



CERTIFICATE OF CALIBRATION

Certificate No.: 21CA1021 05-02

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Item tested

Description: Acoustical Calibrator (Class 1)
Manufacturer: Honglim Co., Ltd.
Type/Model No.: HLES-02
Serial/Equipment No.: 2019612534
Adaptors used:

Item submitted by

Customer: Lam Environmental Services Limited
Address of Customer:
Request No.:
Date of receipt: 21-Oct-2021

Date of test: 25-Oct-2021

Reference equipment used in the calibration

Description:	Model:	Serial No.	Expiry Date:	Traceable to:
Lab standard microphone	B&K 4180	2341427	04-May-2022	SCL
Preamplifier	B&K 2673	2239857	31-May-2022	CEPREI
Measuring amplifier	B&K 2610	2346941	01-Jun-2022	CEPREI
Signal generator	DS 360	33873	27-May-2022	CEPREI
Digital multi-meter	34401A	US36087050	27-May-2022	CEPREI
Audio analyzer	8903B	GB41300350	28-May-2022	CEPREI
Universal counter	53132A	MY40003662	02-Jun-2022	CEPREI

Ambient conditions

Temperature: 22 ± 1 °C
Relative humidity: 55 ± 10 %
Air pressure: 1005 ± 5 hPa

Test specifications

- The Sound Calibrator has been calibrated in accordance with the requirements as specified in IEC 60942 1997 Annex B and the lab calibration procedure SMTP004-CA-156.
- The calibrator was tested with its axis vertical facing downwards at the specific frequency using insert voltage technique.
- The results are rounded to the nearest 0.01 dB and 0.1 Hz and have not been corrected for variations from a reference pressure of 1013.25 hectoPascals as the maker's information indicates that the instrument is insensitive to pressure changes.

Test results

This is to certify that the sound calibrator conforms to the requirements of annex B of IEC 60942: 1997 for the conditions under which the test was performed. This does not imply that the sound calibrator meets IEC 60942 under any other conditions.

Details of the performed measurements are presented on page 2 of this certificate.

Approved Signatory:


Feng Junqi

Date: 26-Oct-2021

Company Chop:



Comments: The results reported in this certificate refer to the condition of the instrument on the date of calibration and carry no implication regarding the long-term stability of the instrument. The results apply to the item as received.

**CERTIFICATE OF CALIBRATION**

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1, Measured Sound Pressure Level

The output Sound Pressure Level in the calibrator head was measured at the setting and frequency shown using a calibrated laboratory standard microphone and insert voltage technique. The results are given in below with the estimated uncertainties.

(Output level in dB re 20 μ Pa)			
Frequency Shown Hz	Output Sound Pressure Level Setting dB	Measured Output Sound Pressure Level dB	Estimated Expanded Uncertainty dB
1000	94.00	94.02	0.10

2, Sound Pressure Level Stability - Short Term Fluctuations

The Short Term Fluctuations was determined by measuring the maximum and minimum of the fast weighted DC output of the B&K 2610 measuring amplifier over a 20 second time interval as required in the standard. The Short Term Fluctuation was found to be:

At 1000 Hz STF = 0.011 dB

Estimated expanded uncertainty 0.005 dB

3, Actual Output Frequency

The determination of actual output frequency was made using a B&K 4180 microphone together with a B&K 2673 preamplifier connected to a B&K 2610 measuring amplifier. The AC output of the B&K 2610 was taken to an universal counter which was used to determine the frequency averaged over 20 second of operation as required by the standard. The actual output frequency at 1 KHz was:

At 1000 Hz Actual Frequency = 998.27 Hz

Estimated expanded uncertainty 0.1 Hz Coverage factor k = 2.2

4, Total Noise and Distortion

For the Total Noise and Distortion measurement, the unfiltered AC output of the B&K 2610 measuring amplifier was connected to an Agilent Type 8903 B distortion analyser. The TND result at 1 KHz was:

At 1000 Hz TND = 0.4 %

Estimated expanded uncertainty 0.7 %

The expanded uncertainties have been calculated in accordance with the ISO Publication "Guide to the expression of uncertainty in measurement", and gives an interval estimated to have a level of confidence of 95%. A coverage factor of 2 is assumed unless explicitly stated.

Calibrated by:

Fung Chi Yip

Date: 25-Oct-2021

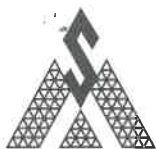
- End -

Checked by:

Chan Yuk Yiu

Date: 26-Oct-2021

The standard(s) and equipment used in the calibration are traceable to national or international recognised standards and are calibrated on a schedule to maintain the required accuracy level.



