Vestas Australia
26 April 2013
Document No. A11C01RP-03

Macarthur Wind Farm

Background Noise Monitoring

Macarthur Wind Farm

Background Noise Monitoring

Prepared for

Vestas Australia

Prepared by

AECOM Australia Pty Ltd
Level 28, 91 King William Street, Adelaide SA 5000, Australia
T +61 8 7100 6400 F +61 8 7100 6499 www.aecom.com
ABN 20 093 846 925

26 April 2013

60157134

AECOM in Australia and New Zealand is certified to the latest version of ISO9001 and ISO14001.

© AECOM Australia Pty Ltd (AECOM). All rights reserved.

AECOM has prepared this document for the sole use of the Client and for a specific purpose, each as expressly stated in the document. No other party should rely on this document without the prior written consent of AECOM. AECOM undertakes no duty, nor accepts any responsibility, to any third party who may rely upon or use this document. This document has been prepared based on the Client's description of its requirements and AECOM's experience, having regard to assumptions that AECOM can reasonably be expected to make in accordance with sound professional principles. AECOM may also have relied upon information provided by the Client and other third parties to prepare this document, some of which may not have been verified. Subject to the above conditions, this document may be transmitted, reproduced or disseminated only in its entirety.

Quality Information

Document Macarthur Wind Farm

Ref 60157134

Date 26 April 2013

Prepared by Adam Cook

Reviewed by Andrew Mitchell

Revision History

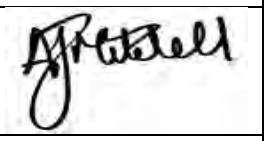
Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
00	11-Mar-2011	Draft - Results of background noise monitoring	Jon Cooper Senior Acoustic Engineer	
01	6-Jul-2011	Included results of background noise monitoring at property Q15A	Jon Cooper Senior Acoustic Engineer	
02	20-Mar-2013	Amended incorrect location ID references R26A and R26B	Andrew Mitchell Principal Acoustics Engineer	
03	26-Apr-2013	Updated meteorological data	Andrew Mitchell Principal Acoustics Engineer	

Table of Contents

1.0 Introduction

AECOM was engaged by Vestas Australian Wind Technology P/L to undertake background noise monitoring at residential locations around the site proposed for the Macarthur Wind Farm near Macarthur, Victoria.

Background noise measurements were undertaken at 25 locations near the proposed site. This report presents the analysis of these measurements with respect to wind speeds measured around the site, to determine environmental noise criteria at the nearest residences to the proposed turbines.

Measurements have previously been undertaken at several properties near the Macarthur site by Hayes McKenzie APW in 2005. Findings were documented in their report, numbered 03.545-01. In light of the time elapsed since these measurements were performed, new measurements were taken to ensure background noise levels reported were indicative of the current noise environment at the receiver locations.

This report therefore presents the results of the updated background noise level measurements and the resulting noise criteria that have been determined.

A version of this report was originally issued in July 2011 with the measured background noise levels and noise criteria referenced to wind data measured at temporary meteorological masts owned by Meridian Energy Limited (one of parties involved in the development of the wind farm). These temporary meteorological masts were installed at the wind farm site for the purpose of the development and design phase, but were removed during construction of the wind farm, after the permanent meteorological masts for the wind farm had been installed and correlated with the temporary meteorological masts.

In accordance with Section 4.5.4 of NZS 6808:1998[1], which is the noise measurement and assessment standard prescribed by the Macarthur Wind Farm Planning Permit[2], the background noise measurements and any subsequent operational noise compliance measurements should be compared with wind speed data measured at the same location.

Since the operational noise compliance measurements will use wind data from the permanent meteorological masts at the wind farm, it has been necessary to update the wind speed data used in the background noise level and noise criteria analysis so that it relates to the wind speeds measured at the permanent meteorological masts.

This revision of the report therefore presents updated background noise level curves and noise criteria curves for each measurement location, in relation to the wind speeds at the location of the permanent meteorological masts.

Acoustic terminology used in this report is summarised in Appendix A.

[1] New Zealand Standard NZS 6808:1998 – *The Assessment and Measurement of Sound From Wind Turbine Generators*
[2] Victorian planning permit number PL-SP/05/0283 as amended 7 April 2011

2.0 Criteria

The Macarthur Wind Farm Planning Permit stipulates NZS 6808:1998 as the standard against which noise emissions from the wind farm development are to be assessed.

NZS 6808:1998 sets an environmental noise emission limit for wind farms as the greater of L_{A95} 40 dB(A) or background noise (L_{A95}) plus 5 dB(A). Background levels are to be correlated to wind speed at turbine hub height, and a regression curve on this relationship is used to determine the criteria.

Furthermore, Condition 16 of the Macarthur Wind Farm Planning Permit requires background noise level compliance to be determined separately for all time and night time data according to the criteria set by NZS 6808:

> *The operation of the wind energy facility must comply with the New Zealand Standard 'Acoustics – The Assessment and Measurement of Sound from Wind Turbine Generators' (NZS 6808:1998) (the 'Standard'), at any dwelling existing in the vicinity of the wind energy facility as at 7 February 2006. In determining compliance with the Standard, the following shall apply:*
>
> *a) The sound level from the operating wind energy facility, measured outdoors within 10 meters of a dwelling at any relevant nominated wind speed, shall not exceed the background noise level (L_{95}) by more than 5dBA or a level of 40dBA L_{95}, whichever is the greater. This 'background sound level' shall be determined by the method specified in NZS 6808:1998. Compliance shall be determined separately for all time data and for night time data. Night time is defined as 10pm to 7am.*
>
> *b) If sound has a special audible characteristic the measured sound level of the source shall have a 5dB penalty applied. The EMP must provide detail on how special audible characteristics are to be determined and the penalty is to be applied.*

NZS 6808 sets noise limits to achieve a reasonable level of noise amenity at properties which have not formed a financial relationship with a wind farm. Properties with financial benefit from a wind farm typically have greater tolerance of wind farm noise, so are not normally assessed against NZS 6808:1998. Planning Condition 17 states:

> *Condition 16 does not apply to any dwelling on which part of the wind energy facility is erected. That exemption shall be given affect through an agreement with the landowner that shall apply to any occupant of the dwelling and must be registered on the title to the land.*

We understand that an agreement capping noise levels to the greater of 48dB(A) or 5dB(A) above the background noise level (L_{A95}) has been reached with the landowners at properties identified as R21A, R21B, U21A and V21A.

3.0 Wind data

The wind speeds and directions were measured at two temporary development meteorological masts during the background noise monitoring period. These temporary meteorological masts were correlated with the permanent meteorological masts prior to being decommissioned during construction of the wind farm, so that the equivalent wind speeds at the permanent meteorological mast locations could be determined. Details of the temporary meteorological masts are presented in Appendix F.

The equivalent wind speeds and directions at the permanent meteorological masts were provided by wind engineering consultant Garrad Hassan, based on analysis of meteorological data gathered during a period between July 2011 and August 2012 when both the temporary mast and the permanent masts were operational. This data has been used in the analysis of the background noise levels and criteria, since operational noise compliance monitoring is also to reference wind data from the permanent meteorological masts, and Section 4.5.4 of NZS 6808:1998 requires the same meteorological mast locations to be used for both the background and operational noise assessments.

There are six permanent meteorological masts at the wind farm, which are located at the positions given in Table 1, below. The positions of the meteorological masts are also marked on the site map presented in Appendix C.

Table 1 Meteorological Mast Locations

Meteorological Mast ID	GPS Coordinates of Logger (UTM WGS84 Zone 54H)	
	Easting	Northing
M1	603659	5794791
M2	601520	5792228
M3	600644	5785321
M4	605928	5784988
M5	604870	5788838
M6	599468	5787226

The nature of the wind farm layout means that all the meteorological masts are located at positions where they may be affected by the wake of the wind turbines for certain wind directions when the wind farm is operational.

The wind data used for the operational noise compliance assessment of the wind farm is therefore to be derived from a combination of the six meteorological masts, to ensure that all wind data used for operational noise assessment is not wake affected, as required by Section 4.5.4 of NZS 6808:1998.

To be consistent with the meteorological mast locations that are to be used for operational noise compliance assessment, the wind data used for the background noise analysis must also be taken from the same combination of meteorological masts.

A procedure to determine wake free wind speed data from the six meteorological masts when the wind farm is operational was provided by Garrad Hassan.

The procedure can be summarised as follows:

- A lead meteorological mast is selected from either M1, M4 or M6, based on whichever of those masts is the closest to the noise monitoring location;
- The wind direction measured at the lead meteorological mast is used to determine whether the mast would be in the wake of the wind turbines for any particular time interval.
- For periods where the lead mast is determined to be in the wake of the wind turbines, wind speed data is taken from an alternative meteorological mast that is not in the wake of the wind turbines for that particular wind direction.
- A directional correlation ratio that has been derived between the two meteorological masts is then applied to adjust the wind speed from the alternative meteorological mast to the equivalent wind speed at the lead meteorological mast.

- Details of the directions where the lead masts are wake-affected, the alternative meteorological masts used, and the directional correlation ratios between the two masts, are presented in Appendix G.

In this manner, a composite times series of wind speed data from wake free meteorological masts is synthesised and related back to the lead meteorological mast location.

The wind speed data used in the analysis of the background noise measurement results is the wind speed at 84m above ground level (wind turbine hub-height).

4.0 Background noise assessment

4.1 Background Noise Measurements

Monitoring was performed at each property for a period of approximately 4 weeks, with all measurements occurring between 19 August 2010 and 6 January 2011. Both wind speed and noise data were measured across 10 minute measurement periods throughout the monitoring. In all cases, the microphone was located 1.2 metres above the ground and at least five metres from any significant reflecting surface or vegetation.

The residences at which background noise levels were monitored are shown, grouped by the lead meteorological mast used for the wind data, on Table 2. Appendix B includes photographs of the equipment at of each of the monitoring sites. A site map showing the location of the residences is provided in Appendix C.

Table 2: Background noise monitoring locations

Location	GPS coordinates* (UTM coordinate system, Zone 54H)	
	Easting	Northing
Lead mast M1		
Q15A	600502	5793440
T12A	603598	5796359
T12B	603815	5796320
V16A	605784	5792936
W14A	606609	5794537
X16A	607370	5792812
Y17A	608292	5791311
Y18A	608783	5790831
Lead mast M4		
Q20A	600173	5788999
R21A	602113	5787729
R21B	602058	5787979
R26B	601359	5782851
S26A	602530	5783089
S26B	602391	5782879
T20A	603622	5788511
T25A	603608	5783648
T26A	603601	5782898
U21A	605135	5787166
V21A	604975	5787248
W25A	606706	5784135
X21A	607252	5787887
X21B	607084	5787806
X23A	607783	5785328
Lead mast M6		
O18A	598962	5790741
P19A	600007	5789745
P22A	599499	5786216

* Coordinates from hand-held GPS receiver. Typical accuracy +/- 3m

Background noise measurements were undertaken at all properties where the maximum predicted noise level was 36 dB(A) or higher, except at the following locations:

- Q26B – Letter requesting permission for the measurements sent to the address via post, but was returned unopened. Property was unable to be located during the site visits.
- R26A – Letter sent to the owner, and spoke with him by phone. He indicated that he was not interested in the wind farm as the developer had refused his offer to host turbines, so did not want a noise survey to be undertaken.
- X16B – Landlord gave permission for the measurements, but the tenant hung up on us when trying to arrange a time to place the logger. Visited the property twice in an attempt to negotiate placement of the noise logger but tenants not home on both occasions.

At Q15A the noise logging equipment malfunctioned during the attempted measurements. Permission to repeat the measurements was not able to be negotiated and instead noise data was purchased from a consultant who had been engaged by the resident. The data from this consultant's logging has been used in the analysis in this report revision.

4.2 Data Analysis

The correlation between wind speed and background noise level were calculated by a least-squares regression formula. Data periods where rain was recorded or where the measurements appear to have been affected by extraneous noise sources have been excluded from the assessment. The regression curves and their equations are included in Appendix D.

As required by Condition 16 of the Macarthur Wind Farm Planning Permit, background noise criteria was determined separately for all time data and night time data. All time data is presented first below.

4.3 All time measurements and noise criteria

The measured $L_{A95,10min}$ 'All-time' background noise levels at each residence are shown on Table 3.

Table 3: $L_{A95,10min}$ background noise levels for all time periods in dB(A)

84m Wind Speed (ms^{-1})	Background Noise Levels – All time ($L_{A95,10min}$) by Location Monitoring start date Monitoring finish date								
	O18A 09/12/2010 07/01/2011	P19A 19/09/2010 15/10/2010	P22A 16/09/2010 19/10/2010	Q15A 21/11/2010 06/12/2010	Q20A 09/11/2010 07/12/2010	R21A 19/08/2010 15/09/2010	R21B 19/08/2010 15/09/2010	R26B 08/12/2010 07/01/2011	S26A 10/11/2010 07/12/2010
0	-	-	24	35	28	-	-	-	-
1	20	30	24	34	29	32	34	32	29
2	22	30	24	33	30	33	35	31	29
3	24	30	25	34	31	33	35	32	30
4	25	30	26	34	31	33	36	32	30
5	27	30	27	34	32	34	37	32	31
6	28	31	29	35	33	34	38	33	32
7	30	31	31	35	34	35	38	34	33
8	32	32	34	36	35	36	39	35	34
9	33	33	36	37	36	37	40	36	35
10	35	34	39	38	37	38	41	37	36
11	37	35	41	39	38	40	42	39	38
12	38	37	44	40	39	41	43	40	39
13	40	38	46	41	39	43	45	42	41
14	41	40	48	43	40	44	46	43	43
15	43	42	50	44	41	46	47	45	45
16	45	44	52	46	42	48	48	46	47
17	46	-	-	48	-	50	50	47	49
18	48	-	-	-	-	52	51	49	-
19	49	-	-	-	-	55	53	50	-
20	51	-	-	-	-	57	54	51	-
21	53	-	-	-	-	-	56	53	-
22	54	-	-	-	-	-	57	53	-
23	56	-	-	-	-	-	59	54	-
24	-	-	-	-	-	-	-	55	-
25	-	-	-	-	-	-	-	55	-

84m Wind Speed (ms^{-1})	Background Noise Levels – All time ($L_{A95,10min}$) by Location Monitoring start date Monitoring finish date							
	S26B 16/09/2010 20/10/2010	T12A 15/09/2010 19/10/2010	T12B 15/09/2010 19/10/2010	T20A 19/08/2010 15/09/2010	T25A 17/09/2010 19/10/2010	T26A 16/09/2010 19/10/2010	U21A 19/08/2010 15/09/2010	V21A 19/08/2010 15/09/2010
0	31	32	31	-	26	22	-	-
1	30	32	31	29	26	24	25	-
2	30	33	31	29	27	25	27	32
3	30	33	32	29	28	27	28	33
4	30	33	32	30	29	28	29	34
5	31	34	33	31	30	29	31	35
6	32	35	34	31	31	31	32	36
7	33	36	35	32	33	32	34	37
8	34	36	36	33	34	34	35	38
9	35	37	37	34	35	35	37	40
10	37	38	38	36	36	37	38	41
11	38	40	40	37	38	38	40	42
12	40	41	42	38	39	39	41	43
13	42	42	43	40	41	41	43	45
14	44	43	45	42	42	42	44	46
15	47	45	47	43	44	-	46	47
16	49	46	49	45	46	-	47	49
17	51	48	52	47	47	-	49	50
18	54	50	54	50	49	-	50	52
19	-	-	-	52	51	-	52	53
20	-	-	-	54	-	-	53	55
21	-	-	-	57	-	-	54	56
22	-	-	-	59	-	-	56	58
23	-	-	-	62	-	-	57	60
24	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-

84m Wind Speed (ms^{-1})	Background Noise Levels – All time ($L_{A95,10min}$) by Location Monitoring start date Monitoring finish date							
	W14A 10/11/2010 07/12/2010	W25A 16/09/2010 19/10/2010	X16A 10/11/2010 07/12/2010	X21A 10/11/2010 07/12/2010	X21B 10/11/2010 07/12/2010	X23A 16/09/2010 19/10/2010	Y17A 08/12/2010 07/01/2011	Y18A 10/11/2010 07/12/2010
0	-	29	30	30	26	24	-	-
1	28	29	31	30	27	25	28	34
2	29	29	32	30	27	25	28	34
3	30	30	34	31	28	26	28	34
4	30	30	35	31	29	27	28	34
5	31	31	36	32	31	27	29	35
6	32	32	37	33	32	28	31	35
7	33	33	38	34	33	29	33	36
8	34	35	39	35	35	31	35	37
9	35	36	40	36	36	32	37	38
10	36	38	41	37	38	34	39	39
11	38	40	42	39	39	35	42	41
12	39	42	44	40	41	37	44	42
13	40	44	45	42	43	39	47	43
14	42	46	46	44	45	41	49	45
15	43	49	47	46	47	43	52	47
16	45	51	48	48	49	45	54	49
17	47	54	49	50	51	48	56	51
18	-	57	-	-	-	50	58	-
19	-	-	-	-	-	-	59	-
20	-	-	-	-	-	-	60	-
21	-	-	-	-	-	-	60	-
22	-	-	-	-	-	-	60	-
23	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-

The regression curves for the 'All time' background noise data were used to determine the $L_{A95,10min}$ noise criteria at the residential noise receivers for the wind farm.

The derived noise criteria levels are summarised in Table 4.

Table 4: $L_{A95,10min}$ noise criteria levels for all time periods in dB(A)

84m Wind Speed (ms^{-1})	Noise Criteria – All time ($L_{A95,10min}$) by Location								
	O18A	P19A	P22A	Q15A	Q20A	R21A	R21B	R26B	S26A
0	40	40	40	40	40	48	48	40	40
1	40	40	40	40	40	48	48	40	40
2	40	40	40	40	40	48	48	40	40
3	40	40	40	40	40	48	48	40	40
4	40	40	40	40	40	48	48	40	40
5	40	40	40	40	40	48	48	40	40
6	40	40	40	40	40	48	48	40	40
7	40	40	40	40	40	48	48	40	40
8	40	40	40	41	40	48	48	40	40
9	40	40	41	42	41	48	48	41	40
10	40	40	44	43	42	48	48	42	41
11	42	40	46	44	43	48	48	44	43
12	43	42	49	45	44	48	48	45	44
13	45	43	51	46	44	48	50	47	46
14	46	45	53	48	45	49	51	48	48
15	48	47	55	49	46	51	52	50	50
16	50	49	57	51	47	53	53	51	52
17	51	-	-	53	-	55	55	52	54
18	53	-	-	-	-	57	56	54	-
19	54	-	-	-	-	60	58	55	-
20	56	-	-	-	-	62	59	56	-
21	58	-	-	-	-	-	61	58	-
22	59	-	-	-	-	-	62	58	-
23	61	-	-	-	-	-	64	59	-
24	63	-	-	-	-	-	-	60	-
25	-	-	-	-	-	-	-	60	-

84m Wind Speed (ms^{-1})	Noise Criteria – All time ($L_{A95,10min}$) by Location							
	S26B	T12A	T12B	T20A	T25A	T26A	U21A	V21A
0	40	40	40	40	40	40	48	48
1	40	40	40	40	40	40	48	48
2	40	40	40	40	40	40	48	48
3	40	40	40	40	40	40	48	48
4	40	40	40	40	40	40	48	48
5	40	40	40	40	40	40	48	48
6	40	40	40	40	40	40	48	48
7	40	41	40	40	40	40	48	48
8	40	41	41	40	40	40	48	48
9	40	42	42	40	40	40	48	48
10	42	43	43	41	41	42	48	48
11	43	45	45	42	43	43	48	48
12	45	46	47	43	44	44	48	48
13	47	47	48	45	46	46	48	50
14	49	48	50	47	47	47	49	51
15	52	50	52	48	49	-	51	52
16	54	51	54	50	51	-	52	54
17	56	53	57	52	52	-	54	55
18	59	55	59	55	54	-	55	57
19	-	-	-	57	56	-	57	58
20	-	-	-	59	-	-	58	60
21	-	-	-	62	-	-	59	61
22	-	-	-	64	-	-	61	63
23	-	-	-	67	-	-	62	65
24	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-

84m Wind Speed (ms^{-1})	Noise Criteria – All time ($L_{A95,10min}$) by Location							
	W14A	W25A	X16A	X21A	X21B	X23A	Y17A	Y18A
0	40	40	40	40	40	40	40	40
1	40	40	40	40	40	40	40	40
2	40	40	40	40	40	40	40	40
3	40	40	40	40	40	40	40	40
4	40	40	40	40	40	40	40	40
5	40	40	41	40	40	40	40	40
6	40	40	42	40	40	40	40	40
7	40	40	43	40	40	40	40	41
8	40	40	44	40	40	40	40	42
9	40	41	45	41	41	40	42	43
10	41	43	46	42	43	40	44	44
11	43	45	47	44	44	40	47	46
12	44	47	49	45	46	42	49	47
13	45	49	50	47	48	44	52	48
14	47	51	51	49	50	46	54	50
15	48	54	52	51	52	48	57	52
16	50	56	53	53	54	50	59	54
17	52	59	54	55	56	53	61	56
18	-	62	-	-	-	55	63	-
19	-	-	-	-	-	-	64	-
20	-	-	-	-	-	-	65	-
21	-	-	-	-	-	-	65	-
22	-	-	-	-	-	-	65	-
23	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-

The coefficients of determination (R^2) for each order of polynomial fit line for all time data at each of the residential monitoring locations are included in Table 5.

Table 5: Coefficients of determination for each polynomial order at each residence

Location	Coefficient of Determination (R^2) - 24 hour		
	Linear	Order 2	Order 3
O18A	**0.3466**	0.3474	0.3566
P19A	0.0495	**0.0580**	0.0597
P22A	0.3997	0.4081	**0.4107**
Q15A	0.1504	**0.1639**	0.1639
Q20A	**0.1675**	0.1676	0.1848
R21A	0.4294	**0.4552**	0.4626
R21B	0.3060	**0.3121**	0.3132
R26B	0.2144	0.2241	**0.2275**
S26A	0.3446	**0.3613**	0.3957
S26B	0.4544	0.5001	**0.5007**
T12A	0.2601	**0.2692**	0.2696
T12B	0.3425	**0.3603**	0.3621
T20A	0.3970	**0.4229**	0.4232
T25A	0.3616	**0.3646**	0.3646
T26A	**0.1407**	0.1452	0.1632
U21A	**0.5800**	0.5803	0.5814
V21A	0.4703	**0.4725**	0.4735
W14A	0.1860	**0.1900**	0.2128
W25A	0.4798	**0.5068**	0.5070
X16A	**0.2555**	0.2570	0.2669
X21A	0.2591	**0.2747**	0.2865
X21B	0.3644	**0.3700**	0.3887
X23A	0.1988	**0.2072**	0.2090
Y17A	0.5299	0.5379	**0.5532**
Y18A	0.2058	**0.2213**	0.2239

For each location, the regression coefficient shown in bold corresponds to the polynomial order that provided the "best fit" to the background noise data. The "best fit" was determined as the curve which provided both a sensible match to the shape of the data and a reasonable regression coefficient. Curves up to sixth order were trialled, however higher order curves often provided an erratic fit. The coefficient shown in bold also corresponds to that of the fit line used on the all-time plots in Appendix D.

4.4 Night time measurements and noise criteria

The monitored background noise data was also used to generate $L_{A95,10min}$ noise levels for the night time period 10pm – 7am.

Night time background noise levels for each of the receiver locations are shown on Table 6.

Table 6: $L_{A95,10min}$ background noise levels for night time period in dB(A)

84m Wind Speed (ms^{-1})	Background Noise Levels - Night ($L_{A95,10min}$) by Location								
	O18A	P19A	P22A	Q15A	Q20A	R21A	R21B	R26B	S26A
0	-	-	20	29	-	-	-	-	-
1	17	-	19	30	-	-	-	31	-
2	19	-	19	30	27	-	-	29	33
3	20	26	20	31	27	-	-	28	30
4	22	25	21	31	28	-	-	28	28
5	23	24	23	32	29	36	40	28	27
6	25	25	24	33	29	35	40	29	27
7	26	25	27	34	30	36	40	30	28
8	28	26	29	35	31	36	41	31	29
9	29	28	32	35	32	36	41	33	31
10	31	29	34	36	33	37	42	34	32
11	32	30	37	37	34	38	43	36	34
12	34	30	40	38	35	40	43	38	36
13	35	30	43	40	36	41	44	39	38
14	37	-	46	41	37	43	45	41	40
15	38	-	49	42	38	45	46	42	41
16	40	-	52	43	40	48	48	43	42
17	41	-	-	44	-	50	49	44	43
18	43	-	-	-	-	53	50	45	-
19	45	-	-	-	-	56	52	45	-
20	46	-	-	-	-	60	54	-	-
21	48	-	-	-	-	-	55	-	-
22	49	-	-	-	-	-	57	-	-
23	51	-	-	-	-	-	-	-	-
24	52	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-	-

84m Wind Speed (ms^{-1})	Background Noise Levels - Night ($L_{A95,10min}$) by Location							
	S26B	T12A	T12B	T20A	T25A	T26A	U21A	V21A
0	34	29	33	-	25	19	-	-
1	32	30	33	-	26	21	-	-
2	32	31	33	30	26	22	-	-
3	31	32	32	29	26	23	-	-
4	31	32	32	29	27	25	33	40
5	31	33	33	29	28	26	33	39
6	31	33	33	30	29	27	34	39
7	31	34	34	30	30	29	35	39
8	32	34	34	31	31	30	35	40
9	33	35	35	32	32	31	36	40
10	34	35	37	33	33	33	37	40
11	36	36	38	34	35	34	38	41
12	38	37	39	35	36	35	39	42
13	40	37	41	37	38	37	41	43
14	43	39	-	39	39	38	42	44
15	45	40	-	41	41	39	44	45
16	48	42	-	43	43	-	45	47
17	52	43	-	45	-	-	47	48
18	55	46	-	48	-	-	49	50
19	-	-	-	51	-	-	51	52
20	-	-	-	54	-	-	53	54
21	-	-	-	57	-	-	55	56
22	-	-	-	60	-	-	57	59
23	-	-	-	64	-	-	60	61
24	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-

84m Wind Speed (ms^{-1})	Background Noise Levels - Night ($L_{A95,10min}$) by Location							
	W14A	W25A	X16A	X21A	X21B	X23A	Y17A	Y18A
0	-	29	-	-	-	21	-	-
1	-	29	-	-	-	21	28	-
2	27	29	30	27	25	21	28	33
3	27	29	31	27	25	22	27	33
4	28	29	32	27	26	22	27	32
5	28	30	33	28	27	23	28	32
6	28	30	34	29	28	24	28	32
7	29	32	35	30	29	25	29	33
8	30	33	36	31	31	26	31	33
9	31	34	37	32	32	28	32	34
10	32	36	39	34	34	29	35	35
11	33	38	40	35	35	31	37	37
12	34	40	41	37	37	33	40	38
13	35	42	43	39	39	35	43	40
14	37	45	44	41	41	38	46	42
15	39	48	46	42	43	40	50	44
16	40	-	47	44	45	-	-	47
17	42	-	49	45	47	-	-	50
18	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-
23	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-

The regression curves for the night time data were used to determine the $L_{A95,10min}$ noise criteria at the residential noise receivers for the wind farm.

The derived noise criteria levels are summarised in Table 7.

Table 7 $L_{A95,10min}$ noise criteria levels for night time period in dB(A)

84m Wind Speed (ms^{-1})	Noise Criteria - Night ($L_{A95,10min}$) by Location								
	O18A	P19A	P22A	Q15A	Q20A	R21A	R21B	R26B	S26A
0	40	40	40	40	40	48	48	40	40
1	40	40	40	40	40	48	48	40	40
2	40	40	40	40	40	48	48	40	40
3	40	40	40	40	40	48	48	40	40
4	40	40	40	40	40	48	48	40	40
5	40	40	40	40	40	48	48	40	40
6	40	40	40	40	40	48	48	40	40
7	40	40	40	40	40	48	48	40	40
8	40	40	40	40	40	48	48	40	40
9	40	40	40	40	40	48	48	40	40
10	40	40	40	41	40	48	48	40	40
11	40	40	42	42	40	48	48	41	40
12	40	40	45	43	40	48	48	43	41
13	40	40	48	45	41	48	49	44	43
14	42	-	51	46	42	48	50	46	45
15	43	-	54	47	43	50	51	47	46
16	45	-	57	48	45	53	53	48	47
17	46	-	-	49	-	55	54	49	48
18	48	-	-	-	-	58	55	50	-
19	50	-	-	-	-	61	57	50	-
20	51	-	-	-	-	65	59	-	-
21	53	-	-	-	-	-	60	-	-
22	54	-	-	-	-	-	62	-	-
23	56	-	-	-	-	-	64	-	-
24	57	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-	-

84m Wind Speed (ms^{-1})	Noise Criteria - Night ($L_{A95,10min}$) by Location							
	S26B	T12A	T12B	T20A	T25A	T26A	U21A	V21A
0	40	40	40	40	40	40	48	48
1	40	40	40	40	40	40	48	48
2	40	40	40	40	40	40	48	48
3	40	40	40	40	40	40	48	48
4	40	40	40	40	40	40	48	48
5	40	40	40	40	40	40	48	48
6	40	40	40	40	40	40	48	48
7	40	40	40	40	40	40	48	48
8	40	40	40	40	40	40	48	48
9	40	40	40	40	40	40	48	48
10	40	40	42	40	40	40	48	48
11	41	41	43	40	40	40	48	48
12	43	42	44	40	41	40	48	48
13	45	42	46	42	43	42	48	48
14	48	44	-	44	44	43	48	49
15	50	45	-	46	46	44	49	50
16	53	47	-	48	48	-	50	52
17	57	48	-	50	-	-	52	53
18	60	51	-	53	-	-	54	55
19	-	-	-	56	-	-	56	57
20	-	-	-	59	-	-	58	59
21	-	-	-	62	-	-	60	61
22	-	-	-	65	-	-	62	64
23	-	-	-	69	-	-	65	66
24	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-

84m Wind Speed (ms^{-1})	Noise Criteria - Night ($L_{A95,10min}$) by Location							
	W14A	W25A	X16A	X21A	X21B	X23A	Y17A	Y18A
0	40	40	40	40	40	40	40	40
1	40	40	40	40	40	40	40	40
2	40	40	40	40	40	40	40	40
3	40	40	40	40	40	40	40	40
4	40	40	40	40	40	40	40	40
5	40	40	40	40	40	40	40	40
6	40	40	40	40	40	40	40	40
7	40	40	40	40	40	40	40	40
8	40	40	41	40	40	40	40	40
9	40	40	42	40	40	40	40	40
10	40	41	44	40	40	40	40	40
11	40	43	45	40	40	40	42	42
12	40	45	46	42	42	40	45	43
13	40	47	48	44	44	40	48	45
14	42	50	49	46	46	43	51	47
15	44	53	51	47	48	45	55	49
16	45	-	52	49	50	-	-	52
17	47	-	54	50	52	-	-	55
18	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-
23	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-

The coefficients of determination (R^2) for each order of polynomial for night time data at each of the residential monitoring locations are included in Table 8.

