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GLANLLYNFI GARTH WIND FARM

Draft Environmental Statement

Appendix 13D - Operational Wind Turbine Noise

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Contents

1. Operational Wind Turbine Noise

1.1 Modelling and Prediction

1.1.1 Operational wind turbine noise levels have been predicted using ISO 9613-2:2024[1], incorporating the additional recommendations set out in the Institute of Acoustics Good Practice Guidance (IOA GPG)[2] regarding sound propagation across valleys and limiting the attenuation attributable to topographic and barrier screening to a maximum of 2 dB.

1.1.2 The calculation method is used to determine the sound pressure level at the point of interest under downwind conditions. Whilst the IOA GPG includes an additional method to take account of wind direction (e.g. under upwind or side conditions), this has not been applied in this assessment so the resulting noise levels can be considered worst case, assuming downwind propagation of noise from all wind turbines even in a situation where there are wind turbines in opposite directions of a receiver.

1.1.3 The ISO 9613-2 prediction method determines the sound pressure level at the point of interest (receiver) based on the sound power level of the source and considering the effects of directivity, geometric divergence, atmospheric absorption, ground absorption, barrier attenuation and other miscellaneous factors. The following equation is applied:

Predicted Octave Band Sound Pressure Level = $L_W + D_c - A_{div} - A_{atm} - A_{gr} - A_{bar} - A_{misc}$

1.1.4 Each of the above terms are considered in more detail below.

1.1.5 Where there are multiple noise sources affecting the resulting noise level, the equation can be applied numerous times (once for each source), with the results combined to determine the final all-encompassing sound pressure level.

1.1.6 A detailed three-dimensional noise model has been generated for the Proposed Development and surrounding area within the CadnaA noise modelling suite. The model has been set to apply the ISO 9613-2:2024 calculation method with the following settings made to ensure compliance with the IOA GPG:

- ground absorption: G=0.5;
- receptor height: 4 m;
- a correction from $L_{Aeq,T}$ to $L_{A90,T}$ of -2 decibel (dB) was applied;
- temperature: 10°C; and
- humidity: 70%.

1.1.7 Within the noise model, each wind turbine forming part of the Proposed Development, and those forming the identified cumulative developments, were represented as individual, geographically located point sources. The point source heights were raised above ground to hub height, as required by the IOA GPG.

[1] International Organisation for Standardisation (ISO). (2024). ISO 9613-2:2024 - Acoustics — Attenuation of sound during propagation outdoors. Part 2: Engineering method for the prediction of sound pressure levels outdoors.
[2] Institute of Acoustics (2013). A Good Practice Guide to the Application Of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise. [online]. Including Supplementary Guidance Notes 1 to 6. Available at: https://www.ioa.org.uk/publications/wind-turbine-noise [Accessed 22 June 2026].

L_w – Sound Power Level

1.1.8 This is the octave band sound power level, in decibels, produced by the sound source (in this case the wind turbine), relative to a reference sound power of one picowatt (1pW).

1.1.9 Manufacturers sound power level data have been applied for each of the wind turbines modelled, with the source set at hub height. In accordance with the IOA GPG, checks have been carried out to determine whether appropriate corrections for uncertainty have been included within the adopted data. In accordance with the IOA GPG, and to maintain a worst-case approach, an appropriate uncertainty correction (e.g. +2 dB) will be applied to the modelled cumulative noise levels once the data has been reviewed.

1.1.10 In some cases, manufacturers data is referenced to standardised 10 m height wind speed as required for compliance with the IOA GPG. In other cases, data are referenced to hub height windspeed, in which case the data are corrected to standardised 10 m height through the application of the hub height to 10 m correction detailed in **Section 1.2** below.

1.1.11 The sound power level data adopted for the wind turbines in the Proposed Development and the identified cumulative developments are tabulated / listed in the main body of the **Chapter 13: Noise**.

