Dick Bowdler
Acoustic Consultant
01383 882 644
077 8535 2534
dick@dickbowdler.co.uk

CLOCAENOG FOREST SSA

Wind Farms Cumulative Impact Assessment v2.1

20th December 2012

The Haven, Low Causeway, Culross, Fife. KY12 8HN

CLOCAENOG FOREST SSA

Wind Farms Cumulative Impact Assessment

1 INTRODUCTION

1.1 This report is prepared on the instructions of and with the co-operation of Denbighshire County Council and Conwy County Borough Council. In September 2007 I produced a report, on behalf of New Acoustics, setting out a proposed method for dealing with the cumulative noise impact of wind farms at planning application stage. The recommendations in that report have been used in principle for conditions at Brenig and Derwydd Bach and this current report is to update the original recommendations in the light of intervening events.

1.2 The Welsh Assembly Government set out Strategic Search Areas in TAN 8. These areas include Clocaenog Forest. It is therefore intended that the SSA will be the site of a number of wind farms and that there may eventually be 100 turbines or more in the area. The location of these within the SSA is not known. This report suggests a framework for assessing and conditioning individual applications in the light of the cumulative impact.

1.3 My recommendations are required to comply with the general framework of ETSU-R-97 and also local policy MEW 10(iv). MEW 10(iv) says that *wind turbines or windfarms . . . will be permitted provided that . . . the proposal does not lead to unacceptable noise levels to residential amenity in the surrounding area.* I have tried to set a standard that would provide the best protection for residents whilst accepting that decision makers are required to take into account targets for renewable energy that are enshrined in Government policy. This does not guarantee that there will be no loss of amenity at local residences.

1.4 Appendix 1 of the report has draft planning conditions and Appendix 2 is a copy of the original 2007 report prepared by me when I was a Director of New Acoustic.

1.5 All noise levels in this paper are shown as L_{A90} unless otherwise stated, in accordance with ETSU-R-97.

2 SUMMARY OF THE PROBLEM AND THE 2007 RECOMMENDATIONS

2.1 Applications for wind farms will normally be made and considered on an individual basis. If one development "uses up" all the noise standard then no other developments in the surrounding area (perhaps up to several kilometres away) could be permitted. It is therefore in the interests of all parties – particularly residents and developers – that a

framework is established to assess individual applications in the context of their cumulative effect.

2.2 To assess turbine noise levels at residential properties requires, in part at least, a comparison with the pre-existing background noise level at each wind speed. This introduces several difficulties:

> The background noise level must be that without existing turbines running. This introduces for applicants of later developments the problem of measuring the background noise without the influence of existing turbines.
>
> Background noise levels vary according to the distribution of wind direction during the measurement period, the time of year, the position of the anemometer mast at which the wind speed is measured and other factors many of which are still not entirely clear. This means that two developers could measure different background noise levels at the same property. Since the permitted noise level from turbines is based on the background noise it seems quite unreasonable for one developer to be allowed to run turbines louder than another when measured at the same property.

2.3 Accordingly the original proposal was to adopt a set of background noise levels typical of the area and use it as a base for the assessment of turbine noise. This also has the advantage that the developer would be saved the task of measuring the background noise levels. Measurements had been made prior to 2007 in the area for Brenig and Gorsedd Bran. Those that were not affected by turbine noise from Tir Mostyn were selected to form a set of Standard Background Noise Levels.

2.4 The 2007 report also proposed a common method of calculating turbine noise at sensitive properties.

2.5 In order to assess how a number of wind farms affect the total noise, existing and hypothetical wind farms were modelled at real neighbouring properties, taking account of the effect of wind direction. The results were that the maximum cumulative noise level varied from 0.1 to 3.5dB more than the worst case downwind noise levels from the individual wind farm with the highest level at the property.

2.6 The conclusion and recommendation was that the standard adopted for individual properties should be 3dB above background noise level or 35dB, whichever is the higher, to apply at all times. This would normally result in a maximum cumulative level of 38dB or 5dB above background noise at any property.

2.7 The format of these noise limits is taken from ETSU-R-97 "The Assessment and Rating of Noise from Wind Farms". This adopts a limit of 5dB over background noise except where background noise is low, when a lower fixed limit applies. This lower fixed limit is between 35 and 40dB during the day, depending on a number of factors and 43dB at

night. This is discussed in more detail in section 5 of the report in Appendix 2.

3 THE CURRENT POSITION

3.1 There have been a number of developments and changes in best practice since my original report. I set these out below together with an explanation of the effect these might have on my original recommendations.

3.2 The background noise levels which were used to derive the "standard" background noise were plotted against the wind speed measured at a height of 10m on a 10m mast. For completeness it may be stated that the measurements used were all those over the complete 24 hour period, not separately for night and not excluding the middle of the day. This is because background noise levels in this area are similar during the day and night so it is not necessary to make a distinction. This is also the reason for adopting the same noise condition day time and night time.

