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Submission to the Select Committee on

Wind Turbines

Application of regulatory governance and economic impact of wind turbines

by

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Preamble:

I did not originally intend to contribute comments, as the areas of “regulatory governance and economic impact” lie mostly outside my experience. However, looking at some of the submissions shows that others have chosen to widen the scope of their comments into any area which they wished and, in doing this, have supplied you with certain information which I believe to be incorrect.

My following submission is intended to correct some of these misleading contributions, which largely relate to infrasound and its effects.

Although I have worked periodically for the wind industry, mainly in my specialist areas, no one from the industry has either prompted me or rewarded me in the preparation of this submission. It is based on my independent beliefs, which were largely developed prior to my first working for the wind industry.

1. **A bit about me.** I am a UK based acoustical consultant and a former President of the UK Institute of Acoustics. I work internationally on problems of noise and, in recent years, have worked for Australian, Canadian and USA companies. About half of my long working life has been as an academic and half as a consultant (approximately 30 years in each capacity). During my time as an academic, I ran the Acoustics Research Group at London University and personally supervised 30 PhD students to completion of their theses, including a number on infrasound and low frequency noise. I have had a scientific interest in infrasound and low frequency noise since the late 1960s and my first publication in the area was in 1971 – about 45 years ago. One of my many publications on low frequency noise has been downloaded from the internet over 40,000 times (Leventhall 2004). I was well-established as an expert in infrasound and low frequency noise before the advent of modern wind turbines and have applied my existing expertise to them.
2. Much of my work has been on how people are affected by noise, how they respond to it and the psychological stress effects which might occur. Additionally, I have initiated and guided a UK Government supported project on helping people to accommodate to unsolvable noise problems (Leventhall , Robertson et al. 2012). Some of these problems have arisen when all required criteria are satisfied, but a small number of people were still distressed by the noise.
3. I believe that I am better qualified and experienced than many others to contribute to the debate around infrasound from wind turbines and responses to infrasound.

Infrasound

4. There are many misconceptions about infrasound. It has become a favourite of weird websites, which associate it with surreal and paranormal events, or describe it as a subtle weapon and cause of illness. Many opponents of wind turbines have latched into this and have used infrasound as a stick with which to beat wind turbines. For the past 10 years, or more, the leading objectors to wind turbines have led a very successful propaganda campaign against wind turbines, partly centred on supposed dangers of infrasound. We are now in a

confused situation in which many people hold sincere beliefs about infrasound, but these beliefs are based on false information, which has been fed to them by objector groups and their allies. The leading objectors to wind turbine developments are culpable in this. Their skilful, and successful, misinformation campaign, largely based on repetition, only serves to heighten adverse effects, whilst holding back research in significant areas. Frequent repetition of a fiction does not make it true, although repetition may eventually convince some that it is so.

5. Acousticians, and others, coming new to the area of infrasound and low frequency noise, through their work on wind turbines or otherwise, now do so in the shadow of this misinformation and it is difficult for thought patterns and emotions to remain unaffected by it. A result is that far more emphasis has been given to these topics than they merit. (Leventhall 2006). A very calm, unemotional and resolutely logical approach is required for consideration of wind turbine infrasound, in order to separate fact from speculation and reality from misinformation.
6. I note that some submissions relate occasional, or even one-off, uncomfortable incidents and then attribute these to infrasound. I urge caution in assessing these as, in order to have credence, decisions cannot be based on another person's speculation.
7. Experiences are very real to those who are affected. I have never doubted this, but care must be taken to assess the true cause of these experiences. It often transpires that many are the result of stress related reactions, where the cause of the stress is often an aversion to, for example, a source of audible noise. The effects can be explained by the well-established psychoacoustical research on audible noise, without invoking infrasound. As will be shown later, I believe this to be the explanation of the problems at Cape Bridgewater Wind Farm.
8. There is always the possibility of existence of a few extremely sensitive persons – outliers on the noise sensitivity curve. Criteria are not intended to protect

these persons. In fact, many noise criteria are set at levels at which it is known that about 10% of people will be annoyed by the noise.

9. Legislators produce criteria which are satisfactory for the majority of persons, for example to protect 90% of those affected. The criteria may be influenced by the plight of individual extremes, but cannot be controlled by these. It is the responsibility of the GP to help the individual and the responsibility of the legislator to consider the needs of the majority of people, as a group, so enabling the modern world to continue to progress.

The Steve Cooper Cape Bridgewater Report.

