# Proven WT6000 Wind Turbine

## Mounted on TM1500 15m self supporting tower

## Noise Emission Report

### General

The dB (A) scale is the most common measure used to quantify noise. It covers sound intensity over the entire audible scale *and* takes account of the sensitivity of the human ear to give an overall measure of "loudness".

### Typical dB(A) Levels

| Sound Level | dB (A) |
|---|---|
| Threshold of hearing | 0 |
| Whisper | 30 |
| Talking | 60 |
| City Traffic | 90 |
| Rock Concert | 120 |
| Jet Engine (10m away) | 150 |

### Current Best Practice

In assessing the noise from a proposed wind turbine installation we are often interested in what noise levels will be at various distances from the wind turbine. It is accepted practice to *calculate* noise contributions from the wind turbine. This is because it is only practical to *measure* the wind turbine contribution accurately when it is 10 dBA above background noise. For example, background noise in a "quiet" environment is typically 30-40 dBA making it impossible to *measure* contributions less than 40-50 dB(A).

### Proven WT6000 Wind Turbine Noise Calculations

Figure 1 shows how the noise emitted by a Proven WT6000 wind turbine on a 15m mast will disperse over the local environment. Maximum noise output at the base of the machine was recorded at 60dB(A) at a wind speed of 20 m/s. The noise output at the base of the mast in light winds 5m/s was 40 dB(A). The sound meter was held at a height of 1.5m from the ground. Background noise is louder than the turbine when more than 25m from the mast in both cases.

Figure 2 shows how the combined noise of wind turbine plus background; this is what will be detected by the human ear.

Figure 3 graphs the dBA difference between wind turbine and background plus common complaint classifications. *It can be generally taken that there will be no noise complaints where the turbine specific noise is 10dBA less than background.* This happens at a distance of 40-75m depending on wind speed.

Details of the calculations used in these graphs are given in Appendices B & C.

