Annex F – Wind Speed Calculations

F.1 The IOA GPG[64] requires that noise data recorded every 10 minutes are related to standardised ten metre wind speeds experienced at the hub height of the turbines, at a location on the wind farm representative of the wind farm. These wind speeds can be either measured directly at the turbine hub height or derived by calculation from measurements at two heights, with measurements at the upper height not less than 60% of the turbine hub height and measurements at least 15 metres below that. These are referred to as 'Method A' or 'Method B' in the IOA GPG which describes these as the preferred methods to use. IOA GPG SGN4[65] provides additional guidance on these methods.

F.2 The site of the Proposed Development has a temporary LIDAR remote sensing measuring system installed which measured wind conditions at various heights, the data used for wind shear calculation were as follows:

- 129 metre wind speed
- 129 metre wind direction
- 89 metre wind speed
- 89 metre wind direction

F.3 These measurement heights meet the requirements of the IOA GPG: the upper measurement height being at least 60% of the proposed candidate hub height of 134 metres (m) and the 89 m height anemometer being at least 15 m lower than the upper measurement. The LIDAR meets the accuracy and calibration requirements of the IOA GPG.

F.4 Wind speed data were used to perform a calculation of the shear exponent found between the two wind speed measurement heights for every ten-minute period, by using Equation 3 of IOA GPG SGN4. Where wind speeds were the same at both heights or lower at greater height, the shear exponent was assumed to be zero. The shear exponent so calculated for every ten-minute period was then used to calculate the hub height wind speed using Equation 2 of SGN4 for each ten-minute period. Equation 1 of SGN4 was then used to calculate a standardised ten-metre height wind speed from the hub height wind speed every ten minutes assuming the reference roughness length of 0.05 metres.

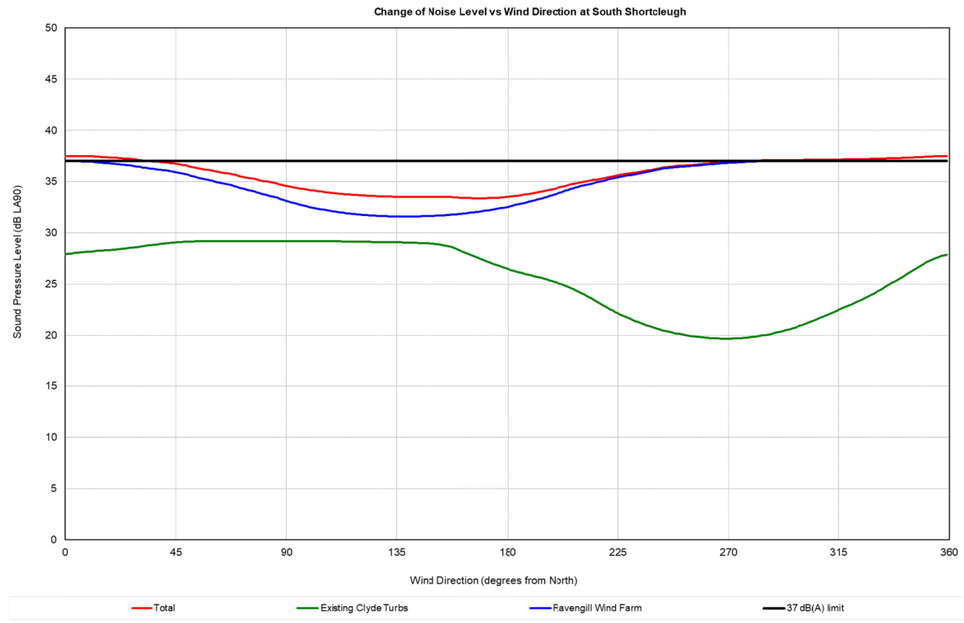
F.5 Wind speeds are standardised to a height of ten metres assuming a reference ground roughness length of 0.05 metres as described in the IOA GPG. This approach is of the same form as that given in BS EN 61400-11:2003[66] for calculating ten metre wind speeds related to hub height wind speeds when providing source noise emission data for wind turbines.

