



Planning &
Environment

Wind Energy: Noise Assessment Bulletin

***For State significant wind
energy development***

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Purpose

This Noise Assessment Bulletin provides proponents of wind energy projects and the community with advice about how noise impacts are assessed for large-scale wind energy development projects that are State significant development (SSD).

The NSW Government is seeking to promote a planning and assessment framework which is consistent with the standards that apply nationwide. This Bulletin explains the framework that will be adopted together with additional clarification around key noise assessment matters such as low frequency noise and monitoring.

This Bulletin has been prepared jointly by the Department of Planning and Environment (the Department) and the Environment Protection Authority (EPA), and should be read in conjunction with the more general assessment requirements outlined in the *Wind Energy Guideline*.

In NSW, the EPA regulates noise associated with large scale wind energy projects via an environment protection licence (EPL) issued under the *Protection of the Environment Operations Act 1997*. The EPL will typically include noise performance requirements.

Application of this Bulletin

This Bulletin applies to all new SSD wind energy proposals that obtain Secretary's environmental assessment requirements (SEARs) after the date of publication of this Bulletin. The Bulletin also applies to all modification applications made after the date of publication of this Bulletin.

Consent authorities will also apply the Noise Monitoring and Noise and Health sections of this Bulletin for applications which have been submitted but not determined at the date of publication of this Bulletin.

Objective of this Bulletin

This Bulletin provides practical guidance to proponents, planners, regulatory authorities, acoustic specialists and the broader community on how to measure and assess environmental noise impacts from wind energy projects. Given the unique characteristics of noise generated by wind turbines, this Bulletin provides greater clarity and rigour for the assessment and regulation of wind energy development noise, including low frequency noise, tonality and auditing and compliance issues. The objective is to ensure that the noise impacts of wind energy projects are appropriately identified, mitigated and managed.

This Bulletin will be reviewed from time to time as required, such as to reflect changes in technology and contemporary assessment methods.



Background

Wind energy development is a key component of the Government's commitment to increase renewable energy in NSW. Wind energy projects require reliable wind resources which may be located in quiet, rural areas. Noise generated by wind energy development is often raised as a concern for people living in these areas.

To ensure acceptable noise levels for people living in the area surrounding a proposed wind energy project, the NSW Government has adopted clear standards for conducting a noise impact assessment to accurately predict noise levels at surrounding dwellings.

The assessment of noise impacts arising from wind energy development is unique in three key ways:

- Wind turbines operate under very different conditions to other industrial noise sources in that they only function when there is wind, and the noise level from each wind turbine rises as the wind speed at the site increases. However, an increase in wind speed typically results in an equal or greater increase in the background noise at receiver locations due to aerodynamic and foliage noise which may mask turbine noise. The increase in background noise with wind speed is generally site specific and needs to be determined in the assessment process.
- The height of the noise source centre (the machinery inside the enclosure at the top of the tower, called the nacelle) is highly elevated compared to other noise sources such as roads, railways, mines and most industrial facilities. As a result, there is less opportunity to mitigate or shield the propagation of wind turbine noise.
- In rural areas, farming and agricultural activities can generate significant noise from sources such as road traffic and farm machinery. Whilst noise from wind turbines is not likely to be dominant, the characteristics of wind turbine noise may be perceived as being different to other noise sources.

Given these unique characteristics, specific guidance on the assessment of noise generated by wind energy projects is warranted.

