

# ภาคผนวก ง

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ใบรับรองการสอบเทียบเครื่องมือ





รายการเครื่องมือที่ใช้ในการวิเคราะห์ / ทดสอบ

Sample Name	Parameter	Equipment Name	ID No.	Calibrated Date	Next Cal	Freq. Calibrate (Months)
Noise	Noise Contour	Sound Calibrator	RYG_FS0496	10-Jan-22	10-Jan-23	12
Noise	Noise Contour	Sound Level Meter	RYG_FS0493	10-Jan-22	10-Jan-23	12
pH at 25 °C	pH meter	pH meter	RYG_EN0183	17-Mar-22	17-Mar-23	12
Sea Water	Dissolved Oxygen	Chamber (Cold Room)	RYG_EN0184	22-Feb-22	22-Feb-23	12
Turbidity	Turbidity	Chamber (Cold Room)	RYG_EN0184	22-Feb-22	22-Feb-23	12
Sea Water	BOD (5 days at 20°C)	DO meter with Sensor	RYG_EN0032	14-Feb-22	15-Aug-23	18
Sea Water	BOD (5 days at 20°C)	Incubator	RYG_EN0154	22-Apr-22	21-Oct-23	18
Sea Water	Total Dissolved Solids 180°C	Electronic Balance	RYG_EN0002	23-Mar-22	23-Mar-23	12
Sea Water	Total Dissolved Solids 180°C	Hot Air Oven	RYG_EN0010	20-Oct-22	20-Apr-24	18
Sea Water	Salinity	Conductivity meter	RYG_EN0029	23-Feb-22	24-Aug-23	18
Sea Water	Conductivity	Conductivity meter	RYG_EN0029	23-Feb-22	24-Aug-23	18
Sea Water	Temperature	pH Meter	RYG_FS0420	14-Mar-22	14-Mar-23	12
Sea Water	Total Suspended Solids	Electronic Balance	RYG_EN0002	23-Mar-22	23-Mar-23	12
Sea Water	Total Suspended Solids	Hot Air Oven	RYG_EN0010	20-Oct-22	20-Apr-24	18
Rayong Lab	BOD (5 days at 20°C)	DO meter with Sensor	RYG_EN0032	14-Feb-22	15-Aug-23	18
Rayong Lab	BOD (5 days at 20°C)	Incubator	RYG_EN0154	22-Apr-22	21-Oct-23	18
Rayong Lab	Total Suspended Solids	Electronic Balance	RYG_EN0002	23-Mar-22	23-Mar-23	12
Rayong Lab	Total Suspended Solids	Hot Air Oven	RYG_EN0010	20-Oct-22	20-Apr-24	18
Rayong Lab	pH at 25 °C	pH meter	RYG_EN0183	17-Mar-22	17-Mar-23	12
Rayong Lab	Temperature	pH Meter	RYG_FS0420	14-Mar-22	14-Mar-23	12
Rayong Lab	Salinity	Conductivity meter	RYG_EN0029	23-Feb-22	24-Aug-23	18

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Sample Name	Parameter	Equipment Name	ID No.	Calibrated Date	Next Cal	Freq. Calibrate (Months)
Rayong Lab	Conductivity	Conductivity meter	RYG_EN0029	23-Feb-22	24-Aug-23	18
Rayong Lab	Total Dissolved Solids 180°C	Electronic Balance	RYG_EN0002	23-Mar-22	23-Mar-23	12
Rayong Lab	Total Dissolved Solids 180°C	Hot Air Oven	RYG_EN0010	20-Oct-22	20-Apr-24	18
Rayong Lab	Turbidity	Chamber (Cold Room)	RYG_EN0184	22-Feb-22	22-Feb-23	12
Rayong Lab	Dissolved Oxygen	Chamber (Cold Room)	RYG_EN0184	22-Feb-22	22-Feb-23	12

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Sample Name	Parameter	Equipment Name	ID No.	Calibrated Date	Next Cal	Freq. Calibrate (Months)
Ambient	Total Suspended Particulate	High Volume	RYG_FS0179	-	-	On site Calibration
Ambient	Total Suspended Particulate	High Volume	RYG_FS0175	-	-	On site Calibration
Ambient	Total Suspended Particulate	High Volume	RYG_FS0174	-	-	On site Calibration
Ambient	Total Suspended Particulate	High Volume	RYG_FS0181	-	-	On site Calibration
Ambient	Total Suspended Particulate	Digital Balance	RYG_EN0001	23-Mar-22	23-Mar-23	12
Ambient	Particulate Matter (PM-10)	High Volume	RYG_FS0398	-	-	On site Calibration
Ambient	Particulate Matter (PM-10)	High Volume	RYG_FS0183	-	-	On site Calibration
Ambient	Particulate Matter (PM-10)	High Volume	RYG_FS0187	-	-	On site Calibration
Ambient	Particulate Matter (PM-10)	High Volume	RYG_FS0192	-	-	On site Calibration
Ambient	Particulate Matter (PM-10)	Digital Balance	RYG_EN0001	23-Mar-22	23-Mar-23	12
Ambient	Nitrogen Dioxide	NO <sub>2</sub> Analyzer	RYG_FS0461	1-Jul-22	1-Jan-23	6
Ambient	Nitrogen Dioxide	NO <sub>2</sub> Analyzer	RYG_FS0252	1-Jul-22	1-Jan-23	6
Ambient	Nitrogen Dioxide	NO <sub>2</sub> Analyzer	RYG_FS0453	1-Jul-22	1-Jan-23	6
Ambient	Nitrogen Dioxide	NO <sub>2</sub> Analyzer	RYG_FS0455	1-Jul-22	1-Jan-23	6
Ambient	Sulfur Dioxide	SO <sub>2</sub> Analyzer	RYG_FS0460	1-Jul-22	1-Jan-23	6
Ambient	Sulfur Dioxide	SO <sub>2</sub> Analyzer	RYG_FS0251	1-Jul-22	1-Jan-23	6
Ambient	Sulfur Dioxide	SO <sub>2</sub> Analyzer	RYG_FS0452	1-Jul-22	1-Jan-23	6
Ambient	Sulfur Dioxide	SO <sub>2</sub> Analyzer	RYG_FS0454	1-Jul-22	1-Jan-23	6
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0412	29-Jul-21	27-Jan-23	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	BKX_FS0141	7-Jun-21	6-Dec-22	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0413	29-Jul-21	27-Jan-23	18

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Sample Name	Parameter	Equipment Name	ID No.	Calibrated Date	Next Cal	Freq. Calibrate (Months)
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0328	31-Jan-22	29-Jul-23	18
Stack	Total Suspended Particulate	Console Control Unit	BKX_FS0327	12-Jul-22	12-Jan-23	6
Stack	Total Suspended Particulate	Console Control Unit	BKX_FS0347	12-Jul-22	12-Jan-23	6
Stack	Total Suspended Particulate	Console Control Unit	RYG_FS0315	12-Jul-22	12-Jan-23	6
Stack	Total Suspended Particulate	Flue gas Analyzer	RYG_FS0653	9-Dec-21	9-Dec-22	12
Stack	Total Suspended Particulate	Flue gas Analyzer	RYG_FS0464	18-Jan-23	18-Jan-23	12
Stack	Total Suspended Particulate	Digital Balance	RYG_EN0003	23-Mar-22	23-Mar-23	12
Stack (CEMs)	Oxides of Nitrogen	Analyzer - System calibration, Standard gas	-	-	-	-
Stack (CEMs)	Sulfur Dioxide	Analyzer - System calibration, Standard gas	-	-	-	-
Noise	Leq 24 hrs	Sound Calibrator	RYG_FS0216	31-Aug-22	31-Aug-23	12
Noise	Leq 24 hrs	Sound Level Meter	RYG_FS0027	10-Jan-23	10-Jan-23	12
Noise	Leq 24 hrs	Sound Level Meter	RYG_FS0031	20-Jun-22	20-Jun-23	12
Noise	Leq 8 hrs	Sound Calibrator	RYG_FS0216	31-Aug-22	31-Aug-23	12
Noise	Leq 8 hrs	Sound Level Meter	RYG_FS0439	7-Sep-23	7-Sep-23	12
Noise	Noise Dose, TWA	Dose Badge Reader	RYG_FS0497	14-Mar-22	14-Mar-23	12
Heat	Heat Stress	Heat Stress Monitor	RYG_FS0523	7-Mar-22	7-Mar-23	12
Heat	Heat Stress	Heat Stress Monitor	RYG_FS0521	7-Mar-22	7-Mar-23	12
Heat	Heat Stress	Heat Stress Monitor	RYG_FS0524	8-Mar-22	8-Mar-23	12
Heat	Heat Stress	Heat Stress Monitor	RYG_FS0558	16-Feb-22	16-Feb-23	12
Illuminance	Illuminance	Lux Meter	RYG_FS0200	22-Sep-21	22-Sep-22	12

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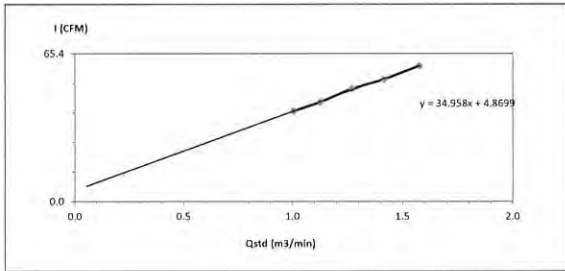
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## High Volume Air Sampler Calibration Worksheet

Project Site : GLOW ENERGY PUBLIC COMPANY LIMITED  
 โรงพลาสมาผลิตเสริมสุขภาพสำนักงาน  
 สาขาส่ง  
 Calibrate Location : โรงพลาสมาส่งเสริมสุขภาพสำนักงาน  
 สาขาส่ง  
 Calibrate Date : 15-Aug-22  
 CalibrationSheet No.: C-150822-RYG\_FS0179  
 Calibrator ID: RYG\_FS0205  
 Calibrator Model: TE-5028A  
 Calibrator S/N: 1166  
 Barometric Pressure (mm Hg) : 755  
 Temperature (°C) : 30  
 High Volume ID : RYG\_FS0179  
 High Volume Model : TE-5170D  
 High Volume S/N : 4805  
 Calibrator Slope : 1.53016  
 Calibrator Intercept : -0.0468

Test No.	Delta H <sub>2</sub> O (inch)	Q <sub>std</sub> (m <sup>3</sup> /min)	I : Chart (CFM)	Linear Regression
1	2.2	1.0049	40	Slope : 34.9582 Intercept : 4.8699 Correlation Coefficient : 0.9987
2	2.8	1.1277	44	
3	3.6	1.2724	50	
4	4.5	1.4171	54	
5	5.6	1.5754	60	



Calibrated by :   
 (Mr. Apichart Wilars)  
 Field Scientist (1)

Approved by :   
 (Mr. Noppog Juntarupan)  
 Enviro Field Coordinator Scientist (3)

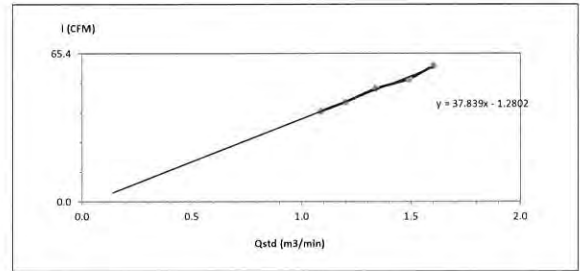
FORM NO.: F 06-073 REVISION NO.: ISSUE DATE: 14/03/16



## High Volume Air Sampler Calibration Worksheet

Project Site : GLOW ENERGY PUBLIC COMPANY LIMITED  
 โรงพลาสมาผลิตเสริมสุขภาพสำนักงาน  
 สาขาส่ง  
 Calibrate Location : โรงพลาสมาส่งเสริมสุขภาพสำนักงาน  
 สาขาส่ง  
 Calibrate Date : 15-Aug-22  
 CalibrationSheet No.: C-150822-RYG\_FS0175  
 Calibrator ID: RYG\_FS0205  
 Calibrator Model: TE-5028A  
 Calibrator S/N: 1166  
 Barometric Pressure (mm Hg) : 755  
 Temperature (°C) : 30  
 High Volume ID : RYG\_FS0175  
 High Volume Model : TE-5170D  
 High Volume S/N : 4801  
 Calibrator Slope : 1.53016  
 Calibrator Intercept : -0.0468

Test No.	Delta H <sub>2</sub> O (inch)	Q <sub>std</sub> (m <sup>3</sup> /min)	I : Chart (CFM)	Linear Regression
1	2.6	1.0884	40	Slope : 37.8390 Intercept : -1.2802 Correlation Coefficient : 0.9957
2	3.2	1.2023	44	
3	4.0	1.3387	50	
4	5.0	1.4912	54	
5	5.8	1.6025	60	



Calibrated by :   
 (Mr. Apichart Wilars)  
 Field Scientist (1)

Approved by :   
 (Mr. Noppog Juntarupan)  
 Enviro Field Coordinator Scientist (3)

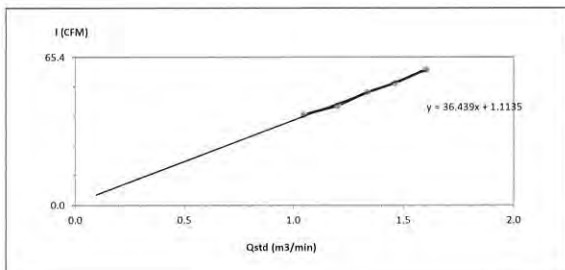
FORM NO.: F 06-073 REVISION NO.: ISSUE DATE: 14/03/16



## High Volume Air Sampler Calibration Worksheet

Project Site : GLOW ENERGY PUBLIC COMPANY LIMITED  
 โรงพลาสมาผลิตเสริมสุขภาพสำนักงาน  
 สาขาส่ง  
 Calibrate Location : โรงพลาสมาส่งเสริมสุขภาพสำนักงาน  
 สาขาส่ง  
 Calibrate Date : 15-Aug-22  
 CalibrationSheet No.: C-150822-RYG\_FS0174  
 Calibrator ID: RYG\_FS0205  
 Calibrator Model: TE-5028A  
 Calibrator S/N: 1166  
 Barometric Pressure (mm Hg) : 755  
 Temperature (°C) : 30  
 High Volume ID : RYG\_FS0174  
 High Volume Model : TE-5170D  
 High Volume S/N : 4800  
 Calibrator Slope : 1.53016  
 Calibrator Intercept : -0.0468

Test No.	Delta H <sub>2</sub> O (inch)	Q <sub>std</sub> (m <sup>3</sup> /min)	I : Chart (CFM)	Linear Regression
1	2.4	1.0475	40	Slope : 36.4386 Intercept : 1.1135 Correlation Coefficient : 0.9965
2	3.2	1.2023	44	
3	4.0	1.3387	50	
4	4.8	1.4621	54	
5	5.8	1.6025	60	



Calibrated by :   
 (Mr. Apichart Wilars)  
 Field Scientist (1)

Approved by :   
 (Mr. Noppog Juntarupan)  
 Enviro Field Coordinator Scientist (3)

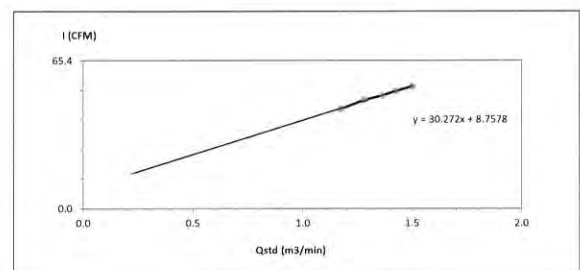
FORM NO.: F 06-073 REVISION NO.: ISSUE DATE: 14/03/16



## High Volume Air Sampler Calibration Worksheet

Project Site : GLOW ENERGY PUBLIC COMPANY LIMITED  
 โรงพลาสมาผลิตเสริมสุขภาพสำนักงาน  
 สาขาส่ง  
 Calibrate Location : โรงพลาสมาส่งเสริมสุขภาพสำนักงาน  
 สาขาส่ง  
 Calibrate Date : 3-Dec-22  
 CalibrationSheet No.: C-031222-RYG\_FS0181  
 Calibrator ID: RYG\_FS0205  
 Calibrator Model: TE-5028A  
 Calibrator S/N: 1166  
 Barometric Pressure (mm Hg) : 757  
 Temperature (°C) : 31  
 High Volume ID : RYG\_FS0181  
 High Volume Model : TE-5170D  
 High Volume S/N : 5334  
 Calibrator Slope : 1.50765  
 Calibrator Intercept : -0.02043

Test No.	Delta H <sub>2</sub> O (inch)	Q <sub>std</sub> (m <sup>3</sup> /min)	I : Chart (CFM)	Linear Regression
1	3.1	1.1744	44	Slope : 30.2724 Intercept : 8.7578 Correlation Coefficient : 0.9971
2	3.7	1.2811	48	
3	4.2	1.3636	50	
4	4.6	1.4261	52	
5	5.1	1.5005	54	



Calibrated by :   
 (Mr. Nornanon Tathongkham)  
 Field Scientist (1)

Approved by :   
 (Mr. Noppog Juntarupan)  
 Enviro Field Coordinator Scientist (3)

FORM NO.: F 06-073 REVISION NO.: ISSUE DATE: 14/03/16





**PENTA CALIBRATION CO., LTD.**  
66/124 The Connect 33 Village Kanchanaphisek Road  
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Tel : +66 (0) 2069-9773  
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## Certificate of Calibration

Represent to Certificate of Calibration : PTC/07/22102

Certificate No.: PTC/07/22102 Page: 1 of 2  
Equipment: Digital Balance Condition: Normal  
Manufacturer: Sartorius Serial No: 25409684  
Model: LA1305-F ID No: RYG\_EN0001  
Type of Balance: Single Interval



Customer: ALS Laboratory Group (Thailand) Co., Ltd.  
616/10 Moo 5 T.Maenamkoo, A.Pluakdaeng,  
Rayong 21140, Thailand



Environment Condition: Temperature 23.9 °C ± 0.3 °C  
Humidity 58.1 %RH ± 4.4 %RH  
Air density 1.17 kg/m<sup>3</sup>

Calibration Place: ALS Laboratory Group (Thailand) Co., Ltd.  
616/10 Moo 5 T.Maenamkoo, A.Pluakdaeng,  
Rayong 21140, Thailand

The Method used: In house method, PTC-WI-07, base on Euramet cg. 18

Traceability: This certificate is traceable to the SI Units through Thai Calibration Service Co., Ltd.  
NSC-ONSAC Accreditation No.: Calibration 0189

Date Received: March 23, 2022

Calibration Date: March 23, 2022

Issued Date: March 25, 2022

Calibration By: Mr. Rungroj Metakul



Approved By: (Mr. Keattisak Kerdto)  
Laboratory Manager

Reviewed by: (Mr. Kongsak Kalasri)

This certificate is issued this unit of measurement according to the International System of Units (SI). It provides traceability of measurement to International or national standard or other recognized national standard laboratories.

This measurement uncertainty stated is the expanded uncertainty which is obtained from the standard uncertainty multiplied by the coverage factor (k = 2) to provide a level of confidence of approximately 95%. It is determined in accordance with the Guide to Expression of Uncertainty in Measurement (GUM). The effect that the results relate only to the items calibrated.

This calibration certificate shall not be reproduced except in full only, without written approval from Penta Calibration Co., Ltd.

PTC-FMC-07-02 21Feb-2020



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Certificate No.: PTC/07/22102

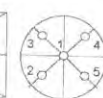
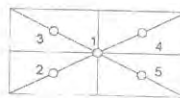
Page: 2 of 2

## Measurement Results:

Without Adjustment :

Function Calibration: Non Adjustment

Eccentric Error: Weight to be 1/3, 1/2 or of Maximum capacity



Eccentricity test 50 (g)				
Position (g)				
1	2	3	4	5
0.0000	0.0000	-0.0001	0.0000	0.0001
Maximum deviation:				0.0001

Repeatability Test Weight to be  $1/2 \leq L_1 \leq$  Maximum capacity

Determination of the standard deviation of weighing balance, Readability 0.0001 (g)

Nominal test value (g)	Standard Deviation
100	0.00009

Error of indication : from nominal value, Readability 0.0001 (g)

Nominal Value (g)	Conventional Mass (g)	Indication (g)	Correction of Balance (g)	Uncertainty (g)	k
0	0.00000	0.0000	0.0000	0.00026	2.87
0.01	0.01000	0.0100	0.0000	0.00026	2.65
0.05	0.05000	0.0500	0.0000	0.00026	2.65
0.1	0.10000	0.1000	0.0000	0.00026	2.65
0.5	0.50000	0.4999	0.0001	0.00026	2.65
1	1.00000	0.9999	0.0001	0.00026	2.65
2	2.00000	1.9999	0.0001	0.00026	2.65
5	5.00001	5.0000	0.0000	0.00026	2.65
10	10.00000	10.0001	-0.0001	0.00026	2.65
20	20.00003	20.0001	-0.0001	0.00026	2.52
100	100.00004	100.0001	-0.0001	0.00027	2.18

Note: Weight of adjust (g)

The End of Certificate

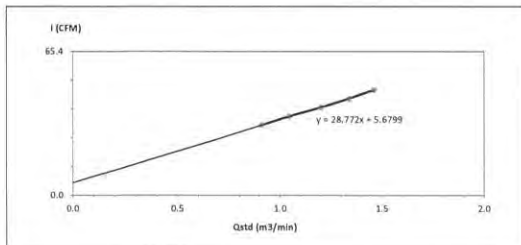
PTC-FMC-07-02 21Feb-2020



## High Volume Air Sampler Calibration Worksheet

Project Site: GLOW ENERGY PUBLIC COMPANY LIMITED  
โครงการก่อสร้างและพัฒนาระบบ  
Calibrate Location: 8798  
Calibrate Date: 15 Aug 22  
Calibration Sheet No.: C-150822-RYG-FS0398  
Calibrator ID: RYG-FS0205  
Calibrator Model: TE-5028A  
Calibrator S/N: 1166  
Barometric Pressure (mm Hg): 755  
Temperature (°C): 30  
High Volume ID: RYG-FS0398  
High Volume Model: TE-5009X  
High Volume S/N: 5684  
Calibrator Slope: 1.53016  
Calibrator Intercept: -0.0468

Test No.	Delta H <sub>2</sub> O (inch)	Q <sub>air</sub> (m <sup>3</sup> /min)	I: Chart (CFM)	Linear Regression
1	1.8	0.9135	32	Slope: 28.7720 Intercept: 5.6799 Correlation Coefficient: 0.9993
2	2.4	1.0475	36	
3	3.2	1.2023	40	
4	4.0	1.3387	44	
5	4.8	1.4621	48	



Calibrated by: (Mr. Apichart Wilars)  
Field Scientist (1)

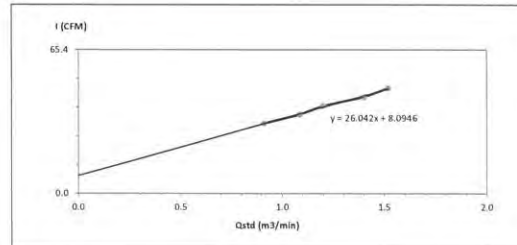
Approved by: (Mr. Noppong Juntarupan)  
Enviro Field Coordinator Scientist (3)



## High Volume Air Sampler Calibration Worksheet

Project Site: GLOW ENERGY PUBLIC COMPANY LIMITED  
โครงการก่อสร้างและพัฒนาระบบ  
Calibrate Location: 8798  
Calibrate Date: 15 Aug 22  
Calibration Sheet No.: C-150822-RYG-FS0183  
Calibrator ID: RYG-FS0205  
Calibrator Model: TE-5028A  
Calibrator S/N: 1166  
Barometric Pressure (mm Hg): 755  
Temperature (°C): 30  
High Volume ID: RYG-FS0183  
High Volume Model: TE-5009X  
High Volume S/N: 4791  
Calibrator Slope: 1.53016  
Calibrator Intercept: -0.0468

Test No.	Delta H <sub>2</sub> O (inch)	Q <sub>air</sub> (m <sup>3</sup> /min)	I: Chart (CFM)	Linear Regression
1	1.8	0.9135	32	Slope: 26.0416 Intercept: 8.0946 Correlation Coefficient: 0.9968
2	2.6	1.0884	36	
3	3.2	1.2023	40	
4	4.4	1.4018	44	
5	5.2	1.5198	48	



Calibrated by: (Mr. Apichart Wilars)  
Field Scientist (1)

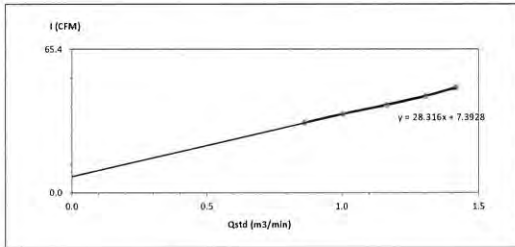
Approved by: (Mr. Noppong Juntarupan)  
Enviro Field Coordinator Scientist (3)



### High Volume Air Sampler Calibration Worksheet

Project Site : GLOW ENERGY PUBLIC COMPANY LIMITED Barometric Pressure (mm Hg) : 755  
 Calibrate Location : กรุงเทพมหานคร Calibrate Date : 15-Aug-22 Temperature (°C) : 30  
 Calibration Sheet No. : C-150822-RYG\_FS0187 High Volume ID : RYG\_FS0187 High Volume Model : TE-5009X  
 Calibrator ID : RYG\_FS0205 High Volume S/N : 4795  
 Calibrator Model : TE-5028A Calibrator Slope : 1.53016  
 Calibrator S/N : 1166 Calibrator Intercept : -0.0468

Test No.	Delta H <sub>2</sub> O (Inch)	Q <sub>std</sub> (m <sup>3</sup> /min)	I: Chart (CFM)	Linear Regression
1	1.6	0.8639	32	Slope: 28.3165 Intercept: 7.3928 Correlation Coefficient: 0.9982
2	2.2	1.0049	36	
3	3.0	1.1657	40	
4	3.8	1.3060	44	
5	4.5	1.4171	48	



Calibrated by: (Mr. Apichart Wilars) Field Scientist (1)  
 Approved by: (Mr. Noppong Juntarun) Enviro Field Coordinator Scientist (3)

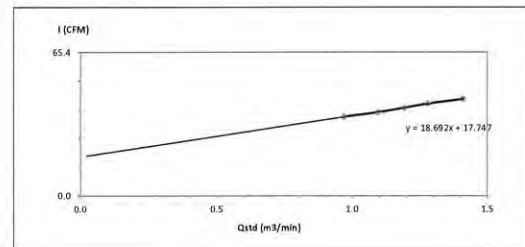
FORM NO. F 06-074 REVISION NO.: ISSUE DATE: 14/03/16



### High Volume Air Sampler Calibration Worksheet

Project Site : GLOW ENERGY PUBLIC COMPANY LIMITED Barometric Pressure (mm Hg) : 757  
 Calibrate Location : กรุงเทพมหานคร (เขตวัฒนา) Calibrate Date : 3-Dec-22 Temperature (°C) : 31  
 Calibration Sheet No. : C-031222-RYG\_FS0192 High Volume ID : RYG\_FS0192 High Volume Model : TE-5009X  
 Calibrator ID : RYG\_FS0205 High Volume S/N : 5331  
 Calibrator Model : TE-5028A Calibrator Slope : 1.50765  
 Calibrator S/N : 1166 Calibrator Intercept : -0.02043

Test No.	Delta H <sub>2</sub> O (Inch)	Q <sub>std</sub> (m <sup>3</sup> /min)	I: Chart (CFM)	Linear Regression
1	2.1	0.9702	36	Slope: 18.6925 Intercept: 17.7474 Correlation Coefficient: 0.9976
2	2.7	1.0974	38	
3	3.2	1.1929	40	
4	3.7	1.2811	42	
5	4.5	1.4108	44	



Calibrated by: (Mr. Nuranon Thongkham) Field Scientist (1)  
 Approved by: (Mr. Noppong Juntarun) Enviro Field Coordinator Scientist (3)

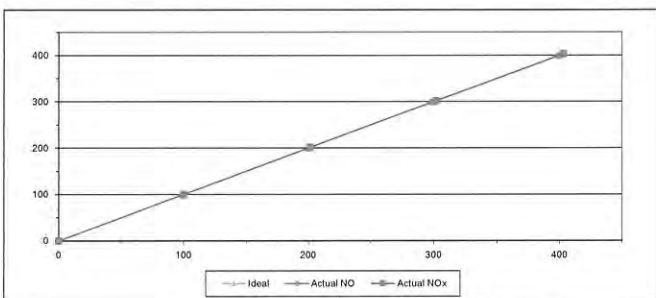
FORM NO. F 06-074 REVISION NO.: ISSUE DATE: 14/03/16



### MULTIPOINT CALIBRATION REPORT

Calibration Date : 1-Jul-22 Equipment Name : NOx Analyzer  
 Manufacturer : HORIBA Model : APNA-370  
 Serial No. : T95HWM41 Equipment ID : RYG\_FS0461  
 Calibrator Manufacturer : Teledyne API Model : 700  
 Serial No. : 947  
 Std. Gas Concentration (PPM) : 55.88 Cylinder No. : GN0027222  
 Cylinder Pressure (psi) : 1800 Certified By : Airgas Inc.  
 Certified Date : 9-Feb-22 Expired Date : 9-Feb-30

Point	CALIBRATION RESULTS						
	Ideal	Actual NO	Error NO	%Error NO	Actual NOx	Error NOx	%Error NOx
ZERO	0.00	0.10	0.10	0.10	0.10	0.10	0.10
1	100.00	98.70	-1.30	-1.30	100.10	0.10	0.10
2	200.00	201.00	1.00	0.50	201.40	1.40	0.70
3	300.00	298.30	-1.70	-0.57	302.10	2.10	0.70
4	400.00	398.40	-1.60	-0.40	403.50	3.50	0.88
AVERAGE (%)				-0.33	0.50		



Calibrated By: (Mr. Jirawut Sakam) Field Environmental Scientist (3)  
 Approved By: (Mr. Sarayuth Jittrantorn) Assistant General Manager

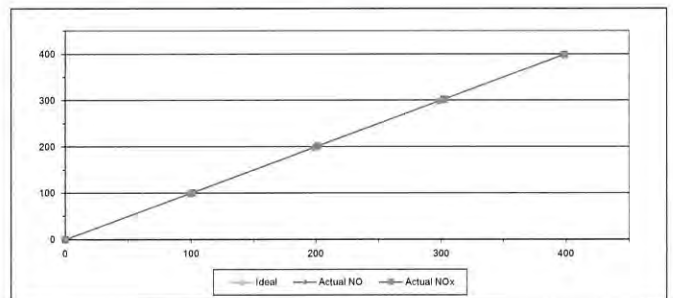
ALS Laboratory Group  
 FORM NO. F 06-056 REVISION NO.: ISSUE DATE: 02/04/12



### MULTIPOINT CALIBRATION REPORT

Calibration Date : 1-Jul-22 Equipment Name : NOx Analyzer  
 Manufacturer : Teledyne API Model : T200  
 Serial No. : 2198 Equipment ID : RYG\_FS0252  
 Calibrator Manufacturer : Teledyne API Model : 700  
 Serial No. : 947  
 Std. Gas Concentration (PPM) : 55.88 Cylinder No. : GN0027222  
 Cylinder Pressure (psi) : 1800 Certified By : Airgas Inc.  
 Certified Date : 9-Feb-22 Expired Date : 9-Feb-30

Point	CALIBRATION RESULTS						
	Ideal	Actual NO	Error NO	%Error NO	Actual NOx	Error NOx	%Error NOx
ZERO	0.00	0.10	0.10	0.10	0.10	0.10	0.10
1	100.00	98.80	-1.20	-1.20	101.00	1.00	1.00
2	200.00	198.00	-2.00	-1.00	201.30	1.30	0.65
3	300.00	298.10	-1.90	-0.63	302.30	2.30	0.77
4	400.00	398.20	-1.80	-0.45	398.80	-1.20	-0.30
AVERAGE (%)				-0.64			0.44



Calibrated By: (Mr. Jirawut Sakam) Field Environmental Scientist (3)  
 Approved By: (Mr. Sarayuth Jittrantorn) Assistant General Manager

ALS Laboratory Group  
 FORM NO. F 06-056 REVISION NO.: ISSUE DATE: 02/04/12

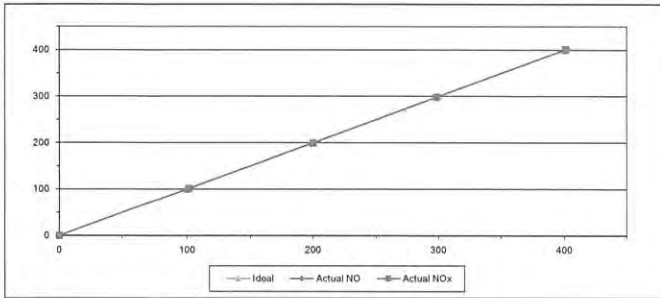




## MULTIPOINT CALIBRATION REPORT

Calibration Date	1-Jul-22	Equipment Name	NOx Analyzer
Manufacturer	HORIBA	Model	APNA-370
Serial No.	AWXG87CR	Equipment ID	RYG_FS0453
Calibrator Manufacturer	Teledyne API	Model	700
Serial No.	947		
Std. Gas Concentration (PPM)	55.88	Cylinder No.	GN0027222
Cylinder Pressure (psi)	1800	Certified By	Airgas Inc.
Certified Date	9-Feb-22	Expired Date	9-Feb-30

Point	CALIBRATION RESULTS						
	Ideal	Actual NO	Error NO	%Error NO	Actual NOx	Error NOx	%Error NOx
ZERO	0.00	0.10	0.10	0.10	0.10	0.10	0.10
1	100.00	99.60	-0.40	-0.40	101.40	1.40	1.40
2	200.00	198.60	-1.40	-0.70	199.80	-0.20	-0.10
3	300.00	299.00	-1.00	-0.33	298.50	-1.50	-0.50
4	400.00	402.10	2.10	0.53	401.20	1.20	0.30
AVERAGE (%)				-0.16			0.24



