

Certificate of Calibration

Calibration Certification Information

Cal. Date: October 21, 2019 **Rootsmeter S/N:** 438320 **Ta:** 295 °K
Operator: Jim Tisch **Pa:** 744.2 mm Hg
Calibration Model #: TE-5025A **Calibrator S/N:** 2456

Run	Vol. Init (m3)	Vol. Final (m3)	ΔVol. (m3)	ΔTime (min)	ΔP (mm Hg)	ΔH (in H2O)
1	1	2	1	1.4200	3.2	2.00
2	3	4	1	1.0180	6.3	4.00
3	5	6	1	0.9030	7.9	5.00
4	7	8	1	0.8620	8.8	5.50
5	9	10	1	0.7120	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)
0.9849	0.6936	1.4066	0.9957	0.7012	0.8904
0.9808	0.9635	1.9892	0.9915	0.9740	1.2592
0.9787	1.0838	2.2240	0.9894	1.0957	1.4078
0.9775	1.1340	2.3325	0.9882	1.1464	1.4765
0.9724	1.3658	2.8131	0.9831	1.3807	1.7808
QSTD	m=	2.08799	QA	m=	1.30746
	b=	-0.03545		b=	-0.02244
	r=	0.99989		r=	0.99989

Calculations

Vstd=	$\Delta Vol((Pa-\Delta P)/Pstd)(Tstd/Ta)$	Va=	$\Delta Vol((Pa-\Delta P)/Pa)$
Qstd=	$Vstd/\Delta Time$	Qa=	$Va/\Delta Time$
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

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**TSP SAMPLER CALIBRATION CALCULATION SPREADSHEET**

Project : Environmental Monitoring Works For Contract No. KLN/2015/07

Date of Calibration: 29-Nov-19

Location : KTD1a

Next Calibration Date: 28-Feb-20

Brand: Tisch

Technician: Tony Wan

Model: TE-5170

S/N: 4037

CONDITIONS

Sea Level Pressure (hPa): 1022.3 Corrected Pressure (mm Hg): 767
Temperature (°C): 19.7 Temperature (K): 293

CALIBRATION ORIFICE

Make: Tisch Qstd Slope: 2.08799
Model: TE-5025A Qstd Intercept: -0.03545
Calibration Date: 21-Oct-19 Expiry Date: 21-Oct-20
S/N: 2456

CALIBRATION

Plate No.	H2O (L) (in)	H2O (R) (in)	H2O (in)	Qstd (m ³ /min)	I (chart)	IC (corrected)	LINEAR REGRESSION
18	6.20	-6.10	12.300	1.719	52.00	52.70	Slope = 26.6948 Intercept = 5.6112 Corr. coeff.: 0.9921
13	4.70	-5.30	10.000	1.552	46.00	46.62	
10	3.90	-3.50	7.400	1.337	40.00	40.54	
7	2.40	-2.20	4.600	1.058	32.00	32.43	
5	1.20	-1.40	2.600	0.800	28.00	28.38	

Calculations: $Qstd = 1/m[\text{Sqrt}(H2O(Pa/Pstd)(Tstd/Ta)) - b]$ $IC = I[\text{Sqrt}(Pa/Pstd)(Tstd/Ta)]$

Qstd = standard flow rate

IC = corrected chart response

I = actual chart response

m = calibrator Qstd slope

b = calibrator Qstd intercept

Ta = actual temperature during calibration (deg K)

Pa = actual pressure during calibration (mm Hg)

Tstd = 298 deg K

Pstd = 760 mm Hg

For subsequent calculation of sampler flow: $1/m(I[\text{Sqrt}(298/Tav)(Pav/760)] - b)$

