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

MEMORANDUM

Attention:	**Jonathan Upson**	Date:	**19 August 2013**
Company:	**Infigen Energy**	Pages:	**1 of 9**
Email:	**Jonathan.Upson@infigenenergy.com**	Document No:	**50B-08-0089-GCO-790684-2**
From:	**Anton Steketee**	Reviewed By:	**Peter Teague** **Andrew Leonard**
Subject:	**Response to SKM Peer Review**		

CC:	Name:	Company:	Email:

Dear Sir,

Re: **Response to SKM Peer Review**

Sinclair Knight Merz (SKM) have undertaken a peer review of the Flyers Creek Wind Farm Noise assessment and background monitoring conducted by Vipac, and associated responses to these reports by third parties. Vipac provide the following comments regarding the details requested by SKM to support the application.

1. REFERENCES

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

[2] *Noise Impact Assessment, Flyers Creek Wind Farm*, Vipac Document No. 50B-08-0089-TRP-773906-2, Vipac Engineers & Scientists, 21 December 2010

[3] *Flyers Creek Windfarm – Technical Review of Supporting Documentation*, Draft 2, Sinclair Knight Merz Pty Ltd, 24 March 2013.

[4] *Wind Farms: Environmental Noise Guidelines*, SA Environment Protection Authority, SA Government, Dec 2003. (SA03)

[5] *Commercial Documentation, Wind Turbine Generator Systems, GE 2.5xl – 50Hz & 60Hz, Product Acoustic Specifications*, ©2009 GE Company

2. RESPONSE TO CONCLUSIONS

1. *'More information to be provided on the meteorological conditions in the area particularly on dominant wind directions and the probability of occurrences of conditions that exacerbate impacts'*

The predominant wind directions at the site are ENE and WSW. Based on almost 3 years of measurements by Infigen, wind within ±45^{o} of these directions occurs approximately 35% of the time for each direction. The average windspeed when the wind is from the ENE is 12m/s (at 78.6m AGL) whilst the average windspeed with wind from the WSW direction is 6m/s. Therefore the potentially higher noise impact of the windfarm will be to the receivers to the ENE (e.g. R023), as these receivers are influenced by the lower average windspeed, where background noise is low and higher frequency of downwind propagation conditions, where noise transfer from the source to receiver is higher. The impact to the WSW is reduced in comparison, as the higher average wind speeds leads to increased background noise, and therefore a reduction in the impact of downwind propagation conditions.

Noise predictions are undertaken based on downwind propagation from every wind turbine to every receiver, and assume the worst-case wind direction. Therefore the difference in impact in different directions around the wind farm has been considered.

2. *'Clearly outline noise mitigation, monitoring and management measures that would be applied to the project'*

Noise mitigation was included in Vipac's Noise Impact Assessment [2] in the form of turbine derating. This is based on manufacturer provided sound power data for de-rated turbines, and the proposed impact of the wind farm would be reduced compared to turbines operating at full power.

The Noise Impact Assessment report stated that if all turbines are operated at full power, there were minor predicted exceedances at three receivers during certain wind speeds (7.7m/s – 10.4m/s at hub height – approximately 20% of the time). Providing details of these predicted exceedances were included in the report, followed by the mitigation strategy to reduce the impact, and the noise impact once mitigation measures are put in place was considered. However, to avoid confusion between the full power and derated predicted noise levels, only one set of data was provided, after noise mitigation was put in place.

Turbine derating is feasible and effective (as specified by manufacturer data), however this results in a reduction in electricity generated as well as the associated reduction in noise levels. As the manufacturer provides the sound power levels for this configuration, it does not alter the effectiveness or accuracy of the noise modeling undertaken.

As required by the applicable environmental noise guidelines, compliance monitoring will be undertaken after construction of the wind farm. This process will then be used to determine if there are any exceedances to the noise criteria applied and at this point, a contingency strategy for additional attenuation could be in the form of further derating or non-operation of turbines in specific conditions (i.e. using wind sector management in worst case wind direction, and for certain wind speeds).

3. *'Clearly define input data to the ISO and CONCAWE models and explain clearly what was used and why'*

Noise modeling and predictions were undertaken by Vipac using both the ISO and CONCAWE models. The input data (detailed in Section 6 of [2]), was as follows:

- ISO
    - Ground attenuation fully reflective (G=0.0)
    - Temperature: 10°C
    - 80% RH
- CONCAWE
    - Ground attenuation partially reflective (G=0.7)
    - Temperature: 10°C
    - 80% RH

This input data for the models has been selected to provide a conservative assessment, based on Vipac's previous experience in this area, including post construction wind farm compliance testing and reinforced by published material since the noise assessment was undertaken (e.g. Evans and Cooper, 2012).

