**Noise Impact Statement for Windcrop Micro Wind System Installations**

*This statement is a generic assessment and should be read in conjunction with the accompanying Design and Access Statement which contains information specific to the site.*

**Introduction**

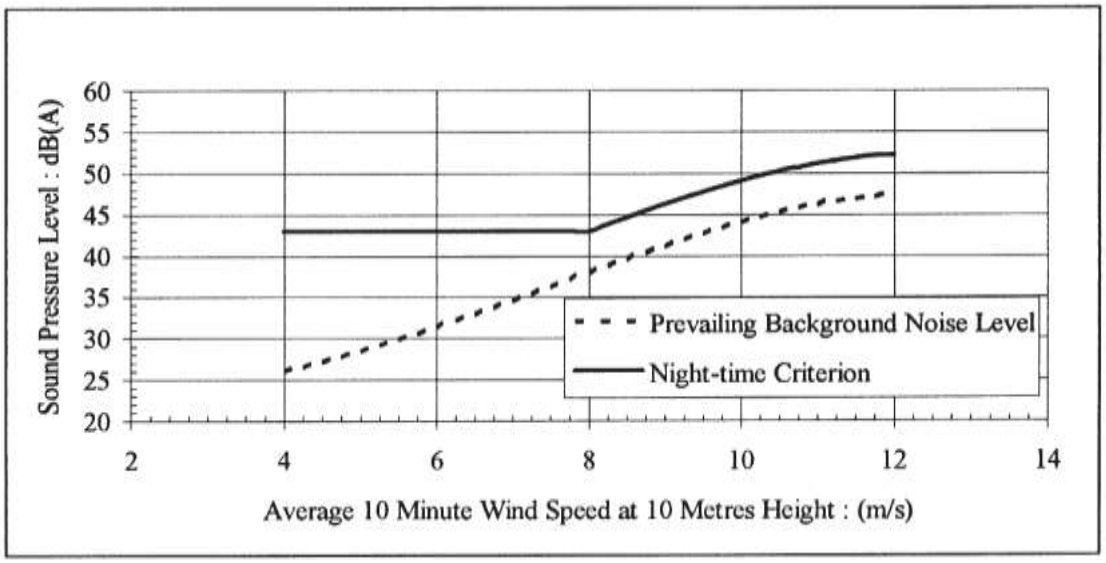
A noise assessment process has been defined as part of the Micro-generation Certification Scheme installer standard which covers turbines of the proposed size. However in our experience this has not always been acceptable to Environmental Health Officers. Site specific characteristics are not taken into account and generates siting distances that are seen as too close to neighbouring properties.

Windcrop has therefore been working proactively with local Environmental Health Officers in the East of England to develop a practicable and clear method of presenting the expected impact that sets the noise generated by the wind system in the context of the local background noise levels. This document sets up the methodology that has been developed and its application in impact assessment.

**ETSU-R-97**

In the impact assessment of large wind farms, a specific methodology was developed to overcome the problem of relating noise generation to background noise and this is now generally in use. The ETSU-R-97 assessment approach takes into account not only the noise levels at noise sensitive locations but also sets these against the expected background noise levels for the normally experienced range of site wind speeds.

Under the ETSU-R-97 methodology, the site background noise is measured against wind speed over a period of months and this is then compared against the expected noise immission from the wind turbines. The acceptance criteria are set as being below the higher of either 43dB (the ETSU recommended night time criteria) or background +5dB. This is shown below:

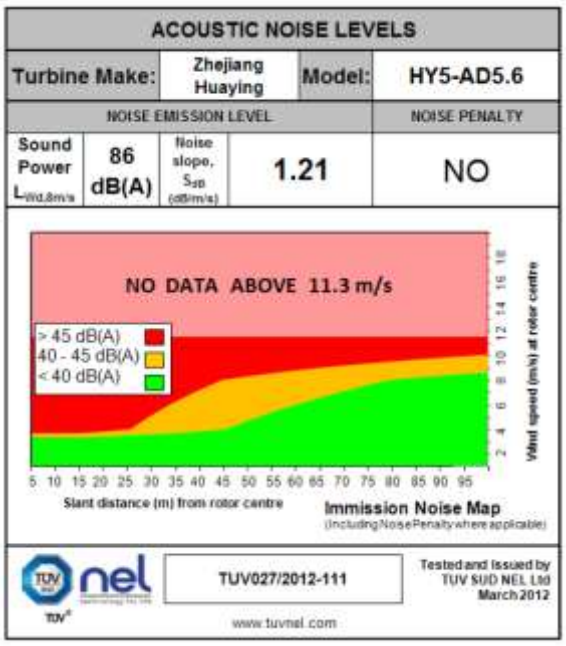



There are two key problems that make the use of this approach difficult in assessing micro wind systems. Firstly, to undertake this type of testing for a small system is considered disproportionate to the scale of development. Acquiring sufficient data to generate a representative curve across the full range of wind speeds takes several months and requires the installation and operation of an anemometer and sound meter for this period. Secondly,

the threshold levels for acceptance under ETSU-R-97 have been regarded as being too lax by Environmental Health Officers in a typical quiet rural setting and it is assumed that in setting levels for large wind developments, a less rigorous threshold has been set in light of the strategic significance of large renewable energy developments. It has therefore been necessary to develop a methodology that overcomes these issues.

**Basis of Methodology**

The approach that has been developed is based on taking an assumed curve of background noise vs wind speed that is sufficiently cautious that interested parties can feel confident that any real world site would be found to have a higher level of background noise if it were measured. Such a curve has been proposed, based on the best data available for a very quiet rural site. This data was generated as part of the original ETSU-R-97 development and is the best available from the very limited sources. More information on the proposed assumed background noise curve is given below.




In order to assess the noise impact of the installation of one or more wind systems onto a site, it is necessary to generate a noise immission curve for the system. All MCS certified systems have their noise emission measured under strictly controlled conditions and independently certified by an accredited certification body. The full test reports for all MCS certified systems are available but the test output for a typical system is summarised in a standard form as shown to the right.

The contour plot is not relevant here as this is used by the MCS approach, but the Sound Power at 8m/s and the Noise Slope enable a noise immission curve to be calculated for any distance from the wind system(s).

It is worth noting that the noise emission levels are calculated as an uncertainty corrected $L_{Wd}$ of the noise measurements made and as such represents an elevated level for noise

generation whilst the background noise data is $L_{90}$ the bottom 10th centile data and as such this approach introduces a large level of additional caution to the comparison.

To quantify this, the declared 8m/s noise emission at 89.0dB(A) is 2.2dB(A) higher than the measured mean noise level of 86.8dB(A) in order to allow for an uncertainty Uc of 1.37dB. Taking the $L_{90}$ Background noise represents a reduction of 2dB to the mean giving a total combined correction of 4.4dB.

Working with the linear data fit from the MCS test report for this system provides a line of noise emission from the system against wind speed as follows:

| Wind Speed at 15m (m/s) | 3 | 4 | 5 | 6 | 6.67 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| Sound Power, dB(A) | 78.5 | 80.6 | 82.7 | 84.8 | 86.2 | 86.9 | 89.0 | 91.1 | 93.2 |

The sound energy in the propagation direction of the sound is inversely proportional to the increasing surface area the sound propagates through and can be expressed as:

$Lp = Lw + 10 \log[(Q/4\pi)(1/r12+ 1/r22+ ...+1/rn2) + 4/R]$ (1)
or modified for a single source:

$Lp = Lw + 10 \log(Q/(4\pi r2) + 4/R)$ (1b)

where

Lp = sound pressure level (dB)

Lw = sound power level source in decibel (dB)

Q = directivity coefficient (1 uniform spherical, 2 uniform half spherical (single reflecting surface), 4 uniform radiation over 1/4 sphere (two reflecting surfaces, corner)

r = distance from source (m)

R = room constant (m2)

With uniform spherical radiation (1) can be modified to express the sound pressure level from a single sound source as:

$Lp = Lw + 10 \log(1/(4\pi r2)$

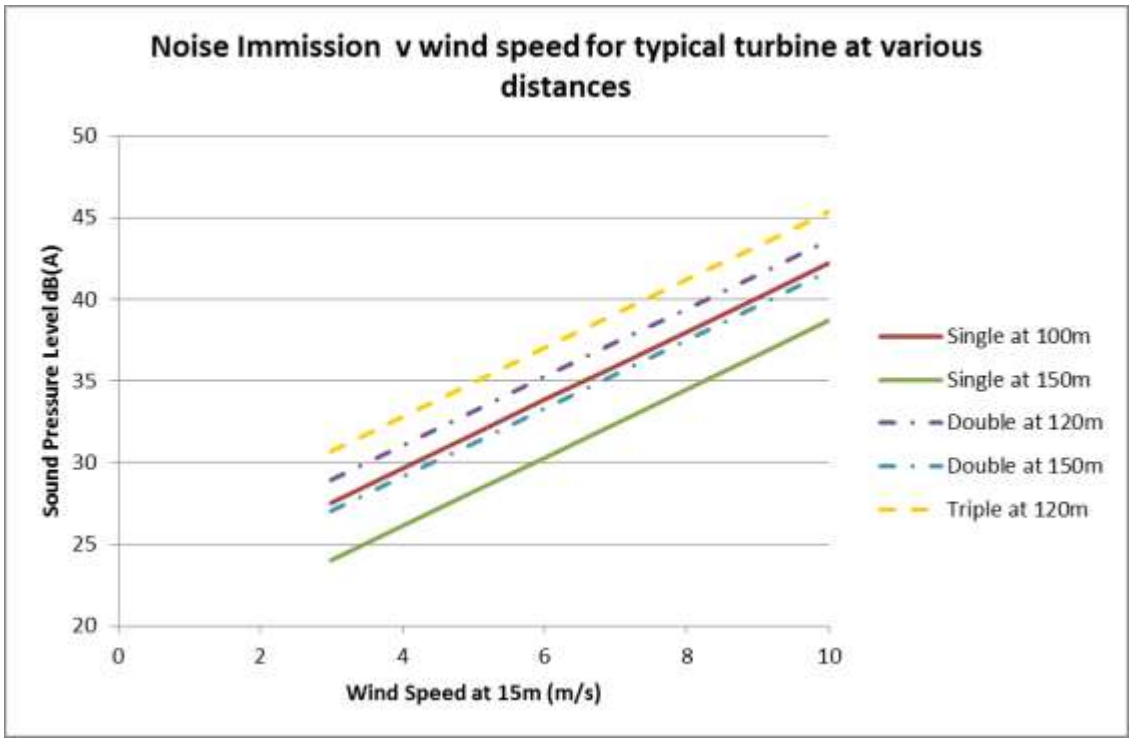
$= Lw - 10 \log( 4 \pi r2)$ (2)

Since Q = 1 and $R \approx \infty$

(2) can also be expressed as:

Lp = Lw - 20 log( r) + K'  (2b)

where K' = -11 (single sound source and spherical radiation)
The above calculations provide a set of curves for noise immission at a range of sample distances for a single turbine and for twin and triple installations as follows:

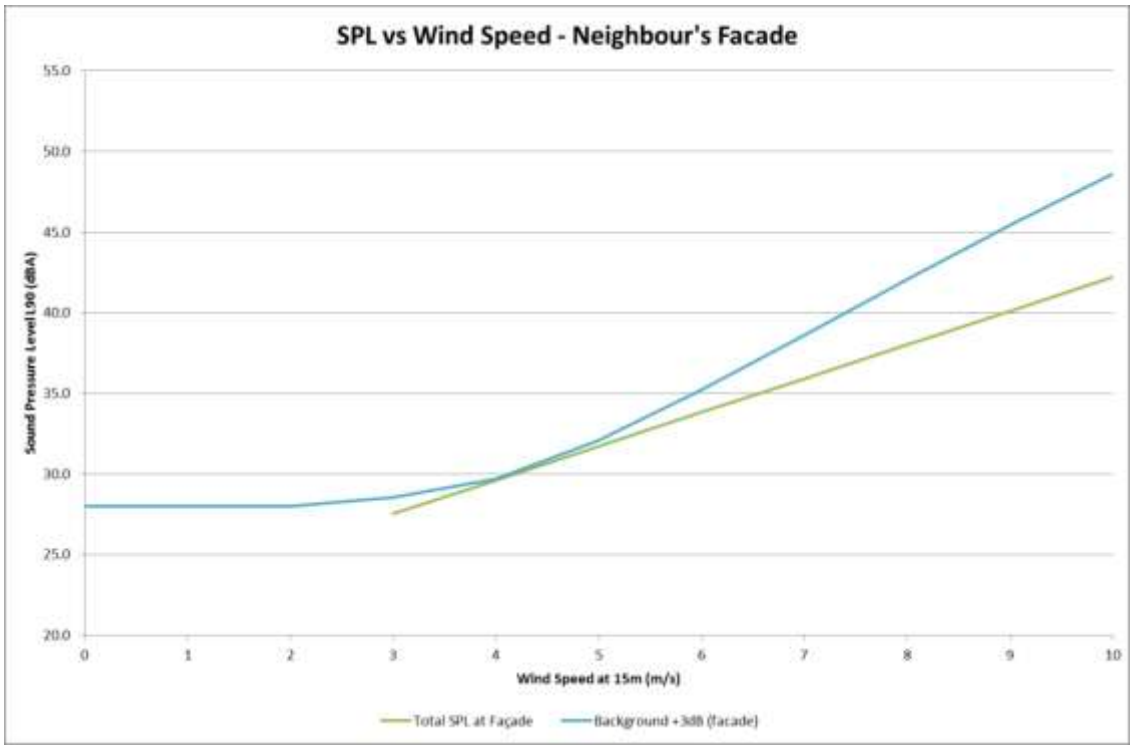


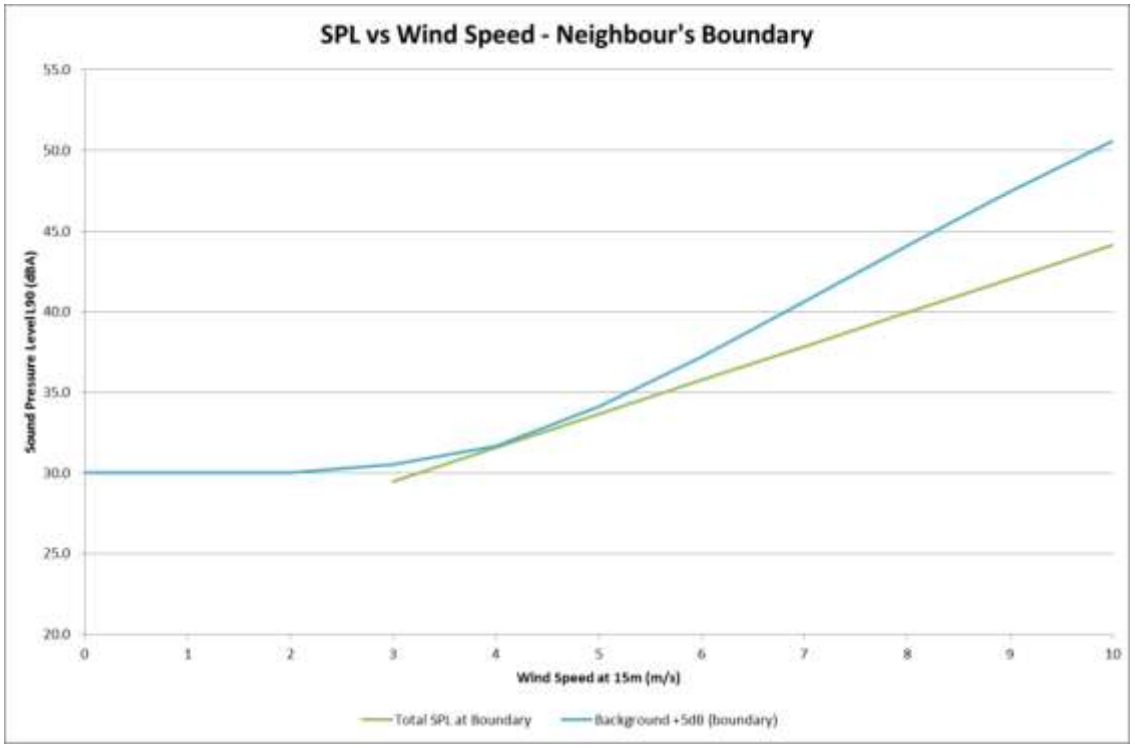

**Immission Level against Background Noise Levels**

Taking the sound power immitted at the noise sensitive location against wind speed and comparing it with typical background noise minimum levels for a very low noise, rural site provides a clear indication of the relative noise levels.

