

## ภาคผนวก ง

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ใบรับรองเอกสารการสอบเทียบเครื่องมือตรวจวิเคราะห์



รายการเครื่องมือที่ใช้ในการวิเคราะห์ / ทดสอบ

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Sample Name	Parameter	Equipment Name	ID No.	Calibrated Date	Next Cal	Freq. Calibrate (Months)
Ambient	Particulate Matter (PM10)	high Volume	RYG-F5069-B			On-site Calibration
Ambient	Particulate Matter (PM10)	high Volume	RYG-F50205			On-site Calibration
Ambient	Particulate Matter (PM10)	high Volume	RYG-F50192			On-site Calibration
Ambient	Particulate Matter (PM10)	high Volume	RYG-F50184	22-Feb-24	22-Feb-25	On-site Calibration
Ambient	Particulate Matter (PM10)	high Volume	RYG-F50001			12
Ambient	Total Suspended Particulate	high Volume	RYG-F50292			On-site Calibration
Ambient	Total Suspended Particulate	high Volume	RYG-F5064			On-site Calibration
Ambient	Total Suspended Particulate	high Volume	R.G.F50662			On-site Calibration
Ambient	Total Suspended Particulate	high Volume	RYG-F50182			On-site Calibration
Ambient	Total Suspended Particulate	Digital Balance	RYG-F50001	22-Feb-24	22-Feb-25	12
Ambient	Sulfur Dioxide	DO Analyzer	RYG-F50034	5-Jul-24	5-Jan-25	6
Ambient	Sulfur Dioxide	DO Analyzer	RYG-F50462	5-Jul-24	5-Jan-25	6
Ambient	Sulfur Dioxide	DO Analyzer	RYG-F50454	5-Jul-24	5-Jan-25	6
Ambient	Sulfur Dioxide	DO Analyzer	RYG-F50458	5-Jul-24	5-Jan-25	6
Ambient	Nitrogen Dioxide	NO <sub>2</sub> Analyzer	RYG-F50261	2-Jul-24	2-Jan-25	6
Ambient	Nitrogen Dioxide	NO <sub>2</sub> Analyzer	RYG-F50463	3-Jul-24	3-Jan-25	6
Ambient	Nitrogen Dioxide	NO <sub>2</sub> Analyzer	R.G.F50455	3-Jul-24	3-Jan-25	6
Ambient	Nitrogen Dioxide	NO <sub>2</sub> Analyzer	RYG-F50459	3-Jul-24	3-Jan-25	6
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG-F50045	21-Aug-23	21-Jan-25	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG-F50029	18-Aug-23	18-Feb-25	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG-F50609	18-Jul-24	18-Jan-26	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG-F50328	18-Aug-23	18-Feb-25	18
Stack	Total Suspended Particulate	Console Control Unit	RYG-F50315	10-Jul-24	10-Jan-25	6
Stack	Total Suspended Particulate	Console Control Unit	R.F50036	10-Jul-24	10-Jan-25	6
Stack	Total Suspended Particulate	Console Control Unit	R.F50029	10-Jul-24	10-Jan-25	6
Stack	Total Suspended Particulate	Pilot Tube	RYG-F50321	10-Jul-24	10-Jan-25	6
Stack	Total Suspended Particulate	Pilot Tube	BKH-F50561	10-Jul-24	10-Jan-25	6
Stack	Total Suspended Particulate	Pilot Tube	BKH-F50551	5-Jul-24	3-Jan-25	6
Stack	Total Suspended Particulate	Hue gas Analyzer	R.G.F50711	18-Jul-24	18-Jul-25	12
Stack	Total Suspended Particulate	Digital Balance	RYG-F50001	22-Feb-24	22-Feb-25	12
Stack-CEMU	Carbon Monoxide	Analyzer - System Calibration, Standard Gas				
Stack-CEMU	Oxides of Nitrogen	Analyzer - System Calibration, Standard Gas				
Stack-CEMU	Sulfur Dioxide	Analyzer - System Calibration, Standard Gas				
Stack-CEMU	Chlorine	Analyzer - System Calibration, Standard Gas				
Noise	Leq 24 hrs	Sound Calibrator	RYG-F50045	21-Jan-24	21-Jan-25	12
Noise	Leq 24 hrs	Sound Level Meter	RYG-F50386	9-Oct-24	9-Oct-25	12
Noise	Leq 24 hrs	Sound Level Meter	RYG-F50432	22-Feb-24	21-Feb-25	12
Noise	Leq 24 hrs	Sound Level Meter	RYG-F50037	12-Jan-24	11-Jan-25	12
Noise	Leq 24 hrs	Sound Level Meter	RYG-F50184	9-Oct-24	9-Oct-25	12
Noise	Leq 24 hrs	Sound Level Meter	RYG-F50431	22-Feb-24	21-Feb-25	12
Noise	Leq 24 hrs	Sound Level Meter	RYG-F50033	22-Feb-24	21-Feb-25	12
Noise	Leq 8 hrs	Sound Calibrator	RYG-F50033	28-Feb-24	27-Feb-25	12
Noise	Leq 8 hrs	Sound Level Meter	RYG-F50017	22-Jan-24	21-Jan-25	12
Noise	Leq 8 hrs	Sound Calibrator	RYG-F50013	28-Feb-24	27-Feb-25	12
Noise	Leq 8 hrs	Sound Level Meter	RYG-F50024	25-Jan-24	24-Jan-25	12
Heat	Heat Stress	Heat Stress Monitor	RYG-F50218	15-Feb-24	14-Feb-25	12
Heat	Heat Stress	Heat Stress Monitor	RYG-F50220	11-Jan-24	10-Jan-25	12
Heat	Heat Stress	Heat Stress Monitor	RYG-F50217	8-Jan-24	7-Jan-25	12
Heat	Heat Stress	Heat Stress Monitor	RYG-F50216	15-Feb-24	14-Feb-25	12
Ravine Lab	Chloride	Ion SE Meter	RYG-F50032	14-Dec-23	14-Jan-25	18
Ravine Lab	Lead 24 Hr	Ion Meter	RYG-F50032	14-Dec-23	14-Jan-25	18
Ravine Lab	Color Lab (OrpH, pH)	Spectrophotometer	RYG-F50037	18-Sep-23	18-Mar-25	18
Ravine Lab	Color Lab (pH, TSS)	Spectrophotometer	RYG-F50037	18-Sep-23	18-Mar-25	18
Ravine Lab	DO	DO meter with Sensor	RYG-F50032	27-Jul-23	24-Jan-25	18
Ravine Lab	DO	DO meter	RYG-F50034	1-Nov-24	1-May-26	18
Ravine Lab	DO	Spectrophotometer	RYG-F50037	18-Sep-23	18-Mar-25	18

