Stockyard Hill Wind Farm

Initial Acoustic Compliance Report

S3425.2C16C

March 2022

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INTRODUCTION

The Permit for the Stockyard Hill Wind Farm (the **Wind Farm**) relevantly includes:

28. For the purposes of determining compliance, the following requirements apply:

…

c) An initial acoustic compliance report must be submitted within six months of the commissioning of the first turbine, and at six monthly intervals thereafter until full operation has commenced (following completion of construction and commissioning).

This report summarises the assessment of initial acoustic compliance at the Wind Farm.

The Noise Compliance Test Plan (the **NCTP**) outlines the procedure to be undertaken to conduct the compliance monitoring for the Wind Farm. As full compliance testing can only be conducted once all turbines have been commissioned and are operating, the NCTP proposes the testing close to an operating turbine for the initial compliance testing. This “near field" test is then compared with the predicted noise levels resulting from a noise model to determine if the Wind Farm is on target to achieve compliance. The near field test does not definitively demonstrate compliance or non-compliance. That determination is provided by the full compliance monitoring at residences, when the Wind Farm is operating at full capacity.

The near field test has been conducted in accordance with International Standard IEC61400-11. The full procedure, equipment and results are described in the Sonus Report with reference S3425.2C17.

NOISE MODEL

Predictions of the noise levels at residences have been made using the noise propagation model, *ISO 9613-2:1996 Acoustics – Attenuation of sound during propagation outdoors* (**ISO 9613-2**). ISO 9613-2 provides a methodology for predicting noise levels at sensitive land uses under meteorological conditions favourable to noise propagation. It is known as a downwind model, based on the conservative assumption of being downwind (resulting in the highest noise level) of all WTGs operating simultaneously. The noise prediction model inputs are in accordance with the *May 2013 UK IOA Good Practice Guide* (the **IOA Guide**) and the model is therefore accepted internationally as an accurate model. The inputs include:

- 10°C temperature;
- 70% relative humidity;
- 50% acoustically hard ground and 50% acoustically soft ground;
- barrier attenuation of no greater than 2 dB(A);
- 4m receiver height;
- correction factor of 2 dB(A) used to convert from L_{eq} to L_{90} (used for compliance monitoring); and,
- application of a 3 dB(A) correction where a "concave" ground profile exists as defined by the IOA Guide.

The layout of the Wind Farm consists of six different turbine configurations, comprising the Goldwind GW3S model with three power ratings and four types of blade serrations. The various configurations and number of each can be seen in Table 1 below. The noise from these installed turbines has been previously measured on-site and the results of which have been used as the inputs to the noise model.

Table 1: Turbine configurations.

Turbine Model	Rated Power	Blade Configuration	Number Present in Wind Farm
GW3S	3570	Clean Blades	1
GW3S	3570	3/4/5 TES	7
GW3S	3570	V4 TES	18
GW3S	3570	V5 TES	102
GW3S	3400	V5 TES	19
GW3S	3000	V5 TES	2

Predictions (shown in Table 2 below) have been made for a wind speed of 11m/s, as this corresponds with the highest noise level emissions from the turbines based on the previous measurement data.

PREDICTED NOISE LEVELS

The predicted noise levels resulting from the noise model can be seen in Table 2 below. Noise contours of the predictions can also be seen in Figure 1 below.

Table 2: Predicted noise levels.

