THE ACOUSTIC GROUP PTY LTD
CONSULTING ACOUSTICAL & VIBRATION ENGINEERS

SUPPLEMENTARY SUBMISSION

RENEWABLE ENERGY (ELECTRICITY) AMENDMENT

(EXCESSIVE NOISE FROM WIND FARMS) BILL 2012

42.5006.R4A:ZSC

Date: 27th *November, 2012*

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ATTACHMENTS

SUPPLEMENTARY SUBMISSION

In the matter of Renewable Energy (Electricity)
Amendment (Excessive Noise from Wind Farms) Bill
2012

1.0 INTRODUCTION

I provided a submission to the Senate Environment and Communication - Legislation Committee (dated 1 November 2012) that supported the proposed amendments, with minor corrections to address the technical terminology to accompany the amendments (submission 142).

The submission set out my qualifications and experience as an Acoustical Consulting Engineer and contained measurements of wind farms conducted in Australia by me that identified a number of technical issues with respect to the measurement of wind farm noise that highlighted the suggested minor corrections to the Bill.

On Wednesday 14th November 2012 I appeared before the committee and provided evidence.

Following questions from Senators Madigan, Xenophon and Back, the Chair asked a number of questions with a request for supplementary material to clarify a number of my answers. In view of the questions asked during my appearance this response (and attachments) is provided as a supplementary submission.

A subsequent request from the Secretary to the Committee (Dr Holland) included an additional question in relation to my evidence in chief, and a second question following statements by the representative from Infigen.

During my evidence the Chair raised questions in relation to Peer-Reviewed technical papers to which a response was provided in relation to Peer-Reviews. The Secretary to the Committee has sought clarification in relation to the response provided.

As identified in my evidence, I have conducted a number of Peer-Reviews in relation to wind farm applications that being the case of a professional review of an application which is the normal procedure used in NSW for matters before The Land & Environment Court.

The "Peer-Reviews" that I have conducted in relation to wind farm applications are as follows:

- *Peer Review of Acoustic Assessment, Flyers Creek Wind Farm* (reference 41.4963.R1 dated 15th December 2011), prepared for Flyers Creek Wind Turbine Awareness Group Inc.
- *Peer Review of Noise Impact Assessment, Stony Wind Farm* (reference 42.4989.R1 dated 26th May 2012), prepared for the regional Council of Goyder.
- *Peer Review of Environmental Noise Assessment, Bodangora Wind* Farm (reference 42.4989.R1 dated 6th August 2012), prepared for Bodangora Wind Turbine Awareness Group.
- *Peer Review of Noise Impact Assessment, Keyneton Wind Farm* (reference 42.4999.R1 dated 8th August 2012), prepared for Eastern Mount Lofty Rangers Landscape Guardians Inc.
- *Peer Review of Environmental Noise Assessment, Cherry Tree Wind Farm* (reference 42.5005.R1 dated 12th September 2012), prepared for Trawool Valley-Whiteheads Creek Landscape Guardians.
- *Peer Review of Environmental Noise Assessment, Collector Wind Farm* (reference 42.5006.R1, dated 23th September), prepared for Friends of Collector.
- *Peer Review of proposed Denmark Community Wind Farm* (reference 42.5009.LR1, dated 4th October 2012), prepared for Pete Mortimer.

In relation to the Ethics Article appearing in Appendix C of my submission, prior to submission of the article to The Australian Acoustical Society it was reviewed by Professor Hansen, Dr Thorne, Mr L Huson and Mr N Koikas, all being members of The Australian Acoustical Society. It is noted that a technical note in the journal identifies the article as not formally being peer-reviewed although I note that the Editor of the journal, Dr Kessissoglou did peer-review the document by reason of correspondence from her requiring minor amendments to the article and also removal of one reference paper that was listed in the contents for the proceedings of a New Zealand/Australian Acoustical Conference, but the paper is not available online.

During my evidence the Chair asked if I had looked at the Sonus 2010 report to which I replied, 'Which one?'

I identified to the Chair that there are two reports that are generally available, one about wind farm environmental noise and one about infrasound.

On checking my database I have available to me three reports from Sonus dated 2010:

- *'Waubra Wind Farm'*, prepared for the Clean Energy Council and dated October 2010,
- *'Wind Farms Technical Paper, Environmental Noise'*, prepared for Clean Energy Council and dated November 2010,
- *'Infrasound measurements from wind farms and other sources'*, prepared for Pacific Hydro Pty Limited dated November 2010.

I note that all of the above reports were prepared for the wind industry and there are questions as to the independence of the reports in terms of the Code of Ethics of the Australian Acoustical Society.

2.0 RESPONSE TO QUESTIONS

I was asked by the Chair to provide evidence as to the Infrasound paper being misleading and lack of competency in the Sonus paper. As there are a number of errors to be identified, each error is expressed in the context of its presentation and then discussed as a comment.

2.1 Sonus Infrasound Report

1. The Executive Summary of the infrasound report "identifies a wide range of man-made sources that can generate infrasound". The Executive Summary identifies the theoretical reduction in infrasound is 6 dB per doubling of distance, which can be measured from a wind turbine.

   The text on page 22 of the report claims that Tables 5, 6 and 7 indicate a reduction in the order of 6 dB is achieved using the below ground technique, but not for the above ground technique.

The tables referred to in the Sonus report provide 1/3 octave data below 20 Hz and does not include a dB(A) value as per normal wind farm assessments (and the subject of the Bill) but provides a dB(G) result.

Comment:

If one examines the low frequency components that are associated with the blade-pass frequency of the turbine (i.e. around 1 Hz) and multiple harmonics, then the material for either inside the chamber or outside the chamber does not agree with the concept of 6 dB per doubling of distance.

The use of dB(G) for the measurement of infrasound associated with turbines has not been substantiated and when one looks to the spectral characteristics that are associated with low frequency emission from turbines and then compares those results with the weighting curve shown in Appendix D21 to my submission then it is obvious the dB(G) curve is inappropriate for infrasound.

Limiting an assessment of propagation to between 85 metres and 360 metres is of no assistance in determining or substantiation of claim of distance attenuation where infrasound impacts upon residents that are further removed from a wind farm.

Measurements conducted by the Federal Institute for Geosciences and Natural Resources (Hanover Germany) have looked at specific frequencies being the dominate components for infrasound and as set out on Page D20 of my submission shows the rate of attenuation is clearly not 6dB per doubling.

Furthermore, the Wind Turbine Health Impact Study Report for Massachusetts Department of Environmental Protection cited by Professor Chapman reinforces on page 10 that the above statement concerning propagation is incorrect:

It is known that low frequency waves propagate with less attenuation than high-frequency waves. Measurements have shown that the amplitude for the airborne infrasonic waves can be cylindrical in nature, decaying at a rate inversely proportional to the square root of the distance from the source. Normally the decay of the amplitude of an acoustic wave is inversely proportional to the distance (Shepherd & Hubbard, 1991).

2. Page 4 of the Executive Summary identifies infrasound measured at a number of locations with the results presented in 1/3 octave band levels and compared, 'against the perception threshold for infrasound established in international research as 85 dB(G)'.

Comment:

Examination of material in relation to the dB(G) curve does not find that the curve was developed for the purpose of assessing wind turbines.

International Standard ISO 7196:1995 (E) '*Acoustics - Frequency-weighting characteristics for infrasound measurements'*, identifies a methodology for the determination of a measured level for the frequencies between 1 and 20 Hz that would be supplementary to standardised measurements covering the audio frequency range.

The Standard identifies that the preferred method is to utilise a measurement system that has a purpose built G-weighted filter to provide the measurement results, with Section A.7 of the Standard indicating an approximate determination of the G-weighted sound pressure level can be obtained by 1/3 octave band analysis and application of the weighting values to give the curve.

Examination of the bibliography to the Standard indicates a number of papers pertaining to the assessment of low frequency noise and vibration but none of the reference documents specifically identify that they are related to turbine noise.

The committee received evidence from Professor Salt who is a world authority in terms of the perception of infrasound to indicate that the concept of infrasound as detected by the inner ear is not the same as consideration of thresholds as described by the 85 dB(G) curve.

Dr Swinbanks (UK) has identified the issue of crest factors associated with the pulsations from turbines that can give raise to peak levels significantly greater than an RMS level with respect to measurements of turbines that therefore alters the matter of perception. Professor Salt has identified the different rates of perception for infrasound compared to audible sound.

Examination of the bibliography to the ISO Standard 7196 reveals that the thresholds, both in terms of audible and low frequency sounds, are normally related to pure tones or broadband noise across frequency bands.

Sonus should be aware that in the audible frequency range the presence of narrow band tones results in a different threshold audibility when compared to broadband noise having the same energy content over a similar 1/3 octave band.

Examination of the narrow band spectra in relation to noise emitted from turbines that appear in the upper figure of Appendix D17 of my submission clearly shows that the noise from turbines is not broadband and therefore in terms of perception will have an entirely different response to an assumed perception for broadband sound.

3. The last paragraph of the Executive Summary claims that levels of infrasound inside a dwelling will be lower than the levels outside a dwelling for an external noise source. Apparently the Sonus report relies upon the dB(G) levels that appear in Tables 8 and 9 on page 23 of the report.

Comment:

If one examines the linear 1/3 octave band levels in those tables, one can see that at the blade-pass frequency, which at the present time is assumed without any explanation in the report to be at 1 Hz, that the inside measurement is 13 dB greater than the outside measurement. Similarly looking at the 1.25 Hz 1/3 octave band the inside measurement is 4dB greater than the outside, the 1.6 Hz 1/3 octave band is 1dB greater inside than outside, the 2 Hz 1/3 octave band is 7dB greater inside than outside and the 2.5 Hz 1/3 octave band is 5 dB greater inside the room than outside the room.

Therefore if one looks at the critical frequencies of concern, the Sonus report has measurement data that contradicts the claim that levels inside the dwelling will be lower than outside.

If one considers the concept of outside to inside in terms of the dB(A) value I acknowledge that on the dB(A) basis the noise level inside a dwelling will be lower than outside a dwelling.

