ETSU-R-97. AN ALTERNATIVE VIEW

ETSU-R-97

ETSU-R-97 – "The Assessment and Rating of Noise from Wind Farms" was published in 1996 and is the UK government's preferred method of assessing wind farm noise for planning purposes. It was the work of a Noise Working Group set up about two years earlier by the then Department of Trade and Industry (DTI) whose renewables role is now performed by the Department of Energy and Climate Change (DECC). DECCs role in the control of noise from wind farms is unusual. In almost all other types of noise control it would be DEFRA, in England, and equivalent government departments in Scotland, Wales and Northern Ireland or, in practice, individual environmental health departments in Local Authorities. Other renewables are simply controlled locally. For example biomass plants may have to meet levels of 25dBA at night in quiet countryside whilst wind turbines can operate at over 40dBA when background noise may be well below 30dBA.

ETSU-R-97 compares the turbine noise with a level 5dB above background noise but, when background noise levels are low, it sets a lower limit. The day time lower limit can be anywhere between 35 and 40dB and the night time lower limit is 43dB. All these noise levels are quoted as LA90 and so are about 2dBA less than the LAeq. The most bizarre result is that night time noise can be up to 8dBA more than the day time noise. No other standard anywhere in the world has a night time limit higher than a day time limit. After more than a decade of insisting that ETSU-R-97 is fit for purpose DECC has asked the IOA carry out a review of the document. However, this review is not a proper independent review by the IOA as does not include the limits which, we are told, "are government policy". If ETSU-R-97 is government policy then the whole document is government policy, not just the noise limits. In any case there is nothing to stop the IOA setting up an independent working group to look at any aspect of government policy it feels needs looking at. So the review is not able to tackle the real problems of the assessment of wind farm noise. Indeed, it will not be truly independent because, as we heard from the chair of the group at the Wind Farm meeting in January, the work of the group "would be in vain if government did not feel they could endorse it at the end of the day".

ETSU-R-97 clearly needs a complete re-think not a pact up. This article presents an alternative assessment methodology which is transparent, fair and complies with the law.

Environmental Impact Regulations

If a scheme meets ETSU-R-97 then it passes the planning noise test, if it does not meet it, it fails the test. It is prescriptive. But the purpose of the planning system is to allow development to take place whilst still protecting the environment and the amenity of people. It has to achieve a balance in the public interest between the case made for a development and the predicted impact(s) on neighbours and the general environment. It is supposed to be a transparent and fair process in which the impact is clearly set out in a way that will allow the decision maker to make an informed decision and the public – particularly those directly affected – to understand how the decision was made.

The impact on the environment and people is determined, in larger projects, by an environmental assessment but the principle behind the regulations applies to all planning assessments including the smallest noise assessment. In this way there can be complete clarity throughout the process and people on both sides of debate can understand each others points of view. The requirement to describe the impact of a development in this way is set out in EU Environmental Assessment Directive 99/337/EEC [CD] and incorporated into law in the UK by means of Regulations. Article 3 of the directive says *The environmental impact assessment shall identify, describe and assess in an appropriate manner, in the light of each individual case and in accordance with Articles 4 to 11, the direct and indirect effects of a project on . . . human beings*. Annexe IV requires that *an estimate, by type and quantity, of expected residues and emissions (water, air and soil pollution, noise, vibration, light, heat, radiation, etc.) resulting from the operation of the proposed project is made*. It also requires *A description of the likely significant effects of the proposed project on the environment resulting from . . . . . - the emission of pollutants*. What is required is that the assessment clearly describes the impact the development will have.

ETSU-R-97 does not fulfil the requirement of a *description of the likely significant effects* in the EU Directive. For example at night the lower ETSU-R-97 limit is 43dB. At a wind speed of around 6m/s when turbines might have reached more or less their maximum noise output they could be running at this limit of 43dB. At one site, perhaps near a main road, the background noise level could be 38dB and so the margin of turbine noise over background noise is 5dB. At another site out in a quiet rural area the background noise might be 28dB and the margin 15dB. Clearly the significance of the impact is more in the second case than in the first but ETSU-R-97 is blind to this. Consequently it does not provide residents with a description of the significant effects of the development and so they do not know whether the impact is small or great – merely that it meets a target noise level set, in part, in such a way as to avoid placing unreasonable restrictions on wind farm development.

The problem with the prescriptive nature of ETSU-R-97 limits is that it results in inappropriate noise limits being set. Fig 1 shows how the noise levels permitted at two small agricultural developments are significantly higher than those permitted for the 250 turbine 500 Megawatt wind farm at Whitelee south of Glasgow. Since the purpose of planning is to balance the need and scale of the development with the impact on residents larger renewable developments would expect to get higher noise limits than small ones rather than the other way round as is the case with these examples.

