Planned Acoustic Assessment at the Proposed Hill of Fare Wind Farm

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Revision History

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1.0 INTRODUCTION

The aim of this document is to propose a suitable methodology and to identify the most appropriate locations for undertaking background noise surveys at the proposed Hill of Fare wind farm (pre-planning) in order that the acoustic impact may be assessed.

2.0 METHODOLOGY

The framework most commonly used within the UK for assessing the impact of noise from wind farms is the Department of Trade and Industry's 'The Assessment and Rating of Noise from Wind Farms', hereafter referred to as 'ETSU-R-97' [1]. The methodology described in this document 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. It provides a robust basis for assessing the noise impact of a wind farm and has been applied at the vast majority of wind farms currently operating in the UK.

The ETSU-R-97 document is endorsed for use in assessing and rating noise from wind energy developments within Scotland by Planning Advice Note 1/2001: Planning and Noise [2] and is therefore recommended for use in the assessment of the proposed Hill of Fare Wind Farm.

In accordance with the recommendations of ETSU-R-97, the acceptance of the proposed wind farm is established by comparing the noise levels anticipated to be produced by the operation of the proposed wind turbines with appropriate noise limits at nearby residential properties.

The Good Practice Guide [3], issued by the Institute of Acoustics in May 2013, provides guidance on all aspects of the use of ETSU-R-97 and has been adopted for use in this assessment.

2.1 Wind Turbines

The turbine type for the proposed Hill of Fare wind farm has not been finalised but a candidate turbine which is expected to be acoustically similar to the turbine that would be deployed shall be selected for the purposes of the acoustic assessment. Acoustic emission data shall be taken from the most relevant, reliable and up to date source available.

2.2 Noise Propagation Model

Whilst there are several sound propagation models available, here RES shall use the ISO 9613 Part 2 model [4]. A specific interpretation of the ISO 9613 Part 2 propagation model is followed according to the methodology recommended by a group of independent acousticians experienced in wind farm noise issues working for both wind farm developers, local planning authorities and third parties in an article published as detailed in the Institute of Acoustics Bulletin publication in 2009 [5] and the subsequent Good Practice Guide.

The model takes account of:

- attenuation due to geometric spreading
- atmospheric absorption
- ground effects
- barrier effects

The predicted noise level is changed from the L_{Aeq} to the L_{A90} descriptor by the use of an adjustment factor of -2 dB(A), as specified by ETSU-R-97.

2.3 Noise Limit

The general principle of ETSU-R-97 is that the noise limits should be based on existing background noise levels (reflecting the variation in background noise with wind speed) except for very low background noise levels, in which case a fixed limit is applied.

Since background noise levels depend upon wind speed, as do wind turbine noise emissions, it is important when making reference measurements to put them in that context. The assessment of background noise levels at potentially noise sensitive neighbouring locations 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 proposed site rather than at the properties, since it is this wind speed that would subsequently govern the wind farm's noise generation. Often the neighbouring properties themselves will be sheltered from the wind and might consequently have relatively low background noise levels.

The recommendations of ETSU-R-97 state that where there are groups of properties that are likely to have a similar background noise environment, it is appropriate to use data from one representative location as the basis for assessment at the other properties.

2.3.1 Calculating the Noise Limit

In order to derive appropriate noise limits the ETSU-R-97 guidance requires the correlation of background noise survey data and wind speed data referenced to 10m height. To do this the following process shall be followed:

- To account for site specific shear the wind speed shall be converted to a standardised 10m wind speed as described in the Appendix. This approach is consistent with that presented in the Institute of Acoustics Bulletin and the subsequent Good Practice Guide.

- Noise data shall be filtered according to time of day periods as defined by ETSU-R-97, with a quality control process ensuring that periods during rainfall, having instrumentation error, or identified as extraneous are removed before any derivation of noise limits.

- The noise and wind speed data are then correlated together to derive the best-fit line upon which the noise limit is based according to ETSU-R-97.

2.4 Assessment

The acceptability of the proposed wind farm shall be determined by comparing the predicted noise levels to the noise limits for day and night-time periods at each property.

2.5 Cumulative Assessment

An assessment of the cumulative acoustic impact of the proposed Hill of Fare Wind Farm with any nearby existing or consented turbines shall be carried out if necessary. Any additional nearby turbines that are in planning by the time of the application being submitted shall also be considered.