Dwelling	Associated (Yes/No)	Predicted Noise Level	Dwelling	Associated (Yes/No)	Predicted Noise Level	Dwelling	Associated (Yes/No)	Predicted Noise Level
B004	No	33 dB(A)	B094	No	34 dB(A)	B167	No	37 dB(A)
B005	No	35 dB(A)	B096	No	32 dB(A)	B168	Yes	44 dB(A)
B006	No	37 dB(A)	B097	Yes	42 dB(A)	B170*	Yes	44 dB(A)
B007	No	32 dB(A)	B098	No	37 dB(A)	B171	No	38 dB(A)
B026	No	30 dB(A)	B102	Yes	40 dB(A)	B172	No	36 dB(A)
B027	No	37 dB(A)	B103	Yes	44 dB(A)	B198	No	33 dB(A)
B028	No	36 dB(A)	B104	Yes	44 dB(A)	B201	No	33 dB(A)
B029	No	37 dB(A)	B106	No	32 dB(A)	B203	Yes	41 dB(A)
B030	No	36 dB(A)	B107	No	31 dB(A)	B204	No	34 dB(A)
B031	No	35 dB(A)	B108	No	35 dB(A)	B206	No	30 dB(A)
B032	No	35 dB(A)	B109	No	35 dB(A)	B207	No	31 dB(A)
B033	No	37 dB(A)	B110	No	38 dB(A)	B208	No	30 dB(A)
B034	No	36 dB(A)	B111	No	38 dB(A)	B209	No	30 dB(A)
B038	No	31 dB(A)	B112	No	39 dB(A)	B210	No	31 dB(A)
B039	No	33 dB(A)	B113	No	38 dB(A)	B211	No	30 dB(A)
B040	No	34 dB(A)	B114	No	38 dB(A)	B212	No	31 dB(A)
B041	No	36 dB(A)	B115	Yes	37 dB(A)	B231	No	34 dB(A)
B042	No	35 dB(A)	B116	No	30 dB(A)	B232	No	33 dB(A)
B044	No	31 dB(A)	B117	No	31 dB(A)	B241	No	33 dB(A)
B051	No	33 dB(A)	B118	No	35 dB(A)	B245	Yes	41 dB(A)
B053	Yes	41 dB(A)	B119	No	38 dB(A)	B318	Yes	43 dB(A)
B054	No	32 dB(A)	B120	Yes	44 dB(A)	B322	Yes	39 dB(A)
B055	No	32 dB(A)	B121	No	37 dB(A)	B328	No	36 dB(A)
B056	No	31 dB(A)	B122	No	38 dB(A)	B334	No	33 dB(A)
B058	Yes	42 dB(A)	B123	No	35 dB(A)	B335	No	35 dB(A)
B060	Yes	39 dB(A)	B124	Yes	40 dB(A)	B337	No	35 dB(A)
B061	Yes	39 dB(A)	B125	No	36 dB(A)	B343	Yes	41 dB(A)
B064	Yes	40 dB(A)	B126	No	32 dB(A)	B345	Yes	42 dB(A)
B065	No	36 dB(A)	B127	Yes	42 dB(A)	B346	No	32 dB(A)
B066	No	35 dB(A)	B128	No	27 dB(A)	B352	No	32 dB(A)
B067	Yes	35 dB(A)	B135	No	33 dB(A)	B360	No	31 dB(A)
B068	Yes	36 dB(A)	B136	No	33 dB(A)	B366	No	38 dB(A)
B069	No	32 dB(A)	B138	No	33 dB(A)	B372	No	32 dB(A)
B078	No	33 dB(A)	B140	Yes	43 dB(A)	B374	No	35 dB(A)
B079	No	36 dB(A)	B141	Yes	40 dB(A)	B376	No	33 dB(A)
B080	Yes	43 dB(A)	B142	Yes	37 dB(A)	B377	No	33 dB(A)
B081	No	36 dB(A)	B143	Yes	41 dB(A)	B379	No	34 dB(A)
B082	Yes	36 dB(A)	B144	Yes	39 dB(A)	B386	No	34 dB(A)
B083	No	38 dB(A)	B145	Yes	44 dB(A)	B387	No	32 dB(A)
B084	No	37 dB(A)	B146	Yes	42 dB(A)	B388	No	32 dB(A)
B085	Yes	36 dB(A)	B149	Yes	43 dB(A)	B420	No	35 dB(A)
B086	No	35 dB(A)	B150	No	33 dB(A)	B421	Yes	44 dB(A)
B091	No	35 dB(A)	B151	Yes	37 dB(A)			
B092	No	35 dB(A)	B152	No	32 dB(A)			