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Sample Name	Parameter	Equipment Name	ID No.	Calibrated Date	Next Cal	Freq. Calibrate (Months)
Ravine Lab	Total Suspended Solids	Electronic Balance	RYG-F50040	22-Feb-24	22-Feb-25	12
Ravine Lab	Total Suspended Solids	High Air Oven	RYG-F50010	21-Mar-24	21-Sep-25	18
Ravine Lab	Total Dissolved Solids (TDS)	Electronic Balance	RYG-F50002	22-Feb-24	22-Feb-25	12
Ravine Lab	Total Dissolved Solids (TDS)	High Air Oven	RYG-F50010	21-Mar-24	21-Sep-25	18
Ravine Lab	Oil & Grease	Electronic Balance	RYG-F50040	22-Feb-24	22-Feb-25	12
Ravine Lab	Oil & Grease	High Air Oven	RYG-F50010	21-Mar-24	21-Mar-25	12
Ravine Lab	Oil & Grease	Water Bath	RYG-F50061	21-Mar-24	22-Sep-25	18
Ravine Lab	Temperature	Oil meter	RYG-F50035	2-Jul-24	2-Jul-25	12
Ravine Lab	Total Kjeldahl Nitrogen	Block Digestion Unit	RYG-F50178	11-Mar-24	11-Sep-25	18
Ravine Lab	Total Kjeldahl Nitrogen	pH Meter	RYG-F50032	14-Dec-23	14-Jan-25	18
Ravine Lab	Starch	Spectrophotometer	RYG-F50037	18-Sep-23	18-Mar-25	18
Water Lab	Iron	CF-MS	B.K.F. E0041	8-Oct-24	3-Apr-26	18
Water Lab	Iron	Hot Block	B.K.F. E0054	22-Sep-23	22-Mar-25	18
Water Lab	Iron	Chamber (Cooling Room)	B.K.F. E0067	6-Dec-23	6-Jun-25	18
Water Lab	Copper	CF-MS	B.K.F. E0041	8-Oct-24	3-Apr-26	18
Water Lab	Copper	Hot Block	B.K.F. E0054	22-Sep-23	22-Mar-25	18
Water Lab	Copper	Chamber (Cooling Room)	B.K.F. E0067	6-Dec-23	6-Jun-25	18

