Appendix 9.2

Noise Modelling and Prediction

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9 Noise Modelling and Prediction

9.1 Modelling and Prediction Method

9.1.1 Method Description

1. In accordance with the Institute of Acoustics: *A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise* (IoA GPG), operational wind turbine noise levels have been determined through application of the ISO 9613-2: *Acoustics – Attenuation of sound during propagation outdoors* calculation methodology, also including for the additional recommendations that the IoA GPG makes with respect to propagation across a valley and the limitations afforded by topographic/barrier screening.

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.

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 taking into account the effects of directivity, geometric divergence, atmospheric absorption, ground absorption, barrier attenuation and other miscellaneous factors. The following equation is applied:

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

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

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.

6. A detailed three-dimensional noise model has been generated for the Site and surrounding area within the CadnaA® noise modelling suite. The model has been set to apply the ISO 9613-2 calculation method with the following setting made to ensure compliance with the IoA GPG:

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

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.

9.1.2 L_w – Sound Power Level

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).

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 each case, to ensure a worst case approach, and in accordance with the IoA GPG, a +2dB uncertainty correction has been applied to the modelled data.

10. In some cases the manufacturers data is referenced to standardised 10m height wind speed as required for compliance with the IoA GPG. Where data was referenced to hub height windspeed, this has been corrected to standardised 10m height through the application of the hub height to 10m correction detailed in **Appendix 9.3 Wind Shear Correction**.

11. The sound power level data adopted for the wind turbines in the Proposed Development and the identified cumulative developments are tabulated in the main body of the **Chapter 9: Noise** of the EIAR.

9.1.3 D_c – Directivity

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.

9.1.4 A_{div} – Geometric Divergence Attenuation

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.

9.1.5 A_{atm} – Atmospheric Attenuation

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.

9.1.6 A_{gr} – Ground Attenuation

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.

9.1.7 Abar – Barrier Attenuation

16. This is the attenuation of sound, in decibels, due to barriers, for example that which could arise as a result 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 can account for large degrees of screening attenuation (e.g. 10dB 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 2dB, 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.

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

9.1.8 A_{misc} – Miscellaneous Attenuations

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.

9.1.9 Concave Ground Profiles

19. The IoA GPG advises that a correction of +3dB (or +1.5dB 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.

20. The +3dB 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.

21. Therefore, the model outputs have been adjusted such that this +3dB is applied in all cases where this test is met.

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