Calibrated By

(Mr. Jirawut Sakam)  
Field Environmental Scientist (3)

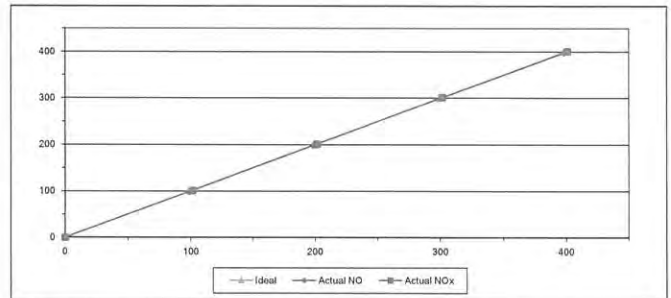
Approved By

(Mr. Sarayuth Jittrantorn)  
Assistant General ManagerALS Laboratory Group  
FORM NO. : F 06-056 REVISION NO. : ISSUE DATE: 02/04/12

## MULTIPOINT CALIBRATION REPORT

Calibration Date	1-Jul-22	Equipment Name	NOx Analyzer
Manufacturer	HORIBA	Model	APNA-370
Serial No.	ALP0V0WY	Equipment ID	RYG_FS0455
Calibrator Manufacturer	Teledyne API	Model	700
Serial No.	947		
Std. Gas Concentration (PPM)	55.88	Cylinder No.	GN0027222
Cylinder Pressure (psi)	1800	Certified By	Airgas Inc.
Certified Date	9-Feb-22	Expired Date	9-Feb-30

Point	CALIBRATION RESULTS						
	Ideal	Actual NO	Error NO	%Error NO	Actual NOx	Error NOx	%Error NOx
ZERO	0.00	0.10	0.10	0.10	0.10	0.10	0.10
1	100.00	98.60	-1.40	-1.40	101.60	1.60	1.60
2	200.00	198.70	-1.30	-0.65	201.40	1.40	0.70
3	300.00	301.00	1.00	0.33	301.80	1.80	0.60
4	400.00	398.20	-1.80	-0.45	401.20	1.20	0.30
AVERAGE (%)				-0.41			0.66



Calibrated By

(Mr. Jirawut Sakam)  
Field Environmental Scientist (3)

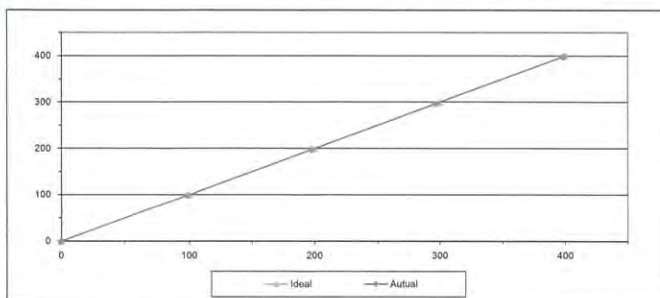
Approved By

(Mr. Sarayuth Jittrantorn)  
Assistant General ManagerALS Laboratory Group  
FORM NO. : F 06-056 REVISION NO. : ISSUE DATE: 02/04/12

## MULTIPOINT CALIBRATION REPORT

Calibration Date	1-Jul-22	Equipment Name	SO2 Analyzer
Manufacturer	HORIBA	Model	APSA-370
Serial No.	VABF9LSH	Equipment ID	RYG_FS0480
Calibrator Manufacturer	Teledyne API	Model	700
Serial No.	947		
Std. Gas Concentration (PPM)	56.3	Cylinder No.	GN0027222
Cylinder Pressure (psi)	1800	Certified By	Airgas Inc.
Certified Date	9-Feb-22	Expired Date	9-Feb-30

Point	CALIBRATION RESULTS			
	Ideal	Actual	Error	%Error
ZERO	0.00	0.10	0.10	0.10
1	100.00	98.70	-1.30	-1.30
2	200.00	197.80	-2.20	-1.10
3	300.00	296.50	-3.50	-1.17
4	400.00	398.30	-1.70	-0.42
AVERAGE (%)				-0.78



Calibrated By

(Mr. Jirawut Sakam)  
Field Environmental Scientist (3)

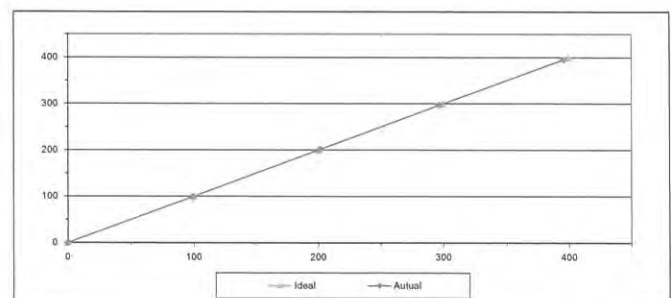
Approved By

(Mr. Sarayuth Jittrantorn)  
Assistant General ManagerALS Laboratory Group  
FORM NO. : F 06-056 REVISION NO. : ISSUE DATE: 02/04/12

## MULTIPOINT CALIBRATION REPORT

Calibration Date	1-Jul-22	Equipment Name	SO2 Analyzer
Manufacturer	Teledyne API	Model	T100
Serial No.	1773	Equipment ID	RYG_FS0251
Calibrator Manufacturer	Teledyne API	Model	700
Serial No.	947		
Std. Gas Concentration (PPM)	56.3	Cylinder No.	GN0027222
Cylinder Pressure (psi)	1800	Certified By	Airgas Inc.
Certified Date	9-Feb-22	Expired Date	9-Feb-30

Point	CALIBRATION RESULTS			
	Ideal	Actual	Error	%Error
ZERO	0.00	0.10	0.10	0.10
1	100.00	99.60	-0.40	-0.40
2	200.00	201.80	1.80	0.90
3	300.00	297.20	-2.80	-0.93
4	400.00	396.00	-4.00	-1.00
AVERAGE (%)				-0.27



Calibrated By

(Mr. Jirawut Sakam)  
Field Environmental Scientist (3)

Approved By

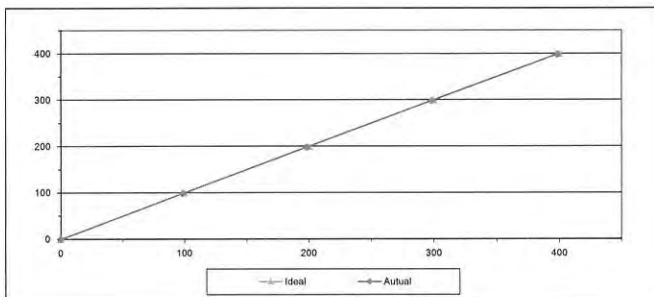
(Mr. Sarayuth Jittrantorn)  
Assistant General ManagerALS Laboratory Group  
FORM NO. : F 06-056 REVISION NO. : ISSUE DATE: 02/04/12



## MULTIPOINT CALIBRATION REPORT

Calibration Date	1-Jul-22	Equipment Name	SO2 Analyzer
Manufacturer	HORIBA	Model	APSA-370
Serial No.	90U0XJ31	Equipment ID	RYG_FS0452
Calibrator Manufacturer	Teledyne API	Model	700
Serial No.	947		
Std. Gas Concentration (PPM)	56.3	Cylinder No.	GN0027222
Cylinder Pressure (psi)	1800	Certified By	Airgas Inc.
Certified Date	9-Feb-22	Expired Date	9-Feb-30

Point	CALIBRATION RESULTS			
	Ideal	Actual	Error	%Error
ZERO	0.00	0.10	0.10	0.10
1	100.00	98.60	-1.40	-1.40
2	200.00	198.00	-2.00	-1.00
3	300.00	298.10	-1.90	-0.63
4	400.00	398.20	-1.80	-0.45
AVERAGE (%)				-0.68



Calibrated By

(Mr.Jirawut Sakam)  
Field Environmental Scientist (3)

Approved By

(Mr.Sarayuth Jitranont)  
Assistant General Manager

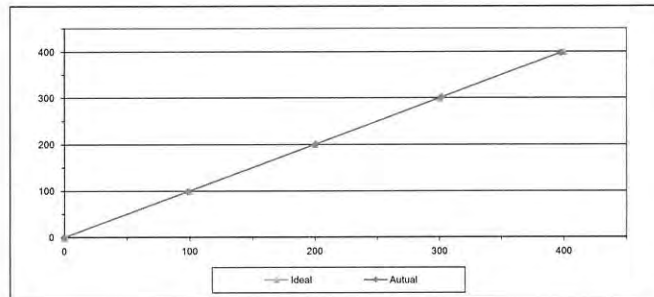
ALS Laboratory Group  
FORM NO. : F 06-056 REVISION NO. : ISSUE DATE: 02/04/12



## MULTIPOINT CALIBRATION REPORT

Calibration Date	1-Jul-22	Equipment Name	SO2 Analyzer
Manufacturer	HORIBA	Model	APSA-370
Serial No.	H0S3D9FA	Equipment ID	RYG_FS0454
Calibrator Manufacturer	Teledyne API	Model	700
Serial No.	947		
Std. Gas Concentration (PPM)	56.3	Cylinder No.	GN0027222
Cylinder Pressure (psi)	1800	Certified By	Airgas Inc.
Certified Date	9-Feb-22	Expired Date	9-Feb-30

Point	CALIBRATION RESULTS			
	Ideal	Actual	Error	%Error
ZERO	0.00	0.10	0.10	0.10
1	100.00	98.30	-1.70	-1.70
2	200.00	200.80	0.80	0.40
3	300.00	301.90	1.90	0.63
4	400.00	397.50	-2.50	-0.63
AVERAGE (%)				-0.24



Calibrated By

(Mr.Jirawut Sakam)  
Field Environmental Scientist (3)

Approved By

(Mr.Sarayuth Jitranont)  
Assistant General Manager

ALS Laboratory Group  
FORM NO. : F 06-056 REVISION NO. : ISSUE DATE: 02/04/12



63/14-15,67/35-36, Soi Petchkasem 7/7/1, Petchkasem Rd,  
Wattthapra, Bangkokyai,Bangkok 10600 Thailand.

Tel.: (66) 02-8680812#13 Fax.: (66) 02-8680860 www.jiranatee.com



63/14-15,67/35-36, Soi Petchkasem 7/7/1, Petchkasem Rd,  
Wattthapra, Bangkokyai,Bangkok 10600 Thailand.

Tel.: (66) 02-8680812#13 Fax.: (66) 02-8680860 www.jiranatee.com

## CERTIFICATE OF CALIBRATION

Certificate No. WS 12072021  
Page 1 of 2 pages

Measurement Item	Cup anemometer with data logger		
Manufacturer	Data logger: Novinka Cup anemometer: Novinka		
Model/Type	Data logger: 230 WD-26LB Cup anemometer: WS-02P		
Serial Number	Data logger: A5074 Cup anemometer:		
IP No.	Data logger: R00750412 Cup anemometer:		
Customer	ALS Laboratory Group (Private) Co., Ltd. 104 Petchkasem Rd, Wattthapra, Bangkok 10600 Thailand		
Test Conditions	Wind tunnel speed test condition area	900 m <sup>2</sup>	
	Anemometer function area	100 m <sup>2</sup>	
	Direction of anemometer	WS	
	Exposure rate of anemometer	0.111 (1)	
Test Conditions	Atmospheric pressure	1013.25 hPa	
	Atmospheric humidity	75.0 %	
	Relative air humidity	52.1 %	
Calibration Procedure	The calibration was performed by the Jiranatee Calibration Procedure, version 1.0, 2019.		
Traceability	The calibration was performed by the Jiranatee Calibration Procedure, version 1.0, 2019.		
Measurement Date	July 20, 2021		
Issued Date	July 20, 2021		

REVIEW BY: *[Signature]*  
APPROVED BY: *[Signature]*  
NEXT CAL DATE: 27/1/23



Approved By: *[Signature]*  
Mr. Pichai Boonchaisri  
General Manager  
and Calibration Manager

Continuation of Certificate of Calibration Number

Certificate No. WS 12072021  
Page 2 of 2 Pages

Result of calibration: ☒ With adjustment ☐ With no adjustment  
Calibration is in the range of 1 to 400 m/s at a calibration interval of 1 year.  
The results of calibration and associated measurement uncertainties are reported in the table below.

V <sub>ref</sub> Reading m/s	V <sub>act</sub> Reading m/s	Error (m/s)	Uncertainty (%)
2.075	2.0	-0.1	2.6
4.150	4.1	0.1	1.3
6.225	6.0	0.0	0.6
8.300	8.1	0.1	0.6
10.375	10.1	0.1	0.7
12.450	12.2	0.2	0.6
14.525	14.3	0.3	0.4
16.600	16.4	0.4	0.5
18.675	18.3	0.3	0.4
20.750	20.2	0.2	0.5
22.825	22.1	0.1	0.5
24.900	24.1	0.0	0.6
26.975	26.1	0.1	0.6
29.050	28.1	0.1	0.6
31.125	30.1	0.1	0.6
33.200	32.1	0.1	0.6
35.275	34.1	0.1	0.6
37.350	36.1	0.1	0.6
39.425	38.1	0.1	0.6
41.500	40.1	0.1	0.6
43.575	42.1	0.1	0.6
45.650	44.1	0.1	0.6
47.725	46.1	0.1	0.6
49.800	48.1	0.1	0.6
51.875	50.1	0.1	0.6
53.950	52.1	0.1	0.6
56.025	54.1	0.1	0.6
58.100	56.1	0.1	0.6
60.175	58.1	0.1	0.6
62.250	60.1	0.1	0.6
64.325	62.1	0.1	0.6
66.400	64.1	0.1	0.6
68.475	66.1	0.1	0.6
70.550	68.1	0.1	0.6
72.625	70.1	0.1	0.6
74.700	72.1	0.1	0.6
76.775	74.1	0.1	0.6
78.850	76.1	0.1	0.6
80.925	78.1	0.1	0.6
83.000	80.1	0.1	0.6
85.075	82.1	0.1	0.6
87.150	84.1	0.1	0.6
89.225	86.1	0.1	0.6
91.300	88.1	0.1	0.6
93.375	90.1	0.1	0.6
95.450	92.1	0.1	0.6
97.525	94.1	0.1	0.6
99.600	96.1	0.1	0.6
101.675	98.1	0.1	0.6
103.750	100.1	0.1	0.6
105.825	102.1	0.1	0.6
107.900	104.1	0.1	0.6
109.975	106.1	0.1	0.6
112.050	108.1	0.1	0.6
114.125	110.1	0.1	0.6
116.200	112.1	0.1	0.6
118.275	114.1	0.1	0.6
120.350	116.1	0.1	0.6
122.425	118.1	0.1	0.6
124.500	120.1	0.1	0.6
126.575	122.1	0.1	0.6
128.650	124.1	0.1	0.6
130.725	126.1	0.1	0.6
132.800	128.1	0.1	0.6
134.875	130.1	0.1	0.6
136.950	132.1	0.1	0.6
139.025	134.1	0.1	0.6
141.100	136.1	0.1	0.6
143.175	138.1	0.1	0.6
145.250	140.1	0.1	0.6
147.325	142.1	0.1	0.6
149.400	144.1	0.1	0.6
151.475	146.1	0.1	0.6
153.550	148.1	0.1	0.6
155.625	150.1	0.1	0.6
157.700	152.1	0.1	0.6
159.775	154.1	0.1	0.6
161.850	156.1	0.1	0.6
163.925	158.1	0.1	0.6
166.000	160.1	0.1	0.6
168.075	162.1	0.1	0.6
170.150	164.1	0.1	0.6
172.225	166.1	0.1	0.6
174.300	168.1	0.1	0.6
176.375	170.1	0.1	0.6
178.450	172.1	0.1	0.6
180.525	174.1	0.1	0.6
182.600	176.1	0.1	0.6
184.675	178.1	0.1	0.6
186.750	180.1	0.1	0.6
188.825	182.1	0.1	0.6
190.900	184.1	0.1	0.6
192.975	186.1	0.1	0.6
195.050	188.1	0.1	0.6
197.125	190.1	0.1	0.6
199.200	192.1	0.1	0.6
201.275	194.1	0.1	0.6
203.350	196.1	0.1	0.6
205.425	198.1	0.1	0.6
207.500	200.1	0.1	0.6
209.575	202.1	0.1	0.6
211.650	204.1	0.1	0.6
213.725	206.1	0.1	0.6
215.800	208.1	0.1	0.6
217.875	210.1	0.1	0.6
219.950	212.1	0.1	0.6
222.025	214.1	0.1	0.6
224.100	216.1	0.1	0.6
226.175	218.1	0.1	0.6
228.250	220.1	0.1	0.6
230.325	222.1	0.1	0.6
232.400	224.1	0.1	0.6
234.475	226.1	0.1	0.6
236.550	228.1	0.1	0.6
238.625	230.1	0.1	0.6
240.700	232.1	0.1	0.6
242.775	234.1	0.1	0.6
244.850	236.1	0.1	0.6
246.925	238.1	0.1	0.6
249.000	240.1	0.1	0.6
251.075	242.1	0.1	0.6
253.150	244.1	0.1	0.6
255.225	246.1	0.1	0.6
257.300	248.1	0.1	0.6
259.375	250.1	0.1	0.6
261.450	252.1	0.1	0.6
263.525	254.1	0.1	0.6
265.600	256.1	0.1	0.6
267.675	258.1	0.1	0.6
269.750	260.1	0.1	0.6
271.825	262.1	0.1	0.6
273.900	264.1	0.1	0.6
275.975	266.1	0.1	0.6
278.050	268.1	0.1	0.6
280.125	270.1	0.1	0.6
282.200	272.1	0.1	0.6
284.275	274.1	0.1	0.6
286.350	276.1	0.1	0.6
288.425	278.1	0.1	0.6
290.500	280.1	0.1	0.6
292.575	282.1	0.1	0.6
294.650	284.1	0.1	0.6
296.725	286.1	0.1	0.6
298.800	288.1	0.1	0.6
300.875	290.1	0.1	0.6
302.950	292.1	0.1	0.6
305.025	294.1	0.1	0.6
307.100	296.1	0.1	0.6
309.175	298.1	0.1	0.6
311.250	300.1	0.1	0.6
313.325	302.1	0.1	0.6
315.400	304.1	0.1	0.6
317.475	306.1	0.1	0.6
319.550	308.1	0.1	0.6
321.625	310.1	0.1	0.6
323.700	312.1	0.1	0.6
325.775	314.1	0.1	0.6
327.850	316.1	0.1	0.6
329.925	318.1	0.1	0.6
332.000	320.1	0.1	0.6
334.075	322.1	0.1	0.6
336.150	324.1	0.1	0.6
338.225	326.1	0.1	0.6
340.300	328.1	0.1	0.6
342.375	330.1	0.1	0.6
344.450	332.1	0.1	0.6
346.525	334.1	0.1	0.6
348.600	336.1	0.1	0.6
350.675	338.1	0.1	0.6
352.750	340.1	0.1	0.6
354.825	342.1	0.1	0.6
356.900	344.1	0.1	0.6
358.975	346.1	0.1	0.6
361.050	348.1	0.1	0.6
363.125	350.1	0.1	0.6
365.200	352.1	0.1	0.6
367.275	354.1	0.1	0.6
369.350	356.1	0.1	0.6
371.425	358.1	0.1	0.6
373.500	360.1	0.1	0.6
375.575	362.1	0.1	0.6
377.650	364.1	0.1	0.6
379.725	366.1	0.1	0.6
381.800	368.1	0.1	0.6
383.875	370.1	0.1	0.6
385.950	372.1	0.1	0.6
388.025	374.1	0.1	0.6
390.100	376.1	0.1	0.6
392.175	378.1	0.1	0.6
394.250	380.1	0.1	0.6
396.325	382.1	0.1	0.6
398.400	384.1	0.1	0.6
400.475	386.1	0.1	0.6
402.550	388.1	0.1	0.6
404.625	390.1	0.1	0.6
406.700	392.1	0.1	0.6
408.775	394.1	0.1	0.6
410.850	396.1	0.1	0.6
412.925	398.1	0.1	0.6
415.000	400.1	0.1	0.6
417.075	402.1	0.1	0.6
419.150	404.1	0.1	0.6
421.225	406.1	0.1	0.6
423.300	408.1	0.1	0.6
425.375	410.1	0.1	0.6
427.450	412.1	0.1	0.6
429.525	414.1	0.1	0.6
431.600	416.1	0.1	0.6
433.675	418.1	0.1	0.6
435.750	420.1	0.1	0.6
437.825	422.1	0.1	0.6
439.900	424.1	0.1	0.6
441.975	426.1	0.1	0.6
444.050	428.1	0.1	0.6
446.125	430.1	0.1	0.6
448.200	432.1	0.1	0.6
450.275	434.1	0.1	0.6
452.350	436.1	0.1	0.6
454.425	438.1	0.1	0.6
456.500	440.1	0.1	0.6
458.575	442.1	0.1	0.6
460.650	444.1	0.1	0.6
462.725	446.1	0.1	0.6
464.800	448.1	0.1	0.6
466.875	450.1	0.1	0.6
468.950	452.1	0.1	0.6
471.025	454.1	0.1	0.6
473.100	456.1	0.1	0.6
475.175	458.1	0.1	0.6
477.250	460.1	0.1	0.6
479.325	462.1	0.1	0.6
481.400	464.1	0.1	0.6
483.475	466.1	0.1	0.6
485.550	468.1	0.1	0.6
487.625	470.1	0.1	0.6
489.700	472.1	0.1	0.6
491.775	474.1	0.1	0.6
493.850	476.1	0.1	0.6
495.925	478.1	0.1	0.6
498.000	480.1	0.1	0.6
500.075	482.1	0.1	0.6
502.150	484.1	0.1	0.6
504.225	486.1	0.1	0.6
506.300	488.1	0.1	0.6
508.375	490.1	0.1	0.6
510.450	492.1	0.1	0.6
512.525	494.1	0.1	0.6
514.600	496.1	0.1	0.6
516.675	498.1	0.1	0.6
518.750	500.1	0.1	0.6
520.825	502.1	0.1	0.6
522.900	504.1	0.1	0.6
524.975	506.1	0.1	0.6
527.050	508.1	0.1	0.6
529.125	510.1	0.1	0.6
531.200	512.1	0.1	0.6
533.275	514.1	0.1	0.6
535.350	516.1	0.1	0.6
537.425	518.1	0.1	0.6
539.500	520.1	0.1	0.6
541.575	522.1	0.1	0.6
543.650	524.1	0.1	0.6
545.725	526.1	0.1	0.6
547.800	528.1	0.1	0.6
549.875	530.1	0.1	0.6
551.950	532.1	0.1	0.6
554.025	534.1	0.1	0.6
556.100	536.1	0.1	0.6
558.175	538.1	0.1	0.6
560.250	540.1	0.1	0.6
562.325	542.1	0.1	0.6
564.400	544.1	0.1	0.6
566.475	546.1	0.1	0.6
568.550	548.1	0.1	0.6
570.625	550.1	0.1	0.6
572.700	552.1	0.1	0.6
574.775	554.1	0.1	0.6
576.850	556.1	0.1	0.6
578.925	558.1	0.1	0.6
581.000	560.1	0.1	0.6
583.075	562.1	0.1	0.6
585.150	564.1	0.1	0.6
587.225	566.1	0.1	0.6
589.300	568.1	0.1	0.6
591.375	570.1	0.1	0.6
593.450	572.1	0.1	0.6
595.525	574.1	0.1	0.6
597.600	576.1	0.1	0.6
599.675	578.1	0.1	0.6
601.750	580.1	0.1	0.6
603.825	582.1	0.1	0.6
605.900	584.1	0.1	0.6
607.975	586.1	0.1	0.6
610.050	588.1	0.1	0.6
612.125	590.1	0.1	0.6
614.200	592.1	0.1	0.6</

## CERTIFICATE OF CALIBRATION

Certificate No: WD-12072021  
Page 1 of 2 pages

Measurement Item: Wind direction sensor with data logger

Manufacturer: Data logger: Novallink  
Wind direction sensor: Novallink

Model/Type: Data logger: 200-WB-251B  
Wind direction sensor: WS-02R

Serial Number: Data logger: A5374  
Wind direction sensor:

ID No: Data logger: RND-FS0412  
Wind direction sensor:

Customer: AIS laboratory group (Thailand) Co., Ltd.  
104 Phatthanasak 40, Phatthanasak Rd, Khwaeng Suan Luang, Khet Suan Luang, Bangkok 10250  
Thailand

Environmental Condition:  
The measurement was carried out in an ambient temperature of (23.5)°C, and relative humidity of (40) (100%.

Measurement Method:  
The wind direction sensor calibration according to comparison method with reference angle measurement electronic theodolite and the laser is used for axis control. The measurement were taken at 45° intervals in clockwise and counterclockwise directions.

Note: The UUC was warned up for 1 hour prior to the calibration being performed.

Traceability:  
The measurement results are traceable to the international system of units (SI) through Certificate No: GC563-07-0045, Certificate No: KW563/0044.

Measurement Date: 1 Jul 29, 2021  
Issued Date: 1 Jul 29, 2021



Approved Signatory:

Mr. Panya Boonchorn  
Technical Support  
and Calibration Manager

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Continuation of Certificate of Calibration Number

Certificate No: WD-12072021  
Page 2 of 2 pages

Result of calibration: ☐ Without adjustment ☒ With adjustment.  
Calibration in the range of 0 - 360 ° at a calibration interval of 45°.

The results of calibration and associated measurement uncertainties are reported in table below.

NO	Turning Direction	Nominal Angle (°)	Standard Reading (°)	UUC* Reading (°)	Error (°)	Uncertainty (°)
1	Clockwise	0/350	360	359	-1	3.0
2		45	45	42	-3	3.0
3		90	90	87	-3	3.0
4		135	135	93	-2	3.0
5		180	180	178	-2	3.0
6		225	225	226	1	3.0
7		270	270	273	3	3.0
8		315	315	318	3	3.0
9	Counter Clockwise	0/350	360	359	-1	3.0
10		45	45	42	-3	3.0
11		90	90	87	-3	3.0
12		135	135	133	-2	3.0
13		180	180	178	-2	3.0
14		225	225	226	1	3.0
15		270	270	273	3	3.0
16		315	315	318	3	3.0

UUC\* Unit Under Calibration: The reported expanded uncertainty is based on standard uncertainty multiplied by a coverage factor  $k=2$  providing a level of confidence of approximately 95%.

\*\*\*End of Certificate of Calibration\*\*\*



## CERTIFICATE OF CALIBRATION

Certificate No: WS-01062021  
Page 1 of 2 pages

Measurement Item: Cup anemometer with data logger

Manufacturer: Data logger: Novallink  
Cup anemometer: Novallink

Model/Type: Data logger: WS-25DL  
Cup anemometer: WS-02R

Serial Number: Data logger: A4481  
Cup anemometer:

ID No: Data logger: RND-FS0414  
Cup anemometer:

Customer: AIS laboratory group (Thailand) Co., Ltd.  
104 Phatthanasak 40, Phatthanasak Rd, Khwaeng Suan Luang, Khet Suan Luang, Bangkok 10250  
Thailand

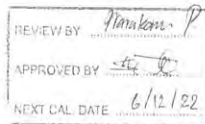
Test Conditions:  
Wind tunnel cross test section area: 900 m<sup>2</sup>  
Reference frontal area: 100 m<sup>2</sup>  
Diameter of mounting pipe: 400 mm  
Blockage ratio of test object: 0.11

Test Conditions:  
Air temperature: 23.7 ±0.5 °C  
Air pressure: 1012.3 ±0.4 hPa  
Relative air humidity: 59.1 ±2.5 %RH

Calibration Procedure:  
Calibration was carried out using:  
IEC 61400-12:2011-2020 Power Performance Measurements of Electricity Producing Wind Turbines  
MBS2007 Anemometer Calibration Procedure - Version 01/2020

Traceability:  
This calibration documents the traceable to national standards which realize the unit of measurement according to the international system of units (SI) through National Institute of Metrology (Thailand) (NIM).

Measurement Date: 1 Jun 06, 2021  
Issued Date: 1 Jun 07, 2021



Approved Signatory:

Mr. Panya Boonchorn  
Technical Support  
and Calibration Manager

Calibrated by:  
☒ Mr. Sorned Thachkai  
☐ Miss Orana Waiwattay

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Continuation of Certificate of Calibration Number

Certificate No: WS-01062021  
Page 2 of 2 pages

Result of calibration: ☒ Without adjustment ☐ With adjustment.  
Calibration in the range of 1 - 10 m/s at a calibration interval of 1 m/s.

The results of calibration and associated measurement uncertainties are reported in the table below.

V <sub>ref</sub> Reading m/s	V <sub>unc</sub> Reading m/s	Error (m/s)	Uncertainty (m/s)
2.055	2.0	0.1	2.6
4.124	4.0	-0.1	1.2
5.59	5.0	0.5	1.01
6.03	6.0	0.3	0.74
9.59	10.1	0.1	0.60
11.55	12.2	0.7	0.67
14.03	14.4	0.4	0.45
15.03	15.5	0.6	0.35
15.01	15.5	0.5	2.6
12.99	13.2	0.3	0.41
10.99	11.2	0.2	0.53
9.01	9.3	0.3	1.2
7.05	7.0	0.0	0.77
5.121	5.0	0.1	0.68
3.048	3.0	0.0	1.6
1.058	1.0	0.1	5.3

UUC\* Unit Under Calibration:

The reported expanded uncertainty is based on standard uncertainty multiplied by a coverage factor  $k=2$  providing a level of confidence of approximately 95%.

Appendix 1: Information

NO	Serial	Manufacturer	Model/Type	Calibration Date	Certificate Report Number	Range
1	1191010	TECH INC.	DS32145	July 16, 2020	MA-DC35-20	5 - 30 m/s
2	Pressure Differential Pressure Meter	Zepeda	TPM0520	July 16, 2020	MA-DC35-20	5 - 30 m/s
3	Accuracy Inductor (ref. val)	TEAC	64512	July 16, 2020	MA-DC35-20	0 - 5 m/s
4	Temperature	Togian	DSR-TMP	March 30, 2021	C-412-H04	20 - 20 °C
5	Relative Humidity	Zogad	SRH-TMP	March 30, 2021	RH-C33-2021	2 - 100 %RH
6	Atmospheric pressure	Zogad	SRP-TMP	March 30, 2021	BP-G10-2021	500 - 1100 hPa
7	WiFi router	CSSCOM	MP33C0			0 - 50 m/s

\*\*\*End of certificate of calibration\*\*\*







## CERTIFICATE OF CALIBRATION

Certificate No: WD-13072021  
Page 1 of 2 pages

Measurement Item: Wind direction sensor with data logger

Manufacturer: Data logger: Novolyte  
Wind direction sensor: Novolyte

Model/Type: Data logger: 200-WS-251-B  
Wind direction sensor: WS-02P

Serial Number: Data logger: A5375  
Wind direction sensor: ~

ID No: Data logger: R90\_F80413  
Wind direction sensor: ~

Customer: A.S. laboratory group (Thailand) Co., Ltd.  
104 Phachanasan 40, Phachanasan Rd Khwaeng Suan Luang, Khet Suan Luang, Bangkok 10250, Thailand

### Environmental Condition:

The measurement was carried out in an ambient temperature of  $(23 \pm 3)^\circ\text{C}$ , and relative humidity of  $(40 \pm 10)\%$ .

### Measurement Method:

The wind direction sensor calibration according to comparison method with reference angle measurement electronic theodolite and line laser is used for axis control. The measurement were taken at  $45^\circ$  intervals in clockwise and counter-clockwise directions.

Note: The UUC was warmed up for 1 hour prior to the calibration being performed.

### Traceability:

The measurement results are traceable to the international system of units (SI) through Certificate No: 02563-07/0045, Certificate No: 02563/0044.

Measurement Date: Jul 29, 2021  
Issued Date: Jul 29, 2021

Performed by:  
☒ Mr. Sorani Thachalad  
☐ Ms. Chantel Wwekibaya



Approved Signatory:

*[Signature]*

Mr. Panyia Booncharoen,  
Technica, Support  
and Calibration Manager

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Continuation of Certificate of Calibration Number

Certificate No: WD-13072021  
Pages 2 of 2 pages

Result of calibration: ☐ Without adjustment ☒ With adjustment.  
Calibration in the range of  $0 - 360^\circ$  at a calibration interval of  $45^\circ$ .

The results of calibration and associated measurement uncertainties are reported in table below:

NO	Turning Direction	Nominal Angle ( $^\circ$ )	Standard Reading ( $^\circ$ )	UUC* Reading ( $^\circ$ )	Error ( $^\circ$ )	Uncertainty $\pm$ ( $^\circ$ )
1	Clockwise	0/360	360	359	-1	3.0
2		45	45	42	-3	3.0
3		90	90	87	-3	3.0
4		135	135	134	-1	3.0
5		180	180	181	1	3.0
6		225	225	228	3	3.0
7		270	270	273	3	3.0
8		315	315	318	3	3.0
9	Counter Clockwise	0/360	360	359	-1	3.0
10		45	45	42	-3	3.0
11		90	90	87	-3	3.0
12		135	135	134	-1	3.0
13		180	180	181	1	3.0
14		225	225	228	3	3.0
15		270	270	273	3	3.0
16		315	315	318	3	3.0

UUC\* Unit Under Calibration The reported expanded uncertainty is based on standard uncertainty multiplied by a coverage factor  $k=2$  providing a level of confidence of approximately 95%.

