aercoustics

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ACOUSTIC MEASUREMENT REPORT - **Project: 14284**

Grand Renewable Wind Farm
Transformer Station Acoustic Audit

REA Number: 0300-8UQPKR
Near Haldimand Road 20
Haldimand County, N0A 1E0

Prepared for:

Grand Renewable Wind LP

Prepared by:

Adelaide Denison, B.A.Sc., P.Eng.

Payam Ashtiani, B.A.Sc., P.Eng.

4 June 2018

Table of Contents

1 Introduction

Grand Renewable Wind LP ("GRWLP") has retained the services of Aercoustics Engineering Limited ("Aercoustics") to complete a post-construction acoustic audit of the main power transformer for the Grand Renewable Wind Farm ("GRWF"), REA # 0300-8UQPKR. The transformer audit was conducted as per IEEE standard C57.12.90-2010, section 13. Supplementary measurements were also taken in the far field to verify sound levels at receptors.

This report summarizes the results of the acoustic audit conducted on May 20, 2015.

2 Acoustic Environment

Aercoustics visited the GRWF site on May 20, 2015 to observe and measure the main 166 MVA transformer, located in the facility substation. See Figure 1 for the scaled location of the sources and receptors based on the source and receptor coordinates obtained from the Grand Renewable Energy Park Noise Assessment Report dated 29 May, 2012.

The substation contains the main transformers for both the GRWF as well as the Grand Renewable Solar Farm. The ground cover of the transformer substation is gravel, and the surrounding ground cover is predominantly field crops. The audit was conducted during the night hours, during which the solar farm transformer was completely shut down for maintenance purposes. There was one standby generator operating near the solar farm transformer for the duration of the audit.

3 Measurement Instrumentation

Two sound level meters were used for the audit to allow for simultaneous measurements of the top and bottom portions of the transformer. The measurement equipment utilized for the acoustic audit is presented below in Table 1. The microphones and pre-amps were calibrated before and after the measurements. Calibration certificates for all equipment used can be found in Appendix E.

Table 1 Measurement Equipment

Equipment	Make	Model	Serial #
Sound Level Meter 1	Brüel & Kjær	2250	2630243
Microphone 1	Brüel & Kjær	4189	2237528
Pre-amp 1	Brüel & Kjær	ZC0032	21913
Sound Level Meter 2	Brüel & Kjær	2250	2630244
Microphone 2	Brüel & Kjær	4189	2386059
Pre-amp 2	Brüel & Kjær	ZC0032	7946
Calibrator	Brüel & Kjær	4231	3012378

4 Transformer Details

The following is a summary of the specifications for the GRWF main transformer:

- Type: ONAN/ONAF/ONAF Sealed Transformer
- Power Rating (MVA): 100/133/166
- Phase: 3 | Frequency: 60Hz
- HV: 240,000 Volts
- LV: 34,500 Volts
- Manufacturer: Hyundai
- Transformer Height: 4 m

During the measurement, all cooling fans on the transformer were manually turned on and operational for the duration of the audit. Additionally, the measurement period was scheduled during a time when the winds were low; the wind farm was generating approximately 30MW, or 20% of its maximum power capacity. These conditions were as close as practically possible to the no-load operating conditions stipulated in IEEE C57.12.90-2010 section 13. See Appendix A for a graph of facility power output.

5 Site Specific Measurement Conditions

During the measurement period, the wind speeds were between 0-6 m/s from the north-west, the temperature was between 7-9°C, and the relative humidity was between 40-85%.

A barrier was located off the north side of the transformer between the solar and wind power transformers. This barrier was a source of reflection that could not be avoided in the measurements. It is taken as a source of conservatism.

During the measurement period the solar farm, including the solar power transformer, was offline for maintenance purposes. The only source of noise from the solar facility was a generator that was used to power lights and monitoring equipment used for the solar staff conducting the maintenance. This generator was audible at the west face of the GRWF transformer.

The dominant noise sources on the transformer is the hum of the electrical components and the cooling fans. The transformer exhibited an audible tone near the equipment, but this tone was inaudible at the nearest receptors.

6 Measurements

Audit measurements were conducted in the near field of the transformer as well as at the two nearest receptors.

6.1 Near Field Measurements

Sound level measurements took place at the GRWF substation on the night of May 20, 2015 between 22:00 and 02:00 hours. Sound pressure level measurements were taken in 1m intervals, at 1/3 and 2/3 the total transformer height (1.3 m and 2.7 m, respectively). Due to safety concerns, measurements were not able to be performed at the stipulated 0.3m distance. Instead, a consistent distance of 2m away from the transformer was used. The 2m distance is in accordance with international standard IEEE C57.12.90-2010 for measurement locations near faces with fans located on them. The near field measurement locations are shown in Figure 2.

The average overall sound pressure level measured by Aercoustics was 61 dBA (L_{eq}). The average sound pressure measured in each octave band is summarized in Table 2. The complete set of measurement data is presented in Appendix B.

Table 2 Near field Noise Measurements

1/1 Octave Band (Hz)	31.5	63	125	250	500	1000	2000	4000	8000	Total
Sound Pressure Level (dB)	58	58	64	61	63	51	41	37	35	61dBA

6.2 Receptor Measurements

Spot check measurements, as well as qualitative audibility assessments were performed at the two nearest receptors, R307 and R575. The transformer was inaudible and R307, and barely perceptible at R575. No tones were audible at either location, and the spot check measured a level of 28dBA and 26dBA at receptors R307 and R575 respectively.

7 Transformer Sound Power

Based on evaluation procedures outlined in IEEE C57.12.90, the transformer has a calculated sound power level of 86 dBA. The octave-band sound power spectrum is provided in Table 3.

Table 3: Calculated Transformer Sound Power

1/1 Octave Band (Hz)	31.5	63	125	250	500	1000	2000	4000	8000	Total
Sound Power Level (dB)	84	84	90	86	88	77	67	63	61	86 dBA

Key details used to determine the calculated sound power level are provided below:

- Perimeter Area of Enclosing Measurement Surface = 200 sq.m.
- Transformer top area = 154 sq.m.
- Total Measurement Surface Area = 354 sq.m.

The primary noise source was the transformer core hum. Based on Aercoustics observations of the site and the subjective tonality assessment, a 5 dB tonal penalty has been applied to the calculated sound power level. The prescribed sound power level after all adjustments is 91dBA.

8 Assessment of Compliance

The compliance of the main transformer was assessed with respect to both the far field and near field measurement data obtained during Aercoustics' site visit.

8.1 Near Field Measurements

The calculated sound power level of the transformer is 91 dBA including a tonal penalty. The sound power level utilized in the facility's Acoustic Assessment Report (AAR) and stipulated in the facility REA is 90dBA including a tonality penalty. The transformer calculated sound power level exceeded the sound power level stipulated in the facility REA by 1 dB. As such a combination of far field measurements and acoustic modelling have been completed to demonstrate compliance with the MOECC sound level limits at the worst-case receptors near to the transformer.

8.2 Far Field Measurements

Far-field spot check measurements were taken at the two nearest receptors, R307 and R575. These two receptors are 288m and 132m, respectively, away from the transformer. At R307, the measured level was 28dBA and the transformer was inaudible. At R575, the measured level was 26dBA, and the transformer was barely perceptible. No tonality was qualitatively observed at either location. The combination of the inaudibility and the very low measured level indicates a noise impact of the transformer that is well below the sound level limit.

8.3 Acoustic Model

Additionally, the cumulative sound level at all receptors has been assessed from the main power Transformer and other turbines/transformers in the acoustic model to demonstrate compliance. The cumulative impact from turbines and transformer was assessed using the measured Transformer sound power level and the maximum of the measured sound power level or manufacturer sound power level for all other Grand Renewable sources in the acoustic model.
Table 4 below presents the predicted sound levels at the receptors within 1km of the transformer. The predicted sound levels at all receptors were found to be in compliance with the MOECC sound level limits.

Table 4 Predicted Sound Level at receptors near to Transformer

Receptor ID	Description	Modelled Sound Level (dBA)			Receptor Height (m)
		Contribution (dBA)		Total (dBA)	
		Transformer	Other Noise Sources		
307	non-participating receptor	21.3	33.3	33.6	1.5
362	non-participating receptor	15.6	31.9	32	1.5
363	non-participating receptor	17.4	32.2	32.3	1.5
364	non-participating receptor	14.4	33.9	33.9	7.5
377	participating receptor	21.3	35.3	35.5	4.5
378	non-participating receptor	17	33.0	33.1	1.5
455	non-participating receptor	20.3	34.4	34.6	4.5
457	non-participating receptor	23	34.6	34.9	4.5
459	participating receptor	21.3	33.4	33.7	1.5
460	non-participating receptor	14.9	34.4	34.4	4.5
574	non-participating receptor	18.3	34.6	34.7	4.5
575	non-participating receptor	24.1	35.5	35.8	4.5
576	non-participating receptor	22.1	35.1	35.3	4.5
577	non-participating receptor	22.1	35.3	35.5	4.5
1317	non-participating receptor	22.5	35.1	35.3	4.5
3664	vacant non-participating receptor	15	34.2	34.3	4.5

8.4 Statement of Compliance

Results of the audit completed by Aercoustics on the night of May 20, 2015 and acoustic modelling support that the GRWF substation transformer is in compliance with the acoustic requirements stipulated in the facility REA #0300-8UQPKR, specifically Section E.

9 Conclusion

If you have any questions please do not hesitate to contact the authors of this report.

10 References

1. Zephyr North, Grand Renewable Energy Park – Noise Assessment Report rev2, 29 May 2012

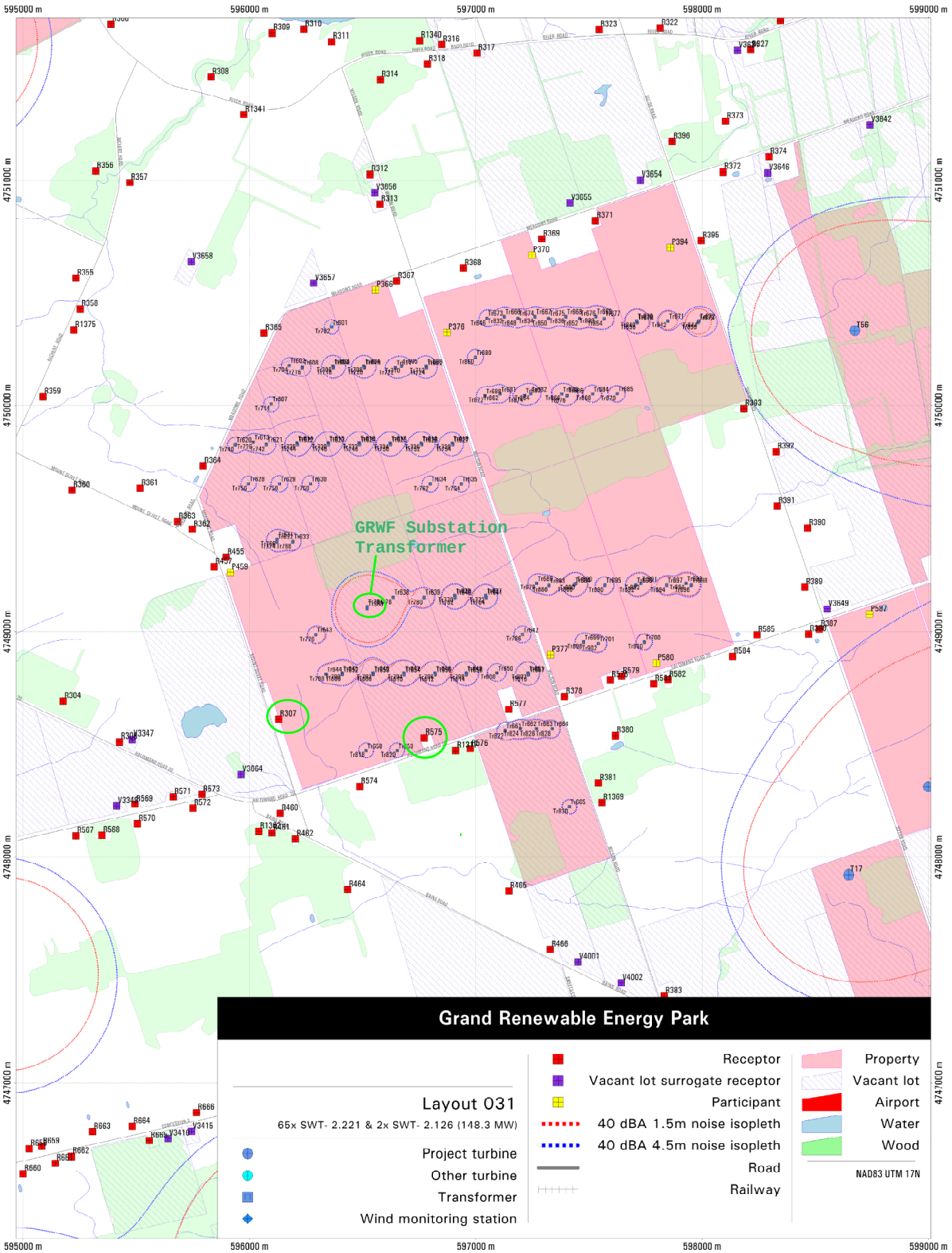
2. IEEE Standard C57.12-90-2010, “Test Code for Liquid Immersed Distribution, Power and Regulating Transformers”