Steps shall be taken so that operational noise from any existing wind turbines does not affect the measured background noise levels. This can be verified by reviewing the collected data for signs of corruption and applying filters or corrections if needed.

3.0 BACKGROUND NOISE SURVEY

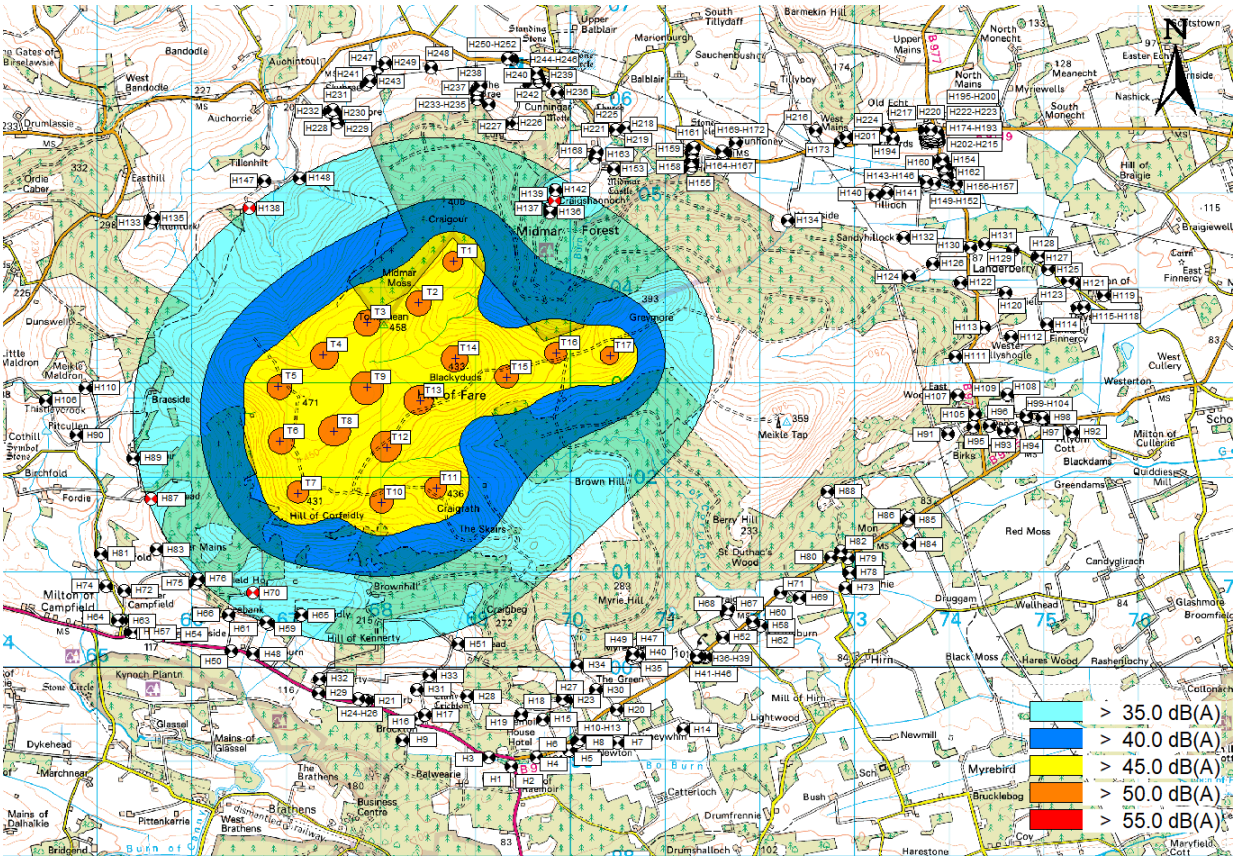
3.1 Identifying General Noise Survey Locations

ETSU-R-97 made clear that background noise surveys (to derive the relevant limits) were not required at all nearby properties, but only a sub-set thereof. RES has undertaken a preliminary noise study to identify appropriate monitoring locations. In choosing survey locations RES has aimed to encompass properties where the greatest wind farm noise levels are predicted as well as locations geographically dispersed around the site to capture any variation in the background noise environment and better represent the properties in the vicinity of the Proposed Development. The expected wind rose along with the impact of terrain sheltering has also been taken into consideration along with the likelihood of gaining permission from the resident.