Table 8: Coefficients of determination for each polynomial order at each residence during the night time

Location	Coefficient of Determination (R^2) - Night		
	Linear	Order 2	Order 3
O18A	**0.3215**	0.3478	0.3802
P19A	0.0705	0.0749	**0.0794**
P22A	0.5421	0.5367	**0.5654**
Q15A	0.2057	**0.2082**	0.2187
Q20A	0.2174	**0.2236**	0.2269
R21A	0.2675	**0.3469**	0.3489
R21B	0.1833	**0.2075**	0.2238
R26B	0.1485	0.1768	**0.1834**
S26A	0.3744	0.4637	**0.4950**
S26B	0.2463	**0.3686**	0.3686
T12A	0.1527	0.1552	**0.1593**
T12B	0.1803	**0.2095**	0.2095
T20A	0.4049	**0.4956**	0.4958
T25A	0.3663	**0.3811**	0.3812
T26A	**0.2915**	0.2917	0.2920
U21A	0.3255	**0.3498**	0.3546
V21A	0.1855	**0.2414**	0.2429
W14A	0.1668	**0.1827**	0.1835
W25A	0.4446	**0.4996**	0.5019
X16A	0.2440	**0.2483**	0.2485
X21A	0.3036	0.3176	**0.3197**
X21B	0.3423	**0.3529**	0.3571
X23A	0.2781	**0.2974**	0.3015
Y17A	0.3549	**0.4349**	0.4360
Y18A	0.1768	**0.2433**	0.2433

For each location, the regression coefficient shown in bold corresponds to the polynomial order that provided the "best fit" to the background noise data. The "best fit" was determined as the curve which provided both a good regression coefficient and a sensible match to the data. Curves up to sixth order were trialled, however higher order curves often provided an erratic fit. The coefficient shown in bold also corresponds to that of the fit line used on the night time plots in Appendix D.

5.0 Instrumentation

The details of the noise loggers and equipment used to record noise levels at the 24 residential locations are summarised in Table 9.

Table 9: Noise Loggers used at Locations

Location	Noise Logger (Serial Number)
O18A	Rion NL-21 (Serial #00465445)
P19A	Rion NL-21 (Serial #00409176)
P22A	Rion NL-21 (Serial #00187448)
Q20A	Rion NL-21 (Serial #00865768)
R21A	Rion NL-21 (Serial #00409168)
R21B	Rion NL-21 (Serial #00465446)
R26B	Rion NL-21 (Serial #00465439)
S26A	Rion NL-21 (Serial #00765699)
S26B	Rion NL-21 (Serial #00187447)
T12A	Rion NL-21 (Serial #00465439)
T12B	Rion NL-21 (Serial #00765699)
T20A	Rion NL-21 (Serial #00354110)
T25A	Rion NL-21 (Serial #00465446)
T26A	Rion NL-21 (Serial #00409168)
U21A	Rion NL-21 (Serial #00865768)
V21A	Rion NL-21 (Serial #00465445)
W14A	Rion NL-21 (Serial #00187447)
W25A	Rion NL-21 (Serial #00465445)
X16A	Rion NL-21 (Serial #00409167)
X21A	Rion NL-21 (Serial #00265112)
X21B	Rion NL-21 (Serial #00465445)
X23A	Rion NL-21 (Serial #00265112)
Y17A	Rion NL-21 (Serial #00187447)
Y18A	Rion NL-21 (Serial #00465439)
Calibrator	Rion NC-74 (Serial #34483784)

Rion NL-21's are Type 2 instruments suitable for background noise measurements in accordance with NZS 6808. All noise loggers were field calibrated at the start and finish of the measurement periods, and no significant drift in calibration was observed.

All items of equipment used carry a current calibration certificate from a NATA accredited laboratory. Copies of the calibration certificates are attached in Appendix E.

Measurements at property Q15A were undertaken by the resident's acoustic consultant. The resident has been assured by their consultant that the measurements were made completely in accordance with the requirements of NZS 6808:1998, and therefore that calibrated equipment was used.

Appendix A

Glossary

Appendix A Glossary

A-weighting	The A-weighting scale is used to adjust the noise level to the subjective response of the human ear to sound.
dB(A)	A-weighted noise levels are expressed in units of dB(A).
$L_{A95,10min}$	The A-weighted noise level exceeded 95% of the 10 minute measurement period. This descriptor is used to represent the background noise level.

Appendix B

Photographs

Appendix B Photographs

Figure B1: O18A logger location

Figure B2: O18A logger location

Figure B3: P19A logger location

Figure B4: P19A logger location

Figure B5: P22A logger location

Figure B6: P22A logger location

Figure B7: Q15A logger location

Figure B8: Q15A logger location

Note that the images for property Q15A show the location of the AECOM logger placed on the property. We understand that the consultant's logger was placed directly adjacent to this logger.

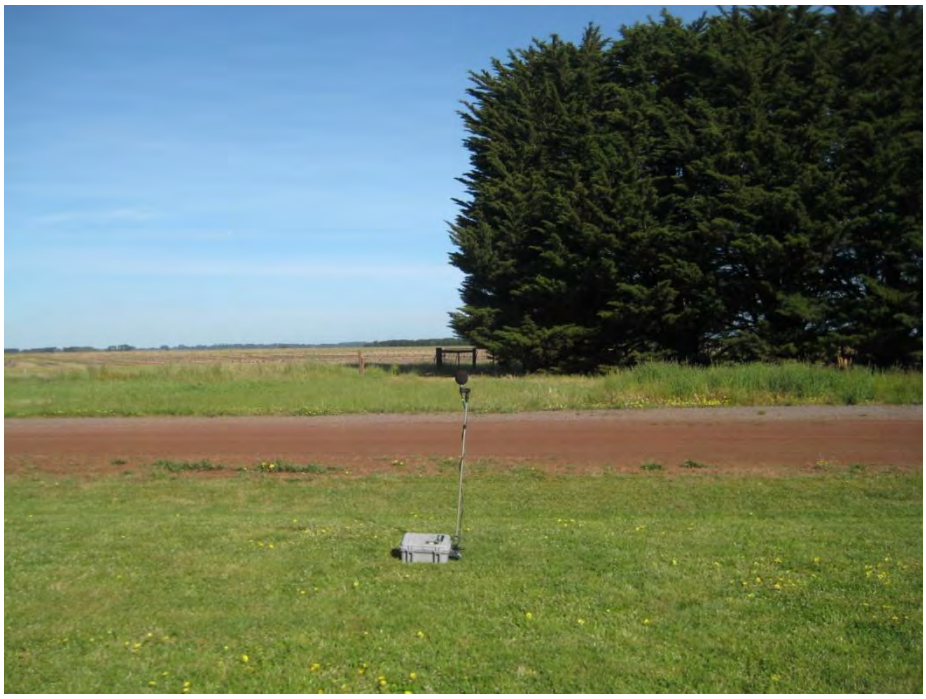


Figure B9: Q20A logger location

Figure B10: Q20A logger location

Figure B11: R21A logger location

Figure B12: R21A logger location

Figure B13: R21B logger location

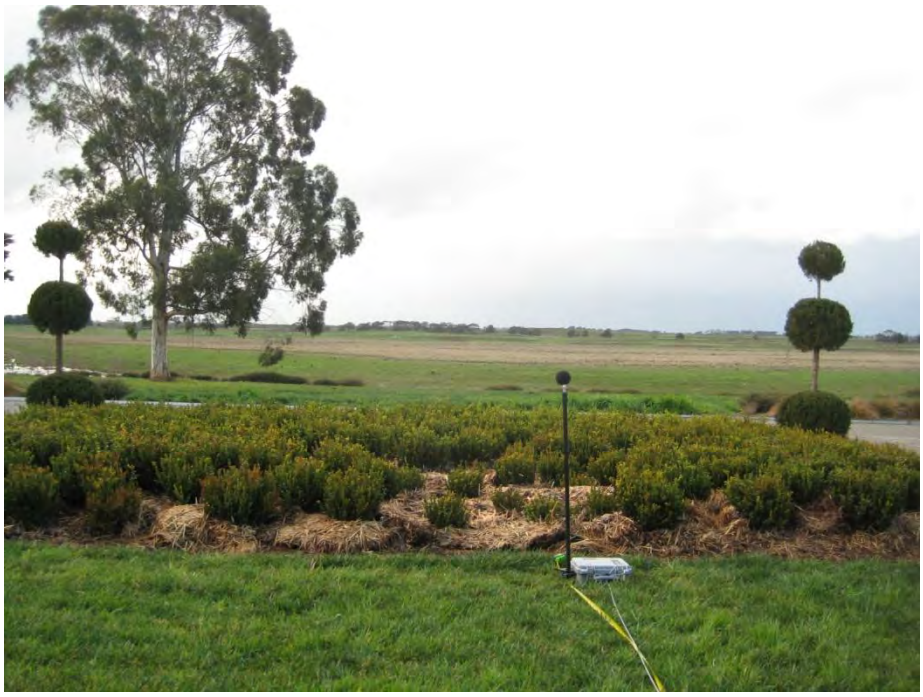


Figure B14: R21B logger location

Figure B15: R26B logger location

Figure B16: R26B logger location

Figure B17: S26A logger location

Figure B18: S26A logger location

Figure B19: S26B logger location

Figure B20: S26B logger location

Figure B21: T12A logger location

Figure B22: T12A logger location

Figure B23: T12B logger location

Figure B24: T12B logger location

Figure B25: T25A logger location

Figure B26: T25A logger locations

Figure B27: T26A logger location

Figure B28: T26A logger location

Figure B29: U21A logger location

Figure B30: U21A logger location

Figure B31: V21A logger location

Figure B32: V21A logger location

Figure B33: W14A logger location

Figure B34: W14A logger location

Figure B35: W25A logger location

Figure B36: W25A logger location

Figure B37: X16A logger location

Figure B38: X16A logger location

Figure B39: X21A logger locations

Figure B40: X21A logger locations

Figure B41: X21B logger location

Figure B42: X21B logger locations

Figure B43: X23A logger location

Figure B44: X23A logger location

Figure B45: Y17A logger location

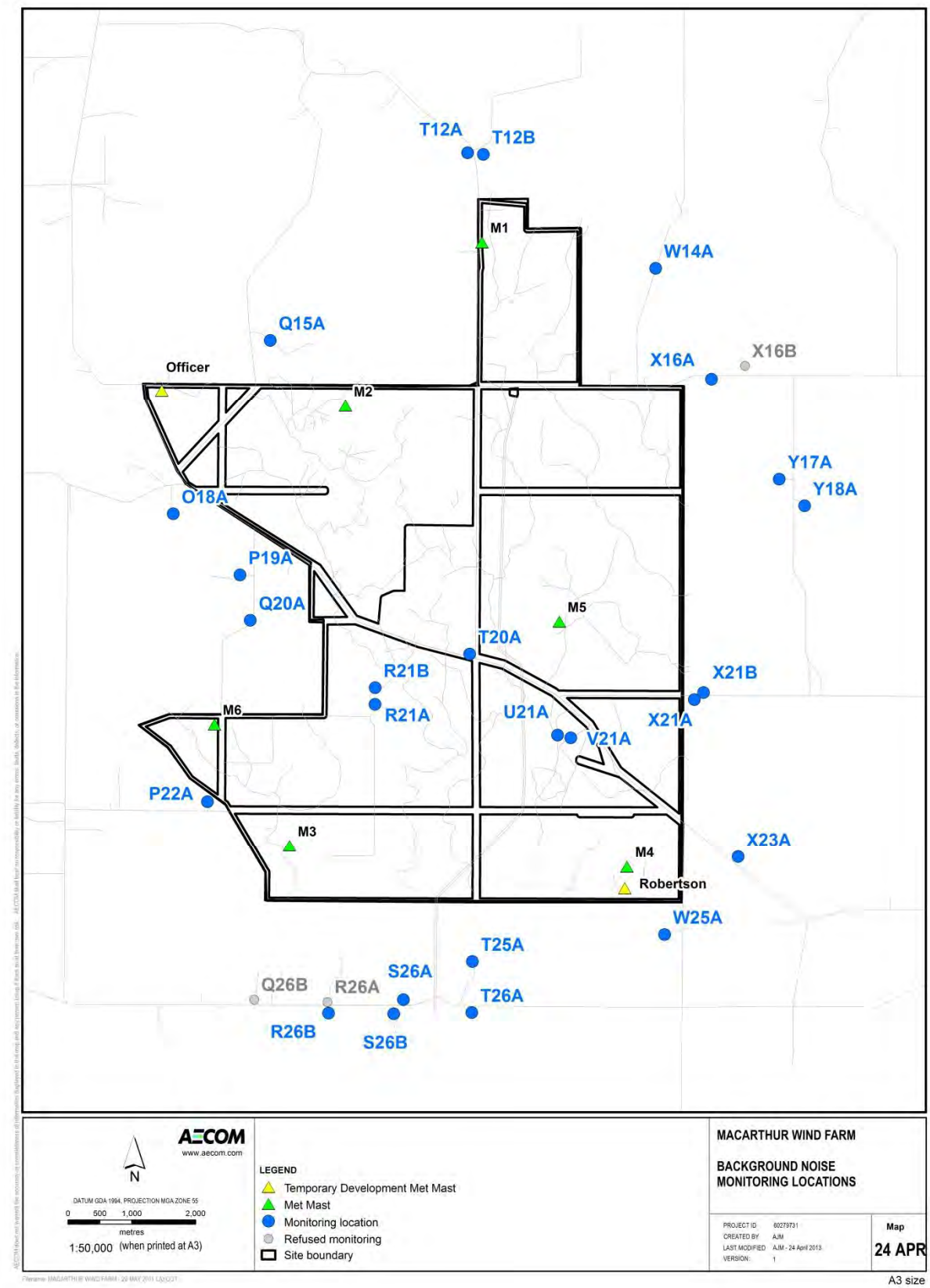
Figure B46: Y17A logger location

Figure B47: Y18A logger location

Figure B48: Y18A logger location

Appendix C

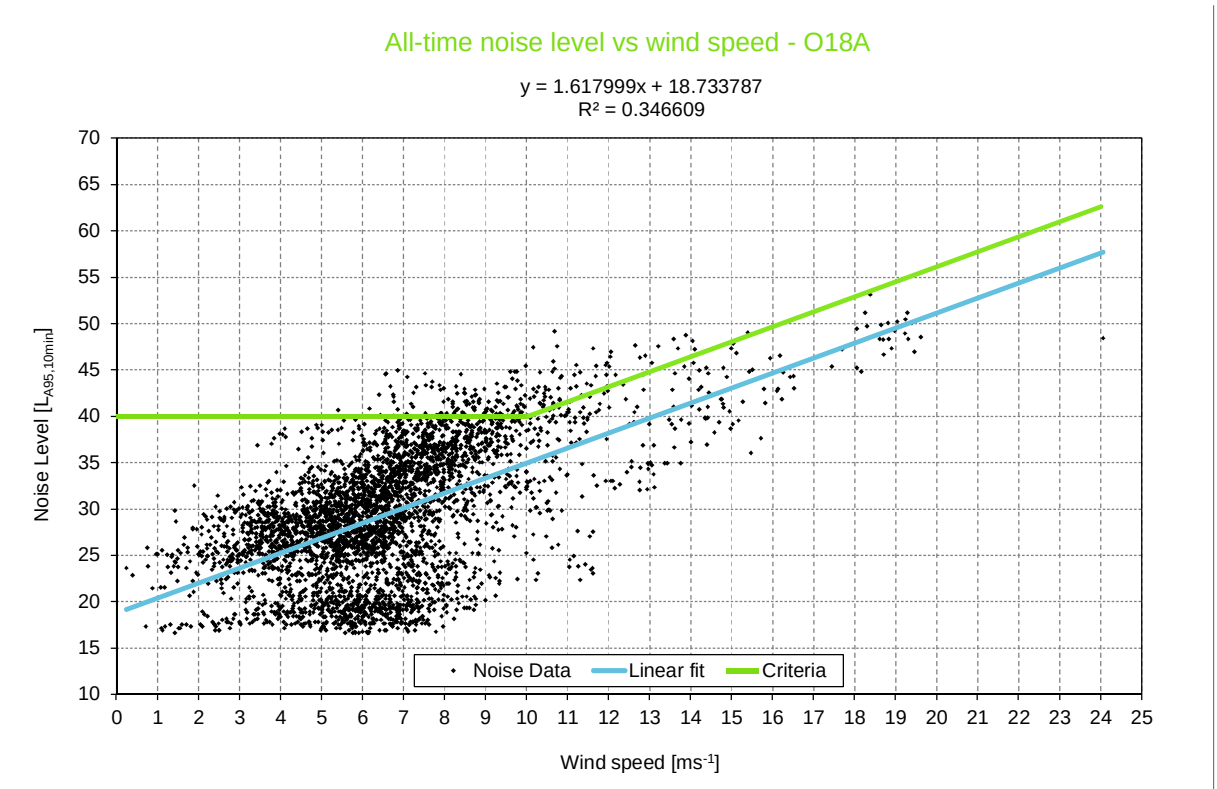
Site Map


T12A
T12B
M1
W14A
Q15A
Officer
M2
X16A
X16B
Y17A
Y18A
O18A
P19A
Q20A
M5
T20A
R21B
X21B
R21A
U21A
X21A
V21A
M6
P22A
M3
X23A
M4
Robertson
W25A
T25A
S26A
Q26B
R26A
T26A
R26B
S26B
AECOM
www.aecom.com
N
DATUM GDA 1994, PROJECTION MGA ZONE 55
0 500 1,000 2,000
metres
1:50,000 (when printed at A3)
LEGEND
Temporary Development Met Mast
Met Mast
Monitoring location
Refused monitoring
Site boundary
MACARTHUR WIND FARM
BACKGROUND NOISE MONITORING LOCATIONS
PROJECT ID 60279731
CREATED BY AJM
LAST MODIFIED AJM - 24 April 2013
VERSION: 1
Map
24 APR
A3 size

Appendix D

Regression Curves

Appendix D Regression Curves



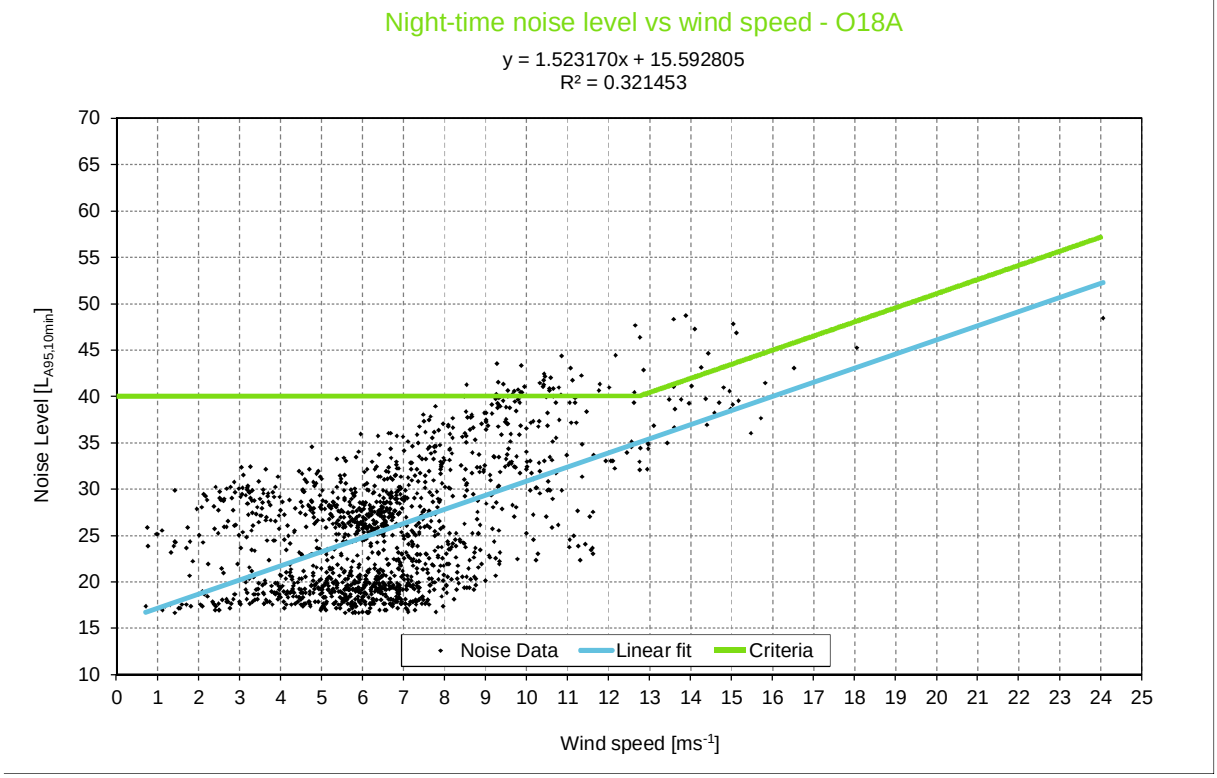
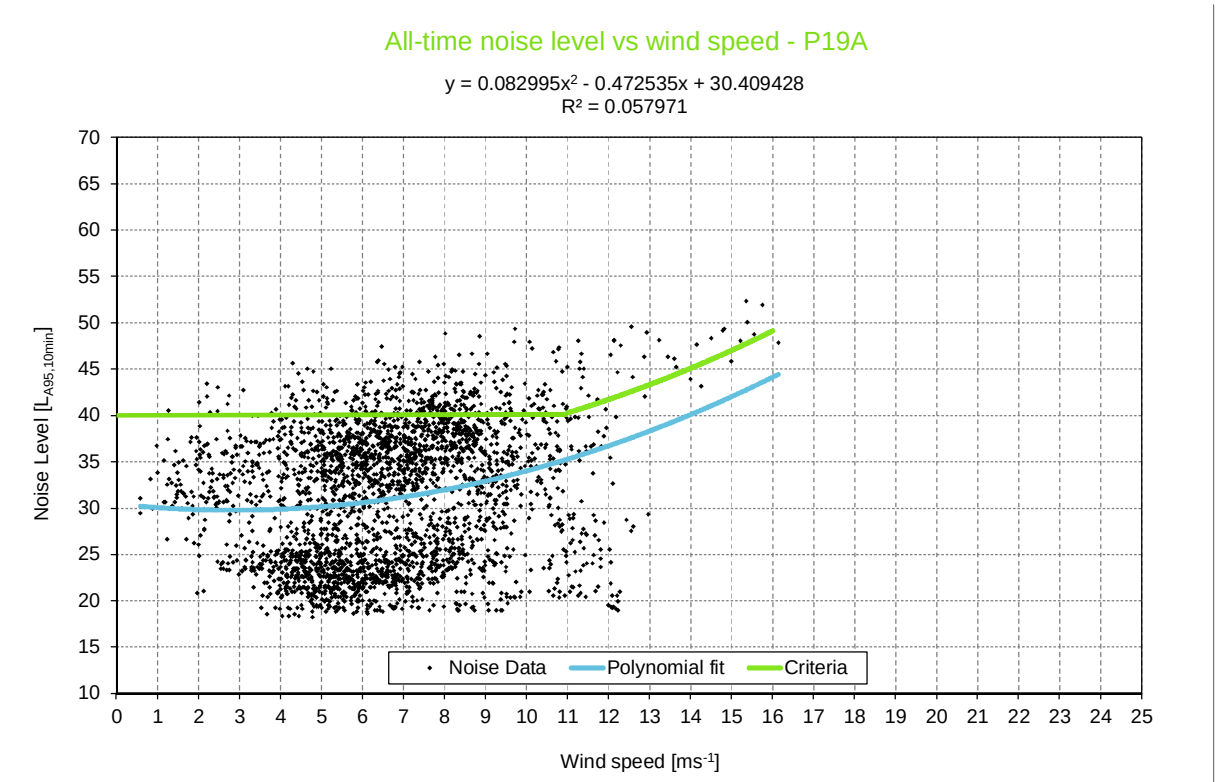


Figure D1: O18A background noise curves



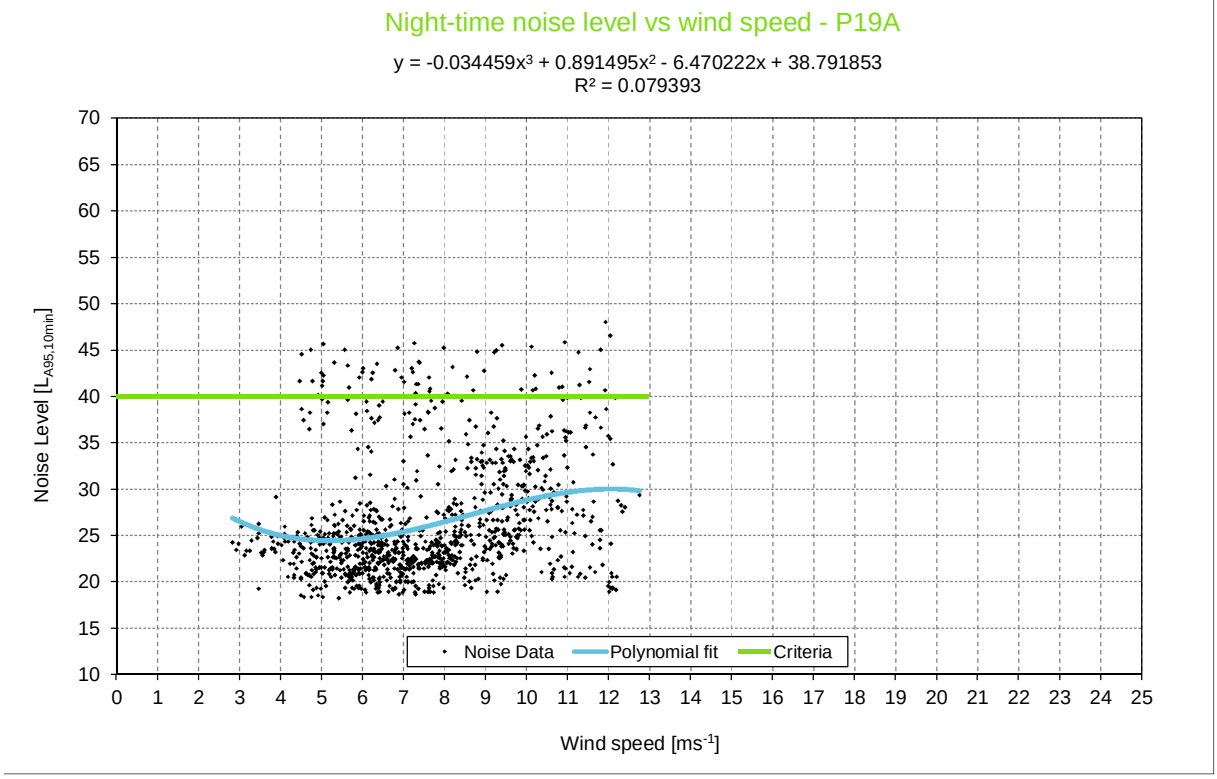
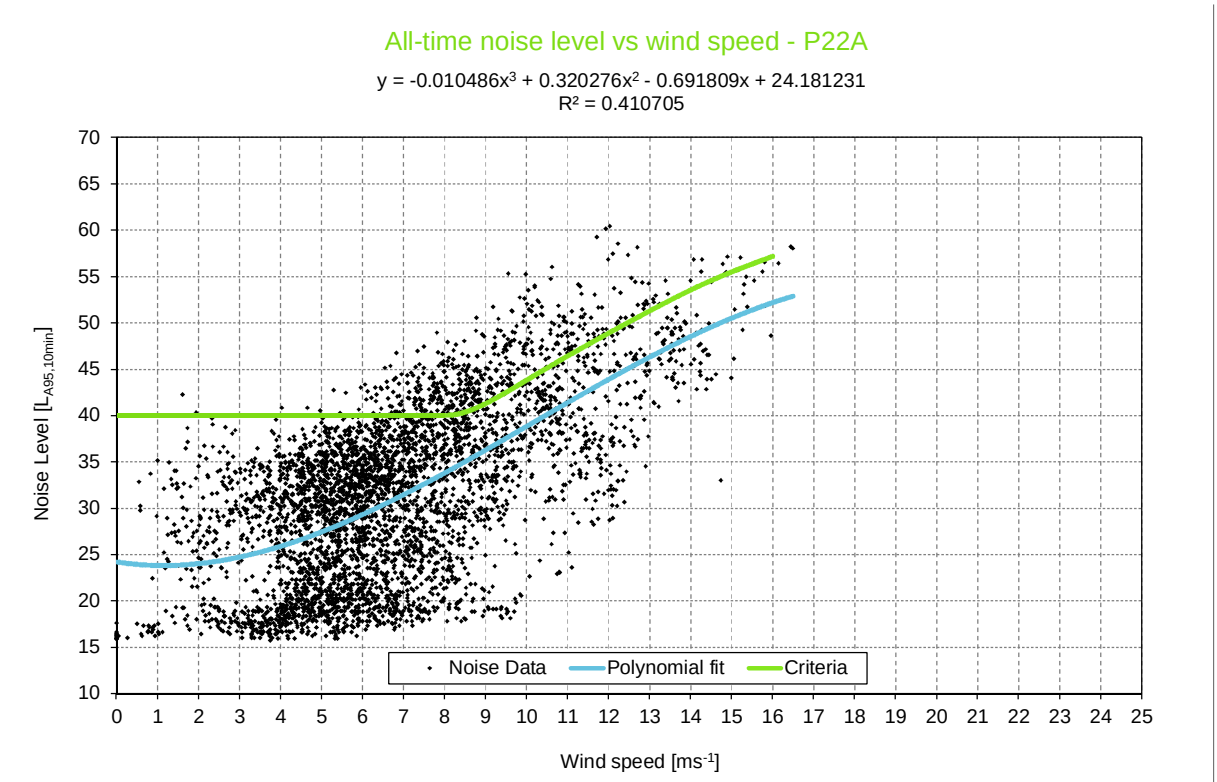


