Fullabrook Wind Farm

Noise Compliance Assessment 2014

Review of Report HM:2761/R1

September 2014

Report No: ***RD/0914/NDC01***

For:

North Devon Council
Civic Centre
Barnstaple
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1 Introduction

1.1 Complaints about noise were received from residents in the vicinity of the Fullabrook Wind Farm after the wind farm became operational in 2011. Specific noise limits (in terms of noise levels not-to-be exceeded at residential properties) were imposed on the development by way of planning conditions (Appendix 1 to this report). These conditions also required the operator to carry out noise measurements, following the commissioning of the wind farm, to demonstrate that the prescribed noise limits were complied with when all wind turbines were operating. The planning conditions also require the operator to carry out noise compliance measurements in the event of reasonable complaints about noise.

1.2 During the construction of the wind farm, the owner (ESBI) appointed the Hayes McKenzie Partnership (HMP) to carry out predictions to enable the operator, in conjunction with the turbine manufacturer, to develop an operating scheme intended to ensure that the wind farm noise levels would comply with the noise limits at all dwellings in all conditions of wind speed and direction. This was necessary since it was clear at the design stage (and accepted by the Inspector at the planning appeal in 2006) that to meet the noise limits the Vestas V90 wind turbines would have to be operated in 'reduced-noise' modes. At that stage the appropriate 'mix' of operating modes for each of the 22 turbines was not defined. HMP were also commissioned to carry out a programme of noise measurements (a 'noise compliance survey') at representative dwellings around the wind farm following commissioning, to determine whether the noise limits were being complied with.

1.3 I was instructed by North Devon Council to work with officers of the Council's Environmental Health and Housing Services Department to monitor the noise compliance survey and data analysis procedures, and to liaise with HMP/ESBI as necessary, to ensure as far as possible that the noise compliance assessment was carried out in an objective and robust manner.

1.4 During the first six months of 2012, HMP carried out noise monitoring at locations close to 12 representative properties. The measurement locations and procedures were agreed with the Council. The results were submitted to the Council in Report HM: 2467/R2 dated 28 September 2012. I reviewed this report and submitted my own report to the Council in October 2012. My main conclusions were as follows:

- The measurements showed that the measured broadband noise levels (L_{A90}) from the wind farm exceeded the noise limits in Condition 20, in some wind speeds and directions, at four locations - Borland Farm, Metcombe, Patsford and Northleigh.

- Noise levels (L_{A90}) at Beara, Hal singer, Fullabrook and Binalong appeared to comply with the noise limits but by small margins.

- Noise levels (L_{A90}) at Crackaway, Greenhill, Pippacott and Luscott appeared to be significantly lower than the noise limits.

- However, audio recordings (initially made at 4 locations only) showed the presence of audible tones at some wind speeds. Depending on the audibility of the tones (as determined according to a standard calculation procedure) these would incur a 'penalty' of up to 5dB, to be added to the measured noise level for comparison with the noise limits. At that time the values to be assigned to these tonal penalties could not be reliably determined because of inadequate data, but it was clear that the addition of tonal noise penalties was likely to result in tone-corrected noise levels exceeding the noise limits at most if not all of the measurement locations.

1.5 At that stage, ESBI committed to the following actions:

i. In conjunction with HMP and Vestas, the turbine supplier, they would implement a mitigation strategy (as set out in the HMP report) to reduce broadband noise (excluding tonal penalties) to levels complying with the noise limits. The mitigation strategy would involve operating turbines in different 'noise modes' in some wind speeds and directions.

ii. Further noise monitoring would be carried out to demonstrate the effects of the mitigation. The scope of this further monitoring would be discussed and agreed between ESBI/HMP and the Council and these measurements carried out as soon as practicable.

iii. Investigations by Vestas into the tonal noise 'issue' had already started and would continue. It was anticipated that some remedial work to the turbines would be required. The timescale for the investigations was not defined at that

stage, although I recommended that ESBI should be requested to put forward a detailed work scope and programme.

