Memorandum

24Acoustics

To: Andy Cole, North Devon Council
From: Bob Davis/Dave Coles, 24 Acoustics Limited
Date: 2 March 2021
Job: Batsworthy Cross – Noise Issues
Ref: R7792-2 Rev 0

Batsworthy Cross Wind Farm – Noise Compliance Assessment - Noise Levels at locations around Birchwood House: Review of effect of proposed mitigation measures

It is inappropriate that this report does not provide the caveat that it relies on predicted noise levels while "The Planning Conditions ... require the noise levels to be determined by noise measurements. There is no reference to the use of predictions to adjust or correct measured noise data." [Mr Bob Davis 06/11/2020]

Background

1 The noise compliance measurements carried out so far at Batsworthy Cross demonstrate compliance with the noise limits at all the agreed monitoring locations at all wind speeds, except at the location representing Birchwood House and adjoining properties. The most recent survey at this location (strictly the 'Birchwood House proxy' but referred to in this note as 'Birchwood House') was commissioned by the Council and carried out in February – March I 2019 by 24 Acoustics/RD Associates (Report R7792-1). The results showed that the wind farm noise level at that location complied with the noise limits except that the night noise limit of 40 dB L_{A90} was exceeded by 1.5 dB at a wind speed (at 10m height) of 7 m/s. *(Note that noise levels in this note refer to L_{A90} levels, as referred to in the noise conditions. Unless specified, wind speeds refer to wind speeds measured at a height of 10 m above ground level).*

The opening statement above is false:

- So far, noise compliance measurements for Batsworthy demonstrate compliance with the noise limits at just one of the agreed six locations and even there, not for all wind speeds.
- The compliance assessment at Birchwood is ongoing.
- Statements of compliance at the other four locations are conjecture.

2 The site operator (RES) has not questioned the reliability of these noise measurements, although they have disputed the reliance on wind speed measurements made at the permanent anemometer mast. (Different noise limits are applied at different wind speeds and the measured noise levels therefore have to be 'matched' with the wind speeds measured during the same time intervals). The operator has claimed that using wind speeds measured at this mast as a reference for the noise measurements (as agreed prior to the commencement of the monitoring exercise, and in accordance with the planning conditions) will overstate the derived noise levels to the extent that the noise limits at Birchwood House are not actually exceeded. The suggestion by RES was that the wind speeds should be measured at a location

where the wind conditions are representative of the conditions at the original mast position, as used for obtaining background noise measurements prior to the planning application: the site noise limits were based on wind speed measurements at that original location. The RES Report by Jeremy Bass (Reference GT01-502040 - October 2019) sets out the rationale for this assertion. The Council has rejected the view that the noise compliance measurements should be reassessed using a different location for obtaining reference wind speeds: RES have accepted this decision and have put forward the proposed mitigation to address the breach of the noise limits. However, the above RES report presents information (specifically in relation to wind shear) that we believe should be taken into consideration in our assessment of the effects of the proposed noise mitigation, to ensure that this assessment is robust, as explained in paragraph 11.

RES' attempts to use calculated wind speeds and directions from a mast that does not exist instead of from the on site mast, are irrelevant to this report. If RES desire to use such a mast, they need to apply to vary the planning conditions.

However the last sentence above is important because RES' reference to wind shear is critical to the derivation of the predicted turbine noise levels i.e. the local wind shear has to be taken into account when predicting turbine noise levels. It is appropriate that officers have recognised the significance of using the 'cumulative' wind shear to inform predicted noise levels.

However officers failed to bring this knowledge to the table when they reviewed HLA's "Batsworthy Cross Wind Farm, Devon Supplementary Analysis Report 16/06/2017" the result being that the predicted turbine noise levels which informed officers conjecture on compliance, were understated because they did not take into account that wind speeds measured at 10 m height on the current mast may be about 10% lower, for a given wind speed at hub height, than would be measured at the original mast position. Obviously this needs to be addressed before Condition 37 can be discharged.