From the noise footprint in Figure 1 it is suggested that background measurements should be carried out at the four properties highlighted in red (H70, H87, H138 & H139). Turbine numbers (and locations) are subject to change through the design stage although they are more likely to decrease than increase so the layout shown in the footprint is expected to represent the greatest extent.

Figure 1 Predicted Preliminary Noise Footprint for Proposed Wind Farm

Turbine locations are indicative only. The $L_{A90,10min}$ descriptor has been used. The noise footprint has been calculated at the standardised 10m wind speed corresponding to the maximum predicted noise level using the ISO 9613-2 propagation model with all barrier attenuation (i.e. shielding by hills) removed. The figure may therefore show conservative results and should be considered illustrative only. Grid Intervals are 1 km. Red receiver icons indicate the proposed background noise measurement locations.



3.2 *Specific Location of Noise Surveys*

The specific requirements for monitoring locations, as detailed by ETSU-R-97, are that measurements should be made where the amenity of the property is expected to be enjoyed and in free field conditions, i.e. an environment in which there are no reflective surfaces (except the ground) affecting the measurements.

To this end, incorporating best-practice and the specific instructions from ETSU-R-97, the specific measurement locations are;

- Selected to minimize effects of reflection as measurements performed at or near a façade could result in raised noise levels. ETSU-R-97 recommends measurement positions are at least 10 m from building façades unless sheltered locations close to the property are most often used for rest and relaxation in which case it may be appropriate to make measurements closer than 10 m but no closer than 3.5 m from the façade;

- Preferred where possible to be located so as not to be subject of a specific noise source that is not a permanent feature – for example a boiler flue, a deciduous tree or bush, pond pumps or running water.

In all cases where these criteria cannot be met, ETSU-R-97 recommends measurements of free-field noise should be made at alternative locations which can be expected to be the same as at the property.

The proposed background noise measurement locations have been selected based on the above criteria along with a desk-based map and aerial photography study. Limits for properties where surveys haven't taken place shall be inferred from the nearest survey location unless the measured data indicates the presence of location specific noise sources in which case it shall be taken from another survey location deeded more representative.

3.3 *Noise Survey Instrumentation*

3.3.1 Sound Level Meters

The sound level meters employed shall conform to IEC 61672-1:2013 Class 1 instruments [6]. All instrumentation shall be subject to laboratory calibration traceable to national standards to ensure accuracy.

Noise levels shall be monitored continuously, and summary statistics stored every 10 minutes in the internal memory of each meter. As a minimum the $L_{A90,10min}$ (The A-weighted sound pressure level exceeded for 90% of the 10 minute interval), and $L_{Aeq,10min}$ (the equivalent A-weighted continuous sound pressure level) shall be measured. Outdoor monitoring kit shall be used to house the equipment, including an appropriate wind shield to provide protection from wind induced noise and an element of water resistance. The sound level meters shall be acoustically calibrated on-site by a suitable calibrator (itself calibrated to national standards).

3.3.2 Wind Speed and Direction

Wind speed and direction are measured 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 reference that is adopted for use is the same wind speed reference as that which drives the turbine noise levels.

The adoption of this wind speed reference was presented as appropriate within the article published in the Institute of Acoustics Bulletin and the subsequent Good Practice Guide.

3.3.3 Rain Data

Rain data shall also be collected over the concurrent period so that acoustic data impacted by rainfall can be excluded from the analysis. Both the data period during which rainfall is recorded, along with the preceding ten minute period shall be filtered out as recommended in the Good Practice Guide.

3.4 Details of Survey Locations

The following are the proposed background noise survey locations. It should be noted in each case that the final position of the sound level meter may change if upon arrival it is judged that a more appropriate measurement location could be found elsewhere.

3.4.1 Location 1 – H70

This location is to the south of the proposed wind farm site and the suggested meter position is an area of grass to the south as indicated in Figure 2.

