

# Certificate of Calibration

Calibration Certification Information			
Cal. Date: September 11, 2020	Rootsmer S/N: 438320	Ta: 297	°K
Operator: Jim Tisch		Pa: 755.4	mm Hg
Calibration Model #: TE-5025A	Calibrator S/N: <b>2154</b>		

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)	$\sqrt{\Delta H \left( \frac{Ta}{Pa} \right)}$ (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
<b>QSTD</b>	<b>m=</b>	<b>2.11508</b>	<b>QA</b>	<b>m=</b>	<b>1.32442</b>
	<b>b=</b>	<b>-0.02962</b>		<b>b=</b>	<b>-0.01860</b>
	<b>r=</b>	<b>0.99993</b>		<b>r=</b>	<b>0.99993</b>

Calculations	
<b>Vstd=</b> $\Delta Vol \left( \frac{Pa - \Delta P}{Pstd} \right) \left( \frac{Tstd}{Ta} \right)$	<b>Va=</b> $\Delta Vol \left( \frac{Pa - \Delta P}{Pa} \right)$
<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
<b>Key</b>	
ΔH:	calibrator manometer reading (in H2O)
ΔP:	rootsmer 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

**TSP SAMPLER CALIBRATION CALCULATION SPREADSHEET**

Project : Contract No. HY/2019/01 - Hong Kong-Zhuhai-Macao Bridge				Date of Calibration: 23-Jan-21	
Location : AMS2				Next Calibration Date: 22-Apr-21	
Brand:	Tisch		Technician: Ting Chan		
Model:	TE-5170	S/N:	HVS-01		

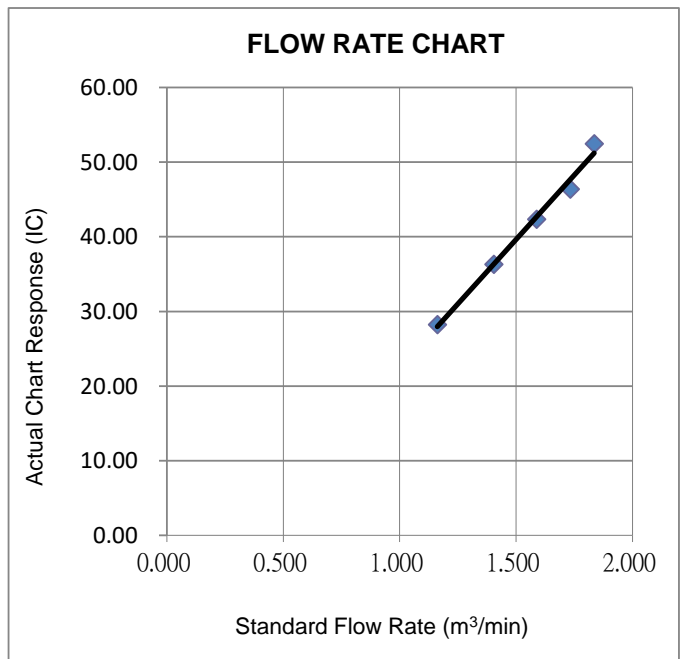
CONDITIONS					
Sea Level Pressure (hPa):	1014	Corrected Pressure (mm Hg):	761		
Temperature (°C):	20.2	Temperature (K):	293		

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 <sup>3</sup> /min)	I (chart)	IC (corrected)	LINEAR REGRESSION
18	7.20	-7.40	14.600	1.836	52.00	52.44	Slope = 34.5148 Intercept = -12.1705 Corr. coeff.: 0.9952
13	6.40	-6.60	13.000	1.733	46.00	46.39	
10	5.40	-5.50	10.900	1.588	42.00	42.36	
7	3.80	-4.70	8.500	1.404	36.00	36.31	
5	2.20	-3.60	5.800	1.162	28.00	28.24	

**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



**Wan Ka Ho**  
 Project Consultant

**Report Date:** 25/1/2021

**TSP SAMPLER CALIBRATION CALCULATION SPREADSHEET**

Project : Contract No. HY/2019/01 - Hong Kong-Zhuhai-Macao Bridge				Date of Calibration: 23-Jan-21	
Location : AMS3C				Next Calibration Date: 22-Apr-21	
Brand:	Tisch		Technician: Ting Chan		
Model:	TE-5170	S/N:	HVS-02		

