# Acoustic Impact Assessment Scoping Report for Oyster Bay Wind Farm

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## 1.0 INTRODUCTION

The purpose of this report is to determine whether the proposed Oyster Bay wind farm development has significant acoustic implications.

### *1.1 Experience*

RES Group has been actively involved in the development and construction of over 5GW of wind energy worldwide. Where applicable, this has involved the assessment of acoustic impact from the proposed wind farm development according to relevant policy and legislation. As appropriate, an in-house Member of the Institute of Acoustics[1] shall have active involvement in the assessment of acoustic impact for any site considered by RES.

RES Group have been project co-ordinators for several Joule[2] projects, leading European research into wind turbine noise and were involved in producing the guideline 'The Assessment and Rating of Noise from Wind Farms' for the UK Department of Trade and Industry in 1996. This guideline has become the de facto noise standard relating to wind farm noise for England, Scotland, Wales and Northern Ireland.

In addition RES Group has carried out noise assessments and reported to several local authorities on wind energy projects including taking measurements on newly constructed wind farms to ensure compliance with planning conditions. Several papers have been produced for the Institute of Acoustics and other professional bodies.

For example, such papers include:

- An Investigation of Blade Swish from Wind Turbines, by Dr P Dunbabin, RES;
- An Automated System for Wind Turbine Tonal Assessment, Ms R Ruffle, RES, both in proceedings of Internoise 1996 & International Congress on Noise Control Engineering.
- A Critical Appraisal of Wind Farm Noise Propagation, ETSU W/13/00385/REP, 2000 Dr J Bass, RES
- Aerodynamic Noise Reduction for Variable Speed Turbines, ETSU/W/45/00504/REP, 2000, Dr P Dunbabin, RES
- Noise from Variable Speed Turbines, JOR3CT950045, October 2000, Dr P Dunbabin, RES

RES Group is currently on the steering group managing research into Amplitude Modulation on behalf of Renewable UK, the industry body in the UK.

### *1.2 Legislative Framework & Guidance*

The following regulations have been considered to be relevant to the acoustic impact assessment at Oyster Bay:

- SANS 10328 (2008), "Methods for environmental noise impact assessments" specifies methodology to assess the noise impacts on the environment due to a proposed activity that might impact on the environment;

- SANS 10103 (2008), "The measurement and rating of environmental noise with respect to annoyance and to speech communication" provides indicative noise levels found in particular environments;

[1] The Institute of Acoustics is the UK's professional body for those working in acoustics, noise and vibration
[2] DGXII European Commission funded projects in the field of Research and Technological Development in non nuclear energy

- ‘ETSU-R-97’, ‘The Assessment and Rating of Noise from Wind Farms’ provides specific guidance as to appropriate noise levels for wind farm assessment. 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 in the UK. 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 (over 200). 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.”*

  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; &

- BS 5228 ‘Noise control on construction and open sites’ gives guidance on appropriate methods for minimising noise from construction activities.

## 2.0 PROPOSED PLAN OF STUDY

The steps described are used to determine the estimated environmental noise impact:

### *2.1 Estimation of the Sound Emission from the Wind Turbines*

There are two quite distinct types of noise source 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. Since the early 1990’s there has been a significant reduction in the mechanical noise generated by wind turbines, and it is now usually less than, or of a similar level to, the aerodynamic noise. Aerodynamic noise from wind turbines is generally unobtrusive.

The noise emission characteristics of the wind turbines as measured in accordance with IEC 61400:11 “Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques” shall be adopted for use in the impact assessment.

The final number and size of wind turbines will be determined based on further studies of wind regime, terrain and environmental constraints. This may be approximately 50 turbines assuming a turbine size of 3MW each or approximately 80 turbines assuming a turbine size of 1.8 MW each. To illustrate the noise emission level of such machine types (to be regarded as an illustration only), Table 1 below shows the sound power level from 2 turbine types that may fit this description. Further details clarifying the candidate machine shall be provided in the Environmental Impact Assessment report.