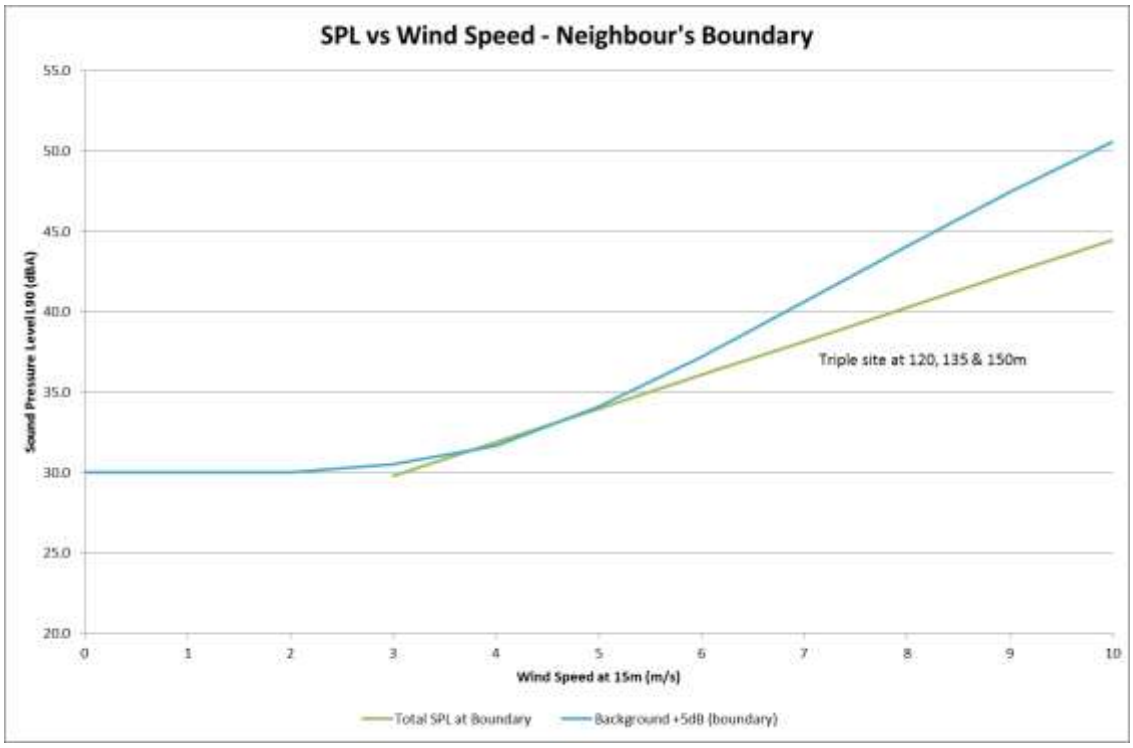
Having discussed acceptability criteria with a number of local authorities it has been agreed that the noise immission should be no more than +3dB above background at the façade of a neighbouring property and no more than +5dB above background at the amenity boundary of a neighbouring property.

Taking an example property, and proposing to install a wind system at a distance of 80m to the amenity boundary and 100m to the façade it can be shown that these are the effective minimum siting distances for a single Quiet Revolution HY5 turbine in order to meet the acceptability criteria above. This is the basis for the graphs used in the accompanying design and access statement.




A similar approach to the combined effect of two or more wind systems can be taken to provide a site specific assessment. For example, in the case of a neighbour to a proposed site for three turbines where the turbines are 120, 135 and 150m from the boundary, the assessment would look as below:




This shows that the noise impact on the neighbour would just exceed the acceptability criteria of no more than 5dB above background.

**Higher Background Noise Level Sites**

All the assessment above is based on the assumption that the site is a very quiet rural one with a baseline background noise when there is no wind of 25dB. There are many sites where there are higher background noise levels, possibly due to close proximity to a major road or due to proximity to another noise source such as an industrial or farming site.