3. ISO Standard 9613-2.2, “Acoustics – Attenuation of Sound during Propagation Outdoors”

4. ISO Standard 1996-2, “Acoustics –Description, measurement and assessment of Environmental Noise”

5. Ontario Ministry of Environment, “Model Municipal Noise Control By-Law, Final Report”, 1978

6. Ontario Ministry of Environment, “Stationary and Transportation Sources – Approval and Planning”, NPC-300, 2013



N

Scale: NTS
Drawn by: DH
Reviewed by: RJ
Date: May 29, 2015
Revision: 1

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Project ID: 14284

Project Name

Grand Renewable Wind Farm - Transformer Acoustic Audit

Figure Title

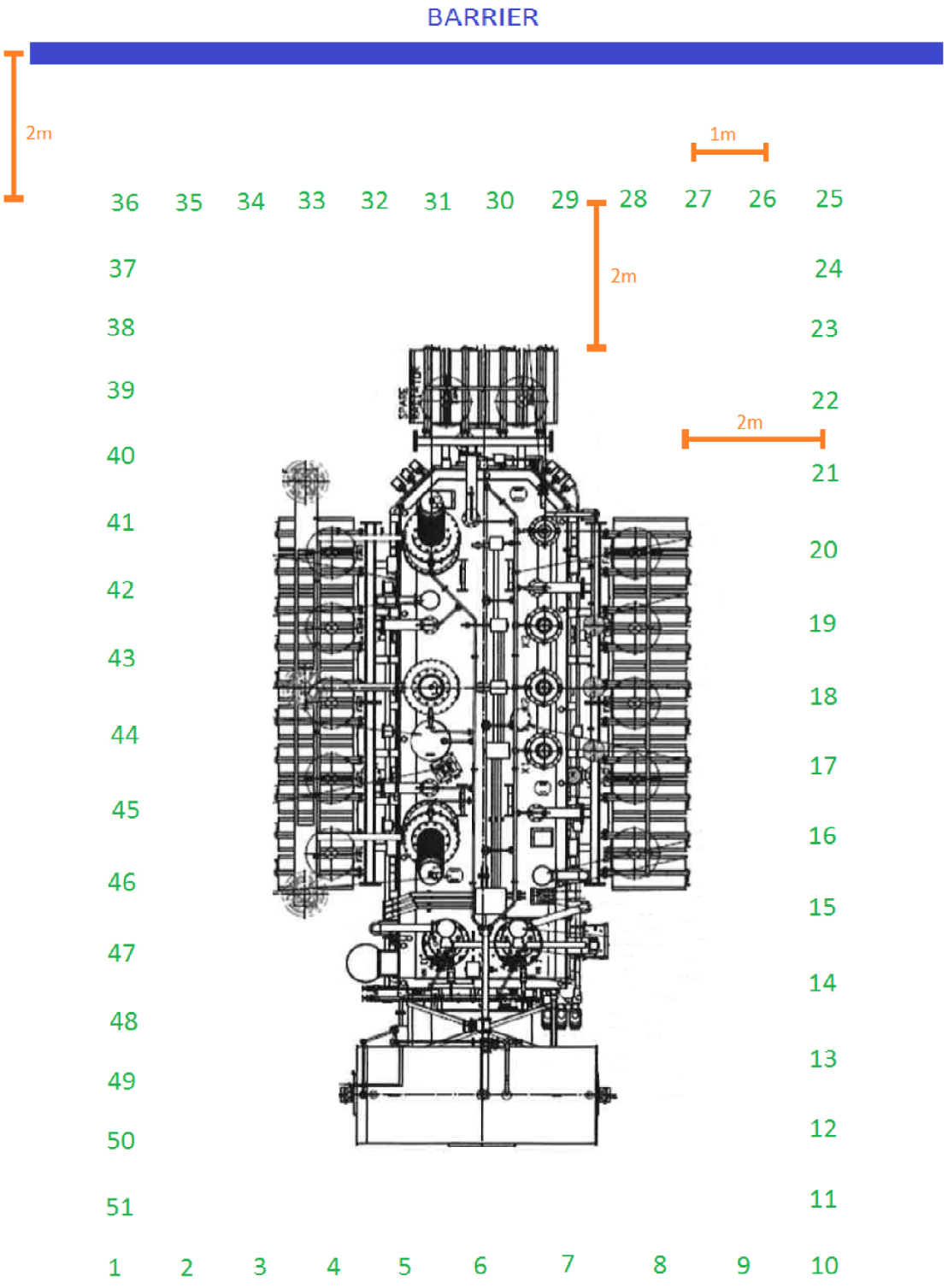
Site Plan

Figure 1

Perimeter Area: 200 m^2

Top Area: 154 m^2

Total Measurement Surface Area: 354 m^2



N

Scale: NTS
Drawn by: DH
Reviewed by: RJ
Date: May 29, 2015
Revision: 1

aercoustics

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Project Name

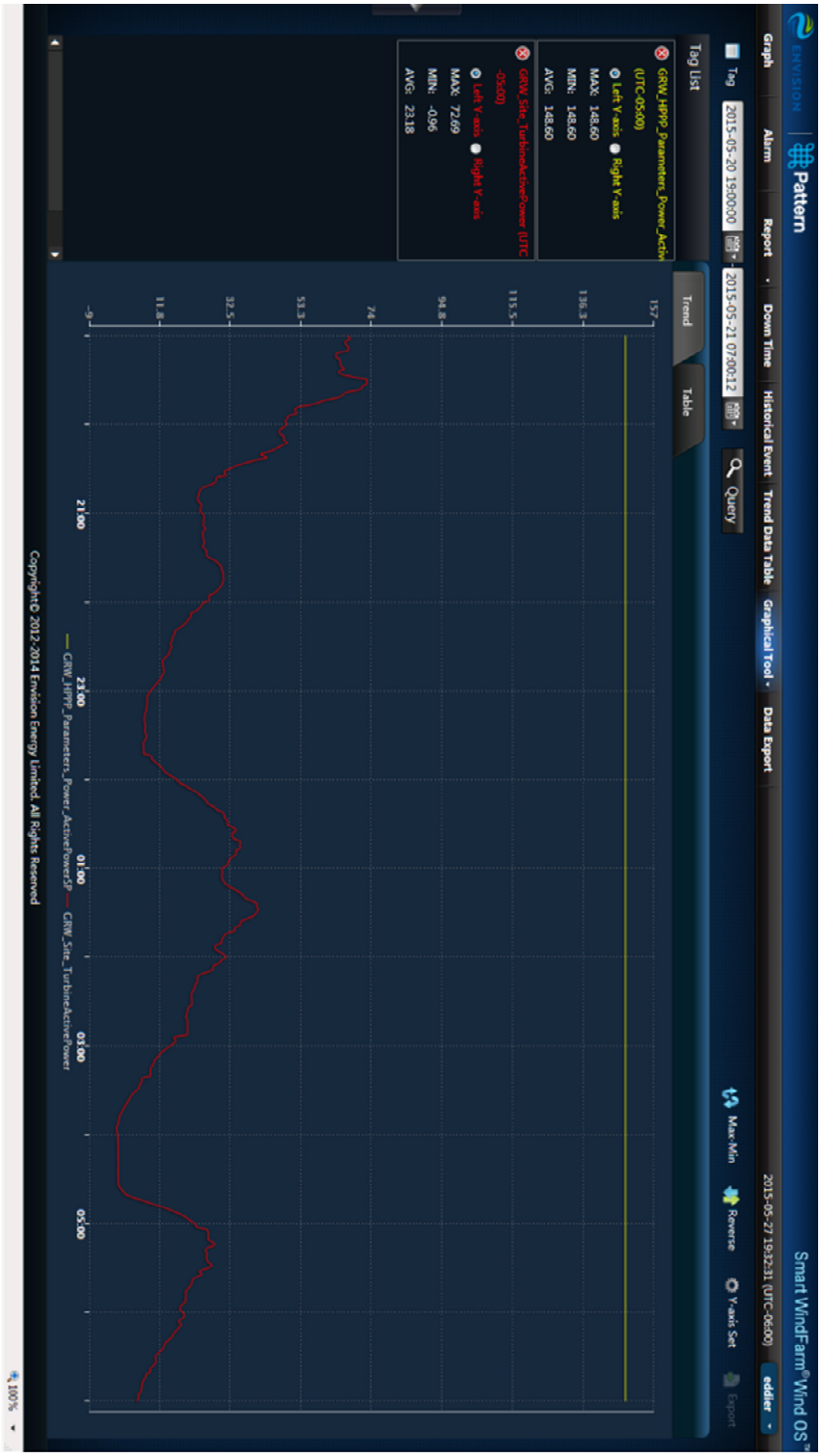
Grand Renewable Wind Farm - Transformer Acoustic Audit

Figure Title

Near Field Measurement Locations

Figure 2

APPENDIX A – FACILITY POWER OUTPUT DURING AUDIT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Historical Event
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100%

APPENDIX B – NEARFIELD MEASUREMENT RESULTS

Microphone Position (see Figure 2)	Sound Pressure Level (1/3 transformer height) [dBA re. 20 µPa]	Sound Pressure Level (2/3 transformer height) [dBA re. 20 µPa]
1	58	54
2	55	55
3	58	57
4	54	57
5	57	58
6	58	55
7	57	57
8	54	55
9	58	56
10	56	55
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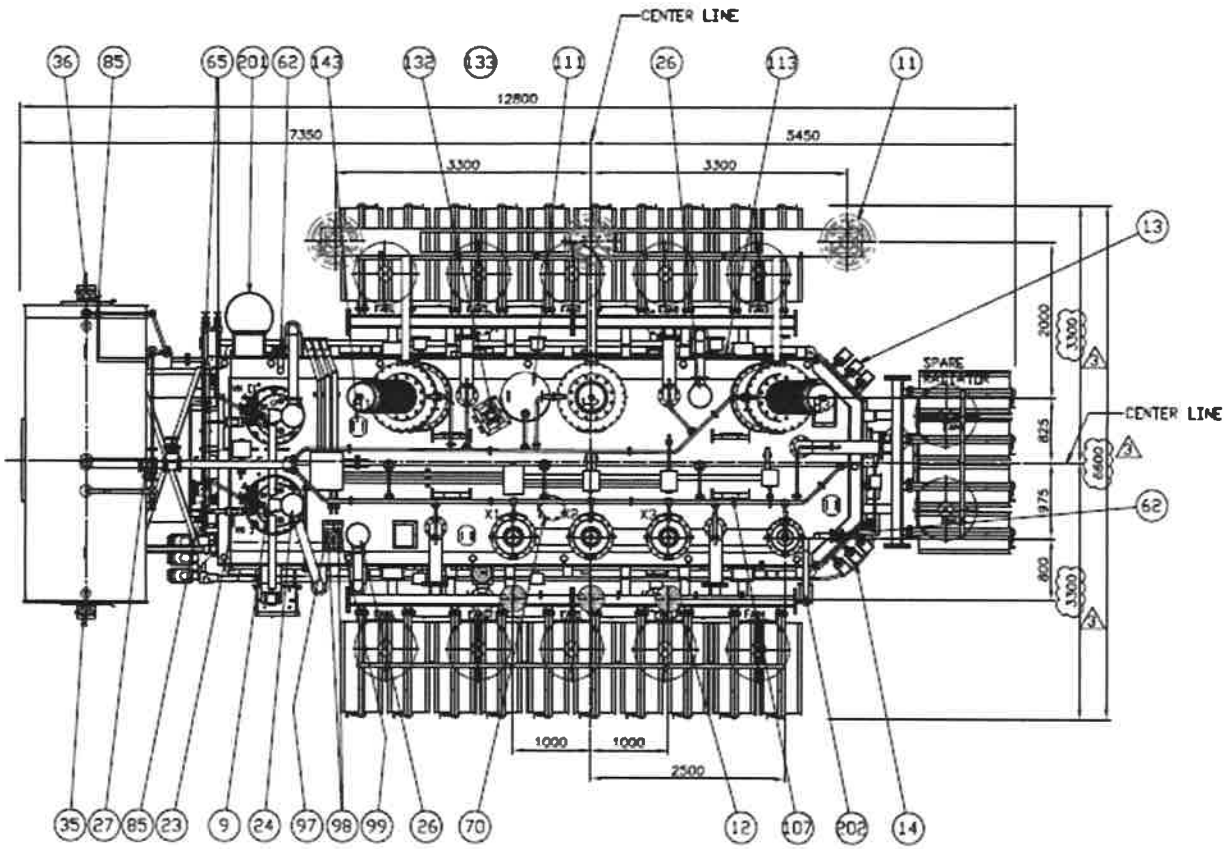
39	62	59
40	62	65
41	62	59
42	65	62
43	63	64
44	59	58
45	62	61
46	65	60
47	64	59
48	58	59
49	63	58
50	63	60
51	57	60

APPENDIX C – FAR FIELD MEASUREMENT DATA

1/1 Octave Band (Hz)	31.5	63	125	250	500	1000	2000	4000	8000	Total
Receptor R307	57	50	38	27	20	16	13	13	13	28 dBA
Receptor R575	44	36	27	26	24	17	17	17	13	26 dBA

APPENDIX D - DIMENSIONED TRANSFORMER DRAWINGS

5.4 Outline for Power Transformers (1 / 3) – 166MVA TR

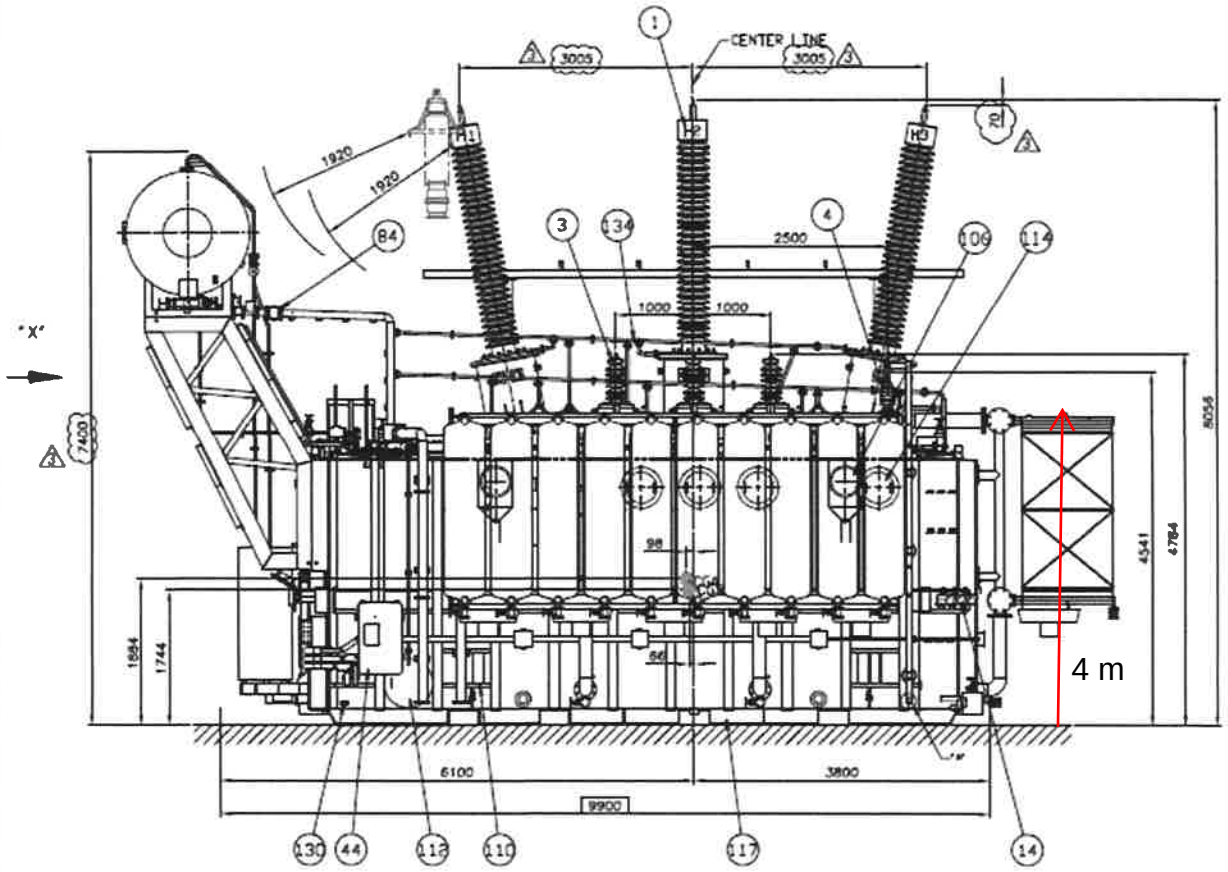


RATINGS	
PHASE	3 PH
FREQUENCY	60 HZ
CAPACITY	100/133/166MVA
RATED VOLTAGE	240/34.5 KV

WEIGHT (KG)	
CORE/COIL ASSEMBLY	92200
OIL(61600LT)	55500
TANK & FITTINGS	49000
TOTAL WEIGHT	196700

No.	Accessory
9	OLTC
13,14	Surge Counter for HV / XV
24,26	P.R.D for OLTC / Tank
27	Buchholz Relay
62	Upper Filtering Valve
70	Vacuum Valve
132, 133	Core / Clamp Grounding Device
143	Fall Arrest Plate for Unit Hoist
202	Ground Bus & Insulator for X.0 Bushing

5.4 Outline for Power Transformers (2 / 3) – 166MVA TR



RATINGS	
PHASE	3 PH
FREQUENCY	60 HZ
CAPACITY	100/133/166MVA
RATED VOLTAGE	240/34.5 KV

WEIGHT (KG)	
CORE/COIL ASSEMBLY	92200
OIL(61600LT)	55500
TANK & FITTINGS	49000
TOTAL WEIGHT	196700

No.	Accessory
1,3,4	HV / XV / X0 Bushing with Bushing Terminal Lug
14	Surge Counter for XV
44	Motor Drive Unit for OLTC
106	Lifting Hook for Complete Transformer
110	Jack Pad with Pulling Eye
117	Skid Base
130	Grounding Pad for Main Body
134	Air / Gas Venting Pipe Line

APPENDIX E - CALIBRATION RECORDS

West Caldwell Calibration Laboratories Inc.

Certificate of Calibration

for

HAND-HELD ANALYZER

Manufactured by:	**BRUEL & KJAER**
Model No:	**2250**
Serial No:	**2630243**
Calibration Recall No:	**23388**

Submitted By:

Customer:

Company: **Aercoustics Engineering, Ltd.**
Address:

The subject instrument was calibrated to the indicated specification using standards traceable to the National Institute of Standards and Technology or to accepted values of natural physical constants. This document certifies that the instrument met the following specification upon its return to the submitter.

West Caldwell Calibration Laboratories Procedure No. **2250** **BRUE**

Upon receipt for Calibration, the instrument was found to be:

Within **(X)** **see attached Report of Calibration.**

the tolerance of the indicated specification.

West Caldwell Calibration Laboratories' calibration control system meets the requirements, ISO 10012-1 MIL-STD-45662A, ANSI/NCSL Z540-1, IEC Guide 25, ISO 9001:2008 and ISO 17025.

Note: With this Certificate, Report of Calibration is included.

Calibration Date: **09-Sep-13**

Certificate No: **23388 - 10**

Approved by:

FC

Felix Christopher (QA Mgr.)

ISO/IEC 17025:2005

ACCREDITED

Calibration Lab. Cert. # 1533.01

uncompromised calibration West Caldwell Calibration Laboratories, Inc.
1575 State Route 96, Victor, NY 14564, U.S.A.

ISO/IEC 17025: 2005

West Caldwell Calibration Laboratories, Inc.
uncompromised calibration

ACCREDITED

1575 State Route 96, Victor NY 14564

Calibration Lab. Cert. # 1533.01

REPORT OF CALIBRATION

for

Brüel & Kjær Hand-held Analyzer **Model No.: 2250** **Serial No.: 2630243**

Company : Aercoustics Engineering Ltd. **ID No: XXXX**

Calibration results:	**All Tests:**	**Pass**	**Before data:**	**After data:**	
	Sensitivity & Reference	**Pass**		**Before & after data same:**	
	Frequency Response:	**Pass**	Laboratory Environment:		
	1dB steps	**Pass**	Ambient Temperature:	**20.4**	°C
	Linearity:	**Pass**	Ambient Humidity:	**52.5**	% RH
	Noise:	**Pass**	Ambient Pressure:	**99.776**	kPa
	Random signal:	**Pass**	Calibration Date:	**9-Sep-2013**	
	Time Constant:	**Pass**	Calibration Due:	**9-Sep-2014**	
	Function:	**Pass**	Report Number:	**23388 -10**	
	Octave & 1/3 Octave Filters:	**Pass**	Control Number:	**23388**	

Note: Base cover missing, Batt. Latch damaged, reset button overlay damaged.