Table 1 Sound Power Levels for 10m Height Wind Speeds for Example Wind Turbines Fitting General Description of Likely Turbines

| $v_{10}$ / $ms^{-1}$ | Sound power level / dB(A) | |
|---|---|---|
| | Vestas V90 1.8MW | Vestas V112 3.0MW |
| 4 | 95.0 | 97.5 |
| 5 | 99.4 | 101.2 |
| 6 | 102.6 | 104.5 |
| 7 | 104.3 | 106.5 |
| 8 | 105.0 | 106.5 |
| 9 | 105.0 | 106.5 |
| 10 | 105.0 | 106.5 |
| 11 | 105.0 | 106.5 |
| 12 | 105.0 | 106.5 |

## 2.2 *Identification of Noise Sensitive Locations*

The proposed wind farm shall be located in a rural/agricultural area approximately 6 km north of the town of Oyster Bay in the Eastern Cape Province of South Africa. The site is south of the Impofu Dam and ~22 km west of the town of St. Francis Bay, ~23 km south of the town of Humansdorp and ~39 km north west from the coastal settlement of Jeffery's Bay. Jeffery's Bay is the largest town and the administrative seat of the Kouga Local Municipality. The dominant land use within the proposed site and the surrounding area is linked to deciduous fruit and dairy farming and game farming.

This environment would be described acoustically as a "rural district", as per SANS 10103.

For the proposed locations of the wind turbines, the nearest, or most noise sensitive, neighbours shall be determined by inspection of relevant maps, aerial photography and through site visits - for the area considered the likely sensitive locations have been identified as shown in Figure 1. It is only the nearest, most critical properties at which any assessment must be undertaken as the suitability of the proposed development at these properties ensures suitability at more remote locations. Likewise, if individual properties are considered adequately represented by another property they may not be individually listed in the assessment.

## 2.3 *Estimation of Future Noise Levels*

An estimate of noise levels at the nearest neighbours, using the ISO 9613 Part 2 model, shall be made. This model□ has been identified as the most appropriate for use [ETSU, 2000]. A specific interpretation of the ISO 9613 Part 2 propagation methodology shall be employed as 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 UK Institute of Acoustics bulletin publication in February 2009 [Acoustics Bulletin, 2009].

The model shall assume that the turbines can be modelled as a point source at hub-height and shall take account of:

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

The ISO9613:2 model is expected slightly over-estimate noise levels at nearby dwellings, as demonstrated by measurement-based verification studies [ETSU, 2000]. Examples of additional conservatism are:

- downwind propagation is modelled in all directions. In reality, noise propagation biases towards downwind locations, therefore predicted values are over-estimations upwind and crosswind of the proposed wind turbines;
- receiver heights shall be modelled at 4.0 m above local ground level, which equates roughly to first floor window level. This results in a predicted noise level anything up to 2 dB(A) higher than at the 'standard' assessment height of 1.2 - 1.8 m;
- trees and other non-terrain shielding effects shall not be considered; &
- all barrier attenuation according to the ISO 9613 Part 2 method shall be discounted. In lieu of this, where there is no direct line of sight between the property in question and any part of the wind turbine 2dB attenuation shall be assumed, as recommended in the aforementioned Institute of Acoustics bulletin article.

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

## *2.4 Estimation of Desired Noise Levels*

SANS 10103 describes the likely community response in relation to existing levels, as shown in Table 2. It may be seen that a raising of the noise levels by less than 5dB(A) is unlikely to cause more than sporadic complaints at most, and therefore, it may be inferred, should not be considered to cause significant impact. This is in agreement with other noise legislation and literature such as ETSU-R-97 and BS 4142 and is therefore considered relevant to the impact assessment of the Oyster Bay wind farm.

**Table 2 Extract from SANS 10103: Estimated Community Response**

| 1 | 2 | 3 |
|---|---|---|
| **Excess** $(\Delta L_{Reg,T})^a$ **dBA** | **Estimated community or group response** | |
| | **Category** | **Description** |
| 0 to 10 | Little | Sporadic complaints |
| 5 to 15 | Medium | Widespread complaints |
| 10 to 20 | Strong | Threats of community or group action |
| >15 | Very strong | Vigorous community or group action |

### 2.4.1 Simple Fixed Desired Noise Levels

Table 3 below, shows the expected noise level in a rural district such as considered at Oyster Bay according to SANS 10103 to be 35dB(A) $L_{eq}$ at night time, and 45dB(A) $L_{eq}$ during daytime.

