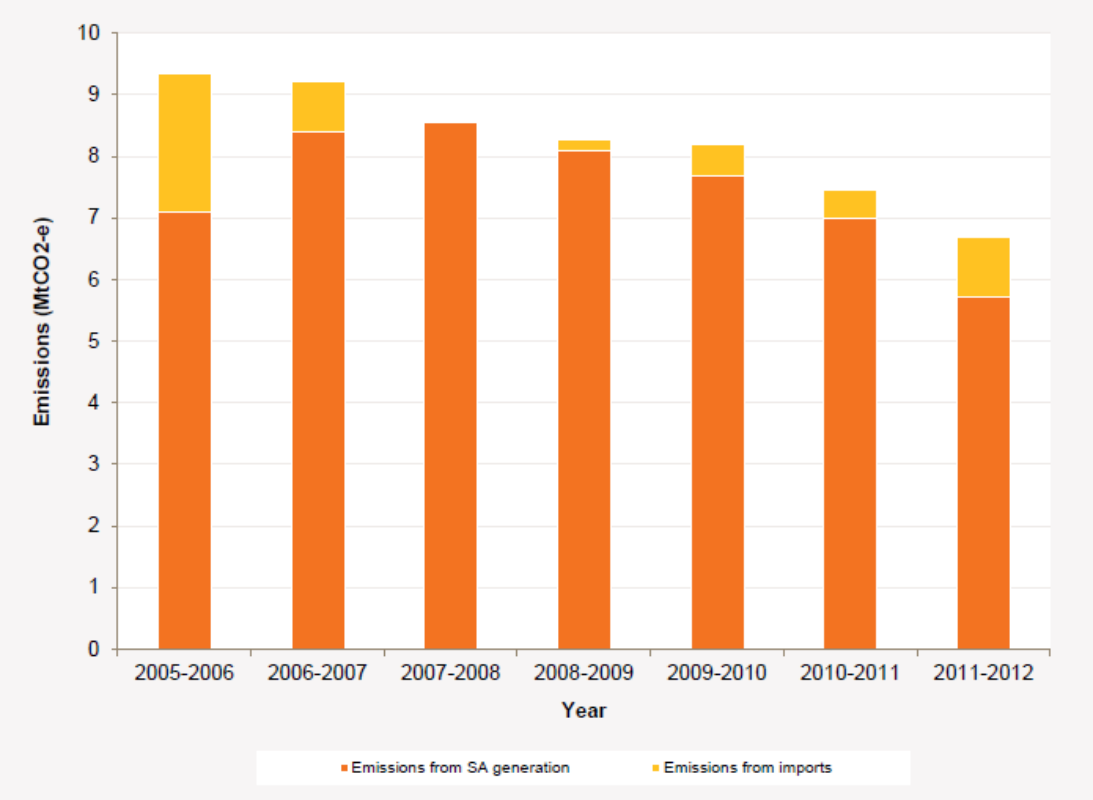
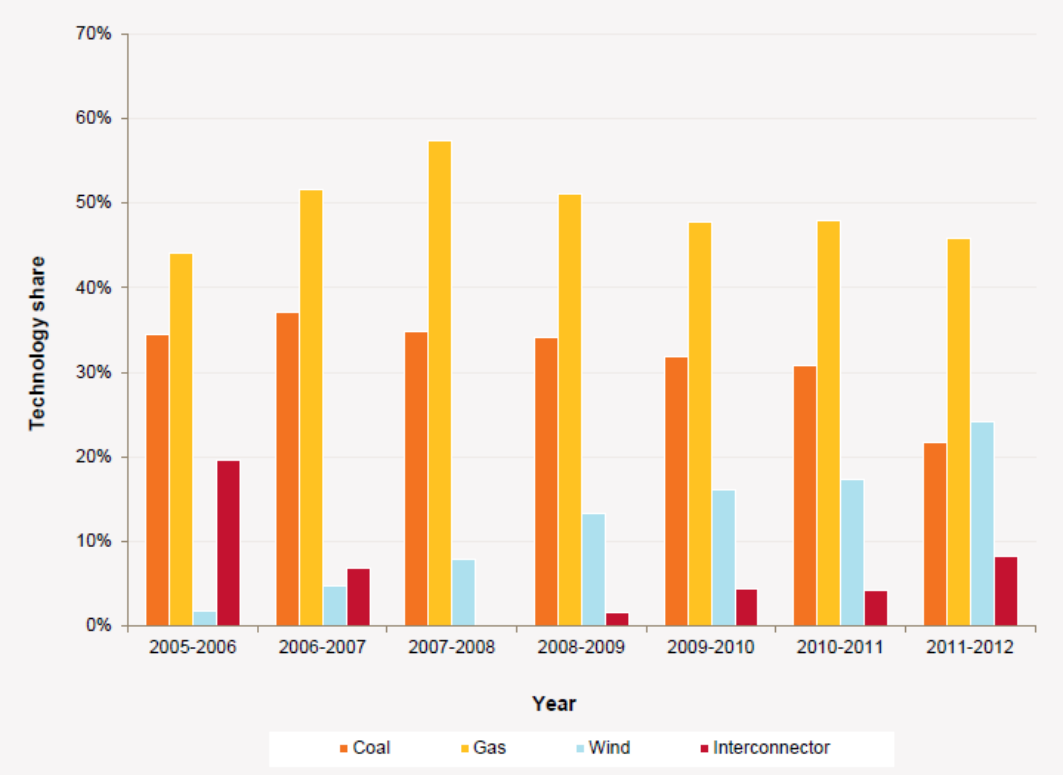
Appendix A



Graph showing greenhouse gas emission reductions in SA, AEMO



Graph showing rise of wind energy in SA and decline of gas and coal fired generation, AEMO

Appendix B

Dear Sir/Madam

On behalf of Wattle Range Council I make the following submissions to the Senate Inquiry into the social and economic impact of rural windfarms -

> There are 4 operating windfarms (Lake Bonney Stage 1; Canunda; Lake Bonney Stage 2 and Lake Bonney Stage 3) and during the planning phase for these projects there was considerable community support for the windfarm.

> Council has received no complaints or advice of any adverse health effects suffered by people living in close proximity to the windfarms operating in the Council region. Council is aware of the current concerns being expressed by segments of the community about the potential health impacts on people living in close proximity to windfarms but is not aware of any substantiated evidence supporting this position.

> Council has received no complaints or advice of concerns about excessive noise and vibrations being emitted from the windfarms operating in the Council region impacting on residences in close proximity to the windfarms.

> The windfarms constructed in our Council region have provided significant employment opportunities during the construction phase and some ongoing employment to operate and maintain the windfarm. This employment provided flow-on economic activity to local businesses, especially during the construction phase.

> The impact on property values has not been significant, however there has been flow-on increases to farm incomes due to the lease/rental arrangements between landowners and the windfarm operator. This has been welcomed income in times when farm incomes have been depressed.

Thank you for the opportunity to provide a submission to the Senate Inquiry.

If you wish to discuss this matter further please do not hesitate to contact me at your convenience.

Yours Sincerely

FN (Frank) Brennan
Chief Executive Officer
WATTLE RANGE COUNCIL

Appendix C

Sonus Pty Ltd
17 Ruthven Avenue
ADELAIDE SA 5000
Phone: +61 8 8231 2100
www.sonus.com.au
ABN: 67 882 843 130
Contact: Jason Turner
jturner@sonus.com.au
0410 920 122

FLYERS CREEK WIND FARM

REVIEW OF REPORT No 41.4963.R1A:ZSC – 15th December 2011

Review of The Acoustic Group Pty Ltd "Peer Review of Acoustic Assessment Report for Flyers Creek Wind Farm" No 41.4963.R1A:ZSC report dated 15th December 2011.

Prepared for

Infigen Energy
Level 23, HWT Tower, 40 City Road
SOUTHBANK 3006

March 2012
S3870C1

Background

The "Peer Review of Acoustic Assessment Report for Flyers Creek Wind Farm" No. 41.4963.R1A:ZSC report dated 15th December 2011 (the Acoustic Group report) was prepared by The Acoustic Group Pty Ltd (Mr Steven Cooper) for the Flyers Creek Wind Turbine Awareness Group Inc.

The report is a "*desk-top review of the acoustic documents….for the Flyers Creek Wind Farm"* and includes *"…preliminary sound monitoring at an existing operational wind farm (the Capital Wind Farm).* (Executive Summary, Paragraph 1). The "acoustic documents" are taken to comprise the following ViPAC Engineers and Scientists (ViPAC) reports:

1. ViPAC Engineers and Scientists Ltd (Leonard, A) 2010 "Flyers Creek Wind Farm – Background Noise Monitoring Survey Report" 50B-08-0089-TRP-771535-1 (the ViPAC background noise report); and
2. ViPAC Engineers and Scientists Ltd (Leonard, A) 2010 "Flyers Creek Wind Farm – Noise Impact Assessment" 50B-08-0089-TRP-773906-2 (the ViPAC report).

The conclusions of the Acoustic Group report (Executive Summary) include:

1. *"The Background Noise Monitoring Survey Report has been found to be flawed:*
2. *The Noise Impact Assessment….has been found to be inadequate and likely to be inaccurate.*
3. *There has been found to be a fundamental inadequacy in the acoustic assessments in that they do not attempt to discuss or examine the actual noise impact for the community.*
4. *Fundamental inconsistencies and omissions in the South Australian legislative framework relating to wind farm noise have been identified.*
5. *The proposed wind farm will result in the generation of offensive noise breaching the New South Wales legislative framework.*
6. *Preliminary testing at the Capital Wind Farm demonstrates low frequency noise and infrasound at levels and fluctuations likely to impact on residents.*
7. *…approval of the Flyers Creek Wind Farm proposal would expose the surrounding community to intrusive and offensive noise and leave the approval authority, land owners and the proponent open to litigation and complaint accordingly."*

Sonus was engaged by Infigen Energy to conduct an independent and expert peer review of the Acoustic Group report.

Relevant Experience

Sonus was formed in 2002 and provides professional consultancy in all areas of acoustic engineering, including environmental noise, building acoustics and occupational noise.

Sonus engineers have been involved in the monitoring, prediction, data analysis, policy development and assessment of environmental noise from factories, road, rail, aircraft, commercial and industrial sources, with extensive experience specifically related to wind farms, in particular:

- Development and implementation of the first jurisdictional response to wind farm noise assessment in the *South Australian EPA Wind Farm Guidelines 2003* (the SA Guidelines) which has been adopted in a number of other States, including NSW;

- Representing the National Environment Protection Council on the Australian Standard Technical Committee EV-016, responsible for the development of the Australian Standard AS4959 – 2010 *Acoustics – Measurement, prediction and assessment of noise from wind turbine generators*;

- Development of the South Australian *Environment Protection (Noise) Policy 2007* (the Policy) and associated draft User's Guidelines;

- Environmental noise assessment of over 30 wind farms throughout Australia;

- Appearances as expert witnesses in the NSW Land & Environment Court and the South Australian Environment Resources and Development Court for wind farm appeal proceedings; and

- Measurement of infrasound from wind farms in Victoria and South Australia.

Review Findings

In order for the conclusions of the Acoustic Group report to be valid, the following minimum elements would need to be included in that report:

1. A direct comparison between the background noise measurement data and analysis presented in the ViPAC background noise report and the applicable NSW assessment criteria provided by the *Environmental Noise Guidelines: Wind Farms, South Australian Environment Protection Authority, 2003* (the SA Guidelines);

2. A direct comparison between the environmental noise assessment presented in the ViPAC report and the applicable NSW assessment criteria provided by the SA Guidelines;

3. A demonstrated understanding of the rationale that underpins the SA Guidelines and the stringency of the approach provided by the Guidelines;

4. A measurement methodology that separates the wind farm noise from other noise in the environment by conducting a wide range of repeatable noise level measurements with and without the wind farm operating under similar meteorological conditions;

5. An infrasound measurement methodology that reduces the influence of wind on the microphone; and

6. A comparison of the results of the infrasound measurements against established thresholds for perception and/or against measurements of other typical natural and engineered noise sources experienced in rural environments.

The Acoustics Group report does not provide these minimum elements. In addition, the report suggests additional requirements beyond those contained within the SA Guidelines utilised by the NSW Government without justification. Areas where further information from ViPAC is recommended to be provided are identified in the following detailed summary. The above elements are also discussed in further detail below.

1. *A direct comparison between the background noise measurement data and analysis presented in the ViPAC background noise report and the applicable NSW assessment criteria provided by the SA Guidelines*

   The Acoustics Group report notes that sound level meters used for the background noise monitoring at locations 78 and 89 appear to have a noise floor of greater than 20 dB(A).

   The SA EPA Guidelines permit the use of Type 1 sound level meters and do not require a maximum noise floor level. ViPAC has stated that the background noise monitoring regime utilised Type 1 sound meters which typically have a noise floor of about 20 dB(A).

   Recommendation: Re-analyse the data at locations 78 and 89 to remove the potential adverse impact of any noise floor. Alternatively, conduct a monitoring regime at these locations using noise level meters with low noise floors to collect the minimum 2000 valid data points required by the SA Guidelines.

