[redacted]
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Dear Ms Morris

I am writing to provide my opinions concerning some of the problems associated with the 2009 SA Guidelines for wind farm noise and in particular I am writing in support of the comments made by the well-respected acoustical consultant, Mr [redacted] in his February, 2014 report reviewing the Flyers Creek wind farm approval and his November, 2011 report for the Cooranga North Community in which he described his outside to inside noise reduction measurements. The opinions I express here are my own and are not necessarily endorsed by The University of Adelaide.

One of the more important incorrect assumptions implicit in the guidelines is that there is a substantial reduction in noise when travelling from outdoors to indoors. To satisfy World Health Organisation (WHO) Guidelines, the maximum allowable noise level in a bedroom at night is 30 dBA if the sleep of 90% of people is not to be disturbed. This implies that to protect 90% of people, there must be a minimum noise reduction from outdoors to indoors of 10 dBA if the allowed outside noise level is 40 dBA. The validity of this assumption is discussed below.

The A-weighted noise reduction, from outside noise levels to inside noise levels, that will be experienced by any dwelling will depend on the following factors:

1. The construction of the dwelling (wall materials, number of windows, roof materials etc).
2. The area of openings due to windows being open, particularly in walls facing the source of the sound.
3. The character of the noise: low-frequency noise is less attenuated by houses than high-frequency noise. Thus if the noise consists of mainly low-frequency components (as does wind farm noise at distances of 1 km or more from the nearest turbine in a wind farm), then the noise reduction from outside to inside will be much less and sound will intrude through open windows that are not even facing the turbines.

During the course of undertaking our Australian Research Council funded project on the impact of wind farm noise on rural communities, my research team has made a substantial number of measurements of the reduction in wind farm noise levels from outside to inside for a number of residences in the vicinity of the Waterloo wind farm. All of our measurements have been for the situation where all windows and doors were closed. For this case we have measured between 12 and 15 dBA noise reductions at times during the night when it was clear that the wind farm was the dominant noise source. However, if windows were open, the noise reduction would be substantially less than this and this is supported by the measurements taken by Mr [redacted] and reported in his November, 2011 report. Especially at low frequencies, inside noise levels are very dependent on where in a room they are measured, which means that there would need to be multiple inside measurements taken to properly define an average outside to inside noise reduction and the noise source would need to have a similar frequency content as the predicted wind farm noise at each particular location.

It is clear that specification of 40 dBA of allowable outdoor noise levels is no guarantee that noise levels indoors will not exceed 30 dBA at night so it would be safer to specify average indoor noise levels and the number and location of measurement microphones. During compliance checking it would be preferable to measure indoor noise levels during times when the local wind strength is low to avoid contamination of the data due to noise generated by wind blowing past vegetation and other objects. Taking measurements indoors would also mean that large microphone wind shields would be unnecessary. To avoid contamination of the data by internal noise sources in a residence, the measurements would need to be attended. If this caused problems, compliance checking could consist of outside to inside noise reduction measurements using an artificial sound source and outdoor noise measurements with just the wind farm noise.

A complicating factor that should be mentioned here is that the 30 dBA limit recommended by WHO for people to not suffer sleep disturbance is based on the noise being dominated by traffic noise which is not so heavily weighted towards low-frequencies as wind turbine noise is. It is well-known that low-frequency noise is more annoying than noise spread over low, mid and high frequencies for the same total A-weighted level (dBA). Thus 30 dBA of predominantly low—frequency noise as produced at distant residences by a wind farm will cause more annoyance than 30 dBA of traffic noise. The 30 dBA limit proposed by WHO is also based on the response of people living in the suburbs of European cities where levels of background noise experienced and accepted by residents would be much greater than experienced in an Australian rural environment. Of course there are always a certain percentage of individuals even in an urban environment who will be disturbed at levels of 30 dBA. Finally, distant traffic noise is not modulated, does not vary rapidly over short periods of time and is thus much less likely to cause annoyance than noise of the same average level produced at residences by wind farms, which does vary substantially over very short time periods as well as over long time periods.

The SA EPA wind farm guidelines also suffer from the additional limitations listed below.

1. Compliance checking is based on the measurement of LA90 noise levels, which are the noise levels that are exceeded 90% of the time. Reporting these measurements thus misses the 90% of the data that exceed the reported level. Typically, average LAeq levels would be at least 2 dBA above the LA90 levels (much more for modulated sound which often characterises wind farm noise) and it is the average levels (over a 10-minute time period) that are used in the noise level prediction process specified in the guidelines. Compliance checking also implements the dubious process of fitting a regression line to a large number of data points of measured noise level vs wind speed at the turbine nacelle height. There is usually a large spread in these data of at least 20 dBA. This means that there can be many 10-minute periods for which the average noise level exceeds the allowed exterior noise level by a very large amount, resulting in excessive interior noise levels for significant periods of time, even though the wind farm will be deemed compliant. Thus compliance checking is over-generous to the developer and the process is unfair to the residents as it overlooks extensive time periods where the wind farm noise levels exceed those that are allowed. Therefore I believe that the guidelines should be changed so that the allowable noise levels are “not to exceed” average indoor noise levels, rather than regression-line fitted outdoor noise levels. This is particularly important for the night time, when there is a risk of people being awakened by a loud event. After such an event, the person may have trouble going back to sleep and may lie awake in anticipation of the next noise event.