There are some residential dwellings that I have measured infrasound levels to be lower inside the house than outside, and other houses I have measured higher noise levels inside than outside.

Examination of Figure 8 on Appendix D17 of my submission and Figure 9 on Appendix D18 of my submission proves that the frequencies of around 2 and 2 ½ Hz when assessed in a narrow band methodology, the inside levels in a dwelling 1300 metres from the Waterloo Wind Farm are higher than outside.

My measurements and even Sonus's measurements show infrasound level inside houses to be greater than outside so the last paragraph of the Executive Summary is clearly misleading.

4. The allocation of infrasound to various locations commences on page 25 of the report claiming that testing was conducted at Cape Bridgewater wind farm.

   The text indicates that about point 5 on page 25 that testing was conducted on 2nd June in the early hours of the morning under a clear night sky with a light breeze to reveal noise levels in the infrasound region. Tables 10, 11 and 12 on page 26 are purporting to indicate no real significant difference in the infrasound region with and without the turbines operating.

   Comment:

   The particulars as to the wind direction, the strength of the wind and the variability in the wind strength during the 20 continuous one minute measurements is not provided. Similarly the results identified on page 26 do not show the range of noise levels recorded during the measurements or to indicate whether the results are a background level, or a Leq level.

   Examination of the 1/3 octave band figures and Appendix D16 of my submission reveal that over a 10 minute sample period the statistical variation in the levels is significant and as such is an important factor in identifying noise emission from the turbine.

5. Page 27 of the Sonus report purports to identify infrasound measurements at locations removed from the wind farm. With a claim that by use of the dB(G) method the noise levels from at the beach and the cliff face are higher than that of the natural wind or that generated by the turbines. The results for the supplementary locations are shown in Figure 10.

   Comment:

   The report fails to identify the circumstances in relation to the measurements and the relevance of those measures with respect to the environment at the time.

For example there is no information provided on page 27 to identify the wind and weather conditions at the time of measurement. The beach identified as Cape Bridgewater is on a vast open bay and as such if wind was coming from the north east or east then the wind strength at the beach position (assumed to be adjacent to the Cape Bridgewater Beach car park) would be significantly more than if the wind came from the south by reason of the topography behind the beach.

The report does not identify the distance from the monitoring location to the waves at the time or the height of the waves that were breaking on the beach. If one assumes that the noise was not constant then the levels provided are not identified in terms of the various (and different) acoustic parameters.

Similar questions as to the weather conditions and the source of noise that gives rise to the levels in Table 14 and Table 15 therefore become obvious.

Attendance to the Sonus measurement location found that the blowhole location was not at the edge of the cliff top or adjacent the blowhole, but somewhat removed from the edge of the cliff (and the blowhole) on the turning circle to the lookout.

6. Map 1 on page 29 identifies locations associated with Cape Bridgewater wind farm measurements.

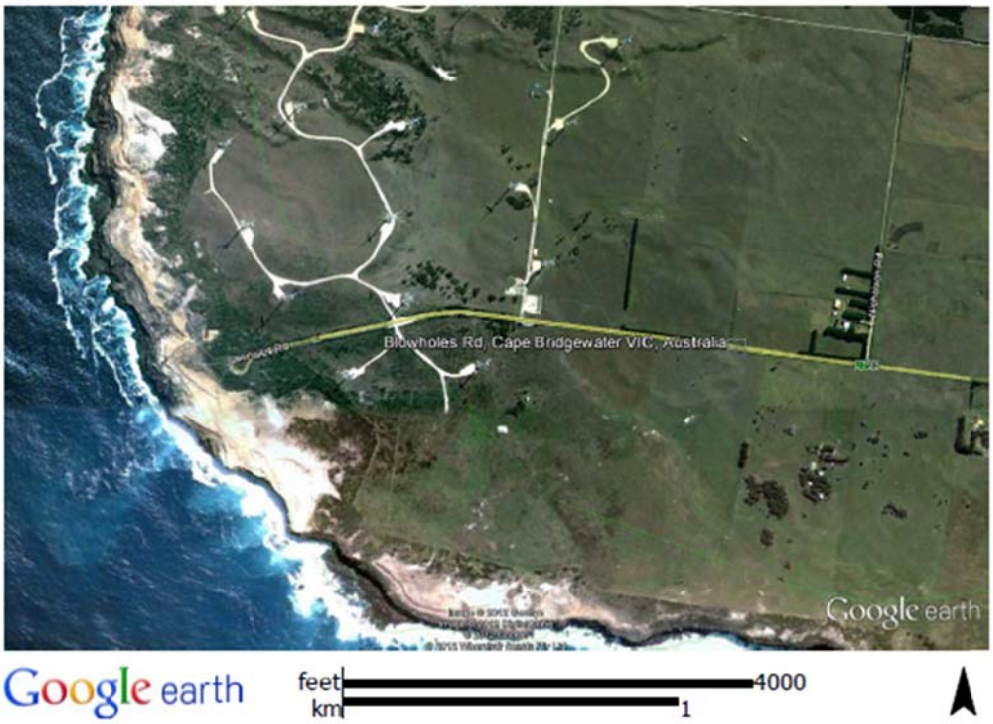
   The figure identifies that the blowhole measurement location is somewhat removed from the single turbine and therefore by reason of the report would suggest to the reader that the blowhole measurement location is not influenced by the wind farm as it is significantly removed from turbine 27.

   Comment:

   Attendance to the Cape Bridgewater wind farm measurement locations found a different perspective with respect to turbines that does not agree with Map 1 in the Sonus report.

By reference to Google Earth, one can obtain a picture that is dated March 2010 to show that there are significantly more turbines in the subject area than that indicated in the Sonus report as shown below.

Map 1: Cape Bridgewater Wind Farm Measurement Locations



Goggle Earth, Map 1

Examination of Map 1 from the Sonus report portrays the position that with respect to a location on the turning circle to the blowhole lookout that there is only 1 turbine in existence with respect to the monitoring location, that being identified as turbine 27.

The sample from Google Earth that is identified as occurring in March of that year shows a different situation in relation to turbines and I am instructed by residents in the area that multiple turbines have been in situ for quite a few years.

So as to place the context of the Sonus report with respect to reality Photograph 1 shows a photograph taken from the Sonus monitoring location looking back towards turbine 27 (identified in Map 1) to find that there are more turbines in the photo than suggested by Sonus.

Photograph 1

Photograph 2 is from the Sonus blowhole monitoring position looking up the access road and again shows more than 1 turbine.

Photograph 2

Photograph 3 is from the Sonus blowhole monitoring location viewing towards the north where under the Sonus report there is a suggestion of there being no turbines yet the photo would show otherwise.

Photograph 3

The blowhole itself is further to the west of the location nominated as a measurement location in the Sonus report. There is a walkway which takes one out to a viewing platform where the viewing platform is to the south of the blowhole discharge in the top of the cliff and east of the ocean blowhole inlet.

Photograph 4 shows a photo from midway of the access to the blowhole lookout looking back towards the nominated turbine 27 to reveal more than a single turbine.

Photograph 4

Photograph 5 is looking at this position at the centre of the platform looking towards the north-east.

Photograph 5

Photograph 6 is at the same position on the platform but a view further to the west.

The photographs taken from the blowhole platform and access reveal more turbines than indicated by Sonus. To any reasonable person the identification of the Cape Bridgewater wind farm measurements is not correct and therefore is misleading.

7. The conclusion of the Sonus report commences at page 34 and acknowledges that wind turbines generate infrasound. The conclusion identifies that infrasound has been measured in both the rural, coastal and open environments and suggests that the infrasound is the same order as that measured within 100 metres of a wind turbine.

   Figure 12 on page 35 provides a summary of measurements at Cape Bridgewater Farm but also includes additional noise measurements for Adelaide CBD, a power station and an ambient at Blackwood.

   Figure 13 on the following page provides a summary of measurements for Clements Gap Wind Farm with comparison of the CBD measurement, the power station measurement, a beach measurement and an ambient level at Blackwood.

Comment:

Comparison of the measured wind farm levels with the ambient at Blackwood reveals both the Cape Bridgewater Wind Farm and the Clements Gap Wind Farm for measurements up to 360 metres are significantly higher than the ambient measurement at Blackwood. Whilst not identified in the report it would appear that the Blackwood measurements may very well be the levels in a "designated forest area approximately 80 km inland from the coast under conditions of negligible wind" (that appears as the fifth bullet point on page 25).

In comparing the Waterloo turbine measurements I provided in Appendix D16 of my submission, and utilising the green results in the two figures, there would appear to be general agreement in relation to noise emission from the turbine.

However the Sonus report has not identified the presence of infrasound measurements from turbines at positions removed from the wind farm, nor has the Sonus report identified the actual noise signature that is associated with the turbine.

As identified above in terms of the perception of noise there is a significant difference between narrowband and broadband noise of the same level. The Sonus report has not identified this situation, nor has provided any material to identify the unique signature of wind turbines compared to broadband noise.

Appendix D7 in my primary submission identifies discrete frequencies that appear at a regular pattern being the multiples (harmonics) of the blade pass frequency. In examining Figure 7 in Appendix D17 of my primary submission, the first peak which is around 0.8 Hz if expressed in a linear format needs to be increased by 10 dB due to the low pass filter arrangement of the analyser - which has clearly been identified in the peer-review reports that have contained that material.

This becomes critical in that the discrete frequencies associated with the operation of wind farms in both audible and inaudible noise become the issue of concern rather than broadband 1/3 octave measurements. This concept is somewhat similar to the material provided to the committee identifies the inadequacy of the dB(A) level for addressing both low frequency and infrasound.

The failure of Sonus to identify the discrete components in relation to infrasound associated with wind farms is of significance when one is seeking to determine the impact at residential receivers. The infrasound report from Sonus does not actually address the noise level at residential receivers, the attenuation obtained over such distances and the audible characteristics of the turbine noise in addition to infrasound characteristics.

The Sonus tables of 1/3 octave bands highlight the inadequacy of the dB(G) for turbines and a truly independent assessment should have raised the need to consider the Linear levels over the infrasound region and an alternative concept.