\*\*\*End of Certificate of Calibration\*\*\*



## CERTIFICATE OF CALIBRATION

Certificate No: WS-03012022  
Page 1 of 2 pages

Measurement Item: Cup anemometer with data logger

Manufacturer: Data logger: Novolyte  
Cup anemometer: Novolyte

Model/Type: Data logger: 200-WS-251-B  
Cup anemometer: WS-02P

Serial Number: Data logger: A5101  
Cup anemometer: ~

ID No: Data logger: R90\_F50328  
Cup anemometer: ~

Customer: A.S. laboratory group (Thailand) Co., Ltd.  
104 Phachanasan 40, Phachanasan Rd Khwaeng Suan Luang, Khet Suan Luang, Bangkok 10250, Thailand

Test Conditions: Wind tunnel speed test in axis: 0/30 m/s  
Air pressure: 100 kPa  
Direction of rotating: ~  
Relative humidity: 0/11 %

Test Conditions: Air temperature: 23.9  $\pm$  0.5  $^\circ\text{C}$   
Air pressure: 100.6  $\pm$  0.5 kPa  
Relative humidity: 5.9  $\pm$  1.0 %RH

Calibration Procedure: Calibration was carried out based on:  
ISO 61420-12.1, 12.11, 2005 First, Performance Measurements of Weather Wind  
Turbines  
MCAQNT Accredited Calibration Procedure - Version 2 2006

Traceability: The calibration equipment, the accuracy in terms, standard, which include the unit of measurement, including to the international system of units (SI) through Technical Notice of Metrology Thailand (NMT)

Measurement Date: Jan 28, 2022  
Issued Date: Jan 28, 2022

Calibrated by:  
☒ Mr. Sorani Thachalad  
☐ Ms. Chantel Wwekibaya



Approved Signatory:

*[Signature]*

Mr. Panyia Booncharoen,  
Calibration (Technical) Manager

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Continuation of Certificate of Calibration Number

Certificate No: WS-03012022  
Page 2 of 2 Pages

Result of calibration: ☒ Without adjustment ☐ With adjustment.  
Calibration in the range of 1 - 10 m/s at a calibration interval of 1 m/s.

The results of calibration and associated measurement uncertainties are reported in the table below:

$V_{ref}$ Reading m/s	$V_{UUC}$ Reading m/s	Error m/s	Uncertainty (m/s)
2.578	2.0	0.1	2.4
4.129	4.0	0.1	1.8
6.07	6.0	0.2	1.8
8.01	7.0	0.1	1.3
10.00	9.8	0.2	0.69
11.95	11.9	0.1	0.67
14.00	13.5	0.4	2.8
15.98	15.7	0.3	1.6
16.92	14.8	0.6	1.1
18.03	18.8	0.5	1.5
19.01	18.6	0.5	1.2
20.2	19.7	0.3	0.90
21.22	21.7	0.3	0.94
23.102	23.1	0.1	1.5
25.75	25.0	0.6	2.2
10.24	0.8	0.2	4.8

UUC\* Unit Under Calibration

The reported expanded uncertainty is based on standard uncertainty multiplied by a coverage factor  $k=2$  providing a level of confidence of approximately 95%.

### Appendix 1: Calibration Data

NO	Sensor	Manufacturer	Model/Type	Calibration Date	Certificate Report Number	Range
1	Wind gauge	10370-R2	0032145	Aug 07 2021	MA-0304-21	0 - 30 m/s
2	Pressure Differential Pressure Meter	Zigzag	0002600	Aug 07 2021	MA-0304-21	0 - 30 m/s
3	Novolyte (anemometer) (cup) (wind)	TS-NAC	8455-10	Aug 08 2021	MA-0305-21	0 - 5 m/s
4	Temperature	Zigzag	0017100	Mar 30 2021	EL-0274-21	30 - 70 $^\circ\text{C}$
5	Relative humidity	Zigzag	0017100	Mar 30 2021	EL-0274-21	0 - 100 %RH
6	Atmospheric pressure	Zigzag	0017100	Mar 30 2021	EL-0274-21	500 - 1100 hPa
7	Wind turbine	0100M	003300		BP-010272-21	0 - 50 m/s

\*\*\*End of certificate of calibration\*\*\*





## CERTIFICATE OF CALIBRATION

Certificate No: WD-06012022  
Page 1 of 2 pages

Measurement Item : Wind direction sensor with data logger

Manufacturer : Data logger: Novolytik  
Wind direction sensor: Novolytik

Model/Type : Data logger: ZDC WS-25LE  
Wind direction sensor: WS-02F

Serial Number : Data logger: A5191  
Wind direction sensor:

ID No : Data logger: RML\_F50038  
Wind direction sensor:

Customer : ALS laboratory group (Thailand) Co.,Ltd.  
104 Phrasmanan 40, Phrasmanan Rd,Khuang Suan Luang, Khet Suan Luang, Bangkok 10250  
Thailand

Environmental Condition:  
The measurement was carried out in an ambient temperature of (23±3) °C, and relative humidity of (40±10) %.

Measurement Method:  
The wind direction sensor calibration according to comparison method with reference angle measurement electronic theodolite and the ass\* is used for axis control. The measurement was taken at 45° intervals in clockwise and counterclockwise directions.

Note: The UUC was warmed up for 1 hour prior to the calibration being performed.

Traceability:  
The measurement results are traceable to the international system of units (SI) through Certificate No. Q21065014, Certificate No. KW56410025.

Measurement Date : JAN 26, 2022  
Issued Date : JAN 31, 2022

Performed by:  
☒ Mr. Sakrit Phaisangphut  
☐ Mr. Drata Whaititaya



Approved Signatory:

Mr. Panya Somchulchai  
Calibration Department Manager

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Continuation of Certificate of Calibration Number

Certificate No: WD-06012022  
Page 2 of 2 pages

Result of calibration: ☐ Without adjustment ☒ With adjustment  
Calibration is in the range of 0 - 360 ° at a calibration interval of 45°  
The results of calibration and associated measurement uncertainties are reported in table below.

NO	Turning Direction	Nominal Angle (°)	Standard Reading (°)	UUC* Reading (°)	Error (°)	Uncertainty ±1°
1	Clockwise	0/360	0	1	1	3.0
2		45	45	45	0	3.0
3		90	90	91	1	3.0
4		135	135	134	-1	3.0
5		180	180	179	-1	3.0
6		225	225	225	0	3.0
7		270	270	272	2	3.0
8		315	315	319	4	3.0
9	Counter Clockwise	0/360	0	1	1	3.0
10		45	45	45	0	3.0
11		90	90	91	1	3.0
12		135	135	134	-1	3.0
13		180	180	179	-1	3.0
14		225	225	225	0	3.0
15		270	270	272	2	3.0
16		315	315	319	4	3.0

UUC\*: Unit Under Calibration. The reported expanded uncertainty is based on standard uncertainty multiplied by a coverage factor k=2 providing a level of confidence of approximately 95%.

\*\*\*End of Certificate of Calibration\*\*\*



## DIGITAL TEMPERATURE CALIBRATION DATA SHEET

Calibration Date :	12 Jul 22	Ambient Temperature (°C) :	30
Calibration sheet No. :	C-120722-BKK_FS0528	Relative Humidity (%) :	70
Digital Temperature ID :	BKK_FS0508	Reference Temperature ID :	BKK_FS0609
Console Serial No. :	1503017	Serial No. :	7688004
Console Model :	XC-672-V	Model :	FLUKE 714
		Next Calibrate :	26 Jul 23

Location	Reference Temperature °C	Digital Temperature °C	Error °C	Remark
Stack	0	2	2	
	25	24	-1	
	50	51	1	
	100	103	3	
	150	151	1	
	200	202	2	
	250	251	1	
	300	301	1	
Probe	500	503	3	
	1000	1001	1	
	1200	1202	2	
	100	101	1	
	125	126	1	
	150	153	3	
	100	101	1	
	125	126	1	
Oven	150	151	1	
	100	102	2	
	125	125	0	
	150	152	2	
	0	0	0	
	10	10	0	
	20	20	0	
	0	0	0	
Meter	25	25	0	
	50	50	0	
	0	0	0	
	25	25	0	
	50	50	0	
	0	0	0	
	25	25	0	
	50	50	0	

Calibrated by

Sakrit Phaisangphut

( Mr.Sakrit Phaisangphut )  
Field Scientist (4)

Approved by

Nattaporn Jangwong

( Mr.Nattaporn Jangwong )  
Field Specialist(1)

Form 281-048 (12/10/2022)

## CONSOLE CONTROL UNIT CALIBRATION TEST REPORT

Calibration of Date : 12 Jul 22  
Next Cal. Date : 12 Jan 23  
Barometric Pressure (mm.Hg) : 755  
Relative Humidity (%) : 70.0  
Temperature (°C) : 30.0

### Reference Dry Gas Meter Data

Serial No. : 1507009  
Model No. : SK25EXSR-QC6  
Correction Factor (Yr) : 1.0060  
Next Calibration Date : 7 Oct 22

### Console Control Meter Data

Calibration No. : C-120722-BKK\_FS0527  
Dry Gas Meter No. : BKK\_FS05027  
Serial No. : 1508053  
Model No. : XC-672-V

ΔH (mm H <sub>2</sub> O)	Θ Minutes	Reference Dry Gas Meter Calibration					Console Control Drygas Meter					Dry Gas Meter Correction Factor (%)	Office Calibration Factor ΔH <sub>g</sub>
		Wt (liters)			Tr (°C)	Vm (liters)			Ti (°C)	To (°C)	Avg.Tm (°C)		
		Final	Initial	Total		Final	Initial	Total					
15	11.26	150.00	0.00	150.00	30.0	264388.6	264222.0	146.80	30.0	30.0	30.0	1.0278	39.1930
25	8.93	150.00	0.00	150.00	31.0	264526.8	264380.0	146.80	31.0	31.0	31.0	1.0254	40.1496
50	6.32	150.00	0.00	150.00	31.0	264685.2	264539.0	146.20	31.0	31.0	31.0	1.0271	41.1361
100	4.45	150.00	0.00	150.00	31.0	264845.0	264699.0	146.00	31.0	31.0	31.0	1.0296	40.7867
150	3.67	150.00	0.00	150.00	31.0	265059.0	264912.0	147.00	31.0	31.0	31.0	1.0318	41.6143
											Avg	1.0322	40.6743

Y : Ratio of reading of reference to dry gas meter, tolerance for individual values ± 0.02 from average.  
ΔH<sub>g</sub> : Office pressure differential that equates to 21.24 in of air @ 25 °C and 760 mm of mercury, mmHgO, tolerance for individual values ± 5.08 from average.

Procedure: 40 CFR 80 APP A METH SEC 5.3 & 7

Calibrated by:

Sakrit Phaisangphut

( Mr.Sakrit Phaisangphut )  
Field Scientist(4)

Approved by:

Nattaporn Jangwong

( Mr.Nattaporn Jangwong )  
Field Specialist(1)

FORM NO. 1 Page 1 REVISION NO. 1 ISSUE DATE 2/10/2022



### Pitot Tube Calibration Data

Pitot Tube Identification Number : BKK\_FS0531 Calibration Date : 12 Jul 22  
Lab test duct Number : 258-1-13-01 Standard Pitot ID : BKK\_FS0441  
Calibration Sheet No. : C-120722-BKK\_FS0531 Cp Standard : 0.99

Type S Pitot Tube Coefficient Data					
	Type s pitot tube Leg A,B	Standard pitot tube ( $\Delta P$ , mm H <sub>2</sub> O)	Type s pitot tube ( $\Delta P$ , mm H <sub>2</sub> O)	Cp (s) Leg A	Cp (s) Leg B
Test 1	A	12.00	16.60	0.842	-
	B	12.00	16.60	-	0.842
Test 2	A	12.00	16.60	0.842	-
	B	12.00	16.60	-	0.842
Test 3	A	12.00	16.60	0.842	-
	B	12.00	16.60	-	0.842
$\bar{C}_p$				0.842	0.842

$$Cp(S) = Cp = \sqrt{\frac{\Delta P (std)}{\Delta P (s)}}$$

$$|Cp(A) - Cp(B)| \text{ must BE } \leq 0.01$$

$$\text{Average deviation(A or B)} = \frac{\sum [Cp(s) - Cp(A \text{ or } B)]}{3} \text{ must BE } \leq 0.01$$

Calibrated by Saksit Phaisanphisit Approved by Nattapong Jengwareewong  
( Mr Saksit Phaisanphisit ) ( Mr Nattapong Jengwareewong )  
Field Scientist (4) Field Specialist (1)

Form 281-046 (04/03/02)



### Pitot Tube Calibration Data

Pitot Tube Identification Number : BKK\_FS0532 Calibration Date : 12 Jul 22  
Lab test duct Number : 258-1-13-01 Standard Pitot ID : BKK\_FS0441  
Calibration Sheet No. : C-120722-BKK\_FS0532 Cp Standard : 0.99

Type S Pitot Tube Coefficient Data					
	Type s pitot tube Leg A,B	Standard pitot tube ( $\Delta P$ , mm H <sub>2</sub> O)	Type s pitot tube ( $\Delta P$ , mm H <sub>2</sub> O)	Cp (s) Leg A	Cp (s) Leg B
Test 1	A	12.00	16.60	0.842	-
	B	12.00	16.60	-	0.842
Test 2	A	12.00	16.60	0.842	-
	B	12.00	16.60	-	0.842
Test 3	A	12.00	16.60	0.842	-
	B	12.00	16.60	-	0.842
$\bar{C}_p$				0.842	0.842

$$Cp(S) = Cp = \sqrt{\frac{\Delta P (std)}{\Delta P (s)}}$$

$$|Cp(A) - Cp(B)| \text{ must BE } \leq 0.01$$

$$\text{Average deviation(A or B)} = \frac{\sum [Cp(s) - Cp(A \text{ or } B)]}{3} \text{ must BE } \leq 0.01$$

Calibrated by Saksit Phaisanphisit Approved by Nattapong Jengwareewong  
( Mr Saksit Phaisanphisit ) ( Mr Nattapong Jengwareewong )  
Field Scientist (4) Field Specialist (1)

Form 281-046 (04/03/02)

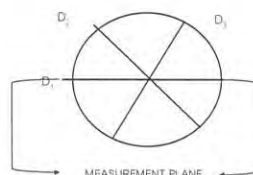


### PROBE NOZZLE DIAMETER CALIBRATION DATA SHEET

Calibration Date : 12 Jul 22 Nozzle Set ID : BKK\_FS0533  
Calibration Sheet No. : C-120722-BKK\_FS0533 Vernier Caliper ID : BKK\_FS0626

Nozzle ID #	Nozzle Diameter (mm.)			Hi - Lo $\Delta D$	$(D_1 + D_2 + D_3) / 3$
	$D_1$	$D_2$	$D_3$		
1	0.318	0.318	0.318	0.000	0.318
2	0.475	0.475	0.475	0.000	0.475
3	0.635	0.635	0.635	0.000	0.635
4	0.792	0.792	0.792	0.000	0.792
5	0.952	0.952	0.952	0.000	0.952
6	1.110	1.110	1.110	0.000	1.110
7	1.270	1.270	1.270	0.000	1.270

Where :  
 $D_1, D_2, D_3$  : There different nozzle diameters at 60 degrees to each other, each measured the nearest 0.025 mm  
 $\Delta D$  : Maximum distance between any two diameters, must be  $\leq 0.100$  mm.  
 $D_{avg}$  :  $(D_1 + D_2 + D_3) / 3$



Calibrated by Saksit Phaisanphisit Approved by Nattapong Jengwareewong  
( Mr Saksit Phaisanphisit ) ( Mr Nattapong Jengwareewong )  
Field Scientist (4) Field Specialist (1)

Form No. QS 281-028 (2/3/02) (03)

### CONSOLE CONTROL UNIT CALIBRATION TEST REPORT

Calibration Date : 12 Jul 22 Barometric Pressure (mm.Hg) : 754  
Next Calibration Date : 12 Jun 23 Relative Humidity (%) : 62.0  
Temperature (°C) : 31.0  
Reference Dry Gas Meter Data : BKK\_FS0629  
Serial No. : 1607009  
Correction Factor (Yr) : 1.0160  
Next Calibration Date : 25 Nov 23

Reference Dry Gas Meter Calibration		Console Control Dry Gas Meter		Dry Gas Meter Correction Factor		Office Calibration	
$\Delta H$ (mm H <sub>2</sub> O)	Minutes	Vr (Liters)		Tr (°C)		Factor	
		Final	Initial	Final	Initial	(Yr)	$\Delta H$
15	12.48	150.00	0.00	150.00	31.0	0.9992	48.0774
25	9.50	150.00	0.00	150.00	31.0	0.9996	48.3277
50	6.68	150.00	0.00	150.00	31.0	0.9919	46.1688
60	5.75	150.00	0.00	150.00	33.0	0.9871	45.9275
120	4.25	150.00	0.00	150.00	33.0	0.9862	44.9893
Avg						0.9920	46.3011

Y : Rate of reading of reference to dry gas meter, tolerance for individual values  $\pm 0.02$  from average  
 $\Delta H$  : Office pressure differential that requires to 21.24 in of air @ 75°C and 760 mmHg, tolerance for individual values  $\pm 5.0$  from average

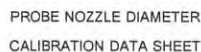
Procedure: 40 CFR 60 APP A METH. SEC 5.3 & 7

Calibrated by Prasert S. Approved by Saksit Ph.  
( Mr Prasert Sunhuan ) ( Mr Saksit Phaisanphisit )  
Field Scientist (3) Specialist (1)







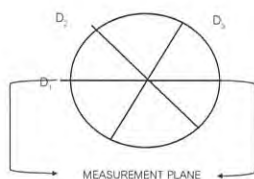


Where

$D_1, D_2, D_3$  = Three different nozzle diameters at 60 degrees to each other, each measured the nearest 0.025 mm

$\Delta D$  = Maximum distance between any two diameters, must be  $\leq 0.100$  mm

$D_{\text{avg}}$  =  $(D_1 + D_2 + D_3) / 3$



Calibrated by Prasert S.

Approved by 

Mr Prasert Surakhan  
Field Scientist (3)

Mr Samart Roo-ngan  
Specialist (1)

RECEIVED, 7-24-06; ACCEPTED, 10-2-06

# CONSOLE CONTROL UNIT CALIBRATION TEST REPORT

Barometric Pressure (mm.Hg)	755
Relative Humidity (%)	70.0
Temperature (°C)	30.0

Reference Dry Gas Meter Data

A20003240

DGM-SK25RM-QS8

.0160

17 May 23

1000

C-120722-RYG\_FS0315

C-120722-RYG\_FS0315

RYG\_FS0315

1706091

KC-572-V

4. 910.001

$\Delta H$	$\Theta$	Reference Dry Gas Meter Calibration				Console Control / Drygas Meter						Dry Gas Meter Correction Factor	Orifice Calibration Factor
		W (Liters)			Tr (°C)	Vm (Liters)			Ti (°C)	To (°C)	Avg.Tm (°C)		
		Final	Initial	Total		Final	Initial	Total					
15	12.30	150.00	0.00	150.00	27.0	144.0203.0	144.0505.0	145.00	27.0	27.0	27.0	1.0495	46.1284
25	9.45	150.00	0.00	150.00	30.0	144.4395.0	144.249.0	146.00	28.0	28.0	28.0	1.0344	46.1390
50	6.73	150.00	0.00	150.00	31.0	144.4742.0	144.536.0	146.00	28.0	28.0	28.0	1.0285	47.1115
100	4.70	150.00	0.00	150.00	31.0	144.0501.0	144.805.0	146.00	30.0	30.0	30.0	1.0304	45.6506
150	3.81	150.00	0.00	150.00	33.0	144.5299.0	144.994.0	145.00	30.0	30.0	30.0	1.0297	45.5919

Ratio of reading of reference to dry gas meter: tolerance for individual values  $\pm 0.02$  from average.

Orifice pressure differential that equates to 21.24 lm of air @ 25°C and 760 mm of mercury, minH<sub>2</sub>O; tolerance for individual values ± 5.08 from average.

Procedure; 40 CFR 60 APP A, METH, SEC 5.3 & 7

Calibrated by:

Approved by:

Walter Thompson

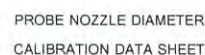
doi:10.1017/S0022292412001902



Calibration Date	12-Jul-22	Ambient Temperature (°C)	30	
Calibration sheet No.	C-120722-RYG_FS0316	Relative Humidity (%)	70	
Digital Temperature ID	RYG_FS0316	Reference Temperature ID	BKK_FS1144	
Console Serial No.	1700091	Serial No.	201000000013	
Console Model	XC-572-V	Model	Digicon-CC-VT-MS	
		Next Calibrate	31 Jan 23	
Location	Reference Temperature °C	Digital Temperature °C	Error °C	Remark
Stack	0	0	0	
	25	27	2	
	50	53	3	
	100	104	4	
	150	154	4	
	200	202	2	
	250	253	3	
	300	304	4	
Probe	500	505	5	
	1000	1003	3	
	1200	1202	2	
	100	104	4	
	125	129	4	
	150	154	4	
	100	104	4	
	125	129	4	
Oven	150	154	4	
	100	104	4	
	125	129	4	
Filter	150	154	4	
	100	104	4	
	125	129	4	
Exit	150	154	4	
	0	0	0	
	10	11	1	
Meter	20	22	2	
	0	0	0	
	25	27	2	
AUX	50	52	2	
	0	0	0	
	25	27	2	
	50	53	2	

Calibrated by \_\_\_\_\_  
( Mr. tinnakorn Kulchart )  
Field Scientist (1)

Approved by Nattaporn Jengwareewong  
( Mr.Nattaporn Jengwareewong )  
Field Specialist(1)



Calibration Date	12 Jul 22	Nozzle Set ID :	RYG_FS0319
Calibration Sheet No :	C-102722-RYG_FS0319	Vernier Caliper ID :	BKK_FS0626

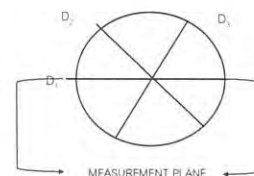
Nozzle ID #	Nozzle Diameter (cm.)			Hi - Lo	$(D_1 + D_2 + D_3) / 3$
	$D_1$	$D_2$	$D_3$	$\Delta D$	$D_{avg}$
1	0.300	0.300	0.300	0.000	0.300
2	0.470	0.465	0.465	0.005	0.467
3	0.600	0.600	0.600	0.006	0.600
4	0.770	0.760	0.755	0.015	0.762
5	0.920	0.930	0.930	0.010	0.927
6	1.080	1.080	1.085	0.005	1.082
7	1.240	1.220	1.235	0.020	1.232
8	1.550	1.570	1.540	0.030	1.553

Where:

$D_1, D_2, D_3$  = Three different nozzle diameters at 60 degrees to each other, each measured the nearest 0.025 mm.

$\Delta D$  = Maximum distance between any two diameters must be  $\leq 0.100$  mm.

$D_{\text{avg}}$  =  $(D_1 + D_2 + D_3) / 3$



Calibrated by \_\_\_\_\_  
(Tinnakorn Kulchai)  
Field Scientist (I)

Approved by \_\_\_\_\_  
( Mr.Natthapol Jhengwareewong,  
Field Specialist(1)

Form No. OS 281-025 (11/01/03)





## Pitot Tube Calibration Data

Pitot Tube Identification Number : RYG\_FS0320 Calibration Date : 12 Jul 22  
Lab test duct Number : 258-1-13-01 Standard Pitot ID : BKK\_FS0441  
Calibration Sheet No. : C-120722-RYG\_FS0320 Cp Standard : 0.99

Type S Pitot Tube Coefficient Data					
	Type s pitot tube Leg A,B	Standard pitot tube ( $\Delta P$ , mm H <sub>2</sub> O)	Type s pitot tube ( $\Delta P$ , mm H <sub>2</sub> O)	Cp (s) Leg A	Cp (s) Leg B
Test 1	A	12.00	16.60	0.842	-
	B	12.00	16.60	-	0.842
Test 2	A	12.00	16.60	0.842	-
	B	12.00	16.60	-	0.842
Test 3	A	12.00	16.60	0.842	-
	B	12.00	16.60	-	0.842
$\bar{C}_p$				0.842	0.842

$$Cp(S) = Cp = \sqrt{\frac{\Delta P(Std)}{\Delta P(s)}}$$

$$[Cp(A) - Cp(B)] \text{ must BE } \leq 0.01$$

$$\text{Average deviation(A or B)} = \frac{\sum [Cp(s) - Cp(A \text{ or } B)]}{3} \text{ must BE } \leq 0.01$$

Calibrated by

(Mr Innakorn Kulchar)

Field Scientist (1)

Approved by

(Mr Natthapol Jengwareewong)

Field Specialist(1)

Form 281-046 (04/03/02)



## Pitot Tube Calibration Data

Pitot Tube Identification Number : RYG\_FS0321 Calibration Date : 12 Jul 22  
Lab test duct Number : 258-1-13-01 Standard Pitot ID : BKK\_FS0441  
Calibration Sheet No. : C-120722-RYG\_FS0321 Cp Standard : 0.99

Type S Pitot Tube Coefficient Data					
	Type s pitot tube Leg A,B	Standard pitot tube ( $\Delta P$ , mm H <sub>2</sub> O)	Type s pitot tube ( $\Delta P$ , mm H <sub>2</sub> O)	Cp (s) Leg A	Cp (s) Leg B
Test 1	A	12.00	16.60	0.842	-
	B	12.00	16.60	-	0.842
Test 2	A	12.00	16.60	0.842	-
	B	12.00	16.60	-	0.842
Test 3	A	12.00	16.60	0.842	-
	B	12.00	16.60	-	0.842
$\bar{C}_p$				0.842	0.842

$$Cp(S) = Cp = \sqrt{\frac{\Delta P(Std)}{\Delta P(s)}}$$

$$[Cp(A) - Cp(B)] \text{ must BE } \leq 0.01$$

$$\text{Average deviation(A or B)} = \frac{\sum [Cp(s) - Cp(A \text{ or } B)]}{3} \text{ must BE } \leq 0.01$$

Calibrated by

(Mr Innakorn Kulchar)

Field Scientist (1)

Approved by

(Mr Natthapol Jengwareewong)

Field Specialist(1)

Form 281-046 (04/03/02)



## Calibration certificate Kalibrier-Zertifikat

4319391

Object Gegenstand: Controlunit 1350  
Manufacturer Hersteller: TESTO SE & Co. KGaA  
Type description Typ: 0632 3511  
Serial no. Serien Nr.: 03580098  
Inventory no. Inventar Nr.: ---  
Test equipment no. Prüfmittel Nr.: ---  
Equipment no. Equipment Nr.: 14672501  
Location Standort: ---  
Customer Auftraggeber: ALS Laboratory Group (Thailand) Co., Ltd  
Customer ID no. Kunden Nr.: 1031994  
Order no. Auftrags Nr.: 10642828 / 0520 0055

Hereby we confirm that the performing calibration laboratory is working with a management system according to ISO 9001:2015 and ISO/IEC 17025:2018. Accreditation certificates can be found under [www.testo.de](http://www.testo.de). The measuring installations used for calibration are regularly calibrated and traceable to the national standards of the German Federal Physical Technical Institute (PTB) or other national standards. Should no national standards exist, the measuring procedure corresponds with the technical regulations and norms valid at the time of the measurement. The documents established for this procedure are available for viewing. All the necessary measured data can be found on this calibration certificate.

Hiermit bestätigen wir, dass das durchführende Kalibrierlabor ein Managementsystem nach ISO 9001:2015, sowie ISO/IEC 17025:2018 eingeführt hat. Die Urkunden finden Sie auf [www.testo.de](http://www.testo.de). Die für die Kalibrierung verwendeten Messanordnungen werden regelmäßig kalibriert und sind rückführbar auf die nationalen Normale der Physikalisch-Technischen Bundesanstalt (PTB) Deutschlands oder auf andere nationale Normale. Wo keine nationalen Normale existieren, entspricht das Messverfahren den derzeit gültigen technischen Regeln und Normen. Die für diesen Vorgang angefertigten Dokumentationen finden eingehenden werden. Alle erforderlichen Messdaten sind in diesem Kalibrier-Zertifikat aufgeführt.

### Conformity statement Konformitätsaussage

- ☒ Measured value(s) within the allowable deviation<sup>1</sup>. Messwert(e) innerhalb der zulässigen Abweichung<sup>1</sup>.  
☐ Measured value(s) outside of the allowable deviation<sup>1</sup>. Messwert(e) außerhalb der zulässigen Abweichung<sup>1</sup>.

<sup>1</sup> The expanded measurement uncertainty was calculated according to EA-4-02 M:2013 with a coverage probability of approx. 95% and contains the uncertainty of the reference, the method and the uncertainty of the unit under test. The statement of conformity is based on the decision rule "Vertrauensniveau 50" (confidence level 50).

<sup>2</sup> Die erweiterte Messunsicherheit wurde nach EA-4-02 M:2013 mit einer Überdeckungswahrscheinlichkeit von etwa 95% berechnet und enthält die Unsicherheit der Referenz, die Verfahren sowie die Unsicherheit des Prüflings. Die Konformitätsaussage beruht nach der Entscheidungsregel "Vertrauensniveau 50".

This calibration certificate may not be reproduced other than in full except with the permission of the issuing laboratory. Calibration certificates without signature and seal are not valid. Dieses Kalibrierzertifikat darf nur vollständig weiterverbreitet werden. Auszüge oder Änderungen bedürfen der Genehmigung des ausstellenden Kalibrierlaboratoriums. Kalibrierzertifikate ohne Unterschrift und Stempel haben keine Gültigkeit.

## Calibration certificate Kalibrier-Zertifikat

4319391

### Measuring equipment Messanordnungen

Index	Reference	Traceability	Next cal.	Certificate no.	Eq. no.
	Referenz	Rückführung	Rekal.	Zertifikat-Nr.	Eq.-Nr.
a	Test gas medium 1 Prüfgas Medium 1	SCS-SC50026 2021-03	2024-03	4017586	12898876
b	Test gas medium 3 Prüfgas Medium 3	SCS-SC50026 2021-03	2022-03	4017586	12898876
c	Test gas medium 5 Prüfgas Medium 5	SCS-SC50026 2021-03	2022-03	4017591	12898884
d	Test gas medium 8 Prüfgas Medium 8	SCS-SC50026 2021-07	2022-10	4220471	12898887
e	Test gas medium 7 Prüfgas Medium 7	SCS-SC50026 2021-03	2022-03	4017586	12898886
f	Test gas medium 11 Prüfgas Medium 11	ISO-ISO 6141 2021-04	2022-04	4017602	14087664
g	Digistart 4420 Digistart 4420	15070-01-01 2021-07	2022-07	1188673	12866901
h	Pneumator Pneumator	15070-01-01 2021-07	2022-07	053219	12965547

Reference certificates are available at [www.primasonline.com](http://www.primasonline.com). Referenzzertifikate sind auf [www.primasonline.com](http://www.primasonline.com) abrufbar.

### Ambient conditions Umgebungsbedingungen

Temperature Temperatur: (20...26) °C Humidity Feuchte: (20...60) % RH rF

### Measuring procedure Messverfahren

The calibration was carried out by comparison measurement with calibrated test gases, a calibrator of temperature and pressure.

Die Kalibrierung erfolgte durch Vergleichsmessung mit kalibrierten Prüfgasen, einem Temperatur- und Druckkalibrator.

### Measuring results Messergebnisse

Channel/Kanal: ---

Unit	Reference	Indicated measured	Deviation	Allowed deviation <sup>2</sup>	Measurement	Confirmation
Einheit	Bezugswert	angezeigter Messwert	Abweichung	Zulässige Abweichung <sup>2</sup>	unsicherheit (k=2)	überprüfung
CO						
ppm	100.1 <sup>a</sup>	102	1.9	± 11	3.3	pass
ppm	401.0 <sup>b</sup>	401	0.0	± 21	8.5	pass
ppm	700.0 <sup>c</sup>	725	25.0	± 36	14.4	pass
NO						
ppm	150.3 <sup>a</sup>	151	0.7	± 9	4.0	pass
ppm	300 <sup>d</sup>	302	2	± 16	6.9	pass
NO2						
ppm	99.9 <sup>a</sup>	102.7	2.8	± 5.1	3.20	pass
SO2						
ppm	100.1 <sup>f</sup>	97	-3.1	± 6	3.5	pass
O2						
Vol.-%	0.0 <sup>a</sup>	0.06	0.1	± 0.21	0.027	pass
Vol.-%	2.510 <sup>b</sup>	2.56	0.050	± 0.21	0.055	pass
Vol.-%	5.000 <sup>b</sup>	5.08	0.080	± 0.21	0.102	pass
Temperatur						
°C	100.0 <sup>h</sup>	99.0	-1.0	± 1.1	0.24	pass
°C	200.0 <sup>h</sup>	199.9	-0.1	± 1.1	0.24	pass
Druck:						
hPa	50.0 <sup>h</sup>	49.8	-0.2	± 0.9	0.52	pass
hPa	100.0 <sup>h</sup>	99.9	-0.1	± 1.6	0.52	pass

<sup>2</sup> In accordance with the manufacturer's data.