The above listed instrument meets or exceeds the tested manufacturer's specifications.

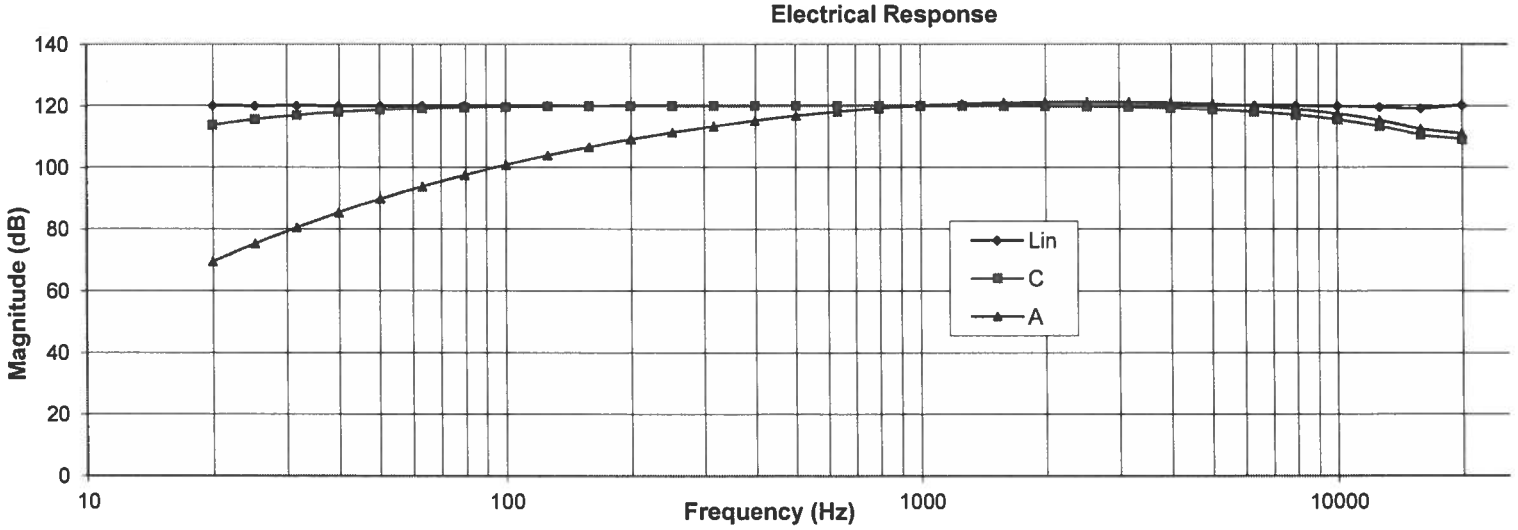
IEC 61672-1:2002 Class 1, IEC 61260:1995 w.Am.1, 1/1 and 1/3 Oct. Band Class 0 specification passed.

IEC 60804:2000 Type 1, IEC 60651:1979 w.Am.1&2 Type 1 specification passed.

This Calibration is traceable through NIST test numbers: 683/281764-12

The absolute uncertainty of calibration: See last page. Unless otherwise noted, the reported values are both "as found" and "as left" data.

The curve is the response recorded with electrical input with 50pF (1V=120dB).



The above listed instrument was checked using calibration procedure documented in West Caldwell Calibration Laboratories Inc. procedure : **Rev. 5.0 Sept. 10, 2010 Doc. # 1038 2250B&K**

Calibration was performed by West Caldwell Calibration Laboratories Inc. under Operating Procedures intended to implement the requirements of ISO10012-1, IEC Guide 25, ANSI/NCSL Z540-1, (MIL-STD-45662A) and ISO 9001:2008, ISO 17025

Measurements performed by: .....

Calibrated on WCCL system type 9700 **Felix Christopher**

West Caldwell Calibration Laboratories Inc.
1575 State Route 96, Victor NY 14564
Tel. (585) 586-3900 FAX (585) 586-4327

Calibration Data Record

for

Brüel & Kjær Hand-held Analyzer **Model No.: 2250** **Serial No.: 2630243**

Company : Aercoustics Engineering Ltd.

Frequency Response (Reference = 94 dB @ 1000Hz)

Frequency (Hz)	Weighting Z	C	A
19.95	120.1	113.8	69.4
25.12	120.0	115.6	75.3
31.62	120.1	117.0	80.5
39.81	119.9	118.0	85.4
50.12	120.0	118.7	89.8
63.1	120.0	119.1	93.8
79.43	120.0	119.5	97.5
100	120.0	119.7	100.9
125.89	120.0	119.8	103.9
158.49	120.0	119.9	106.7
199.53	120.0	120.0	109.1
251.19	120.0	120.0	111.4
316.23	120.0	120.0	113.4
398.11	120.0	120.0	115.2
501.19	120.0	120.0	116.8
630.96	120.0	120.0	118.1
794.33	120.0	120.0	119.2
1000	120.0	120.0	120.0

Frequency (Hz)	Weighting Z	C	A
1258.93	120.0	120.0	120.6
1584.89	120.0	119.9	121.0
1995.26	120.0	119.8	121.2
2511.89	120.0	119.7	121.3
3162.28	120.0	119.5	121.2
3981.07	120.0	119.2	121.0
5011.87	120.0	118.7	120.6
6309.57	120.0	118.0	119.9
7943.28	120.0	117.0	118.9
10000	119.9	115.5	117.4
12589.25	119.5	113.3	115.2
15848.93	119.1	110.6	112.5
19952.62	120.2	109.2	111.1

Instruments used for calibration:			Date of Cal.	Traceability No.	Cal. Due Date
Brüel & Kjær	4134	S/N 1942286	5-Oct-2012	683/281764-12	6-Oct-2013
HP	34401A	S/N US360641	8-Oct-2012	,287708	8-Oct-2013
HP	33120A	S/N S3604371	8-Oct-2012	,287708	8-Oct-2013
Brüel & Kjær	2669	S/N 2053834	2-Nov-2012	683/281764-12	3-Nov-2013
Brüel & Kjær	4228	S/N 1742061	5-Oct-2012	683/281764-12	6-Oct-2013
Brüel & Kjær	4144	S/N 1410002	5-Oct-2012	683/281764-12	6-Oct-2013

Cal. Date: 9-Sep-2013 **Tested by: Felix Christopher**

Calibrated on WCCL system type 9700

West Caldwell Calibration Laboratories Inc.

1575 State Route 96, Victor NY 14564

Tel. (585) 586-3900 FAX (585) 586-4327

Calibration Data Record

for

Brüel & Kjær Hand-held Analyzer **Model No.: 2250** **Serial No.: 2630243**

Company : Aercoustics Engineering Ltd. **ID No: XXXX**

Level Accuracy (Reference = 120 dB @ 1000Hz)

Nom. Value [dB]	Meas. Value [dB]	Tolerance Limits [dB]	Dev. in the last 1 dB [dB]	Deviation Rel. to 94.0 dB [dB]
135.0	135.0	0.5	0.0	0.1
134.0	134.0	0.5	0.0	0.1
133.0	133.0	0.5	0.0	0.1
132.0	132.0	0.5	0.0	0.1
131.0	131.0	0.5	0.0	0.0
130.0	130.0	0.5	0.0	0.0
129.0	129.0	0.5	0.0	0.0
128.0	128.0	0.5	0.0	0.0
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99.0	99.0	0.5	0.0	0.0
98.0	98.0	0.5	0.0	0.0
97.0	97.0	0.5	0.0	0.0
96.0	96.0	0.5	0.0	0.0
95.0	95.0	0.5	0.0	0.0
94.0	94.0	0.5	0.0	0.0
93.0	93.0	0.5	0.0	0.0
92.0	92.0	0.5	0.0	0.0
91.0	91.0	0.5	0.0	0.0
90.0	90.0	0.5	0.1	0.0
89.0	89.0	0.5	0.0	0.0
88.0	88.0	0.5	0.0	0.0
87.0	87.0	0.5	0.0	0.0
86.0	86.0	0.5	0.0	0.0

Nom. Value [dB]	Meas. Value [dB]	Tolerance Limits [dB]	Dev. in the last 1 dB [dB]	Deviation Rel. to 94.0 dB [dB]
85.0	85.0	0.5	0.0	0.0
84.0	84.0	0.5	0.0	0.0
83.0	83.0	0.5	0.0	0.0
82.0	82.0	0.5	0.0	0.0
81.0	81.0	0.5	0.0	0.0
80.0	80.0	0.5	0.0	0.0
79.0	79.0	0.5	0.0	0.0
78.0	78.0	0.5	0.0	0.0
77.0	77.0	0.5	0.0	0.0
76.0	76.0	0.5	0.0	0.0
75.0	75.0	0.5	0.0	0.0
74.0	74.0	0.5	0.0	0.0
73.0	73.0	0.5	0.0	0.0
72.0	72.0	0.5	0.0	0.0
71.0	71.0	0.5	0.0	0.0
70.0	70.0	0.5	0.0	0.0
69.0	69.0	0.5	0.0	0.0
68.0	68.0	0.5	0.0	0.0
67.0	67.0	0.5	0.0	0.0
66.0	66.0	0.5	0.0	0.0
65.0	65.0	0.5	0.0	0.0
64.0	64.0	0.5	0.0	0.0
63.0	63.0	0.5	0.0	0.0
62.0	62.0	0.5	0.0	0.0
61.0	61.0	0.5	0.0	0.0
60.0	60.0	0.5	0.0	0.0
59.0	59.0	0.5	0.0	0.0
58.0	58.0	0.5	0.0	0.0
57.0	57.0	0.5	0.0	0.0
56.0	56.0	0.5	0.0	0.0
55.0	55.0	0.5	0.0	0.0
54.0	54.0	0.5	0.0	0.0
53.0	53.0	0.5	0.0	0.0
52.0	52.0	0.5	0.0	0.0
51.0	51.0	0.5	0.0	0.0
50.0	50.0	0.5	0.0	0.0
49.0	49.0	0.5	0.0	0.0
48.0	48.0	0.5	0.0	0.0
47.0	47.0	0.5	0.0	0.0
46.0	46.0	0.5	0.0	0.0
45.0	45.0	0.5	0.0	0.0
44.0	44.0	0.5	0.0	0.0
43.0	43.0	0.5	0.0	0.0
42.0	42.0	0.5	0.0	0.0
41.0	41.0	0.5	0.0	0.0
40.0	40.0	0.5	0.0	0.0
39.0	39.0	0.5	0.0	0.0
38.0	38.0	0.5	0.0	0.0
37.0	37.0	0.5	0.0	0.0
36.0	36.0	0.5	0.0	0.0

	Test Function		Tolerance Min	Tolerance Max	Value	Measured values	Out
,0.	Reading with 94.0dB SPL	dB	93.7	94.3	94	93.9	
,1.	Linearity accuracy				FSD (dB)		
			39.6	40.4	40	40.0	
			49.6	50.4	50	50.0	
			59.6	60.4	60	60.0	
			69.6	70.4	70	70.0	
			79.6	80.4	80	80.0	
			89.6	90.4	90	90.0	
			99.6	100.4	100	100.0	
			109.6	110.4	110	110.0	
			119.6	120.4	120	120.0	
			129.6	130.4	130	130.0	
,2	Frequency Response with mic.				(Hz)		
	A Weighting		53.3	55.9	31.5	54.6	
	Ref. 94.0 dB @ 1kHz		67.0	68.6	63	67.7	
			77.1	78.7	125	77.9	
			84.6	86.2	250	85.3	
			90.0	91.6	500	90.8	
			93.2	94.8	1000	94.0	
			94.4	96.0	2000	95.3	
			94.2	95.8	4000	95.2	
			90.1	94.2	8000	92.6	
			83.9	92.5	12500	89.0	
			0.0	90.2	16000	86.1	
					(Hz)		
	C Weighting		89.7	92.3	31.5	90.9	
			92.4	94.0	63	93.1	
			93.0	94.6	125	93.8	
			93.2	94.8	250	94.0	
			93.2	94.8	500	94.0	
			93.2	94.8	1000	94.0	
			93.0	94.6	2000	93.9	
			92.4	94.0	4000	93.4	
			88.2	92.3	8000	90.7	
			82.0	90.6	12500	87.1	
			0.0	88.3	16000	84.2	
					(Hz)		
	Flat or Lin.		92.7	95.3	31.5	93.9	
			93.2	94.8	63	93.9	
			93.2	94.8	125	94.0	
			93.2	94.8	250	94.0	
			93.2	94.8	500	94.0	
			93.2	94.8	1000	94.0	
			93.2	94.8	2000	94.1	
			93.2	94.8	4000	94.2	
			91.2	95.3	8000	93.7	
			88.2	96.8	12500	93.4	
			0.0	96.8	16000	92.6	

	Test Function	Tolerance Min	Tolerance Max	Value	Measured values	Out
,3	Frequency Response with Electrical Signal			(Hz)		
	A Weighting	67.1	71.9	20.0	69.4	
	Ref. 94.0 dB @ 1kHz	73.4	77.2	25.1	75.3	
		79.2	82.0	31.6	80.5	
		84.0	86.8	39.8	85.4	
		88.9	90.7	50.1	89.8	
		92.9	94.7	63.1	93.8	
		96.6	98.4	79.4	97.5	
		100.0	101.8	100.0	100.9	
		103.0	104.8	125.9	103.9	
		105.7	107.5	158.5	106.7	
		108.2	110.0	199.5	109.1	
		110.5	112.3	251.2	111.4	
		112.5	114.3	316.2	113.4	
		114.3	116.1	398.1	115.2	
		115.9	117.7	501.2	116.8	
		117.2	119.0	631.0	118.1	
		118.3	120.1	794.3	119.2	
		119.1	120.9	1000.0	120.0	
		119.7	121.5	1258.9	120.6	
		120.1	121.9	1584.9	121.0	
		120.3	122.1	1995.3	121.2	
		120.3	122.2	2511.9	121.3	
		120.3	122.1	3162.3	121.2	
		120.1	121.9	3981.1	121.0	
		119.6	121.9	5011.9	120.6	
		118.0	121.3	6309.6	119.9	
		116.0	120.3	7943.3	118.9	
		113.6	119.4	10000.0	117.4	
		109.8	118.6	12589.3	115.2	
		112.1	116.3	15848.9	112.5	
		0.0	113.6	19952.6	111.1	
				(Hz)		
	C Weighting	111.4	116.2	20.0	113.8	
		113.7	117.5	25.1	115.6	
		115.6	118.4	31.6	117.0	
		116.6	119.4	39.8	118.0	
		117.8	119.6	50.1	118.7	
		118.3	120.1	63.1	119.1	
		118.6	120.4	79.4	119.5	
		118.8	120.6	100.0	119.7	
		118.9	120.7	125.9	119.8	
		119.0	120.8	158.5	119.9	
		119.1	120.9	199.5	120.0	
		119.1	120.9	251.2	120.0	
		119.1	120.9	316.2	120.0	
		119.1	120.9	398.1	120.0	
		119.1	120.9	501.2	120.0	
		119.1	120.9	631.0	120.0	
		119.1	120.9	794.3	120.0	
		119.1	120.9	1000.0	120.0	
		119.1	120.9	1258.9	120.0	
		119.0	120.8	1584.9	119.9	
		118.9	120.7	1995.3	119.8	
		118.8	120.6	2511.9	119.7	
		118.6	120.4	3162.3	119.5	
		118.3	120.1	3981.1	119.2	

