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Evaluation of Noise Impact Assessment (Section 11 page 60)

submitted as part of the ADAS (UK) Ltd Environmental Appraisal

for the
Proposed wind cluster Sedborough Farm Parkham
(Planning application number: 1/0242/2008/FUL)

by

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1.0 Background and experience in relation to Wind Farms

1.1 MAS Environmental is an expanding expert partnership in Environmental Health based in Cambridge, East Anglia which I set up in 1994. I have 33 years experience in this field of work and I specialise in planning and noise and noise nuisance issues. I have given evidence at a considerable number of tribunals both in relation to court proceedings, including at the Crown and High Courts and also extensively at Planning Inquiries.

1.2 I have studied a number of wind farm developments and am currently undertaking research into those effects which are not adequately considered under the present available guidance, in particular the impact within dwellings. I have both observed and measured low frequency noise and excessive sound energy modulation within residential accommodation caused by wind turbines neither of which are addressed by guidance.

1.3 In 2005 I undertook a detailed study of the ETSU-R-97 guidance and an analysis of a number of patent inadequacies within the document. The desktop study identified a series of concerns which I then tested in the field. These revealed significant issues with the guidance and led to a more detailed assessment which is now underway.

1.4 Currently, concerns arise that wind farm noise emissions may trigger Vibro-Acoustic Disease (VAD). Some cases have been studied in Portugal which are related to wind turbine noise. I am directly involved with one case in the UK where this is potentially an issue. I am not involved with the medical research but am providing evidence of the noise impact that arises. Research into VAD is continuing. I understand concerns arise in particular as there appear to be clusters of VAD in close proximity to wind farms, sufficient to warrant closer scrutiny.

2.0 Summary findings on Noise Impact Assessment.

2.1 The ADAS UK report for this site contains inadequate information to reach an informed decision because a full Environmental Statement based on a properly conducted EIA has not been included with in the planning application.

2.2 I understand research undertaken in the UK by Andrew Bullmore, an acoustician working on behalf of the British Wind Energy Association, recommends turbines are situated a minimum distance of 700 metres from any dwelling (reported at a one day conference in Hartlepool July 2004). Another UK study by the Noise Association (Location, Location, Location released in July 2006) considered 1 mile an appropriate minimum separation distance, and in France the National Academy of Science recommend 1.5km. In this case dwellings are as close as 527 metres (refer to figure 11.1 of the report for the proximity of turbines to properties).

2.3 The noise element of the report is seriously defective and planning permission should not be granted on the basis of the information supplied, for the reasons set out in this report. There is serious and repeated misapplication of guidance and in particular the decision not to provide background noise data for the assessment in this case is deeply flawed and directly contrary to ETSU-R-97. Such an approach is only advised with single turbines and large distances to property. In this case dwellings are, in wind turbine terms, very close.

2.4 Serious error also arises in relation to the modelling applied to noise propagation which significantly under-estimates the noise levels. I have dealt with this in detail later. The consequence is that the assessment is unreliable.

2.5 Another serious flaw relates to the reliance on remote weather data. Guidance is clear that measurements on site are required and also which identify the relationship between hub height and 10m height wind speeds. This has not been undertaken. The topographical features and proximity of the sea result in particular characteristics that are site specific. The data at St Mawgan will be significantly different as it is on a much narrower peninsular and is without the Devon land mass and moors to the south. The site is facing a northerly bay but St Mawgan faces a westerly bay giving very different effects.

2.6 The assessment is not based on worst case noise emissions and a mid range sound power level was chosen.

2.7 Criticisms of the report relate directly to several of the matters raised by the local authority officers for example, model accuracy.

3.0 Why ETSU-R-97 should not be relied upon to assess noise impact from these large wind turbines.

3.1 The Noise Impact Assessment which accompanies the planning application relies on ETSU-R-97, applied slavishly to this situation. This is deeply flawed. ETSU-R-97 is a planning tool which should be used but it does not follow that it should be applied blindly to this development. ETSU-R-97 is incapable of addressing the noise impact issues created by large turbines and thus while it is important to use this tool, its guidance and advice must be modified to reflect the differences that arise. Failure to do this renders the assessment of little value.

