DRAFT 2

Proposed Wind Farm at Rushley Lodge Farm, Matlock

Review of Noise Issues

March 2009

Report No: ***RD/0309/JMcL01***

For:

Mr J McLeod
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Prepared by:

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Date**:** March 2009

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Curriculum Vitae – Robert A Davis

I hold the degree of Bachelor of Science in Engineering from the University of Southampton, and I am a member of the Institute of Acoustics. I have worked in the fields of acoustics and noise control since 1968, and as an acoustics consultant since 1971. I have carried out assessments of environmental noise from existing and proposed industrial sites at numerous locations throughout the UK, and I have presented evidence on these matters in Court and at Public Inquiries.

From 1990-2001 I was Technical Manager of ISVR Consultancy Services (now ISVR Consulting), a consultancy unit within the Institute of Sound and Vibration Research at Southampton University. The Institute is recognised internationally as a centre for teaching, research and consultancy in most aspects of acoustics, noise and vibration. I represent the Institute on British Standards Committees concerned with the measurement and assessment of noise. I left the Institute in 2001 to set up my own practice. I also continue to work with ISVR as an Associate Consultant.

I have experience of the prediction and assessment of noise from wind farms through involvement in research programmes carried out by ISVR and from the assessment of the noise impact of proposed wind farms on specific sites. I have advised local authorities and residents' groups on the prediction and assessment of noise from approximately 30 proposed UK wind turbine installations and I have presented technical evidence on noise at a number of Public Inquiries relating to wind farm planning applications. I was a member of the Noise Working Group assembled by the DTI in 2006 to review the results of recent research into the causes of complaints from wind farm neighbours about low-frequency noise effects.

1 Introduction

1.1 North East Derbyshire District Council have received a planning application on behalf of Derbyshire Wind Energy Limited for a wind farm comprising five wind turbines to be installed on a site at Rushley Lodge Farm, about 2.5 km NE of Matlock. I have been requested by Mr J McLeod, on behalf of local residents, to advise on the noise issues in connection with the application. This Report presents my preliminary observations and recommendations.

1.2 I refer to the following documents:

- The Environmental Statement (ES) dated January 2009 prepared by West Coast Energy Limited and submitted in support of the application. Chapter 11 of the ES deals with noise.

- Relevant planning guidance, standards and technical literature.

2 Wind Farm Noise Assessment – General Principles

2.1 Noise will be generated during the construction and decommissioning of a wind farm. In operation, wind turbines generate noise ('operational noise'). Noise generated during construction and decommissioning activities is of relatively short duration and can be controlled (for example, by limiting working hours, specifying working methods, and specifying access routes) by existing powers available to the Council. Therefore I do not consider that the noise impact from construction and decommissioning works is a matter that should influence a decision on granting planning permission for the development. However, I consider that the ES should have included some assessment of construction (and decommissioning) noise, since in the event that planning permission is granted it may be necessary to impose conditions relating to construction activities (such as working hours restrictions). Some information on the likely impact of construction noise is required to inform the content and scope of such conditions.

2.2 This report is concerned only with the effects of noise resulting from normal operation of the wind turbines, and provides a review of the noise assessment in the ES.

2.3 The noise generated by a wind turbine is dependent on the local wind speed: turbines usually start to rotate at a wind speed of about 4m/s, and achieve maximum power at wind speeds around 12m/s. Noise levels generally increase with wind speed.

2.4 The usual approach to assessing the likely impact of a 'new' industrial noise source is to compare the new noise levels at noise-sensitive locations (usually houses) with the existing background (ambient) noise level at the same locations, the increase in noise level providing a measure of the noise impact.

Background noise levels will also generally depend on wind speed, because of wind-generated noise in trees and vegetation. For assessing the noise impact of wind turbines, whose noise level also varies with wind speed, the comparison between 'new' noise and background noise needs to be made over a range of wind speeds. Both wind turbine noise levels and background noise levels are referred to a 'reference' wind speed at a height of 10 metres above local ground level on the actual wind farm site.

2.5 It is accepted practice to assess both background noise and wind turbine noise in terms of the L_{A90} noise level in decibels (dB). L_{A90} is the noise level exceeded for 90% of the time in any measurement period. For wind turbines, a measurement period of 10 minutes is adopted: a measurement of the L_{A90} level over a 10 minute period is designated $L_{A90,10m}$. All noise levels referred to in this report (unless otherwise stated) are $L_{A90,10m}$ levels, although for clarity they are generally expressed simply as 'dB' levels.

2.6 The standard procedure for assessing noise from a proposed wind farm follows guidance in the ETSU-R-97 Report '*The Rating and Assessment of Noise from Wind Farms'* ('ETSU') as follows:

- Noise levels at the nearest noise-sensitive receptors (usually dwellings), resulting from the operation of the wind turbines, are predicted. The noise emission from a wind turbine increases as wind speed increases, and noise levels are highest at positions downwind of a wind turbine. For the purposes of a noise assessment, noise levels at each receptor are predicted for a range of wind speeds, and it is generally assumed as a 'worst case' that the receptor is downwind of the turbines.
- Predicted noise levels are compared with existing background noise levels across a range of wind speeds (typically up to a wind speed of 12m/s). The excess of predicted wind turbine noise above the existing background noise can be taken to be a measure of the noise impact of the development. The UK Government, through PPS22, has endorsed the recommendations in the ETSU Report, which recommends upper limits of acceptability for noise from wind farms, as measured close to dwellings, in the form of numerical values set as follows:
- At night (23.00 – 07.00) noise levels should not exceed a level 5dB above the existing night-time background noise levels or 43dB, whichever is greater.
- At other times, noise levels should not exceed a level 5 dB above the existing daytime background noise levels or a level in the range 35-40dB (the selection of the limit in this range being dependent on local circumstances), whichever is greater.