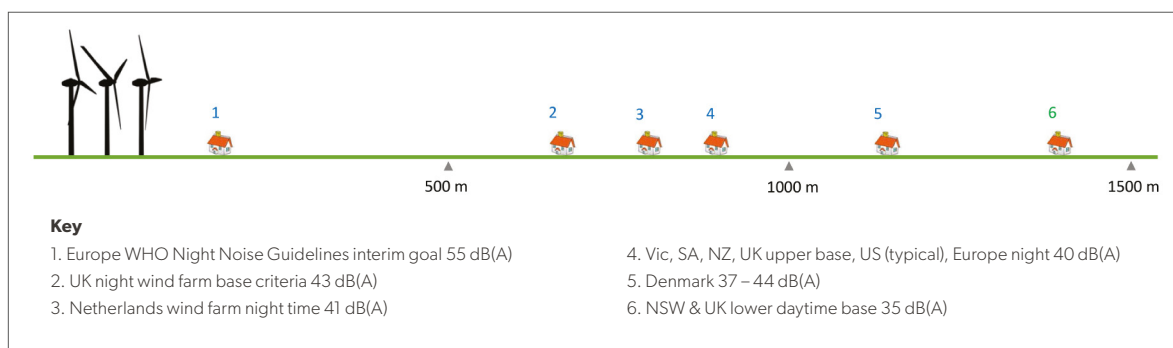
Framework for noise assessment

The NSW Government has adopted the 2009 South Australian document *Wind farms – environmental noise guidelines* (SA 2009)¹. SA 2009 will form the basis of the regulatory noise standard and assessment methodology that will apply when SSD wind energy proponents are assessed and determined in NSW. Adopting SA 2009 will facilitate increased regulatory consistency between states and result in consistent standards applying to significant areas of Australia with high quality accessible wind resources.

SA 2009 sets out the methodology that proponents are required to follow when assessing the noise impacts associated with a proposed wind energy project, and the documentation requirements for a noise impact assessment. Proponents of wind energy projects in NSW are required to apply the provisions of SA 2009, however, in recognition that the regional areas of NSW with high quality wind resources are more populated than the equivalent regions in South Australia, the SA 2009 Guideline has been supplemented with the specific variations for NSW requirements discussed below.

Figure 1 below shows the average distances at which compliance with different noise standards is expected to occur, using noise standards from other Australian states and international jurisdictions as examples.

Figure 1. Conceptual diagram showing representative distances at which a range of noise objectives may be achieved² (modelled using ISO 9613.2 algorithm for 3 typical turbines directly upwind of receivers).



The criteria in this Bulletin have been developed to address potential noise impacts on the amenity of residents and other relevant receivers in the vicinity of a proposed wind energy project. Wind energy proponents commonly negotiate agreements with private land owners where applicable noise limits may not be achievable at relevant receiver locations. A negotiated agreement will be considered as part of the assessment of a wind

¹ Wind farms – environmental noise guidelines, SA Environmental Protection Authority, (2009) available at: http://www.epa.sa.gov.au/data_and_publications/all_publications/for_councils/wind_farm_noise

² NOTE: Comparison of inter-jurisdictional wind farm criteria is complex. The noise setback distances above are indicative only and do not account for site specific conditions which may increase or decrease the noise level, such as topography. The NSW criteria would typically be achieved at setback distances of between 0.8 – 1.5km due to project and site-specific factors such as turbine configuration, design, intervening topography and vegetation.

energy project, as will the requirements of SA 2009 and this Bulletin. The proponent's EIS should clearly identify the expected noise levels at all receiver locations including host properties to ensure that affected persons are appropriately informed regarding the development proposal.

If development consent is granted for an SSD wind energy project, the proponent will need to obtain an environment protection licence (EPL) from the EPA before commencing construction.

Scoping and pre-lodgement assessment

Proponents of wind energy projects are required to consider the potential noise impacts of a wind energy project at all stages of the project, including during the site selection and project design phase, where the development should be designed to minimise noise impacts.

At the pre-lodgement stage, a proponent should undertake an indicative noise impact assessment of noise levels expected at all receivers. The indicative noise assessment will form part of the Preliminary Environmental Assessment to be submitted when making a request for SEARs. While it is recognised that a project's design may change at the development application stage, it is important to provide early indicative noise predictions using simple modelling techniques and conservative assumptions. Such assumptions would include using the maximum sound power level of the likely turbine proposed and calculated under the worst case noise propagation conditions. These indicative predictions should be compared against the base criteria adopted in NSW of 35 dB(A), unless detailed studies support more elevated criteria on the basis of prevailing background noise levels.

Environmental Impact Statement

The proponent must prepare a report detailing the noise assessment undertaken and include it in the Environmental Impact Statement (EIS) that is submitted to the Department with the SSD application. By this stage, the proponent will need to have undertaken monitoring to determine the background noise levels and modelling of the predicted noise levels of the proposed turbines.

As a minimum, the noise assessment report must include the following information:

- the model used to predict the wind energy project noise levels and input assumptions and factors used in the model, noting that noise management mode or sector management (i.e. stopping individual turbines or combinations, or operating in low noise mode, during identified meteorological conditions) should not be used in the primary modelling or predicting of noise levels. Any modelling and predictions which incorporate noise management mode or sector management must be reported separately;
- background noise measurement locations including time and duration of the background noise monitoring program;
- wind speed monitoring locations within the project area, heights above ground and graphical correlation plot of hub height wind speed versus background noise level data;

- a summary of the environmental noise criteria for the project at each integer wind speed based on the above correlation;
- make and model of the representative wind turbine(s) along with the positions of the wind turbines;
- predicted noise levels at the closest non-associated dwellings to the wind energy project at each integer wind speed;
- a comparison of the predicted noise levels against the criterion at each integer wind speed for the closest non-associated dwellings to the wind energy project; and
- modifications or operating strategy that would be employed to address any unforeseen non-compliances. The error margins of the noise model used should be considered in developing such modifications or strategies.

