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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

$$Vstd = \text{Diff. Vol} [(Pa - \text{Diff. Hg}) / 760] (298 / Ta)$$

$$Qstd = Vstd / \text{Time}$$

$$Va = \text{Diff Vol} [(Pa - \text{Diff Hg}) / Pa]$$

$$Qa = Va / \text{Time}$$

For subsequent flow rate calculations:

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

$$Qa = 1/m \{ [\text{SQRT} H2O (Ta/Pa)] - b \}$$



# Certificate of Calibration

Calibration Certification Information			
Cal. Date: January 24, 2018	Rootsmeter S/N: 438320	Ta: 293	°K
Operator: Jim Tisch		Pa: 756.9	mm Hg
Calibration Model #: TE-5025A	Calibrator S/N: <b>3166</b>		

Run	Vol. Init (m3)	Vol. Final (m3)	ΔVol. (m3)	ΔTime (min)	ΔP (mm Hg)	ΔH (in H2O)
1	1	2	1	1.4430	3.2	2.00
2	3	4	1	1.0270	6.4	4.00
3	5	6	1	0.9220	7.9	5.00
4	7	8	1	0.8780	8.7	5.50
5	9	10	1	0.7270	12.6	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)
1.0087	0.6990	1.4233	0.9958	0.6901	0.8799
1.0044	0.9780	2.0129	0.9915	0.9655	1.2443
1.0024	1.0872	2.2505	0.9896	1.0733	1.3912
1.0013	1.1404	2.3603	0.9885	1.1259	1.4591
0.9961	1.3701	2.8467	0.9834	1.3526	1.7598
<b>QSTD</b>	<b>m=</b>	<b>2.12231</b>	<b>QA</b>	<b>m=</b>	<b>1.32895</b>
	<b>b=</b>	<b>-0.06016</b>		<b>b=</b>	<b>-0.03719</b>
	<b>r=</b>	<b>0.99999</b>		<b>r=</b>	<b>0.99999</b>

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

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



## Calibration Data for High Volume Sampler (TSP Sampler)

Location : CMA1b  
 Equipment no. : HVS001

Calibration Date : 08-Mar-18  
 Calibration Due Date : 08-May-18

### CALIBRATION OF CONTINUOUS FLOW RECORDER

Ambient Condition			
Temperature, T <sub>a</sub>	288	Kelvin	Pressure, P <sub>a</sub>
			1019 mmHg

Orifice Transfer Standard Information					
Equipment No.	Ori001	Slope, m <sub>c</sub>	2.02533	Intercept, b <sub>c</sub>	-0.03593
Last Calibration Date	20-Mar-17	$(H \times P_a / 1013.3 \times 298 / T_a)^{1/2}$ $m_c \times Q_{std} + b_c$			
Next Calibration Date	20-Mar-18				

Calibration of TSP						
Calibration Point	Manometer Reading			Q <sub>std</sub> (m <sup>3</sup> / min.) X-axis	Continuous Flow Recorder, W (CFM)	IC (W(P <sub>a</sub> /1013.3x298/T <sub>a</sub> ) <sup>1/2</sup> /35.31) Y-axis
	(up)	(down)	(difference)			
1	1.6	1.6	3.2	0.9187	28	28.5620
2	2.5	2.5	5.0	1.1439	36	36.7225
3	3.8	3.8	7.6	1.4062	44	44.8831
4	5.0	5.0	10.0	1.6104	52	53.0436
5	6.2	6.2	12.4	1.7913	60	61.2042

By Linear Regression of Y on X

Slope, m = 36.7366                      Intercept, b = -5.5976  
 Correlation Coefficient\* = 0.9978  
 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 EL452 to HVS001 with respect to the update in quality management system.

Calibrated by : Jackey MA  
 Date : 08-Mar-18

Checked by : Pauline Wong  
 Date : 08-Mar-18



## Calibration Data for High Volume Sampler (TSP Sampler)

Location : CMA1b  
 Equipment no. : HVS001

Calibration Date : 03-May-18  
 Calibration Due Date : 03-Jul-18

### CALIBRATION OF CONTINUOUS FLOW RECORDER

Ambient Condition			
Temperature, $T_a$	300	Kelvin	Pressure, $P_a$
			1014 mmHg

Orifice Transfer Standard Information					
Equipment No.	Ori002	Slope, $m_c$	2.12231	Intercept, $b_c$	-0.06016
Last Calibration Date	19-Jan-18	$(H \times P_a / 1013.3 \times 298 / T_a)^{1/2}$ $m_c \times Q_{std} + b_c$			
Next Calibration Date	19-Jan-19				

Calibration of TSP						
Calibration Point	Manometer Reading			$Q_{std}$ ( $m^3 / \text{min.}$ ) X-axis	Continuous Flow Recorder, W (CFM)	IC ( $W(P_a/1013.3 \times 298/T_a)^{1/2}/35.31$ ) Y-axis
	(up)	(down)	(difference)			
1	1.5	1.5	3.0	0.8420	24	23.9281
2	2.4	2.4	4.8	1.0576	32	31.9042
3	3.8	3.8	7.6	1.3234	40	39.8802
4	4.9	4.9	9.8	1.4990	46	45.8622
5	6.1	6.1	12.2	1.6692	52	51.8443

By Linear Regression of Y on X

Slope, m = 33.2506                      Intercept, b = -3.8183  
 Correlation Coefficient\* = 0.9995  
 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 EL452 to HVS001 with respect to the update in quality management system.