	Test Function	Tolerance Min	Tolerance Max	Value	Measured values	Out
		117.8	120.1	5011.9	118.7	
		116.1	119.4	6309.6	118.0	
		114.1	118.4	7943.3	117.0	
		111.7	117.5	10000.0	115.5	
		107.9	116.7	12589.3	113.3	
		110.1	114.4	15848.9	110.6	
		105.1	111.7	19952.6	109.2	
				(Hz)		
	Flat or Lin.	118.6	121.4	20.0	120.1	
		118.6	121.4	25.1	120.0	
		118.6	121.4	31.6	120.1	
		118.6	121.4	39.8	119.9	
		118.6	121.4	50.1	120.0	
		119.1	120.9	63.1	120.0	
		119.1	120.9	79.4	120.0	
		119.1	120.9	100.0	120.0	
		119.1	120.9	125.9	120.0	
		119.1	120.9	158.5	120.0	
		119.1	120.9	199.5	120.0	
		119.1	120.9	251.2	120.0	
		119.1	120.9	316.2	120.0	
		119.1	120.9	398.1	120.0	
		119.1	120.9	501.2	120.0	
		119.1	120.9	631.0	120.0	
		119.1	120.9	794.3	120.0	
		119.1	120.9	1000.0	120.0	
		119.1	120.9	1258.9	120.0	
		119.1	120.9	1584.9	120.0	
		119.1	120.9	1995.3	120.0	
		119.1	120.9	2511.9	120.0	
		119.1	120.9	3162.3	120.0	
		119.1	120.9	3981.1	120.0	
		117.1	121.4	5011.9	120.0	
		117.1	121.4	6309.6	120.0	
		117.1	121.4	7943.3	120.0	
		114.1	122.9	10000.0	119.9	
		114.1	122.9	12589.3	119.5	
		110.1	122.9	15848.9	119.1	
		110.1	122.9	19952.6	120.2	
,4	Inherent noise level				Pass	
		dB	dB			
,5	Random signal	89.6	90.4	Fast	90.4	
	90 dB Test Level	89.6	90.4	Slow	90.1	
,6	Time Constant	dB	dB			
	90 dB 2kHz Test Level	88.1	89.4	Fast	89.1	
		84.1	87.9	Slow	86.1	
,7	Fast	93.6	94.4	94.0	93.9	
	Slow	93.6	94.4	94.0	93.9	
	Impulse	93.6	94.4	94.0	93.9	
	Leq	93.6	94.4	94.0	93.9	
	Peak	96.1	97.9	97.0	97.2	
	Max	93.6	94.4	94.0	93.9	
	Min	93.6	94.4	94.0	93.9	
	SEL	103.5	104.3	103.9	103.9	

Test Function ,8 1/3 Octave filter check					
		Before			Out
Filter Hz		87.5 to 92.5	93.5 to 94.5	87.5 to 92.5	
20		92.0	94.0	88.3	
25		92.0	94.0	88.5	
31.5		91.8	94.0	88.7	
40		91.6	93.9	88.7	
50		91.6	94.0	88.9	
63		91.5	94.0	89.0	
80		91.4	94.0	89.1	
100		91.3	94.0	89.0	
125		91.4	94.0	89.2	
160		91.3	94.0	89.4	
200		91.1	94.0	89.5	
250		91.0	94.0	89.7	
315		90.9	94.0	89.9	
400		90.7	94.0	89.9	
500		90.7	94.0	90.1	
630		90.5	94.0	90.2	
800		90.4	94.0	90.3	
1K		90.3	94.0	90.2	
1.25K		90.4	94.0	90.4	
1.6K		90.2	94.0	90.6	
2K		90.0	94.0	90.7	
2.5k		89.9	94.0	90.8	
3.15k		89.8	94.0	91.0	
4k		89.6	94.0	91.1	
5k		89.6	94.0	91.2	
6.3k		89.4	94.1	91.3	
8k		89.3	94.0	91.3	
10k		89.1	93.9	91.1	
12.5k		89.0	93.6	90.8	
16k		89.0	94.0	91.0	
20k		88.5	94.0	92.1	

1/1 Octave Filter Check					Out
Filter Hz		88.8 to 91.8	93.5 to 94.5	88.8 to 91.8	
31.5		90.9	94.0	89.9	
63		90.8	94.0	89.9	
125		90.7	94.0	90.1	
250		90.6	94.0	90.2	
500		90.5	94.0	90.3	
1K		90.4	94.0	90.4	
2K		90.3	94.0	90.5	
4k		90.2	94.0	90.7	
8k		90.1	94.0	90.5	
16k		90.0	94.0	92.1	

The expanded uncertainty of calibration at 95% confidence level with a coverage factor of k=2.

Parameter	Test Instrumentation Uncertainty	DUT Uncertainty	Total DUT Uncertainty
Reading with mic. @ 1kHz:	0.09	0.1	0.16
Meter linearity:	0.008	0.1	0.12
Attenuator accuracy:	0.008	0.1	0.12
Freq. Response: 63Hz to 12.5kHz	0.15	0.1	0.21
Freq. Response: 31.5Hz & 16kHz	0.17	0.1	0.23
Electrical Freq. Resp.: 20Hz to 20kHz	0.008	0.1	0.12
Inherent noise level:	0.3	0.1	0.37
Crest Factor:	0.3	0.1	0.37
Time Constant:	0.3	0.1	0.37
Functions:	0.09	0.1	0.16
Sensitivity:	0.09	0.1	0.16
1/3 & 1/1 Filters:	0.008	0.1	0.12

Cal. Date: 9-Sep-2013 Measurements By: Felix Christopher

Calibrated on WCCL system type 9700

West Caldwell Calibration Laboratories Inc.

Certificate of Calibration

for

MICROPHONE

Manufactured by:	BRUEL & KJAER
Model No:	4189
Serial No:	2237528
Calibration Recall No:	24395

Submitted By:

Customer:

Company: Aercoustics Engineering Ltd.
Address:

The subject instrument was calibrated to the indicated specification using standards traceable to the National Institute of Standards and Technology or to accepted values of natural physical constants. This document certifies that the instrument met the following specification upon its return to the submitter.

West Caldwell Calibration Laboratories Procedure No. 4189 BRUE

Upon receipt for Calibration, the instrument was found to be:

Within (X) see attached Report of Calibration.

the tolerance of the indicated specification.

West Caldwell Calibration Laboratories' calibration control system meets the following requirements, ISO 10012-1 MIL STD 45662A, ANSI/NCSL Z540-1, IEC Guide 25, ISO 9001:2008 and ISO 17025

Note: With this Certificate, Report of Calibration is included.

Calibration Date: 23-Jul-14

Certificate No: 24395 - 3

QA Doc. #1051 Rev. 2.0 10/1/01

Certificate Page 1 of 1

Approved by:

FC

Felix Christopher (QA Mgr.)

ISO/IEC 17025:2005

ACCREDITED

Calibration Lab. Cert. # 1533.01

uncompromised calibration
West Caldwell Calibration Laboratories, Inc.
1575 State Route 96, Victor, NY 14564, U.S.A.

West Caldwell Calibration Laboratories, Inc.
uncompromised calibration
1575 State Route 96, Victor NY 14564

ISO/IEC 17025: 2005
ACCREDITED
Calibration Lab. Cert. # 1533.01

REPORT OF CALIBRATION

for

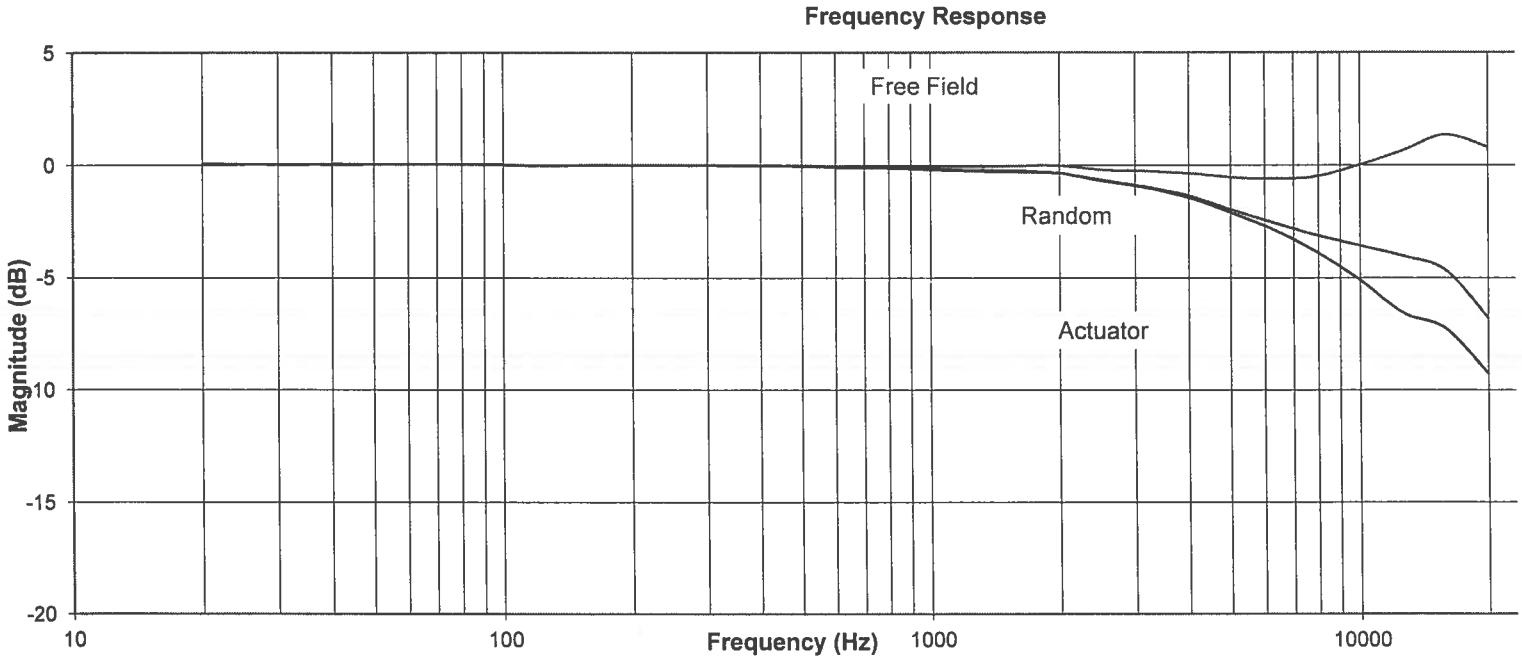
Brüel & Kjær Microphone **Model No.: 4189** **Serial No.: 2237528**
Company : Aercoustics Engineering Ltd. **I. D. No.: XXXX**

Calibration results: Before data: ..... After data: ..✓..
Open Circuit Sensitivity @ 250 Hz and pressure of 98.852 kPa Before & after data same: ..✓..

0 Volts Polarization voltage (External):		Ambient Temperature:	22.7	°C
-25.44 dB re.1V/Pascal		Ambient Humidity:	38.6	% RH
53.46 mV/Pascal		Ambient Pressure:	98.852	kPa
-0.56 Ko (- dB re 50 mV/Pascal)		Calibration Date:	23-Jul-2014	
Sensitivity:	Pass	Re-calibration Due:	23-Jul-2015	
Freq. Response	Pass	Report Number:	24395	-3
All tests:	Pass	Control Number:	24395	

The above listed instrument meets or exceeds the tested manufacturer's specifications
The IEC 651:1979 & 1993 Type 1 specification passed.
This Calibration is traceable through NIST test numbers: 683/281764-12
The expanded uncertainty of calibration: 0.18dB at 95% confidence level with a coverage factor of k=2.

The lower curve is the pressure response recorded with electrostatic actuator.



The above listed instrument was checked using calibration procedure documented in West Caldwell Calibration Laboratories Inc. procedure : **Rev. 7.0 Jan. 24, 2014 Doc. # 1038 4189B&K**
Calibration was performed by West Caldwell Calibration Laboratories Inc. under Operating Procedures intended to implement the requirements of ISO10012-1, IEC Guide 25, ANSI/NCSL Z540-1, (MIL-STD-45662A) and ISO 9001:2008, ISO 17025

Measurements performed by: .....
Felix Christopher

Calibrated on WCCL system type 9700

West Caldwell Calibration Laboratories Inc.
1575 State Route 96, Victor NY 14564
Tel. (585) 586-3900 FAX (585) 586-4327

Calibration Data Record

for

Brüel & Kjær Microphone **Model No.: 4189** **Serial No.: 2237528**

Company : Aercoustics Engineering Ltd. **I. D. No.: XXXX**

Frequency Response (Reference = 0 dB @ 250Hz)

Frequency [Hz]	Actuator [dB]	Random (dB)	Free Field (dB)	Frequency [Hz]	Actuator [dB]	Random (dB)	Free Field (dB)
20.00	0.07	0.07	0.07	631.00	-0.10	-0.10	-0.06
25.10	0.05	0.05	0.05	794.30	-0.13	-0.13	-0.06
31.60	0.03	0.03	0.03	1000.00	-0.18	-0.20	-0.08
39.80	0.06	0.06	0.06	1258.90	-0.23	-0.26	-0.08
50.10	0.04	0.04	0.04	1584.90	-0.25	-0.31	-0.03
63.10	0.05	0.05	0.05	1995.30	-0.35	-0.35	-0.03
79.40	0.04	0.04	0.04	2511.90	-0.68	-0.65	-0.21
100.00	0.03	0.03	0.03	3162.30	-0.98	-0.95	-0.27
125.90	-0.02	-0.02	-0.02	3981.10	-1.42	-1.33	-0.36
158.50	0.01	0.01	0.01	5011.90	-2.11	-1.97	-0.54
199.50	0.00	0.00	0.00	6309.60	-2.88	-2.56	-0.60
251.20	0.00	0.00	0.00	7943.30	-3.87	-3.12	-0.48
316.20	0.00	0.00	0.00	10000.00	-5.10	-3.56	0.02
398.10	-0.03	-0.03	-0.02	12589.30	-6.54	-4.03	0.65
501.20	-0.04	-0.04	-0.02	15848.90	-7.23	-4.65	1.36
				19952.60	-9.25	-6.77	0.80

Freq. response: Expanded Uncertainty (dB) with coverage factor K = 2
20 to 25 Hz 0.8dB, 25 to 160 Hz 0.5dB, 160 to 2kHz 0.3dB, 2k to 10kHz 0.5dB, 10k to 20kHz 1.3dB.

Instruments used for calibration:			Date of Cal.	Traceability No.	Re-cal. Due Date
Brüel & Kjær	4134	S/N 1942286	2-Oct-2013	683/281764-12	3-Oct-2014
HP	33120A	S/N 36043716	8-Oct-2013	,287708	8-Oct-2014
Brüel & Kjær	2636	S/N 1324082	3-Oct-2013	683/281764-12	3-Oct-2014
HP	34401A	S/N 36064102	8-Oct-2013	,287708	8-Oct-2014
Brüel & Kjær	2669	S/N 1835082	3-Oct-2013	683/281764-12	3-Oct-2014
HP	34401A	S/N 36102471	8-Oct-2013	,287708	8-Oct-2014

Cal. Date: 23-Jul-2014 **Tested by: Felix Christopher**

Calibrated on WCCL system type 9700

West Caldwell Calibration Laboratories Inc.

Certificate of Calibration

for

HAND-HELD ANALYZER

Manufactured by:	BRUEL & KJAER
Model No:	2250
Serial No:	2630243
Calibration Recall No:	25699

Submitted By:

Customer:

Company: AERCOUSTICS ENGINEERING LTD

Address:

The subject instrument was calibrated to the indicated specification using standards traceable to the National Institute of Standards and Technology or to accepted values of natural physical constants. This document certifies that the instrument met the following specification upon its return to the submitter.

West Caldwell Calibration Laboratories Procedure No. 2250 BRUE

Upon receipt for Calibration, the instrument was found to be:

Within (X)

tolerance of the indicated specification. See attached Report of Calibration.

West Caldwell Calibration Laboratories' calibration control system meets the following requirements, ISO 10012-1 MIL STD 45662A, ANSI/NCSL Z540-1, IEC Guide 25, ISO 9001:2008 and ISO 17025

Note: With this Certificate, Report of Calibration is included.

Calibration Date: 25-Sep-15

Certificate No: 25699 - 3

Approved by:

FC

Felix Christopher (QA Mgr.)
ISO/IEC 17025:2005

ACCREDITED

Calibration Lab. Cert. # 1533.01

West Caldwell Calibration Laboratories, Inc.
uncompromised calibration
1575 State Route 96, Victor, NY 14564, U.S.A.

