# Calibration Certificate

***Certificate Number 2016005141***

***Customer:***
**LAM Environmental Services Ltd**
**11/F Centre Point**
**181-185 Gloucester Road**
**Wanchai, , Hong Kong**

| | |
|---|---|
| ***Model Number*** | LxT SE |
| ***Serial Number*** | 0004797 |
| ***Test Results*** | **Pass** |
| ***Initial Condition*** | As Manufactured |
| ***Description*** | Sound Expert LxT |

| | | | |
|---|---|---|---|
| ***Procedure Number*** | D0001.8384 | | |
| ***Technician*** | Ron Harris | | |
| ***Calibration Date*** | 8 Jun 2016 | | |
| ***Calibration Due*** | | | |
| ***Temperature*** | 22.36 | °C | ± 0.01 °C |
| ***Humidity*** | 50.5 | %RH | ± 0.5 %RH |
| ***Static Pressure*** | 86.11 | kPa | ± 0.03 kPa |

***Evaluation Method***

***Tested with:***
PRMLxT1L. S/N 042622
377B02. S/N 163704

***Data reported in dB re 20 µPa.***

***Compliance Standards*** Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8378:

| | |
|---|---|
| IEC 60651:2001 Type 1 | ANSI S1.4-2014 Class 1 |
| IEC 60804:2000 Type 1 | ANSI S1.4 (R2006) Type 1 |
| IEC 61252:2002 | ANSI S1.11 (R2009) Class 1 |
| IEC 61260:2001 Class 1 | ANSI S1.25 (R2007) |
| IEC 61672:2013 Class 1 | ANSI S1.43 (R2007) Type 1 |

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the SI through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005.
**Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.**

The quality system is registered to ISO 9001:2008.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.



**Standards Used**

| Description | Cal Date | Cal Due | Cal Standard |
|---|---|---|---|
| SRS DS360 Ultra Low Distortion Generator | 06/24/2015 | 06/24/2016 | 006311 |
| Hart Scientific 2626-H Temperature Probe | 06/17/2015 | 06/17/2016 | 006798 |
| Larson Davis CAL200 Acoustic Calibrator | 08/12/2015 | 08/12/2016 | 007027 |
| Larson Davis Model 831 | 03/01/2016 | 03/01/2017 | 007182 |
| 1/2 inch Microphone - P - 0V | 03/07/2016 | 03/07/2017 | 007185 |
| Larson Davis CAL291 Residual Intensity Calibrator | 09/24/2015 | 09/24/2016 | 007287 |

Larson Davis, a division of PCB Piezotronics, Inc
1681 West 820 North
Provo, UT 84601, United States
716-684-0001

ACCREDITED Cert. #3622.01

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A PCB PIEZOTRONICS DIV.

## Acoustic Calibration

Measured according to IEC 61672-3:2013 10 and ANSI S1.4-2014 Part 3: 10

| Measurement | Test Result [dB] | Lower Limit [dB] | Upper Limit [dB] | Expanded Uncertainty [dB] | Result |
|---|---|---|---|---|---|
| 1000 Hz | 114.00 | 113.80 | 114.20 | 0.14 | Pass |

## Acoustic Signal Tests, C-weighting

Measured according to IEC 61672-3:2013 12 and ANSI S1.4-2014 Part 3: 12 using a comparison coupler with Unit Under Test (UUT) and reference SLM using S-time-weighted sound level

| Frequency [Hz] | Test Result [dB] | Expected [dB] | Lower Limit [dB] | Upper Limit [dB] | Expanded Uncertainty [dB] | Result |
|---|---|---|---|---|---|---|
| 125 | -0.21 | -0.20 | -1.20 | 0.80 | 0.21 | Pass |
| 1000 | 0.03 | 0.00 | -0.70 | 0.70 | 0.21 | Pass |
| 8000 | -2.39 | -3.00 | -5.50 | -1.50 | 0.21 | Pass |

