LETTER TO THE EDITOR

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Response to article by S. Cooper, "Wind farm noise - an ethical dilemma for the Australian Acoustical Society?", *Acoustics Australia* **40**(2), 139-142 (2012)

I was disappointed to read Stephen Cooper's technical note asking if the acoustical engineers and consultants preparing wind farm noise assessments in Australia are acting in accordance with the Australian Acoustical Society's Code of Ethics. It is apparent that Mr Cooper believes that many of the acoustical engineers and consultants who undertake these assessments are acting unethically on the basis that they *are* relying on ill-informed standards and guidelines and not challenging those guidelines or looking beyond them.

I have been fortunate enough to have recently been engaged by several government agencies to undertake an independent review of the standards and guidelines relating to the assessment of wind farm noise. Since I have never previously consulted to either the wind farm developers or the wind farm opponent groups I was able to approach this work from a 'neutral' position. The study has allowed me to develop an over-arching and contemporary view of the practice of wind farm noise assessment in Australia – a view which leads me to largely reject Mr Cooper's accusations.

I agree that there is genuine community concern regarding the potential for adverse effects associated with noise from wind farm developments, and a great deal of publicity regarding wind farm noise, particularly in the popular media. Nevertheless, much of the publicity is inaccurate and ill-informed, and articles such as Mr Cooper's technical note will, at best, only serve to reinforce the public perception that there is still significant disagreement amongst 'acoustic experts' regarding the best ways to measure, predict and assess wind farm noise - there is not. At worst, it will be adopted as a 'key reference' by wind farm development opponents.

In his note, Mr Cooper contrasts the lack of informed consideration of the 'acoustic impact of wind farms' against the apparently more robust acoustic and socio-acoustic studies which informed the 'aircraft noise debate' following the opening of the third runway at Kingsford Smith Airport in Sydney. He then provides an account of his own contribution to the prediction of aircraft noise, in particular, the identification of several 'errors' in the common prediction methodology. The implication is that consultants are making similar errors in their prediction and assessment of wind farm noise, particularly by simply adopting international standards, with no 'localisation' to Australian conditions.

It is fair to say that the assessment methodology and choice of assessment criteria for wind farms is not perfect. But, as discussed in Isaac Asimov's enlightening and entertaining essay *The Relativity of Wrong* [1], it is important not to assume that 'that which isn't perfectly and completely right, is totally and equally wrong'. In practice, most of us are able to accept that there are no criteria, or guidelines, or assessment techniques that are ever perfect. They are always the result of compromise and an attempt to *balance* the impact of noise on the amenity of the community against the wider benefits that the noise source provides. It therefore must be accepted that noise criteria, whether they are for industrial noise, noise from pubs, or barking dogs, or even wind farms, could always result in some adverse impact, particularly on people who have heightened sensitivity to noise.

My view is that consultants in Australia are doing their best to provide a reasonable and fair assessment of noise from wind farms. Much of this is based on reliable research and technical work that has been, and continues to be undertaken overseas by Geoff Leventhall, Andrew Bullmore, Dick Bowdler and other prominent acoustic engineers [2-7], research that appears to have been overlooked by Mr Cooper.

There are also many consultants and engineers in Australia and New Zealand who are undertaking excellent research, people like Tom Evans, Jon Cooper, Christophe Delaire and Colin Tickell amongst others in Australia, and Michael Smith and Stephen Chiles in New Zealand. These engineers are exploring new techniques to measure and assess noise from wind farms in a fair and equitable way [8-10], for example, by exploring 'bin analysis' of measured background and wind farm noise level [11] rather than the cumbersome 'regression' analysis which is usually adopted.

Furthermore, the continuing research into the potential health effects of wind farm noise is not being ignored; rather, the New Zealand Standard is based on a *reasonable* interpretation of the current research, and the New Zealand standards technical committee and other experts continue to review work such as that by Møller and Pedersen [12] and from DELTA [13, 14].

Mr Cooper has also published a peer review of the acoustic assessment undertaken for the Flyers Creek Wind Farm [15] which demonstrates several fundamental misunderstandings and inaccuracies which are also worthwhile examining.