Calibrated by : Jackey MA  
 Date : 03-May-18

Checked by : Pauline Wong  
 Date : 03-May-18





## Calibration Data for High Volume Sampler (TSP Sampler)

Location : CMA2a Calibration Date : 08-Mar-18  
 Equipment no. : HVS002 Calibration Due Date : 08-May-18

### CALIBRATION OF CONTINUOUS FLOW RECORDER

Ambient Condition			
Temperature, $T_a$	288	Kelvin	Pressure, $P_a$
			1019 mmHg

Orifice Transfer Standard Information					
Equipment No.	Ori001	Slope, $m_c$	2.02533	Intercept, $b_c$	-0.03593
Last Calibration Date	20-Mar-17	$(H \times P_a / 1013.3 \times 298 / T_a)^{1/2}$ $m_c \times Q_{std} + b_c$			
Next Calibration Date	20-Mar-18				

Calibration of TSP						
Calibration Point	Manometer Reading			$Q_{std}$ ( $m^3 / \text{min.}$ ) X-axis	Continuous Flow Recorder, W (CFM)	IC ( $W(P_a/1013.3 \times 298/T_a)^{1/2}/35.31$ ) Y-axis
	(up)	(down)	(difference)			
1	1.6	1.6	3.2	0.9187	30	30.6021
2	2.5	2.5	5.0	1.1439	38	38.7627
3	3.9	3.9	7.8	1.4244	50	51.0035
4	5.2	5.2	10.4	1.6420	55	56.1038
5	6.5	6.5	13.0	1.8337	62	63.2443

By Linear Regression of Y on X

Slope, m = 35.6180 Intercept, b = -1.6563  
 Correlation Coefficient\* = 0.9966  
 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 EL449 to HVS002 with respect to the update in quality management system.

Calibrated by : Jackey MA Checked by : Pualine Wong  
 Date : 08-Mar-18 Date : 08-Mar-18



## Calibration Data for High Volume Sampler (TSP Sampler)

**Location** : CMA2a **Calibration Date** : 03-May-18  
**Equipment no.** : HVS002 **Calibration Due Date** : 03-Jul-18

### CALIBRATION OF CONTINUOUS FLOW RECORDER

Ambient Condition			
Temperature, $T_a$	300	Kelvin	Pressure, $P_a$
			1014 mmHg

Orifice Transfer Standard Information					
Equipment No.	Ori002	Slope, $m_c$	2.12231	Intercept, $b_c$	-0.06016
Last Calibration Date	19-Jan-18	$(H \times P_a / 1013.3 \times 298 / T_a)^{1/2}$ $m_c \times Q_{std} + b_c$			
Next Calibration Date	19-Jan-19				

Calibration of TSP						
Calibration Point	Manometer Reading			$Q_{std}$ ( $m^3 / min.$ ) X-axis	Continuous Flow Recorder, W (CFM)	IC ( $(W(P_a/1013.3 \times 298/T_a)^{1/2}/35.31)$ ) Y-axis
	(up)	(down)	(difference)			
1	1.6	1.6	3.2	0.8687	25	24.9251
2	2.5	2.5	5.0	1.0788	32	31.9042
3	4.0	4.0	8.0	1.3571	43	42.8712
4	5.1	5.1	10.2	1.5287	50	49.8503
5	6.5	6.5	13.0	1.7221	56	55.8323

By Linear Regression of Y on X

Slope,  $m$  = 37.0288 Intercept,  $b$  = -7.4710  
 Correlation Coefficient\* = 0.9991  
 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 EL449 to HVS002 with respect to the update in quality management system.

**Calibrated by** : Jackey MA **Checked by** : Pualine Wong  
**Date** : 03-May-18 **Date** : 03-May-18



## Calibration Data for High Volume Sampler (TSP Sampler)

Location : CMA3a  
 Equipment no. : HVS012

Calibration Date : 09-Mar-18  
 Calibration Due Date : 09-May-18

### CALIBRATION OF CONTINUOUS FLOW RECORDER

Ambient Condition						
Temperature, T <sub>a</sub>	288		Kelvin	Pressure, P <sub>a</sub>	1023 mmHg	
Orifice Transfer Standard Information						
Equipment No.	Ori001		Slope, m <sub>c</sub>	2.02533	Intercept, b <sub>c</sub>	-0.03593
Last Calibration Date	20-Mar-17		$(H \times P_a / 1013.3 \times 298 / T_a)^{1/2}$ $m_c \times Q_{std} + b_c$			
Next Calibration Date	20-Mar-18					
Calibration of TSP						
Calibration Point	Manometer Reading			Q <sub>std</sub> (m <sup>3</sup> / min.)  X-axis	Continuous Flow Recorder, W (CFM)	IC   Y-axis
	(up)	(down)	(difference)			
1	1.5	1.5	3.0	0.8918	34	34.7504
2	2.4	2.4	4.8	1.1234	40	40.8828
3	3.7	3.7	7.4	1.3905	48	49.0594
4	4.8	4.8	9.6	1.5813	54	55.1918
5	6.0	6.0	12.0	1.7659	59	60.3021
By Linear Regression of Y on X						
Slope, m		=	29.6409	Intercept, b		= 8.0050
Correlation Coefficient*		=	0.9995			
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 EL333 to HVS012 with respect to the update in quality management system.