* Denotes a dwelling owned by the Wind Farm

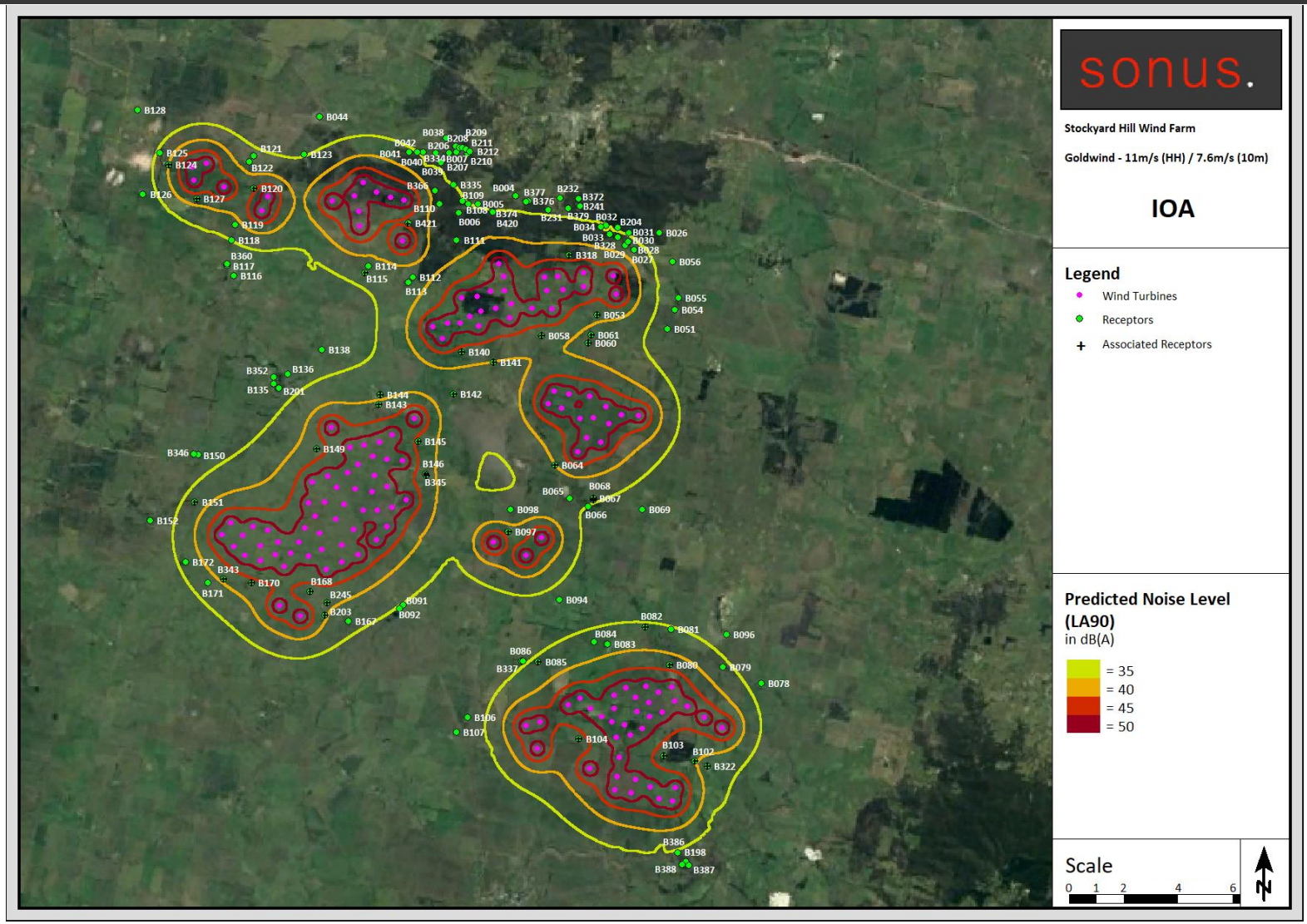

Figure 1: Noise level contours.

It is understood that B148 is owned by the Wind Farm and is pending demolition. The predicted level has therefore not been reported, though it has been included in the above figure for completeness.

As per the NCTP, the baseline (most onerous) noise criteria which apply are as follows:

- For a non-participant dwelling, a L_{90} level of 40 dB(A); and,
- For a participant dwelling, a L_{90} level of 45 dB(A).

It is noted that criteria may be higher at certain receptors based upon the background noise level at these locations. Nonetheless, compliance with the baseline criteria will ensure compliance irrespective of the background noise level. From the results above, it can be seen that the Wind Farm is on track to achieve compliance at all nearby sensitive receptors, subject to the turbine noise levels used for this assessment being applicable (i.e., not exceeded).

NEAR FIELD NOISE MEASUREMENTS

In order to confirm the accuracy of the turbine noise levels used for the predictions, near field noise measurements were taken at one of the currently operating wind turbines on the site. WTG18 was chosen, as it is a GW3S turbine operating at 3570KW with V5 TES blades, which is the most common configuration employed for the Wind Farm. The predictions were based on a sound power level of 111.0 at WTG 18.

Noise monitoring equipment was placed in the proximity of the turbine between 10 January 2022 and 12 January 2022. Table 3 below provides the coordinates and distance from WTG18. The location of the noise monitoring equipment relative to the turbine can be seen in Figure 2 below.

Table 3: Noise monitoring location.

Coordinates		Distance (m)
Easting	Northing	
703444	5840608	166

Figure 2: Noise monitoring equipment relative to WTG18.

Apparent Sound Power Levels

In order to be consistent with the noise levels used for the noise model, the apparent sound power level should be no more than 111.0 dB(A) at any integer wind speed.

Measured noise levels were correlated against the hub height wind speed, as measured by the SCADA system at the turbine. The correlation can be seen in the graph in Figure 3 below, with outliers removed.