3.2 In ETSU-R-97 impact from turbines up to a hub height of 32 metres were considered. Turbines up to 32m are generally considered as medium sized and are small compared to some of the behemoths now being constructed. There is no direct point of transition between medium and large turbines but those with hub heights of 50 metres and blade diameters also of 50 metres or more are clearly large turbines.

3.3 Paragraph 22 of Planning Policy Statement (PPS22) states you should use ETSU-R-97 **but** it can only be used where it is applicable or its guidance addresses the sound energy impacts likely to arise. The Companion Guide to PPS22 recognises it is not applicable in all situations. The main PPS22 is silent

on its limitations and it is clear the reader must go to the Companion Guide for detailed advice. The Companion Guide also provides much more pertinent advice.

3.4 I have set out below in more detail why slavish application of ETSU-R-97 leads to a flawed assessment.

3.5 Companion Guide

3.6 **Paragraph 3 & 4** - Here it makes it clear the guidance does not apply to vertical axis turbines or those used for pumping water. Similarly there is separate detailed consideration of small turbines which do not fall within the scope of ETSU-R-97 and where it is not applied despite the advice in PPS22. It follows that the guidance should only be applied to circumstances which fall within its parameters. Large turbines do not fall within those parameters.

3.7 In general large wind turbines are being assessed in accordance with ETSU-R-97. My investigations reveal that this arises primarily because local authority officers do not have the expertise or working knowledge of ETSU-R-97 to establish why it is limited and should not be applied directly and also they automatically apply it as the developer's consultant used it. There is no alternative guidance and it is natural to try and make that which is nearest fit. Finally, *prima-facie* PPS22 suggests ETSU-R-97 has to be used. That statement is without clarification.

3.8 I have set out below some of the reasons why ETSU-R-97 should not be applied without modification in the case of large turbines. I have also listed some of the other issues ETSU-R-97 does not address.

3.9 Paragraph 41

> *Located so that increases in ambient noise around dwellings etc. are kept to acceptable levels in relation to existing background noise.*

3.10 Background noise levels are relevant therefore regardless of the advice in ETSU-R-97 about 35dB cut off.

> *Under most operating conditions it is likely the turbine noise will be totally masked by wind-generated background noise.*

3.11 Research we are conducting shows that this is not the case in many situations. Thus where turbine noise is not so masked it is clear it becomes necessary to go beyond the guidance in ETSU-R-97, as that also operates on the same premise. Thus ETSU-R-97 is not appropriate where turbine noise is not generally masked by wind-generated noise.

3.12 In ETSU-R-97 it appears to have been assumed that if the turbine noise is masked externally then it will also be masked internally. This simply is not the case. See below.

3.13 Paragraph 42

> *Aerodynamic noise from turbines is generally unobtrusive – it is broad-band in nature and in this respect is similar to, for example, the noise of wind in trees.*

3.14 This is broadly true for medium sized turbines on which the ETSU-R-97 report was based and when relatively close to them but modern large turbines have different aerodynamic noise characteristics such that this statement does not hold true. In particular the modulation of the noise from large turbines readily exceeds the point where it could continue to be described as steady noise. This is an important distinction as the limits proposed in ETSU-R-97 are based on comparison with guidance for steady noise.

3.15 In ETSU-R-97 modulation was considered to be up to 3dB which is generally true for medium sized turbines but with large turbines this will generally exceed 5dB and may be nearer 9dB. This is a significant change in noise character placing them outside of its scope.

3.16 As stated, the tallest turbine used in the ETSU-R-97 study was 32 metres to hub height. Modern large turbines are up to and sometimes in excess of 100 metres. The swept area of the blades increases dramatically therefore in the case of large turbines compared to those used in the ETSU study. For example a turbine of 30m height, blade radius of 20 metres and rotational speed of 20rpm will have a typical tip speed about 40m/s. A large turbine of 100m with a blade radius of 40 metres and rotational speed of 20rpm will have a tip speed of 84m/s. In the case of the Vestas V80 at 19 rpm and 80 metre blade diameter the tip speed will be 80 m/s.) The tips are the main cause of aerodynamic noise which is generally produced on the downward stroke. Larger turbines have a much larger downward stroke at far greater speed cutting through air that is differentially variable in speed to a greater extent.

