	42.8	42.8
H27	35.0	35.0	35.0	35.0	37.4	39.7	41.6	42.6	42.8	42.8
H28	35.0	35.0	35.0	35.0	37.4	39.7	41.6	42.6	42.8	42.8
H29	35.0	35.0	35.0	35.0	37.4	39.7	41.6	42.6	42.8	42.8
H30	35.0	35.0	35.0	35.0	37.4	39.7	41.6	42.6	42.8	42.8
H31	35.0	35.0	35.0	35.0	37.4	39.7	41.6	42.6	42.8	42.8
H32	35.0	35.0	35.0	35.0	37.4	39.7	41.6	42.6	42.8	42.8
H33	35.0	35.0	35.0	35.0	37.4	39.7	41.6	42.6	42.8	42.8
H34	35.0	35.0	35.0	35.0	37.4	39.7	41.6	42.6	42.8	42.8
H35	35.0	35.0	35.0	35.0	37.4	39.7	41.6	42.6	42.8	42.8
H36	35.0	35.0	35.0	35.0	37.4	39.7	41.6	42.6	42.8	42.8
H37	35.0	35.0	35.0	35.0	37.4	39.7	41.6	42.6	42.8	42.8
H38	35.0	35.0	35.0	35.0	37.4	39.7	41.6	42.6	42.8	42.8
H39	35.0	35.0	35.0	35.0	37.4	39.7	41.6	42.6	42.8	42.8
H40	35.0	35.0	35.0	35.0	37.4	39.7	41.6	42.6	42.8	42.8
H41	35.0	35.0	35.0	35.0	37.4	39.7	41.6	42.6	42.8	42.8
H42	35.0	35.0	35.0	35.0	37.4	39.7	41.6	42.6	42.8	42.8
H43	35.0	35.0	35.0	35.0	37.4	39.7	41.6	42.6	42.8	42.8
H44	35.0	35.0	35.0	35.0	37.4	39.7	41.6	42.6	42.8	42.8
Night-time										
H1	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.4
H2	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.4
H3	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.4
H4	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.4
H5	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.4
H6	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.4
H7	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.4
H8	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.4
H9	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.4
H10	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.4

Property ID	Standardised 10m height Wind Speed, m.s <sup>-1</sup>									
	3	4	5	6	7	8	9	10	11	12
H11	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.4
H12	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.4
H13	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.4
H14	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.4
H15	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.4
H16	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.4
H17	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.4
H18	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.4
H19	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.4
H20	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.4	39.4
H21	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	40.2	41.6
H22	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	40.2	41.6
H23	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	40.2	41.6
H24	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	40.2	41.6
H25	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	40.2	41.6
H26	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	40.2	41.6
H27	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	40.2	41.6
H28	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	40.2	41.6
H29	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	40.2	41.6
H30	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	40.2	41.6
H31	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	40.2	41.6
H32	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	40.2	41.6
H33	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	40.2	41.6
H34	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	40.2	41.6
H35	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	40.2	41.6
H36	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	40.2	41.6
H37	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	40.2	41.6
H38	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	40.2	41.6
H39	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	40.2	41.6
H40	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	40.2	41.6
H41	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	40.2	41.6
H42	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	40.2	41.6
H43	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	40.2	41.6
H44	38.0	38.0	38.0	38.0	38.0	38.0	38.0	38.0	40.2	41.6

## Construction & Decommissioning

- 11.5.6 Background/baseline noise levels detailed above are relatively low, as would be expected for a rural area such as that considered here, and existing ambient noise levels are also considered low. As a result, lower limiting values, as discussed previously with reference to the ‘ABC method’ provided within BS 5228-1, are used to inform discussion as to the potential impacts during construction.
- 11.5.7 Existing sources of vibration in the area are expected to be related to HGV movements along local roads, localised construction/maintenance activities and the occasional earthquake and/or tremor, which may well be perceptible to people in the locale but with a certain level of habituation for some residents depending on the source. In general, existing sources of vibration are expected to be intermittent and would not be expected to be significant in terms of normal guidance in this respect.

## 11.6 Assessment of Potential Effects

### Operation

- 11.6.1 **Table 11.13** shows the maximum predicted operational noise levels resulting from the introduction of the Proposed Development operating in isolation, over a range of standardised 10m height wind speeds and assuming downwind propagation at the nearest residential properties using the prediction methodology detailed in Section 11.4.
- 11.6.2 The site has been designed on an iterative basis with a view to minimising the projected operational sound levels with due regard to the ETSU-R-97 limits and all other site constraints.

**Table 11.13: Predicted Operational Noise Levels, dB L<sub>A90</sub>**

Property ID	Standardised 10 height Wind Speed, m s <sup>-1</sup>									
	3	4	5	6	7	8	9	10	11	12
H1	15.1	16.3	20.4	24.3	25.7	25.9	26.2	26.5	26.6	26.6
H2	16.6	17.7	21.9	25.8	27.1	27.4	27.6	27.9	28.1	28.1
H3	18.4	19.6	23.8	27.6	29.0	29.3	29.5	29.8	29.9	29.9
H4	16.6	17.7	21.9	25.8	27.1	27.4	27.6	27.9	28.1	28.1
H5	16.7	17.8	22.0	25.9	27.2	27.5	27.8	28.0	28.2	28.2
H6	16.7	17.8	22.0	25.9	27.2	27.5	27.8	28.0	28.2	28.2
H7	18.0	19.2	23.4	27.2	28.6	28.9	29.1	29.4	29.5	29.5
H8	18.5	19.6	23.8	27.7	29.0	29.3	29.6	29.8	30.0	30.0