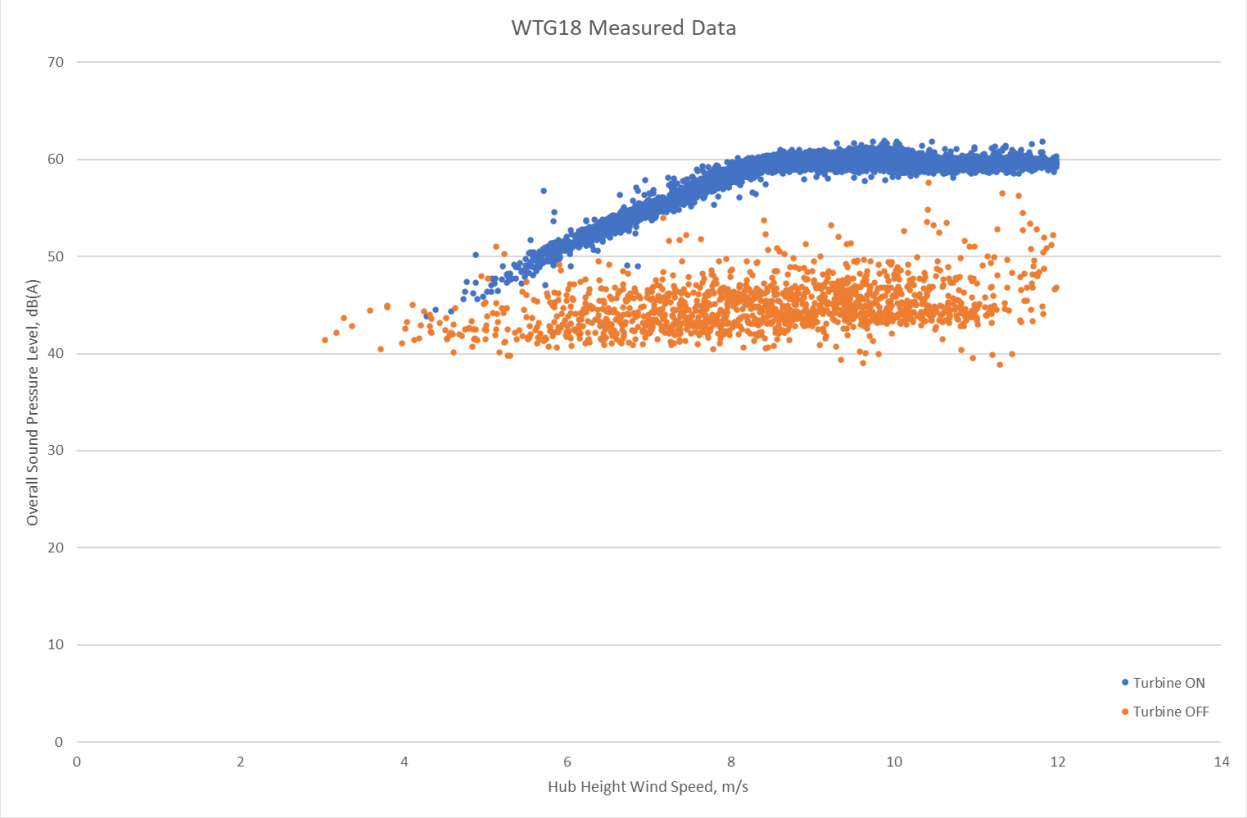

Figure 3: Noise measurement results.

Based on the above measured values, Table 4 below shows the resultant apparent sound power levels at each integer wind speed.

Table 4: Apparent Sound Power levels.

Integer Wind Speed (m/s)	6	7	8	9	10	11	12
Apparent Sound Power Level (dB(A))	101.6	105.6	109.3	110.7	110.9	110.5	110.3

The above table indicates that the apparent sound power levels are no greater than 111.0 dB(A). Thus, the turbine is not expected to generate a higher level of noise than that used in the noise model, regardless of wind speed. This means that the noise levels at the nearby sensitive receptors are expected to be no greater than those shown in Table 2 above.

Special Audible Characteristics

Assessments of tonality and amplitude modulation were conducted at each integer wind speed. The tonality assessment was conducted in accordance with Annex C of International Standard ISO 1996-2:2007 and amplitude modulation assessment was conducted in accordance with the interim method described in New Zealand Standard NZS6808:2010.

No excessive tonality or amplitude modulation was identified in the near field tests.

CONCLUSION

Compliance testing for the completed Wind Farm will be undertaken in accordance with the procedure laid out in the NCTP. Prior to full operation of the Wind Farm, an initial assessment has been conducted in order to gauge the likelihood of achieving compliance upon completion of the Wind Farm.

A noise model was prepared in accordance with ISO 9613-2 to predict the noise at the nearby sensitive receptors. The noise levels used for this model were taken from previous measurements of the configurations of turbines used for this Wind Farm.

Near field noise measurements were conducted for the most common turbine configuration in order to compare the noise levels against those used for the noise model. The results of these measurements show that the highest noise level produced by the constructed turbine is no greater than that used for the predicted noise assessment. The measurements also found no excessive tonality or amplitude modulation. This indicates that the Wind Farm is on target to achieve compliance.

Full compliance monitoring will be conducted to definitively determine compliance, once all of the turbines have been commissioned and are operating.

ARUP

Stockyard Hill Wind Farm Pty Ltd

Stockyard Hill Wind Farm

Verification Audit of Initial Acoustic Compliance Report

Reference:

Issue | 8 March 2022

Job number 286169-00

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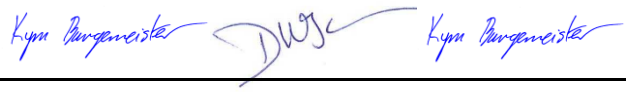
		Signature			
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Issue Document Verification with Document ☑

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Auditor Declaration

Verification of Stockyard Hill Wind Farm Initial Acoustic Compliance Report.

I, David W Spink, an environmental auditor appointed pursuant to the *Environmental Protection Act 2017*, having:

1. Been requested by Stockyard Hill Wind Farm Pty Limited to verify the Initial Acoustic Compliance Report for the Stockyard Hill Wind Farm (SHWF), undertaken by Sonus Pty Ltd (Sonus Reference: Report S3425.2C16C, dated March 2022) (Initial Acoustic Compliance Report) and associated Acoustic Analysis of Wind Turbine Generator 18 (Sonus Reference: Report S3425.2C17, February 2022) (Technical Report).
2. Specifically, I have been requested to independently verify whether or not the acoustic assessment as provided in the Initial Acoustic Compliance Report and associated Technical Report complies with the relevant conditions of the Planning Permit and the endorsed Noise Compliance Test Plan (NCTP).
3. Having regard to, (amongst other things);