Calibrated by : Jackey MA  
 Date : 09-Mar-18

Checked by : Pauline Wong  
 Date : 09-Mar-18



## Calibration Data for High Volume Sampler (TSP Sampler)

Location : CMA3a  
 Equipment no. : HVS012

Calibration Date : 04-May-18  
 Calibration Due Date : 04-Jul-18

### CALIBRATION OF CONTINUOUS FLOW RECORDER

Ambient Condition						
Temperature, T <sub>a</sub>	297		Kelvin	Pressure, P <sub>a</sub>	1016 mmHg	
Orifice Transfer Standard Information						
Equipment No.	Ori002		Slope, m <sub>c</sub>	2.12231	Intercept, b <sub>c</sub>	-0.06016
Last Calibration Date	19-Jan-18		$(H \times P_a / 1013.3 \times 298 / T_a)^{1/2}$ $m_c \times Q_{std} + b_c$			
Next Calibration Date	19-Jan-19					
Calibration of TSP						
Calibration Point	Manometer Reading			Q <sub>std</sub> (m <sup>3</sup> / min.) X-axis	Continuous Flow Recorder, W (CFM)	IC (W(P <sub>a</sub> /1013.3x298/T <sub>a</sub> ) <sup>1/2</sup> /35.31) Y-axis
	(up)	(down)	(difference)			
1	1.3	1.3	2.6	0.7904	32	32.0965
2	2.2	2.2	4.4	1.0197	38	38.1146
3	3.5	3.5	7.0	1.2787	46	46.1387
4	4.6	4.6	9.2	1.4618	50	50.1508
5	5.7	5.7	11.4	1.6240	56	56.1689
By Linear Regression of Y on X						
Slope, m		=	28.4850	Intercept, b		= 9.3566
Correlation Coefficient*		=	0.9982			
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 EL333 to HVS012 with respect to the update in quality management system.

Calibrated by : Jackey MA  
 Date : 04-May-18

Checked by : Pauline Wong  
 Date : 04-May-18





## Calibration Data for High Volume Sampler (TSP Sampler)

Location : CMA4a  
 Equipment no. : HVS004

Calibration Date : 09-Mar-18  
 Calibration Due Date : 09-May-18

### CALIBRATION OF CONTINUOUS FLOW RECORDER

Ambient Condition			
Temperature, $T_a$	288	Kelvin	Pressure, $P_a$
			1023 mmHg

Orifice Transfer Standard Information					
Equipment No.	Ori001	Slope, $m_c$	2.02533	Intercept, $b_c$	-0.03593
Last Calibration Date	20-Mar-17	$(H \times P_a / 1013.3 \times 298 / T_a)^{1/2}$ $m_c \times Q_{std} + b_c$			
Next Calibration Date	20-Mar-18				

Calibration of TSP						
Calibration Point	Manometer Reading			$Q_{std}$ ( $m^3 / min.$ )	Continuous Flow Recorder, W (CFM)	IC ( $W(P_a/1013.3 \times 298/T_a)^{1/2}/35.31$ )
	H (inches of water)					
	(up)	(down)	(difference)			
1	1.5	1.5	3.0	0.8918	28	28.6180
2	2.5	2.5	5.0	1.1462	38	38.8387
3	3.8	3.8	7.6	1.4089	48	49.0594
4	4.9	4.9	9.8	1.5975	54	55.1918
5	6.2	6.2	12.4	1.7948	62	63.3683

By Linear Regression of Y on X

Slope,  $m$  = 38.0787      Intercept,  $b$  = -5.0704  
 Correlation Coefficient\* = 0.9995  
 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 EL390 to HVS004 with respect to the update in quality management system.

Calibrated by : Jackey MA

Checked by : Pauline Wong

Date : 09-Mar-18

Date : 09-Mar-18



## Calibration Data for High Volume Sampler (TSP Sampler)

Location : CMA4a  
 Equipment no. : HVS004

Calibration Date : 04-May-18  
 Calibration Due Date : 04-Jul-18

### CALIBRATION OF CONTINUOUS FLOW RECORDER

Ambient Condition			
Temperature, $T_a$	297	Kelvin	Pressure, $P_a$
			1016 mmHg

Orifice Transfer Standard Information					
Equipment No.	Ori002	Slope, $m_c$	2.12231	Intercept, $b_c$	-0.06016
Last Calibration Date	19-Jan-18	$(H \times P_a / 1013.3 \times 298 / T_a)^{1/2}$ $m_c \times Q_{std} + b_c$			
Next Calibration Date	19-Jan-19				

Calibration of TSP						
Calibration Point	Manometer Reading			$Q_{std}$ ( $m^3 / min.$ ) <b>X-axis</b>	Continuous Flow Recorder, $W$ (CFM)	IC ( $W(P_a/1013.3 \times 298/T_a)^{1/2}/35.31$ ) <b>Y-axis</b>
	(up)	(down)	(difference)			
1	1.5	1.5	3.0	0.8469	24	24.0724
2	2.3	2.3	4.6	1.0420	34	34.1025
3	3.7	3.7	7.4	1.3140	44	44.1327
4	4.9	4.9	9.8	1.5078	50	50.1508
5	6.2	6.2	12.4	1.6926	56	56.1689

By Linear Regression of Y on X

Slope,  $m$  = 37.2631      Intercept,  $b$  = -5.9956  
 Correlation Coefficient\* = 0.9954  
 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 EL390 to HVS004 with respect to the update in quality management system.