CERTIFICATE OF CALIBRATION

Certificate No.: 21CA0326 03-02

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Item tested

Description:	Sound Level Meter (Type 1)	, Microphone
Manufacturer:	Larson Davis	, PCB
Type/Model No.:	LxT1	, 377B02
Serial/Equipment No.:	0003737	, 171529
Adaptors used:	-	, -

Item submitted by

Customer Name:	Lam Environmental Services Limited.
Address of Customer:	-
Request No.:	-
Date of receipt:	26-Mar-2021

Date of test: 31-Mar-2021

Reference equipment used in the calibration

Description:	Model:	Serial No.	Expiry Date:	Traceable to:
Multi function sound calibrator	B&K 4226	2288444	23-Aug-2021	CIGISMEC
Signal generator	DS 360	33873	19-May-2021	CEPREI

Ambient conditions

Temperature:	21 ± 1 °C
Relative humidity:	55 ± 10 %
Air pressure:	1005 ± 5 hPa

Test specifications

- 1, The Sound Level Meter has been calibrated in accordance with the requirements as specified in BS 7580: Part 1: 1997 and the lab calibration procedure SMTP004-CA-152.
- 2, The electrical tests were performed using an electrical signal substituted for the microphone which was removed and replaced by an equivalent capacitance within a tolerance of ±20%.
- 3, The acoustic calibration was performed using an B&K 4226 sound calibrator and corrections was applied for the difference between the free-field and pressure responsiveness of the Sound Level Meter.

Test results

This is to certify that the Sound Level Meter conforms to BS 7580: Part 1: 1997 for the conditions under which the test was performed.

Details of the performed measurements are presented on page 2 of this certificate.

Actual Measurement data are documented on worksheets.

Approved Signatory:


Feng Junqi

Date: 07-Apr-2021

Company Chop:



Comments: The results reported in this certificate refer to the condition of the instrument on the date of calibration and carry no implication regarding the long-term stability of the instrument. The results apply to the item as received.



CERTIFICATE OF CALIBRATION

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Certificate No.:

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1, Electrical Tests

The electrical tests were performed using an equivalent capacitance substituted for the microphone. The results are given in below with test status and the estimated uncertainties. The "Pass" means the result of the test is inside the tolerances stated in the test specifications. The "-" means the result of test is outside these tolerances.

Test:	Subtest:	Status:	Expanded Uncertainty (dB)	Coverage Factor
Self-generated noise	A	Pass	0.3	2.1
	C	Pass	0.8	
	Lin	Pass	1.6	
Linearity range for Leq	At reference range, Step 5 dB at 4 kHz	Pass	0.3	2.2
	Reference SPL on all other ranges	Pass	0.3	
	2 dB below upper limit of each range	Pass	0.3	
	2 dB above lower limit of each range	Pass	0.3	
	At reference range, Step 5 dB at 4 kHz	Pass	0.3	
Linearity range for SPL	A	Pass	0.3	
	C	Pass	0.3	
	Lin	Pass	0.3	
	Single Burst Fast	Pass	0.3	
Time weightings	Single Burst Slow	Pass	0.3	
	Single 100µs rectangular pulse	Pass	0.3	
Peak response	Crest factor of 3	Pass	0.3	
R.M.S. accuracy	Single burst 5 ms at 2000 Hz	Pass	0.3	
Time weighting I	Repeated at frequency of 100 Hz	Pass	0.3	
	1 ms burst duty factor 1/10 ³ at 4kHz	Pass	0.3	
Time averaging	1 ms burst duty factor 1/10 ⁴ at 4kHz	Pass	0.3	
	Single burst 10 ms at 4 kHz	Pass	0.4	
Pulse range	Single burst 10 ms at 4 kHz	Pass	0.4	
Sound exposure level	SPL	Pass	0.3	
Overload indication	Leq	Pass	0.4	

2, Acoustic tests

The complete sound level meter was calibrated on the reference range using a B&K 4226 acoustic calibrator with 1000Hz and SPL 94 dB. The sensitivity of the sound level meter was adjusted. The test result at 125 Hz and 8000 Hz are given in below with test status and the estimated uncertainties.

Test:	Subtest	Status	Expanded Uncertainty (dB)	Coverage Factor
Acoustic response	Weighting A at 125 Hz	Pass	0.3	
	Weighting A at 8000 Hz	Pass	0.5	

3, Response to associated sound calibrator

N/A

The expanded uncertainties have been calculated in accordance with the ISO Publication "Guide to the expression of uncertainty in measurement", and gives an interval estimated to have a level of confidence of 95%. A coverage factor of 2 is assumed unless explicitly stated.