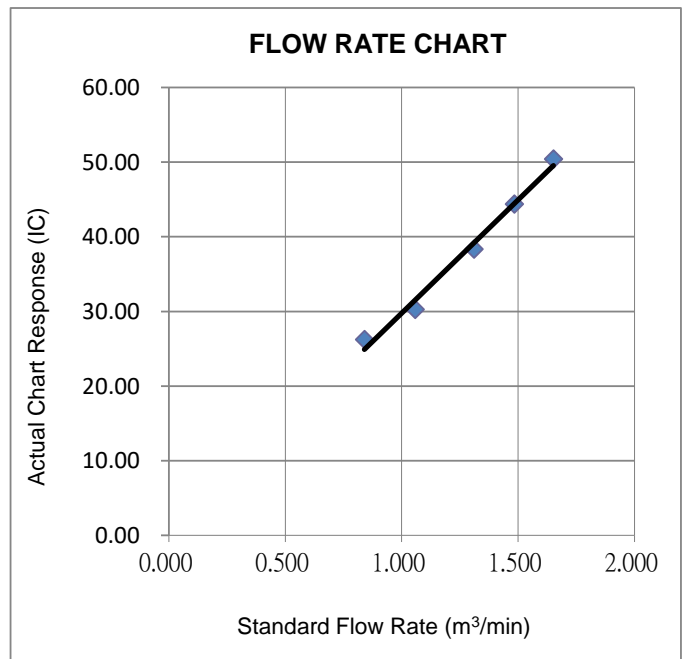
CONDITIONS					
Sea Level Pressure (hPa):	1014	Corrected Pressure (mm Hg):	761		
Temperature (°C):	20.2	Temperature (K):	293		

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 <sup>3</sup> /min)	I (chart)	IC (corrected)	LINEAR REGRESSION
18	6.40	-5.40	11.800	1.652	50.00	50.43	Slope = 30.3249 Intercept = -0.5636 Corr. coeff.: 0.9937
13	5.20	-4.30	9.500	1.484	44.00	44.38	
10	4.30	-3.10	7.400	1.311	38.00	38.32	
7	2.60	-2.20	4.800	1.059	30.00	30.26	
5	1.80	-1.20	3.000	0.840	26.00	26.22	

**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



**Wan Ka Ho**  
 Project Consultant

**Report Date:** 25/1/2021



## CALIBRATION REPORT OF WIND METER

<b>Project:</b> Contract No. HY/2019/01 - Hong Kong-Zhuhai-Macao Bridge	<b>Date of Calibration:</b> 31-Dec-2020
<b>Location:</b> AMS3C	<b>Next Calibration Date:</b> 30-Jun-2021
<b>Brand:</b> Global Water	<b>Technician:</b> Sam Fong
<b>Model:</b> GL500-7-2	
<b>Anemometer</b>	
<b>Brand:</b> Benetech	<b>Equipment ID:</b> 08
<b>Model:</b> GM816	
<b>Procedures:</b>	
1. <b>Wind Still Test:</b>	The wind speed sensor was held by hand until stabilized.
2. <b>Wind Speed Test:</b>	The wind meter was calibrated in-situ and compared with the Anemometer.
3. <b>Wind Direction Test:</b>	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)
1.2	1.0
1.5	1.2
2.8	2.6

**Wind Direction Test:**

	Marine Compass (o)
358	0
266	262
154	152
18	18

**Wan Ka Ho**  
Project Consultant

**Report Date:** 5/1/2021

Report No. : 183057CA200894(3)

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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-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 : Leung Kwok Tai Date : 20-6-2020

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

Leung Kwok Tai (Assistant Manager)

\*\* End of Report \*\*

Report no. : 940891CA202730(3)

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## 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. : 620480  
 Specification Limit : NA  
 Next Calibration Date : 22-Nov-2021