3 The further mitigation now proposed by RES involves changes to the operating modes of the turbines for the range of wind directions between 200 and 350 degrees (from N), the range of wind directions for wich Birchwood House will be downwind of the wind farm and will therefore experience the highest noise levels.

4 RES have provided predictions, presented in the email shown in Appendix 1, showing that changing the operating modes in the way proposed would result in a reduction in the 2019 noise levels of 1.5 dB at a wind speed of 7 m/s, and that the night noise limit of 40 dB would therefore be complied with. There would also be noise reductions at other wind speeds (although the noise limits are already complied with at all other wind speeds).

The above statement in brackets is false because in the last assessment, noise levels at wind speeds of 8m/s and above were not shown to be compliant or non compliant with the noise limits. Indeed the preceding assessment showed exceedances of the noise limit at 8m/s.

5 RES have requested that the Council accepts these predictions as evidence that the proposed mitigation would result in noise levels complying with the noise limits. The Council has provisionally accepted this approach, subject to the predictions being independently reviewed. This Note presents an analysis by 24 Acoustics of the effects of the proposed mitigation.

It is concerning that officers made the decision to take this approach without consulting members.

This concern is offset only by the fact that officers state it does “not preclude the Council requesting further noise measurements and monitoring.” [Mr Cole S&R 01/02/21]

Basis of Predictions

6 Noise levels at locations around a wind farm can be predicted using an industry-standard prediction model based on ISO 9613-2. The *absolute* levels of noise calculated by the prediction model are subject to some uncertainty, particularly in hilly terrain, but the calculation of *changes* in noise levels resulting from a change in the ‘at source’ noise levels (the Sound Power Levels of the turbines), with all other factors remaining the same, can be expected to be accurate. In this case the calculated change in noise level resulting from the operating mode changes, applied by way of corrections to the pre-curtailment noise levels measured in February-April 2019, would be expected to provide a robust assessment of the wind farm noise levels that would be experienced at Birchwood House following mitigation.

What do Mr Davis and Mr Cole mean by their statement “can be expected to be accurate”? Are they saying that in these circumstances the predictions are accurate or that they are not accurate?

Proposed Changes to Operating Modes

7 Wind turbines can be operated in different ‘modes’, which provide the means of reducing the noise emitted from the turbine (the Sound Power Level) over a range of wind speeds, although operation in a ‘reduced-noise’ mode results in some loss of electrical power generation. For the Senvion MM82 turbines three different standard modes are available (A, B and C), with C being the lowest-noise mode. The combinations of operating modes in effect when the 2019 noise surveys were carried out, the modes currently in use, and the modes now proposed to achieve additional noise reduction, are shown in the documents in Appendices 1 and 2 and summarised below. These modes apply only for wind directions between 200º and 350º (from N) in which Birchwood House is downwind of the wind farm.

		Turbine number								
Date	*Wind directions (degrees from N)*	101	102	103	104	105	106	107	108	109
2019 (during noise survey)	1 200-255	A	B	C	B	A	A	A	A	A
	2 255-350	A	B	C	B	A	C	A	A	A
Current	3 200-350	A	C	C	C	C	C	A	A	A
Proposed	4 200-350	C	C	C	C	C	C	A	C	A

Table 1 Turbine Operating modes – 2019 (during noise survey), Current and Proposed

The loss of electrical power generation is irrelevant to this report.

The turbines can also be switched off at times when they would otherwise cause exceedances of the noise limits

The obvious issue with the proposed reductions to the turbine noise levels is that Turbine 103 is one of the three nearest turbines to Birchwood but the noise from it will not be reduced.

