

Wind Farm Consent Conditions After NZS6808:2010

M Miklin Halstead

Marshall Day Acoustics Limited, Wellington, New Zealand

ABSTRACT

In New Zealand, commercial scale wind farms require resource consents where environmental effects, including noise, are considered. Conditions of consent prescribe noise limits and management and assessment methodologies which apply to the project under consideration. As experience with wind farm noise has accumulated, these conditions have become more complex. In 2010, the second edition of New Zealand Standard NZS6808 was released, which included a model set of conditions intended as a simple and robust set of requirements, when used in conjunction with the standard itself. This paper examines the degree to which subsequent wind farm consents have adopted and relied upon the Standard and the model conditions, and considers whether additional consent conditions that have been included point to matters which should be incorporated into the next edition of the standard.

1. INTRODUCTION

In New Zealand, all commercial scale wind farms require resource consents. This requires that issues including noise effects be fully considered, and provides an opportunity for local authorities or the courts to impose specific controls on noise emissions which are suited to the particular wind farm application.

The history of New Zealand's wind farms stretches back to 1993, and over that time noise emissions have shifted to the forefront in wind farm resource consent consideration. The complexity of the consent conditions regarding noise has increased dramatically over time. Several factors have contributed to this, including:

- The increasing size and sound output of wind turbines and wind farms
- Local experience gathered through the post-construction management of wind farm noise emissions
- Political concerns over fears surrounding wind farm noise
- Evolution of world-wide best practice

In 1998 the first edition of New Zealand Standard NZS6808 was published, as a means of gathering best practice information for the prediction and measurement of wind farm noise, and to offer guidelines on assessing and controlling noise effects. In 2010 a revised edition of this standard was published, again providing updated guidance on best practice around these matters.

Both editions of the Standard attempted to address concerns raised around noise from wind farms which surfaced as wind farms were applied for and constructed. NZS6808:2010 specifically addressed the growing complexity of noise-related resource consent conditions, and offered a model set of conditions which largely relied on reference to relevant sections of the Standard.

In this paper, the consent conditions which have been issued following the release of NZS6808:2010 are examined, and comment is made on whether they point to matters that indicate further revision of the Standard is necessary.

2. A BRIEF HISTORY OF NZ WIND FARMS AND THEIR CONSENT CONDITIONS

The first wind farm in New Zealand was the Brooklyn turbine, a single 225kW turbine installed in Wellington in 1993 (NZWEA n.d.). In the absence of an established New Zealand document on the management of wind farm noise, a general requirement to develop a "noise monitoring and problem solving agreement" was adopted by the Wellington City Council (Aburn 1991). These requirements were addressed by Malcolm Hunt Associates in the preparation of a report drawing on international best practice at the time (Hunt 1993).

Subsequent farms were of larger scale, and while the conditions of consent which were issued either did not address noise or relied on ad hoc assessments of noise effects, the actual noise effects became more significant, and encouraged the development of more standardised approach to wind farm noise assessment.

In 1998 the first edition of New Zealand Standard NZS6808 was issued, and provided a methodology for

measuring and assessing noise. This standard was used in numerous consents, resulting in consent conditions from the simplistic (e.g. Te Apiti Wind Farm, one sentence, (TDC 2003)) to the complex and contradictory (e.g. Te Rere Hau Wind Farm, 5 pages, (EnvC *Te Rere Hau* 2005)).

In 2009, a standards review committee was assembled to draft a new version of the standard. The Committee included government groups, academics, community group representation, as well as acousticians and the wind industry organization. This committee considered the issues raised at recent and current major wind projects including West Wind, Motorimu and Turitea wind farms (Botha 2009). The revised standard set out to address the conflicts presented in these hearings and others, and to provide a structure that would reduce the uncertainty around noise assessments for wind farms.

Figure 1 illustrates the approximate timing of the various wind farm consents issued in New Zealand. The rollout dates of the 1998 and 2010 standards are shown by the orange and blue background shading respectively. The diameter of the sphere representing each wind farm is proportional to the log of its generating capacity.