Figure 2 Background Noise Measurement at Location 1

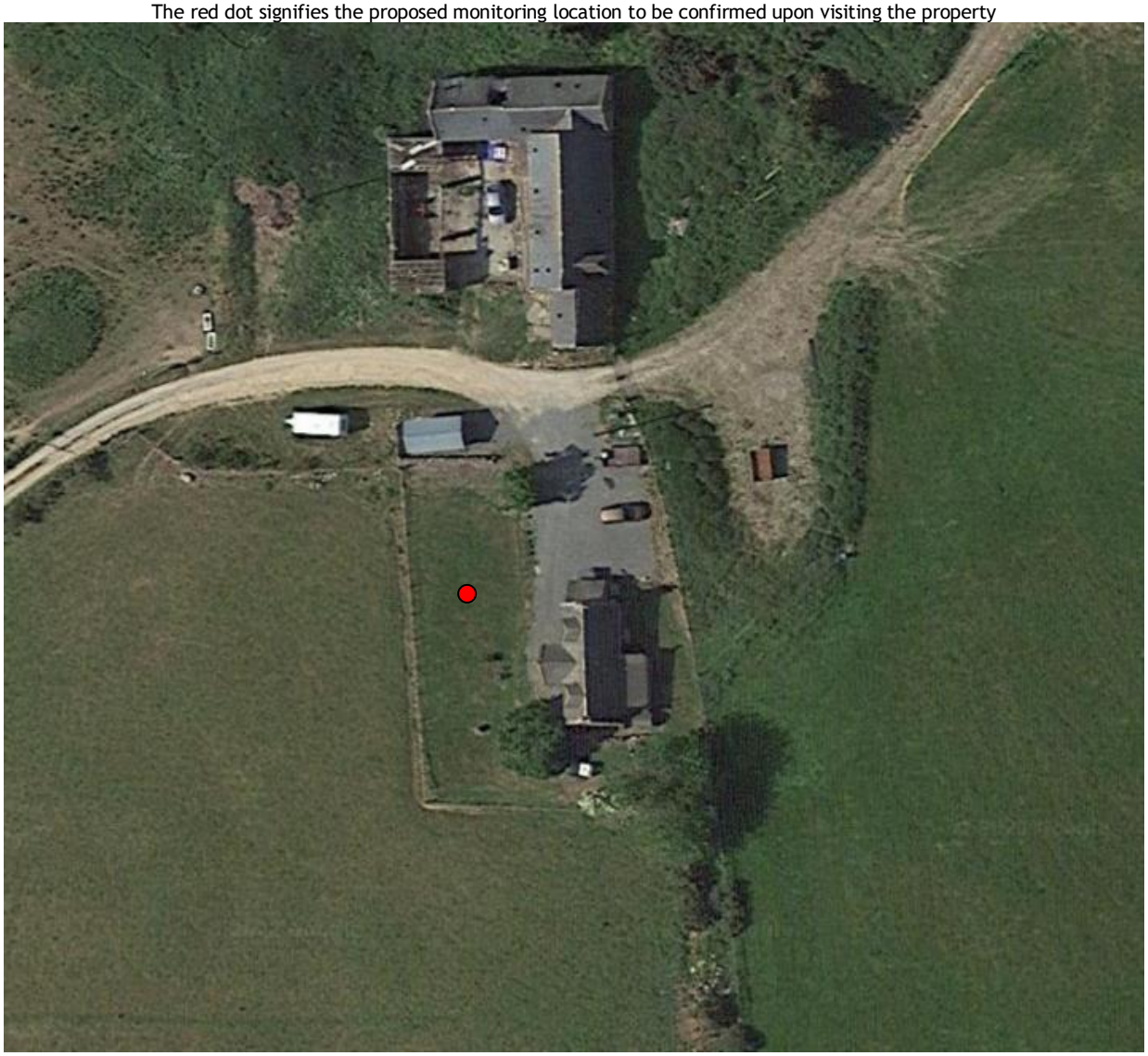
The red dot signifies the proposed monitoring location to be confirmed upon visiting the property

3.4.2 Location 2 – H87

This location is to the west of the proposed wind farm site. The suggested survey position is the garden to the west as indicated in Figure 3.