Interpretation of data

8 On reviewing the available information, it became clear that predicting the reduction in noise levels resulting from the proposed mitigation was not straightforward. Two particular factors became apparent:

• *The operating modes in effect in 2019*

9 The results of the 2019 measurement survey at Birchwood House were based on measurements made when the wind direction was between 200 and 350 degrees (i.e. generally from the West). This is the 'worst case' wind sector for Birchwood House since this location would be downwind of the wind farm. However, the information now available (Appendix 2) shows that the turbines were being operated in slightly different modes for the sectors 200-255º and 255-350º, T106 being in either mode A or mode C. This has the effect that applying the further mitigation will result in less noise reduction for wind directions 255-350º (since noise from T106 is not being further reduced) than for the 200-255º sectors. This is considered in paragraph 16 below. (The 2019 noise survey Report did not include separate assessment of noise in these two sectors).

• *The effects of vertical wind shear*

10 The turbine noise emission (Sound Power Level) of a wind turbine is determined by the wind speed at the hub-height of the turbine (in this case 63 m above ground level). The noise limits in the planning conditions are referred to the wind speed measured 10 metres above the ground and the compliance measurements carried out to date are related to the measurements at 10 m above ground at the site anemometer mast. The wind speed at 10 m is (in almost all situations) lower than the wind speed at hub height ('wind shear'). Turbine manufacturers quote Sound Power Levels in terms of both hub height and 'standardised' 10 metre wind speeds, the 10 m standardised wind speed being calculated on the basis of a 'standard' value for wind shear which is only usually applicable to sites on flat unobstructed ground.

11 For the Batsworthy site there is evidence that the local wind shear is greater than the 'standard' value. The value assigned to wind shear has a significant effect on the prediction of the noise reduction that will result from the proposed mitigation, as explained in paragraphs 12 and 13 below. There are two separate factors involved:

(a) Measurements of wind shear at the position of the original meteorological mast were made prior to the 2012 planning appeal (presented in the Supplementary Environmental Information (SEI). These measurements showed enhanced wind shear (i.e. wind shear greater than the standard value on which the turbine manufacturer's noise data is based). The effect of this was incorporated into the noise predictions presented at the appeal, using the highest value of wind shear (not the average value) for the purposes of predicting the highest noise level likely to occur.

(b) As mentioned in paragraph 2, the site operator (RES) has observed that the anemometer mast used for the wind speed measurements during the compliance surveys is in a more sheltered position than the original site mast. RES have presented the results of computer modelling that indicates that that as a result of the more sheltered mast position the 'effective'

wind shear between the turbine hub height and the current 10 m mast might be further increased. The calculated effect is that wind speeds measured at 10 m height on the current mast may be about 10% lower, for a given wind speed at hub height, than would be measured at the original mast position.

Therefore predicting the noise reduction that would result from the proposed mitigation needs to take account of the combined or 'cumulative' wind shear resulting from these two factors, although this would present a 'worst case', as explained in paragraph 18 below.

12 Figure 1 below shows the Sound Power Levels (the 'at source' noise emission) from the MM82 turbine in the three optional modes (A, B and C) plotted against wind speed at hub height. These levels are obtained from data sheets published by the manufacturer, Senvion.