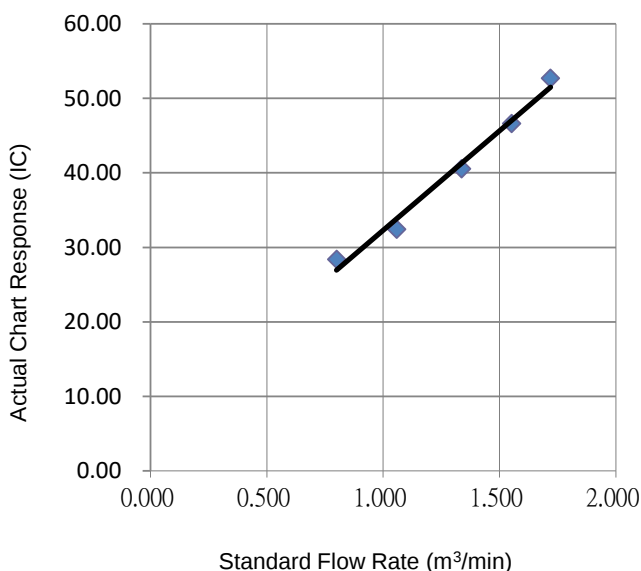
m = sampler slope

b = sampler intercept

I = chart response

Tav = daily average temperature

Pav = daily average pressure

FLOW RATE CHART

Wan Ka Ho
Project Consultant

Report Date: 1/12/2019

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**TSP SAMPLER CALIBRATION CALCULATION SPREADSHEET**

Project : Environmental Monitoring Works For Contract No. KLN/2015/07

Date of Calibration: 29-Nov-19

Location : KTD2b

Next Calibration Date: 28-Feb-20

Brand: Tisch

Technician: Tony Wan

Model: TE-5170

S/N: 3838

CONDITIONS

Sea Level Pressure (hPa): 1022.3 Corrected Pressure (mm Hg): 767
Temperature (°C): 19.7 Temperature (K): 293

CALIBRATION ORIFICE

Make: Tisch Qstd Slope: 2.08799
Model: TE-5025A Qstd Intercept: -0.03545
Calibration Date: 21-Oct-19 Expiry Date: 21-Oct-20
S/N: 2456

CALIBRATION

Plate No.	H2O (L) (in)	H2O (R) (in)	H2O (in)	Qstd (m ³ /min)	I (chart)	IC (corrected)	LINEAR REGRESSION
18	5.40	-5.10	10.500	1.590	50.00	50.68	Slope = 26.8950 Intercept = 7.9538 Corr. coeff.: 0.9961
13	4.20	-4.30	8.500	1.432	46.00	46.62	
10	2.80	-3.80	6.600	1.264	42.00	42.57	
7	2.00	-2.40	4.400	1.035	34.00	34.46	
5	1.00	-1.20	2.200	0.737	28.00	28.38	

Calculations: $Qstd = 1/m[\text{Sqrt}(H2O(Pa/Pstd)(Tstd/Ta)) - b]$ $IC = I[\text{Sqrt}(Pa/Pstd)(Tstd/Ta)]$

Qstd = standard flow rate

IC = corrected chart response

I = actual chart response

m = calibrator Qstd slope

b = calibrator Qstd intercept

Ta = actual temperature during calibration (deg K)

Pa = actual pressure during calibration (mm Hg)

Tstd = 298 deg K

Pstd = 760 mm Hg

For subsequent calculation of sampler flow: $1/m((I) [\text{Sqrt}(298/Tav)(Pav/760)] - b)$