Figure 3 Background Noise Measurement at Location 2

The red dot signifies the proposed monitoring location to be confirmed upon visiting the property

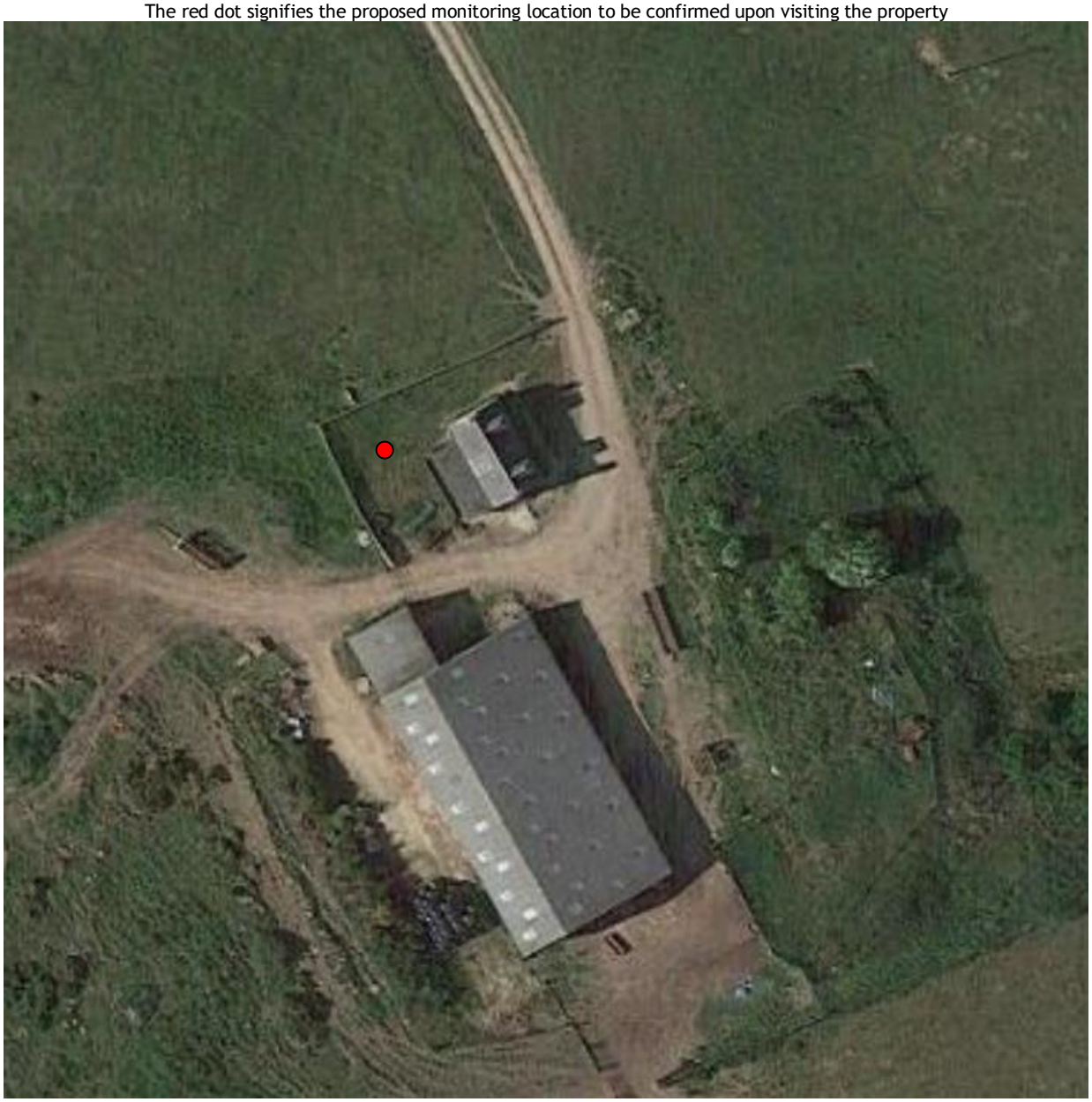


3.4.3 Location 3 – H138

This location is to the north-west of the proposed wind farm site. The suggested survey position is in the garden to the west as indicated in Figure 4.

Figure 4 Background Noise Measurement at Location 3

The red dot signifies the proposed monitoring location to be confirmed upon visiting the property



3.4.4 Location 4 – H139

This location is to the north-east of the proposed wind farm site. The suggested survey position is in the garden to the east as indicated in Figure 5.

Figure 5 Background Noise Measurement at Location 4

The red dot signifies the proposed monitoring location to be confirmed upon visiting the property

4.0 CONCLUSIONS

It is planned to undertake an assessment of the acoustic impact from the proposed Hill of Fare wind farm conforming to the requirements set out in ETSU-R-97 and described within this report.