3.3 It is now considered best practice to use a "standardised" wind speed which is the hub height wind speed reduced to a height of 10m using a standard wind shear rather than a real wind shear. Particularly at lower wind speeds the standardised 10m wind speed is generally higher than the actual 10m wind speed because real wind shear tends to be greater than standard wind shear. This results in the noise data points being plotted further to the right and so, effectively, the background noise curve will be lower.

3.4 The second point is that more wind farms in the area have been approved with conditions and clearly these conditions will have to be respected.

3.5 The third point is that of the inspector's decision at the Gorsedd Bran inquiry and the subsequent Judicial Review and Court of Appeal decision. In summary the Court of Appeal upheld the inspector's decision that, notwithstanding compliance with ETSU-R-97 the fact that residents would receive turbine noise from all directions would be in breach of local policy.

3.6 The fourth point is that there are now a number of consents for small turbines within the SSA and surrounding area. It is also likely that there will be increasing numbers of such turbines. Some of these can be almost as noisy as large turbines.

3.7 Finally there are some aspects of turbine noise propagation that need to be taken account of. First is the propagation over concave ground – that is to say broadly across valleys. The second is that, as turbines get taller the upwind shadow zone gets further away – that is to say larger turbines can be heard further upwind than smaller ones.

3.8 These matters are all discussed in the next five sections.

4 STANDARD BACKGROUND NOISE

4.1 I have first compared the background noise levels in the 2007 report (based on the Brenig and Gorsedd Bran EIAs) with background noise measurements made for Wern Ddu and Derwydd Bach which were not available to me previously. The average levels are very similar to those in the 2007 report as related to a measured 10m wind speed. The original background noise levels have been re-processed to relate noise levels to standardised 10m wind speed instead of measured 10m wind speed. In the absence of long term (one year) wind shear data for this area I have used data from a site with similar topography in the north of England. The shear values taken are the average values at each wind speed for the whole 24 hour period. The wind speed in this case is the measured wind speed at 10m.

Wind Speed m/s	4	5	6	7	8	9	10
Shear Exponent	0.31	0.29	0.27	0.25	0.23	0.22	0.21

Although wind shear will be higher at night (and therefore background noise less) this is compensated for, in terms of protection for residents, in the overall recommendations because the night time lower limit is taken as 35dB for an individual wind farm rather than 43dB in ETSU-R-97.

4.2 The result of this is that the background noise levels are apparently slightly lower than before as shown in the table below where wind speed is standardised at 10m.

Wind Speed m/s	4	5	6	7	8	9	10
Background dB	25	27	29	31	34	36	39

I have also examined the average of those background measurements made for the Clocaenog Forest proposal by Hayes McKenzie – excluding those that were affected by water or other continuous noise. I find that there is an average difference of 0.3dB over all wind speeds and a maximum difference of 1.5dB between these figures and the figures in my table. All the above suggests that these levels are representative of the SSA and surrounding area, irrespective of the location of the noise meter and the anemometer mast.

5 NOISE CONDITIONS FOR EXISTING CONSENTS

5.1 There are existing conditions for Tir Mostyn, Wern Ddu, Brenig and Derwydd Bach.

5.2 The Tir Mostyn condition says that the noise of turbines shall not exceed 40dBA at any wind speed up to 9m/s. This means that there is no margin left under the ETSU maximum day time limit of 40dB and therefore no further turbine noise is permitted. In addition some properties will be in excess of the cumulative standard set out in my 2007 report without any addition from other wind farms. Future turbine noise levels will therefore need to be limited at some identified properties to protect amenity properly.

5.3 The Wern Ddu condition is 40dB or 5dB above background during the day and 43dB or 5dB above background at night – again the highest levels permitted by ETSU so sterilising the surrounding area. Identified properties will need to be limited as far as further wind turbine noise is concerned.

5.4 The Brenig condition gives the following limits:

At Ty Newydd, Pennant Uchaf, Garreg Lwyd, and Awel y Brenig:

Wind Speed m/s	4	5	6	7	8	9	10
Individual Standard dB	43	43	43	43	43	43	43

At all other properties:

Wind Speed m/s	4	5	6	7	8	9	10
Individual Standard dB	35	35	35	35	38	40	42

It should be noted that the value of 43dB in the first table is the individual limit applicable to Brenig wind farm for financially involved properties and nothing to do with the ETSU-R-97 night time limit. The second table is 3dB above the notional background noise level or 35dB – which is my original recommended individual wind farm limit. All properties here therefore comply with the original individual standard.

5.5 The Derwydd Bach condition gives the following limits:

At Bod Petryal, Pendre Bach, Pendre Fawr, Ty-Hên, Pentre, Parc, Bryn Goleu, Minffordd, Tyn-y-Graig, Pen-y-Bryn, Tan-y-Bwlch and Bryn-Celyn:

Wind Speed m/s	4	5	6	7	8	9	10
Individual Standard dB	38	38	38	39	41	43	43

At all other properties:

Wind Speed m/s	4	5	6	7	8	9	10
Individual Standard dB	35	35	35	35	38	40	42

The limits in the second table are the individual limits set out in my 2007 report. The limits in the first table are the limits for those properties that could not meet the individual limit and are the worst case predicted noise level at any property. These were permitted following an explanation by the applicant in the terms of the exceptions to the individual limits set out in the 2007 report though they are slightly higher than the cumulative limit. The properties in the first table will need specific limits for future wind farms.