    - *Environment Protection Act 2017* as amended by the *Environment Protection Amendment Act 2018*
    - *Environment Protection Amendment (Interim) Regulations 2021* (Regulations)
    - *Planning Permit PL-SP/05/0548/B under the Pyrenees Planning Scheme (Amendment dated 23 July 2018)* (Planning Permit)
    - *New Zealand Standard NZS 6808:2010 Acoustics – Wind Farm Noise* (Standard)
    - *Noise Compliance Test Plan* (Sonus Report No. S3425.2CS dated January 2018) (NCTP)

    and the following relevant documents

    - *Initial Acoustic Compliance Report* (Sonus Report No. S3425.2C16C, March 2022) (Initial Acoustic Compliance Report)
    - *Acoustic Analysis of Wind Turbine Generator 18* (Sonus Report S3425.2C17, February 2022) (Technical Report)
    - *Stockyard Hill Wind Farm Pre-Development Noise Assessment* (Marshall Day Acoustics Report No. 001 R04 20170840, 20 December 2017).
    - *Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria (DELWP, July 2021)*
    - *Wind Energy Facility Noise Regulation Guidelines* (EPA Publication, March 2022)
    - *Development of Wind Farm Facilities in Victoria – Policy and Planning Guidelines* (DELWP, March 2019) (2019 DELWP Guideline)
    - *Wind Energy Facility Noise Auditor Guidelines* (EPA Publication 1692, October 2018) (2018 EPA Guideline)
    - *Environmental Auditor Guidelines – Provision of statements and reports for environmental audits and preliminary risk screen assessments* (EPA Publication 2022, August 2021)
    - *Environmental Auditor Guidelines for the Preparation of Environmental Audit Reports on Risk to The Environment* (EPA Publication 952)
    - *Environmental Auditor Guidelines for Conducting Environmental Audits* (EPA Publication 953)

- *International Standard IEC61400-11:2012 Wind turbines – Part 11: Acoustic noise measurement techniques* (IEC 61400-11:2012)
- *International Standard ISO 1996-2:2007 Acoustics – Description, measurement and assessment of environmental noise – Part 2: Determination of environmental noise levels* (ISO 1996-2:2007)

4. Hereby declare that I am of the opinion that:
    - The initial acoustic compliance testing has been conducted in accordance with the approved Noise Compliance Test Plan, by a suitably qualified and experienced acoustics expert, in compliance with Planning Permit Condition 27.
    - The analysis and reporting of the initial acoustic compliance assessment, as provided in the Initial Acoustic Compliance Report and associated Technical Report, has been prepared by a suitable qualified and independent acoustics expert, in compliance with Planning Permit Condition 28(a).
    - The initial acoustic compliance assessment demonstrates that based on the sound power output from the turbines measured on site, the SHWF is likely to comply with the noise limits set out in the Standard, and Planning Permit Condition 21.

Dated: 08/03/2022

Signed:

David W Spink

Environment Auditor (Industrial Facilities) – Appointed pursuant to the *Environment Protection Act 2017*

List of Acronyms

Acronym	Definition
AGL	**Above Ground level**
EPA	**Environment Protection Authority, Victoria**
DELWP	**Department of Environment, Land, Water, and Planning (Victoria)**
dBL_{WA}	**Overall A-weighted Sound Power Level, dB re 1pW**
dB re 1pW	**deciBels relative to a reference sound power level of 1 pico-Watt**
NCTP	**Noise Compliance Test Plan**
NMP	**Noise Management Plan**
NZS	**New Zealand Standard**
SAC	**Special Audible Characteristic**
Standard	**NZS 6808:2010 Acoustics – Wind Farm Noise**
SHWF	**Stockyard Hill Wind Farm**
TES	**Trailing Edge Serrations**
WEF	**Wind Energy Facility**

1. Overview

1.1 Background to Verification of the Stockyard Hill Wind Farm Initial Acoustic Compliance Report

Stockyard Hill Wind Farm Pty Ltd is developing the Stockyard Hill Wind Farm (SHWF), located across an area between Ballarat and Ararat, nominally approximately 35 km to the west of Ballarat within the Pyrenees Shire.

Planning Permit PL-SP/05/0548/B (as amended 23 July 2018) issued under the Pyrenees Planning Scheme require a Noise Compliance Testing Plan (NCTP) approved by the Minister for Planning before commissioning of the SHWF (Condition 27), and a Noise Compliance Assessment to be conducted (Condition 28).

An initial acoustic compliance assessment has been prepared for the SHWF by Sonus Pty Ltd (Sonus) in accordance with the requirement to provide initial *Near Field and Intermediate* testing of the wind turbines documented in the NCTP, to comply with Condition 28(c) of the Planning Permit (which requires an *initial acoustic compliance report* to be submitted).

