NZS 6808:2010 Acoustics – Wind farm noise

Dr Stephen Chiles

BEng, PhD, CPEng(NZ), CEng(UK), FIOA,

Chairman, NZS 6808:2010 Technical Committee

Principal, Acoustics Engineer, URS New Zealand Ltd

Introduction

The 2010 revision of NZS 6808, the New Zealand Standard for wind farm noise, updates and enhances the 1998 version. These improvements have been welcomed by the New Zealand Acoustical Society and others working in this field.

In the acknowledgements at the front of the 2010 revision of NZS 6808 it is noted that:

"The representative of Massey University, while recognising the revised Standard is an improvement on the original, does not support the Standard."

This paper addresses specific criticism of the standard by Professor Philip Dickinson, Massey University's representative on the NZS 6808 technical committee. To allow free, frank and open debate amongst committee members during the development of a Standard, all Standards New Zealand committee proceedings remain confidential to each committee and will not be discussed here. During the NZS 6808 committee process Professor Dickinson published his main concerns in a conference paper , and his views were circulated on public websites[5,6]. After the Standard was published he was later called to present those concerns at the Board of Inquiry for the proposed Turitea wind farm.

None of Professor Dickinson's concerns are unique to the 2010 revision of NZS 6808. All of the issues he raises relate to concepts from the original 1998 version of NZS 6808, and some are common with other New Zealand Standards. In some instances, Professor Dickinson's concerns are in fact addressed by the 2010 revision. However, in most cases, the other committee members could not reconcile his concerns with the evidence available to the committee. This paper addresses the objective concerns expressed by Professor Dickinson in the conference paper and at the hearing for the Turitea wind farm.

L90 and measuring background sound

The use of the 90% centile level (L90) to measure background sound and wind farm sound is questioned by Professor Dickinson, as he suggests that it is not used for industrial sound sources. He has overlooked the long-standing use of the L90 metric and its current application in situations such as the measurement of transformer sound when near to roads.

The reasons for using the L90 metric for wind farm sound are explained in detail in section 3.1 of NZS 6808. In summary, wind farm sound can only be measured in the presence of wind. The time-average sound level (LEQ), which is used for most other sound sources, is easily contaminated by wind moving the microphone diaphragm and giving readings not related to sound levels, and also by wind moving vegetation and generating elevated background sound. Therefore, the LEQ cannot be used in the windy conditions necessary for wind turbine operation. L90 registers steady continuous sound such as wind farm sound but excludes short-duration peaks such as contamination from wind gusts. This provides a fair representation of the wind farm sound level and reduces contamination by other sounds. Use

About NZS 6808:2010

NZS 6808 provides methods for the prediction, measurement and assessment of sound from wind turbines.

A Standards New Zealand scoping committee identified a need to revise the original 1998 version of NZS 6808. The Energy Efficiency and Conservation Authority and the New Zealand Wind Energy Association co-funded Standards New Zealand to undertake a revision of the Standard starting in 2008. Standards New Zealand identified stakeholders and appointed a technical committee to undertake the revision and make a recommendation to the Standards Council. This resulted in the 2010 edition of NZS 6808.

The organisations represented on the technical committee were: Energy Efficiency and Conservation Authority, Executive of Community Boards, Local Government New Zealand, Massey University, Ministry for the Environment, Ministry of Health, New Zealand Acoustical Society, New Zealand Institute of Environmental Health Inc., New Zealand Wind Energy Association, Resource Management Law Association, and University of Auckland. Additional committee members were appointed to provide technical skills, but each organisation had only one vote.

A discussion of the NZS 6808 revision process and key changes is provided in a separate paper published in the proceedings of the 2010 International Congress on Acoustics[1]. Information about the Standard is also available from Standards New Zealand[2] and the New Zealand Wind Energy Association[3].

of the L90 is a practical and effective solution.

Professor Dickinson asserts that using the L90 metric prevents simple compliance assessment of wind farm sound. NZS 6808 provides a robust procedure in section 7 that allows compliance assessment using the L90 metric. This procedure is not simple because of contamination by wind effects, but it has been proven to work on numerous wind farms in New Zealand, Australia and internationally for over a decade.