5.6 I therefore propose a limit on those specific properties identified above that currently have planning conditions that allow levels in excess of the original 2007 individual limits. I propose that this limit is 32dB at these properties from any future wind farm. The effect of this would be:

> Properties having a limit just above the individual limit of 35dB would be raised to 37dB – below the cumulative limit.
>
> Properties just above the 38dB cumulative limit already would have an increase of 1dB or less.

6 GORSEDD BRAN DECISION

6.1 The Inspector in refusing the Gorsedd Bran appeal gave one reason as:

> *Gorsedd Bran lies to the west and south west of the dwellings most affected by Tir Mostyn noise. This means that the prevailing wind would introduce additional noise to the same dwellings when they might currently expect not to hear the existing turbines. This would significantly increase the general noise nuisance experienced by a significant number of local residents. This cumulative increase in noise, whilst likely to be within ETSU 97 levels, would result in a level of harm which would conflict with UDP policy MEW10 criteria (iv).*

Following a Judicial review the decision was upheld in the Court of Appeal.

6.2 The policy wording is that wind farms will be permitted provided that *iv) the proposal does not lead to unacceptable noise levels to residential amenity in the surrounding areas*. If for no other reason than the risk of a future Judicial Review this ought to be taken into account in the assessment of future applications. It is my opinion that, in the context of the SSA and neighbouring area the structure set out in this report allows for the concerns of the inspector at the Gorsedd Bran inquiry. The maximum level permitted is 38dB except at higher wind speeds and this is 2dB less than the maximum set in ETSU-R-97. This would allow for other wind farms on the opposite side to a property to be 38dB but

not 40dB. In practice, because the indivudual limit for wind farms is normally 35dB, it is likely that worst case levels would normally be less than 38dB.

7 SMALL DEVELOPMENTS

7.1 The problem that arises with small turbines is that a single turbine with a few tens of kW output can restrict the future installation of larger turbines. This is particularly relevant in the SSA where there is a presumption that more turbines will be applied for. There is no definition of small turbines or small developments. It seems sensible that it should be the size of the whole development that is taken into account. So one 200kW turbine might be considered "small" but three such turbines might not. I propose that applications for developments with a total installed capacity of 500kW or less and not more than three turbines are treated as "small developments". This means that they would be subject to lower noise limits. Generally each application in this category would be considered on its merits but proposed guidelines are shown in the next paragraphs.

7.2 In principle small developments should be designed so that, cumulatively with existing or planned developments of other wind turbines, the noise level does not exceed 35dBA at any noise sensitive property at any wind speed.

7.3 Alternatively, for turbines that come within the scope of the BWEA Small Wind Turbine Performance and Safety Standard of February 2008 (swept area of 200 square metres – typically less than 50kW), the individual noise limit for that turbine can be taken as 34dB – but measured as LAeq - at any noise sensitive property without calculations necessary for cumulative noise provided there are no other turbines within 700m.

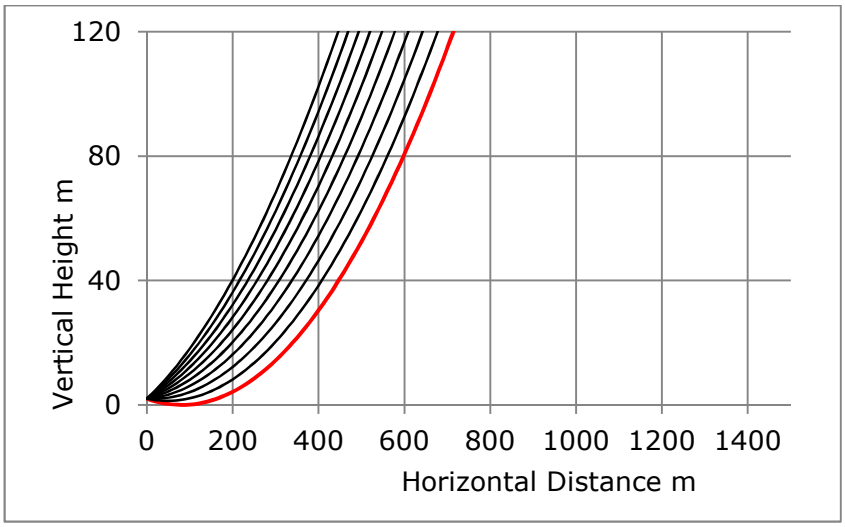
7.4 Finally "micro-turbines" less than 3.5m diameter under certain circumstances may be excluded from assessment altogether as the may be permitted development.