2.7 ETSU prescribes the procedure for determining the existing background noise levels by means on noise surveys at representative receptors. The survey period should be at least one week, and longer if necessary to cover a representative range of wind speeds and directions. Noise measurements are correlated with simultaneous measurements of wind speed, made using an anemometer on the proposed site. The daytime background noise levels are

those measured during specified 'quiet' periods, during evenings and weekends (the so-called 'quiet daytime' or 'amenity hours' periods).

2.8 The comparisons between background noise levels, the noise limits derived from them, and predicted wind turbine noise levels, are usually shown in the form of graphs, as illustrated by the examples in Figures 2.8(a) and (b) below. Provided that the predicted turbine noise curve falls below the ETSU limit curve, noise levels are claimed to be 'acceptable'.

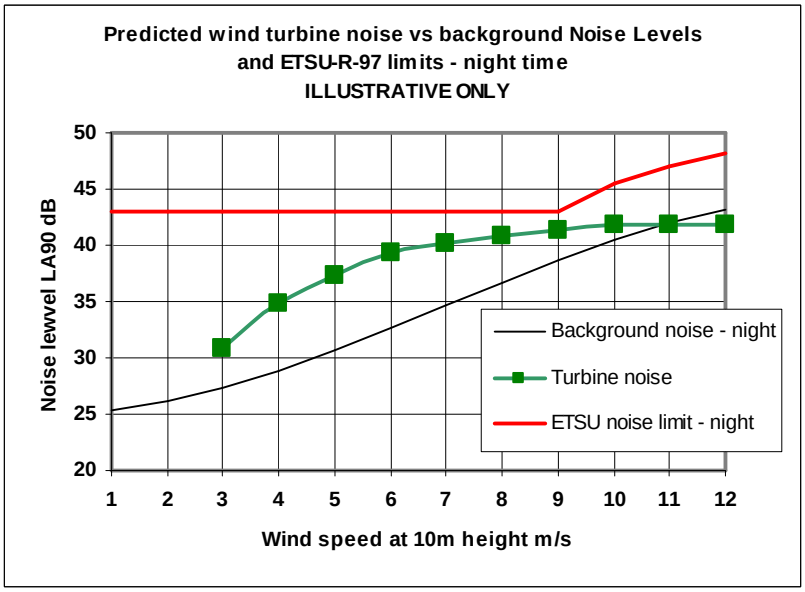

Figure 2.7(a)

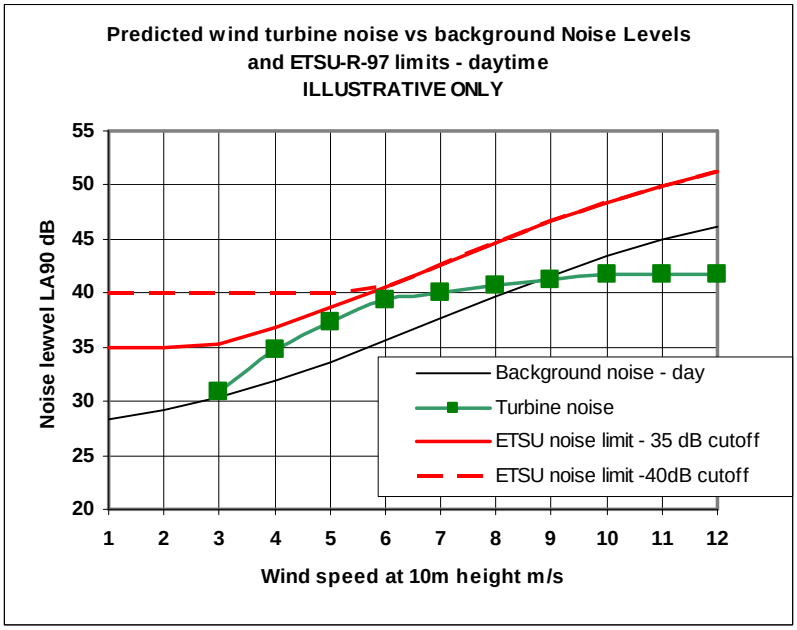

Figure 2.7(b)

3 Limitations of the ETSU approach to noise assessment

3.1 The figures in 2.7 above illustrate one feature of the ETSU noise limits. In quiet rural areas, where background noise levels can be very low (especially when winds are light), turbine noise levels can exceed background noise levels by a considerable margin even though the ETSU noise limits are not exceeded. This is the result of the approach taken by ETSU: the allowable turbine noise level does not 'follow' the background noise level down to low levels, but 'flattens out' at the lower fixed levels (43dB at night, 35-40dB during the day). Therefore the ETSU noise limits can allow a significant increase in noise levels and a possible adverse effect on the amenity of residents living in the area.

3.2 It is recognised that the ETSU noise limits represent a compromise. As stated in ETSU-R-97, they are intended to provide a "*reasonable degree of protection to the wind farm neighbour without being unduly restrictive on developments which are recognised as having wider national and global benefits*". Compliance with the ETSU limits is not therefore confirmation that there is no adverse noise impact but only that (in the view of the UK government) noise levels within ETSU limits are 'acceptable' in view of wider interests.