Figure D2: P19A background noise curves



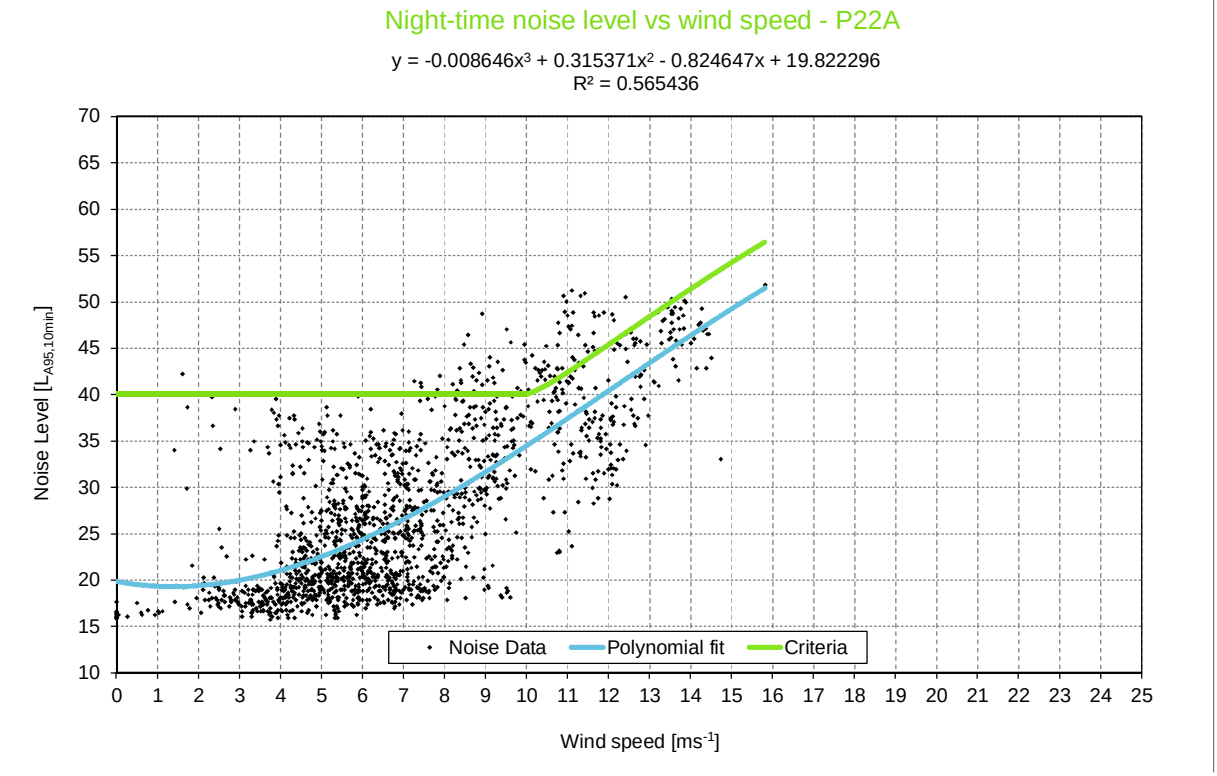
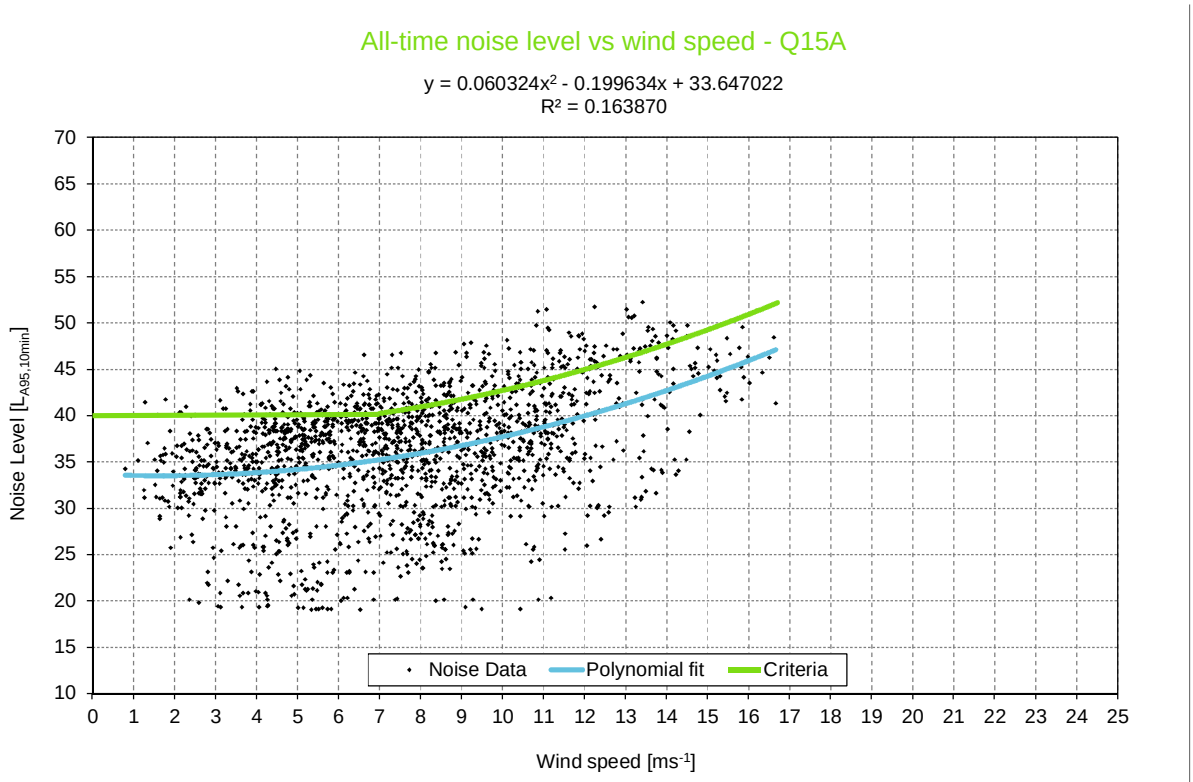


Figure D3: P22A background noise curves



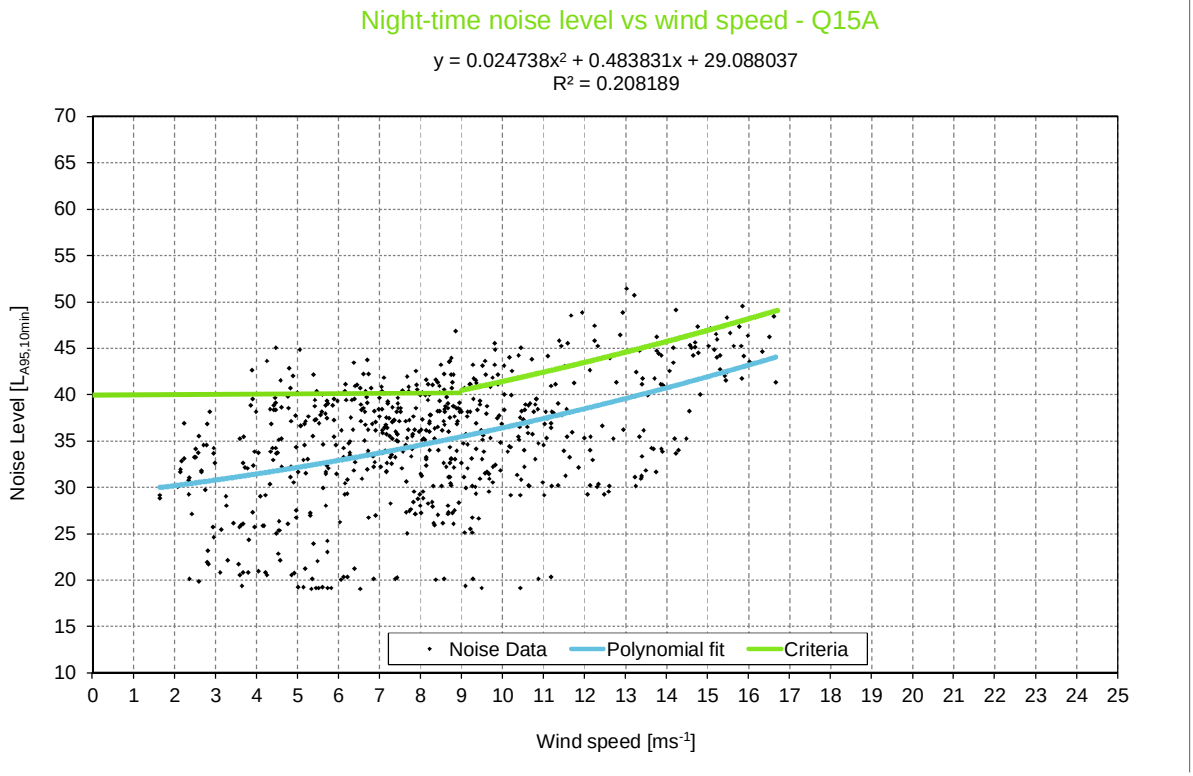
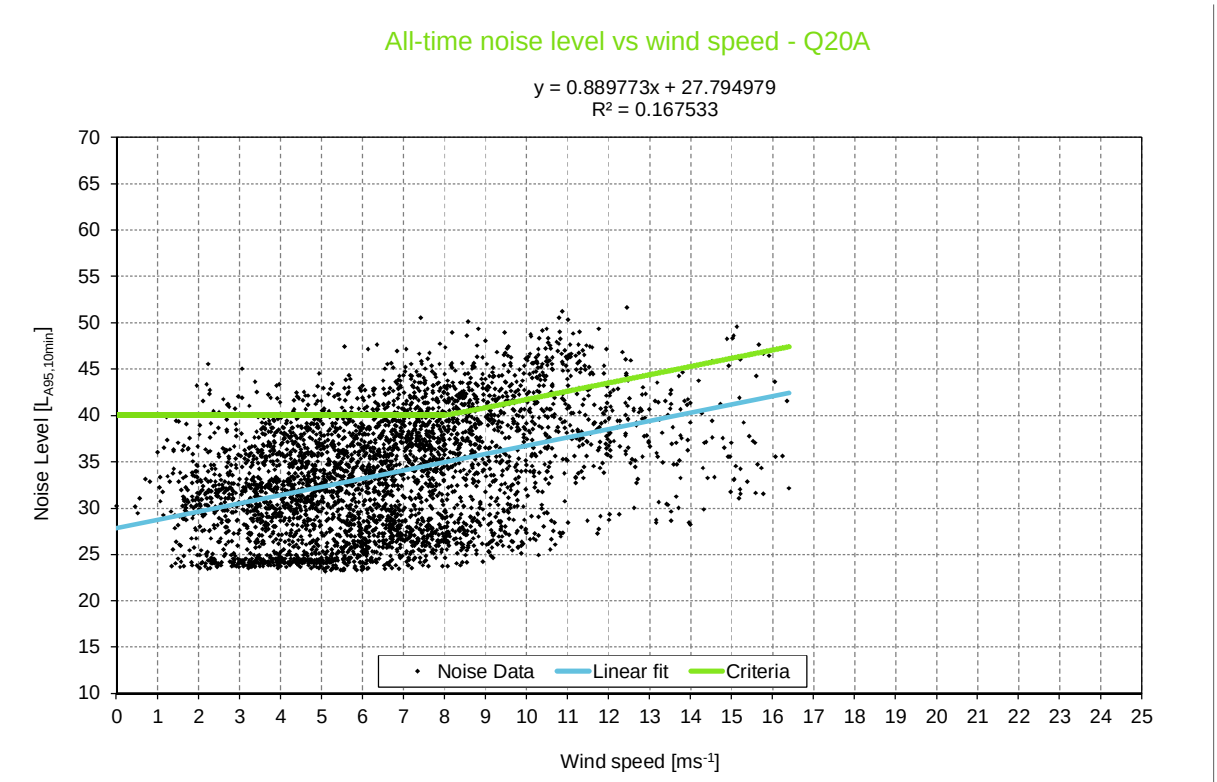


Figure D4: Q15A background noise curves



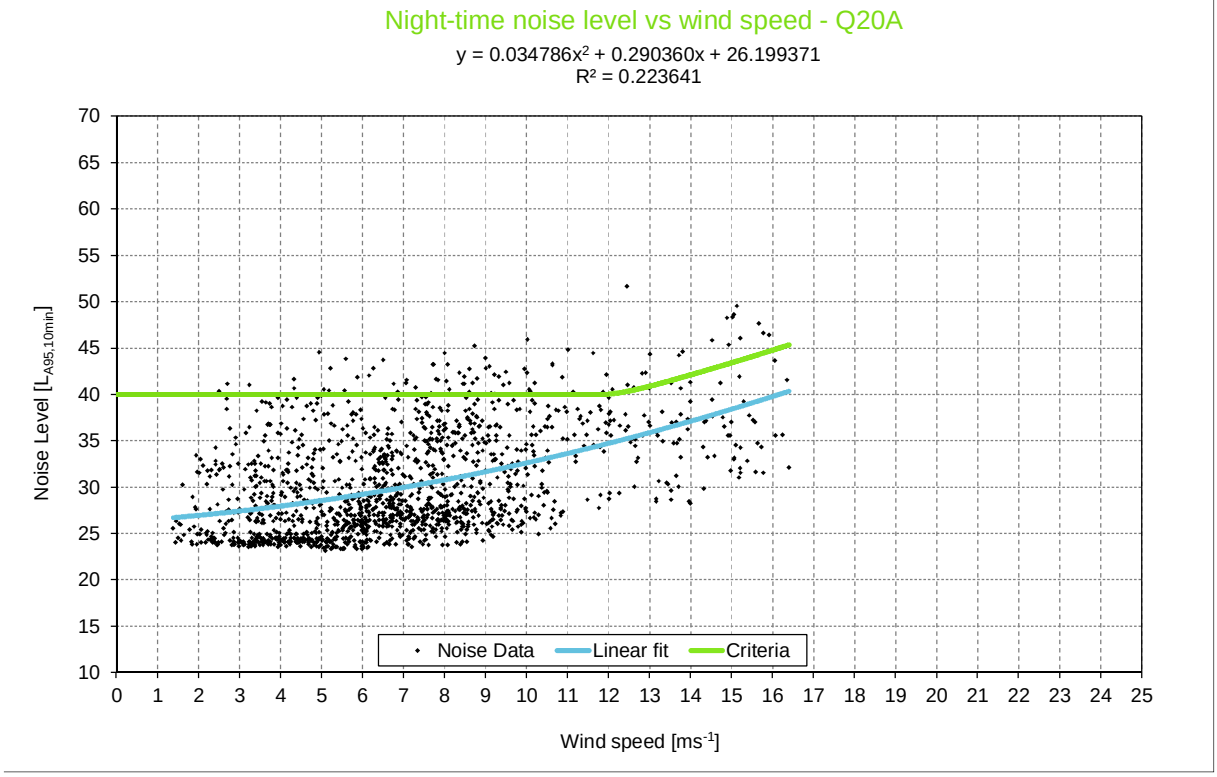
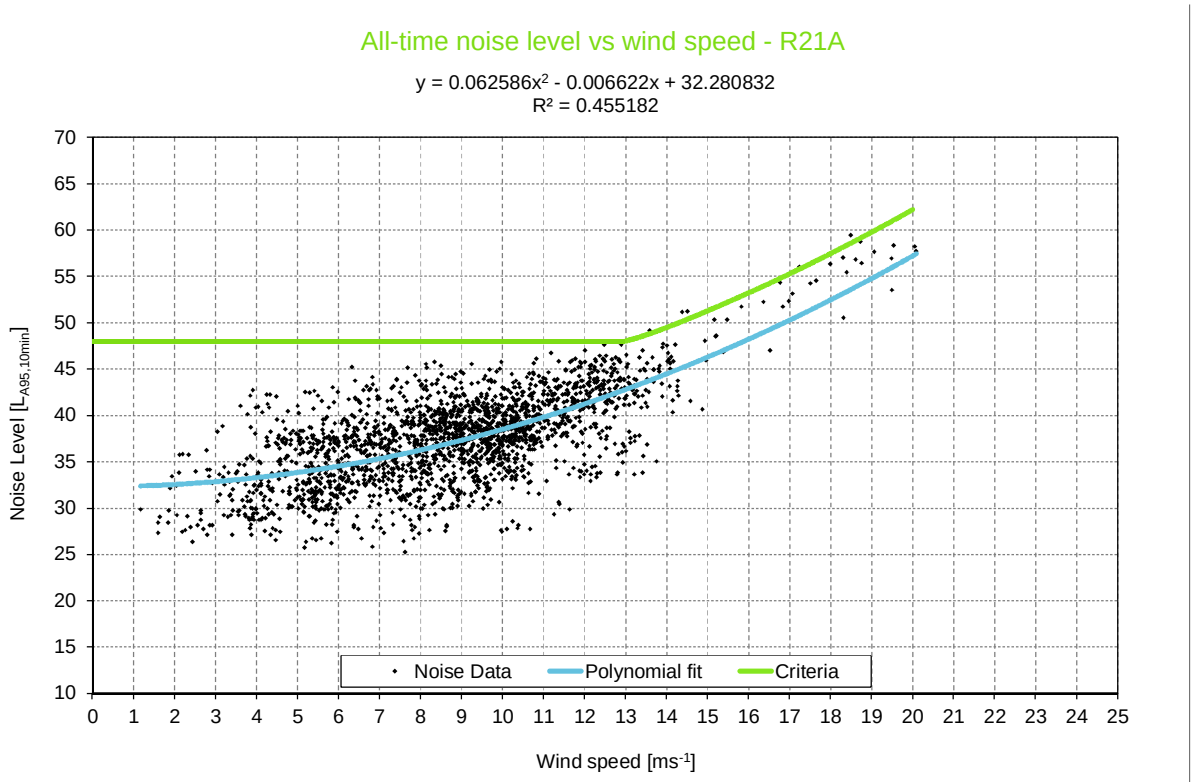


Figure D5: Q20A background noise curves



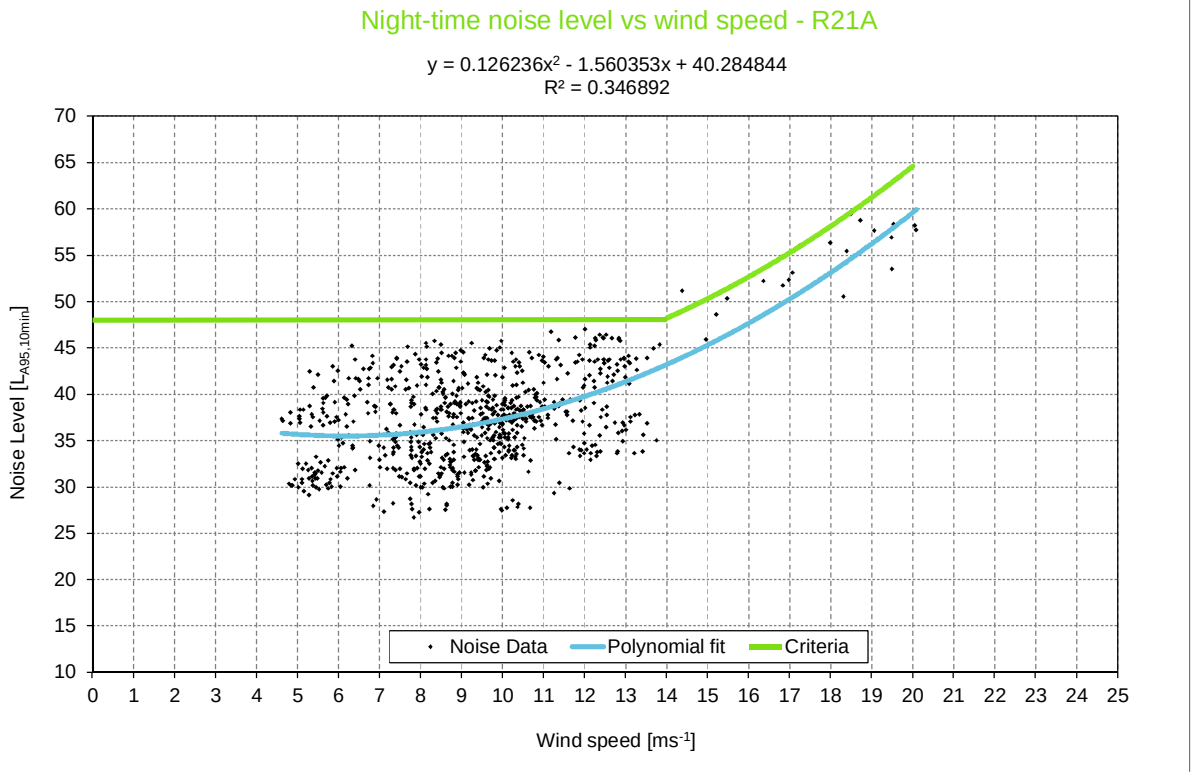
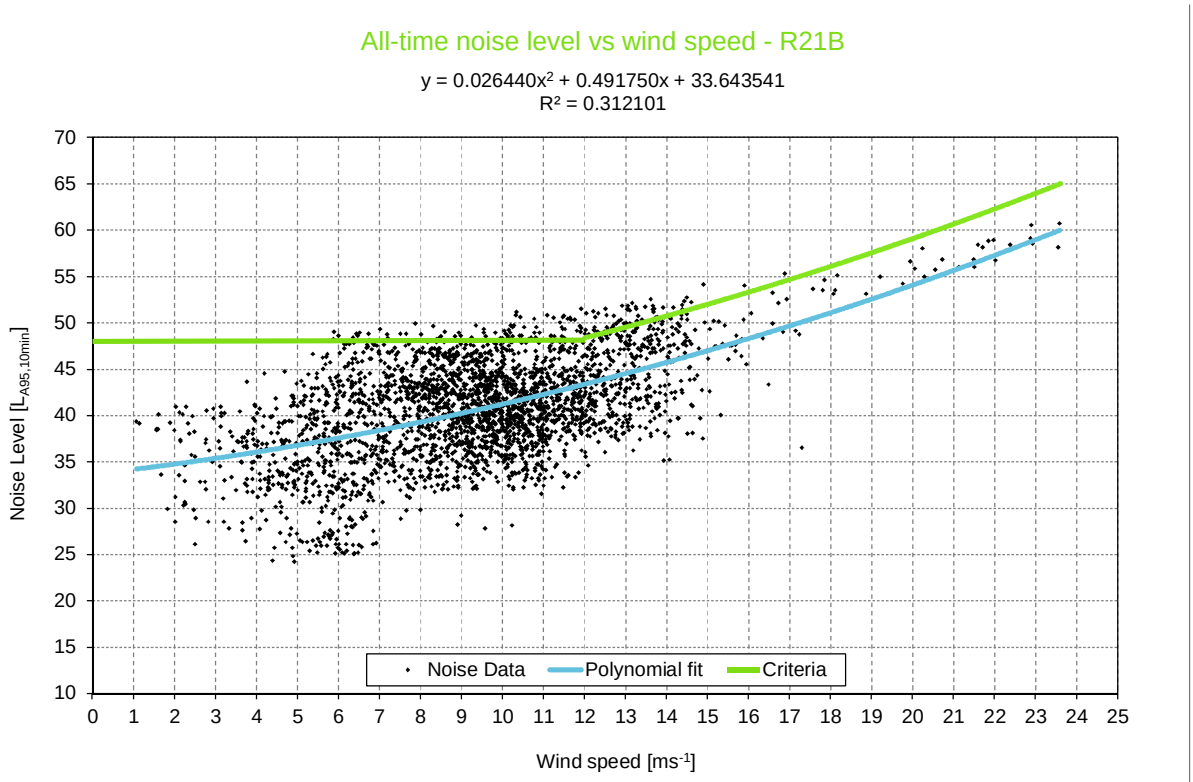


Figure D6: R21A background noise curves



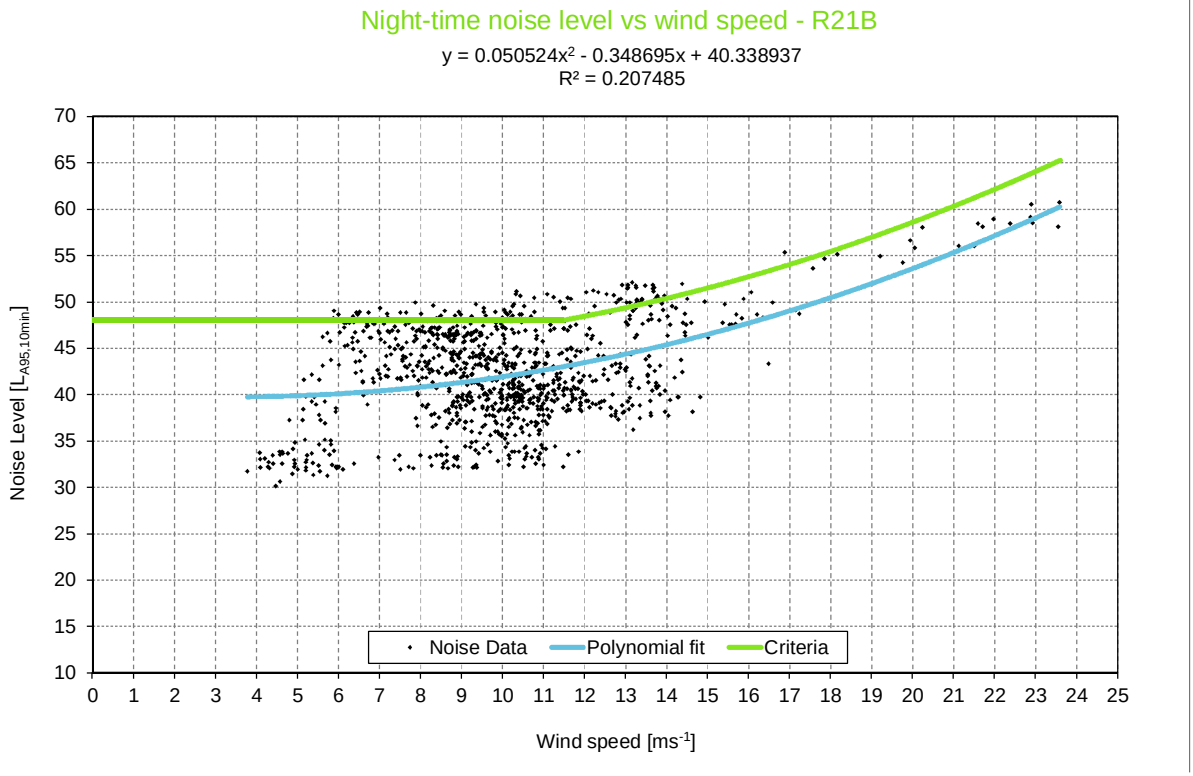
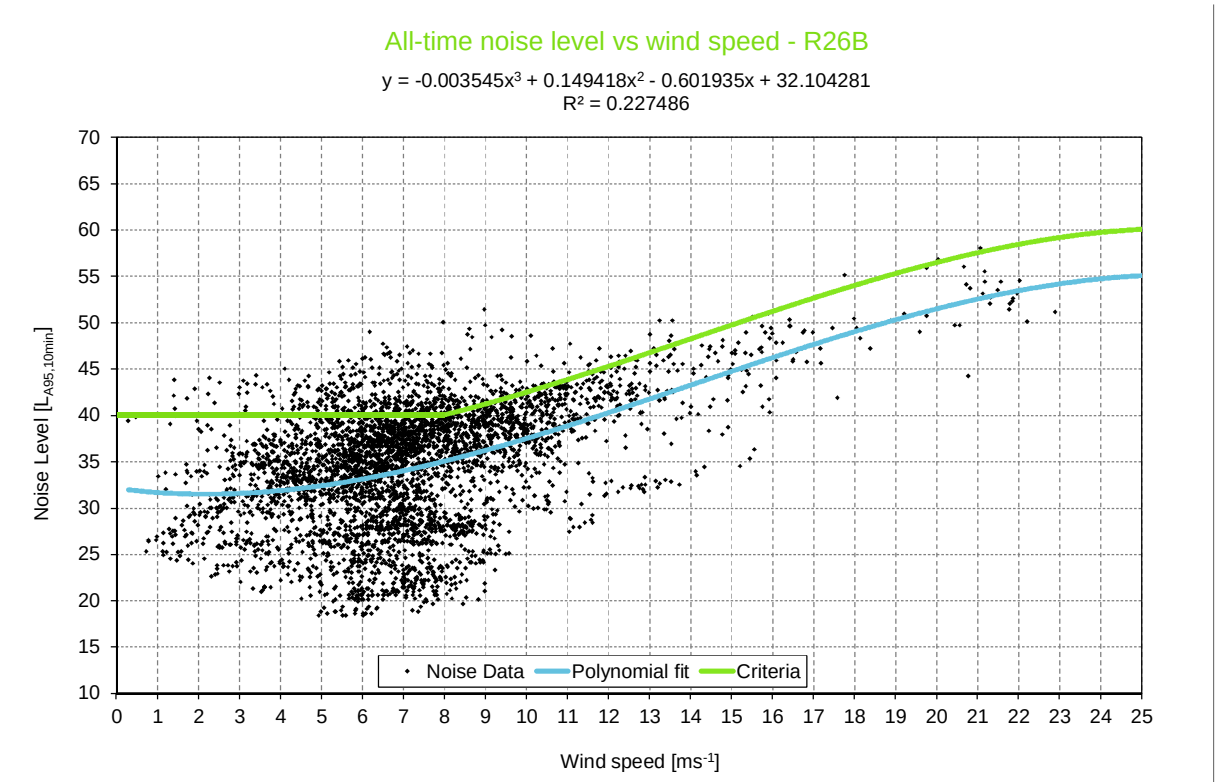