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REPORT OF CALIBRATION

for

Brüel & Kjær Hand-held Analyzer **Model No.: 2250** **Serial No.: 2630243**

Company : Aercoustics Engineering Ltd. **ID No: XXXX**

Calibration results:	All Tests:	Pass	Before data:	After data: ...✓...	
	Sensitivity & Reference	Pass	Before & after data same: ...✓...		
	Frequency Response:	Pass	Laboratory Environment:		
	1dB steps	Pass	Ambient Temperature:	22.1	°C
	Linearity:	Pass	Ambient Humidity:	47.8	% RH
	Noise:	Pass	Ambient Pressure:	100.525	kPa
	Random signal:	Pass	Calibration Date:	25-Sep-2015	
	Time Constant:	Pass	Calibration Due:	25-Sep-2016	
	Function:	Pass	Report Number:	25699 -3	
	Octave & 1/3 Octave Filters:	Pass	Control Number:	25699	

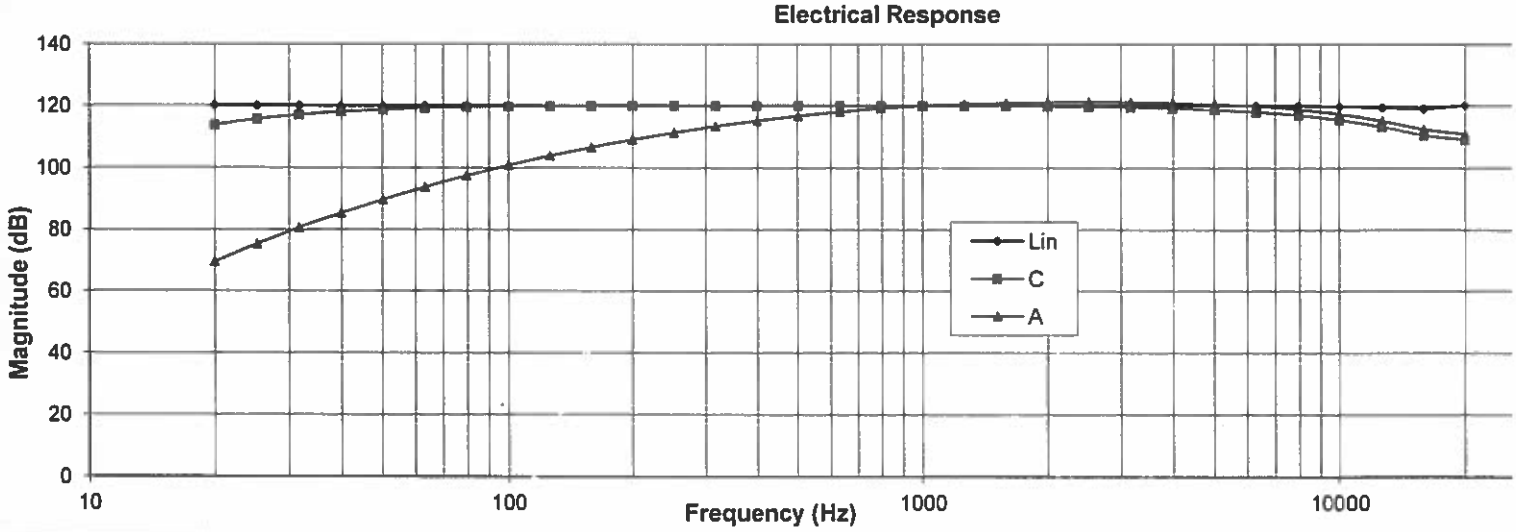
Note: Start Button damaged, usable.

The above listed instrument meets or exceeds the tested manufacturer's specifications.
IEC 61672-1:2002 Class 1, IEC 61260:1995 w.Am.1, 1/1 and 1/3 Oct. Band Class 0 specification passed.
IEC 60804:2000 Type 1, IEC 60651:1979 w.Am.1&2 Type 1 specification passed.

This Calibration is traceable through NIST test numbers: 683/284413-14

The absolute uncertainty of calibration: See last page. Unless otherwise noted, the reported values are both "as found" and "as left" data.

The curve is the response recorded with electrical input with 50pF (1V=120dB).



The above listed instrument was checked using calibration procedure documented in West Caldwell Calibration Laboratories Inc. procedure : **Rev. 7.0 Jan. 24, 2014 Doc. # 1038 2250B&K**

Calibration was performed by West Caldwell Calibration Laboratories Inc. under Operating Procedures intended to implement the requirements of ISO10012-1, IEC Guide 25, ANSI/NCSL Z540-1, (MIL-STD-45662A) and ISO 9001:2008, ISO 17025

Measurements performed by: .....
Felix Christopher

Calibrated on WCCL system type 9700

West Caldwell Calibration Laboratories Inc.
1575 State Route 96, Victor NY 14564
Tel. (585) 586-3900 FAX (585) 586-4327

Calibration Data Record

for

Brüel & Kjær Hand-held Analyzer **Model No.: 2250** **Serial No.: 2630243**

Company : Aerocoustics Engineering Ltd.

Frequency Response (Reference = 94 dB @ 1000Hz)

Frequency (Hz)	Weighting Z	C	A
19.95	120.1	113.7	69.5
25.12	120.0	115.7	75.4
31.62	120.0	117.0	80.6
39.81	119.9	118.1	85.4
50.12	119.9	118.7	89.7
63.1	120.0	119.2	93.8
79.43	120.0	119.5	97.5
100	120.0	119.7	100.9
125.89	120.0	119.8	103.9
158.49	120.0	119.9	106.7
199.53	120.0	120.0	109.1
251.19	120.0	120.0	111.4
316.23	120.0	120.0	113.4
398.11	120.0	120.0	115.2
501.19	120.0	120.0	116.8
630.96	120.0	120.0	118.1
794.33	120.0	120.0	119.2
1000	120.0	120.0	120.0

Frequency (Hz)	Weighting Z	C	A
1258.93	120.0	120.0	120.6
1584.89	120.0	119.9	121.0
1995.26	120.0	119.8	121.2
2511.89	120.0	119.7	121.3
3162.28	120.0	119.5	121.2
3981.07	120.0	119.2	121.0
5011.87	120.0	118.7	120.6
6309.57	120.0	118.0	119.9
7943.28	120.0	117.0	118.9
10000	119.9	115.5	117.4
12589.25	119.5	113.3	115.2
15848.93	119.1	110.6	112.5
19952.62	120.2	109.2	111.1

Instruments used for calibration:				Date of Cal.	Traceability No.	Cal. Due Date
Brüel & Kjær	4134	S/N	1942286	3-Oct-2014	683/284413-14	4-Oct-2015
HP	34401A	S/N	36064102	6-Oct-2014	,287708	6-Oct-2015
HP	33120A	S/N	36043716	6-Oct-2014	,287708	6-Oct-2015
Brüel & Kjær	2669	S/N	2053834	3-Oct-2014	683/284413-14	3-Oct-2015
Brüel & Kjær	4228	S/N	1742061	3-Oct-2014	683/284413-14	4-Oct-2015
Brüel & Kjær	4144	S/N	1410002	3-Oct-2014	683/284413-14	4-Oct-2015

Cal. Date: 25-Sep-2015 **Tested by: Felix Christopher**

Calibrated on WCCL system type 9700

West Caldwell Calibration Laboratories Inc.
1575 State Route 96, Victor NY 14564
Tel. (585) 586-3900 FAX (585) 586-4327

Calibration Data Record

for

Brüel & Kjær Hand-held Analyzer **Model No.: 2250** **Serial No.: 2630243**

Company : Aerocoustics Engineering Ltd. **ID No: XXXX**

Level Accuracy (Reference = 120 dB @ 1000Hz)

Nom. Value [dB]	Meas. Value [dB]	Tolerance Limits [dB]	Dev. In the last 1 dB [dB]	Deviation Rel. to 94.0 dB [dB]
135.0	135.0	0.5	0.0	0.0
134.0	134.0	0.5	0.0	0.0
133.0	133.0	0.5	0.0	0.0
132.0	132.0	0.5	0.0	0.0
131.0	131.0	0.5	0.0	0.0
130.0	130.0	0.5	0.0	0.0
129.0	129.0	0.5	0.0	0.0
128.0	128.0	0.5	0.0	0.0
127.0	127.0	0.5	0.0	0.0
126.0	126.0	0.5	0.0	0.0
125.0	125.0	0.5	0.0	0.0
124.0	124.0	0.5	0.0	0.0
123.0	123.0	0.5	0.0	0.0
122.0	122.0	0.5	0.0	0.0
121.0	121.0	0.5	0.0	0.0
120.0	120.0	0.5	0.0	0.0
119.0	119.0	0.5	0.0	0.0
118.0	118.0	0.5	0.0	0.0
117.0	117.0	0.5	0.0	0.0
116.0	116.0	0.5	0.0	0.0
115.0	115.0	0.5	0.0	0.0
114.0	114.0	0.5	0.0	0.0
113.0	113.0	0.5	0.0	0.0
112.0	112.0	0.5	0.0	0.0
111.0	111.0	0.5	0.0	0.0
110.0	110.0	0.5	0.0	0.0
109.0	109.0	0.5	0.0	0.0
108.0	108.0	0.5	0.0	0.0
107.0	107.0	0.5	0.0	0.0
106.0	106.0	0.5	0.0	0.0
105.0	105.0	0.5	0.0	0.0
104.0	104.0	0.5	0.0	0.0
103.0	103.0	0.5	0.0	0.0
102.0	102.0	0.5	0.0	0.0
101.0	101.0	0.5	0.0	0.0
100.0	100.0	0.5	0.0	0.0
99.0	99.0	0.5	0.0	0.0
98.0	98.0	0.5	0.0	0.0
97.0	97.0	0.5	0.0	0.0
96.0	96.0	0.5	0.0	0.0
95.0	95.0	0.5	0.0	0.0
94.0	94.0	0.5	0.0	0.0
93.0	93.0	0.5	0.0	0.0
92.0	92.0	0.5	0.0	0.0
91.0	91.0	0.5	0.0	0.0
90.0	90.0	0.5	0.0	0.0
89.0	89.0	0.5	0.0	0.0
88.0	88.0	0.5	0.0	0.0
87.0	87.0	0.5	0.0	0.0
86.0	86.0	0.5	0.0	0.0

Nom. Value [dB]	Meas. Value [dB]	Tolerance Limits [dB]	Dev. In the last 1 dB [dB]	Deviation Rel. to 94.0 dB [dB]
85.0	85.0	0.5	0.0	0.0
84.0	84.0	0.5	0.0	0.0
83.0	83.0	0.5	0.0	0.0
82.0	82.0	0.5	0.0	0.0
81.0	81.0	0.5	0.0	0.0
80.0	80.0	0.5	0.0	0.0
79.0	79.0	0.5	0.0	0.0
78.0	78.0	0.5	0.0	0.0
77.0	77.0	0.5	0.0	0.0
76.0	76.0	0.5	0.0	0.0
75.0	75.0	0.5	0.0	0.0
74.0	74.0	0.5	0.0	0.0
73.0	73.0	0.5	0.0	0.0
72.0	72.0	0.5	0.0	0.0
71.0	71.0	0.5	0.0	0.0
70.0	70.0	0.5	0.0	0.0
69.0	69.0	0.5	0.0	0.0
68.0	68.0	0.5	0.0	0.0
67.0	67.0	0.5	0.0	0.0
66.0	66.0	0.5	0.0	0.0
65.0	65.0	0.5	0.0	0.0
64.0	64.0	0.5	0.0	0.0
63.0	63.0	0.5	0.0	0.0
62.0	62.0	0.5	0.0	0.0
61.0	61.0	0.5	0.0	0.0
60.0	60.0	0.5	0.0	0.0
59.0	59.0	0.5	0.0	0.0
58.0	58.0	0.5	0.0	0.0
57.0	57.0	0.5	0.0	0.0
56.0	56.0	0.5	0.0	0.0
55.0	55.0	0.5	0.0	0.0
54.0	54.0	0.5	0.0	0.0
53.0	53.0	0.5	0.0	0.0
52.0	52.0	0.5	0.0	0.0
51.0	51.0	0.5	0.0	0.0
50.0	50.0	0.5	0.0	0.0
49.0	49.0	0.5	0.0	0.0
48.0	48.0	0.5	0.0	0.0
47.0	47.0	0.5	0.0	0.0
46.0	46.0	0.5	0.0	0.0
45.0	45.0	0.5	0.0	0.0
44.0	44.0	0.5	0.0	0.0
43.0	43.0	0.5	0.0	0.0
42.0	42.0	0.5	0.0	0.0
41.0	41.0	0.5	0.0	0.0
40.0	40.0	0.5	0.0	0.0
39.0	39.0	0.5	0.0	0.0
38.0	38.0	0.5	0.0	0.0
37.0	37.0	0.5	0.0	0.0
36.0	36.0	0.5	0.0	0.0

	Test Function		Tolerance Min	Tolerance Max	Value	Measured values	Out
,0.	Reading with 94.0dB SPL	dB	93.6	94.4	94	93.9	
,1.	Linearity accuracy				FSD (dB)		
			39.5	40.5	40	40.0	
			44.5	45.5	45	45.0	
			49.5	50.5	50	50.0	
			54.5	55.5	55	55.0	
			59.5	60.5	60	60.0	
			64.5	65.5	65	65.0	
			69.5	70.5	70	70.0	
			74.5	75.5	75	75.0	
			79.5	80.5	80	80.0	
			84.5	85.5	85	85.0	
			89.5	90.5	90	90.0	
			94.5	95.5	95	95.0	
			99.5	100.5	100	100.0	
			104.5	105.5	105	105.0	
			109.5	110.5	110	110.0	
			114.5	115.5	115	115.0	
			119.5	120.5	120	120.0	
			124.5	125.5	125	125.0	
			129.5	130.5	130	130.0	
,2	Frequency Response with mic.				(Hz)		
	A Weighting		53.2	56.0	31.5	54.5	
	Ref. 94.0 dB @ 1kHz		66.9	68.7	63	67.8	
			77.0	78.8	125	78.0	
			84.5	86.3	250	85.5	
			89.9	91.7	500	90.9	
			93.1	94.9	1000	94.1	
			94.3	96.1	2000	95.2	
			94.1	95.9	4000	94.9	
			90.0	94.3	8000	92.1	
			83.8	92.6	12500	88.7	
			0.0	90.3	16000	87.0	
					(Hz)		
	C Weighting		89.6	92.4	31.5	90.9	
			92.3	94.1	63	93.2	
			92.9	94.7	125	93.9	
			93.1	94.9	250	94.1	
			93.1	94.9	500	94.1	
			93.1	94.9	1000	94.1	
			92.9	94.7	2000	93.9	
			92.3	94.1	4000	93.1	
			88.1	92.4	8000	90.2	
			81.9	90.7	12500	86.8	
			0.0	88.4	16000	85.1	
					(Hz)		
	Flat or Lin.		92.6	95.4	31.5	94.0	
			93.1	94.9	63	94.0	
			93.1	94.9	125	94.1	
			93.1	94.9	250	94.1	
			93.1	94.9	500	94.1	
			93.1	94.9	1000	94.1	
			93.1	94.9	2000	94.0	
			93.1	94.9	4000	93.9	
			91.1	95.4	8000	93.2	
			88.1	96.9	12500	93.1	
			0.0	96.9	16000	93.6	

	Test Function	Tolerance Min	Tolerance Max	Value	Measured values	
						Out
,3	Frequency Response with Electrical Signal			(Hz)		
	A Weighting	67.1	71.9	20.0	69.5	
	Ref. 94.0 dB @ 1kHz	73.4	77.2	25.1	75.4	
		79.2	82.0	31.6	80.6	
		84.0	86.8	39.8	85.4	
		88.9	90.7	50.1	89.7	
		92.9	94.7	63.1	93.8	
		96.6	98.4	79.4	97.5	
		100.0	101.8	100.0	100.9	
		103.0	104.8	125.9	103.9	
		105.7	107.5	158.5	106.7	
		108.2	110.0	199.5	109.1	
		110.5	112.3	251.2	111.4	
		112.5	114.3	316.2	113.4	
		114.3	116.1	398.1	115.2	
		115.9	117.7	501.2	116.8	
		117.2	119.0	631.0	118.1	
		118.3	120.1	794.3	119.2	
		119.1	120.9	1000.0	120.0	
		119.7	121.5	1258.9	120.6	
		120.1	121.9	1584.9	121.0	
		120.3	122.1	1995.3	121.2	
		120.3	122.2	2511.9	121.3	
		120.3	122.1	3162.3	121.2	
		120.1	121.9	3981.1	121.0	
		119.6	121.9	5011.9	120.6	
		118.0	121.3	6309.6	119.9	
		116.0	120.3	7943.3	118.9	
		113.6	119.4	10000.0	117.4	
		109.8	118.6	12589.3	115.2	
		112.1	116.3	15848.9	112.5	
		0.0	113.6	19952.6	111.1	
				(Hz)		
	C Weighting	111.4	116.2	20.0	113.7	
		113.7	117.5	25.1	115.7	
		115.6	118.4	31.6	117.0	
		116.6	119.4	39.8	118.1	
		117.8	119.6	50.1	118.7	
		118.3	120.1	63.1	119.2	
		118.6	120.4	79.4	119.5	
		118.8	120.6	100.0	119.7	
		118.9	120.7	125.9	119.8	
		119.0	120.8	158.5	119.9	
		119.1	120.9	199.5	120.0	
		119.1	120.9	251.2	120.0	
		119.1	120.9	316.2	120.0	
		119.1	120.9	398.1	120.0	
		119.1	120.9	501.2	120.0	
		119.1	120.9	631.0	120.0	
		119.1	120.9	794.3	120.0	
		119.1	120.9	1000.0	120.0	
		119.1	120.9	1258.9	120.0	
		119.0	120.8	1584.9	119.9	
		118.9	120.7	1995.3	119.8	
		118.8	120.6	2511.9	119.7	
		118.6	120.4	3162.3	119.5	
		118.3	120.1	3981.1	119.2	