3.3 The likelihood of significant noise impacts and loss of residential amenity occurring as a result of noise from a wind farm, when the ETSU noise limits are complied with, has not generally been accepted by Inspectors at recent Public Inquiries, who have often accepted the view put forward by the applicants: provided noise levels are judged to be acceptable, in that they comply with the ETSU limits, then noise is not a factor influencing their decision at the Appeal. The Reporter at the recent Rossie Inquiry in Fife (January 2008) said in the decision letter (which dismissed the Appeal):

"My main conclusion on noise is that …the ETSU-R-97 standards would be met. To that extent, the proposal would therefore be acceptable from a noise point of view. However, as the appellant acknowledged, under some conditions during both day and night the turbines would result in a noticeable increase in noise levels at a large number of properties. This is not relevant in terms of ETSU-R-97, which is concerned with acceptability, not audibility. However, when people who are opposed to wind farms are able to hear, as well as see, the turbines, I believe that can increase the impact on residential amenity. Given the close proximity of the turbines to a large number of houses, particularly in Auchtermuchty, I attach some weight to this issue"

3.4 This statement indicates some 'official' recognition that there can be an adverse noise impact on local residents even though noise levels may be 'acceptable' in terms of complying with the ETSU limits. The existence and extent of an adverse noise impact, even when the noise levels would comply with the ETSU limits, can therefore be a consideration in reaching a decision on a wind farm planning application.

4 Comments on the Environmental Statement

4.1 Chapter 11 of the ES is concerned with noise. The assessment covers both construction noise and operational noise (i.e. noise from operating wind turbines). As noted above, I consider only operational noise in this Report.

Predicted Operational Noise Levels

4.2 The noise predictions in the ES are based on the use of a 'candidate' turbine, the RePower MM92. The MM92 is a typical variable-speed pitch-controlled wind turbine with a rated power output of 2MW. Table 11.2 in the ES shows the Sound Power Levels (the 'at source' noise levels) used as input to the predictions. The Table is headed "Likely Warranted Sound Power Levels".

4.3 Noise levels predicted to occur at residential properties ('receptors') are carried out using the method of ISO 9613-2. The ISO 9613 'model' is based on the following inputs:

- The Sound Power Level of the source (the wind turbine), obtained from manufacturer's test data with corrections for measurement uncertainty (and, if appropriate, any additional allowance the manufacturer applies in asserting a 'warranted' level)
- The distances between turbines and receptors and their relative heights.
- The temperature and relative humidity (which affects the absorption of sound in transmission through air)
- The nature of the intervening ground, whether it is hard and reflective or sound-absorbent.
- The profile of the intervening ground and the presence of any obstructions (landform or large buildings) between any turbine and the receptor.

4.4 The results of the predictions using ISO 9613-2 are obviously dependent on the inputs used. There are a number of variable factors: the assumed Sound Power Levels, the assumed receiver height (e.g. ground or first floor), the assumption made about the nature of the ground between sources and receptors (reflective, non-reflective or mixed), and whether any allowance is made for the screening provided by the landform. Many of the consultants working in this field use different combinations of input parameters.

4.5 The input variables adopted for the noise predictions in the ES are explained in paragraphs 11.6.4 – 11.6.12.

Comments – Prediction of Turbine Noise Levels

4.6 The noise predictions are based on the use of the RePower MM92, a 2MW wind turbine. As stated in the Introduction to the ES (1.1.4) the actual type of turbine to be installed would be determined at a later stage, although "it is anticipated that the turbine will have a rated capacity up to 2.5MW". The source of the turbine Sound Power Levels in Table 11.2 is not specified, although the values given are similar (but not identical) to RePower published

data based on test measurements to the accepted test standard (IEC 61400-11). Two points arise (4.7 and 4.8):

4.7 There is an inconsistency between the statement in 1.1.4, that" turbines up to 2.5M capacity" would be installed, and the adoption of a 'candidate' turbine of lower capacity (2MW) for the purposes of the noise assessment. This may not be fundamental, since a 2.5MW turbine does not necessarily generate higher noise levels than the MM92 2MW turbine, but clarification should be requested.

4.8 It is common practice for noise predictions to be based on 'warranted' turbine Sound Power Levels – the levels that the manufacturer guarantees will not be exceeded in a particular application. Warranted noise levels are generally set at levels 1-1.5dB above the levels measured during the manufacturer's tests, to take account of measurement uncertainty. It is not clear that any such allowance has been included in the Sound Power Levels in Table 11.2, and the heading 'Likely Warranted Turbine Source Sound Power Levels" is less-than-convincing. Evidence should be sought to confirm the source of these levels and whether RePower have warranted these levels for other similar sites. Also, I do not understand why no Sound Power data is provided for wind speeds below 5m/s.

4.9 ISO 9613-2 is the generally-accepted method of predicting noise from wind farms. All available evidence is that the use of ISO 9613 can provide realistic predictions of noise levels at receptors that are downwind of the turbines. ('Downwind' is usually taken to mean that the wind is blowing from a direction within 45 degrees of the direct line between turbine and receptor). This is accepted as being the 'worst case'; in 'upwind' conditions, noise levels will generally be at least 10dB lower than the predicted levels.

4.10 I have not checked the results of the predictions but from an overall review of the results I believe that the calculation procedures, as set out in the ES, have been correctly applied. ***However, as explained below (4.29 – 4.31 and Section 5) the comparisons between predicted noise levels at receptors and the existing background noise levels at these locations are suspect, because the effects of wind shear have been taken into account. Since the predicted noise levels at some receptor location are close to the limits of acceptability this requires further investigation.***

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Baseline Noise Measurements (ES 11.5)

4.11 Baseline noise measurements were made over a period of 22 days in April and May 2008 at five locations, identified on Figure 11.1 in the ES.