So the use of ETSU-R97 does not comply with EU law or with UK regulations on environmental impact assessment. What is more it is not fair.

The Alternative

The alternative to ETSU-R-97 and one that complies with EU law and UK regulations is one that sets out the impact of noise from the development on people and the environment. BS 4142 *Method for Rating Industrial Noise Affecting Mixed Residential and Industrial Areas* is a British Standard that has been in existence for over 40 years. Indeed the Noise Working Group that wrote ETSU-R-97 used BS4142 as the basis for their rating method. It is widely used throughout the UK as an assessment tool for planning purposes. It is so widely used that hardly any local authority in the country does not use it for some types of assessment and most require it for assessments of developments where a new non-transportation noise is introduced into an area – even such noise sources as football pitches. It compares the new noise level with the existing background noise level. A simple system of assessment comparing calculated turbine noise with pre-existing background noise is a good starting point to providing the impact of a scheme, particularly if the turbine noise level is adjusted for any significant factors other than simple noise level. Of course it will be more complicated than usual because all the noise levels vary with wind speed.

Background Noise

The background noise measurement process as carried out for ETSU-R-97 assessments, together with a few modifications is fundamentally sound provided that the factors leading to inaccuracy or unrepresentative levels are carefully controlled. Since we are comparing a turbine noise level calculated from the sound power level with the background noise measured at noise sensitive receptors, both the calculated turbine noise and the measured background noise have to be related to the wind speed measured at the same location. It is becoming common practice for this location to be hub height of the turbine. At present this speed at hub height is reduced to 10m height by a standardised method though this is likely to change to hub height when the new turbine noise measurement standard is published. The relation of background noise levels to hub height wind speeds is important because wind speeds at NSRs are usually much less than those at hub height. So if the measured background noise levels were plotted against the wind speed near the NSR instead of at the hub they, and the resulting curve, would be shifted to the left. This means that the background noise curve would be too high when the turbine noise curve (calculated relative to hub height) is compared with it and so the impact would appear to be reduced. Fig 2 shows how the curves vary significantly with measurement height.

The difference between hub height and near ground wind speed is due to two effects. The first is wind shear and the second is shelter provided mostly by topography but also sometimes by trees. High wind shear occurs mostly in flat areas of the country and particularly flat areas in a large bowl surrounded by hills. In more hilly areas wind shear is not generally as high as in flat areas but houses in hilly areas are often built in sheltered valleys whereas the turbines are more likely to be on the hill. So the effect of shelter from valleys in hilly land is the same in principle to the effect of wind shear in flat land. All this results in background noise levels being very variable when related to hub height wind speed. They also vary according to the distribution of wind speed during the measurement period, the time of year, micro-siting of the noise measurement equipment and other factors many of which are still not entirely clear. It is not uncommon for two developers to carry out background noise levels at the same property and produce significantly different results. Fig 3 shows four sets of background noise measurements related to wind speed made at the same property and Fig 4 shows two measurements made at the same property at another location.

So the background noise measurements, if they are to be representative need to be very carefully controlled. At least two measurement periods would be needed at different seasons of the year. The equipment would need to be specified carefully and, in particular, the wind shield. Each measurement period would have to cover the full range of conditions of wind speed and wind direction appropriate for the location and a structure for ensuring this would need to be drafted. Furthermore people's perception of intruding noise is based on what they hear in the quiet times not what they hear on average. The background noise curve should not be based on the best fit or average line but on, say, the average less one standard deviation. This is similar to the principle of taking the quietest part of the night when the dominant noise is road traffic rather than the average over the whole night period.

Calculated Turbine Noise

A common methodology is needed for the calculation of turbine noise. This is an easier problem to deal with and was reasonably well established in the "Prediction and Assessment of Wind Turbine Noise" published in the March/April 2009 edition of the Bulletin though this has no formal status. Some minor adjustments are needed to this methodology – particularly the precise definition of what sound power level should be used and variations in propagation across different topography such as concave and convex topography and water. A methodology for this would be easy to structure.