Calibrated by:

Date:

Fung Chi Yip
31-Mar-2021

- End -

Checked by:

Date:

Chan Yuk Yiu
07-Apr-2021

The standard(s) and equipment used in the calibration are traceable to national or international recognised standards and are calibrated on a schedule to maintain the required accuracy level.



Certificate of Calibration

Calibration Certification Information

Cal. Date: February 3, 2021 Rootsmeter S/N: 438320 Ta: 293 °K
Operator: Jim Tisch Pa: 750.6 mm Hg
Calibration Model #: TE-5025A Calibrator S/N: **3880**

Run	Vol. Init (m3)	Vol. Final (m3)	ΔVol. (m3)	ΔTime (min)	ΔP (mm Hg)	ΔH (in H2O)
1	1	2	1	1.4550	3.2	2.00
2	3	4	1	1.0280	6.4	4.00
3	5	6	1	0.9180	8.0	5.00
4	7	8	1	0.8750	8.8	5.50
5	9	10	1	0.7220	12.8	8.00

Data Tabulation

Vstd (m3)	Qstd (x-axis)	$\sqrt{\Delta H \left(\frac{Pa}{Pstd} \right) \left(\frac{Tstd}{Ta} \right)}$ (y-axis)	Va	Qa (x-axis)	$\sqrt{\Delta H \left(\frac{Ta}{Pa} \right)}$ (y-axis)
1.0002	0.6874	1.4174	0.9957	0.6844	0.8836
0.9959	0.9688	2.0044	0.9915	0.9645	1.2496
0.9937	1.0825	2.2410	0.9893	1.0777	1.3971
0.9927	1.1345	2.3504	0.9883	1.1295	1.4653
0.9873	1.3675	2.8347	0.9829	1.3614	1.7672
QSTD	m=	2.08437	QA	m=	1.30520
	b=	-0.01508		b=	-0.00940
	r=	1.00000		r=	1.00000

Calculations

Vstd=	$\Delta Vol((Pa-\Delta P)/Pstd)(Tstd/Ta)$	Va=	$\Delta Vol((Pa-\Delta P)/Pa)$
Qstd=	Vstd/ΔTime	Qa=	Va/ΔTime
For subsequent flow rate calculations:			
Qstd= $1/m \left(\left(\sqrt{\Delta H \left(\frac{Pa}{Pstd} \right) \left(\frac{Tstd}{Ta} \right)} \right) - b \right)$		Qa= $1/m \left(\left(\sqrt{\Delta H \left(\frac{Ta}{Pa} \right)} \right) - b \right)$	

Standard Conditions

Tstd:	298.15 °K
Pstd:	760 mm Hg
Key	
ΔH: calibrator manometer reading (in H2O)	
ΔP: rootsmeter manometer reading (mm Hg)	
Ta: actual absolute temperature (°K)	
Pa: actual barometric pressure (mm Hg)	
b: intercept	
m: slope	

RECALIBRATION

US EPA recommends annual recalibration per 1998 40 Code of Federal Regulations Part 50 to 51, Appendix B to Part 50, Reference Method for the Determination of Suspended Particulate Matter in the Atmosphere, 9.2.17, page 30



Met One
Instruments

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(541) 471-7111
(541) 471-7116 (Fax)
Service@metone.com

Calibration Certificate

The calibration results on this report certify that this instrument complies with the product specifications at the time of calibration. Calibration was performed according to accepted industry methods using equipment, procedures, and standards that are traceable to NIST and ISO.

Recommended calibration interval is 12 months from the first day of use.

Instrument Model# 831

Instrument Serial# R14332

Date of Calibration 2/18/2021

Sensor # 12228

J. Chester **AT1**

AT14 **MAR 02 2021**

Calibration Technician

Quality Check

Temperature 30 °C

Relative Humidity 33 %

Test Procedure: **831-6100**

PSL Size (µm)	Test Results	Test Spec.	Lot# NIST	Expiration
0.5	Pass	± 10%	219480	11/30/2022
0.7	Pass	± 10%	229561	08/31/2023
1.0	Pass	± 10%	229294	8/31/2023
2.5	Pass	± 10%	REF	NA
4.0	Pass	± 10%	REF	NA
5.0	Pass	± 10%	REF	NA
7.0	Pass	± 10%	REF	NA
10.0	Pass	± 10%	REF	NA

Standards	Model	SN	Cal Due
Flowmeter	DCL-M	103751	3/14/2021
DMM	189 Multimeter	92130180	10/26/2021
RH/TEMP SENSOR	083E-1-6	R20313	9/17/2021
Particle Counter	GT-526	M1760	5/19/2021

This calibration certificate shall not be reproduced except in full, without the written approval of Met One Instruments Inc.



