

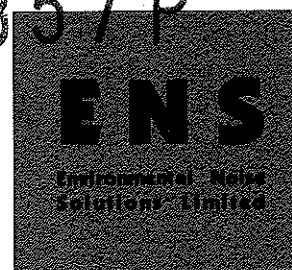
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ANC
THE ASSOCIATION OF
NOISE CONSULTANTS



By email only: rich.walters@knightfrank.com

Dear Sir,

**NOISE IMPACT ASSESSMENT FOR A PROPOSED SINGLE WIND TURBINE
HUNTROYDE HOME FARM, WHINS LANE, SIMONSTONE, BURNLEY**

1.00 INTRODUCTION

- 1.01 Environmental Noise Solutions Limited (ENS) has been commissioned to undertake an assessment of the potential noise impact on local residents associated with the proposed installation of a single wind turbine at Huntroyde Home Farm, Whins Lane, Simonstone, Burnley.
- 1.02 The proposal consists of the erection of an Enercon E-33 wind turbine, 330 kW rated power generating capacity. The turbine is to be mounted on a free standing tubular steel tower with 44.0 metres hub height, 33.4 metres blade diameter and a tip height of 60.7 metres. The turbine incorporates a direct drive mechanism (as opposed to a geared drive train) to minimise noise emissions, with a cut in wind speed specified as 3 metres per second.
- 1.03 The proposed wind turbine is to be installed on agricultural land at grid reference **E378271 N436147**, with the nearest noise sensitive receptors (NSRs) considered to be:
- NSR1 – Moor Barn (non-associated) located approximately 569 metres to the north east of the proposed wind turbine;
 - NSR2 – Cavaliers (non-associated) located approximately 590 metres to the east north east of the proposed wind turbine;
 - NSR3 – Paddy Bank Farm (non-associated) located approximately 585 metres to the east south east of the proposed wind turbine;
 - NSR4 – Trapp House (non-associated) located approximately 603 metres to the south south west of the proposed wind turbine; and
 - NSR5 – Brogden Farm (non-associated) located approximately 665 metres to the north west of the proposed wind turbine (and wholly screened by local topography).
- 1.04 A site plan illustrating the relative location of the proposed wind turbine and the nearest NSRs is contained in Appendix 1 for reference.
- 1.05 This report has been prepared to accompany a planning application to be submitted to Burnley Borough Council for the proposed wind turbine.
- 1.06 This report has been prepared for Empirica Investments for the sole purpose described above and no extended duty of care to any third party is implied or offered. Third parties making reference to the report should consult ENS, Empirica Investments and/or Knight Frank LLP (planning consultant) as to the extent to which the findings may be appropriate for their use.
- 1.07 The information reported herein has been based on the wind turbine manufacturer's noise emission data and has been accepted in good faith as being accurate and valid.
- 1.08 A glossary of acoustic terms is contained in Appendix 2 for reference.

2.00 ETSU-R-97 ASSESSMENT CRITERIA

- 2.01 Principles and guidelines for the environmental assessment of wind turbine related noise are given in the report entitled ETSU-R-97 'The Assessment and Rating of Noise from Wind Farms', based on the findings of the Working Group on Noise from Wind Turbines.
- 2.02 This document describes a framework for the measurement of wind turbine noise and suggests noise limits to offer a reasonable degree of protection to the neighbouring properties, whilst, at the same time, bearing in mind the significance of wind turbine development as a renewable energy source.
- 2.03 ETSU-R-97 recommends the imposition of noise limits set relative to the existing background noise (except in low noise environments, where lower absolute noise limits apply) at the nearest noise sensitive properties, taking into consideration the variation in both turbine source noise and background noise with wind speed.
- 2.04 ETSU-R-97 considers that the $L_{A90, 10 \text{ min}}$ descriptor should be used for both the background noise and wind turbine noise for assessment purposes. It further states that the $L_{A90, 10 \text{ min}}$ for wind turbines is of the order of 1.5–2.5 dB lower than the L_{Aeq} over the same time period.
- 2.05 The following table shows the recommended noise limits for wind turbine related noise at the nearest noise sensitive properties in line with ETSU-R-97.