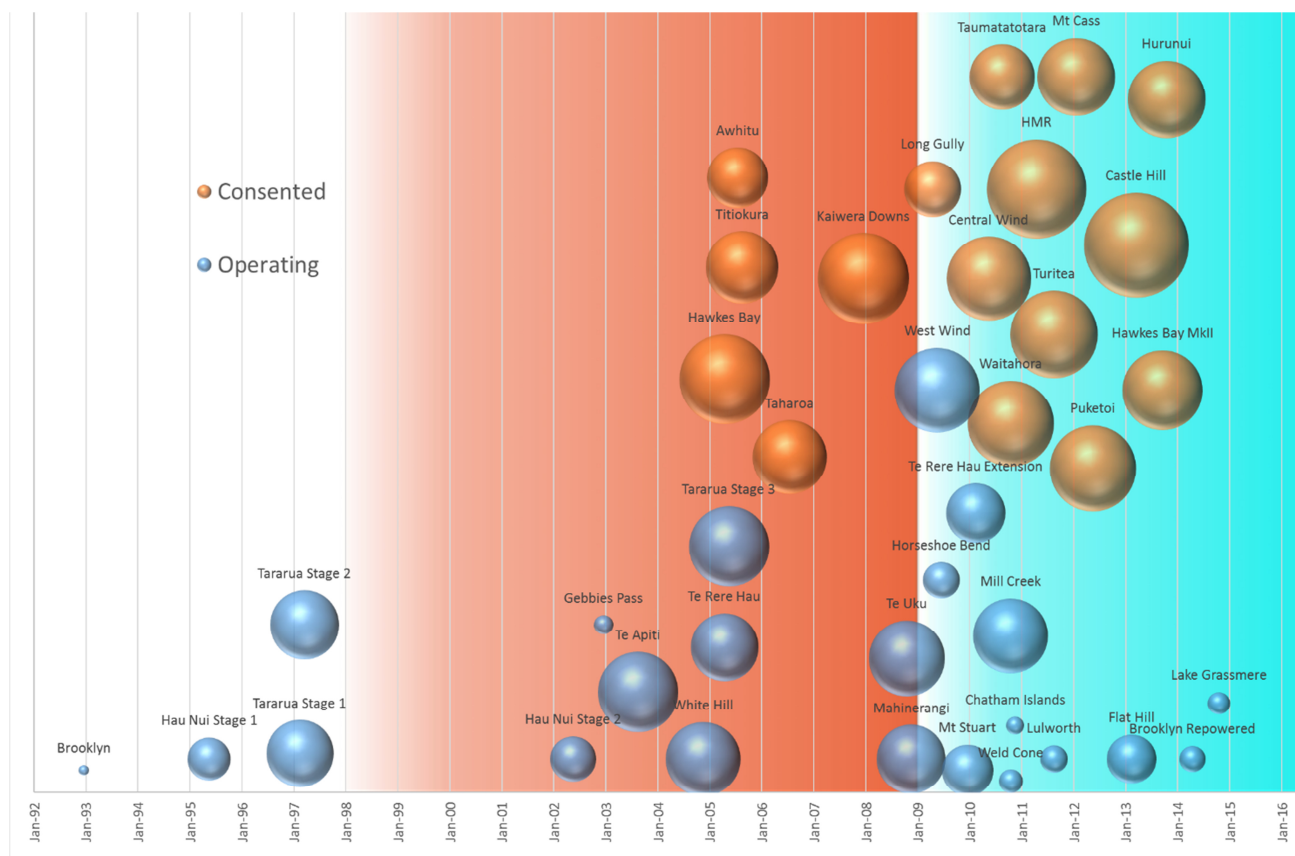


Figure 1: Approximate Timeline of NZ Wind Farm Consents

3. NZS6808:2010 MODEL CONDITIONS

NZS6808:2010 offers a set of model conditions in “Appendix A – Recommended Consent Conditions”, which is an informative section. The appendix states that the comprehensive methods of measurement and assessment provided by the standard should minimise the need for additional conditions.

The conditions relating to wind turbine noise are as follows (SNZ 2010):

1. WIND TURBINE OPERATIONAL SOUND

1.1 The consent holder shall ensure that, at the specified assessment positions, at any wind speed, wind farm sound levels do not exceed:

- (a) A noise limit of 40 dB $L_{A90(10 \text{ min})}$, provided that the following noise limit shall apply in the circumstances stated in (b);
- (b) When the background sound level is greater than 35 dB $L_{A90(10 \text{ min})}$, the noise limit shall be the background sound level $L_{A90(10 \text{ min})}$ plus 5 dB.

[In cases where a more stringent high amenity noise limits may be justified, the following form of rule 1.1 as follows would be used:]

1.1 The consent holder shall ensure that wind farm sound levels comply with:

- (a) During daytime or at any time when the wind speed is greater than [a certain threshold], the noise limit shall be 40 dB $L_{A90(10 \text{ min})}$, provided that the noise limit in (c) shall apply in the circumstances stated;
- (b) During evening and night-time at any wind speed less than or equal to [a certain threshold], the noise limit shall be 35 dB $L_{A90(10 \text{ min})}$, provided that the noise limit in (c) shall apply in the circumstances stated;
- (c) At any time when the background sound level plus 5 dB is greater than the noise limits in (a) or (b) the noise limit shall be the background sound level $L_{A90(10 \text{ min})}$ plus 5 dB;
- (d) For the purposes of these conditions, unless otherwise specified, [daytime, evening and night-time are described].

1.2 Wind farm sound shall be measured and assessed in accordance with NZS 6808:2010.

1.3 The assessment positions shall be outside at the noise sensitive locations, defined in accordance with NZS 6808:2010, shown on [figure X] attached.

4. COMPLIANCE REPORTS

4.1 A compliance assessment report shall be submitted to the [designated council officer] in accordance with section 8.4.1 of NZS 6808:2010.

[If a 'consenting envelope' approach has been taken or an application provides for different turbine options, the following conditions should be included:]

4.2 A prediction report shall be submitted to the [designated council officer] in accordance with section 8.4.2 of NZS 6808:2010, unless the selected wind turbine layout is the same as a layout for which predictions were provided in the application, and the selected wind turbines have sound power levels no greater than the levels used in those predictions.

The conditions provided in this appendix are kept brief and to the point by reference to the contents of the standard itself, which contains the complex and comprehensive details. The matters which are to be explicitly stated in the consent conditions are:

- The numerical noise limits
- The locations at which assessment is to be carried out
- A description of the authorities to whom reporting is to be made

The standard itself specifies how the following matters will be dealt with during the design of the wind farm, assessment of the application, and assessment of compliance:

- Definition of relevant terminology
- Big-picture outline of the prediction/measurement/assessment process
- Management of reverse sensitivity
- Identification of noise sensitive locations

- Establishment of noise limits, including a discussion of the background and justification for the recommendations, and criteria for considering more stringent limits
- Assessment of special audible characteristics, including adjustments to noise limits when these are present
- Discussion of the relevance of ultrasound, infrasound and vibration
- Consideration of cumulative effects
- Information on the influence of uncertainty on noise assessments
- Guidelines for appropriate noise prediction methodologies
- Guidelines for establishing appropriate sound power levels for modelling
- Methodologies for measuring background sound (before construction) and operational sound
- Guidelines for collecting wind data for noise curve correlation
- Instructions for analysing data for assessment, both for evaluating a consent application and for determining compliance
- Documentation and reporting requirements

It is the stated intention of the Standard to provide enough detail on these matters to avoid the need for further clarification in consent conditions, except as necessary to describe specific issues such as measurement locations, applicable limits and responsible consenting authorities.