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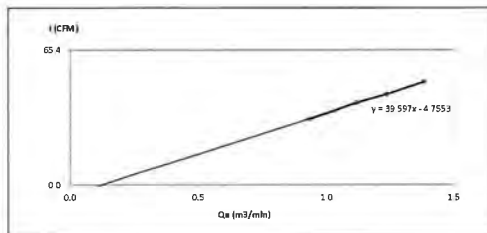
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High Volume Air Sampler Calibration Worksheet

Project Site:	GLOW ENERGY PUBLIC COMPANY LIMITED	Barometric Pressure (mm Hg):	757.2
Calibrate Location:	ศูนย์วิจัยและพัฒนาสิ่งแวดล้อมภาค 1 (A1)	Temperature (°C):	32.9
Calibrate Date:	25-Oct-24	High Volume ID:	RYG-F50668
Calibration Sheet No:	C-251024-RYG-F50668	High Volume Model:	TE-5009X
Calibrator ID:	RYG-F50206	High Volume S/N:	6267
Calibrator Model:	TE-5028A	Calibrator Slope:	0.92987
Calibrator S/N:	1543	Calibrator Intercept:	-0.01578

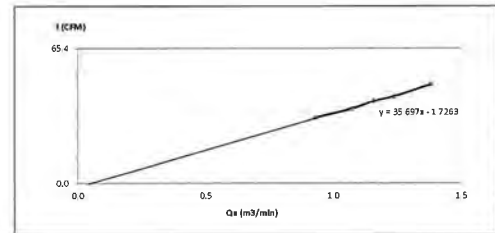
Test No.	Delta H <sub>2</sub> O (Inch)	Q <sub>a</sub> (m <sup>3</sup> /min)	I: Chart (CFM)	Linear Regression
1	1.8	0.933	32	Slope: 39.5974
2	2.2	1.030	36	Intercept: -4.7553
3	2.6	1.118	40	Correlation Coefficient: 0.9991
4	3.2	1.239	44	
5	4.0	1.383	50	



High Volume Air Sampler Calibration Worksheet

Project Site:	GLOW ENERGY PUBLIC COMPANY LIMITED	Barometric Pressure (mm Hg):	757.2
Calibrate Location:	ศูนย์วิจัยและพัฒนาสิ่งแวดล้อมภาค 2 (A2)	Temperature (°C):	32.9
Calibrate Date:	25-Oct-24	High Volume ID:	RYG-F50295
Calibration Sheet No:	C-251024-RYG-F50295	High Volume Model:	TE-5009X
Calibrator ID:	RYG-F50206	High Volume S/N:	5502
Calibrator Model:	TE-5028A	Calibrator Slope:	0.92987
Calibrator S/N:	1543	Calibrator Intercept:	-0.01578

Test No.	Delta H <sub>2</sub> O (Inch)	Q <sub>a</sub> (m <sup>3</sup> /min)	I: Chart (CFM)	Linear Regression
1	1.8	0.933	32	Slope: 35.6969
2	2.4	1.075	36	Intercept: -1.7263
3	2.8	1.160	40	Correlation Coefficient: 0.9964
4	3.2	1.239	42	
5	4.0	1.383	48	

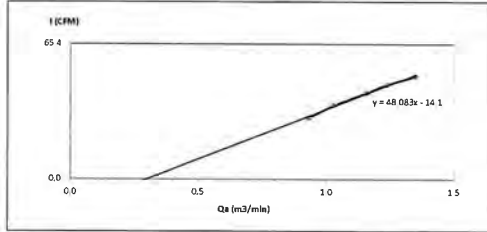




### High Volume Air Sampler Calibration Worksheet

Project Site : GLOW ENERGY PUBLIC COMPANY LIMITED  
Barometric Pressure (mm Hg) : 757.2  
Calibrate Location : กรุงเทพมหานคร (AS)  
Temperature (°C) : 32.9  
Calibrate Date : 25-Oct-24  
High Volume ID : RYG\_P50192  
Calibration Sheet No : C-251024-RYG\_P50192  
High Volume Model : TE-5009X  
Calibrator ID : RYG\_P50206  
High Volume S/N : 5331  
Calibrator Model : TE-5028A  
Calibrator Slope : 0.92987  
Calibrator S/N : 1543  
Calibrator Intercept : -0.01578