The Department and the EPA will assess the noise assessment report to determine whether it has been undertaken in accordance with the requirements of SA 2009 and this Bulletin, and whether the predicted noise levels comply with the applicable criteria.

Determination and post approval regulation

Following assessment of a wind energy project application, the consent authority will determine whether the project should be approved on its merits. The consent authority will consider the noise impacts of the project alongside the other environmental, social and economic considerations, including the public interest. If consent is granted, it will be subject to conditions which will include a requirement that monitoring of the noise generated by the operation of wind turbines is undertaken to ensure they do not exceed the relevant criteria.

The purpose of operational noise monitoring is to assess whether a wind energy project is operating in compliance with approved noise limits and to ensure any exceedances identified are rectified satisfactorily. The conditions of consent will require the proponent to prepare a specific compliance assessment methodology and to undertake noise compliance monitoring. This methodology will be considered as part of the Department's assessment.

If noise compliance monitoring indicates that noise from turbines exceeds the approved noise limits, the proponent will identify reasonable and feasible noise mitigation and management measures to achieve compliance with the noise limits, including a timetable for implementation. These measures will be dependent on the nature of the issue and implemented on a case-by-case basis.

Noise limits and objectives

The purpose of setting noise level objectives for wind turbines is to retain noise levels that are compatible with surrounding land uses and to ensure that noise levels do not significantly affect the living experience of people residing in the area.

Under SA 2009, a higher base noise level is permitted in land use zones associated with high intensity farming practices and a lower base noise level applies in land use zones associated with residential uses. Excursions above the base criterion are allowed provided this level does not exceed the ambient background noise level + 5 dB(A).

The NSW Government recognises that rural land use zones in NSW are often more densely settled than those of South Australia and that there is a relatively high density of rural residential living in parts of regional NSW with reliable wind resources.

Therefore only the lower base noise criteria in SA 2009 will be applied in NSW. This criteria is defined as:

The predicted equivalent noise level (LAeq,10 minute), adjusted for tonality and low frequency noise in accordance with these guidelines, should not exceed 35 dB(A) or the background noise (LA90(10 minute)) by more than 5 dB(A), whichever is the greater, at all relevant receivers for wind speed from cut-in to rated power of the wind turbine generator and each integer wind speed in between.*

** Determined in accordance with SA 2009, Section 4.*

Note: While the noise criteria is established on the basis of a 24-hour period, noise readings are taken at 10 minute intervals.

Special noise characteristics

While the main noise assessment criteria for wind energy projects is the base noise level, there are alternate special noise criteria which need to be considered as part of the noise assessment process of any wind energy project.

Tonality

In addition to sound pressure level (measured in decibels, dB), the way sound is perceived is partially determined by its pitch or frequency (measured in Hertz, Hz). Human hearing covers frequencies from 20 Hz to 20,000 Hz and is less sensitive at low and high frequencies. Sounds which have unusually high levels of energy in a relatively narrow band of frequencies may be referred to as being tonal. Audible tonal sounds from wind turbines are generally related to rotational equipment in the turbine nacelle and can have a specific pitch dependent on the speed of rotation. This can cause the noise to be more annoying or noticeable. These tonal characteristics (as defined below) typically do not occur in well designed and well maintained wind turbines. If present, they are usually caused by a turbine maintenance issue³.

3 Guidance Note on Noise Assessment of Wind Turbine Operations at EPA Licensed Sites (NG3), Environmental Protection Agency, Ireland (2011).

SA 2009 requires that development applications for wind energy projects report the following:

“To help determine whether there is tonality, the method and results of testing (such as in accordance with IEC 61400-11) carried out on the proposed WTG model to determine the presence of tonality should also be specified in the development application”.

Further SA 2009 indicates in Section 4 – Compliance checking the following:

“Where, in the opinion of an officer authorised under the EP Act or an acoustical engineer (see definition in Glossary), the wind farm exhibits tonality as a characteristic, the developer or wind farm operator should conduct a tonality test in accordance with a procedure acceptable to the EPA”.