Figure D7: R21B background noise curves



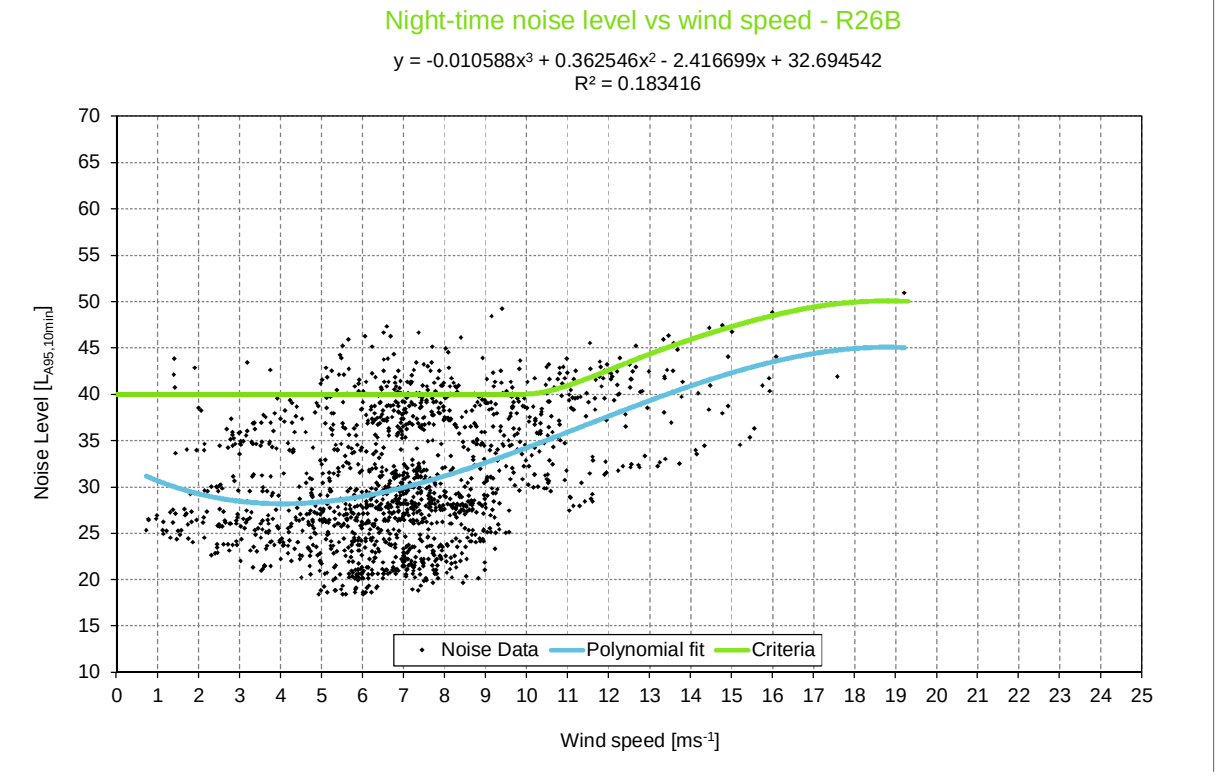
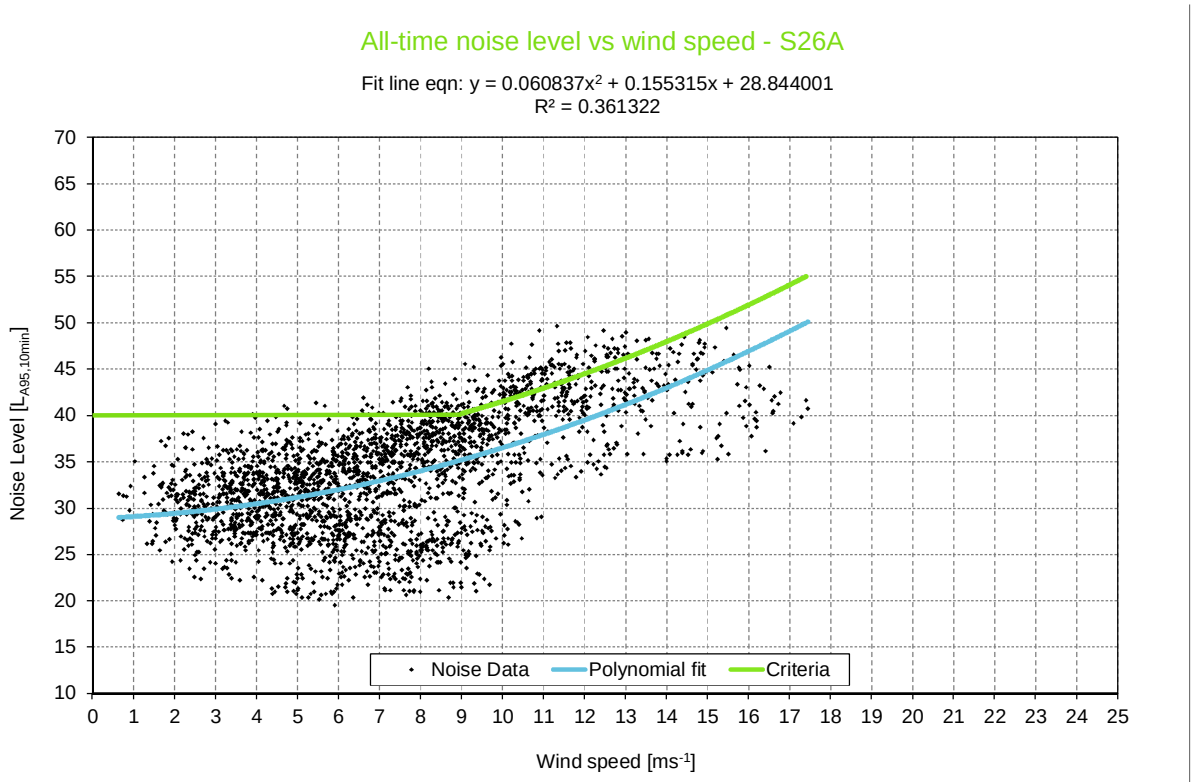


Figure D8: R26B background noise curves



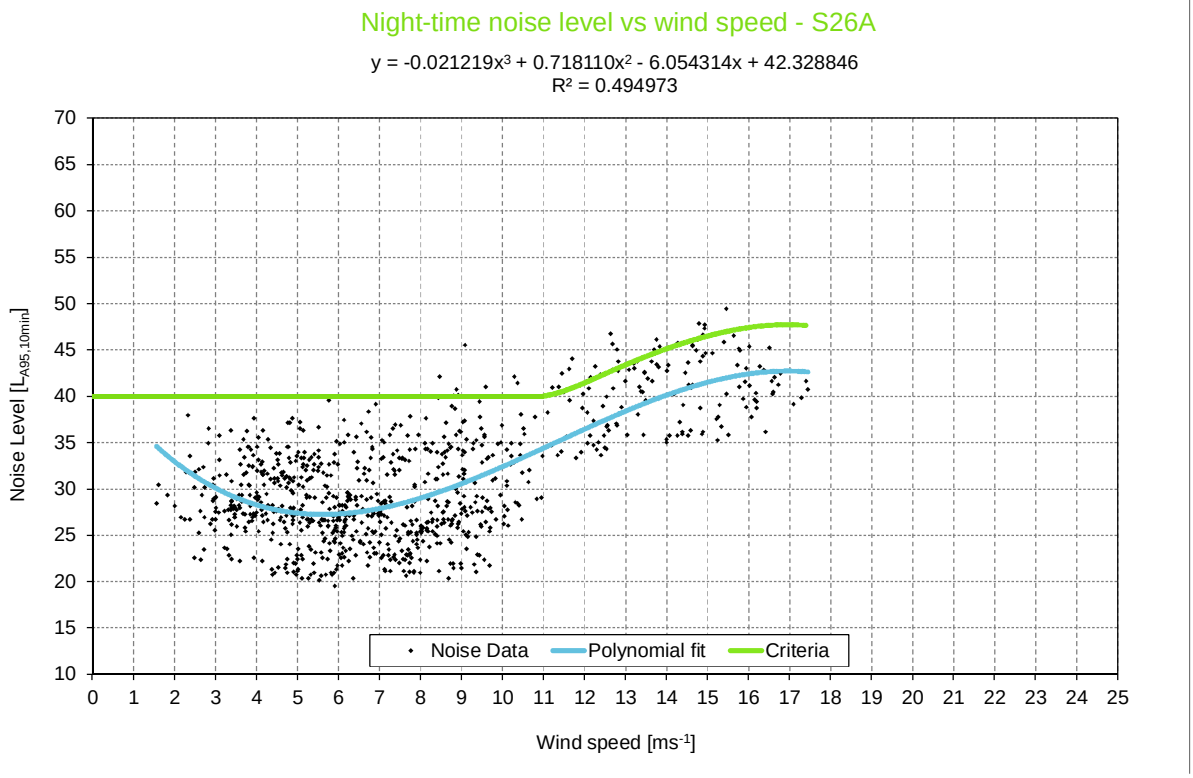
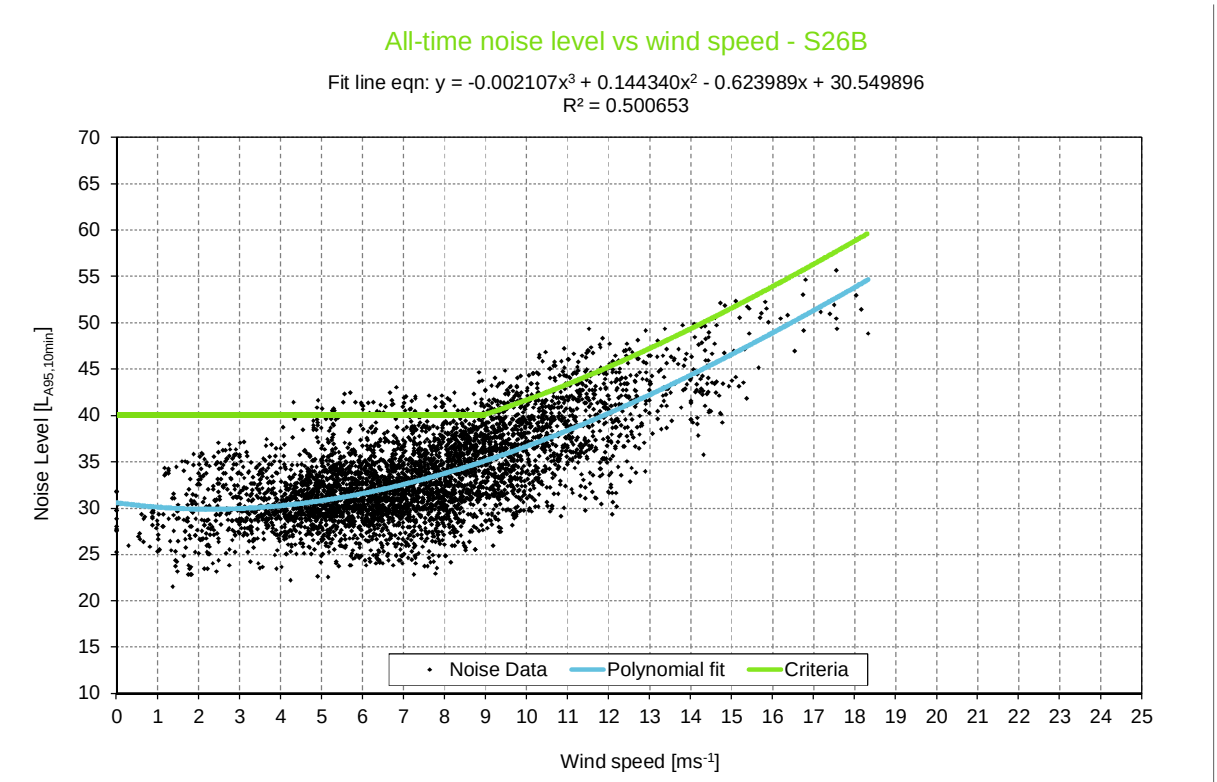


Figure D9: S26A background noise curves



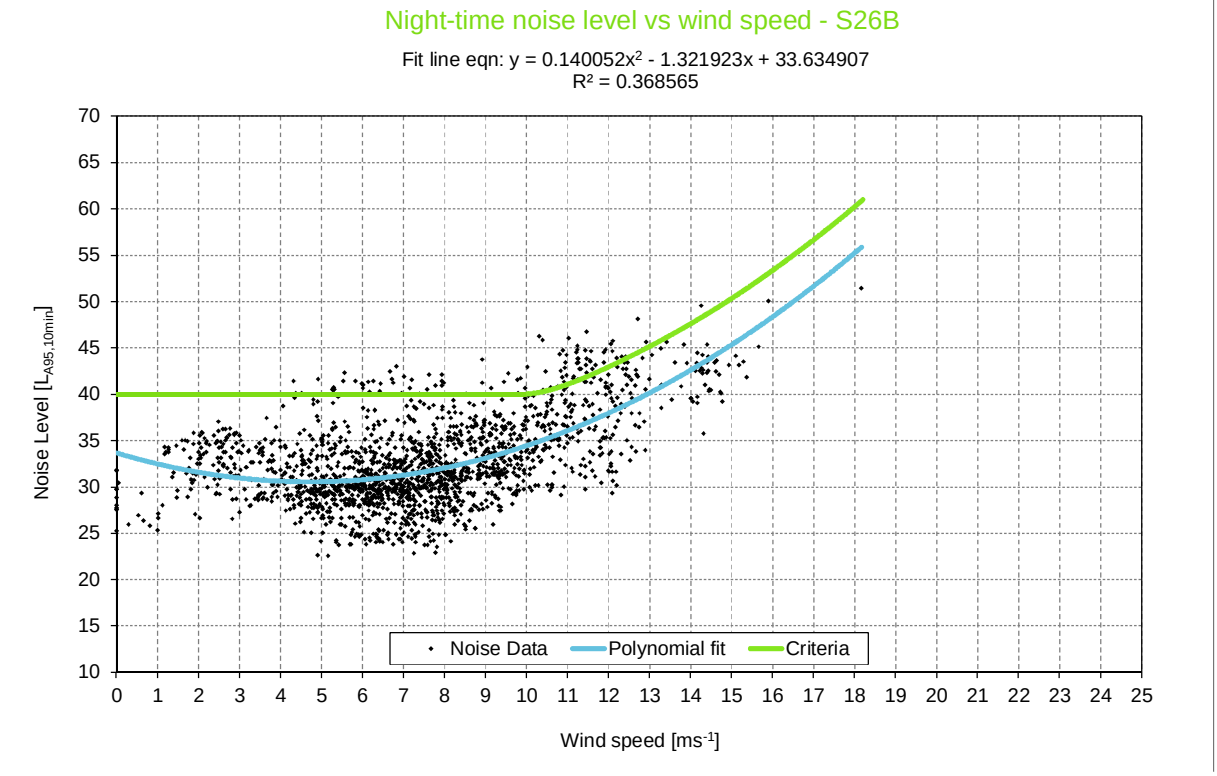
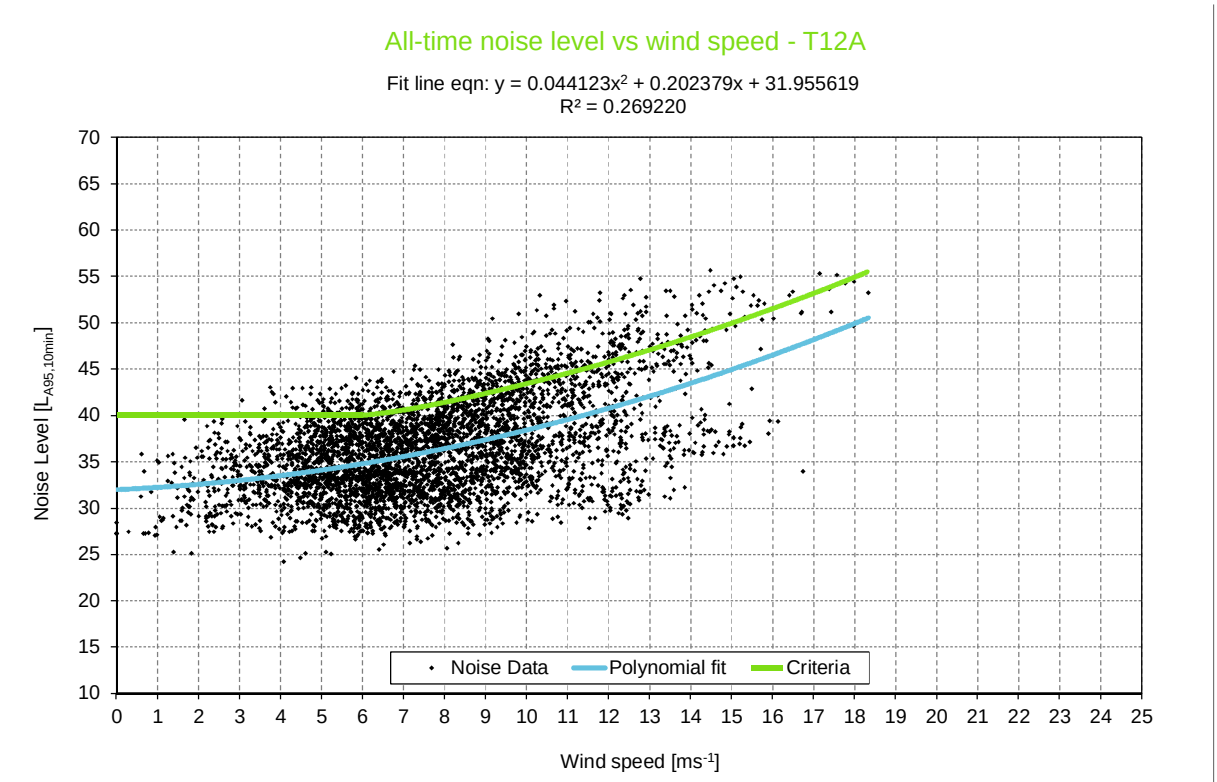


Figure D10: S26B background noise curves



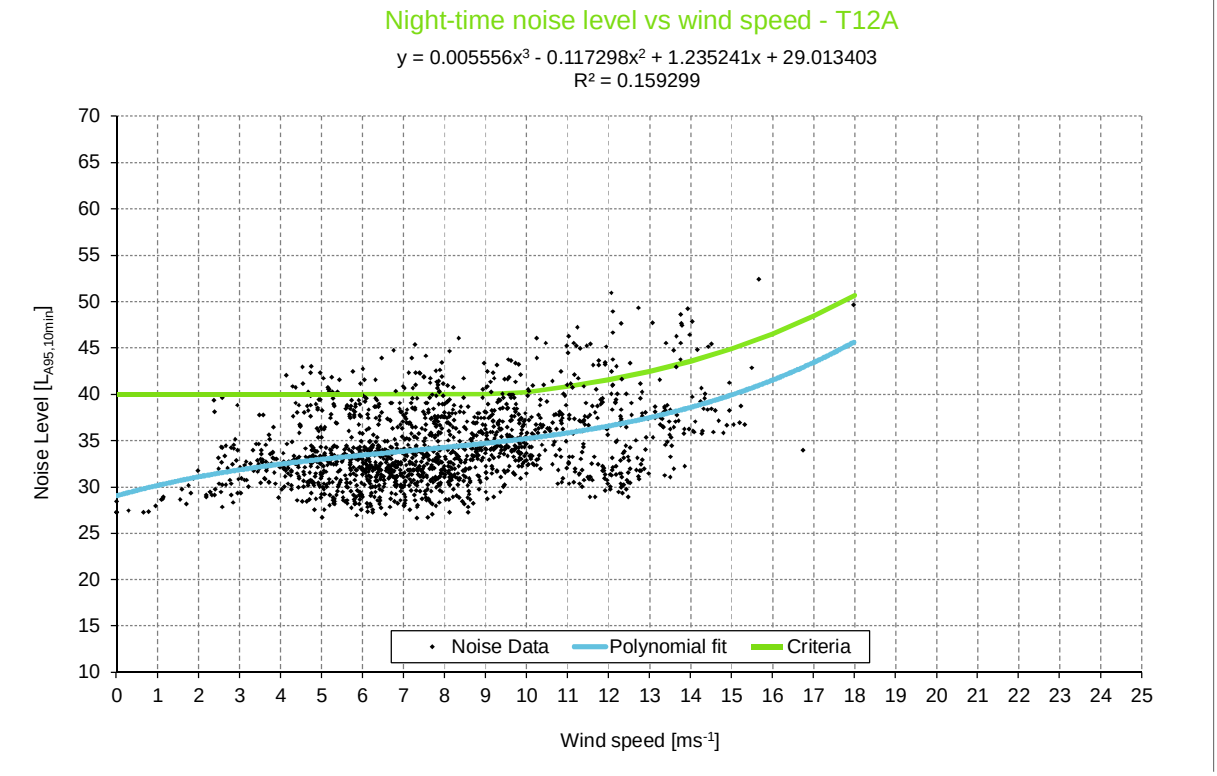
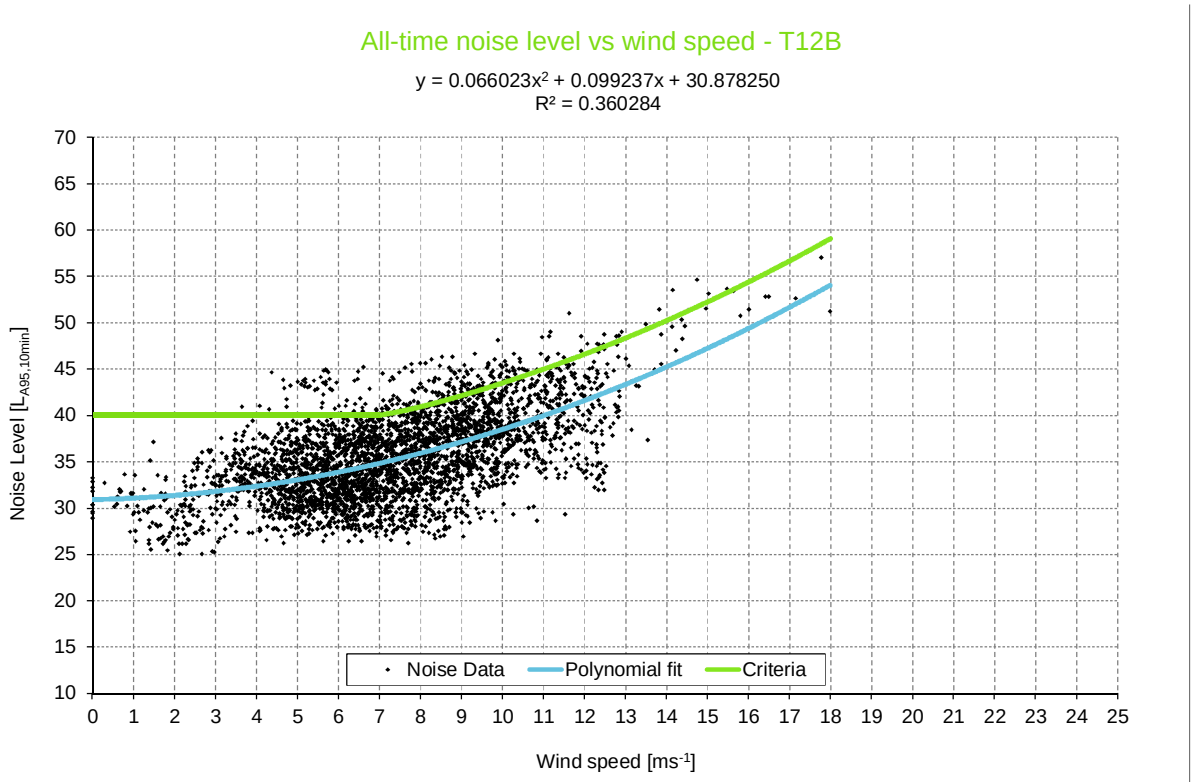


Figure D11: T12A background noise curves



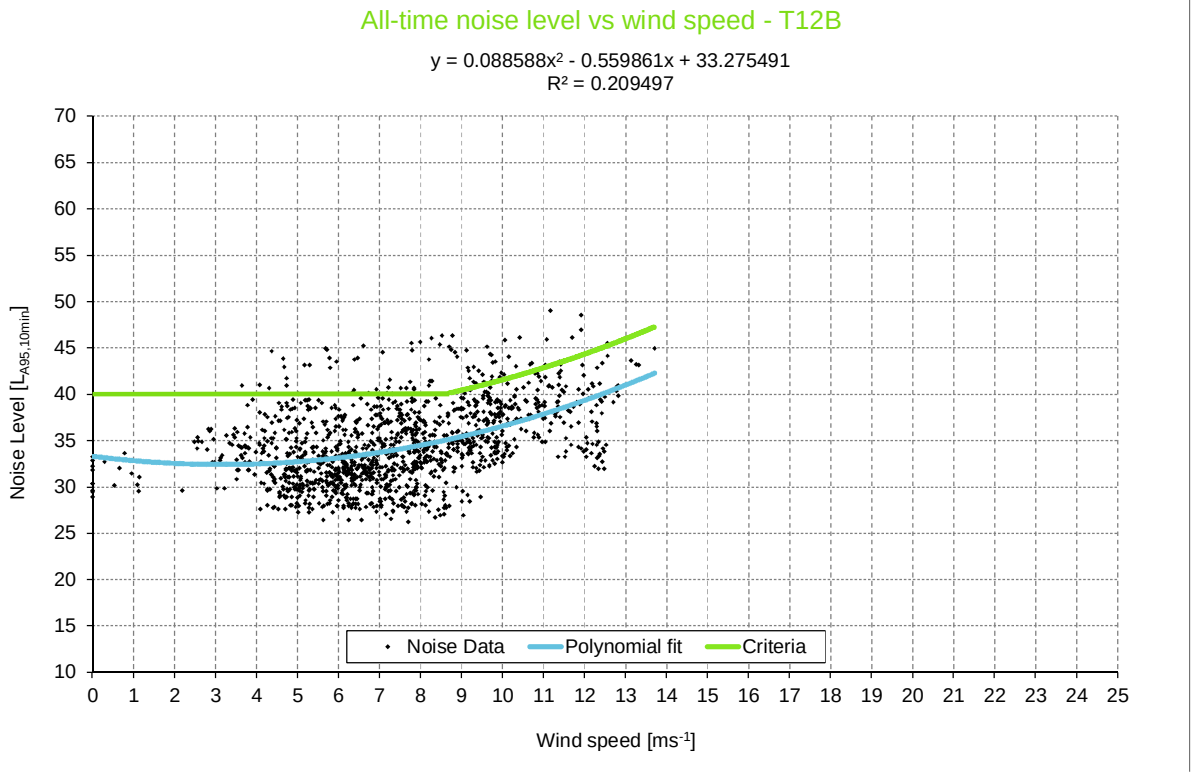
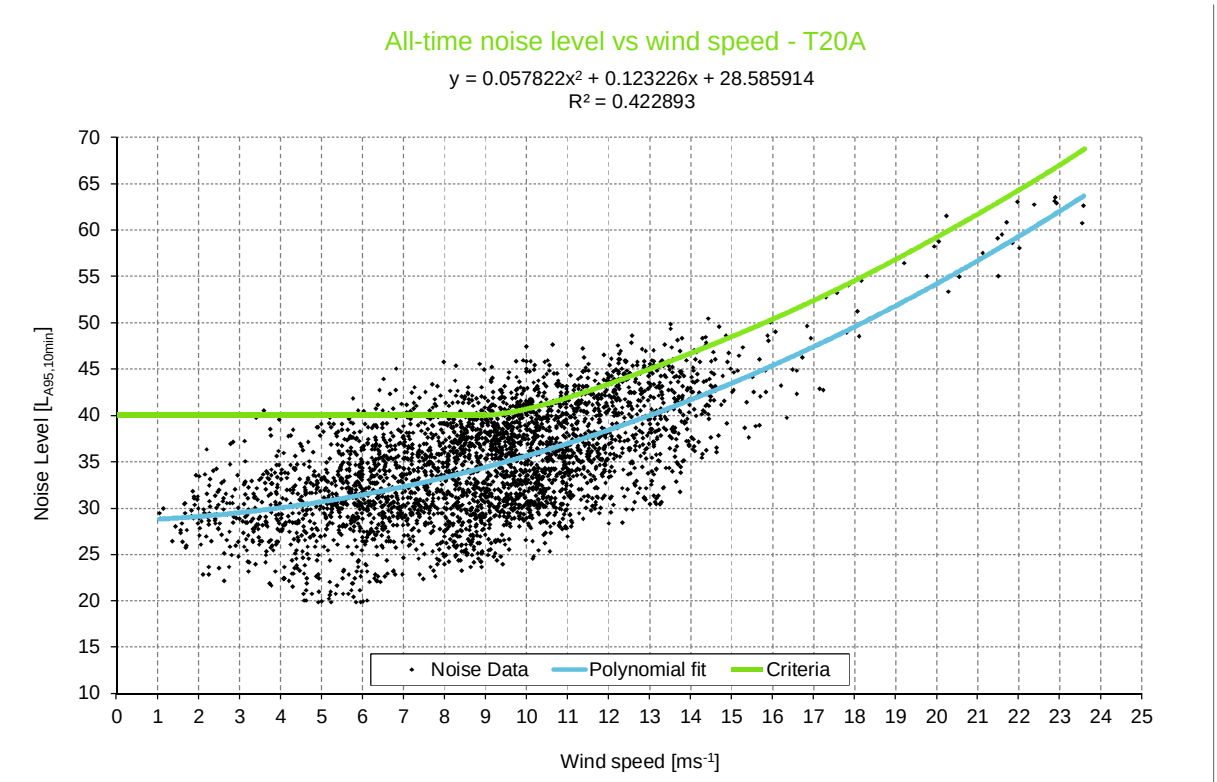


Figure D12: T12B background noise curves



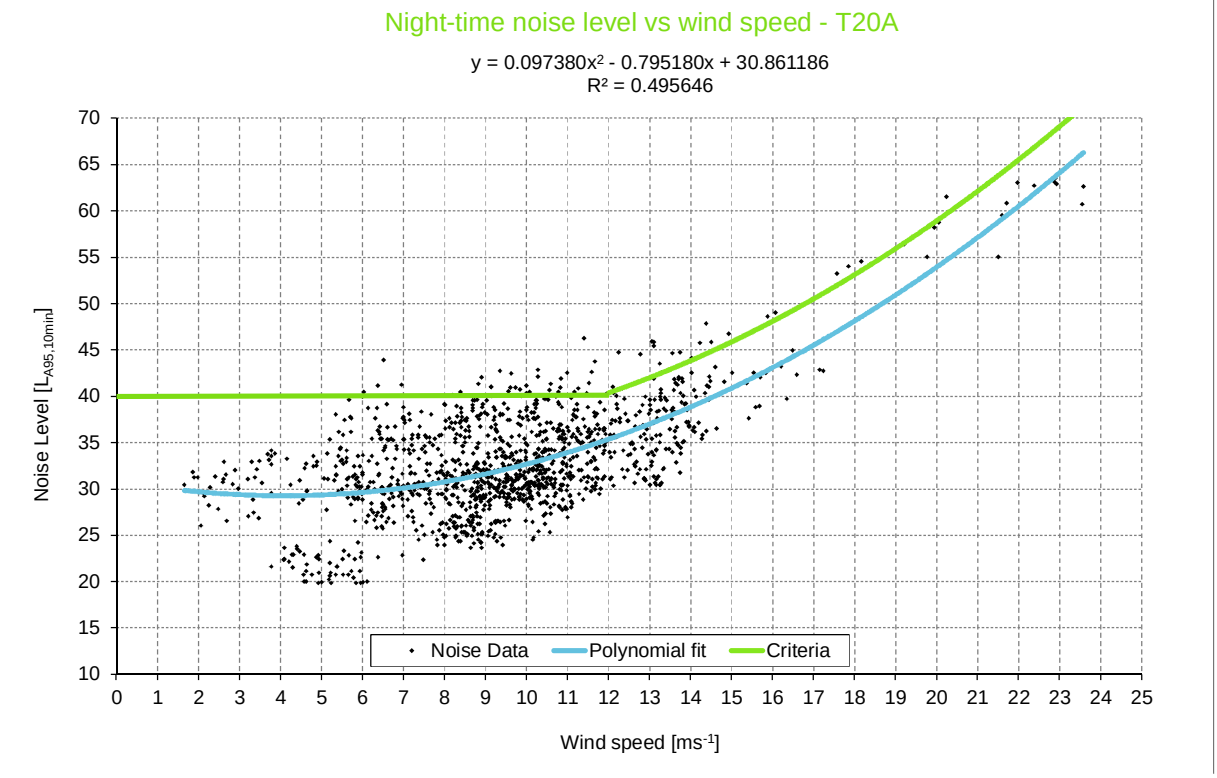
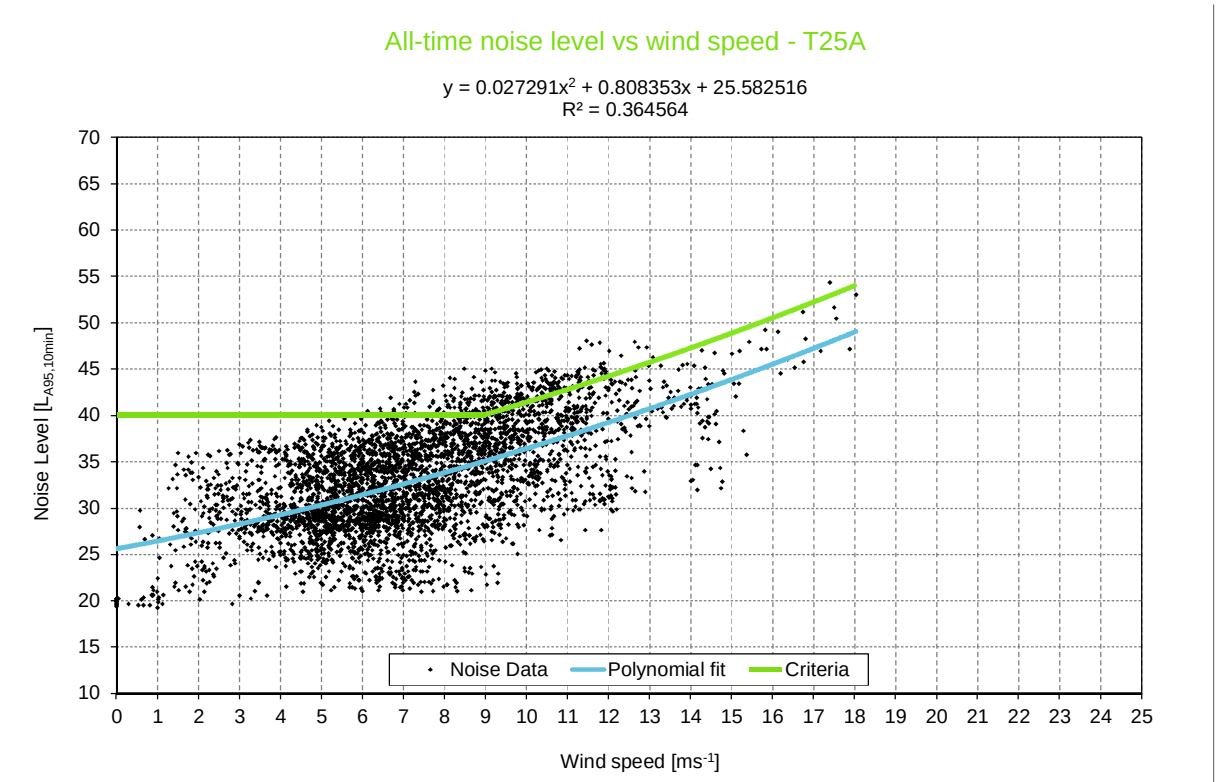


