TISCH Environmental

RECALIBRATION DUE DATE:
September 11, 2021

Certificate of Calibration

Calibration Certification Information					
Cal. Date:	September 11, 2020	**Rootsmeter S/N:** 438320	**Ta:** 297	°K	
Operator:	Jim Tisch		**Pa:** 755.4	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	1.4510	3.3	2.00
2	3	4	1	1.0340	6.4	4.00
3	5	6	1	0.9260	8.0	5.00
4	7	8	1	0.8780	8.9	5.50
5	9	10	1	0.7250	13.0	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)	$\sqrt{\Delta H\left(Ta/Pa\right)}$ (y-axis)
0.9929	0.6843	1.4123	0.9956	0.6862	0.8868
0.9888	0.9563	1.9973	0.9915	0.9589	1.2541
0.9867	1.0656	2.2330	0.9894	1.0685	1.4021
0.9855	1.1225	2.3420	0.9882	1.1255	1.4705
0.9801	1.3519	2.8246	0.9828	1.3556	1.7735
QSTD	**m=**	**2.11508**	**QA**	**m=**	**1.32442**
	b=	**-0.02962**		**b=**	**-0.01860**
	r=	**0.99993**		**r=**	**0.99993**

Calculations

Vstd=	ΔVol((Pa-ΔP)/Pstd)(Tstd/Ta)	**Va=**	ΔVol((Pa-ΔP)/Pa)
Qstd=	Vstd/ΔTime	**Qa=**	Va/ΔTime

For subsequent flow rate calculations:

Qstd= $1/m\left(\left(\sqrt{\Delta H\left(\frac{Pa}{Pstd}\right)\left(\frac{Tstd}{Ta}\right)}\right)-b\right)$

Qa= $1/m\left(\left(\sqrt{\Delta H\left(Ta/Pa\right)}\right)-b\right)$

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

isch Environmental, Inc.
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FAX: (513)467-9009

FUGRO TECHNICAL SERVICES LIMITED
Room 723 & 725, 7/F, Block B,
Profit Industrial Building,
1-15 Kwai Fung Crescent, Kwai Fong,
Hong Kong.

TSP SAMPLER CALIBRATION CALCULATION SPREADSHEET

Project : Contract No. HY/2019/01 - Hong Kong-Zhuhai-Macao Bridge — Date of Calibration: 24-Oct-20
Location : AMS2 — Next Calibration Date: 23-Jan-20
Brand: Tisch — Technician: Ting Chan
Model: TE-5170 S/N: HVS-01

CONDITIONS

Sea Level Pressure (hPa):	1013.9	Corrected Pressure (mm Hg):	760
Temperature (℃):	23.8	Temperature (K):	297

CALIBRATION ORIFICE

Make:	Tisch	Qstd Slope:	2.11508
Model:	TE-5025A	Qstd Intercept:	-0.02962
Calibration Date:	11-Sep-20	Expiry Date:	11-Sep-21
S/N:	2154		

CALIBRATION

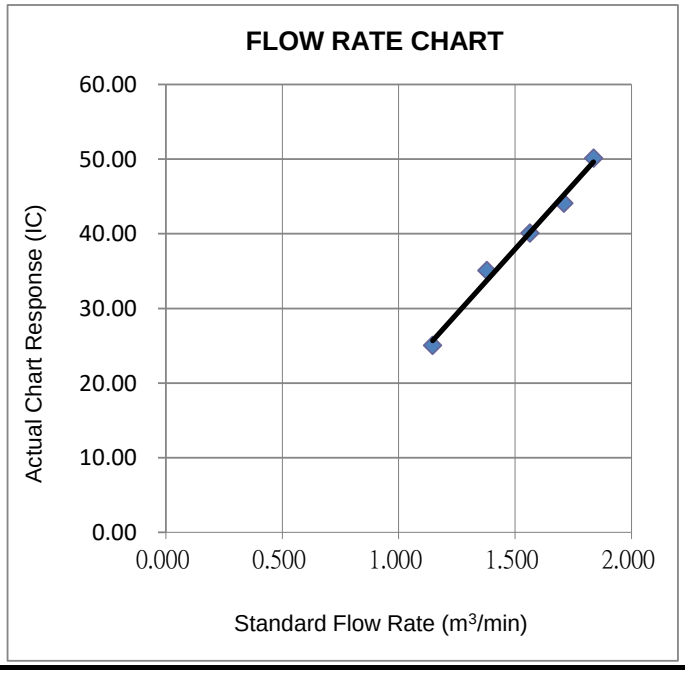
Plate No.	H2O (L) (in)	H2O (R) (in)	H2O (in)	Qstd (m^3/min)	I (chart)	IC (corrected)	LINEAR REGRESSION	
18	6.80	-8.00	14.800	1.837	50.00	50.12	Slope =	34.5919
13	6.00	-6.80	12.800	1.709	44.00	44.10	Intercept =	-13.9348
10	4.90	-5.80	10.700	1.564	40.00	40.09	Corr. coeff.=	0.9951
7	3.70	-4.60	8.300	1.379	35.00	35.08		
5	1.90	-3.80	5.700	1.145	25.00	25.06		