Darwin Lakes
Grouse Cottage Farm
Cuckoostone Cottage
Cuckoostone House Farm
Sydnope Stand.

4.12 The actual measurement positions are illustrated in the photographs in Figures 11.2 - 11.6. A rain gauge was installed at Sydnope Stand to enable noise measurements made during rainfall to be excluded from subsequent analysis. Observations made during visits to set up and remove equipment are noted in paragraphs 11.5.4 – 11.5.8.

4.13 Noise measurements were made over consecutive 10-minute periods and correlated with average wind speed measured over the same intervals using an anemometer on a mast at a height of 10 metres on the application site.

4.14 The range of wind speeds and directions during the surveys is illustrated in Appendix 11.1.

4.15 The results of the baseline noise surveys are shown graphically on Figures 11.8 – 11.19. There are two figures for each survey location, the upper figure referring to night time (2300-0700) noise levels and the lower figure to the 'quiet daytime (or amenity hours) noise levels. On these figures each data point (cross) represents a single 10 minute measurement. The thin solid line is the calculated 'average' baseline noise level, as a function of wind speed, derived from the measured data using regression analysis to construct a 'best fit' curve.

Comments – Baseline Surveys

4.16 The noise assessment relies to a significant extent on a comparison between predicted wind turbine noise levels, at receptors, and the existing background noise levels at these locations. It is therefore essential that the baseline noise surveys are correctly performed and that appropriate background noise levels are assigned to each receptor location. In most situations, it is not practicable to carry out baseline surveys at all properties likely to be affected by noise: the survey locations should therefore be selected to be representative of all other properties in the area.

4.17 From examination of a map of the area and from the information presented in the ES I would say that the selected monitoring locations, and the duration of the surveys, were generally adequate, subject to my comments below.

4.18 The microphone positions at each of the five survey locations are illustrated on the photographs in Figures 11.2 – 11.6 in the ES. Without visiting these locations it is difficult to judge whether these positions were appropriate. The position should be selected such that it would be exposed to the noise from the proposed wind turbines and that the background noise levels are representative of the levels normally experienced in areas close to the house used for recreation and relaxation. The selection of suitable positions relies on the judgment of those installing the equipment. It is common practice in carrying out these surveys to agree the microphone positions in advance with a noise specialist from the Local Authority Environmental Health Department: the ES does not state that this agreement was reached in this case. From Figure 11.6 the microphone position at Sydnope Stand is close to a border

containing shrubs, a small tree and a section of hedge. The movement of these plants by wind will create noise at a level which may not be typical of other positions in the vicinity of the house, such that background noise levels elsewhere may be lower than the measured levels. The use of over-stated background noise levels leads to higher (less-restrictive) noise limits and therefore an under-statement of the impact of wind turbine noise. I therefore have some reservations about the microphone position at Sydnope Stand. I also have comments on the measurements at Grouse Cottage Farm in 4.26 – 4.27 below.

4.19 I have no reason to question the reliability of the measurements (in that they represent the noise levels recorded by the instruments at the chosen locations over the period of the survey). The equipment used was suitable for the purpose.

4.20 The on-site wind speed, to which the baseline noise measurements are referenced, was measured with an anemometer at 10m above the ground (11.35). This is an important point when the possible effects of wind shear are assessed, as explained in Section 5 in this Report.

4.21 There is considerable scatter of data points shown on Figures 11.8 – 11.19, particularly at low wind speeds (up to about 5m/s) and at night. This is particularly evident on Figure 11.10, relating to Grouse Cottage Farm, where at wind speeds up to 4m/s there are many data points clustered at or close to 18 dB (the 'noise floor' – the lowest measurable level – of the sound level meter used) but many outlying points in the 30-40 dB range. The outlying points obviously contribute significantly to the level of the derived 'average' curve. I suspect that this large scatter may be the result of early morning noise from birdsong (the 'dawn chorus'), which would be included in the night-time (2300-0700) analysis. Inclusion of noise from early-morning birdsong in deriving average night time noise levels can lead to an over-statement of noise levels during the earlier part of the night, including the periods when residents are going to sleep. Birdsong noise also tends to be seasonal. It is common practice to exclude from the analysis data measured in the early morning which appears to be affected by birdsong: this can be recognised from inspection of the 'raw' data. This data is not provided in the ES, although it is offered in the form of 'Figures' if requested (11.5.13). It is assumed that measurements affected by birdsong have not been identified and excluded from the analysis in the ES.

4.22 The 'best fit' curves (noise level against wind speed) shown on Figures 11.8 – 11.19 are derived using a third order polynomial curve (i.e. using an equation with x^3, x^2 and x terms). In some cases, where data is sparse at the higher wind speeds (the night-time figures) this results in an 'S'-shaped curve which shows a rise in noise level at low wind speeds and a fall in level at high wind speeds (see Figure 11.10, for example). This could not actually occur in practice: the noise limits derived from the 'average baseline noise' are therefore shown in the ES as 'levelling-off' at wind speeds above 8m/s (at night) and 9m/s during the day, as explained in 11.7.2. This is a conservative

assumption (it will tend to lead to more restrictive noise limits) and is therefore a reasonable one.

4.23 It is generally accepted that in most rural areas the curves (of noise level against wind speed) of background noise for 'day' and 'night' will run together at higher wind speeds, when noise levels will be dominated by wind moving trees and foliage. At low wind speeds, daytime noise levels tend to be higher than at night, because of greater human activity, including more road traffic. To provide a more realistic 'picture' of the variation of average noise level against wind speed I prefer to 'adjust' the night-time curves in the ES to follow this pattern, as illustrated (for Grouse Cottage Farm) in Figure 4.23 below.