My submission shows in Figure 8 the nature of the infrasound components at a house 1300 metres from the nearest turbine for Waterloo Wind Farm where some of the discrete low frequency components are evident both outside the house (Figure 8) and inside the house (Figure 9) – Appendix D17 and D18 of my submission.

Of relevance is the same characteristic of what I have identified as a turbine signature was also measured at a house approximately 8000 metres from the Waterloo Wind Farm. Figure 11 in Appendix D19 of my submission shows the distinct narrow bands which do not become apparent in the 1/3 octave spectra appearing at Figure 10 on the preceding page.

If one considers the 1 Hz 1/3 octave band set out in Figure 10 of my submission (Appendix D18) and for the purpose of the exercise consider it is a level of 65 dB, and can accept that there was no wind at the residence at all, then the presence of that level of infrasound (which is similar to the level measured at both 85 and 185 metres from the Clements Gap Wind Farm Figure 13 of the Sonus report) reveals there is clearly an issue in terms of propagation out to those distances that either by distance attenuation or enhancement due to weather effects.

This is another example of the Sonus report claim of 6 dB per doubling of distance for infrasound having a problem.

8. Sonus presentation of wind data and the resultant spectrum is not established in the report, although by reference to Table 11 and 12 there is a suggestion that the wind generates a spectrum that is similar to a wind turbine at 200 metres.

Comment:

There is no material in the Sonus report to identify the wind strength at the time and any variation in the wind that would give rise to the levels that are provided.

As a direct result of questioning the Sonus infrasound report, having attended the blowhole location and observed turbines that were not shown in the Sonus report, for the purpose of my peer review on the Collector Wind Farm I attended a residential property on the ridge above Collector where I conducted ambient noise level measurements over a standard 10 minute sample period.

The dB(A) variation over the 10 minute period is shown as Figure 14 in Appendix D22 of my submission. The short duration peaks that go up to 45 dB(A) relate to birds in trees that were within 20 metres of the monitoring location. The noise levels so recorded by the microphone with a 170 mm diameter windscreen involves wind noise on the microphone (somewhat attenuated by the wind screen) and noise generated by the leaves in the trees.

During the course of the measurement as depicted in Figure 14 there were wind strengths up to 7 m/s observed during the monitoring.

The 1/3 octave band spectra of the 10 minute sample appears as the upper graph in Figure 15 on Appendix D23 of my submission. The 1/3 octave band levels associated with the wind if confined to less than 20 Hz are less than that shown in Figure 9 at page 29 of the Sonus report.

Of more significance in terms of the measurements is the FFT results being a 400 line sample for a 50 Hz bandwidth over the entire 10 minutes to reveal as a linear (Leq) average there is a peak around 1.5 Hz but the spectrum is completely absent the turbine periodic pattern that appears in Figure 7 on Appendix D17.

Conclusion

The Sonus report acknowledges that infrasound is generated by wind turbines, which is contrary to the position suggested in the South Australian EPA guidelines, if one assumes Cape Bridgewater wind farm is well maintained.

The Sonus report suggests that for the frequencies below 20 Hz (identified as the infrasound region) that the levels occurring in the natural environment are similar to that generated from turbines at distances between 100 to 400 metres.

The examination of the report reveals that there is significant information missing in relation to the measurement data and in particular identification of the locations and the wind that occurred at the time.

The ambient data measurement for a forest location (where it would appear that there is negligible wind) shows that the "ambient" level in the Sonus report is noticeably lower than that generated by turbines and therefore the report whilst not identifying the fact must imply that the presence of wind gives rise to an increase in the infrasound levels. However without identifying the level of the wind at the time of the measurement then there is not an appropriate comparison of the infrasound level.

Furthermore there is no identification or acknowledgement in the Sonus report that the infrasound levels recorded near a turbine can also vary, dependent upon the wind strength. This is relevant in that the noise assessments include data in the dB(A) value that indicate as the wind strength increases so does the noise emission from a turbine.

Therefore the relevance of the wind strength to the noise levels generated by a turbine being tested is important when considering both audible and inaudible noise.

The wind speed at the time of testing becomes relevant in that the noise levels I recorded at 138 metres from the base of the Waterloo turbines (Appendix D16 of my submission) occurred in an average wind speed at ground level of 2 m/s with a maximum level of 3.4 m/s recorded by a wind gauge near the microphone. The turbines operated continuously throughout the measurements.

The absence of identifying the weather conditions, the location and relevance of the surf at the Cape Bridgewater Beach position and also the blowhole position, together with the Sonus report suggesting only 1 turbine leads one to question the conclusions of the report.

Examination of the photographic material can only lead one to a conclusion this information is misleading.

Furthermore the absence of identifying the infrasound components at locations removed from wind farm, and the narrowband components of the infrasound from turbines versus that from wind cannot support the conclusions contained in the Sonus report.

2.2 Other Sonus Reports

Examination of other reports from Sonus to support wind farm applications will find reference to the Infrasound report discussed above. However another significant issue becomes apparent when one examines the Sonus report *Cherry Tree Wind Farm, Environmental Noise Assessment* dated 18th April 2012 (report ref S3768C3).

The above report has not actually identified the noise impact that will be generated by the proposed wind farm. This would appear to be a fundamental failure in the obligations of the author(s) of the acoustic assessment, i.e. a failure of the obligation to provide a meaningful document in relation to actual noise impacts that the community can understand.

The acoustic assessment for Cherry Tree Wind Farm has not explained to the community the impact that the proposed wind farm will have upon the existing acoustic environment of the area nor whether the operation of the wind farm will affect their daily activities or their night time sleeping patterns. Complaints from residents in proximity to other wind farms frequently refer to sleep disturbance.

If Sonus was to identify to the community there would be no impact/an impact /an adverse impact or severe impact from the proposed wind farm it would be appropriate for the report to discuss the relevance of the predicted noise levels versus the regression curve and/or the minimum background levels that relate to the various wind speeds.

However describing the actual noise impact did not occur in the Sonus Cherry Hill Wind Farm "Environmental Noise Assessment". Therefore how can one determine the report is not misleading? The same issue is apparent in other Sonus reports.

After the community meeting held in Wellington by Bondangara Wind Turbine Awareness Group to provide information to the community in relation to a proposed wind farm, the applicant had Sonus set up on the opposite side of the road a "demonstration" for the community of wind turbine noise with markings on the footpath at various distances nominating dB(A) noise levels from the "wind farm". When one examined the basis of the "demonstration" the validity of the "demonstration" is questioned.

The "demonstration" failed to identify the nature of the existing background level at the time and therefore the relevance of the "demonstration".

If one acknowledges the ambient background levels in the town are higher than that in the rural area, particularly at night, then the existing ambient background levels provided a masking of the wind turbine noise in the demonstration.

The "demonstration" should have identified to the community the ambient levels at the time and therefore the limits of such testing. As rural residents know noises from various sources can be heard at significant distances from the source when in the "bush" the audibility test of the "wind farm noise" that disappeared only a short distance from the relatively small speakers was not a valid "demonstration".

The audible sound from the "demonstration" did not appear to have any low frequency noise and the small sound system used for the "demonstration" could not generate the appropriate levels of infrasound or low frequency that are emitted from modern day turbines. Accordingly there are questions as to whether the Sonus "demonstration" was misleading.

2.3 Infrasound at 7 km

Following the comments from the Chair in relation to the infrasound paper, I was asked to confirm that I could pick up noise from a wind turbine 7 km away.

I confirm that I could measure noise and that I also measured infrasound. Reference to Figure 10 and Figure 11 appearing in Appendix D18 and D19 of my submission identifies that the residence was approximately 8 km from the turbines. I confirm my verbal evidence that I could clearly hear a low frequency noise outside the residence.

In relation to the Chair's question as to health issues, I defer that to persons who are qualified in the area as to those impacts, in that I am only qualified to provide material as to the sound level measurements.

2.4 IEC 61400 – 11 questions

The Chair asked me questions in relation to the IEC Standard and I provided a number of items in terms of deficiencies in the Standard to which the Chair requested to give a plain English analysis of the deficiencies.

In the first instance the Standard is seeking to determine the sound power level of a turbine by measurement at a position on the ground utilising the dB(A) value with optional acoustic data that may be reported being directivity, low frequency noise, infrasound, impulsive, amplitude modulation, and other noise characteristics if any.

The Standard seeks to determine the noise emission level from a turbine at each integer wind speed from 6 to 10 m/s. However turbines operate at speeds lower than 6 m/s and if one takes the view that the ambient background level at residential receivers is lower or potentially non-existent when the turbines cut in then the Standard does not provide the necessary data for assessment purposes in dealing with the impact for residential receivers.

The Standard identifies positions in Figure 4A for microphones to show that they are not influenced by the wind or direct noise generated from the turbines, whereas the measurement of the anemometer height that appears in Figure 6 has the monitoring of the wind at a much higher position and more relative to the turbines.

The Standard does not identify or provide a correction for the difference between the noise levels determined on axis of a wind turbine versus the position at ground level.

In dealing with industrial noise sources the measurement of the sound power level of a source requires one to be at a set distance from the source to create a surface area for calculation purposes and does not permit the measurement of the sound power by reference to a single position significantly to the side of the noise radiating source.

Section 8.3 of the Standard identifies that the calculation of the apparent sound power level is at 20 log of the slant distance in metres from the hub centre, which becomes equivalent to 6 dB per doubling of distance. As identified in response to an earlier question from the Chair, reference was provided to the Massachusetts study and the German study that the low frequency falls off at a different rate, i.e. not 6 dB per doubling of distance.

If one considers for example a noise level of 100 dB at a distance of 100 metres from a source then every time the distance is doubled the noise level would go down 6 dB such that at 3200 metres the level would become 72 dB. However if the attenuation drops off at 4 dB per doubling of distance then for a 100 dB at 100 metres the level at 3200 metres would be 80 dB as shown by the following table.