In the following sections, several consents issued under the guidance of NZS6808:2010 are considered, and the conditions which have been issued are compared with the treatment of the relevant matters within the standard.

4. REVIEWED CONDITIONS

The wind farm consent conditions described in this section have been approved for construction – they have all successfully proceeded through either the local authority stage (and in some cases Environment Court review), or through the “call in” process by which projects of national significance can be elevated directly to Environment Court level. All conditions reviewed in this paper have been issued for public viewing. The particular consents considered are as follows.

4.1 Brooklyn Wind Turbine (Repowered)

The Brooklyn Wind Turbine was first consented in 1991, and was repowered by Meridian Energy in 2015 with a new consent issued for its operation. The new turbine is larger than the original, and produces a sound power level slightly higher than the previous turbine at full speed, although it has a significantly lower sound power level than the original at lower wind speeds. The turbine is located near to the Wellington suburbs, and is a visual landmark and city icon.

4.2 Castle Hill Wind Farm

Genesis Energy applied for consent for the Castle Hill wind farm in mid-2011, and received consent in June 2012, with confirmation of the consents by the environment court in July 2013. The farm has not yet been constructed, but could cover around 20,000 hectares of rural land, and could comprise up to 286 turbines with a potential generation capacity of up to 860MW (Genesis n.d.).

4.3 Flat Hill Wind Farm

Flat Hill Wind Farm was opened in August 2015, following a final Environment Court decision in March 2013. The Farm comprises eight 850kW turbines, located near Bluff (NZWEA n.d.).

4.4 Hawke’s Bay Wind Farm (Maungaharuru wind project)

Hawke’s Bay Wind Farm was originally consented in 2005, and this consent was purchased by Meridian Energy in 2010 along with the neighbouring Titiokura Wind Farm. The farm was redesigned and variations to the consent were approved in 2015, along with a lapse period expiring in 2023 (Meridian n.d.).

4.5 Hurunui Wind Farm

Meridian Energy was granted consent for the Hurunui Wind Farm in April 2013, by direct referral to the Environment Court. The project is in the upper South Island, and would comprise up to 31 turbines (NZWEA n.d.).

4.6 Mill Creek Wind Farm

Meridian Energy's Mill Creek wind farm was consented in February 2009, with appeals to the Environment Court being decided in August 2011. Construction of the farm was completed in 2014, consisting of 26 turbines with a capacity of 60MW. This project is adjacent to Meridian Energy's West Wind wind farm which has operated since 2009 (NZWEA n.d.).

4.7 Mount Cass Wind Farm

MainPower applied for consent for the Mount Cass wind farm in 2009, but was initially declined. On appeal to the Environment Court in 2011, the consent was approved. The Farm would have a capacity of between 33 and 78 MW depending on the chosen turbines (NZWEA n.d.).

4.8 Turitea Wind Farm

Mighty River Power initially applied for consent for the 122-turbine Turitea Wind Farm in January 2009, but following initial review by the Board of Inquiry, revised the plan to 104 turbines (NZWEA n.d.). The Board ultimately gave consent for 60 turbines, with a maximum capacity of 180MW. Although the Conditions of Consent reference NZS6808:2010, much of the deliberation over the farm occurred prior to the release of the new version of the standard. As a result, the consent conditions are a mix of approaches of the two "eras".

5. REVIEW OF CONDITIONS

In this section, each of the reviewed conditions of consent are examined to determine how much direct reference to NZS6808:2010 is made, what additional consent conditions are imposed, and what issues are being addressed by those conditions.

5.1 Reference to NZS6808:2010

All the wind farm applications reviewed which have been issued since the release of the new standard make reference to NZS6808:2010. A period of transition occurred around the release date, where consents which were under consideration at the time of release took some guidance from the pre-release consultation version of the standard in terms of best practice, or used the standard to settle outstanding issues arising from use of the 1998 version.

A notable example is the Turitea Wind Farm, which was first submitted to the Board of Inquiry in December 2008. Initial hearings proceeded between July 2009 and March 2010, and the final report was released in February 2011 (BOI 2011). Although the noise assessment in the original application was carried out using the 1998 version of the standard, the matters discussed during the later parts of the hearing were considered using the new standard, and the consent conditions were issued with reference to the rules contained in the 2010 version. In particular, the Conditions apply the secondary (high amenity) noise limit, adopt the objective test method for tonality, and require that background noise measurements and reporting be carried out using the methods set out in the 2010 version of the standard. Nevertheless, the conditions of consent were extremely complex, and replicated and replaced much of the advice contained in NZS6808.

For consents in which NZS6808:2010 was the prevailing version of the standard from the beginning of the application process, conditions generally make an overarching reference to the standard, with the blanket condition, "*Wind farm sound shall be measured and assessed in accordance with NZS6808: 2010 Acoustics – Wind farm noise.*" A slightly different wording except is employed in the Mt Cass Wind Farm consent conditions (EnvC Mount Cass 2012).