With regard to low-frequency noise, Mr Cooper notes that a significant number of papers report low-frequency noise impacting on residents where the wind farm '*give[s] rise to frequencies below that of the human ear*' (sic).

His measurements of wind farm indoor and outdoor noise levels at residences near the Capital wind farm are claimed to show an impact from low-frequency noise from the wind turbines. However, only noise levels measured both with the wind farm operating in windy conditions and without the wind turbines operating, in calm conditions, are presented. The necessary case of the wind farm *not* operating in windy conditions is not shown, and would be likely to show low frequency noise due to increased environmental noise

generation. It is accepted that this type of measurement is difficult, or impossible to do without the participation of the wind farm operator – nevertheless, such a significant omission makes the subsequent analysis meaningless.

For example, it seems irrational to suggest that '*typically when the wind farm was generating an electrical output [that] the background level increased, and when the wind farm reduced generating electrical output the background reduced*' infers that the wind farm is solely responsible for the background noise, while ignoring the fact that high ambient wind conditions, which is a necessary condition for the wind turbine to operate, also generates significant noise.

With regards to the internal noise level measurements undertaken inside nearby properties, Cooper's report states that '*no noise associated with the turbines could be detected inside the dwelling because the sound pressure levels recorded in those bands are below the nominal threshold of hearing*'.

There are further anomalies; data in Appendix G of the Flyer's Creek review showing a so-called 'Pulse Time Analysis' analyses the measured wind farm sound level using *fast response exponential averaging at 50ms*. Yet 125 ms is commonly accepted as a time constant representing that of human hearing, and the measurements shown in Appendix G does not appear to be exponentially averaged. While the figure title suggests a 24.4 Hz high-pass filter was applied, the measured levels only roll-off below around 5 Hz. Similarly, the results shown in Appendix H do not appear to have been high-pass filtered as suggested in the text.

Finally, he concludes that the measured Capital wind farm sound levels exceed various low frequency noise criteria. This includes the suggestion that Norm Broner has proposed a low-frequency noise limit of the dB(A) level + 30 dB '*where the C-weighted value is above 30 dB(A)*' (sic). Actually, Dr Broner recommends a 'desirable' outdoor L_{eq} limit of 60 dBC, with a maximum limit of 65 dB(C) for night-time operation [16]. In any case, the wind farm sound levels Mr. Cooper measured near the Capital wind farm are below the internationally recognised guidance limits of 85 dB(G) and 65 dB(C) [14, 17].

In order to constructively contribute to the wind farm noise discussion, it is helpful to examine some of those key aspects of wind farm noise measurement and assessment that would benefit most from additional research in order to *improve* the way that wind farms are measured and assessed.

Firstly, I agree with Mr Cooper that there is value in undertaking psycho-acoustic studies of the impact and annoyance of noise from operating wind farms – this was recommended by the Senate Enquiry into the Social and Economic Impact of Rural Wind Farms [18]. This would help to inform the science. This should particularly look at understanding the influence of amplitude modulation on the audibility and subjective response of wind turbine noise. The measurement of background and wind farm noise also requires improvement; the current regression techniques are quite cumbersome and not particularly transparent. While filtering by day, night, season, wind direction or atmospheric stability (or some combination of these) usually helps, perhaps alternative 'bin' type analysis (proposed to be adopted in the 3rd revision of IEC 61400-11) might prove more appropriate. The proposed *Good practice guide to wind turbine noise assessment* currently being developed by the UK IoA is likely help to inform the procedure.

The application of penalties for so-called 'Special Audible Characteristics' (or SACs) to measured noise levels requires further refinement – should penalties be applied to individual 10 minute measurements (and included in the regression, as implied in NZS 6808), or applied in bulk to the regression curve should a particular threshold of occurrence be exceeded?

We require better definition about when it might be appropriate to suggest or apply a more conservative limit (such as the High Amenity limit in NZS 6808-2010), and when the base limit is reasonable.

We should consider some standardisation of the structure of assessment studies and compliance reports, so that the community can be assured of some minimum level of information.