   The Acoustics Group report indicates that the noise logger at location 12 was relocated from a position approximately 165m from the dwelling to a position approximately 34m from the dwelling.

   In general terms, a remote location can provide representative background noise levels at a dwelling, provided the trees and structures in the vicinity replicate those adjacent the dwelling. It is possible that the background noise levels will be lower at a remote location away from trees or structures, which might result in the establishment of more stringent criteria. Notwithstanding, we understand that ViPAC did not utlise any noise logger data from the remote (165m) location in their report.

   Recommendation: Based on no data being utilised from the 'remote' logger location, no further action is required.

The Acoustics Group report notes the following:

- The background level results do not continue below 3 m/s;
- "Essential" correlations should be made between wind speed at the wind farm site and wind speeds at each receiver;
- Wind direction during the background noise measurements should be reported on, otherwise the regression data in invalid.

The above actions are not requirements of the SA Guidelines as the actions do not provide any additional information that would assist in the assessment of the wind farm environmental noise levels:

- The background noise data below 3m/s is not used as the turbines do not operate in low wind environments;
- The important correlation is the wind speed at the wind farm site (which governs the noise generated by the turbine) against the background noise level at each receiver (which establishes the level of masking and also the assessment criteria at this receiver);
- The methodology and assessment criteria of the SA Guidelines are established on the basis that wind direction is not an important element in the background noise monitoring regime.

Recommendation: No further action.

2. *A direct comparison between the environmental noise assessment presented in the ViPAC report and the applicable NSW assessment criteria provided by the SA Guidelines;*

The Acoustics Group report notes that the ViPAC report does not conduct a prediction of tonality as part of the assessment.

The SA Guidelines do not require a prediction to be made with respect to tonality as part of the development application procedure. It is good practice to establish a guarantee as part of the procurement process that the turbine will not exhibit tonality. In circumstances where this is not achieved, the SA Guidelines apply a significant 5 dB(A) penalty to the operation of the wind farm. In general terms, a 5 dB(A) penalty could result in up to two thirds of the wind farm not being able to operate. Such a penalty therefore results in pro-active rectification of tonality issues should they arise.

In Section 12.7 of the Environment Assessment, the proponent stipulates that the wind turbine selected for the Flyers Creek project will not exhibit tonality as defined by the SA Guidelines.

Recommendation: No further action as the development application stipulates that only wind turbines without tonality will be considered for the project.

The Acoustics Group report considers the ViPAC report fails to properly examine modulation, interference patterns, low frequency noise and infrasound.

The SA Guidelines do not require an assessment to be made of modulation, interference patterns, low frequency noise or infrasound as the stringent criteria established by the SA Guidelines take into account the fundamental noise characteristics of a wind farm, which includes modulation or "swish" and acknowledges that low frequency content and infrasound are not significant features. It is also worth noting that the SA EPA Guidelines consider the potential of infrasound created by wind turbines, but states in the Guidelines that,

> *"The EPA has…completed an extensive literature search but is not aware of infrasound being present at any modern wind farm site."*

Recommendation: No further action.

The Acoustics Group report indicates that the ViPAC assessment does not take into account the effect of temperature inversion in the noise propagation model. A table is included in the Acoustics Group report that suggests an increase in the order of 7 dB(A) might be applied to the predicted noise levels.

The noise predictions in the ViPAC report were conducted using two noise propagation models: CONCAWE and ISO9613. The CONCAWE model has the ability to account for worst-case (highest noise level) meteorological conditions, including temperature inversions. Based on the inputs to the model as documented in the ViPAC report, the worst-case (highest noise level) meteorological conditions are accounted for.

The ISO9613 model is inherently established on meteorological conditions that relate to either a downwind condition or a temperature inversion.

A separate noise prediction model has not been developed as part of this review to confirm the outputs of the ViPAC modelling. Notwithstanding, the models utilised by ViPAC consider the potential effect of temperature inversions.

Recommendation: No further action

The Acoustic Group report indicates that the ViPAC assessment does not adequately account for sub-station noise levels.

In NSW, the noise from the substation is assessed against the criteria provided by the NSW *Industrial Noise Policy 2000* (the INP). Based on the INP, the most stringent criterion with the application of a penalty for tonality is 30 dB(A) at the nearest receiver. The ViPAC report predicts a noise level of 30 dB(A) at the nearest receiver. The ViPAC report utilises a "conservative" sound power level for the substation of 97 dB(A). Substation sound power levels can be derived from the Australian / New Zealand Standard AS/NZS60076.10.2009. The Standard indicates the sound power levels are conservative for two 80MVA transformers.

Recommendation: No further action

3. *A demonstrated understanding of the rationale the underpins the SA Guidelines and the stringency of the approach provided by the Guidelines*

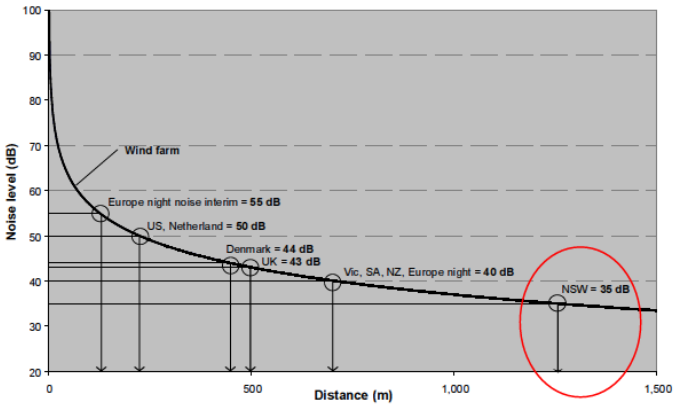
   The Acoustic Group report contends that there is a discrepancy between the indicative noise levels for a rural area under the *Environment Protection (Noise) Policy 2007* (the Policy) and the objective criteria of the SA Guidelines. On this basis, it is contended the Policy provides a more stringent approach than the SA Guidelines and therefore wind farms "contravene the obligations created under the legislative framework".

   The SA Guidelines were updated by the South Australian Government in 2009. A key reason for the update as expressed by the Environment Protection Authority (EPA) was to ensure consistency between the objective criteria of the Policy and the wind farm Guidelines in rural areas.

   The 2009 Guidelines ***relaxed*** the baseline criteria for wind farms, which is 35 dB(A) in the 2003 version, to a baseline limit of 40 dB(A) in the 2009 version. This relaxation is the opposite of the contentions made within the Acoustic Group report.

   Notwithstanding the above, the 2003 SA Guidelines are considered to represent one of the most onerous wind farm assessment procedures of any jurisdiction in the world. The Draft for Consultation NSW Planning Guidelines for Wind Farms (December 2011) provides the following figure which indicates the 35 dB(A) baseline criterion relative to other approaches:

Figure 2 – Comparison of NSW baseline A-weighted noise criteria with other jurisdictions



Note 1. Noise setback distances are indicative only and do not account for site specific conditions which may increase or decrease the noise level. In NSW noise setback distances typically vary between 0.8 – 1.5 km due to project and site-specific factors such as turbine configuration, design, intervening topography and vegetation.

Note 2. Both the SA and NZ guidelines also set lower levels for areas of high amenity which attract a criteria of 35 dB(A). The SA guidelines apply 35 dB(A) in land use zones where the focus of the zoning is on "rural living" rather than primary production. In NSW, most wind farm applications have tended to be in areas where the focus of the land use zoning has been on primary production (e.g. RU1 Primary Production) rather than rural living (e.g. R5 Large Lot Residential).

NSW Department of Planning and Infrastructure NSW Planning Guidelines: Wind Farms 6

Recommendation: No further action

4. *A measurement methodology that separates the wind farm noise from other noise in the environment by conducting a wide range of repeatable noise level measurements with and without the wind farm operating under similar meteorological conditions*.

   The Acoustic Group report presents the results of monitoring at the Capital Wind Farm "in order to test (the) hypothesis" that the "Flyers Creek Wind Farm will result in the generation of intrusive and offensive noise."

   The SA Guidelines require a specific compliance checking procedure due to the inherent difficulties of identifying a noise source in an ambient noise environment where masking noise is often present and dominant. The Capital Wind Farm noise measurements conducted by The Acoustic Group were not conducted in accordance with the SA Guidelines, which require correlation of the wind speed data at the wind farm against the results of the noise monitoring.

   In addition, the noise measurement methodology and results do not enable the wind turbine noise to be separated from the other noise in the environment. These are fundamental flaws in a wind farm assessment procedure.

   The ambient noise generated by wind in the trees is often the dominant component of noise at a dwelling in the vicinity of a wind farm and average noise levels of more than 10 dB(A) above those caused by the wind turbines themselves are common. Longstanding environmental noise policy procedures indicate that there are no impacts from a noise source in such circumstances, and therefore the masking effect of the ambient environment is a positive and advantageous influence. However, the masking effect presents inherent difficulties in identifying the wind farm noise and complex measurement techniques are required. These techniques have not been employed by the Acoustic Group.

   A suitable methodology would include a series of repeatable measurements with the turbines on and off over similar timeframes and meteorological conditions, including wind speed and direction.

   Without either a specific methodology to identify the wind turbine noise from the other noise in the environment or a test procedure in accordance with the SA Guidelines, conclusions regarding the Capital Hill wind farm exceeding its noise limits are invalid.

5. *An infrasound measurement methodology that reduces the influence of wind on the microphone:*

   The Acoustics Group report presents results for infrasound testing conducted outside of dwellings.

   The measurement of infrasound at low levels requires specific equipment and a specific methodology, as it is readily affected by wind on the microphone.

   The external results appear to be based on measurements made above the ground without reference to a specific methodology. Therefore, the study does not establish that the measurements of infrasound are not adversely influenced by wind on the microphone, which would be likely.

   A fundamental element in any methodology associated with infrasound measurements is to establish how the influence of wind on the microphone will be reduced such that the noise source of interest can be reliably identified. These tests would comprise measurements in a similar environment, including wind speed and direction at the microphone, without the influence of wind turbines. Based on experience, such a test, even in light breeze conditions and in close proximity to turbines, would be dominated by the influence of wind on the microphone. Such testing has not been conducted as part of the study, and therefore, the infrasound levels recorded are more likely to be wind on the microphone rather than the wind turbines themselves

   It is also not established that the equipment used is suitable for infrasound measurements. It is noted that some measurements were made with a SVANTEK 957 Type 1 calibrated sound and vibration analyser. Whilst this meter has a measured frequency response to 0.5 Hz, its standard ½" microphone does not and therefore a specific ½" free field microphone with a frequency response to 1 Hz is required to be used with the meter for infrasound measurements. The study does not establish that all meter and microphone arrangements are suitable for measurement of noise levels in the infrasound range.

   Without accounting for the influence of wind on the microphone using a specific methodology, or without clearly establishing that suitable equipment was employed, the external results relating to infrasound cannot be considered to be valid.

6. *Comparison of the results of the infrasound measurements against established thresholds for perception and/or against measurements of other typical natural and engineered noise sources experienced in rural environments:*

   The Acoustics Group report contends that based on infrasound measurements conducted inside of dwellings in the vicinity of the Capital Hill Wind Farm "the resident would be subject to the influence of infrasound".

   State and International jurisdictions such as the Queensland Government (DERM) and the UK Department for Environment, Food and Rural Affairs provide a human infrasound perception threshold limit of 85 dB(G) as the acceptable level of infrasound in the environment from a noise source to protect against the potential onset of annoyance. The Acoustics Group report does not reference the above objective standard and does not establish why this and other widely used studies are not relevant.

   Notwithstanding, the results (which include all noise sources in the environment) are well within the infrasound perception threshold limit used by State and International jurisdictions, and therefore the infrasound would not be detectable or be able to be perceived by humans.

   The study does not present any measurement results for other typical natural and engineered noise sources experienced in rural environments. These levels can be of a similar order to the results of the study and, at times, would be expected to be significantly higher. The Acoustics Group report fails to establish how its findings can be made in the context of other noise sources experienced in a typical rural environment.