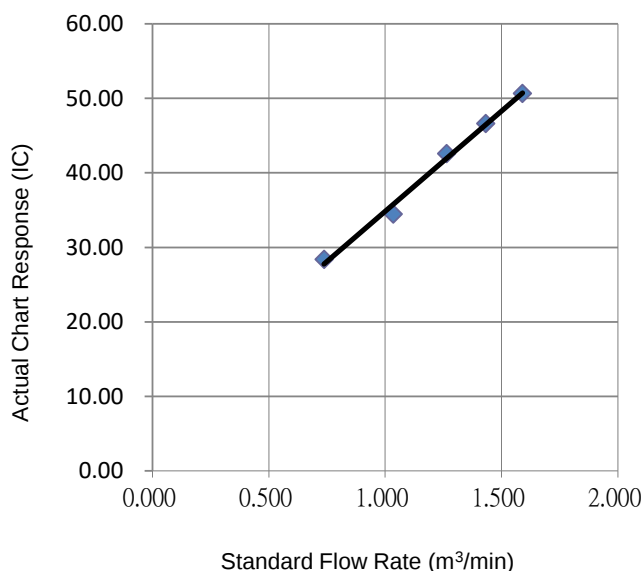
m = sampler slope

b = sampler intercept

I = chart response

Tav = daily average temperature

Pav = daily average pressure

FLOW RATE CHART

Wan Ka Ho
Project Consultant

Report Date: 1/12/2019

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**TSP SAMPLER CALIBRATION CALCULATION SPREADSHEET**

Project : Environmental Monitoring Works For Contract No. KLN/2015/07

Date of Calibration: 29-Nov-19

Location : KER1b

Next Calibration Date: 28-Feb-20

Brand: Tisch

Technician: Tony Wan

Model: TE-5170

S/N: 3482

CONDITIONS

Sea Level Pressure (hPa): 1022.3 Corrected Pressure (mm Hg): 767
Temperature (°C): 19.7 Temperature (K): 293

CALIBRATION ORIFICE

Make: Tisch Qstd Slope: 2.08799
Model: TE-5025A Qstd Intercept: -0.03545
Calibration Date: 21-Oct-19 Expiry Date: 21-Oct-20
S/N: 2456

CALIBRATION

Plate No.	H2O (L) (in)	H2O (R) (in)	H2O (in)	Qstd (m ³ /min)	I (chart)	IC (corrected)	LINEAR REGRESSION
18	6.20	-6.20	12.400	1.726	56.00	56.76	Slope = 29.6075 Intercept = 5.2880 Corr. coeff.: 0.9934
13	4.00	-4.60	8.600	1.440	48.00	48.65	
10	2.80	-3.40	6.200	1.226	40.00	40.54	
7	1.60	-2.80	4.400	1.035	34.00	34.46	
5	1.00	-1.60	2.600	0.800	30.00	30.41	

Calculations: $Qstd = 1/m[\sqrt{H2O(Pa/Pstd)(Tstd/Ta)}] - b$ $IC = I[\sqrt{Pa/Pstd)(Tstd/Ta)}]$

Qstd = standard flow rate

IC = corrected chart response

I = actual chart response

m = calibrator Qstd slope

b = calibrator Qstd intercept

Ta = actual temperature during calibration (deg K)

Pa = actual pressure during calibration (mm Hg)

Tstd = 298 deg K

Pstd = 760 mm Hg

For subsequent calculation of sampler flow: $1/m(I[\sqrt{298/Tav}(Pav/760)] - b)$

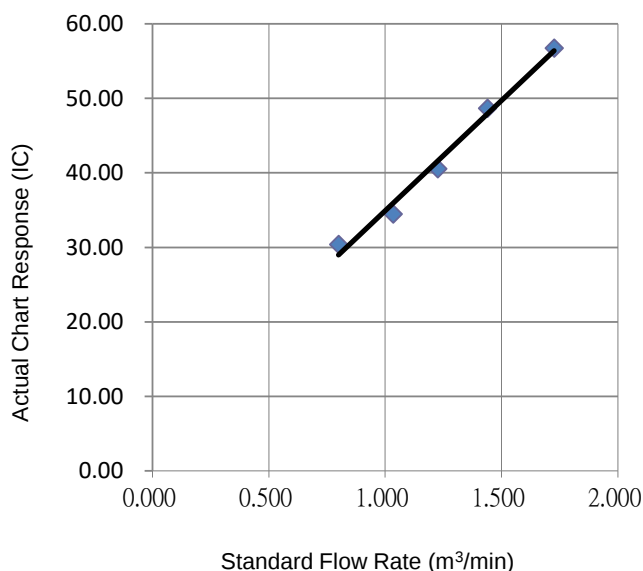
m = sampler slope

b = sampler intercept

I = chart response

Tav = daily average temperature

Pav = daily average pressure

FLOW RATE CHART

Wan Ka Ho
Project Consultant

Report Date: 1/12/2019

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Report no.: 183057CA196119(1)

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CALIBRATION CERTIFICATE OF SOUND LEVEL METER

Client Supplied Information

Client : Fugro Technical Services Ltd.

Project : Calibration Services

Details of Unit Under Test, UUT

Description : Sound Level Meter

Manufacturer : Casella

Model No.

Serial No.