The results from the ISO model were included in the main body of the report as these levels were slightly higher (and therefore more conservative) than the noise levels predicted using CONCAWE. For completeness, the CONCAWE results were attached in Appendix G of the noise impact assessment report [2].

4. *'Clearly explain the choice of noise logger locations and the rationale for choosing the background noise levels for each residential location'*

The noise logger locations were spread out evenly (i.e. covering all main compass directions) throughout the proposed development so that indicative background noise levels for each residence (representative of each sector) could be determined. The rationale for assignment of the background noise levels to other residential receivers was topographical exposure, foliage density and proximity to a residence where noise logging was undertaken.

If the criteria based on the lowest background noise levels measured at any receiver was applied to all houses where monitoring was not undertaken, then all predicted noise levels (with the currently proposed noise de-rating applied) would match, or be less than, the criteria at all locations. However, the methodology applied to determine the criteria relevant to each receiver location as detailed in the noise report is in accordance with the 2003 Wind Farm noise guidelines, and is therefore appropriate methodology, which has been successfully applied to numerous previous wind farms.

5. '*Clearly explain the rationale for choosing the single mast as a basis for wind data'*

A single mast was used, as stated in the SKM review, for simplicity, and to reduce uncertainty for further noise assessments (both pre and post construction). There was little variability between the met masts, and

this would have a minimal impact upon the outcome of the background noise assessments. The highest total average wind speed during the background noise measurement campaign between all met mast was measured at the middle met mast. Therefore the use of the middle met mast to determine the background noise criteria is conservative (as other met masts would show the same noise levels at slightly lower wind speeds). The distance between the three met masts is relatively small and the average standard deviation between the measured wind speeds was 0.8m/s, therefore all met mast windspeeds are similar and the middle mast is representative of the entire site.

6. *'Clearly explain the difference between "accuracy" and "uncertainty". Clearly explain the application of ±4-5 dB and the implication with respect to certainty of compliance and management of potential exceedances'*

For most prediction locations, the average accuracy of the noise model is about ±2 dB(A), based on actual validation and compliance data from previous wind farms. However, a variation in predicted levels from the model in the order of ±4 to 5 dB(A) can be expected in some circumstances due to changes in meteorological and propagation conditions. The model takes into account the effects of meteorological conditions including wind propagation effects and temperature inversions.

The model has conservative assumptions applied (such as each residence being downwind of every turbine, which can not occur at the same time) and as a result means that it has an in-built safety margin (likely to be at least 2 dB(A) and up to 5 dB(A) depending on residence location, topography etc).

It is acknowledged that this variability may lead to variation between the operational noise levels and the predicted noise levels, and this would be determined during the post compliance noise monitoring. Any measured or confirmed potential exceedances would then be managed by noise mitigation measures as discussed in response to *Conclusions* question 2 (e.g. further turbine de-rating or shutdowns at certain wind directions and speeds).

3. RESPONSE TO OTHER QUESTIONS/QUERIES

SECTION 4: THE VIPAC REPORTS

4.1 Noise Impact Assessment Report

SKM have requested more details regarding the *small disparity between daytime and night time results* noted in Vipac's Noise Impact Assessment (NIA) Report. For all monitored locations except R89, the day time average background noise levels are 3 to 5dB(A) higher than the night time levels at most wind speeds, with a larger disparity occurring at some locations at higher wind speeds, which may be exacerbated by having a smaller sample size at these wind speeds. Day time noise levels at R89 were only slightly higher than night time levels for windspeeds up to 9m/s (at hub height). It is typical that daytime noise levels are higher than night time noise levels and may be caused by an increase in noise due to traffic, people, animals during the day time near the monitoring locations and changes in wind shear between daytime and night time. SA03 does not require any separation of day time or night time background noise levels, therefore this difference will not significantly affect compliance with the requirements of SA03. It is however, noted in the Noise Impact Assessment Report as a matter of completeness.

SKM have also questioned the references to four and five monitored sites on page 7. Background noise monitoring was undertaken at five sites. As the noise levels measured at R89 were notably higher than all other sites, these noise levels were not used to determine criteria at any of the non-monitored locations. Therefore, background noise criteria were developed for non-monitored sites based on four of the monitored sites as discussed in paragraph 2 on page 7 of the NIA report.