Distance Attenuation

Distance (m)	**100**	**200**	**400**	**800**	**1600**	**3200**
6dB/doubling	100	94	88	82	96	72
4dB/doubling	100	96	92	88	84	80

Therefore if the infrasound falls off at a lower rate than the dB(A) value then use of the 6 dB per doubling of distance as suggested in the Sonus infrasound report will underestimate the noise impact.

Another matter that I raised during my evidence concerning the Standard is the limitation in terms of frequencies of the instrumentation used for measurements.

Appendix B to the Standard indicates that requirements for tape recorders (be it digital or analogue) used for any measurements would have issues in terms of measuring levels below 30 Hz. Accordingly the Standard even though referring to infrasound measurements in terms of dB(G) cannot provide measurement results if utilising any recording or instrumentation equipment which cannot measure that low.

Bearing in mind that extremely low frequencies have very long wavelengths then the propagation of low frequency sound over distance can be subject to variations as an enhancement of sound and then a reduction in sound. When one considers multiple turbines operating at various speeds in different locations then one can get a phasing or interaction between the turbines to give a variation in the levels.

2.5 Wind Farm Guidelines

The Chair asked a number of questions in relation to wind farm noise criteria and what has been purported to be stringent guidelines in Australia.

Clarification was provided that the South Australian guidelines used to say 35 dB(A) and background +5dB(A), but has been increased in some instances to 40 dB(A) or background +5 dB(A), but that the regression curve for the background level is over the entire 24 hour period.

The draft wind farm guidelines for New South Wales issued in December 2011 identifies in Figure 2 in a graphical format that the New South Wales guidelines would be more stringent than the Victorian, South Australian and New Zealand and European guidelines when considering the base level of 35 dB(A).

At the present point in time there is no information to indicate what will become the final guidelines for New South Wales and therefore the answers that I provided during my evidence were qualified in terms of what could occur to the New South Wales guidelines.

In relation to the second question provided by the Secretary there are matters pertaining to the draft New South Wales guidelines and monitoring that have the provision of the New South Wales planning guidelines (even as draft format) may be of assistance together with a submission that I provided in relation to those guidelines that identified a number of technical issues requiring modification.

In relation to criteria for wind farms that may be used overseas there are modifications to noise limits that in some cases can be more stringent than the concepts used in Australia. In Denmark there is proposed a dB(A) internal noise limit that has no relationship to the background level.

2.6 Industrial Noise

The Chair asked questions in relation to industry of which I provided answers relative to that occurring in New South Wales.

If the committee is provided a copy of the New South Wales EPA's "Industrial Noise Policy", it can be seen quite clearly that there are two criteria that apply to industrial premises. In Chapter 2 of the INP the first criterion is identified as the intrusive noise criterion and is summarised as having an Leq less than or equal to the rating background level +5 dB(A).

The INP identifies the Leq level as being the sound pressure level of the source and is to be assessed at the most affected point on or within the residential property boundary – or, if that is more than 30 metres from the residence, at the most affected point within 30 metres of the residence.

The background level upon which the intrusive noise criteria is a rating background level exceeded for 90% of the time and excludes any measurements conducted in wind speeds greater than 5 m/s.

Therefore in terms of the intrusive noise criteria that has applied for industry in New South Wales the noise target of background +5dB(A) is more stringent than the criteria applied to wind farms on the basis that it is of the minimum background level +5 and has no base threshold.

The second noise criteria related to industrial noise emission in New South Wales is identified as the amenity criterion and considers the Leq level over the entire period being either day, evening or night. Table 2.1 in the INP identifies that the acceptable level for industrial noise in rural areas is to be not more than 40 dB(A) with a maximum level of 45 dB(A).

Where there is an existing noise from other industry then the criteria applicable to new industry is modified by adjustments set out in Table 2.2 of the INP.

Attachment A provides an extract from the Industrial Noise Policy identified above.

Therefore as identified in my evidence the concept of background +10 dB(A) is significantly higher than that applied to industry in New South Wales in terms of the intrusive criteria and also becomes irrelevant in terms of the amenity criteria.

If there are already industrial premises in operation then the noise criteria applicable to additional industrial developments under the amenity criterion can be around 10 dB below the acceptable amenity criterion and therefore dependent upon the background in the location in which the industry exists the amenity target can in effect be below the background level.

The complex nature of assessing a new industrial noise with respect to existing industrial noise is set out in Chapter 10 of the INP of which I wrote the original version of that chapter as part of a joint EPA/Industry Consultation Committee. That Chapter identifies a noise reduction programs for existing sites and new plants. The noise reduction is both practical and feasible as it is the noise reduction program that I developed for the ICI chemical plant complex at Botany and was also applied to the Amcor Paper Mill at Botany and a number of flour mills in regional areas of New South Wales.

Therefore by reference to the EPA document for industrial noise it can be seen that if a criterion of background 10 dB(A) was applied to industry, then industry would welcome such a criteria with open arms in that it would permit higher noise levels than that permitted by the New South Wales EPA.

2.7 Question 2 from the Committee Secretary

In the afternoon sessions involving representatives of the wind industry the representative from Infigen (Mr Upson) made a number of statements in relation to acoustic matters of which I was asked to respond although the latest question from the Secretary only refers to parts of that material.

9. Mr Upson referred to an article by Sonus published in Acoustics Australia as to the matter of infrasound which would appear on page 45 of the April edition of Acoustics Australia as, "*Measurement and Level of Infrasound from Wind Farms and other Sources*" . That paper provides information extracted from the aforementioned Sonus 2010 infrasound report without actually providing that report as a reference.

Comment:

The inadequacies of the Sonus Infrasound report have already been discussed earlier in section 2.1 of this supplementary submission and therefore would indicate that the level of peer review to which Mr Upson is placing some significant emphasis has not actually occurred. It would appear the "peer review process" claimed by Mr Upson did not examine the basis of the article or the relevance of the data to actual turbine infrasound.

It is similar to the use of the Sonus Infrasound report by Marshall Day Acoustics in the Collector Wind Farm application where there is reliance upon the Sonus report without actually checking the contents of the report. Bearing in mind Marshall Day Acoustics have been involved in the measurement of wind farms and aware of complaints by residents of noise disturbance one can see that after having conducted measurements are residences and near wind farms to find significant questions as to compliance data how the Ethics Paper provided in Appendix C of my submission came into being.

10. Mr Upson provides comments in relation to perception of infrasound but is not qualified to measure or determine what perceivable infrasound levels are.

11. Mr Upson referred to matters of needing the wind at hub height and determination of compliance separately to my report identifying noise above that permitted on the consent.

The methodology of determining predicted noise levels from wind farms that appear in various environmental impact statements are to calculate the predicted dB(A) noise level at residential receivers versus the wind speed at either the hub height or in some cases 10 metres above ground at the wind farm.

Therefore if one has a base level noise limit of 35 or 40 dB(A) and background +5 dB(A) where the background is determined as a regression analysis from measurements of ambient background level versus the hub height wind speed then for the purpose of full compliance you need noise level at residential receivers and the hub height wind speed. It is noted that on earlier assessment the wind was determined 10 metre above ground at the wind farm.

Comment:

Mr Upson made statements concerning Capital Wind Farm.

Examination of the relevant extract from the consolidated development consent (provided in Attachment B) identifies that the operational noise criteria for the wind farm is not in terms of background +5 dB(A) by relates to noise emission from the wind farm at receiver locations which is expressed in terms of 35 dB(A) or in some cases a level higher than 35 dB(A).

For the benefit of the committee I note condition 55 of the consolidated consent puts the measurement point at the most affected point within the residential boundary, or the most affected point within 30 metres the dwelling where the dwelling is more than 30 metres from the boundary, i.e. **the distance nominated in the Bill.**

Condition 54 of the Consent refers to Table 1 of the acoustic assessment where for Sunnybrook identifies the results are considered to be representative of a number of nearby houses.

The consolidated consent identifies in condition 53 that the noise level at receiver location G10 is not to exceed 37 dB(A) at any time. The EA acoustic report utilised Sunnybrook (G8) for the background level regression line that was applicable to locations G10, G13 and G16.

Examination of the Environmental Assessment for the Capital wind farm finds that the noise contours indicate that the maximum noise level expected from the operation of the wind farm at house G 13 in would be somewhere between 32 and 36 dB(A).

My assessment for the Flyers Creek report are measurements conducted at house G13 that clearly show on Wednesday, 9 November between 9 and 10 pm the background noise level was above 40 dB(A) with the Leq level slightly higher.

I was in attendance at house G13 specifically at that time and standing 10 metres from the residence there was no wind at the residence. The noise that was controlling the background was that from the turbines. Approximately 2 hours earlier the turbines were not operating, there was no wind at the site and the background level was around 30 dB(A).

Therefore the attended measurements found that the noise level at house G13 was above that provided in the Environmental Assessment. Under that assessment the noise at G10 would be higher than for house G13. Under higher wind strengths the consent indicates at house G10 a limit of 37 dB(A) and 35 dB(A) for lower speeds.

Even if one considered the wind at the turbine was up to 12 m/s then the noise level at house G13 exceeded the limits provided for the specified house G10, that from the environmental assessment referred in Condition 54 is representative for houses G13 and G16.

In light of the limited monitoring available for the review of the Flyers Creek application, and the absence of material pertaining to the wind at Capital Wind Farm a series of extended measurements were conducted at house G16. During my attended measurements at night to house G16 noise could be detected from Capital Wind Farm and at other times noise from the Woodlawn Wind Farm where tonal noise from the turbines could be clearly detected both inside and out the residence.

My review of the Flyers Creek wind farm application included the supplementary unattended noise logging and attended measurements in relation to house G16, which from the environmental assessment identified the noise level at a wind speed at 12 m/s at the turbines would be no greater than 32 dB(A) at that house.

Appendix J of the Flyers Creek wind farm review contained a series of unattended noise logger results to show that the ambient noise level when the wind farms were operating was at times significantly greater than that indicated in the environmental assessment.