Property ID	Standardised 10 height Wind Speed, m s <sup>-1</sup>									
	3	4	5	6	7	8	9	10	11	12
H9	17.7	18.9	23.0	26.9	28.2	28.5	28.8	29.1	29.2	29.2
H10	13.8	15.0	19.1	23.0	24.4	24.7	24.9	25.2	25.3	25.3
H11	13.8	15.0	19.1	23.0	24.4	24.6	24.9	25.2	25.3	25.3
H12	13.8	15.0	19.1	23.0	24.3	24.6	24.9	25.2	25.3	25.3
H13	13.8	15.0	19.1	23.0	24.4	24.6	24.9	25.2	25.3	25.3
H14	13.6	14.8	18.9	22.8	24.2	24.5	24.7	25.0	25.1	25.1
H15	18.0	19.2	23.4	27.2	28.6	28.9	29.1	29.4	29.5	29.5
H16	18.5	19.6	23.8	27.7	29.0	29.3	29.6	29.8	30.0	30.0
H17	13.1	14.2	18.4	22.3	23.6	23.9	24.2	24.4	24.6	24.6
H18	13.1	14.2	18.4	22.3	23.6	23.9	24.1	24.4	24.6	24.6
H19	18.3	19.4	23.6	27.5	28.8	29.1	29.4	29.6	29.8	29.8
H20	18.4	19.5	23.7	27.6	28.9	29.2	29.5	29.7	29.9	29.9
H21	21.6	22.8	26.9	30.8	32.1	32.4	32.7	33.0	33.1	33.1
H22	20.9	22.0	26.2	30.1	31.4	31.7	31.9	32.2	32.4	32.4
H23	20.3	21.4	25.6	29.5	30.8	31.1	31.4	31.7	31.8	31.8
H24	20.3	21.5	25.6	29.5	30.8	31.1	31.4	31.7	31.8	31.8
H25	19.7	20.8	25.0	28.9	30.2	30.5	30.8	31.1	31.2	31.2
H26	19.4	20.6	24.7	28.6	30.0	30.3	30.5	30.8	30.9	30.9
H27	19.0	20.2	24.3	28.2	29.5	29.8	30.1	30.4	30.5	30.5
H28	18.9	20.1	24.3	28.2	29.5	29.8	30.0	30.3	30.4	30.4
H29	18.6	19.8	23.9	27.8	29.2	29.4	29.7	30.0	30.1	30.1
H30	18.3	19.4	23.6	27.5	28.8	29.1	29.4	29.7	29.8	29.8
H31	17.3	18.4	22.6	26.5	27.8	28.1	28.4	28.7	28.8	28.8
H32	17.3	18.4	22.6	26.5	27.8	28.1	28.4	28.7	28.8	28.8
H33	17.1	18.3	22.5	26.4	27.7	28.0	28.2	28.5	28.6	28.6
H34	14.7	15.9	20.0	23.9	25.3	25.5	25.8	26.1	26.2	26.2
H35	13.9	15.0	19.2	23.1	24.4	24.7	25.0	25.3	25.4	25.4
H36	14.4	15.5	19.7	23.6	24.9	25.2	25.4	25.7	25.9	25.9
H37	14.4	15.5	19.7	23.6	24.9	25.2	25.4	25.7	25.9	25.9
H38	14.3	15.5	19.7	23.6	24.9	25.2	25.4	25.7	25.8	25.8
H39	15.4	16.6	20.7	24.6	25.9	26.2	26.5	26.8	26.9	26.9
H40	16.1	17.3	21.4	25.3	26.7	26.9	27.2	27.5	27.6	27.6
H41	19.9	21.1	25.2	29.1	30.5	30.7	31.0	31.3	31.4	31.4

Property ID	Standardised 10 height Wind Speed, m s <sup>-1</sup>									
	3	4	5	6	7	8	9	10	11	12
H42	18.4	19.6	23.7	27.6	28.9	29.2	29.5	29.8	29.9	29.9
H43	16.5	17.7	21.8	25.7	27.0	27.3	27.6	27.9	28.0	28.0
H44	20.0	21.1	25.3	29.2	30.5	30.8	31.1	31.4	31.5	31.5

11.6.3 The assessment shows that predicted noise levels from the Proposed Development at all nearest residential properties are below 35dB L<sub>A90</sub>, indicating that the noise immission levels would be regarded as acceptable and the resident's amenity as receiving 'sufficient protection' without further assessment requiring to be undertaken. As a result, operational sound levels are considered **not significant**.

11.6.4 A contour plot corresponding to a standardised 10m height wind speed of 8ms<sup>-1</sup> resulting from the Proposed Development is provided in **Figure 11.1**.

11.6.5 An acoustic assessment considering the operation of the proposed BESS, can be found in **Technical Appendix 11.3 and Figure 11.2**. The assessment demonstrates that the BESS would be considered **not significant** in terms of current planning policy due the particularly low levels of predicted sound potentially generated by the facilities reaching neighbouring properties.

### Construction & Decommissioning

11.6.6 Primary activities creating noise during the construction period of wind farm developments include the construction of the turbine bases; the erection of the turbines; the excavation of trenches for cables; and the construction of associated hard standings, access tracks and construction compound(s). Noise from vehicles on local roads and access tracks would also arise due to the delivery of turbine components and construction materials, notably aggregates, concrete and steel reinforcement.