### Laboratory Information

Description : 1. Balance 2. TSP high volume air sampler  
 Equipment ID. / Serial no. : 1. C-065-9 2. 4350  
 Date of Calibration : 23-Nov-2020 Ambient Temperature : 25 ± 10 °C  
 Calibration Location : General Chemical Laboratory of FTS and 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 <sup>3</sup> )	Total count for 1 hour	CPM (Count per minute)
0.0915	3211	53.52
0.0469	2732	45.53
0.1172	3659	60.98

### Remarks:

1. The equipment being used in this calibration is traceable to recognized National Standards.
2. The interpolation equation : Concentration (mg/m<sup>3</sup>) = K x [ UUT reading (CPM) ], where K = 0.001597
3. Correlation coefficient (r) : 0.9909

Checked by : Canny Date : 15-12-2020 Certified by : K. Kwok Tai Date : 15-12-2020  
 CA-R-297 (22/07/2009) Leung Kwok Tai (Assistant Manager)

\*\* End of Report \*\*

Report no. : 940891CA202793(1)

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## 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. : 761106  
Specification Limit : NA  
Next Calibration Date : 26-Nov-2021

### Laboratory Information

Description : 1. Balance                      2. TSP high volume air sampler  
Equipment ID. / Serial no. : 1. C-065-9                      2. 4350  
Date of Calibration : 27-Nov-2020                      Ambient Temperature : 25 ± 10 °C  
Calibration Location : General Chemical Laboratory of FTS and 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 <sup>3</sup> )	Total count for 1 hour	CPM (Count per minute)
0.3486	5134	85.57
0.1257	4394	73.23
0.0943	4408	73.47

### Remarks:

1. The equipment being used in this calibration is traceable to recognized National Standards.
2. The interpolation equation : Concentration (mg/m<sup>3</sup>) = K x [ UUT reading (CPM) ], where K = 0.002448
3. Correlation coefficient (r) : 0.9916

Checked by : Conny Date : 30-12-2020 Certified by : K.T. Leung Date : 5-1-2021

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

Leung Kwok Tai (Assistant Manager)

\*\* End of Report \*\*

**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. : 892185  
 Specification Limit : NA  
 Next Calibration Date : 22-Nov-2021

**Laboratory Information**

Description : 1. Balance 2. TSP high volume air sampler  
 Equipment ID. / Serial no. : 1. C-065-9 2. 4350  
 Date of Calibration : 23-Nov-2020 Ambient Temperature : 25 ± 10 °C  
 Calibration Location : General Chemical Laboratory of FTS and 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 <sup>3</sup> )	Total count for 1 hour	CPM (Count per minute)
0.0915	3263	54.38
0.0469	2909	48.48
0.1172	3562	59.37

**Remarks:**

1. The equipment being used in this calibration is traceable to recognized National Standards.
2. The interpolation equation : Concentration (mg/m<sup>3</sup>) = K x [ UUT reading (CPM) ], where K = 0.001576
3. Correlation coefficient (r) : 0.9945

Checked by : Canny Date : 15-12-2020 Certified by : K. Leung Date : 15-12-2020  
 CA-R-297 (22/07/2009) Leung Kwok Tai (Assistant Manager)

**\*\* End of Report \*\***



Report no.: 203258CA201700(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.	: <table border="1" style="display: inline-table; vertical-align: middle;"> <tr> <th>Meter</th> <th>Microphone</th> <th>Preamplifier</th> </tr> <tr> <td>CEL-63X</td> <td>CE-251</td> <td>CEL-495</td> </tr> <tr> <td>Serial No.</td> <td>1488270</td> <td>04228</td> </tr> <tr> <td>Equipment ID</td> <td colspan="2">N/A</td> </tr> </table>	Meter	Microphone	Preamplifier	CEL-63X	CE-251	CEL-495	Serial No.	1488270	04228	Equipment ID	N/A	
Meter	Microphone	Preamplifier											
CEL-63X	CE-251	CEL-495											
Serial No.	1488270	04228											
Equipment ID	N/A												
Serial No.	: <table border="1" style="display: inline-table; vertical-align: middle;"> <tr> <th>Meter</th> <th>Microphone</th> <th>Preamplifier</th> </tr> <tr> <td>CEL-63X</td> <td>CE-251</td> <td>CEL-495</td> </tr> <tr> <td>Serial No.</td> <td>1488270</td> <td>04228</td> </tr> <tr> <td>Equipment ID</td> <td colspan="2">N/A</td> </tr> </table>	Meter	Microphone	Preamplifier	CEL-63X	CE-251	CEL-495	Serial No.	1488270	04228	Equipment ID	N/A	
Meter	Microphone	Preamplifier											
CEL-63X	CE-251	CEL-495											
Serial No.	1488270	04228											
Equipment ID	N/A												
Equipment ID	: N/A												
Next Calibration Date	: 26-Aug-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	: 27-Aug-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-weighting frequency response	4000Hz	1.1
	2000Hz	1.2
	1000Hz	-0.1
	500Hz	-3.4
	250Hz	-8.8
	125Hz	-16.2
	63Hz	-26.2
	31.5Hz	-39.1
Differential level linearity	94dB-104dB	± 0.6
	104dB-114dB	± 0.6