Figure D13: T20A background noise curves



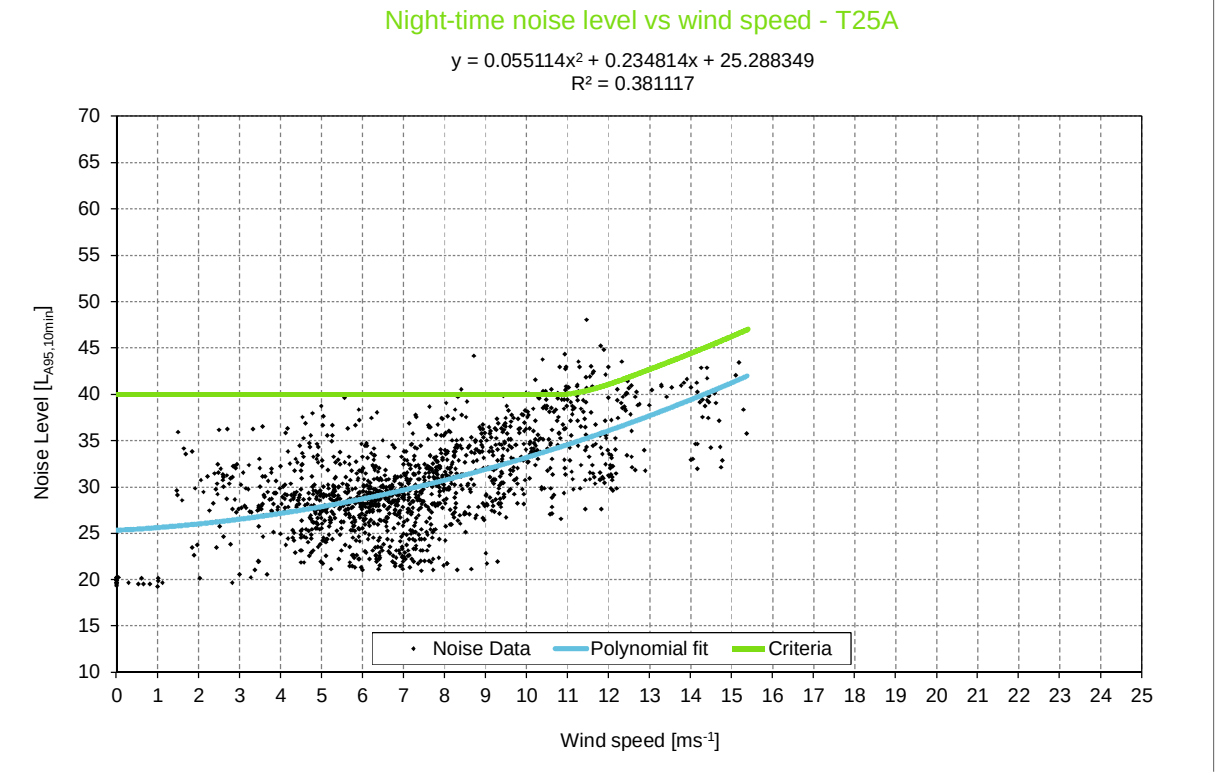


Figure D14: T25A background noise curves

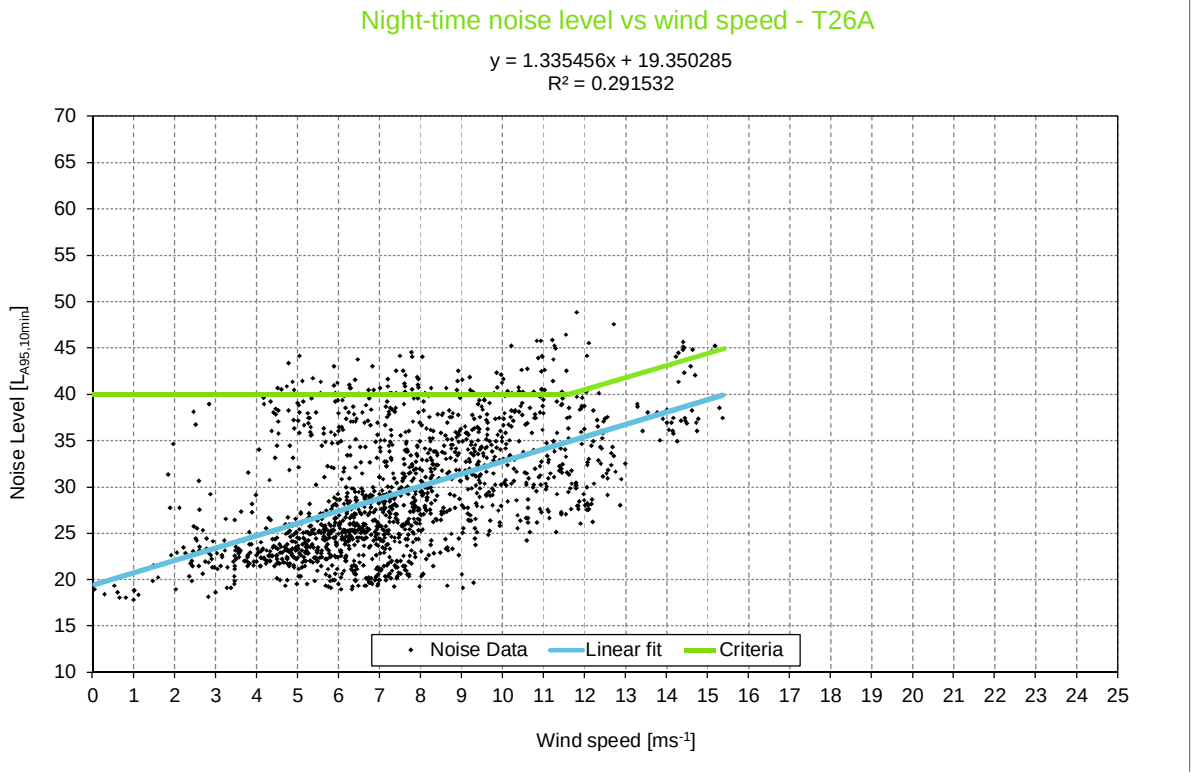
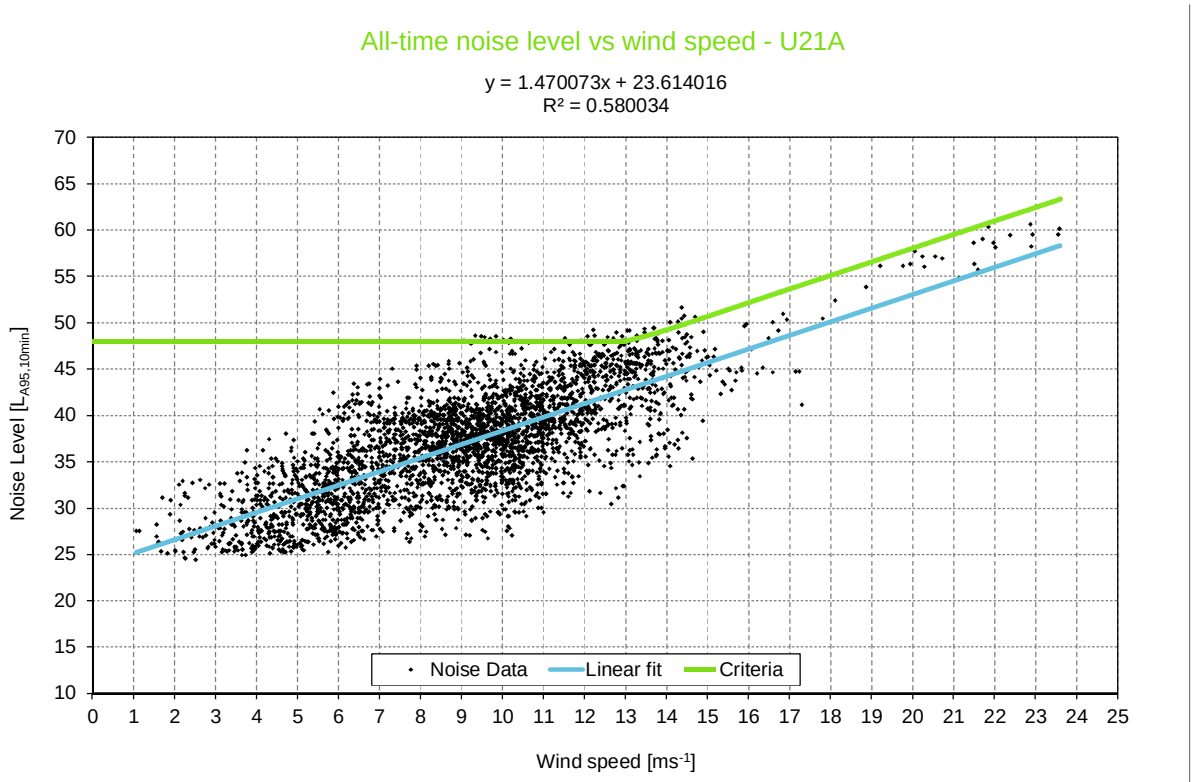


Figure D15: T26A background noise curves



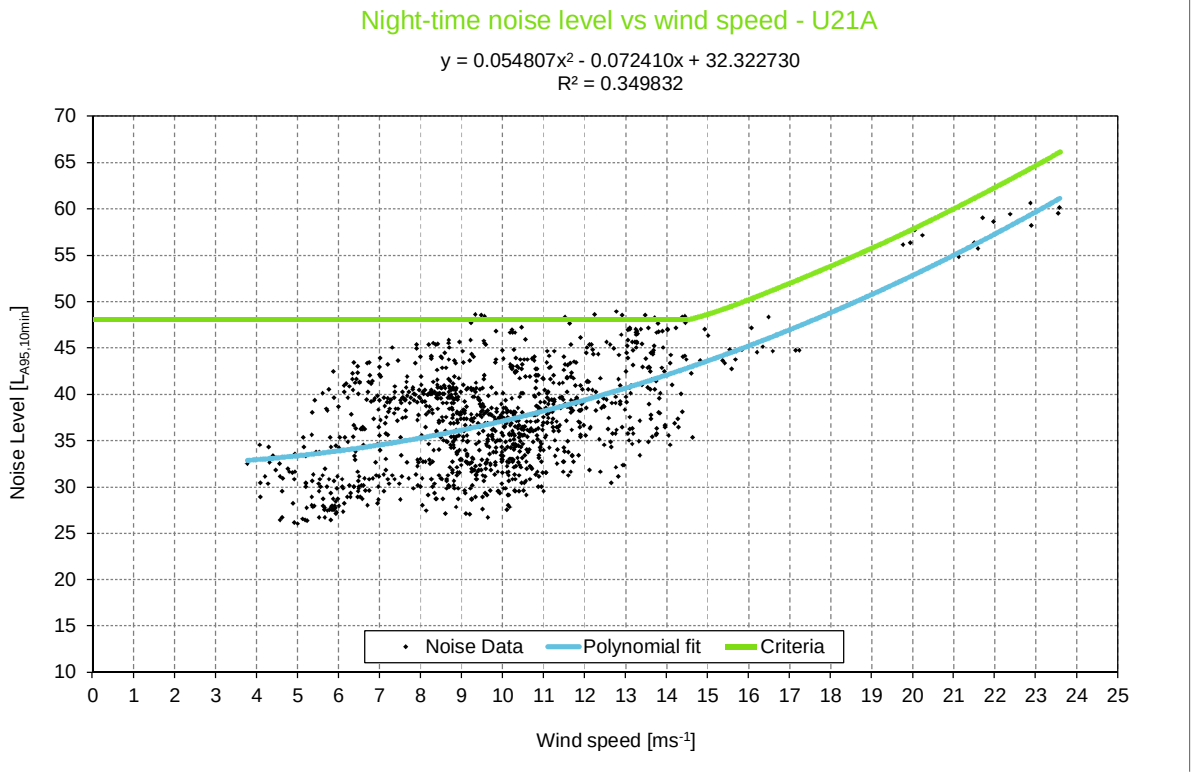
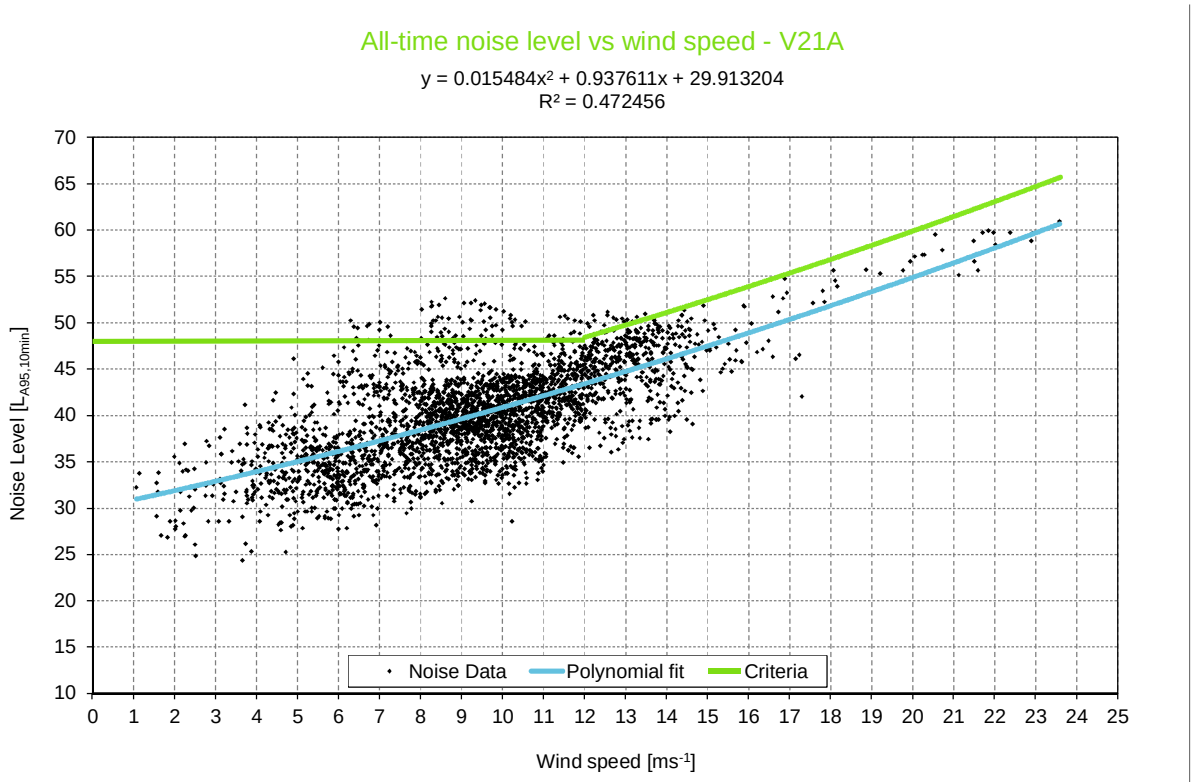


Figure D16: U21A background noise curves



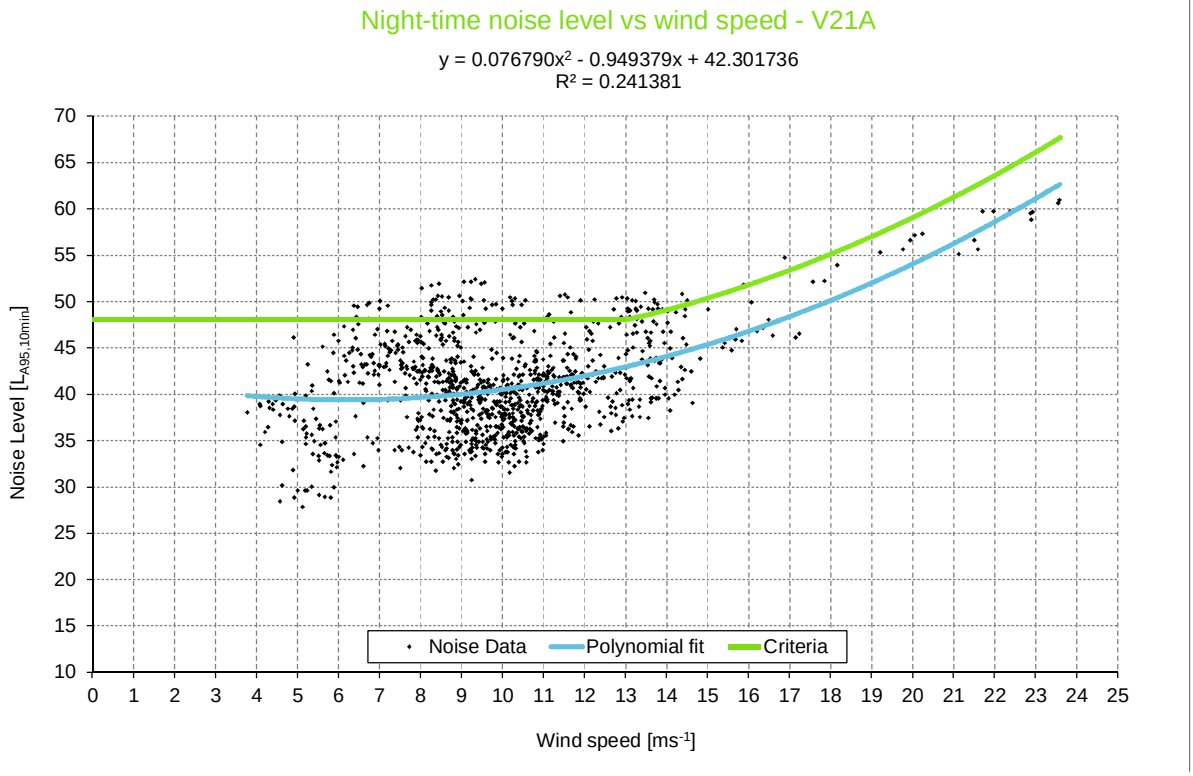
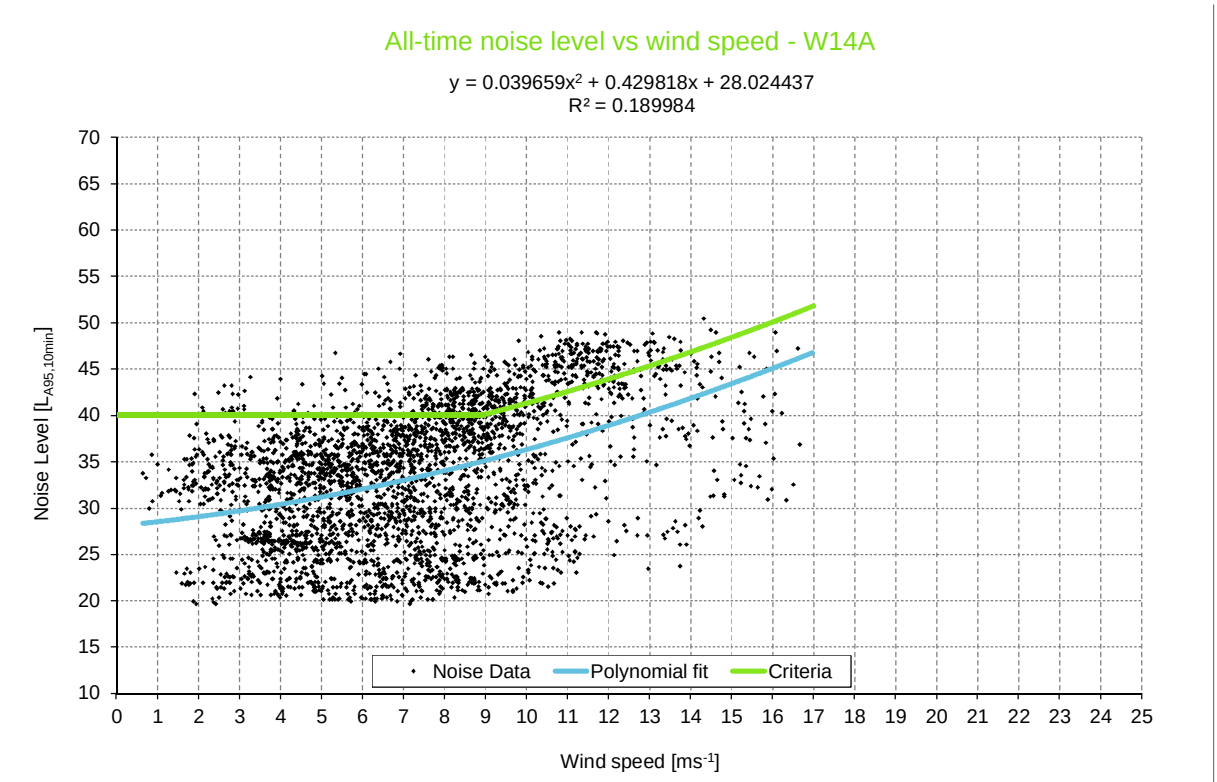


Figure D17: V21A background noise curves



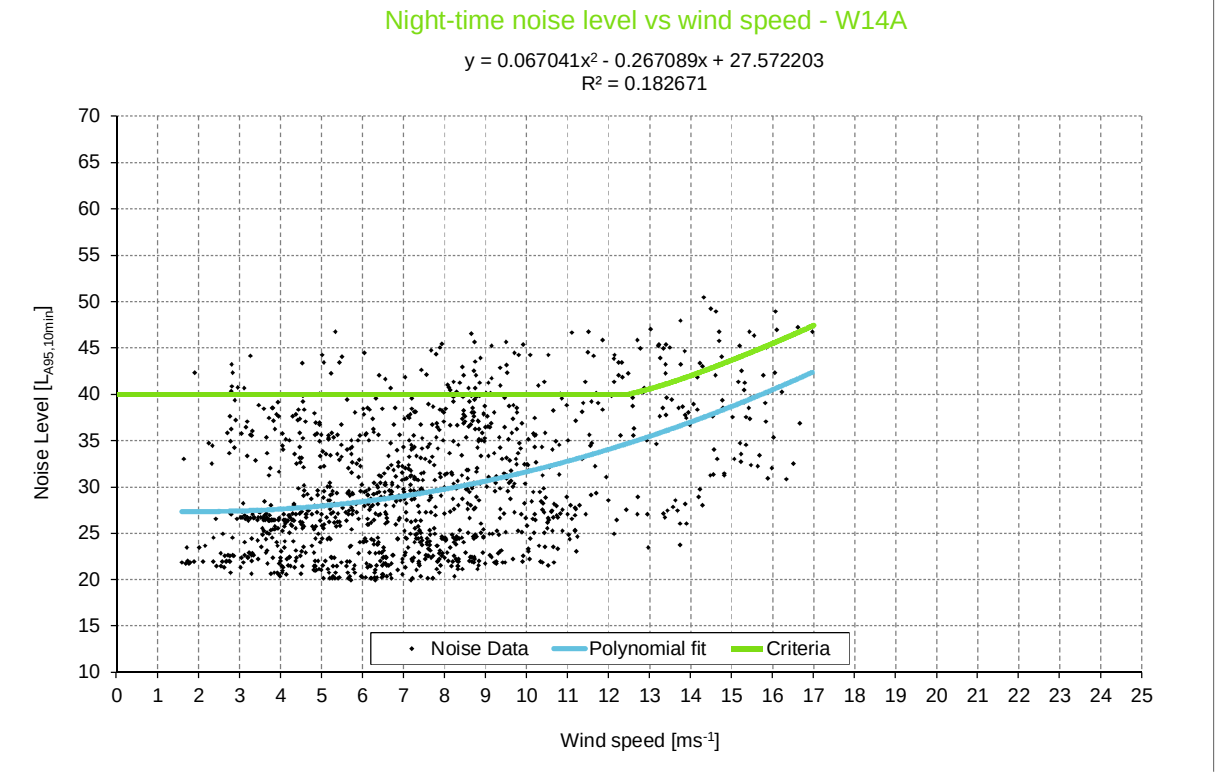
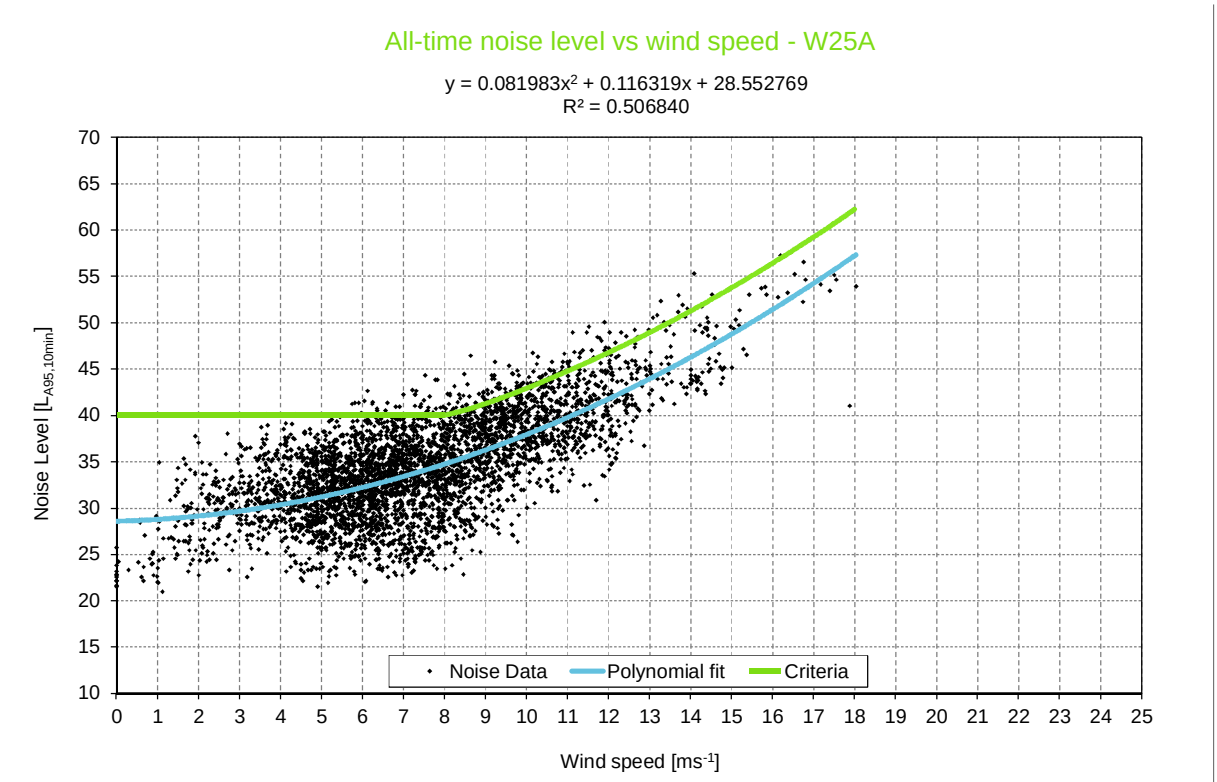