10. This report has received many plaudits in the media, ranging from “ground-breaking” to “pointing the way for future medical research”. Following a detailed study of the report, I do not agree that these plaudits are deserved. The report is useful in its detail, but it reveals little new and has ignored what should be its most obvious conclusions. It is clear that Mr Cooper came to the work with the firm conviction that inaudible infrasound was a problem and cared only to develop that theme. However, what the report actually shows is that those affected are responding to audible noise, and exhibiting well known stress responses to an unwanted noise, even though this noise is normally at a very low level. The report indicates that infrasound is not an issue. I came to this conclusion in the following way.
11. If you look at, for example, Appendix K for House 88, which is the most complete, all the daily variations have coloured arrows, which I believe were inserted by hand by Mr Cooper. These show a Blue arrow for Noise Perception, a Green arrow for Vibration Perception and a Red arrow for Sensation Perception. Each arrow carries a number from 1 to 5. Number 1 means no perception and 2 to 5 are increasing levels of perception. I recommend that you run your eyes along the daily blue arrows. You will see that there are very few at level 1 (no perception of noise) and most of these occur when the turbines are not operating. Thus, the residents are themselves saying that they are hearing an audible noise from the turbines. Further, by looking at both the noise and sensation levels, it becomes clear that the level of sensation is related to

the level of noise. In fact, it is possible to show a high statistical correlation between the higher noise levels and the higher sensation levels.

12. I find it astonishing that Mr Cooper was so dazzled by infrasound that he did not see what was before his eyes as he entered the data on the charts. Human psychoacoustical response to an audible noise is a well-researched field and, in my opinion, the residents are reacting in the typical manner of highly stressed persons, who are affected by a noise which they do not wish to hear, irrespective of its low, criterion-compliant, level. I have interacted with, and helped, many similar persons. (Leventhall , Robertson et al. 2012) . There is no evidence that inaudible infrasound is a factor at Cape Bridgewater.

13. The Cape Bridgewater Wind Farm report has, unfortunately, been misrepresented by some, the main distortion being with respect to audibility. We may expect distortion from the media but not from fellow scientists. However, shortly after the Cooper report was released, American acoustician Paul Schomer came out with a statement on the report which included the following

“This study finds that these 6 people sense the operation of the turbine(s) via other pathways than hearing or seeing, and that the adverse reactions to the operations of the wind turbine(s) correlates directly with the power output of the wind turbine and fairly large changes in power output.”

As shown in Para 10 above, the first phrase of this quote is simply not true. The residents themselves confirm that they heard the turbines, some of which were also visible from their homes. Changes in turbine operation caused changes in audible noise level, which drew attention to the turbines and led to responses.

I can find no rational explanation for Schomer’s error.

14. Schomer has also sent you a submission (No 77). In this he repeats his error on inaudibility and cites papers which he claims support Cooper’s work. However, I believe that these papers are not relevant to wind turbine infrasound

at levels of 40-50dB in the region around 1Hz to 5Hz, which was Cooper's focus. For example, the ISO 1996-1 Standard refers largely to assessment of audible sound, not sound which is about 60dB below the hearing threshold. Additionally, its companion standard ISO 1996-2 recommends G-weighting for assessment of very low frequency sound. The G-weighting approximately follows the low frequency hearing threshold and rejects sounds in the frequency region of wind turbine tones.

15. Schomer's use of the paper by Nussbaum and Reiniss is also suspect. This paper concentrates on effects of 8Hz infrasound at levels over 100dB, and mainly at 130dB. Cooper showed house internal levels of wind turbine noise of around 40dB at 8Hz. It is misleading to compare the Nussbaum and Reiniss work at 130dB at 8Hz with Cooper's measurements of around 40dB at 8Hz. In fact a sound at 130dB has a billion times more acoustic energy than a sound at 40dB. The comparison is invalid.

16. Schomer also refers to his own recently published paper (Schomer, Erdreich et al. 2015). However, his theory is clearly flawed as it leads to a false outcome. In science, a theory must give a result which is in accord with experience. For example, a theory which leads to the result that apples rise upward when they detach from the tree would be unacceptable, whilst a theory which confirms our experience that apples fall downwards has some promise for development. Schomer's conclusion from his theory is that a tone of 0.7Hz at 54dB, which is typical of the blade passing characteristics of modern wind turbines, has a similar nauseogenic effect to a 5ms^{-2} peak acceleration at the same frequency. He does not develop this further. However, it is very easy to show that the 0.7Hz, 5ms^{-2} peak acceleration is associated with a peak displacement of 0.25m, which is accompanied by a 0.7Hz pressure change at the ear of over 100dB. Thus, Schomer is expecting us to believe that 0.7Hz, 54dB from wind turbines has a similar effect on us to being shaken up and down at 0.7Hz with a peak displacement of 0.25m whilst experiencing over 100dB at the ear! There is clearly something wrong with Schomer's theory and I have taken this up with the Editors of the Journal in which it was published, but have not yet had a reply.