5.2 Application of Noise Limit

Most of the reviewed conditions of consent accepted and applied the noise limit recommendations of NZS6808:2010 – that the noise limit shall not exceed 40 dB $L_{A90(10 \text{ min})}$ or the "background plus 5 dB", whichever is the greater. However, the Flat Hill Wind Farm deleted the "background plus 5 dB" portion of the limit, controlling noise received at relevant assessment locations to 40 dB $L_{A90(10 \text{ min})}$ at all wind speeds (EnvC Flat Hill 2013).

In several projects, it was deemed appropriate to include reference to the secondary (high amenity) noise limit:

- At the Mill Creek Wind Farm, a 35 dB $L_{A90(10 \text{ min})}$ noise limit applies at night-time (8pm – 7am) when the wind speed is less than 6 m/s. This wind speed threshold was examined in detail during the hearing, against a proposal that the wind speed threshold should be higher (therefore causing the high amenity noise limit to apply more often). Ultimately the recommendation of NZS6808:2010, that the wind speed threshold should be 6 m/s, was accepted (EnvC *Mill Creek* 2012, WCC 2013). This more stringent secondary noise limit is justified in this application on the basis that the permitted activity noise limits in the subject area are particularly stringent – 35 dB LAeq at night-time at notional boundaries.
- At the Turitea Wind Farm, a similar secondary (high amenity) noise limit was imposed – a limit of 35 dB $L_{A90(10 \text{ min})}$ which would apply between 10pm and 7am when the wind speed is below 6 m/s. This limit was justified by the Board of Inquiry on the weight of public submission, rather than by an existing “high amenity” provision in the district plan. As with the Mill Creek wind farm, there was a proposal by residents’ groups that the wind speed threshold should be raised to 8 or 10 m/s from 6 m/s, but this was rejected by the Board of Inquiry.

5.3 Reliance on the Standard for Technical Advice

NZS6808:2010 provides a detailed methodology for measuring and assessing wind farm noise, and for reporting the results. This allows writers of consent conditions to omit technical detail from the conditions, and by doing so avoid confusion and conflict that can arise when wording differs slightly from what is contained in the standard.

The consent issued to the Brooklyn Wind Turbine when it was repowered is an example of a straightforward set of consent conditions which accomplish this. The details provided in the conditions set out the project-specific details such as the chosen numerical noise limits, a requirement around which of the optional objective tonality tests should be applied, the locations where assessments should occur, the required reporting dates, and to whom reports should be issued (Shaw 2014). An additional condition was included regarding tonality, as discussed below, but the conditions generally allow adherence to the methodology in NZS6808:2010 to direct a full assessment of compliance.

At other wind farms, the methodologies of the standard are supplemented or replaced as discussed in the following sections.

5.4 Reiteration of Technical Advice

In several cases, technical advice already contained in NZS6808:2010 which is required of the applicant by the blanket condition (“*shall be measured and assessed in accordance with NZS6808:2010*”) is reiterated within the consent conditions, sometimes prefaced by “for the avoidance of doubt” and sometimes not.

For example, the Hurunui consent conditions include the following clause (EnvC *Hurunui* 2013):

18. For the avoidance of doubt, all measurements of wind farm sound must include assessment of special audible characteristics such as impulsiveness, tonality and/or amplitude modulation in accordance with NZS6808:2010.

A similar clause is found in the Flat Hill wind farm consent conditions, requiring testing of special audible characteristics and assigning a penalty if indicated, both in accordance with the relevant clauses of the standard. In this case, the phrase “for the avoidance of doubt” is not used. Assessment of special audible characteristics is a mandatory part of the NZS6808:2010 assessment which a consultant would be required to consider and report.

In the Mount Cass Wind Farm conditions, the following condition is included:

134. For the purposes of assessing compliance with conditions 132 and 133, detailed testing shall be undertaken in accordance with section 7.5 of NZS6808:2010...

The requirement to employ a specific portion of the standard could be misconstrued as requiring only a portion of the standard to be applied. Similarly, the requirement to carry out “detailed testing” suggests that a higher level of testing could be required than would normally be the case, or that the standard could include provision for several levels of testing which it does not.

5.5 Common Supplementary Clauses

All the conditions of consent reviewed included some matters which were additional to those recommended in the model conditions of NZS6808:2010. Several recurring themes arise, and may be useful matters for consideration in future iterations of NZS6808.

The following sections describe these matters, and give examples of how they were addressed in consent conditions.

5.5.1 Turbine Noise Characteristics

One common theme in several consents was ensuring that the turbines selected for a project would be free of tonal noise. Conditions have been included requiring the council to be supplied with documentation about turbine characteristics prior to construction.

The Castle Hill Wind Farm was consented on an “envelope basis”, and in addition to the requirement to provide a prediction report demonstrating that the final layout would comply with the noise limits, the consent conditions also require that turbine noise characteristics are described to Council (EnvC *Castle Hill* 2013):

27. Prior to the installation of any turbine, the Consent Holder shall:

(a) provide an acoustic emissions report to the Council for each type of selected wind turbine generator. The report shall be in accordance with IEC61400-11, Wind Turbine Generator Systems Part 11, Acoustic Noise Measurement Techniques and shall include the A-weighted sound power levels, spectra, and tonality at integer wind speeds from 6 to 10 m/s and up to 95% of rated power for each type of individual wind turbine to be installed.