**Table 3 Extract from SANS 10103: Typical Rating Levels in Different Districts**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Type of district | Equivalent continuous rating level ($L_{Req,T}$) for noise dBA | | | | | |
| | Outdoors | | | Indoors, with open windows | | |
| | Day/night $L_{R,dn}$ [a] | Daytime $L_{Req,d}$ [b] | Night-time $L_{Req,n}$ [b] | Day/night $L_{R,dn}$ [a] | Daytime $L_{Req,d}$ [b] | Night-time $L_{Req,n}$ [b] |
| a) Rural districts | 45 | 45 | 35 | 35 | 35 | 25 |
| b) Suburban districts with little road traffic | 50 | 50 | 40 | 40 | 40 | 30 |
| c) Urban districts | 55 | 55 | 45 | 45 | 45 | 35 |
| d) Urban districts with one or more of the following: workshops; business premises; and main roads | 60 | 60 | 50 | 50 | 50 | 40 |
| e) Central business districts | 65 | 65 | 55 | 55 | 55 | 45 |
| f) Industrial districts | 70 | 70 | 60 | 60 | 60 | 50 |

As previously described the wind farm should not seek to increase the existing noise level by more than 5dB so as to avoid widespread complaints. To do so the wind farm would need to ensure it did not exceed an $L_{eq}$ level of 38.3dB(A)[3].

It is therefore proposed that in the first instance should the predicted wind farm $L_{eq}$ not exceed 38.3dB(A) at the location of the most sensitive neighbours then no significant impact shall be likely to be caused and the wind farm shall be considered acoustically acceptable.

### 2.4.2 Desired Noise Levels in Relation to Measured Background Noise Levels

If the wind farm noise levels are predicted to be in excess of the simple fixed level (as detailed in Section 2.4.1) then it is proposed that the principle of the ETSU-R-97 document is adopted for use whereby the noise limit (the level the desired noise level should be below) is based relative to existing background noise levels, except for very low background noise levels, in which case a fixed limit may be applied. As background noise levels depend upon wind speed, as indeed do wind turbine noise emissions, the assessment of background noise levels at potentially sensitive neighbouring locations requires the measurement of not only noise levels but concurrent wind conditions, covering a representative range. These wind measurements are made at the wind turbine site rather than at the properties, since it is this wind speed that will subsequently govern the wind farm's noise generation. This approach has the advantage that the limits can directly reflect the existing noise environment at the nearest properties and the impact that the wind farm may have on this environment.

The ETSU-R-97 guidelines state that different limits should be applied during quiet waking hours and night-time hours. The quiet waking hours limits are intended to preserve amenity (outdoor), while the night-time limits are intended to prevent sleep disturbance (indoor). Here, the time of day definitions as stated in SANS 10328 are proposed for use:

**Table 4 Definition of Time of Day Periods to be Employed**

| Time of Day | Definition |
|---|---|
| Day time hours | • 06:00 - 22:00 every day |
| Night-time hours | • 22:00 - 06:00 every day |

[3] Logarithmically 38.3dB wind farm noise + 35dB existing noise = 40dB, 5dB above pre-existing levels.

Additional to specifying the noise limits to be +5dB(A) above existing background levels ETSU-R-97 further suggests that an absolute lower limit should be imposed as, in particularly low noise environments, limits based upon background levels are not necessary in order to offer a reasonable degree of protection to the wind farm neighbour. With due regard to the typical rural noise levels as specified in SAN 10103 (as Section 2.4.1) and the values suggested as relevant in ETSU-R97, it is proposed that the absolute lower $L_{A90}$ limit of at least 36.3dB(A)[4] is adopted.

The night-time criterion is derived from sleep disturbance criterion referred to in ETSU-R-97, with an allowance of 10 dB(A) for attenuation through an open window.

The desired noise levels are therefore those levels set out in Table 5.