Calibrated by : Jackey MA

Checked by : Pauline Wong

Date : 04-May-18

Date : 04-May-18



## Calibration Data for High Volume Sampler (TSP Sampler)

Location : CMA5b  
 Equipment no. : HVS010

Calibration Date : 09-Mar-18  
 Calibration Due Date : 09-May-18

### CALIBRATION OF CONTINUOUS FLOW RECORDER

Ambient Condition				
Temperature, T <sub>a</sub>	288	Kelvin	Pressure, P <sub>a</sub>	1023 mmHg

Orifice Transfer Standard Information					
Equipment No.	Ori001	Slope, m <sub>c</sub>	2.02533	Intercept, b <sub>c</sub>	-0.03593
Last Calibration Date	20-Mar-17	$(H \times P_a / 1013.3 \times 298 / T_a)^{1/2}$ $= m_c \times Q_{std} + b_c$			
Next Calibration Date	20-Mar-18				

Calibration of TSP						
Calibration Point	Manometer Reading			Q <sub>std</sub> (m <sup>3</sup> / min.) X-axis	Continuous Flow Recorder, W (CFM)	IC (W(P <sub>a</sub> /1013.3x298/T <sub>a</sub> ) <sup>1/2</sup> /35.31) Y-axis
	(up)	(down)	(difference)			
1	1.5	1.5	3.0	0.8918	32	32.7062
2	2.5	2.5	5.0	1.1462	40	40.8828
3	3.9	3.9	7.8	1.4271	48	49.0594
4	5.1	5.1	10.2	1.6294	54	55.1918
5	5.9	5.9	11.8	1.7512	59	60.3021

By Linear Regression of Y on X

Slope, m = 31.3759                      Intercept, b = 4.6699  
 Correlation Coefficient\* = 0.9989  
 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 EL222 to HVS010 with respect to the update in quality management system.

Calibrated by : Jackey MA  
 Date : 09-Mar-18

Checked by : Pauline Wong  
 Date : 09-Mar-18



## Calibration Data for High Volume Sampler (TSP Sampler)

Location : CMA5b  
 Equipment no. : HVS010

Calibration Date : 04-May-18  
 Calibration Due Date : 04-Jul-18

### CALIBRATION OF CONTINUOUS FLOW RECORDER

Ambient Condition			
Temperature, $T_a$	297	Kelvin	Pressure, $P_a$
			1016 mmHg

Orifice Transfer Standard Information				
Equipment No.	Ori002	Slope, $m_c$	2.12231	Intercept, $b_c$
Last Calibration Date	19-Jan-18	$(H \times P_a / 1013.3 \times 298 / T_a)^{1/2}$ $= m_c \times Q_{std} + b_c$		
Next Calibration Date	19-Jan-19			

Calibration of TSP						
Calibration Point	Manometer Reading			$Q_{std}$ ( $m^3 / min.$ ) X-axis	Continuous Flow Recorder, W (CFM)	IC ( $W(P_a/1013.3 \times 298/T_a)^{1/2}/35.31$ ) Y-axis
	H (inches of water)	(up)	(down)			
1	1.5	1.5	3.0	0.8469	30	30.0905
2	2.3	2.3	4.6	1.0420	38	38.1146
3	3.9	3.9	7.8	1.3483	46	46.1387
4	5.0	5.0	10.0	1.5229	52	52.1568
5	6.4	6.4	12.8	1.7192	56	56.1689

By Linear Regression of Y on X

Slope, m = 29.7383      Intercept, b = 5.9977  
 Correlation Coefficient\* = 0.9953  
 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 EL222 to HVS010 with respect to the update in quality management system.

Calibrated by : Jackey MA  
 Date : 04-May-18

Checked by : Pauline Wong  
 Date : 04-May-18



## Calibration Data for High Volume Sampler (TSP Sampler)

Location : MA1e  
 Equipment no. : HVS007

Calibration Date : 09-Mar-18  
 Calibration Due Date : 09-May-18

### CALIBRATION OF CONTINUOUS FLOW RECORDER

Ambient Condition			
Temperature, T <sub>a</sub>	288	Kelvin	Pressure, P <sub>a</sub>
			1023 mmHg

Orifice Transfer Standard Information			
Equipment No.	Ori001	Slope, m <sub>c</sub>	2.02533
		Intercept, b <sub>c</sub>	-0.03593
Last Calibration Date	20-Mar-17	$(H \times P_a / 1013.3 \times 298 / T_a)^{1/2}$ $m_c \times Q_{std} + b_c$	
Next Calibration Date	20-Mar-18		

Calibration of TSP						
Calibration Point	Manometer Reading			Q <sub>std</sub> (m <sup>3</sup> / min.) X-axis	Continuous Flow Recorder, W (CFM)	IC (W(P <sub>a</sub> /1013.3x298/T <sub>a</sub> ) <sup>1/2</sup> /35.31) Y-axis
	(up)	(down)	(difference)			
1	1.6	1.6	3.2	0.9205	30	30.6621
2	2.5	2.5	5.0	1.1462	38	38.8387
3	4.0	4.0	8.0	1.4451	48	49.0594
4	5.2	5.2	10.4	1.6452	54	55.1918
5	6.5	6.5	13.0	1.8373	62	63.3683

By Linear Regression of Y on X

Slope, m = 34.9949      Intercept, b = -1.5278  
 Correlation Coefficient\* = 0.9991  
 Calibration Accepted = Yes/No\*\*

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

Remarks : As per client's provided information, the equipment reference no. of the calibrated High Volume Sampler has been re-assigned from EL455 to HVS007 with respect to the update in quality management system.