2 Further Actions and Noise Surveys

2.1 The August 2014 HMP Report describes the results of further noise surveys carried out following the implementation of the mitigation measures referred to in 1.5 (i) above and any modifications to the wind turbines devised by Vestas to reduce tonal noise. I review below the content of the August 2014 report: where I refer to specific paragraphs or sections of that report these are identified ***in bold italics.***

2.2 Investigations by Vestas into the tonal noise issues continued into 2013. As a result, modifications were made to the generators in all wind turbines. These were intended to reduce the level of a low-frequency (99 Hz) tonal component observed at the sites where audio recordings had been made.

2.3 The further measurements were made at 8 locations: Burland Farm, Binalong, Crackaway, Halsinger, Beara, Patsford, Metcombe and Northleigh (see ***Table 3***), commencing in August 2013. These locations were agreed to be representative of properties that would be exposed to the highest levels of wind farm noise: there was reasonable certainty that if noise levels at these locations were complied with then this would also be the case at all other properties in the vicinity of the wind farm

2.4 Audio recordings were made at all 8 locations for the purpose of assessing tonal noise and calculating the appropriate tonal 'penalties' where appropriate. The protocol for determining the broadband noise levels and tonal penalties was agreed with HMP: these protocols are described in ***Section 4*** of the HMP August 2014 Report.

2.5 It was initially anticipated that the surveys could be completed by November 2013, although it was recognised that the timescale was weather-dependent. At any location, wind farm noise levels depend on wind speed (because the noise emission from a wind turbine depends on the wind speed) and wind direction (broadband noise levels, although not necessarily tone levels, being at a maximum in the 'downwind' direction). Measurements made during rainfall are discarded. It was therefore agreed that the monitoring would be continued until sufficient valid data had been

obtained to enable robust determinations of noise levels to be made. In the event, this position was not reached at 6 of the 8 locations until July 2014.

2.6 HMP then analysed the data in accordance with the agreed procedures. Where noise levels (with any added tonal penalties) were found to exceed the noise limits, a mitigation strategy was devised. The results of the measurements are presented in the HMP report. The proposed mitigation strategy is set out in ***Appendix D***.

2.7 During the further noise surveys and the subsequent analysis I was kept informed by HMP of progress. Decisions to terminate the surveys (dependent on the adequacy of the collected data) were made in conjunction with me and the Council (Martin Smith). I am satisfied that the measurements and analysis were carried out in a thorough and objective manner and that the results, subject to any qualifications made below, can be relied upon.

3 Results of Further Compliance Surveys

3.1 The results are set out in graphical and tabular form in ***Appendices B and C*** of the HMP August 2014 Report. The presentation is necessarily quite complex:

- Noise is assessed separately for evening (18:00 - 23:00) and night (23:00 and 07:00) periods, since different noise limits apply during these periods.

- The limits apply to wind turbine noise only, whereas measured noise levels necessarily include ambient ('background') noise from other sources. Therefore it is necessary to 'subtract' the background noise from the measured noise to establish the 'true' level of wind turbine noise, except where the measured noise level (with any tonal correction) is within the noise limits, in which case it is self-evident that the wind turbine noise alone (being lower than the measured level) must also be within the limits. Typical values of background noise level were measured during the late evening, with turbines shut down. These levels were taken to be representative of background noise levels during both evening and night time periods. The background noise 'correction' is necessarily approximate, particularly when the total measured noise level is very close (within 3dB) of the background noise level. However, I consider that the approach taken is reasonable.

- Separate assessments are4 carried out for broadband noise (the L_{A90} levels) and tonal noise. In each case the noise levels and tonal corrections are determined for a range of wind speeds (ideally up to 12 m/s) and for four wind direction 'sectors' (0-90, 90-180, 180-270, 270 - 360 degrees from north).

- The tonal corrections are calculated according to the procedure in ETSU-R-97 (as Note B to the noise conditions). These corrections (the penalties to be added to the measured broadband levels) are shown on ***Tables 7-10*** in ***Appendix B.*** It is seen that tonal penalties are applicable at all the 8 locations for some wind speeds and some direction sectors. At some locations the tonal penalty is 5dB, the maximum value.