The SHWF consists of 149 approved Model GW3S turbines, with varying rated power generation between 3.00 MW and 3.57MW. The near-field testing has been undertaken on Turbine WTG18, a GW3S turbine rated at 3.57 MW with V5 TES blades – this turbine represents the most commonly installed turbine configuration at the SHWF (102). This turbine was tested in accordance with:

- International Standard IEC61400-11:2012 Wind turbines – Part 11: Acoustic noise measurement techniques (IEC 61400-11:2012) – to determine overall sound power levels
- International Standard ISO 1996-2:2007 Acoustics – Description, measurement and assessment of environmental noise – Part 2: Determination of environmental noise levels (ISO 1996-2:2007) – to determination presence of excessive tonality
- New Zealand Standard NZS 6808:2010 Acoustics – Wind Farm Noise (Standard). Also referred to as the Standard. – to determine the presence of excessive amplitude modulation

Condition 28(g) of the Planning Permit requires that all noise compliance reports must be accompanied by a report from an Environmental Auditor appointed under the *Environment Protection Act 1970* (this Act has now been replaced by the *Environment Protection Act 2017*), with their opinion on the methodology and results contained in the noise compliance testing. This requirement aligns with the requirement of Reg 131D(3)(b) of the *Environment Protection Amendment (Interim) Regulations 2021*. This audit is termed a verification audit. The verification audit has been undertaken by David Spink, an Environmental Auditor appointed under the *Environment Protection Act 2017*. Technical support was provided by Dr Kym Burgemeister, Principal and Australasian Regional Acoustics Leader, Arup Australasia.

It is noted that the work to date is not the *final* compliance testing and report, which will be undertaken upon completion of the construction and commissioning of the SHWF at the sensitive receiver locations identified in the NCTP in accordance with the Standard. That work will be subject to a separate verification process in accordance with Planning Permit Condition 28(d) and Regulation 131D of the *Environment Protection Amendment (Interim) Regulations 2021*, when the SHWF is completed.

The EPA and DELWP requirements refer to a wind farm as a Wind Energy Facility (WEF); however, the term Wind Farm has been used in this Verification Audit Report for consistency with terminology used in the Sonus reports and the Standard.

1.2 Planning Permit requirements

The original Planning Permit under the Pyrenees Planning Scheme was issued on 26 October 2010, with the current permit No PL-SP/05/0548/B issued on 23 July 2018. This Planning Permit included conditions which specified requirements for the control of noise from the SHWF.

Key conditions related to this Verification Audit are as follows;

Condition	Requirement
26. Noise Compliance Testing Plan	A noise compliance testing plan (NCTP) must be prepared by a suitably qualified and experienced acoustics expert
27. Noise Compliance Testing	Noise compliance testing shall be carried out by a suitably qualified and experienced expert in accordance with the approved testing plan
28 Noise Compliance Assessment	a) Acoustic compliance reports shall be prepared by a suitably qualified and experienced independent acoustic engineer to demonstrate compliance with the noise limits specified in the standard
	c) An initial acoustic compliance report must be submitted within six months of the commissioning of the first turbine, and at six monthly intervals thereafter until full operation has commenced (following completion of construction and commissioning).
	g) All noise compliance reports must be accompanied by a report from an environmental auditor appointed under the *Environment Protection Act 1970* with their opinion on the methodology and results contained in the noise compliance testing.

1.3 EPA Requirements

The introduction of the *Environment Protection Act 2017* and *Environment Protection Regulations* 2021 (and updated with issue of the *Environment Protection Amendment (Interim) Regulations 2021)* (Regulations)) has altered the post-construction Assessment Audit process from a "S53V" statutory audit (under the *Environment Protection Act 1970*) to a non-statutory "Auditor's Opinion", termed a Verification Audit. Specially, Reg 131D of the Regulations provides requirements for the Post-construction Noise Assessment, that states in part:

(2) A post-construction noise assessment must-

(a) be conducted in accordance with NZS 6808:2010 by a suitably qualified and experienced acoustician; and

(b) demonstrate whether or not the facility complies with the noise limits set out in accordance with NZS 6808:2010.

(3) The operator must –

(a) ensure that a report of the post-construction noise assessment is prepared; and

(b) engage an environmental auditor to prepare a report under regulation 164(ca)(i) in relation to the post-construction noise assessment.

Regulation 164(ca(i)) specifies that the auditor is to:

… independently verify whether or not any noise assessment conducted for the wind energy facility was conducted in accordance with the relevant noise standard.

1.4 Relevant Guidelines

1.4.1 Department of Environment, Land, Water and Planning (DELWP)

The DELWP has previously issued guidance through the publication - *Development of Wind Farm Facilities in Victoria – Policy and Planning Guidelines* (DELWP, March 2019) (2019 DELWP Guideline). Following introduction of the *Environment Protection Act 2017* in July 2021, DELWP updated this through the publication - *Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria (DELWP, July 2021).*

1.4.2 Environment Protection Authority (Victoria) (EPA)

EPA has previously issued *Wind Energy Facility Noise Auditor Guidelines* (Publication 1692, October 2018) (2018 EPA Guideline) that complements the 2019 DELWP Guideline and updated 2021 DELWP guidelines, that set out the requirements for an audit of post-construction noise (Section 2.4.2). EPA has recently issued a new publication - *Wind Energy Facility Noise Regulation Guidelines (EPA Publication, March 2022).*

In addition, EPA provides guidance on audits, primarily:

- *Environmental Auditor Guidelines for the Preparation of Environmental Audit Reports on Risk to The Environment (Publication 952).*
- *Environmental Auditor Guidelines for Conducting Environmental Audits (Publication 953)*

The audit of the SHWF was consistent with these guidelines.