Assessment

BS4142 says that *A difference of around 10dB or higher indicates that complaints are likely. A difference of around 5 dB is of marginal significance*. However, turbine noise is measured by a different parameter (LA90) from all other industrial noise (LAeq). The difference between the two parameters in the case of wind turbines is 2dB so this needs to be subtracted from the margin above background noise in order to rate the noise under BS 4142. Thus, in wind turbine noise measurement parameters BS4142 says that a difference of around 8dB or more is likely to cause complaint and a difference of around 3dB is marginal. We could postulate that if the turbine noise level was predicted to be likely to give rise to complaints then this would constitute a major loss of amenity. Bearing in mind that this would mean turbine noise was twice as loud as the background LA90 this seems a reasonable interpretation. At a point that BS4142 describes as marginal that could be considered a marginal loss of amenity. Interpolating between these we can construct the following table to describe the basic measure of objective significance. All noise levels are LA90.

A difference of 1dB or less – insignificant
A difference of 2 to 4dB – marginal loss of amenity
A difference of 5 to 7dB – significant loss of amenity
A difference of 8dB or more – major loss of amenity

BS4142 also includes a penalty to reflect the nature of the noise. If it is tonal, has clicks and bang or is otherwise likely to attract attention then a penalty is applied of 5dB. ETSU-R-97 includes a penalty for tonal noise on a sliding scale which is probably more acceptable than a choice of 5dB or nothing. There is no penalty for amplitude modulation in ETSU-R-97 but it is possible that a robust one could be devised in the near future when the results of the RenewableUK research project are known.

The final question in the objective assessment whether we should take account of non-acoustic factors in assessing impact? That there are often significant non-acoustic factors in people's perception of noise has been well documented for over 20 years. In an international study of wind farm noise at in 1993 [1] it was found that the "amount of annoyance was hardly related to the objective sound level". Pedersen et al established that wind turbine noise annoys more than most other noise with similar loudness [2]. Dani Fiumicelli discussed some of these issues in the Nov/Dec 2011 Issue of the Bulletin.

It is likely that, in the UK and some other countries, wind turbine noise is perceived to be worse that other noise of a similar level because of the way wind farms are procured. People quite simply see the process as unfair and this perception has increased over the years by the actions of developers and government. Though there are some exceptions, developers in the UK have not involved communities and have been secretive and unco-operative. They may consult but only after the design and siting has been more or less established. Government has been dismissive of wind farm objectors and has put out and still does put out inaccurate and misleading information. In contrast, in parts of Germany, where there is a much greater take up of wind energy than the UK and less complaints [3] communities are often involved before the site is chosen or the wind far designed.

The fact that people complain even at relatively low noise levels because they don't see the process as fair and open does not mean that such objections are not valid. Wolsink et al concluded in their 1993 paper [1] that, whilst sound level had hardly any effect on annoyance, *This conclusion must not be misunderstood. The fact that sound level is not predicting annoyance does not mean that people are "not really annoyed" when they are reporting it*. It is the responsibility of the noise maker and more particularly government, to ensure that noise is managed properly. That is as important as ensuring that the noise levels themselves are low enough. Schomer [4] takes the view that *adjustment for "public relations,". . . . can range from a 5dB penalty to a 5dB bonus depending on the quality of the relations between the noisemaker and the community*. So, in the same way as residents with a financial involvement in a wind farm can have

5dB more than the standard, perhaps there should be a 5dB penalty on wind farm noise for those not involved until those affected feel they are being treated fairly.

The Decision

We now have the calculated turbine noise levels modified as necessary for other factors and the "worst case" background noise levels. We can compare the two and use the objective descriptions set out above at each noise sensitive receptor at each wind speed. This all needs to be accompanied by a narrative to describe the likely subjective impact that the noise will have on each sensitive receptor. That narrative will include those factors that are not taken into account by the objective test – for example for how long do particular levels of impact last, is the noise likely to be masked by the background noise or are the frequency characteristics quite different, does the intruding noise have significant levels of low frequency. This is all set out in such a way that everyone understands the position and then a proper planning decision can be made.

References

[1] Wolsink et al. Annoyance from Wind Turbine Noise on Sixteen Sites in Three Countries. European Community Wind Energy Conference, 8-12 March 1993.

[2] Pedersen et al.: Response to wind farm noise. J. Acoust. Soc. Am., Vol. 126, No. 2, August 2009 p641

[3] Maarten Wolsink and Sylvia Breukers. Contrasting the Core beliefs regarding the effective implementation of wind power. An international study of stakeholder perspectives. Journal of Environmental Planning and Management 53:5 535-558.

[4] Schomer P.D. (2005). Criteria for assessment of noise annoyance. Noise Control Eng J 53(4), 132-144.