- The overall noise assessment for each location is provided in ***Tables 13 -25***. The tonal penalties from ***Tables 7-10*** are added to the measured broadband noise levels (corrected for background noise) to give the so-called 'rating level' which is to be compared with the noise limit at each wind speed. The shaded rows titled *'Noise Level **exceeded by**'* show where the noise limits are exceeded (a negative value indicates that noise levels are lower than the limits).

- The assessment is only carried out for wind direction sectors where the receptor location is effectively downwind of wind turbines: For other sectors, measured noise levels were of the same order as the background noise levels and it was (reasonably) concluded that wind turbine noise was not a significant contributor.

3.2 The graphs in ***Appendix C*** show the measured noise levels, the background noise levels, the measured noise levels corrected for background noise (the wind turbine noise), the rating noise level (the wind turbine noise with the added tonal penalty), and the relevant noise limits.

3.3 The results show that the wind turbine noise levels exceed the noise limits in some wind speeds and directions at 7 of the 8 survey locations (i.e. all except Crackaway). The overall situation (i.e. whether noise limits are complied with or not, for each wind direction sector) is summarised in ***Table 6***. From ***Tables 11-26*** in ***Appendix C*** some of the exceedances are relatively minor (1 dB or less) but at Patsford, Metcombe, Beara, Binalong and Burland Farm the exceedances for some wind speeds and directions are of the order of 5 dB, which is significant. At these

locations, in particular, reducing the noise levels to comply with the limits would be expected to be recognised as a substantial reduction in perceived noise.

3.4 In my view the noise levels as presented in the Report can be considered to be robust and in some cases are likely to be over-stated, particularly at the higher wind speeds (11-12 m/s). At these wind speeds, for most wind directions, insufficient background noise data was collected to enable reliable values of typical background ('shut down') noise levels to be derived. The assumption has therefore been made that the background noise level does not increase further above a wind speed of 9 or 10 m/s (as shown by the red dotted lines on the graphs in ***Appendix C***). In practice, background noise levels (caused by wind in vegetation) will continue to increase with wind speed. This assumption leads to the background noise correction being under-estimated at high wind speeds in some cases. The extent of this under-estimate cannot be determined: however, for this reason the wind farm rating levels are in some cases actually lower at wind speeds in excess of around 10m/s than indicated in the analysis, and therefore the degree to which noise levels exceed the noise limits is less than shown. Therefore at these wind speeds the assessments are likely to be conservative and mitigation measures designed to address any exceedances will in some cases inevitably have an inherent (although generally small) 'safety margin'.

3.5 From the results presented in the August 2014 HMP Report the noise levels resulting from operation of the wind farm clearly breach the limits set out in Condition 20 at a number of properties, in some combinations of wind speed and direction. The main reason for these breaches is the imposition of penalties for tonal noise: it is clear that the modifications carried out by Vestas have not adequately addressed the tonal noise issue. Further mitigation measures are therefore required to comply with the noise limits.

4 Proposed Mitigation

4.1 The Report proposes a mitigation strategy, as detailed in ***Appendix D***. The tables in that Appendix indicate how it is proposed to operate each turbine at different times of the day/night. ***Table 27*** sets out how turbines will be operated in different 'modes', as required. Some turbines will be shut down altogether in some conditions (***Tables 28 and 29)*** since noise levels cannot be sufficiently reduced by operating turbines in any available 'noise-reduced' mode.

4.2 The predicted noise level reductions resulting from the proposed mitigation are set out in ***Tables 30 and 31***. These are typically in the range 1-8 dB.

4.3 These predictions rely on data from Vestas on the effect of the mode changes. I have not reviewed seen the Vestas data on which the post-mitigation predictions are based, although I am satisfied that HMP have carried out the noise predictions correctly, based on the Vestas data. Whilst I cannot verify the reliability of the Vestas data, the effect of the mitigation will have to be confirmed, in any event, by further noise surveys.