8 SOUND PROPAGATION

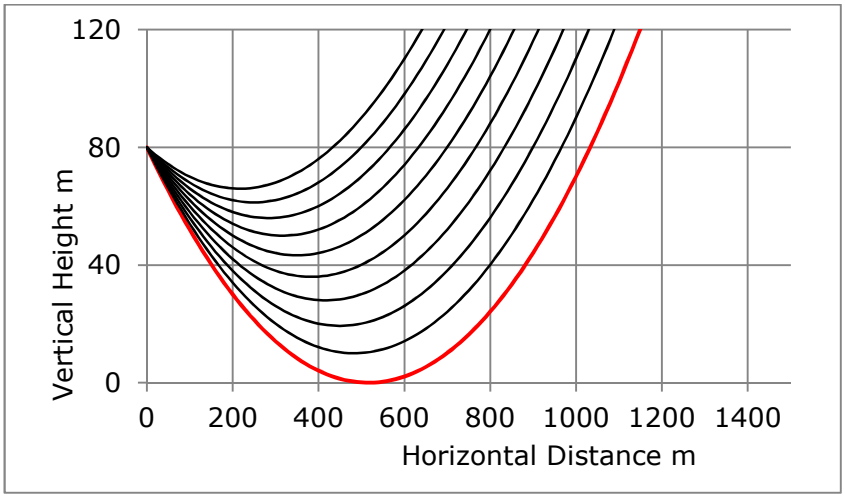
8.1 The main recommendations for turbine noise calculations in the 2007 report are similar to those set out subsequently in the "Prediction and Assessment of Wind Turbine Noise" published in the Acoustics Bulletin in 2009. In addition the latest practice in calculating turbine noise levels includes a reduction of 3dB in the attenuation (that is to say increase the predicted turbine noise level by 3dB) where the ground between the turbine and the receptor is concave – essentially propagation across a valley. This was first proposed by Bass et al in a report to the European Commission in 1998 called "Development of a Wind Farm Noise

Propagation Prediction Model" and was confirmed in a recent Australian Paper by Evans and Cooper.

8.2 The second point about propagation is that, as turbines get taller, the distance at which they can be heard upwind increases. In the next diagram the wind is blowing from right to left. As the sound propagated from left to right, the wind shear tends to bend the sound waves upwards so that after a certain distance defined by the red line there is an acoustic shadow. Here the sound from a source at low level can be heard up to about 100m.



8.3 In the second case the noise source is at 80m and the turbine can be heard upwind up to about 500m. Note that in the space to the left of the red line and the Y-axis the listener will receive the direct sound down form the noise source.



8.4 As turbines get taller the distance they are heard upwind increases so there needs to be some minimum distance from turbines to properties to avoid this. Ideally it should be a function of the height to blade tip. I suggest eight times the height to blade tip though this is somewhat arbitrary.

8.5 A further factor that should be considered and relates to an earlier point is that sound travelling upwind across a valley (over concave ground) will travel further than across flat ground.

9 RECOMMENDATIONS

9.1 To prevent significant upwind propagation, no turbine should be closer to a noise sensitive receptor than eight times the height to blade tip of the turbine.

9.2 I have calculated for Tir Mostyn, Wern Ddu and Derwydd Bach which properties will have noise levels in excess of the individual limit provided that the planning condition is adhered to. At each of these properties the noise level from any future wind farm shall not exceed 32dB. The properties are shown in the three tables below. The table heading shows the name of the wind farm currently causing noise in excess of the individual limit.

Tir Mostyn	Easting	Northing
Bryn Bach	302113	358774
Gareg Lwyd	300283	359585
Glan Ceirw	301774	355689
Glydfa	300220	360300
Hafod ty ddu	301566	359340
Hafotty-Las	300877	359679
Pennant Isaf	299604	359943
Pennant Uchaf	299038	359509
Ty-Newydd	299453	359377
Ty'n-y-ffynnon	301132	360113

Wern Ddu	Easting	Northing
Bryn ffynnon	305513	348435
Bryn-halen-bach	305180	348645
Plassau	306541	348892
Tan-y-bryn	305644	349362

Derwydd Bach	Easting	Northing
Bod Petryal	303760	351070
Bryn Goleu	302830	348380
Bryn-Celyn	302060	349890
Minffordd	302790	348240
Parc	302940	348520
Pendre Bach	303653	349689
Pendre Fawr	303610	349500
Pentre	303570	348815
Pen-y-Bryn	301700	349700
Tan-y-Bwlch	301870	349880
Ty-Hên	303690	349210
Tyn-y-Graig	302340	348280

9.3 The noise level at all other properties shall not exceed the level shown in the table below. The wind speed is to be standardised from hub height to 10m using a roughness length of 0.05m.

Wind Speed m/s	4	5	6	7	8	9	10
Noise Limit dB	35	35	35	35	37	39	42

9.4 At properties in which the occupier has a financial involvement in a wind farm the noise limit can, for that wind farm only, be 43dB at all wind speeds.

9.5 The method to be used for calculating turbine noise to demonstrate compliance is that set out in ISO9613-2 using the following parameters:

Manufacturers measured turbine noise levels (as opposed to warranted figures.)

Air absorption at 15 degrees Celsius and 75% relative humidity.