Met One
Instruments

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Calibration Certificate

The calibration results on this report certify that this instrument complies with the product specifications at the time of calibration. Calibration was performed according to accepted industry methods using equipment, procedures, and standards that are traceable to NIST and ISO.

Recommended calibration interval is 12 months from the first day of use.

Instrument Model# Aerocet 831

Instrument Serial# Y23153

Date of Calibration 9/9/2021

Sensor # 19493

JGoddard ^A₈

Calibration Technician

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Quality Check

Temperature 22 °C

Relative Humidity 41 %

Test Procedure: Aerocet 831-6100

PSL Size (µm)	Test Results	Test Spec.	Lot# NIST	Expiration
0.3	Pass	± 10%	223077	04/30/2023
0.5	Pass	± 10%	219480	11/30/2022
1.0	Pass	± 10%	229294	8/31/2023
2.0	Pass	± 10%	REF	NA
5.0	Pass	± 10%	REF	NA
3.0	Pass	± 10%	REF	NA
5.0	Pass	± 10%	REF	NA
10.0	Pass	± 10%	REF	NA

Standards	Model	SN	Cal Due
RH/TEMP SENSOR	083E-1-35	U20080	11/23/2021
Flowmeter	DCL-M	103751	4/1/2022
RH/TEMP SENSOR	083E-1-6	R20313	9/17/2021
DMM	289	27720071	8/24/2022

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Lam Environmental Services Limited

Calibration Data for High Volume Sampler (TSP Sampler)

Location : AMS1

Equipment no. : HVS020

Calibration Date : 8-Nov-21

Calibration Due Date : 8-Jan-22

CALIBRATION OF CONTINUOUS FLOW RECORDER

Ambient Condition						
Temperature, T _a	303.1		Kelvin	Pressure, P _a	1010 mmHg	

Orifice Transfer Standard Information						
Equipment No.	3166		Slope, m _c	1.88375	Intercept, b _c	0.03970
Last Calibration Date	3-Aug-21		$\left(H \times P_a / 1013.3 \times 298 / T_a \right)^{1/2}$ $= m_c \times Q_{std} + b_c$			
Next Calibration Date	3-Aug-22					

Calibration of TSP						
Calibration Point	Manometer Reading			Q _{std} (m ³ / min.) X-axis	Continuous Flow Recorder, W (CFM)	IC (W(P _a /1013.3x298/T _a) ^{1/2} /35.31) Y-axis
	(up)	(down)	(difference)			
1	1.5	1.5	3.0	0.8893	24	23.7632
2	2.6	2.6	5.2	1.1775	35	34.6546
3	3.5	3.5	7.0	1.3696	46	45.5460
4	4.6	4.6	9.2	1.5732	56	55.4474
5	5.5	5.5	11.0	1.7222	66	65.3487

By Linear Regression of Y on X

Slope, m = 49.8862 Intercept, b = -22.2130

Correlation Coefficient* = 0.9955

Calibration Accepted = Yes/No**

* if Correlation Coefficient < 0.990, check and recalibration again.

** Delete as appropriate.

Remarks : _____

Calibrated by : Alan Ng

Date : 8-Nov-21

Checked by : Garry Yu

Date : 8-Nov-21



Lam Environmental Services Limited

Calibration Data for High Volume Sampler (TSP Sampler)

Location : AMS2

Equipment no. : HVS019

Calibration Date : 8-Nov-21

Calibration Due Date : 8-Jan-22

CALIBRATION OF CONTINUOUS FLOW RECORDER

Ambient Condition						
Temperature, T _a	303.1		Kelvin	Pressure, P _a	1010 mmHg	

Orifice Transfer Standard Information					
Equipment No.	3166	Slope, m _c	1.88375	Intercept, b _c	0.03970
Last Calibration Date	3-Aug-21	$\left(H \times P_a / 1013.3 \times 298 / T_a \right)^{1/2}$ $= m_c \times Q_{std} + b_c$			
Next Calibration Date	3-Aug-22				