Determination of acoustic compliance with respect to the regression curves presents difficulty in that the 10 metres high wind speed at the wind farm is not available. One could from the regression line provided in the environmental assessment determine the likely background level for various wind speeds and logarithmically subtract those levels from the measured levels in the Flyers Creek report that would then suggest that not only are there are levels above that permitted up to 12 m/s from wind speed for the wind farm but the levels are higher than that specified for lower wind speeds.

Therefore the statement of Mr Upson identifying that one could not find noise above that permitted on the consent is completely incorrect. Attended sound level measurements have recorded levels above that permitted on the consent.

As to complete verification of the noise conditions on the Consent for all wind speeds I have been unable to provide the answer as the wind farm wind speed is not available.

This statement is consistent with my submission on the draft NSW Wind Farm Guidelines (my reference report 42.4963.R2, dated 14th March 2012). I note Mr Upson failed to advise the Committee of my comments re the provision of wind speed and my statement that I could not determine compliance with the conditions of consent without wind data.

In the Executive Summary of my review into the Draft NSW Wind Farm Guidelines points 8 – 11 are relevant to Mr Upson's incorrect statements and matters before the Committee:

8. *The measurement procedure in relation to specific noise characteristics describes measurements conducted over a 10 minute period.* ***This does not permit identification of these characteristics which are associated with swish, modulation, discrete tones and low frequency noise****. This is demonstrated with analysis of data from operating wind farms. Criteria in relation to amplitude modulation are uncertain.*

9. *Examination of data demonstrates that compliance monitoring can only be effective with the provision of permanent noise monitoring within the wind farm, recording noise levels, wind speed and direction at receiver locations and recording wind speed and direction at hub height.* ***The Guidelines do not, but should, provide for such permanent noise monitoring supplemented with temporary remote monitoring in real time to deal with complaints.***

10. *The provision of permanent noise monitoring data together with real time presentation of the wind speed and direction at the hub, the power output and operational status of individual turbines must be provided in the* ***public domain*** *to permit independent compliance testing. There is no provision for this in the Draft Guidelines.*

11. ***Compliance procedures are ineffective. The Guidelines do not provide a clear indication of what triggers non-compliance. The specified effects of non-compliance are vague.*** *There are no provisions requiring a cessation of operations if the wind farm is not compliant.*

Page 5 of my review stated:

Appendix D sets out the results of the unattended monitoring and includes the wind speed at the microphone. One cannot plot the turbine hub speed on the graphs as that material is not available.

The absence of the turbine hub speed or any data in the Environmental Assessment for the Capital Wind Farm to identify the relationship of the hub wind speed to residential locations presents some difficulty in undertaking an independent compliance test.

Table 5 in the Background Noise Monitoring Report for the Capital Wind Farm provides the background noise level at integer wind speeds. This is the wind noise level which is suggested in the Guidelines as the value taken of the measured noise level of wind and turbines in order to determine a contribution.

On page 6 I stated:

On this basis there are periods of time from the logger graphs that indicate excessive noise. ***Obviously this method of estimating the noise impact is not satisfactory for compliance purposes and automatically requires the Draft Guidelines to require the wind farm weather details to be available in the public domain.***

It is noted that the Capital Wind Farm does not provide any noise or weather data on their web site, nor any acoustic compliance report(s). Without such material and identification of the output of the wind farm it is impossible for anybody to check the "compliance" testing/ reports.

Following Mr Upson's incorrect statement as to noise levels recorded near Capital Wind Farm there were questions from Senator Xenophon in relation to noise levels from Capital Wind Farm and acoustic compliance. Mr Upson's response was not in relation to the compliance.

Section 4.5 of my review report into the draft NSW Wind Farm Guidelines discussed the issue of Compliance Testing and the absence of factual material to support the claim of acoustic compliance:

4.3 Compliance Testing

The Project Approval for the Capital Wind Farm from the Minister for Planning states that the conditions are required to:

- *Prevent, minimise, and/or offset adverse environmental impacts;*
- *Set standards and performance measures for acceptable environmental performance; require regular monitoring and report; and*
- *Provide for the ongoing environmental management of the project.*

Complaints from residents of sleep disturbance and headaches would suggest that the selection of noise criteria and the conditions/management of the Wind Farm have failed to prevent, minimise and/or offset adverse environmental impacts.

As identified in the FCWTAG submission there are no acoustic compliance reports for the Capital Wind Farm in the public domain. A review report "Technical Review of the Capital Wind Farm Noise Compliance Assessment Report. Including a review of a Specialist Reports on Noise by Vipac Engineers"-by an officer of the Department of Planning is on the Department's website under major projects - Capital Wind Farm. The officer's report relies upon reports prepared by Vipac that are not in the public domain or on the Department's website.

Accordingly there is no material from Capital to permit an examination of the subject wind farm's apparent "acoustic compliance".

To this end a FOI application was made last year on behalf of residents to access the Vipac compliance reports for Capital Wind Farm. The two documents released under FOI have the majority of the reports blanked out – apparently due to the reports being "commercial in confidence". The material that remains in the reports is of no assistance in ascertaining acoustic compliance – or in fact non-compliance.

An appeal was made in relation to the blanked out sections of the report and that Appeal was upheld with the full report provided. An examination of the report and the basis of the claimed assessment is underway as there are issues with the suggested acoustic compliance.

However the wind data is still not available for the Capital Wind Farm despite a laborious and lengthy freedom of information process (and Appeal).

2.8 Compliance Monitoring

The SA EPA Guidelines identify in Section 4.8 under a heading of "Excessive Noise" that the wind farm should comply with the criteria at all relevant receivers. The Guideline does not define excessive noise in a numerical sense.

However Mr Upson provided in his evidence:

> *Excessive noise, by definition, is a noise above what the state noise limits are. If you are over that limit, then it is excessive. It is simple enough.*

The SA EPA Guidelines set out a procedure to determine a regression curve for the noise from the wind farm and background noise and compare that curve with the original regression line determined for the wind farm. There is no requirement under the SA EPA Guidelines to place the compliance report in the public domain.

However the NSW Draft Guideline (if approved) requires noise monitoring during periods commensurate with the 'worst case' operational and meteorological factors (including temperature inversions) and make the noise compliance report publicly available to the community consultation committee and on the proponent's website.

There appears to be some debate as to the provision of wind data and the claim of "commercial in confidence" that is clouding the issue of monitoring.

I have conducted noise monitoring of large industrial site for many years and utilised permanent noise monitoring of plants where noise levels were measured on or inside the plant boundary that were calibrated to the resultant noise levels at residential locations. By determining baseline data the plant could have notification as to the level approaching a threshold and take appropriate action.

With the advent of computerised monitoring systems the provision of such monitoring is both reasonable and feasible.

In NSW it is not uncommon for the EPA or consultants (suitably qualified) to nominated noise levels at locations between the plant and the residential areas that ensures acoustic compliance with corrections to the threshold level that take into account prevailing weather conditions.

Attachment C provides the compliance and permanent monitoring section of my submission to the NSW Draft Guidelines that has been available to the wind industry for some eight months.

From an acoustic viewpoint I see no issue in identifying the wind at the hub height in the public domain and can see no reason for acousticians representing the wind industry to not apply themselves to the community concerns as to acoustic compliance, and therefore from Mr Upson non-compliance that automatically becomes excessive noise under state guidelines also can be used for determination of excessive noise as proposed by the Bill.

However to progress the consideration of the provision of noise monitoring (that even Professor Chapman agreed should be available) I provide the following concept.

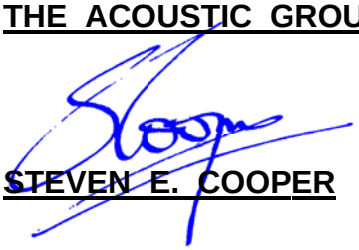
- The noise levels at locations on the wind farm boundary should be in the public domain in real time.
- The predicted levels at the critical receivers can also be shown – having established by remote simultaneous monitoring and correlating the boundary levels with the weather corrections.
- The predicted levels require the measurement of the hub height wind conditions.

- From time to time the provision of remote terminals 30 metres from residences would also show the noise levels in real time.
- The real time monitoring can indicate breach of the state limits or the Bill's excessive limits without disclosing the "commercial –in-confidence" wind data.
- The entire data of wind, noise, weather and operational parameters of the wind farm would then be available to the Regulator who is responsible for addressing the excessive noise.

As set out in my submission the noise monitoring of aircraft operations around airports is regularly used to check noise complaints and the provision for the real time data assists the community in ascertaining what is happening with the detailed data interrogated by the Regulatory Authority.

Yours faithfully,

THE ACOUSTIC GROUP PTY LTD



STEVEN E. COOPER

ATTACHMENT A: Extract from Chapter 2 of NSW EPA Industrial Noise Policy

2 Industrial Noise Criteria

The assessment procedure for industrial noise sources has two components:

- controlling intrusive noise impacts in the short term for residences
- maintaining noise level amenity for particular land uses for residences and other land uses.

In assessing the noise impact of industrial sources, both components must be taken into account for residential receivers, but, in most cases, only one will become the limiting criterion and form the project-specific noise levels for the industrial source. The worked case studies in *Appendix A* show how both components work together.

The procedures specified in the policy differentiate between low- and high-noise-risk developments, with simpler procedures available for developments with low noise risk. Differentiation between these two types of developments is on the basis of magnitude (for example, level of noise expected) and extent of impact (for example, expected area of affectation). Hence, a development that is likely to make excessive noise affecting a large area can be considered to be a high-risk development, and vice versa for low risk.

2.1 Intrusive noise impacts

The intrusiveness of an industrial noise source may generally be considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (represented by the L_{Aeq} descriptor), measured over a 15-minute period, does not exceed the background noise level measured in the absence of the source by more than 5 dB.

To account for the temporal variation of background noise levels, the method outlined in *Section 3.1* is recommended for determining the background noise level (rating background level—RBL) to be used in the assessment. This approach aims to result in the intrusive noise criterion being met for at least 90% of the time periods over which annoyance reactions can occur (taken to be periods of 15 minutes).