This information is required by the standard to be used in the design process, but is not intended to be directly communicated to the Council except possibly as a supplement to a prediction report. The inclusion of this requirement in these consent conditions presumably is intended to allow detailed review by the council noise experts, and possibly as an explicit disclosure of the expected performance of the turbines.

The Hurunui Wind Farm has a less specific requirement to provide “A report stating the make, model and sound power level for the selected wind turbines” along with the final turbine layout and the final prediction report (EnvC *Hurunui* 2013 para 19.b). It is likely that any prediction report would include this information, but the explicit requirement in this condition provides certainty that enough information is provided to the Council presumably to allow it to carry out some degree of independent corroboration of predicted compliance.

The Mill Creek Wind Farm consent conditions focus on ensuring that special audible characteristics are not present, and explicitly stating the operation parameters required to achieve compliance:

18. Prior to the installation of any turbine, the consent holder must submit to the Compliance Monitoring Officer certified copies of independent test results confirming that the turbines supplied for Mill Creek do not exhibit special audible characteristics, when assessed against NZS 6808:2010.

19. A prediction report shall be submitted to the Compliance Monitoring Officer in accordance with section 8.4.2 of NZS 6808:2010 based upon certified noise emission profiles supplied by the manufacturer for the turbines that are to be installed for Project Mill Creek. The report shall detail any wind turbine controls necessary to achieve full predicted compliance at all specified assessment positions, including those where the houses have not yet been built but have all permissions necessary at the time consent was granted for Project Mill Creek. Any wind turbine controls necessary to achieve full predicted compliance at all occupied houses shall be implemented as soon as the turbines are operating.

Similarly, the Mount Cass Wind Farm consent includes the following conditions aimed at explicitly describing the turbine noise emissions:

133[a] Prior to commissioning of any turbine, the Consent Holder shall provide the Hurunui District Council... with an Acoustic Emissions Report which details the sound power level of the selected turbines, and confirms the selected turbines do not have special audible characteristics.

A nearly identical condition is found in the Turitea Consent:

26 Prior to commencement of operation of the wind farm, the Consent Holder shall provide Palmerston North City Council's Principal Planner with an Acoustic Emissions Report in accordance with NZS6808 which details

the sound power level of the selected turbines, and confirms the selected turbines are not expected to have special audible characteristics.

5.6 Relevance of Background Noise Levels Within Lapse Period

In several instances the wind farm applications have included a significant (5 – 10 year) lapse period—a period of time within which the wind farm construction must commence before the consent expires. The economics of wind farm construction have meant that some farms have not been built immediately, and in fact at least one farm (the Waitahora Wind Farm) has had its consent lapse after five years.

Concern has been raised in some consent hearings that the background sound levels which characterise the potentially affected properties may be significantly different when the farms begin to operate than they were when the application was heard, affecting the relevant noise limit (where “background + 5dB” applies), the “pre-construction” noise level which is subtracted from the operational noise level to determine the turbine emissions in compliance testing, and the relevance of statements about noise effects relative to existing sound levels.

For this reason, several consents include a condition that background noise levels be measured close to the time that construction commences, and that these measurements are used to set noise limits and represent pre-construction noise levels.

One such example is found in the Castle Hill Wind Farm consent, which includes a 10-year lapse period:

27. Prior to the installation of any turbine, the Consent Holder shall... provide a report detailing the findings of an assessment, to be undertaken by a suitably qualified and experienced acoustical expert, of background sound levels at representative locations of all dwellings within the predicted 35 dBA noise contour for the turbine layout proposed.... Background sound level monitoring shall be undertaken not more than 2 years before the initial post installation compliance testing at each location and shall not be affected by noise from any wind farm. The assessment report shall be adequate to allow future compliance monitoring to be accurately undertaken at all dwellings within the predicted 35 dBA contour for the turbine layout proposed.

At the Flat Hill Wind Farm (with a 5-year lapse period) a slightly different approach was taken – on/off testing was used rather than statistical measurements which rely on establishing statistical background noise levels. In this case, the noise limit was restricted to 40 dB $L_{A90(10 \text{ min})}$ without a “background plus 5 dB” moving limit.

The relevant condition is as follows:

22. On-off compliance measurements shall be performed in accordance with Section 7.7 of NZS 6808:2010 at the following locations... within three months of first operating at turbine: [Four locations described]

5.7 Progressive Compliance Testing

At several wind farms, conditions have been included to verify turbine and wind farm performance by measuring the first few turbines, and in particular doing so before turbines are erected near to noise sensitive activities.

At Castle Hill Wind Farm, particular attention is given to early detection of special audible characteristics:

28. Prior to the operation of any turbine within 3km of an External Dwelling, the Consent Holder shall submit a report to the... District Council demonstrating from testing of a representative sample of turbines that at a distance of approximately 600 – 800 metres from the turbines no special audible characteristics are present.

The Castle Hill consent conditions go on to require compliance testing to be carried out and reported to the Council throughout construction, to ensure that the anticipated long construction period does not delay the opportunity for any non-compliant activity to be addressed and rectified:

29. The Consent Holder shall arrange for a minimum of three continuous Noise Monitoring Terminals (NMT) to be installed at appropriate locations around the wind farm site, and moved as different turbines (or groups of turbines) become operational. The NMTs shall be installed from when the first wind turbine becomes operational, until three months after the last turbine becomes operational or until such time as an appropriately qualified and experienced acoustic consultant engaged by the Consent Holder determines that sufficient representative monitoring has been undertaken of all contributing turbines, operating in representative wind speeds.