Calibration of TSP						
Calibration Point	Manometer Reading			Q _{std} (m ³ / min.) X-axis	Continuous Flow Recorder, W (CFM)	IC (W(P _a /1013.3x298/T _a) ^{1/2} /35.31) Y-axis
	(up)	(down)	(difference)			
1	1.6	1.6	3.2	0.9192	25	24.7533
2	2.7	2.7	5.4	1.2003	37	36.6349
3	3.7	3.7	7.4	1.4088	46	45.5460
4	4.5	4.5	9.0	1.5558	55	54.4572
5	5.7	5.7	11.4	1.7536	64	63.3684

By Linear Regression of Y on X

Slope, m = 46.6577 Intercept, b = -18.8541

Correlation Coefficient* = 0.9982

Calibration Accepted = Yes/No**

* if Correlation Coefficient < 0.990, check and recalibration again.

** Delete as appropriate.

Remarks : _____

Calibrated by : Alan Ng

Date : 8-Nov-21

Checked by : Garry Yu

Date : 8-Nov-21



Lam Environmental Services Limited

Calibration Data for High Volume Sampler (TSP Sampler)

Location : AMS1

Equipment no. : HVS020

Calibration Date : 7-Jan-22

Calibration Due Date : 9-Mar-22

CALIBRATION OF CONTINUOUS FLOW RECORDER

Ambient Condition						
Temperature, T _a	291.6		Kelvin	Pressure, P _a	1022 mmHg	

Orifice Transfer Standard Information						
Equipment No.	3880		Slope, m _c	2.08437	Intercept, b _c	-0.01508
Last Calibration Date	3-Aug-21		$\left(H \times P_a / 1013.3 \times 298 / T_a \right)^{1/2}$ $= m_c \times Q_{std} + b_c$			
Next Calibration Date	3-Aug-22					

Calibration of TSP						
Calibration Point	Manometer Reading			Q _{std} (m ³ / min.) X-axis	Continuous Flow Recorder, W (CFM)	IC (W(P _a /1013.3x298/T _a) ^{1/2} /35.31) Y-axis
	(up)	(down)	(difference)			
1	1.2	1.2	2.4	0.7617	38	38.5718
2	2.0	2.0	4.0	0.9812	44	44.6620
3	2.8	2.8	5.6	1.1596	50	50.7523
4	3.5	3.5	7.0	1.2957	55	55.8275
5	4.4	4.4	8.8	1.4519	59	59.8877

By Linear Regression of Y on X

Slope, m = 31.6638 Intercept, b = 14.1601

Correlation Coefficient* = 0.9985

Calibration Accepted = Yes/No**

* if Correlation Coefficient < 0.990, check and recalibration again.

** Delete as appropriate.

Remarks : _____

Calibrated by : Harry Po

Date : 7-Jan-22

Checked by : Alan Ng

Date : 7-Jan-22



Lam Environmental Services Limited

Calibration Data for High Volume Sampler (TSP Sampler)

Location : AMS2
Equipment no. : HVS019

Calibration Date : 7-Jan-22
Calibration Due Date : 9-Mar-22

CALIBRATION OF CONTINUOUS FLOW RECORDER

Ambient Condition						
Temperature, T _a	292.6		Kelvin	Pressure, P _a	1022 mmHg	

Orifice Transfer Standard Information					
Equipment No.	3166	Slope, m _c	2.08437	Intercept, bc	-0.01508
Last Calibration Date	3-Aug-21	$\left(H \times P_a / 1013.3 \times 298 / T_a \right)^{1/2}$ $= m_c \times Q_{std} + b_c$			
Next Calibration Date	3-Aug-22				

Calibration of TSP						
Calibration Point	Manometer Reading			Q _{std} (m ³ / min.) X-axis	Continuous Flow Recorder, W (CFM)	IC (W(P _a /1013.3x298/T _a) ^{1/2} /35.31) Y-axis
	H (inches of water)					
	(up)	(down)	(difference)			
1	1.5	1.5	3.0	0.8493	26	26.3461
2	2.4	2.4	4.8	1.0723	32	32.4259
3	3.3	3.3	6.6	1.2562	42	42.5590
4	4.2	4.2	8.4	1.4162	48	48.6389
5	5.4	5.4	10.8	1.6049	55	55.7321

By Linear Regression of Y on X

Slope, m = 40.2920 Intercept, b = -8.8126

Correlation Coefficient* = 0.9951

Calibration Accepted = Yes/No**

* if Correlation Coefficient < 0.990, check and recalibration again.

** Delete as appropriate.

Remarks : _____

Calibrated by : Harry Po
Date : 7-Jan-22

Checked by : Alan ng
Date : 7-Jan-22