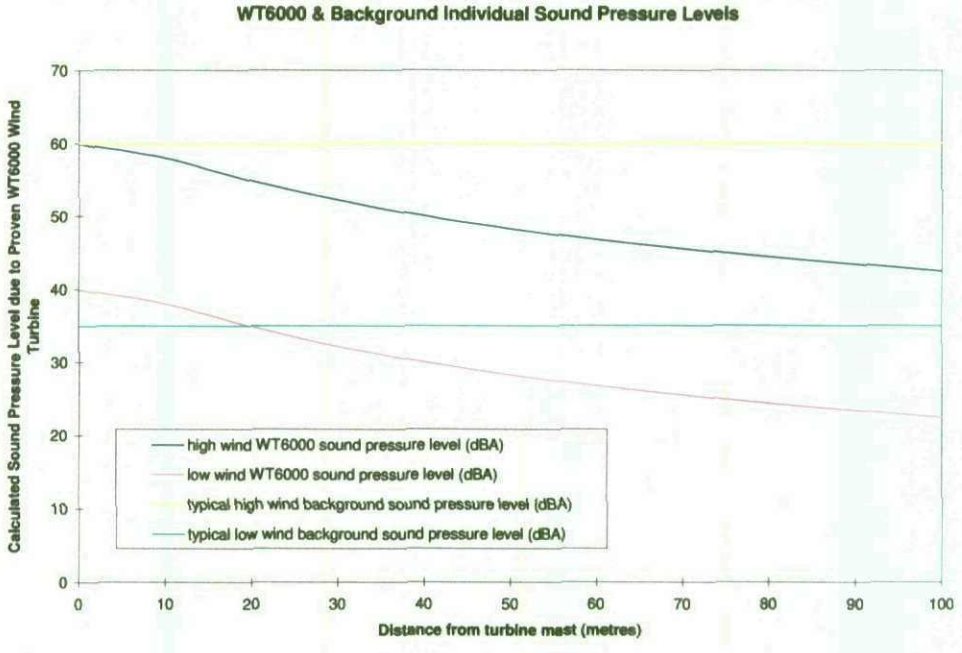


**Figure 1**

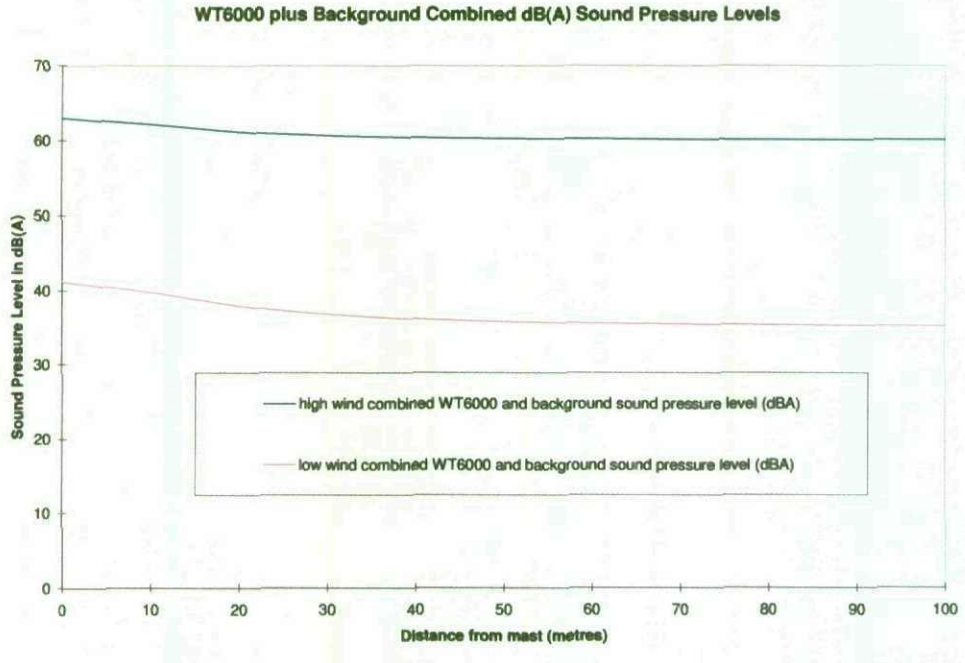


**Figure 2**

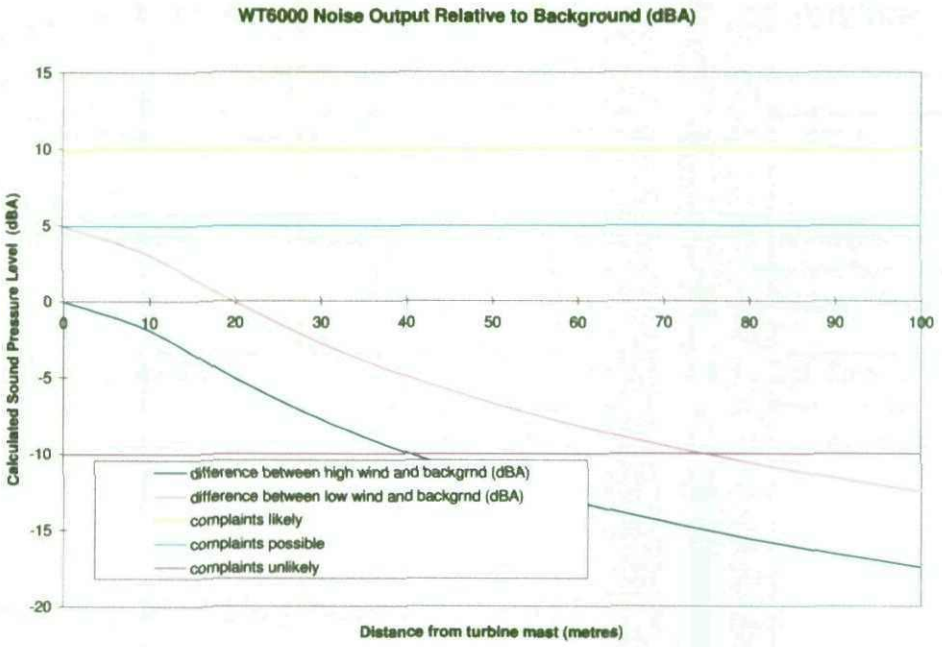


**Figure 3**

## NOTE ON MEASUREMENTS USED IN THIS REPORT

All measurements were taken on a portable SL-25 dBA sound meter at our demonstration wind turbine site in Kilmarnock. Proven Wind Turbines emit a swishing noise only - we do not believe full tonal analysis is needed for our small wind turbines (see also Appendix A).

## COMMENT ON THE CALCULATIONS AND ASSUMPTIONS USED IN THIS REPORT

The above method does not take account of wind "streaming" noise to the downwind side of the turbine. In practice, turbine dBA levels will be shifted downwind by a variable amount depending on the individual site.

In both cases the dB(A) readings taken as coming from the wind turbine **certainly also included a contribution from background noise in a nearby tree.** Secondly, in the graphs shown, the typical background dBA readings have been chosen very conservatively (low).