3.17 Paragraph 43

> *Wind-generated background noise increases with wind speed, and at a faster rate than the wind turbine noise increases with wind speed. The difference between the noise of the wind farm and the background noise is therefore liable to be greatest at low wind speeds.*

3.18 Once again this statement is true for medium sized turbines and when assessed externally but it does not hold true for larger turbines in many circumstances or when assessed internally.

3.19 Larger turbines reach winds in upper layers of air that are moving disproportionately faster than the winds experienced at ground level. As a consequence turbines can be generating noise when there is little air movement at ground level and little masking noise. ETSU-R-97 cannot address these circumstances as it was not developed to address excessive wind shear situations or the effects of larger diameter blades passing through a greater

range of wind speeds. Further the wind direction may change with height. This is not addressed either.

3.20 When inside a dwelling the building envelope serves to attenuate the masking noise created by the wind but it does not have the same masking effect upon the turbine generated noise. ETSU-R-97 appears to assume it does. That may have been true for medium sized turbines used for the ETSU-R-97 report but not for larger turbines located further away and higher up. This arises due to:

a) The direction of the noise source. A turbine may be in direct line of sight of an open window but the local wind generated noise sources are unlikely to be within the same angle of view and may even be totally screened by the building itself. ETSU-R-97 assumes they are both in the same direction and similarly reduced. This is rarely the case.

b) The spectral content is different. The distance to the turbine means that higher frequency noise is reduced disproportionately by the atmospheric effects and the emission energy is dominated to a greater extent by lower frequency noise. Local noise sources have not had the same atmospheric effects to the same extent and thus the turbine source and the wind generated noise sources relationship are markedly different for larger turbines that are generally located further away.

3.21 Paragraph 44

ETSU-R-97 describes a framework for the measurement of wind farm noise and gives indicative levels calculated to offer a reasonable degree of protection to wind farm neighbours.

3.22 ETSU-R-97 does indeed provide a framework but one that is incomplete and suited to medium sized turbines only. There are many scenarios and situations it does not address and its guidance is open to interpretation. Those working for the wind industry seem to have interpreted parts of the guidance in a manner that is favourable to their clients. That does not mean it is a correct interpretation. For example, background noise is assessed by many under all wind directions but it is patently clear that the only relevant wind direction (generally) is when it is from the turbine locations towards the relevant dwelling. When the wind is in the reverse direction, turbine noise will be substantially reduced. However, under negative winds the background noise may be disproportionately high, corrupting the results. This is especially the case with nearby roads on the opposite side of the dwelling. ETSU-R-97 is silent on this issue but it is patently clear only a limited range of wind directions should be included. In my experience those acting for the developers do not assess in that manner.

It can be regarded as *relevant guidance and good practice*.

3.23 This is the only UK guidance available that is specifically directed at this matter and thus it follows this is an eminently correct statement. However, that does not mean the guidance should be applied slavishly to all situations, especially when the issues arising fall outside of its scope. In the case of large turbines there are a number of issues which fall outside of its scope. Some have been identified in this document.

> *It overcomes some of the disadvantages of BS4142 when assessing the noise effects of wind farms*

3.24 This statement is incorrect. The ETSU guidance identifies problems with the BS4142 approach but does not then go on to address them. In fact it leaves the problems open to the acoustician to resolve. It follows that any method used to overcome the problems BS4142 presents could equally be used to overcome the same problems that ETSU-R-97 avoids addressing. For example, BS4142 is limited to low wind situations as it wishes to prevent influence of wind generated noise. ETSU-R-97 recognises this is a problem but does not provide a solution to it.