**-- End of measurement results--**

## Self-generated Noise

Measured according to IEC 61672-3:2013 11.1 and ANSI S1.4-2014 Part 3: 11.1

| Measurement | Test Result [dB] |
|---|---|
| Low Range, 20 dB gain | 64.17 |

**-- End of measurement results--**

**-- End of Report--**

Signatory: *Ron Harris*

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1681 West 820 North
Provo, UT 84601, United States
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ACCREDITED Cert. #3622.01

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# Calibration Certificate

***Certificate Number 2016010424***

***Customer:***
**LAM Environmental Services Ltd**
**11/F Centre Point**
**181-185 Gloucester Road**
**Wanchai, , Hong Kong**

| | | | | | |
|---|---|---|---|---|---|
| ***Model Number*** | CAL200 | ***Procedure Number*** | D0001.8386 | | |
| ***Serial Number*** | 13128 | ***Technician*** | Scott Montgomery | | |
| ***Test Results*** | **Pass** | ***Calibration Date*** | 22 Nov 2016 | | |
| ***Initial Condition*** | Inoperable | ***Calibration Due*** | 22 Nov 2017 | | |
| | | ***Temperature*** | 24 | °C | ± 0.3 °C |
| ***Description*** | Larson Davis CAL200 Acoustic Calibrator | ***Humidity*** | 30 | %RH | ± 3 %RH |
| | | ***Static Pressure*** | 101.4 | kPa | ± 1 kPa |

***Evaluation Method*** The data is aquired by the insert voltage calibration method using the reference microphone's open circuit sensitivity. Data reported in dB re 20 µPa.

***Compliance Standards*** Compliant to Manufacturer Specifications per D0001.8190 and the following standards:
IEC 60942:2003 ANSI S1.40-2006

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the SI through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005.
**Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.**

The quality system is registered to ISO 9001:2008.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.



**Standards Used**

| Description | Cal Date | Cal Due | Cal Standard |
|---|---|---|---|
| Agilent 34401A DMM | 09/07/2016 | 09/07/2017 | 001021 |
| Sound Level Meter / Real Time Analyzer | 04/07/2016 | 04/07/2017 | 001051 |
| Microphone Calibration System | 08/17/2016 | 08/17/2017 | 005446 |
| 1/2" Preamplifier | 10/06/2016 | 10/06/2017 | 006506 |
| Larson Davis 1/2" Preamplifier 7-pin LEMO | 08/22/2016 | 08/22/2017 | 006507 |
| 1/2 inch Microphone - RI - 200V | 03/15/2016 | 03/15/2017 | 006510 |
| Pressure Transducer | 07/01/2016 | 07/01/2017 | 007368 |

## Output Level

| Nominal Level [dB] | Pressure [kPa] | Test Result [dB] | Lower limit [dB] | Upper limit [dB] | Expanded Uncertainty [dB] | Result |
|---|---|---|---|---|---|---|
| 94 | 101.4 | 94.00 | 93.80 | 94.20 | 0.14 | Pass |
| 114 | 101.4 | 114.00 | 113.80 | 114.20 | 0.13 | Pass |

**-- End of measurement results--**

## Frequency

| Nominal Level [dB] | Pressure [kPa] | Test Result [Hz] | Lower limit [Hz] | Upper limit [Hz] | Expanded Uncertainty [Hz] | Result |
|---|---|---|---|---|---|---|
| 94 | 101.4 | 999.97 | 990.00 | 1,010.00 | 0.20 | Pass |
| 114 | 101.4 | 999.95 | 990.00 | 1,010.00 | 0.20 | Pass |

**-- End of measurement results--**

## Total Harmonic Distortion + Noise (THD+N)

| Nominal Level [dB] | Pressure [kPa] | Test Result [%] | Lower limit [%] | Upper limit [%] | Expanded Uncertainty [%] | Result |
|---|---|---|---|---|---|---|
| 114 | 101.4 | 0.30 | 0.00 | 2.00 | 0.25 | Pass |
| 94 | 101.4 | 0.41 | 0.00 | 2.00 | 0.25 | Pass |