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## Appendix A - Noise Reduction Features in Proven Wind Turbines

| Feature | Benefit |
|---|---|
| Proven rotors are specially designed to operate at low rpm (typical max Tip Speed Ratio 6) | Blades and bearings rotate slowly keeping air noise to a minimum. |
| Direct Drive Permanent Magnet Generator | There is no gearbox as the rotor is coupled direct to the generator. This eliminates the gearbox hum which is the main source of noise in turbines with gearboxes. There are no touching parts. |
| Specially shaped blade tips | The rounded tips on Proven Wind Turbine blades are designed to reduce the vortices present at the end of any aerofoil. This keeps wind noise to a minimum. |

## Appendix B - Calculating Sound Pressure Levels

**DEFINITIONS**

1. Sound Pressure Level in dB(A) = 10 x $\log_{10}$ (sound power in W/m$^2$)

2. Sound Power in Watts/m$^2$ = $10^{0.1 \times (dB-120)}$

Given a sound power $P_1$ at distance $d_1$ from a noise source the sound power $P_2$ at distance $d_2$ may be calculated by the formula

3. $P_2 = P_1 x \left(\frac{d_1}{d_2}\right)^2$

**ADDING DBA SOUND PRESSURE LEVELS FROM DIFFERENT SOURCES AT POINT X**

First convert the dBA ratings at their initial distances to sound powers using equation 2.

Use the equation 3 to work out the sound powers at point X where you are interested in the total sound pressure level

Add all the sound powers together to find $P_{total}$

Convert back using equation 1 to find $dB(A)_{total}$

# Appendix C - Calculations used in this report

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | height to hub | 15 | | dBA high | 60 | | | | | | | |
| | height meter | 1.5 | | dBA low | 40 | | | | | | | |
| | initial height | 13.5 | | | | | | | | | | |
| | inital dist | 0 | | | | | | | | | | |
| | db=10log(power in w/m2)+120 | | | | | | | | | | | |
| | sound power=10^(0.1(db-120) | | | | | | | | | | | |
| | horizontal distance (m) | actual distance | sound high (w/m2) | sound low (W/m2) | high wind WT2500 sound pressure level (dBA) | low wind WT2500 sound pressure level (dBA) | typical high wind background sound pressure level (dBA) | typical low wind background sound pressure level (dBA) | combined WT6000 plus background sound high | combined WT6000 plus background sound low | high wind combined WT6000 and background sound pressure level (dBA) | low wind combined WT6000 and background sound pressure level (dBA) |
| | 0 | 13.5 | 0.000001 | 1E-08 | 60 | 40 | 60 | 35 | 0.000002 | 1.32E-08 | 63 | 41 |
| | 10 | 16.8 | 6.46E-07 | 6.46E-09 | 58 | 38 | 60 | 35 | 1.65E-06 | 9.62E-09 | 62 | 40 |
| | 20 | 24.1 | 3.13E-07 | 3.13E-09 | 55 | 35 | 60 | 35 | 1.31E-06 | 6.29E-09 | 61 | 38 |
| | 30 | 32.9 | 1.68E-07 | 1.68E-09 | 52 | 32 | 60 | 35 | 1.17E-06 | 4.85E-09 | 61 | 37 |
| | 40 | 42.2 | 1.02E-07 | 1.02E-09 | 50 | 30 | 60 | 35 | 1.1E-06 | 4.18E-09 | 60 | 36 |
| | 50 | 51.8 | 6.79E-08 | 6.79E-10 | 48 | 28 | 60 | 35 | 1.07E-06 | 3.84E-09 | 60 | 36 |
| | 60 | 61.5 | 4.82E-08 | 4.82E-10 | 47 | 27 | 60 | 35 | 1.05E-06 | 3.64E-09 | 60 | 36 |
| | 70 | 71.3 | 3.59E-08 | 3.59E-10 | 46 | 26 | 60 | 35 | 1.04E-06 | 3.52E-09 | 60 | 35 |
| | 80 | 81.1 | 2.77E-08 | 2.77E-10 | 44 | 24 | 60 | 35 | 1.03E-06 | 3.44E-09 | 60 | 35 |
| | 90 | 91.0 | 2.2E-08 | 2.2E-10 | 43 | 23 | 60 | 35 | 1.02E-06 | 3.38E-09 | 60 | 35 |
| | 100 | 100.9 | 1.79E-08 | 1.79E-10 | 43 | 23 | 60 | 35 | 1.02E-06 | 3.34E-09 | 60 | 35 |
| | | | | | | | | | | | | |
| | | | | | | | sound w/m | sound w/m2 | | | | |
| | | | | | | | 0.000001 | 3.16E-09 | | | | |

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# NOISE REPORT STATEMENT - July 07

This measurement has been taken using a handheld noise meter at our wind turbine test facility located at Proven Energy Ltd, Stewarton, Scotland.
The results are merely an indication of the level of noise produced by our wind turbines and it may be inconsistent when measuring a similar wind turbine at a different location.

Proven Energy is committed to providing high quality products, and is in the process of commissioning and collating further noise reports on its range of wind turbines.

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