REFERENCE LIST

The Acoustic Group Pty Ltd (Cooper, S), 2011 “Peer Review of Acoustic Assessment Flyers Creek Wind Farm 41.4963.R1A:ZSC

ViPAC Engineers and Scientists Ltd (Leonard, A) 2010 “Flyers Creek Wind Farm – Background Noise Monitoring Survey Report” 50B-08-0089-TRP-771535-1

ViPAC Engineers and Scientists Ltd (Leonard, A) 2010 “Flyers Creek Wind Farm – Noise Impact Assessment” 50B-08-0089-TRP-773906-2

Environmental Noise Guidelines: Wind Farms, South Australian Environment Protection Authority, 2003

ISO 7196:1995 “Acoustics – Frequency weighting characteristics for infrasound measurements”

Moeller, H, and C. S. Pedersen. “Hearing at Low and Infrasonic Frequencies”, Noise and Health 2004, v6 issue 23, 37-57, 2004

Queensland EPA, “Guideline: Assessment of Low Frequency Noise”

Appendix D

VIPAC ENGINEERS & SCIENTISTS

Vipac Engineers & Scientists Limited A.C.N. 005 453 627 A.B.N. 33 005 453 627

17-19 King William Street, Kent Town SA 5067, PO Box 2419 Kent Town SA 5071
Telephone (+61 8) 8362 5445, Facsimile (+61 8) 8362 0793, www.vipac.com.au

TECHNICAL MEMORANDUM

Attention:	**Jonathan Upson**	Date:	**25 Jan 2012**
Company:	**Infigen Energy**	Pages:	**1 of 11**
Email:	**Jonathan.upson@infigenenergy.com**	Document No:	**50B-08-0089-GCO-777609-2**
From:	**Andrew Leonard**	Reviewed By:	**Dr Peter Teague**
Subject:	**Peer Review Report Response**		

CC:	Name:	Company:	Facsimile:

Dear Sir,

Re: **Peer Review Report Response**

This document is written in response to two peer reviewed reports provided on our Noise Impact Assessment for Flyers Creek Wind Farm, NSW. The two reports, "Peer Review of Acoustic Assessment Flyers Creek Wind Farm" prepared by Steven E. Cooper of The Acoustic Consulting Group Pty Ltd, 15th December 2011, and "Review: Noise Impact Assessment Prepared by Aurecon for Flyers Creek Wind Farm" by W Les Huson of Huson and Associates, November 2011.

1. REFERENCES

[1] "Peer Review of Acoustic Assessment Flyers Creek Wind Farm" by The Acoustic Consulting Group Pty Ltd, Steven E. Cooper, 15th December 2011,

[2] "Review: Noise Impact Assessment Prepared by Aurecon for Flyers Creek Wind Farm" by Huson and Associates, W Les Huson, November 2011

[3] *Background Noise Monitoring Report, Flyers Creek Wind Farm*, Vipac Document No. 50B-08-0089-TRP-771535-0, Vipac Engineers & Scientists, 7 June 2010

[4] *Noise Impact Assessment, Flyers Creek Wind Farm*, Vipac Document No. 50B-08-0089-TRP-773906-0, Vipac Engineers & Scientists, 21 December 2010

[5] "*Wind Farms: Environmental Noise Guidelines*", SA Environment Protection Authority, SA Government, Dec 2003.

[6] "*Wind Farms: Environmental Noise Guidelines*", SA Environment Protection Authority, SA Government, July 2009 (ISBN 978-1-876562-43-9).

[7] Leventhall, G., 2003, A Review of Published Research on Low Frequency Noise and its Effects, DEFRA Report.

[8] BWEA Report, 2005, Low Frequency Noise and Wind Turbines Technical Annex, British Wind Energy Association.

[9] Bellhouse, G., 2004, Low Frequency Noise and Infrasound from Wind Turbine Generators: A Literature Review, Prepared for EECA, Bel Acoustic Consulting, NZ.

[10] Turnbull, CP, Turner JP, , Measurement of Infrasound from Wind Farms and Other Sources, *Acoustics Australia*, April 2012, Sonus Pty. Ltd.

2. RESPONSE TO REPORT PROVIDED BY THE ACOUSTIC GROUP

The Acoustic Group provided a peer review [1] of both our background noise monitoring report [3] and our noise impact assessment [4] for Flyers Creek Wind Farm, NSW. The report was generally negative towards our background noise assessment and noise impact assessment primarily due to their reliance on the 2003 and 2009 SA EPA Wind Farm Noise Guidelines [5][6]. While our reports carried out the noise assessments in accordance with these guidelines, the 2003 Guidelines [5] were accepted by the NSW Department of Planning as being their standard for the analysis of wind farms at the time. Our reports were criticized for following the guidelines which were considered acceptable by relevant authorities and were required to be followed per the Director-General's Requirements (DGRs) for the project.

2.1. Section 2.0 – The Basis of Assessment

The Acoustic Group Report [1] (further referred to as "Report 1") outlines that there were no noise guidelines issued by the Department of Environment, Climate Change and Water ("DECCW"), we note that since the publication of Report 1, there are now draft NSW Wind Farm Planning Guidelines available (Dec 2011), which closely follow the SA EPA Wind Farm Noise Guidelines.

Report 1 has pointed out that we have used the newer version of the SA EPA Wind Farm noise Guidelines [6] over the 2003 guidelines [5], we note that this was done to provide a more robust assessment in line with the new/current guidelines, rather than follow a dated guideline.

The report also states that we have identified a tolerance of ±4dB, and also ±2dB elsewhere in the report. In paragraph 2 of section 6 in our report, we state that the accuracy is likely to be at least ±2dB(A), however in section 6.2 we state that the accuracy (95% confidence level of ISO 9613 model) may be in the order of ±4 to 5 dB(A), under high propagation conditions. We stress that this was a discussion of the confidence of the model under higher than expected propagation conditions, and that both statements are not contradictory.

2.2. Section 3.0 Background Noise Monitoring Report

2.2.1. Section 3.1 No True Ambient Background Levels

Paragraph 2 of Section 3.1 of Report 1 states that a tolerance for measurements is not stated in the report. As stated in Section 4 of [3], we used Type 1 environmental noise loggers for the background noise measurements (which have a better tolerance and precision than Type 2 loggers). The tolerances for different classes or types of noise loggers (or sound level meters) are given in IEC 61672, and the tolerance is implied with this reference.

Paragraph 4 and 7 of section 3.1 states that the background noise at low noise levels is not an accurate representation of the background noise, as there is a flat line on the graphs. We note that the noise floor of a typical type 1 sound level meter is in the order of 18-20dB(A). Whilst it is true that the measured noise levels may not be a true representation of the actual background noise during very low noise periods, we consider that these noise levels are extremely quiet events. As outlined in the SA EPA Guidelines, this is an acceptable error [5][6], as it allows the use of Type 1 Class noise loggers. Furthermore, as the criteria set

from the background noise level is a maximum of the background noise level plus 5dB(A) or 35dB(A), a noise floor of 20dB(A) will not significantly affect these criteria, as an extremely quiet environment (say, below 20dB(A) at a particular wind speed), the criterion will remain unchanged at 35dB(A). We do not agree that sound pressure measuring instruments which measure lower than 20dB(A) is required, as a background level lower than this will still attract a criterion of 35dB(A).

Paragraph 8 of section 3.1 states that background level results do not continue below 3 m/s, and that the background noise level is not defined when there is no wind present, and that this is not in line with procedures used by the NSW DECCW (now OEH) for the assessment of industrial noise sources. We note that wind farms are unique in that their noise output is a function of the wind speed experienced at the wind farm towers. Generally, the typical sound power of a turbine increases with increasing wind speed. Specific Wind Farm Noise Guidelines have been created by government bodies to tackle this uniqueness, and therefore we consider it a simplistic approach to suggest regulating wind turbine noise under general industrial noise regulations. Industrial noise regulations typically require noise monitoring at relatively low wind speeds. Wind farms produce negligible noise levels at wind speeds lower than their 'cut-in' wind speed, that is, the wind speed required at the wind turbine hub height to produce energy. Therefore, industrial noise regulations are pointless to apply to wind turbines as they typically require noise monitoring when the wind turbines are not operating and not generating appreciable noise.

In line with the SA EPA Wind Farm Noise Guidelines [5][6], background noise was paired with wind speeds at a representative wind farm meteorological tower (to represent typical wind speeds at the wind farm), to determine the noise levels in these cases. It is worth noting that this is purposely not the local wind speed at the receiver site. Therefore, a 3m/s wind speed at the wind farm site may not necessarily mean that there is any wind at the receiver site at all. The SA EPA guidelines state that any noise data below cut-in wind speed at the wind farm, be excluded from the analysis, which we have performed, therefore we have performed our background analysis in compliance with the relevant guidelines.

2.2.2. Section 3.1: Logger Positions With Respect to Residences and Trees Not Identified

Photographs of each logger measurement position were taken to show the surrounding environment of the noise logger placement, and were attached in Appendix B of the report. Paragraph 5 of Section 3.1 outlines that the logger at Location 12 was placed at a position approximately 165m from the dwelling, and then relocated to a position closer to the residence. We confirm that the initial logger placement was 165m away from the property (under initial direction from the resident after concern about trees nearer the dwelling), and this logger placement was in error. We returned to place the logger in a position closer to the residence in compliance with the guidelines. A logger is required to be placed near the residence, as this is ultimately where the background noise is required to be defined. No data from the noise logger placed at Location 12 at 165m away from the residence was used in the assessment (and as such, documentation of the change of logger position in the report was not material).

2.2.3. Section 3.3: Essential Wind Speed Correlations Not Identified

Paragraph 2 states that there are wind speed measurements shown on Location 12's graph (indicating the presence of a weather station), however, weather station information was not given in the report. We note that there was no weather station placed at Location 12, and this information shown on the graph was the indicative wind speeds taken from another representative site during the monitoring campaign.

Paragraph 3 states that there is not a good correlation for microphone wind speed to the meteorological mast wind speed for location 89. We consider that there is a good correlation in the microphone wind speed to meteorological mast wind speed for all locations including location 89.

Paragraph 5 states that no correlation was performed between the meteorological mast data at 80m versus meteorological mast data at 10m as well as the microphone meteorological station. As shown in our plots in Appendix C of the report, we have plotted the hub height wind speed and the microphone wind speed. Additionally, this correlation is not required to be undertaken, it is only the regression fit of meteorological mast wind data vs. the noise data which is required. The microphone wind speed is used to exclude data above 5m/s where wind over the microphone affects the measurement results (5m/s is the maximum effectiveness of typical wind shields over the microphone). We note that we used high wind speed wind shields, which we expect to provide wind shielding up to 7m/s; however, any wind speed above 5m/s measured at the microphone was still excluded. The correlation between hub height wind speed data and 10m AGL wind speed data is explained in paragraph 9 in section 6.1. Additionally further explanation of why this was performed is provided in Section 5 of our Noise Impact Assessment report [4], paragraph 9. The analysis was performed using noise levels vs hub height wind data scaled down to 10m using the method outlined in IEC61400-11, as sound power level data at the time was provided at a 10m AGL reference. However IEC61400-11 calculates this 10m AGL data from a hub height wind speed, and scales it down to a 10 m reference. Therefore if background noise data is correlated to a hub height reference wind speed, and scales down to 10m AGL wind speed, this gives a more robust and accurate correlation than using real 10m AGL wind data, as the sound power generated by a wind farm is dependent on the wind speed at hub height, and therefore cancels out wind shear differences between the sound power level test site and the wind farm in question. As stated in out background noise monitoring report, all regression data was performed with hub height wind speeds, scaled to 10m AGL wind speed, and then a linear interpolation was performed to gather the representative criteria at the integer wind speeds (to directly correlate to integer sound power levels of the turbines at 10m AGL wind speeds).

2.2.4. Section 3.4: Wind Direction Analysis.

Section 3.4. states that a wind direction analysis was not considered or performed, and therefore the regression data is invalid; however at the end of section 5 of our report we state that this has been performed.

There is no requirement in the SA EPA Guidelines to breakdown background noise measurements by wind direction. One reason for this is that the Noise Prediction Model assumes every resident is downwind from every turbine which is just one of the conservative assumptions built into the wind turbine noise monitoring.

2.3. Section 4.0 Vipac Noise Impact Assessment

Paragraph 1 of Section 4.0 states that the criteria used is from background noise data paired to wind speed data at the wind farm site (and not the noise monitoring locations). As stated previously, there is no requirement, or need, to compare noise levels to wind speeds at the residence; it is the wind speed at the turbine which “creates” the noise. The assessment has been performed as required by the SA EPA Guidelines.

2.3.1. Section 4.1: Lack of Data Re Turbine Characteristics

Paragraph 2 of Section 4.1. states that spectral characteristics has not been provided of the turbine used in the assessment. This statement is in error, as Appendix E of the noise impact assessment report [4] provides an octave band sound power spectrum of the wind turbine used in the modelling. Our report outlined that there

was a tone present in preliminary data from the manufacturer, at 7m/s with a tonal audibility factor ($\Delta L_{a,k}$) of 0.82dB.

This paragraph also states that we have provided an unsubstantiated assertion that whilst a tone may be obtained in the near field of the turbines, it is not likely to be audible at residential receivers. As stated in this report, this was a suggestion of what would be likely, as the tones (that may be detectable in the close vicinity or near field of turbines) may attenuate and/or be masked by background noise at the nearest residential receiver. Paragraph 6 of Section 6 of [4] outlines that this will need to be substantiated and assessed either once the wind farm is constructed or can be shown at another site where this proposed turbine is installed. We note however that this point is moot, as stated in Section 6 of [4], the proponent has outlined that they will not install a Wind Turbine which displays tonal characteristics (measured in accordance with IEC 61400-11), and if a different wind turbine is to be installed, that further modelling and a new noise impact assessment is required to be conducted.