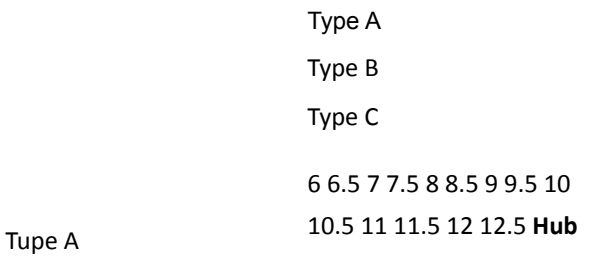

Illustration of Sound Power Levels of MM82 turbine for different operating modes

Figure 1

13 The above graph shows that the noise reduction resulting from changing to a 'lower noise' mode is very dependent on the hub height wind speed. The compliance assessment is based on wind speed measured at 10 m height – in this case we are concerned with noise levels when the 10 m height wind speed is around 7 m/s. For 'standard' wind shear, a wind speed at 10 m height of 7 m/s corresponds to a hub-height wind speed of about 9.4 m/s. At this hub height wind speed, mode C is more than 4 dB quieter than mode A, and more than 2 dB quieter than mode B. However, higher wind shear means that a hub height wind speed higher than 9.4 m/s is required to achieve a 7 m/s wind speed at 10 m height. Increasing hub height wind speed increases the noise level (although only marginally in mode A, because the curve 'flattens out' at high wind speeds) but, more importantly, has the effect of reducing the noise benefit of changing to a 'quieter' mode. For example, at a hub-height wind speed of 12 m/s, which could correspond to a 10 m height wind speed of 7 m/s in very high wind shear conditions, mode C is only about 2 dB quieter than Mode A and less than 1 B quieter than Mode B.

14 This means that the predicted noise reduction resulting from the proposed mode changes is very dependent on the value assigned to wind shear. The range of likely values of wind shear, based on the available information, has been assessed in the following analysis.

How can predicted noise reductions be 'expected to be accurate' if they are 'very dependent' on "likely" wind shear values.

Results of Predictions

15 Predictions using ISO 9613-2, following the recommendations in the Institute of Acoustics Good Practice Guide and associated documents, show the following reduction in wind farm noise level at Birchwood House at a 10 m wind speed of 7 m/s. As discussed above the result is dependent on the value assumed for wind shear:

How can predicted noise reductions be 'expected to be accurate' if they are dependent on the value of "assumed" wind shear.

Wind shear	Effect of mitigation at 7 m/s wind speed	
	Wind sector 200-255º	Wind sector 255-350°
1 No excess (’standard’) wind shear	-2.3 dB	-1.9 dB
2 Site wind shear as SEI (highest values)	**-1.4 dB**	-1.1 dB
3 Cumulative shear - (2)+effect of mast position	-1.0 dB	-0.8 dB

Table 2 - Predicted noise reductions at 7 m/s (10 m height) wind speed for different wind shea r

16 As expected, the noise reduction achieved for winds in the 255-350° sector is less than for the 200-255° sector for the reason explained in paragraph 9. However the predictions also show that the noise levels at Birchwood House when the winds are in the 255-350° sector would be 0.3 dB lower than for the 200-255° sector. Examination of the 2019 noise survey data confirms this differential (a greater difference was actually deduced from the measurements). This lower ‘starting point’ compensates for the lesser noise reduction in the 255-300° sector. Therefore the assessment can be based on the values in the ‘200-255°’ column above and the values in the ‘255-350°' column can be ignored.

It is unsurprising but of note bearing in mind officers' reliance on predictions, that in the above circumstances, the predicted difference is less than the measured difference between the two wind sectors considered above i.e. the predictions are shown not to be accurate.

17 The RES prediction of noise reduction (Appendix 1) was based on the same input as (2) above (i.e. the maximum wind shear value from the SEI, not including the additional shear indicated by RES’s own calculations). On this basis, RES predicted a 1.5 dB reduction: this compares with our prediction of 1.4 dB. The difference of 0.1 dB is trivial and is probably explained by differences in the way the wind shear effect is calculated, which requires some manual interpolation between wind speeds.

As shown in the above, the predictions are again found to be inaccurate, this time depending upon who is performing the “manual interpolation” between wind speeds.

Importantly, Mr Davis and Mr Cole already find the operator’s predicted noise reductions to fall short by 0.1dB.

18 For the ‘cumulative’ wind shear (3) the predictions show that the noise reduction would be limited to 1.0 dB, resulting in a mitigated noise level of 40.5 dB at 7 m/s wind speed. However the compliance assessment is intended to cover a range of conditions (although always for the downwind direction): predictions (2) and (3) assume the ‘worst case’ wind shear values from the SEI data and these would not be experienced over an extended period. The ‘cumulative’ wind shear prediction will therefore overstate the mitigated average

noise level (and understate the average noise reduction). For this reason there is reasonable certainty that the average noise reduction would be greater than 1.0 dB, and therefore that the average noise level at Birchwood House, after the proposed mitigation, would be lower than 40.5 dB L_{A90}.