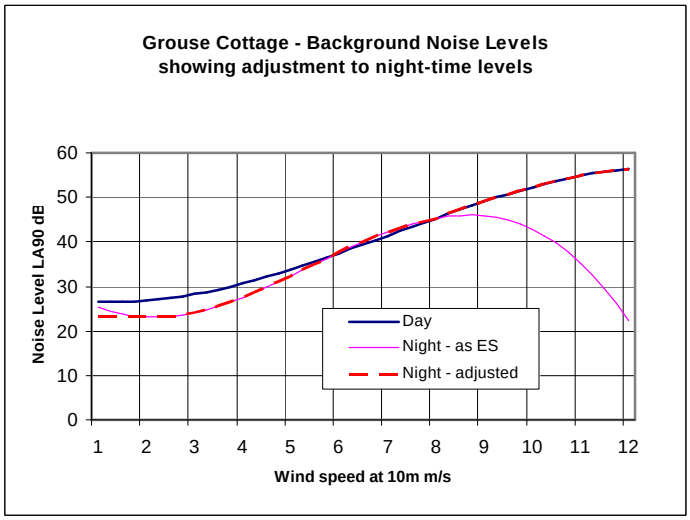

Figure 4.23

4.24 The adjusted night-time curve then matches the daytime curve at wind speeds above 6m/s, but falls to a lower level at the lower wind speeds. The adjusted curve effectively corrects the anomalies introduced by the curve-fitting procedure. As noted above, this is not a fundamental issue as far as the noise assessment is concerned, but it does enable the night-time background noise levels at different locations to be more readily compared, as shown in Figure 4.25(a) below.

4.25 Figures 4.25 (a) and (b) below show the comparisons between the background noise levels measured at the five locations. I have adjusted the night-time levels, as described above, to correct the unrepresentative shape of the curve introduced by the curve-fitting procedure

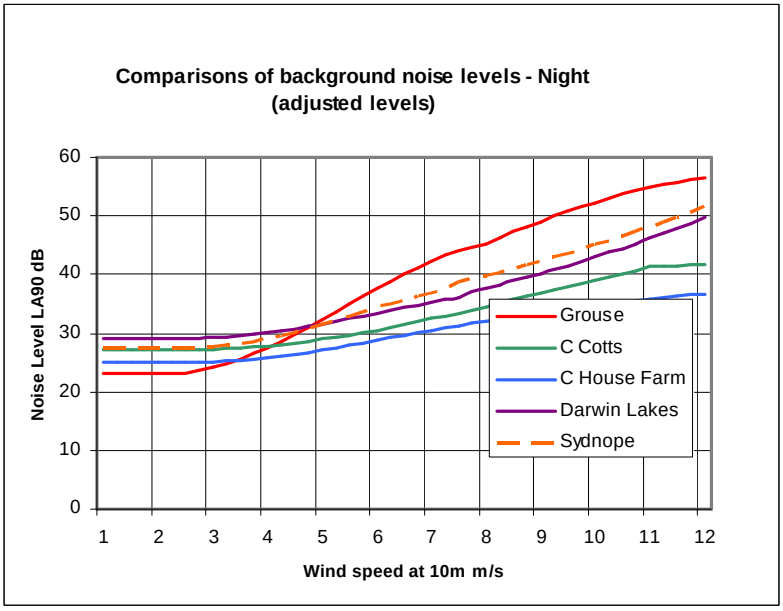

Figure 4.25(a)

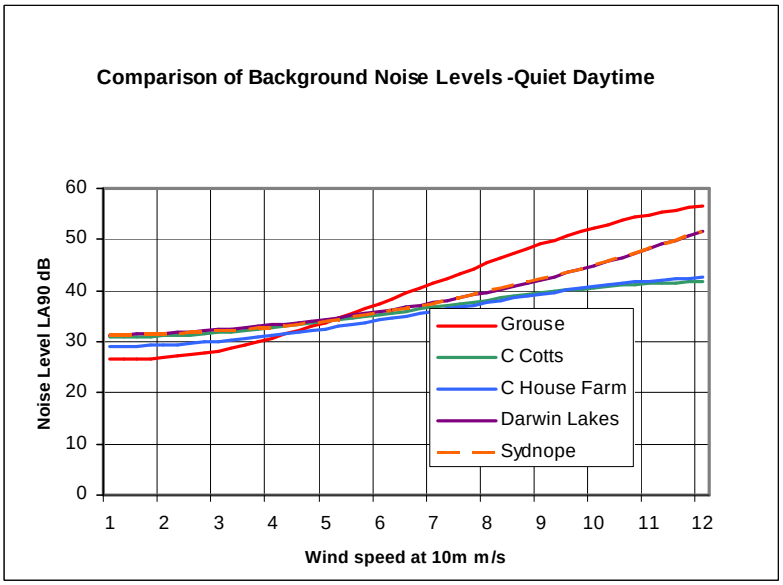

Figure 4.25(b)

4.26 From these comparisons, I have concerns about the levels of background noise measured at Grouse Cottage Farm. The comparison shows that noise level at Grouse Cottage Farm, whilst the lowest of all locations at low wind speeds, rises more quickly with wind speed and at high wind speeds (8m/s upwards) are higher than the levels at some of the other four locations, by more than 10dB in some cases. Levels at the other 4 locations are more tightly 'bunched'. From the photographs (11.13) of the measurement position at Grouse Cottage it appears that there is a row of trees relatively close to the measurement position (on the right of the lower photograph in ES Figure 11.3) which may account for this difference, since the other sites appear to be relatively 'open'.