Table 5-3 in the NIA provides noise criteria for each monitored site for 3 – 9 m/s windspeeds (at 10m AGL). (which is approximately 4-12.5 m/s at hub height) SKM suggest that an additional two wind speeds are required to achieve the full range of required wind speeds, from cut in to rated power required by SA03. However, 3 m/s is the cut in windspeed and 9 m/s is wind speed (at 10m AGL) required to achieve rated power [5] and therefore meets the requirements of SA03.

Regarding point 4 of Section 6.3 – a uniform wind field means that wind shear is not accounted for in the modelling. During typical meteorological conditions, the wind speed at ground level (and the receiver locations) is lower than the hub height wind speed. However, in the noise modelling the wind speed is assumed to be uniform at all elevations. This leads to an overestimation of the propagation of noise from turbines, as the propagation of noise increases with an increase in wind speed, which is being overestimated at ground level.

Section 6.2 of the NIA notes that both the Concawe and ISO9613 models states that there is enough built-in conservatism for any possible inaccuracies. Some of the reasons for this conservatism are noted in Section 6.2. These reasons include the predictions being based on every receiver being downwind of every turbine – an impossible situation which over predicts the total noise level from the wind farm. There is also conservatism in the modelling due to the ground absorption factors chosen (which are conservative, see response to *Conclusions* question 3 above) and the assumption of a uniform wind field (without any correction for windshear).

There are two main heights referred to in the NIA report, 78.6m and 85m. The turbines proposed have hub height of 85m and the meteorological mast at Flyers Creek measures wind speeds at 78.6m AGL. The noise modelling undertaken of this turbine layout and Sound Power Levels provided are all based on the 85m hub height. Based on the wind profile exponents calculated for data collected at the Flyers Creek middle met mast, wind speeds at 78.6m would be between 97% and 101% of the 85m AGL wind speed. However as both the noise predictions and noise measurements have been assessed with windspeeds measured at 10m AGL, this very minor difference does not affect the assessment.

4.2 Background Noise Monitoring Survey Report

As stated at Section 5 of the NIA, the sites where background noise monitoring was undertaken were matched to the other sites with a similar acoustic environment. This included consideration of the degree of exposure to winds (by matching geographically local and topographically similar sites) and type and amount of vegetation at the residence location (by examination of aerial imagery).

All noise loggers used at the site were Type 1 Sound Level Meters, which exceeds the minimum requirement for Type 2 Sound Level Meters specified in SA03. The noise floor of each logger used for background noise monitoring is shown below.

- LD812 (SN 0529): 17.0 dB(A)

- LD812 (SN 0711): 17.5 dB(A)
- LD824 (SN A2596): 16.6 dB(A)
- LD870 (SN 0181): 28.9 dB(A)
- LD870 (SN 1463): 17.5 dB(A)
- ARL EL316 (SN 16-004-025): 23.5 dB(A)
- BK 2236 (SN 1914120): 20.0 dB(A)

A discussion of the potential influence of a higher noise floor is discussed in response Section 6 below.

SKM have requested more information showing the performance of the windshields used for background noise monitoring. As stated in the background noise monitoring reports, manufacturer supplied windshields were used with all noise loggers. These were a combination of 90mm round windshields and 95mm diameter conical windshields with bird spikes. All noise data where the microphone level wind speed was measured to be higher than 5m/s had been removed from the analysis, which, according to the requirements of SA03, is considered sufficient to ensure that noise levels aren't influenced by high wind speed across the microphone. Based on prior experience with the windshields used and discussions with the manufacturer, Vipac consider 5m/s to be a conservative limit.

SKM have questioned the reason for the use of only three monitors for measuring microphone level wind speed. This is the accepted practice within SA03 as the monitored locations have similar topographical exposure to the other non-monitored locations where this data has been applied. The data for non-monitored locations is applied based on another location that is a relatively short distance away, at similar elevations and only sheltered from the wind from similar directions.

SECTION 5: THE ACOUSTICS GROUP REPORTS

SKM have noted that measurement of background noise during occasions when the level is very low as conducted by Vipac is acceptable, as these levels do not present a problem in setting of the criteria, which has a lower limit of 35dB(A) at all wind speeds. SKM also agree that documentation of wind speeds below the cut in wind speed is not required, as there is no noise produced by the wind farm in this situation. This approach is also consistent with SA03.

