SADBERGE PARISH COUNCIL

# NOISE FROM WIND FARMS

## 1. Introduction

This note gives a summary of the issue of aerodynamic modulation of noise from wind farms. A more detailed analysis (16 pages) and copies of the source documents are available on request.

## 2. Conclusions

2.1 There is a phenomenon called **aerodynamic modulation (AM)** that causes wind turbine noise to take on a loud, "thumping" character and to become audible at a considerable distance from the wind turbines.

2.2 The fluctuating (amplitude modulated) noise caused by aerodynamic modulation is more noticeable and annoying than broadband noise of the same sound level.

2.3 The Government is aware of the existence of aerodynamic modulation and has acknowledged that it can be an issue in the case of planning applications for wind farms close to residences in low background noise areas. The Government has, however, refused to take action to update the noise guidelines embodied in ETSU-R-97.

2.4 The noise monitoring recommended in ETSU-R-97 is totally ineffective in protecting residents from aerodynamic modulation noise, because the specified noise descriptor ($L_{A90,\ 10min}$) ignores the noisiest 90% of each ten-minute measurement period and gives a result based on the loudest noise during the quietest 10% of the period.

2.5 ETSU-R-97's recommendation that noise monitoring is carried out at the nearest noise-sensitive properties fails to take account of the fact that aerodynamic modulation noise can be heard at considerable distances from a wind farm and can be difficult to detect closer to the wind farm.

2.6 It is highly likely that one form of aerodynamic modulation is caused by stable atmospheric conditions.

2.7 The noise limits recommended by ETSU-R-97 will over-estimate the level of wind-induced background noise near ground level during stable atmospheric conditions. Therefore, when the atmosphere is stable, the ETSU-R-97 noise limits will allow wind turbines to generate noise significantly above the background noise level.

2.8 During stable atmospheric conditions wind turbines will generate higher levels of noise than would be predicted from the wind speed at 10 metres above ground level and the logarithmic wind speed profile equation. Wind farm developers need to be aware of this when assessing whether their wind turbines will meet noise-related planning conditions.

## 3. Discussion

### 3.1 Noise from wind turbines

There are two main types of noise from a wind turbine – mechanical noise from the gearbox, generator, etc. and aerodynamic noise caused by passage of air over the wind turbine blades.

The aerodynamic noise is amplitude modulated; i.e. its volume rises and falls as the turbine blades rotate. Amplitude modulated noise is more noticeable and annoying than non-modulated noise.

ETSU-R-97 refers to the amplitude modulation of aerodynamic noise as *"blade swish"*.

### 3.2 Aerodynamic Modulation

In 2004 the DTI commissioned consultants Hayes McKenzie to investigate complaints about low frequency noise at three UK wind farms. Their report, published in 2006, concluded that *"the common cause of complaints associated with wind turbine noise at all three wind farms is not associated with low frequency noise, but is the audible modulation of the aerodynamic noise, especially at night"*, that *"the presence of aerodynamic modulation which is greater than that originally foreseen by the authors of ETSU-R-97, particularly during the night hours, can result in internal wind farm noise levels which are audible and which may provoke an adverse reaction from a listener"* and that *"to take account of periods when aerodynamic modulation is a clearly audible feature within the incident noise, it is recommended that a means to assess and apply a correction to the incident noise is developed."*

The Government reconvened its Noise Working Group (NWG), and on their advice Defra, BERR and CLG commissioned the University of Salford to carry out an investigation into amplitude modulation of noise from wind farms. The researchers surveyed 133 wind farm sites in the UK and found that amplitude modulation was a factor in four of the sites and a possible factor in another eight. Their report, issued in 2007, said that amplitude modulation *"is not fully predictable at current state of the art."*

Although the Noise Working Group recommended that additional work should be done to analyse data from sites where amplitude modulation had been identified, BERR decided not to commission any further research but to *"continue to keep the issue under review."*

In response to a legal challenge from the Renewable Energy Foundation, the Secretary of State for BERR said *"Nowhere in the 2007 Statement does the Government suggest that AM is not an issue in the UK, nor does it suggest that AM will not and cannot be an issue in the case of future applications for wind farms close to residences in low background noise areas. ..... It is clear beyond argument that the Secretary of State was aware that AM was an issue in the UK, albeit that the number of complaints was limited."*

### 3.3 ETSU-R-97 and Aerodynamic Modulation

ETSU-R-97 specifies that noise from wind turbines should be measured using a noise descriptor, $\mathbf{L_{A90,\,10min}}$. This descriptor is totally unsuited to characterising noise subject to a significant degree of amplitude modulation.