The methodology therefore needs to allow an adjustment to the assumed background curve in such cases. In order to do this, Windcrop either carries out a standard BS4142 background noise assessment under still conditions or provides evidence from other sources of elevated background noise levels. This is then used to elevate the noise curve as follows:

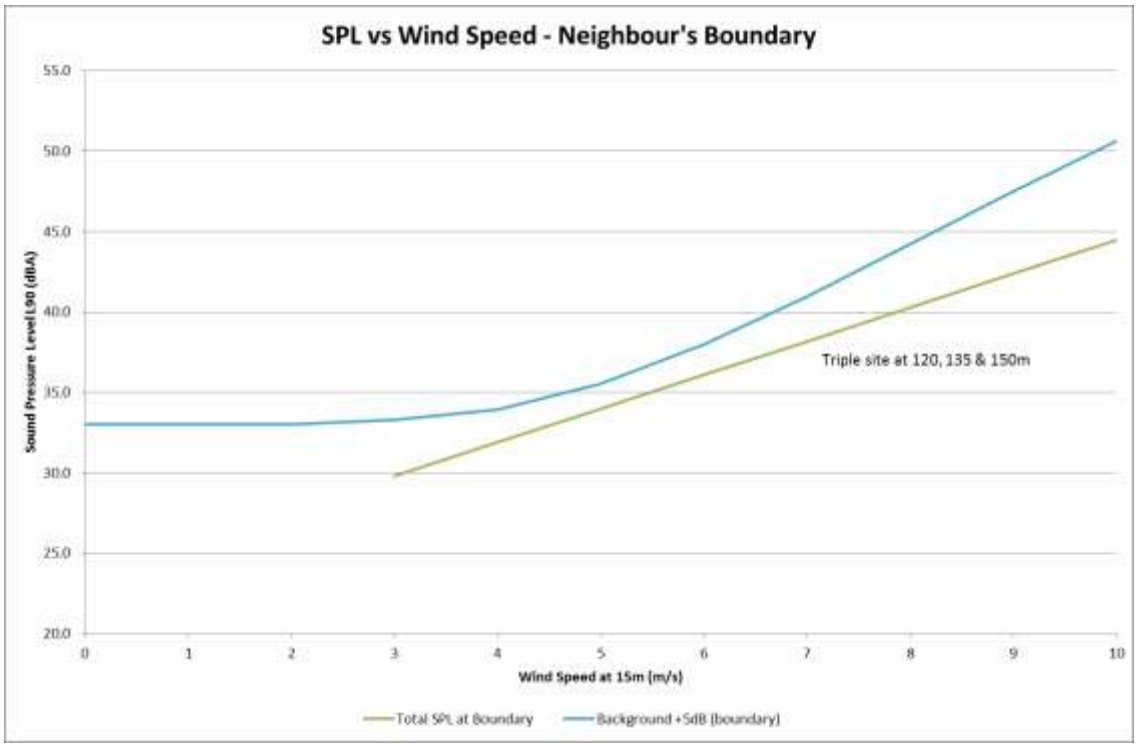
| Wind Speed at 15m | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Agreed Lowest Rural Background | 25.0 | 25.0 | 25.0 | 25.5 | 26.7 | 29.1 | 32.2 | 35.6 | 39.1 | 42.4 | 45.6 |
| ETSU wind component | | | | 16.3 | 21.8 | 27.0 | 31.3 | 35.2 | 38.9 | 42.4 | 45.6 |
| 25dB Background | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| Sum | 25.0 | 25.0 | 25.0 | 25.5 | 26.7 | 29.1 | 32.2 | 35.6 | 39.1 | 42.4 | 45.6 |

By substituting the actual measured background noise for the assumed 25dB level the table can be recalculated as follows:

| Wind Speed at 15m | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Agreed Lowest Rural Background | 25.0 | 25.0 | 25.0 | 25.5 | 26.7 | 29.1 | 32.2 | 35.6 | 39.1 | 42.4 | 45.6 |
| ETSU wind component | | | | 16.3 | 21.8 | 27.0 | 31.3 | 35.2 | 38.9 | 42.4 | 45.6 |
| 28dB Background | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 |
| Sum | 28.0 | 28.0 | 28.0 | 28.3 | 28.9 | 30.5 | 33.0 | 36.0 | 39.3 | 42.5 | 45.6 |

As can be seen this has little effect at the higher wind speeds but does increase the acceptable level at lower wind speeds.

If we look back at the example above of a triple site that was not acceptable on a 25dB background site, if a BS4142 assessment were carried out and showed a 28dB minimum background level, the graph would be re-plotted as follows:




This site would then be acceptable provided the BS4142 site assessment supported the use of the elevated baseline noise level.