Table 2.1 – ETSU-R-97 Noise Limits for Wind Turbine Related Noise

Period	Lower absolute noise limit $L_{A90,10\text{min}}$ (dB)	Relative noise limit $L_{A90,10\text{min}}$ (dB)
Daytime (07:00–23:00)	35 – 40	5 dB(A) above background noise
Night time (23:00–07:00)	43	5 dB(A) above background noise

Note: At low wind speeds (where background noise is expected to be quieter), the lower absolute noise limits apply, until the background noise has risen to within 5 dB of this level (as wind speed increases) wherein the relative noise limits come into force.

- 2.06 The fixed daytime limits (35–40 dB(A)) are understood to have been chosen such that they offer a reasonable degree of protection to occupants of nearby noise sensitive properties, whilst at the same time not placing unreasonable restrictions on the development of wind turbines. ETSU-R-97 advises that the actual limit chosen should depend on a number of factors, including the number of dwellings in the vicinity of the site.
- 2.07 The fixed night time limit (43 dB(A)) has been derived from the 35 dB(A) sleep disturbance criteria referred to in Planning Policy Guidance Note 24 (PPG 24). An allowance of 10 dB(A) has been made for attenuation through an open window (free field to internal) and 2 dB(A) subtracted to account for the use of $L_{A90,10\text{min}}$ rather than $L_{Aeq,10\text{min}}$.
- 2.08 ETSU-R-97 considers that for occupants of the nearest noise sensitive properties with a financial interest in the wind turbine development, relatively higher noise limits may be appropriate. It is recommended that both the daytime and night time lower fixed limits may be relaxed to 45 dB(A) and that consideration should also be given to increasing the permissible margin above background noise levels (at higher wind speeds).
- 2.09 The noise levels recommended in ETSU-R-97 take into account the character of noise described as 'blade swish', although an appropriate penalty should be imposed for any 'tonal' components in the wind turbine noise emissions.
- 2.10 ETSU-R-97 recommends a simplified assessment method for situations where it can be demonstrated that noise limits will be met until quite high wind speeds even if there is no increase in the background noise levels. It is considered that if noise emissions from the wind turbine are limited to 35 dB $L_{A90, 10\text{min}}$ up to a wind speed of 10 metres per second (at 10 metres height), then this condition alone is deemed sufficient to provide an adequate level of protection against noise. Wind speeds in excess of 10 metres per second at the wind turbine site will generate some additional background noise at the nearest noise sensitive properties, even in sheltered areas. It is considered that this type of condition may be suitable for single wind turbine developments (as is the case here).