Calibrated by : Jackey MA  
 Date : 09-Mar-18

Checked by : Pauline Wong  
 Date : 09-Mar-18



## Calibration Data for High Volume Sampler (TSP Sampler)

Location : MA1e  
 Equipment no. : HVS007

Calibration Date : 04-May-18  
 Calibration Due Date : 04-Jul-18

### CALIBRATION OF CONTINUOUS FLOW RECORDER

Ambient Condition			
Temperature, T <sub>a</sub>	297	Kelvin	Pressure, P <sub>a</sub>
			1016 mmHg

Orifice Transfer Standard Information			
Equipment No.	Ori002	Slope, m <sub>c</sub>	2.12231
		Intercept, b <sub>c</sub>	-0.06016
Last Calibration Date	19-Jan-18	$(H \times P_a / 1013.3 \times 298 / T_a)^{1/2}$ $m_c \times Q_{std} + b_c$	
Next Calibration Date	19-Jan-19		

Calibration of TSP						
Calibration Point	Manometer Reading			Q <sub>std</sub> (m <sup>3</sup> / min.) X-axis	Continuous Flow Recorder, W (CFM)	IC (W(P <sub>a</sub> /1013.3x298/T <sub>a</sub> ) <sup>1/2</sup> /35.31) Y-axis
	(up)	(down)	(difference)			
1	1.5	1.5	3.0	0.8469	26	26.0784
2	2.4	2.4	4.8	1.0638	34	34.1025
3	3.7	3.7	7.4	1.3140	44	44.1327
4	4.9	4.9	9.8	1.5078	50	50.1508
5	6.2	6.2	12.4	1.6926	58	58.1749

By Linear Regression of Y on X

Slope, m = 37.5826      Intercept, b = -5.7663  
 Correlation Coefficient\* = 0.9993  
 Calibration Accepted = Yes/No\*\*

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

Remarks : As per client's provided information, the equipment reference no. of the calibrated High Volume Sampler has been re-assigned from EL455 to HVS007 with respect to the update in quality management system.

Calibrated by : Jackey MA  
 Date : 04-May-18

Checked by : Pauline Wong  
 Date : 04-May-18





## Calibration Data for High Volume Sampler (TSP Sampler)

Location : MA1w  
 Equipment no. : HVS008

Calibration Date : 09-Mar-18  
 Calibration Due Date : 09-May-18

### CALIBRATION OF CONTINUOUS FLOW RECORDER

Ambient Condition			
Temperature, T <sub>a</sub>	288	Kelvin	Pressure, P <sub>a</sub>
			1023 mmHg

Orifice Transfer Standard Information			
Equipment No.	Ori001	Slope, m <sub>c</sub>	2.02533
		Intercept, b <sub>c</sub>	-0.03593
Last Calibration Date	20-Mar-17	$(H \times P_a / 1013.3 \times 298 / T_a)^{1/2}$ $= m_c \times Q_{std} + b_c$	
Next Calibration Date	20-Mar-18		

Calibration of TSP						
Calibration Point	Manometer Reading			Q <sub>std</sub> (m <sup>3</sup> / min.)  X-axis	Continuous Flow Recorder, W (CFM)	IC (W(P <sub>a</sub> /1013.3x298/T <sub>a</sub> ) <sup>1/2</sup> /35.31)  Y-axis
	(up)	(down)	(difference)			
1	1.6	1.6	3.2	0.9205	22	22.4855
2	2.5	2.5	5.0	1.1462	30	30.6621
3	3.8	3.8	7.6	1.4089	39	39.8607
4	5.0	5.0	10.0	1.6136	45	45.9932
5	6.4	6.4	12.8	1.8232	52	53.1476

By Linear Regression of Y on X

Slope, m = 33.7575                      Intercept, b = -8.2390  
 Correlation Coefficient\* = 0.9995  
 Calibration Accepted = Yes/No\*\*

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

Remarks : As per client's provided information, the equipment reference no. of the calibrated High Volume Sampler has been re-assigned from EL080 to HVS008 with respect to the update in quality management system.

Calibrated by : Jackey MA  
 Date : 09-Mar-18

Checked by : Pauline Wong  
 Date : 09-Mar-18



## Calibration Data for High Volume Sampler (TSP Sampler)

Location : MA1w  
 Equipment no. : HVS008

Calibration Date : 04-May-18  
 Calibration Due Date : 04-Jul-18

### CALIBRATION OF CONTINUOUS FLOW RECORDER

Ambient Condition			
Temperature, $T_a$	297	Kelvin	Pressure, $P_a$
			1016 mmHg

Orifice Transfer Standard Information				
Equipment No.	Ori002	Slope, $m_c$	2.12231	Intercept, $b_c$
Last Calibration Date	19-Jan-18	$(H \times P_a / 1013.3 \times 298 / T_a)^{1/2}$ $= m_c \times Q_{std} + b_c$		
Next Calibration Date	19-Jan-19			

Calibration of TSP						
Calibration Point	Manometer Reading			$Q_{std}$ ( $m^3 / min.$ )  X-axis	Continuous Flow Recorder, W (CFM)	IC ( $W(P_a/1013.3 \times 298 / T_a)^{1/2} / 35.31$ )  Y-axis
	(up)	(down)	(difference)			
1	1.5	1.5	3.0	0.8469	20	20.0603
2	2.4	2.4	4.8	1.0638	28	28.0844
3	3.7	3.7	7.4	1.3140	36	36.1086
4	4.8	4.8	9.6	1.4927	42	42.1267
5	6.2	6.2	12.4	1.6926	50	50.1508

By Linear Regression of Y on X

Slope, m = 34.9679                      Intercept, b = -9.5219  
 Correlation Coefficient\* = 0.9993  
 Calibration Accepted = Yes/No\*\*

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

Remarks : As per client's provided information, the equipment reference no. of the calibrated High Volume Sampler has been re-assigned from EL080 to HVS008 with respect to the update in quality management system.