3.25 Many acousticians and Environmental Health Practitioners (EHPs – formerly called EHOs) assume that use of over-sized windshields address this problem but data shows it does not. Larger windshields provide marginal improvements over the standard windshields. Many have not been tested and thus provide unknown levels of corruption and render the noise meter no longer a type 1 meter. I am unaware of any reports presented by acousticians where they have corrected for these errors or indeed any accurate method to determine them. It is not practicable to correct for errors as ETSU-R-97 uses LA90's and the spectrum of the noise energy making up a particular LA90 is unknown. Further, if it was calculated and adjusted it would no longer be an LA90 level in any event.

> *ETSU-R-97 should be used by Planning Authorities when assessing and rating noise from wind energy developments.*

3.26 This statement is also sensible but using a document such as ETSU-R-97 which is a tool to aid assessment is not the same as following its guidelines slavishly that are themselves only applicable in a limited sphere of circumstances. <u>Large turbines automatically fall outside these criteria.</u>

3.27 Extract from ETSU-R-97 in Companion Guide

3.28 This extract states that the LA90,10min is likely to be about 1.5-2.5dB(A) less than the LAeq measured over the same period and the LA90 allows reliable measurements to be made without corruption from relatively loud, transitory noise events from other sources.

3.29 This statement is not entirely true and it will depend on the percentage of time the troughs in the fluctuating turbine noise exceed 10%.

3.30 In general this LA90 and LAeq relationship appears to hold true for medium sized turbines as assessed under ETSU-R-97 but not for larger turbines where the peak to trough variation can be much larger. As a consequence LA90 is not a suitable descriptor of the noise impact for large turbines and until the relationship is known, if indeed there is one, LA90 is not appropriate. This is an example therefore where larger turbines fall outside of the parameters in the ETSU-R-97 guidance.

3.31 Low Frequency noise (Infrasound) – Paragraphs 45-46.

3.32 This section of the guidance only addresses ground borne vibrations and not airborne low frequency noise. I have personally measured airborne propagated low frequency noise within a dwelling affected by wind turbines and also externally closer to a single large turbine. It is clear therefore that airborne low frequency noise is a potential issue not addressed by ETSU-R-97 or the planning guidance *per-se*.

3.33 Summary of general matters ETSU-R-97 does not address

3.34 Not all of these matters are covered in the comments outlined above as they are not referred to in the planning guidance.

1) Amplitude modulation is far greater than the 1-3dB identified in ETSU-R-97 meaning the fluctuations in sound energy are highly noticeable for large turbines.

2) Large turbines penetrate higher atmospheric layers where there is a greater variation in wind shear.

3) Larger turbines do generate audible airborne low frequency noise that is not masked when observed within dwellings.

4) The audible low frequency noise generated pulsates with potentially far greater adverse impact than mid frequency noise. Pulsating low frequency noise is more disturbing than pulsating mid frequency noise.

5) ETSU-R-97 relies on complaint generation to formulate acceptability criteria but evidence shows that a very small percentage complain and most will suffer without complaint. This is particularly so with wind turbines as a complaint affects property value as much if not more than the occurrence of the intrusive noise. Residents will often refuse to complain in order to avoid having to declare it at the time of sale of their property.

6) The only research on which ETSU-R-97 is based is taken from smaller, older turbines.

7) ETSU-R-97 is not based on internal noise measurements and data but assumptions made on the relationship between external and internal noise levels but which are incorrect for this type of source of noise.

8) Impact determination is based on wind shear relationship assumptions which are incorrect. The error factors are small for medium height turbines but increase disproportionately for large turbines.

9) Human reaction to wind turbine noise is not addressed and assumptions were made on relatively benign sources unlike the noise from modern large turbines.

10) Measurements are corrupted by wind noise generated over the microphone wind shields. This problem is recognised but not addressed by ETSU-R-97. Thus there is no validated method for measuring wind farm noise externally which can eliminate the corrupted noise element.

11) ETSU-R-97 does not address distance differences in local wind generated noise compared to that produced by the turbines. A gust at the turbines could take two minutes to reach a dwelling but the noise generated at the same moment in time travels there within 2 seconds.