4.4 HMP make the point at ***paragraphs 6.3 and 6.4*** that the flexibility of the turbine management system in changing between noise modes is restricted: As a result, in some cases more mitigation will be applied at some locations, in some wind conditions, than is actually necessary (according to the predictions) to comply with the noise limits. For example, the reduction required to meet the noise limit at Patsford at night, for a wind speed of 9 m/s and wind direction in 'Sector 1', is shown on Table 25 as 4.7 dB. The predicted effect of the proposed mitigation (***Table 3)*** is predicted to be 7.5 dB. The restrictions on the use of different operating modes will therefore result in a modest 'safety margin' at some locations and in some conditions, since it will not always be possible to operate the turbines in such a way as to comply with the noise limits by only a 'tight' margin. This factor means that the mitigation strategy is in some cases conservative – noise levels would be reduced by a greater extent than strictly necessary to comply with the noised limits.

4.5 The proposed mitigation will also result in noise reductions at other locations not included in this monitoring programme. There is reasonable certainty that if the noise levels at the 8 locations named in the report are within the noise limits, then the levels at all other dwellings will also be compliant.

5 Conclusions and Recommendations

5.1 Overall, I consider that the information presented in the August 2014 HMP Report (HM: R2761/R1) adequately describes the current situation. From the results presented, the noise levels resulting from operation of the wind farm clearly breach

the limits set out in Condition 20 at a number of properties, in some combinations of wind speed and direction. The main reason for these breaches is the imposition of penalties for tonal noise: it is clear that the modifications carried out by Vestas have not adequately addressed the tonal noise issue. Further mitigation measures are therefore required to comply with the noise limits.

5.2 A mitigation strategy is proposed in the HMP Report. This requires some turbines to be operated in different 'noise modes', or shut down, at some times and in some combinations of wind speed and direction. I have not verified the predicted mitigated noise levels, but in any case it will be necessary to confirm the effects of the mitigation by further compliance measurements. The scope of these further measurements (locations etc.) requires discussion and agreement.

5.3 Provided that the further compliance measurements demonstrate that noise levels at the agreed locations are compliant with the limits in Condition 20, it would be appropriate for the Council to discharge Condition 21.

5.4 It must be recognised that this is a very complex site, in terms of the distribution of wind turbines and dwellings and topography. Noise levels at dwellings are dependent on wind speed, wind direction and other variable weather factors. The compliance monitoring measurements carried out, although very comprehensive, are inevitably not exhaustive. In many conditions turbine noise levels will be operating close to the limits: this is inevitable, given the original design approach, which recognised that turbines would have to be operated in reduced-noise modes at all times to comply with the noise limits. Also without specific information on the causes of tonal noise from the V90 turbines it is not clear whether tonal levels could change over the life of the turbines (for example, as a result of advancing wear in mechanical components). Therefore the risk of some exceedances of the noise limits, perhaps in relatively infrequently-experienced weather conditions, cannot be ruled out, even if the further surveys confirm compliance. Condition 22 provides for investigations to be carried out, at the operator's expense, in the event that noise complaints are received, subject to the proviso that the Council would have to decide that the complaint to be 'reasonable'. This condition therefore provides a remedy in the event that noise levels increase in the future, or if reasonable complaints are made concerning noise occurring in particular weather conditions not specifically identified in the surveys to date.

5.5 To maintain the noise levels at those finally measured prior to the discharge of Condition 21 it is obviously essential that the operating parameters of the turbines (as set out in the adopted mitigation strategy) remain unchanged. My understanding is that these parameters are set by Vestas and cannot be changed by the operator. In the interests of transparency I recommend that ESBI should provide to the Council a document from Vestas setting out the full details of the turbine operating parameters as finally adopted prior to the discharge of Condition 21. I recommend that ESBI should also be asked to provide an undertaking (transferable to any future operator) that they would provide to the Council, on request, confirmation from Vestas of the turbine operating parameters at any time, enabling the Council to satisfy itself that these had not been changed (subject to 5.6 below).