Adjustments are to be applied to the level of noise produced by the source that is received at the assessment point before comparison with this criterion. Where the noise source contains annoying characteristics—such as prominent tonal components, impulsiveness, intermittency, irregularity and dominant low-frequency content—adjustments as outlined in *Section 4* apply.

Procedures for considering meteorological effects such as temperature inversions and wind are outlined in *Section 5* to account for characteristic weather conditions under which the intrusiveness criterion applies.

The intrusiveness criterion is summarised as follows:

$$L_{Aeq,\ 15\ minute} \leq \text{rating background level plus 5}$$

where:

$L_{Aeq,\ 15\ minute}$ represents the equivalent continuous (energy average) A-weighted sound pressure level **of the source** over 15 minutes. **Other descriptors may be used as appropriate provided they can be justified on the basis of being characteristic of the source (see *Section 2.3*).** This is to be assessed at the most-affected point on or within the **residential** property boundary—or, if that is more than 30 m from the residence, at the most-affected point within 30 m of the residence.

Rating background level is the background level to be used for assessment purposes as deter-mined by the method outlined in *Section 3.1*.

A 15-minute sampling period is used when measuring the level of intrusive noise. There has been no definitive research to quantify the time period over which annoyance to intrusive noise varies. Clearly, annoyance reactions are likely to occur over periods of less than a day, and there will be variations depending on individual tolerance and characteristics of the noise. The 15-minute period has been selected as a reasonable estimate of the period over which annoyance may occur. This time period has been used by the EPA for some time, and experience

has shown that it is a reasonable approach to assessing intrusive noise impacts.

In some rural situations, the rating background level may be the same for the day and night. In these cases, it is recognised that excursions of noise above the intrusiveness criterion during the day would not usually have the same impact as they would at night. This is due to the more sensitive nature of activities likely to be disturbed at night (for example, sleep and relaxation).

2.2 Protecting noise amenity

To limit continuing increases in noise levels, the maximum ambient noise level within an area from industrial noise sources should not normally exceed the acceptable noise levels specified in *Table 2.1*. Meeting the acceptable noise levels in *Table 2.1* will protect against noise impacts such as speech interference, community annoyance and, to some extent, sleep disturbance. These levels represent current best practice for assessing industrial noise sources, based on research and a review of assessment practices used overseas and within Australia.

Table 2.1 also includes recommended maximum noise levels for different land uses. These recommended maximum values provide guidance on an upper limit to the level of noise from industry. In all cases it is expected that all feasible and reasonable mitigation measures would be applied before the recommended maximum noise levels are referenced.

In some instances it may not be possible to achieve even the recommended maximum noise level, even after all feasible and reasonable noise mitigation has been applied. Such cases are expected to have a large adverse noise impact. Where a proposed development exceeds the recommended maximum noise levels in *Table 2.1*, substantial benefits in other areas, including a high degree of social worth, would need to be demonstrated.

Where the existing noise level from industrial noise sources is close to the acceptable noise level, the noise level from any new source(s) must be controlled to preserve the amenity of an area. If the total noise level from industrial sources already exceeds the acceptable noise level for the area in question, the L_{Aeq} noise level from any new source should not be greater than:

- 10 dB below the acceptable noise level if there is a reasonable expectation that existing levels may be reduced in the future; or
- 10 dB below the existing level if there is no such reasonable expectation that existing levels will fall (for example, in cases where surrounding areas are fully developed) and no significant changes to land use are expected.

Table 2.2 sets out the implications of this requirement for noise from industrial sources.

Adjustments are to be applied to the source noise level received at the assessment point, before comparison with this criterion, where the noise source contains annoying characteristics such as prominent tonal components, impulsiveness, intermittency, irregularity and dominant low-frequency content, as outlined in *Section 4*.

Procedures for considering meteorological effects such as temperature inversions and wind are outlined in *Section 5* to account for characteristic weather conditions under which the amenity criteria apply.

In determining the existing L_{Aeq} noise level from industry, noise from transportation-related sources (road traffic, rail traffic and aircraft) may be excluded. Criteria for noise from these sources are defined separately. Research and experience indicates that residents distinguish and respond separately to noise from road traffic, rail traffic, aircraft and industrial sources, rather than registering an overall noise annoyance related to the total L_{Aeq} noise level. *Section 3.2* gives guidance on how to determine existing noise levels. Practical means by which transportation noise (road traffic in particular) may be excluded from a measurement of existing noise levels are presented in *Section 3.2.1*.

Where existing traffic noise levels are continuously high, the existing level of the traffic noise (determined by using the method outlined in *Section 3.2*) can be 10 dB or more above the recommended acceptable noise level shown in *Table 2.1*. In these situations the industrial source may be inaudible, even where it produces noise levels higher than the acceptable noise level. The criterion to be applied in this case is set out in *Section 2.2.3*.

Table 2.1. Amenity criteria

Recommended L_{Aeq} noise levels from industrial noise sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level, dB(A) *(see Note 8 in Section 2.2.1)*	
(*see Notes in Section 2.2.1)*			**Acceptable** *(See Note 11)*	**Recommended Maximum** *(See Note 11)*
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45
	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
	Urban	Day	60	65
		Evening	50	55
		Night	45	50
	Urban/Industrial Interface – for existing situations only	Day	65	70
		Evening	55	60
		Night	50	55
School classroom—internal	All	Noisiest 1-hour period when in use	35 *(See Note 10)*	40
Hospital ward —internal —external	 All All	 Noisiest 1-hour period Noisiest 1-hour period	 35 50	 40 55
Place of worship—internal	All	When in use	40	45
Area specifically reserved for passive recreation (e.g. National Park)	All	When in use	50	55
Active recreation area (e.g. school playground, golf course)	All	When in use	55	60
Commercial premises	All	When in use	65	70
Industrial premises	All	When in use	70	75

Where there is a reasonable expectation that the cumulative noise level from industrial sources could increase in future (for example, through the development of further new sources), this should be considered in setting noise levels, as outlined in *Section 2.2.4*.

Table 2.2. Modification to acceptable noise level (ANL)* to account for existing level of industrial noise

Total existing L_{Aeq} noise level from industrial sources, dB(A)	Maximum L_{Aeq} noise level for noise from new sources alone, dB(A)
≥ Acceptable noise level plus 2	If existing noise level is *likely to decrease* in future: acceptable noise level minus 10 If existing noise level is *unlikely to decrease* in future: existing level minus 10
Acceptable noise level plus 1	Acceptable noise level minus 8
Acceptable noise level	Acceptable noise level minus 8
Acceptable noise level minus 1	Acceptable noise level minus 6
Acceptable noise level minus 2	Acceptable noise level minus 4
Acceptable noise level minus 3	Acceptable noise level minus 3
Acceptable noise level minus 4	Acceptable noise level minus 2
Acceptable noise level minus 5	Acceptable noise level minus 2
Acceptable noise level minus 6	Acceptable noise level minus 1
< Acceptable noise level minus 6	Acceptable noise level

** ANL = recommended acceptable L_{Aeq} noise level for the specific receiver, area and time of day from Table 2.1.*

2.2.1 Notes to support the noise level tables

1. The recommended acceptable noise levels refer only to noise from industrial sources. However, they refer to noise from all such sources at the receiver location, and not only noise due to a specific project under consideration. The levels represent outdoor levels except where otherwise stated.

2. In assessing noise levels at residences, the noise level is to be assessed at the most-affected point on or within the residential property boundary or, if this is more than 30 m from the residence, at the most-affected point within 30 m of the residence.

3. In assessing noise levels at commercial or industrial premises, the noise level is to be assessed at the most-affected point on or within the property boundary.

4. Where internal noise levels are specified in *Table 2.1*, they refer to the noise level at the centre of the habitable room that is most exposed to the noise and are to apply with windows opened sufficiently to provide adequate ventilation. In cases where the gaining of internal access for monitoring is difficult, then external noise levels 10 dB above the internal levels apply.

5. In assessing noise levels at passive and active recreational areas, the noise level is to be assessed at the most-affected point within 50 m of the area boundary.

6. Types of receivers are defined as follows. *Section 2.2.2* offers some guidance for the selection of the appropriate receiver types.

   Rural—means an area with an acoustical environment that is dominated by natural sounds, having little or no road traffic. Such areas may include:

   —an agricultural area, except those used for intensive agricultural activities

   —a rural recreational area such as resort areas

   —a wilderness area or national park

   —an area generally characterised by low background noise levels (except in the immediate vicinity of industrial noise sources).

   This area may be located in either a **rural, rural-residential, environment protection**

zone or scenic protection zone, as defined on a council zoning map (Local Environmental Plan (LEP) or other planning instrument).

Suburban—an area that has local traffic with characteristically intermittent traffic flows or with some limited commerce or industry. This area often has the following characteristics:

—decreasing noise levels in the evening period (1800–2200); and / or

—evening ambient noise levels defined by the natural environment and infrequent human activity.

This area may be located in either a **rural, rural-residential or residential zone,** as defined on an LEP or other planning instrument.

Urban—an area with an acoustical environment that:

—is dominated by 'urban hum' or industrial source noise

—has through traffic with characteristically heavy and continuous traffic flows during peak periods

—is near commercial districts or industrial districts

—has any combination of the above,

where 'urban hum' means the aggregate sound of many unidentifiable, mostly traffic-related sound sources.

This area may be located in either a **rural, rural-residential or residential** zone as defined on an LEP or other planning instrument, and also includes mixed land-use zones such as mixed commercial and residential uses.

Urban/industrial interface—an area defined as for 'urban' above that is in close proximity to industrial premises and that extends out to a point where the existing industrial noise from the source has fallen by 5 dB. Beyond this region the amenity criteria for the 'urban' category applies. This category may be used only for existing situations. (See example of how this category is used in *Appendix A, Section A5*).

Commercial—an area defined as a **business** zone, except neighbourhood business zone, on an LEP.

Industrial—an area defined as an **industrial** zone on an LEP. For isolated residences within an industrial zone the industrial amenity criteria would usually apply.

7. **Time of day:**

—day: the period from 7:00 am to 6:00 pm Monday to Saturday; or 8:00 am to 6:00 pm on Sundays and public holidays

—evening: the period from 6:00 pm to 10:00 pm

—night: the remaining periods.