11.6.7 The exact methodology and timing of construction activities for the Proposed Development have not yet been defined and a reliable assessment of expected construction noise levels is not possible as a result. However, as discussed in Sections 11.4.27 to 11.4.31, works expected to be undertaken at or around the proposed turbine locations would occur at distances that are unlikely to result in noise levels that would breach typical criteria at neighbouring residences in this regard.



- 11.6.8 The access route for the Proposed Development is expected to pass reasonably close to some dwellings and with some upgrade works to existing access tracks and local roads also expected to occur in close proximity to some dwellings. In these instances, the level of noise generated by construction works could be close to the limits defined as part of the 'ABC method', as discussed earlier. As a result, typical construction noise mitigation measures are provided in **Section 11.7** which aim to minimise noise as far as reasonably practicable and/or reasonable.
- 11.6.9 The movement of additional vehicles, including HGVs, along local roads and access routes may well be noticeable to residents adjacent to these in terms of the noise and vibration generated by them. The resultant impacts on local roads, that are already well used by local traffic and existing HGV movements, would be relatively minor in terms of the increase in average noise levels resulting from the additional vehicles on the roads. However, the individual events may well be noticeable to residents, with resulting levels for individual events being similar to that created by existing HGV movements. The resultant noise levels on parts of the route that are less well used by existing traffic would be noticeable to residents located along the route. However, the resultant noise and vibration levels from vehicles passing the dwellings would be unlikely to breach the adopted construction noise limits and accepted vibration thresholds.
- 11.6.10 The noise associated with blasting at 'borrow pit' locations may well be audible to neighbouring residents. However, the level of noise, overpressure and vibration generated by each blast would be well below levels that would be expected to cause damage to the nearest housing and/or structures. Section 11.7 provides details as to standard mitigation measures to be incorporated into the blasting processes and may also be included within the detailed CEMP.

## 11.7 Mitigation

### Operation

- 11.7.1 Predicted operational noise levels associated with the introduction of the Proposed Development, as shown in **Table 11.13**, and cumulative noise levels resulting from the Proposed Development operating at the same time as the existing Dunmaglass Wind Farm, Glen Kyllachy Wind Farm and Farr Wind Farm in addition to the under construction Aberarder Wind Farm, as shown at Section 11.9, meet the limiting requirements of ETSU-R-97 in all instances. As a result, operational noise mitigation is not required to reduce the potential operational noise impacts.

## Construction & Decommissioning

- 11.7.2 For all activities, measures would be taken to reduce noise levels with due regard to practicality and cost as per the concept of 'best practicable means' as defined in Section 72 of the Control of Pollution Act 1974<sup>10</sup>.
- 11.7.3 BS 5228-1:2009+A1:2014 states that the 'attitude of the contractor' is important in minimising the likelihood of complaints and therefore consultation with the local authority and Community Liaison Group is advised to inform residents of intended activity. Non-acoustic factors, which influence the overall level of complaints such as mud on roads and dust generation, would also be controlled through construction practices adopted on the site. Furthermore, the following noise mitigation options could be implemented where appropriate:
- Consideration would be given to noise emissions when selecting plant and equipment to be used on site;
  - All equipment should be maintained in good working order and fitted with the appropriate silencers, mufflers or acoustic covers where applicable;
  - Stationary noise sources would be sited as far away as reasonably possible from residential properties; and
  - The movement of vehicles to and from the site would be controlled and employees instructed to ensure compliance with the noise control measures adopted.
- 11.7.4 Site operations would be limited to 07:00 - 19:00 Monday to Saturday except during turbine erection and commissioning or during periods of emergency work.

## 11.8 Assessment of Residual Effects

### Operation

- 11.8.1 The operational acoustic assessment demonstrates that predicted noise levels from the Proposed Development at residential properties do not exceed the derived noise limits across all wind speeds for the isolative scenario detailed in Section 11.6 and cumulative scenario detailed in Section 11.9. Therefore, no significant impacts in terms of operational noise are expected. This should not be interpreted to mean that operational noise would be inaudible (or masked by background noise) under all conditions, but that the levels of noise are acceptable under ETSU-R-97 and associated guidance.

## Construction & Decommissioning

11.8.2 Noise and vibration during the construction and decommissioning of the Proposed Development may well be audible and/or perceptible to people residing in the area, but the levels would be below established noise limits and planning requirements in this respect due to the large distances between the site and the surrounding dwellings. Where construction noise relating to the provision of access to the site, including the upgrade of local roads and their use thereof, is expected to occur in close proximity to residences, enhanced mitigation measures would be adopted to reduce noise and vibration where necessary. The impacts resulting from blasting at ‘borrow pits’ are only considered in terms of the steps to limit any resulting impact through appropriate blast design and best practice, which also involves keeping residents informed as to planned blasting activities, with no significant impacts being expected.

## 11.9 Assessment of Cumulative Effects

### Operation

11.9.1 A further operational assessment has been undertaken which incorporates the predicted operational noise levels from the Proposed Development operating cumulatively with the existing Dunmaglass Wind Farm, Glen Kyllachy Wind Farm and Farr Wind Farm in addition to Aberarder Wind Farm, which is currently under construction. The assessment has been undertaken to demonstrate that it is possible to operate all of the sites considered here whilst maintaining compliance with the overall requirements of ETSU-R-97 and to determine relevant planning control limits for the Proposed Development.