3.00 ENERCON E-33 WIND TURBINE NOISE PREDICTIONS

- 3.01 The latest / current noise emission data for an Enercon E-33 330 kW wind turbine has been provided by the manufacturer (test report M66 650/1 khl; a summary extract is contained in Appendix 3 for reference).
- 3.02 The data illustrates that the apparent sound power level (L_{WA}) of the wind turbine varies from 86.6 dB(A) at 4 m/s wind speed to 99.5 dB(A) at 8 m/s wind speed and above (note: this data is in relation to a standardised hub height of 10.0 metres. The data illustrates that there is a requirement for the imposition of a 5.0 decibel noise penalty to account for tonality at wind speeds from 6 to 7 m/s, reducing to 4.6 decibel noise penalty at wind speeds above 8 m/s. Furthermore, in line with the manufacturer's recommendations, a 0.9 decibel safety factor is applicable to the noise emission data to account for typical measurement uncertainties
- 3.03 For the purpose of the calculations, the octave band sound power level data for an Enercon E-33 has been also been sourced test report M66 650/1 khl.
- 3.04 In accordance with ETSU-R-97, the $L_{A90, 10min}$ descriptor has been used for the purpose of this assessment, by applying a -2 dB correction to the predicted SPL at the receptor positions.
- 3.05 Of particular importance is the way noise propagation from wind turbines is modeled since this is not covered by the ETSU-R-97 guidance which only deals with assessment of any such predicted noise levels. This issue was covered by a recent statement on agreed practice by a number of consultants acting for wind farm developers, local authorities and third party groups in an article published in the Institute of Acoustics Bulletin in 2009 (as reproduced in the Hayes McKenzie Partnership Ltd Research Contract 'Analysis of How Noise Impacts are Considered in the Determination of Wind Farm Planning Applications', dated 6th April 2011, prepared for Department of Energy and Climate Change). In summary:
- Atmospheric absorption increases linearly with distance, affecting higher frequency sound more than lower frequency sound and varying with temperature and relative humidity. It is not appropriate to model all the possible variations in temperature and relative humidity so a reasonable worst case is usually assumed. It should be noted that this is covered by the Institute of Acoustics Bulletin Article which recommends the assumption of a temperature of 10 degrees Celsius and relative humidity of 70 percent.
 - Ground attenuation is caused by the interaction of the direct sound wave from the source with that reflected by the ground which depends, in turn, on the acoustic impedance of the ground between the source and receiver. This is modeled in different ways by different prediction methodologies but all categorize the ground around and between the source and receiver as hard, porous, semi-porous or other variant. In general terms 'hard' ground represents a more conservative approach (higher predicted noise levels) than 'porous' ground (lower predicted noise levels). This is also covered by the Institute of Acoustics Bulletin Article which recommends the assumption of semi-porous ground (G=0.5) where manufacturers' warranted sound power level data is assumed, or alternatively where reported sound power level data including measurement uncertainty is assumed. Where test report data alone is assumed, it recommends the use of G=0 (hard ground).
 - Although the assumed receiver height can have a very small (miniscule) effect on the separation distance between source and receiver and also (similarly miniscule in most cases) on barrier/screening attenuation, it can have a more significant effect on the ground attenuation. The Institute of Acoustics Bulletin Article recommends the assumption of a 4 metre receiver height.
- 3.06 In order to calculate the free field equivalent continuous sound pressure level ($L_{Aeq, T}$) associated with the operation of the wind turbine at the nearest NSRs, the following relationship may be employed:

$$\text{SPL} = \text{SWL} - 20 \log(r) - 11 - A - 2 \text{ dB(A)} \quad \text{where:}$$

SWL is the rated sound power level of the wind turbine (dB(A))

SPL is the predicted sound pressure level at the receptor position (dB(A))

r is the distance to the receptor (in metres)

A is attenuation due to atmospheric absorption, ground effect, barriers and miscellaneous effects

Note: - 2 is the correction from $L_{Aeq}(10 \text{ min})$ to the $L_{A90}(10 \text{ min})$ in accordance with ETSU-R-97.

3.07 **For the purpose of the calculations, a ground factor of $G=0.5$ (semi-porous ground) has been assumed (in conjunction with reported sound power level data including measurement uncertainty and tonal penalty for the wind turbine).**

3.08 On the basis of the above, and with reference to the noise emission data contained in Appendix 3, noise emissions associated with the proposed wind turbine have been calculated at the nearest NSRs as detailed in the table below (rounded to the nearest tenth of a decibel).

Table 3.1 – Predicted noise levels due to operation of Enercon E-33

Wind Speed (ms^{-1})	Sound Power Level of Wind Turbine + Uncertainty + Tonal Penalty dB(A)	NSR1 dB L_{A90} , 10 min	NSR2 dB L_{A90} , 10 min	NSR3 dB L_{A90} , 10 min	NSR4 dB L_{A90} , 10 min	NSR5 dB L_{A90} , 10 min
4	87.5 = 86.6+0.9	18.6	18.2	18.3	18.0	14.0*
5	92.3 = 91.4+0.9	24.0	23.6	23.7	23.4	19.4*
6	101.3 = 95.4+0.9+5.0	32.2	31.9	32.0	31.6	27.6*
7	104.1 = 98.2+0.9+5.0	34.9	34.5	34.6	34.3	30.2*
8	105.2 = 99.5+0.9+4.6	35.8	35.4	35.5	35.2	31.1*
9	105.2 = 99.7+0.9+4.6	36.0	35.6	35.7	35.4	31.3*
10+	105.2 = 99.7+0.9+4.6	36.0	35.6	35.7	35.4	31.3*