F.6 By using this method, measured background noise levels were correlated to ten metre wind speeds calculated from wind speeds at hub height. Any likely difference in the shear profile during the 24 hours of the day will be accounted for within the method and be reflected in the resulting standardised ten metre wind speed data. The method used to calculate ten metre wind speeds from those at hub height is the same as that used when deriving noise emission data for the turbines. Because the same method has been used, direct comparison of background noise levels, noise limits and predicted turbine noise immission levels may be undertaken. This method is consistent with guidance published in the IOA GPG.

64 A Good Practice Guide to the Application of ETSU R 97 for the Assessment and Rating of Wind Turbine Noise, M. Cand, R. Davis, C. Jordan, M. Hayes, R. Perkins, Institute of Acoustics, May 2013.
65 A Good Practice Guide to the Application of ETSU R 97 for the Assessment and Rating of Wind Turbine Noise - Supplementary Guidance Note 4: Wind Shear, M. Cand, R. Davis, C. Jordan, M. Hayes, R. Perkins, Institute of Acoustics, July 2014.
66 IEC 61400 11:2003 Wind turbine generator systems - Part 11: Acoustic noise measurement techniques.

Annex G – Directional Predictions

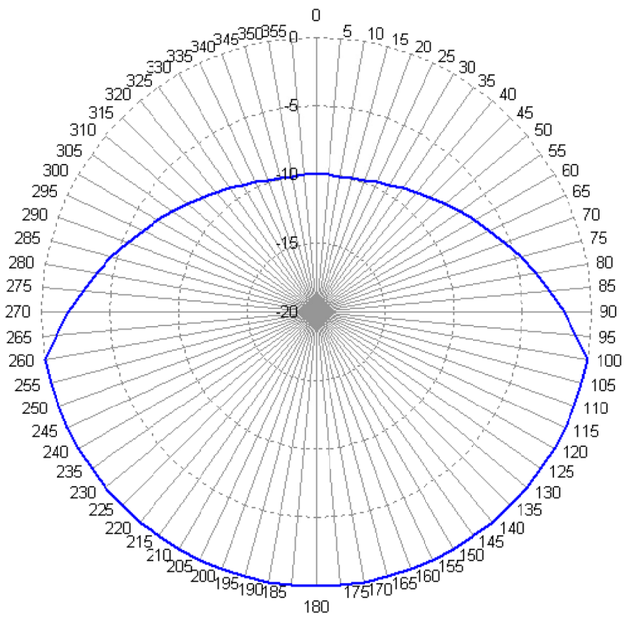
Figure G1 - Chart of ETSU-R-97 based day-time noise limits appropriate for the assessment location of South Shortcleugh, as well as predicted noise immission levels shown by wind direction for the Proposed Development, the other wind farms considered and the cumulative total, for a wind speed of 6 m/s.



G.1 Figure G2 below illustrates the relationship assumed between the reduction in turbine noise levels and wind heading that may occur, because of propagation effects. This relationship is based on the advice in Paragraph 4.4.2 of the IOA GPG.

G.2 Directional prediction in Figure G1 shows that predicted cumulative noise levels at South Shortcleugh reach a maximum of 37.5 dB(A) at 6 m/s at a narrow northernly wind sector (350° to 15°). An exceedance of 0.5 dB is unlikely to be perceptible in practice and furthermore, the direction predicted levels have been based on conservative propagation assumptions as detailed below and a 0.5 dB exceedance is unlikely to occur in practice.

Figure G2 - Relationship of the change of noise levels with wind direction, 180° is where the receptor is directly downwind of the turbine and 0° where the receptor is directly upwind of the turbine.



Direction	Attenuation
0	-10.0
15	-9.9
30	-9.3
45	-8.3
60	-6.7
75	-4.6
90	-2.0
105	0.0
120	0.0
135	0.0
150	0.0
165	0.0
180	0.0
195	0.0
210	0.0
225	0.0
240	0.0
255	0.0
270	-2.0
285	-4.6
300	-6.7
315	-8.3
330	-9.3
345	-9.9
360	-10.0

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