5.6 Noise exceedances are to a large extent the result of the penalties added to the measured noise levels because of the presence of tonal noise. I note from ***paragraph 6.7*** that ESBI are still pursuing, with Vestas, means of reducing tonal noise to minimise or eliminate the tonal penalties. The suggestion is that if these reductions are achieved the operator would seek to revise the operating parameters of the turbines (i.e. modify the mitigation strategy) whilst still complying with noise limits. There could be no reasonable objection to this, although in my view it would be essential for further compliance measurements to be carried out to demonstrate compliance, and for the Council to be provided with the any revised operating parameters.

Note: During the preparation of this report I was informed by HMP that Vestas have revised the noise data for the V90 turbines operating in different noise modes. Therefore the mitigation strategy in ***Appendix D*** *and the predicted effects of the mitigation strategy (****Tables 30 and 31****) are likely to be revised. The overall conclusions of this report will not be changed by any such revision, but a supplermentary note covering any changes to the mitigation strategy will be submitted.*

Appendix I

Fullabrook - Extract from Planning Conditions

Conditions 20-23 and Guidance Notes A and B refer to Noise

seeded with a suitable grass mixture to be agreed in advance with the local planning authority.

17 No wind turbine or anemometry mast shall be externally lit for any purpose unless otherwise previously approved in writing by the local planning authority.

18 Prior to the commencement of the development the details of the concrete batching plant including the means of access and site restoration shall be submitted to the local planning authority and agreed in writing. The concrete batching plant shall only be constructed in accordance with the approved details.

19 Prior to the commencement of the development details of the external treatment of the sub-station including access from the public highway and landscaping measures shall be submitted to the local planning authority and approved in writing. The sub-station shall only be constructed in accordance with drawing MPS/102/10 Rev A and the approved details.

20 The levels of noise resulting from the combined effects of the wind turbines on the development site when measured and corrected in accordance with Notes A and B below shall not exceed the following limits at any dwelling in existence at the date of this permission:

Between the hours 23.00 – 07.00:
The greater of 43 dB $L_{A90,10m}$ or 5dB L_{A90} above the established night-time background noise level at that property.
At all other times
The greater of 40 dB $L_{A90,10m}$ or 5dB L_{A90} above the established quiet daytime background noise level at that property.

Except that at any dwelling occupied by persons having a financial involvement with the development the levels of noise shall not exceed the following

Between the hours 23.00 – 07.00:
The greater of 45 dB $L_{A90,10m}$ or 5dB L_{A90} above the established night-time background noise level at that property.
At all other times
The greater of 45 dB $L_{A90,10m}$ or 5dB L_{A90} above the established quiet daytime background noise level at that property.

For the purposes of compliance with Condition 20 the night time and quiet daytime background noise levels at any wind speed shall be taken as those given in the following table.

Location		**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Fullabrook	BG Daytime	33	33	34	34	35	36	37	38	39
	BG Night	33	33	34	34	35	36	37	38	39
Halsinger	BG Daytime	30	32	33	35	36	37	38	38	39
	BG Night	30	32	34	35	36	37	37	37	37
Crackaway	BG Daytime	32	33	35	36	36	37	37	38	40
	BG Night	33	35	36	37	37	37	37	37	38
Burland	BG	34	35	36	36	36	37	38	39	41

Farm	Daytime									
	BG Night	35	36	37	38	38	38	38	38	40
South Burland	BG Daytime	38	38	38	37	37	38	40	40	40
	BG Night	35	36	36	37	37	37	38	39	41
Lower Metcombe	BG Daytime	35	36	36	36	36	37	39	40	40
	BG Night	33	35	36	36	37	37	37	37	38
Ash Barton	BG Daytime	32	34	35	37	38	38	39	40	39
	BG Night	32	34	35	36	37	37	38	38	38
Patsford	BG Daytime	35	35	35	35	36	38	40	40	40
	BG Night	33	34	35	36	36	37	37	37	37
Beara Charter	BG Daytime	34	35	36	36	37	38	38	39	39
	BG Night	34	35	36	36	37	38	38	39	39
Luscott Barton	BG Daytime	33	35	36	36	38	39	40	40	40
	BG Night	33	35	36	36	37	37	37	37	38
Northleigh	BG Daytime	31	32	34	35	35	36	36	36	37
	BG Night	30	32	33	34	35	35	36	36	37
Pippacott	BG Daytime	36	36	36	37	37	37	37	38	37
	BG Night	35	35	35	35	36	37	38	38	38
West Stowford Barton	BG Daytime	35	35	35	36	39	40	40	40	40
	BG Night	34	35	36	37	37	38	38	38	38