30. The Council may reasonably direct testing required by Condition 29 to take place at any External Dwellings [dwellings not on properties which are part of the wind farm] existing at the date of issue of the resource

consent that are located within the 35 dBA contour provided in Appendix B of the Noise Effects Assessment report....

31. The Consent Holder shall submit monthly reports to the... District Council outlining the results of the noise monitoring and reporting on compliance with the noise consent conditions. The first of these reports shall be submitted no later than 60 working days after the first wind turbine becomes operational, and the last of the reports provided within 60 working days of the last turbine becoming operational.

At Flat Hill Wind Farm, progressive compliance testing is required from the commissioning of the first turbine onward:

24. A compliance assessment report shall be submitted to the Director of Environmental and Planning Services in accordance with Section 8.4.1 of NZS 6808:2010 within 3 months of operating each turbine, and each successive turbine, until the compliance report has covered all eight turbines operating together.

At the Hurunui Wind Farm, progressive compliance assessment is taken a step further, by requiring that measurements of the first turbines are used to validate the noise prediction report to demonstrate that the completed wind farm will be compliant:

20. The consent holder must submit a report to the consent authority's Manager Environmental Services detailing the measurements and assessment undertaken for the purposes of validating the noise levels in the noise prediction report supplied to the consent authority in the application and Assessment of Environmental Effects (or in accordance with condition 19, if applicable) within three weeks of the completion of the measurements. The measurements and assessment must be undertaken as follows:

- (a) Measurements of the noise from at least two wind turbines must be undertaken as soon as practicable following the date on which any wind turbine first generates electricity;*
- (b) At least one location for measurement must be chosen by the consent holder in consultation with the consent authority provided that the site is no more than 1000m from the turbines which are tested; and*
- (c) The measurements will be used to validate the noise prediction report for the wind turbines that were operational during the testing and the results used in an assessment of the predictions from the entire wind farm; and*
- (d) If the report shows that the wind farm will exceed the noise limits set out in conditions 17, it must*
 - (i) Identify what corrective action needs to be taken (on what turbines and by when); and*
 - (ii) demonstrate how the incremental commissioning of the wind farm will not result in the noise limits set out in condition 17 being exceeded.*

21. If the report required by condition 20 shows that the wind farm will not exceed the noise limits set out in condition 17, no further action on the part of the consent holder under condition 20 will be necessary.

The Hurunui Consent Conditions go on to require compliance testing at various stages of construction, with the intention that any delays or staging of construction do not hinder the completion of compliance testing as required to avoid non-compliant operation:

22. In addition to any other noise monitoring, the consent holder must undertake background sound level and compliance measurements. Subject to the approval of the respective land owners, these measurements must be undertaken at [certain properties described]. The compliance measurements must be undertaken:

- (a) If the wind farm is built in stages and any stage generates electricity, at the conclusion of the construction of each stage; or*
- (b) If construction of the wind farm begins and its completion is delayed for any reason but the wind farm generates electricity; or*
- (c) On the completion of the wind farm; ...*

23 Upon completion of any background sound level and compliance measurements required by condition 22, the consent holder must submit a compliance assessment report to the consent authority prepared in accordance with Section 8.4.1 of NZS 6808:2010.

At Mill Creek Wind Farm, as with Castle Hill wind farm, the focus of progressive testing is the presence of special audible characteristics:

21 The sound from three wind turbines shall be measured prior to completion of the wind farm. The turbines that are installed at the wind farm shall be same type as those measured pursuant to this condition. These measurements shall be conducted at a single meteorologically sheltered location between 600 and 1000 metres from the turbines. For the purposes of this condition only, this location shall be treated as if it were a noise sensitive location in accordance with NZS6808:2010. The three turbines to be tested and the measurement location shall be agreed with the Compliance Monitoring Officer. A compliance assessment report from one of the three turbines operating alone and for all three turbines operating together shall be submitted to the Compliance Monitoring Officer in accordance with Section 8.4.1 of NZS 6808:2010. A copy of this report must also be provided to the Community Liaison Group as soon as it is available. Turbines K03, F13, and F14 shall not be operated unless this report has been submitted and it shows that no special audible characteristics are present, when assessed in accordance with NZS 6808:2010. If special audible characteristics are detected at any subsequent time during the operation of the wind farm, the NZS 6808:2010 cl 5.4.2 penalty of up to 6dB shall be imposed when assessing compliance of the wind farm with the conditions of consent. The reference test method for tonality shall be that prescribed as Annex C to ISO 1996-2:2007.

Note: The intention is that selected turbines sited away from residents are tested for tonality, in accordance with Annex C to ISO 1996 – 2:2007. A report is then forwarded to the compliance monitoring office, Wellington City Council that shows the tested turbines are not tonal. This report is required before the operation of turbines at the wind farm that are sited close enough to residents, that if tonal, may expose residents to special audible characteristics when assessed in accordance with NZS 6808: 2010.

At the Mount Cass Wind Farm, similar requirements to the above were put in place to detect special audible characteristics prior to turbines being erected near to the potentially affected dwelling:

134[a] The sound from at least two wind turbines shall be measured prior to commissioning the wind farm. These measurements shall be conducted at a location within 1000m from the turbines. A compliance assessment report for the turbines shall be submitted to the Hurunui District Council... in accordance with Section 8.4.1 of NZS6808:2010. [Certain turbines] shall not be operated until a report on this test has been submitted and it shows that no special audible characteristics are present, when assessed in accordance with NZS6808/2010. The reference test method for tonality shall be that prescribed as Annex C to ISO 1996 – 2:2007.

