



Certificate of Calibration

Calibration Certification Information			
Cal. Date: October 17, 2018	Rootsmeter S/N: 438320	Ta: 294	°K
Operator: Jim Tisch		Pa: 755.7	mm Hg
Calibration Model #: TE-5025A	Calibrator S/N: 2154		

Run	Vol. Init (m3)	Vol. Final (m3)	ΔVol. (m3)	ΔTime (min)	ΔP (mm Hg)	ΔH (in H2O)
1	1	2	1	1.4590	3.2	2.00
2	3	4	1	1.0410	6.4	4.00
3	5	6	1	0.9310	7.9	5.00
4	7	8	1	0.8840	8.8	5.50
5	9	10	1	0.7320	12.7	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)
1.0035	0.6878	1.4197	0.9958	0.6825	0.8821
0.9993	0.9599	2.0078	0.9915	0.9525	1.2475
0.9973	1.0712	2.2448	0.9895	1.0629	1.3948
0.9961	1.1268	2.3543	0.9884	1.1180	1.4628
0.9909	1.3536	2.8394	0.9832	1.3432	1.7642
QSTD	m=	2.13015	QA	m=	1.33386
	b=	-0.04186		b=	-0.02601
	r=	0.99996		r=	0.99996

Calculations			
Vstd=	$\Delta Vol \left(\frac{Pa - \Delta P}{Pstd} \right) \left(\frac{Tstd}{Ta} \right)$	Va=	$\Delta Vol \left(\frac{Pa - \Delta P}{Pa} \right)$
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

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TSP SAMPLER CALIBRATION CALCULATION SPREADSHEET

Project : Environmental Monitoring Works For Contract No. KLN/2015/07				Date of Calibration: 17-Sep-19	
Location : KER1b				Next Calibration Date: 16-Dec-19	
Brand:	Tisch		Technician: Tony Wan		
Model:	TE-5170	S/N:	3482		

CONDITIONS					
Sea Level Pressure (hPa):	1009.0	Corrected Pressure (mm Hg):	757		
Temperature (°C):	29.2	Temperature (K):	302		

CALIBRATION ORIFICE					
Make:	Tisch	Qstd Slope:	2.13015		
Model:	TE-5025A	Qstd Intercept:	-0.04186		
Calibration Date:	17-Oct-18	Expiry Date:	17-Oct-19		
S/N:	2154				

CALIBRATION							
Plate No.	H2O (L) (in)	H2O (R) (in)	H2O (in)	Qstd (m ³ /min)	I (chart)	IC (corrected)	LINEAR REGRESSION
18	4.00	-8.10	12.100	1.638	51.00	50.54	Slope = 28.2944 Intercept = 4.4062 Corr. coeff.: 0.9984
13	2.50	-7.00	9.500	1.453	46.00	45.58	
10	1.40	-6.10	7.500	1.294	42.00	41.62	
7	0.90	-5.40	6.300	1.187	38.00	37.66	
5	0.60	-4.20	4.800	1.039	34.00	33.69	

Calculations:

$$Q_{std} = 1/m[\sqrt{(H_2O(Pa/P_{std})(T_{std}/T_a))}] - b]$$

$$IC = I[\sqrt{(Pa/P_{std})(T_{std}/T_a)}]$$

Qstd = standard flow rate

IC = corrected chart response

I = actual chart response

m = calibrator Qstd slope

b = calibrator Qstd intercept

T_a = actual temperature during calibration (deg K)

P_a = actual pressure during calibration (mm Hg)

T_{std} = 298 deg K

P_{std} = 760 mm Hg

For subsequent calculation of sampler flow:

$$1/m((I)[\sqrt{(298/T_{av})(P_{av}/760)}] - b)$$

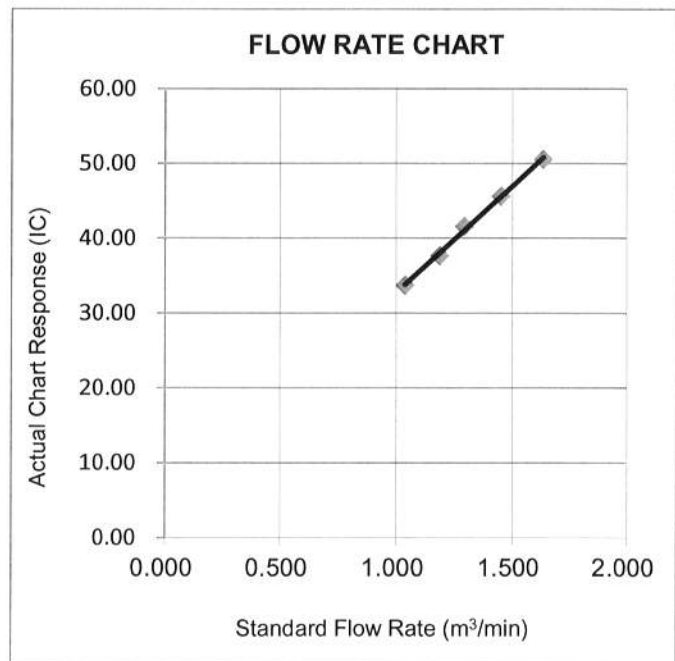
m = sampler slope

b = sampler intercept

I = chart response

T_{av} = daily average temperature

P_{av} = daily average pressure



Wan Ka Ho
Project Consultant

Report Date: 20-Sep-2019

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TSP SAMPLER CALIBRATION CALCULATION SPREADSHEET

Project : Environmental Monitoring Works For Contract No. KLN/2015/07 Date of Calibration: 17-Sep-19
Location : KTD1a Next Calibration Date: 16-Dec-19
Brand: Tisch Technician: Tony Wan
Model: TE-5170 S/N: 4037

CONDITIONS

Sea Level Pressure (hPa): 1009.0 Corrected Pressure (mm Hg): 757
Temperature (°C): 29.2 Temperature (K): 302

CALIBRATION ORIFICE

Make: Tisch Qstd Slope: 2.13015
Model: TE-5025A Qstd Intercept: -0.04186
Calibration Date: 17-Oct-18 Expiry Date: 17-Oct-19
S/N: 2154

CALIBRATION

Plate No.	H2O (L) (in)	H2O (R) (in)	H2O (in)	Qstd (m ³ /min)	I (chart)	IC (corrected)	LINEAR REGRESSION
18	6.20	-5.80	12.000	1.631	39.00	38.65	Slope = 32.5384
13	4.90	-5.10	10.000	1.491	33.00	32.70	Intercept = -15.3177
10	3.80	-3.60	7.400	1.285	27.00	26.76	Corr. coeff. 0.9922
7	2.50	-2.70	5.200	1.080	18.00	17.84	
5	1.40	-1.60	3.000	0.825	13.00	12.88	

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:

$$1/m((I) [\text{Sqrt}(298/Tav)(Pav/760)]-b)$$

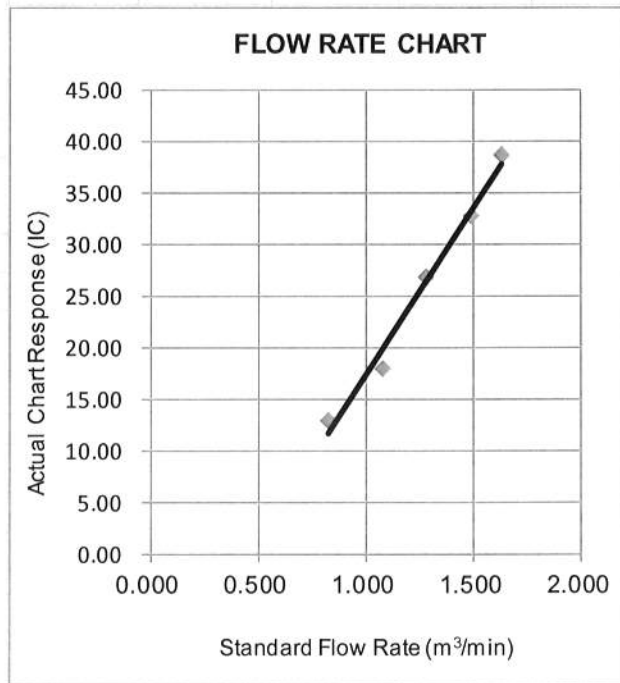
m = sampler slope

b = sampler intercept

I = chart response

Tav = daily average temperature

Pav = daily average pressure



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TSP SAMPLER CALIBRATION CALCULATION SPREADSHEET

Project : Environmental Monitoring Works For Contract No. KLN/2015/07
Date of Calibration: 17-Sep-19
Location : KTD2b
Next Calibration Date: 16-Dec-19
Brand: Tisch
Technician: Tony Wan
Model: TE-5170
S/N: 3838

CONDITIONS

Sea Level Pressure (hPa): 1009.0
Corrected Pressure (mm Hg): 757
Temperature (°C): 29.2
Temperature (K): 302