Calibrated by : Jackey MA  
 Date : 04-May-18

Checked by : Pauline Wong  
 Date : 04-May-18



## CERTIFICATE OF CALIBRATION

Certificate No.: 18CA0322 01 Page 1 of 2

### 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 Geotechnics Ltd.  
Address of Customer: -  
Request No.: -  
Date of receipt: 22-Mar-2018

Date of test: 28-Mar-2018

### Reference equipment used in the calibration

Description:	Model:	Serial No.	Expiry Date:	Traceable to:
Multi function sound calibrator	B&K 4226	2288444	08-Sep-2018	CIGISMEC
Signal generator	DS 360	61227	01-Apr-2018	CEPREI

### Ambient conditions

Temperature:  $21 \pm 1$  °C  
Relative humidity:  $50 \pm 10$  %  
Air pressure:  $1005 \pm 5$  hPa

### Test specifications

- 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.
- 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  $\pm 20\%$ .
- 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 Jun Qi

Date: 06-Apr-2018

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.



## CERTIFICATE OF CALIBRATION

(Continuation Page)

Certificate No.: 18CA0322 01 Page 2 of 2

### 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	
Time weightings	Single Burst Fast	Pass	0.3	
	Single Burst Slow	Pass	0.3	
Peak response	Single 100µs rectangular pulse	N/A	N/A	
R.M.S. accuracy	Crest factor of 3	Pass	0.3	
	Time weighting I	Single burst 5 ms at 2000 Hz	Pass	0.3
Time averaging	Repeated at frequency of 100 Hz	Pass	0.3	
	1 ms burst duty factor 1/10 <sup>3</sup> at 4kHz	Pass	0.3	
	1 ms burst duty factor 1/10 <sup>4</sup> at 4kHz	Pass	0.3	
Pulse range	Single burst 10 ms at 4 kHz	Pass	0.4	
Sound exposure level	Single burst 10 ms at 4 kHz	Pass	0.4	
Overload indication	SPL	Pass	0.3	
	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.

- End -

Calibrated by:

Fung Chi Yip  
28-Mar-2018

Checked by:

Lam Tze Wai  
06-Apr-2018

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.: 18CA0213 02 Page 1 of 2

### Item tested

Description:	Sound Level Meter (Type 1)	Microphone	Preamp
Manufacturer:	B & K	B & K	B & K
Type/Model No.:	2250	4950	ZC0032
Serial/Equipment No.:	2701778	2755097	19223
Adaptors used:	-	-	-

### Item submitted by

Customer Name: Lam Geotechnics Limited.  
Address of Customer: -  
Request No.: -  
Date of receipt: 13-Feb-2018

Date of test: 21-Feb-2018

### Reference equipment used in the calibration

Description:	Model:	Serial No.	Expiry Date:	Traceable to:
Multi function sound calibrator	B&K 4226	2288444	08-Sep-2018	CIGISMEC
Signal generator	DS 360	33873	25-Apr-2018	CEPREI
Signal generator	DS 360	61227	01-Apr-2018	CEPREI

### Ambient conditions

Temperature:  $20 \pm 1$  °C  
Relative humidity:  $50 \pm 10$  %  
Air pressure:  $1000 \pm 5$  hPa

### Test specifications

- 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.
- 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  $\pm 20\%$ .
- 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.

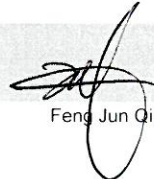
### Test results

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 Jun Qi

Date: 21-Feb-2018

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.



## CERTIFICATE OF CALIBRATION

(Continuation Page)

Certificate No.: 18CA0213 02 Page 2 of 2

### 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	
	C	Pass	0.8	
	Lin	Pass	1.6	
Linearity range for Leq	At reference range, Step 5 dB at 4 kHz	Pass	0.3	
	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	
Time weightings	Single Burst Fast	Pass	0.3	
	Single Burst Slow	Pass	0.3	
Peak response	Single 100µs rectangular pulse	Pass	0.3	
R.M.S. accuracy	Crest factor of 3	Pass	0.3	
Time weighting I	Single burst 5 ms at 2000 Hz	Pass	0.3	
	Repeated at frequency of 100 Hz	Pass	0.3	
Time averaging	1 ms burst duty factor 1/10 <sup>3</sup> at 4kHz	Pass	0.3	
	1 ms burst duty factor 1/10 <sup>4</sup> at 4kHz	Pass	0.3	
Pulse range	Single burst 10 ms at 4 kHz	Pass	0.4	
Sound exposure level	Single burst 10 ms at 4 kHz	Pass	0.4	
Overload indication	SPL	Pass	0.3	
	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.

- End -

Calibrated by:

Date:

Fung Chi Yip  
21-Feb-2018

Checked by:

Date:

Lam Tze Wai  
21-Feb-2018

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.: 18CA0309 01 Page 1 of 2

### Item tested

Description:	Sound Level Meter (Type 1)	Microphone	Preamp
Manufacturer:	B & K	B & K	B & K
Type/Model No.:	2250-L	4950	ZC0032
Serial/Equipment No.:	2722310	2698702	13318
Adaptors used:	-	-	-

### Item submitted by

Customer Name: Lam Geotechnics Ltd.  
Address of Customer: -  
Request No.: -  
Date of receipt: 09-Mar-2018

Date of test: 10-Mar-2018

### Reference equipment used in the calibration

Description:	Model:	Serial No.	Expiry Date:	Traceable to:
Multi function sound calibrator	B&K 4226	2288444	08-Sep-2018	CIGISMEC
Signal generator	DS 360	33873	25-Apr-2018	CEPREI
Signal generator	DS 360	61227	01-Apr-2018	CEPREI

### Ambient conditions

Temperature:  $21 \pm 1$  °C  
Relative humidity:  $50 \pm 10$  %  
Air pressure:  $1000 \pm 5$  hPa

### Test specifications

- 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.
- 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  $\pm 20\%$ .
- 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 responses 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 Jun Q.