In technical terms, $L_{A90,\ 10min}$ is the tenth percentile of the distribution of the A-rated sound level measured over a ten minute period. In non-technical terms, $L_{A90,\ 10min}$ is calculated by measuring the noise level over a ten minute period, disregarding the noisiest 90% of the time and taking the maximum noise level in the remaining (quietest) 10% of the time.

This might be a reasonable approach if the noise level is fairly constant, but if the noise exhibits significant fluctuations in amplitude then $L_{A90,\ 10min}$ effectively ignores the peaks and gives an estimate of the noise 'floor level'.

Figures 1 and 2 illustrate how $L_{A90,\ 10min}$ characterises fluctuating noise levels.

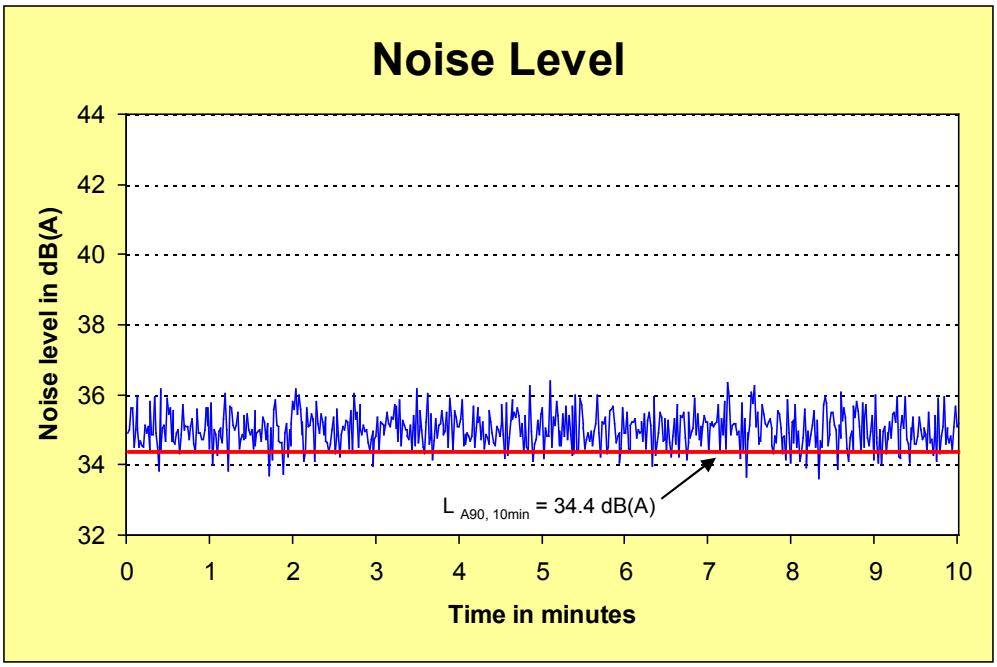


Figure 1

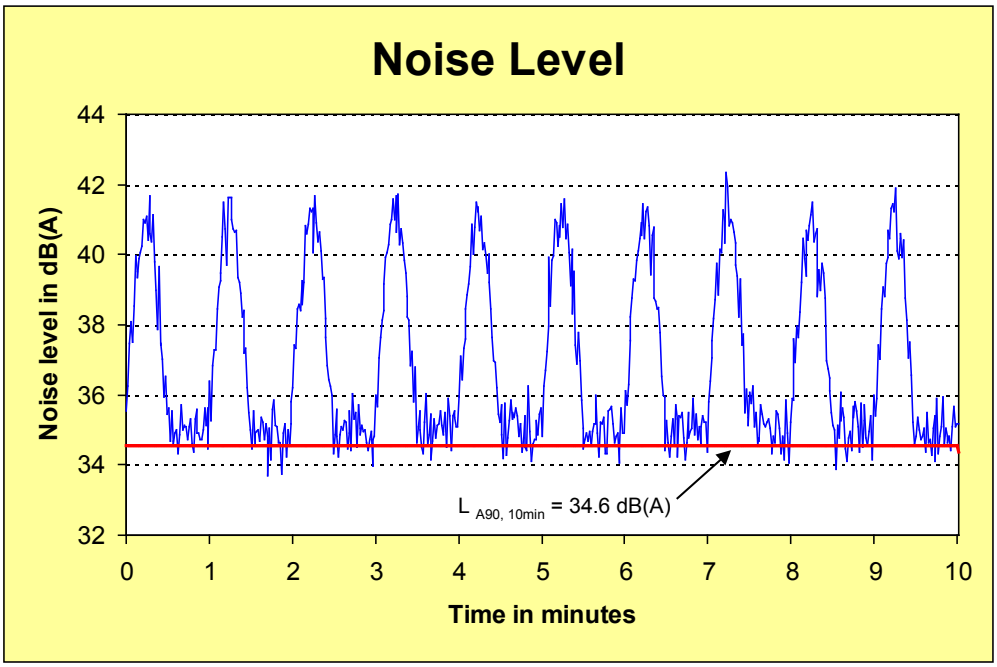


Figure 2

In figure 1 there is a small random fluctuation in the noise level. $L_{A90,\ 10min}$ gives a reading of 34.4 dB(A).

Figure 2 shows the same small random fluctuations plus a series of peaks with a height of 6 dB(a). $L_{A90,\ 10min}$ gives a reading of 34.6 dB(A).

So, despite the large fluctuations in noise levels in figure 2, the $L_{A90,\ 10min}$ value hardly changes from figure 1 to figure 2.

To illustrate the effect of this, the wind turbines could be making a noise like a jet plane taking off in next door's garden for nine out of every ten minutes. $L_{A90,\ 10min}$ would ignore that and characterise the noise based on the remaining one quiet minute.

Planning conditions based on the ETSU-R-97 recommendation of using $L_{A90,\ 10min}$ as the descriptor of the noise from wind turbines are therefore inappropriate for protecting local residents from annoyance and harm caused by aerodynamic modulation of noise from wind turbines.