Figures

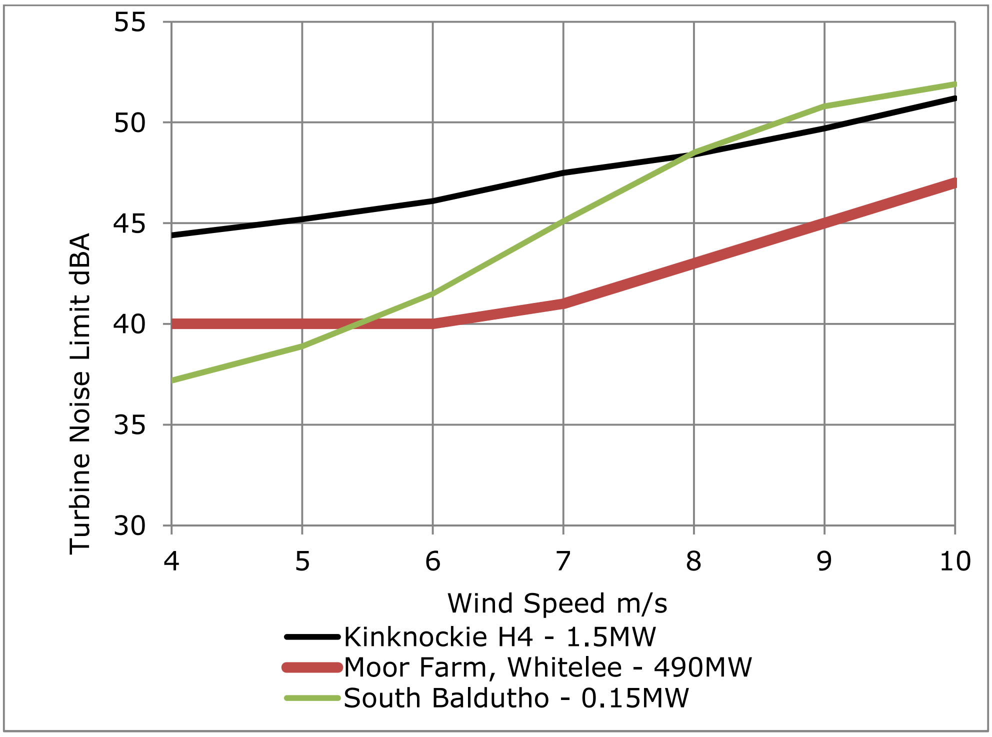

Fig 1 – ETSU noise limits at three sites. Black line is two 750kW turbines, green line is two turbines, one of 100kW and one of 50kW. The thick red line is the 490,000kW Whitelee Wind Farm.

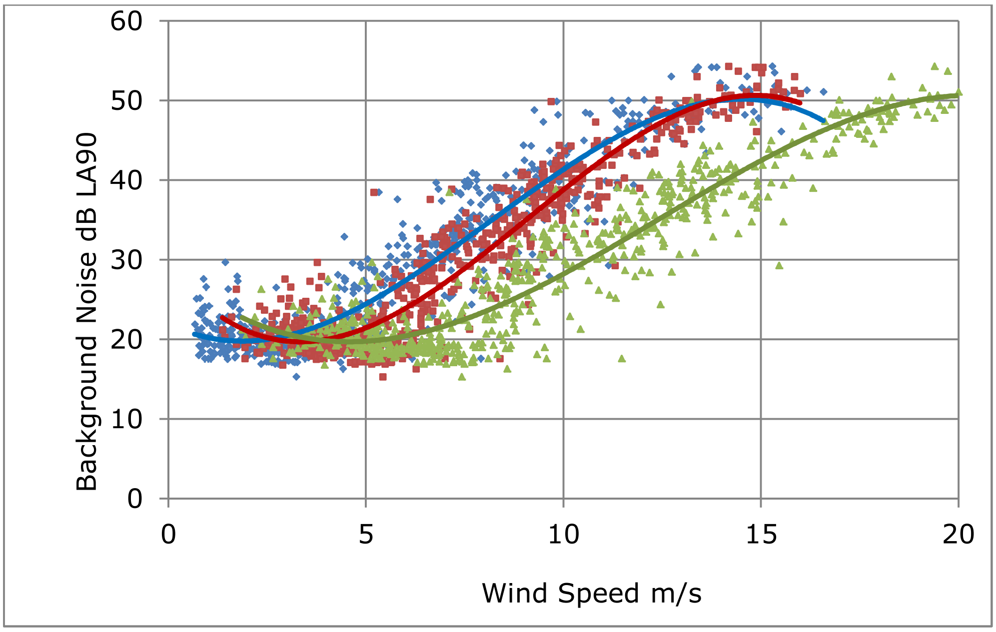

Fig 2 – Effect of wind speed measurement parameter. Noise data is identical in all three cases. The blue data and best fit line show the noise data plotted against the measured 10m wind speed. Red shows the noise data plotted against "Standardised" 10m wind speed – ie hub height standardised to 10m using a roughness length of 0.05. Green shows noise data plotted against the measured hub height wind speed.