* Includes – 3 dB topography screening

4.00 ASSESSMENT OF RESULTS

- 4.01 On the basis of the predicted noise levels detailed in Table 3.1, it is evident that noise emissions at the nearest noise sensitive receptors due to the operation of the proposed Enercon E-33 wind turbine is circa 36 dB $L_{A90, 10min}$ at a wind speed of 10 metres per second (at 10 metres height).
- 4.02 It is considered that noise emissions associated with the operation of the proposed wind turbine should not cause any unacceptable loss of amenity to the occupants of the nearest noise sensitive receptor.
- 4.03 The predicted wind turbine noise emissions fall well within the ETSU-R-97 lower absolute noise limits of 35 to 40 dB $L_{A90, 10min}$ during the quiet daytime period. It is reiterated that the 35 to 40 dB $L_{A90, 10min}$ range of fixed quiet daytime noise limits for low noise environments is understood to have been chosen so as to offer a reasonable degree of protection to occupants of nearby noise sensitive properties, whilst at the same time not placing unreasonable restrictions on the development of wind turbines and associated global environmental benefits.
- 4.04 The amenity limits have been set in ETSU-R-97 on the basis of protecting the amenity of residents whilst outside their dwellings in garden areas. ETSU-R-97 describes three criteria to consider when determining the fixed part of this limit in the range of 35 dB $L_{A90, 10min}$ to 40 dB $L_{A90, 10min}$. They are:
- The number of noise-affected properties;
 - The potential impact on the power output of the wind turbine; and
 - The likely duration and level of exposure.
- 4.05 There is a degree of interpretation and practitioner judgement to be employed when considering these factors, but more prescriptive guidance could be considered to assist these choices and provide more consistency. The Hayes Mackenzie Partnership report 'Analysis of How Noise Impacts are considered in the Determination of Wind Farm Planning Applications' Ref HM: 2293/R1 dated 6th April 2011 (the 'HMP Report'), suggested that *"best practice guidance could very usefully identify a more prescriptive and definitive approach."*
- 4.06 In response to this suggestion, the following paragraphs set out the various ways that the Institute of Acoustics (IoA) Noise Working Group (NWG) proposes that this might be done in order to prompt a discussion of the setting of the criteria.
- 4.07 It is the working group's opinion there are difficulties in providing a prescriptive approach to determining fixed limits as suggested by the HMP Report. The following method is nevertheless presented as an example which the working group developed in response to the request and is proposing for consideration as part of the present consultation. It may assist some practitioners in undertaking a systematic evaluation of the three criteria set out in ETSU-R-97.
- 4.08 In this method, for each of the three criteria, a four-category rating (A to D) is considered. "D" would correspond to a lower impact or higher scheme benefit (therefore corresponding to a higher limit), "A" to a higher impact and reduced planning merit (and therefore a lower limit).
- 4.09 Given the review of the criteria provided in the ETSU-R-97 method, it is the IoA NWG's opinion there are difficulties in providing a generalized prescriptive approach to determining fixed limits as required by the HMP Report. The following example method is nevertheless presented as an example which the IoA NWG developed in response to the request and is proposing for consideration as part of the present consultation.