	Test Function	Tolerance Min	Tolerance Max	Value	Measured values	Out
		117.8	120.1	5011.9	118.7	
		116.1	119.4	6309.6	118.0	
		114.1	118.4	7943.3	117.0	
		111.7	117.5	10000.0	115.5	
		107.9	116.7	12589.3	113.3	
		110.1	114.4	15848.9	110.6	
		105.1	111.7	19952.6	109.2	
				(Hz)		
	Flat or Lin.	118.6	121.4	20.0	120.1	
		118.6	121.4	25.1	120.0	
		118.6	121.4	31.6	120.0	
		118.6	121.4	39.8	119.9	
		118.6	121.4	50.1	119.9	
		119.1	120.9	63.1	120.0	
		119.1	120.9	79.4	120.0	
		119.1	120.9	100.0	120.0	
		119.1	120.9	125.9	120.0	
		119.1	120.9	158.5	120.0	
		119.1	120.9	199.5	120.0	
		119.1	120.9	251.2	120.0	
		119.1	120.9	316.2	120.0	
		119.1	120.9	398.1	120.0	
		119.1	120.9	501.2	120.0	
		119.1	120.9	631.0	120.0	
		119.1	120.9	794.3	120.0	
		119.1	120.9	1000.0	120.0	
		119.1	120.9	1258.9	120.0	
		119.1	120.9	1584.9	120.0	
		119.1	120.9	1995.3	120.0	
		119.1	120.9	2511.9	120.0	
		119.1	120.9	3162.3	120.0	
		119.1	120.9	3981.1	120.0	
		117.1	121.4	5011.9	120.0	
		117.1	121.4	6309.6	120.0	
		117.1	121.4	7943.3	120.0	
		114.1	122.9	10000.0	119.9	
		114.1	122.9	12589.3	119.5	
		110.1	122.9	15848.9	119.1	
		110.1	122.9	19952.6	120.2	
,4	Inherent noise level					
		less than	20	A Slow	12.9	
		less than	27	C Slow	11.4	
		less than	30	F Slow	23.9	
		dB	dB			
,5	Random signal	89.6	90.4	Fast	90.3	
	90 dB Test Level	89.6	90.4	Slow	90.0	
,6	Time Constant	dB	dB			
	90 dB 2kHz Test Level	88.1	89.4	Fast	89.1	
		84.1	87.9	Slow	86.1	
,7	Fast	93.6	94.4	94.0	93.9	
	Slow	93.6	94.4	94.0	93.9	
	Impulse	93.6	94.4	94.0	93.9	
	Leq	93.6	94.4	94.0	93.9	
	Peak	96.1	97.9	97.0	97.1	
	Max	93.6	94.4	94.0	93.9	
	Min	93.6	94.4	94.0	93.9	
	SEL	103.5	104.3	103.9	103.9	

Test Function ,8 1/3 Octave filter check					
		Before			Out
Filter Hz		87.5 to 92.5	93.5 to 94.5	87.5 to 92.5	
20		91.8	93.9	88.8	
25		91.9	93.9	88.6	
31.5		91.8	94.0	88.8	
40		91.6	94.0	88.5	
50		91.6	94.0	88.7	
63		91.5	94.0	88.7	
80		91.4	94.0	88.8	
100		91.3	94.0	89.0	
125		91.4	94.0	89.1	
160		91.3	94.0	89.0	
200		91.1	94.0	89.2	
250		91.0	94.0	89.5	
315		90.9	94.0	89.5	
400		90.7	94.0	89.7	
500		90.7	94.0	89.9	
630		90.5	94.0	89.9	
800		90.4	94.0	90.1	
1K		90.3	94.0	90.2	
1.25K		90.4	94.0	90.3	
1.6K		90.2	94.0	90.2	
2K		90.0	94.0	90.4	
2.5k		89.9	94.0	90.6	
3.15k		89.8	94.0	90.7	
4k		89.6	94.0	90.8	
5k		89.6	94.0	91.0	
6.3k		89.4	94.0	91.0	
8k		89.3	94.0	91.2	
10k		89.1	93.9	91.3	
12.5k		89.0	93.8	91.3	
16k		88.3	93.6	91.1	
20k		88.2	94.3	90.7	

1/1 Octave Filter Check					Out
Filter Hz		88.8 to 91.8	93.5 to 94.5	88.8 to 91.8	
31.5		90.9	94.0	89.7	
63		90.9	93.9	89.9	
125		90.8	94.0	90.0	
250		90.7	94.0	90.1	
500		90.6	94.0	90.2	
1K		90.5	94.0	90.3	
2K		90.4	94.0	90.4	
4k		90.3	94.0	90.5	
8k		90.2	94.0	90.7	
16k		90.1	94.0	90.5	

The expanded uncertainty of calibration at 95% confidence level with a coverage factor of k=2.

Parameter	Test Instrumentation Uncertainty	DUT Uncertainty	Total DUT Uncertainty
Reading with mic. @ 1kHz:	0.078	0.1	0.16
Meter linearity:	0.024	0.1	0.12
Attenuator accuracy:	0.024	0.1	0.12
Freq. Response: 63Hz to 12.5kHz	0.14	0.1	0.21
Freq. Response: 31.5Hz & 16kHz	0.15	0.1	0.23
Electrical Freq. Resp.: 20Hz to 20kHz	0.024	0.1	0.12
Inherent noise level:	0.3	0.1	0.37
Crest Factor:	0.3	0.1	0.37
Time Constant:	0.3	0.1	0.37
Functions:	0.024	0.1	0.16
Sensitivity:	0.078	0.1	0.16
1/3 & 1/1 Filters:	0.024	0.1	0.12

Cal. Date: 25-Sep-2015

Measurements By: Felix Christopher

Calibrated on WCCL system type 9700

West Caldwell Calibration Laboratories Inc.

Certificate of Calibration

for

MICROPHONE

Manufactured by:	**BRUEL & KJAER**
Model No:	**4189**
Serial No:	**2237528**
Calibration Recall No:	**25699**

Submitted By:

Customer:

Company: **AERCOUSTICS ENGINEERING LTD**
Address:

The subject instrument was calibrated to the indicated specification using standards traceable to the National Institute of Standards and Technology or to accepted values of natural physical constants. This document certifies that the instrument met the following specification upon its return to the submitter.

West Caldwell Calibration Laboratories Procedure No. 4189 BRUE

Upon receipt for Calibration, the instrument was found to be:

Within (X)

tolerance of the indicated specification. See attached Report of Calibration.

West Caldwell Calibration Laboratories' calibration control system meets the following requirements, ISO 10012-1 MIL STD 45662A, ANSI/NCSL Z540-1, IEC Guide 25, ISO 9001:2008 and ISO 17025

Note: With this Certificate, Report of Calibration is included.

Calibration Date: 30-Sep-15

Certificate No: 25699 - 4

Approved by:

FC

Felix Christopher (QA Mgr.)
ISO/IEC 17025:2005

ACCREDITED
Calibration Lab. Cert. # 1533.01

uncompromised calibration
West Caldwell Calibration Laboratories, Inc.
1575 State Route 96, Victor, NY 14564, U.S.A.

West Caldwell Calibration Laboratories, Inc.
uncompromised calibration
1575 State Route 96, Victor NY 14564

ISO/IEC 17025: 2005
ACCREDITED
Calibration Lab. Cert. # 1533.01

REPORT OF CALIBRATION

for

Brüel & Kjær Microphone **Model No.: 4189** **Serial No.: 2237528**

Company : Aercoustics Engineering Ltd **I. D. No.: XXXX**

Calibration results:

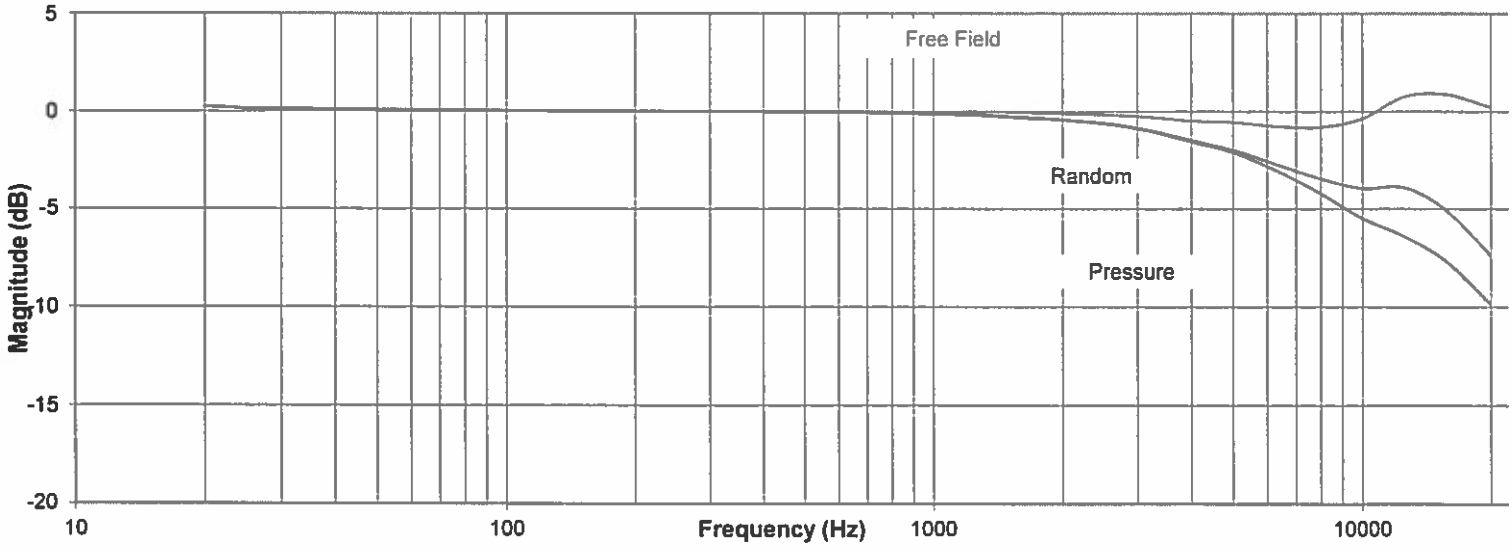
Combined Sensitivity @	**250**	**Hz**	**and pressure of**	**99.18**	**kPa**
(Sens. with mic. and preamp.)	**0**	Volts Polarization voltage (External):			
	-25.86	**dB re.1V/Pascal**			
	50.95	**mV/Pascal**			
	-0.14	**Ko (- dB re 50 mV/Pascal)**			
	Sensitivity:	**Pass**			
	Freq. Response:	**Pass**			
	All tests:	**Pass**			

Before & after data same: ...X.....

Ambient Temperature:	22.0	°C
Ambient Humidity:	50.2	% RH
Ambient Pressure:	99.180	kPa
Calibration Date:	30-Sep-2015	
Re-calibration Due:	30-Sep-2016	
Report Number:	25699	-4
Control Number:	25699	

The above listed instrument meets or exceeds the tested manufacturer's specifications.
The IEC 651:1979 & 1993 Type 1 specification passed.
This Calibration is traceable through NIST test numbers: 683/284413-14
The expanded uncertainty of calibration: 0.18dB at 95% confidence level with a coverage factor of k=2.
The pressure response recorded with electroacoustic method.

Frequency Response



The above listed instrument was checked using calibration procedure documented in West Caldwell Calibration Laboratories Inc. procedure : **Rev. 7.0 Jan. 24, 2014 Doc. # 1038 P4189B&K**
Calibration was performed by West Caldwell Calibration Laboratories Inc. under Operating Procedures intended to implement the requirements of ISO10012-1, IEC Guide 25, ANSI/NCSL Z540-1, (MIL-STD-45662A) and ISO 9001:2008, ISO 17025

Measurements performed by: .....
Felix Christopher

Calibrated on WCCL system type 9700

West Caldwell Calibration Laboratories Inc.
1575 State Route 96, Victor NY 14564
Tel. (585) 586-3900 FAX (585) 586-4327

Calibration Data Record

for

Brüel & Kjær Microphone **Model No.: 4189** **Serial No.: 2237528**
I. D. No.: XXXX

Company : Aercoustics Engineering Ltd

Frequency Response (Reference = 0 dB @ 250Hz)

Frequency [Hz]	Pressure [dB]	Free Field (dB)	Random (dB)
19.95	0.25	0.25	0.25
25.12	0.15	0.15	0.15
31.62	0.13	0.13	0.13
39.81	0.11	0.11	0.11
50.12	0.10	0.10	0.10
63.10	0.08	0.08	0.08
79.43	0.06	0.06	0.06
100.00	0.04	0.04	0.04
125.89	0.03	0.03	0.03
158.49	0.01	0.01	0.01
199.53	0.01	0.01	0.01
251.19	0.00	0.00	0.00
316.23	-0.01	0.00	-0.01
398.11	-0.02	-0.01	-0.02
501.19	-0.03	0.00	-0.03
630.96	-0.04	0.00	-0.04
794.33	-0.07	0.00	-0.07
1000.00	-0.11	-0.01	-0.13
1258.93	-0.15	0.00	-0.19
1584.89	-0.26	-0.04	-0.32
1995.26	-0.42	-0.10	-0.42
2511.89	-0.63	-0.15	-0.59
3162.28	-0.98	-0.26	-0.94
3981.07	-1.53	-0.47	-1.44
5011.87	-2.11	-0.53	-1.97
6309.57	-3.03	-0.75	-2.71
7943.28	-4.17	-0.79	-3.42
10000.00	-5.47	-0.35	-3.93
12589.25	-6.41	0.78	-3.90
15848.93	-7.72	0.87	-5.13
19952.62	-9.83	0.22	-7.35

Freq. response: Expanded Uncertainty (dB) with coverage factor K = 2
20 to 25 Hz 0.8dB, 25 to 160 Hz 0.5dB, 160 to 2kHz 0.3dB, 2k to 10kHz 0.5dB, 10k to 20kHz 1.3dB.

Instruments used for calibration:			Date of Cal.	Traceability No.	Re-cal. Due Date
Brüel & Kjær	4226	S/N 1445428	12-Nov-2014	683/284413-14	13-Nov-2015
Brüel & Kjær	4134	S/N 1942286	3-Oct-2014	683/284413-14	4-Oct-2015
Bruel & Kjaer	3560	S/N 2202374	13-Nov-2014	683/284413-14	13-Nov-2015
HP	33120A	S/N 36043716	6-Oct-2014	,287708	6-Oct-2015
Brüel & Kjær	4228	S/N 1742061	3-Oct-2014	683/284413-14	4-Oct-2015
HP	34401A	S/N 36064102	6-Oct-2014	,287708	6-Oct-2015

Cal. Date: 30-Sep-2015 **Tested by: Felix Christopher**

Calibrated on WCCL system type 9700

West Caldwell Calibration Laboratories Inc.

Certificate of Calibration

for

MICROPHONE

Manufactured by:	**BRUEL & KJAER**
Model No:	**4189**
Serial No:	**2386059**
Calibration Recall No:	**24296**

Submitted By:

Customer:

Company: **AERCOUSTICS ENGINEERING LTD**
Address:

The subject instrument was calibrated to the indicated specification using standards traceable to the National Institute of Standards and Technology or to accepted values of natural physical constants. This document certifies that the instrument met the following specification upon its return to the submitter.

West Caldwell Calibration Laboratories Procedure No. **4189** **BRUE**

Upon receipt for Calibration, the instrument was found to be:

Within **(X)** **see attached Report of Calibration.**

the tolerance of the indicated specification.

West Caldwell Calibration Laboratories' calibration control system meets the requirements, ISO 10012-1 MIL-STD-45662A, ANSI/NCSL Z540-1, IEC Guide 25, ISO 9001:2008 and ISO 17025.

Note: With this Certificate, Report of Calibration is included.

Calibration Date: **23-Jun-14**

Certificate No: **24296 - 3**

Approved by:

FC

Felix Christopher (QA Mgr.)
ISO/IEC 17025:2005

ACCREDITED
Calibration Lab. Cert. # 1533.01

West Caldwell Calibration Laboratories, Inc.
uncompromised calibration
1575 State Route 96, Victor, NY 14564, U.S.A.