Note: the intention is that testing is carried out prior to operating the turbines closest to the [XXX] property.

The Turitea Wind Farm endured significant scrutiny over potential cumulative noise effects relating to other existing wind farms in the area. Partly for this reason, progressive monitoring and reporting features significantly in the conditions of consent:

29 The Consent Holder shall arrange for a minimum of 3 continuous NMT [noise monitoring terminals] to be installed at appropriate locations around the wind farm site, and moved as different turbines (or groups of turbines) become operational. The NMTs shall be installed from when the first wind turbine (or group of turbines) become operational, until 3 months after the last turbine (or group of turbines) become operational or until such time as an appropriately qualified and experienced acoustic consultant engaged by the Consent Holder determines that sufficient representative monitoring has been undertaken of all contributing turbines, operating in representative wind speeds, directions and times of day/night.

30 The NMT shall be capable of carrying out audio recordings as necessary.

31 The NMT shall also be capable of producing a “regression curve” based on a rolling 10-day block of data, which is suitable for comparison with the noise limit regression curve in accordance with the procedures specified in NZS6808.

32 The Consent Holder shall ensure that after the first 2 weeks of monitoring, the rolling “regression curve” is emailed to the Palmerston North City Council’s Environmental Compliance Manager on a weekly basis for the remainder of the monitoring period, and after that, provided as requested by the local authority.

33 The appropriate number and locations for the NMT, and weather stations necessary for undertaking the necessary assessment, shall be determined as required throughout the monitoring period, by an appropriately qualified and experienced acoustic consultant engaged by the Consent Holder in consultation with the Environmental Compliance Manager of Palmerston North City Council or Tararua District Council as appropriate. In making this determination, the acoustic consultant shall in particular have regard to the number and location of contributing turbines currently operational and/or about to become operational, and their proximity to any residential properties.

34 The Consent Holder shall submit a monthly report to the Palmerston North City Council's Environmental Compliance Manager outlining the results of the noise monitoring undertaken in accordance with condition 29, and reporting on compliance with the noise consent conditions. The first of these reports shall be provided 1 month after the first wind turbine (or group of turbines) becomes operational, and the last of these reports provided within 20 working days of the last turbine (or group of turbines) becoming operational.

5.8 Remedial Measures

The basic requirement of the operational noise condition in the standard (and adopted by most of the consent conditions) is similar to *"The consent holder shall ensure that, at the specified assessment positions, at any wind speed, wind farm sound levels do not exceed"* certain noise levels (except Mill Creek wind farm, where the requirement not to exceed the stated noise limits is merely implied).

However, many of the consents include conditions describing the steps to be taken following demonstration of non-compliance.

In the Castle Hill Wind Farm consent, the following condition is included:

35. Where compliance is not achieved with the noise conditions, the Consent Holder shall operate the wind turbine generators at a reduced noise output until remedies are identified and implemented. If sound emissions cannot be reduced such that they comply, the Consent Holder shall cease to operate the wind turbine generators causing the non-compliance until modifications are made to reduce the noise. Further operation of the wind turbine generators causing the non-compliance shall only be for sound measurement checks as specifically agreed with the ... District Council to demonstrate compliance. This condition shall not limit or restrict any statutory right or power to take enforcement action that the Councils may have under the provisions of the Resource Management Act 1991.

The Flat Hill Wind Farm consent uses an identical condition, whereas the Hurunui Wind farm consent includes a slightly different version:

24 In the event that noise levels exceed the limits given in condition 17, the consent holder must notify the consent authority within one working day of the non-compliance being identified and provide the proposed methodology and timeframe for achieving compliance with condition 17. For the avoidance of doubt, this condition does not confer a right on the consent holder to operate any turbine in a manner which does not comply with the noise limits in condition 17.

The Mount Cass wind farm consent addresses non-compliance, and includes timeframes for responses to notification of non-compliance:

135. If, at any time, testing shows that the wind farm does not comply with the noise conditions of this consent, the Consent Holder shall undertake remedial measures to achieve compliance at all dwellings in accordance with the following timeframes:

Remedial measures for non-compliance of 3dB or less shall be undertaken within 10 working days;

Remedial measures for non-compliance of between 3dB-8dB shall be undertaken within 5 working days;

Remedial works for non-compliance of more than 8 dB shall be undertaken within 24 hours.

The remedial measures may include de-rating turbines, or shutting down turbines. If turbines are shut down, such turbines shall remain off (other than for testing) until such time as any necessary remedial work to achieve compliance is complete. On completion of any remedial work, an additional report shall be submitted to Council demonstrating compliance.

Turitea Wind Farm contains a long and complicated set of conditions relating to non-compliance response, relating to the potential for cumulative noise effects from other existing wind farms. These steps are required to be considered either in response to ongoing monitoring revealing non-compliance, or in response to complaints from the community:

44 If the review of the NMT data is conclusive as to any non-compliance with the noise consent conditions, and the causes of this, the results of the review shall be submitted to the Environmental Compliance Manager of the appropriate Council within 10 working days after completion of the review.

45 If the review of the NMT data is not conclusive as to any non-compliance with the noise consent conditions, and the causes of this, the acoustic consultant shall as soon as reasonably practicable considering the relevant meteorological conditions undertake any additional field measurements they consider necessary to reach a conclusion as to the cause and validity of the noise complaint. The results of the field investigations shall be submitted to the Environmental Compliance Manager of the appropriate Council within 10 working days of the investigations being completed.