Figure D18: W14A background noise curves



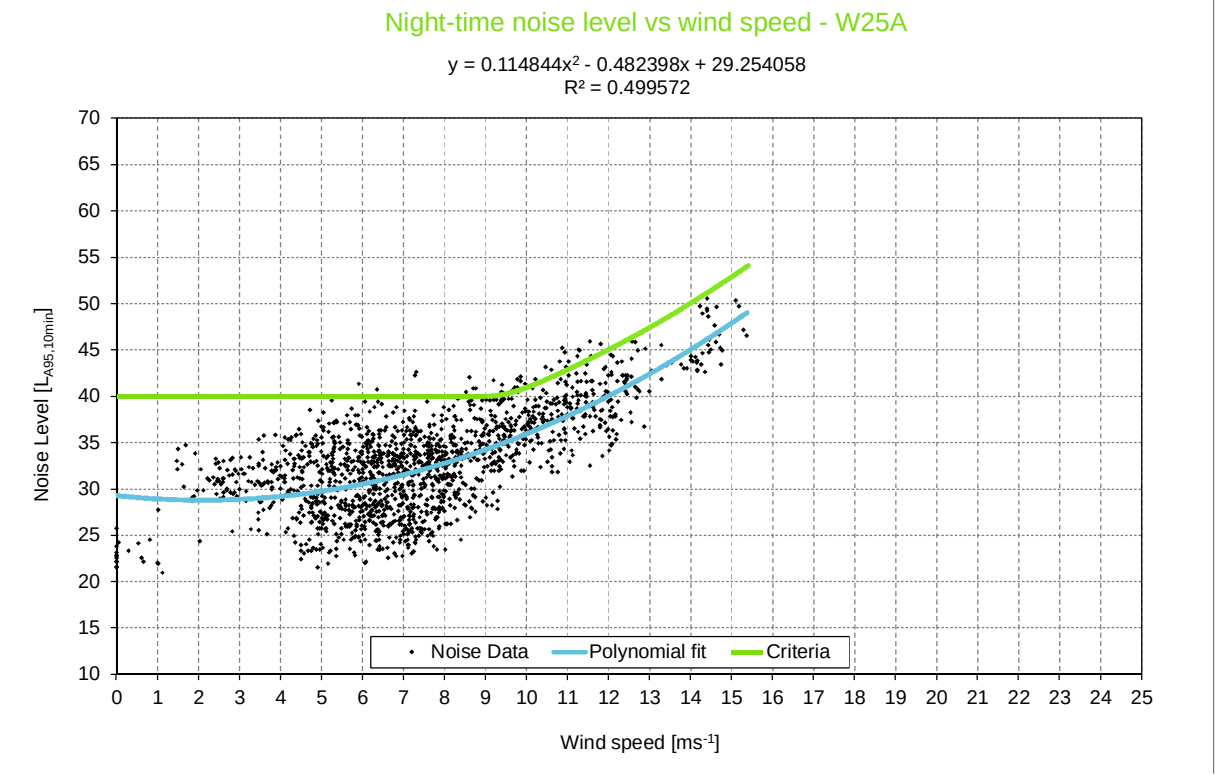
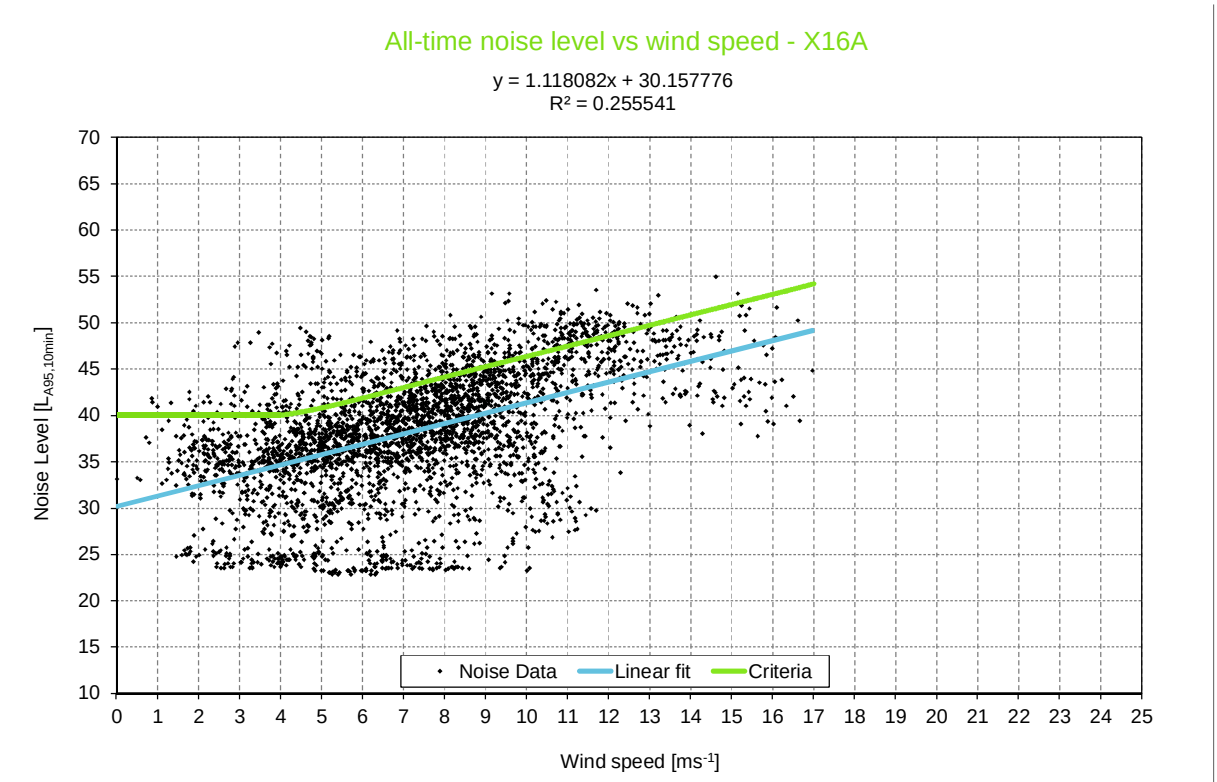


Figure D19: W25A background noise curves



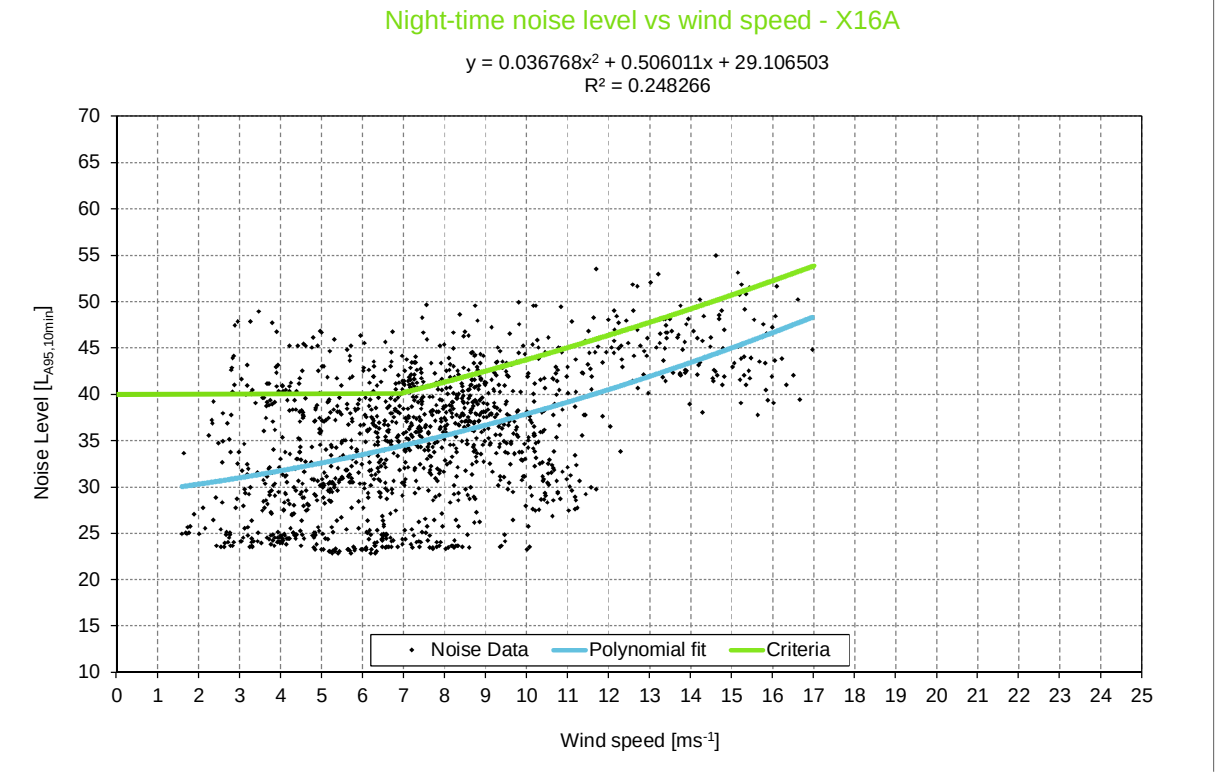
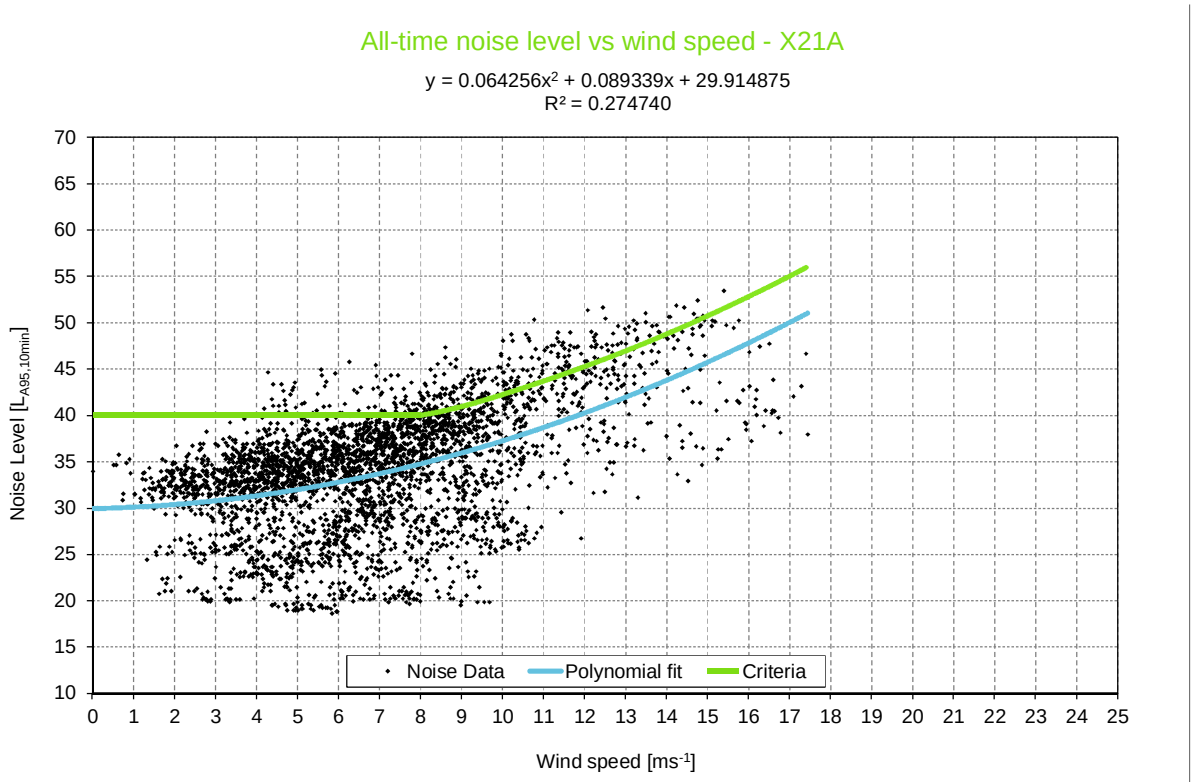


Figure D20: X16A background noise curves



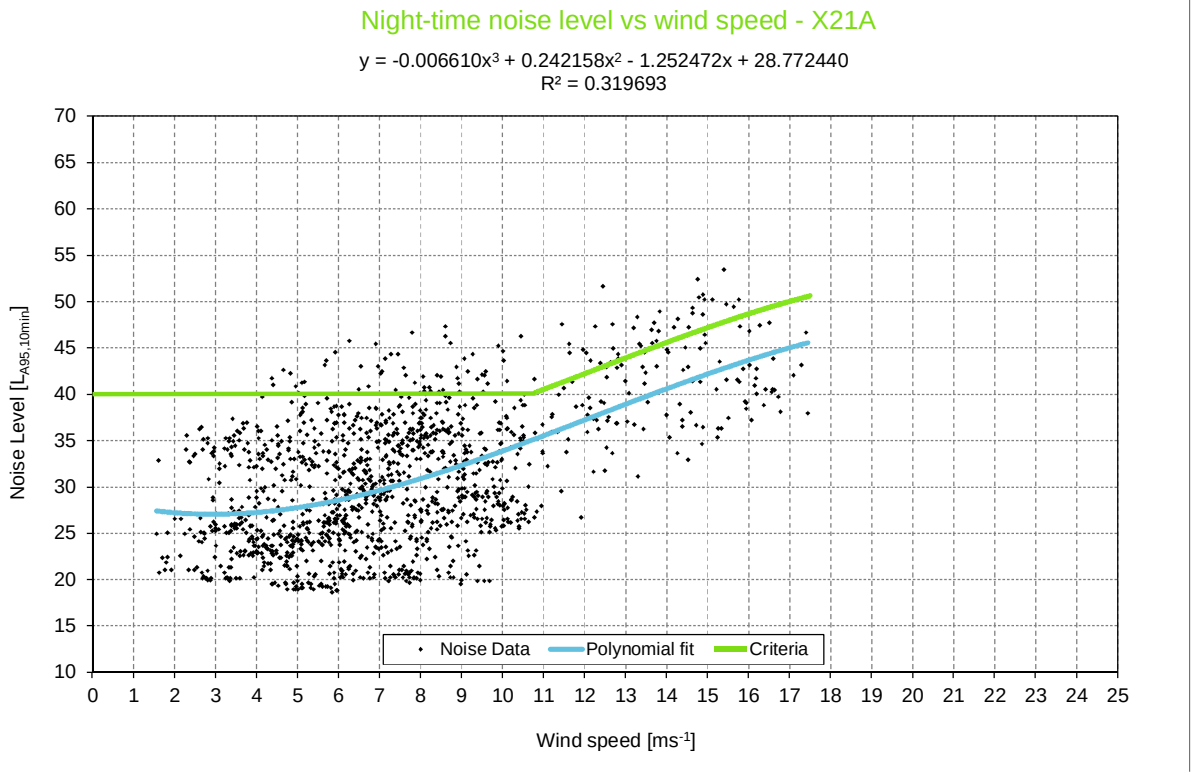
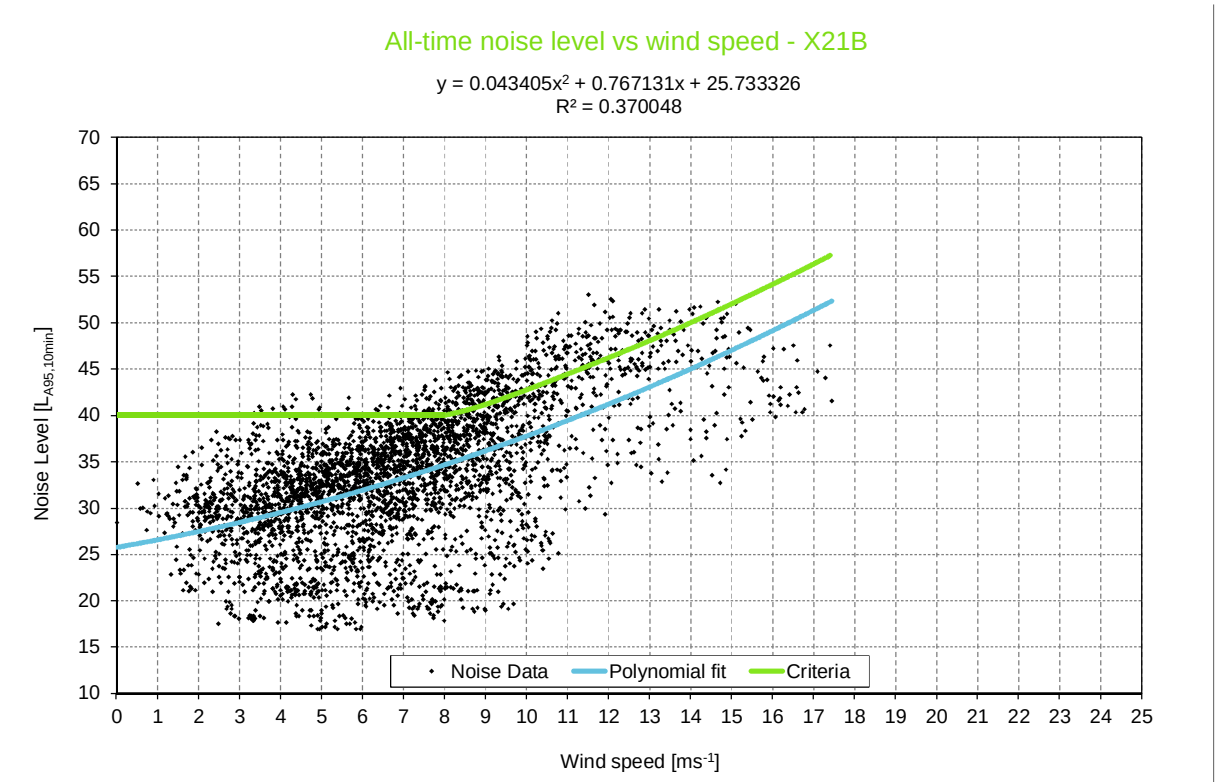


Figure D21: X21A background noise curves



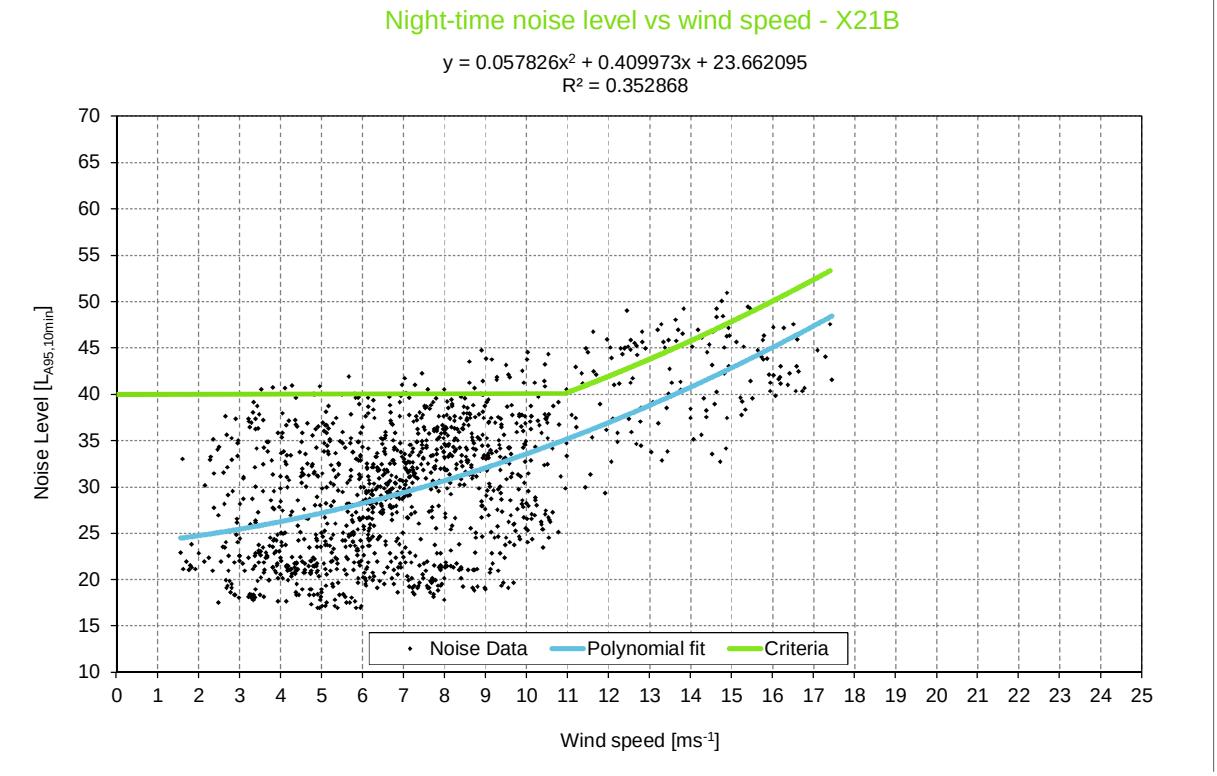
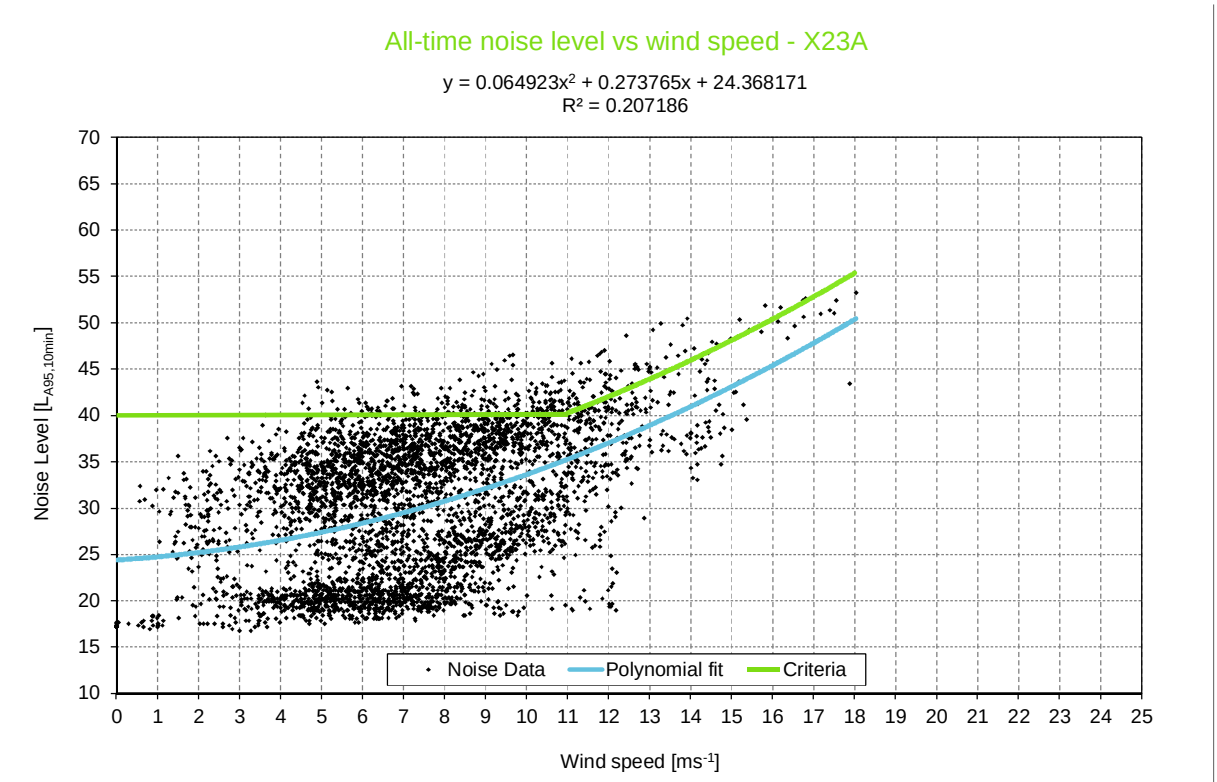


Figure D22: X21B background noise curves



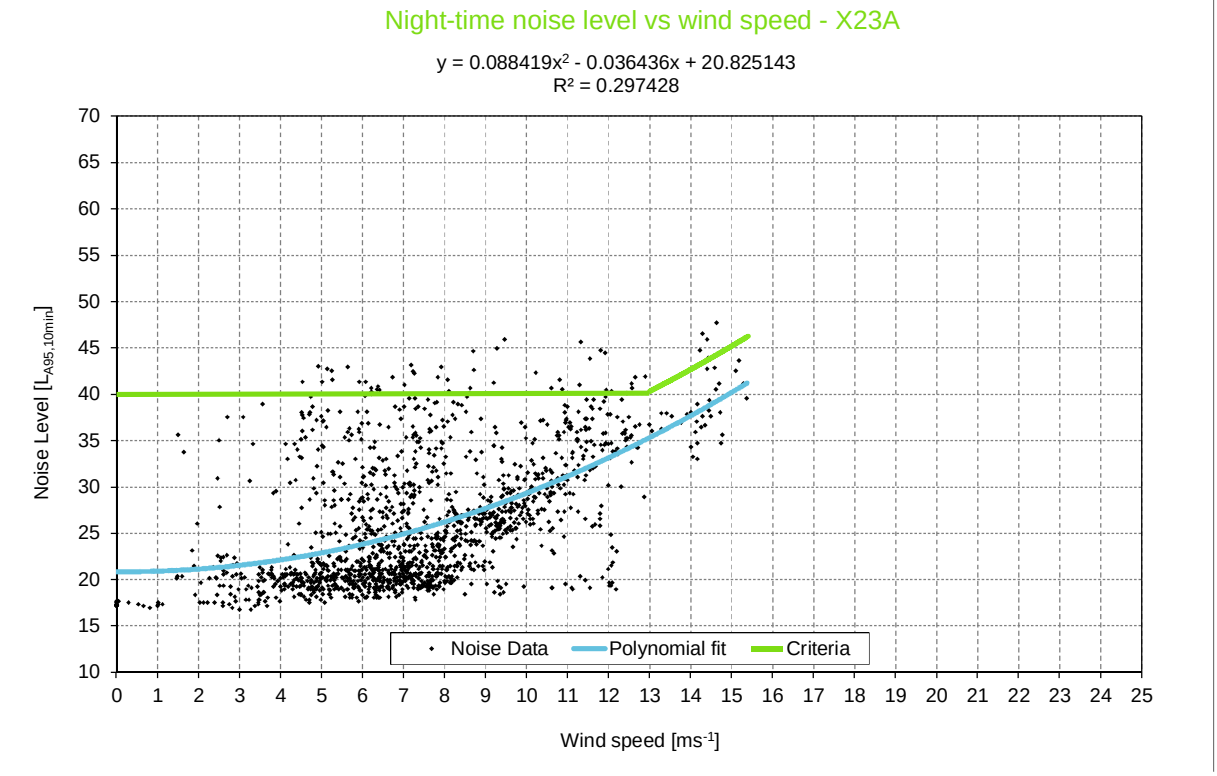
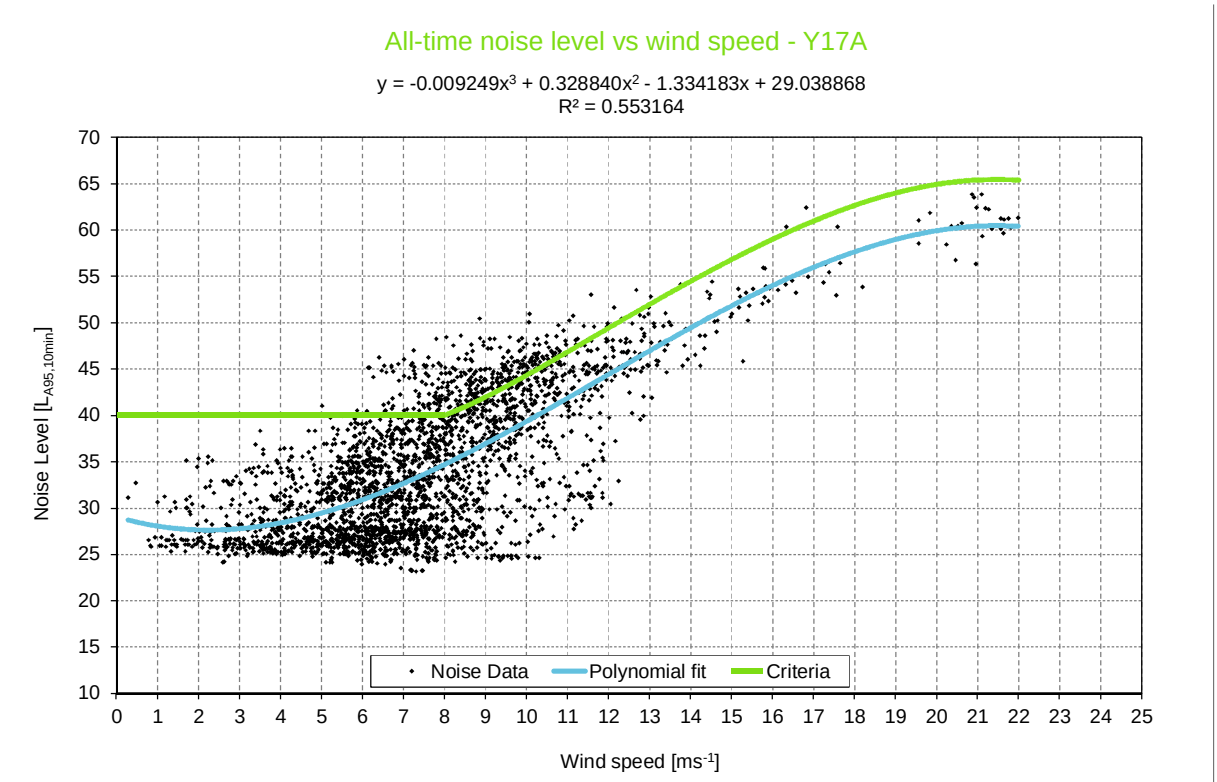


Figure D23: X23A background noise curves



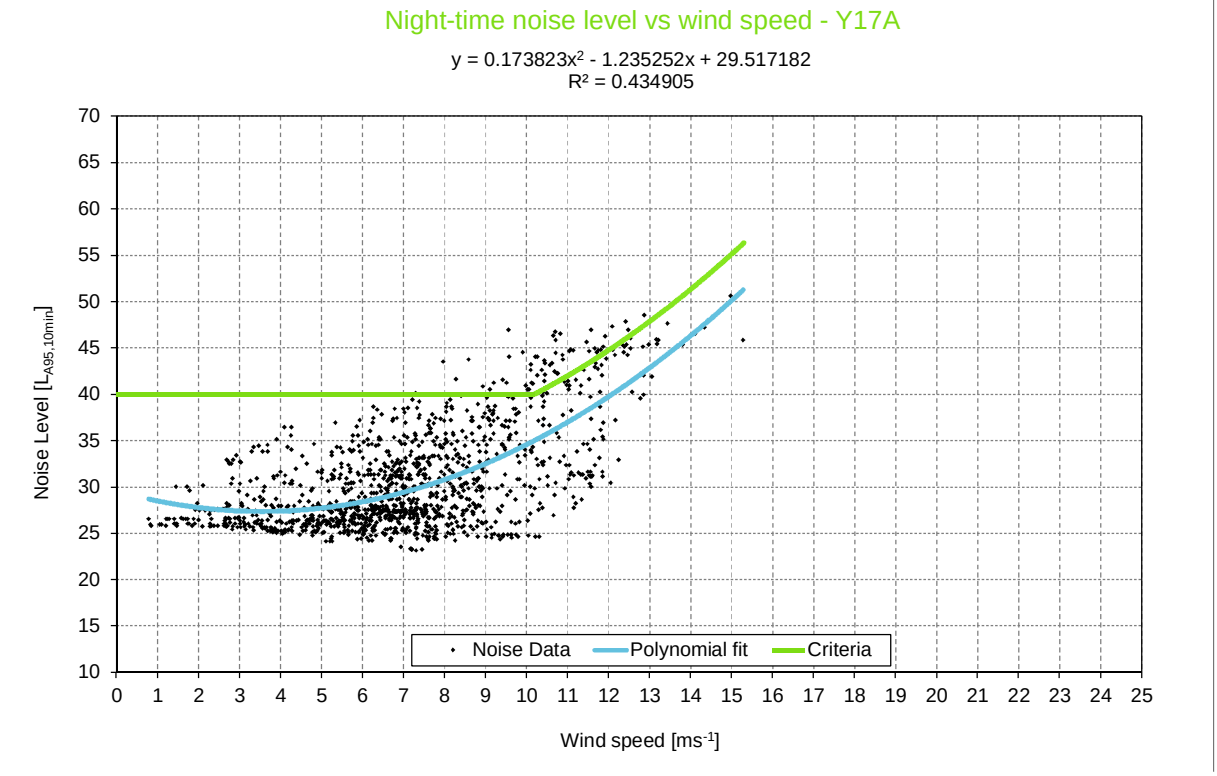
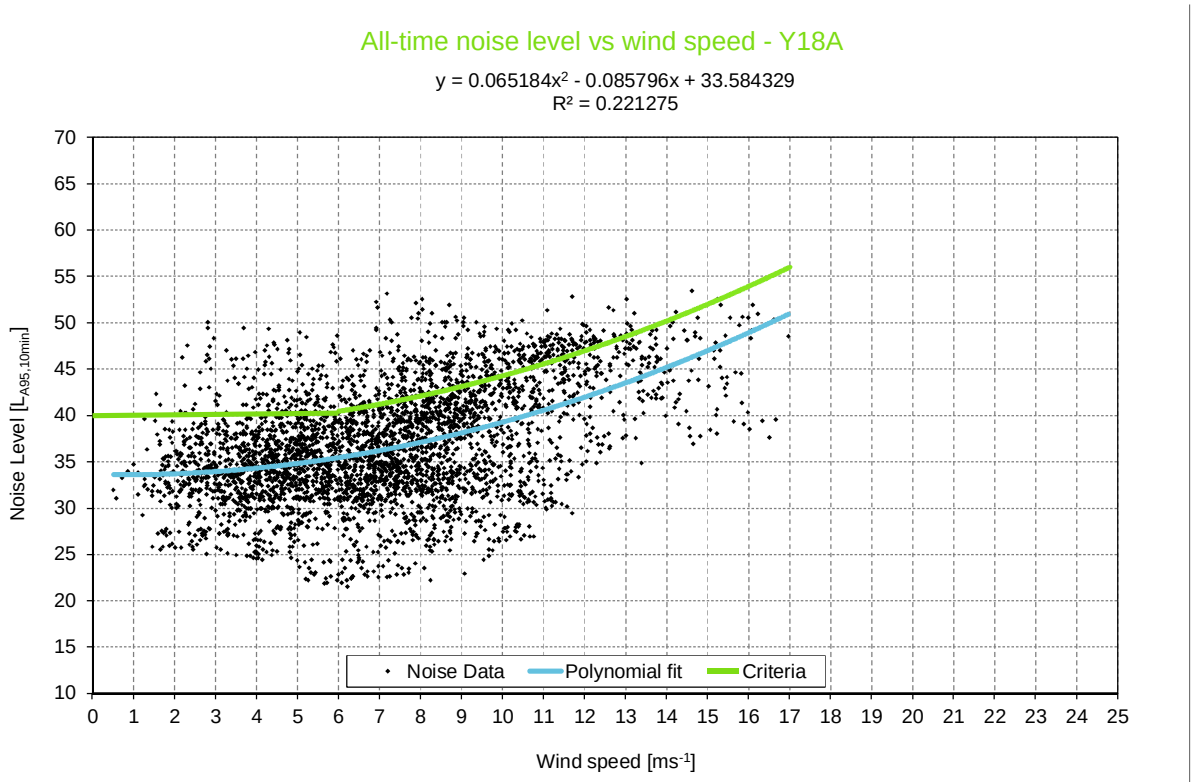