12) Statistical averaging and regression curves, as used in ETSU-R-97, do not provide a true analysis of logarithmic recorded sound energy values. This is a simple matter of mathematics. The errors may be small for medium sized turbines but are compounded for larger turbines and there is no validation whatsoever.

13) Arithmetical averaging of the wind over 10 minutes does not relate to logarithmic averaging of the sound energy over the same period. This is also a matter of mathematics. To simplify this, the same average wind speed can produce markedly different average noise levels. For example, consider the following simplistic scenario. A constant wind speed of 10m/s produced 50dB(A) and a constant wind speed of 5m/s produced 40dB(A). If the wind was at 10m/s for half the time and still for the other half then the average speed is 5m/s but the noise level would not be 40dB(A), it is 47dB(A). Thus two average wind speeds can produce markedly different results. It is entirely a matter of chance as to the average wind versus noise level relationship.

14) ETSU-R-97 recognises it does not address wind shadow situations such as in courtyards or valleys. Any dwelling which is screened from wind generated noise sources is not covered by ETSU-R-97 guidance.

15) ETSU-R-97 cannot address situations where the background noise levels measured away from buildings are not representative of the background noise level at the building façade. This is often the case.

16) ETSU-R-97 is applied based on an incorrect interpretation of other guidance and a failure to recognise how that other guidance applied to specific sources of noise. The differences with medium turbines is not as great as that for large turbines and so this error is not of consequence for medium turbines.

4.0 Specific comments on the Noise Impact Assessment (NIA) detailed in section 11 of the ADAS UK Ltd Environmental Appraisal, Sedborough Farm Wind Farm development.

4.1 The ADAS Environmental appraisal in relation to noise is based on a report by NVC dated 25th November 2007. That report provides more detail than the ADAS appraisal and the latter document represents extracts almost entirely of the NVC report.

4.2 **General** – There is slavish and incorrect reliance on ETSU-R-97. This is addressed above. Further, the assessment of noise propagation is based on a flawed approach. See comments on modelling below. The report generally identifies an incorrect application of other guidance.

4.3 PPG24 does not provide limits for this type of noise. It only provides limits for transport noise sources affecting new dwellings. There are major differences in the source type here. Furthermore the noise exposure categories in PPG24 relate to people moving to the noise and not imposing a new noise on people. The effects are very different due to the preconception of the existing noise environment.

4.4 WHO Guidelines apply only to steady continuous noise and then various caveats are applied. Also it relates to critical health effects and their onset.

4.5 BS8233 1999 **clearly states** its guideline values (based on WHO values) only apply to **anonymous steady** noise. Therefore, the writer misapplies guidance.

4.6 The DTI study referred to does not show low frequency noise and Amplitude Modulation are not issues of concern. It did not find low frequency noise in one situation relating to a limited number of older windfarms, but I have recorded low frequency noise from a windfarm with modern large turbines. The research on Amplitude Modulation was a desk top study which is widely criticised. It identified a small proportion of wind farms causing complaints but it made various assumptions about the causes of complaints or factors preventing complaints. When properly compared, statistically, then proportionate to industry or residential locations, complaints about wind farms feature extremely high. Further, I am personally aware of at least four sites causing complaints about amplitude modulation (two of which were not considered in the studies) and have been advised there are others.

4.7 It is patently clear the assessment fails as it only assesses in accordance with the noise criteria in ETSU-R-97. I have shown that in this case it is inapplicable to apply its criteria without modification.

4.8 **Section 11.2.1, paragraph 1, page 61.** The report identifies an incorrect assessment of a planning matter on the basis of statutory nuisance. The courts have identified that these are wholly separate rafts of law with different objectives and one cannot be used to determine the other. This confusion

undermines any assessment as it demonstrates a failure to understand the issues in the mind of the assessor.

4.9 **Section 11.2.1, paragraph 2, page 61.** BS4142 1997 is incorrectly reported as applying only to fixed sources. There are no such limitations in the standard and the expert committee who updated the standard made it clear it is equally applicable to mobile sources. This also undermines the reliance on the advice contained.