The night-time background noise levels in this table shall apply between the hours of 23.00 to 07.00 and the quiet day-time levels in this table shall apply at all other times. Where there is no background noise data for any specific property then the background noise data shall be taken from the nearest property for which such data is available.

21 No wind turbine shall be operated on the site until a scheme has been submitted to and agreed with the local planning authority for monitoring noise levels at up to 5 selected residential locations (or at representative locations close to these properties, to be agreed with the local planning authority) during the 6 months following the grid connection and full operation of all the turbines on the site. The duration of such monitoring shall be sufficient to provide comprehensive information on noise levels in a representative range of wind speeds and wind directions with all wind turbines operating. Monitoring shall be carried out in accordance with the approved monitoring scheme and the results provided to the local planning authority within 4 months of completion of the scheme.

22 At the request of the local planning authority and in the event of a complaint relating to noise from the turbines, the operator of the development shall measure and assess at its

expense the level of noise emissions from the wind turbines following the procedures referred to in Notes A and B and the results shall be provided to the local planning authority within 4 months of such request.

23 Throughout the period of operation of the wind farm the operator of the development shall record wind speed and direction data. This data shall include records of wind speed (in m/s) and wind direction (in 10 degree sectors) for each 10 minute period. Where wind data is measured at a height other than 10 metres above local ground level the wind speed data shall be converted to the equivalent wind speed at 10, 25 and 65 metres height, accounting for wind shear using a method of which details shall be provided to the LPA. At the request of the LPA the recorded wind data shall be made available to them.

Note A to Noise Conditions

For the purposes of compliance with Conditions 20 to 23, noise levels from the combined effects of the wind turbines shall be measured in accordance with the procedures in Section 2 (Steps 2-5) on Pages 102-103 of 'The Assessment and Rating of Noise from Wind Farms, ETSU-R-97'; prepared by the Energy Technology Support Unit for the Department of Trade and Industry.

Note B to Noise Conditions

For the purposes of compliance with Conditions 20 to 23, tonal noise shall be assessed in accordance with the procedures in Section 2 (Step 6) on Pages 103-104 and Section 2.1 on Pages 104 – 109 of 'The Assessment and Rating of Noise from Wind Farms, ETSU-R-97'; prepared by the Energy Technology Support Unit for the Department if Trade and Industry. The appropriate penalty for tonal noise shall be added to the measured noise levels for the purposes of comparison with the noise limits in Condition 20.

24 Prior to the commencement of the development a scheme for the implementation of ecological surveys to provide sufficient survey data and mitigation proposals to ensure that habitats and species of principal importance (as listed in section 74(2) of the Countryside and Rights of Way Act 2000) that have been identified during the application as requiring special consideration shall be submitted to the local planning authority and approved in writing. The survey and mitigation scheme shall be carried out as approved.

25 Development shall not be begun until full construction details of the visibility splays at the site entrance and on the unclassified road between Burland Cross and Metcombe Cross and the highway have been submitted to and approved in writing by the local planning authority and have been carried out in accordance with the approved details.

26 No development shall take place within the development site until the implementation of a programme of archaeological work has been implemented in accordance with a written scheme of investigation previously submitted to and approved by the local planning authority. Such a programme shall include timetabled provision for a nominated archaeologist to be given reasonable access to undertake a "watching brief" during the excavation of access tracks, hedgerow openings, turbine foundations and other operational areas of the development site during the construction phase.

27 No development shall take place on site until a scheme to secure the investigation and alleviation of any electro-magnetic interference to TV and radio reception caused by the operation of the turbines has been submitted to and approved by the local planning