Seal/Stempel



Supervisor Fachverantwortlicher

Martin Förderer

Technician Fachkraft

Johannes Wängler

Calibration certificate Kalibrier-Zertifikat 4319391

Special remarks Besondere Bemerkungen

Instrument description : Flue gas analyzer  
Instrument model : Testo 350New  
Instrument serial no. : 62087344  
ID no. or control no. : RYG\_FS0464  
Manufacturer : testo SE  
Probe description :  
Probe model :  
Probe serial :  
Customer name : ALS LABORATORY GROUP (THAILAND) CO.,LTD.  
Customer address : 104 Phatthanakan 40, Phatthanakan Road, Khwaeng Phatthanakan, Khet Suan Luang, Bangkok, 10250 Thailand  
Total pages of certificate : 3 Pages  
Receiving no. : L-220079  
Receiving date : 14-Jan-22  
Parameter of calibration : Gas Calibration(Oxygen 2.501,10.00,21.00 %Vol, Carbon Monoxide 80.97,309.9,1003 ppm, Nitrogen Dioxide 10.19,80.62,202.2 ppm, Nitric Oxide 10.08,150.9,320.6 ppm, Sulphur Dioxide 50.04,100.9,601.1 ppm)  
Condition of UUC. : Used  
Ambient condition : All of the Measurement were carried out the stabilized laboratory  
Temperature : 23 ± 5 °C  
Humidity : 55 ± 15 %RH  
Calibration place : 17/121 Soi Ngamwongwan 47 Yaek 48, Toongsongkhong, Laksi, Bangkok 10210  
Calibration procedure no. : WI-CL-28-C

REVIEW BY : *Franken P.*  
APPROVED BY : *He K.*  
NEXT CAL. DATE : 15/1/23

The calibration certificate expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by coverage factor  $k=2$ , which for a normal distribution corresponds to a coverage probability of approximately 95%. This certificate is applied only to item under test Environmental condition. This Calibration Certificate may not be reproduced other than in full except with the permission of the issuing laboratory. Calibration certificates without signature and seal not valid. This calibration certificate documents are traceability to national standards, which realize measurement according to the International System of Units (SI).  
Date of calibration : 18-Jan-22

*Sam*  
Mr. Sedawut Nueathong  
Calibration Technician

*P. Wuttich*  
Mrs. Nongluck Wongsettee  
Technical Manager

Standard References (Table 1)

Standard	Certificate No.	Vendor	Due date
Oxygen ( O <sub>2</sub> ) 2.501 % Vol	2431/19	Linde	16-Jul-23
Oxygen ( O <sub>2</sub> ) 10.00 % Vol	2453/19	Linde	18-Jul-23
Oxygen ( O <sub>2</sub> ) 21.00 % Vol	2426/19	Linde	16-Jul-23
Carbon monoxide ( CO ) 80.97 ppm	2842/21	Linde	24-Jun-23
Carbon monoxide ( CO ) 309.9 ppm	2803/21	Linde	22-Jun-23
Carbon monoxide ( CO ) 1003 ppm	2829/21	Linde	23-Apr-23
Nitrogen Dioxide ( NO <sub>2</sub> ) 10.19 ppm	3372/21	Linde	02-Aug-23
Nitrogen Dioxide ( NO <sub>2</sub> ) 80.62 ppm	3240/21	Linde	25-Jul-23
Nitrogen Dioxide ( NO <sub>2</sub> ) 202.2 ppm	3239/21	Linde	20-Jul-23
Nitric Oxide ( NO ) 10.08 ppm	3241/21	Linde	25-Jul-23
Nitric Oxide ( NO ) 150.9 ppm	2857/21	Linde	27-Jun-23
Nitric Oxide ( NO ) 320.6 ppm	2944/21	Linde	2-Jul-23
Sulphur Dioxide ( SO <sub>2</sub> ) 50.04 ppm	3205/21	Linde	25-Jul-23
Sulphur Dioxide ( SO <sub>2</sub> ) 100.9 ppm	4942/20	Linde	20-Nov-23
Sulphur Dioxide ( SO <sub>2</sub> ) 601.1 ppm	3204/21	Linde	20-Jul-23

Measured room conditions

Temperature : 22.6 °C Humidity : 54.3 %RH Pressure : 1015.3 mbar

Calibration conditions

Gas Temperature : 23 °C Flow rate : 1,200 ml/min Gas pressure : 1021.9 mbar

Calibration Results Before Adjustment (Table 2)

Parameter of Standard	Standard Values	Mean of UUC	Error	Uncertainty (±)
O <sub>2</sub> (%Vol)	2.501	2.53	0.029	0.20
O <sub>2</sub> (%Vol)	10.00	10.04	0.04	0.40
O <sub>2</sub> (%Vol)	21.00	21.12	0.12	0.80
CO (ppm)	80.97	82	1.03	2.8
CO (ppm)	309.9	311	1.1	11
CO (ppm)	1003	1004	1	34
NO <sub>2</sub> (ppm)	10.19	8.8	-1.39	1.5
NO <sub>2</sub> (ppm)	80.62	78.9	-1.72	5.0
NO <sub>2</sub> (ppm)	202.2	200.3	-1.9	5.0
NO (ppm)	10.08	7	-3.08	3.0
NO (ppm)	150.9	144	-6.9	5.0
NO (ppm)	320.6	299	-21.6	10
SO <sub>2</sub> (ppm)	50.04	48	-2.04	5.0
SO <sub>2</sub> (ppm)	100.9	98	-2.9	5.0
SO <sub>2</sub> (ppm)	601.1	592	-9.1	14

Calibration Results After Adjustment (Table 3)

Parameter of Standard	Standard Values	Mean of UUC	Error	Uncertainty (±)
O <sub>2</sub> (%Vol)	2.501	2.53	0.029	0.20
O <sub>2</sub> (%Vol)	10.00	10.04	0.04	0.40
O <sub>2</sub> (%Vol)	21.00	21.12	0.12	0.80
CO (ppm)	80.97	82	1.03	2.8
CO (ppm)	309.9	311	1.1	11
CO (ppm)	1003	1004	1	34
NO <sub>2</sub> (ppm)	10.19	8.8	-1.39	1.5
NO <sub>2</sub> (ppm)	80.62	78.9	-1.72	5.0
NO <sub>2</sub> (ppm)	202.2	200.3	-1.9	5.0
NO (ppm)	10.08	9	-1.08	3.0
NO (ppm)	150.9	150	-0.9	5.0
NO (ppm)	320.6	317	-3.6	10
SO <sub>2</sub> (ppm)	50.04	48	-2.04	5.0
SO <sub>2</sub> (ppm)	100.9	98	-2.9	5.0
SO <sub>2</sub> (ppm)	601.1	592	-9.1	14

Remark : 1 cmol/mol = 1 %vol, 1 μmol/mol = 1 ppm.

End of Report





**PENTA CALIBRATION CO., LTD.**  
66/124 The Connect 33 Village Kanchanachisek Road  
Dokma Pravei Bangkok 10250  
Tel: +66 (0) 2069-9773  
www.pentalab.com

## Certificate of Calibration

Represent to Certificate of Calibration ,PTC/07/22099

Certificate No.: PTC/07/22099 Page: 1 of 2  
Equipment: Digital Balance Condition: Normal  
Manufacturer: Sartorius Serial No: 31709552  
Model: MSU224S-100-DU ID No: RYG EN0003  
Type of Balance: Single interval



Customer: ALS Laboratory Group (Thailand) Co., Ltd.  
616/10 Moo 5 T.Maenamkoo, A Pluakdaeng,  
Rayong 21140, Thailand

REVIEW BY: *Thantit*  
APPROVED BY: *P. P.*  
NEXT CAL DATE: 09/03/09

Environment Condition: Temperature 23.0 °C ± 0.3 °C  
Humidity 58.1 %RH ± 4.4 %RH  
Air density 1.17 kgm<sup>-3</sup>

Calibration Place: ALS Laboratory Group (Thailand) Co., Ltd.  
616/10 Moo 5 T.Maenamkoo, A Pluakdaeng,  
Rayong 21140, Thailand

The Method used: In house method, PTC-WI-07, base on Euramet cg 18

Traceability: This certificate is traceable to the SI Units through Thai Calibration Service Co., Ltd.  
, NSC-ONSC Accreditation No.: Calibration 0189

Date Received: March 23, 2022

Calibration Date: March 23, 2022

Issued Date: March 25, 2022

Calibration By: Mr Rungroje Metakul



Reviewed by:  
(Mr. Kongsak Kalsen)

Approved By: *P. P.*  
(Mr. Keattisak Kerdto)  
Laboratory Manager

This certificate is issued the units of measurement according to the International System of Units (SI). It provides traceability of measurement to international or national standard or other recognized national standard laboratories.

The measurement uncertainty stated is the expanded uncertainty which is obtained from the standard uncertainty multiplied by the coverage factor (k=2) to provide a level of confidence of approximately 95%. It is determined in accordance with the Guide to Expression of Uncertainty in Measurement (GUM). The effect that the results relate only to the items calibrated.

This calibration certificate shall not be reproduced except in full only, without written approval from Penta Calibration Co., Ltd.

PTC-FMC02-02 27 Feb 2020



**PENTA CALIBRATION CO., LTD.**  
66/124 The Connect 33 Village Kanchanachisek Road  
Dokma Pravei Bangkok 10250  
Tel: +66 (0) 2069-9773  
www.pentalab.com

Represent to Certificate of Calibration ,PTC/07/22099

Certificate No.: PTC/07/22099

Page: 2 of 2

### Measurement Results:

Without Adjustment:

Function Calibration: Non Adjustment

Eccentric Error: Weight to be 1/3, 1/2 or of Maximum capacity

Eccentricity test

100

(g)

Position (g)				
1	2	3	4	5
0.0000	0.0000	-0.0001	-0.0001	0.0001
Maximum deviation			0.0001	

Repeatability Test: Weight to be 1/2 ≤ L ≤ Maximum capacity

Determination of the standard deviation of weighing balance. Readability 0.0001 (g)

Nominal test value (g)	Standard Deviation
200	0.00007

Error of indication: from nominal value, Readability 0.0001 (g)

Nominal Value (g)	Conventional Mass (g)	Indication (g)	Correction of Balance (g)	Uncertainty (g)	k
0	0.00000	0.0000	0.0000	0.00020	2.65
0.01	0.01000	0.0099	0.0001	0.00020	2.43
0.1	0.10000	0.1000	0.0000	0.00020	2.43
0.5	0.50000	0.5000	0.0000	0.00020	2.43
1	1.00000	1.0000	0.0000	0.00020	2.43
5	5.00001	5.0000	0.0000	0.00020	2.43
10	10.00000	10.0000	0.0000	0.00020	2.43
20	20.00003	20.0000	0.0000	0.00020	2.43
50	50.00004	50.0000	0.0000	0.00021	2.32
100	100.00004	99.9999	0.0001	0.00022	2.17
200	200.00011	200.0000	0.0001	0.00027	2.05

Note: Weight of adjust (g)

The End of Certificate

PTC-FMC02-02 27 Feb 2020



Lot No.: 2296246-1

### ANALYZER CALIBRATION DATA

Client: GLOW ENERGY PCL. Location: CTG HRSG (Phase 5)  
Date: 17 Aug 22 Test Operator: Navaphut S.

O<sub>2</sub> ANALYZER Model: TELEDYNE API 200EH Serial No.: 774  
Span (%): 25

	Cylinder Value (%)	Initial Analyzers Calibration Response (%)	Final Analyzers Calibration Response (%)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.10	0.40
Low-Level Gas	8.05	8.00	8.00	0.00
Span Gas	16.06	16.00	15.90	0.40

NO<sub>x</sub> ANALYZER Model: TELEDYNE API 200EH Serial No.: 774  
Span (ppm): 100

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.60	0.60
Low-Level Gas	50.32	50.20	50.00	0.20
Span Gas	79.86	79.80	79.30	0.50

SO<sub>2</sub> ANALYZER Model: TELEDYNE API 100EH Serial No.: 437  
Span (ppm): 100

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.00	0.00
Low-Level Gas	50.27	50.20	49.90	0.30
Span Gas	79.95	80.00	79.60	0.40

CO ANALYZER Model: TELEDYNE API 300EM Serial No.: 425  
Span (ppm): 100

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.30	0.30
Low-Level Gas	49.99	50.00	49.90	0.10
Span Gas	80.10	80.10	79.40	0.70

Calibrated by

*Navaphut S.*

(Mr. Navaphut Srivirya)

Environmental Field Scientist (2)

FORM NO. F-06-002 REVISION NO. 2 ISSUE DATE 3/06/19

ALS Laboratory Group



Lot No.: 2296246-1

### SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client: GLOW ENERGY PCL. Location: CTG HRSG (Phase 5)  
Date: 17 Aug 22 Test Operator: Navaphut S.

O<sub>2</sub> ANALYZER Cylinder Conc. (ppm): 16.08 Span (%): 25

	O <sub>2</sub> Analyzer Calibration Response	Initial Values System Calibration Response	System Cal Bias (% of Span)	Final Values System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.00	0.00	0.00	0.10	0.40	0.40
Upscale Gas	16.00	15.90	0.40	15.90	0.40	0.00

NO<sub>x</sub> ANALYZER Cylinder Conc. (ppm): 79.88 Span (ppm): 100

	NO <sub>x</sub> Analyzer Calibration Response	Initial Values System Calibration Response	System Cal Bias (% of Span)	Final Values System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.00	0.70	0.70	0.60	0.60	0.10
Upscale Gas	79.80	79.30	0.50	79.30	0.50	0.00

SO<sub>2</sub> ANALYZER Cylinder Conc. (ppm): 79.95 Span (ppm): 100

	SO <sub>2</sub> Analyzer Calibration Response	Initial Values System Calibration Response	System Cal Bias (% of Span)	Final Values System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.00	0.00	0.00	0.00	0.00	0.00
Upscale Gas	80.00	79.50	0.50	79.60	0.40	0.10

CO ANALYZER Cylinder Conc. (ppm): 80.10 Span (ppm): 100

	CO Analyzer Calibration Response	Initial Values System Calibration Response	System Cal Bias (% of Span)	Final Values System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.00	0.40	0.40	0.30	0.30	0.10
Upscale Gas	80.10	79.40	0.70	79.40	0.70	0.00

Calibrated by

*Navaphut S.*

(Mr. Navaphut Srivirya)

Environmental Field Scientist (2)

FORM NO. F-06-002 REVISION NO. 2 ISSUE DATE 3/06/19

ALS Laboratory Group



## EMISSION TEST RESULT

Client	GLOW ENERGY PCL.	Run #	1
Date	17 Aug 22	Location	CTG HRSG (Phase 5)
Start Time	11:30	Test Operator	Navaphut S.
SO <sub>2</sub> Analyzer Model	TELEDYNE API 100EH	Finish Time	11:50
NO <sub>x</sub> /O <sub>2</sub> Analyzer Model	TELEDYNE API 200EH	Serial No.	437
CO/CO <sub>2</sub> Analyzer Model	TELEDYNE API 300EM	Serial No.	774
		Serial No.	425

Time (min)	O <sub>2</sub> (%)	CO <sub>2</sub> (%)	NO <sub>x</sub> (ppm)	SO <sub>2</sub> (ppm)	CO (ppm)	Remark
11:30	13.82	4.20	7.57	0.02	0.38	
11:31	13.84	4.20	7.55	0.01	0.34	
11:32	13.85	4.18	7.40	0.00	0.35	
11:33	13.84	4.20	7.35	0.01	0.41	
11:34	13.84	4.19	7.35	0.01	0.40	
11:35	13.84	4.18	7.37	0.01	0.40	
11:36	13.84	4.20	7.39	0.02	0.38	
11:37	13.83	4.22	7.45	0.02	0.40	
11:38	13.83	4.20	7.54	0.02	0.38	
11:39	13.84	4.22	7.58	0.02	0.39	
11:40	13.82	4.17	7.62	0.01	0.36	
11:41	13.81	4.22	7.65	0.02	0.33	
11:42	13.83	4.19	7.66	0.01	0.41	
11:43	13.83	4.18	7.64	0.02	0.35	
11:44	13.83	4.20	7.67	0.03	0.35	
11:45	13.84	4.17	7.69	0.01	0.34	
11:46	13.84	4.22	7.71	0.01	0.33	
11:47	13.84	4.19	7.75	0.01	0.38	
11:48	13.85	4.18	7.71	0.01	0.33	
11:49	13.84	4.19	7.73	0.01	0.29	
11:50	13.83	4.22	7.76	0.01	0.33	
Average	13.84	4.20	7.58	0.01	0.38	

Navaphut S.

(Mr. Navaphut Srivithya)

Environmental Field Scientist (2)

FORM NO. F-06-002 REVISION NO. 2 ISSUE DATE: 3/06/18

ALS Laboratory Group



## EMISSION TEST RESULT

Client	GLOW ENERGY PCL.	Run #	2
Date	17 Aug 22	Location	CTG HRSG (Phase 5)
Start Time	11:51	Test Operator	Navaphut S.
SO <sub>2</sub> Analyzer Model	TELEDYNE API 100EH	Finish Time	12:11
NO <sub>x</sub> /O <sub>2</sub> Analyzer Model	TELEDYNE API 200EH	Serial No.	437
CO/CO <sub>2</sub> Analyzer Model	TELEDYNE API 300EM	Serial No.	774
		Serial No.	425

Time (min)	O <sub>2</sub> (%)	CO <sub>2</sub> (%)	NO <sub>x</sub> (ppm)	SO <sub>2</sub> (ppm)	CO (ppm)	Remark
11:51	13.83	4.17	7.81	0.01	0.37	
11:52	13.83	4.19	7.86	0.01	0.33	
11:53	13.83	4.23	7.88	0.01	0.34	
11:54	13.84	4.17	7.87	0.01	0.38	
11:55	13.84	4.18	7.87	0.02	0.33	
11:56	13.84	4.20	7.83	0.01	0.33	
11:57	13.85	4.20	7.79	0.01	0.33	
11:58	13.85	4.24	7.79	0.00	0.34	
11:59	13.86	4.18	7.81	0.02	0.34	
12:00	13.87	4.17	7.81	0.02	0.33	
12:01	13.86	4.20	7.79	0.02	0.33	
12:02	13.86	4.19	7.85	0.01	0.35	
12:03	13.87	4.15	7.86	0.02	0.33	
12:04	13.87	4.19	7.77	0.02	0.33	
12:05	13.86	4.19	7.73	0.01	0.33	
12:06	13.84	4.16	7.76	0.02	0.28	
12:07	13.84	4.18	7.83	0.01	0.36	
12:08	13.86	4.19	7.88	0.02	0.33	
12:09	13.87	4.14	7.85	0.01	0.29	
12:10	13.87	4.17	7.80	0.01	0.34	
12:11	13.87	4.17	7.80	0.01	0.32	
Average	13.85	4.19	7.82	0.01	0.33	

Navaphut S.

(Mr. Navaphut Srivithya)

Environmental Field Scientist (2)

FORM NO. F-06-002 REVISION NO. 2 ISSUE DATE: 3/06/18

ALS Laboratory Group



## EMISSION TEST RESULT

Client	GLOW ENERGY PCL.	Run #	3
Date	17 Aug 22	Location	CTG HRSG (Phase 5)
Start Time	12:12	Test Operator	Navaphut S.
SO <sub>2</sub> Analyzer Model	TELEDYNE API 100EH	Finish Time	12:32
NO <sub>x</sub> /O <sub>2</sub> Analyzer Model	TELEDYNE API 200EH	Serial No.	437
CO/CO <sub>2</sub> Analyzer Model	TELEDYNE API 300EM	Serial No.	774
		Serial No.	425

Time (min)	O <sub>2</sub> (%)	CO <sub>2</sub> (%)	NO <sub>x</sub> (ppm)	SO <sub>2</sub> (ppm)	CO (ppm)	Remark
12:12	13.87	4.22	7.81	0.01	0.25	
12:13	13.88	4.18	7.80	0.02	0.26	
12:14	13.87	4.18	7.79	0.02	0.29	
12:15	13.86	4.17	7.79	0.01	0.32	
12:16	13.87	4.19	7.78	0.01	0.26	
12:17	13.88	4.22	7.77	0.02	0.31	
12:18	13.88	4.16	7.81	0.02	0.25	
12:19	13.88	4.18	7.84	0.02	0.31	
12:20	13.87	4.20	7.86	0.02	0.30	
12:21	13.88	4.22	7.85	0.01	0.30	
12:22	13.89	4.15	7.86	0.00	0.28	
12:23	13.89	4.14	7.81	0.01	0.34	
12:24	13.88	4.15	7.81	0.01	0.29	
12:25	13.89	4.16	7.78	0.01	0.32	
12:26	13.89	4.16	7.80	0.00	0.33	
12:27	13.87	4.15	7.87	0.01	0.33	
12:28	13.88	4.18	7.88	0.02	0.29	
12:29	13.88	4.14	7.86	0.02	0.31	
12:30	13.89	4.19	7.79	0.01	0.28	
12:31	13.87	4.14	7.77	0.01	0.34	
12:32	13.87	4.17	7.79	0.01	0.32	
Average	13.88	4.18	7.81	0.01	0.30	

Navaphut S.

(Mr. Navaphut Srivithya)

Environmental Field Scientist (2)

FORM NO. F-06-002 REVISION NO. 2 ISSUE DATE: 3/06/18

ALS Laboratory Group



## ANALYZER CALIBRATION DATA

Lot No. 2296530-1

Client	GLOW ENERGY PCL.	Location	CTG HRSG (Phase 5)
Date	23 Sep 22	Test Operator	Bakait P.
O <sub>2</sub> ANALYZER			
Model	TELEDYNE API T803	Serial No.	81
Span (%)	25		

	Cylinder Value (%)	Initial Analyzers Calibration Response (%)	Final Analyzers Calibration Response (%)	Difference (Percent of Span)
Zero Gas	0.00	-0.04	0.00	0.16
Low-Level Gas	8.02	7.98	8.02	0.16
Span Gas	16.17	16.13	16.17	0.16

NO <sub>x</sub> ANALYZER			
Model	TELEDYNE API T200H	Serial No.	482
Span (ppm)	100		

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.05	0.00	0.05
Low-Level Gas	54.64	50.69	50.64	0.05
Span Gas	81.85	81.20	81.35	0.05

SO <sub>2</sub> ANALYZER			
Model	TELEDYNE API T100H	Serial No.	324
Span (ppm)	100		

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.01	0.00	0.01
Low-Level Gas	54.34	54.35	54.34	0.01
Span Gas	79.92	79.93	79.92	0.01

CO ANALYZER			
Model	TELEDYNE API T300M	Serial No.	377
Span (ppm)	100		

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.02	0.00	0.02
Low-Level Gas	54.42	54.44	54.42	0.02
Span Gas	79.73	79.75	79.73	0.02

CO <sub>2</sub> ANALYZER			
Model	TELEDYNE API T803	Serial No.	81
Span (%)	25		

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (%)	Final Analyzers Calibration Response (%)	Difference (Percent of Span)
Zero Gas	0.00	0.02	0.00	0.08
Low-Level Gas	15.03	15.05	15.03	0.08
Span Gas	22.01	22.03	22.01	0.08

Calibrated by

Bakait P.

(Mr. Bakait Phaisanphibut)

Environmental Field Scientist (4)

FORM NO. F-06-104 REVISION NO. 1 ISSUE DATE: 3/06/18

ALS Laboratory Group





Lot No 2296830-1

## SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client : GLOW ENERGY PCL. Location : CTG HRSG (Phase 5)  
Date : 23 Sep 22 Test Operator : Saklat P.O<sub>2</sub> ANALYZER  
Cylinder Conc. (%) : 16.17 Span (%) : 25

	O <sub>2</sub> Analyzer Calibration Response	Initial Values System Calibration Response	System Cal Bias (% of Span)	Final Values System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	-0.04	-0.04	0.00	0.00	0.16	0.16
Upscale Gas	16.13	16.13	0.00	16.17	0.16	0.16

NO<sub>x</sub> ANALYZER  
Cylinder Conc. (ppm) : 81.85 Span (ppm) : 100

	NO <sub>x</sub> Analyzer Calibration Response	Initial Values System Calibration Response	System Cal Bias (% of Span)	Final Values System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.05	0.05	0.00	0.00	0.05	0.05
Upscale Gas	81.90	81.90	0.00	81.85	0.05	0.05

SO<sub>2</sub> ANALYZER  
Cylinder Conc. (ppm) : 79.92 Span (ppm) : 100

	SO <sub>2</sub> Analyzer Calibration Response	Initial Values System Calibration Response	System Cal Bias (% of Span)	Final Values System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.01	0.01	0.00	0.00	0.01	0.01
Upscale Gas	79.93	79.93	0.00	79.92	0.01	0.01

CO ANALYZER  
Cylinder Conc. (ppm) : 79.73 Span (ppm) : 100

	CO Analyzer Calibration Response	Initial Values System Calibration Response	System Cal Bias (% of Span)	Final Values System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.02	0.02	0.00	0.00	0.02	0.02
Upscale Gas	79.75	79.75	0.00	79.73	0.02	0.02

CO<sub>2</sub> ANALYZER  
Cylinder Conc. (%) : 22.01 Span (%) : 25

	CO <sub>2</sub> Analyzer Calibration Response	Initial Values System Calibration Response	System Cal Bias (% of Span)	Final Values System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.02	0.02	0.00	0.00	0.08	0.08
Upscale Gas	22.03	22.03	0.00	22.01	0.08	0.08

Calibrated by

Saklat P.

(Mr. Saklat Phaisanphut)

Environmental Field Scientist (4)

FORM NO. F-06-104. REVISION NO. - ISSUE DATE 3/08/19

ALS Laboratory Group



## CEMs Data

Client Name : GLOW ENERGY PCL. Date : 23 Sep 22  
Plant Name : Glow Phase 5 Location : CTG HRSG (Phase 5)

Run No. 1										Run No. 2													
Time Base : 21 min										Time Base : 21 min													
Date	Time	SO <sub>2</sub>	NO <sub>x</sub>	CO	O <sub>2</sub>	Load	CO <sub>2</sub>	NO <sub>2</sub>	NO	Date	Time	SO <sub>2</sub>	NO <sub>x</sub>	CO	O <sub>2</sub>	Load	CO <sub>2</sub>	NO <sub>2</sub>	NO				
23 Sep 22	10:50	0.00	0.00	7.28	-	13.64	242.14	11.11	0.00	7.68	-	13.65	242.80	11.12	0.00	7.68	-	13.65	242.80				
23 Sep 22	10:51	0.00	0.00	7.29	-	13.64	241.96	11.12	0.00	7.68	-	13.65	242.80	11.12	0.00	7.68	-	13.65	242.80				
23 Sep 22	10:52	0.00	0.00	7.30	-	13.64	241.95	11.13	0.00	7.67	-	13.65	241.40	11.13	0.00	7.67	-	13.65	241.40				
23 Sep 22	10:53	0.00	0.00	7.30	-	13.64	242.00	11.14	0.00	7.65	-	13.65	241.40	11.14	0.00	7.65	-	13.65	241.40				
23 Sep 22	10:54	0.00	0.00	7.30	-	13.64	242.04	11.15	0.00	7.66	-	13.65	241.40	11.15	0.00	7.66	-	13.65	241.40				
23 Sep 22	10:55	0.00	0.00	7.35	-	13.65	242.21	11.16	0.00	7.62	-	13.65	242.43	11.16	0.00	7.62	-	13.65	242.43				
23 Sep 22	10:56	0.00	0.00	7.42	-	13.65	243.50	11.17	0.00	7.60	-	13.65	242.77	11.17	0.00	7.60	-	13.65	242.77				
23 Sep 22	10:57	0.00	0.00	7.32	-	13.65	242.74	11.18	0.00	7.54	-	13.65	242.45	11.18	0.00	7.54	-	13.65	242.45				
23 Sep 22	10:58	0.00	0.00	7.34	-	13.65	243.17	11.19	0.00	7.57	-	13.64	243.52	11.19	0.00	7.57	-	13.64	243.52				
23 Sep 22	10:59	0.00	0.00	7.44	-	13.65	243.74	11.20	0.00	7.60	-	13.64	243.77	11.20	0.00	7.60	-	13.64	243.77				
23 Sep 22	11:00	0.00	0.00	7.54	-	13.65	243.21	11.21	0.00	7.60	-	13.65	243.70	11.21	0.00	7.60	-	13.65	243.70				
23 Sep 22	11:01	0.00	0.00	7.40	-	13.65	243.86	11.22	0.00	7.57	-	13.65	244.50	11.22	0.00	7.57	-	13.65	244.50				
23 Sep 22	11:02	0.00	0.00	7.36	-	13.65	242.82	11.23	0.00	7.47	-	13.65	244.52	11.23	0.00	7.47	-	13.65	244.52				
23 Sep 22	11:03	0.00	0.00	7.37	-	13.65	242.48	11.24	0.00	7.53	-	13.64	243.55	11.24	0.00	7.53	-	13.64	243.55				
23 Sep 22	11:04	0.00	0.00	7.27	-	13.65	242.80	11.25	0.00	7.59	-	13.64	243.55	11.25	0.00	7.59	-	13.64	243.55				
23 Sep 22	11:05	0.00	0.00	7.16	-	13.65	242.44	11.26	0.00	7.67	-	13.65	242.72	11.26	0.00	7.67	-	13.65	242.72				
23 Sep 22	11:06	0.00	0.00	7.87	-	13.65	242.68	11.27	0.00	7.47	-	13.65	242.72	11.27	0.00	7.47	-	13.65	242.72				
23 Sep 22	11:07	0.00	0.00	7.44	-	13.65	243.03	11.28	0.00	7.60	-	13.65	243.51	11.28	0.00	7.60	-	13.65	243.51				
23 Sep 22	11:08	0.00	0.00	7.56	-	13.65	242.56	11.29	0.00	7.54	-	13.65	244.12	11.29	0.00	7.54	-	13.65	244.12				
23 Sep 22	11:09	0.00	0.00	7.28	-	13.65	242.49	11.30	0.00	7.69	-	13.65	242.47	11.30	0.00	7.69	-	13.65	242.47				
23 Sep 22	11:10	0.00	0.00	7.82	-	13.65	243.69	11.31	0.00	7.70	-	13.65	242.58	11.31	0.00	7.70	-	13.65	242.58				
Max	0.00	7.87	-	13.65	243.69	11.31	0.00	7.70	-	13.65	242.58	11.31	0.00	7.70	-	13.65	242.58	11.31	0.00	7.70	-	13.65	242.58
Avg	0.00	7.48	-	13.65	243.50	11.25	0.00	7.60	-	13.65	243.10	11.25	0.00	7.60	-	13.65	243.10	11.25	0.00	7.60	-	13.65	243.10

Run No. 3										Run No. 4												
Time Base : 21 min										Time Base : 21 min												
Date	Time	SO <sub>2</sub>	NO <sub>x</sub>	CO	O <sub>2</sub>	Load	CO <sub>2</sub>	NO <sub>2</sub>	NO	Date	Time	SO <sub>2</sub>	NO <sub>x</sub>	CO	O <sub>2</sub>	Load	CO <sub>2</sub>	NO <sub>2</sub>	NO			
		ppm	ppm	%	%	kg/hr	kg/hr	ppm	ppm			ppm	ppm	%	%	kg/hr	kg/hr	ppm	ppm			
23 Sep 22	11:32	0.07	7.39	-	13.64	243.12	11.32	0.00	7.58	23 Sep 22	11:33	0.00	7.58	-	13.79	248.58	11.33	0.00	7.58	-	13.79	248.58
23 Sep 22	11:33	0.07	7.28	-	13.64	242.45	11.34	0.00	6.91	23 Sep 22	11:34	0.00	7.08	-	13.80	248.40	11.34	0.00	7.08	-	13.80	248.40
23 Sep 22	11:34	0.07	7.28	-	13.64	242.45	11.35	0.00	6.91	23 Sep 22	11:35	0.00	6.91	-	13.80	248.00	11.35	0.00	6.91	-	13.80	248.00
23 Sep 22	11:35	0.07	7.51	-	13.81	243.93	11.36	0.00	7.18	23 Sep 22	11:36	0.00	7.18	-	13.79	248.00	11.36	0.00	7.18	-	13.79	248.00
23 Sep 22	11:36	0.06	7.57	-	13.84	243.56	11.37	0.00	7.45	23 Sep 22	11:37	0.00	7.45	-	13.80	248.00	11.37	0.00	7.45	-	13.80	248.00
23 Sep 22	11:37	0.06	7.67	-	13.84	242.64	11.38	0.00	7.13	23 Sep 22	11:38	0.00	7.13	-	13.80	248.00	11.38	0.00	7.13	-	13.80	248.00
23 Sep 22	11:38	0.06	6.97	-	13.84	243.72	11.39	0.00	7.13	23 Sep 22	11:39	0.00	7.13	-	13.79	248.00	11.39	0.00	7.13	-	13.79	248.00
23 Sep 22	11:39	0.06	7.43	-	13.84	242.73	11.40	0.00	7.13	23 Sep 22	11:40	0.00	7.12	-	13.79	248.00	11.40	0.00	7.12	-	13.79	248.00
23 Sep 22	11:40	0.06	7.79	-	13.85	242.82	11.41	0.00	7.12	23 Sep 22	11:41	0.00	7.12	-	13.79	248.00	11.41	0.00	7.12	-	13.79	248.00
23 Sep 22	11:41	0.06	7.52	-	13.84	243.74	11.42	0.00	7.21	23 Sep 22	11:42	0.00	7.21	-	13.79	248.00	11.42	0.00	7.21	-	13.79	248.00
23 Sep 22	11:42	0.06	7.59	-	13.84	243.51	11.43	0.00	7.14	23 Sep 22	11:43	0.00	7.14	-	13.79	248.00	11.43	0.00	7.14	-	13.79	248.00
23 Sep 22	11:43	0.06	6.52	-	13.84	248.81	11.44	0.00	6.72	23 Sep 22	11:44	0.00	6.72	-	13.79	248.00	11.44	0.00	6.72	-	13.79	248.00
23 Sep 22	11:44	0.06	6.54	-	13.85	248.40	11.45	0.00	6.92	23 Sep 22	11:45	0.00	6.92	-	13.79	248.00	11.45	0.00	6.92	-	13.79	248.00
23 Sep 22	11:45	0.06	6.99	-	13.85	248.00	11.46	0.00	6.79	23 Sep 22	11:46	0.00	6.79	-	13.79	248.00	11.46	0.00	6.79	-	13.79	248.00
23 Sep 22	11:46	0.06	6.85	-	13.79	247.80	11.47	0.00	6.92	23 Sep 22	11:47	0.00	6.92	-	13.79	248.00	11.47	0.00	6.92	-	13.79	248.00
23 Sep 22	11:47	0.06	7.16	-	13.80	247.79	11.48	0.00	7.14	23 Sep 22	11:48	0.00	7.14	-	13.79	248.00	11.48	0.00	7.14	-	13.79	248.00
23 Sep 22	11:48	0.06	6.89	-	13.80	247.87	11.49	0.00	6.92	23 Sep 22	11:49	0.00	6.92	-	13.79	248.00	11.49	0.00	6.92	-	13.79	248.00
23 Sep 22	11:49	0.06	6.90	-	13.81	247.39	11.50	0.00	7.03	23 Sep 22	11:50	0.00	7.03	-	13.79	248.00	11.50	0.00	7.03	-	13.79	248.00
23 Sep 22	11:50	0.06	6.86	-	13.81	248.63	11.51	0.00	6.99	23 Sep 22	11:51	0.00	6.99	-	13.79	248.00	11.51	0.00	6.99	-	13.79	248.00
23 Sep 22	11:51	0.06	6.55	-	13.80	247.12	11.52	0.00	7.01	23 Sep 22	11:52	0.00	7.01	-	13.79	248.00	11.52	0.00	7.01	-	13.79	248.00
23 Sep 22	11:52	0.06	7.03	-	13.79	248.34	11.53	0.00	6.84	23 Sep 22	11:53	0.00	6.84	-	13.79	248.00	11.53	0.00	6.84	-	13.79	248.00
Max		0.07	7.79	-	13.85	248.34		Max		0.00	7.51	-	13.79	248.00		Max		0.00	7.51	-	13.79	248.00
Avg		0.06	7.11	-	13.80	246.14		Avg		0.00	7.08	-	13.79	248.00		Avg		0.00	7.08	-	13.79	248.00