2. Although there is a penalty of 5 dBA to be added to the measured noise levels if the noise is shown to be "tonal" in nature, there is no consideration of any penalty to be applied if the noise is excessively amplitude modulated (AM) or if it varies substantially over short time periods or if it is predominantly low-frequency in nature. The methodology used to determine the level of AM should be clearly specified and should be based on the results of listening tests. It may be necessary to consider AM of specific third-octave bands rather than the overall level. Findings from the Renewable UK report released in 2013 could provide a basis for an acceptable criteria and method of establishing and quantifying AM.

3. Another limitation is associated with the method of tonality assessment which according to the SA guidelines should follow the method recommended in the standard, IEC 61 400-11. This standard suggests that the assessment should be based on measurements made near a turbine, but it would seem more appropriate to make the measurements near houses where residents are subjected to the noise. The guidelines should also include a requirement to use night-time as well as day-time measurements and should analyse data from all wind directions, not just downwind. In addition all data should be assessed, rather than just the 2 minutes closest to the integer wind speed, all wind speeds should be investigated rather than focusing on only 6 – 10 m/s at 10 m height and instructions should be given on whether to apply the 5 dBA correction to the affected measurement only or to apply it to the value calculated from the regression curve.

4. Another limitation of the SA guidelines is associated with the establishment of the allowable levels when the wind speed becomes sufficient that background noise levels exceed the specified allowed level (35 or 40 dBA, depending on whether the site is zoned "rural living" or "rural industry"). One aspect of the problem is that, especially in conditions of high wind shear, wind at the residence location is not necessarily related to the wind speed and direction at hub height. A second aspect is that according to the guidelines, night-time data are averaged with day-time data to provide a single regression curve which represents the "measured" background noise levels that will be used in compliance checking. A serious draw-back with this approach is that the night time background noise levels are generally substantially lower than day-time levels, so as a result of day-time and night-time averaging, residents are being subjected to excessive noise right at the time they are trying to sleep. Thus there should be different regression curves presented for day-time and night-time. Also the night-time hours should be specified to be between midnight and 5am as this is usually the quietest time period.

5. The guidelines do not address the issue of the noise spectrum being dominated by low frequency noise at the location of the affected residences. To address this highly probable event, limits should be provided that are directed at the low-frequency part of the spectrum such as the DEFRA guidelines published in 2005.

6. Another limitation is associated with the development assessment in many cases, and this is the classification of rural residences as "rural industry" if they produce goods that they sell, rather than the much more reasonable "rural living", as people need to be able to sleep in these "rural industry" zones, something that is not generally a requirement in other industrial zones. In terms of allowed outdoor noise levels, the difference in the above-mentioned classifications is 5 dBA. As the aim of the specification of acceptable noise levels in the case of wind farm

developments is primarily to ensure that the majority of people exposed do not suffer sleep disturbance, and in Australia all wind farm developments are in rural areas, the use of zoning does not make sense – there should just be a single number specified that ensured that people could sleep without being interrupted by wind farm noise. The selected noise limit should be based on a dose response study specific to South Australian rural areas.

7. If on/off testing is to be done to assist in determining compliance, it should be done according to Australian Standard, AS4959:2010 at the "critical wind speed", which is the wind speed associated with the predicted smallest margin of compliance.

8. Implicit in the EPA guidelines is the assumption that external background noise is capable of masking wind farm noise provided that wind farm noise does not exceed the background noise by more than 5 dBA. However, there is no evidence in the literature that supports this assumption. Further work is required in this area, including the analysis of the masking potential of background noise in relation to typical indoor wind turbine spectra, to determine a suitable threshold.

9. Since measurements of wind farm noise are often required in windy conditions, the guidelines should include specifications for secondary windshields for microphones, which will minimise the contamination of the data from noise resulting from atmospheric turbulence as well as noise produced by wind blowing across the measurement microphones.

10. The effect of air density, wind shear, inflow turbulence and inflow angle at hub height on the turbine sound power levels should be included in the noise predictions so that an upper bound to the turbine sound power is used rather than the values measured in flat terrain with little in-flow turbulence and negligible wind shear. Alternatively an acceptable safety margin could be applied to the sound power levels provided by the manufacturer that takes into account variations between turbines as well as the effects mentioned above.

11. More recent sound propagation models such as Nord2000 and harmonoise are now available and should be investigated for their suitability. In particular, the guidelines should address the uncertainty associated with use of a particular model and the allowable predicted noise levels should take this uncertainty into account.

In conclusion, I believe that there is a strong case for revisiting and modifying the 2009 SA EPA Guidelines for wind farm noise.

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