Figure D24: Y17A background noise curves



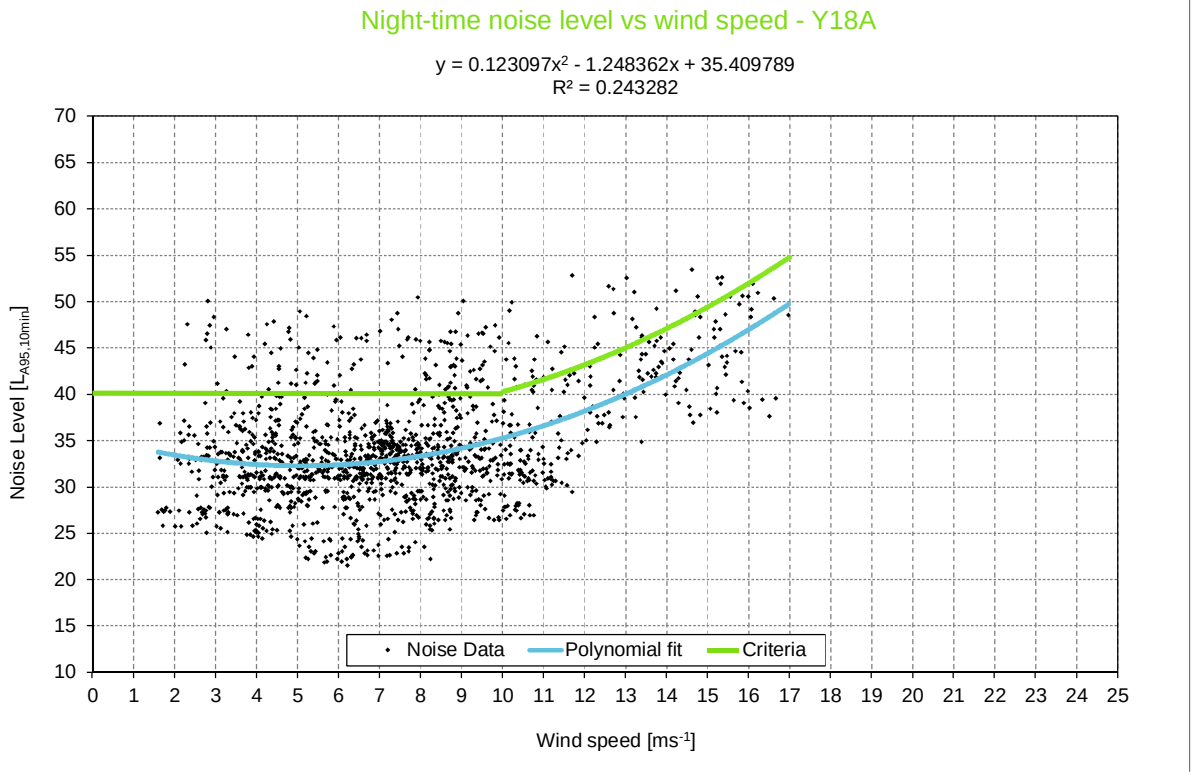
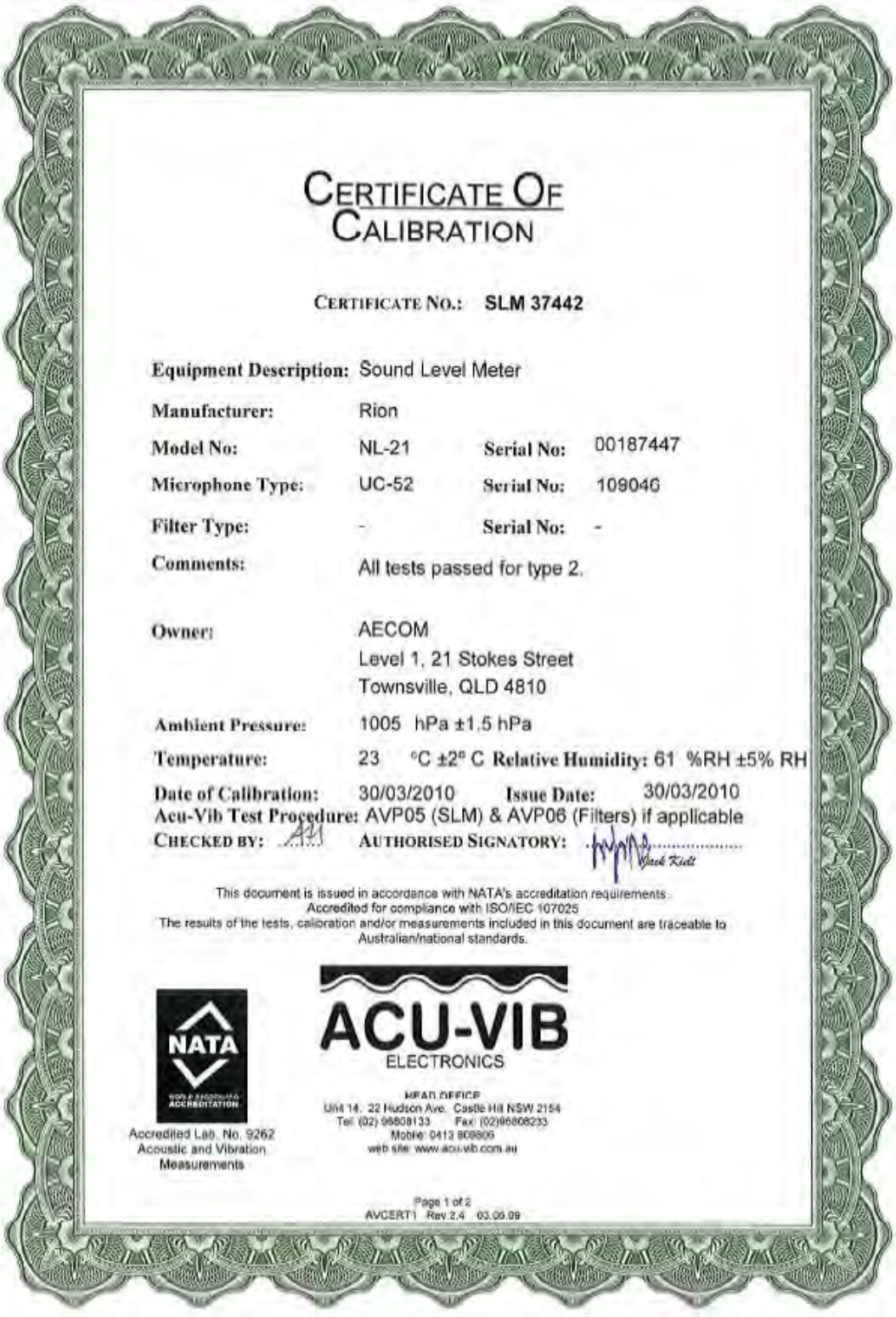


Figure D25: Y18A background noise curves

Appendix E

Calibration Certificates

Appendix E Calibration Certificates



CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 37442

Equipment Description:	Sound Level Meter		
Manufacturer:	Rion		
Model No:	NL-21	Serial No:	00187447
Microphone Type:	UC-52	Serial No:	109046
Filter Type:	-	Serial No:	-
Comments:	All tests passed for type 2.		
Owner:	AECOM Level 1, 21 Stokes Street Townsville, QLD 4810		
Ambient Pressure:	1005 hPa ±1.5 hPa		
Temperature:	23 °C ±2° C	Relative Humidity:	61 %RH ±5% RH
Date of Calibration:	30/03/2010	Issue Date:	30/03/2010
Acu-Vib Test Procedure:	AVP05 (SLM) & AVP06 (Filters) if applicable		
CHECKED BY:		AUTHORISED SIGNATORY:	Mark Kidd

This document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 107025
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

NATA
Accredited Lab. No. 9262
Acoustic and Vibration Measurements

ACU-VIB ELECTRONICS
HEAD OFFICE
Unit 14, 22 Hudson Ave, Castle Hill NSW 2154
Tel: (02) 96808133 Fax: (02)96808233
Mobile: 0413 809806
web site: www.acu-vib.com.au

Page 1 of 2
AVCERT1 Rev.2.4 03.06.09

CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 37521

Equipment Description:	Sound Level Meter		
Manufacturer:	Rion		
Model No:	NL-21	**Serial No:**	00187448
Microphone Type:	UC-52	**Serial No:**	116615
Filter Type:	-	**Serial No:**	-
Comments:	All tests passed for type 2.		
Owner:	AECOM Level 11, 44 Market Street Sydney NSW 2000		
Ambient Pressure:	995 hPa ±1.5 hPa		
Temperature:	23 °C ±2° C	**Relative Humidity:**	41 %RH ±5% RH
Date of Calibration:	11/05/2010	**Issue Date:**	12/05/2010
Acu-Vib Test Procedure:	AVP05 (SLM) & AVP06 (Filters) if applicable		

CHECKED BY: ..... **AUTHORISED SIGNATORY:** .....
Jack Rielt

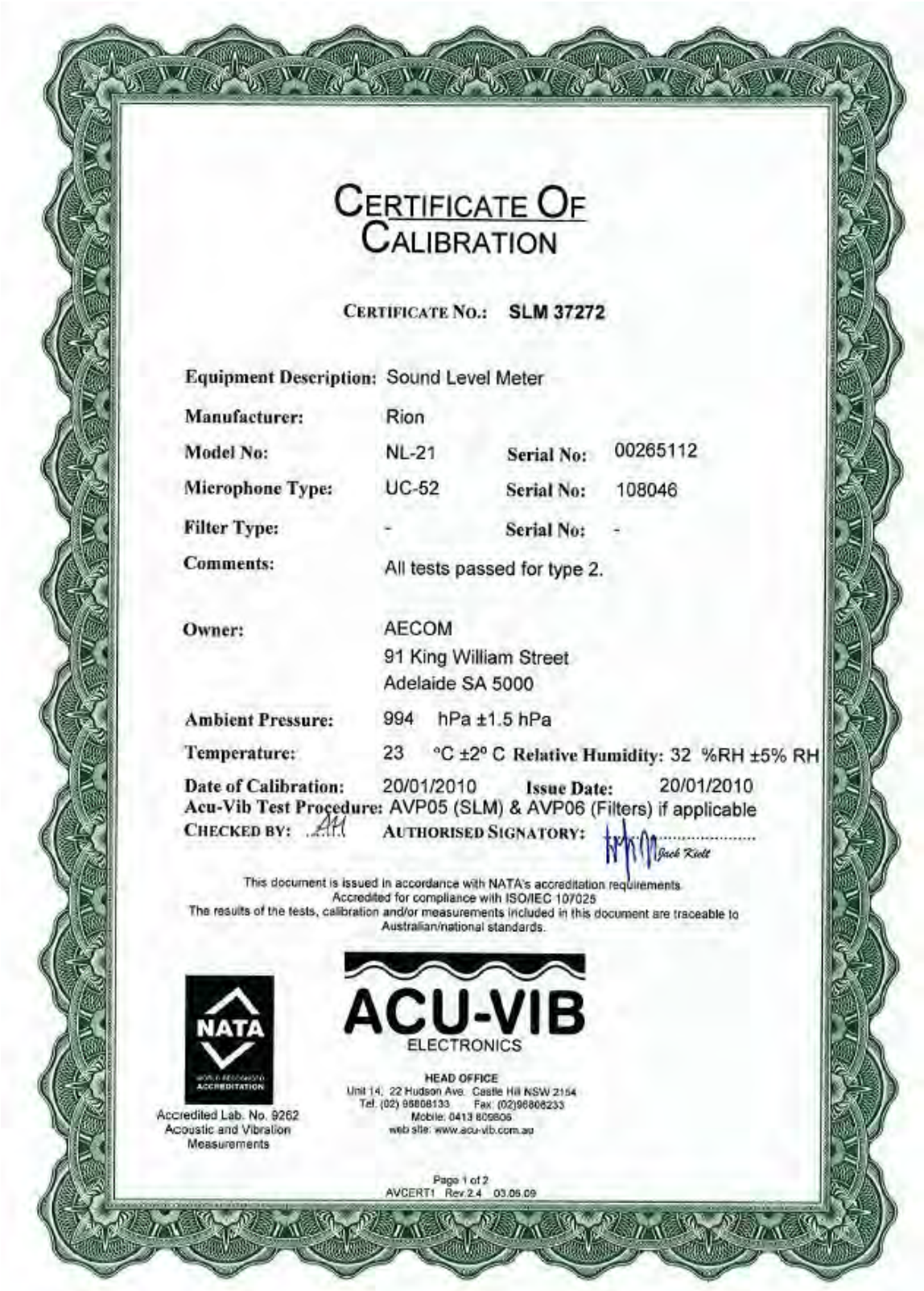
This document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 107025
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

NATA
MUTUAL RECOGNITION ARRANGEMENT ACCREDITATION
Accredited Lab. No. 9262
Acoustic and Vibration Measurements

ACU-VIB
ELECTRONICS

HEAD OFFICE
Unit 14, 22 Hudson Ave. Castle Hill NSW 2154
Tel: (02) 96806133 Fax: (02)96808233
Mobile: 0413 809806
web site: www.acu-vib.com.au

Page 1 of 2
AVCERT1 Rev.2.4 03.06.09



CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 37272

Equipment Description:	Sound Level Meter		
Manufacturer:	Rion		
Model No:	NL-21	**Serial No:**	00265112
Microphone Type:	UC-52	**Serial No:**	108046
Filter Type:	-	**Serial No:**	-
Comments:	All tests passed for type 2.		
Owner:	AECOM 91 King William Street Adelaide SA 5000		
Ambient Pressure:	994 hPa ±1.5 hPa		
Temperature:	23 °C ±2° C	**Relative Humidity:**	32 %RH ±5% RH
Date of Calibration:	20/01/2010	**Issue Date:**	20/01/2010

Acu-Vib Test Procedure: AVP05 (SLM) & AVP06 (Filters) if applicable

CHECKED BY: ..... **AUTHORISED SIGNATORY:** ..... Jack Riolt

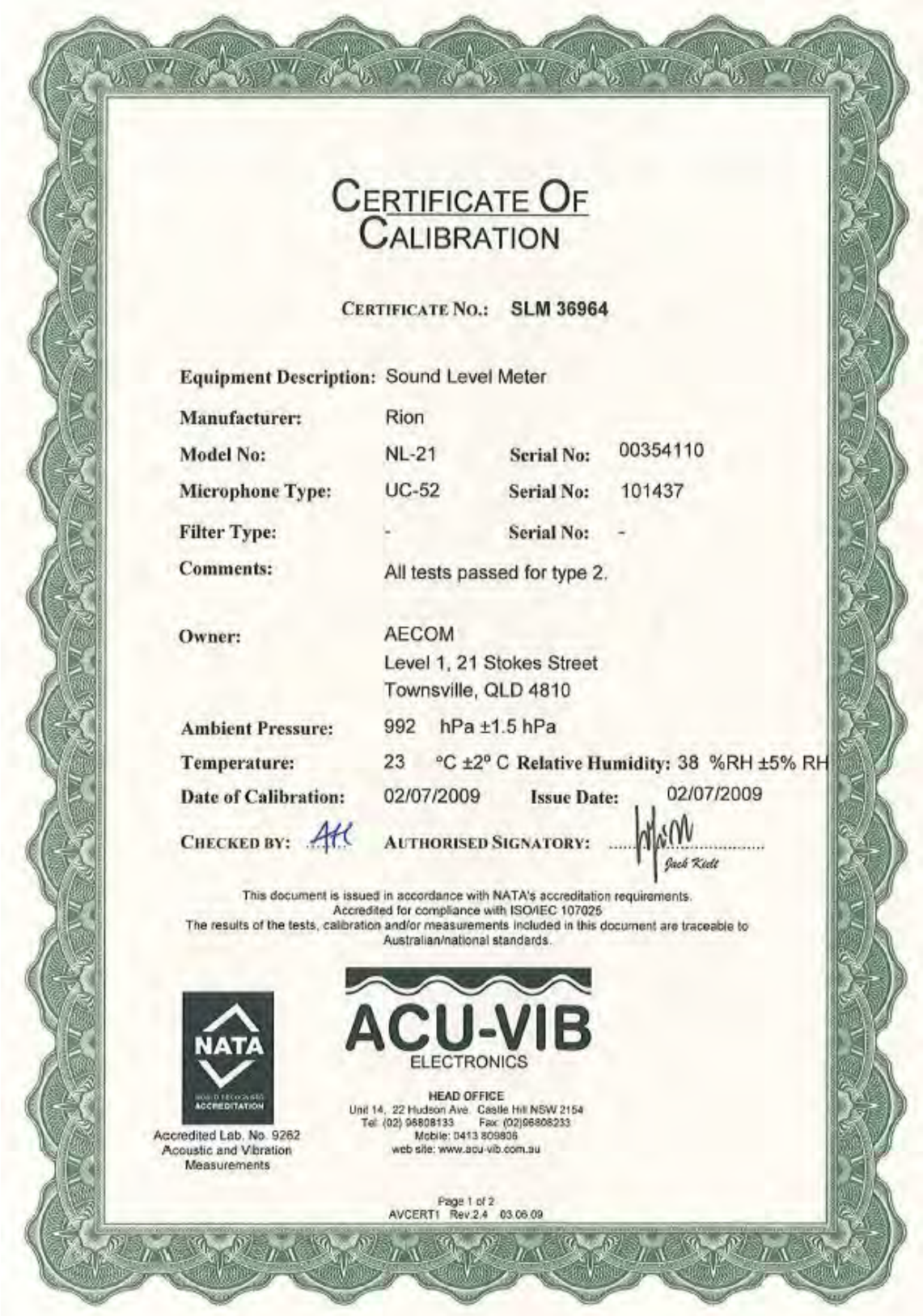
This document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 107025
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

NATA
ACCREDITATION
Accredited Lab. No. 9262
Acoustic and Vibration Measurements

ACU-VIB
ELECTRONICS

HEAD OFFICE
Unit 14, 22 Hudson Ave. Castle Hill NSW 2154
Tel. (02) 98806133 Fax: (02)98806233
Mobile: 0413 809806
web site: www.acu-vib.com.au

Page 1 of 2
AVCERT1 Rev 2.4 03.06.09



CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 36964

Equipment Description:	Sound Level Meter		
Manufacturer:	Rion		
Model No:	NL-21	**Serial No:**	00354110
Microphone Type:	UC-52	**Serial No:**	101437
Filter Type:	-	**Serial No:**	-
Comments:	All tests passed for type 2.		
Owner:	AECOM Level 1, 21 Stokes Street Townsville, QLD 4810		
Ambient Pressure:	992 hPa ±1.5 hPa		
Temperature:	23 °C ±2° C	**Relative Humidity:**	38 %RH ±5% RH
Date of Calibration:	02/07/2009	**Issue Date:**	02/07/2009

CHECKED BY: AHC **AUTHORISED SIGNATORY:** Jack Kidd

This document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 107025
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

NATA
MUTUAL RECOGNITION ARRANGEMENT ACCREDITATION
Accredited Lab. No. 9262
Acoustic and Vibration Measurements

ACU-VIB
ELECTRONICS

HEAD OFFICE
Unit 14, 22 Hudson Ave. Castle Hill NSW 2154
Tel: (02) 96808133 Fax: (02)96808233
Mobile: 0413 809806
web site: www.acu-vib.com.au

Page 1 of 2
AVCERT1 Rev.2.4 03.06.09

CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 37663

Equipment Description:	Sound Level Meter		
Manufacturer:	Rion		
Model No:	NL-21	**Serial No:**	00409167
Microphone Type:	UC-52	**Serial No:**	129217
Filter Type:	-	**Serial No:**	-
Comments:	All tests passed for type 2.		
Owner:	AECOM Level 11, 44 Market Street Sydney NSW 2000		
Ambient Pressure:	1007 hPa ±1.5 hPa		
Temperature:	23 °C ±2° C	**Relative Humidity:**	59 %RH ±5% RH
Date of Calibration:	28/07/2010	**Issue Date:**	29/07/2010

Acu-Vib Test Procedure: AVP05 (SLM) & AVP06 (Filters) if applicable

CHECKED BY: AH **AUTHORISED SIGNATORY:** .....
Jack Kiely

This document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 107025
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

NATA
ACCREDITATION
Accredited Lab. No. 9262
Acoustic and Vibration Measurements

ACU-VIB
ELECTRONICS

HEAD OFFICE
Unit 14, 22 Hudson Ave. Castle Hill NSW 2154
Tel: (02) 98808133 Fax: (02)96808233
Mobile: 0413 809808
web site: www.acu-vib.com.au

Page 1 of 2
AVCERT1 Rev.2.4 03.08.09

CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 37623

Equipment Description:	Sound Level Meter		
Manufacturer:	Rion		
Model No:	NL-21	**Serial No:**	00409168
Microphone Type:	UC-52	**Serial No:**	128702
Filter Type:	-	**Serial No:**	-
Comments:	All tests passed for type 2.		
Owner:	AECOM Level 11, 44 Market Street Sydney NSW 2000		
Ambient Pressure:	1004 hPa ±1.5 hPa		
Temperature:	23 °C ±2° C	**Relative Humidity:**	58 %RH ±5% RH
Date of Calibration:	07/07/2010	**Issue Date:**	08/07/2010

Acu-Vib Test Procedure: AVP05 (SLM) & AVP06 (Filters) if applicable

CHECKED BY: A.H. **AUTHORISED SIGNATORY:** ..... Jack Rietz

This document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 107025
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

NATA
ACCREDITATION
Accredited Lab. No. 9262
Acoustic and Vibration Measurements

ACU-VIB
ELECTRONICS

HEAD OFFICE
Unit 14, 22 Hudson Ave. Castle Hill NSW 2154
Tel: (02) 96808133 Fax: (02)96808233
Mobile: 0413 809806
web site: www.acu-vib.com.au

Page 1 of 2
AVCERT1 Rev 2.4 03.06.08

Acoustic Research Laboratories
Proprietary Limited A.B.N. 47 050 100 804
Noise and Vibration Monitoring Instrumentation for Industry and the Environment

Sound Level Meter Test Report

Report Number : 10309

Date of Test : 25/06/2010

Report Issue Date : 28/06/2010

Equipment Tested/ Model Number: **Rion NL-21 Sound Level Meter**

Instrument Serial Number: 00409176

Microphone Serial Number: 128729

Preamplifier Serial Number: 32344

Client Name : Wavecom Instruments
257A Grange Road
Findon SA 5023

Contact Name : George Stamelos

Tested by : Michelle Youssef

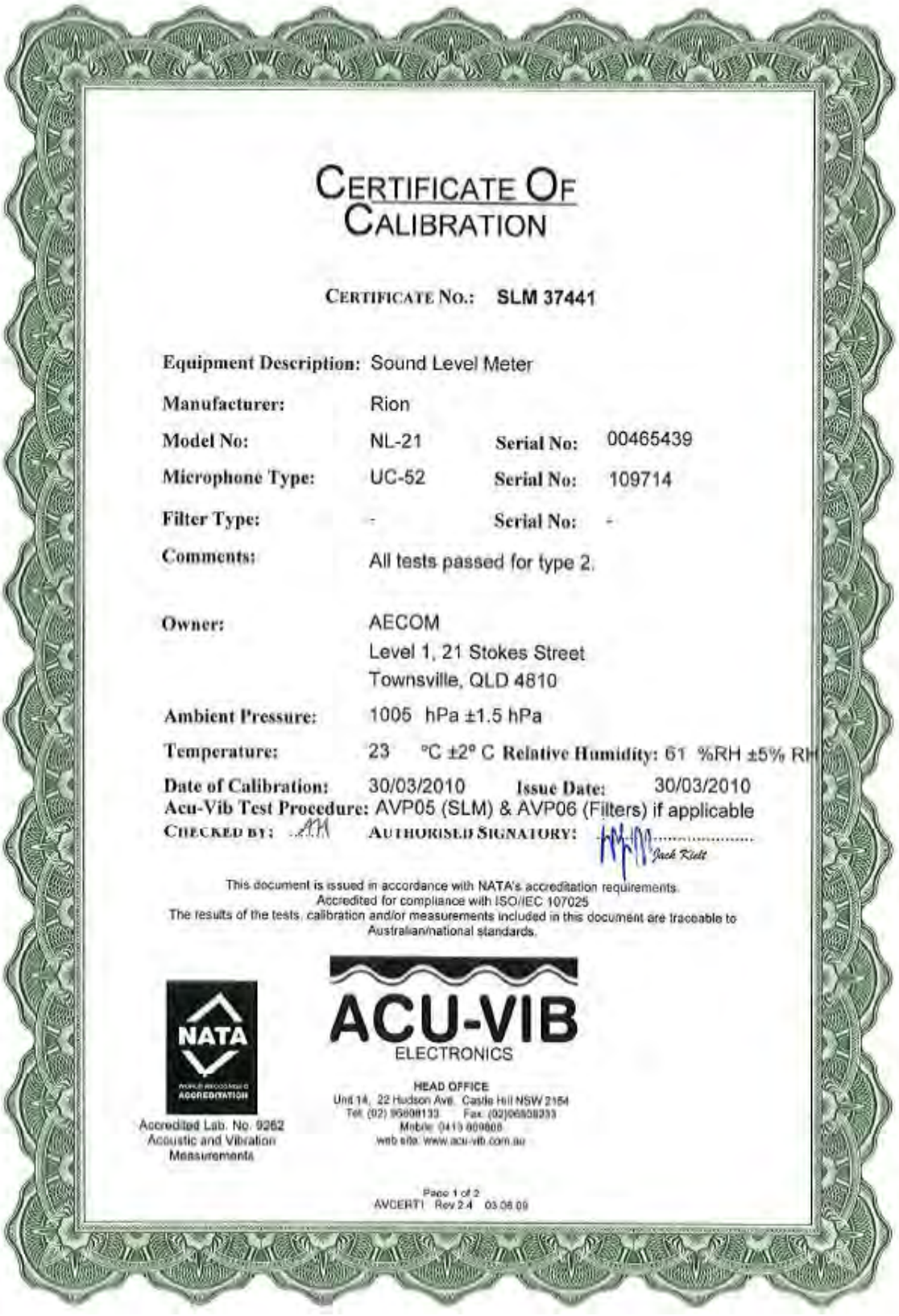
Approved Signatory :

Date : 28 June 2010

NATA
WORLD RECOGNISED ACCREDITATION

Acoustic Research Laboratories Pty Ltd is NATA Accredited Laboratory Number. 14172.
This document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025
This document shall not be reproduced except in full.