## Reference Method Data



## PM CEMS Data

Client Name		GLOW ENERGY PCL		Date		23 Sep 22	
Plant Name		Glow Phase 5		Location		CTG HRSG (Phase 5)	
Run No.	Time	SO2	NOx	CO	O2	CO2	CO2
		(ppm)	(ppm)	(ppm)	(%)	(%)	(%)
23 Sep 22	12:56	0.01	0.01	0.01	15.10	15.10	15.10
23 Sep 22	12:57	0.01	0.01	0.01	15.10	15.10	15.10
23 Sep 22	12:58	0.01	0.01	0.01	15.11	15.11	15.11
23 Sep 22	12:59	0.01	0.01	0.01	15.10	15.10	15.10
23 Sep 22	13:00	0.01	0.01	0.01	15.10	15.10	15.10
23 Sep 22	13:01	0.01	0.01	0.01	15.10	15.10	15.10
23 Sep 22	13:02	0.01	0.01	0.01	15.10	15.10	15.10
23 Sep 22	13:03	0.01	0.01	0.01	15.11	15.11	15.11
23 Sep 22	13:04	0.01	0.01	0.01	15.11	15.11	15.11
23 Sep 22	13:05	0.01	0.01	0.01	15.10	15.10	15.10
23 Sep 22	13:06	0.01	0.01	0.01	15.11	15.11	15.11
23 Sep 22	13:07	0.01	0.01	0.01	15.10	15.10	15.10
23 Sep 22	13:08	0.01	0.01	0.01	15.11	15.11	15.11
23 Sep 22	13:09	0.01	0.01	0.01	15.11	15.11	15.11
23 Sep 22	13:10	0.01	0.01	0.01	15.11	15.11	15.11
23 Sep 22	13:11	0.01	0.01	0.01	15.10	15.10	15.10
23 Sep 22	13:12	0.01	0.01	0.01	15.10	15.10	15.10
23 Sep 22	13:13	0.01	0.01	0.01	15.10	15.10	15.10
23 Sep 22	13:14	0.01	0.01	0.01	15.11	15.11	15.11
23 Sep 22	13:15	0.01	0.01	0.01	15.11	15.11	15.11
23 Sep 22	13:16	0.01	0.01	0.01	15.11	15.11	15.11
Max		0.01	0.01	0.01	15.11	15.11	15.11
Avg		0.01	0.01	0.01	15.10	15.10	15.10

Client Name		GLOW ENERGY PCL		Date		23-Sep-22	
Plant Name		Glow Phase 5		Location		CTG HRSG (Phase 6)	
Run No. 1	Time	Dust	SO2	NOx	CO	O2	CO2
		(mg/m <sup>3</sup> )	(ppm)	(ppm)	(ppm)	(%)	(%)
10:30	n/a	n/a	11:25	n/a	12:20	n/a	13:15
10:31	n/a	11:26	n/a	12:21	1.06	13:16	n/a
10:32	n/a	11:27	n/a	12:22	1.06	13:17	n/a
10:33	n/a	11:28	1.06	12:23	n/a	13:18	n/a
10:34	n/a	11:29	1.06	12:24	n/a	13:19	n/a
10:35	1.06	11:30	n/a	12:25	n/a	13:20	n/a
10:36	1.06	11:31	n/a	12:26	n/a	13:21	n/a
10:37	n/a	11:32	n/a	12:27	n/a	13:22	n/a
10:38	n/a	11:33	n/a	12:28	n/a	13:23	n/a
10:39	n/a	11:34	n/a	12:29	n/a	13:24	1.06
10:40	n/a	11:35	n/a	12:30	n/a	13:25	1.06
10:41	n/a	11:36	n/a	12:31	1.06	13:26	n/a
10:42	n/a	11:37	n/a	12:32	1.06	13:27	n/a
10:43	n/a	11:38	n/a	12:33	n/a	13:28	n/a
10:44	n/a	11:39	1.06	12:34	n/a	13:29	n/a
10:45	n/a	11:40	1.06	12:35	n/a	13:30	n/a
10:46	1.06	11:41	n/a	12:36	n/a	13:31	n/a
10:47	1.06	11:42	n/a	12:37	n/a	13:32	n/a
10:48	n/a	11:43	n/a	12:38	n/a	13:33	n/a
10:49	n/a	11:44	n/a	12:39	n/a	13:34	n/a
10:50	n/a	11:45	n/a	12:40	n/a	13:35	1.06
10:51	n/a	11:46	n/a	12:41	n/a	13:36	1.06
10:52	n/a	11:47	n/a	12:42	1.06	13:37	n/a
10:53	n/a	11:48	n/a	12:43	1.06	13:38	n/a
10:54	n/a	11:49	1.06	12:44	n/a	13:39	n/a
10:55	n/a	11:50	1.06	12:45	n/a	13:40	n/a
10:56	1.06	11:51	n/a	12:46	n/a	13:41	n/a
10:57	1.06	11:52	n/a	12:47	n/a	13:42	n/a
10:58	n/a	11:53	n/a	12:48	n/a	13:43	n/a
10:59	n/a	11:54	n/a	12:49	n/a	13:44	n/a
11:00	n/a	11:55	n/a	12:50	n/a	13:45	1.06
11:01	n/a	11:56	n/a	12:51	n/a	13:46	1.06
11:02	n/a	11:57	n/a	12:52	n/a	13:47	n/a
11:03	n/a	11:58	n/a	12:53	1.06	13:48	n/a
11:04	n/a	11:59	n/a	12:54	1.06	13:49	n/a
11:05	n/a	12:00	1.06	12:55	n/a	13:50	n/a
11:06	n/a	12:01	1.06	12:56	n/a	13:51	n/a
11:07	1.06	12:02	n/a	12:57	n/a	13:52	n/a
11:08	1.06	12:03	n/a	12:58	n/a	13:53	n/a
11:09	n/a	12:04	n/a	12:59	n/a	13:54	n/a
11:10	n/a	12:05	n/a	13:00	n/a	13:55	n/a
11:11	n/a	12:06	n/a	13:01	n/a	13:56	1.06
11:12	n/a	12:07	n/a	13:02	n/a	13:57	1.06
11:13	n/a	12:08	n/a	13:03	1.06	13:58	n/a
11:14	n/a	12:09	n/a	13:04	1.06	13:59	n/a
11:15	n/a	12:10	1.06	13:05	n/a	14:00	n/a
11:16	n/a	12:11	1.06	13:06	n/a	14:01	n/a
11:17	1.06	12:12	n/a	13:07	n/a	14:02	n/a
11:18	1.06	12:13	n/a	13:08	n/a	14:03	n/a
Avg.	1.06	Avg.	1.06	Avg.	1.06	Avg.	1.06



Airgas Specialty Gases  
Airgas USA, LLC  
6141 Easton Road  
Bldg 1  
Plumsteadville, PA 18949  
Airgas.com



Airgas Specialty Gases  
Airgas USA, LLC  
6141 Easton Road  
Bldg 1  
Plumsteadville, PA 18949  
Airgas.com

## CERTIFICATE OF ANALYSIS

### Grade of Product: EPA Protocol

Part Number E04N189E3HA0023 Reference Number 160-401754137-1  
Cylinder Number GN0024388 Cylinder Volume 247.2 CF  
Laboratory 124 - Plumsteadville - PA Cylinder Pressure 2215 PSIG  
PGVP Number A12020 Valve Outlet 560  
Gas Code CO,NO,NOX,SO2,BALN Certification Date Mar 26, 2020

Expiration Date: Mar 26, 2028

Certification performed in accordance with EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012) document EPA 600/R-12/031, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals

Component		ANALYTICAL RESULTS		Total Relative		Assay	
		Requested Concentration	Actual Concentration	Uncertainty		Dates	
NOX		50.00 PPM	50.32 PPM	G1 +/- 0.5% NIST Traceable		03/19/2020 03/26/2020	
CARBON MONOXIDE		50.00 PPM	49.99 PPM	G1 +/- 0.5% NIST Traceable		03/19/2020	
NITRIC OXIDE		50.00 PPM	50.32 PPM	G1 +/- 0.5% NIST Traceable		03/19/2020 03/26/2020	
SULFUR DIOXIDE		50.00 PPM	50.27 PPM	G1 +/- 0.5% NIST Traceable		03/19/2020 03/26/2020	
NITROGEN		Balance					
Type		Lot ID		Cylinder No		Concentration	
						Uncertainty	
						Expiration Date	
NTRM		11010130		KAL004536		97.31 PPM CARBON MONOXIDE/NITROGEN	
NTRM		13010405		KAL003984		97.60 PPM NITRIC OXIDE/NITROGEN	
NTRM		13010405		KAL003984		97.60 PPM NITRIC OXIDE/NITROGEN	
NTRM		16010235		KAL004419		97.69 PPM SULFUR DIOXIDE/NITROGEN	
Instrument/Make/Model		Analytical Principle		Last Multipoint Calibration			
MKS FTIR - CO - 000928781		FTIR		Mar 12 2020			
MKS FTIR - NO - 000928781		FTIR		Mar 05 2020			
MKS FTIR - NOx - 000928781		FTIR		Mar 05 2020			
MKS FTIR - SO2 - 000928781		FTIR		Mar 19 2020			

Triad Data Available Upon Request

NOTES: Gross Weight 47.7 Kg, Net Weight 7.5 Kg



*Michael A. Hubers*  
Approved for Release

Page 1 of 160-401754137-1

## CERTIFICATE OF ANALYSIS

### Grade of Product: EPA Protocol

Part Number E04N189E3HA0002 Reference Number 160-401754138-1  
Cylinder Number GN0024383 Cylinder Volume 247.2 CF  
Laboratory 124 - Plumsteadville - PA Cylinder Pressure 2215 PSIG  
PGVP Number A12020 Valve Outlet 560  
Gas Code CO,NO,NOX,SO2,BALN Certification Date Mar 26, 2020

Expiration Date: Mar 26, 2028

Certification performed in accordance with EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012) document EPA 600/R-12/031, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals

ANALYTICAL RESULTS						
Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates	
NOX	80.00 PPM	79.86 PPM	G1	+/- 0.8% NIST Traceable	03/19/2020, 03/26/2020	
CARBON MONOXIDE	80.00 PPM	80.10 PPM	G1	+/- 0.5% NIST Traceable	03/19/2020	
NITRIC OXIDE	80.00 PPM	79.86 PPM	G1	+/- 0.8% NIST Traceable	03/19/2020, 03/26/2020	
SULFUR DIOXIDE	80.00 PPM	79.95 PPM	G1	+/- 0.8% NIST Traceable	03/19/2020, 03/26/2020	
NITROGEN	Balance					
CALIBRATION STANDARDS						
Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date	
NTRM	11010130	KAL004536	97.31 PPM CARBON MONOXIDE/NITROGEN	+/- 0.4%	Oct 04 2021	
NTRM	13010405	KAL003984	97.60 PPM NITRIC OXIDE/NITROGEN	+/- 0.8%	Jul 23 2025	
NTRM	13010405	KAL003984	97.60 PPM NOx/NITROGEN	+/- 0.8%	Jul 23 2025	
NTRM	16010235	KAL004419	97.69 PPM SULFUR DIOXIDE/NITROGEN	+/- 0.8%	Dec 23 2021	
ANALYTICAL EQUIPMENT						
Instrument/Make/Model		Analytical Principle		Last Multipoint Calibration		
MKS FTIR - CO - 000928781		FTIR		Mar 12 2020		
MKS FTIR - NO - 000928781		FTIR		Mar 05 2020		
MKS FTIR - NOx - 000928781		FTIR		Mar 05 2020		
MKS FTIR - SO2 - 000928781		FTIR		Mar 19 2020		



## CERTIFICATE OF ANALYSIS

Customer Detail: <b>ALS Laboratory Group (Thailand)</b>		Production Order Number: <b>90145553</b> Material Number: <b>478100-J-44</b> Certification Date: <b>07-Dec-2017</b> Expiry Date: <b>07-Dec-2025</b>	
Cylinder Description: <b>STEEL 47L</b>			
The manufacturer of this cylinder material is responsible for its quality. The information provided is for reference only. The actual analysis is performed by ALS Laboratory Group (Thailand) Ltd. The results are expressed on a mole basis, unless otherwise specified. The reported concentration is based on a standard uncertainty of $\pm 0.5\%$ (excluding a level of confidence of approximately 95%).			
Certificate Number: <b>3983/17</b>	Analyst: <b>Arin Sara T.</b> ARINSARA THONGNURU		
Cylinder Number: <b>40233</b>			
Nominal Cylinder Content: <b>6.520 M<sup>3</sup></b>	Approve: <b>SUKANVA KAMUTHARAT</b>		
Nominal Pressure: <b>145.0 Bar</b>			
Valve Outlet: <b>CGA 590 BRASS</b>	To Re-Order Please Quote: <b>478100-J-44</b>		
Comment: <ul style="list-style-type: none"> <li>It is recommended that this product be not used below 5% of actual contents or should not be used when its gas pressure is below 150psig.</li> <li>Other impurities that detect by analytical condition of this mixture shall be report if it is more than 10% of minimum minor component.</li> <li>Keep and use in well-ventilated and secure area.</li> </ul>			

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บริษัท ลินด์ (ประเทศไทย) จำกัด (มหาชน)  
 15 ถนนพหลโยธิน 2/3 หมู่ 14 แขวงสามยุคใหม่ แขวง 6.5 กรุงเทพฯ  
 กรุงเทพฯ, สมุทรปราการ 10140, Tel: (66) 2338-6100 Fax: (66) 2338-6333  
 โทรสาร: (66) 2338-6100 Fax: (66) 2338-6333  
 Thailand, Tel: (66) 2338-6100 Fax: (66) 2338-6333

Linde (Thailand) Public Company Limited  
 15 Floor, Bangna Tower A, 2/3 Moo 14, Bangna Trid Road, 6.5 Road, Bangkok  
 Bangkok, Samutprakarn 10140, Tel: (66) 2338-6100 Fax: (66) 2338-6333  
 Thailand, Tel: (66) 2338-6100 Fax: (66) 2338-6333

**Airgas**  
 an Air Liquide company

Airgas Specialty Gases  
 Airgas USA, LLC  
 8141 Easton Road  
 Bldg 1  
 Plumsteadville, PA 18949  
 Airgas.com

### CERTIFICATE OF ANALYSIS

#### Grade of Product: EPA Protocol

Part Number: E02N184E15A07B7  
 Cylinder Number: CC740033  
 Laboratory: 124 - Plumsteadville - PA  
 PGVP Number: A12020  
 Gas Code: O2,BALN  
 Reference Number: 160-401948145-1  
 Cylinder Volume: 145.6 CF  
 Cylinder Pressure: 2015 PSIG  
 Valve Outlet: 590  
 Certification Date: Nov 11, 2020  
 Expiration Date: Nov 11, 2028

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA-600/R-12/021, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.  
 Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS					
Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
OXYGEN	16.00 %	16.06 %	G1	±0.2% NIST Traceable	11/11/2020
NITROGEN	Balance				
CALIBRATION STANDARDS					
Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	16060503	CC108542	23.204 % OXYGEN/NITROGEN	±0.2%	Dec 24, 2021
ANALYTICAL EQUIPMENT					
Instrument/Make/Model	Analytical Principle		Last Multipoint Calibration		
SIEMENS OXYMAT 6 - N1-V6-951 - O2	PARAMAGNETIC		Oct 26, 2020		

Triad Data Available Upon Request  
 NOTES:  
 Gross Weight: 27.8 Kg  
 Net Weight: 4.7 Kg



Approved for Release

Page 1 of 160-401948145-1

## CERTIFICATE OF ANALYSIS

Analytical Result							
Component	Request Concentration	Certified Concentration	Certified Uncertainty	Method	Assay Date		
Oxygen	8.00 %	8.05 %	± 1% relative	(2) 1-PB-354	04-Dec-2017		
In Nitrogen							
Reference Standard used in Assay							
Reference Standard	Cylinder No.	Concentration	Expired Date				
Oxygen	113553SG	9.976 ± 0.02 %	26-Mar-2018				
In Nitrogen							
Analytical Instruments used in Assay							
Instrument/Make/Model	Analytical Principle		Last Multipoint Calibration				
Servomex 4100 O2 Analyzer	Paramagnetic		04-Dec-2017				
Method of Analysis: 1. Gas Chromatograph 2. Paramagnetic Oxygen Analyzer 3. Electrochemical Oxygen Analyzer 4. Electrochemical Nitrogen Analyzer 5. Total Hydrocarbon Analyzer 6. Other specified							
Cylinder Number <b>40233</b> Production Order Number <b>90145553</b>			Certification Date: <b>07-Dec-2017</b> Expiration Date: <b>07-Dec-2025</b>				

Page 2 of 2

บริษัท ลินด์ (ประเทศไทย) จำกัด (มหาชน)  
 15 ถนนพหลโยธิน 2/3 หมู่ 14 แขวงสามยุคใหม่ แขวง 6.5 กรุงเทพฯ  
 กรุงเทพฯ, สมุทรปราการ 10140, Tel: (66) 2338-6100 Fax: (66) 2338-6333  
 โทรสาร: (66) 2338-6100 Fax: (66) 2338-6333  
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Linde (Thailand) Public Company Limited  
 15 Floor, Bangna Tower A, 2/3 Moo 14, Bangna Trid Road, 6.5 Road, Bangkok  
 Bangkok, Samutprakarn 10140, Tel: (66) 2338-6100 Fax: (66) 2338-6333  
 Thailand, Tel: (66) 2338-6100 Fax: (66) 2338-6333

## SITHIPHORN ASSOCIATES CO.,LTD.

### CALIBRATION LABORATORY

451-451/1 Sirirathorn Rd, Bangbunru, Bangplud Bangkok 10700 THAILAND.  
 Tel:0-2435-8800 Fax:0-2433-1679 e-mail:cal-center@sithiphorn.com http://www.sithiphorn.com



Cert. No.: ACC22024  
 Pages: 1 of 3

### Calibration Certificate

Equipment: SOUND CALIBRATOR  
 Manufacturer: RION  
 Model: NC-74  
 Serial No.: 34178124  
 ID No.: RYG\_FS0216

Condition As Found: GOOD

Customer: ALS LABORATORY GROUP (THAILAND) CO., LTD.  
 104 PHATTHANAKAN 40, PHATTHANAKAN ROAD,  
 KHWAENG PHATTHANAKAN, KHET SUAN LUANG,  
 BANGKOK, 10250 THAILAND.

Location:  
 Ambient Temperature: ( 23.0 ± 3 ) °C  
 Pressure: ( 101.3 ± 3 ) kPa  
 Relative Humidity: ( 50.0 ± 20 ) %

Received Date: 22 AUGUST 2022  
 Calibration Date: 31 AUGUST 2022  
 Date of Issue: 02 SEPTEMBER 2022

Calibrated by: Nathakorn Pisutpaisan

Approved by: **T. Petchurai**  
 (Thanakul Petchurai)

This certificate is issued in accordance with the requirements of ISO/IEC 17025 standard, may not be reproduced other than in full, except with the prior written approval of the head of Calibration Laboratory.

## Continuation of Calibration Certificate

Cert. No. : ACC22024  
Job No. : VC65AC0077  
Pages : 2 of 3

Calibration Procedure : CP-AC-03

## Calibration Method :

This equipment was calibrated by based on IEC-60942-2003 Standard.

The sound pressure level, frequency and total distortion of the sound calibrator was measured using the reference microphone.

## Condition of this result of calibration :

## 1. Reference Standard Instruments :

Instrument	Model	Serial No.	Cert. No.	Due Date
Waveform Generator	33511B	MY52302742	EF-0008-22	04-Feb-23
Digital Multimeter	33461A	MY53220104	EEL.BP. 04/0265	09-Feb-23
Digital Multimeter	33461A	MY53220076	EEL.BP. 03/0265	09-Feb-23
Digital Multimeter	33461A	MY60024273	EEL.BP. 05/0265	09-Feb-23
Programmable Attenuator	MAT-1070	62100114	EF-0009-22	07-Feb-23
Condenser Microphone	4180	2977900	AA-1013-22	24-Feb-23
Measuring Amplifier	NA-42KAI	34560495	AA-3005-22	22-Feb-23
Audio Analyzer	AVR-3360A	V744B6069	EF-0010-22	07-Feb-23

2. This result of calibration was found accurate as shown on date and place of calibration for this calibrated item only.

3. This certificate is traceable to the international system of unit maintained at :

3.1 National Institute of Metrology (Thailand).

3.2 Thailand Institute of Scientific and Technological Research (TISTR).

## Continuation of Calibration Certificate

Cert. No. : ACC22024  
Job No. : VC65AC0077  
Pages : 3 of 3

## Result of calibration :

## 1. Sound pressure level

Specified sound pressure level (dB)	Measured value (dB)	Deviated value (dB)	Uncertainty (dB)	Tolerance limit (dB)
94	94.21	0.21	0.14	0.40

## 2. Frequency

Specified Frequency (Hz)	Measured value (Hz)	Deviated value (%)	Uncertainty (%)	Tolerance limit (%)
1000	1001.3	0.1	0.1	1.0

## 3. Total distortion

Measured value (%)	Uncertainty (%)	Tolerance limit (%)
1.95	0.10	3.0

The reported uncertainty is based on a standard uncertainty multiplied by coverage factor  $k = 2$  or any value following calculation, providing a level of confidence of approximately 95 %

End of Calibration Certificate

QF-TS12-04-04-020664

QF-TS12-04-04-020664

SITHIPORN ASSOCIATES CO.,LTD.  
CALIBRATION LABORATORY451-451/1 Sirinthorn Rd, Bangbunru, Bangplud Bangkok 10700 THAILAND  
Tel:0-2433-8800 Fax:0-2433-1679 e-mail:cal-center@sithiporn.com http://www.sithiporn.comCert. No. : ACL22025  
Pages : 1 of 8

## Calibration Certificate

Equipment : SOUND LEVEL METER  
Manufacturer : RION  
Model : NL-42/ Microphone UC-52 / Preamplifier NH-24  
Serial No.: 00734221 / 145286 / 34371  
ID No.: RYG FS0027

Condition As Found : GOOD

Customer : ALS LABORATORY GROUP (THAILAND) CO., LTD.  
104 PHATTHANAKAN 40, PHATTHANAKAN ROAD,  
KJWAENG PHATTHANAKAN, KHET SUAN LUANG,  
BANGKOK, 10250 THAILAND.

Location :  
Ambient Temperature : ( 23.0 ± 3 ) °C  
Pressure : ( 101.3 ± 3 ) kPa  
Relative Humidity : ( 50.0 ± 20 ) %

Received Date : 05 JANUARY 2022  
Calibration Date : 10-12 JANUARY 2022  
Date of Issue : 13 JANUARY 2022

Calibrated by : Nathakorn Pisutpaisan

Approved by :

*T. Petchurai*  
( Thanakul Petchurai )

This certificate is issued in accordance with the requirements of ISO/IEC 17025 standard, may not be reproduced other than in full, except with the prior written approval of the head of Calibration Laboratory.

QF-TS12-04-04-020664

## Continuation of Calibration Certificate

Cert. No. : ACL22025  
Job No. : VC65AC0040  
Pages : 2 of 8

Calibration Procedure : CP-AC-01

## Calibration Method :

This equipment was calibrated by based on IEC-61672-3 (2013) Standard for sound level meter (SLM).

The SLM had tests to Acoustical and Electrical signal tests of frequency weighting with Anechoic chamber and Reference Standard Instruments.

For tests results of each items were made by observation of each Instruments display and also with SLM's display.

## Condition of this result of calibration :

## 1. Reference Standard Instruments :

Instrument	Model	Serial No.	Cert. No.	Due Date
Waveform Generator	33210A	MY48017076	EF-0012-21	10-Feb-22
Waveform Generator	33511B	MY52302742	EF-0011-21	10-Feb-22
Digital Multimeter	33461A	MY53220104	EEL.BP.05/0264	10-Feb-22
Digital Multimeter	33461A	MY53220076	EEL.BP. 03/0264	08-Feb-22
Digital Multimeter	34461A	MY60024273	1-15180725251-1	15-Sep-22
Programmable Attenuator	MAT-1070	62100114	1500-07774E	08-Mar-22
Condenser Microphone	4180	2977900	AA-1008-21	05-Feb-22
Measuring Amplifier	NA-42KAI	34560495	AA-3003-21	16-Feb-22

2. This result of calibration was found accurate as shown on date and place of calibration for this calibrated item only.

3. This certificate is traceable to the international system of unit maintained at :

3.1 National Institute of Metrology (Thailand).

3.2 Thailand Institute of Scientific and Technological Research (TISTR).

QF-TS12-04-04-020664



## Continuation of Calibration Certificate

Cert. No. : ACL22025  
Job No. : VC65AC0040  
Pages : 3 of 8

## Summary of Measurement Result :

Parameter	Pass	Fail	Uncertainty (dB)	Maximum-permitted uncertainty of measurement (dB)
1. Absolute sensitivity	✓	-	0.2	N/A
2. Self-generated noise	✓	-	0.2	N/A
3. Acoustical signal tests of frequency weightings				
125 Hz	✓	-	0.3	0.6
1000 Hz	✓	-	0.3	0.6
8000 Hz	✓	-	0.3	0.7
4. Electrical signal tests of frequency weightings				
For 10 Hz to 4 kHz	✓	-	0.3	0.6
For > 4 kHz to 10 kHz	✓	-	0.3	0.7
For > 10 kHz to 20 kHz	-	-	-	1.0
5. Frequency and time weightings at 1 kHz	✓	-	0.2	0.2
6. Long - term stability	✓	-	0.1	0.1
7. Level linearity on the reference level range	✓	-	0.2	0.3
8. Level linearity including the level range control	✓	-	0.2	0.3
9. Tone burst response	✓	-	0.2	0.3
10. Peak C sound level	✓	-	0.2	0.35
11. Overload indication	✓	-	0.2	0.25
12. High level stability	✓	-	0.1	0.1

## Continuation of Calibration Certificate

Cert. No. : ACL22025  
Job No. : VC65AC0040  
Pages : 4 of 8

## Result of calibration :

## 1. Absolute sensitivity

Reference Acoustic Signal ( dB )	Measured Value ( dB )	Deviation ( dB )	Acceptance Limit ( dB )
93.9 (93.96)	93.9	0.0	±0.3

## 2. Self-generated noise

## 2.1 Normal test

Measured Value ( dB )
16.2

## 2.2 The microphone of the sound level meter was replaced by electrical signal input device.

Frequency Weighting	Measured value ( dB )
A - weight	11.6
C - weight	18.0
Flat	23.9

## 3. Acoustical signal tests of frequency weightings

Meter free-field acoustic response at a level of 84 dB

Frequency ( Hz )	Deviation from various frequency weighting response curve (dB)			
	Flat	C-weight	A-weight	Acceptance Limits
125	0.5	0.5	0.6	± 1.5
1000	0.0	0.0	0.1	± 1.0
8000	-2.3	-2.3	-2.3	±5.0

QF-TS12-04-04-020664

T P.T.A

## Continuation of Calibration Certificate

Cert. No. : ACL22025  
Job No. : VC65AC0040  
Pages : 5 of 8

## 4. Electrical signal tests of frequency weightings

Weighting network response with relative to 1 kHz.

Frequency ( Hz )	Deviation from various frequency weighting response curve (dB)			
	Flat	C-weight	A-weight	Acceptance Limits
63	0.0	0.0	0.0	±2.0
125	0.0	0.0	0.0	±1.5
250	0.0	0.0	0.0	±1.5
500	0.0	0.1	0.0	±1.5
1000	0.0	0.0	0.0	±1.0
2000	0.0	0.1	0.0	±2.0
4000	0.0	0.0	0.0	±3.0
8000	0.0	0.1	0.1	±5.0

## 5. Frequency and time weightings at 1 kHz

## 5.1 Frequency weightings at 1 kHz

Frequency Weighting	Measured Value ( dB )	Deviated Value ( dB )	Acceptance Limits ( dB )
A - weight	94.0	0.0	-
C - weight	94.0	0.0	± 0.2
Flat	94.0	0.0	± 0.2

## 5.2 Time weighting at 1 kHz

Frequency Weighting	Measured Value ( dB )	Deviated Value ( dB )	Acceptance Limits ( dB )
Fast	94.0	0.0	-
Slow	94.0	0.0	± 0.1
1.sq	94.0	0.0	± 0.1

## 6. Long - term stability

Frequency Weighting	SLM Display at initial ( dB )	SLM Display at final ( dB )	Deviated Value ( dB )	Acceptance Limits ( dB )
A - weight	94.0	94.1	0.1	± 0.3

QF-TS12-04-04-020664

T P.T.A

## Continuation of Calibration Certificate

Cert. No. : ACL22025  
Job No. : VC65AC0040  
Pages : 6 of 8

## 7. Level linearity on the reference level range

Anticipated Value ( dB )	Measured Value ( dB )	Deviated Value ( dB )	Acceptance Limits ( dB )
137.0	137.0	0.0	± 1.1
136.0	136.0	0.0	± 1.1
135.0	135.0	0.0	± 1.1
134.0	134.0	0.0	± 1.1
133.0	133.0	0.0	± 1.1
132.0	132.0	0.0	± 1.1
131.0	131.0	0.0	± 1.1
129.0	129.0	0.0	± 1.1
124.0	124.0	0.0	± 1.1
119.0	119.0	0.0	± 1.1
114.0	114.0	0.0	± 1.1
109.0	109.0	0.0	± 1.1
104.0	104.0	0.0	± 1.1
99.0	99.0	0.0	± 1.1
94.0	94.0	0.0	± 1.1
89.0	89.0	0.0	± 1.1
84.0	84.0	0.0	± 1.1
79.0	79.0	0.0	± 1.1
74.0	74.0	0.0	± 1.1
69.0	69.0	0.0	± 1.1
64.0	64.0	0.0	± 1.1
59.0	59.0	0.0	± 1.1
54.0	54.0	0.0	± 1.1
49.0	49.0	0.0	± 1.1
44.0	44.0	0.0	± 1.1
39.0	38.9	-0.1	± 1.1
34.0	34.0	0.0	± 1.1
30.0	30.0	0.0	± 1.1
29.0	29.0	0.0	± 1.1
28.0	28.0	0.0	± 1.1
27.0	27.0	0.0	± 1.1
26.0	26.0	0.0	± 1.1
25.0	25.0	0.0	± 1.1

QF-TS12-04-04-020664

T P.T.A

## Continuation of Calibration Certificate

Cert. No. : ACL22025  
Job No. : VC65AC0040  
Pages : 7 of 8

## 8. Level linearity including the level range control

Range	Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Auto	94,0	94,0	0,0	±1,1

## 9. Tone burst response

Time Weighting	Tone burst duration, Tb (ms)	Cycle	Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Fast	0,25	1	108,0	108,0	0,0	1,5; -5,0
	2	8	117,0	117,0	0,0	1,0; -2,5
	200	800	134,0	134,1	0,1	±1,0
Slow	2	8	108,0	108,0	0,0	1,5; -5,0
	200	800	127,6	127,6	0,0	±1,0
SEL	0,25	1	99,0	98,9	-0,1	1,5; -5,0
	2	8	108,0	108,0	0,0	1,0; -2,5
	200	800	128,0	128,1	0,1	±1,0

## 10. Peak C sound level

Number of cycle in test signal	Anticipated Value (dB)	Measured Value, Lepeak (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Continuous	133,0	133,0	0,0	-
One	136,4	136,3	-0,1	±3,0

Number of cycle in test signal	Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Continuous	133,0	133,0	0,0	-
Positive half cycle	135,4	135,1	-0,3	±2,0
Negative half cycle	135,4	135,1	-0,3	±2,0

QF-TS12-04-04-020664

7 P.T.A

SITHIPORN ASSOCIATES CO.,LTD.  
CALIBRATION LABORATORY451-451/1 Sirinthorn Rd.,Bangbunru, Bangplud Bangkok 10700 THAILAND.  
Tel:0-2433-8800 Fax:0-2433-1679 e-mail:cal-center@sithiphorn.com http://www.sithiphorn.comCert. No. : ACL22154  
Pages : 1 of 8

## Calibration Certificate

Equipment : SOUND LEVEL METER  
Manufacturer : RION  
Model : NL-42/ Microphone UC-52 / Preamplifier NH-24  
Serial No.: 00734218 / 146937 / 34368  
ID No.: RYG\_FS0031

Condition As Found : GOOD

Customer : ALS LABORATORY GROUP (THAILAND) CO., LTD.  
104 PHATTHANAKAN 40, PHATTHANAKAN ROAD,  
KHWAENG PHATTHANAKAN, KHET SUAN LUANG,  
BANGKOK, 10250 THAILAND.