2. Objectives of the Verification Audit

The objectives of the Verification Audit were to assess compliance of the Initial Acoustic Compliance Assessment of the SHWF undertaken by Sonus with the relevant requirements set out in the Planning Permit. Specifically, the Verification Audit evaluated:

- Whether the initial acoustic compliance testing was carried out by a suitably qualified and experienced acoustics expert, in accordance with the approved NCTP (ie in accordance with the Standard and variations described in the Planning Permit) (Condition 27).
- Whether the analysis and reporting of the initial noise compliance assessment, as provided in the Initial Acoustic Compliance Report and associated Technical Report, has been prepared by a suitable qualified and independent acoustics expert, in compliance with Planning Permit 28(a).
- Whether the initial acoustic compliance assessment demonstrates that based on the sound power output from the turbines measured on site, the SHWF is likely to comply with the noise limits set out in the Standard, and Planning Permit Condition 21.

3. Methodology for Verification Audit

As stated above, EPA has very recently published guidance entitled *Wind Energy Facility Noise Regulation Guidelines (EPA Publication, March 2022).* However, this publication does not provide detailed guidance regarding requirements for Verification Audits conducted under Reg 131D of the Regulations. The audit methodology adopted was therefore relatively consistent with Section 2.4.2 of the 2018 EPA Guideline, and included:

- Inception meeting with SHWF management.
- Review of Noise Compliance Test Plan

- Technical verification of the initial compliance noise report and assessment, including:
    - methodology applied to conduct the assessment
    - noise monitoring equipment and parameters used
    - sound modelling programs employed
    - verification that assessment conducted in line with applicable standards.
- Review of initial compliance noise assessment against project commitments.
- Residual risk assessment, including a qualitative statement on the risk of non-compliance (and operational plans to manage potentially adverse impacts) – this was omitted for this stage of the Audit Verification process.
- Preparation of the verification audit report.

3.1 Documents Reviewed for the Audit

- *Environment Protection Act 2017* as amended by the *Environment Protection Amendment Act 2018*
- *Environment Protection Amendment (Interim) Regulations 2021* (Regulations)
- *Planning Permit PL-SP/05/0548/B under the Pyrenees Planning Scheme (Amendment dated 23 July 2018)* (Planning Permit)
- *New Zealand Standard NZS 6808:2010 Acoustics – Wind Farm Noise* (Standard)
- *Noise Compliance Test Plan* (Sonus Report No. S3425.2CS dated January 2018) (NCTP)
- *Initial Acoustic Compliance Report* (Sonus Report No. S3425.2C16C, March 2022) (Initial Compliance Assessment Report)
- *Acoustic Analysis of Wind Turbine Generator 18* (Sonus Report S3425.2C17, February 2022) (Technical Report)
- *Stockyard Hill Wind Farm Pre-Development Noise Assessment* (Marshall Day Acoustics Report No. 001 R04 20170840, 20 December 2017).
- *Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria* (DELWP, July 2021)
- *Wind Energy Facility Noise Regulation Guidelines* (EPA Publication, March 2022)
- *Development of Wind Farm Facilities in Victoria – Policy and Planning Guidelines* (DELWP, March 2019) (2019 DELWP Guideline)
- *Wind Energy Facility Noise Auditor Guidelines* (EPA Publication 1692, October 2018) (2018 EPA Guideline)
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- *Environmental Auditor Guidelines for the Preparation of Environmental Audit Reports on Risk to The Environment* (EPA Publication 952)
- *Environmental Auditor Guidelines for Conducting Environmental Audits* (EPA Publication 953)
- *International Standard IEC61400-11:2012 Wind turbines – Part 11: Acoustic noise measurement techniques* (IEC 61400-11:2012)

- *International Standard ISO 1996-2:2007 Acoustics – Description, measurement and assessment of environmental noise – Part 2: Determination of environmental noise levels* (ISO 1996-2:2007)

4. Review of the Noise Compliance Test Plan

The NCTP for the SHWF (Sonus report *Stockyard Hill Wind Farm, Noise Compliance Test Plan*, Report S3425.2C5, January 2018) outlines the procedures to be undertaken for the operational (post-construction) noise compliance monitoring. The NCTP has been reviewed separately and was endorsed by the Minister for Planning on 17 May 2018.

Section 2 of the NCTP provides a methodology for undertaking *Near Field and Intermediate Testing* which form the basis of the Initial Acoustic Compliance Report. The measurements allow the character of the noise from the turbines to be reviewed (particularly in relation to tonality and amplitude modulation) and to confirm that the input assumptions for the pre-construction stage assessment prior to the total construction and commissioning of the wind farm.

The NCTP includes the following requirements;

- Undertake nearfield measurements to derive apparent sound power level in general accordance with IEC 61400-11:2012
- Undertake tonality calculations in accordance with Appendix C of ISO1996.12:2007 for representative periods
- Undertake an assessment of amplitude modulation in accordance with the 'interim test method' provided in the Standard.

As noted earlier, the more detailed noise compliance testing undertaken at the residential dwellings in accordance with the Standard (and documented in Section 3 of the NCTP) has *not* been undertaken at this stage of the project, and is therefore not documented in the Initial Acoustic Compliance Report. Those tests will be undertaken post-completion and commissioning of the SHWF in accordance with the permit conditions and the NCTP, and will be subject to additional review by an EPA-appointed Auditor.