4.10 **Section 11.2.1, paragraph 1 page 63.** The writer fails to identify that the guidelines on which reliance was placed i.e. the 1980 WHO Criteria had long been superseded i.e. as early as 1995 and so was based on out of date advice / guidance.

4.11 **Section 11.2.1, paragraph 4 page 63 to paragraph 4 page 65.** Here the writer applies an interpretation of the ETSU-R-97 guidance which reiterates many of the points that I have already addressed above. In essence it misses the problems with ETSU-R-97 and why large wind turbines fall outside of its scope or at least why the noise criteria are inapplicable.

4.12 **Section 11.2.2, paragraph 5 page 65 & paragraph 1 page 66, & section 11.2.3, paragraph 1 page 67.** The writer misinterprets PPG24 as its noise limit values only apply to new residential development. Direct comparison in the manner used is wholly inappropriate because of the differences in source type, anonymous nature of transport sources and application to new housing only which may be near new roads. It does not strictly set the limits the writer suggests in any event showing further confusion. This *apple and pears* comparison undermines the entire approach.

4.13 **Section 11.2.3, paragraph 2 page 67.** BS8233 1999 **clearly states** its guideline values (based on WHO values) only apply to **anonymous steady** noise. Therefore, the writer misapplies the guidance. The standard specifically identifies that it is unsuitable to be used for comparison with site specific noise sources.

4.14 **Section 11.2.3, paragraph 3 page 67.** This is incorrect. See above.

4.15 **Section 11.2.3, paragraph 1 page 68.** The guidance for minerals development is inadequately reported and misrepresents the situation. Wind turbines operate indiscriminately 24 hours day and night, 7 days a week. It is wholly inappropriate to compare noise from quarries which are generally limited to normal working hours.

4.16 **Inappropriate comparisons.** There is widespread misapplication of guidance and inappropriate comparisons which wholly undermine the assessment made. Selective reading of guidance in this way does not allow any confidence in the assessment.

4.17 **Section 11.3.1 iii page 68.** This is an incorrect interpretation of the ETSU guidance. The guidance identifies that in cases of single turbines or large

separation distances, a simplified approach is acceptable and background readings unnecessary. In this case there are two turbines and they are located well within recommended separation distances. In this instance it is a misuse of the guidance principles relied upon by the applicants to fail to undertake a full background noise survey. This particular case is not one of the exceptions permitting a change.

4.18 **Section 11.3.1, paragraph 2 page 69.** It is evident that assessment has not been based on site wind data but that at a distant weather station where there is no correlation with topographical effects. The nearby sea means there will be daily changes due to coastal effects that are weather dependent and also relative to height. In other words, wind speed and direction measurements at 10 metres at a remote weather station cannot predict effects at this site.

4.19 The topographical features and proximity of the sea result in particular characteristics that are site specific. The data at St Mawgan will be significantly different as it is on a much narrower peninsular and is without the Devon land mass and moors to the south. The site is facing a northerly bay but St Mawgan faces a westerly bay giving very different effects.

4.20 It is crucial in this case to measure wind at hub and 10 metre height on the site, in accordance with the guidance in PPS22. This departure from both ETSU-R-97 and PPS22 has no justification or merit.

4.21 **Section 11.5.1, paragraph 3 page 71.** The writer suggests that above 3m/s wind speeds it would increasingly affect ambient noise levels up to a point where the noise produced dominates the noise climate. I have already identified this is not necessarily the case and certainly is not the case within dwellings.

4.22 **Section 11.5.1, paragraph 5 page 71.** Here there is reliance on average wind speeds and direction. This is unhelpful as impact depends upon wind speed, direction and seasonal effects. For example on a warm night most will try to sleep with windows open but if this is also a period when wind is more likely to be from the wind farm to the dwellings then it creates a worst case for impact. Averaging over many years does not assist as there is no separation of crucial night time hours from daytime or seasonal impact.