**-- End of measurement results--**

## Level Change Over Pressure

Tested at: 114 dB, 24 °C, 30 %RH

| Nominal Pressure [kPa] | Pressure [kPa] | Test Result [dB] | Lower limit [dB] | Upper limit [dB] | Expanded Uncertainty [dB] | Result |
|---|---|---|---|---|---|---|
| 101.3 | 101.1 | 0.00 | -0.30 | 0.30 | 0.04 ‡ | Pass |
| 108.0 | 108.0 | -0.05 | -0.30 | 0.30 | 0.04 ‡ | Pass |
| 92.0 | 91.9 | 0.04 | -0.30 | 0.30 | 0.04 ‡ | Pass |
| 83.0 | 83.0 | 0.04 | -0.30 | 0.30 | 0.04 ‡ | Pass |
| 74.0 | 74.0 | -0.03 | -0.30 | 0.30 | 0.04 ‡ | Pass |
| 65.0 | 64.9 | -0.21 | -0.30 | 0.30 | 0.04 ‡ | Pass |

**-- End of measurement results--**

## Frequency Change Over Pressure

Tested at: 114 dB, 24 °C, 30 %RH

| Nominal Pressure [kPa] | Pressure [kPa] | Test Result [Hz] | Lower limit [Hz] | Upper limit [Hz] | Expanded Uncertainty [Hz] | Result |
|---|---|---|---|---|---|---|
| 101.3 | 101.1 | 0.00 | -10.00 | 10.00 | 0.20 ‡ | Pass |
| 92.0 | 91.9 | 0.00 | -10.00 | 10.00 | 0.20 ‡ | Pass |
| 108.0 | 108.0 | -0.02 | -10.00 | 10.00 | 0.20 ‡ | Pass |
| 83.0 | 83.0 | 0.00 | -10.00 | 10.00 | 0.20 ‡ | Pass |
| 74.0 | 74.0 | 0.00 | -10.00 | 10.00 | 0.20 ‡ | Pass |
| 65.0 | 64.9 | 0.01 | -10.00 | 10.00 | 0.20 ‡ | Pass |

**-- End of measurement results--**

*Certificate Number 2016010424*

## Total Harmonic Distortion + Noise (THD+N) Over Pressure

Tested at: 114 dB, 24 °C, 30 %RH

| Nominal Pressure [kPa] | Pressure [kPa] | Test Result [%] | Lower limit [%] | Upper limit [%] | Expanded Uncertainty [%] | Result |
|---|---|---|---|---|---|---|
| 101.3 | 101.1 | 0.30 | 0.00 | 2.00 | 0.25 ‡ | Pass |
| 92.0 | 91.9 | 0.30 | 0.00 | 2.00 | 0.25 ‡ | Pass |
| 108.0 | 108.0 | 0.31 | 0.00 | 2.00 | 0.25 ‡ | Pass |
| 83.0 | 83.0 | 0.28 | 0.00 | 2.00 | 0.25 ‡ | Pass |
| 74.0 | 74.0 | 0.27 | 0.00 | 2.00 | 0.25 ‡ | Pass |
| 65.0 | 64.9 | 0.27 | 0.00 | 2.00 | 0.25 ‡ | Pass |

**-- End of measurement results--**

Signatory: Scott Montgomery

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ACCREDITED Cert. #3622.01

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# Calibration Data for High Volume Sampler (TSP Sampler)

| | | | | | |
|---|---|---|---|---|---|
| **Location** | : | Ning Po No.2 College | **Calibration Date** | : | 08-Feb-17 |
| **ID** | : | HVS003 | **Calibration Due Date** | : | 08-May-17 |