No ground absorption (G=0)

No barrier reduction except only 2dB when turbine is completely screened.

An addition of 3dB to the noise level from any turbine where the average propagation height from the turbine to the receiver over the ground is more than one and a half times what it would be if the ground between the source and the receiver was a straight line.

9.6 In circumstances where the applicant considers that the Standard Background Noise Level is inappropriate for a particular location measured figures may be submitted. These measured figures should be made on two separate periods not less than four months apart and each period should be not less than two weeks and consist of a range of wind

speeds and directions that can be demonstrated to be similar to those occurring over a long term at the site in question.

9.7 Where the applicant considers that properties affected by the application site are unlikely to be affected by other applications in the future then a commentary may be provided describing why this is the case for submission to the Council. The commentary should also demonstrate that the cumulative standard will not be breached by the application wind farm, all existing and consented wind farms and any other wind farms in the planning process identified by the Local Authority.

APPENDIX 1 – NOISE CONDITIONS

This appendix contains model noise conditions for small developments and for large developments. As defined previously a small development is one with a total installed capacity of 500kW or less.

The procedure for defining the limits for a small development as described in 7.2 above is that the applicant provides calculations of the noise level of the proposed development, together with all other consented developments and valid planning applications for any wind turbines within 3km of the application turbine or turbines (relevant turbines). If any turbine of a wind farm or group of turbines is within this distance the noise from the whole wind farm or group should be taken into account. These calculations shall take account of wind direction and should assume that each turbine or group of turbines is running to its consented limits (or to 35dB if not consented). The calculations at each affected property are carried out for all relevant turbines when the wind is in the direction from the application turbine(s) to the property.

The total noise level of all the wind turbines defined in this way at each noise sensitive property calculated at a wind speed of 10m/s is then deducted logarithmically from 35dB and the resulting noise level is the noise limit available for the application turbine. For example, if all the wind turbines defined in this way produce a total noise level of 31dB at a particular property then this is subtracted from 35dB and the limit for the application turbine is therefore 33dB. This gives the value "X" in Noise Condition 1.

Model conditions are shown below. [Square brackets] indicate optional or alternative text.

Noise Condition 1 – Developments 500kW or Under

The wind turbine noise rating level (that is to say including any tonal correction) at any residential property or other noise sensitive premises shall not exceed XdB measured as LA90 over any period of 5 minutes. A tonal correction of 5dB shall be applied if, in the opinion of the Local Planning Authority the noise is significantly tonal. Alternatively, at the applicant's discretion, tonal noise and a resulting penalty may be defined using the methodology in ETSU-R-97.

On receipt of a complaint, the LPA shall investigate the matter and if it considers the complaint is justified it shall instruct the operator of the turbine[s] to arrange for an appropriately qualified independent consultant to measure the noise level of the turbines and test compliance with this condition.

If, in the opinion of the LPA, the timescale of the compliance testing is unreasonable in relation to the perceived noise impact, it shall instruct the operator to turn off the turbine[s] (except during a reasonable period of compliance testing) until the compliance test is complete.

Noise Condition 2 – Alternative for Developments 50kW or Under

The wind turbine noise rating level (that is to say including any tonal correction) at any residential property or other noise sensitive premises shall not exceed 34dB measured as LAeq over any period of 5 minutes. A tonal correction of 5dB shall be applied if, in the opinion of the Local Planning Authority the noise is significantly tonal. Alternatively, at the applicant's discretion, tonal noise and a resulting penalty may be defined using the methodology in ETSU-R-97.

On receipt of a complaint, the LPA shall investigate the matter and if it considers the complaint is justified it shall instruct the operator of the turbine[s] to arrange for an appropriately qualified independent consultant to measure the noise level of the turbines and test compliance with this condition.

If, in the opinion of the LPA, the timescale of the compliance testing is unreasonable in relation to the perceived noise impact, it shall instruct the operator to turn off the turbine[s] (except during a reasonable period of compliance testing) until the compliance test is complete.

Noise Condition 3 – Developments over 500kW

A The operator shall record average wind speed and average wind direction data [at hub height on the meteorological mast]/[on each individual turbine at the nacelle duly corrected for the presence of the rotating blades] on the site. The operator shall also record the status of operation of each turbine during each ten minute period. The data shall be recorded on a continuous basis in consecutive 10 minute periods and retained for a period of at least 12 months from the date of recording. Wind speeds shall be taken from the [meteorological mast]/[nacelle anemometers on the 5 nearest turbines to the noise measurement location] and standardised to 10 metres height using a ground roughness of 0.05 metres using the formula on Page 120 of ETSU-R-97.

B The wind turbine noise rating level (that is to say including any tonal correction) at any residential property or other noise sensitive premises shall not exceed the limits for that property in this table.