In NSW, in addition to the SA 2009 requirements, for both environmental assessment and compliance purposes, the presence of excessive tonality (a special noise characteristic) shall be consistent with the methodology described in *ISO 1996.2: 2007 Acoustics - Description, measurement and assessment of environmental noise – Determination of environmental noise levels (Annex D – Objective method for assessing the audibility of tones in noise – Simplified method)*. Tonality is defined as when the level of one-third octave band* exceeds the level of the adjacent bands on both sides by:

- 5 dB or more if the centre frequency of the band containing the tone is in the range 500 Hz to 10,000 Hz;
- 8 dB or more if the centre frequency of the band containing the tone is in the range 160 Hz to 400 Hz; and/or
- 15 dB or more if the centre frequency of the band containing the tone is in the range 25 Hz to 125 Hz.

* The descriptor shall be in accordance with SA 2009, Section 4

If tonality is found to be a repeated characteristic of the wind turbine noise, 5 dB(A) should be added to measured noise levels from the wind energy project. The tonal characteristic penalty applies only if the tone from the wind turbine is audible at the relevant receiver. Absence of tone in noise emissions measured at an intermediate location is sufficient proof the wind energy project noise is not tonal at a receiver location. The assessment for tonality should only be made for frequencies of concern from 25 Hz to 10,000 Hz and for sound pressure levels above the threshold of hearing (as defined in *ISO 389.7:2005 Acoustics – Reference zero for the calibration of audiometric equipment – Part 7: Reference threshold of hearing under free-field and diffuse-field listening conditions*).

Note 1: Narrow band analysis using the reference method in ISO1996-2:2007, Annex C may be required by the consent / regulatory authority where it appears that a tone is not being adequately identified, for example where it appears that the tonal energy is at or close to the third octave band limits of contiguous bands.

Note 2: Noise assessments for wind energy projects shall, however, also report the results of tonality assessments under IEC61400-11 for the particular turbine being considered.

Low frequency noise

Low frequency noise is present in all types of environmental noise and is particularly difficult to measure in the presence of wind due to the increased level of background noise. Analysis of wind turbine spectra shows that low frequency noise is typically not a significant feature of modern wind turbine noise when it complies with the A-weighted criteria applied by this Bulletin.

In NSW, contemporary approvals include the following requirement for low frequency noise:

The presence of excessive low frequency noise that is a repeated characteristic [i.e. noise from the wind farm that is repeatedly greater than 60 dB(C)] will incur a 5 dB(A) penalty, to be added to the measured noise level for the wind farm, unless a detailed low frequency noise assessment to the satisfaction of the Secretary demonstrates compliance with the proposed criteria for the assessment of low frequency noise disturbance (UK Department for Environment, Food and Rural Affairs (DEFRA, 2005)) for a steady state noise source.*

** The descriptor shall be in accordance with SA 2009, Section 4*

In the unlikely event that excessive low frequency noise is found to be a repeated characteristic of the wind turbine noise, 5 dB(A) should be added to the predicted or measured noise level from the wind energy project. Noise assessments for proposed wind energy projects shall assess the potential for non-associated residential receiver locations to experience low frequency noise levels exceeding 60 dB(C).

Note: Appropriate care needs to be taken when measuring C-weighted noise levels as wind at microphone height can influence the measured levels. The performance of the selected microphone / wind screen combination needs to be considered so that data potentially affected by wind induced noise across the microphone can be excluded.

Penalties for special noise characteristics

A special noise characteristic is defined as a repeated and excessive characteristic if it occurs for more than 10 per cent of an assessment period. This equates to being identified for more than 144 minutes in any day (24 hours).

SA 2009 applies an addition of 5 dB(A) to the measured noise level only where tonality is identified. When undertaking compliance checking to confirm that the operational wind energy project is meeting the applicable noise criteria, the wind energy project noise level is to be adjusted where excessive levels of tonality, low frequency noise, or a combination of both is identified in accordance with this bulletin to a maximum adjustment of 5 dB(A). Results of the calculations should be reported in the noise monitoring report.

Typically, monitoring campaigns designed to identify special noise characteristics would be not greater than one week.

Noise monitoring

Use of alternative / intermediate noise monitoring locations

Once operational, measurement of the operational noise of a wind energy project for a specified period will be required through a condition of consent. During typical operating conditions, wind turbine noise may be fully or partially masked, or substantially contaminated by wind or other extraneous noises. Measurement of wind turbine noise in these conditions is often difficult and in some cases not possible. To improve the ability to undertake compliance measurements, NSW regulators may accept alternative techniques. Such alternate techniques will need to be assessed individually and on their merits.