The NZS 6808 compliance assessment procedure involves a large number of measurements to correctly assess the wind farm sound level under different wind speeds, wind directions and times of day, and also to obtain reliable averages to discount potential contamination by other sound sources. This complexity is unavoidable and to ignore it could result in unrepeatable and unrepresentative measurements. While Professor Dickinson criticises this approach, his alternative of using a series of say twenty LEQ measurements *"...when the sound from the wind farm dominates the environment..."*[4] does not address the fundamental issue of contamination by wind effects, or the reality that in most instances the wind farm sound does not dominate the environment. The limitation of Professor Dickinson's proposed method with respect to contamination may be a reason why he considers conventional wind farm sound level predictions to be inaccurate based on his own measurements. The alternative measurement method proposed in NZS 6808 is on/off testing, which was included specifically to account for contamination by other sounds.

The issues Professor Dickinson raises with respect to the noise floor of instrumentation and wind shields (i.e. the lowest sound level that can accurately be measured) are explicitly addressed in section 7.2.3 of NZS 6808. Instrumentation with an appropriate noise floor is readily available.

Relationship between wind speed and background sound

Professor Dickinson also questions the use of relationships between hub height wind speed and background sound levels at noise sensitive locations. The benefit of analysis using the hub height wind speed is the direct relationship with wind farm sound. The revised standard provides detailed guidance on this matter in section 7.4, and the issues raised by Professor Dickinson are largely addressed by following those instructions, such as production of separate plots for different conditions. There is unavoidable scatter in background sound levels as the measurements include sound from varying natural processes. The effect of this scatter is mitigated by conducting a large number of measurements to give robust datasets, which NZS 6808 requires.

Sound insulation of New Zealand homes

The World Health Organisation assumes a reduction of 15 dB for sound travelling from outside to inside a house with the windows partially open for ventilation. Professor Dickinson disputes this value, although he does not reference any actual sound insulation measurements. Two separate measurement exercises conducted in New Zealand in 2000 for the Manukau City Council and the Building Industry Authority, show that the World Health Organisation value is appropriate for New Zealand homes. There is no conflicting evidence in this matter.

Professor Dickinson asserts that people should be able to sleep on a deck or veranda or with windows fully open. There are no other sound sources in New Zealand where an internal noise limit has been applied in such circumstances. To take such an approach would be moving towards an 'inaudibility' criterion, discussed next. To adopt such a criterion would significantly restrict most residential, recreational, commercial and industrial activity throughout New Zealand.

Inaudibility criteria

Professor Dickinson asserts that due to the low population density in New Zealand *"...there is no need for any wind turbine noise intrusion on local communities."*[7] This statement is essentially calling for a criterion of inaudibility and absolutely no adverse noise effects. There are no sound sources for which such a criterion is adopted in New Zealand, and in this respect there is no evidence to suggest sound from wind farms should be treated differently. For all sound sources the criteria are determined to protect health and maintain reasonable amenity.

There are many constraints on the location of a wind farm, including: wind resources, access, transmission, visual effects, ecological effects and land ownership. These issues together with noise effects are all considered under the Resource Management Act, which aims to achieve sustainable management of natural and physical resources. The Resource Management Act does not require activities to have no adverse effects. It would be contrary to an effects-based assessment under this legislative framework to impose an absolute criterion of inaudibility for wind farm sound or any other sound.

It has been suggested that wind farms should only be located where there is a buffer of several kilometres, or more, from the nearest neighbours. This is essentially seeking an inaudibility criterion. Controls of this nature do not take into account the actual noise effects of a wind farm, which depend on background sound, wind conditions, topography, receiver locations, turbine layout, number, size and type. All of these factors are addressed by the NZS 6808 method.

A further criticism made by Professor Dickinson is the use of "background plus" as part of the NZS 6808 noise limits. The background plus approach is required as wind turbines only generate sound when it is windy and when background levels usually increase. Critically, a noise limit at or below the background sound level could not be reliably measured or enforced. The remainder of the committee considered it unreasonable to dogmatically restrict wind farm operation at times when sleep disturbance could arise from a variety of unavoidable background sounds.