Next Calibration Date : 25-Aug-2020

Specification Limit : EN 61672: 2003 Type 1

Meter	Microphone	Preamplifier
CEL-63X	CE-251	CEL-495
1488303	02650	003916

Laboratory Information

Description : B & K Acoustic Multifunction Calibrator 4226 (Traditional free field setting)

Equipment ID. : R-108-1

Date of Calibration : 26-Aug-2019 Ambient Temperature : 22 °C

Calibration Location : Calibration Laboratory of FTS

Method Used : By direct comparison

Calibration Results :

Parameters		Mean Value (dB)	Specification Limit(dB)
A-weighting frequency response	4000Hz	1.9	2.6 to -0.6
	2000Hz	1.6	2.8 to -0.4
	1000Hz	0.2	1.1 to -1.1
	500Hz	-3.1	-1.8 to -4.6
	250Hz	-8.5	-7.2 to -10.0
	125Hz	-16.0	-14.6 to -17.6
	63Hz	-26.0	-24.7 to -27.7
	31.5Hz	-39.0	-37.4 to -41.4
Differential level linearity	94dB-104dB	0.0	± 0.6
	104dB-114dB	0.0	± 0.6

Remarks :

1. The equipment used in this calibration is traceable to recognized National Standards.
2. The mean value is the average of four measurements.
3. For calibration: Reference SPL are 94, 104 & 114dB, range setting is 20-140dB & time weighting is fast
4. The equipment does comply with EN 61672: 2003 Type 1 sound level meter for the above measurement.
5. The values given in this Calibration Certificate only relate to the unit-under-test and the values measured at the time of the test. Uncertainties will not include allowances for the environmental changes, variation and shock during transportation, or the capability of any other laboratory to repeat the measurement.

Checked by : William Date : 5-9-2019 Certified by : K. Leung Date : 6-9-2019
CA-R-297 (22/07/2009) Leung Kwok Tai (Assistant Manager)

** End of Report **

Report no.: 183057CA196458

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CALIBRATION CERTIFICATE OF SOUND LEVEL METER

Client Supplied Information

Client : Fugro Technical Services Ltd.

Project : Calibration Services

Details of Unit Under Test, UUT

Description : Sound Level Meter

Manufacturer : Casella

	Meter	Microphone	Preamplifier
Model No.	CEL-63X	CE-251	CEL-495
Serial No.	2451048	02789	004065

Equipment ID : N/A

Next Calibration Date : 21-Nov-2020

Specification Limit : EN 61672: 2003 Type 1

Laboratory Information

Details of Reference Equipment -

Description : B & K Acoustic Multifunction Calibrator 4226 (Traditional free field setting)

Equipment ID : R-108-1

Date of Calibration : 22-Nov-2019 Ambient Temperature : 22 °C

Calibration Location : Calibration Laboratory of FTS

Method Used : By direct comparison

Calibration Results :

Parameters		Mean Value (dB)	Specification Limit(dB)
A-weighting frequency response	4000Hz	1.9	2.6 to -0.6
	2000Hz	1.5	2.8 to -0.4
	1000Hz	0.0	1.1 to -1.1
	500Hz	-3.4	-1.8 to -4.6
	250Hz	-8.8	-7.2 to -10.0
	125Hz	-16.2	-14.6 to -17.6
	63Hz	-26.2	-24.7 to -27.7
	31.5Hz	-38.9	-37.4 to -41.4
Differential level linearity	94dB-104dB	0.0	± 0.6
	104dB-114dB	0.0	± 0.6

Remarks :

1. The equipment used in this calibration is traceable to recognized National Standards.
2. The mean value is the average of four measurements.
3. For calibration: Reference SPL are 94, 104 & 114dB, range setting is 20-140dB & time weighting is fast
4. The equipment does comply with EN 61672: 2003 Type 1 sound level meter for the above measurement.

Checked by : William Date : 27-11-2019 Certified by : K. Kwok Date : 28-11-2019

CA-R-297 (22/07/2009)

Leung Kwok Tai (Assistant Manager)

** End of Report **

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MaterialLab

Report no.: 183057CA196350(4)

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CALIBRATION CERTIFICATE OF SOUND CALIBRATOR

Client Supplied Information

Client : Fugro Technical Services Ltd.