So, taking guidance from Dr. Asimov who concludes that 'theories are not so much wrong, as incomplete', until the outcomes of the research are available, I see no 'unethical behaviour' in using existing theory and the tools that are currently available to assess noise from wind farms.

Yours sincerely,

Dr Kym Burgemeister

REFERENCES

[1] I. Asimov, *The Relativity of Wrong*, 1988. Full text available at http://hermiene.net/essays-trans/relativity_of_wrong.html

[2] G. Leventhall, A. Bullmore, M. Jiggins, M. Hayes, A. McKenzie, R. Bowdler and R. Davis, "Prediction and assessment of wind turbine noise, Agreement about the relevant factors for noise assessment from wind energy projects", *Acoustics Bulletin* **34**(2), 35-37, March/April (2009)

[3] Hayes McKenzie Partnership Ltd, *Analysis of how noise impacts are considered in the determination of wind farm planning applications.* Report 2293/R1, Research Contract 01.08.09.01/492A (Analysis), UK Department of Energy and Climate Change, April 2011

[4] UK Institute of Acoustics, *Good practice guide to wind turbine noise assessment, Working Group terms of reference* http://www.ioa.org.uk/pdf/ioa-good-practice-guide-terms-of-reference-v-09-12-11-version-5.pdf (last accessed November 2012)

[5] A. Bullmore, J. Adcock, M. Jiggins and M. Cand, "Wind farm noise predictions and comparison with measurements", *Proceedings of the 3rd International Meeting on Wind Turbine Noise*, Aalborg, Denmark, 17-19 June 2009

[6] A. Bullmore, M. Jiggins, M. Cand, M. Smith and S. Von-Hunerbein, "Wind turbine amplitude modulation: Research to improve understanding as to its cause & effect", *Proceedings of the 4th International Meeting on Wind Turbine Noise*, Rome, Italy, 11-14 April 2011

[7] D. Bowdler, "Amplitude modulation of wind turbine noise, A review of the evidence", *Acoustics Bulletin* **33**(4), July/August 2008, pp. 31-35

[8] C.E. Tickell, J.T. Ellis and M. Bastasch, "Wind turbine generator noise prediction – Comparison of computer models", *Proceedings of Acoustics 2004*, Gold Coast, Australia, 3-5 November 2004, pp. 45-50

[9] T. Evans and J. Cooper, "Comparison of predicted and measured wind farm noise levels and implications for assessments of new wind farms", *Proceedings of Acoustics 2011*, Gold Coast, Australia, 2-4 November 2011

[10] J. Cooper, D. Leclercq and M. Stead, "Wind induced aerodynamic noise on microphones from atmospheric measurements", *Proceedings of the 20th International Congress on Acoustics*, Sydney, Australia, 23-27 August 2010

[11] M. Smith and S. Chiles, "Analysis techniques for wind farm sound level measurements", *Acoustics Australia* **40**(1), 51-56 (2012)

[12] H. Møller and C.S. Pedersen, "Low-frequency noise from large wind turbines", *Journal of the Acoustical Society of America*, **129**(6), 3727-3744 (2011)

[13] B. Søndergaard and K.D. Madsen, *Low frequency noise from large wind turbines: Results from sound power measurements*, DELTA Acoustics & Electronics, AV136/08, 2008

[14] T.H. Pedersen, *Low frequency noise from large wind turbines: A procedure for evaluation of the audibility for low frequency sound and a literature study*, DELTA Acoustics & Electronics, AV1098/08, 2008

[15] S. Cooper, *Peer review of acoustic assessment*, Flyers Creek wind farm, The Acoustic Group Pty Ltd. Report 41.4963. R1A:ZSC, 15 December 2011

[16] N. Broner, "A simple outdoor criterion for assessment of low frequency noise emission", *Acoustics Australia* **39**(1), 7-14 (2011)

[17] D.M. Hessler and G.F. Hessler, "Recommended noise level design goals and limits at residential receptors for wind turbine developments in the United States", *Noise Control Engineering Journal* **59**(1), 94-104 (2011)

[18] The Senate Community Affairs References Committee, *The social and economic impact of rural wind farms*, Australian Senate June 2011 http://apo.org.au/node/25321