Professor Dickinson discusses various mechanisms which he asserts could give rise to special audible characteristics from wind turbines. NZS 6808 provides specific procedures to penalise any special audible characteristics from wind

farm sound in section 5.4 and Appendix B. Sound exhibiting special audible characteristics causes greater annoyance than sound of the same level without such characteristics. Therefore, if special audible characteristics are present the sound is penalised and in effect is treated as if it were louder for the purposes of compliance assessment.

ISO 9613 and the accuracy of predictions

One of the most significant criticisms that Professor Dickinson makes is with regards to the prediction of wind farm sound. Firstly, it must be kept in mind that regardless of any predictions, a compliance assessment using sound measurements is required once a wind farm is operating. Therefore, any significant errors in the predictions will be found during commissioning, and will be required to be rectified to achieve compliance with the noise limits.

The 2010 revision of NZS 6808 suggests the use of the ISO 9613-2 prediction method that has been in use for wind farms in New Zealand and internationally for over a decade. Other than Professor Dickinson, the committee were not aware of any cases where significant errors have been found using this method. Professor Dickinson is correct that this method was not written for wind farms and that wind turbines do not comply with the stated limitations of the method. However, in practice the method has been shown to be accurate. The most recent example is the measurements at the West Wind wind farm, which validated the predictions using ISO 9613-2[8].

There has been substantial recent research into sound generating mechanisms of wind turbines, using modern techniques including noise cameras[9]. This research shows that the dominant sound is not from the very tip of the blade, as asserted by Professor Dickinson on the basis of older research on propellers in water. The question raised about the source height used in the model is addressed in section D1 of NZS 6808:2010.

Professor Dickinson proposes that wind farms should be modelled as line sources, which would result in attenuation of 3 dB with a doubling of distance. A line source is a theoretical construct to represent a series of point sources. As computer models can directly model an array of point sources there is no benefit in using the intermediate step of a line source, and in fact it will cause a loss of accuracy. Using either approach will result in the same theoretical attenuation with distance. Sound from an individual point source will attenuate at 6 dB with a doubling of distance. However, for both a long array of point sources and a long line source the attenuation will be 3 dB with a doubling of distance.

Low frequency sound and vibration

Professor Dickinson considers that there should be a low frequency wind farm noise limit. The available research does not show a low frequency component to wind farm sound that requires specific control. This has been extensively researched on behalf of the Danish Energy Authority[10]. Wind farm sound like most other sounds does include low frequencies, but these are within appropriate limits.

There is an argument that a simple low frequency sound test should be included in NZS 6808 to provide reassurance to the public, even though research does not show concerning levels of low frequency sound. However, internationally standardised wind turbine sound test data does not require this frequency range to be reported, and therefore a low frequency test cannot be implemented with predicted levels at this time.

Extended measurements that would be required in bedrooms of private households are also problematic, as access may not be available and spaces would need to be unoccupied. In his comments on this issue Professor Dickinson does not acknowledge these practical limitations.

Professor Dickinson draws attention to natural room resonances, known as modes. Room modes exist in all spaces and extend up to high frequencies. When there is furniture in a space the low frequency modes discussed by Professor Dickinson become distributed across a wider range, lessening amplification effects.

Most environmental sounds include energy at lower frequencies and as noted above, research shows wind farm sound to have a typical frequency distribution.

Conclusions

Professor Dickinson has raised numerous issues with NZS 6808. Some of these matters are addressed by the 2010 revision.

On examination of the other issues in the light of substantial recent research and data from actual wind farms over an extended period, the remainder of the committee could not reconcile Professor Dickinson's concerns with the evidence.

References

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[3] http://windenergy.org.nz/documents/factsheets/nzs6808.pdf

[4] P.J. Dickinson. (2009). Nonsense on stilts, A new draft wind turbine noise standard. Proceedings of Acoustics 2009. Adelaide.

[5] http://www.windaction.org/documents/20774

[6] http://www.wind-watch.org/documents/concerns-regarding-draft-standard-for-wind-farm-noise/

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[10] http://www.madebydelta.com/delta/Business_units/TC/Services+by+technology/Acoustics/Low+frequency+noise/Low+frequency+noise+from+large+wind+turbines.page