Project : Calibration Services

Details of Unit Under Test, UUT

Description : Sound Calibrator
Manufacturer : Casella (Model CEL-120/1)
Serial No. : 2383707
Equipment ID : N/A
Next Calibration Date : 23-Oct-2020
Specification Limit : EN 60942: 2003 Type 1

Laboratory Information

Description : Reference Sound level meter
Equipment ID. : R-119-1
Date of Calibration : 24-Oct-2019 Ambient Temperature : 22 °C
Calibration Location : Calibration Laboratory of FTS
Method Used : By direct comparison

Calibration Results :

Parameters (Setting of UUT)	Mean Value (error of measurement)	Specification Limit(dB)
94dB	-0.2 dB	±0.4dB
114dB	-0.1 dB	

Remarks :

1. The equipment used in this calibration is traceable to recognized National Standards.
2. The mean value is the average of four measurements.
3. The equipment does comply with the specification limit.
4. The values given in this Calibration Certificate only relate to the values at the time of the test and any uncertainties will not include allowance for the equipment long term drift, variations with environment changes, vibration and shock during transportation, overloading, mis-handling or the capability of any other laboratory to repeat the measurement.

Checked by : William Date : 1-11-2019 Certified by : R. L. Tse Date : 1-11-2019
CA-R-297 (22/07/2009) Leung Kwok Tai (Assistant Manager)

** End of Report **

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Report no.: 183057CA195873(1)

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CALIBRATION CERTIFICATE OF SOUND CALIBRATOR

Client Supplied Information

Client : Fugro Technical Services Ltd.

Project : Calibration Services

Details of Unit Under Test, UUT

Description : Sound Calibrator
Manufacturer : Casella (Model CEL-120/1)
Serial No. : 4358251
Equipment ID : N-34
Next Calibration Date : 25-Jul-2020
Specification Limit : EN 60942: 2003 Type 1

Laboratory Information

Description : Reference Sound level meter
Equipment ID. : R-119-1
Date of Calibration : 26-Jul-2019 Ambient Temperature : 22 °C
Calibration Location : Calibration Laboratory of MaterialLab
Method Used : By direct comparison

Calibration Results :

Parameters (Setting of UUT)	Mean Value (error of measurement)	Specification Limit(dB)
94dB	-0.1 dB	±0.4dB
114dB	0.0 dB	

Remarks :

1. The equipment used in this calibration is traceable to recognized National Standards.
2. The mean value is the average of four measurements.
3. The equipment does comply with the specification limit.
4. The values given in this Calibration Certificate only relate to the values at the time of the test and any uncertainties will not include allowance for the equipment long term drift, variations with environment changes, vibration and shock during transportation, overloading, mis-handling or the capability of any other laboratory to repeat the measurement.

Checked by : William Date : 26-7-2019 Certified by : P.T. Leung Date : 26-7-2019
CA-R-297 (22/07/2009)

Leung Kwok Tai (Assistant Manager)

** End of Report **

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Report No. : 183057CA195782(1)

Page 1 of 1

CALIBRATION CERTIFICATE OF ANEMOMETER

Client Supplied Information

Client : Fugro Technical Services Ltd.

Project : Calibration Services

Details of Unit Under Test, UUT

Description : Anemometer

Manufacturer : Benetech

Model No. : GM816

Serial No. : N/A

Equipment ID. : WS-08

Next Calibration Date : 17-Jun-2020

Laboratory Information

Details of Reference Equipment –

Description : Reference Anemometer

Equipment ID. : R-101-4

Date of Calibration : 18-Jun-2019 Ambient Temperature : 22 °C

Calibration Location : Calibration Laboratory of FTS

Method Used : R-C-279

Calibration Results :

Reference Reading (m/s)	UUT Reading (m/s)	Error (m/s)
2.05	1.0	-1.1
4.08	3.1	-1.0
6.07	4.8	-1.3
8.03	6.7	-1.3
10.14	8.8	-1.3

Remark :

1. The equipment being used in this calibration is traceable to recognized National Standards.

Checked by : William Date : 20-6-2019 Certified by : K.T. Leung Date : 24-6-2019
CA-R-297 (22/07/2009) Leung Kwok Tai (Assistant Manager)

** End of Report **