**CALIBRATION OF CONTINUOUS FLOW RECORDER**

| **Ambient Condition** | | | | | |
|---|---|---|---|---|---|
| **Temperature, $T_a$** | 291 | Kelvin | **Pressure, $P_a$** | 1017 | mmHg |

| **Orifice Transfer Standard Information** | | | | | |
|---|---|---|---|---|---|
| **Equipment No.** | **Ori002** | **Slope, $m_c$** | 2.10714 | **Intercept, bc** | -0.05158 |
| **Last Calibration Date** | 20-May-16 | $(H \times P_a / 1013.3 \times 298 / T_a)^{1/2}$ | | | |
| **Next Calibration Date** | 20-May-17 | $= m_c \times Q_{std} + b_c$ | | | |

**Calibration of TSP**

| **Calibration Point** | **Manometer Reading H (inches of water)** (up) | (down) | (difference) | **$Q_{std}$** ($m^3$ / min.) **X-axis** | **Continuous Flow Recorder, W** (CFM) | **IC** ($W(P_a/1013.3 \times 298/T_a)^{1/2}/35.31$) **Y-axis** |
|---|---|---|---|---|---|---|
| **1** | 1.2 | 1.2 | 2.4 | 0.7698 | 26 | 26.3588 |
| **2** | 2.0 | 2.0 | 4.0 | 0.9867 | 32 | 32.4417 |
| **3** | 3.1 | 3.1 | 6.2 | 1.2225 | 40 | 40.5521 |
| **4** | 4.0 | 4.0 | 8.0 | 1.3853 | 44 | 44.6073 |
| **5** | 5.4 | 5.4 | 10.8 | 1.6056 | 50 | 50.6901 |

By Linear Regression of Y on X

Slope, m = 29.4381 Intercept, b = 3.7810

Correlation Coefficient* = 0.9988

Calibration Accepted = Yes/~~No~~**

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

** Delete as appropriate.

Remarks : As per client's provided information, the equipment reference no. of the calibrated High Volume Sampler has been re-assigned from EL086 to HVS003 with respect to the update in quality management system.

| | | | | | |
|---|---|---|---|---|---|
| **Calibrated by** | : | Jackey MA | **Checked by** | : | Pauline Wong |
| **Date** | : | 08-Feb-17 | **Date** | : | 08-Feb-17 |

# Calibration Data for High Volume Sampler (TSP Sampler)

| | | | | | |
|---|---|---|---|---|---|
| **Location** | : | Ning Po No.2 College | **Calibration Date** | : | 05-May-17 |
| **ID** | : | HVS003 | **Calibration Due Date** | : | 05-Aug-17 |

**CALIBRATION OF CONTINUOUS FLOW RECORDER**

| Ambient Condition | | | | | |
|---|---|---|---|---|---|
| **Temperature, $T_a$** | 299 | Kelvin | **Pressure, $P_a$** | 1014 | mmHg |

| Orifice Transfer Standard Information | | | | | |
|---|---|---|---|---|---|
| **Equipment No.** | **Ori002** | **Slope, $m_c$** | 2.10714 | **Intercept, bc** | -0.05158 |
| **Last Calibration Date** | 20-May-16 | $(H \times P_a / 1013.3 \times 298 / T_a)^{1/2}$ | | | |
| **Next Calibration Date** | 20-May-17 | $= m_c \times Q_{std} + b_c$ | | | |

**Calibration of TSP**

| Calibration Point | Manometer Reading H (inches of water) (up) | (down) | (difference) | $Q_{std}$ ($m^3$ / min.) X-axis | Continuous Flow Recorder, W (CFM) | IC $(W(P_a/1013.3 \times 298/T_a)^{1/2}/35.31)$ Y-axis |
|---|---|---|---|---|---|---|
| 1 | 1.5 | 1.5 | 3.0 | 0.8454 | 22 | 21.9708 |
| 2 | 2.5 | 2.5 | 5.0 | 1.0843 | 31 | 30.9588 |
| 3 | 4.0 | 4.0 | 8.0 | 1.3650 | 36 | 35.9522 |
| 4 | 5.0 | 5.0 | 10.0 | 1.5232 | 41 | 40.9455 |
| 5 | 6.5 | 6.5 | 13.0 | 1.7333 | 48 | 47.9362 |