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



Report Date: 25/10/2020

Wan Ka Ho
Project Consultant

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TSP SAMPLER CALIBRATION CALCULATION SPREADSHEET

Project : Contract No. HY/2019/01 - Hong Kong-Zhuhai-Macao Bridge — Date of Calibration: 24-Oct-20
Location : AMS3C — Next Calibration Date: 23-Jan-20
Brand: Tisch — Technician: Ting Chan
Model: TE-5170 S/N: HVS-02

CONDITIONS

Sea Level Pressure (hPa):	1013.9	Corrected Pressure (mm Hg):	760
Temperature (℃):	23.8	Temperature (K):	297

CALIBRATION ORIFICE

Make:	Tisch	Qstd Slope:	2.11508
Model:	TE-5025A	Qstd Intercept:	-0.02962
Calibration Date:	11-Sep-20	Expiry Date:	11-Sep-21
S/N:	2154		

CALIBRATION

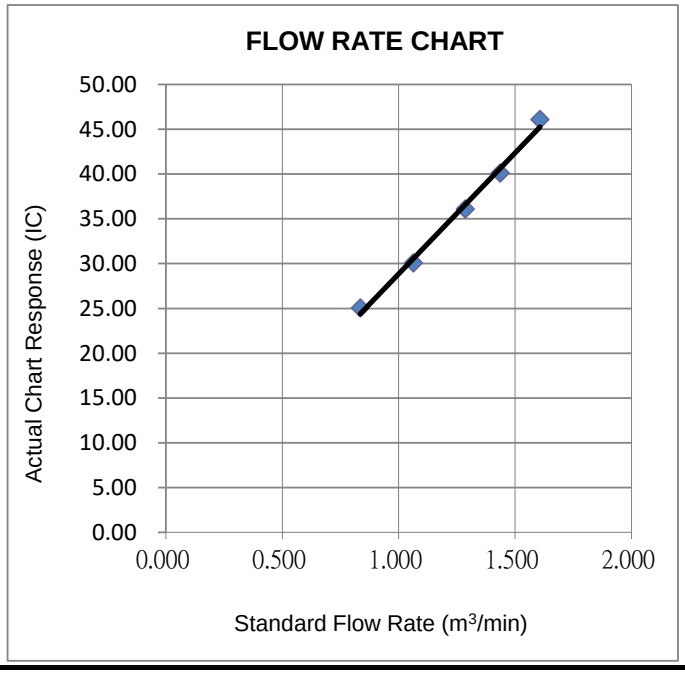
Plate No.	H2O (L) (in)	H2O (R) (in)	H2O (in)	Qstd (m^3/min)	I (chart)	IC (corrected)	LINEAR REGRESSION	
18	6.20	-5.10	11.300	1.607	46.00	46.11	Slope =	27.0241
13	5.00	-4.00	9.000	1.436	40.00	40.09	Intercept =	1.8312
10	4.20	-3.00	7.200	1.286	36.00	36.08	Corr. coeff.=	0.9965
7	2.80	-2.10	4.900	1.063	30.00	30.07		
5	2.00	-1.00	3.000	0.835	25.00	25.06		

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



Report Date: **25/10/2020**

Wan Ka Ho
Project Consultant

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TSP SAMPLER CALIBRATION CALCULATION SPREADSHEET

Project : Contract No. HY/2019/01 - Hong Kong-Zhuhai-Macao Bridge — Date of Calibration: 24-Oct-20
Location : AMS7B — Next Calibration Date: 23-Jan-20
Brand: Tisch — Technician: Ting Chan
Model: TE-5170 S/N: HVS-03

CONDITIONS

Sea Level Pressure (hPa):	1013.9	Corrected Pressure (mm Hg):	760
Temperature (℃):	23.8	Temperature (K):	297

CALIBRATION ORIFICE

Make:	Tisch	Qstd Slope:	2.11508
Model:	TE-5025A	Qstd Intercept:	-0.02962
Calibration Date:	11-Sep-20	Expiry Date:	11-Sep-20
S/N:	2154		