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 background noise monitoring 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. 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).

As shown clearly in the photographs in Appendix B, logger locations were chosen in accordance with the requirements of SA03. Therefore loggers were placed with 20m of the residences, more than 5m away from any reflecting surfaces and also away from significant trees, which may increase the typical background noise levels at the measurement location.

SKM also go on to state that the discussion provided regarding any tonality, low frequency, infrasound and other significant characteristics is appropriate. The discussion goes on to point out that the unique characteristics of wind turbines is included within the approach used for the noise assessment and that these characteristics are unlikely to pose a problem with the final constructed wind farm.

SKM have requested more information regarding the 'issue of meteorological conditions', without specifying any concerns where the approach to meteorological conditions within the NIA is deemed inadequate. In any case, a summary of the prevailing weather conditions relevant to wind farm noise has been included in response to *Conclusions* question 1 above. The noise predictions undertaken are to capture the worst case noise emissions from the wind farm and provides predicted noise levels for the worst case meteorological conditions (including any possible temperature inversions).

SKM confirm that the SA03 guideline sets the approach to the wind farm noise to be taken for this development proposal, and that this is not the avenue for public policy debate. Therefore reliance upon the tools and techniques for assessment recommend by SA03 is considered appropriate for this wind farm assessment.

SECTION 6: THE L HUSON REVIEW

A discussion of the choice of wind speed loggers is included above in Section 5.

Huson has queried which data has been removed due to equipment failure. One of the equipment failures was the microphone level meteorological monitor resulting in some data being excluded in November 2009 at R89 (where the weather station had been blown over). Therefore all data from this period has been excluded. The only other equipment failures were flat batteries at times during the monitoring – in these cases, the battery was replaced and calibration of the noise monitor was checked, therefore satisfying the requirement of instrument spot calibration prior to and after the monitoring. The percentages of data listed as excluded, in Table 5-1 of the Background Noise Monitoring are for when all equipment was fully operational.

Table 3-1 lists the events of where equipment failure was present throughout the monitoring period. Even though the noise loggers were recording data at Location 89 after the weather monitor had blown over, this data was excluded from the analysis and therefore the absence of wind data from this period had no impact on the overall results.

Table 3-1: List of equipment failure events

Location	Date From	Date Until	Reason
Location 12	26/11/2009 21:30	4/12/2009 12:50	Battery Failure (Solar Panel Disconnected)
Location 27	20/11/2009 17:00	4/12/2009 8:50	Battery failure, download cable not present. Logger removed to office and then re-installed at site.
Location 89	16/11/2009 02:40	26/11/2009 13:40	Weather monitor blew over
Location 89	1/12/2009 04:50	4/12/2009 11:40	Battery Failure
Location 89	8/12/2009 13:50	10/12/2009 9:00	Battery Failure

It is noted that the high noise floor of the LD870 installed at R89 for some of the measurement period may affect the final results of the regression analysis. However noise levels from the other loggers at this location with lower noise floor used did not measure a significant number of data points with noise below the noise floor of this LD870. Additionally, this appears to marginally affect the resultant noise regression curve at the lower wind speeds (by approximately 1dB) The two noise loggers used at location 78 had noise floors of 20dB(A) and 23.5dB(A), which is an acceptable limit. Where microphone level wind speed data was missing from November 2009, this data was not included in the final regression analysis.

SKM and Huson have requested more information about how non-compliance of the wind farm may be addressed, and this is included in response to *Conclusions* question 2.

SECTION 7: THE VIPAC RESPONSE TO REVIEW REPORTS

7.2 L Huson Report

With respect to the wind speed measured at the microphone, only three measurement locations were required as described in response to Section 4.2.

SKM have questioned whether noise from wind across the microphone is significant for wind speeds lower than 5m/s. Exclusion of noise data from wind speeds greater than 5m/s is the industry standard for exclusion of data due to excess wind speed (as reflected in the SA09 guidelines, the NSW industrial noise policy and AS 1055-1 *Acoustics – Description and measurement of environmental noise*). Where no other information is available, this is considered current best practice.

Discussion of application of background noise levels to non-monitored locations is included in response to *Conclusions* question 4.

The only noise logger location which was changed during testing was the logger location at residence 12 as previously discussed.

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 –

A. Steketee

Anton Steketee
Project Engineer