**Remarks :**

- The equipment used in this calibration is traceable to recognized National Standards.
- The mean value is the average of four measurements.
- For calibration: Reference SPL are 94, 104 & 114dB, range setting is 20-140dB & time weighting is fast
- The UUT complies with EN 61672-1: 2003 Class 1 sound level meter for the above measurement.
- 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 : 3-9-2020 Certified by : K.T. Young Date : 3-9-2020  
 CA-R-297 (22/07/2009) Leung Kwok Tai (Assistant Manager)

\*\* End of Report \*\*

Report no.: 203258CA202302(3)

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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. :

Equipment ID :

Next Calibration Date :

Specification Limit :

Meter	Microphone	Preamplifier
CEL-63X	CE-251	CEL-495
2451048	00995	003341

N/A

29-Oct-2021

EN 61672-1: 2003 Class 1

### Laboratory Information

Details of Reference Equipment -

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

Equipment ID. : R-108-1

Date of Calibration : 30-Oct-2020

Calibration Location : Calibration Laboratory of FTS

Ambient Temperature : 20±2 °C

Method Used : By direct comparison

Relative Humidity : &lt;80% R.H.

### Calibration Results :

Parameters	Mean Value (dB)	Specification Limit(dB)
A-weighting frequency response	4000Hz	0.8
	2000Hz	1.1
	1000Hz	0.0
	500Hz	-3.3
	250Hz	-8.7
	125Hz	-16.1
	63Hz	-26.2
	31.5Hz	-39.1
Differential level linearity	94dB-104dB	0.0
	104dB-114dB	0.0

### Remarks :

- The equipment used in this calibration is traceable to recognized National Standards.
- The mean value is the average of four measurements.
- For calibration: Reference SPL are 94, 104 & 114dB, range setting is 20-140dB & time weighting is fast.
- The UUT does comply with EN 61672-1: 2003 Class 1 sound level meter for the above measurement.
- 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 : 4-11-2020 Certified by : K.T. Leung Date : 4-11-2020  
 CA-R-297 (22/07/2009) Leung Kwok Tai (Assistant Manager)

**\*\* End of Report \*\***

Report no.: 203258CA201298(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. : 2383886  
 Equipment ID : N/A  
 Next Calibration Date : 13-Jul-2021  
 Specification Limit : EN 60942: 2003 Type 1

**Laboratory Information**

Description : Reference Sound level meter  
 Equipment ID. : R-119-1  
 Date of Calibration : 14-Jul-2020 Ambient Temperature : 20±2 °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	-0.1 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 : 21-7-2020 Certified by : Leung Kwok Tai Date : 21-7-2020  
 CA-R-297 (22/07/2009) Leung Kwok Tai (Assistant Manager)

**\*\* End of Report \*\***

Report no.: 183057CA200894(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. : 3321858  
 Equipment ID : N/A  
 Next Calibration Date : 14-Jun-2021  
 Specification Limit : EN 60942: 2003 Type 1

**Laboratory Information**

Description : Reference Sound level meter  
 Equipment ID. : R-119-1  
 Date of Calibration : 15-Jun-2020 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	-0.1 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 : 20-6-2020 Certified by : F. Leung Date : 20-6-2020  
 CA-R-297 (22/07/2009) Leung Kwok Tai (Assistant Manager)

\*\* End of Report \*\*