What is meant by an “extended period”; what is the frequency and duration of the ‘worst case’ wind shear conditions. Such nebulous statements need refining and backing up with evidence.

Importantly, Mr Davis and Mr Cole find the operator’s predicted noise reductions to fall short by a further 0.4dB i.e. the operator’s predicted noise reductions are short by 0.5dB in total, the predicted turbine noise levels being 40.5dB.

Referencing average noise levels, Mr Davis and Mr Coles write of “reasonable certainty that the average noise level … would be lower than 40.5 dB L_{A90}.”
However, following the C37 methodology approved by Mr Davis, the average noise level needs to be lower than or equal to 40 dB L_{A90} not lower than 40.5 dB L_{A90}.
Further, the compliance condition, Condition 37 refers to condition 35 which refers to noise levels not to “average” noise levels so all in all the above paragraph 18 says little of consequence.

Added to which, if you put your head in the oven and your feet in the fridge, on “average” you’ll be perfectly comfortable.

19 It is standard practice (as adopted in BS4142-2014, for example) to ‘round’ environmental noise levels to the nearest integer value. It should be noted that the noise limits in the planning conditions, although based on background noise levels that were originally quoted to one decimal place, are ‘rounded’ values. The ‘rounding’ process also recognises that a noise level difference of less than 0.5 dB is subjectively undetectable. Therefore a calculated noise level below 40.5 dB (between, say, 39.6 and 40.4 dB) is rounded to a level of 40 dB.

The assessment method under consideration in this report is ETSU-R-97 not BS4142.

Mr Davis and Mr Cole write that a noise level of “below” 40.5 dB is rounded to a level of 40 dB. This explicitly implies that a noise level of “equal to or above” 40.5 dB is rounded up to 41 dB.

Further, UK Noise Policy requires that where there is scientific uncertainty, the precautionary principle applies which means that the polluter pays so in the case of a wind turbine noise level of 40.5dB, if rounding were to be applied it would be to 41 dB.

The operator’s noise consultant, HLA do not round their predictions to the nearest integer in their “Batsworthy Cross Wind Farm, Devon Supplementary Analysis Report 16/06/2017” let alone round a predicted noise level of 40.5 dB down to 40 dB so how on earth do Mr Davis and Mr Cole find it appropriate to do so.

Besides what is the point of working with predictions that Mr Davis and Mr Cole say “can be expected to be accurate” if they are going to make them inaccurate by rounding them to the nearest integer.

Conclusions

20 From the available information, our judgement is that if the proposed mitigation (as set out in Table 1) is applied there is reasonable certainty that the average wind farm noise level at Birchwood House at a wind speed of 7 m/s, in downwind conditions, would be lower than 40.5 dB. Therefore, when rounded to the nearest integer value in accordance with standard industry practice, the noise level would not exceed 40 dB. This would then comply with the night time noise limit at this wind speed at this location.

Had they insisted on actual noise measurements, Mr Davis and Mr Cole would not be bound by the available information and would be able to make more than a ‘judgement’ or ‘consideration’ of compliance.

Condition 37 does not refer to judgement or reasonable certainty or average noise levels or 40.5 dB limit for 7 m/s downwind speeds for Birchwood.
Condition 37 refers to directly measured noise levels being lower than or equal to 40dB not 40.5dB for 7 m/s downwind speeds for Birchwood.

See comments under paragraph 19 re the rounding.

21 It should also be noted that the proposed mitigation applied in the 200-350° wind sector (at all times) has the further effect of reducing noise at lower wind speeds – about 2 dB at 5 m/s, for example, for these wind directions. Noise levels are already lower than the limits at these wind speeds, although noise is audible at some dwellings and a reduction of 2 dB could be detectable. Therefore this is a secondary effect of the proposed mitigation that might be perceived as a benefit at dwellings around Birchwood House and also, in some wind directions, at other dwellings including Dikens and All Angels

It would be discriminatory to Birchwood should there be any suggestion or even perceived suggestion that a significant predicted noise decrease at other locations should provide some form of validation of acceptance of exceedances at Birchwood.