Date: 12-Mar-2018

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.



## CERTIFICATE OF CALIBRATION

(Continuation Page)

Certificate No.: 18CA0309 01 Page 2 of 2

### 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	
	C	Pass	0.8	
	Lin	Pass	1.6	
Linearity range for Leq	At reference range, Step 5 dB at 4 kHz	Pass	0.3	
	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	
Linearity range for SPL	At reference range, Step 5 dB at 4 kHz	Pass	0.3	
	A	Pass	0.3	
Frequency weightings	C	Pass	0.3	
	Lin	Pass	0.3	
	Time weightings	Single Burst Fast	Pass	0.3
Peak response	Single Burst Slow	Pass	0.3	
	Single 100µs rectangular pulse	Pass	0.3	
R.M.S. accuracy	Crest factor of 3	Pass	0.3	
	Time weighting I	Single burst 5 ms at 2000 Hz	Pass	0.3
Time averaging	Repeated at frequency of 100 Hz	Pass	0.3	
	1 ms burst duty factor 1/10 <sup>3</sup> at 4kHz	Pass	0.3	
Pulse range	1 ms burst duty factor 1/10 <sup>4</sup> at 4kHz	Pass	0.3	
	Single burst 10 ms at 4 kHz	Pass	0.4	
Sound exposure level	Single burst 10 ms at 4 kHz	Pass	0.4	
	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.

- End -

Calibrated by:

Date: 10-Mar-2018

Fung Chi Yip

Checked by:

Date: 12-Mar-2018

Lam Tze Wai

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.: 18CA0413 02 Page 1 of 2

### Item tested

Description:	Sound Level Meter (Type 1)	Microphone	Preamp
Manufacturer:	B & K	B & K	B & K
Type/Model No.:	2250-L	4950	ZC0032
Serial/Equipment No.:	2722311	2698703	13321
Adaptors used:	-	-	-

### Item submitted by

Customer Name: Lam Geotechnics Ltd.  
Address of Customer: -  
Request No.: -  
Date of receipt: 13-Apr-2018

Date of test: 18-Apr-2018

### Reference equipment used in the calibration

Description:	Model:	Serial No.	Expiry Date:	Traceable to:
Multi function sound calibrator	B&K 4226	2288444	08-Sep-2018	CIGISMEC
Signal generator	DS 360	33873	25-Apr-2018	CEPREI

### Ambient conditions

Temperature:  $20 \pm 1$  °C  
Relative humidity:  $50 \pm 10$  %  
Air pressure:  $1000 \pm 5$  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  $\pm 20\%$ .
- 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: 18-Apr-2018

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.



## CERTIFICATE OF CALIBRATION

(Continuation Page)

Certificate No.: 18CA0413 02 Page 2 of 2

### 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	
	C	Pass	0.8	
	Lin	Pass	1.6	
Linearity range for Leq	At reference range, Step 5 dB at 4 kHz	Pass	0.3	
	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	
Linearity range for SPL	At reference range, Step 5 dB at 4 kHz	Pass	0.3	
	Frequency weightings			
Time weightings	A	Pass	0.3	
	C	Pass	0.3	
	Lin	Pass	0.3	
Peak response	Single Burst Fast	Pass	0.3	
	Single Burst Slow	Pass	0.3	
R.M.S. accuracy	Single 100µs rectangular pulse	Pass	0.3	
	Crest factor of 3	Pass	0.3	
Time weighting I	Single burst 5 ms at 2000 Hz	Pass	0.3	
	Repeated at frequency of 100 Hz	Pass	0.3	
Time averaging	1 ms burst duty factor 1/10 <sup>3</sup> at 4kHz	Pass	0.3	
	1 ms burst duty factor 1/10 <sup>4</sup> at 4kHz	Pass	0.3	
Pulse range	Single burst 10 ms at 4 kHz	Pass	0.4	
	Sound exposure level	Single burst 10 ms at 4 kHz	Pass	0.4
Overload indication	SPL	Pass	0.3	
	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.

- End -

Calibrated by:

Date:

Fung Chi Yip  
18-Apr-2018

Checked by:

Date:

Lam Tze Wai  
18-Apr-2018

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.: 18CA0116 01 Page 1 of 2

### Item tested

Description:	Sound Level Meter (Type 1)	Microphone	Preamp
Manufacturer:	B & K	B & K	B & K
Type/Model No.:	2250L	4950	ZC0032
Serial/Equipment No.:	3002695	2940839	18582
Adaptors used:	-	-	-

### Item submitted by

Customer Name: Lam Geotechnics Ltd.  
Address of Customer: -  
Request No.: -  
Date of receipt: 16-Jan-2018

Date of test: 18-Jan-2018

### Reference equipment used in the calibration

Description:	Model:	Serial No.	Expiry Date:	Traceable to:
Multi function sound calibrator	B&K 4226	2288444	08-Sep-2018	CIGISMEC
Signal generator	DS 360	33873	25-Apr-2018	CEPREI
Signal generator	DS 360	61227	01-Apr-2018	CEPREI

### Ambient conditions

Temperature:  $21 \pm 1$  °C  
Relative humidity:  $50 \pm 10$  %  
Air pressure:  $1005 \pm 5$  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  $\pm 20\%$ .
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 Jun Qi

Date: 18-Jan-2018

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.