Paragraph 3 of Section 4.1 states that "recent closures of turbines at night at the Hallett 2 wind farm in South Australia apparently as a result of tonality, highlight the significance of identifying tonality at the outset. It appears that there was a failure to identify tonality in the Vipac reports for Hallett 2". Vipac did not undertake the initial noise impact assessment for AGL's Hallett 2 wind farm project, and therefore, we are not aware of the exact details of the night-time shut down of Hallett 2 wind farm, and whether or not it was a result of tonality.

2.3.2. Section 4.2: Failure to Properly Examine Modulation, Interference Patterns, Low Frequency Noise and Infrasound

Paragraph 1 of section 4.2 outlines that there is significant and published material in relation to noise issues concerning wind farms. We agree that there is significant and published material about modulation, low frequency noise and infrasound; however, the peer reviewed publications around the world do not support that there is significant impact or occurrence (Leventhall, 2003; Bellhouse, 2004; BWEA, 2005).

Paragraph 3 of section 4.2. states that Vipac has failed to address the matter of infrasound, however our report (quoted in section 4.2 of Report 1) discusses low frequency noise and infrasound, and states that it is well below the threshold of human perception. There have been peer reviewed reports (Leventhall, 2003; Bellhouse, 2004; BWEA, 2005, Turnbull et al. 2012) which have shown that low frequency noise and infrasound at distance from a modern wind turbine generator is much lower than human perception. Therefore the allegation that our comments on infrasound from wind turbines are unqualified is incorrect. Additionally, paragraph 6 of section 4.2 states that the occurrence of low frequency noise, infrasound and health effects is disputed by persons living near wind farms both in Australia and internationally. We note that this information is anecdotal and not confirmed via acknowledged peer reviewed research.

Paragraph 7 of section 4.3 states that the Director-General's requirements specifically require that the assessment to examine the levels and character of the predicted noise, including "tonality, impulsiveness etc.", and that the noise impact assessment make a proper attempt to address these issues. We deem that our noise impact assessment has properly addressed these issues in section 6 or our report, especially the issue of tonality and low frequency noise. Impulsiveness was not addressed as this does not occur with wind farms (only excessive amplitude modulation has been reported on rare occasions, but it has not been confirmed).

2.3.3. Section 4.3: Failure to Identify the Impact of Meteorological Conditions

Paragraph 1 of Section 4.3 outlines that we did not include the allowance of temperature inversions and other meteorological conditions, however, this is included in the CONCAWE propagation model, as outlined in paragraphs 1 and 2 in Section 6 of our Noise Impact Assessment.

2.3.4. Section 4.4: Failure to Identify Impact of Individual Noise Sources

Section 4.4 states that we did not identify the impact for the various noise sources for the wind farm would be, and that we did not examine all noise components of the project. Section 7 and subsections of our report [4] clearly identify the noise impact of all relevant noise components of the wind farm project.

2.3.4.1. Section 4.4.1: Substation

In paragraph 2 of section 4.4.1, the question is raised by what is considered significant at receiver locations for substation noise has not been identified. We note that it was considered not significant due to the fact that it is very unlikely to have a detrimental effect on amenity of residents as it is lower than turbine noise predicted at the residence, and it also meets the criteria for industrial noise set by the DECCW.

Paragraph 3 states that the substation noise will be significantly higher than the background level of 25dB(A); however, we note that the background noise level is at least 25dB only in low wind situations when the wind farm, and substation, will not be operating. In addition, our assessment assumed uniform hemispherical radiation of the noise however with worst case wind propagation effects.

2.3.4.2. Section 4.4.2: Construction Noise

It was outlined in section 4.4.2 that the rating background level (RBL) is not the average background level nominated by Vipac, which strictly is true. We note that although our assessment did not correctly use the RBL, the RBL is likely to be close to, and slightly below, the average background L_{A90} that was determined (typically within about 2 to 3 dB). Note that the average background L_{A90} is used by other regulatory authorities in other states.

However, our predicted construction noise assessment was undertaken on the basis of multiple plant operating simultaneously at maximum operating load/power, which is unlikely to occur, and therefore provides a worst-case scenario for the noise expected. Hence, our assessment is conservative and would more than account for the difference between the RBL and average background L_{A90}.

Paragraph 7 outlines that construction operations occurred outside of the approved times for Capital Wind Farm and potentially gave rise to noise impacts. The proponent presumably obtained permission for the great majority of this out-of-hours construction work, but this is a matter for the proponent.

2.3.4.3. Section 4.4.4: Failure to Examine the Noise Impact of the Wind Farm as a Whole

Section 4.4.4 outlines that there was not separate subsection in Section 7 which deals with the noise impact of the wind farm as a whole. However, Section 7 and subsections, as well as section 6 and the Executive Summary of our noise impact assessment report do deal with the noise impact of the wind farm. As the noise from wind turbines and the other components (substation noise, construction noise etc.) falls under different noise impact guidelines, it is required to assess these impacts separately; this was performed and reported.

Additionally, the noise impacts are shown to meet their respective requirements/limits, and therefore do not have an adverse impact (assuming that the guidelines in place ensure there is no adverse impact). Guidelines and criteria are in place to set limits and define acceptable noise requirements due to wind farms and

industrial noise sources, and the guidelines for wind farm noise in Australia are among the strictest in the world.

Paragraph 3 of section 4.4.4 outlines that the reliance on the World Health Organisation (WHO) report for unreasonable sleep interference or sleep disturbance is unsubstantiated as it does not directly relate to wind farms. We note that the WHO report is accepted as an appropriate guide and criterion, and is recommended in the SA EPA guidelines.

The last paragraph in section 4.4.4 outlines that at no point in the Vipac acoustic assessment is there any identification of what is an "acceptable impact". However, all our assessments have been undertaken against the criteria specified by the NSW Department of Planning and the project's Director General's Requirements. These have been specified as the definition of an "acceptable impact", and as previously stated, are amongst the most stringent wind farm noise regulations in the world.

2.4. Section 7.0 Conclusions

Dot point 1 of the conclusions in Section 7 of the report states that the background monitoring report is flawed. It states that the background noise data does not truly reflect the ambient background noise levels. We believe this statement is in error, as they were measured in accordance with the applicable guidelines. Photographs of the logger positions were provided in the report, as well as coordinates of the loggers, to identify their relation to the residences. Additionally, section 5 of our report clearly states that wind direction has been analysed and sufficient percentage of worst case wind directions were present during the monitoring period.

Dot point 3 alleges that the Noise Impact Assessment fails to deal adequately with the lack of data for the type of turbines assumed. We disagree, and have outlined any potential issues in the data, and how they will be addressed by the proponent.

Dot Point 4 states that the computer prediction provides tolerances greater that that nominated in the predicted levels, which is not correct as discussed.

Dot point 5 outlines that there is no adequate, specific examination of substation noise, construction noise or transmission line noise, however sections 7.1, 7.2 and 7.3 of our report clearly identify and address these issues.

Dot point 6 states that there is no analysis of the noise impact of the wind farm site as a whole; however, the report details how both the noise from the wind turbine generators and the noise from the substation, construction noise and transmission line noise meet their respective selected criteria. Therefore, the impacts from all noise sources from the wind farm as a whole have been addressed and met. The WHO guidelines referenced in this dot point are accepted as an appropriate guide and criterion, and is recommended in the SA EPA guidelines, as well as being accepted good practice.

Dot point 9 alleges that preliminary testing undertaken at Capital Wind Farm (NSW) suggests that the assessment and its predictions are incorrect. We note that the monitoring conducted as outlined in The Acoustic Group's report is insufficient and invalid due to the lack of wind speed data and correlation of this data to recorded noise levels amongst many other issues.

3. RESPONSE TO REPORT PROVIDED BY L HUSON AND ASSOCIATES

L Huson and Associates provided a peer review [2] of both our background noise monitoring report [3] and our noise impact assessment [4] for Flyers Creek Wind Farm, NSW. The report was generally negative towards our background noise assessment and noise impact assessment due to its reliance on the 2003 and 2009 SA EPA Wind Farm Noise Guidelines [5][6], which both reports conducted the assessment against. Although our reports carried out the noise assessments in accordance with these guidelines (which at the time the 2003 Guidelines [5] were specified by the NSW Department of Planning as being the applicable guidelines for the analysis of wind farms), our reports were criticized for following them. In addition, these guidelines were required to be followed per the Director-General's Requirements (DGRs) for the project.

3.1. Choice of Wind Turbine

The second paragraph of the Choice of Wind Turbine section in the report states that the turbine modelled was chosen as it has the 'best sound profile in its class', and questions the validity of this choice as being representative of available or general turbines. We note that our assessment was conducted using the turbine model specified by the proponent. However, we note that our noise impact assessment [4] (Section 6, paragraph 7), outlines that:

"The proponent is aware that if a different WTG model is selected for the project, remodelling and further acoustic assessment will be required"

Therefore, if another WTG is selected, then remodelling and a new noise impact assessment will need to be undertaken.

3.2. Background Noise Report Appendix G1

Paragraph 1 of this section states that we have undertaken the noise assessment under the newer, revised 2009 SA EPA noise guidelines, instead of the 2003 SA EPA noise Guidelines. This was undertaken to make the noise impact assessment more robust and accurate by incorporating the 2009 method (which is now reflected in the new draft NSW wind farm noise guidelines).

Paragraphs 2 and 4 allege that we did not measure wind speed and rainfall data at every location, rather that we only measured these items at a few representative locations. The report states that the 2003 and 2009 SA EPA guidelines require determination of wind speed across each microphone used in the background study. This statement is not true, as the 2009 SA EPA noise guidelines state that a representative weather monitor at the microphone from one site can be used for wind speed and rainfall data for other noise monitoring sites located in the monitoring area. We placed a total of three wind direction and wind speed monitors out at different microphone locations, as well as two rainfall detectors, which is greater than the requirement.

Paragraph 3 outlines that we did not correct for wind screen at the microphone. Although we used wind shields capable of working effectively at wind speeds up to 7m/s, there is no data provided by the manufacturer as to the exact response. Therefore, we have taken a conservative approach, as there is no manufacturer's data available, of removing any data where the wind speed exceeds 5m/s, as required in the guidelines [6]. The wind speed monitoring equipment used did not provide statistical data, therefore the average wind speeds were used which is stated in the guidelines as being acceptable.

Paragraph 5 states that data collected when equipment failure was present (such as equipment not calibrating) then this data should not be used. We note that during the entire campaign, the only equipment failure encountered was the sound level meter shutting down, or running out of batteries, therefore there was no data recorded. All the noise loggers were calibrated before and after each site trip, and were found to be consistent. Therefore, whilst the equipment failure precipitated in no data being recorded during a period of time, no data during these failure times was used in the final assessment.

Paragraph 5 also states that the continuous noise level graph for Location 78 was not included in the report. This was an oversight, and will be an additional addendum to the report with this information. Additionally, the graphs were appended so that they looked like a continuous line, however data where there was equipment failure was not shown. We draw specific attention to the continuous noise graph for Location 89, and the dates along the bottom, there is a large gap in data between the 23rd November and the 27th November (and the 1st and 4th of December), however the graph is shown to be continuous, with the dates at the bottom jumping.

Paragraph 6 states that the background noise is applied to other residences using an educated guess procedure, and provides an alternative solution to apply the lowest noise curve obtained from the monitored stations. This method however may be inappropriate for some sites, and the approach we have provided is sufficient.

Paragraph 8 states that the noise floor at location 89 is suspicious, as the noise floor drops from 30dB(A) to below 20dB(A). This can be explained as a result of the replacement of noise logger instrumentation at this site. The noise logger that was installed previously had a higher noise floor, which was replaced with a lower noise floor instrument once this was noticed, and does not significantly affect the results.

Paragraph 10 states that trend analysis is to be undertaken up to a second order polynomial, and that the SA EPA guidelines (2009) [6] note that the correlation coefficients (R^2) are to be provided for each order from linear to third order. First, the EPA guidelines clearly state that a third order polynomial is acceptable. Second, while the correlation coefficients could have been provided for each order polynomial, it is typical to provide only the best fit correlation coefficient.

Paragraph 11 states that the assessment should be repeated for measurement locations 25, 27 and 89, as one meteorological mast is insufficient. We note that it is fine to use only one meteorological mast as long as it is representative across the site, which is the case here as the middle mast was selected to be used and the masts are not very far apart.

Paragraph 12 states that the General Electric 2.5xl wind turbine will not be used, and therefore should not have been used in the noise assessment. The basis for this statement is that GE is working on a solution to the low level of tonality present in measurements taken in 2008. It is quite possible that GE has, or will have, resolved this issue by the time Flyers Creek tenders for turbines. Our report [4] clearly states (Section 6 Paragraph 7) that further modelling and assessment will be required if a different WTG is selected. This further modelling and assessment will have to demonstrate full compliance with the SA EPA wind farm noise guidelines.

3.3. Noise Predictions Appendix G2 and Chapter 12 Main Report

Paragraph 1 of the noise prediction chapter of the review undertaken by L Huson and Associates alleges that some noise propagation models are altered within the SoundPlan software suite utilised for the report. All noise predictions were used with SoundPlan software, for which the incorporated noise propagation models have been tested and validated, and they have not been altered.