5. Technical Verification of the Initial Acoustic Compliance Report

Initial nearfield sound level measurements have been undertaken by Sonus near to one of the operational turbines (WTG18) for the purpose of reviewing the apparent sound power level emissions, tonality and amplitude modulation characteristics of the installed turbines. The measurements and analysis are documented generally in the Initial Acoustic Compliance Report (Sonus Report S3425.2C16C, March 2022), and in more detail within Acoustic Analysis of Wind Turbine Generator 18 (Sonus Report S3425.2C17, February 2022).

The measurements have been undertaken and the reports prepared by acoustic engineers from Sonus, who are suitably qualified and experienced to undertake the work.

The nearfield measurements have been undertaken using the measurement methodology in accordance with IEC 61400-11:2012)using microphones mounted on a ground-plane measurement board with appropriate primary and secondary wind-shields. The measurement microphones were located at approximately 200 m slant distance from the nacelle of WTG18 (Goldwind GW3S 3.57MW) in accordance with IEC 61400-11:2012. The measurement equipment that has been used is appropriate.

Wind speed and direction during the measurements were determined from instruments located on the WTG nacelle and averaged over 10-second periods. Direction data was adjusted by Sonus based on field observations.

The wind speed and noise level data has been processed to discard measurements with extraneous noise, where rainfall was identified, and where measurements were not within ±15° downwind of one of the two microphone locations. Over 4,000 wind speed and noise level data pairs were recorded over the measurement period, between wind speeds of 6–12 m/s.

5.1 Turbine Sound Power Emission

The apparent sound power level emitted by the turbine has been determined from the measurements in accordance with the general procedure outlined in IEC 61400-11. The maximum measured overall apparent sound power level of the turbine is 110.9 dBL_{WA} re 1pW. This measured value is marginally lower than the reference sound power level of 111 dBL_{WA} adopted for the updated noise modelling presented in the Initial Acoustic Compliance Report.

The assessment indicates that the predicted noise levels at the nominated receiver locations will achieve the base noise level limits of 45 dBA (associated dwellings) and 40 dB(A) (all other dwellings) at all of the sensitive receivers.

5.2 Tonality

Tonality of the wind farm noise has been assessed in accordance with the reference method for assessing the audibility of tones in noise, documented in Annex C of ISO 1996-2:2007.

The analysis has determined that for the sample of time periods and wind conditions that have been assessed, no tones that would warrant a penalty under Section C.2.4 of ISO 1996-2:2007 were detectable. That is, there were no tones measured in the near field of the turbine with a tonal audibility (ΔL_{ta}) greater or equal to 4 dB.

On the basis that there are no penalizable tones in the near-field of the turbines, it is unlikely that the wind turbines would result in any significant tones at the receiver locations.

5.3 Amplitude Modulation

Similarly, representative audio recordings from each integer wind speed have been analysed for excessive amplitude modulation in accordance with the interim test method for the assessment of amplitude modulation in Section B3.2 of the Standard. In accordance with that method, Amplitude Modulation is subject to a penalty of 5 dB if the measured A-weighted peak-to-trough levels exceed 5 dB on a regularly varying basis.

The measured A-weighted peak-to-trough levels vary between 1–3.5 dB, and for the representative samples shown, do not exceed 5 dB at any time.

It is therefore accepted that the wind turbines do not generate amplitude modulation in the near-field at a level that would warrant a penalty under Section B3 of the Standard.

On that basis, it is unlikely that the wind turbines would result in any penalizable amplitude modulation at the receiver locations.

6. Additional Auditor Comments

It is noted by the Auditor that the GW3S-3.57MW turbine has a maximum measured overall apparent sound power level of 110.9 dBL_{WA} (re 1 pW) when operating at a hub-height wind speed of 10 m/s. This is approximately 3.4 dB higher than the maximum turbine sound power level (107.5 dBL_{WA}) adopted for the noise modelling undertaken for the Pre-Development Noise Assessment.

Nevertheless, the predictions of A-weighted wind turbine noise levels at the sensitive receivers based on turbine sound power levels of 111 dBL_{WA}, shown in Table 2 and Figure 1 of the Initial Acoustic Compliance Report indicate that the required base noise level limits of 45 dBA (associated dwellings) and 40 dB(A) (all other dwellings) will still be achieved at all of the sensitive receivers.

7. Audit Conclusions

The following conclusions relate specifically to the stated objectives of the Verification Audit of the Initial Acoustic Compliance Report and associated Technical Report for the SHWF undertaken by David Spink, an Environmental Auditor appointed under the *Environment Protection Act 2017*. Technical support was provided by Dr Kym Burgemeister, Principal and Australasian Regional Acoustics Leader, Arup Australasia.

Based on the above Verification Audit process, it is concluded that:

- The initial acoustic compliance testing has been conducted in accordance with the approved Noise Compliance Test Plan by a suitably qualified and experienced acoustics expert, in compliance with Planning Permit Condition 27.
- The analysis and reporting of the initial acoustic compliance assessment, as provided in the Initial Acoustic Compliance Report and associated Technical Report, has been prepared by a suitable qualified and independent acoustics expert, in compliance with Planning Permit 28(a).
- The initial acoustic compliance assessment demonstrates that based on the sound power output from the turbines measured on site, the SHWF likely to comply with the noise limits set out in the Standard, and Planning Permit Condition 21.