**Conclusion**

This methodology provides a safe and clearly traceable methodology that enables all interested parties including neighbours to assess the noise impact of micro wind systems. Windcrop are continuing to generate data to further support the assumptions made and it is hoped that these will enable future refinements to this approach to be agreed but in the meantime this methodology is recommended.

## Annex 1 – Generation of Assumed Minimum Background Noise Levels

In the absence of relevant local data on rural background noise vs wind speed, data has been sought from all available sources. However there is very limited data available and the best source found is the work carried out to support the original ETSU-R-97 methodology.

This provides three data sets and the curve fit to the L90 sound pressure levels due to background noise. The first (ref A3) is for all data, the second (A5) is night time only and the third (A7) is for wind directions in the South to West only. In considering the data sets, the A3 which is a full 24 data set has been used as this shows a 25dB base noise level at low wind speeds and this is representative of sites in our region and the A5 data set is clearly short of valid data in the higher wind speeds leading to an unrepresentative curve shape.

Taking the curve fit provided this gives a base level data set for $L_{90}$ background noise. However it is clear that the curve fit does not extrapolate to zero wind speed and so the curve is adjusted to 25.0dB at these wind speeds as follows:

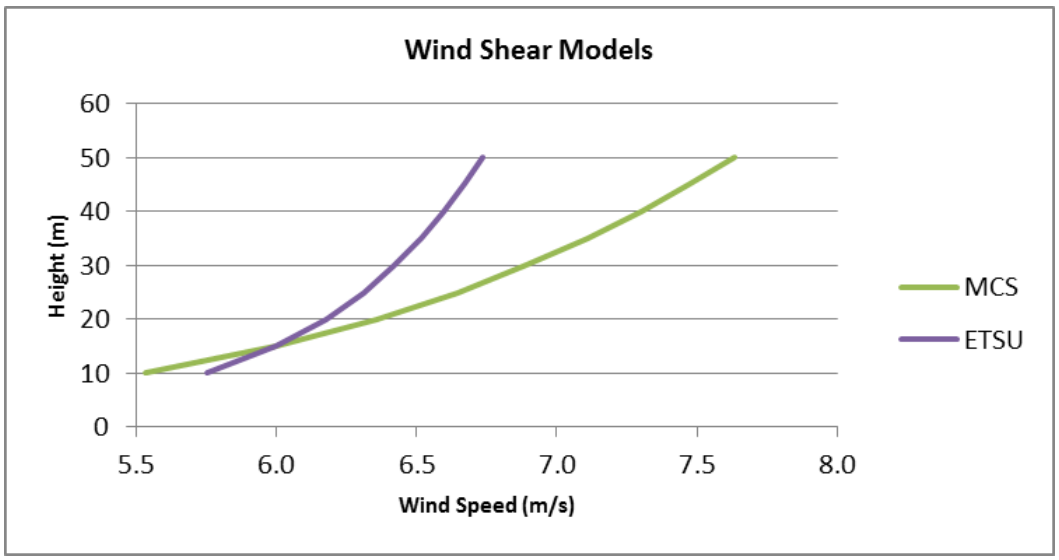
| **Wind Speed (m/s)** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| L90 | 38.8 | 31.1 | 27.0 | 25.6 | 26.0 | 27.7 | 30.1 | 33.0 | 36.1 | 39.2 | 42.2 |
| | | | | | $v^5$ | $v^4$ | $v^3$ | $v^2$ | v | n | |
| curve fit factors: | | | | | $-1.62E^{-4}$ | $9.16E^{-3}$ | $-2.11E^{-1}$ | 2.3753 | -9.8803 | 38.818 | |
| **A3 Derived (30m)** | **25.0** | **25.0** | **25.0** | **25.6** | **26.0** | **27.7** | **30.1** | **33.0** | **36.1** | **39.2** | **42.2** |

This is however the background noise levels against the prevailing wind speed measured at 30m. The data needed is to compare against noise generated by a turbine at 15m hub height and so the wind speeds need to be corrected. This is done by reference to a correction factor generated by modelling the reduction in wind speed with height or wind shear. The methodology to do this contained in the MCS process is not appropriate as this deliberately overestimates wind shear in order to generate cautious (ie low) wind speeds at lower heights for the purpose of estimating energy generation. For this purpose we need to take the opposite approach and assume a small reduction in order to generate the lowest background noise levels.