**Table 5 Permissible Noise Level Criteria ($L_{A90}$)**

| Time of Day | Permissible Noise Level |
|---|---|
| Day-Time hours | • 36.3 dB(A) for $L_B$ less than 31.3 dB(A)<br>• $L_B$ + 5 dB(A), for $L_B$ greater than 31.3 dB(A) |
| Night-time hours | • 43 dB(A) for $L_B$ less than 38 dB(A)<br>• $L_B$ + 5 dB(A), for $L_B$ greater than 38 dB(A) |

As recommended in ETSU-R-97 the absolute lower noise limits may be increased up to 45 dB(A) if the occupant has a financial involvement in the wind farm.

**The Background Noise Survey**

As required, background noise measurements shall be undertaken in accordance with ETSU-R-97. In summary this means that:

- noise levels shall be monitored continuously, and summary statistics stored every 10 minutes in the internal memory of each meter. The relevant statistics for noise assessment are: $L_{A90,10min}$ (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);
- the microphones shall be placed at a height of approximately 1.5 m above ground;
- the meters shall be placed in moderately exposed positions, away from reflecting walls and vegetation;
- at least one week of noise surveys shall be undertaken at the relevant survey locations; &
- measurements shall be made at representative noise sensitive dwellings around the site. As recommended by ETSU-R-97, where there are groups of properties that are likely to have a similar background noise environment, it would be appropriate to use data from one representative location as the basis for assessment at the other properties.

The background noise survey measurements shall be synchronised with wind speed data as recorded by an on-site meteorological mast.

Prior to any analysis, instances of unexpected 'peaks' removed – such as may be caused by rainfall or infrequent human activities such as periodic or intermittent operation of farm machinery. For each set of survey data a 'best fit' line shall be fitted from which the applicable noise limit may be derived.

[4] As ETSU-R-97 uses the $L_{A90}$ descriptor, and specifies that an appropriate adjustment factor for wind farm noise is 2dB(A), this equates to a lower absolute $L_{Aeq}$ limit of at least 38.3dB(A) – equal to the fixed limit as described in Section 2.4.1

## 2.5 *Evaluation of Acoustic Impact*

Noise will have an impact but with due consideration and careful planning the aim is to minimise impact and not exceed existing guidelines.

The acceptance and significance of the proposed wind farm shall be established by comparing the noise levels produced by the proposed operation of the wind turbines with appropriate noise limits at nearby residential properties. Should the appropriate noise levels be exceeded then due regard may be given to the adoption of higher noise limits, in accordance with ETSU-R-97 and the likely community response as suggested by SANS 10103.

The noise impact study shall be made during Environmental Impact Assessment phase when a turbine layout shall be provided. The final siting of the turbines (and the turbine type) presented shall be ensured to have given due regard to likely noise levels at nearby neighbours.

Other relevant noise including vibration, low frequency noise, infrasound & amplitude modulation, shall be considered appropriately with due regard to available literature and current industry knowledge.

# 3.0 CONCLUSIONS

Noise can have an effect on the environment and on the quality of life enjoyed by individuals and communities. The effect of noise can therefore be a material consideration in the determination of applications for Environmental Authorisation for a wind farm.

This scoping report has identified that the potential for noise impact from the wind farm exists at nearby dwellings should due regard to turbine selection and siting of the turbines at distance from dwellings not be made. Therefore, once such details are known it is recommended that further investigation be undertaken to confirm the acceptability and impact significance of the wind farm.

The most noise sensitive receptors are as identified in Figure 1.

## REFERENCES


- 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
- International Organisation for Standardisation, "Acoustics - Attenuation of Sound During Propagation Outdoors, Part 2: General Method of Calculation", ISO 9613-2:1996
- ETSU, "A Critical Appraisal of Wind Farm Noise Propagation", ETSU Report W/13/00385/REP, 2000
- Institute of Acoustics Bulletin volume 34, no 2 "Prediction and Assessment of Wind Turbine Noise", signed by 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

**Figure 1 Development Boundary of Proposed Wind Farm and Nearest Neighbours**
Pink house icons represent occupied houses to be considered in assessment
The red line represents the site boundary
1km grid squares shown