4.23 Simple comparison of table 11.2 and 11.3 for the two periods averaged shows there is no continuity even in long term data. This is further complicated as different parameters have been used to determine the percentage of time at certain wind speeds. The first column in table 11.2 goes from 0-5.99m/s but the second table goes from 0-4.6m/s. The reason for obscure averaging must be questioned and it does not assist assessment other than to identify the data is inadequate for St Mawgan, let alone this site.

4.24 **Section 11.5.1, paragraph 1 page 74 to paragraph 1 page 75.** This section of the report provides selective information of wind effects on noise propagation. I do not take issue with the information *per-se* but it is not helpful in this case. All the guidance relates to ground based noise sources and in one case it relates

to urban environments i.e. Heathrow and Birmingham. The study referred to concluded there can be "complex relationships between wind speed and direction conditions." The study also found LAeq and LA90 were differentially affected. This merely suggests that reliance on the LA90 to determine the LAeq as found in ETSU-R-97 is not useful.

4.25 **Section 11.7, paragraph 4 page 77.** It is stated the sound power for the Vestas V80 varies up to 102.7dBW for the turbine example being considered. Planning assessment is usually undertaken based on worst case. According to Vestas data, these turbines can produce up to 105.5dBW. Worst case has not been assessed therefore.

4.26 **Section 11.8.4, paragraph 1 page 81 and paragraph 1 page 82.** The writer repeats many common myths about wind farm noise. Our research shows that even at distances approaching a kilometre wind farms can generate distinct thumps and periodic "whoomphs" that are clearly intrusive and contain significant low frequency content. They are less noticeable externally than internally. I can state this as I have personally observed and measured the noise. It is pertinent to note that in the case of industrial noise BS4142 1997 recognises a source of noise may need to be 10-15dB below the background noise level before there is a positive indication that complaints will not occur. It follows that the simplistic comparison with other sources in Table 1 does not indicate acceptability.

4.27 **Section 11.12 and modelling** – See below

4.28 **Section 11.12.4, paragraph 1 page 91.** Table 11.6 shows a very rudimentary understanding of wind farm noise as it suggests the reduction from external to internal is 10-15dB. This may be correct for a façade level noise from a broadband traffic source under most conditions but it is not relevant to wind farm noise incident on a window that is in direct line of sight of the turbines. In these circumstances reductions can be significantly below 10dB. Notwithstanding all the other modelling errors, this calculation is also misleading and incorrect.

4.29 If 3dB modelling errors are added to the 2dB source noise error already identified and the wind effects that the use of ISO9613 in an un-modified approach fails to reflect are accounted then the noise levels can be about 6dB higher than the levels predicted. However, these levels are LA90's and we know that for large turbines the 1.5-2.5 increase to get the LAeq (average noise energy) is insufficient. The increase could be in the region of 5-6dB and possibly much higher. Thus the LAeq of the turbines should be expected to exceed the predicted LA90's by 11-12dB. This ignores use of point source calculations rather than line source, atmospheric enhancement in stable air and noise due to turbulent air effects that can arise with large turbines.

4.30 The error factors are such and the lack of predictability for large turbines under specific weather conditions i.e. stable atmospheres, mean that it is unsafe to attempt to predict impact in this case without substantially more data. This is

especially true in relation to wind and atmosphere but also in relation to measured local background noise levels.

4.31 **Section 11.12.6, paragraph 1 page 95. Low frequency noise** - A study is referred to where low frequency noise was not found to be an issue. However, I have measured at a wind farm site and found significant low frequency noise in certain conditions. The fact that it was not found during a study under limited conditions does not equate to its non-existence. In the case I monitored the low frequency components varied under different conditions but particularly concerning was modulating low frequency noise in the 125, 160 and 200Hz third octave bands within a dwelling. The research into this case is still continuing and is due to be reported in July 2008.

4.32 Other

4.33 The precise turbines have not been determined. This is unacceptable as turbines can vary significantly in their noise footprint and operational characteristics. The application is incomplete and cannot be approved, especially as Environmental Impact Assessment is or could be relevant.

4.34 **Wind shear** (Section 11.12.7, page 95).