This has been done by using the BS standard method as recommended in the ETSU-R-97 standard and using a very low terrain factor of 0.0008. This is the factor for completely bare open land or water and is the minimum possible. The correction comparison is as follows:

| | Height (m) | MCS | BS |
|---|---|---|---|
| Correction to 15m from: | 10 | 1.08 | 1.04 |
| | 15 | 1.00 | 1.00 |
| | 20 | 0.94 | 0.97 |
| | 25 | 0.90 | 0.95 |
| | 30 | 0.87 | 0.93 |
| | 35 | 0.84 | 0.92 |
| | 40 | 0.82 | 0.91 |

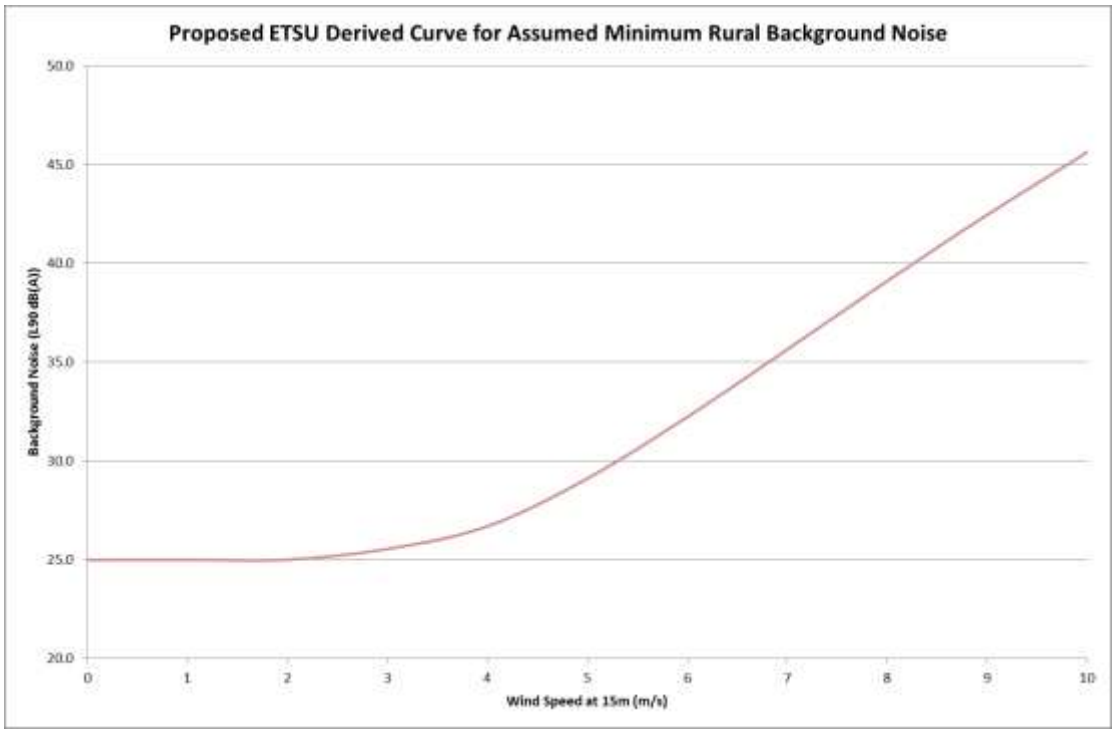
This shown graphically as the increase in wind speed from a 6m/s wind measured at 15m with increasing height to 50m:




Taking this height correction means that when we measure a 6m/s wind at 15m, the wind at 30m is actually 6.4m/s and so the background level is adjusted upward as follows:

| **Wind Speed at 15m** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Wind Speed at 30m | 0.00 | 1.12 | 2.24 | 3.37 | 4.49 | 5.61 | 6.73 | 7.86 | 8.98 | 10.10 | 11.22 |
| **A3 derived at 15m wind speed** | **25.0** | **25.0** | **25.0** | **25.5** | **26.7** | **29.1** | **32.2** | **35.6** | **39.1** | **42.5** | **45.6** |

This is the curve that has been used as the baseline curve for all assessments:


Proposed ETSU Derived Curve for Assumed Minimum Rural Background Noise
Background Noise (L90 dB(A))
50.0
45.0
40.0
35.0
30.0
25.0
20.0
0
1
2
3
4
5
6
7
8
9
10
Wind Speed at 15m (m/s)