11.9.2 Only the current operational and consented turbines have been considered in the cumulative assessment as detailed in the ‘Planned Acoustic Assessment at the Proposed Clune Wind Farm’ report (04707-7990135) sent to the EHO at Highland Council. The cumulative assessment does not consider any projects that are at the scoping stage, i.e. Highland Wind Farm (24/01107/SCOP) and Kyllachy Wind Farm (24/03494/SCOP) as they are in the earliest stages of planning. The assessment methodology was agreed with the EHO, post receipt of the Scoping Opinion as set out in **Table 11.1**.

11.9.3 **Table 11.14** shows the maximum predicted operational noise levels for any given wind direction resulting from the combined unrestricted operation of the developments at the nearest residential properties, using the methodology and assumptions described in Section 11.4, over a range of standardised 10m height wind speeds.

**Table 11.14: Overall Cumulative Predicted Operational Noise Levels, dB LA90**

Property ID	Standardised 10 height Wind Speed, m.s <sup>-1</sup>									
	3	4	5	6	7	8	9	10	11	12
H1	23.8	24.6	26.2	28.2	29.2	29.9	30.7	31.1	31.2	31.2
H2	19.7	20.6	23.5	26.7	27.9	28.3	28.8	29.1	29.2	29.2
H3	25.4	26.5	28.3	30.6	31.7	32.2	32.9	33.3	33.4	33.4
H4	25.6	26.6	28.2	30.0	31.0	31.6	32.5	32.9	33.0	33.0
H5	25.6	26.6	28.1	30.0	31.0	31.6	32.5	32.9	33.0	33.0
H6	25.6	26.6	28.1	30.0	31.0	31.6	32.5	32.9	33.0	33.0
H7	26.5	27.5	29.0	31.1	32.2	32.8	33.5	33.9	34.0	34.0
H8	26.7	27.6	29.2	31.3	32.4	33.0	33.7	34.1	34.2	34.2
H9	26.2	27.1	28.7	30.7	31.7	32.3	33.1	33.6	33.6	33.6
H10	18.8	19.6	21.9	24.7	25.9	26.3	26.9	27.3	27.4	27.4
H11	18.8	19.6	21.9	24.7	25.9	26.3	26.9	27.3	27.4	27.4
H12	18.7	19.6	21.9	24.6	25.8	26.3	26.9	27.3	27.3	27.3
H13	18.8	19.6	21.9	24.6	25.8	26.3	26.9	27.3	27.4	27.4
H14	18.7	19.5	21.8	24.5	25.7	26.2	26.8	27.2	27.2	27.2
H15	27.2	28.1	29.4	31.2	32.3	32.9	33.7	34.1	34.2	34.2
H16	26.7	27.7	29.1	31.0	32.0	32.6	33.3	33.7	33.8	33.8
H17	18.8	19.6	21.7	24.3	25.5	26.0	26.6	27.0	27.1	27.1
H18	18.8	19.6	21.7	24.3	25.5	26.0	26.6	27.0	27.1	27.1
H19	27.0	28.0	29.4	31.1	32.1	32.7	33.5	33.9	34.0	34.0
H20	26.8	27.7	29.0	30.8	31.9	32.5	33.2	33.7	33.7	33.7
H21	25.1	26.3	28.8	31.6	32.8	33.2	33.8	34.1	34.2	34.2
H22	24.8	25.7	28.0	30.8	32.1	32.4	32.9	33.3	33.4	33.4
H23	25.0	25.9	27.8	30.2	31.5	31.9	32.6	33.0	33.0	33.0
H24	24.9	25.8	27.7	30.2	31.5	31.9	32.5	32.9	33.0	33.0
H25	25.5	26.4	27.7	29.8	31.0	31.4	32.2	32.6	32.7	32.7
H26	24.2	25.2	27.5	30.2	31.3	31.8	32.4	32.8	32.9	32.9

Property ID	Standardised 10 height Wind Speed, m.s <sup>-1</sup>									
	3	4	5	6	7	8	9	10	11	12
H27	24.2	25.1	27.4	30.0	31.2	31.7	32.2	32.6	32.7	32.7
H28	24.2	25.2	27.4	30.0	31.1	31.6	32.2	32.6	32.7	32.7
H29	23.7	24.6	26.9	29.6	30.8	31.3	31.9	32.2	32.3	32.3
H30	23.5	24.5	26.7	29.4	30.6	31.1	31.6	32.0	32.1	32.1
H31	24.0	24.7	26.6	28.9	30.1	30.6	31.3	31.7	31.8	31.8
H32	23.7	24.5	26.5	28.9	30.0	30.6	31.2	31.6	31.7	31.7
H33	23.8	24.8	26.8	29.1	30.3	30.8	31.5	31.9	31.9	31.9
H34	22.9	23.7	25.3	27.4	28.4	29.1	29.9	30.3	30.3	30.3
H35	21.9	22.7	24.4	26.5	27.6	28.2	29.0	29.4	29.4	29.4
H36	22.5	23.2	24.8	26.8	27.9	28.6	29.4	29.8	29.9	29.9
H37	22.7	23.5	25.1	27.1	28.2	28.8	29.6	30.1	30.1	30.1
H38	17.6	18.6	21.4	24.6	25.9	26.3	26.7	27.1	27.2	27.2
H39	18.3	19.3	22.2	25.5	26.8	27.2	27.6	28.0	28.1	28.1
H40	23.1	24.0	25.9	28.2	29.3	29.8	30.5	31.0	31.0	31.0
H41	24.8	25.8	27.9	30.5	31.6	32.1	32.7	33.1	33.2	33.2
H42	24.5	25.4	27.5	29.9	31.1	31.6	32.2	32.6	32.7	32.7
H43	23.5	24.4	26.2	28.5	29.6	30.2	30.9	31.3	31.4	31.4
H44	25.0	26.1	28.3	30.9	32.0	32.5	33.1	33.5	33.6	33.6