(These periods may be varied where appropriate, for example, see *Section 3.3*.)

8. The L_{Aeq} noise level for a specific period represents the L_{Aeq} level calculated or measured over the applicable day, evening or night period (i.e. $L_{Aeq, period}$) except where otherwise stated (for example, school classroom, hospital).

9. If existing noise levels from industrial noise sources already approach or exceed the recommended acceptable noise levels in *Table 2.1*, any increase in these levels should be strictly limited, as described in *Table 2.2*.

10. In the case where existing schools are affected by noise from existing industrial noise sources, the acceptable L_{Aeq} noise level may be increased to 40 dB $L_{Aeq(1hr)}$.

11. The acceptable and recommended maximum L_{Aeq} noise levels can provide a guide to applying the negotiation process set out in *Section 8*. While negotiation between the proponent and the community for an agreed noise level can occur at any time, typically the proponent would negotiate with the EPA where noise-level emissions fall between the acceptable and recommended maximum. For site levels beyond the recommended maximum levels, the proponent would need to negotiate directly with the community.

2.2.2 Determining the receiver type

The selection of the type of receiver is important in determining which noise amenity criteria level should apply. In most instances the receiver cat-

ATTACHMENT B: Extract of Consolidated Consent for Capital Wind Warm

Project Approval

Section 75J of the *Environmental Planning and Assessment Act 1979*

I, the Minister for Planning, approve the project referred to in Schedule 1, subject to the conditions in Schedule 2.

These conditions are required to:

- prevent, minimise, and/or offset adverse environmental impacts;
- set standards and performance measures for acceptable environmental performance;
- require regular monitoring and reporting; and
- provide for the ongoing environmental management of the project.

Modification 1 indicated in red
Modification 2 indicated in green
Modification 3 indicated in yellow (NB – fully superseded by later modifications)
Modification 4 indicated in blue
Modification 5 indicated in violet

Frank Sartor MP
Minister for Planning

Sydney 2006 File No: S04/01018-3

SCHEDULE 1

Application No:	05_0179
Proponent:	Renewable Power Ventures Pty Ltd
Approval Authority:	Minister for Planning.
Land:	Lot 80 in DP 754819, Lot 10 in DP 237079, Lot 11 in DP 237079, Lot 17 in DP 535180, No 414 Book 2073, No.56 Book 1886, Vol 6429 Fol 101, Lot 1 in DP 658449, Lot 2 in DP 720169, Lot 5 in DP 837873, Lot 76 in DP 754919, Lot 78 in DP 754919, Lot 79 in DP 754919, Lot 48 in DP 754877, Lot 45 in DP754877, Lot 16 in DP535180, Lot 18 in DP535179, Lot 48 in DP754877, Crown Road Reserves, Osborne Trig Reserve.
Project:	The construction and operation of a wind farm comprising 67 x 2.1 megawatt wind turbine generators, an electrical substation to facilitate connection to an existing TransGrid 330 000 volt transmission line, a facilities building, temporary and permanent wind monitoring towers, underground cables, a

(b) the delivery of materials as requested by Police or other authorities for safety reasons; and

(c) emergency work to avoid the loss of lives, property and/or to prevent environmental harm.

Any work undertaken outside the specified construction hours, other than those specified in (a) – (c) of this Condition No. 52, must not be undertaken without prior consent of the Director-General.

Operational Noise Criteria

53 Noise generated from the Development must not exceed the equivalent noise level ($L_{Aeq, 10}$) adjusted for any tonality as presented in the tables below.

10m (height)wind speed (m/s)	Noise level $L_{Aeq\ (10\ minute)}$ – at receiver locations*			
	Property described in the EA as Lakoona (G4)	Property described in the EA as Widgemore (G6)	Property described in the EA as La Granja (G10)	Property described in the EA as The Patch (H15)
0-4	35	35	35	35
5	35	35	35	35
6	35	35	35	35
7	35	35	36	35
8	35	35	37	35
9	35	35	37	35
10	35	35	37	35
11	35	35	37	35
12	35	35	37	35

10m (height)wind speed (m/s)	Noise level $L_{Aeq\ (10\ minute)}$ – at receiver locations*			
	Property described in the EA as Wroxham (H24)	Property described in the EA as (E7)		
0-4	35	35		
5	35	35		
6	35	35		
7	35	36		
8	35	36		
9	35	37		
10	35	37		
11	35	37		
12	35	37		

*Receiver locations as identified in the *Environmental Assessment – Capital Wind Farm Environmental Assessment* prepared by Connell Wagner PPI dated February 2006. If compliance assessments are required at other non-associated residences as identified in the Environmental Assessment, the applicable noise limits are $L_{Aeq\ 10\ minute}$35 dB(A) where the predicted level is below $L_{Aeq\ 10\ minute}$35 dB(A), and the predicted level is above $L_{Aeq\ 10\ minute}$35 dB(A). The predicted levels are identified in the aforementioned Environmental Assessment.

54 The noise limits applied to the eight properties identified in Condition No. 53 must be applied to all residences that were identified as being 'representative' as described in *Table 1: Representative background sites with similar noise criteria*, Appendix H1 –

Background Noise Monitoring Report found in Volume 2 – Appendices to the Capital Wind Farm Environmental Assessment.

55 Noise from the Premises is to be measured at the most affected point within the residential boundary, or at the most affected point within 30 metres of the dwelling where the dwelling is more than 30 metres from the boundary, to determine compliance with the noise level limits set out in the tables at Condition No. 53.

56 The modification factors presented in Section 4 of the *New South Wales Industrial Noise Policy* (NSW EPA, January, 2000), must be applied to the measured noise level where applicable.

Noise Compliance Monitoring During Operation

57 The Applicant must prepare a *Noise Compliance Assessment Plan* which must be submitted to the DEC prior to Commissioning of the wind turbines. The *Noise Compliance Assessment Plan* must outline how the *Noise Compliance Assessment,* as described in Conditions Nos. 58-59, will be achieved.

58 The *Noise Compliance Assessment* must include, but not be limited to:

(a) an assessment of the performance of the wind farm against the noise limits contained in Condition No.53.
(b) a commitment that noise compliance monitoring must be undertaken within three calendar months of the commissioning of the wind turbines at the locations identified in Condition No. 53[1]. If prevailing meteorological conditions do not allow the required monitoring to be undertaken in this period, the DEC must be notified and an extension of time may be sought; and
(c) a requirement that all noise compliance monitoring results are to be submitted to the DEC within one month of completion of the monitoring. The DEC may request that additional noise compliance monitoring be undertaken and completed within a timeframe defined by the DEC.

59 In the event that the *Noise Compliance Assessment* indicates that noise from the wind turbines exceeds the noise limits contained in Condition No. 53, the Proponent must investigate and propose the mitigation and management measures that are available to achieve compliance with the noise limits. The *Noise Compliance Assessment* must be undertaken in accordance with the procedures presented in the *SA Guidelines*.

Note: The data obtained using the compliance assessment procedures outlined in the SA Guidelines should be used to establish the noise levels contributed by the wind farm. Other predictive compliance assessment techniques, where these techniques can be justified, may be considered. Whilst not directly applicable to wind farms, the NSW Industrial Noise Policy (INP) may provide additional guidance on predictive compliance assessment techniques.

[1] The EPA may require the Proponent to repeat the *Noise Compliance Assessment* procedure if the initial *Noise Compliance Assessment* indicates that this is necessary. The EPA may require additional compliance assessment at locations not nominated in Condition No. 53 on the basis of *bona fide* complaint(s).

ATTACHMENT C: Extract from Submission re NSW Draft Wind Farm Guidelines

4.4 Noise Assessment

From the above material arising from the attempt to undertake compliance testing it is apparent that the matters set out on page 36 for the noise assessment report require modification.

There is a need to identify the background noise level at receiver locations under varying wind strengths and wind direction as part of the environmental impact statement.

The logger measurements for house G16 (Capital wind farm) show that there can be a significant difference between the background levels for different two week periods. For house H15, there is a significant difference for the application background level and the compliance shut down level. **The variability in the data demonstrate that the monitoring period for background level must be increased.** It is noted that it is highly unlikely given the capital expenditure for a wind farm that the assessment of a site would restrict wind measurements to only a two week period.

For the purpose of a future compliance and clarification as to the assessment that has been undertaken, one needs to provide a correlation between the wind speed and wind direction at the wind farm weather monitoring position, versus the background levels that occur at residential receivers. **Such a correlation requires significantly more than two weeks of data.**

Typically noise conditions for industrial developments may be expressed with respect to weather conditions as:

> The maximum allowable noise contributions apply under wind speeds up to 3 ms-1 (measured at 10 metres above ground level), or under temperature inversion conditions of up to 3ºC/100 metres and under

wind speeds up to 2 ms-1 (measured at 10 metres above ground level), i.e. covering a range of weather conditions.

It therefore follows that there should be at least two weeks of valid data points for **each of the various weather scenarios** that can be experienced at the receiver site.

As in the course of environmental assessment for large scale industrial developments the noise modelling should in the first instance provide the noise contributions at critical receiver locations with the wind farm operating under neutral weather conditions for the cut – in speed and say the maximum power speed.

One can then provide the noise predictions for a downwind scenario from source to receiver for the same two wind speeds and the noise prediction for an upwind scenario of a light wind from the receiver to the source.

The modelling should then consider the propagation under temperature inversion conditions.

This would give a range of levels that can be generated from the wind farm and clearly identify the range of noise emission levels, and the controls to ensure the intent as set out on page 35 of the Draft Wind Farm Guidelines for the noise to be under the nominated limit for a worst-case scenario.

The application of the above material to identify the background level expected at residential receivers for different wind speed and direction scenarios, together with the predicted noise levels under different weather scenarios would then permit in a compliance regime to take account of the propagation factors in considering the measured levels at receiver locations. This would then permit the adjustment of the results to account for the prevailing weather conditions.