By Linear Regression of Y on X

Slope, m = 27.8279 Intercept, b = -0.9084

Correlation Coefficient* = 0.9933

Calibration Accepted = Yes/~~No~~**

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

** Delete as appropriate.

Remarks : As per client's provided information, the equipment reference no. of the calibrated High Volume Sampler has been re-assigned from EL086 to HVS003 with respect to the update in quality management system.

| | | | | | |
|---|---|---|---|---|---|
| **Calibrated by** | : | Jackey MA | **Checked by** | : | Pauline Wong |
| **Date** | : | 05-May-17 | **Date** | : | 05-May-17 |

Pilot Testing Limited
Room B12, Block B, 5/F, Tonic Industrial Centre, 19 Lam Hing Street, Kowloon Bay, Kowloon.
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TISCH Environmental

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# ORIFICE TRANSFER STANDARD CERTIFICATION WORKSHEET TE-5025A

Date - Mar 20, 2017 Rootsmeter S/N 0438320 Ta (K) - 293
Operator Tisch Orifice I.D. - 0005 Pa (mm) - 759.46

| PLATE OR Run # | VOLUME START (m3) | VOLUME STOP (m3) | DIFF VOLUME (m3) | DIFF TIME (min) | METER DIFF Hg (mm) | ORFICE DIFF H2O (in.) |
|---|---|---|---|---|---|---|
| 1 | NA | NA | 1.00 | 1.3960 | 3.2 | 2.00 |
| 2 | NA | NA | 1.00 | 0.9970 | 6.4 | 4.00 |
| 3 | NA | NA | 1.00 | 0.8910 | 7.8 | 5.00 |
| 4 | NA | NA | 1.00 | 0.8500 | 8.7 | 5.50 |
| 5 | NA | NA | 1.00 | 0.6990 | 12.7 | 8.00 |

## DATA TABULATION

| Vstd | (x axis) Qstd | (y axis) | | Va | (x axis) Qa | (y axis) |
|---|---|---|---|---|---|---|
| 1.0120 | 0.7249 | 1.4257 | | 0.9958 | 0.7133 | 0.8784 |
| 1.0078 | 1.0108 | 2.0163 | | 0.9916 | 0.9946 | 1.2423 |
| 1.0058 | 1.1288 | 2.2543 | | 0.9896 | 1.1107 | 1.3889 |
| 1.0047 | 1.1820 | 2.3643 | | 0.9885 | 1.1630 | 1.4567 |
| 0.9993 | 1.4296 | 2.8514 | | 0.9832 | 1.4066 | 1.7568 |
| Qstd slope (m) = | | 2.02533 | | Qa slope (m) = | | 1.26823 |
| intercept (b) = | | -0.03593 | | intercept (b) = | | -0.02214 |
| coefficient (r) = | | 0.99983 | | coefficient (r) = | | 0.99983 |
| y axis = SQRT[H2O(Pa/760)(298/Ta)] | | | | y axis = SQRT[H2O(Ta/Pa)] | | |

## CALCULATIONS

Vstd = Diff. Vol[(Pa-Diff. Hg)/760](298/Ta)
Qstd = Vstd/Time

Va = Diff Vol [(Pa-Diff Hg)/Pa]
Qa = Va/Time

For subsequent flow rate calculations:

Qstd = 1/m{[SQRT(H2O(Pa/760)(298/Ta))]- b}
Qa = 1/m{[SQRT H2O(Ta/Pa)]- b}