4.10 For example:

- For a site surrounded by isolated, individual dwellings and farms, this would fall in category D; the presence of extensive settlements or villages would correspond to category A, and intermediate situations to category B or C. Consideration could be taken of the prevailing wind directions in the area, as well as the relative size of the scheme (for example through the size of the predicted 35 dB $L_{A90, 10min}$ noise contour).
- A single-turbine scheme would arguably fall in category A, whilst a major scheme (>50MW) would be in category D. Intermediate-sized sites would be rated as B or C.
- The rating can be evaluated by considering the relative levels of predicted turbine noise levels and derived baseline noise levels. As it is related to the likely excess of turbine noise relative to baseline noise levels, sites surrounded by locations which are sheltered in deep valleys or (equivalently) with high levels of wind shear would be more likely to be in category A, whilst sites more exposed to wind would be in category C or D, and intermediate situations in category B.
- Following this evaluation, a "score" of 1 (A), 2 (B), 3 (C) or 4 (D)) is then determined as follows:

Table 4.1 – Criteria Relevant to Lower Absolute (Quiet Daytime) Noise Limits

Category	Properties	Generation	Exposure
A	1 (Large Settlements)	1 (Low Generation)	1 (High Exposure)
B	2 (Medium Settlements)	2 (Low to Medium Generation)	2 (High to Medium Exposure)
C	3 (Small Settlements)	3 (Medium to High Generation)	3 (Medium to Low Exposure)
D	4 (Single Property)	4 (High Generation)	4 (Low Exposure)

- The numbers in each of the three categories are then summed up to obtain a total rating between 3 and 12 in this example method. The resulting rating would offer more systematic guidance as to whether the limit should be set at the lower, middle or upper level of the range 35-40 dB $L_{A90, 10min}$ limit, with higher numbers tending to relate to the upper end of the range, and lower ratings to the lower end. It would also encourage a detailed and explicit consideration of all three criterion in line with ETSU-R-97, in addition to planning considerations.

4.11 In the specific case of the proposed Enercon E-33 (330 kW) wind turbine at Huntroyde Home Farm, the following ratings are considered appropriate.

Table 4.2 – Lower Absolute (Quiet Daytime) Noise Limits Rating Score

Category	Properties	Generation	Exposure
A	-	1 point 330 kW rated turbine	-
B	-	-	-
C	3 points 4 dwellings just > 35 dB	-	-
D	-	-	4 points Exposed site
Total	8 points awarded		

4.12 With the resulting rating being 8 points (in comparison to a minimum of 3 points and a maximum of 12 points), this would tend to relate to the middle end of the range (40 dB $L_{A90, 10min}$) rather than the lower end of the range (35 dB $L_{A90, 10min}$). On this basis, the proposed Enercon E-33 (330 kW) wind turbine at Huntroyde Home Farm is considered acceptable.

- 4.13 For reference, ETSU-R-97 relative noise limits are set at the background noise level + 5 dB(A). In order for the predicted wind turbine noise emissions not to comply with the ETSU-R-97 relative noise limits, the background noise level at the nearest non-financially involved receptors would have to be less than 31 dB $L_{A90, 10min}$ under wind speeds of 8 metres per second at 10 metres height. Considering the exposed nature of the site, such a scenario is inconceivable. It is therefore considered that the predicted wind turbine noise emissions would readily comply with the ETSU-R-97 relative noise limits during the quiet daytime period.
- 4.14 In order to assess compliance with ETSU-R-97 relative noise limits (i.e. background noise level + 5 dB(A)), consideration may be given to the 'Small Wind Turbine Performance and Safety Standard' published by the British Wind Energy Association (BWEA). This document states that whilst the background noise level varies greatly from site to site (depending on the presence of trees, buildings and other structures and also the proximity of roads, railways and other noise sources including wildlife), the typical background noise level in the middle of a country field can be determined by the equation $L_{p, bgd} = 28 + 2.25 * V$, where V is the wind speed at 10 metres height. It is noted that these measurements have been obtained with the microphone placed on a ground mounted board and therefore a -6 dB correction should be applied to establish free field background noise levels i.e. $L_{p, bgd} = 22 + 2.25 * V$.
- 4.15 At an 8 m/s wind speed, the predicted turbine noise emissions at the nearest noise sensitive receptors are circa 36 dB $L_{A90, 10 min}$. In accordance with the BWEA Standard, the derived (see Para 5.09, 3rd bullet point) background noise level is calculated to be circa 40 dB(A). This level is also consistent with Figure 8 'Typical Variation of Background Noise Level with Wind Speed' in ETSU-R-97 (reproduced in Appendix 4 for reference).
- 4.16 To reiterate, considering the exposed nature of the site, it is inconceivable that the background noise level could be as low as 31 dB $L_{A90, 10 min}$ during 8 metres per second wind speeds (at 10 metres height).
- 4.17 For reference, as an aside, it is noteworthy that recent revisions to the General Permitted Development Order (GDPO) set the threshold of acceptance for daytime noise associated with a wind turbine (up to a certain height and generating capacity) at 42 dB $L_{Aeq, 5 min}$, which, for wind turbine noise, is effectively 40 dB $L_{A90, 5 min}$; which is comparable with the upper end ETSU-R-97 lower absolute limits of 35 to 40 dB $L_{A90, 10 min}$ for the quiet daytime period. It therefore follows that the Government considers that residential amenity is still protected at such levels of wind turbine noise.
- 4.18 For reference, during the night time period, the predicted wind turbine noise emissions at the nearest noise sensitive receptors are significantly below the fixed noise limit of 43 dB $L_{A90, 10min}$ specified in ETSU-R-97.