CALIBRATION ORIFICE

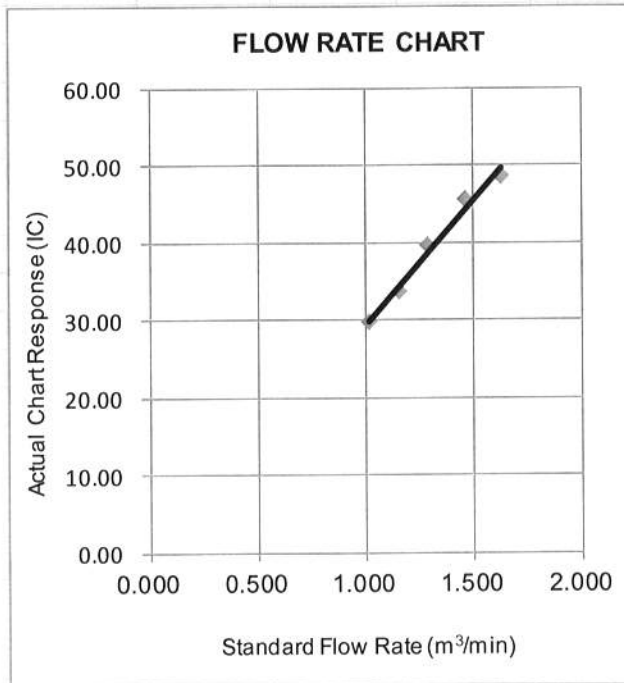
Make: Tisch
Qstd Slope: 2.13015
Model: TE-5025A
Qstd Intercept: -0.04186
Calibration Date: 17-Oct-18
Expiry Date: 17-Oct-19
S/N: 2154

CALIBRATION

Plate No.	H2O (L) (in)	H2O (R) (in)	H2O (in)	Qstd (m ³ /min)	I (chart)	IC (corrected)	LINEAR REGRESSION	
							Slope =	Intercept =
18	5.80	-6.20	12.000	1.631	49.00	48.56	32.1209	
13	4.90	-4.80	9.700	1.469	46.00	45.58	-2.7664	
10	4.20	-3.30	7.500	1.294	40.00	39.64	0.9921	
7	3.70	-2.30	6.000	1.159	34.00	33.69		
5	3.40	-1.20	4.600	1.017	30.00	29.73		

Calculations:

Qstd = $1/m[\text{Sqrt}(\text{H2O}(\text{Pa}/\text{Pstd})(\text{Tstd}/\text{Ta})) - b]$
 IC = $I[\text{Sqrt}(\text{Pa}/\text{Pstd})(\text{Tstd}/\text{Ta})]$
 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:
 $1/m((I)[\text{Sqrt}(298/\text{Tav})(\text{Pav}/760)] - b)$
 m = sampler slope
 b = sampler intercept
 I = chart response
 Tav = daily average temperature
 Pav = daily average pressure



Report Date: 20-Sep-2019

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Report no.: 183057CA196181

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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 : 01-Oct-2020

Specification Limit : EN 61672: 2003 Type 1

Meter	Microphone	Preamplifier
CEL-63X	CE-251	CEL-495
1488272	02552	003942

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 : 02-Oct-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	2.0
	2000Hz	1.4
	1000Hz	0.0
	500Hz	-3.4
	250Hz	-8.8
	125Hz	-16.3
	63Hz	-26.3
	31.5Hz	-39.3
Differential level linearity	94dB-104dB	± 0.6
	104dB-114dB	± 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 : 4-10-2019 Certified by : KL Leung Date : 6-10-2019

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

Leung Kwok Tai (Assistant Manager)

** End of Report **

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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 : 10-Sep-2020

Specification Limit : EN 61672: 2003 Type 1

Meter	Microphone	Preamplifier
CEL-63X	CE-251	CEL-495
1488287	02695	003984

Laboratory Information

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

Equipment ID. : R-108-1

Date of Calibration : 11-Sep-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	-0.2
	2000Hz	0.7
	1000Hz	-0.1
	500Hz	-3.3
	250Hz	-8.7
	125Hz	-16.1
	63Hz	-26.1
	31.5Hz	-38.5
Differential level linearity	94dB-104dB	± 0.6
	104dB-114dB	± 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 : 18-9-2019 Certified by : R.T. Leung Date : 18-9-2019
CA-R-297 (22/07/2009) Leung Kwok Tai (Assistant Manager)

** End of Report **

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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
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** End of Report **

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Report no.: 183057CA195873(2)

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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. : 4358250
Equipment ID : N-33
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 FTS
Method Used : By direct comparison

Calibration Results :

Parameters (Setting of UUT)	Mean Value (error of measurement)	Specification Limit(dB)
94dB	0.0 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 : F. T. Leung Date : 26-7-2019
CA-R-297 (22/07/2009) Leung Kwok Tai (Assistant Manager)

** End of Report **

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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

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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-07

Next Calibration Date : 07-Jun-2020

Laboratory Information

Details of Reference Equipment --

Description : Reference Anemometer

Equipment ID.: R-101-4

Date of Calibration : 08-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)
2.06	1.9	-0.2
4.02	4.4	0.4
6.05	6.5	0.5
8.06	8.6	0.5
10.25	10.1	-0.2

Remark :

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

Checked by : William Date : 20-6-2019 Certified by : Kit Leung Date : 24-6-2019
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** End of Report **