Property ID	Standardised 10 height Wind Speed, m.s <sup>-1</sup>									
	3	4	5	6	7	8	9	10	11	12
H7	-9.9	-8.9	-7.4	-5.7	-5.3	-5.7	-6.3	-7.3	-7.9	-7.9
H8	-9.7	-8.8	-7.2	-5.5	-5.1	-5.5	-6.1	-7.1	-7.7	-7.7
H9	-10.2	-9.3	-7.7	-6.1	-5.8	-6.2	-6.7	-7.6	-8.3	-8.3
H10	-17.6	-16.8	-14.5	-12.1	-11.6	-12.2	-12.9	-13.9	-14.5	-14.5
H11	-17.6	-16.8	-14.5	-12.1	-11.6	-12.2	-12.9	-13.9	-14.5	-14.5
H12	-17.7	-16.8	-14.5	-12.2	-11.7	-12.2	-12.9	-13.9	-14.6	-14.6
H13	-17.6	-16.8	-14.5	-12.2	-11.7	-12.2	-12.9	-13.9	-14.5	-14.5
H14	-17.7	-16.9	-14.6	-12.3	-11.8	-12.3	-13.0	-14.0	-14.7	-14.7
H15	-9.2	-8.3	-7.0	-5.6	-5.2	-5.6	-6.1	-7.1	-7.7	-7.7
H16	-9.7	-8.7	-7.3	-5.8	-5.5	-5.9	-6.5	-7.5	-8.1	-8.1
H17	-17.6	-16.8	-14.7	-12.5	-12.0	-12.5	-13.2	-14.2	-14.8	-14.8
H18	-17.6	-16.8	-14.7	-12.5	-12.0	-12.5	-13.2	-14.2	-14.8	-14.8
H19	-9.4	-8.4	-7.0	-5.7	-5.4	-5.8	-6.3	-7.3	-7.9	-7.9
H20	-9.6	-8.7	-7.4	-6.0	-5.6	-6.0	-6.6	-7.5	-8.2	-8.2
H21	-9.9	-8.7	-6.2	-3.4	-4.6	-6.5	-7.8	-8.5	-8.6	-8.6
H22	-10.2	-9.3	-7.0	-4.2	-5.3	-7.3	-8.7	-9.3	-9.4	-9.4
H23	-10.0	-9.1	-7.2	-4.8	-5.9	-7.8	-9.0	-9.6	-9.8	-9.8
H24	-10.1	-9.2	-7.3	-4.8	-5.9	-7.8	-9.1	-9.7	-9.8	-9.8
H25	-9.5	-8.6	-7.3	-5.2	-6.4	-8.3	-9.4	-10.0	-10.1	-10.1
H26	-10.8	-9.8	-7.5	-4.8	-6.1	-7.9	-9.2	-9.8	-9.9	-9.9
H27	-10.8	-9.9	-7.6	-5.0	-6.2	-8.0	-9.4	-10.0	-10.1	-10.1
H28	-10.8	-9.8	-7.6	-5.0	-6.3	-8.1	-9.4	-10.0	-10.1	-10.1
H29	-11.3	-10.4	-8.1	-5.4	-6.6	-8.4	-9.7	-10.4	-10.5	-10.5
H30	-11.5	-10.5	-8.3	-5.6	-6.8	-8.6	-10.0	-10.6	-10.7	-10.7
H31	-11.0	-10.3	-8.4	-6.1	-7.3	-9.1	-10.3	-10.9	-11.0	-11.0
H32	-11.3	-10.5	-8.5	-6.1	-7.4	-9.1	-10.4	-11.0	-11.1	-11.1
H33	-11.2	-10.2	-8.2	-5.9	-7.1	-8.9	-10.1	-10.7	-10.9	-10.9
H34	-12.1	-11.3	-9.7	-7.6	-9.0	-10.6	-11.7	-12.3	-12.5	-12.5
H35	-13.1	-12.3	-10.6	-8.5	-9.8	-11.5	-12.6	-13.2	-13.4	-13.4
H36	-12.5	-11.8	-10.2	-8.2	-9.5	-11.1	-12.2	-12.8	-12.9	-12.9
H37	-12.3	-11.5	-9.9	-7.9	-9.2	-10.9	-12.0	-12.5	-12.7	-12.7
H38	-17.4	-16.4	-13.6	-10.4	-11.5	-13.4	-14.9	-15.5	-15.6	-15.6
H39	-16.7	-15.7	-12.8	-9.5	-10.6	-12.5	-14.0	-14.6	-14.7	-14.7
H40	-11.9	-11.0	-9.1	-6.8	-8.1	-9.9	-11.1	-11.6	-11.8	-11.8

11.9.4 Table 11.15 shows the daytime and night-time margins by which the predicted operational noise levels resulting from the combined operation of the Proposed Development with the existing Dunmaglass Wind Farm, Glen Kyllachy Wind Farm, Farr Wind Farm and the under construction Aberarder Wind Farm meets the noise limits set out in Table 11.12. A negative number indicates that levels are below the relevant limits.