4.27 Obviously noise from wind in these trees is a feature of the noise environment in the vicinity of this house. The inclusion of noise from this source in the survey measurements would only be open to criticism if there were other

locations close to the house which were (potentially) exposed to the predicted wind turbine noise levels but were relatively screened from the noise generated by wind in trees. If that were the case, the baseline noise levels assigned to Grouse Cottage Farm, and the noise limits derived from them, would be artificially high. I am unable to assess the suitability of the measurement position from the information available. However, the applicant's consultant should be asked for an explanation of the reason for the background noise levels at Grouse Cottage Farm being significantly higher than t the other four survey locations, particularly because predicted wind turbine noise level at this location are, as shown in Figures 11.10 and 11.11 in the ES, only marginally within the maximum-acceptable noise limits, which are themselves based on the baseline noise levels. Reliable definition of the background noise levels at this location is therefore particularly critical.

Noise Assessment

4.28 The ES provides an assessment of potential operational noise effects at the five 'sample' receptors plus Cuckoostone Grange, in paras. 11.7.7 - 11.7.18. It is stated that the Figures show that the predicted noise levels are below the ETSU noise limits at all locations. In para. 11.7.21 it is concluded that noise limits would also be complied with at all other locations, since all other dwellings are further from the site than the 'selected' receptors. These comments are reflected in the overall conclusion on 11.8.4 – "worst case predicted wind turbine noise levels at all residential locations meet the relevant night-time and lower daytime noise limits under all wind conditions".

Comments on the Noise Assessment in the ES

4.29 The comparisons between predicted noise levels and derived noise limits appear to have been carried out in accordance with the accepted procedures. The comparisons show that noise levels will comply with the ETSU limits at all locations, although at Grouse Cottage Farm (Figure 11.11), Cuckoostone Cottage (Figure 11.13) and Cuckoostone House Farm and Cuckoostone Grange the margin between predicted noise levels and the lower (35dB) daytime limit is marginal – 1dB or less at wind speeds around 5-6 m/s. Therefore the reliability of both the background noise surveys (on which the noise limits are based), and of the noise predictions, demand close scrutiny.

4.30 There is no assessment of the significance of noise impact. The assessment is based solely on a comparison between the predicted noise levels at the ETSU noise limits. Comparison with the ETSU limits enables the noise from the wind farm to be assessed as either 'acceptable' or 'unacceptable' on the basis of official guidance (in that ETSU-R-97 is endorsed in PPS22). Logically, noise levels do not instantaneously change from having no adverse impact to being unacceptable as a threshold is reached. It follows, as noted in Section 3 above, that adverse noise impact can occur at noise levels lower than the ETSU limits. In this case predicted noise levels are shown to exceed existing background noise by large margins, up to 10dB at some locations at some

wind speeds, and noise from wind turbines will often be audible at some dwellings. Such increases amount to an adverse noise impact that should, in my view, be accorded some weight when the benefits and adverse effects of the development are balanced.

4.31 Furthermore, and most importantly, I believe that the assessment is fundamentally flawed in that the baseline noise surveys are based on wind speeds measured at 10 metres height on the application site. This approach takes no account of site-specific wind shear and is likely to result in noise limits being set at too high a level, or predicted noise levels being understated: in either case, the effect could be that wind turbine noise levels would exceed the noise limits. As noted above, the noise assessments at some locations, where noise levels are shown to comply with limits by a small margin, are consequently very sensitive to the adopted values for background noise levels and the accuracy of the predicted wind turbine noise levels. The possible effect of wind shear on these factors is examined in some detail in Section 5 below.

5 Wind Shear

5.1 It is an inherent assumption in the noise predictions in the ES that there is a constant relationship between the wind speed at a height of 10 metres on the development site (to which the baseline noise levels and noise limits are referenced) and the wind speed at turbine hub height (which determines the noise generated by the turbine). The hub height wind speed is higher than the wind speed at 10 metres because of wind shear – air closer to the ground is 'slowed down' by friction at the ground surface and the effect of hills and other features and obstructions. The ratio between the wind speed at 80 metres (the proposed turbine hub height in this case) and at 10 metres is typically around 1.5:1. However, on some sites, and in some atmospheric conditions, enhanced wind shear can occur and the ratio can be greater: therefore for a given 10 metre wind speed the wind speed at hub height, and therefore the turbine noise level, will be higher than the level calculated on the assumption that wind shear is 'fixed' which is the basis of the noise assessment in the ES.

5.2 In this case the wind speed was measured at a height of 10 metres on the application site. The ES does not identify the location of the anemometry mast. There are extensive forestry plantations to the W and SE of the site, and I am informed by residents that the trees adjoining the site are of a greater height than 10 metres. The presence of the trees will have two competing effects:

- The wind speed at the anemometer position will be reduced, compared with a measurement made at a height of 10 metres on an open unobstructed site, by the screening effect of the trees. This would result in increased wind shear between 10 metres and hub height, relative to an open site.

- The increased 'roughness' presented by the trees, compared with open ground, will lead to increased mixing of air flows and would therefore tend to reduce wind shear.

5.3 It is not clear which of these factors will be dominant in this case and I consider that wind speed measurements should have been made using measurements at different heights (say 40 and 60m) on a high anemometry mast, to eliminate this uncertainty. Reliance on a 10m measurement is, in my view, particularly unreliable in this case because of the presence of surrounding dense woodland.