To this end background noise surveys are proposed to be undertaken at the properties identified in Section 3. It should be noted that the final position of the measurement equipment may change if upon arrival it is judged that a more appropriate measurement location could be found elsewhere.

5.0 REFERENCES

[1] ETSU, "The Assessment and Rating of Noise from Wind Farms", The Working Group on Noise from Wind Turbines, ETSU Report for the DTI, ETSU-R-97, September 1996, http://webarchive.nationalarchives.gov.uk/20090609003228/http://www.berr.gov.uk/energy/sources/renewables/explained/wind/onshore-offshore/page21743.html

[2] Scottish Government "Planning Advice Note 1/2011: Planning and Noise", March 2011

[3] Institute of Acoustics, "A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise", May 2013

[4] ISO 9613-2:1996, "Acoustics - Attenuation of Sound During Propagation Outdoors, Part 2: General Method of Calculation", International Organisation for Standardisation

[5] Institute of Acoustics, 2009. "Prediction and Assessment of Wind Turbine Noise", Dr A Bullmore and M Jiggins (Hoare Lea Acoustics), Dr A McKenzie and M Hayes (Hayes McKenzie Partnership), D Bowdler (New Acoustics), R Davis (RD Associates) & Dr G Leventhall, Acoustics Bulletin Vol 34 No 2 March/April 2009

[6] IEC 61672-1:2013, "Electroacoustics - Sound level meters - Part 1: Specifications", September 2013

[7] IEC 61400-11, "Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques", December 2010

APPENDIX: METHODOLOGY FOR CALCULATING STANDARDISED 10M WIND SPEED

In order to derive appropriate noise limits the ETSU-R-97 guidance requires the correlation of background noise survey data and wind speed data referenced to a 10m height. In contrast to this, acoustic emission measurements on wind turbines are undertaken following the international standard IEC 61400-11 [7], "Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques" which specifies that the turbine noise emission should be reported as a function of a standardised wind speed at 10m height. In practice this translates as extrapolation of wind speed at hub height down to 10m height, using a specified, and fixed, relationship.

To account for the effects of wind shear (the change of wind speed with height) the approach that shall be used is consistent with that presented as appropriate by a group of independent acoustic consultants working for both wind farm developers, local planning authorities and third parties in an article published in the Institute of Acoustics Bulletin and the subsequent Good practice Guide.

At Hill of Fare wind farm a remote sensing device located on the proposed wind farm site shall be used to measure wind speed concurrently with the background noise survey. To account for site specific wind shear effects, the standardised 10 m height wind speed is calculated from the data measured during the noise survey period. The methodology used to convert the measured wind speed to standardised 10 m height wind speed is by:

1. Extrapolating the wind speed from the measurement height to the proposed hub height by use of a calculated wind shear exponent. The wind shear exponent is a commonly used, empirically based, engineering description of the rate of change of wind speed with height and may vary according to atmospheric conditions and be affected by interactions between ground features and the wind flow. The hub height wind speed for each 10 minute period may be calculated from the measured wind speed and the calculated wind shear exponent as follows:

$$v_{hub} = v_{H1}\left(\frac{h_{hub}}{h_{H1}}\right)^{\alpha}$$

Where: v_{H1} = measured wind speed
v_{hub} = wind speed at proposed hub height
h_{H1} = measurement height
h_{hub} = proposed hub height
a = calculated wind shear exponent from measured site data

2. The corresponding standardised 10 m wind speeds are then determined from the calculated hub height wind speed according to the reporting of wind turbine noise emissions in the international standard IEC 61400-11, "Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques". The standardised wind speed is essentially a proxy for hub height wind speed (the primary driver of noise emission from the turbine) and is found by extrapolating the hub height wind speed to 10 m height according to the following formula. It is this resultant standardised 10 m wind speed that shall be used in correlation with the measured noise levels to derive the appropriate limits:

$$v_S = v_Z \left[\frac{\ln \frac{z_{ref}}{z_{0ref}}}{\ln \frac{z}{z_{0ref}}} \right]$$

Where: v_s is the standardised wind speed
v_z is the wind speed at height z (the hub height wind speed calculated in step 1)
z_{0ref} is the reference roughness length (0.05 m)
z_{ref} is the reference height, 10 m
z is the proposed hub height