Wind Speed m/s	4	5	6	7	8	9	10
Specific Properties	Individual levels						
All other properties	35	35	35	35	37	39	42

C Within 21 days of a written request from the Local Planning Authority (LPA) following a complaint in relation to noise at a residential property or other noise sensitive premises, the operator shall provide to it all relevant operational data collected in terms of clause A of this condition and engage a suitably qualified consultant to carry out noise monitoring at the property to which the complaint relates generally in accordance with the procedure described in ETSU-R-97 in the section numbered 2.0 starting on page 102 but excluding sub-paragraph 1. Reference to superseded standards should be taken to mean their closest replacement. Reference to "critical wind speed" shall be taken to mean "wind speeds and directions during which the noise is most intrusive" and the number of data points shall be sufficient to obtain a reliable best fit curve covering only those conditions during which the noise is most intrusive.

D Within 6 weeks of their engagement (unless a longer period is agreed in writing by the LPA) the consultant shall forward to the LPA a report setting out the consultant's conclusions as to whether or not the noise limits defined in section B have been exceeded.

E Should the noise limits defined in section B be exceeded, the operator shall, within 7 days of the receipt of the consultant's report by the LPA take steps to ensure that noise immissions from the wind farm are reduced to a level below the noise limits. Thereafter, and within 21 days of the receipt of the consultant's report by the LPA, the operator shall submit a scheme for the permanent mitigation of wind farm noise for the written approval of the LPA. Thereafter the approved mitigation measures shall be implemented in full by the operator.

Reason: To control operational noise, in the interests of residential amenity.

APPENDIX 2 – 2007 REPORT

34 Old Mill Road
Duntocher
Clydebank
Dunbartonshire
G81 6BX
Scotland

01389 878891 T
01389 890516 F
07785352534 M
dick@newacoustics.co.uk E
www.newacoustics.co.uk W

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Wind Farms Cumulative Impact Assessment

12th September 2007

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Wind Farms Cumulative Impact Assessment

1 INTRODUCTION

1.1 This report is prepared on the instructions of Denbighshire County Council. The purpose is to examine the issues associated with the cumulative impact of wind turbines within the SSA and to suggest a framework for assessing and conditioning individual applications in the light of the cumulative impact.

1.2 The Welsh Assembly Government set out Strategic Search Areas in TAN 8. These areas include Clocaenog Forest. It is therefore intended that the SSA will be the site of a number of wind farms with a target capacity of 140MW. This suggests (depending heavily on the size of the turbines) that there may eventually be in the order of 100 turbines in the area. The location of these within the SSA is not known.

1.3 Applications for wind farms will normally be made and considered on an individual basis. If one development "uses up" all the noise standard then no other developments in the surrounding area (perhaps up to about 5km away) could be permitted. It is therefore in the interests of all parties – particularly residents and developers – that a framework is established to assess individual applications in the context of their cumulative effect.

1.4 All noise levels in this paper are shown as L_{A90} unless otherwise stated, in accordance with ETSU-R-97.

2 BACKGROUND NOISE

2.1 To assess turbine noise levels at residential properties requires, in part at least, a comparison with the pre-existing background noise level at each wind speed. This introduces several difficulties:

The background noise level must be that without existing turbines running. This introduces for applicants of later developments the problem of measuring the background noise without the influence of existing turbines. This has already been shown to be a problem with the Brenig application.

Background noise levels vary according to the distribution of wind speed during the measurement period, the time of year, the position of the anemometer mast at which the wind speed is measured 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. An inspection of the background noise measurements at Ty Newydd made in 2000 for Tir Mostyn and in 2006 for Brenig demonstrates this. At 6m/s the Tir Mostyn measurements are about 39dB and the Brenig measurements 32dB. At 10m/s the Tir Mostyn measurements are 53dB and the Brenig measurements 38dB. Since the permitted noise level from turbines is based on the background noise it seems quite unreasonable for one developer to be allowed to run turbines 7 to 15dB louder than another when measured at the same property.

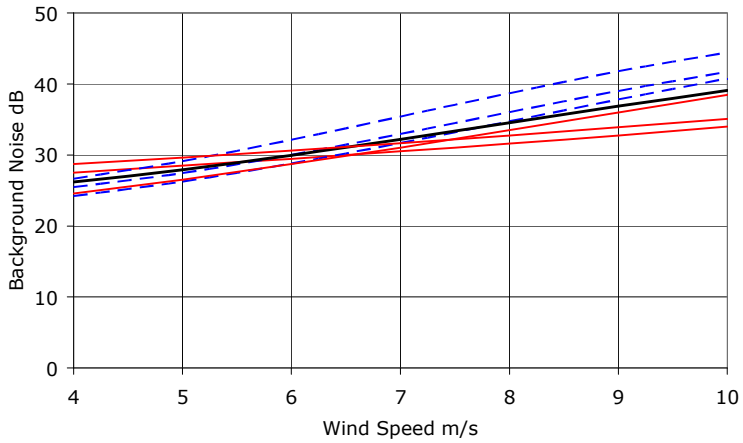
2.2 Accordingly I believe it is necessary to establish a common background noise level typical of the area and use it as a base for the assessment of turbine noise. This also has the advantage that the developer would be saved the task of measuring the background noise levels.