Location :  
Ambient Temperature : ( 23,0 ± 3 ) °C  
Pressure : ( 101,3 ± 3 ) kPa  
Relative Humidity : ( 50,0 ± 20 ) %

Received Date : 17 JUNE 2022  
Calibration Date : 20-22 JUNE 2022  
Date of Issue : 27 JUNE 2022

Calibrated by : Nathakorn Pisutpaisan

Approved by :

T. Petchurai  
( Thanakul Petchurai )

This certificate is issued in accordance with the requirements of ISO/IEC 17025 standard, may not be reproduced other than in full, except with the prior written approval of the head of Calibration Laboratory.

## Continuation of Calibration Certificate

Cert. No. : ACL22025  
Job No. : VC65AC0040  
Pages : 8 of 8

## 11. Overload indication

Measured value (dB)		Deviated Value (dB)	Acceptance Limits (dB)
Positive one-half cycle	Negative one-half cycle		
89,5	89,6	0,1	±1,5

## 12. High level stability

Frequency Weighting	SLM Display at initial (dB)	SLM Display at final (dB)	Deviated Value (dB)	Acceptance Limits (dB)
A-weight	137,0	137,0	0,0	±0,3

The reported uncertainty is based on a standard uncertainty multiplied by coverage factor  $k = 2$  or any value following calculation, providing a level of confidence of approximately 95 %

End of Calibration Certificate

QF-TS12-04-04-020664

7 P.T.A

SITHIPORN / SITHIPORN ASSOCIATES CO.,LTD.  
ASSOCIATES CALIBRATION LABORATORY

## Continuation of Calibration Certificate

Cert. No. : ACL22154  
Job No. : VC65AC0068  
Pages : 2 of 8

Calibration Procedure : CP-AC-01

## Calibration Method :

This equipment was calibrated by based on IEC-61672-3 (2013) Standard for sound level meter (SLM).  
The SLM had tests to Acoustical and Electrical signal tests of frequency weighting with Anechoic chamber and Reference Standard Instruments.  
For tests results of each items were made by observation of each Instruments display and also with SLM's display.

## Condition of this result of calibration :

## 1. Reference Standard Instruments :

Instrument	Model	Serial No.	Cert. No.	Use Date
Waveform Generator	33210A	MY48017076	EF-0007-22	04-Feb-23
Waveform Generator	33511B	MY52302742	EF-0008-22	04-Feb-23
Digital Multimeter	33461A	MY53220104	EEL.BP. 04/0265	09-Feb-23
Digital Multimeter	33461A	MY53220076	EEL.BP. 03/0265	09-Feb-23
Digital Multimeter	34461A	MY60024273	EEL.BP. 05/0265	09-Feb-23
Programmable Attenuator	MAT-1070	62100114	EF-0009-22	07-Feb-23
Condenser Microphone	4180	2977900	AA-1013-22	24-Feb-23
Measuring Amplifier	NA-42KA1	34560495	AA-3005-22	22-Feb-23

2. This result of calibration was found accurate as shown on date and place of calibration for this calibrated item only.

3. This certificate is traceable to the international system of unit maintained at :

- 3.1 National Institute of Metrology (Thailand).
- 3.2 Thailand Institute of Scientific and Technological Research (TISTR).

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7 P.T.A



## Continuation of Calibration Certificate

Cert. No. : ACL22154  
Job No. : VC65AC0068  
Pages : 3 of 8

## Summary of Measurement Result :

Parameter	Pass	Fail	Uncertainty (dB)	Maximum-permitted uncertainty of measurement (dB)
1. Absolute sensitivity	✓	-	0.2	N/A
2. Self-generated noise	✓	-	0.2	N/A
3. Acoustical signal tests of frequency weightings				
125 Hz	✓	-	0.3	0.6
1000 Hz	✓	-	0.3	0.6
8000 Hz	✓	-	0.3	0.7
4. Electrical signal tests of frequency weightings				
For 10 Hz to 4 kHz	✓	-	0.3	0.6
For > 4 kHz to 10 kHz	✓	-	0.3	0.7
For > 10 kHz to 20 kHz	-	-	-	1.0
5. Frequency and time weightings at 1 kHz	✓	-	0.2	0.2
6. Long - term stability	✓	-	0.1	0.1
7. Level linearity on the reference level range	✓	-	0.2	0.3
8. Level linearity including the level range control	✓	-	0.2	0.3
9. Tone burst response	✓	-	0.2	0.3
10. Peak C sound level	✓	-	0.2	0.35
11. Overload indication	✓	-	0.2	0.25
12. High level stability	✓	-	0.1	0.1

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## Continuation of Calibration Certificate

Cert. No. : ACL22154  
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## 4. Electrical signal tests of frequency weightings

Weighting network response with relative to 1 kHz.

Frequency (Hz)	Deviation from various frequency weighting response curve (dB)			
	Flat	C-weight	A-weight	Acceptance Limits
63	-0.1	-0.1	0.0	±2.0
125	0.0	0.0	0.0	±1.5
250	0.0	0.0	-0.1	±1.5
500	0.0	0.0	-0.1	±1.5
1000	0.0	0.0	0.0	±1.0
2000	0.0	0.0	0.0	±2.0
4000	0.0	0.0	0.0	±3.0
8000	0.0	0.1	0.1	±5.0

## 5. Frequency and time weightings at 1 kHz

## 5.1 Frequency weightings at 1 kHz

Frequency Weighting	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
A - weight	94.0	0.0	-
C - weight	94.0	0.0	± 0.2
Flat	94.0	0.0	± 0.2

## 5.2 Time weighting at 1 kHz

Frequency Weighting	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Fast	94.0	0.0	-
Slow	94.0	0.0	± 0.1
Leq	94.0	0.0	± 0.1

## 6. Long - term stability

Frequency Weighting	SLM Display at initial (dB)	SLM Display at final (dB)	Deviated Value (dB)	Acceptance Limits (dB)
A - weight	94.0	94.0	0.0	± 0.3

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## Continuation of Calibration Certificate

Cert. No. : ACL22154  
Job No. : VC65AC0068  
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## Result of calibration :

## 1. Absolute sensitivity

Reference Acoustic Signal (dB)	Measured Value (dB)	Deviation (dB)	Acceptance Limit (dB)
93.9 (93.95)	93.9	0.0	±0.3

## 2. Self-generated noise

## 2.1 Normal test

Measured Value (dB)
20.1

2.2 The microphone of the sound level meter was replaced by electrical signal input device.

Frequency Weighting	Measured value (dB)
A - weight	11.6
C - weight	17.4
Flat	23.1

## 3. Acoustical signal tests of frequency weightings

Meter free-field acoustic response at a level of 84 dB

Frequency (Hz)	Deviation from various frequency weighting response curve (dB)			
	Flat	C-weight	A-weight	Acceptance Limits
125	0.5	0.5	0.5	± 1.5
1000	0.1	0.1	0.1	± 1.0
8000	-1.5	-1.5	-1.4	±5.0

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## Continuation of Calibration Certificate

Cert. No. : ACL22154  
Job No. : VC65AC0068  
Pages : 6 of 8

## 7. Level linearity on the reference level range

Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
137.0	137.0	0.0	± 1.1
136.0	136.0	0.0	± 1.1
135.0	135.0	0.0	± 1.1
134.0	134.0	0.0	± 1.1
133.0	132.9	-0.1	± 1.1
132.0	131.9	-0.1	± 1.1
131.0	130.9	-0.1	± 1.1
129.0	128.9	-0.1	± 1.1
124.0	123.9	-0.1	± 1.1
119.0	119.0	0.0	± 1.1
114.0	114.0	0.0	± 1.1
109.0	109.0	0.0	± 1.1
104.0	104.0	0.0	± 1.1
99.0	99.0	0.0	± 1.1
94.0	94.0	0.0	± 1.1
89.0	89.0	0.0	± 1.1
84.0	84.0	0.0	± 1.1
79.0	79.0	0.0	± 1.1
74.0	74.0	0.0	± 1.1
69.0	69.0	0.0	± 1.1
64.0	64.0	0.0	± 1.1
59.0	59.0	0.0	± 1.1
54.0	54.0	0.0	± 1.1
49.0	49.0	0.0	± 1.1
44.0	44.0	0.0	± 1.1
39.0	39.0	0.0	± 1.1
34.0	34.0	0.0	± 1.1
30.0	29.9	-0.1	± 1.1
29.0	29.0	0.0	± 1.1
28.0	28.0	0.0	± 1.1
27.0	27.0	0.0	± 1.1
26.0	25.9	-0.1	± 1.1
25.0	24.9	-0.1	± 1.1

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Continuation of Calibration Certificate

Cert. No. : ACL22154  
Job No. : VC65AC0068  
Pages : 7 of 8

8. Level linearity including the level range control

Range	Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Auto	94.0	94.0	0.0	±1.1

9. Tone burst response

Time Weighting	Tone burst duration, Tb (ms)	Cycle	Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Fast	0.25	1	108.0	107.9	-0.1	1.5 ; -5.0
	2	8	117.0	117.0	0.0	1.0 ; -2.5
	200	800	134.0	134.0	0.0	±1.0
Slow	2	8	108.0	108.0	0.0	1.5 ; -5.0
	200	800	127.6	127.6	0.0	±1.0
SEL	0.25	1	99.0	98.9	-0.1	1.5 ; -5.0
	2	8	108.0	108.0	0.0	1.0 ; -2.5
	200	800	128.0	128.0	0.0	±1.0

10. Peak C sound level

Number of cycle in test signal	Anticipated Value (dB)	Measured Value, L <sub>peak</sub> (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Continuous	133.0	133.0	0.0	-
One	136.4	135.7	-0.7	±3.0

Number of cycle in test signal	Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Continuous	133.0	133.0	0.0	-
Positive half cycle	135.4	135.1	-0.3	±2.0
Negative half cycle	135.4	135.1	-0.3	±2.0

Continuation of Calibration Certificate

Cert. No. : ACL22154  
Job No. : VC65AC0068  
Pages : 8 of 8

11. Overload indication

Measured value (dB)		Deviated Value (dB)	Acceptance Limits (dB)
Positive one-half cycle	Negative one-half cycle		
89.6	89.6	0.0	±1.5

12. High level stability

Frequency Weighting	SLM Display at initial (dB)	SLM Display at final (dB)	Deviated Value (dB)	Acceptance Limits (dB)
A-weight	137.0	137.0	0.0	±0.3

The reported uncertainty is based on a standard uncertainty multiplied by coverage factor  $k = 2$  or any value following calculation, providing a level of confidence of approximately 95 %

End of Calibration Certificate

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CALIBRATION LABORATORY

451-451/1 Sirinthorn Rd., Bangbunru, Bangplud Bangkok 10700 THAILAND.  
Tel.0-2435-8800 Fax.0-2433-1679 e-mail:cal-center@sithiporn.com http://www.sithiporn.com



Cert. No. : ACC22024  
Pages : 1 of 3

Calibration Certificate

Equipment : SOUND CALIBRATOR  
Manufacturer : RION  
Model : NC-74  
Serial No.: 34178124  
ID No.: RYG\_FS0216

Condition As Found : GCOD

Customer : ALS LABORATORY GROUP (THAILAND) CO., LTD.  
104 PHATTHANAKAN 40, PHATTHANAKAN ROAD,  
KHWAENG PHATTHANAKAN, KHET SUAN LUANG,  
BANGKOK, 10250 THAILAND.

Location :  
Ambient Temperature : ( 23.0 ± 3 ) °C  
Pressure : ( 101.3 ± 3 ) kPa  
Relative Humidity : ( 50.0 ± 20 ) %

Received Date : 22 AUGUST 2022  
Calibration Date : 31 AUGUST 2022  
Date of Issue : 02 SEPTEMBER 2022

Calibrated by : Nathakorn Pisutpaisan

Approved by : *T. Petchurai*  
( Thanakul Petchurai )

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Continuation of Calibration Certificate

Cert. No. : ACC22024  
Job No. : VC65AC0077  
Pages : 2 of 3

Calibration Procedure : CP-AC-03

Calibration Method :

This equipment was calibrated by based on IEC-60942-2003 Standard.  
The sound pressure level, frequency and total distortion of the sound calibrator was measured using the reference microphone.

Condition of this result of calibration :

1. Reference Standard Instruments :

Instrument	Model	Serial No.	Cert. No.	Due Date
Waveform Generator	33511B	MY52302742	EF-0008-22	04-Feb-23
Digital Multimeter	33461A	MY53220104	EEL-BP_04/0265	09-Feb-23
Digital Multimeter	33461A	MY53220076	EEL-BP_03/0265	09-Feb-23
Digital Multimeter	33461A	MY60024273	EEL-BP_05/0265	09-Feb-23
Programmable Attenuator	MAT-1070	62100114	FF-0009-22	07-Feb-23
Condenser Microphone	4180	2977900	AA-1013-22	24-Feb-23
Measuring Amplifier	NA-42KA1	34560495	AA-3005-22	22-Feb-23
Audio Analyzer	AVR-3360A	V744B6069	EF-0010-22	07-Feb-23

2. This result of calibration was found accurate as shown on date and place of calibration for this calibrated item only.

3. This certificate is traceable to the international system of unit maintained at :

- 3.1 National Institute of Metrology (Thailand).
- 3.2 Thailand Institute of Scientific and Technological Research (TISTR).

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Continuation of Calibration Certificate

Cert. No. : ACC22024  
Job No. : VC65AC0077  
Pages : 3 of 3

Result of calibration :

1. Sound pressure level

Specified sound pressure level (dB)	Measured value (dB)	Deviated value (dB)	Uncertainty (dB)	Tolerance limit (dB)
94	94.21	0.21	0.14	0.40

2. Frequency

Specified Frequency (Hz)	Measured value (Hz)	Deviated value (%)	Uncertainty (%)	Tolerance limit (%)
1000	1001.3	0.1	0.1	1.0

3. Total distortion

Measured value (%)	Uncertainty (%)	Tolerance limit (%)
1.95	0.10	3.0

The reported uncertainty is based on a standard uncertainty multiplied by coverage factor  $k = 2$  or any value following calculation providing a level of confidence of approximately 95 %

End of Calibration Certificate

QF-TS12-04-04-020664

Continuation of Calibration Certificate

Cert. No. : ACL22195  
Job No. : VC65AC0081  
Pages : 2 of 8

Calibration Procedure : CP-AC-01

Calibration Method :

This equipment was calibrated by based on IEC-61672-3 (2013) Standard for sound level meter (SLM).  
The SLM had tests to Acoustical and Electrical signal tests of frequency weighting with Anechoic chamber and Reference Standard Instruments.  
For tests results of each items were made by observation of each Instruments display and also with SLM's display.

Condition of this result of calibration :

1. Reference Standard Instruments :

Instrument	Model	Serial No.	Cert. No.	Due Date
Waveform Generator	33210A	MY48017076	EI-0007-22	04-Feb-23
Waveform Generator	33511B	MY52302742	EF-0008-22	04-Feb-23
Digital Multimeter	33461A	MY53220104	EEL.BP. 04/0265	09-Feb-23
Digital Multimeter	33461A	MY53220076	EEL.BP. 03/0265	09-Feb-23
Digital Multimeter	34461A	MY60024273	EEL.BP. 05/0265	09-Feb-23
Programmable Attenuator	MAT-1070	62100114	EF-0009-22	07-Feb-23
Condenser Microphone	4180	2977900	AA-1013-22	24-Feb-23
Measuring Amplifier	NA-42KA1	34560495	AA-3005-22	22-Feb-23

2. This result of calibration was found accurate as shown on date and place of calibration for this calibrated item only.

3. This certificate is traceable to the international system of unit maintained at :

3.1 National Institute of Metrology (Thailand).

3.2 Thailand Institute of Scientific and Technological Research (TISTR).

451-451/1 Srinthorn Rd, Banghumru, Bangplud Bangkok 10700 THAILAND  
Tel:0-2435-8800 Fax:0-2433-1679 e-mail:cal-center@sithiporn.com http://www.sithiporn.com



Cert. No. : ACL22195  
Pages : 1 of 8

Calibration Certificate

Equipment : SOUND LEVEL METER  
Manufacturer : RION  
Model : NL-42/ Microphone UC-52 / Preamplifier NH-24  
Serial No. : 00597169 / 180411 / 88181  
ID No. : RYG\_FS0439

Condition As Found : GOOD

Customer : A.I.S LABORATORY GROUP (THAILAND) CO., LTD.  
104 PHATTHANAKAN 40, PHATTHANAKAN ROAD,  
KHAENG PHATTHANAKAN, KHET SUAN LUANG,  
BANGKOK, 10250 THAILAND.

Location :  
Ambient Temperature : ( 23.0 ± 3 ) °C  
Pressure : ( 101.3 ± 3 ) kPa  
Relative Humidity : ( 50.0 ± 20 ) %

Received Date : 06 SEPTEMBER 2022  
Calibration Date : 07-09 SEPTEMBER 2022  
Date of Issue : 14 SEPTEMBER 2022



Calibrated by : Nathakorn Pisutpaisan

Approved by : *T. Petchuraj*  
( Thanakul Petchuraj )

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Continuation of Calibration Certificate

Cert. No. : ACL22195  
Job No. : VC65AC0081  
Pages : 3 of 8

Summary of Measurement Result :

Parameter	Pass	Fail	Uncertainty (dB)	Maximum-permitted uncertainty of measurement (dB)
1. Absolute sensitivity	✓	-	0.2	N/A
2. Self-generated noise	✓	-	0.2	N/A
3. Acoustical signal tests of frequency weightings				
125 Hz	✓	-	0.3	0.6
1000 Hz	✓	-	0.3	0.6
8000 Hz	✓	-	0.3	0.7
4. Electrical signal tests of frequency weightings				
For 10 Hz to 4 kHz	✓	-	0.3	0.6
For > 4 kHz to 10 kHz	✓	-	0.3	0.7
For > 10 kHz to 20 kHz	-	-	-	1.0
5. Frequency and time weightings at 1 kHz	✓	-	0.2	0.2
6. Long - term stability	✓	-	0.1	0.1
7. Level linearity on the reference level range	✓	-	0.2	0.3
8. Level linearity including the level range control	✓	-	0.2	0.3
9. Tone burst response	✓	-	0.2	0.3
10. Peak C sound level	✓	-	0.2	0.35
11. Overload indication	✓	-	0.2	0.25
12. High level stability	✓	-	0.1	0.1

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## Continuation of Calibration Certificate

Cert. No. : ACL22195  
Job No. : VC65AC0081  
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## Result of calibration :

## 1. Absolute sensitivity

Reference Acoustic Signal ( dB )	Measured Value ( dB )	Deviation ( dB )	Acceptance Limit ( dB )
93.9 (93.95)	93.9	0.0	±0.3

## 2. Self-generated noise

## 2.1 Normal test

Measured Value ( dB )
15.1

## 2.2 The microphone of the sound level meter was replaced by electrical signal input device.

Frequency Weighting	Measured value ( dB )
A - weight	13.1
C - weight	19.3
Flat	24.8

## 3. Acoustical signal tests of frequency weightings

Meter free-field acoustic response at a level of 84 dB

Frequency ( Hz )	Deviation from various frequency weighting response curve (dB)			
	Flat	C-weight	A-weight	Acceptance Limits
125	0.1	0.1	0.1	± 1.5
1000	0.0	0.0	0.0	± 1.0
8000	1.2	1.3	1.2	±5.0

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T. Petch.

## Continuation of Calibration Certificate

Cert. No. : ACL22195  
Job No. : VC65AC0081  
Pages : 5 of 8

## 4. Electrical signal tests of frequency weightings

Weighting network response with relative to 1 kHz.

Frequency ( Hz )	Deviation from various frequency weighting response curve (dB)			
	Flat	C-weight	A-weight	Acceptance Limits
63	-0.1	-0.1	-0.1	±2.0
125	0.0	0.0	0.0	±1.5
250	0.0	0.0	0.0	±1.5
500	0.0	0.0	0.0	±1.5
1000	0.0	0.0	0.0	±1.0
2000	0.0	0.0	0.0	±2.0
4000	0.0	0.0	0.0	±3.0
8000	0.0	0.1	0.1	±5.0

## 5. Frequency and time weightings at 1 kHz

## 5.1 Frequency weightings at 1 kHz

Frequency Weighting	Measured Value ( dB )	Deviated Value ( dB )	Acceptance Limits ( dB )
A - weight	94.0	0.0	-
C - weight	94.0	0.0	± 0.2
Flat	94.0	0.0	± 0.2

## 5.2 Time weighting at 1 kHz

Frequency Weighting	Measured Value ( dB )	Deviated Value ( dB )	Acceptance Limits ( dB )
Fast	94.0	0.0	-
Slow	94.0	0.0	± 0.1
Leq	94.0	0.0	± 0.1

## 6. Long - term stability

Frequency Weighting	SLM Display at initial ( dB )	SLM Display at final ( dB )	Deviated Value ( dB )	Acceptance Limits ( dB )
A - weight	94.0	94.0	0.0	± 0.3

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T. Petch.

## Continuation of Calibration Certificate

Cert. No. : ACL22195  
Job No. : VC65AC0081  
Pages : 6 of 8

## 7. Level linearity on the reference level range

Anticipated Value ( dB )	Measured Value ( dB )	Deviated Value ( dB )	Acceptance Limits ( dB )
137.0	137.0	0.0	± 1.1
136.0	136.0	0.0	± 1.1
135.0	135.0	0.0	± 1.1
134.0	134.0	0.0	± 1.1
133.0	133.0	0.0	± 1.1
132.0	132.0	0.0	± 1.1
131.0	131.0	0.0	± 1.1
129.0	129.0	0.0	± 1.1
124.0	124.0	0.0	± 1.1
119.0	119.0	0.0	± 1.1
114.0	114.0	0.0	± 1.1
109.0	109.0	0.0	± 1.1
104.0	104.0	0.0	± 1.1
99.0	99.0	0.0	± 1.1
94.0	94.0	0.0	± 1.1
89.0	89.0	0.0	± 1.1
84.0	84.0	0.0	± 1.1
79.0	79.0	0.0	± 1.1
74.0	74.0	0.0	± 1.1
69.0	69.0	0.0	± 1.1
64.0	64.0	0.0	± 1.1
59.0	59.0	0.0	± 1.1
54.0	53.9	-0.1	± 1.1
49.0	49.0	0.0	± 1.1
44.0	44.0	0.0	± 1.1
39.0	39.0	0.0	± 1.1
34.0	34.0	0.0	± 1.1
30.0	30.0	0.0	± 1.1
29.0	29.0	0.0	± 1.1
28.0	28.0	0.0	± 1.1
27.0	27.0	0.0	± 1.1
26.0	26.0	0.0	± 1.1
25.0	25.0	0.0	± 1.1

QF-TS12-04-04-020664

T. Petch.

## Continuation of Calibration Certificate

Cert. No. : ACL22195  
Job No. : VC65AC0081  
Pages : 7 of 8

## 8. Level linearity including the level range control

Range	Anticipated Value ( dB )	Measured Value ( dB )	Deviated Value ( dB )	Acceptance Limits ( dB )
Auto	94.0	94.0	0.0	±1.1

## 9. Tone burst response

Time Weighting	Tone burst duration, Tb ( ms )	Cycle	Anticipated Value ( dB )	Measured Value ( dB )	Deviated Value ( dB )	Acceptance Limits ( dB )
Fast	0.25	1	108.0	107.9	-0.1	1.5 ; -5.0
	2	8	117.0	117.0	0.0	1.0 ; -2.5
	200	800	134.0	134.1	0.1	±1.0
Slow	2	8	108.0	108.0	0.0	1.5 ; -5.0
	200	800	127.6	127.6	0.0	±1.0
SEL	0.25	1	99.0	98.9	-0.1	1.5 ; -5.0
	2	8	108.0	108.0	0.0	1.0 ; -2.5
	200	800	128.0	128.0	0.0	±1.0

## 10. Peak C sound level

Number of cycle in test signal	Anticipated Value ( dB )	Measured Value, Lepeak ( dB )	Deviated Value ( dB )	Acceptance Limits ( dB )
Continuous	133.0	133.0	0.0	-
One	136.4	136.3	-0.1	±3.0

Number of cycle in test signal	Anticipated Value ( dB )	Measured Value ( dB )	Deviated Value ( dB )	Acceptance Limits ( dB )
Continuous	133.0	133.0	0.0	-
Positive half cycle	135.4	135.2	-0.2	±2.0
Negative half cycle	135.4	135.2	-0.2	±2.0

QF-TS12-04-04-020664

T. Petch.



Continuation of Calibration Certificate

Cert. No. : ACL22195  
Job No. : VC65AC0081  
Pages : 8 of 8

11. Overload indication

Measured value ( dB )		Deviated Value ( dB )	Acceptance Limits ( dB )
Positive one-half cycle	Negative one-half cycle		
89.5	89.6	0.1	±1.5

12. High level stability

Frequency Weighting	SLM Display at initial ( dB )	SLM Display at final ( dB )	Deviated Value ( dB )	Acceptance Limits ( dB )
A - weight	137.0	137.0	0.0	±0.3

The reported uncertainty is based on a standard uncertainty multiplied by coverage factor  $k = 2$   
or any value following calculation, providing a level of confidence of approximately 95 %

End of Calibration Certificate

CERTIFICATE OF CALIBRATION

ISSUED BY Cirrus Research plc  
DATE OF ISSUE 14/03/22 CERTIFICATE NUMBER 171513

REVIEW BY *Nigel Smith*  
APPROVED BY *Nigel Smith*  
NEXT CAL DATE 14/3/23

Cirrus Research plc  
Acoustic House  
Bridlington Road  
Hunmanby  
North Yorkshire  
YO14 0PH  
United Kingdom

Page 1 of 1  
Test engineer:  
Nigel Smith  
Electronically signed:  
*Nigel Smith*

doseBadge Reader

Instrument

Manufacturer: Cirrus Research plc Serial Number: 92612  
Model Number: RC110A Notes:

Calibration Procedure

The tests were carried out in accordance with the requirements of IEC 60942:2003 where applicable.  
Date of Calibration: 14 March 2022

Functionality Results

Function	Result
Keypad	Pass
Battery Power	Pass
Display	Pass
Communication	Pass
2 way IR link	Pass
Clock	Pass

Calibration Results

	Level (dB)	Frequency (Hz)	Distortion (% THD + Noise)
Initial	113.90	1000.4	0.38
Adjusted	114.00	1000.4	0.38
Uncertainty	± 0.11	± 0.14	± 0.10
Tolerances	± 0.60	± 2.00	± 4.00

Environmental Conditions

Pressure: 101.30 kPa  
Temperature: 21.3 °C  
Humidity: 42.5 %

Notes

This certificate provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory. The results within this certificate relate only to the items calibrated. The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor  $k=2$ , providing a coverage probability of approximately 95%.

QF-TS12-04-04-020664



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CERTIFICATE OF CALIBRATION

Certificate No. : CL-042-65  
Page 1 of 2

Equipment Name: Digital thermometer with RTD  
Manufacturer: DeltaOHM  
Model: HD32.2  
Serial No: 20032243  
ID No: RYG\_FS0523

Customer:  
Name: ALS laboratory group (thailand) Co., Ltd.  
Address: 104 Phatthanasri 40, Phatthanasri  
Rd., Khwaeng Suan Luang, Khet Suan Luang Bangkok  
10250 Thailand.

Received date: 25 FEB 2022  
Calibration date: 7 MAR 2022  
Issue date: 10 MAR 2022

Reference Used During Calibration  
1 Standard Temperature Probe Model: STS 100 AS00  
Serial No. : 667682-09, Due date: 25 Mar 2022  
2 Digital Temperature Indicator Model: DTI-1000-A MK  
II, Serial No. : 671407-00591 Due date: 04 June 2022

Calibration Condition  
Temperature: (23±3) °C  
Relative Humidity: (55±15)%

Calibration Procedure  
The temperature calibration was done by in House  
calibration method as WI CL 001 according to  
comparison method with standard digital temperature  
indicator and standard temperature probe. The  
temperature scale use was based on ITS 90.

Traceability  
The measurement results are traceable to the  
international system of units (SI) through National  
Institute of Metrology Thailand (NIMT) Certificate  
number: TT 0036-21 Certificate number: ER 0032  
21

REVIEW BY *Nigel Smith*  
APPROVED BY *Nigel Smith*  
NEXT CAL DATE 14/3/23

Calibrated by  
☒ Mr. Sorawit Thachalad  
☐ Miss Orathai Wiatwattayak



Approved Signatory: *Nigel Smith*  
Mr. Pinyan Booncharoen  
Calibration Department Manager



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Certificate No. : CL-042-65  
Page 2 of 2

Result of Calibration: ☒ Without Adjustment ☐ With Adjustment

Calibration Range: 20 - 40 °C

Function:

Table 1: This equipment was connected with wet bulb probe Model: HP3201.2 S/N: 21001219.  
Dimension: Diameter 14 mm. Length 170 mm.

Immersion Depth (mm)	Standard Reading (°C)	UUC Reading (°C)	Error (°C)	Uncertainty (°C)
30	20.060	20.0	0.1	0.099
30	25.047	25.0	0.0	0.099
30	30.034	30.0	0.0	0.099
30	35.021	35.0	0.0	0.099
30	40.005	40.0	0.0	0.099

Table 2: This equipment was connected with temperature probe Model: TP3207.2 S/N: 21001786.  
Dimension: Diameter 14 mm. Length 150 mm.

Immersion Depth (mm)	Standard Reading (°C)	UUC Reading (°C)	Error (°C)	Uncertainty (°C)
70	20.058	20.2	0.1	0.099
70	25.045	25.1	0.1	0.099
70	30.032	30.0	0.0	0.099
70	35.021	34.9	0.1	0.099
70	40.001	39.7	0.3	0.099

Table 3: This equipment was connected with Globe thermometer probe Model: TP3276.2 S/N: 21001243.  
Dimension: Diameter 8 mm. Length 170 mm.

Immersion Depth (mm)	Standard Reading (°C)	UUC Reading (°C)	Error (°C)	Uncertainty (°C)
110	20.059	20.0	0.1	0.099
110	25.047	25.0	0.0	0.099
110	30.032	30.0	0.0	0.099
110	35.016	35.0	0.0	0.099
110	40.007	40.0	0.0	0.099

UUC\* : Unit Under Calibration

The reported expanded uncertainty is based on standard uncertainty multiplied by a coverage factor  $k=2$  providing a level of confidence of approximately 95%.

★ End of Certificate ★





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## CERTIFICATE OF CALIBRATION

Certificate No. : CL-040-65  
Page 1 of 2

Equipment Name: Digital thermometer with RTD  
Manufacturer: DeltaOHM  
Model: HD32.2  
Serial No: 20032241  
ID No: RYG\_FS0521

Customer  
Name: ALS laboratory group (thailand) Co., Ltd  
Address: 104 Phatthanakan 40, Phatthanakan  
Rd., Khwaeng Suan Luang, Khet Suan Luang, Bangkok  
10250 Thailand.

Received date: 25 FEB 2022  
Calibration date: 7 MAR 2022  
Issue date: 10 MAR 2022

### Reference Used During Calibration

1. Standard Temperature Probe Model: STS 100 A500, Serial No.: 667682 09, Due date: 25 Mar 2022
2. Digital Temperature Indicator Model: DTI-1000 A MK II, Serial No.: 671407 00591 Due date: 04 June 2022

### Calibration Procedure

The temperature calibration was done by In-House calibration method as WI CL 001 according to comparison method with standard digital temperature indicator and standard temperature probe. The temperature scale use was based on ITS 90.

### Calibration Condition

Temperature: (23±3) °C  
Relative Humidity: (55±15)%

### Traceability

The measurement results are traceable to the international system of units (SI) through National Institute of Metrology Thailand (NIMT) Certificate number, TT-0036-21, Certificate number, ER-0032-21.

REVIEW BY: *Manon P*  
APPROVED BY: *Mr. P*  
NEXT CAL DATE: 4/1/23

Calibrated by  
☒ Mr. Sorawit Thachalad  
☐ Miss Orathai Wiwatwittaya



Approved Signatory: *Mr. P*  
Mr. Parinya Booncharoen  
Calibration Department Manager

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## CERTIFICATE OF CALIBRATION

Certificate No. : CL-043-65  
Page 1 of 2

Equipment Name: Digital thermometer with RTD  
Manufacturer: DeltaOHM  
Model: HD32.2  
Serial No: 20032249  
ID No: RYG\_FS0524

Customer  
Name: ALS laboratory group (thailand) Co., Ltd  
Address: 104 Phatthanakan 40, Phatthanakan  
Rd., Khwaeng Suan Luang, Khet Suan Luang, Bangkok  
10250 Thailand.

Received date: 25 FEB 2022  
Calibration date: 8 MAR 2022  
Issue date: 10 MAR 2022

### Reference Used During Calibration

1. Standard Temperature Probe Model: STS 100 A500, Serial No.: 667682 09, Due date: 25 Mar 2022
2. Digital Temperature Indicator Model: DTI-1000 A MK II, Serial No.: 671407 00591 Due date: 04 June 2022

### Calibration Procedure

The temperature calibration was done by In-House calibration method as WI CL 001 according to comparison method with standard digital temperature indicator and standard temperature probe. The temperature scale use was based on ITS 90.

### Calibration Condition

Temperature: (23±3) °C  
Relative Humidity: (55±15)%

### Traceability

The measurement results are traceable to the international system of units (SI) through National Institute of Metrology Thailand (NIMT) Certificate number, TT-0036-21, Certificate number, ER-0032-21.

REVIEW BY: *Manon P*  
APPROVED BY: *Mr. P*  
NEXT CAL DATE: 8/1/23

Calibrated by  
☒ Mr. Sorawit Thachalad  
☐ Miss Orathai Wiwatwittaya



Approved Signatory: *Mr. P*  
Mr. Parinya Booncharoen  
Calibration Department Manager

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Certificate No. : CL-040-65  
Page 2 of 2

Result of Calibration: ☒ Without Adjustment ☐ With Adjustment

Calibration Range: 20 - 40 °C

### Function:

Table 1: This equipment was connected with wet bulb probe Model: HP3201.2 S/N: 21001217.  
Dimension: Diameter 14 mm, Length 170 mm.