West Caldwell Calibration Laboratories, Inc.
uncompromised calibration
1575 State Route 96, Victor NY 14564

ISO/IEC 17025: 2005
ACCREDITED
Calibration Lab. Cert. # 1533.01

REPORT OF CALIBRATION

for

Brüel & Kjær Microphone **Model No.: 4189** **Serial No.: 2386059**
Company : Aercoustics Engineering, Ltd. **I. D. No.: 2M**

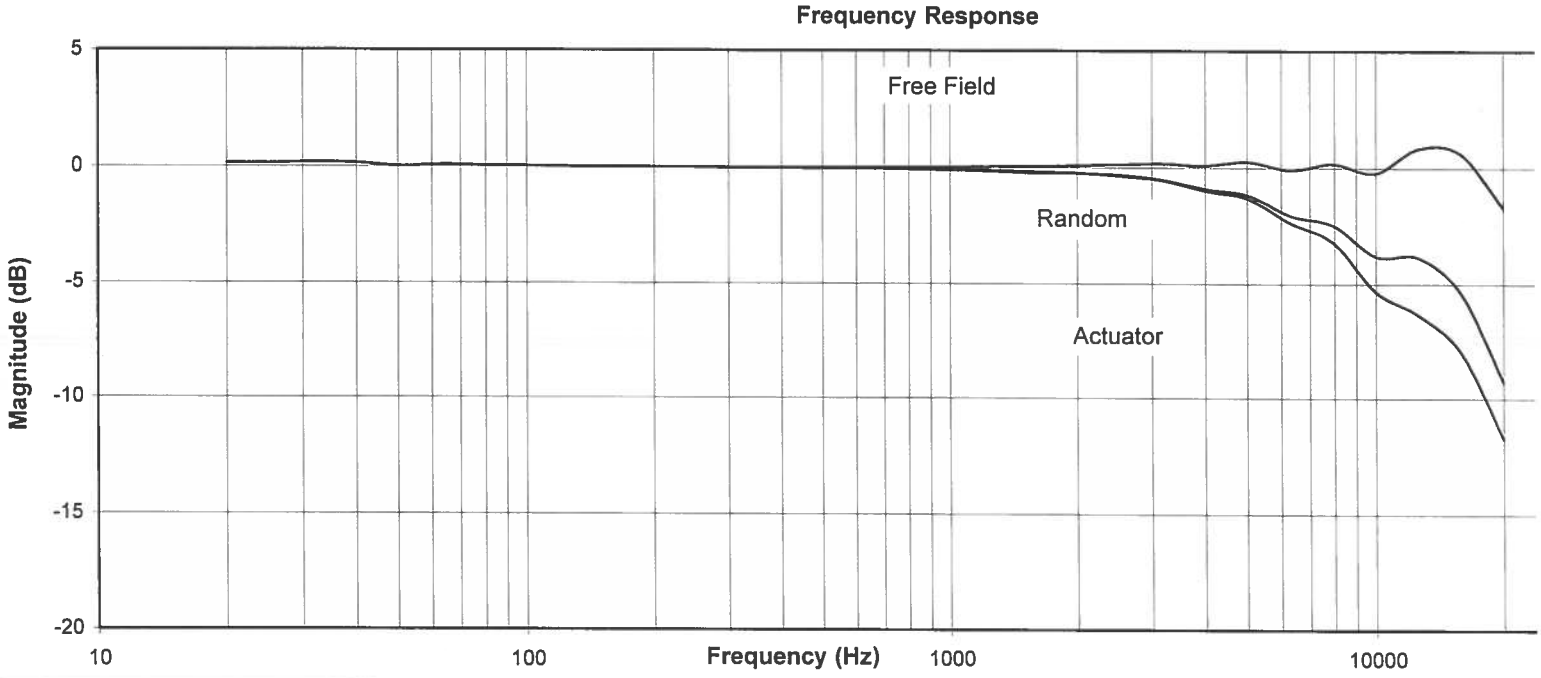
Calibration results: Before data: ..... After data: .....

Open Circuit Sensitivity @ 250 Hz and pressure of 99.423 kPa Before & after data same: ..X.....

0 Volts Polarization voltage (External):

-26.41 dB re.1V/Pascal	Ambient Temperature:	20.4	°C
47.80 mV/Pascal	Ambient Humidity:	45.5	% RH
0.41 Ko (- dB re 50 mV/Pascal)	Ambient Pressure:	99.423	kPa
Sensitivity: Pass	Calibration Date:	23-Jun-2014	
Freq. Response Pass	Re-calibration Due:	23-Jun-2015	
All tests: Pass	Report Number:	24296	-3
	Control Number:	24296	

The above listed instrument meets or exceeds the tested manufacturer's specifications
The IEC 651:1979 & 1993 Type 1 specification passed.
This Calibration is traceable through NIST test numbers: 683/281764-12
The expanded uncertainty of calibration: 0.18dB at 95% confidence level with a coverage factor of k=2.
The lower curve is the pressure response recorded with electrostatic actuator.



The above listed instrument was checked using calibration procedure documented in West Caldwell Calibration Laboratories Inc. procedure : **Rev. 7.0 Jan. 24, 2014 Doc. # 1038 4189B&K**

Calibration was performed by West Caldwell Calibration Laboratories Inc. under Operating Procedures intended to implement the requirements of ISO10012-1, IEC Guide 25, ANSI/NCSL Z540-1, (MIL-STD-45662A) and ISO 9001:2008, ISO 17025

Measurements performed by: .....
Stephen Johnson

Calibrated on WCCL system type 9700

West Caldwell Calibration Laboratories Inc.
1575 State Route 96, Victor NY 14564
Tel. (585) 586-3900 FAX (585) 586-4327

Calibration Data Record

for

Brüel & Kjær Microphone **Model No.: 4189** **Serial No.: 2386059**

Company : Aercoustics Engineering, Ltd. **I. D. No.: 2M**

Frequency Response (Reference = 0 dB @ 250Hz)

Frequency [Hz]	Actuator [dB]	Random (dB)	Free Field (dB)	Frequency [Hz]	Actuator [dB]	Random (dB)	Free Field (dB)
20.00	0.16	0.16	0.16	631.00	-0.04	-0.04	0.00
25.10	0.14	0.14	0.14	794.30	-0.06	-0.06	0.01
31.60	0.19	0.19	0.19	1000.00	-0.08	-0.10	0.02
39.80	0.15	0.15	0.15	1258.90	-0.10	-0.14	0.05
50.10	0.02	0.02	0.02	1584.90	-0.15	-0.21	0.07
63.10	0.09	0.09	0.09	1995.30	-0.22	-0.22	0.11
79.40	0.05	0.05	0.05	2511.90	-0.33	-0.30	0.14
100.00	0.05	0.05	0.05	3162.30	-0.54	-0.50	0.18
125.90	0.02	0.02	0.02	3981.10	-0.97	-0.88	0.10
158.50	0.01	0.01	0.01	5011.90	-1.31	-1.17	0.27
199.50	0.01	0.01	0.01	6309.60	-2.36	-2.04	-0.08
251.20	0.00	0.00	0.00	7943.30	-3.20	-2.45	0.19
316.20	-0.02	-0.02	-0.01	10000.00	-5.33	-3.80	-0.21
398.10	-0.02	-0.02	-0.01	12589.30	-6.35	-3.85	0.84
501.20	-0.03	-0.03	-0.01	15848.90	-7.97	-5.38	0.62
				19952.60	-11.72	-9.24	-1.67

Freq. response: Expanded Uncertainty (dB) with coverage factor K = 2
20 to 25 Hz 0.8dB, 25 to 160 Hz 0.5dB, 160 to 2kHz 0.3dB, 2k to 10kHz 0.5dB, 10k to 20kHz 1.3dB.

Instruments used for calibration:			Date of Cal.	Traceability No.	Re-cal. Due Date
Brüel & Kjær	4134	S/N 1942286	2-Oct-2013	683/281764-12	3-Oct-2014
Hewlett Packard	33120A	S/N 36043716	8-Oct-2013	,287708	8-Oct-2014
Brüel & Kjær	2636	S/N 1324082	3-Oct-2013	683/281764-12	3-Oct-2014
Hewlett Packard	34401A	S/N 36064102	8-Oct-2013	,287708	8-Oct-2014
Brüel & Kjær	2669	S/N 1835082	3-Oct-2013	683/281764-12	3-Oct-2014
Hewlett Packard	34401A	S/N 36102471	8-Oct-2013	,287708	8-Oct-2014

Cal. Date: 23-Jun-2014 **Tested by: Stephen Johnson**

Calibrated on WCCL system type 9700

Rev. 7.0 Jan. 24, 2014 Doc. # 1038 4189B&K

West Caldwell Calibration Laboratories Inc.

Certificate of Calibration

for

HAND HELD ANALYZER

Manufactured by:	**BRUEL & KJAER**
Model No:	**2250**
Serial No:	**2630244**
Calibration Recall No:	**24296**

Submitted By:

Customer:

Company: **AERCOUSTICS ENGINEERING LTD**
Address:

The subject instrument was calibrated to the indicated specification using standards traceable to the National Institute of Standards and Technology or to accepted values of natural physical constants. This document certifies that the instrument met the following specification upon its return to the submitter.

West Caldwell Calibration Laboratories Procedure No. **2250** **BRUE**

Upon receipt for Calibration, the instrument was found to be:

Within **(X)** **see attached Report of Calibration.**

the tolerance of the indicated specification.

West Caldwell Calibration Laboratories' calibration control system meets the requirements, ISO 10012-1 MIL-STD-45662A, ANSI/NCSL Z540-1, IEC Guide 25, ISO 9001:2008 and ISO 17025.

Note: With this Certificate, Report of Calibration is included.

Calibration Date: **23-Jun-14**

Certificate No: **24296 - 2**

Approved by:

FC

Felix Christopher (QA Mgr.)

ISO/IEC 17025:2005

uncompromised calibration **West Caldwell Calibration Laboratories, Inc.**
1575 State Route 96, Victor, NY 14564, U.S.A.

ACCREDITED

Calibration Lab. Cert. # 1533.01

West Caldwell Calibration Laboratories, Inc.
uncompromised calibration
1575 State Route 96, Victor NY 14564

ISO/IEC 17025: 2005
ACCREDITED
Calibration Lab. Cert. # 1533.01

REPORT OF CALIBRATION

for

Brüel & Kjær Hand-held Analyzer **Model No.: 2250** **Serial No.: 2630244**

Company : Aercoustics Engineering, Ltd. **ID No: 2**

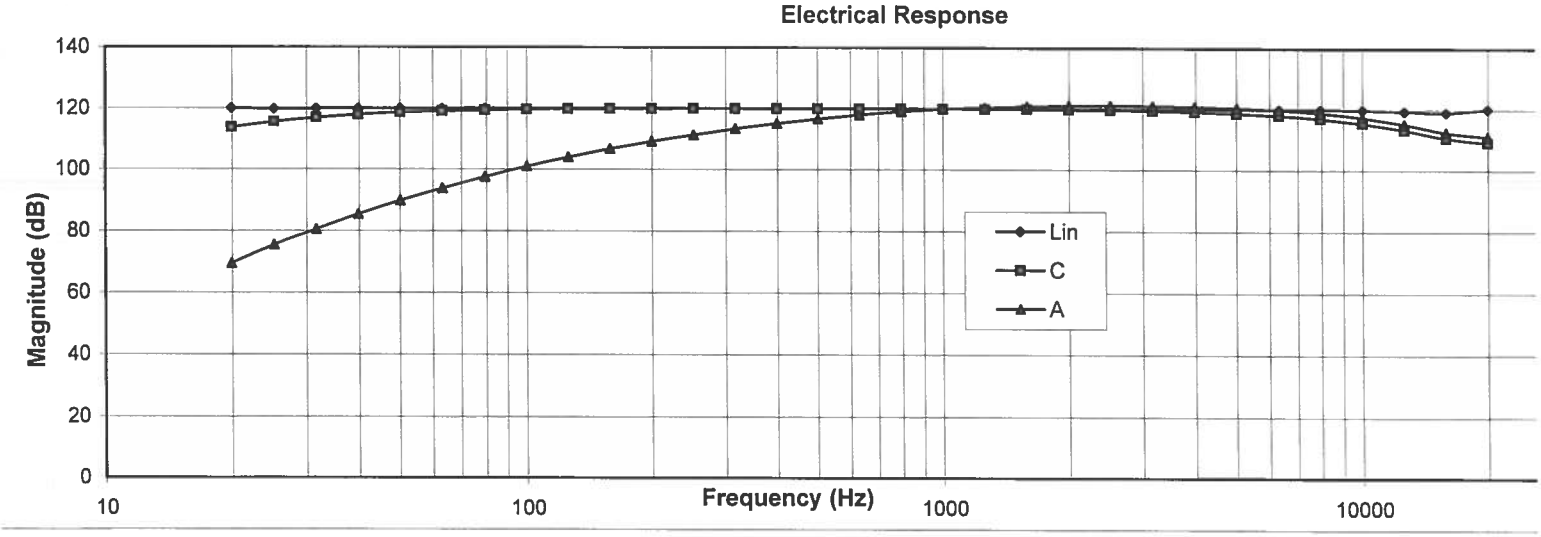
Calibration results:	All Tests:	Pass	Before data:	After data:	
	Sensitivity & Reference	Pass	Before & after data same:	✓	
	Frequency Response:	Pass	Laboratory Environment:		
	1dB steps	Pass	Ambient Temperature:	20.4	°C
	Linearity:	Pass	Ambient Humidity:	45.5	% RH
	Noise:	Pass	Ambient Pressure:	99.423	kPa
	Random signal:	Pass	Calibration Date:	23-Jun-2014	
	Time Constant:	Pass	Calibration Due:	23-Jun-2015	
	Function:	Pass	Report Number:	24296 -2	
	Octave & 1/3 Octave Filters:	Pass	Control Number:	24296	

The above listed instrument meets or exceeds the tested manufacturer's specifications.
IEC 61672-1:2002 Class 1, IEC 61260:1995 w.Am.1, 1/1 and 1/3 Oct. Band Class 0 specification passed.
IEC 60804:2000 Type 1, IEC 60651:1979 w.Am.1&2 Type 1 specification passed.

This Calibration is traceable through NIST test numbers: 822/275722-13

The absolute uncertainty of calibration: See last page. Unless otherwise noted, the reported values are both "as found" and "as left" data.

The curve is the response recorded with electrical input with 50pF (1V=120dB).



The above listed instrument was checked using calibration procedure documented in West Caldwell Calibration Laboratories Inc. procedure : **Rev. 7.0 Jan. 24, 2014 Doc. # 1038 2250B&K**

Calibration was performed by West Caldwell Calibration Laboratories Inc. under Operating Procedures intended to implement the requirements of ISO10012-1, IEC Guide 25, ANSI/NCSL Z540-1, (MIL-STD-45662A) and ISO 9001:2008, ISO 17025

Measurements performed by: .....
Stephen Johnson

Calibrated on WCCL system type 9700

West Caldwell Calibration Laboratories Inc.
1575 State Route 96, Victor NY 14564
Tel. (585) 586-3900 FAX (585) 586-4327

Calibration Data Record

for

Brüel & Kjær Hand-held Analyzer **Model No.: 2250** **Serial No.: 2630244**

Company : Aercoustics Engineering, Ltd.

Frequency Response (Reference = 94 dB @ 1000Hz)

Frequency (Hz)	Weighting Z	C	A
19.95	120.0	113.7	69.4
25.12	119.9	115.6	75.4
31.62	119.9	116.9	80.6
39.81	119.9	118.0	85.4
50.12	120.0	118.7	89.8
63.1	120.0	119.1	93.8
79.43	120.0	119.5	97.5
100	120.0	119.7	100.9
125.89	120.0	119.8	103.9
158.49	120.0	119.9	106.6
199.53	120.0	120.0	109.1
251.19	120.0	120.0	111.4
316.23	120.0	120.0	113.4
398.11	120.0	120.0	115.2
501.19	120.0	120.0	116.8
630.96	120.0	120.0	118.1
794.33	120.0	120.0	119.2
1000	120.0	120.0	120.0

Frequency (Hz)	Weighting Z	C	A
1258.93	120.0	120.0	120.6
1584.89	120.0	119.9	121.0
1995.26	120.0	119.8	121.2
2511.89	120.0	119.7	121.3
3162.28	120.0	119.5	121.2
3981.07	120.0	119.2	121.0
5011.87	120.0	118.7	120.6
6309.57	120.0	118.0	119.9
7943.28	120.0	117.0	118.9
10000	119.9	115.5	117.4
12589.25	119.6	113.3	115.2
15848.93	119.1	110.6	112.5
19952.62	120.3	109.2	111.1

Instruments used for calibration:			Date of Cal.	Traceability No.	Cal. Due Date
Brüel & Kjær	4134	S/N 173494	13-May-2014	822/275722-14	13-May-2015
Hewlett Packard	34401A	S/N 3146A223	29-Jul-2013	,205342	29-Jul-2014
Hewlett Packard	33120A	S/N 36045845	24-Jul-2013	,205342	24-Jul-2014
Brüel & Kjær	2669	S/N 1835084	8-Nov-2013	683/281764-13	8-Nov-2014
Brüel & Kjær	4228	S/N 1742061	15-Apr-2014	683/281764-14	16-Apr-2015
Brüel & Kjær	4144	S/N 1410002	2-Oct-2013	683/281764-13	3-Oct-2014

Cal. Date: 23-Jun-2014 **Tested by: Stephen Johnson**

Calibrated on WCCL system type 9700

West Caldwell Calibration Laboratories Inc.