5.4 If wind shear at the site is greater than the assumed 'standard' shear, this has an effect on the comparisons between predicted turbine noise levels and noise limits, as shown on Figures 11.8 – 11.19. The potential effect can be represented by shifting the predicted noise curve 'to the left'. A shift of 1m/s, resulting from enhanced wind shear, would have the following effect at Grouse Cottage Farm (for example):

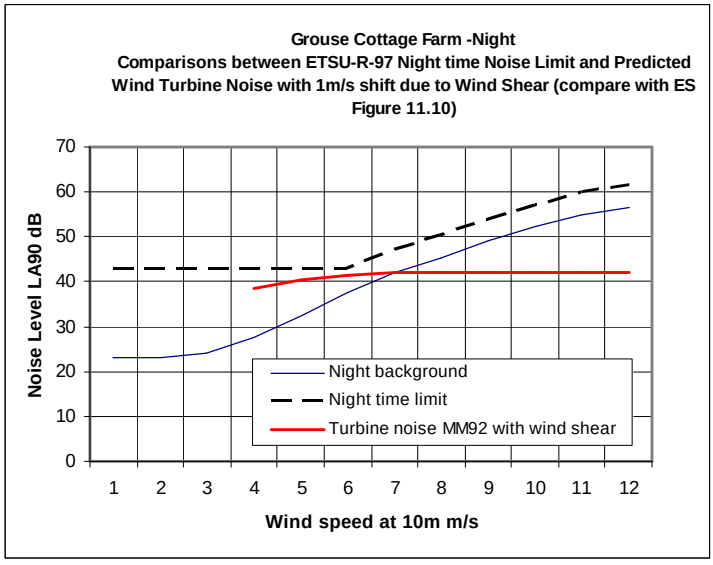

Figure 5.4(a)

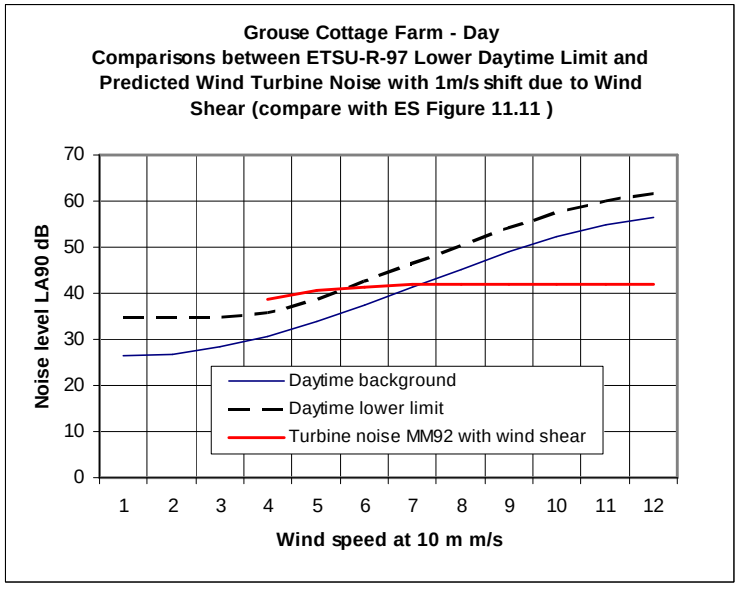

Figure 5.4(b)

5.5 As shown in Figure (b), enhanced wind shear of 1m/s would result in the ETSU lower daytime limit being exceeded at wind speeds around 5-6 m/s. The night-time limit (Figure (a)) would not be exceeded, because of the form of the ETSU noise limit curve which 'levels-off' at 43 dB. However, the difference between the turbine noise and the background noise is increased, compared with the figures in the ES, and the adverse noise impact therefore potentially greater than that illustrated in the ES.

5.6 The ES refers to wind shear in 11.7.22 and 11.7.23. The ES accepts that enhanced wind shear may occur in some conditions, and that this can have the effect of increasing wind turbine noise levels, for a given 10m wind speed, above those predicted. However, it is observed (correctly, as shown on Figure (a) above)) that applying a wind shear correction (i.e. moving the curve of predicted turbine noise level to the left) on the night-time assessment plots demonstrates that the ETSU night-time limits would still be met. The effect is therefore disregarded. However, the ES fails to observe that enhanced wind shear may also occur in the evenings, during the 'quiet daytime' period. As shown on Figure 6.4(b), a 1m/s shift in the turbine noise level curve will result in the ETSU lower daytime limit being exceeded at Grouse Cottage. From examination of the assessment plots in the ES, noise levels at other locations, particularly Cuckoostone House Farm (Figure 11.15) and Cuckoostone Grange (Figure 11.19) would only marginally comply with the ETSU limit with a 1m/s wind shear 'shift' and would exceed the limit if the shift were greater than 1m/s.

5.7 As noted above, the possibility of enhanced wind shear occurring in some atmospheric conditions may be compounded here by the reliance on wind speed measurements taken on a 10m mast at a position partly surrounded by high trees. Because of these factors I consider that the noise assessments presented in the ES are inherently unreliable and may underestimate noise impact at dwellings in the vicinity.

5.8 It would be possible for the Applicant to make further wind speed measurements on the site, using anemometers on a tall mast, to establish the average wind shear characteristics for the site at different times of the day. The noise assessment 'curves' in Figures 11.8 -11.19 could then be corrected to allow for wind shear. This method has been adopted at other sites where wind shear was not taken intro account at the time of the baseline noise surveys. However, this 'retro-fitting' is not, in my view, a safe approach in this case since the predicted noise levels at some receptors are close to maximum-acceptable limits, even without taking wind shear into account, and there can be no certainty that the limits can actually be complied with in practice. The only reliable means of taking wind shear into account is to correlate the baseline noise measurements with a derived ('standardised') 10 metre wind speed calculated from measurements of wind speed made at two heights (typically 40 and 60 metres) at the same time as the baseline noise measurements are made. This procedure was not followed in this case.