46 In the event the expert review and field investigations (if any) demonstrate a non-compliance with the noise consent conditions, and that such non-compliance would not have occurred had there not been any contribution of noise from either or both of the Northern Turbine Zone or Southern Turbine Zone (whether or not there was also any contribution of noise from the turbines of the Te Rere Hau wind farm), the requirements of condition 50 shall apply.

47 For the avoidance of doubt, the NMT required in accordance with condition 41 may be one of the NMTs required in accordance with condition 29.

Response to Noise Monitoring and Assessment

48 The Consent Holder shall provide copies of any reports or assessments submitted in accordance with conditions 34, 36, 40, 44, or 45 to the CLG, within the same timeframes as the respective clauses require they be submitted to the appropriate Council(s).

49 If the monitoring or assessments undertaken in accordance with conditions 29, 35, 38 and 41 show there has not been any non-compliance with the noise consent conditions nor any unreasonable noise finding, then the Consent Holder shall not be required to take any further action by way of response to that monitoring and assessment.

50 If the monitoring or assessments undertaken in accordance with conditions 29, 35 or 38 show there has been any non-compliance with the noise consent conditions and/or there is an unreasonable noise finding, or the circumstances in condition 46 apply:

50.1 As soon as reasonably practicable, the Consent Holder shall engage an appropriately qualified and experienced acoustic consultant to undertake such assessment as may be necessary to determine which turbine(s) are likely to be causing the non-compliance or unreasonable noise (if this has not already been determined);

50.2 Within 1 working day of being advised which turbine(s) are likely to be causing the non-compliance or unreasonable noise, the Consent Holder shall de-rate, including if necessary stopping, those turbines;

50.3 Once de-rated, the relevant turbines may only be re-commissioned after the Consent Holder has undertaken such repairs, testing and/or any other measures as may be necessary to ensure that those turbines can be operated without causing any non-compliance with the noise consent conditions or unreasonable noise;

50.4 For the avoidance of doubt, during the time that any turbine is subject to de rating in accordance with condition 50.3:

a. the relevant turbine(s) may be operated in such circumstances and for such durations as may be necessary for undertaking compliance testing;

b. the relevant turbine(s) may be operated at such times or in such meteorological conditions where the monitoring or assessments undertaken in accordance with conditions 29, 35, 38 and

41 have confirmed that the operation of the turbines in those conditions will not result in any non-compliance with the noise consent conditions; and

c. the Consent Holder shall submit a weekly report to the Palmerston North City Council's Environmental Compliance Manager and the CLG outlining the current status of the investigations being undertaken with respect to the relevant turbines.

50.5 When any turbine (or turbines) are re-commissioned in accordance with condition 50.3, the Consent Holder shall engage an appropriately qualified and experienced acoustic consultant to undertake such further monitoring and assessment as the consultant considers necessary to confirm that the turbine (or turbines) are now operating in compliance with the noise consent conditions. The results of this monitoring or assessment shall be submitted to the Palmerston North City Council's Environmental Compliance Manager and the CLG within 10 working days of the turbine (or turbines) being re commissioned.

50.6 For the avoidance of doubt, if the monitoring and assessment undertaken in accordance with condition 50.5 shows that there is still a non-compliance with the noise consent conditions, the requirements of conditions 50.1 to 50.5 shall apply as appropriate and necessary.

6. CONCLUSIONS

The model conditions provided in Appendix A of NZS6808:2010 provide an adequate basis to incorporate the technical guidance of the standard, and to achieve a robust assessment of the noise emissions at both the design and post-construction stages of a wind farm.

In the course of consenting wind farms during and after the release of NZS6808:2010, several issues have arisen which have to do with the pragmatic matters of timing, enforcement, public perception, and management of risk. The supplementary conditions described above give the local authorities some additional leverage over the way the process is carried out.

It should also be recognised that consent conditions can be included in order to provide comfort to wind farm neighbours and others in the community, and to demonstrate in a public document that certain matters have been considered and addressed. NZS6808:2010 (like all other New Zealand standards) is a specialist technical document, and one which carries a significant purchase cost (NZ\$102 at the time of this writing, (SNZ 2016)). Although technical specialists can be comfortable that the standard provides adequate direction, the public and local authorities have a less direct connection to its guidance and rely on acoustic experts to provide these assurances. For this reason, the requirements of the standard are in some cases reiterated, or supplanted with other requirements which appear to provide the protections being asked of the councils and courts.

Ultimately the requirement that NZS6808:2010 imposes on wind farm developers is to control noise emissions to within specified limits. The pragmatic matters that engage councils and the courts appear to be:

- Ensuring that developers secure sufficient guarantees from turbine manufacturers around acoustic performance of turbines to avoid unexpected special audible characteristics such as tonal noise emissions, and to have recourse in the event that these do occur
- Avoiding unnecessary sensitisation of neighbours to new wind farms
- Ensuring that compliance testing and reporting is done in a timely fashion regardless of staging, and recognising that noise effects may commence before a project is complete
- Ensuring that the timeline for enforcement and remedial work around exceedances of noise limits can occur to an acceptable timeline.

Whether any of these matters constitute technical shortcomings would be a matter for the next Standards review committee to consider, but it is likely that additional requirements built into the standard would not fully satisfy the need for explicit and public words to be included in consent conditions.

In summary, it appears that the matters which have been included in post-NZS6808:2010 consent conditions which are extra to the model conditions in the standard, are included for reasons of management and communication rather than for technical reasons. This assessment suggests that these consent conditions do not

point to shortcomings in the Standard, but rather would be usefully included in a guidance document which would advise local authorities on using the Standard while managing the assessment procedure.

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