## CERTIFICATE OF CALIBRATION

(Continuation Page)

Certificate No.: 18CA0116 01 Page 2 of 2

### 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	
	C	Pass	0.8	
	Lin	Pass	1.6	
Linearity range for Leq	At reference range , Step 5 dB at 4 kHz	Pass	0.3	
	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	
Linearity range for SPL	At reference range , Step 5 dB at 4 kHz	Pass	0.3	
	A	Pass	0.3	
	C	Pass	0.3	
Frequency weightings	Lin	Pass	0.3	
	Single Burst Fast	Pass	0.3	
	Single Burst Slow	Pass	0.3	
Peak response	Single 100µs rectangular pulse	Pass	0.3	
	R.M.S. accuracy	Crest factor of 3	Pass	0.3
Time weighting I	Single burst 5 ms at 2000 Hz	Pass	0.3	
	Repeated at frequency of 100 Hz	Pass	0.3	
Time averaging	1 ms burst duty factor 1/10 <sup>3</sup> at 4kHz	Pass	0.3	
	1 ms burst duty factor 1/10 <sup>4</sup> at 4kHz	Pass	0.3	
Pulse range	Single burst 10 ms at 4 kHz	Pass	0.4	
Sound exposure level	Single burst 10 ms at 4 kHz	Pass	0.4	
Overload indication	SPL	Pass	0.3	
	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.

- End -

Calibrated by:

Fung Chi Yip

Date: 18-Jan-2018

Checked by:

Lain Tze Wai

Date: 18-Jan-2018

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.: 17CA1110 02

Page: 1 of 2

### Item tested

Description: Acoustical Calibrator (Class 1)  
Manufacturer: Rion Co., Ltd.  
Type/Model No.: NC-73  
Serial/Equipment No.: 10707358  
Adaptors used: -

### Item submitted by

Customer: Lam Geotechnics Ltd.  
Address of Customer: -  
Request No.: -  
Date of receipt: 10-Nov-2017

Date of test: 14-Nov-2017

### Reference equipment used in the calibration

Description:	Model:	Serial No.	Expiry Date:	Traceable to:
Lab standard microphone	B&K 4180	2341427	11-Apr-2018	SCL
Preamplifier	B&K 2673	2239857	05-May-2018	CEPREI
Measuring amplifier	B&K 2610	2346941	03-May-2018	CEPREI
Signal generator	DS 360	61227	01-Apr-2018	CEPREI
Digital multi-meter	34401A	US36087050	25-Apr-2018	CEPREI
Audio analyzer	8903B	GB41300350	21-Apr-2018	CEPREI
Universal counter	53132A	MY40003662	22-Apr-2018	CEPREI

### Ambient conditions

Temperature:  $21 \pm 1$  °C  
Relative humidity:  $50 \pm 10$  %  
Air pressure:  $1010 \pm 5$  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:

Huang Jian Min/Feng Jun Qi

Date: 15-Nov-2017

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.



## CERTIFICATE OF CALIBRATION

(Continuation Page)

Certificate No.: 17CA1110 02

Page: 2 of 2

### 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.

Frequency Shown Hz	Output Sound Pressure Level Setting dB	Measured Output Sound Pressure Level dB	(Output level in dB re 20 $\mu$ Pa)
			Estimated Expanded Uncertainty dB
1000	94.00	93.93	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 = 0.008 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 = 991.5 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 = 0.3 %**

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:

  
Lai Sheng Jie  
Date: 14-Nov-2017

- End -

Checked by:

  
Fung Chi Yip  
Date: 15-Nov-2017

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.: 18CA0309 02 Page: 1 of 2

### Item tested

Description: Acoustical Calibrator (Class 1)  
Manufacturer: Larson Davis  
Type/Model No.: CAL200  
Serial/Equipment No.: 13098  
Adaptors used: -

### Item submitted by

Customer: Lam Environmental Service Ltd.  
Address of Customer: -  
Request No.: -  
Date of receipt: 09-Mar-2018

Date of test: 12-Mar-2018

### Reference equipment used in the calibration

Description:	Model:	Serial No.	Expiry Date:	Traceable to:
Lab standard microphone	B&K 4180	2341427	11-Apr-2018	SCL
Preamplifier	B&K 2673	2239857	05-May-2018	CEPREI
Measuring amplifier	B&K 2610	2346941	03-May-2018	CEPREI
Signal generator	DS 360	61227	01-Apr-2018	CEPREI
Digital multi-meter	34401A	US36087050	25-Apr-2018	CEPREI
Audio analyzer	8903B	GB41300350	21-Apr-2018	CEPREI
Universal counter	53132A	MY40003662	22-Apr-2018	CEPREI

### Ambient conditions

Temperature:  $21 \pm 1$  °C  
Relative humidity:  $50 \pm 10$  %  
Air pressure:  $1000 \pm 5$  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:  Date: 12-Mar-2018 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.



# CERTIFICATE OF CALIBRATION

(Continuation Page)

Certificate No.: 18CA0309 02

Page: 2 of 2

## 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.

Frequency Shown Hz	Output Sound Pressure Level Setting dB	Measured Output Sound Pressure Level dB	(Output level in dB re 20 µPa)	
			Estimated Uncertainty dB	Expanded Uncertainty dB
1000	94.0	93.81	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 = 1000.0 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 = 0.6 %**

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.

- End -

Calibrated by:

Fung Chi Yip

Date: 12-Mar-2018

Checked by:

Lam Tze Wai

Date: 12-Mar-2018

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.