Immersion Depth (mm)	Standard Reading (°C)	UUC Reading (°C)	Error (°C)	Uncertainty (°C)
30	20.054	20.1	0.0	0.099
30	25.047	25.1	0.1	0.099
30	30.031	30.1	0.1	0.099
30	35.016	35.1	0.1	0.099
30	40.016	40.1	0.1	0.099

Table 2: This equipment was connected with temperature probe Model: TP3207.2 S/N: 21001783.  
Dimension: Diameter 14 mm, Length 150 mm.

Immersion Depth (mm)	Standard Reading (°C)	UUC Reading (°C)	Error (°C)	Uncertainty (°C)
70	20.055	20.2	0.0	0.099
70	25.045	25.0	0.0	0.099
70	30.029	29.9	0.1	0.099
70	35.010	34.8	0.2	0.099
70	40.011	39.7	-0.3	0.099

Table 3: This equipment was connected with Globe thermometer probe Model: TP3275.2 S/N: 21001242.  
Dimension: Diameter 8 mm, Length 170 mm.

Immersion Depth (mm)	Standard Reading (°C)	UUC Reading (°C)	Error (°C)	Uncertainty (°C)
110	20.055	20.0	0.1	0.099
110	25.049	25.0	0.0	0.099
110	30.028	30.0	0.0	0.099
110	35.015	35.0	0.0	0.099
110	40.010	40.0	0.0	0.099

### UUC\* : Unit Under Calibration

The reported expanded uncertainty is based on standard uncertainty multiplied by a coverage factor k=2 providing a level of confidence of approximately 95%.

★ End of Certificate ★



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Certificate No. : CL-043-65  
Page 2 of 2

Result of Calibration: ☒ Without Adjustment ☐ With Adjustment

Calibration Range: 20 - 40 °C

### Function:

Table 1: This equipment was connected with wet bulb probe Model: HP3201.2 S/N: 21001215.  
Dimension: Diameter 14 mm, Length 170 mm.

Immersion Depth (mm)	Standard Reading (°C)	UUC Reading (°C)	Error (°C)	Uncertainty (°C)
30	20.057	20.1	0.0	0.099
30	25.046	25.1	0.1	0.099
30	30.032	30.1	0.1	0.099
30	35.013	35.1	0.1	0.099
30	39.998	40.0	0.0	0.099

Table 2: This equipment was connected with temperature probe Model: TP3207.2 S/N: 21001785.  
Dimension: Diameter 14 mm, Length 150 mm.

Immersion Depth (mm)	Standard Reading (°C)	UUC Reading (°C)	Error (°C)	Uncertainty (°C)
70	20.057	20.1	0.0	0.099
70	25.046	25.0	0.0	0.099
70	30.035	29.9	0.1	0.099
70	35.023	34.7	-0.3	0.099
70	40.002	39.6	-0.4	0.099

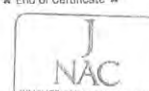
Table 3: This equipment was connected with Globe thermometer probe Model: TP3275.2 S/N: 21001244.  
Dimension: Diameter 8 mm, Length 170 mm.

Immersion Depth (mm)	Standard Reading (°C)	UUC Reading (°C)	Error (°C)	Uncertainty (°C)
110	20.056	20.0	0.1	0.099
110	25.048	25.0	0.0	0.099
110	30.032	30.0	0.0	0.099
110	35.015	35.0	0.0	0.099
110	39.992	39.9	-0.1	0.099

### UUC\* : Unit Under Calibration

The reported expanded uncertainty is based on standard uncertainty multiplied by a coverage factor k=2 providing a level of confidence of approximately 95%.

★ End of Certificate ★



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Walthapa, Bangkholai, Bangkok 10600 Thailand.  
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Certificate No.: CL-021-65  
Page 2 of 2

## CERTIFICATE OF CALIBRATION

Certificate No.: CL-021-65  
Page 1 of 2

Equipment Name: Heat Stress Monitor with Sensor  
Manufacturer: DeltaOHM  
Model: HD32.2  
Serial No: 18018313  
ID No: RYG\_FS0358

Customer  
Name: ALS laboratory group (thailand) Co. Ltd.  
Address: 104 Phatthanakan 40, Phatthanakan  
Rd., Khwaeng Suan Luang, Khet Suan Luang, Bangkok  
10250 Thailand.

Received date: 10 JAN 2022  
Calibration date: 16 FEB 2022  
Issue date: 17 FEB 2022

Reference Used During Calibration  
1. Standard Temperature Probe Model: STS 100 A500,  
Serial No: 667682 09, Due date: 25 Mar 2022  
2. Digital Temperature Indicator Model: DTI-1000-A MK  
II, Serial No: 671407-00591, Due date: 04 June 2022

Calibration Condition  
Temperature: (23.43) °C  
Relative Humidity: (55.115)%

Calibration Procedure  
The temperature calibration was done by in-house  
calibration method as WI-CL-001 according to  
comparison method with standard digital temperature  
indicator and standard temperature probe. The  
temperature scale use was based on ITS 90.

Traceability  
The measurement results are traceable to the  
international system of units (SI) through National  
Institute of Metrology Thailand (NIMT) Certificate  
number: TT-0036-21, Certificate number: ER-0032-  
21

REVIEW BY: *[Signature]*  
APPROVED BY: *[Signature]*  
NEXT CAL DATE: 16/2/23

Calibrated by  
[ ] Mr. Sorawit Thachalad  
[ ] Miss Orathai Wiwatwattaya



Approved Signatory: *[Signature]*  
Mr. Pavinia Boonchayoon  
Calibration Department Manager

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TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)  
CORPORATE SERVICES 3: EQUIPMENT CALIBRATION AND TESTING SERVICES  
53/4 PATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG, BANGKOK 10250  
TEL: 0-2717-3000-24 FAX: 0-2716-9484



## Certificate of Calibration

Certificate No.: 21PH487  
Page: 1 of 2

Cert. No.: 21PH487  
Page: 2 of 2

Equipment: Lux Meter  
Manufacturer: Delta OHM  
Model: HD2102.21  
Serial No.: 16002032  
ID No.: RYG\_FS0200

Condition As-Received: Used Item  
Received Date: 15 September 2021  
Calibration Date: 22 September 2021

Reference: 2109-0563WSC  
Ambient Temperature: ( 23 ± 2 ) °C  
Relative Humidity: ( 50 ± 15 ) %

Submitted by: ALS Laboratory Group (Thailand) Co., Ltd.

104 Phatthanakan 40, Phatthanakan Rd.,  
Khwaeng Phatthanakan, Khet Suan Luang,  
Bangkok 10250 Thailand

Procedure used: Calibration were conducted using in-house calibration procedure CP-PH01 by measuring against  
luminous-intensity standard lamp (source-based method) According to the inverse square law measurement  
method

### Condition of this result of calibration

1. Reference standards instruments:

Instrument	Model	Serial No.	Certificate No.	Due Date
1) Photometry & Encoder	LMguide 9.6 m	120RC003	61-140006-1	30 Apr 2022
2) High-accuracy Irradiance Standard	OL-FEL-U	F-1472	TP-1045-20	20 Oct 2021

2. This result of calibration was made on requested at the point specified by customer.

3. Test Equipment: Programmable Voltage/Current Source ( Model: OL83A, S/N: 09220284 ).

4. Test Equipment: Illuminance Meter ( Model: 51002, S/N: 080129 ).

5. The certificate is valid only to the item calibrated on date and place of calibration.

6. This Certification is traceable to the International System of Unit maintained at:-

-National Institute of Metrology Thailand (NIMT)

REVIEW BY: *[Signature]*  
APPROVED BY: *[Signature]*  
NEXT CAL DATE: 22/9/22

Calibrated by: Nuntawat Khanchai  
Issue Date: 24 September 2021

Approved Signatory: *[Signature]*  
[ ] Phalinee Prapapal  
[ ] Chatchawan Khunpluok

Result of calibration: ( \* ) Without adjustment ( ) After adjustment  
Function: Illuminance Measurement Range: Autorange

Standard Value	UUC* Reading	Error	Uncertainty
( lx )	( lx )	( lx )	( ± lx )
0	0.00	0.00	0.060
15	14.44	-0.56	0.20
100	96.83	-3.17	1.3
500	480.8	-19.2	6.5
1000	973.0	-27.0	13
2000	1976.2	-23.8	26
3000	2976	-24	39
4000	3975	-25	52
5000	4985	-14	65

The reported uncertainty of measurement was based on a standard uncertainty multiplied by  
a coverage factor  $k = 2$ , providing a level of confidence of approximately 95 %

Calibration with probe sensor s/n. 20011666

UUC\* = Unit Under Calibration.

-000-

# SITHIPORN ASSOCIATES CO.,LTD. CALIBRATION LABORATORY

451-451/1 Sirinithorn Rd.,Bangbunru, Bangplud Bangkok 10700 THAILAND  
Tel:0-2435-8800 Fax:0-2433-1679 e-mail:cal-center@sithiporn.com http://www.sithiporn.com



Cert. No. : ACC22001  
Pages : 1 of 3

## Calibration Certificate

Equipment : SOUND CALIBRATOR  
Manufacturer : RION  
Model : NC-75  
Serial No. : 35002736  
ID No. : -

Condition As Found : GOOD

Customer : ALS LABORATORY GROUP (THAILAND) CO., LTD.  
104 PHATTHANAKAN 40, PHATTHANAKAN ROAD,  
KHWAENG PHATTHANAKAN, KHET SUAN LUANG,  
BANGKOK, 10250 THAILAND.

Location :  
Ambient Temperature : ( 23.0 ± 3 ) °C  
Pressure : ( 101.3 ± 3 ) kPa  
Relative Humidity : ( 50.0 ± 20 ) %

Received Date : 05 JANUARY 2022  
Calibration Date : 10 JANUARY 2022  
Date of Issue : 13 JANUARY 2022

REVIEW BY : *Nathakorn P.*  
APPROVED BY : *T. Petchurui*  
NEXT CAL DATE : 10/1/23

Calibrated by : Nathakorn Pisutpaisan

Approved by :

*T. Petchurui*  
( Thanakul Petchurui )

This certificate is issued in accordance with the requirements of ISO/IEC 17025 standard, may not be reproduced other than in full, except with the prior written approval of the head of Calibration Laboratory.

QF-TS12-04-04-020664

# SITHIPORN / SITHIPORN ASSOCIATES CO.,LTD. CALIBRATION LABORATORY

## Continuation of Calibration Certificate

Cert. No. : ACC22001  
Job No. : VC65AC0040  
Pages : 2 of 3

Calibration Procedure : CP-AC-03

### Calibration Method :

This equipment was calibrated by based on IEC-60942-2003 Standard.

The sound pressure level, frequency and total distortion of the sound calibrator was measured using the reference microphone.

### Condition of this result of calibration :

#### 1. Reference Standard Instruments :

Instrument	Model	Serial No.	Cert. No.	Due Date
Waveform Generator	33511B	MY52302742	EF-0011-21	10-Feb-22
Digital Multimeter	33461A	MY53220104	EEL.BP. 05/0264	10-Feb-22
Digital Multimeter	33461A	MY53220076	EEL.BP. 03/0264	08-Feb-22
Digital Multimeter	33461A	MY60024273	1-15180725251-1	15-Sep-22
Programmable Attenuator	MAT-1070	62100114	1500-07774E	08-Mar-22
Condenser Microphone	4180	2977900	AA-1008-21	05-Feb-22
Measuring Amplifier	NA-42KA1	34560495	AA-3003-21	16-Feb-22
Audio Analyzer	AVR-3360A	V744B6069	EF-0010-21	10-Feb-22

2. This result of calibration was found accurate as shown on date and place of calibration for this calibrated item only.

3. This certificate is traceable to the international system of unit maintained at :

3.1 National Institute of Metrology (Thailand).

3.2 Thailand Institute of Scientific and Technological Research (TISTR).

QF-TS12-04-04-020664

*T. Petchurui*

# SITHIPORN / SITHIPORN ASSOCIATES CO.,LTD. CALIBRATION LABORATORY

## Continuation of Calibration Certificate

Cert. No. : ACC22001  
Job No. : VC65AC0040  
Pages : 3 of 3

# SITHIPORN ASSOCIATES CO.,LTD. CALIBRATION LABORATORY

451-451/1 Sirinithorn Rd.,Bangbunru, Bangplud Bangkok 10700 THAILAND  
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Cert. No. : ACL22027  
Pages : 1 of 8

## Calibration Certificate

Equipment : SOUND LEVEL METER  
Manufacturer : RION  
Model : NL-42/ Microphone UC-52 / Preamplifier NH-24  
Serial No. : 00900072 / 188465 / 01734  
ID No. : RYG\_FS0493

Condition As Found : GOOD

Customer : ALS LABORATORY GROUP (THAILAND) CO., LTD.  
104 PHATTHANAKAN 40, PHATTHANAKAN ROAD,  
KHWAENG PHATTHANAKAN, KHET SUAN LUANG,  
BANGKOK, 10250 THAILAND.

Location :  
Ambient Temperature : ( 23.0 ± 3 ) °C  
Pressure : ( 101.3 ± 3 ) kPa  
Relative Humidity : ( 50.0 ± 20 ) %

Received Date : 05 JANUARY 2022  
Calibration Date : 10-12 JANUARY 2022  
Date of Issue : 13 JANUARY 2022

REVIEW BY : *Nathakorn P.*  
APPROVED BY : *T. Petchurui*  
NEXT CAL DATE : 10/1/23

Calibrated by : Nathakorn Pisutpaisan

Approved by :

*T. Petchurui*  
( Thanakul Petchurui )

This certificate is issued in accordance with the requirements of ISO/IEC 17025 standard, may not be reproduced other than in full, except with the prior written approval of the head of Calibration Laboratory.

QF-TS12-04-04-020664

### 1. Sound pressure level

Specified sound pressure level (dB)	Measured value (dB)	Deviated value (dB)	Uncertainty (dB)	Tolerance limit (dB)
94	93.99	-0.01	0.14	0.40

### 2. Frequency

Specified Frequency (Hz)	Measured value (Hz)	Deviated value (%)	Uncertainty (%)	Tolerance limit (%)
1000	1000.0	0.0	0.1	1.0

### 3. Total distortion

Measured value (%)	Uncertainty (%)	Tolerance limit (%)
0.28	0.10	3.0

The reported uncertainty is based on a standard uncertainty multiplied by coverage factor  $k = 2$  or any value following calculation, providing a level of confidence of approximately 95 %

End of Calibration Certificate

QF-TS12-04-04-020664

*T. Petchurui*



## Continuation of Calibration Certificate

Cert. No. : ACL22027  
Job No. : VC65AC0040  
Pages : 2 of 8

Calibration Procedure : CP-AC-01

## Calibration Method :

This equipment was calibrated by based on IEC-61672-3 (2013) Standard for sound level meter (SLM).

The SLM had tests to Acoustical and Electrical signal tests of frequency weighting with Anechoic chamber and Reference Standard Instruments.

For tests results of each items were made by observation of each Instruments display and also with SLM's display.

## Condition of this result of calibration :

## 1. Reference Standard Instruments :

Instrument	Model	Serial No.	Cert. No.	Due Date
Waveform Generator	33210A	MY48017076	EF-0012-21	10-Feb-22
Waveform Generator	33511B	MY52302742	EF-0011-21	10-Feb-22
Digital Multimeter	33461A	MY53220104	EEL.BP. 05/0264	10-Feb-22
Digital Multimeter	33461A	MY53220076	EEL.BP. 03/0264	08-Feb-22
Digital Multimeter	34461A	MY60024273	1-15180725251-1	15-Sep-22
Programmable Attenuator	MAT-1070	62100114	1500-07774E	08-Mar-22
Condenser Microphone	4180	2977900	AA-1008-21	05-Feb-22
Measuring Amplifier	NA-42KAI	34560495	AA-3003-21	16-Feb-22

2. This result of calibration was found accurate as shown on date and place of calibration for this calibrated item only.

3. This certificate is traceable to the international system of unit maintained at :

3.1 National Institute of Metrology (Thailand).

3.2 Thailand Institute of Scientific and Technological Research (TISTR).

QF-TS12-04-04-020664

T. Retch.

## Continuation of Calibration Certificate

Cert. No. : ACL22027  
Job No. : VC65AC0040  
Pages : 4 of 8

## Result of calibration :

## 1. Absolute sensitivity

Reference Acoustic Signal ( dB )	Measured Value ( dB )	Deviation ( dB )	Acceptance Limit ( dB )
93.9 (93,96)	93.9	0.0	±0.3

## 2. Self-generated noise

## 2.1 Normal test

Measured Value ( dB )
14.8

## 2.2 The microphone of the sound level meter was replaced by electrical signal input device.

Frequency Weighting	Measured value ( dB )
A - weight	9.9
C - weight	16.9
Flat	22.6

## 3. Acoustical signal tests of frequency weightings

Meter free-field acoustic response at a level of 84 dB

Frequency ( Hz )	Deviation from various frequency weighting response curve (dB)			
	Flat	C-weight	A-weight	Acceptance Limits
125	0.4	0.4	0.4	± 1.5
1000	0.0	0.0	0.0	± 1.0
8000	-1.2	-1.1	-1.1	±5.0

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T. Retch.

## Continuation of Calibration Certificate

Cert. No. : ACL22027  
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## Summary of Measurement Result :

Parameter	Pass	Fail	Uncertainty (dB)	Maximum-permitted uncertainty of measurement (dB)
1. Absolute sensitivity	✓	-	0.2	N/A
2. Self-generated noise	✓	-	0.2	N/A
3. Acoustical signal tests of frequency weightings				
125 Hz	✓	-	0.3	0.6
1000 Hz	✓	-	0.3	0.6
8000 Hz	✓	-	0.3	0.7
4. Electrical signal tests of frequency weightings				
For 10 Hz to 4 kHz	✓	-	0.3	0.6
For > 4 kHz to 10 kHz	✓	-	0.3	0.7
For > 10 kHz to 20 kHz	-	-	-	1.0
5. Frequency and time weightings at 1 kHz	✓	-	0.2	0.2
6. Long - term stability	✓	-	0.1	0.1
7. Level linearity on the reference level range	✓	-	0.2	0.3
8. Level linearity including the level range control	✓	-	0.2	0.3
9. Tone burst response	✓	-	0.2	0.3
10. Peak C sound level	✓	-	0.2	0.35
11. Overload indication	✓	-	0.2	0.25
12. High level stability	✓	-	0.1	0.1

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T. Retch.

## Continuation of Calibration Certificate

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## 4. Electrical signal tests of frequency weightings

Weighting network response with relative to 1 kHz.

Frequency ( Hz )	Deviation from various frequency weighting response curve (dB)			
	Flat	C-weight	A-weight	Acceptance Limits
63	-0.1	-0.1	-0.1	±2.0
125	0.0	0.0	-0.1	±1.5
250	0.0	0.0	-0.1	±1.5
500	0.0	0.0	-0.1	±1.5
1000	0.0	0.0	0.0	±1.0
2000	0.0	0.0	0.0	±2.0
4000	0.0	0.0	0.0	±3.0
8000	0.0	0.0	0.0	±5.0

## 5. Frequency and time weightings at 1 kHz

## 5.1 Frequency weightings at 1 kHz

Frequency Weighting	Measured Value ( dB )	Deviated Value ( dB )	Acceptance Limits ( dB )
A - weight	94.0	0.0	-
C - weight	94.0	0.0	± 0.2
Flat	94.0	0.0	± 0.2

## 5.2 Time weighting at 1 kHz

Frequency Weighting	Measured Value ( dB )	Deviated Value ( dB )	Acceptance Limits ( dB )
Fast	94.0	0.0	-
Slow	94.0	0.0	± 0.1
Lcq	94.0	0.0	± 0.1

## 6. Long - term stability

Frequency Weighting	SLM Display at initial ( dB )	SLM Display at final ( dB )	Deviated Value ( dB )	Acceptance Limits ( dB )
A - weight	94.0	94.0	0.0	± 0.3

QF-TS12-04-04-020664

T. Retch.

## Continuation of Calibration Certificate

Cert. No. : ACL22027  
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## 7. Level linearity on the reference level range

Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
137.0	137.0	0.0	± 1.1
136.0	136.0	0.0	± 1.1
135.0	135.1	0.1	± 1.1
134.0	134.1	0.1	± 1.1
133.0	133.0	0.0	± 1.1
132.0	132.0	0.0	± 1.1
131.0	131.0	0.0	± 1.1
129.0	129.0	0.0	± 1.1
124.0	124.0	0.0	± 1.1
119.0	119.1	0.1	± 1.1
114.0	114.0	0.0	± 1.1
109.0	109.0	0.0	± 1.1
104.0	104.1	0.1	± 1.1
99.0	99.0	0.0	± 1.1
94.0	94.0	0.0	± 1.1
89.0	89.0	0.0	± 1.1
84.0	84.0	0.0	± 1.1
79.0	79.0	0.0	± 1.1
74.0	74.0	0.0	± 1.1
69.0	69.0	0.0	± 1.1
64.0	64.0	0.0	± 1.1
59.0	59.0	0.0	± 1.1
54.0	54.0	0.0	± 1.1
49.0	49.0	0.0	± 1.1
44.0	44.0	0.0	± 1.1
39.0	39.0	0.0	± 1.1
34.0	34.0	0.0	± 1.1
30.0	30.0	0.0	± 1.1
29.0	29.0	0.0	± 1.1
28.0	28.0	0.0	± 1.1
27.0	27.0	0.0	± 1.1
26.0	26.1	0.1	± 1.1
25.0	25.1	0.1	± 1.1

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## Continuation of Calibration Certificate

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Job No. : VC65AC0040  
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## 8. Level linearity including the level range control

Range	Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Auto	94.0	94.0	0.0	±1.1

## 9. Tone burst response

Time Weighting	Tone burst duration, Tb (ms)	Cycle	Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Fast	0.25	1	108.0	107.9	-0.1	1.5 ; -5.0
	2	8	117.0	116.9	-0.1	1.0 ; -2.5
	200	800	134.0	134.0	0.0	±1.0
Slow	2	8	108.0	108.0	0.0	1.5 ; -5.0
	200	800	127.6	127.6	0.0	±1.0
SEL	0.25	1	99.0	98.8	-0.2	1.5 ; -5.0
	2	8	108.0	107.9	-0.1	1.0 ; -2.5
	200	800	128.0	128.0	0.0	±1.0

## 10. Peak C sound level

Number of cycle in test signal	Anticipated Value (dB)	Measured Value, Lepeak (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Continuous	133.0	133.0	0.0	-
One	136.4	136.0	-0.4	±3.0

Number of cycle in test signal	Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Continuous	133.0	133.0	0.0	-
Positive half cycle	135.4	135.1	-0.3	±2.0
Negative half cycle	135.4	135.1	-0.3	±2.0

QF-TS12-04-04-020664

## Continuation of Calibration Certificate

Cert. No. : ACL22027  
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## 11. Overload indication

Measured value (dB)		Deviated Value (dB)	Acceptance Limits (dB)
Positive one-half cycle	Negative one-half cycle		
89.6	89.6	0.0	±1.5

## 12. High level stability

Frequency Weighting	SLM Display at initial (dB)	SLM Display at final (dB)	Deviated Value (dB)	Acceptance Limits (dB)
A - weight	137.0	137.0	0.0	±0.3

The reported uncertainty is based on a standard uncertainty multiplied by coverage factor  $k = 2$  or any value following calculation, providing a level of confidence of approximately 95 %

End of Calibration Certificate



TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)  
CORPORATE SERVICES 3: EQUIPMENT CALIBRATION AND TESTING SERVICES  
538-1 PATTANAKARN ROAD SUB 18, SI AN LUANG, SI AN LUANG BANGKOK, 10250  
TEL. 0 2717-3000-27 FAX. 0 2719-9454

Cert.No.: 22CH405  
Page.: 1 of 3

## Certificate of Calibration

Equipment : pH Meter  
Manufacturer : Mettler Toledo  
Model : Seven Compact S220  
Serial No. : C104059460  
ID No. : RYG\_EN0183  
Condition As-Received : Used Item  
Received Date : 16 March 2022  
Calibration Date : 17 March 2022  
Reference : 2203-0611DSC-4  
Submitted by : ALS Laboratory Group (Thailand) Co.,Ltd.  
Rayong Branch  
616/10 Moo 5 T.Maenam Khu,  
A.Pluakdaeng, Rayong 21140, Thailand

Ambient Temperature : (25 ± 2.5) °C  
Relative Humidity : (50 ± 15) %  
Calibration Procedure : In - house method  
- CP-CH5 by direct measurement with standard voltage calibrator and direct measurement with certified reference material (CRM)  
- CP-CH8 by comparison with standard thermometer

Calibrated by : Warakorn Lernagatrakul

Approved by :   
Approved Signatory(✓) Malee Bulkruea  
( ) Sathip Meangmai  
( ) Warakorn Lernagatrakul

Issue Date : 22 March 2022

The Uncertainties are for a confidence probability of approximately 95%

This certificate may not be reproduced other than in full, except with the prior written  
Approval of the head of Corporate Services 3: Equipment Calibration and Testing Services

QF-TS12-04-04-020664

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Cert.No.: 22CH405  
Page.: 2 of 3

#### Condition of this calibration result

##### 1. Reference Standard Instrument :-

Instrument	Serial No.	ID No.	Cert. No.	Due Date
1) Document Process Calibrator	54030049	130RC116	21E2682	25 Aug 2022
2) Ref. Standard Thermometer	4982054	110RC044	21I1201	26 Oct 2022

This certification is traceable to the International System of Unit maintained at:-  
- Traceable to National Institute of Metrology (Thailand), NIMT

##### 2. Certified Reference Materials :- The measurement results are traceable to SI through CPA chem Ltd., ANSI-ASQ National Accreditation Board, Accredited No. AR-1835

Buffer Solution	Manufacturer	Lot No.	Exp. date
pH 4.008	CPA chem	786995	01 Jan 2024
pH 6.982	CPA chem	761017	02 Aug 2022
pH 10.015	CPA chem	766824	04 Sep 2022

3. This certificate is valid only to the item calibrated on date and place of calibration.

#### Calibration Results

##### Function : mV Measurement

##### Performing standard curve by Fluke at pH (4,7,10)

Unit Under Calibration	Nominal Value	Standard Voltage Input		Actual Reading		Uncertainty of Measurement ( $\pm$ mV)	Coverage factor k
	pH	mV	mV	mV	pH		
pH Meter S/N.: C104059460	4.000	177.48	177.4	4.000	0.058	2.00	
	7.000	0.00	-0.1	7.000	0.058	2.00	
	10.000	-177.48	-177.5	10.000	0.058	2.00	



Cert.No.: 22CH405  
Page.: 3 of 3

#### Calibration Results

##### Function : pH Measurement

##### Performing three buffers standard curve by using buffer nominal pH (4,7,10)

Unit Under Calibration	Standard pH Buffer Solution	Actual pH Reading	Actual mV Reading (mV)	Uncertainty of pH measurement ( $\pm$ )	Coverage factor k
pH Electrode S/N.: 1453404	4.008	4.010	177.7	0.0046	2.00
	6.982	6.988	3.6	0.0084	2.00
	10.015	10.010	-172.9	0.0073	2.05

#### Function : Temperature Measurement

##### (\*) Without adjustment

This equipment was connected with Temperature Probe;

- Model :	InLab Expert Pro-ISM
- Serial No. :	1453404
Dimension of probe;	
- Length :	120 mm.
- Diameter :	12 mm.
- Immersion Depth :	100 mm.

Calibration Point (°C)	Standard Temperature (°C)	UUC* Reading (°C)	Error (°C)	Uncertainty of measurement ( $\pm$ °C)	Coverage factor k
25.0	25.002	24.9	-0.102	0.13	2.00

Remark : - UUC\* = Unit Under Calibration

The reported uncertainty of measurement was based on a standard uncertainty multiplied by a coverage factor k, providing a level of confidence of approximately 95 %.

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TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)  
CORPORATE SERVICES 3: EQUIPMENT CALIBRATION AND TESTING SERVICES  
53/4 PATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG, BANGKOK 10250  
TEL. 0-2717-3000-24 FAX. 0-2719-9484



## Certificate of Calibration

Certificate No.: 22E986  
Page : 1 of 2

Equipment : pH Meter  
Manufacturer: Motter Toledo  
Model : SevenCompact S220  
Serial No.: C104059460  
ID No.: RYG\_EN0183

Condition As-Received: Used item  
Received Date: 16 March 2022  
Calibration Date: 21 March 2022

Reference: 2203-0611DSC  
Ambient Temperature: ( 23  $\pm$  2 ) °C  
Relative Humidity: ( 50  $\pm$  10 ) %  
Submitted by: ALS Laboratory Group (Thailand) Co., Ltd. Rayong Branch  
616/10 Moo 5 T.Maenam Khu, A.Pluakdaeng, Rayong  
21140, Thailand

Procedure used: Calibration were conducted using in-house calibration Procedure CP-E17 According to direct measurement method with Multi-Product Calibrator.

#### Condition of this result of calibration

##### 1. Reference standards instruments :-

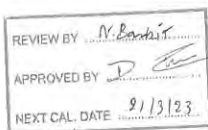
Instrument	Model	Serial No.	Certificate No.	Due Date
1) Multi-Product Calibrator	5500A	8440007	21E1444	07 May 2022

2 This result of calibration was made on requested at the point specified by customer.

3. The certificate is valid only to the item calibrated on date and place of calibration.

4. This Certification is traceable to the International System of Unit maintained at:-

- National Institute of Metrology Thailand (NIMT)



Calibrated by : Pongsagorn Boonyaporn  
Issue Date : 22 March 2022

Approved Signatory :  
[ ] Phalinee Prabpai  
[ ] Nuntawat Khamchai  
[ ] Ponthippa Tameyakul

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Cert. No.: 22E986  
Page.: 2 of 2

#### Result of calibration :- (\*) Without adjustment ( ) After adjustment

Function:	DC voltage measurement	Range:	2000 mV	
	Standard Value	UUC* Reading	Error	Uncertainty
	( mV )	( mV )	( mV )	( $\pm$ $\mu$ V )
	-200.0000	-200.0	0.0	72
	-150.0000	-150.0	0.0	69
	-100.0000	-100.0	0.0	65
	-50.0000	-50.0	0.0	62
	0.0000	0.0	0.0	58
	50.0000	50.0	0.0	62
	100.0000	100.0	0.0	65
	150.0000	150.0	0.0	69
	200.0000	200.0	0.0	72

The reported uncertainty of measurement was based on a standard uncertainty multiplied by a coverage factor k = 2, providing a level of confidence of approximately 95 %

\*UUC= Unit Under Calibration.

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## Metrological Center

SCI ECO Services Company Limited

33/2 Moo 3, T.Banpa, A.Kaengkhoh, Saraburi 18110, Thailand

Saraburi Tel : +66 3627 3096 Fax : +66 3627 3100

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Website : www.scieco.co.th E-Mail : calibrate@scg.co.th

RYG\_EN0184



## Metrological Center

SCI ECO Services Company Limited

33/2 Moo 3, T.Banpa, A.Kaengkhoh, Saraburi 18110, Thailand



Certificate No. T220384101 "Substitute for Calibration Certificate Number T220384" Page 1 of 4

### Certificate of Calibration

Equipment : Chamber ( Cold Room )

Manufacturer : MODULAR

Model : IREYCOHCOO

Serial No. : C00351459

Customer Code : RYG\_EN0184

ID No. : T1939A5

Customer : ALS Laboratory Group (Thailand) Co.,Ltd. ( Rayong Branch )

616/10 Moo 5 T.Maenam Khu,

A.Pluakdaeng, Rayong 21140

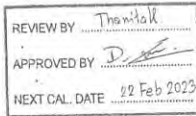
Customer Location : Laboratory

Date of Receipt : 18 February 2022

Calibrated By : Boonchai Suriyawong ( Site Calibration Manager )

Approved By : / Sujjar Naknakred (Site Calibration Manager)

Date of Issue : 18 MAR 2022



The uncertainties are for a confidence probability of approximately 95%.

This Certificate is issued in accordance with the conditions of accreditation granted by the Thai Laboratory Accreditation Scheme which has assessed the measurement capability of the laboratory and its traceability to recognized national standards and to the units of measurement realized at the corresponding national standard laboratory. This certificate may not be reproduced other than in full except with the prior written approval of the Metrological Center.