There are two other significant limitations of ETSU-R-97.

- ETSU-R-97 recommends that the noise limits should be set relative to the existing background noise at the nearest noise-sensitive properties. However, there are consistent reports that aerodynamic modulation is difficult to detect close to wind farms but becomes much more noticeable further away; e.g. at distances of more than 500m.
- ETSU-R-97 uses the wind speed at a height of 10 metres above ground level as an indicator of the level of wind-induced 'masking noise' near the ground. However, under certain atmospheric conditions this relationship breaks down and, in particular, there can be significant wind speeds at a height above the ground while there is virtually no wind – and therefore no wind-induced masking noise – at ground level.

### 3.4 Causes of Aerodynamic Modulation

Dr. Van den Berg of Groningen University has put forward a suggestion – based on both atmospheric physics and experimental results – that aerodynamic modulation occurs when the atmosphere becomes stable. Dr. Van den Berg suggests that the 'thumping' noise of aerodynamic modulation is caused by (a) a larger than normal difference between the wind speeds at the top and bottom of the turbine rotor swept area, and (b) mutual reinforcement of the noise pulses from several different wind turbines running almost synchronously.

Further information about this is included in the separate document **Probable Cause of Aerodynamic Modulation**.

## 4. Contact information

For further information, including copies of the extended version of this note and/or the source documents, please contact Alastair Mackenzie, Clerk to Sadberge Parish Council, by phone on 01325-33333 or via email at alastair@batmail.co.uk.