5.9 The Inspector at the recent Shipdham Appeal (APP/F2605/A/08/208910), where the consultant concerned (The Hayes McKenzie Partnership) had made corrections for wind shear retrospectively, said:

"*Retro-fitting (of wind shear data) is not ideal. Furthermore, fluctuations in wind shear can be substantial, and averages can hide significant details*".

The Appeal was dismissed, mainly because of shortcomings in the baseline noise measurements, the unreliability of the retrospective wind shear corrections, together with the small margin between the predicted noise levels and the ETSU limits and the need to rely on complex conditions of uncertain effectiveness to control noise if the prescribed limits were breached. Some of these criticisms may also apply to the Matlock Moor application.

6 Other Issues

Amplitude Modulation ('AM')

6.1 The ES refers to amplitude modulation (blade swish or 'thump') in 11.4.12 – 11.4.13. There is a risk that turbines installed on this site will exhibit enhanced amplitude modulation (blade swish), audible outside and inside houses, which would have the effect of making turbine noise more intrusive and disturbing than the measured noise levels would indicate.

6.2 The possibility of AM effects occurring at this site is discounted in the ES, on the basis that on the available evidence the risk of its occurrence is (statistically) small, and that Government statements support continued reliance on the guidance in ETSU-R-97, which effectively disregards AM. However, the causes of AM are not understood: the likelihood that it might occur with any specific type of turbine at this site cannot be estimated. The risk of AM is a particular concern where turbines will be operating very close to the maximum acceptable noise limits, as is the case here. Therefore the risk of AM introduces further uncertainty about the adequacy of the noise assessment. Further, in my view it is not possible, given the current state of knowledge, to construct a planning condition that would require corrective action to be taken if excessive AM should occur.

Low frequency noise, infrasound, ground vibration

6.2 The ES discusses the possible significance of low frequency noise and infrasound in 11.7.24 – 11.7.27. It is stated that levels of low-frequency noise and infrasound from wind turbines are of such a low level that these noise components are of no concern. There is a great deal of information on internet sites suggesting that low frequency noise from wind turbines may result in adverse effects on the health of residents in the vicinity: these adverse effects include the so-called 'vibro-acoustic disease (VAD)'. However, I am not aware that there is any robust evidence that low-frequency noise, infrasound (or ground vibration, which is also sometimes cited as a problem) generated by

wind turbines would be detectable at the separation distances we are concerned with here, or that these emissions could have any adverse health effects. The informed consensus is that most of the 'research' suggesting the contrary is flawed and misleading. I do not therefore consider that there is any reasonable basis for objecting to a wind farm application on the grounds that these adverse effects might occur.

7 Overall Conclusions

7.1 The noise assessment in Section 11 of the ES follows the standard procedure adopted for such assessments, except that no assessment of construction (and decommissioning) noise is included: it is concerned only with the noise of operational wind. Construction noise is temporary and can be effectively controlled by appropriate restrictions, where appropriate, and I do not consider that construction noise is an issue that would influence the planning decision. However, some assessment of construction noise should have been included in the ES, for completeness, and to inform the content of any conditions that might be imposed if planning permission is granted.

7.2 I consider that the assessment of wind turbine operational noise in the ES is defective in two main respects, as set out in 7.3 and 7.4 below. Additionally, further information and clarification should be sought on the points listed in 7.5.

7.3 The noise measurements made during the baseline surveys have been related to wind speed measured at a height of 10 metres on the application site. This approach fails to take account of site-specific wind shear characteristics, which are likely to be particularly influenced here by the presence of extensive tree plantations close to the site. The noise assessment is therefore unreliable and likely to underestimate the noise impact on local dwellings.

7.4 Although the ES recognises that enhanced wind shear may occur at night as a result of atmospheric conditions, it fails to recognise that it may also occur during the daytime and particularly during the quiet daytime (evening) periods. During these conditions, noise levels at some wind speeds would be higher than those predicted in the ES.

7.5 The applicant should be asked to provide further information and clarification as follows:

- The inconsistency between the ES Introduction , which refers to wind turbines up to 2.5MW capacity, and the adoption of a 2MW turbine as the 'candidate for the purposes of the noise assessment, should be resolved.

- Documentary evidence should be provided to support the Sound Power Levels in ES Table 11.2. This evidence should include confirmation that RePower have warranted these Sound Power Levels for the MM92 on a similar site, and also data on noise levels at wind speeds below 5m/s.

- A comment on the suitability of the measurement position at Sydnope Stand.

- A comment on the reason for background noise levels at Grouse Cottage Farm being significantly higher, at higher wind speeds, than levels at the other survey locations.

- Plots of noise levels against time (or the raw noise data in 'electronic' spreadsheet form) should be provided to enable possible contributions from birdsong to night-time noise levels to be identified.

- A comment on the extent of the potential error introduced by reliance on a 10 m wind speed measurement and the absence of site-specific wind shear data.

7.6 It may be that after further investigations it is concluded that the principle stated outcome of the ES - that noise levels will comply with the ETSU limits – is confirmed. However, as pointed out in this Report (Section 3) this does not imply that the development would have no adverse noise impact, since in many cases turbine noise levels will be significantly higher than existing background noise levels in some wind conditions. Additionally, there is a possibility that amplitude modulation effects, audible at or inside houses, may occur. Although the risk of AM may be small, the likelihood of AM effects occurring cannot be predicted and it is of particular concern in this case where (on the information available to date) noise levels are close to the upper limits of acceptability.