17. The work of neurologist Alec Salt is often referred to in connection with wind turbine noise. His first paper in this area defines an outer hair cell threshold and it is speculated that exceedance of the threshold may send confusing signals to the brain (Salt and Hullar 2010). However, the threshold is at 100dB at 1Hz, a frequency for which wind turbine blade tones, which are of concern to Cooper and Schomer, are in the 40-50-60dB sound pressure level region, well below this threshold. I do not query the existence of the Salt threshold, but merely point out that it is at a level which is well above the level of wind turbine blade tones and therefore is not relevant to these tones.
18. A recent paper from Salt (Salt and Lichtenhan 2014) has been severely criticised by Dobie in a letter to the Editor of the Journal involved (Dobie 2014). Dobie showed that all the references given by Salt and Lichtenhan to support their paper were for tonal frequencies and at levels higher than those from wind turbines, the most extreme being 30Hz at 120dB. Dobie concluded that, despite its title claiming relevance, the Salt and Lichtenham paper was not relevant to effects from wind turbines.
19. I urge caution in applying Salt's work to wind turbine blade tones, which are at very low levels and very low frequencies. This is not a criticism of Salt's work, but a caution against its inappropriate application.
20. Tones and pulses. The wind turbine blade tones, featured in the Cape Bridgewater Report, are actually the components of a small pulse, which occurs when a blade passes the tower. Recent work has been on the direct perception of similar pulses to those from wind turbines, but in laboratory settings. (Walker and Cerrano 2015) (Tonin and Brett 2015).
21. Walker and Cerrano used large loudspeakers to generate infrasound pulses in a typical room at peak levels up to 97dB. Currently seven persons have been tested for pulse perception and conclusions are:

"To date, subjective reactions to the synthesized signals are not conclusive due to the small number of test subjects and constrained exposure times.

However, no individual thus far has reported any sensation when exposed to infrasound alone at peak levels up to 97 dB.”

22. Tonin and Brett had a different form of excitation, using a pneumatically operated headset to give direct aural stimulation. 72 volunteers were tested, 27 female and 45 male, ranging in age from 17 to 82 years with a median age of 29 years, and experiencing exposures up to 91dB peak. Some of the subjects were primed to be concerned about infrasound and others were primed to be unconcerned. The conclusions are:

“It was found that the volunteers who came into the experiment with pre-conceived notions of infrasound being harmful, generally reported more symptoms than volunteers who began the experiment more sceptical about the potential health impacts of infrasound. These results support the hypothesis that a placebo effect and not a direct physiological effect may be the cause of reported symptoms.”

23. The experiments show that it is unlikely that subjects are affected by the blade pass pulses. It is also of interest that the test pulse peak levels used in these recent experiments are much higher than those given by Swinbanks in his Submission 189, page 30, Fig 4, which shows peak levels of 69-72dB.

24. Conclusions.

1. My main conclusion is that infrasound from wind turbines is not the problem it has been made out to be. In reaching this conclusion it has been necessary to criticise others, but the criticisms have been backed with evidence.
2. I have searched for hard evidence that infrasound from wind turbines affects people, but found none, whilst there is other evidence that it does not have an effect.
3. The problems at Cape Bridgewater Wind Farm are most likely caused by unwanted perception of audible noise from a source which, although it complies with criteria, is nevertheless resented by the listeners. Over time, this is sufficient to build up into the stress effects which the residents exhibit.

4. I believe that much of the public perception of infrasound from wind turbines is falsely based, being hugely influenced by the long-term and misguided campaign which has been organised by objector groups.
5. There are many reasons why a person might object to wind turbines, but there is no evidence that infrasound should be included amongst them.

References.

Dobie, R. (2014). "Letter to the Editor." Acoustics Today 10(2): 14.

Leventhall, G. (2006). "Infrasound from Wind Turbines – Fact, Fiction or Deception " Canadian Acoustics 34(2): 29 - 36.

Leventhall , G., et al. (2012). "Helping sufferers to cope with noise using distance learning cognitive behaviour therapy." J. Low frequency Noise, Vibration and Active Control 31(3): 193-204.

Leventhall, H. G. (2004). "Low frequency noise and annoyance." Noise and Health 6: 59 - 72.

Salt, A. N. and T. E. Hullar (2010). "Responses of the ear to low frequency sounds, infrasound and wind turbines." Hearing Research 268: 12-21.

Salt, A. N. and J. T. Lichtenhan (2014). "How does wind turbine noise affect people?" Acoustics Today 10(1): 20-28.

Schomer, P., et al. (2015). "A theory to explain some physiological effects of the infrasonic emissions at some wind farm sites." J. Ac Soc America 137(3): 1356–1365.

Tonin, R. and J. Brett (2015). "Response to Simulated Wind Farm Infrasound Including Effect of Expectation " Proc. Sixth International Meeting on Wind Turbine Noise, Glasgow.

Walker, B. and L. Cerrano (2015). "Progress Report on Synthesis of Wind Turbine Noise and Infrasound." Proc. Sixth International Meeting on Wind Turbine Noise, Glasgow.