Paragraph 2 of the noise prediction chapter of the review undertaken by L Huson and Associates notes that if an accuracy of ±5dB is used, and with a safety margin of 2dB included in the results, that non-compliance will result. We note that the ±5dB safety margin only applies to high propagation conditions, and generally a ±2dB accuracy is applicable for the model. An added safety margin ensured a conservative model.

Paragraph 4 states that we used ISO 9613 algorithm for all noise modelling results, even though there was reference to CONCAWE. Additionally, it notes that the SA EPA Guidelines outline that a ground factor of 0 (fully reflective) be used, however we used a partially reflective ground factor for CONCAWE and a ground factor of 0 used for ISO9613. These inputs are based on extensive experience with previous verification of models utilising compliance data. Additionally wind propagation conditions were included using CONCAWE modelling, however it was chosen to present the noise data provided by using ISO 9613 (which includes generic downwind propagation effects), as these results generally gave higher noise levels, and therefore results in more conservative predictions. In any case, CONCAWE predicted levels are also presented and given in Appendix G of our report [4].

It also states that the title for Table 6.2 could be misleading since ISO 9613 does not include wind speed or direction, so the reference to wind speed only relates to the wind speed at the wind turbine. This is true, and the wind speed in this table is at the wind turbines. Additionally, it notes that 'Meteorological Conditions G = 0.0' is confusing ground absorption with meteorological conditions. This is a typographical error, and there should have been a comma between 'Meteorological Conditions' and 'G = 0.0'. The phrase 'Meteorological Conditions' should actually read 'ISO 9613 Meteorological Conditions', and separately state 'G = 0.0' for the ground absorption factor.

Paragraph 6 states that the Senate inquiry report into wind farm noise acknowledges that there is no peer reviewed research to support the statements Vipac has made in the report about infrasound. This is not true as there are a significant number of acknowledged peer reviewed references that support these statements (Leventhall, 2003; Bellhouse, 2004; BWEA, 2005, Turnbull et al. 2012). It is also noted that the CSIRO testified at this inquiry that they could not find any peer-reviewed research in the world concerning so-called "wind turbine syndrome".

Paragraph 8 states that only five monitoring locations have been used for all of the residences; these measurements are representative of other sites. Four of the five monitoring sites had very similar results and these were the ones utilised as being representative of the other sites.

Paragraphs 9 to 12: The WHO guidelines referenced in these dot points is accepted as an appropriate guide and criterion, and is recommended in the SA EPA guidelines, as well as being accepted good practice.

We trust that the information provided is satisfactory. However, if you have any queries or require further information, please do not hesitate to contact us.

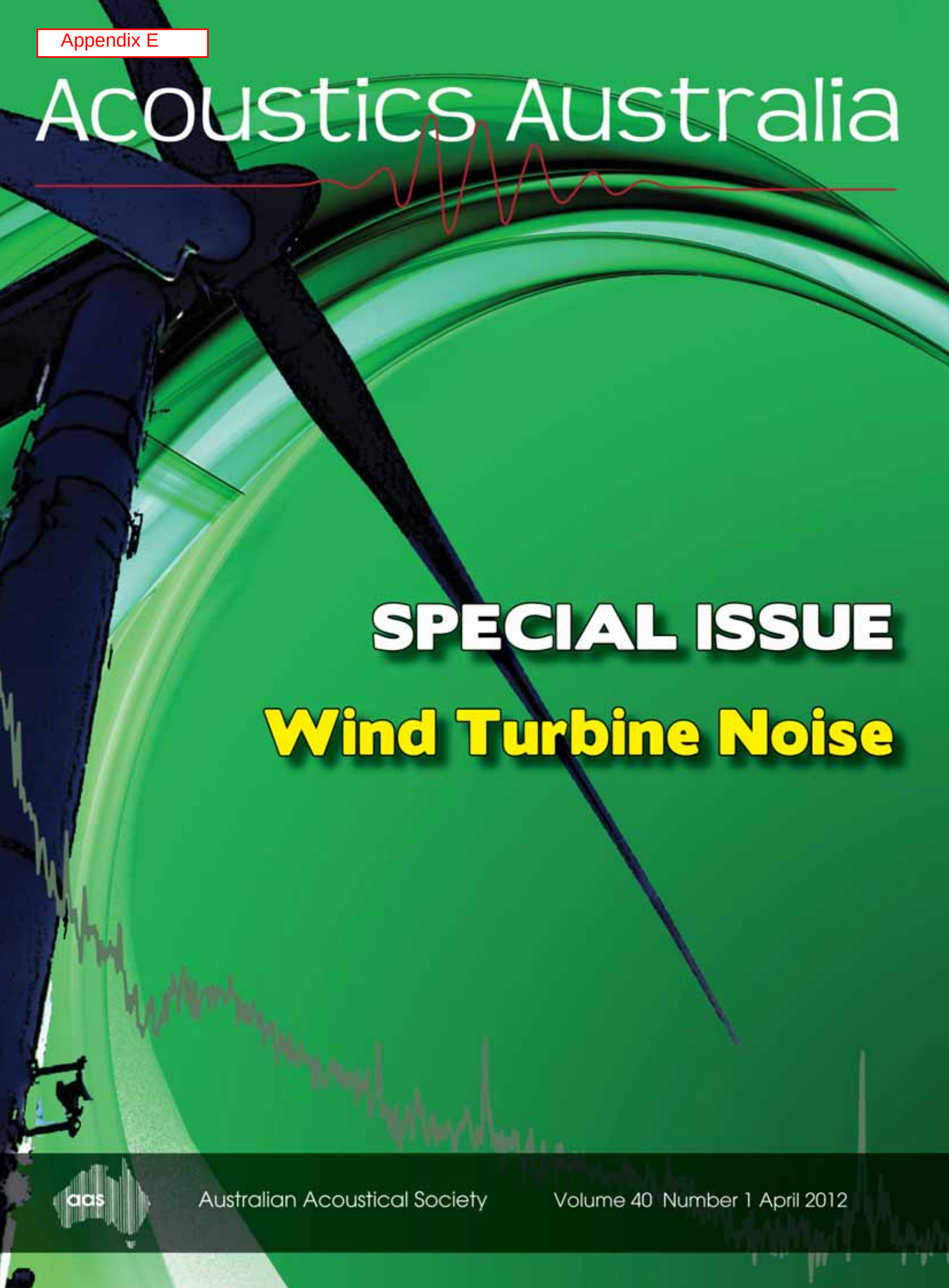
Yours sincerely,

VIPAC ENGINEERS & SCIENTISTS LTD –

Peter Teague and Andrew Leonard

Appendix E

Acoustics Australia



SPECIAL ISSUE

Wind Turbine Noise

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Acoustics Australia
General Business
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Mrs Leigh Wallbank
P O Box 70
OYSTER BAY NSW 2225
Tel (02) 9528 4362
Fax (02) 9589 0547
wallbank@zipworld.com.au

Acoustics Australia
All Editorial Matters
(articles, reports, news, book reviews, new products, etc)
The Editor, Acoustics Australia
c/o Nicole Kessissoglou
School of Mechanical and
Manufacturing Engineering
University of New South Wales
Sydney 2052 Australia
+61 401 070 843 (mobile)
AcousticsAustralia@acoustics.asn.au
www.acoustics.asn.au

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Enquiries see page 94

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PAPERS

TECHNICAL NOTES

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MEASUREMENT AND LEVEL OF INFRASOUND FROM WIND FARMS AND OTHER SOURCES

Chris Turnbull[1], Jason Turner[1] and Daniel Walsh[2]
[1]Sonus Pty Ltd, 17 Ruthven Avenue, Adelaide, South Australia 5000
[2]Pacific Hydro Level 11, 474 Flinders Street, Melbourne, Victoria 3000

Infrasound is generated by a range of natural and engineered sources. The measurement of infrasound at low levels requires a specific methodology, as it is readily affected by even light surface breezes on the microphone. Such a methodology, based on measurements below the ground surface in a test chamber, has been developed to measure infrasound at two Australian wind farms and also in the vicinity of a beach, a coastal cliff, the city of Adelaide and a power station. The measured levels have been compared between each source and against the infrasound audibility threshold of 85 dB(G). The measured level of infrasound within the wind farms is well below the audibility threshold and is similar to that of urban and coastal environments and near other engineered noise sources.

INTRODUCTION

Infrasound is generally considered to be sound at frequencies less than 20 Hz and is often described as inaudible. However, sound below 20 Hz remains audible provided that the sound level is sufficiently high [1]. Infrasound is generated by a range of natural sources, including waves on the coastline, waterfalls and wind. It is also generated by a wide range of engineered sources such as industrial processes, vehicles, air conditioning and wind farms. The thresholds of audibility for infrasound have been determined in a range of studies [2]. The G-weighting has been standardised to determine the human perception and annoyance due to noise that lies within the infrasound frequency range [3]. A common audibility threshold from the range of studies is an infrasound level of 85 dB(G) or greater. The audibility threshold limit of 85 dB(G) is consistent with other European standards and studies, including the UK Department for Environment, Food and Rural Affairs threshold developed in 2003 [2], the UK Department of Trade and Industry study [4], the German Standard DIN 45680 [5] and independent research conducted by Watanabe and Møller [6].

There have been concerns raised in the community regarding the generation of infrasound by Australian wind farms. The generation of infrasound was detected on early international turbine designs, which incorporated the blades 'downwind' of the tower structure [7]. The mechanism for the generation was the blade passing through the wake caused by the presence of the tower. Modern wind turbines now locate the blade 'upwind' of the tower.

Australian States presently assess the noise from wind farms under a range of Standards and Guidelines [8-12]. These Standards and Guidelines do not provide prescriptive requirements for infrasound from wind farms due to the absence of evidence that infrasound should be assessed.

A specific methodology was developed to reduce the influence that even light surface breezes can have on the infrasound results. The methodology is based on measurements being conducted below the ground surface in a test chamber that is approximately 500mm square and 500mm deep. Infrasound was measured using this below ground methodology at two Australian wind farms, Pacific Hydro's Clements Gap Wind Farm which has been operating in the mid-North of South Australia since 2010 and comprises 27 Suzlon S88 wind turbines, each with a rated capacity of 2.1 MW, and at the coastal Cape Bridgewater Wind Farm which has been operating since 2008 in south-western Victoria, and comprises 29 REpower MM82 wind turbines, each with a rated capacity of 2.0 MW. Infrasound was also measured in the vicinity of a beach, a coastal cliff, the city of Adelaide and a power station using the below ground methodology. This paper reports on the study that:

- Develops a methodology to measure infrasound that minimises the influence of wind on the microphone;
- Measures the levels of infrasound at a range of distances from a wind turbine, for two wind farms;
- Compares the results against recognised audibility thresholds; and
- Compares the results with infrasound measurements taken near natural sources, such as beaches, and engineered sources, such as a power station and general activity within the city of Adelaide.

MEASUREMENT TECHNIQUE

Equipment

All measurements were conducted with a SVANTEK 957 Type 1 NATA calibrated sound and vibration analyser. The SVANTEK 957 Type 1 meter has a measured frequency response down to 0.5 Hz. A GRAS 40AZ ½" free field microphone with a frequency response of ±1dB to 1 Hz and ±2dB to 0.5 Hz was used with the SVANTEK meter. The meter and microphone arrangement is therefore suitable for measurement of noise levels in the infrasound range to the level of accuracy required for the assessment.

Microphone Mounting Method

A microphone mounting method is provided in IEC 61400-11 [13]. The method was developed to minimise the influence of wind on the microphone for the measurement of noise in frequencies higher than those associated with infrasound. This

is achieved by mounting the microphone at ground level on a reflecting surface and by protecting the microphone with two windshields constructed from open cell foam. The method was not developed specifically for the measurement of infrasound, and wind gusts can be clearly detected when measuring in the infrasound frequency range using the above method. Therefore, this study has developed an alternative method to reduce the influence of wind on the microphone that would otherwise mask the infrasound from a particular source. A below ground surface method was developed based on a similar methodology [14]. This method has been adapted for this study, and includes a dual windshield arrangement, with an open cell foam layer mounted over a test chamber and a 90mm diameter primary windshield used around the microphone. The microphone mounting arrangement is depicted in Figure 1.

Verification of Technique

The below ground technique was analysed at a remote site away from wind farms, transport corridors and other appreciable noise sources and in very still conditions. The aim of the analysis was to determine the level of transfer of infrasound from outside to inside the chamber. The following procedure was used:

- A constant level of infrasound was generated using a tone signal generator and sub-woofer speaker (B&W Type ASW CDM), mounted 1m above the ground at a distance of 10m horizontally from the chamber. The lowest frequency that could be generated by the signal generator was 8 Hz and therefore the infrasound was generated at a number of discrete frequencies between 8 and 20 Hz.
- The infrasound was measured using the IEC 61400-11 above ground technique;
- The infrasound was measured using the below ground technique;
- The infrasound was measured without the tone signal generator operating to determine the ambient level of infrasound.