4.35 The turbines are sited off the ridge line, either side of the valley. The base of the turbines are at approximately 160 and 170 AGL whereas the hills either side of the valley are at 203 metres and 205 metres as shown on figure 7.1. Is it likely in these conditions the wind speed at different heights will be vastly different creating a further increase in wind shear and added turbulent airflow.

4.36 A number of inaccurate or misleading statements are made. Excessive wind shear occurs in a much higher percentage of situations than previously considered. In this case it is a coastal location the effects of which can lead to much increased wind shear. This is not a deep inland site in terms of atmospheric effects and this factor alone indicates stable air and excessive wind shear are likely. It is also likely that micro jet streams in the atmosphere will occur with air movement in differing directions. This will also increase turbine noise. The writer states there is no evidence at specific wind farm sites of this effect. This is incorrect. Excessive wind shear is particularly prevalent in a number of areas and I am currently investigating noise at one site due to excessive wind shear. Further there is no reason why excess wind shear occurs in Europe but not the UK. The fact that the study referred to was not in this country is not a reason to ignore its findings.

4.37 It is also wrong to suggest this element can be assessed after the development is approved (**Section 11.12.7, paragraph 1, page 98)**. There is no mechanism to address this once approved. The mere suggestion of measurements to assess this factor post development confirms the need to assess it before approval.

4.38 Amplitude Modulation (AM) Section 11.12.8, paragraph 1, page 99.

4.39 Reference is made to the Salford study. This was effectively a desk top study that did not investigate allegations of AM in the field. References to this study do not assist therefore, particularly as cases continue to come to light and which we at MAS are investigating. Our study is far from complete but its occurrence is an important factor associated with large turbines. I have already identified that ETSU-R-97 does not address the impact from large turbines.

4.40 Modelling inaccuracies

4.41 In essence ISO9613-2 has been used but this standard is limited to low wind speed situations and thus cannot factor in the effects of the wind conditions under which the turbines generate noise. The standard assumes a light downwind situation. It is also limited to 1 kilometre. Studies of noise modelling algorithms generally have not considered sources of noise that have significant height. Also the modelling assumes the turbines operate as point sources of noise with all the sound energy emanating from the hub. This is clearly wrong.

4.42 Thus even if ISO9613 was to be used, it should be modelled as line sources in the vertical plane and following the downward arc of the blade tips. Line sources do not attenuate at the same rate as point sources resulting in additional errors in this method.

4.43 It is also basic acoustics that the noise does not radiate equally in all directions when it is affected by wind and yet any model based on ISO9613 only assumes there is even radiation of noise in all directions. ISO9613 is also incapable of considering atmospheric stability.

4.44 The closest modelling procedure that incorporates these effects is an adjusted ISO9613 algorithm which then applies the wind effects and atmospheric stability developed in the CONCAWE model. CONCAWE is the only model that incorporates these effects. Such an approach accords with ISO9613 as it permits a meteorological adjustment. It is also commercially available as a modelling option. Such a modified approach avoids some of the problems found with CONCAWE and equally the inadequacies of ISO9613. Once atmospheric stability, wind direction and speeds are entered into the model it becomes clear noise levels are higher than those predicted using the ISO9613 procedure employed in this case.

4.45 Further errors arise in this case as the writer has only included the error factor for the turbine noise itself and not the error factor identified in ISO9613 which adds a further 3dB. Thus a total error factor of 5dB should have been used and not 2dB as stated.

4.46 Reference is made to an ETSU study of noise prediction models reported in 1995 which favoured ISO9613. However, the writer fails to report that the study was based mainly on a fixed point source (loudspeaker) located up to 15 metres above the ground. Some measurements were undertaken at slightly higher positions but primarily it was based on relatively low heights suited to the assessment of medium and small turbines but not large turbines. It is for this

reasons that a modified approach is considered appropriate. It was also limited to flat land.

4.47 We are yet to undertake this exercise in this case which will follow in due course. Experience in other cases demonstrates levels may be under-estimated by a significant amount.

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