1575 State Route 96, Victor NY 14564
Tel. (585) 586-3900 FAX (585) 586-4327

Calibration Data Record

for

Brüel & Kjær Hand-held Analyzer **Model No.: 2250** **Serial No.: 2630244**

Company : Aercoustics Engineering, Ltd. **ID No: 2**

Level Accuracy (Reference = 120 dB @ 1000Hz)

Nom. Value [dB]	Meas. Value [dB]	Tolerance Limits [dB]	Dev. In the last 1 dB [dB]	Deviation Rel. to 94.0 dB [dB]
135.0	135.0	0.5	0.0	0.1
134.0	134.0	0.5	0.0	0.1
133.0	133.0	0.5	0.0	0.1
132.0	132.0	0.5	0.0	0.1
131.0	131.0	0.5	0.0	0.0
130.0	130.0	0.5	0.0	0.0
129.0	129.0	0.5	0.0	0.0
128.0	128.0	0.5	0.0	0.0
127.0	127.0	0.5	0.0	0.0
126.0	126.0	0.5	0.0	0.0
125.0	125.0	0.5	0.0	0.0
124.0	124.0	0.5	0.0	0.0
123.0	123.0	0.5	0.0	0.0
122.0	122.0	0.5	0.0	0.0
121.0	121.0	0.5	0.0	0.0
120.0	120.0	0.5	0.0	0.0
119.0	119.0	0.5	0.0	0.0
118.0	118.0	0.5	0.0	0.0
117.0	117.0	0.5	0.0	0.0
116.0	116.0	0.5	0.0	0.0
115.0	115.0	0.5	0.0	0.0
114.0	114.0	0.5	0.0	0.0
113.0	113.0	0.5	0.0	0.0
112.0	112.0	0.5	0.0	0.0
111.0	111.0	0.5	0.0	0.0
110.0	110.0	0.5	0.0	0.0
109.0	109.0	0.5	0.0	0.0
108.0	108.0	0.5	0.0	0.0
107.0	107.0	0.5	0.0	0.0
106.0	106.0	0.5	0.0	0.0
105.0	105.0	0.5	0.0	0.0
104.0	104.0	0.5	0.0	0.0
103.0	103.0	0.5	0.0	0.0
102.0	102.0	0.5	0.0	0.0
101.0	101.0	0.5	0.0	0.0
100.0	100.0	0.5	0.0	0.0
99.0	99.0	0.5	0.0	0.0
98.0	98.0	0.5	0.0	0.0
97.0	97.0	0.5	0.0	0.0
96.0	96.0	0.5	0.0	0.0
95.0	95.0	0.5	0.0	0.0
94.0	94.0	0.5	0.0	0.0
93.0	93.0	0.5	0.0	0.0
92.0	92.0	0.5	0.0	0.0
91.0	91.0	0.5	0.0	0.0
90.0	90.0	0.5	0.0	0.0
89.0	89.0	0.5	0.0	0.0
88.0	88.0	0.5	0.0	0.0
87.0	87.0	0.5	0.0	0.0
86.0	86.0	0.5	0.0	0.0

Nom. Value [dB]	Meas. Value [dB]	Tolerance Limits [dB]	Dev. In the last 1 dB [dB]	Deviation Rel. to 94.0 dB [dB]
85.0	85.0	0.5	0.0	0.0
84.0	84.0	0.5	0.0	0.0
83.0	83.0	0.5	0.0	0.0
82.0	82.0	0.5	0.0	0.0
81.0	81.0	0.5	0.0	0.0
80.0	80.0	0.5	0.0	0.0
79.0	79.0	0.5	0.0	0.0
78.0	78.0	0.5	0.0	0.0
77.0	77.0	0.5	0.0	0.0
76.0	76.0	0.5	0.0	0.0
75.0	75.0	0.5	0.0	0.0
74.0	74.0	0.5	0.0	0.0
73.0	73.0	0.5	0.0	0.0
72.0	72.0	0.5	0.0	0.0
71.0	71.0	0.5	0.0	0.0
70.0	70.0	0.5	0.0	0.0
69.0	69.0	0.5	0.0	0.0
68.0	68.0	0.5	0.0	0.0
67.0	67.0	0.5	0.0	0.0
66.0	66.0	0.5	0.0	0.0
65.0	65.0	0.5	0.0	0.0
64.0	64.0	0.5	0.0	0.0
63.0	63.0	0.5	0.0	0.0
62.0	62.0	0.5	0.0	0.0
61.0	61.0	0.5	0.0	0.0
60.0	60.0	0.5	0.0	0.0
59.0	59.0	0.5	0.0	0.0
58.0	58.0	0.5	0.0	0.0
57.0	57.0	0.5	0.0	0.0
56.0	56.0	0.5	0.0	0.0
55.0	55.0	0.5	0.0	0.0
54.0	54.0	0.5	0.0	0.0
53.0	53.0	0.5	0.0	0.0
52.0	52.0	0.5	0.0	0.0
51.0	51.0	0.5	0.0	0.0
50.0	50.0	0.5	0.0	0.0
49.0	49.0	0.5	0.0	0.0
48.0	48.0	0.5	0.0	0.0
47.0	47.0	0.5	0.0	0.0
46.0	46.0	0.5	0.0	0.0
45.0	45.0	0.5	0.0	0.0
44.0	44.0	0.5	0.0	0.0
43.0	43.0	0.5	0.0	0.0
42.0	42.0	0.5	0.0	0.0
41.0	41.0	0.5	0.0	0.0
40.0	40.0	0.5	0.0	0.0
39.0	39.0	0.5	0.0	0.0
38.0	38.0	0.5	0.0	0.0
37.0	37.0	0.5	0.0	0.0
36.0	36.0	0.5	0.0	0.0

	Test Function		Tolerance Min	Tolerance Max	Value	Measured values	Out
,0.	Reading with 94.0dB SPL	dB	93.6	94.4	94	93.8	
,1.	Linearity accuracy				FSD (dB)		
			39.5	40.5	40	40.0	
			49.5	50.5	50	50.0	
			59.5	60.5	60	60.0	
			69.5	70.5	70	70.0	
			79.5	80.5	80	80.0	
			89.5	90.5	90	90.0	
			99.5	100.5	100	100.0	
			109.5	110.5	110	110.0	
			119.5	120.5	120	120.0	
			129.5	130.5	130	130.0	
,2	Frequency Response with mic.				(Hz)		
	A Weighting		53.2	56.0	31.5	54.6	
	Ref. 94.0 dB @ 1kHz		66.9	68.7	63	67.9	
			77.0	78.8	125	77.9	
			84.5	86.3	250	85.3	
			89.9	91.7	500	90.8	
			93.1	94.9	1000	94.0	
			94.3	96.1	2000	95.3	
			94.1	95.9	4000	94.9	
			90.0	94.3	8000	92.2	
			83.8	92.6	12500	89.2	
			0.0	90.3	16000	88.7	
					(Hz)		
	C Weighting		89.6	92.4	31.5	91.0	
			92.3	94.1	63	93.2	
			92.9	94.7	125	93.9	
			93.1	94.9	250	94.0	
			93.1	94.9	500	94.0	
			93.1	94.9	1000	94.0	
			92.9	94.7	2000	93.9	
			92.3	94.1	4000	93.2	
			88.1	92.4	8000	90.3	
			81.9	90.7	12500	87.3	
			0.0	88.4	16000	86.8	
					(Hz)		
	Flat or Lin.		92.6	95.4	31.5	94.1	
			93.1	94.9	63	94.0	
			93.1	94.9	125	94.0	
			93.1	94.9	250	94.0	
			93.1	94.9	500	94.0	
			93.1	94.9	1000	94.0	
			93.1	94.9	2000	94.1	
			93.1	94.9	4000	94.0	
			91.1	95.4	8000	93.3	
			88.1	96.9	12500	93.6	
			0.0	96.9	16000	95.4	

	Test Function	Tolerance Min	Tolerance Max	Value	Measured values	Out
,3	Frequency Response with Electrical Signal			(Hz)		
	A Weighting	67.0	72.0	20.0	69.4	
	Ref. 94.0 dB @ 1kHz	73.3	77.3	25.1	75.4	
		79.1	82.1	31.6	80.6	
		83.9	86.9	39.8	85.4	
		88.8	90.8	50.1	89.8	
		92.8	94.8	63.1	93.8	
		96.5	98.5	79.4	97.5	
		99.9	101.9	100.0	100.9	
		102.9	104.9	125.9	103.9	
		105.6	107.6	158.5	106.6	
		108.1	110.1	199.5	109.1	
		110.4	112.4	251.2	111.4	
		112.4	114.4	316.2	113.4	
		114.2	116.2	398.1	115.2	
		115.8	117.8	501.2	116.8	
		117.1	119.1	631.0	118.1	
		118.2	120.2	794.3	119.2	
		119.0	121.0	1000.0	120.0	
		119.6	121.6	1258.9	120.6	
		120.0	122.0	1584.9	121.0	
		120.2	122.2	1995.3	121.2	
		120.3	122.3	2511.9	121.3	
		120.2	122.2	3162.3	121.2	
		120.0	122.0	3981.1	121.0	
		119.5	122.0	5011.9	120.6	
		117.9	121.4	6309.6	119.9	
		115.9	120.4	7943.3	118.9	
		113.5	119.5	10000.0	117.4	
		109.7	118.7	12589.3	115.2	
		112.0	116.4	15848.9	112.5	
		0.0	113.7	19952.6	111.1	
				(Hz)		
	C Weighting	111.3	116.3	20.0	113.7	
		113.6	117.6	25.1	115.6	
		115.5	118.5	31.6	116.9	
		116.5	119.5	39.8	118.0	
		117.7	119.7	50.1	118.7	
		118.2	120.2	63.1	119.1	
		118.5	120.5	79.4	119.5	
		118.7	120.7	100.0	119.7	
		118.8	120.8	125.9	119.8	
		118.9	120.9	158.5	119.9	
		119.0	121.0	199.5	120.0	
		119.0	121.0	251.2	120.0	
		119.0	121.0	316.2	120.0	
		119.0	121.0	398.1	120.0	
		119.0	121.0	501.2	120.0	
		119.0	121.0	631.0	120.0	
		119.0	121.0	794.3	120.0	
		119.0	121.0	1000.0	120.0	
		119.0	121.0	1258.9	120.0	
		118.9	120.9	1584.9	119.9	
		118.8	120.8	1995.3	119.8	
		118.7	120.7	2511.9	119.7	
		118.5	120.5	3162.3	119.5	
		118.2	120.2	3981.1	119.2	

	Test Function	Tolerance Min	Tolerance Max	Value	Measured values	Out
		117.7	120.2	5011.9	118.7	
		116.0	119.5	6309.6	118.0	
		114.0	118.5	7943.3	117.0	
		111.6	117.6	10000.0	115.5	
		107.8	116.8	12589.3	113.3	
		110.0	114.5	15848.9	110.6	
		105.0	111.8	19952.6	109.2	
				(Hz)		
	Flat or Lin.	118.5	121.5	20.0	120.0	
		118.5	121.5	25.1	119.9	
		118.5	121.5	31.6	119.9	
		118.5	121.5	39.8	119.9	
		118.5	121.5	50.1	120.0	
		119.0	121.0	63.1	120.0	
		119.0	121.0	79.4	120.0	
		119.0	121.0	100.0	120.0	
		119.0	121.0	125.9	120.0	
		119.0	121.0	158.5	120.0	
		119.0	121.0	199.5	120.0	
		119.0	121.0	251.2	120.0	
		119.0	121.0	316.2	120.0	
		119.0	121.0	398.1	120.0	
		119.0	121.0	501.2	120.0	
		119.0	121.0	631.0	120.0	
		119.0	121.0	794.3	120.0	
		119.0	121.0	1000.0	120.0	
		119.0	121.0	1258.9	120.0	
		119.0	121.0	1584.9	120.0	
		119.0	121.0	1995.3	120.0	
		119.0	121.0	2511.9	120.0	
		119.0	121.0	3162.3	120.0	
		119.0	121.0	3981.1	120.0	
		117.0	121.5	5011.9	120.0	
		117.0	121.5	6309.6	120.0	
		117.0	121.5	7943.3	120.0	
		114.0	123.0	10000.0	119.9	
		114.0	123.0	12589.3	119.6	
		110.0	123.0	15848.9	119.1	
		110.0	123.0	19952.6	120.3	
,4	Inherent noise level				Pass	
		dB	dB			
,5	Random signal	89.5	90.5	Fast	90.4	
	90 dB Test Level	89.5	90.5	Slow	90.1	
,6	Time Constant	dB	dB			
	90 dB 2kHz Test Level	88.0	90.0	Fast	89.1	
		84.9	86.9	Slow	86.1	
,7	**Fast**	93.5	94.5	94.0	93.8	
	Slow	93.5	94.5	94.0	93.8	
	Impulse	93.5	94.5	94.0	93.8	
	Leq	93.5	94.5	94.0	93.8	
	Peak	96.0	98.0	97.0	97.0	
	Max	93.5	94.5	94.0	93.8	
	Min	93.5	94.5	94.0	93.8	
	SEL	103.4	104.4	103.9	103.8	

Test Function ,8 1/3 Octave filter check					
		Before			Out
Filter Hz		87.5 to 92.5	93.5 to 94.5	87.5 to 92.5	
20		92.0	94.0	88.3	
25		91.9	94.0	88.4	
31.5		91.8	94.0	88.7	
40		91.6	94.0	88.7	
50		91.6	94.0	88.8	
63		91.5	94.0	88.9	
80		91.4	94.0	89.1	
100		91.3	93.9	89.0	
125		91.4	94.0	89.2	
160		91.2	94.0	89.4	
200		91.1	94.0	89.5	
250		91.0	94.0	89.7	
315		90.9	94.0	89.9	
400		90.7	94.0	89.9	
500		90.7	94.0	90.1	
630		90.5	94.0	90.2	
800		90.4	94.0	90.3	
1K		90.3	94.0	90.2	
1.25K		90.4	94.0	90.4	
1.6K		90.2	94.0	90.6	
2K		90.0	94.0	90.7	
2.5k		89.9	94.0	90.8	
3.15k		89.8	94.0	91.0	
4k		89.6	94.0	91.0	
5k		89.6	94.0	91.2	
6.3k		89.4	94.0	91.3	
8k		89.3	94.0	91.3	
10k		89.2	94.0	91.1	
12.5k		89.3	94.1	91.2	
16k		89.0	94.0	91.9	
20k		88.5	94.1	92.5	

1/1 Octave Filter Check					Out
Filter Hz		88.8 to 91.8	93.5 to 94.5	88.8 to 91.8	
31.5		90.9	94.0	89.8	
63		90.8	93.9	90.0	
125		90.7	94.0	90.1	
250		90.6	94.0	90.2	
500		90.5	94.0	90.3	
1K		90.4	94.0	90.4	
2K		90.3	94.0	90.5	
4k		90.2	94.1	90.7	
8k		90.1	94.5	90.5	
16k		89.9	94.0	92.0	

The expanded uncertainty of calibration at 95% confidence level with a coverage factor of k=2.

Parameter	Test Instrumentation Uncertainty	DUT Uncertainty	Total DUT Uncertainty
Reading with mic. @ 1kHz:	0.09	0.1	0.16
Meter linearity:	0.008	0.1	0.12
Attenuator accuracy:	0.008	0.1	0.12
Freq. Response: 63Hz to 12.5kHz	0.15	0.1	0.21
Freq. Response: 31.5Hz & 16kHz	0.17	0.1	0.23
Electrical Freq. Resp.: 20Hz to 20kHz	0.008	0.1	0.12
Inherent noise level:	0.3	0.1	0.37
Crest Factor:	0.3	0.1	0.37
Time Constant:	0.3	0.1	0.37
Functions:	0.09	0.1	0.16
Sensitivity:	0.09	0.1	0.16
1/3 & 1/1 Filters:	0.008	0.1	0.12

Cal. Date: 23-Jun-2014

Measurements By: Stephen Johnson

Calibrated on WCCL system type 9700

Brüel & Kjær

Calibration Chart

Type 4231 Serial No. 3012376

Sound Pressure Level:

94.00 or 114.00 dB ±0.20 dB
(re 20 µPa at reference conditions)

Frequency: 1000 Hz ±0.1%

Distortion: <1%

Reference Conditions:

Temperature:	23°C
Pressure:	101.325 kPa
Humidity:	50% RH
Load:	0.25 cm³ (½" Brüel & Kjær Mic.)

Date: 14/12/14 *Signed:* Wesson 2.