The measurement results are summarised in Table 1. The measured levels inside and outside of the chamber were consistent at all of the frequencies produced by the signal generator. The measurement of a constant source of infrasound in still conditions is the same above the ground as in the chamber using the technique described above.

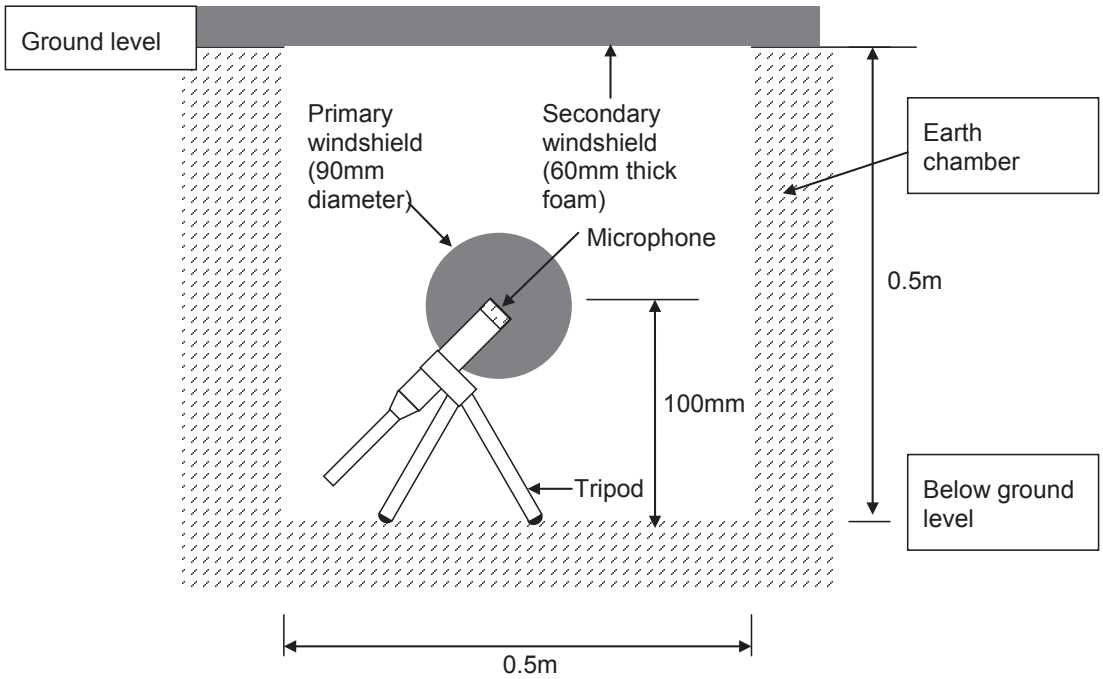

Figure 1. Schematic diagram of the microphone position (not to scale)

Table 1. Measurement at approximately 10m from the controlled source with no wind

Frequency (Hz)		8.00	10.0	12.5	16.0	20.0
Noise Level (dB)	Inside chamber	47	50	54	60	63
	Outside chamber	47	50	54	60	63
	Ambient level	39	38	39	39	37

RESULTS

Infrasound was measured at the Clements Gap Wind Farm and the Cape Bridgewater Wind Farm, using the below ground methodology. In addition, the level of infrasound was measured in the vicinity of a beach, a coastal cliff, a city and a power station using the same methodology. At Clements Gap Wind Farm, the infrasound was measured at distances of 85m, 185m and 360m from the base of a turbine in a downwind direction. The testing was conducted between approximately 7pm and 11pm on Tuesday 11 May 2010, under a clear night sky with a light breeze. Operational data indicates that the turbines were subject to hub height wind speeds of the order of 6 to 8m/s during the period of the testing. The wind speed at ground level was not measured.

At Cape Bridgewater Wind Farm, the infrasound was measured at distances of 100m and 200m from the base of a turbine in a downwind direction. The testing at the wind farm site was conducted between approximately 4am and 6am on Wednesday 2 June 2010, under a clear night sky with a light breeze. During the testing, the operational status of the turbines was constantly observed and confirmed. Measurements were conducted with both the turbines operational and with the turbine blades stationary.

To determine the level of infrasound from natural sources, measurements using the below ground method were made at Cape Bridgewater 25m from the high waterline of a beach, at approximately 250m inland from a coastal cliff face and at 8km inland from the coast. To determine the level of infrasound from other engineered noise sources, measurements using the below ground method were conducted at a distance of approximately 350m from a gas fired power station as well as within the city of Adelaide at least 70m from any major road. The measured levels of infrasound are summarised in Table 2 and are shown graphically in one third octave bands in Figures 2, 3, 4 and 5.

Table 2. Measured levels of infrasound

Noise Source	Measured Level (dB(G))
Clements Gap Wind Farm at 85m	72
Clements Gap Wind Farm at 185m	67
Clements Gap Wind Farm at 360m	61
Cape Bridgewater Wind Farm at 100m	66
Cape Bridgewater Wind Farm at 200m	63
Cape Bridgewater Wind Farm ambient	62
Beach at 25m from high water line	75
250m from coastal cliff face	69
8km inland from coast	57
Gas fired power station at 350m	74
Adelaide CBD at least 70m from any major road	76

DISCUSSION

At the Clements Gap Wind Farm, the level of attenuation with increasing distance from the turbine is consistent with the theoretical reduction of 6dB for each doubling of the distance due to "hemispherical spreading" of the sound wave. This observation confirms that the measured levels were predominantly produced by the turbine. At the Cape Bridgewater Wind Farm, higher ambient noise levels (without the turbines operating) were encountered than at the Clements Gap Wind Farm and therefore the same attenuation with increasing distance was not observed. This indicates that the measured levels included a significant contribution of infrasound from the turbine at 100m but at a distance of 200m, the infrasound from other sources was at least as significant. The levels of infrasound from waves at a beach (in light swell conditions) and in the vicinity of a coastal cliff were in the same order of magnitude as the infrasound measured close to the wind turbines.

At 8km from the coast, the level of infrasound was significantly lower than levels observed in close proximity to the beach and the coastal cliff. The levels of infrasound in the city of Adelaide and in the vicinity of a gas fired power station were greater than the levels observed close to the wind turbines. The measured levels of infrasound from the wind turbines and all other natural and engineered sources were well below the 85dB(G) threshold of audibility.

CONCLUSIONS

A method for measuring infrasound from wind turbines has been successfully demonstrated. The method shows that wind turbines generate infrasound and that close to wind turbines, the level of infrasound is well below the audibility threshold of 85 dB(G). An attenuation rate of 6dB per doubling of distance from a single turbine was also demonstrated. Infrasound is prevalent in urban and coastal environments at similar levels to the level of infrasound measured close to a wind turbine.

ACKNOWLEDGEMENTS

Pacific Hydro commissioned Sonus to conduct a study with the aim of gaining a better understanding of the levels of infrasound from wind farms and more generally in the environment.