Test No.	Delta H <sub>2</sub> O (inch)	Qa (m <sup>3</sup> /min)	I: Chart (CFM)	Linear Regression
1	1.8	0.933	30	Slope: 48.0833
2	2.2	1.030	36	Intercept: -14.0995
3	2.8	1.160	42	Correlation Coefficient: 0.9963
4	3.2	1.239	46	
5	3.8	1.348	50	



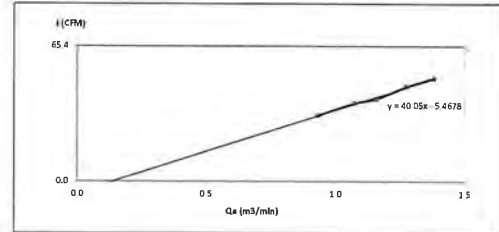
FORM NO: F 06-074 REVISION NO: 2 ISSUE DATE: 20/11/23



### High Volume Air Sampler Calibration Worksheet

Project Site : GLOW ENERGY PUBLIC COMPANY LIMITED  
Barometric Pressure (mm Hg) : 757.2  
Calibrate Location : กรุงเทพมหานคร (AS)  
Temperature (°C) : 32.9  
Calibrate Date : 25-Oct-24  
High Volume ID : RYG\_P50194  
Calibration Sheet No : C-251024-RYG\_P50194  
High Volume Model : TE-5009X  
Calibrator ID : RYG\_P50206  
High Volume S/N : 4792  
Calibrator Model : TE-5028A  
Calibrator Slope : 0.92987  
Calibrator S/N : 1543  
Calibrator Intercept : -0.01578

Test No.	Delta H <sub>2</sub> O (inch)	Qa (m <sup>3</sup> /min)	I: Chart (CFM)	Linear Regression
1	1.8	0.933	32	Slope: 40.0505
2	2.4	1.075	38	Intercept: -5.4678
3	2.8	1.160	40	Correlation Coefficient: 0.9968
4	3.4	1.276	46	
5	4.0	1.383	50	



FORM NO: F 06-074 REVISION NO: 2 ISSUE DATE: 20/11/23

Sartorius (Thailand) Co., Ltd.  
129 Rama 9 Road, Huaykwang, Huaykwang, Bangkok 10010  
Tel: +66 2843 8361-4 Fax: +66 2843 8367, e-mail: service.thailand@sartorius.com



NSC-TS-TIS 17025  
CALIBRATION 0425

SARTORIUS

## Certificate of Calibration

Model Number : LA130S-F  
Description : Analytical Balance  
Serial Number : 25409664  
ID No : RYG\_EN0001  
Manufacturer : Sartorius  
Certificate No : 24BCI0088  
Issued Date : Friday, February 23, 2024  
Reference No : 229196  
Page No : 1 of 2

Customer Name : ALS Laboratory Group (Thailand) Co., Ltd. (Rayong Branch)  
618/10 Moo 5 T Maenam Khu, A.Pluak Daeng, Rayong 21140, Thailand

Calibrated Place : ALS Laboratory Group (Thailand) Co., Ltd. (Balance Room)  
616/10 Moo 5 T Maenam Khu, A.Pluak Daeng, Rayong 21140, Thailand.

Calibrated By : Mr.Chonchai Inthana  
Calibration Date : Thursday, February 22, 2024  
Calibration Procedure No : This calibration was conducted by Using in-house calibration procedure number (WI-003)  
Based on UKAS LAB 14 : 2019

Metrological data :  
Capacity : 150 g Readability : 0.0001 g  
Ambients Conditions :  
Temperature : 23.6 °C ± 5.0 °C  
Humidity : 54.0 % RH ± 10.0 % RH  
Pressure : ±

Reasons for calibration  
☐ New Installation ☐ Service / Repaired ☒ Re-calibration / Maintenance  
Equipment Condition: ☒ Good Operate ☐ Fair

Measurement Method UKAS Publication Ref :Lab 14  
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 calibration certificate documents the traceability to National Standards, which realize the unit of measurement according to the International Standard System of Units (SI). Report of Tolerance came from list of Sartorius Metrological Specifications.