Level 7 • Building 2 • 423 Pennant Hills Rd • Pennant Hills • NSW 2120 • AUSTRALIA
Telephone +61 2 9484 0800 • Facsimile +61 2 9484 0884
www.acousticresearch.com.au



CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 37441

Equipment Description:	Sound Level Meter		
Manufacturer:	Rion		
Model No:	NL-21	**Serial No:**	00465439
Microphone Type:	UC-52	**Serial No:**	109714
Filter Type:	-	**Serial No:**	-
Comments:	All tests passed for type 2.		
Owner:	AECOM Level 1, 21 Stokes Street Townsville, QLD 4810		
Ambient Pressure:	1005 hPa ±1.5 hPa		
Temperature:	23 °C ±2° C	**Relative Humidity:**	61 %RH ±5% RH
Date of Calibration:	30/03/2010	**Issue Date:**	30/03/2010

Acu-Vib Test Procedure: AVP05 (SLM) & AVP06 (Filters) if applicable

CHECKED BY: ..... **AUTHORISED SIGNATORY:** ..... Jack Rielt

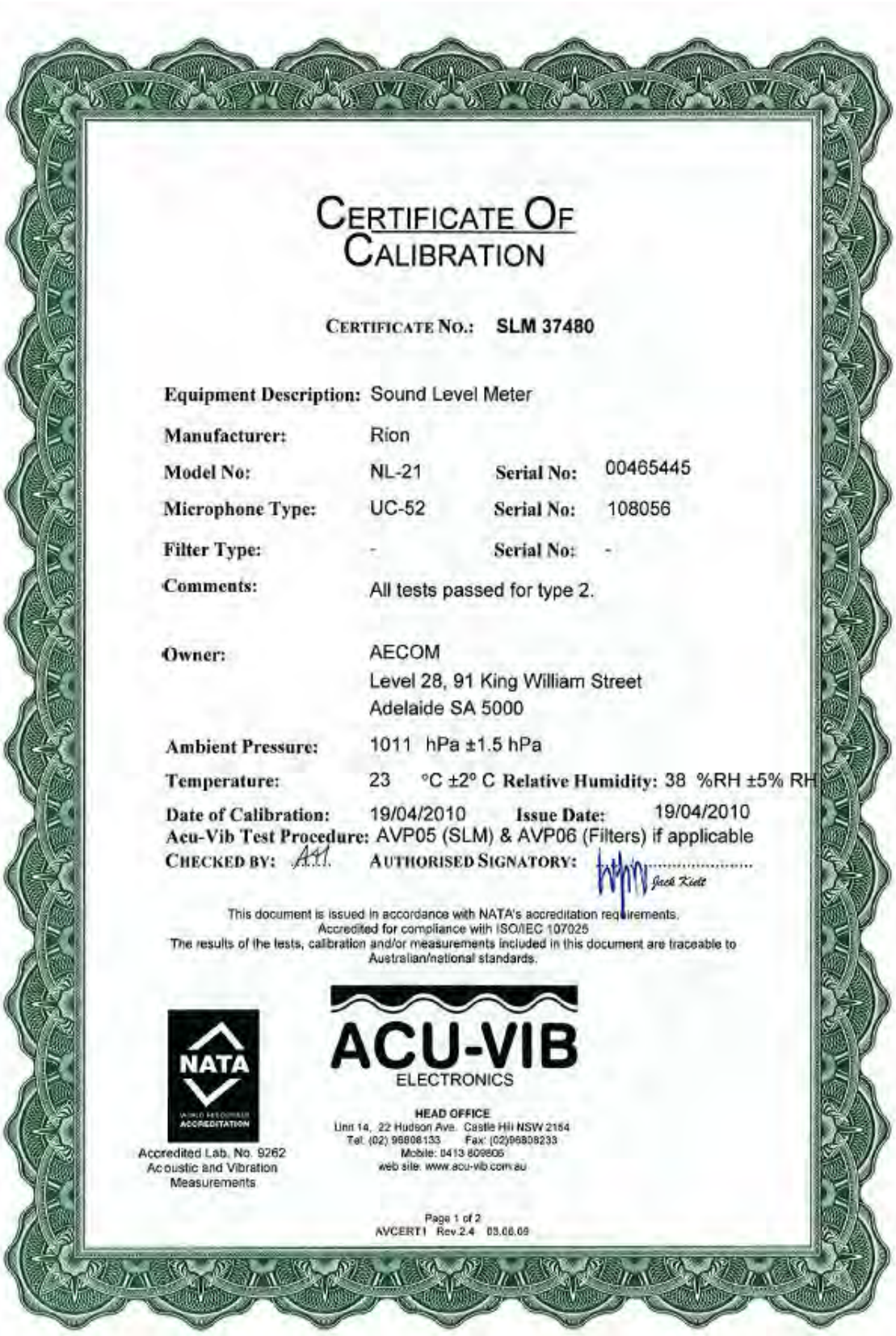
This document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 107025
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

NATA
WORLD RECOGNISED ACCREDITATION
Accredited Lab. No. 9262
Acoustic and Vibration Measurements

ACU-VIB
ELECTRONICS

HEAD OFFICE
Unit 14, 22 Hudson Ave. Castle Hill NSW 2154
Tel: (02) 95698133 Fax: (02)95638233
Mobile: 0413 609808
web site: www.acu-vib.com.au

Page 1 of 2
AVCERTI Rev 2.4 03.06.09



CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 37480

Equipment Description:	Sound Level Meter		
Manufacturer:	Rion		
Model No:	NL-21	**Serial No:**	00465445
Microphone Type:	UC-52	**Serial No:**	108056
Filter Type:	-	**Serial No:**	-
Comments:	All tests passed for type 2.		
Owner:	AECOM Level 28, 91 King William Street Adelaide SA 5000		
Ambient Pressure:	1011 hPa ±1.5 hPa		
Temperature:	23 °C ±2° C	**Relative Humidity:**	38 %RH ±5% RH
Date of Calibration:	19/04/2010	**Issue Date:**	19/04/2010

Acu-Vib Test Procedure: AVP05 (SLM) & AVP06 (Filters) if applicable

CHECKED BY: A.H. **AUTHORISED SIGNATORY:** ..... Jacek Kielt

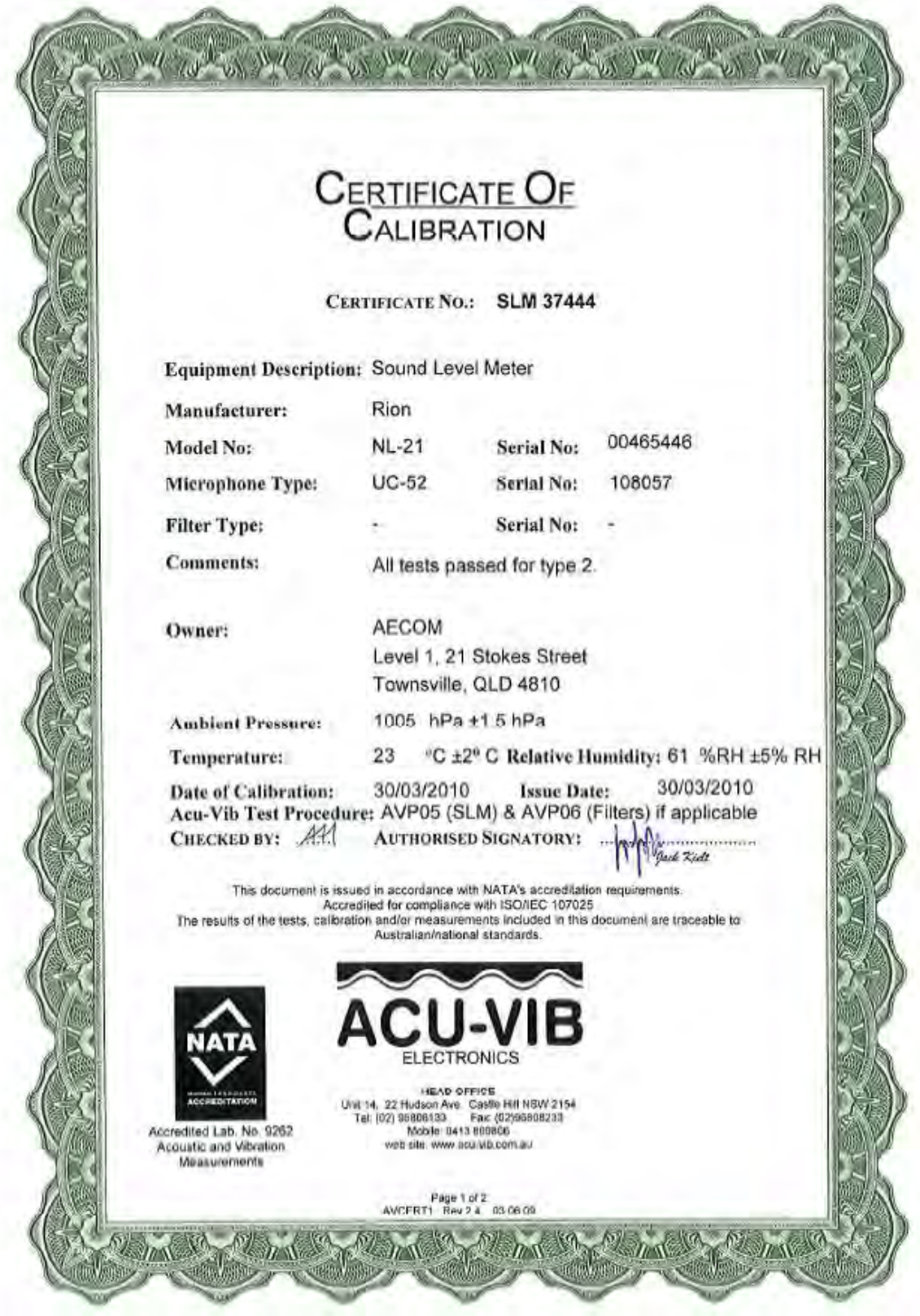
This document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 107025
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

NATA
WORLD RECOGNISED ACCREDITATION
Accredited Lab. No. 9262
Acoustic and Vibration Measurements

ACU-VIB ELECTRONICS

HEAD OFFICE
Unit 14, 22 Hudson Ave. Castle Hill NSW 2154
Tel. (02) 98806133 Fax: (02)96809233
Mobile: 0413 809606
web site: www.acu-vib.com.au

Page 1 of 2
AVCERT1 Rev.2.4 03.08.09



CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 37444

Equipment Description:	Sound Level Meter		
Manufacturer:	Rion		
Model No:	NL-21	**Serial No:**	00465446
Microphone Type:	UC-52	**Serial No:**	108057
Filter Type:	-	**Serial No:**	-
Comments:	All tests passed for type 2.		
Owner:	AECOM Level 1, 21 Stokes Street Townsville, QLD 4810		
Ambient Pressure:	1005 hPa ±1.5 hPa		
Temperature:	23 °C ±2° C	**Relative Humidity:**	61 %RH ±5% RH
Date of Calibration:	30/03/2010	**Issue Date:**	30/03/2010

Acu-Vib Test Procedure: AVP05 (SLM) & AVP06 (Filters) if applicable

CHECKED BY: AM **AUTHORISED SIGNATORY:** Jack Rickt

This document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 107025
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

NATA
ACCREDITATION
Accredited Lab. No. 9262
Acoustic and Vibration Measurements

ACU-VIB
ELECTRONICS

HEAD OFFICE
Unit 14, 22 Hudson Ave. Castle Hill NSW 2154
Tel: (02) 96806133 Fax: (02)96808233
Mobile: 0413 808806
web site: www.acu-vib.com.au

Page 1 of 2
AVCERT1 Rev 2.4 03.06.09

CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 37668

Equipment Description:	Sound Level Meter		
Manufacturer:	Rion		
Model No:	NL-21	**Serial No:**	00765699
Microphone Type:	UC-52	**Serial No:**	109044
Filter Type:	-	**Serial No:**	-
Comments:	All tests passed for type 2.		
Owner:	AECOM Level 9, 8 Exhibition Street Melbourne VIC 3000		
Ambient Pressure:	1000 hPa ±1.5 hPa		
Temperature:	23 °C ±2° C	**Relative Humidity:**	65 %RH ±5% RH
Date of Calibration:	31/07/2010	**Issue Date:**	02/08/2010

Acu-Vib Test Procedure: AVP05 (SLM) & AVP06 (Filters) if applicable

CHECKED BY: AH **AUTHORISED SIGNATORY:** ..... Jack Riedt

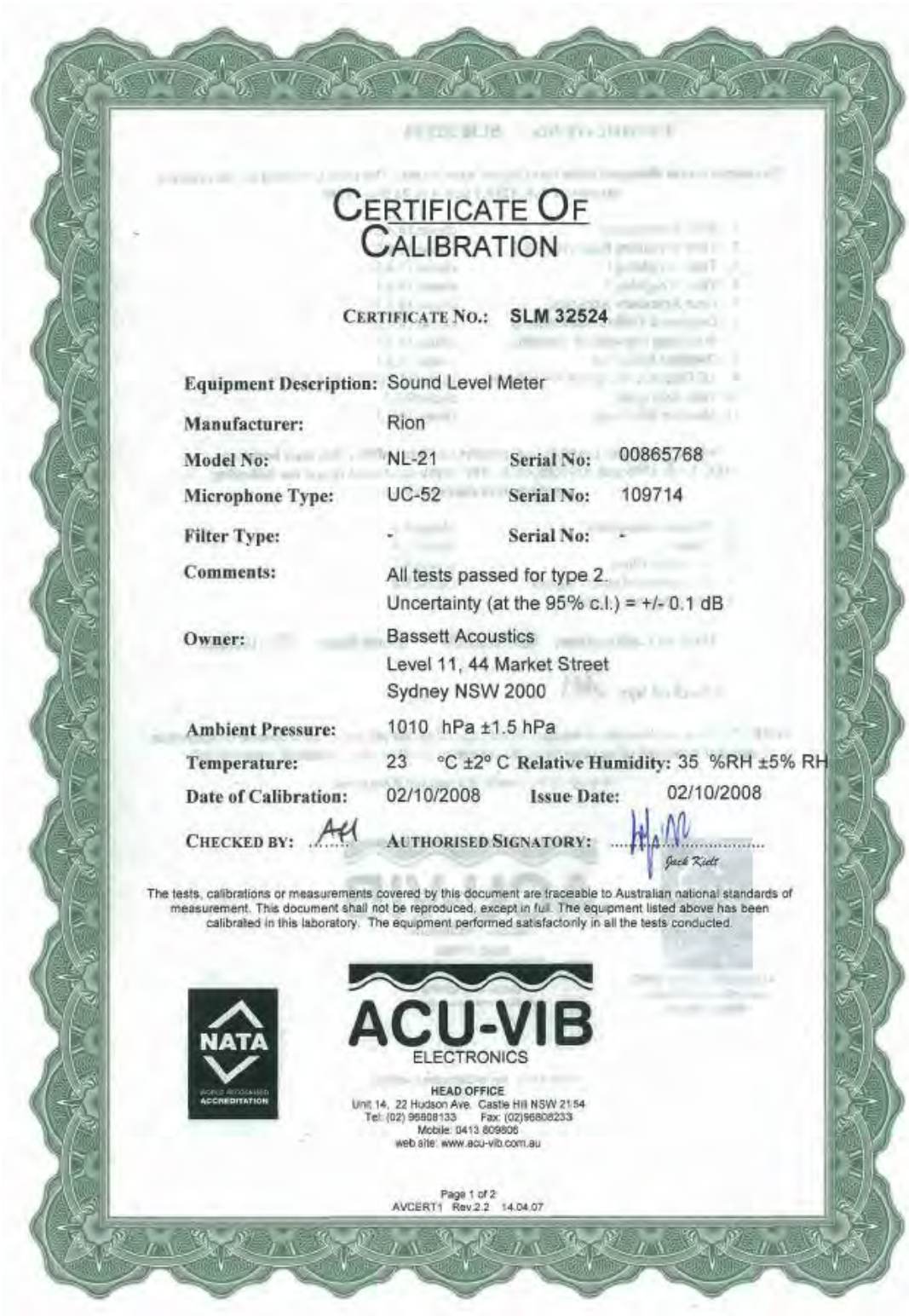
This document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 107025
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

NATA
WORLD RECOGNISED ACCREDITATION
Accredited Lab. No. 9262
Acoustic and Vibration Measurements

ACU-VIB
ELECTRONICS

HEAD OFFICE
Unit 14, 22 Hudson Ave. Castle Hill NSW 2154
Tel: (02) 96808133 Fax: (02)96806233
Mobile: 0413 809806
web site: www.acu-vib.com.au

Page 1 of 2
AVCERT1 Rev.2.4 03.06.09



CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: **SLM 32524**

Equipment Description:	Sound Level Meter		
Manufacturer:	Rion		
Model No:	NL-21	**Serial No:**	00865768
Microphone Type:	UC-52	**Serial No:**	109714
Filter Type:	-	**Serial No:**	-
Comments:	All tests passed for type 2. Uncertainty (at the 95% c.l.) = +/- 0.1 dB		
Owner:	Bassett Acoustics Level 11, 44 Market Street Sydney NSW 2000		
Ambient Pressure:	1010 hPa ±1.5 hPa		
Temperature:	23 °C ±2° C	**Relative Humidity:**	35 %RH ±5% RH
Date of Calibration:	02/10/2008	**Issue Date:**	02/10/2008

CHECKED BY: ..... **AUTHORISED SIGNATORY:** .....
Jack Kiett

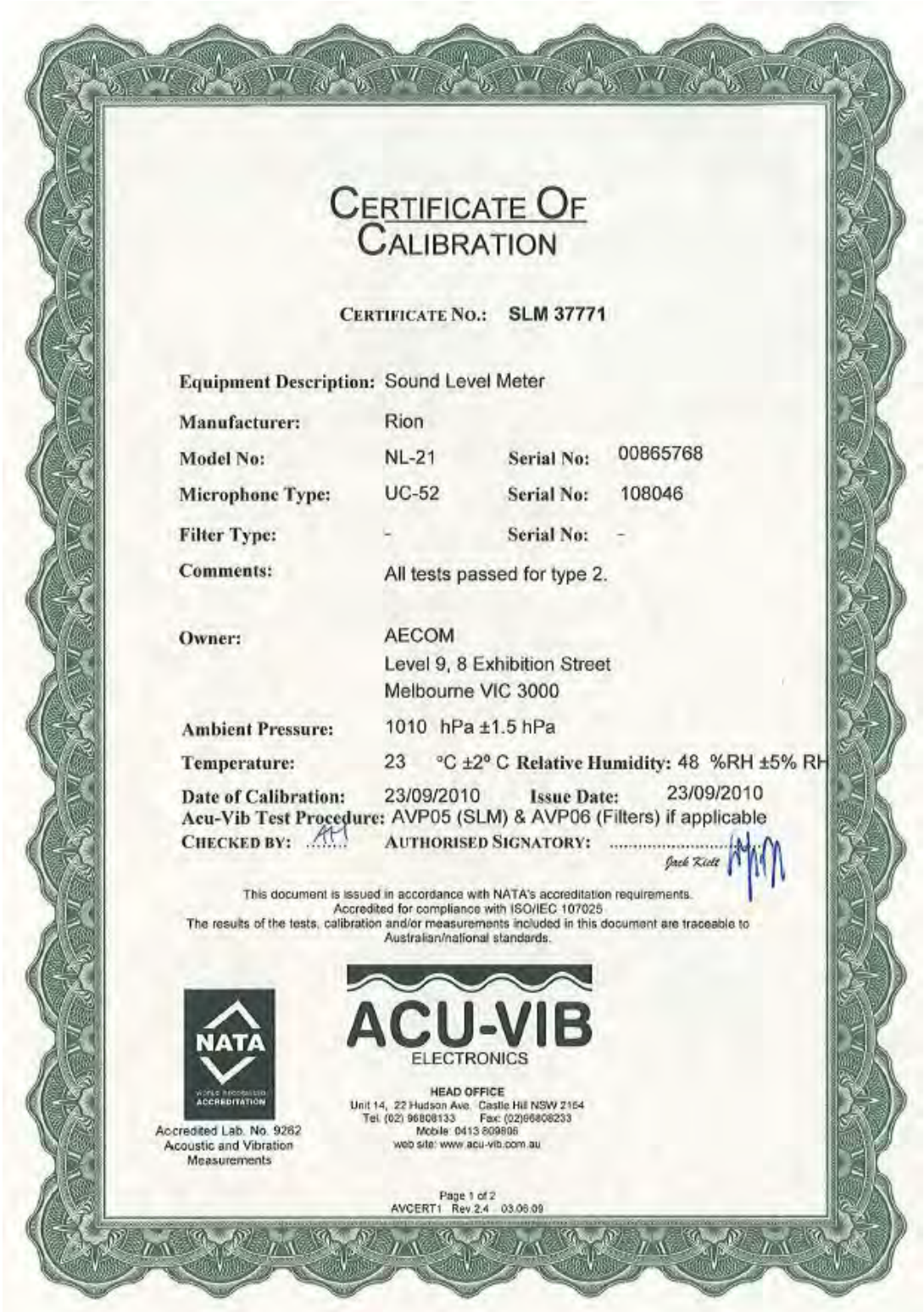
The tests, calibrations or measurements covered by this document are traceable to Australian national standards of measurement. This document shall not be reproduced, except in full. The equipment listed above has been calibrated in this laboratory. The equipment performed satisfactorily in all the tests conducted.

NATA
WORLD RECOGNISED ACCREDITATION

ACU-VIB
ELECTRONICS

HEAD OFFICE
Unit 14, 22 Hudson Ave. Castle Hill NSW 2154
Tel: (02) 96808133 Fax: (02)96808233
Mobile: 0413 809806
web site: www.acu-vib.com.au

Page 1 of 2
AVCERT1 Rev.2.2 14.04.07



CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: SLM 37771

Equipment Description:	Sound Level Meter		
Manufacturer:	Rion		
Model No:	NL-21	**Serial No:**	00865768
Microphone Type:	UC-52	**Serial No:**	108046
Filter Type:	-	**Serial No:**	-
Comments:	All tests passed for type 2.		
Owner:	AECOM Level 9, 8 Exhibition Street Melbourne VIC 3000		
Ambient Pressure:	1010 hPa ±1.5 hPa		
Temperature:	23 °C ±2° C	**Relative Humidity:**	48 %RH ±5% RH
Date of Calibration:	23/09/2010	**Issue Date:**	23/09/2010

Acu-Vib Test Procedure: AVP05 (SLM) & AVP06 (Filters) if applicable

CHECKED BY: ..... **AUTHORISED SIGNATORY:** .....

Jack Ricatt

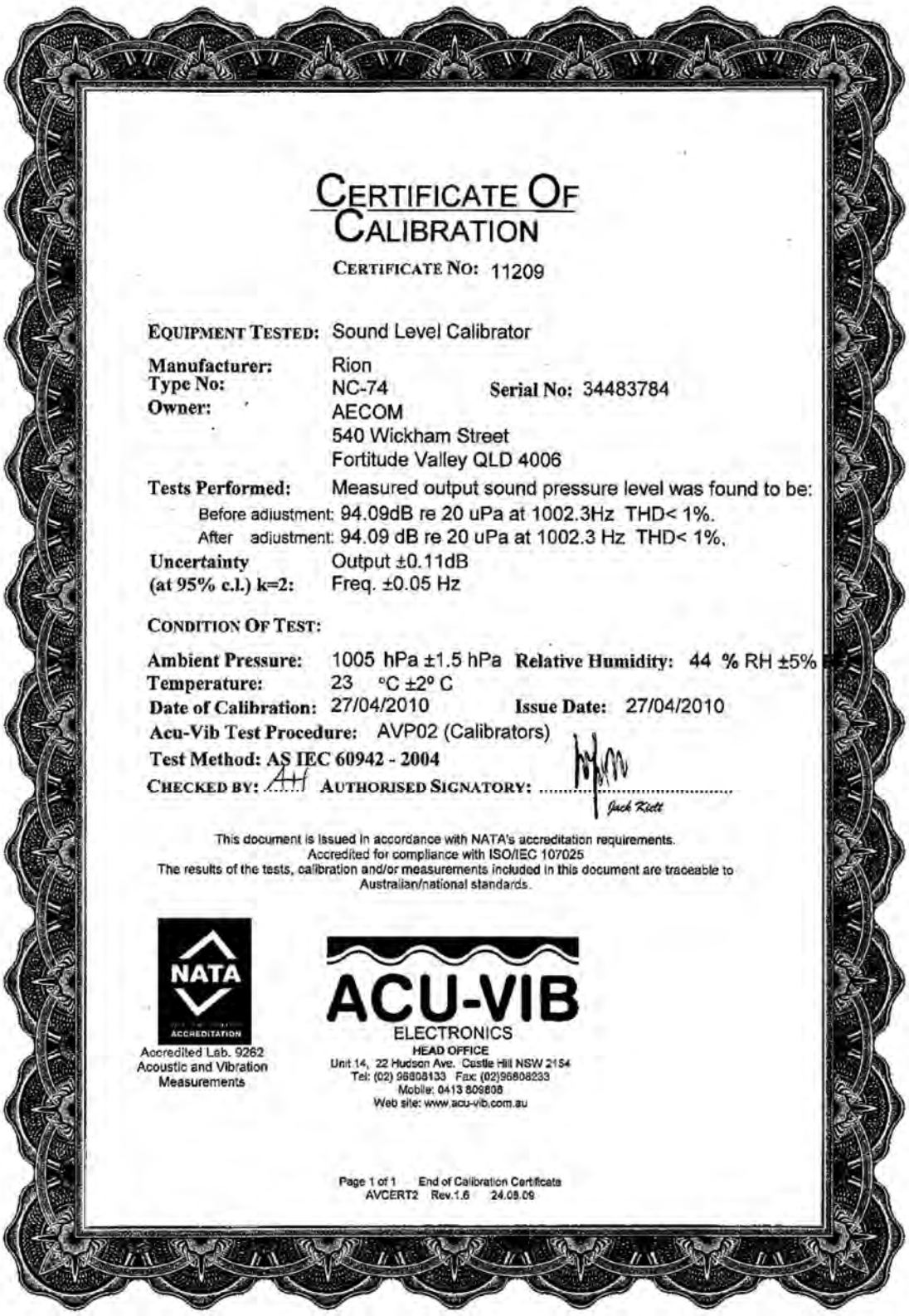
This document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 107025
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

NATA
WORLD RECOGNISED ACCREDITATION
Accredited Lab. No. 9262
Acoustic and Vibration Measurements

ACU-VIB
ELECTRONICS

HEAD OFFICE
Unit 14, 22 Hudson Ave. Castle Hill NSW 2154
Tel. (02) 96808133 Fax: (02)96808233
Mobile 0413 809806
web site: www.acu-vib.com.au

Page 1 of 2
AVCERT1 Rev.2.4 03.06.09



CERTIFICATE OF CALIBRATION

CERTIFICATE NO: 11209

EQUIPMENT TESTED: Sound Level Calibrator

Manufacturer: Rion
Type No: NC-74 **Serial No:** 34483784
Owner: AECOM
540 Wickham Street
Fortitude Valley QLD 4006

Tests Performed: Measured output sound pressure level was found to be:
Before adjustment: 94.09dB re 20 uPa at 1002.3Hz THD< 1%.
After adjustment: 94.09 dB re 20 uPa at 1002.3 Hz THD< 1%.

Uncertainty (at 95% c.l.) k=2: Output ±0.11dB
Freq. ±0.05 Hz

CONDITION OF TEST:

Ambient Pressure: 1005 hPa ±1.5 hPa **Relative Humidity:** 44 % RH ±5%
Temperature: 23 °C ±2° C
Date of Calibration: 27/04/2010 **Issue Date:** 27/04/2010
Acu-Vib Test Procedure: AVP02 (Calibrators)
Test Method: AS IEC 60942 - 2004
CHECKED BY: AH **AUTHORISED SIGNATORY:** Jack Rielt

This document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 107025
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

NATA ACCREDITATION
Accredited Lab. 9262
Acoustic and Vibration Measurements

ACU-VIB ELECTRONICS
HEAD OFFICE
Unit 14, 22 Hudson Ave. Castle Hill NSW 2154
Tel: (02) 96808133 Fax: (02)96808233
Mobile: 0413 809808
Web site: www.acu-vib.com.au

Page 1 of 1 End of Calibration Certificate
AVCERT2 Rev.1.6 24.08.09

Appendix F

Temporary Development Meteorological Mast Details

Appendix F Temporary Development Meteorological Mast Details

Wind speed data for the period when the background noise levels were measured was originally provided by two Meteorological Masts owned by Meridian Energy Limited. The meteorological masts were named in accordance with the nearest landowner, in this case, the masts are known as the Officer and Robertson meteorological masts.

Wind speed data from the Officer and Robertson masts was provided for heights of 30, 50, 70, 88 and 90 meters. This data was used to interpolate the wind speed at the Wind Turbine Generator hub height of 84 meters by establishing the average wind shear over the measured heights, and then applying this to factor to the 88 meter height wind speed.

The locations of the Robertson and Officer Meteorological Masts are shown on Table 10.

Table 10: Meteorological mast locations

Location	GPS coordinates (UTM coordinate system, Zone 54H)	
	Easting	Northing
Robertson meteorological mast	605872	5784654
Officer meteorological mast	598698	5792477

Calibration of the anemometers on these meteorological masts was confirmed following completion of the noise measurements and was found not to have drifted.

Appendix G

Meteorological Mast Selection Procedure Details

Appendix G Meteorological Mast Selection Procedure Details

The alternative masts and directional correlation ratios used to avoid wake affects in each wind direction and relate the data back to the lead mast position were as follows:

For lead met mast M1:

Table 11 Meteorological Masts Used for Wind Speed Data

Wind Direction as Measured at Met Mast M1	Met Mast Used for Wind Speed Data
Greater than or equal to 70 degrees and less than 218 degrees	Met Mast M4
Greater than or equal to 218 degrees or less than 20 degrees	Met Mast M1
Greater than or equal to 20 degrees and less than 70 degrees	Met Mast M6

Table 12 Wind Speed Correction Factors M4 to M1

Wind Direction as Measured at Met Mast M1	Correction Factor applied to M4 Wind Speeds
Greater than or equal to 70 degrees and less than 75 degrees	0.988592
Greater than or equal to 75 degrees and less than 105 degrees	1.097402
Greater than or equal to 105 degrees and less than 135 degrees	1.076224
Greater than or equal to 135 degrees and less than 165 degrees	1.061829
Greater than or equal to 165 degrees and less than 195 degrees	1.068266
Greater than or equal to 195 degrees and less than 218 degrees	1.000269

Table 13 Wind Speed Correction Factors M6 to M1

Wind Direction as Measured at Met Mast M1	Correction Factor applied to M4 Wind Speeds
Greater than or equal to 20 degrees and less than 45 degrees	1.056619
Greater than or equal to 45 degrees and less than 70 degrees	1.020335

For lead met mast M4:

Table 14 Meteorological Masts Used for Wind Speed Data

Wind Direction as Measured at Met Mast M4	Met Mast Used for Wind Speed Data
Greater than or equal to 70 degrees and less than 218 degrees	Met Mast M4
Greater than or equal to 218 degrees and less than 340 degrees	Met Mast M3
Greater than or equal to 340 degrees or less than 70 degrees	Met Mast M6

Table 15 Wind Speed Correction Factors M4 to M3

Wind Direction as Measured at Met Mast M4	Correction Factor applied to M3 Wind Speeds
Greater than or equal to 218 degrees and less than 225 degrees	1.056454
Greater than or equal to 225 degrees and less than 255 degrees	1.023231
Greater than or equal to 255 degrees and less than 285 degrees	1.054981
Greater than or equal to 285 degrees and less than 315 degrees	1.085166
Greater than or equal to 315 degrees and less than 340 degrees	0.993236

Table 16 Wind Speed Correction Factors M6 to M4

Wind Direction as Measured at Met Mast M4	Correction Factor applied to M6 Wind Speeds
Greater than or equal to 340 degrees and less than 345 degrees	1.015667
Greater than or equal to 345 degrees or less than 15 degrees	1.064022
Greater than or equal to 15 degrees and less than 45 degrees	0.983088
Greater than or equal to 45 degrees and less than 70 degrees	0.999326

For lead met mast M6:

Table 17 Meteorological Masts Used for Wind Speed Data

Wind Direction as Measured at Met Mast M6	Met Mast Used for Wind Speed Data
Greater than or equal to 70 degrees and less than 175 degrees	Met Mast M4
Greater than or equal to 175 degrees or less than 70 degrees	Met Mast M6

Table 18 Wind Speed Correction Factors M4 to M6

Wind Direction as Measured at Met Mast M6	Correction Factor applied to M4 Wind Speeds
Greater than or equal to 70 degrees and less than 75 degrees	1.000303
Greater than or equal to 75 degrees and less than 105 degrees	1.00651
Greater than or equal to 105 degrees and less than 135 degrees	0.97507
Greater than or equal to 135 degrees and less than 165 degrees	1.028481
Greater than or equal to 165 degrees and less than 175 degrees	0.987351