CALIBRATION

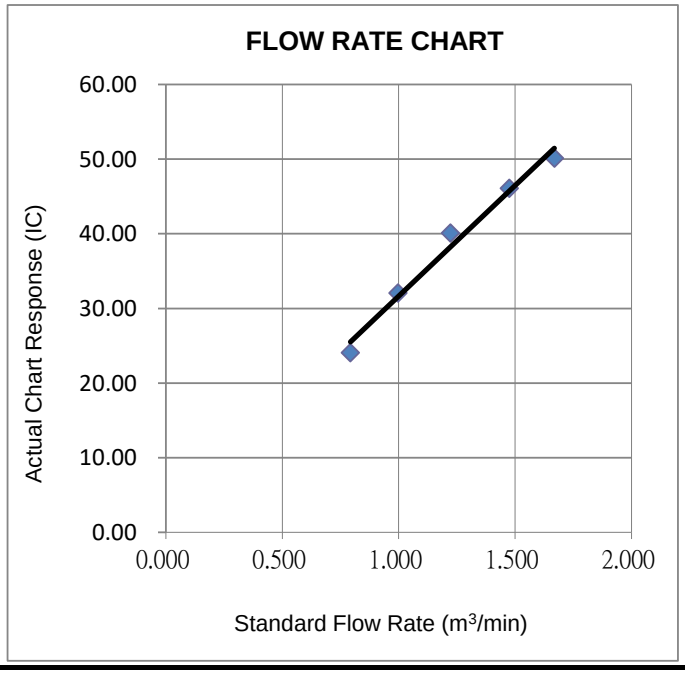
Plate No.	H2O (L) (in)	H2O (R) (in)	H2O (in)	Qstd (m^3/min)	I (chart)	IC (corrected)	LINEAR REGRESSION	
18	4.20	-8.00	12.200	1.669	50.00	50.12	Slope =	29.6215
13	3.00	-6.50	9.500	1.475	46.00	46.11	Intercept =	2.0224
10	1.50	-5.00	6.500	1.222	40.00	40.09	Corr. coeff.=	0.9911
7	0.30	-4.00	4.300	0.997	32.00	32.07		
5	-0.50	-3.20	2.700	0.793	24.00	24.06		

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



Report Date: **25/10/2020**

Wan Ka Ho
Project Consultant

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CALIBRATION REPORT OF WIND METER

Project: Contract No. HY/2019/01 - Hong Kong-Zhuhai-Macao Bridge		**Date of Calibration:**	**2-Jul-2020**
Location:	**AMS3C**	**Next Calibration Date:**	**1-Jan-2021**
		Technician:	**Ting Chan**
Brand:	**Global Water**		
Model:	**GL500-7-2**	**S/N:**	**1847003409**

Anemometer

Brand:	**Benetech**		
Model:	**GM816**	**Equipment ID:**	**08**

Procedures:

1. **Wind Still Test:** **The wind speed sensor was held by hand until stabilized.**
2. **Wind Speed Test:** **The wind meter was calibrated in-situ and compared with the Anemometer.**
3. **Wind Direction Test:** **The wind meter was calibrated in-situ and compared with a marine compass from four directions.**

Wind Still Test:

Wind Speed (m/s)
0.00

Wind Speed Test:

Global Water (m/s)	Anemometer (m/s)
0.9	0.5
2.4	2.6
3.4	3.8

Wind Direction Test:

Global Water (o)	Marine Compass (o)
0	358
247	244
173	172
80	79

Report Date: **3/7/2020**

Wan Ka Ho
Project Consultant

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FUGRO TECHNICAL SERVICES LIMITED
Fugro Development Centre
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Hong Kong

Report No. : 183057CA200894(3)

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 : 14-Jun-2021

Laboratory Information

Details of Reference Equipment –

Description : Reference Anemometer

Equipment ID. : R-101-4

Date of Calibration : 15-Jun-2020 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)
2.02	2.0	0.0
4.15	4.1	-0.1
6.27	6.0	-0.3
8.43	8.0	-0.4
10.75	10.1	-0.7

Remark :

1. The equipment being used in this calibration is traceable to recognized National Standards.
2. The reported readings in this calibration are an average from 10 trials.