D_c – Directivity

1.1.12 This is the directivity correction, in decibels, describing the extent to which the level from the source deviates depending upon the direction. In this case, the calculation assumes that the source is omnidirectional, i.e. sound is generated equally in all directions.

A_{div} – Geometric Divergence Attenuation

1.1.13 As sound propagates from the source, the energy disperses resulting in sound levels reducing relative to distance. Sound from point sources, such as wind turbines, propagates under the inverse square law (spherical spreading), reducing by 6dB per doubling of distance.

A_{atm} – Atmospheric Attenuation

1.1.14 This is the attenuation of sound, in decibels, due to energy absorption in the atmosphere. It is dependent upon both the temperature and the relative humidity. The selection of 10°C temperature and 70% relative humidity within the noise model ensures appropriate corrections are applied in the calculation in accordance with the IOA GPG.

A_{gr} – Ground Attenuation

1.1.15 This is the attenuation of sound, in decibels, due to ground effects. This is taken into account through the application of a ground factor (G), representative of whether the ground is acoustically soft (absorbent) or acoustically hard (reflective). The selection of G=0.5 within the noise model, in conjunction with a receiver height of four metres (m), ensures appropriate corrections are applied in the calculation in accordance with the IOA GPG.

A_{bar} – Barrier Attenuation

1.1.16 This is the attenuation of sound, in decibels, due to barriers, for example that which could arise because of a building or landform between the source and the receiver position. The level of attenuation afforded is dependent upon a number of factors including the geometric relationship between the source and the receiver and the degree to which the barrier obscures the line of sight between the two. The ISO 9613-2 calculation method can apply large degrees of screening attenuation (e.g. 10 dB and greater) which have been found to be significantly greater than those measured for wind turbines noise under downwind conditions. The IOA GPG therefore advises that, unless there is reasoned justification, the barrier attenuation should be capped at 2 dB, with this level only applied where the barrier (e.g. topography) fully obscures the line of sight between the receiver and the wind turbine tip height.

1.1.17 The noise model outputs have therefore been calculated such that the full ISO 9613-2 barrier attenuations are not applied, instead being capped at a maximum 2 dB, and reduced to 0 dB where if there is any of sight to the wind turbine tip height.

A_{misc} – Miscellaneous Attenuations

1.1.18 This is the attenuation of sound, in decibels, due to other miscellaneous effects, such as propagation through foliage, industrial sites or built-up regions of housing. No such miscellaneous attenuations have been included in the completed calculations.

Concave Ground Profiles

1.1.19 The IOA GPG advises that a correction of +3 dB (or +1.5 dB if using G=0.0) should be added to the calculated receiver noise level for scenarios where there is propagation across a valley, i.e. a concave ground profile, or where the ground falls away significantly between the source and receiver location. This is to account for the possible effect of ground reflections focussing at the receiver.

1.1.20 The +3 dB correction is applied where the mean height above ground of the direct line of sight from the receiver to the source is greater than, or equal to, half of the absolute height difference between the source and receiver.

1.1.21 The model outputs have been calculated such that this +3 dB is applied in all cases where this test is met.

1.2 Wind Shear Correction

1.2.1 The IOA GPG advises that the standard procedure should be to reference noise measurement data to standardised 10 metres (m) height wind speed. The standardised 10 m wind speed is obtained from the wind turbine hub height wind speed correcting it to 10 m height using a ground roughness factor of 0.05 m.

1.2.2 Two different methods of determining hub height wind speed are detailed. The first is to measure directly at hub height with use of a hub height anemometer, or a LiDAR or SODAR system. The second method is to use wind speed measurements at two different heights below hub height, from which wind shear (rate of change of wind speed with height) can be determined and hub height wind speed subsequently deduced.