2.3 Measurements have been made in the area for Brenig and Gorsedd Bran. Measurements were made for the Brenig application at Plas Nantglyn, Ty Newydd, Tyn-y-Ffynnon, Pennant Uchaf and Isgaer-Wen. The measured noise at Pennant Uchaf is dominated at low wind speeds by something non-wind related – possibly water noise – so that has been excluded. At Ty Newydd the Tir Mostyn turbine noise levels were so high that the background noise levels cannot reliably be extracted from them so that has also been excluded.

2.4 I have taken the remaining three Brenig sites and extracted the calculated noise from the Tir Mostyn turbines. The calculated turbine noise has been deducted from every separate data point (not just the best fit curves) wherever the measurement position is downwind of them. More specifically 90 degrees either side of a line from the centre of the turbines to the property. So the whole downwind half of the compass has turbine noise deducted because the noise level at 90 degrees to the wind is only about 2dB less than the downwind direction.

2.5 I have also looked at the data collected for the Gorsedd Bran application. Here three of the locations where background noise data was measured were more than 2.5km from Tir Mostyn so that turbine noise was probably insignificant. These are Nant-y-Lladron, Wern Uchaf and Cwm-y-Rhinwedd.

2.6 All these levels are plotted on the graph below. The three thin solid red lines represent the background noise levels taken from the Brenig and the broken blue lines show the data collected for Gorsedd Bran. The thicker black line shows the average of all these six measurements.



2.7 Particularly around 6m/s – which is the wind speed at which turbine noise usually exceeds background noise by the largest margin, the noise levels are very close. Furthermore the average line is similar to the average of a large number of measurements I have seen that have been taken in rural areas.

2.8 I propose therefore to allocate the average background noise levels shown in the graph above to all properties unless there appears to be a good reason not to do so and call these the Standard Background Noise Level. The numbers in tabular form are:

Wind Speed m/s	4	5	6	7	8	9	10
Background dB	26	28	30	32	35	37	39

3 TURBINE NOISE

3.1 To establish a common method of assessment also requires that there is a common method of calculating turbine noise at sensitive properties. The one that I propose to adopt is that set out in ISO9613-2 using the following parameters:

Manufacturers measured turbine noise levels (as opposed to warranted figures.)

Air absorption at 15 degrees Celsius and 75% relative humidity.

No ground absorption (G=0)

No barrier reduction or 2dB when turbine completely screened.

This procedure is currently used by most consultants and is used in principle for Brenig and Gorsedd Bran.

4 MODELLING CUMULATIVE LEVELS

4.1 In order to assess how a number of wind farms affect the total noise at properties I have modelled the known wind farm proposals in the north of the Clocaenog Forest SSA. These are Tir Mostyn, Gorsedd Bran and Brenig. To these, eight groups of ten turbines have been added randomly within the main part of the SSA but keeping at least 1km from any property used for assessment.

4.2 The analysis has been concentrated at the north end of the site because that is where more is known about the likely situation. Noise at eight properties was analysed to assess how the cumulative noise level, taking into account wind direction, compared with the worst case individual noise level from each wind farm.

4.3 Downwind of a noise source the sound waves tend to be bent downwards towards the ground because of wind shear. This can increase the noise level downwind by up to about 2dB as compared with the "neutral" situation. The additional 2dB is taken into account in the methodology described in section 3 above. Upwind the sound waves are bent upwards away from the ground so that the noise level is reduced. Typically, at wind speeds at which turbines would operate, one might expect the noise level upwind beyond about 500m from a turbine to be at least 10dB less than the noise level downwind at the same distance.

4.4 I have used the following formula for the additional attenuation of sound in decibels from each turbine to a receiver, as compared with the downwind situation, due to meteorological conditions.

$$10-(10^{5/3}-(A/18)^{5/3})^{3/5}$$

4.5 Where A is the angle in degrees between the wind direction downwind of the turbine and the line from the turbine to the receiver. This may not be a perfect representation of the position but is a pragmatic basis on which to form a view of the cumulative impact and one that is substantially better than simply adding the worst case values for every wind farm. The formula gives a drop of 2dB between downwind and 90 degrees to downwind and 10dB between downwind and upwind.

4.6 The results were that the maximum cumulative noise level varied from 0.1 to 3.5dB more than the worst case downwind noise levels from the individual wind farm with the highest level at the property.

5 SETTING THE STANDARD

5.1 The noise guidance set out in TAN 8 is in Paragraphs 2.14 and 2.16 of Annex C.

Well designed wind farms should be located so that increases in ambient noise levels around noise-sensitive developments are kept to acceptable levels with relation to existing background noise. This will normally be achieved through good design of the turbines and through allowing sufficient distance between the turbines and any existing noise-sensitive development. Noise levels from turbines are generally low and, under most operating conditions, it is likely that turbine noise would be completely masked by wind-generated background noise.

ETSU-R-97 "Assessment and Rating of Noise from Wind Farms" describes a framework for the measurement of wind farm noise and gives indicative noise levels calculated to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable restrictions on wind farm development or adding unduly to the costs and administrative burdens on wind farm developers or planning authorities.