5.00 CONCLUSIONS

- 5.01 It is concluded that noise emissions associated with the operation of the proposed Enercon E-33 (330 kW) wind turbine are highly unlikely to have any unacceptable impact on the noise amenity of the occupants of the nearest noise sensitive receptors.

I trust the foregoing is to your satisfaction. If you have any queries please do not hesitate to contact me.

Yours sincerely

Jonathan Rigg
For Environmental Noise Solutions Ltd

cc File

APPENDIX 1 – PROPOSED WIND TURBINE LOCATION WITH NEAREST NSRs



APPENDIX 2 – GLOSSARY OF ACOUSTIC TERMS

Sound Pressure Level (L_p)

The basic unit of sound measurement is the sound pressure level. As the pressures to which the human ear responds can range from 20 μ Pa to 200 Pa, a linear measurement of sound levels would involve many orders of magnitude. Consequently, the pressures are converted to a logarithmic scale and expressed in decibels (dB) as follows:

$$L_p = 20 \log_{10}(p/p_0)$$

Where L_p = sound pressure level in dB; p = rms sound pressure in Pa; and p_0 = reference sound pressure (20 μ Pa).

A-weighting Network

A frequency filtering system in a sound level meter, which approximates under defined conditions the frequency response of the human ear. The A-weighted sound pressure level, expressed in dB(A), has been shown to correlate well with subjective response to noise.

Equivalent continuous A-weighted sound pressure level, $L_{Aeq, T}$

The value of the A-weighted sound pressure level in decibels of continuous steady sound that within a specified time interval, T , has the same mean-square sound pressure as a sound that varies with time. $L_{Aeq, 16h}$ (07:00 to 23:00 hours) and $L_{Aeq, 8h}$ (23:00 to 07:00 hours) are used to qualify daytime and night time noise levels.

$L_{A10, T}$

The A-weighted sound pressure level in decibels exceeded for 10% of the measurement period, T . $L_{A10, 18h}$ is the arithmetic mean of the 18 hourly values from 06:00 to 24:00 hours.

$L_{A90, T}$

The A-weighted sound pressure level of the residual noise in decibels exceeded 90% of a given time interval, T . L_{A90} is typically taken as representative of background noise.

$L_{AF \max}$

The maximum A-weighted noise level recorded during the measurement period. The subscript 'F' denotes fast time weighting, slow time weighting 'S' is also used.

Sound Exposure Level (SEL or L_{AE})

The energy produced by a discrete noise event averaged over one second, no matter how long the event actually took. This allows for comparison between different noise events which occur over different lengths of time.

Weighted Sound Reduction Index (R_w)

Single number quantity which characterises the airborne sound insulation properties of a material or building element over a defined range of frequencies (R_w is used to characterise the insulation of a material or product that has been measured in a laboratory).

**APPENDIX 4 - TYPICAL VARIATION OF BACKGROUND NOISE LEVEL
(QUIET DAYTIME PERIOD) WITH WIND SPEED**