Checked by : William Date : 20-6-2020 Certified by : KT Leung Date : 20-6-2020

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

Leung Kwok Tai (Assistant Manager)

** End of Report **

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Report no. : 940891CA200109(14)

CALIBRATION CERTIFICATE OF DUST METER

Client : Fugro Technical Services Limited

Project : Calibration Services

Client Supplied Information

Details of Unit Under Test, UUT

Description	: Laser dust monitor
Manufacturer	: SIBATA
Model No.	: LD-5R
Serial No.	: 761105
Specification Limit	: NA
Next Calibration Date	: 05-Dec-2020

Laboratory Information

Description	: TSP high volume air sampler
Serial No.	: 4350
Date of Calibration	: 06-Dec-2019 Ambient Temperature : 26 °C
Calibration Location	: Ma Wan A1 Site Boundary
Method Used	: By direct comparison the weight of dust particle trapped in a filter paper using high volume sampler (TSP method) for a certain period, with the reading of the UUT. They should be placed at the same location and powered on and off at the same time.

Calibration Results :

Reference concentration (mg/m^3)	Total count for 1 hour	CPM (Count per minute)
0.0393	1260	21.00
0.0681	1519	25.32
0.0504	1327	22.12

Remarks:

1. The equipment being used in this calibration is traceable to recognized National Standards.
2. The interpolation equation : Concentration (mg/m^3) = K x [UUT reading (CPM)], where K = 0.002306
3. Correlation coefficient (r) : 0.9906

Checked by : _____ Date : 10-2-2020 Certified by : _____ Date : 10-2-2020

Leung Kwok Tai (Assistant Manager)

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

** End of Report **

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Report no. : 940891CA200109(12)

CALIBRATION CERTIFICATE OF DUST METER

Client : Fugro Technical Services Limited

Project : Calibration Services

Client Supplied Information

Details of Unit Under Test, UUT

Description	: Laser dust monitor
Manufacturer	: SIBATA
Model No.	: LD-5R
Serial No.	: 882149
Specification Limit	: NA
Next Calibration Date	: 05-Dec-2020

Laboratory Information

Description	: TSP high volume air sampler
Serial No.	: 4350
Date of Calibration	: 06-Dec-2019 Ambient Temperature : 26 °C
Calibration Location	: Ma Wan A1 Site Boundary
Method Used	: By direct comparison the weight of dust particle trapped in a filter paper using high volume sampler (TSP method) for a certain period, with the reading of the UUT. They should be placed at the same location and powered on and off at the same time.

Calibration Results :

Reference concentration (mg/m^3)	Total count for 1 hour	CPM (Count per minute)
0.0393	1511	25.18
0.0681	1799	29.98
0.0504	1590	26.50

Remarks:

1. The equipment being used in this calibration is traceable to recognized National Standards.
2. The interpolation equation : Concentration (mg/m^3) = K x [UUT reading (CPM)], where K = 0.001932
3. Correlation coefficient (r) : 0.9927

Checked by : _____ Date : 10-2-2020 Certified by : _____ Date : 10-2-2020

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

Leung Kwok Tai (Assistant Manager)

** End of Report **

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Report no. : 940891CA201915(1)

CALIBRATION CERTIFICATE OF DUST METER

Client : Fugro Technical Services Limited

Project : Calibration Services

Client Supplied Information

Details of Unit Under Test, UUT

Description	: Laser dust monitor
Manufacturer	: SIBATA
Model No.	: LD-5R
Serial No.	: 892189
Specification Limit	: NA
Next Calibration Date	: 13-Aug-2021

Laboratory Information

Description	: TSP high volume air sampler
Serial no.	: 4350
Date of Calibration	: 14-Aug-2020 Ambient Temperature : 33 °C
Calibration Location	: Ma Wan A1 Site Boundary
Method Used	: By direct comparison the weight of dust particle trapped in a filter paper using high volume sampler (TSP method) for a certain period, with the reading of the UUT. They should be placed at the same location and powered on and off at the same time.

Calibration Results :

Reference concentration (mg/m^3)	Total count for 1 hour	CPM (Count per minute)
0.0632	1507	25.12
0.0687	1541	25.68
0.0543	1458	24.30

Remarks:

1. The equipment being used in this calibration is traceable to recognized National Standards.
2. The interpolation equation : Concentration (mg/m^3) = K x [UUT reading (CPM)], where K = 0.002479
3. Correlation coefficient (r) : 0.9995

Checked by : _____ Date : 16-9-2020 Certified by : _____ Date : 21-9-2020

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

Leung Kwok Tai (Assistant Manager)

** End of Report **

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Report no.: 203258CA201900

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. :	4181568	03456	002850

Equipment ID : N/A
Next Calibration Date : 14-Sep-2021
Specification Limit : EN 61672-1: 2003 Class 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 : 15-Sep-2020
Calibration Location : Calibration Laboratory of FTS
Method Used : By direct comparison
Ambient Temperature : 20±2 °C
Relative Humidity : <80% R.H.