Table 11.15: Cumulative Margin of Compliance, dB

Property ID	Standardised 10 height Wind Speed, m.s <sup>-1</sup>									
	3	4	5	6	7	8	9	10	11	12
Daytime										
H1	-12.6	-11.8	-10.2	-8.6	-8.3	-8.6	-9.1	-10.1	-10.7	-10.7
H2	-16.7	-15.8	-12.9	-10.1	-9.6	-10.2	-11.0	-12.1	-12.7	-12.7
H3	-11.0	-9.9	-8.1	-6.2	-5.8	-6.3	-6.9	-7.9	-8.5	-8.5
H4	-10.8	-9.8	-8.2	-6.8	-6.5	-6.9	-7.3	-8.3	-8.9	-8.9
H5	-10.8	-9.8	-8.3	-6.8	-6.5	-6.9	-7.3	-8.3	-8.9	-8.9
H6	-10.8	-9.8	-8.3	-6.8	-6.5	-6.9	-7.3	-8.3	-8.9	-8.9

Property ID	Standardised 10 height Wind Speed, m.s <sup>-1</sup>									
	3	4	5	6	7	8	9	10	11	12
H41	-10.2	-9.2	-7.1	-4.5	-5.8	-7.6	-8.9	-9.5	-9.6	-9.6
H42	-10.5	-9.6	-7.5	-5.1	-6.3	-8.1	-9.4	-10.0	-10.1	-10.1
H43	-11.5	-10.6	-8.8	-6.5	-7.8	-9.5	-10.7	-11.3	-11.4	-11.4
H44	-10.0	-8.9	-6.7	-4.1	-5.4	-7.2	-8.5	-9.1	-9.2	-9.2
Night-time										
H1	-14.2	-13.4	-11.8	-9.8	-8.8	-8.1	-7.3	-6.9	-7.2	-8.2
H2	-18.3	-17.4	-14.5	-11.3	-10.1	-9.7	-9.2	-8.9	-9.2	-10.2
H3	-12.6	-11.5	-9.7	-7.4	-6.3	-5.8	-5.1	-4.7	-5.0	-6.0
H4	-12.4	-11.4	-9.8	-8.0	-7.0	-6.4	-5.5	-5.1	-5.4	-6.4
H5	-12.4	-11.4	-9.9	-8.0	-7.0	-6.4	-5.5	-5.1	-5.4	-6.4
H6	-12.4	-11.4	-9.9	-8.0	-7.0	-6.4	-5.5	-5.1	-5.4	-6.4
H7	-11.5	-10.5	-9.0	-6.9	-5.8	-5.2	-4.5	-4.1	-4.4	-5.4
H8	-11.3	-10.4	-8.8	-6.7	-5.6	-5.0	-4.3	-3.9	-4.2	-5.2
H9	-11.8	-10.9	-9.3	-7.3	-6.3	-5.7	-4.9	-4.4	-4.8	-5.8
H10	-19.2	-18.4	-16.1	-13.3	-12.1	-11.7	-11.1	-10.7	-11.0	-12.0
H11	-19.2	-18.4	-16.1	-13.3	-12.1	-11.7	-11.1	-10.7	-11.0	-12.0
H12	-19.3	-18.4	-16.1	-13.4	-12.2	-11.7	-11.1	-10.7	-11.1	-12.1
H13	-19.2	-18.4	-16.1	-13.4	-12.2	-11.7	-11.1	-10.7	-11.0	-12.0
H14	-19.3	-18.5	-16.2	-13.5	-12.3	-11.8	-11.2	-10.8	-11.2	-12.2
H15	-10.8	-9.9	-8.6	-6.8	-5.7	-5.1	-4.3	-3.9	-4.2	-5.2
H16	-11.3	-10.3	-8.9	-7.0	-6.0	-5.4	-4.7	-4.3	-4.6	-5.6
H17	-19.2	-18.4	-16.3	-13.7	-12.5	-12.0	-11.4	-11.0	-11.3	-12.3
H18	-19.2	-18.4	-16.3	-13.7	-12.5	-12.0	-11.4	-11.0	-11.3	-12.3
H19	-11.0	-10.0	-8.6	-6.9	-5.9	-5.3	-4.5	-4.1	-4.4	-5.4
H20	-11.2	-10.3	-9.0	-7.2	-6.1	-5.5	-4.8	-4.3	-4.7	-5.7
H21	-12.9	-11.7	-9.2	-6.4	-5.2	-4.8	-4.2	-3.9	-6.0	-7.4
H22	-13.2	-12.3	-10.0	-7.2	-5.9	-5.6	-5.1	-4.7	-6.8	-8.2
H23	-13.0	-12.1	-10.2	-7.8	-6.5	-6.1	-5.4	-5.0	-7.2	-8.6
H24	-13.1	-12.2	-10.3	-7.8	-6.5	-6.1	-5.5	-5.1	-7.2	-8.6
H25	-12.5	-11.6	-10.3	-8.2	-7.0	-6.6	-5.8	-5.4	-7.5	-8.9
H26	-13.8	-12.8	-10.5	-7.8	-6.7	-6.2	-5.6	-5.2	-7.3	-8.7
H27	-13.8	-12.9	-10.6	-8.0	-6.8	-6.3	-5.8	-5.4	-7.5	-8.9
H28	-13.8	-12.8	-10.6	-8.0	-6.9	-6.4	-5.8	-5.4	-7.5	-8.9