Besides, this is not a secondary effect or some sort of accidental bonus for residents, this is the way the noise limits work i.e. compliance with the noise limits at one location impacts residents at other locations. This emphasises the importance of compliance in as much as it impacts residents all around the site. Indeed non compliance at Birchwood results in higher noise levels elsewhere around the site.

Reductions in noise levels elsewhere around the site, especially to the south of the site and especially in lower wind speeds, could mean that any tonal noise is more pronounced resulting in a tonal penalty or a greater tonal penalty. This needs addressing.

22 Overall, we consider that the predictions of the effect of the proposed noise mitigation, when applied to the 2019 noise measurements at Birchwood House, provide robust evidence that the night time noise limit of 40 dB L_{A90} at 7 m/s wind speed at this location will be complied with.

How has the “reasonable certainty” expressed in paragraph 20 morphed into “robust evidence”.

The words “We consider” represent the provision of an opinion.
Condition 37 requires the results of direct noise measurements to show compliance, not opinion.

Compliance is binary; the wind turbines at Batsworthy Cross are either compliant with their noise limits or they are not. The planning conditions make no provision for a judgement of reasonable certainty of compliance based on predictions which depend on assumed likely wind shear values.

Appendix 1

Text of email from S Higman (RES) to NDC (Matthew Brown/A Cole) of 13 January 2021

Thank you for your email of the 5th January 2021. On behalf of Batsworthy Cross Wind Farm,

thank you for your acknowledgement of the satisfactory receipt of information in relation to bullet points 1 and 2.

Whilst BCWF don’t accept the necessity for further curtailment, as detailed in previous

submissions to the Council, in the interest of expediency BCWF would like to propose the following mitigation strategy to bring things to a conclusion:

CurtailmentTurbine Number (Sector 200 – 350°)									
Regime	*101*	*102*	*103*	*104*	*105*	*106*	*107*	*108*	*109*
Current (post)	*A*	*C*	*C*	*C*	*C*	*C*	*A*	*A*	*A*
Proposed (new)	*C*	*C*	*C*	*C*	*C*	*C*	*A*	*C*	*A*

As you can see, compared to the previous mitigation strategy, this new strategy involves putting two additional turbines (101 & 108) into Mode C for the wind direction sector in question, i.e. 200 – 350°.

This new mitigation strategy results in noise immission level predictions for the proxy location @ Birchwood House for this sector as follows:

Curtailment Regime	***Wind Speed at 10 m Height / (m/s)***						
	3	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Feb-Ap 2019 (pre)	*32.9*	*35.5*	*37.6*	*39.2*	*39.9*	*40.3*	*40.9*	*41.3*
Current (post)	*32.7*	*34.5*	*36.1*	*37.9*	*39.0*	*39.8*	*40.7*	*41.3*
Proposed (new)	*32.6*	*33.9*	*35.3*	*37.1*	*38.4*	*39.4*	*40.6*	*41.2*

As you can see, this achieves the 1.5 dB reduction which the Council believe to be necessary, i.e. (39.9 dB - 38.4 dB = 1.5 dB).

I would be grateful if you could confirm that, if BCWF were to implement this strategy, it would resolve the matter and the Council could confirm discharge of planning Condition 35. Once we have this reassurance then BCWF will implement it and provide proof, in the same format as before, that this has been done.

Mitigation strategy applied between February and April 2019 (during a specific period of a noise survey):

Wind Directions	Turbine Number								
	101	102	103	104	105	106	107	108	109
200° to 255°	A	B	C	B	A	A	A	A	A
255° to 350°	A	B	C	B	A	C	A	A	A

Current mitigation strategy implemented:

Wind Directions	Turbine Number								
	101	102	103	104	105	106	107	108	109
200° to 350°	A	C	C	C	C	C	A	A	A