5.2 In turn paragraph 16 of the executive summary of ETSU-R-97 states that *The Noise Working Group is of the opinion that absolute noise limits and margins above background should relate to the cumulative effect of all wind turbines in the area contributing to the noise received at the properties in question.*

5.3 BS4142, which is used as the basis for ETSU-R-97, is the method for comparing noise levels in relation to existing background noise. It says in comparing a new noise with background, that *A difference of around 10dB or higher indicates that complaints are likely. A difference of around 5 dB is of marginal significance*. These figures for the new noise are LAeq. As LA90 these statements would be 8dB and 3dB respectively. The preference is clearly to have an excess of no more than 3dB but where there are several wind farms contributing to the noise level in an area specifically designated for wind farms it would be reasonable permit a higher margin. However, I think it would be contrary to the intent of TAN 8 to permit levels that are likely to cause complaints. BS4142 does not differentiate between day and night except that the time period for measurement is less at night.

5.4 The second standard set out in TAN 8 is the methodology described in ETSU-R-97. This states that turbine noise should be not more than 5dB above background noise or a fixed level, whichever is the greater. The fixed level during the day is between 35dB and 40dB depending on various factors. The fixed level at night is 43dB. The selection within the range 35 to 40 for day time is to be made in accordance with the following tests.

the number of dwellings in the neighbourhood of the wind farm

the effect of noise limits on the number of kWh generated

the duration and level of exposure.

5.5 There is a relatively small number of dwellings in the vicinity of the likely wind farms (inside the SSA and within 1.5km of it) and, because of the projected output of the SSA more stringent limits would probably significantly reduce power generated. This suggests a figure close to 40dB. However, the duration of the exposure at levels close to the

ETSU limit will be much greater than with a single wind farm because many properties will always be downwind of one wind farm or another. I therefore consider that a day time cumulative limit of 38dB or 5dB above background noise would be appropriate.

5.6 On page 63 ETSU-R-97 says that *As the night-time lower fixed limit is greater than the day-time limit, the night-time limit could become superfluous unless background noise levels are less during the night than during the quiet day-time periods. Where the local authority and the developer are in agreement that the background noise levels do not vary significantly between the quiet day-time periods and the night-time, then a single lower fixed limit of 35-40dB(A) can be imposed based upon background noise levels taken during quiet day-time periods and the night analysed together*. An inspection of the background noise measurements for Brenig and Gorsedd Bran, in common with nearly all rural background noise measurements, shows no significant difference between day and night. There is therefore no reason to adopt a different standard at night.

5.7 Looking at the results of the modelling described in section 4, if an ETSU day time lower limit for turbine noise at a residential property were set at 35dB or 3dB above background noise level for every individual wind farm then the cumulative turbine noise level at the property would normally meet ETSU 38dB or 5dB above background and turbine noise levels would normally be no more than 7dB above background noise. I suggest therefore that the standard adopted for individual properties should be 3dB above background noise level or 35dB, whichever is the higher, to apply at all times.

6 EXCEPTIONS

6.1 In circumstances where the applicant considers that the Standard Background Noise Level is inappropriate for a particular location measured figures may be submitted. These measured figures should be made on two separate periods not less than four months apart and each period should be not less than two weeks and consist of a range of wind speeds and directions that can be demonstrated to be similar to those occurring over a long term at the site in question.

6.2 Where the applicant considers that properties affected by the application site are unlikely to be affected by other applications in the future then a commentary may be provided describing why this is the case for the Council. The commentary should also demonstrate that the cumulative standard will not be breached by the application wind farm, all existing and consented wind farms and any other wind farms in the planning process identified by the Local Authority.

6.3 ETSU-R-97 permits properties in which the occupier has a financial involvement in the wind farm to be exposed to noise levels of 45dB or 5dB (or more) above background noise level. Clearly this should only apply to the wind farm or farms in which the occupier has the financial

involvement. In order to allow for the effect of other wind farms I propose that the special standard is 43dB or 5dB above background noise level whichever is the greater.

7 EXISTING NOISE CONDITIONS

7.1 There is already a condition applied to Tir Mostyn. This says that the noise of turbines shall not exceed 40dBA at any wind speed up to 9m/s. This is equivalent to ETSU 40dB or 5dB above background noise, the highest standard ETSU permits. Since the turbines are already installed, calculations could be made of the actual background noise levels at neighbouring properties to see whether this provides a sufficient margin for further development

7.2 There are already conditions applied to Wern Ddu. These are 40dB or 5dB above background during the day and 43dB or 5dB above background at night – the highest levels permitted by ETSU so sterilising the surrounding area. However, in 5.1 of the ES of November 2005 the developer agreed that the turbines installed would not exceed the sound power levels of the candidate turbine used for the calculations. An examination of the calculated levels suggests that all properties might meet 35dB or 5dB above Standard Background Noise Level, though they would not meet 3dB above Standard Background Noise Level. This may provide a sufficient margin for further development but needs further investigation as the actual turbines are not yet installed.