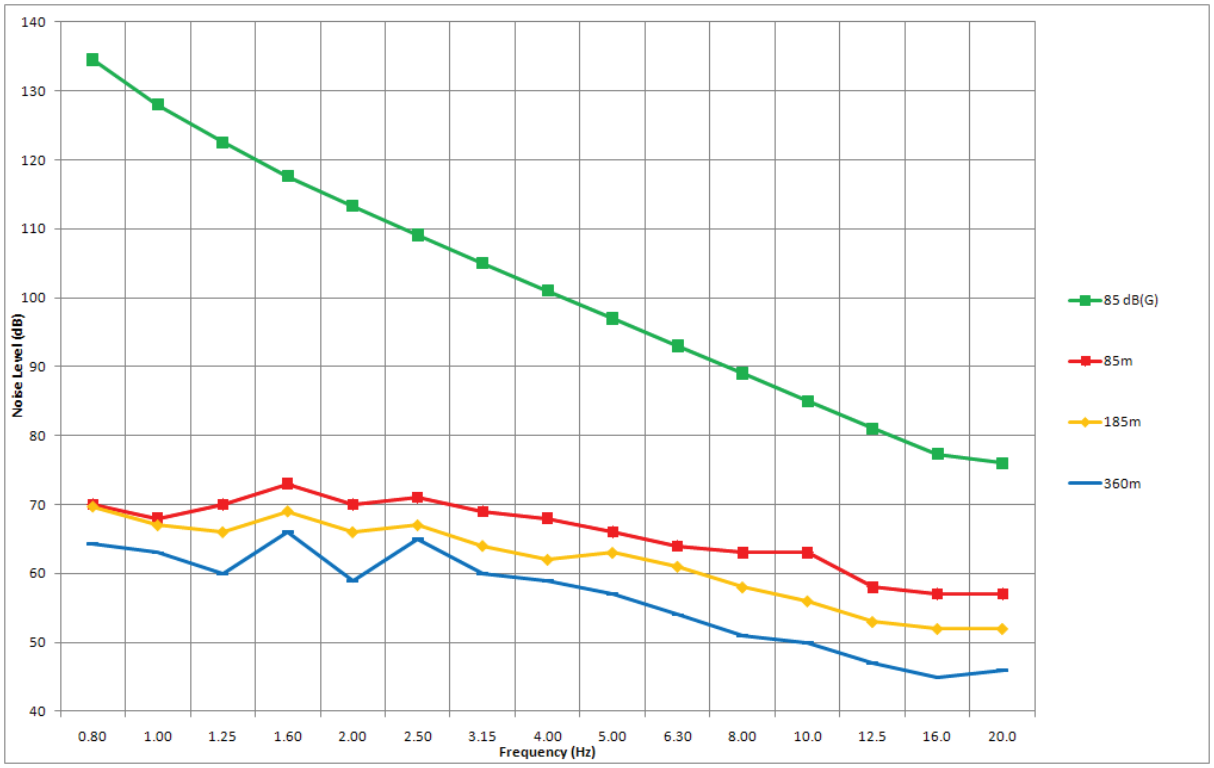

Figure 2. Measured levels of infrasound at Clements Gap Wind Farm

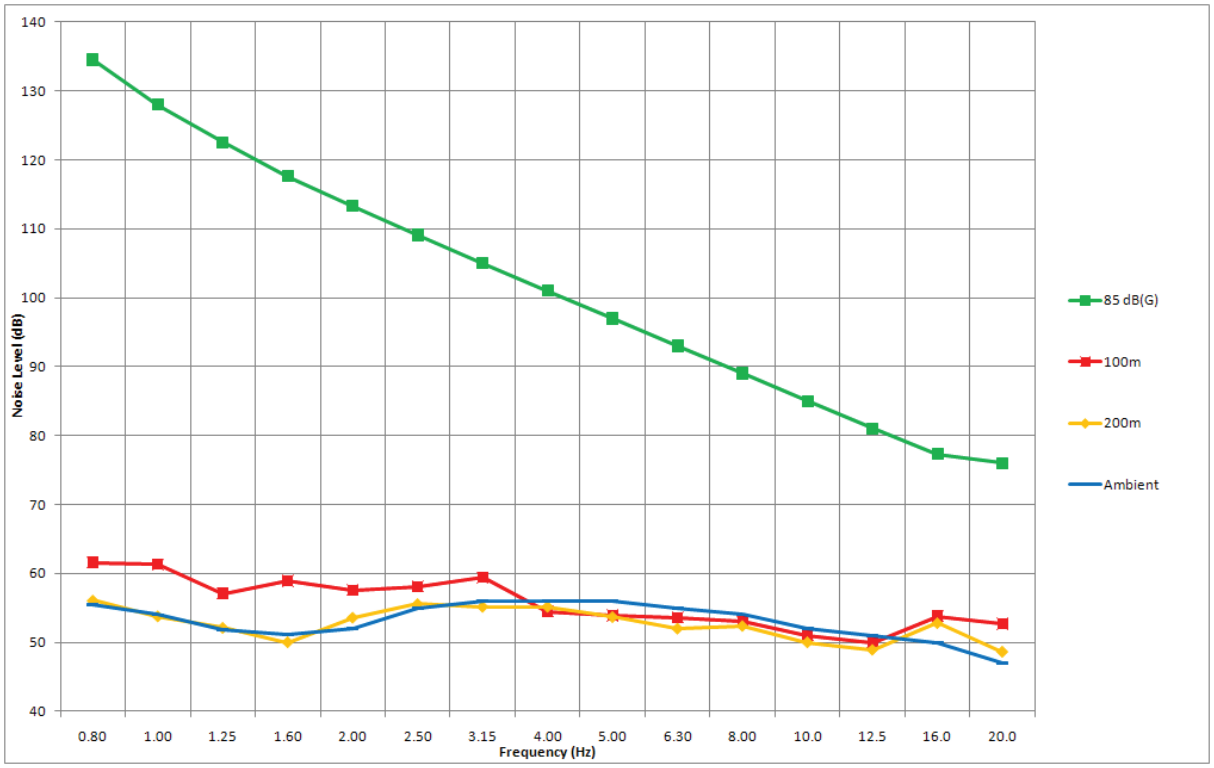

Figure 3. Measured levels of infrasound at Cape Bridgewater Wind Farm

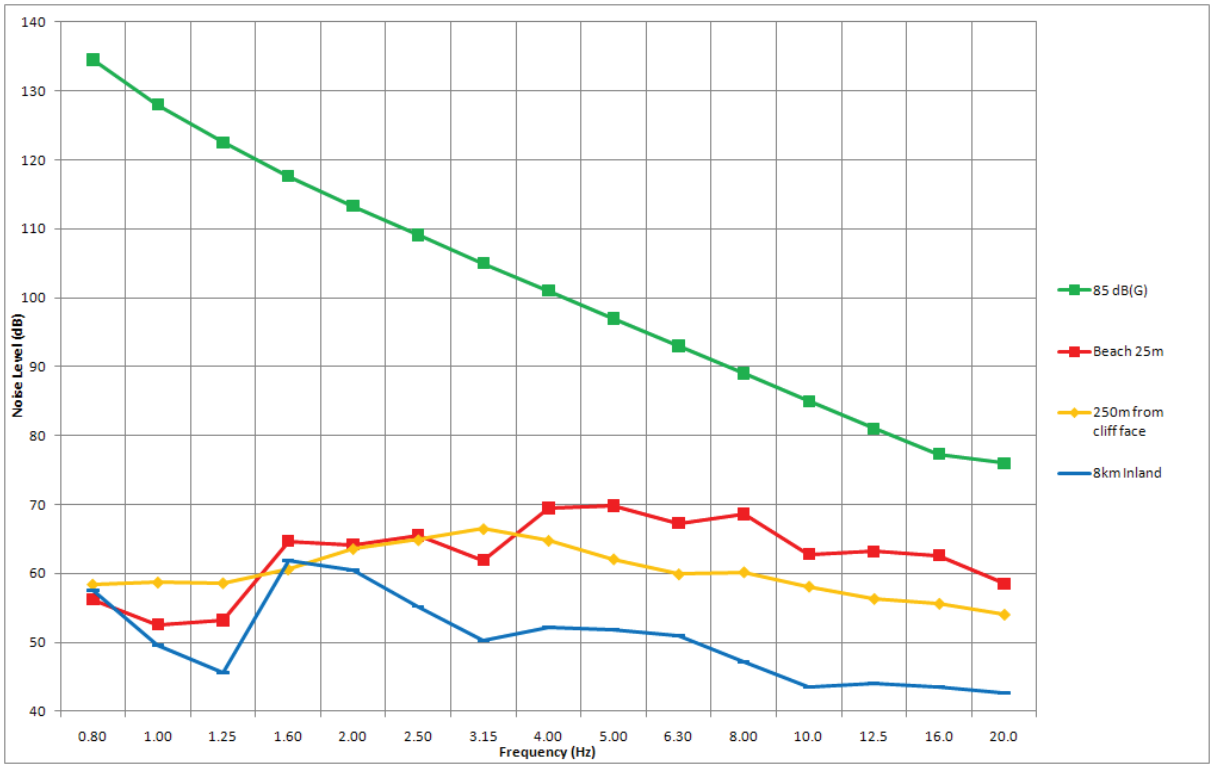

Figure 4. Measured levels of infrasound from natural sources

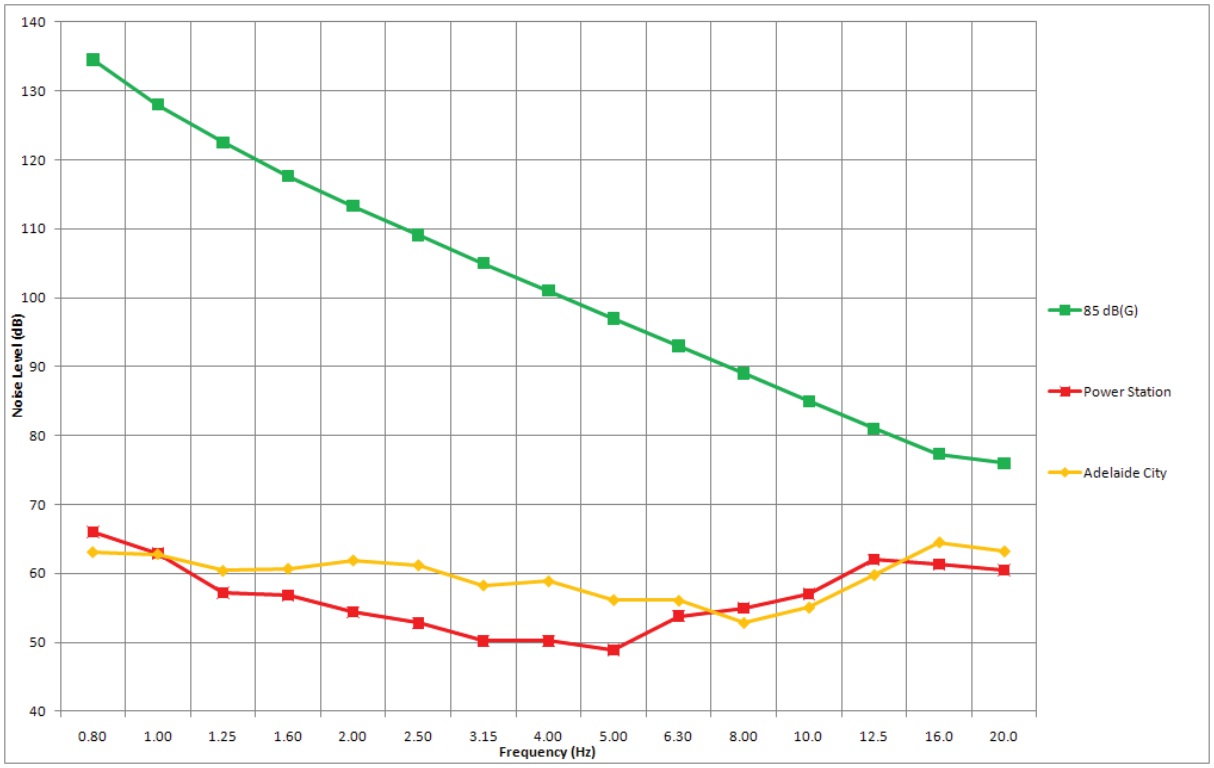

Figure 5. Measured levels of infrasound from engineered sources

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Appendix F

222 Exhibition Street Melbourne VIC 3000
GPO Box 4306 Melbourne VIC 3001
Tel/ 03 9641 1555 Fax/ 03 9641 1222
worksafe.vic.gov.au

10 February 2010

Reference: E10/0002

Mr Nick Wimbush
Panel Chair
Department of Planning and Community Development
GPO Box 2392
MELBOURNE VIC 3001

Dear Mr Wimbush

Berrybank Wind Energy Facility

Thank you for your correspondence of 30 December 2009 on behalf of the planning panel considering public submissions on the Berrybank Wind Energy Facility.

WorkSafe Victoria has met with other government agencies regarding the possible health effects of wind energy facilities.

The Victorian Department of Health (DH) has examined both the peer-reviewed and validated scientific research and also looked at the health aspects of the current planning process.

The DH has determined that the weight of evidence indicates that there are no direct health effects from noise (audible and inaudible) at the levels generated by modern wind turbines. Numerous international reviews on low frequency and infrasound noise, and case studies of actual wind farm noise emissions, have demonstrated that:

- there is insignificant infrasound generated from modern wind turbines; and
- levels of low frequency sound emitted from modern wind turbines are not at a level that would lead to direct health effects.

The Victorian Chief Health Officer, Dr John Carnie, has also referred this matter to the National Health & Medical Research Council (NHMRC) for further consideration and advice.

WorkSafe is reliant upon information from the DH, Victoria's principle health authority, regarding possible adverse effects of low-frequency, sub-audible noise.

As the regulator of workplace safety, WorkSafe will monitor the NHMRC's response to the matters referred and, as necessary and appropriate, address OHS issues that may emerge as a result.

I recommend that you liaise directly with the DH for an update on this matter.

Yours sincerely

Greg Tweedly
Chief Executive
Victorian WorkCover Authority

LET043/02/01.08

Appendix G

Critical appraisal of the Bruce McPherson IFLN Study Report

(Stated authors Stephen E. Ambrose & Robert W. Rand)

http://www.windaction.org/documents/33837

This report purports to provide scientific evidence of an association between health effects and acoustic exposures from wind turbines.

1. Health Outcomes

This health measurement aspect of the study was not developed in a scientifically rigorous manner. There were no objective measures, and all of the subjective measures were unblinded. All measures were taken at the same location. The number of subjects was very small (2) and the 'subjects' were themselves the researchers who were commissioned to produce this report.

Therefore there are a considerable number of design flaws in this study, with the potential for a number of fatal flaws. A fatal flaw is a flaw so serious that it completely discredits the results of the study. Only a single fatal flaw is required to dismiss any evidence from a particular study.

Statistical Power and analysis

Apparently, there was no statistical power calculation conducted a priori. There was no statistical analysis presented assessing the association between health outcomes and noise exposures, and no adjustment for potentially confounding factors in any multivariate analysis.

Explanation of types of flaws in study design and conduct

These flaws can be listed according to scientific type, but a brief explanation of these is first required:

Definition of Bias: Any trend in the collection, analysis, interpretation, publication or review of data that can lead to conclusions that are systematically different from the truth. (Last J. *A dictionary of epidemiology*, 2001)

Bias limits the conclusions that can be drawn from an analysis. It is particularly problematic because, unlike confounding, little can be done to "allow" or "control" for it once the data have been collected. As such it is in many ways an issue of study design, planning and practice.

There are a number of different tpes of bias. The main ones include selection bias and information bias.

Selection bias in epidemiological studies occurs when there is a systematic difference between the characteristics of those selected for the study and those who are not. Selection bias may be due to failure to choose a representative sample (**sample bias**), failure to obtain information about all members of a sample or

population (**non-response bias**), refusal to participate (**non-participant bias**), or selective admission of participants characterised by their occupation, behaviour or other similar characteristic (**membership bias**).

Information bias (**non-sample bias**) is caused by shortcomings in the collecting, recording, coding or analysis of data. This bias may be due to the people who collect the information (**observer bias**), in the use of defective questionnaires or other instruments, or in one-sided responses by the people studies (**response bias, recall bias**). Evidence of exposure to a suspected cause may have been sought more energetically when the outcome was known to be present (**exposure suspicion bias**), or vice versa (**diagnostic suspicion bias**).

Definition of Confounding: Confounding is essentially a mixing of effects that occurs when a factor (confounder) associated with the exposure of interest is also associated with development of the disease or outcome of interest independently of the exposure of interest. Therefore, a distorted estimate of the exposure effect results because the exposure effect is mixed with the effect of extraneous variables.

Critical Appraisal of the methodology used in this study

In this study, there are a number of very serious flaws. These include:

Sample bias – only one location was used and only two subjects are studied with an insufficient number of observations. This alone will constitute a fatal flaw.

Non-response bias / **non-participant bias** – this may well have occurred if all information about all subjects with potentially similar exposures to this windfarm was not included, by design or through refusal. This is a potentially very serious flaw.

Membership bias – The only two subjects were paid to conduct the research in response to claims of health effects. There is definite potential for membership bias here. This alone will constitute a fatal flaw.

Observer bias – the people who collected the information were the same as the people who provided the information – this will result in the extremely high likelihood of observer bias. This alone will constitute a fatal flaw.

Diagnostic suspicion bias – this is almost certain to have occurred in this case, where there were no attempts whatsoever to control for this bias: there was no blinding/masking of those doing the exposure measurements from those being measured for health outcomes. This alone will constitute a fatal flaw.

Response bias - the instruments used to measure health outcomes were not standardised and there is no mention of the variance, repeatability or concurrent validity of the measures used; and there is high suspicion that one-sided responses may have occurred due to the nature of the rationale for the research and the very poor health outcome measurement methodology. This alone will constitute a fatal flaw.

Confounding – There appears to have been no effort to assess any other exposures that may be contributing either to the overall noise levels (see comment in section 1.1); nor is there any measurement of other potentially confounding factors that may have caused or alleviated the health outcomes described (eg medications taken, food or other drugs consumed, pre-existing medical conditions, other exposures). This is a potentially very serious flaw.

Statistical Power and analysis - The sample size for this study appears to be a study population of two observed on 8 occasions, but not independently – with apparently a 'combined' health outcome measure representing each of 8 health data points. This is insufficient statistical power to detect any level of statistical significance for clinically relevant outcomes. This alone will constitute a fatal flaw.

2 Noise exposure measurement

Noise Assessments Unit of the Office of Environment and Heritage has not reviewed the noise component in detail but provided the following initial comments.