Techniques may include the use of alternative or intermediate locations between the wind energy project and the relevant receiver where the signal-to-noise ratio is much higher, and for which there are well established theoretical and empirical relationships to the relevant receivers. Data from such sites may be used to supplement and support conclusions obtained at the receiver locations.

In most cases, it is expected that intermediate locations will be chosen from predicted noise contour maps. Those intermediate locations would be expected to return Leq levels of around 45-50 dB(A) under down-wind conditions or be around 400 metres from the nearest turbines.

Where the use of an intermediate assessment location is proposed, long term noise monitoring and data analysis (pre and post-wind energy development) may be needed to assist in establishing the contribution noise level from the wind energy project.

If proposed, the use of intermediate noise monitoring locations should be identified in the site / project specific compliance assessment methodology required by conditions of consent.

Duration of monitoring

SA 2009 noise compliance checking procedure for operational wind energy projects requires the collection of 2,000 data points including a minimum of 500 from the worst case wind direction. Experience has shown that for some locations in NSW, the worst case wind direction rarely occurs. Therefore if it appears impractical to collect 500 valid data points under the worst-case conditions, data collection should continue for up to six weeks and the valid data collected in this period shall be deemed to be an acceptable quantity in terms of worst case wind direction. However, 2,000 valid data points should be obtained in all cases as part of the noise assessment procedure undertaken to demonstrate that the operating wind energy projects complies with the applicable noise criteria and the conditions of the consent.

Noise management mode and sector management

Noise Management Mode and Sector Management are operating strategies that may be employed by proponents to meet noise criteria and optimise turbine performance. If these strategies are intended to be used, proponents must provide the Department, the EPA and any potentially impacted residents with the parameters and meteorological conditions which trigger their use and an auditable process by which compliance can be independently confirmed.

Noise from ancillary sources

Noise from ancillary operation sources such as electrical substations should be assessed against the relevant guidelines and criteria, which is currently the NSW Industrial Noise Policy or as amended.

Noise and health

High levels of noise are associated with adverse health outcomes. To examine this potential relationship the National Health and Medical Research Council (NHMRC) undertook a comprehensive assessment of the scientific evidence on wind farms and human health. In 2015, the NHMRC concluded that “there is no direct evidence that exposure to wind farm noise affects physical or mental health”, and there is currently no consistent evidence supporting a link between wind energy projects and adverse health outcomes in humans relating to infrasound. More specifically, they stated that, “while exposure to environmental noise is associated with health effects, these effects occur at much higher levels of noise than are likely to be perceived by people living in close proximity to wind farms in Australia”.

The NSW Government’s position on potential health impacts of wind energy projects continues to be informed by the scientific findings of the NHMRC and the advice of NSW Health. In addition, a National Wind Farm Commissioner has been appointed and an Independent Scientific Committee on Wind Turbines established by the federal government to provide advice on the science and monitoring of potential impacts of wind turbine sound on health and the environment. The NSW Government will continue to monitor contemporary scientific research outcomes to ensure its position reflects robust evidence on any health effects, including any advice released from the National Wind Farm Commissioner and the Independent Scientific Committee.



References

Department for Environment, Food and Rural Affairs, UK, 2005. *Proposed criteria for the assessment of low frequency noise disturbance.*

NSW EPA (2000) *NSW Industrial Noise Policy* http://www.environment.nsw.gov.au/resources/ind_noise.pdf

International Electrotechnical Commission. *IEC 61400-11:2012 Wind turbines – Part 11: Acoustic noise measurement techniques.*

NSW Environment Protection Authority, 2000. *Industrial Noise Policy.*

NSW Department of Planning and Environment, 2011. *Draft NSW Planning Guidelines: Wind Farms.*

SA Environment Protection Authority, 2003. *Wind Farms: environmental noise guideline.*

SA Environment Protection Authority, 2009. *Wind Farms: environmental noise guidelines.*

International Organisation of Standards. *ISO 1996.2:2007 Acoustics - Description, measurement and assessment of environmental noise – Determination of environmental noise levels.*

Reference for *ISO 389.7:2005 Acoustics – Reference zero for the calibration of audiometric equipment – Part 7: Reference threshold of hearing under free-field and diffuse-field listening conditions).*

National Health and Medical Research Council (NHMRC) 2015 *NHMRC Statement and Information Paper: Evidence on Wind Farms and Human Health.*

<https://www.nhmrc.gov.au/health-topics/wind-farms-and-human-health>



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