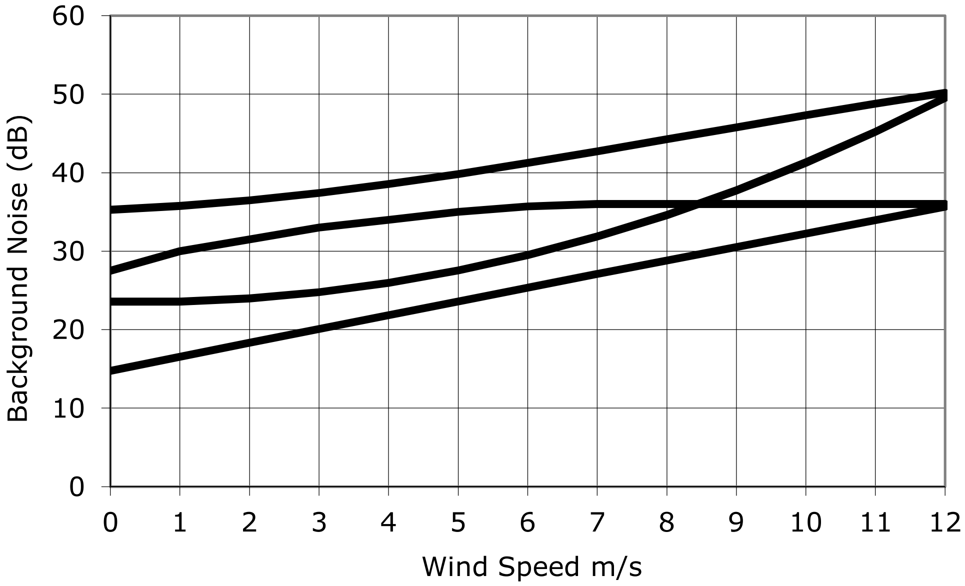

Fig 3 – Best fit curves for background noise measured at the same notional location. Three of the measurement locations are within a few metres of each other.

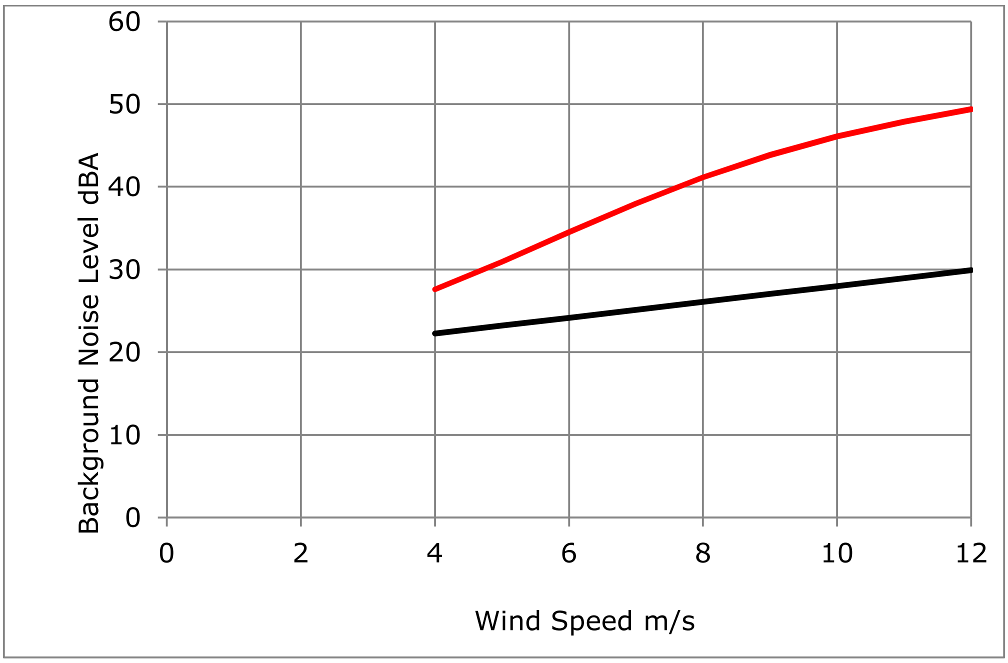

Fig 4 – Best fit curves for another site. Measurements made within a few metres of each other.