### Traceability:

Model Number	Description	Traceability	Certificate No.	Due Date
YCS011-522-00	Sartorius weight set 1mg - 8000g E2.YCS011-522-00	TCS	M2308197S	23-Aug-2025
MHB-382SD	Humidity/Barometer/Temp. Lutron MHB-382SD	DKSH	C19231845	23-Aug-2024

This certificate relate and apply this equipment only.  
This certificate may not be reproduced other than in full except with the prior written approval of the Verification Operation Division  
Sartorius (Thailand) Co., Ltd.

Mr.Chonchai Inthana(Technical Manager)



Sartorius (Thailand) Co., Ltd.  
129 Rama 9 Road, Huaykwang, Huaykwang, Bangkok 10010  
Tel: +66 2843 8361-4 Fax: +66 2843 8367, e-mail: service.thailand@sartorius.com

SARTORIUS

## Certificate of Calibration

Model Number : LA130S-F  
Description : Analytical Balance  
Serial Number : 25409664  
ID No : RYG\_EN0001  
Manufacturer : Sartorius  
Certificate No : 24BCI0088  
Issued Date : Friday, February 23, 2024  
Reference No : 229196  
Page No : 2 of 2

### Calibration Results : Without Adjustment

Repeatability			Eccentricity (Off-center loading error)		
The reproducibility is the ability of a weighing instrument to display nearly identical results under constant test conditions when the same load within a measurement series is placed repeatedly on the weighing pan in the same manner. The standard deviation is used to express reproducibility quantitatively.			The off-center loading error is yielded by the difference between the resultant of the load, i.e. 1/3 or 1/4 of maximum capacity, placed in the middle of the weighing pan and between each of four additional measurement points (positions defined according to OIML R110).		
Nominal Value : (Low Load)	10 g	10.0000 99.9999	Nominal value :	50 g	
Tolerance	0.0001 g	10.0000 100.0001	Tolerance	0.0004 g	
Nominal Value : (High Load)	100 g	10.0000 100.0001			
Tolerance	0.0001 g	10.0000 100.0001			
Standard Deviation	0.00005	0.00008			

Linearity				
The linearity, also called linearity error, describes the deviation of the characteristic curve of a weighing instrument from the linear slope.				
Nominal Value	Conventional Mass Value	Displayed Value	Deviation	Uncertainty
0.01	0.0100	0.0100	0.0000	0.00020
0.05	0.0500	0.0500	0.0000	0.00021
0.1	0.1000	0.1000	0.0000	0.00021
0.5	0.5000	0.5000	0.0000	0.00021
1	1.0000	1.0000	0.0000	0.00021
2	2.0000	2.0000	0.0000	0.00021
5	5.0000	5.0000	0.0000	0.00021
10	10.0000	10.0001	0.0001	0.00024
20	20.0000	20.0001	0.0001	0.00021
100	100.0000	99.9999	-0.0001	0.00024

End of Report.

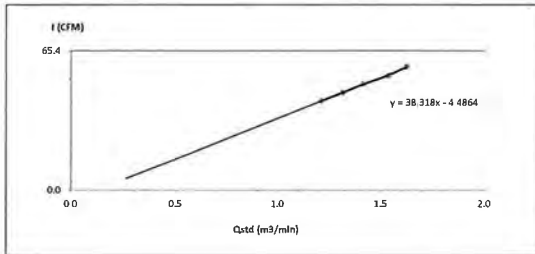
SOP FM 33 03 February 2022



### High Volume Air Sampler Calibration Worksheet

Project Site: GLOW ENERGY PUBLIC COMPANY LIMITED  
Calibrate Location: โรงบำบัดน้ำเสียเทศบาลนครขอนแก่น (A1)  
Calibrate Date: 25-Oct-24  
Calibration Sheet No.: C-251024-RYG\_FS0292  
Calibrator ID: RYG\_FS0206  
Calibrator Model: TE-5028A  
Calibrator S/N: 1543  
Barometric Pressure (mm Hg): 757.2  
Temperature (°C): 32.9  
High Volume ID: RYG\_FS0292  
High Volume Model: TE-5170D  
High Volume S/N: 5497  
Calibrator Slope: 1.48469  
Calibrator Intercept: -0.02523

Test No.	Delta H <sub>2</sub> O (Inch)	Q <sub>std</sub> (m <sup>3</sup> /min)	I: Chart (CFM)	Linear Regression
1	3.2	1.2122	42	Slope: 38.3180 Intercept: -4.4864 Correlation Coefficient: 0.9990
2	3.8	1.3187	46	
3	4.4	1.4171	50	
4	5.2	1.5384	54	
5	5.8	1.6233	58	