At the present time without identification of the prevailing weather at the receiver location and the relationship of predicted noise levels under those specific weather conditions **then it is impossible to ascertain the matter of acoustic compliance**.

This would then permit the normalised emission levels of the wind farm to be assessed under temperature inversion conditions if such conditions did not occur during the compliance testing.

5 COMPLIANCE

At the present point in time the "compliance testing" procedure set out in the Draft Guidelines does not follow the EPA procedure for industrial noise sources. It can therefore be asserted that from a resident's perspective, it is set up with a clear bias towards the wind industry. It may be argued that the compliance mechanism in effect follows that of the South Australian guidelines. Given public criticism by residents in other states that the South Australian guidelines are inadequate, generate noise and health problems, it may also be asserted that it was incumbent upon the author of the noise guidelines for New South Wales to have investigated the South Australian compliance procedures in order to provide justification for the statement (attributed to the Minister) that the NSW Draft Wind Farm Guidelines "would be the most stringent noise guidelines in Australia." On examining the Draft Wind Farm Guidelines one finds that such an investigation cannot have occurred.

5.1 General Issues

- Page 27 of the Draft Wind Farm Guidelines identifies that the Protection of the Operations Act 1997 is to be strengthened with the EPA to have a regulatory role for wind farms classified at State Significant Development. What constitutes "strengthen" of the POEA is not known or specified, nor what happens to wind farms that are not State Significant Development.

- Use of an external noise assessment is inconsistent with some general noise assessments as identified in Section 2.1.2 of the NGLG where the EPA state:

Tips for assessing audibility

Where an authorised officer is having difficulty accessing the habitable rooms of a complainant's residence, they could consider conducting the audibility test outside the affected neighbour's house and making an allowance for a reduction in the noise level from the outside to the inside of the residence. In these cases, the officer should be aware that there is no certainty in determining the level of noise inside the complainant's residence. There have been instances where noise levels inside a dwelling from an external source have been higher than the outside noise level because 'standing sound waves' in the room produce noticeably louder noise inside than outside.

If cases involving the audibility test go to court, the hearing ability of the assessing officer may be brought into question. Officers likely to perform these assessments should obtain an audiogram every one or two years. Audiograms assess a person's ability to hear the normal range of frequencies and identify those frequencies where hearing is impaired.

- Section 2.1.4 of the NGLG discusses an offensive noise test and sets out six questions.

Offensive noise test: Checklist of considerations

Q1: Is the noise loud in an absolute sense? Is it loud relative to other noise in the area?

This establishes that the noise is likely to be heard by neighbours. Its volume alone may be annoying. An example would be music being played at a very high volume in a residence so it can be heard over very noisy activity outside, such as construction work. The noise may also be loud relative to the background noise. An example would be loud fireworks set off late at night. Noise measurements using a sound level meter would help to determine how loud the noise is relative to the background noise level in the area.

Q2: Does the noise include characteristics that make it particularly irritating?

The presence of tones, impulses or fluctuations in volume can make people more likely to react to the noise. These can be judged subjectively but noise measurements will help to quantify the extent of these characteristics. Examples might be screeching sounds from poorly maintained equipment or a 'beeper' alarm that uses a pulsed sound made up of one or two alternating frequency tones, usually higher pitched, that are louder than the background noise in the area.

Q3: Does the noise occur at times when people expect to enjoy peace and quiet?

People usually expect their surroundings to be quieter during the evening and at night. Talk to the complainants about how the noise affects them to see if it is interfering unreasonably with their comfort at home. Is it regularly disturbing their sleep, making it difficult to have a conversation, study, read or hear the TV? Noise that regularly disturbs sleep is likely to be considered offensive by complainants and this should be taken into account in your assessment.

Q4: Is the noise atypical for the area?

Where noise from an activity that is causing nuisance is new or unusual for an area, people are more likely to react. Look at the typical uses of the area and determine whether the activity is consistent with the local environmental plan. An example might be a rock drill used on a residential construction site.

Q5: Does the noise occur often?

Noise can be more annoying when it occurs frequently. Examples might be a leaf blower used every morning or a band that practises frequently without regard to the impact on neighbours.

Q6: Are a number of people affected by the noise?

Only one person needs to be affected by the noise for it to be deemed offensive. However, talking to other neighbours likely to be exposed to the same noise about how it affects them may assist in deciding what action to take. Some councils have a policy of requiring a minimum number of complaints from different individuals before taking formal action.

- Under the NGLG offensive noise test the wind farm noise would be described as offensive noise For a rural environment without turbines one must conclude for the above checklist that the noise from a wind farm at times is loud, is atypical of the area, occurs often, occurs at night when people expect peace and quiet, contains audible characteristics, and affects more than just one
- household.

- The Draft Wind Farm Guideline does not require the assessment to identify the actual acoustic impact. The specification of complying with a noise limit without advising the community that the permitted noise is significantly above the background level, clearly audible inside houses, interferes with a person's sleep and is deemed to be an offensive noise is entirely contrary to intent the expressed in the consent for Capital Wind Farm and is an issue that must be addressed.

- The Draft Wind Farm Guidelines do not provide a clear indication of what action arises from non-compliance. There are no conditions requiring the wind farm to reduce its operations if non-compliance occurs. There is no strict requirement to achieve compliance. For example in the approval for the Uranquinty Gas Fired Power Station where I understand there has been an issue of low frequency noise and infrasound the consent from the Minster states:

3.12A In the event that noise complaints are received under adverse weather conditions from the residences described as "Pine Grove", "The Wardrobe" or "Wallace", the Applicant shall within one week of receiving the complaint undertake night-time operational noise monitoring at the affected residence for a period of two weeks to confirm the occurrence of operational noise levels greater than LAeq(15 minute) 35 dB(A) once the modification factors described in Section 4 of the New South Wales Industrial Noise Policy have been taken into account. Should such an exceedance exist, the Applicant shall employ a suitably qualified independent acoustic professional to prepare, in consultation with the landowner, a Noise Mitigation Design Report with the objective of providing a satisfactory level of internal noise amenity. The report is to be completed within two months of the completion of monitoring or as otherwise agreed by the landowner.

3.12B Within one month of completing the report referred to in condition 3.12A, Applicant is to have entered into an agreement with the landowner to implement suitable feasible and reasonable noise mitigation measures. In the event of a dispute in reaching an agreement or over the agreement itself, either party may refer the matter to the Director-General for resolution. The Director-General's determination of any such dispute shall be final and binding on the parties. Any formal advice or further assessment required by the Director-General to resolve this matter shall be funded by the Applicant.

3.12C Within three months of this consent, the Applicant shall notify all applicable landowners that they are entitled to receive additional noise mitigation measures, per that described by conditions 3.12A and 3.12B.

Noise Monitoring

4.5 15 Within 90 days of the commencement of operation of both Stage 1 and Stage 2 of the development, or as may be agreed by the Director-General, and during a period in which the development is operating under design loads and normal operating conditions, the Applicant shall undertake a program to confirm the noise emission performance of the development. The program shall meet the requirements of the DEC, and shall include, but not necessarily be limited to:

a) noise monitoring, consistent with the guidelines provided in the *New South Wales Industrial Noise Policy* (EPA, 2000), to assess compliance with condition 3.11 of this consent;

b) methodologies for noise monitoring;

c) location of noise monitoring;
d) frequency of noise monitoring;
e) identification of monitoring sites at which pre- and post-development noise levels can be ascertained; and
f) details of any entries in the Complaints Register (condition 5.3 of this consent) relating to noise impacts.

A report providing the results of the program shall be submitted to the Director-General and the DEC with 28 days of completion of the testing required under a).

4.6 In the event that the program undertaken to satisfy condition 4.5 of the consent indicates that the operation of the development, under design loads and normal operating conditions, will lead to greater noise impacts than permitted under condition 3.11 of this consent, then the Applicant shall provide details of remedial measures to be implemented to reduce noise impacts to levels required by that condition. Details of the remedial measures and a timetable for implementation shall be submitted to the Director-General for approval within such period as the Director-General may require, and be accompanied by evidence that the DEC is satisfied that the remedial measures are acceptable.

5.2 Permanent Monitoring

To be able to ascertain compliance it is necessary to have **the wind speed at the hub height at the time of the measurements, and also the wind direction.**

The original environmental assessment must provide details of the **ambient noise level at receiver locations versus the wind speed at the receiver location** to provide meaningful results of the ambient noise versus the wind so as to place the relationship of the acoustic environment (without the wind farm) in the correct context.

Furthermore, **the original environmental assessment must indicate the noise levels at residential receivers that could be obtained under wind turbine operation under neutral conditions relative to the residential receivers**. These noise levels would become the base case upon which would then permit identification of the noise levels under adverse weather conditions of wind from the turbines to the receiver, wind from the receiver to the turbines, and a temperature inversion with a light wind from the turbines to the receiver.

With this information to hand and the measured noise levels at the residential receiver, together with the wind speed and direction at the hub height then, and only then, can an acoustic compliance be evaluated.

In light of the above explanation it becomes obvious that the conduct of two weeks of noise compliance testing is clearly inadequate for the task at hand.

Therefore, what is required is identification of the different propagation characteristics that would occur from the wind farm to residential receivers, both for host receivers and non-host receivers.

The provision of permanent noise monitoring occurring inside the wind farm land or host receivers, say 1000 metres from turbines should occur. With the monitoring results and the benefit of the aforementioned propagation characteristics one could provide a mask to the overall level at each permanent monitoring location to indicate compliance or theoretical non-compliance at residential receivers. This concept of monitoring is identified in the draft guideline on page 30 under the heading of "Supplementary noise measurement locations" and should be placed in the new section to address permanent monitoring.

The permanent noise monitoring can be supplemented by temporary remote monitoring which would occur simultaneously in real time for a residential complainant to supplement and verify the propagation characteristics. This is not dissimilar to the monitoring of aircraft noise for major civilian and military aerodromes.

The provision of permanent noise monitoring together with real time presentation of the measured noise levels, wind speed and direction at the hub, the power output and operational status of individual turbines must be provided in the public domain to permit independent compliance testing.