Google maps and street view do not indicate many tall buildings in the vicinity, but there appears to be a large sewage plant nearby, a number of landfills or quarries, and a number of industrial/commercial/research buildings nearby. All of these could have structures that generate noise as a result of interaction with wind (humming and low frequency pressure pulses from vibration caused by "eddy-shedding"). The report does not explicitly eliminate other possible noise sources in the house (such as the intermittent house pump mentioned in Figure 8b, or any Heating and Ventilation System – air conditioners in buildings are a source of low frequency noise), or the building itself (some buildings sway as the wind speed increases) – there may be building elements that have low frequency resonances at certain wind speeds. The study does not include the obvious component of replicating the measurements in another house in order to reduce the possible influence of sources in the house or vicinity of the house and not from the turbine.

The main methodological shortcoming in the authors claim that the noise characteristics they present are due to the wind turbine is that they have not replicated their measurements with the wind turbine off for the same wind speeds as when they did their measurements with the wind turbine on. This would have confirmed objectively that the wind turbine is the source of the low frequency noise and low pressure fluctuations they seem to have measured, and eliminated some other source, such as a building or structure excited by the relatively high upper level wind speed (Aeolian noise).

The "stepped distance" data on Figure 13 indicates a decreasing level at increasing distances from the Notus wind turbine until the last measurement at the residence, which has the same dBL level as at the previous measurement location, and a higher dBA level. This could be due to a noise source at or close to the residence and additional data is needed to test this.

There is no explanation offered as to why the dBL level is considered to be decreasing consistent with cylindrical spreading, at 3dB per doubling of distance, but the dBA level is decreasing at 6dB/dd. It appears that this may be because they have not allowed for the ambient dBL level.

The dBG, dBL and dBC levels they present are lower than ones NSW Office of Environment and Heritage has measured in rural and urban areas of NSW without wind turbines (and without reported ill effects). Also, the residence is around 500m from the turbine, which is close relative to typical distances in NSW.

In terms of the acoustic measurement methodology:

- The methodology used to calculate G-weighted levels and amplitude modulation of infrasonic and low frequency noise is project specific and does not appear to be referenced to any standard. The approach should not be relied upon in the absence of expert peer review of the methodology.
- The performance of the wind screens, including the external 'RODE blimp' has not been stated or considered. Wind across the microphone has the potential to greatly influence LFN and infrasound measurements.
- As the major conclusions of the report are primarily based on G-weighted sound levels, more detailed justification (including peer reviews) for the measurement and data processing methodology should have been included in the report.

Overall Critical Appraisal Assessment

This study is sufficiently flawed in design, methodology (including duration, study population, sample size, outcome assessment, assessment of confounders and statistical analysis) and probable selection and information biases that it would not be publishable in any recognised properly peer-reviewed national or international journal. The results presented in this study are not only not justified by the information provided, the scientific findings are so poorly collected, analysed and presented that they cannot even be considered as hypothesis generating. At worst this study report can be considered misinformation.

Appendix H

From: Tattam, Steve [mailto:steve.tattam@AirservicesAustralia.com]
Sent: Monday, 18 July 2011 9:38 AM
To: Jonathan Upson
Cc: Wilson, Gayla
Subject: RE: Flyers Ck Wind Farm - Layout adjustment

Hi Jonathan,

Yes that is correct, I do confirm a re-design of the NDB approach is feasible for the current layout.

Airservices will require confirmation that this "current layout" will be installed and that the DA has been approved before the NDB Procedural Redesign can occur.

Can you please confirm that no deviation from the original assessment / layout will occur before we raise our proposal with costings.

Steve Tattam

Aviation Relations Manager
Corporate & International Affairs | Airservices Australia
Ph 02 6268 4891 | Mob 0409 319 139 | Email steve.tattam@airservicesaustralia.com

Secretariat to ASTRA – www.astra.aero

www.airservicesaustralia.com

From: Jonathan Upson [mailto:Jonathan.Upson@infigenenergy.com]
Sent: Monday, 11 July 2011 11:12 AM
To: Tattam, Steve
Subject: RE: Flyers Ck Wind Farm - Layout adjustment

Hi Steve,

Thanks for your email and clarification with regards to the teardrop shape of the NDB approach. I thought there would be a good explanation.

While I agree we would not want to proceed with the re-design right now, can you confirm that a re-design of the NDB approach is feasible for the current layout?

Regards,

Jonathan Upson
Senior Development Manager

Infigen Energy
Level 23, HWT Tower 40 City Road, Southbank VIC 3006
T 03 9674 7173 **F** 02 9247 6086 **M** 0400 501 676

www.infigenenergy.com

Appendix I

From: Danielle Meggos [mailto:Danielle.Meggos@rfs.nsw.gov.au]
Sent: Friday, 20 April 2012 10:40 AM
To: Valentine, Nick
Subject: RE:

Hi Nick

I have spoken briefly to the Group Manager responsible for this area and can confirm that the presence of wind turbines is unlikely to restrict our fire fighting operations. Rather we will adapt to the circumstances and may choose a method other than aerial water bombing if there would be difficulties flying close to the turbines.

I am waiting to get comments back on restrictions on flying around turbines and any comments on the Victorian CFA Guidelines for Wind Farms.

Regards
Danielle

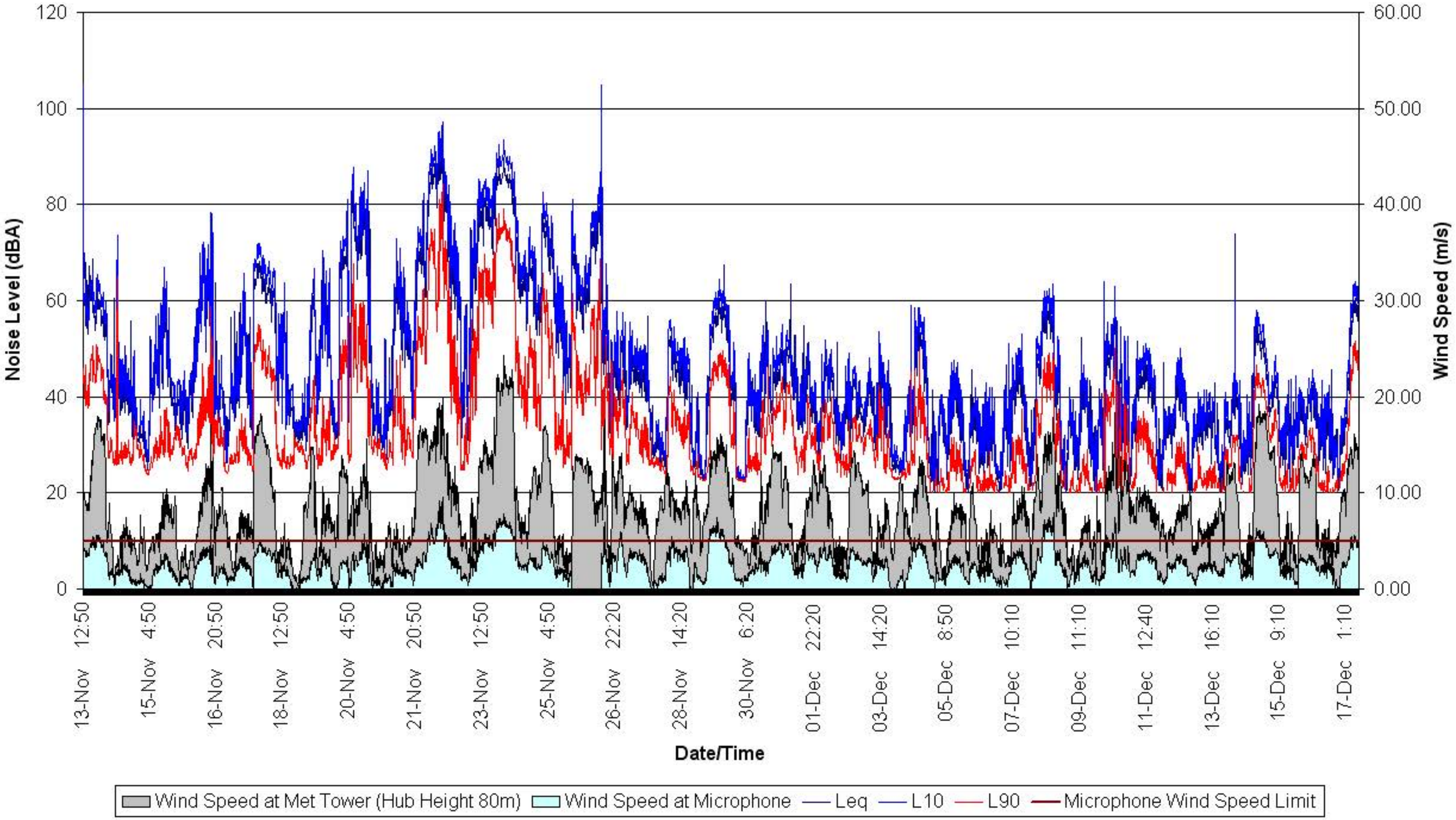
PREPARE. ACT. SURVIVE.

Danielle Meggos
A/Manager
Planning and Development

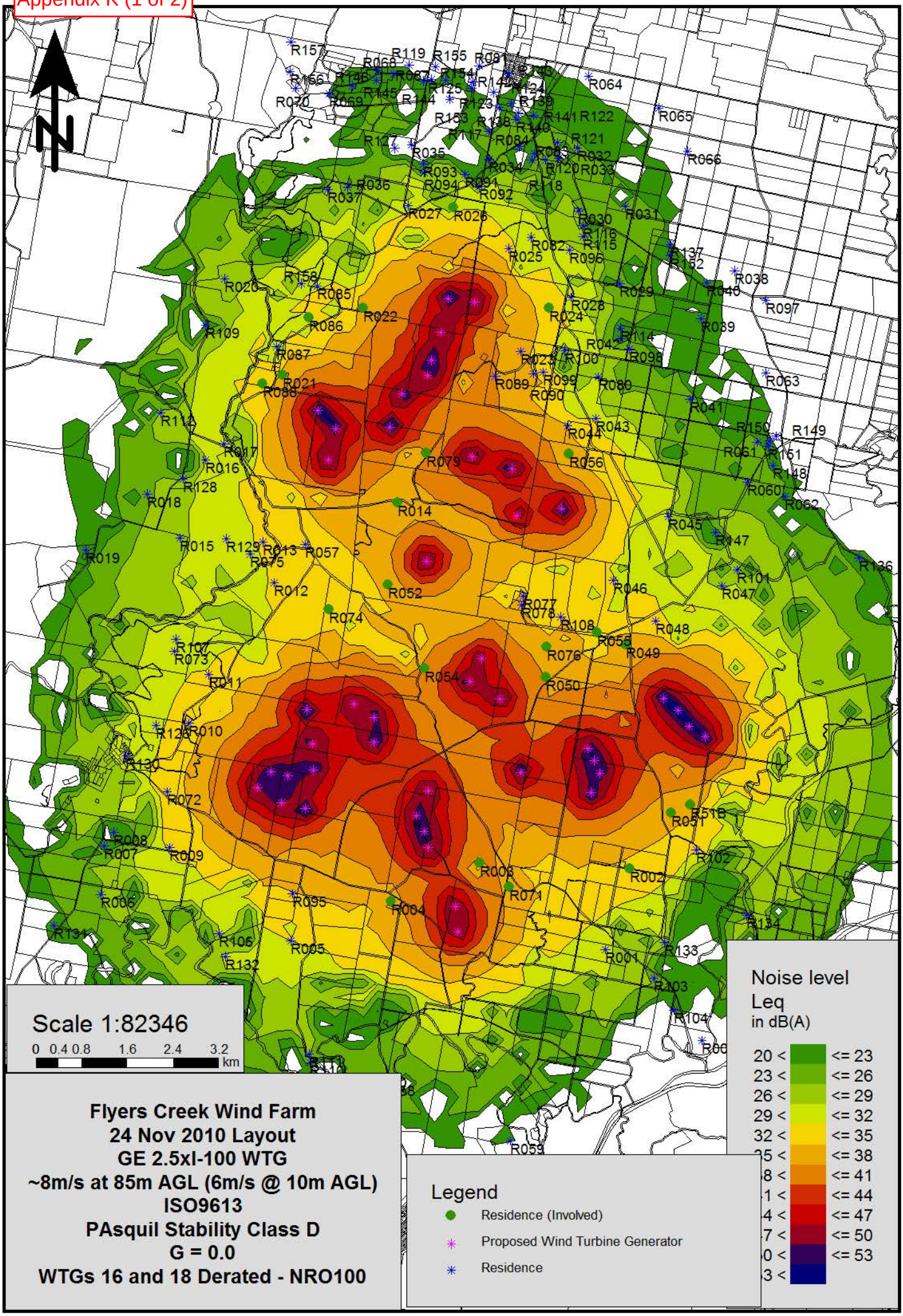
NSW Rural Fire Service
Headquarters | 15 Carter Street | Lidcombe NSW 2141
Locked Bag 17 | Granville NSW 2142
p 02 8741 5445 | f 02 8741 5433| e danielle.meggos@rfs.nsw.gov.au

Appendix J

Loc 78: Measured Noise Levels & Wind Speed vs Time



Appendix K (1 of 2)



Appendix K (2 of 2)