Property ID	Standardised 10 height Wind Speed, m.s <sup>-1</sup>									
	3	4	5	6	7	8	9	10	11	12
H29	-14.3	-13.4	-11.1	-8.4	-7.2	-6.7	-6.1	-5.8	-7.9	-9.3
H30	-14.5	-13.5	-11.3	-8.6	-7.4	-6.9	-6.4	-6.0	-8.1	-9.5
H31	-14.0	-13.3	-11.4	-9.1	-7.9	-7.4	-6.7	-6.3	-8.4	-9.8
H32	-14.3	-13.5	-11.5	-9.1	-8.0	-7.4	-6.8	-6.4	-8.5	-9.9
H33	-14.2	-13.2	-11.2	-8.9	-7.7	-7.2	-6.5	-6.1	-8.3	-9.7
H34	-15.1	-14.3	-12.7	-10.6	-9.6	-8.9	-8.1	-7.7	-9.9	-11.3
H35	-16.1	-15.3	-13.6	-11.5	-10.4	-9.8	-9.0	-8.6	-10.8	-12.2
H36	-15.5	-14.8	-13.2	-11.2	-10.1	-9.4	-8.6	-8.2	-10.3	-11.7
H37	-15.3	-14.5	-12.9	-10.9	-9.8	-9.2	-8.4	-7.9	-10.1	-11.5
H38	-20.4	-19.4	-16.6	-13.4	-12.1	-11.7	-11.3	-10.9	-13.0	-14.4
H39	-19.7	-18.7	-15.8	-12.5	-11.2	-10.8	-10.4	-10.0	-12.1	-13.5
H40	-14.9	-14.0	-12.1	-9.8	-8.7	-8.2	-7.5	-7.0	-9.2	-10.6
H41	-13.2	-12.2	-10.1	-7.5	-6.4	-5.9	-5.3	-4.9	-7.0	-8.4
H42	-13.5	-12.6	-10.5	-8.1	-6.9	-6.4	-5.8	-5.4	-7.5	-8.9
H43	-14.5	-13.6	-11.8	-9.5	-8.4	-7.8	-7.1	-6.7	-8.8	-10.2
H44	-13.0	-11.9	-9.7	-7.1	-6.0	-5.5	-4.9	-4.5	-6.6	-8.0

11.9.5 The cumulative noise levels at all residential properties are below the daytime and night-time noise limits at all wind speeds considered. The minimum margin of the predicted noise level below the derived noise limits during the daytime period is -3.4dB at H21 Easter Strathnoon. Similarly, the minimum margin during night-time periods is -3.9dB at H8 Dalmigavie House, H15 Glen Kyllachy Lodge and H21 Easter Strathnoon. This is shown graphically in **Technical Appendix 11.4**.

11.9.6 The Environmental Health Officer (EHO) dealing with the Proposed Development has recommended that overall cumulative noise levels should not exceed suggested modified ETSU-R-97 limits, as defined in Section 11.5.5, which have been adopted here as an alternative basis of assessment, and that any conditioned noise limits for existing and consented wind farms should be taken into account in the cumulative assessment (i.e. assuming that existing sites may be operating at or near to conditioned values).

- 11.9.7 In this case, the Glen Kyllachy and Farr wind farms already have conditioned noise limits that are the same as those adopted for the overall cumulative noise assessment provided here. However, the predicted noise levels associated with these sites are substantially lower than the conditioned noise limits (by a minimum of 7dB) and, on this basis, it is considered unreasonable to assume that these sites would be operating at the levels conditioned by consent. It should be noted that the predicted noise levels will be conservative as 2 dB has been added to the specified levels for all turbine models as recommended by the IOA GPG. It should also be noted that some of the cumulative sites under consideration do not have noise limits associated with their consent documentation.
- 11.9.8 In consideration of the unlikely event that some of the existing wind farms were operating at their consented limits, this could effectively sterilize the area of any further development. However, even if the existing and under construction cumulative wind farms considered here had resultant levels 2-3dB higher than predicted here (i.e. over and above the 2dB uncertainty already applied in the assessment methodology), the overall limiting requirements would still be met. This provides further confidence in the assessment methodology outlined here.
- 11.9.9 Furthermore, the cumulative sites considered are already built or under construction and the source noise levels for the respective turbines are well known and well defined (i.e. there is limited ambiguity as to what could be installed in comparison to if these sites were at the planned/consented stage of development). As a result, the IOA GPG assumptions regarding uncertainty (i.e. the inclusion of a 2dB margin) are already considered to provide appropriately conservative basis of assessment.
- 11.9.10 The introduction of the Proposed Development will inevitably lead to an increase in the levels of exposure to sound associated with wind farm developments at locations neighbouring the site. However, as demonstrated above, overall expected operational levels are lower than the very minimum requirements of ETSU-R-97 and the limiting levels stipulated by THC. As a result, it is considered this aspect should not constitute a reason to decline planning consent on grounds of additional operational sound generated by the proposal.
- 11.9.11 The assessment shows that predicted cumulative/combined noise levels meet the modified ETSU-R-97 limiting requirements suggested by THC at all properties. Therefore, the operational noise levels resulting from the operation of the Proposed Development in combination with the existing Farr Wind Farm, Glen Kyllachy Wind Farm, Dunmaglass Wind Farm and the, under construction, Aberarder Wind Farm developments are considered not significant.
- 11.9.12 It is recommended that simplified fixed 35dB LA90 (daytime) and 38dB LA90 (night-time) limits, for all wind speeds, be applied as a condition of consent for the Proposed Development as the properties considered most sensitive to cumulative wind farm sound are located between the sites considered here and cannot be downwind of them all at the same time. The sites to the northwest or the southeast of the most sensitive properties will tend to have the dominant levels depending on the wind direction. This will allow for straightforward planning condition and assessment basis that protects residential amenity sufficiently in terms of the overall requirements ETSU-R-97, especially when existing background noise levels are taken into account in defining overall limits relating to planning acceptability (i.e. the background noise level + 5dB part of the ETSU-R-97 and THC suggested limits). This approach also allows for some flexibility in the actual turbine model to be procured and installed at the development site.
- 11.9.13 **Technical Appendix 11.5** contains a set of suggested planning conditions relating to operational sound that the Applicant considers appropriate.
- Construction & Decommissioning**
- 11.9.14 Noise due to the construction and decommissioning of the other wind farms considered in the cumulative operational noise assessment is unlikely to be present at the same time as the construction of the Proposed Development. However, if construction and decommissioning activities are undertaken concurrently this would generally amount to an increase in the frequency of traffic (including HGVs) entering the various sites and passing local residences as a result; and, a slight increase in the overall construction noise levels when building out the infrastructure at each site. As a result, a detailed assessment has not been undertaken and the effect is considered not significant provided that all usual controls and best practice is followed in terms of construction techniques.