FM-L14 117-01-02-64

Certificate No. T220384101

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### Calibration Report

Equipment : Chamber ( Cold Room )

Date of Calibration : 22 February 2022

Environment : Temperature : 23.2-24.3 °C

Line Voltage : 221.8-227.2 V

Relative Humidity : 55 - 65 %RH

#### Condition of this results of calibration :

- This equipment was calibrated by insert 16 standard thermocouples type T into its chamber , the other one standard thermocouples type T use for ambient temperature measurement . The calibration was done in according to WI-T20 ( based on ASTM E145-94 ( Reapproved 2001 ) and AS2853-1986 ). All data show below were final values and the initial data from customer request . The temperature scale used was based on ITS - 90 .
- Reference Standard Instrument :
 

Instrument	Model	Instrument No.	Certificate No.	Due Date
TC	TYPE T	TN141-TN150	T210743	21 April 2022
TC	TYPE T	TN151-TN160	T210743	21 April 2022
DATA LOGGER	34970A	T150	T210743	21 April 2022
- This certificate is traceable to : National Institute of Metrology ( Thailand ) through Metrological Center ( NSC-TISI-TIS 17025 CALIBRATION 0244 )
- Condition of calibrated item : good

#### Equipment Description :

Time Constant : - Hour 40 Minute At 3 °C

Fresh Air Damper : ☐ Open ☐ Min ☐ Medium ☐ Max

☐ Close

☒ Not Available

- Adjustment : ( X ) without adjustment ( ) after adjustment

Approved By



## Metrological Center

SCI ECO Services Company Limited

33/2 Moo 3, T.Banpa, A.Kaengkhoh, Saraburi 18110, Thailand



## Metrological Center

SCI ECO Services Company Limited

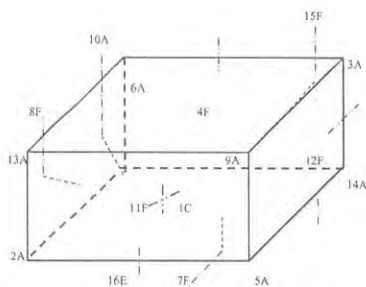
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Certificate No. T220384101

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### Calibration Report



C = Centre , F = Centre of Face , A = Corner , E = Centre of Edge

1C = TN141	12F = TN152
2A = TN142	13A = TN153
3A = TN143	14A = TN154
4F = TN144	15F = TN155
5A = TN145	16E = TN156
6A = TN146	
7F = TN147	
8F = TN148	
9A = TN149	
10A = TN150	
11F = TN151	

Approved By

FM-L15 117-15-05-63

Certificate No. T220384101

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### Calibration Report

#### Measurement Results

Calibration Point	Average Standard Reading at each position ( °C )									
	TN141	TN142	TN143	TN144	TN145	TN146	TN147	TN148	TN149	TN150
3.0	2.80	2.96	2.98	2.97	3.16	3.29	2.95	3.14	3.10	3.45
	TN151	TN152	TN153	TN154	TN155	TN156				
	3.04	3.19	3.03	3.34	3.21	3.11				

Chamber ( Cold Room )			Temperature Distribution				
Setting ( °C )	Reading ( °C )		Average ( °C )	Stability ( ± °C )	Uniformity ( °C )	Uncertainty ( ± °C )	Coverage Factor k
	Min , Max	Average					
3.0	2.7, 4.1	3.5	3.11	1.30	1.30	2.00	2.05

\* The Acuated uncertainty exclude "uniformity"

The calibration result apply only the above calibrated item.

The result of test was found accurate as shown on date and place of test only.

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k which for a t-distribution, providing a level of confidence of approximately 95 % .

Approved By

FM-L15 117-15-05-63

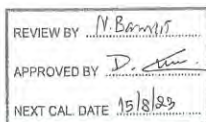




Cert.No.: 22TW34  
Page.: 1 of 2

## Certificate of Testing

Equipment : DO Meter  
Manufacturer : YSI  
Model : 5000-115V  
Serial No. : 15E102796  
ID No. : RYG\_EN0032  
Received Date : 11 February 2022  
Test Date : 14 February 2022  
Reference : 2202-0404DSC-4  
Submitted by : ALS Laboratory Group (Thailand) Co., Ltd.  
(Rayong Branch)  
616/10 Moo 5 T.Maenam Khu, A.Pluakdaeng,  
Rayong 21140, Thailand  
Laboratory Condition : Temperature (25 ± 5) °C  
Humidity (50 ± 20) %  
Test Procedure : In-house method : CP-CH9  
by Comparison Technique with Azide Modification Method  
Tested by : Walalak Sinthean  
Approved by :   
Approved Signatory  
( ) Malee Butkruea  
(✓) Sathip Meangmai  
( ) Warakorn Lernagatrakul  
Issue Date : 18 February 2022



Result : Dissolved Oxygen Meter Adjustment With Air 100 %  
Dissolved Oxygen Probe No.: 15E100464

Titration Method (Azide Modification Method)	DO Meter Reading (mg/L)	Standard Deviation (mg/L)
6.02	8.02	0.0084

This report was certified only for the instrument we tested. It is allowable to use for study the system efficiency. The environmental impact control and present to organization it may concerned intend to use for advertising and referral purpose is prohibited. This report may not be reproduced other in full without written approval of the laboratory

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B 0281285

Sathip

a 1094744



Cert. No.: 22LM12  
Page.: 1 of 2

## Certificate of Calibration

Equipment : DO Meter with Sensor  
Manufacturer : YSI  
Model : 5000-115V  
Serial No. : 15E102796  
ID No. : RYG\_EN0032  
Submitted by : ALS Laboratory Group (Thailand) Co., Ltd. (Rayong Branch)  
616/10 Moo 5 T.Maenam Khu, A.Pluakdaeng,  
Rayong 21140, Thailand  
Location : TPA On Site Calibration Laboratory  
Received Order : 11 February 2022  
Calibrated Date : 21 February 2022  
Ambient Temperature : (26 ± 10) °C  
Relative Humidity : (50 ± 30) %  
AC Line Voltage : (220 ± 22) V  
Calibrated by : Kunchit Promprat  
Approved by :   
Approved Signatory  
( ) Pornthipha Tameyakul  
(✓) Malee Butkruea  
( ) Suwit Imjai  
Issue Date : 21 February 2022



Equipment : DO Meter with Sensor  
Condition As-Received : Used Item  
Reference : 2202-0404DSC-5  
Procedure Used :-

Cert. No.: 22LM12  
Page.: 2 of 2

Calibration were conducted using in-house calibration procedure CP-OT01 according to comparison with Industrial Platinum Resistance Thermometer (IPRT) into Temperature Bath.

The temperature scale used was based on ITS-90.

### Condition of this result of calibration

1. Reference standard instrument:-

Instrument	Model	Serial No.	Cert. No.	Due Date
1) Digital Thermometer	1523	2188080	2111273	22 Nov 2022

2. This certificate is valid only to the item calibrated on date and place of calibration.  
3. This certification is traceable to the International System of Unit.

Result of Calibration :- ( ° ) Without Adjustment

Function : Temperature measurement.

This instrument was connected with temperature sensor, S/N.: 15E100464

Calibration Point ( °C )	Immersion Depth ( mm )	Standard Temperature ( °C )	UUC* Reading ( °C )	Error ( °C )	Uncertainty ( ± °C )	Coverage Factor k
20.00	45	20.001	19.88	-0.121	0.15	2.00

UUC\* : Unit Under Calibration

The reported uncertainty of measurement was based on a standard uncertainty multiplied by a coverage factor k, providing a level of confidence of approximately 95 %.

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The Uncertainties are for a confidence probability of approximately 95 %

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A 0038008

a 1095714



## Certificate of Calibration

Cert. No.: 22TM317  
Page.: 1 of 3

Equipment : Low Temp. Incubator  
Manufacturer : Memmert  
Model : IPP750  
Serial No. : V618.0084  
ID No. : RYG\_EN0154  
Submitted by : ALS Laboratory Group (Thailand) Co., Ltd.  
(Rayong Branch)  
616/10 Moo 5 T. Maenam Khu,  
A. Pluakdaeng, Rayong 21140, Thailand  
Location : BOD Room  
Received Order : 22 April 2022  
Calibration Date : 22 April 2022  
Ambient Temperature :  $(26 \pm 10) ^\circ\text{C}$   
Relative Humidity :  $(50 \pm 30) \%$   
Calibrated by : Man Pattanapongpaiboon

REVIEW BY *N. Samsat*  
APPROVED BY *D. S.*  
NEXT CAL DATE *23/10/23*

Approved by : *Malee*  
Approved Signatory  
( ) Pornthippa Tamayakul  
( ) Malee Butkruea  
( ) Suwit Imjai

Issue Date : 3 May 2022

The Uncertainties are for a confidence probability of approximately 95%

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Approval of the Head of Corporate Services 3: Equipment Calibration and Testing Services

A 0040735



Equipment : Low Temp. Incubator  
Condition As-Received : Used Item  
Reference : 2204-0146OC-1  
Procedure Used :-

Cert. No.: 22TM317  
Page.: 2 of 3

Calibration were conducted using calibration procedure CP-OT02 according to direct measurement  
The temperature scale used was based on ITS-90.

### Condition of this result of calibration

#### 1. Reference standard instrument:-

Instrument	Model	Serial No.	Cert. No.	Due Date
1.) Data Acquisition	34970A	MY44031769	21LM12	02 Sep 2022

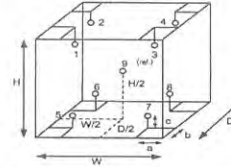
2. This certificate is valid only to the item calibrated on date and place of calibration.

3. This certification is traceable to the International System of Unit.

Result of Calibration :- ( ) Without Adjustment

Function of UUC\* : Temperature Source

Fresh air setting : Close



#### Probe Installation Details :

a = 10 cm  
b = 10 cm  
c = 10 cm

#### Dimension of Chamber :

D = 0.60 m  
W = 1.0 m  
H = 1.2 m  
Capacity = 0.75 m<sup>3</sup>

Environment during calibration		
	Beginning	Finished
Temp. ( °C )	25	25
REL.Humid. ( % )	54	58
AC Supply ( Volt )	221	223

Position :	Ref. Std. ID No.:
1	9RTD-2/1
2	9RTD-2/2
3	9RTD-2/3
4	9RTD-2/4
5	9RTD-2/5
6	9RTD-2/6
7	9RTD-2/7
8	9RTD-2/8
9 (ref.)	9RTD-2/9

*Malee*

a 1106485

RYG\_EN0002



PENTA  
CALIBRATION

PENTA CALIBRATION CO., LTD.  
66/124 The Connect 33 Village Kanchanaphisek Road  
Dokmai Prawat Bangkok 10250  
Tel: +66 (0) 2069-9773  
www.pentacal.com

## Certificate of Calibration

Represent to Certificate of Calibration PTC/07/22103

Certificate No.	PTC/07/22103	Page:	1 of 2
Equipment:	Digital Balance	Condition:	Normal
Manufacturer:	Sartorius	Serial No.:	26207038
Model:	MSE224S-100-DU	ID No.:	RYG_EN0002
Type of Balance	Single interval		

Customer: ALS Laboratory Group (Thailand) Co., Ltd.  
616/10 Moo 5 T. Maenamkoo, A. Pluakdaeng,  
Rayong 21140, Thailand

Environment Condition:	Temperature	23.9 °C	± 0.3 °C
	Humidity	58.1 %RH	± 4.4 %RH
	Air density	1.17	kg/m <sup>3</sup>

Calibration Place: ALS Laboratory Group (Thailand) Co., Ltd.  
616/10 Moo 5 T. Maenamkoo, A. Pluakdaeng,  
Rayong 21140, Thailand

The Method used: in house method, PTC-WI-07, base on Euramet cg. 18

Traceability: This certificate is traceable to the SI Units through Thai Calibration Service Co. Ltd.  
NSC-ONSC Accreditation No. Calibration 0189

Date Received: March 23, 2022

Calibration Date: March 23, 2022

Issued Date: March 25, 2022

Calibration By: Mr Rungroje Metakul

REVIEW BY *D. S.*  
APPROVED BY *D. S.*  
NEXT CAL DATE *23/10/23*



Approved By: *M. Keatissak Kerdta*  
Laboratory Manager

This certificate is issued the unit of measurement according to the International System of Units (SI). It provides traceability of measurement to international or national standard or other recognized national standard laboratories.

The measurement uncertainty stated is the expanded uncertainty which is obtained from the standard uncertainty multiplied by the coverage factor (k=2) to provide a level of confidence of approximately 95%. It is determined in accordance with the Guide to Expression of Uncertainty in Measurement (GUM). The effect that the results relate only to the item calibrated.

This calibration certificate shall not be reproduced except in full, without written approval from Penta Calibration Co., Ltd.



Equipment : Low Temp. Incubator  
Condition As-Received : Used Item  
Reference : 2204-0146OC-1  
Result of Calibration :- ( ) Without Adjustment  
Function of UUC\* : Temperature Source  
Fresh air setting : Close

Cert. No.: 22TM317  
Page.: 3 of 3

Calibration Point (°C)	UUC* Setting (°C)	UUC* Reading (°C)	Temperature stability (± °C)	Temperature uniformity (°C)	Overall Variation (°C)	Uncertainty (± °C)	Coverage Factor k
20.0	20.0	20.0	0.022	0.20	0.22	0.30	2

Calibration Point (°C)	Measured Temperature (°C)								
	Position								
20.0	1	2	3	4	5	6	7	8	9 (ref.)
	20.209	20.174	20.199	20.110	20.075	20.062	20.027	20.069	20.030

Average\* : The average of 30 values in each position.

Temperature stability : One-half of the greatest maximum difference of measured temperature at any one sensor.

Temperature uniformity : The maximum difference of measured temperatures at any sensors and the measured temperature at the reference location, which are observed at the same time or at as close an observation time as possible to determine the temperature pattern or homogeneity within the chamber under steady-state conditions.

Overall Variation : The Difference of the maximum and minimum measured temperatures throughout observation.

UUC\* : Unit Under Calibration

Note : The reported uncertainty of measurement was included stability and excluded uniformity.

The reported uncertainty of measurement was based on a standard uncertainty multiplied by a coverage factor k, providing a level of confidence of approximately 95 %.

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*Malee*

a 1106484





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56/124 The Connect 33 Village Kanchanaphisak Road  
Dokmai Praveit Bangkok 10250  
Tel: +66 (0) 2069-9773  
www.pentalcal.com

Represent to Certificate of Calibration ,PTC/07/22103

Certificate No. PTC/07/22103

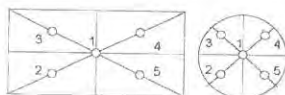
Page: 2 of 2

## Measurement Results:

Without Adjustment

Function Calibration: Non Adjustment

Eccentric Error: Weight to be 1/3, 1/2 or of Maximum capacity



Eccentricity test 100 (g)				
Position (g)				
1	2	3	4	5
0.0000	0.0000	-0.0002	0.0002	0.0002
Maximum deviation: 0.0002				

Repeatability Test : Weight to be  $1/2 \leq L_1 \leq$  Maximum capacity

Determination of the standard deviation of weighing balance, Readability 0.0001 (g)

Nominal test value (g)	Standard Deviation
200	0.00003

Error of indication : from nominal value, Readability 0.0001 (g)

Nominal Value (g)	Conventional Mass (g)	Indication (g)	Correction of Balance (g)	Uncertainty (g)	k
0	0.00000	0.0000	0.0000	0.000085	2.16
0.01	0.01000	0.0100	0.0000	0.00010	2.06
0.1	0.10000	0.1000	0.0000	0.00010	2.06
1	1.00000	1.0000	0.0000	0.00010	2.06
2	2.00000	1.9999	0.0001	0.00010	2.06
5	5.00001	5.0000	0.0000	0.00010	2.06
10	10.00000	10.0000	0.0000	0.00010	2.06
20	20.00003	19.9999	0.0001	0.00011	2.06
50	50.00004	49.9999	0.0001	0.00012	2.00
100	100.00004	100.0001	0.0001	0.00017	2.00
200	200.00011	200.0000	0.0001	0.00027	2.00

Note: Weight of adjust (g)

The End of Certificate



**TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)**  
CORPORATE SERVICES & EQUIPMENT CALIBRATION AND TESTING SERVICES  
334/4 PATTANAKARN ROAD SOE 18, SUANLUANG, SUANLUANG RANGKOK 10250  
TEL: 0-2717-3003-27 FAX: 0-2719-9484



Cert. No.: 21TM827  
Page: 1 of 3

## Certificate of Calibration

Equipment : Hot Air Oven

Manufacturer : Memmert

Model : UFE 500

Serial No. : G511.1572

ID No. : RYG\_EN0010

Submitted by : ALS Laboratory Group (Thailand) Co.,Ltd. (Rayong Branch)  
616/10 Moo 5 T. Maenam Khu.  
A. Pluakdaeng,  
Rayong 21140 Thailand

Location : Oven Room

Received Order : 5 May 2021

Calibration Date : 5 May 2021

Ambient Temperature : (26 ± 10) °C

Relative Humidity : (50 ± 30) %

Calibrated by : Khit Ruttanaprapachai

Approved by :   
Approved Signatory

( ) Ponthippa Tameyakul  
(/ ) Malee Butkruea  
( ) Suwit Imjai

Issue Date : 14 May 2021

The Uncertainties are for a confidence probability of approximately 95%

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A 0028099



Equipment : Hot Air Oven  
Condition As-Received : Used Item  
Reference : 2105-0005OC-4

Cert. No.: 21TM827  
Page: 2 of 3

### Procedure Used :-

Calibration were conducted using calibration procedure CP-OT02 according to direct measurement method with Data Acquisition which connected with Resistance Temperature Detector (RTD) and Thermocouple Type T

The temperature scale used was based on ITS-90.

### Condition of this result of calibration

1. Reference standard instrument:-

Instrument Model Serial No. Cert. No. Due Date  
1) Data Acquisition 34972A MY57013823 21LM3 26 Feb 2022

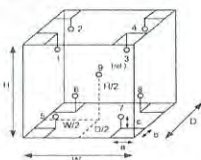
2. This certificate is valid only to the item calibrated on date and place of calibration.

3. This certification is traceable to the International System of Unit.

Result of Calibration :- (\*) Without Adjustment

Function of UUC\* : Temperature Source

Fresh air setting : Close



Probe Installation Details : Dimension of Chamber :  
a = 5.0 cm D = 0.40 m  
b = 5.0 cm W = 0.56 m  
c = 5.0 cm H = 0.48 m  
Capacity = 0.11 m³

Environment during calibration		
	Beginning	Finished
Temp. (°C)	28	29
REL.Humid. (%)	59	56
AC Supply (Volt)	220	221

Ref. Std. ID No.: @ Calibration Point		
Position :	(104) °C	(180) °C
1	21-17RTD-01	19-17TC-01
2	21-17RTD-02	19-17TC-02
3	17RTD-03	19-17TC-03
4	17RTD-04	19-17TC-04
5	17RTD-05	19-17TC-05
6	17RTD-06	19-17TC-06
7	17RTD-07	19-17TC-07
8	17RTD-08	19-17TC-08
9 (ref.)	17RTD-09	19-17TC-09



Equipment : Hot Air Oven  
Condition As-Received : Used Item  
Reference : 2105-0005OC-4  
Result of Calibration :- (\*) Without Adjustment  
Function of UUC\* : Temperature Source

Cert. No.: 21TM827  
Page: 3 of 3

Calibration Point (°C)	UUC* Setting (°C)	UUC* Reading (°C)	Temperature stability (± °C)	Temperature uniformity (°C)	Overall Variation (°C)	Uncertainty (± °C)	Coverage Factor k
104.0	104.0	104.0	0.063	0.54	0.70	0.42	2
180.0	180.0	180.0	0.15	0.89	1.3	1.1	2

Calibration Point (°C)	Measured Temperature (°C)								
	1	2	3	4	5	6	7	8	9 (ref.)
104.0	104.243	103.732	103.760	103.742	103.863	103.743	104.311	103.689	103.815
180.0	180.101	180.481	179.401	179.692	179.980	179.943	180.127	179.915	179.709

Average\* : The average of 30 values in each position.

Temperature stability : One-half of the greatest maximum difference of measured temperature at any one sensor.

Temperature uniformity : The maximum difference of measured temperatures at any sensors and the measured temperature at the reference location which are observed at the same time or at as close an observation time as possible to determine the temperature pattern or homogeneity within the chamber under steady-state conditions.

Overall Variation : The Difference of the maximum and minimum measured temperatures throughout observation.

UUC\* : Unit Under Calibration

Note : The reported uncertainty of measurement was included stability and excluded uniformity.

The reported uncertainty of measurement was based on a standard uncertainty multiplied by a coverage factor k, providing a level of confidence of approximately 95 %.

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TEL. 0-2717-3000-27 FAX 0-2719-9484



Cert. No.: 22TM1517  
Page : 1 of 3

## Certificate of Calibration

Equipment : Hot Air Oven  
Manufacturer : Memmert  
Model : UFE 500  
Serial No. : G511.1572  
ID No. : RYG\_EN0010  
Submitted by : ALS Laboratory Group (Thailand) Co.,Ltd. (Rayong Branch)  
616/10 Moo 5 T. Maenam Khu,  
A. Pluakdaeng,  
Rayong 21140 Thailand  
Location : Oven Room  
Received Order : 20 October 2022  
Calibration Date : 20 October 2022  
Ambient Temperature :  $(26 \pm 10) ^\circ\text{C}$   
Relative Humidity :  $(50 \pm 30) \%$   
Calibrated by : Man Pattanapongpaiboon

REVIEW BY *Thavitak*  
APPROVED BY *P. Butkruea*  
NEXT CAL. DATE *30/04/24*

Approved by : *M. Imjai*  
Approved Signatory

( ) Pornthippa Tameyakul  
(x) Malee Butkruea  
( ) Suwit Imjai

Issue Date : 2 November 2022

The Uncertainties are for a confidence probability of approximately 95%

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Approval of the head of Corporate Services & Equipment Calibration and Testing Services

A 0046908



Equipment : Hot Air Oven  
Condition As-Received : Used Item  
Reference : 2210-03760C-2  
Procedure Used :-

Cert. No.: 22TM1517  
Page : 2 of 3

Calibration were conducted using calibration procedure CP-OT02 according to direct measurement method with Data Acquisition which connected with Resistance Temperature Detector (RTD) and Thermocouple Type T.

The temperature scale used was based on ITS-90.

### Condition of this result of calibration

1. Reference standard instrument:-

Instrument	Model	Serial No.	Cert. No.	Due Date
1) Data Acquisition	34972A	MY49023932	22LM97	29 Jul 2023

2. This certificate is valid only to the item calibrated on date and place of calibration.

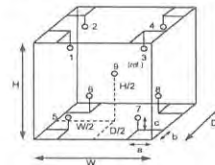
3. This certification is traceable to the International System of Unit.

Result of Calibration :- ( \* ) Without Adjustment

Function of UUC\* : Temperature Source

Fresh air setting : Close

Environment during calibration		
	Beginning	Finished
Temp. ( °C )	25	25
REL.Humid. ( % )	54	59
AC Supply ( Volt )	223	225



Probe Installation Details : Dimension of Chamber :  
a = 5.0 cm D = 0.40 m  
b = 5.0 cm W = 0.56 m  
c = 5.0 cm H = 0.48 m  
Capacity = 0.11 m<sup>3</sup>

Ref. Std. ID No.: @ Calibration Point		
Position :	( 180 ) °C	( 104 ) °C
1	21-16TC-01	20-16RTD-01
2	21-16TC-02	20-16RTD-02
3	21-16TC-03	20-16RTD-03
4	21-16TC-04	20-16RTD-04
5	21-16TC-05	22-16RTD-05
6	21-16TC-06	20-16RTD-06
7	21-16TC-07	20-16RTD-07
8	21-16TC-08	22-16RTD-08
9 (ref.)	21-16TC-09	22-16RTD-09

*M. Imjai*

a 1132466

RYG\_EN0029



Equipment : Hot Air Oven  
Condition As-Received : Used Item  
Reference : 2210-03760C-2  
Result of Calibration :- ( \* ) Without Adjustment  
Function of UUC\* : Temperature Source  
Fresh air setting : Close

Cert. No.: 22TM1517  
Page : 3 of 3

Calibration Point ( °C )	UUC* Setting ( °C )	UUC* Reading ( °C )	Temperature stability ( ± °C )	Temperature uniformity ( °C )	Overall Variation ( °C )	Uncertainty ( ± °C )	Coverage Factor k
104.0	104.0	104.0	0.076	0.52	0.60	0.42	2
180.0	180.0	180.0	0.13	0.88	1.2	1.1	2

Calibration Point ( °C )	Measured Temperature ( °C )							
	Position							
	1	2	3	4	5	6	7	8
104.0	103.768	103.734	103.723	103.800	104.215	104.131	104.132	103.740
180.0	179.723	179.359	179.439	179.489	180.361	180.114	180.131	180.243

Average\* : The average of 30 values in each position.

Temperature stability : One-half of the greatest maximum difference of measured temperature at any one sensor

Temperature uniformity : The maximum difference of measured temperatures at any sensors and the measured temperature at the reference location which are observed at the same time or at as close an observation time as possible to determine the temperature pattern or homogeneity within the chamber under steady-state conditions.

Overall Variation : The Difference of the maximum and minimum measured temperatures throughout observation

UUC\* : Unit Under Calibration

Note : The reported uncertainty of measurement was included stability and excluded uniformity

The reported uncertainty of measurement was based on a standard uncertainty multiplied by a coverage factor k, providing a level of confidence of approximately 95 %.

-000-

*M. Imjai*

a 1132465



TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)  
CORPORATE SERVICES & EQUIPMENT CALIBRATION AND TESTING SERVICES  
534/4 PATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG BANGKOK 10250  
TEL. 0-2717-3000-27 FAX 0-2719-9484



Cert.No.: 22CH283  
Page: 1 of 2

## Certificate of Calibration

Equipment : Conductivity Meter  
Manufacturer : Mettler Toledo  
Model : S230  
Serial No. : B241407147  
ID No. : RYG\_EN0029  
Condition As-Received : Used Item  
Received Date : 22 February 2022  
Calibration Date : 23 February 2022  
Reference : 2202-0732DSC-1  
Submitted by : ALS Laboratory Group (Thailand) Co.,Ltd. (Rayong Branch)  
616/10 Moo 5 T. Maenam Khu, A. Pluakdaeng,  
Rayong 21140, Thailand  
Ambient Temperature :  $(25 \pm 2.5) ^\circ\text{C}$   
Relative Humidity :  $(50 \pm 15) \%$   
Calibration Procedure : In-house method :  
- CP-CH6 : based on direct measurement by using certified reference material (CRM)  
Calibrated by : Walalak Sinithean  
Approved by : *M. Imjai*  
Approved Signatory  
( / ) Malee Butkruea  
( / ) Saitip Meangmai  
( / ) Warakorn Lengagrakul  
Issue Date : 25 February 2022

REVIEW BY *Thavitak*  
APPROVED BY *P. Butkruea*  
NEXT CAL. DATE *30/04/24*

The Uncertainties are for a confidence probability of approximately 95%

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Approval of the head of Corporate Services & Equipment Calibration and Testing Services

A 0038145





Cert.No.: 22CH283

Page.: 2 of 2

**Condition of this result of calibration**

## 1. Reference Standard Instrument :-

Instrument	Serial No.	ID No.	Certificate No.	Due date
1) Thermometer	9549224	130RC003	211451	15 Apr 2022

This certification is traceable to the International System of Unit maintained at:-  
- Traceable to National Institute of Metrology (Thailand), NIMT

## 2. Certified Reference Materials :-

- Conductivity calibration solution, CPA chem Ltd., The measurement results are traceable to SI through CPA chem Ltd., ANSI-ASQ National Accreditation Board, Accredited No. AR-1835

Conductivity Solution	Manufacturer	Lot No.	Exp. date
84.000 $\mu\text{S/cm}$	CPA Chem	754034	26 June 2022
1413.0 $\mu\text{S/cm}$	CPA Chem	766815	04 Sep 2022
12.880 $\text{mS/cm}$	CPA Chem	761022	02 Aug 2022

- Control Conductivity calibration solution temperature by Water bath (25 $\pm$ 0.1)  $^{\circ}\text{C}$   
3. This certificate is valid only to the item calibrated on date and place of calibration.

**Calibration results****Function : Conductivity Measurement**(\*) After Adjustment at 1413.0  $\mu\text{S/cm}$ 

Conductivity Electrode Serial No.: 5821441030

Standard Conductivity Solution	Before Adjustment UUC* Reading	After Adjustment UUC* Reading	Uncertainty of Measurement ( $\pm$ )	Coverage factor k
84.000 $\mu\text{S/cm}$	82.4 $\mu\text{S/cm}$	84.4 $\mu\text{S/cm}$	0.62 $\mu\text{S/cm}$	2.00
1413.0 $\mu\text{S/cm}$	1375 $\mu\text{S/cm}$	1413 $\mu\text{S/cm}$	9.2 $\mu\text{S/cm}$	2.00
12.880 $\text{mS/cm}$	12.54 $\text{mS/cm}$	12.81 $\text{mS/cm}$	0.086 $\text{mS/cm}$	2.00

**Remark** - UUC\* = Unit Under Calibration  
- Cell constant = 0.555236  $\text{cm}^{-1}$

The reported uncertainty of measurement was based on a standard uncertainty multiplied by a coverage factor  $k$ , providing a level of confidence of approximately 95 %.

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TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)  
CORPORATE SERVICES & EQUIPMENT CALIBRATION AND TESTING SERVICES  
3343 PATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG BANGKOK 10250  
TEL. 0-2717-5000-27 FAX. 0-2715-9484



Cert.No.: 22CH377  
Page.: 1 of 2

**Certificate of Calibration**

Equipment :	pH Meter
Manufacturer :	Mettler Toledo
Model :	Seven2Go
Serial No. :	B531256371
ID No. :	RYG_FS0420
Condition As-Received:	Used Item
Received Date :	11 March 2022
Calibration Date :	14 March 2022
Reference :	2203-0495DSC-1
Submitted by :	ALS Laboratory Group (Thailand) Co., Ltd Rayong Branch 616/10 Moo 5 T. Maenam Khu, A. Pluakdaeng, Rayong 21140, Thailand

Ambient Temperature : (25  $\pm$  2.5)  $^{\circ}\text{C}$   
Relative Humidity : (50  $\pm$  15) %  
Calibration Procedure : In-house method  
- CP-CH5 by direct measurement with standard voltage calibrator and direct measurement with certified reference material (CRM)

Calibrated by : Warakorn Lernagatrakul

Approved by :   
Approved Signatory

(✓) Maloe Bulkrusa  
( ) Sathip Moangmai  
( ) Warakorn Lernagatrakul  
Issue Date : 17 March 2022

The Uncertainties are for a confidence probability of approximately 95%

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Approval of the Head of Corporate Services & Equipment Calibration and Testing Services

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Cert. No.: 22CH377  
Page.: 2 of 2

**Condition of this calibration result**

## 1. Reference Standard Instrument :-

Instrument	Serial No.	ID No.	Cert. No.	Due Date
1) Document Process Calibrator	54030049	130RC116	21E2682	25 Aug 2022

This certification is traceable to the International System of Unit maintained at:-  
- Traceable to National Institute of Metrology (Thailand), NIMT

2. Certified Reference Materials The measurement results are traceable to SI through CPA chem Ltd., ANSI-ASQ National Accreditation Board, Accredited No. AR-1835

Buffer Solution	Manufacturer	Lot No.	Exp. date
pH 4.008	CPA chem	766820	23 Sep 2023
pH 6.983	CPA chem	766822	04 Sep 2022
pH 10.015	CPA chem	766824	04 Sep 2022

3. This certificate is valid only to the item calibrated on date and place of calibration.

**Calibration Results****Function : mV Measurement**

Performing standard curve by Fluke at pH (4,7,10)

Unit Under Calibration	Nominal Value	Standard Voltage Input	Actual Reading		Uncertainty of Measurement ( $\pm$ mV)	Coverage factor k
			mV	pH		
pH Meter S/N: B531256371	4.00	177.48	177	4.00	0.58	2.00
	7.00	0.00	0	7.00	0.58	2.00
	10.00	-177.48	-178	10.00	0.58	2.00

**Function : pH Measurement**

Performing three buffers standard curve by using buffer nominal pH (4,7,10)

Unit Under Calibration	Standard pH Buffer Solution	Actual pH Reading	Actual mV Reading (mV)	Uncertainty of pH measurement ( $\pm$ )	Coverage factor k
pH Electrode S/N: 1311407	4.008	4.01	181	0.0079	2.00
	6.983	6.98	7	0.0063	2.00
	10.015	10.01	-171	0.0092	2.00

The reported uncertainty of measurement was based on a standard uncertainty multiplied by a coverage factor  $k$ , providing a level of confidence of approximately 95 %

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Cert. No.: 22LM41  
Page.: 1 of 2

**Certificate of Calibration**

Equipment :	pH Meter with Sensor
Manufacturer :	Mettler Toledo
Model :	Seven2Go
Serial No. :	B531256371
ID No. :	RYG_FS0420
Submitted by :	ALS Laboratory Group (Thailand) Co., Ltd (Rayong Branch) 616/10 Moo 5 T. Maenam Khu, A. Pluakdaeng, Rayong 21140 Thailand
Location :	TPA On Site Calibration Laboratory

Received Order : 11 March 2022  
Calibrated Date : 15 March 2022  
Ambient Temperature : (26  $\pm$  10)  $^{\circ}\text{C}$   
Relative Humidity : (50  $\pm$  30) %  
AC Line Voltage : (220  $\pm$  22) V

Calibrated by : Maloe Bulkrusa

Approved by :   
Approved Signatory

( ) Pemthippa Tamoyakul  
(✓) Suwit Injai

Issue Date : 17 March 2022

The Uncertainties are for a confidence probability of approximately 95%

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Approval of the Head of Corporate Services & Equipment Calibration and Testing Services

A 0039307



Equipment : pH Meter with Sensor

Cert. No.: 22LM41

Condition As-Received : Used Item

Page.: 2 of 2

Reference : 2203-0495DSC-2

Procedure Used :-

Calibration were conducted using in-house calibration procedure CP-OT01 according to comparison with Industrial Platinum Resistance Thermometer ( IPRT ) into Temperature Bath.

The temperature scale used was based on ITS-90.

Condition of this result of calibration

1. Reference standard instrument:-

Instrument	Model	Serial No.	Cert. No.	Due Date
1) Digital Thermometer	1523	2188090	2111273	22 Nov 2022

2. This certificate is valid only to the item calibrated on date and place of calibration

3. This certification is traceable to the International System of Unit.

Result of Calibration :- ( \* ) Without Adjustment

Function : Temperature measurement.

This instrument was connected with temperature sensor, S/N.: 1311407

Calibration Point ( °C )	Immersion Depth ( mm )	Standard Temperature ( °C )	UUC* Reading ( °C )	Error ( °C )	Uncertainty ( ± °C )	Coverage Factor k
25.0	100	25.009	25.4	0.391	0.16	2.00
30.0	100	30.008	30.5	0.492	0.16	2.00
40.0	100	39.997	40.6	0.603	0.16	2.00
50.0	100	49.997	50.6	0.603	0.16	2.00

UUC\* : Unit Under Calibration

The reported uncertainty of measurement was based on a standard uncertainty multiplied by a coverage factor  $k$ , providing a level of confidence of approximately 95 %.

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*Signature*

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