Calibration Results :

Parameters		Mean Value (dB)	Specification Limit(dB)
A-weigthing frequency response	4000Hz	0.9	2.6 to -0.6
	2000Hz	1.2	2.8 to -0.4
	1000Hz	0.1	1.1 to -1.1
	500Hz	-3.2	-1.8 to -4.6
	250Hz	-8.6	-7.2 to -10.0
	125Hz	-16.0	-14.6 to -17.6
	63Hz	-26.0	-24.7 to -27.7
	31.5Hz	-38.8	-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 UUT does comply with EN 61672-1: 2003 Class 1 sound level meter for the above measurement.
5 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 tranportation, overloading, mis-handling or the capability of any other laboratory to repeat the measurement.

Checked by : William Date : 18-9-2020 Certified by : K.T.Leung Date : 19-9-2020

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

Leung Kwok Tai (Assistant Manager)

** End of Report **

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Fugro Development Centre
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Report no.: 203258CA201871

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. :	4181587	02781	002845

Equipment ID : N/A

Next Calibration Date : 07-Sep-2021

Specification Limit : EN 61672-1: 2003 Class 1

Laboratory Information

Details of Reference Equipment -

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

Equipment ID. : R-108-1

Calibration Date : 08-Sep-2020

Calibration Location : Calibration Laboratory of FTS

Method Used : By direct comparison

Ambient Temperature : 20±2 °C

Relative Humidity : <80% R.H.

Calibration Results :

Parameters		Mean Value (dB)	Specification Limit(dB)
A-weigthing frequency response	4000Hz	1.6	2.6 to -0.6
	2000Hz	1.3	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	-16.3	-14.6 to -17.6
	63Hz	-26.3	-24.7 to -27.7
	31.5Hz	-38.8	-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 UUT does comply with EN 61672-1: 2003 Class 1 sound level meter for the above measurement.
5. 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 tranportation, overloading, mis-handling or the capability of any other laboratory to repeat the measurement.

Checked by : Killiam Date : 11-9-2020 Certified by : K T Leung Date : 12-9-2020

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

Leung Kwok Tai (Assistant Manager)

** End of Report **

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Report no.: 203258CA202018(1)

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.	:	2383982
Equipment ID	:	N/A
Next Calibration Date	:	28-Sep-2021
Specification Limit	:	EN 60942: 2003 Class 1

Laboratory Information

Description : Reference Sound level meter

Equipment ID. : R-119-1

Date of Calibration : 29-Sep-2020 Ambient Temperature : 22 °C

Calibration Location : Calibration Laboratory of FTS Relative Humidity : 80% R.H.

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	-0.2 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 tranportation, overloading, mis-handling or the capability of any other laboratory to repeat the measurement.

Checked by : William Date : 6-10-2020 Certified by : K J Leung Date : 6-10-2020

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

Leung Kwok Tai (Assistant Manager)

** End of Report **

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FUGRO TECHNICAL SERVICES LIMITED
Fugro Development Centre
5 Lok Yi Street, Tai Lam
Tuen Mun, NT
Hong Kong

Report no.: 203258CA201871(1)

CALIBRATION CERTIFICATE OF SOUND CALIBRATOR

Client : Fugro Technical Services Ltd.

Project : Calibration Services

Client Supplied Information

Details of Unit Under Test, UUT

Description	:	Sound Calibrator
Manufacturer	:	Casella (Model CEL-120/1)
Serial No.	:	5230736
Equipment ID	:	N-18
Next Calibration Date	:	07-Sep-2021
Specification Limit	:	EN 60942: 2003 Class 1

Laboratory Information

Details of Calibration Equipment

Description	:	Reference Sound level meter
Equipment ID.	:	R-119-1

Calibration Date 08-Sep-2020

Calibration Location : Calibration Laboratory of FTS

Method Used : By direct comparison

Ambient Temperature : 20±2 °C

Relative Humidity : : <80% R.H.

Calibration Results :

Parameters (Setting of UUT)	Mean Value (error of measurement)	Specification Limit(dB)
94dB	0.1 dB	±0.4dB
114dB	0.2 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 unit under test complies with the specification limit.
4. The values given in this Calibration Certificate only relate to the unit-under-test and the values measured at the time of the test. Any uncertainties quoted 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 : 11-9-2020 Certified by : K.T.Leung Date : 12-9-2020

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

Leung Kwok Tai (Assistant Manager)

** End of Report **

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