1.2.3 The shear exponent for each 10-minute measurement period is deduced using the following equation:

$$m = \left(\frac{Log\left({}^{u_1}/_{u_2}\right)}{Log\left({}^{h_1}/_{h_2}\right)}\right)$$

where:

m = wind shear exponent

u_1 = wind speed measurement at the lower height

u_2 = wind speed measurement at the higher height

h_1 = height of the lower wind speed measurement

h_2 = height of the upper wind speed measurement

1.2.4 The equation is rearranged as follows:

$$u_1 = u_2 \times \left(\frac{h_2}{h_1}\right)^m$$

1.2.5 This equation is used to calculate the hub height wind speed, except for periods where a negative shear is determined, in which case the hub height wind speed is assumed to equal the upper measured wind speed.

1.2.6 The hub height wind speed is then corrected to 10 m using the following equation (roughness length shear profile).

$$u_{10} = u_{hh} \times \left(\frac{Log\left({}^{10}/_{z_0}\right)}{Log\left({}^{hh}/_{z_0}\right)}\right)$$

where:

u_{10} = standardised 10 m height wind speed

u_{hh} = hub height wind speed

z_0 = standard ground roughness length of 0.05 m

hh = hub height

1.3 Baseline Noise Survey

1.3.1 The baseline noise survey is currently being prepared and will be detailed in this Appendix for the final ES.

1.3.2 This Appendix will present the detail of the adopted measurement locations, the measurement equipment deployed, the measurement periods, the equipment calibration details and the contemporaneous notes made for each measurement location.

1.4 Baseline Noise Conditions

1.4.1 The baseline noise conditions appendix will be completed following the completion of the baseline noise survey.

1.4.2 This Appendix will present graphs detailing the analysis results for the baseline measurement data obtained at each measurement location. Separate graphs will be presented for quiet daytime and night-time periods. Each graph will include the applied polynomial lines of best fit through the retained data appoints, which represents the relationship between background sound levels and wind speed.

1.5 Modelled Receptor Noise Levels

1.5.1 Noise levels from operation of the Proposed Development and cumulative wind farm developments will be predicted at noise-sensitive receptors using the methodology presented in **Section 1.1.** Predictions will be undertaken for downwind propagation conditions, with all wind speeds referenced to a 10m height (standardised u_{10}) in m/s.

Predicted receptor noise levels – Proposed Development

1.5.2 This section will present unmitigated modelled noise level results for the Proposed Development. If required, a separate appendix presenting mitigated noise levels will be included in the Final ES, where this is found to be necessary to comply with the derived Site-Specific Noise Limits (SSNLs).

Predicted receptor noise levels – Cumulative Developments

1.5.3 This section will present modelled noise level results for the cumulative developments scoped in for consideration in the assessment.

1.6 Noise Limits

1.6.1 The noise limits appendix will be completed following the completion of the baseline noise survey.

1.6.2 This appendix will present the calculated daytime and night-time Total Noise Assessment Criteria (TNAC) for each measurement location. These limits will be derived based on the background noise levels and their relationship with wind speed, to be presented in **Section 1.4**.

1.7 Cumulative Wind Turbine Noise Assessment

1.7.1 The cumulative noise assessment is currently being prepared.

1.7.2 This appendix will present cumulative turbine noise assessment graphs, with separate daytime and night-time plots for each measurement location. Each graph will present the relevant TNACs and calculated cumulative turbine noise levels at each sample receptor position where the limit applies. This format enables a simple visual evaluation of whether the cumulative noise levels comply with or exceed the applicable limits.

1.7.3 If any exceedances of the cumulative noise level limits are identified, additional appendices will be provided to examine whether these exceedances are attributable to the Proposed Development or to other cumulative developments.

1.7.4 Additional appendices will also be provided to present the predicted noise levels and assessment outcomes under mitigation scenarios. Where necessary, these will demonstrate whether noise from the Proposed Development can be appropriately controlled to prevent any cumulative exceedance of the applicable noise limits.

1.7.5 The assessment will include determination of SSNLs for the Proposed Development, compliance with these would ensure that the Proposed Development would not give rise to a cumulative exceedance of the TNACs.