## 11.10 Summary

- 11.10.1 The acoustic impact for the operation of the Proposed Development on nearby residential properties has been assessed in accordance with the guidance on wind farm noise as issued in the DTI publication 'The Assessment and Rating of Noise from Wind Farms', otherwise known as ETSU-R-97, and Institute of Acoustics Good Practice Guide (IOA GPG), as recommended for use by relevant planning policy.

- 11.10.2 The results of background noise surveys conducted in support of other wind farm development in the area have been used to determine appropriate overall noise limits for the Proposed Development and the neighbouring planning, consented, and operational wind farm sites, as required by ETSU-R-97 and the IOA GPG.
- 11.10.3 Operational noise levels were predicted using an appropriate propagation model, incorporating the proposed turbine locations, terrain data, and applicable turbine emission information. The resultant predicted noise levels are below noise limits derived in accordance with ETSU-R-97, which have been further adapted to take into account THC recommendations, at all properties and at all considered wind speeds when the Proposed Development is considered on its own.
- 11.10.4 A cumulative operational noise assessment was completed to determine the potential impact of the Proposed Development at the same time as three existing operational schemes and one development under construction located nearby. The cumulative predicted operational noise levels at all residential properties are also below both the daytime and night-time noise limits recommended by THC at all wind speeds considered.
- 11.10.5 If the existing, planned, consented and under construction cumulative wind farms considered here had resultant levels 3dB higher than assumed here, the overall requirements of ETSU-R-97 would still be met. This provides further confidence in the proposed assessment methodology outlined within this assessment.
- 11.10.6 It is recommended that simplified fixed 35dB  $L_{A90}$  (daytime) and 38dB  $L_{A90}$  (night-time) limits for the Proposed Development alone be applied as a condition of consent.
- 11.10.7 Noise associated with construction and decommissioning has been discussed with reference to BS 5228 and it has been determined that onsite construction noise levels are highly unlikely to exceed typical limiting noise criteria at nearby properties although appropriate mitigation measures will be adopted as a matter of due course. The access route for the proposed wind farm is expected to pass reasonably close to some dwellings and with some upgrade works to existing access tracks and local roads potentially occurring in close proximity to some dwellings. In these instances, the level of noise generated by construction works could be close to typical limits for relatively brief periods. As a result, typical and enhanced construction noise mitigation measures are provided in the Mitigation section which aim to minimise noise as far as reasonably practicable and/or reasonable.
- 11.10.8 The potential impact of the Proposed Development, along with the mitigation proposed and any residual impact, is summarised in **Table 11.16**.

**Table 11.16: Summary of Potential Impacts, Mitigation and Residual Impacts**

Potential Impact	Mitigation Proposed	Means of Implementation	Outcome/ Residual Effect
Operation			
Potential impact on residential amenity due to operational noise	The Proposed Development operating in isolation and cumulatively with other existing operational and proposed wind farm developments meet the limiting requirements of ETSU-R-97. As a result, no mitigation is required.	Not applicable	Not significant
Construction & Decommissioning			
Potential noise from Proposed Development decommissioning activities	<p>Due regard for ‘best practicable means’ (defined by Section 72 of the Control of Pollution Act 1974).</p> <p>A range of noise mitigation measures are proposed for the construction phase in accordance with measures outlined in BS 5228-1:2009.</p> <p>Site operations to be limited to 07:00-19:00 Monday to Saturday (except during wind turbine delivery/erection and commissioning/periods of emergency work).</p> <p>Good practice on blasting shall be followed along with guidance on blast frequency and timing.</p>	Noise mitigation measures would be implemented as part of the CEMP which would be required to be agreed as a condition of consent.	Not significant