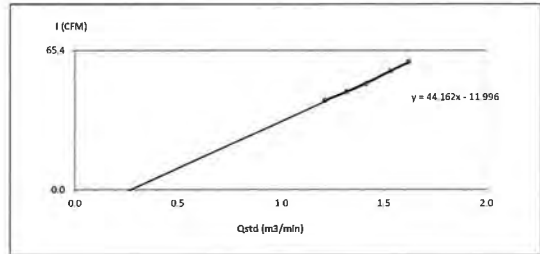
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### High Volume Air Sampler Calibration Worksheet

Project Site: GLOW ENERGY PUBLIC COMPANY LIMITED  
Calibrate Location: ศูนย์บำบัดน้ำเสียเทศบาลนครขอนแก่น (A2)  
Calibrate Date: 25-Oct-24  
Calibration Sheet No.: C-251024-RYG\_FS0664  
Calibrator ID: RYG\_FS0206  
Calibrator Model: TE-5028A  
Calibrator S/N: 1543  
Barometric Pressure (mm Hg): 757.2  
Temperature (°C): 32.9  
High Volume ID: RYG\_FS0664  
High Volume Model: TE-5009X  
High Volume S/N: 6261  
Calibrator Slope: 1.48469  
Calibrator Intercept: -0.02523

Test No.	Delta H <sub>2</sub> O (Inch)	Q <sub>std</sub> (m <sup>3</sup> /min)	I: Chart (CFM)	Linear Regression
1	3.2	1.2122	42	Slope: 44.1621 Intercept: -11.9963 Correlation Coefficient: 0.9983
2	3.8	1.3187	46	
3	4.4	1.4171	50	
4	5.2	1.5384	56	
5	5.8	1.6233	60	



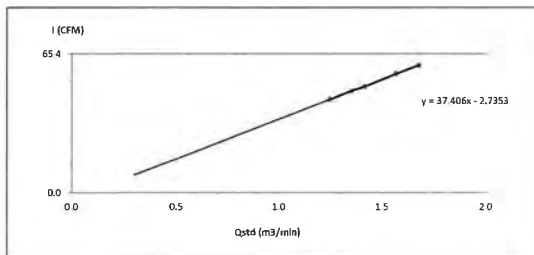
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### High Volume Air Sampler Calibration Worksheet

Project Site: GLOW ENERGY PUBLIC COMPANY LIMITED  
Calibrate Location: เมืองโพนพิสัย (A3)  
Calibrate Date: 25-Oct-24  
Calibration Sheet No.: C-251024-RYG\_FS0662  
Calibrator ID: RYG\_FS0206  
Calibrator Model: TE-5028A  
Calibrator S/N: 1543  
Barometric Pressure (mm Hg): 757.2  
Temperature (°C): 32.9  
High Volume ID: RYG\_FS0662  
High Volume Model: TE-5009X  
High Volume S/N: 6259  
Calibrator Slope: 1.48469  
Calibrator Intercept: -0.02523

Test No.	Delta H <sub>2</sub> O (Inch)	Q <sub>std</sub> (m <sup>3</sup> /min)	I: Chart (CFM)	Linear Regression
1	3.4	1.2488	44	Slope: 37.4061 Intercept: -2.7353 Correlation Coefficient: 0.9997
2	4.0	1.3523	48	
3	4.4	1.4171	50	
4	5.4	1.5672	56	
5	6.2	1.6775	60	



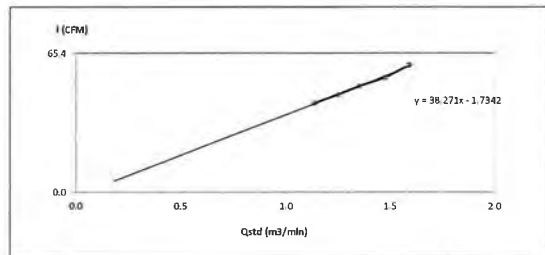
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### High Volume Air Sampler Calibration Worksheet

Project Site: GLOW ENERGY PUBLIC COMPANY LIMITED  
Calibrate Location: โรงบำบัดน้ำเสียเทศบาลนครขอนแก่น (A4)  
Calibrate Date: 25-Oct-24  
Calibration Sheet No.: C-251024-RYG\_FS0182  
Calibrator ID: RYG\_FS0206  
Calibrator Model: TE-5028A  
Calibrator S/N: 1543  
Barometric Pressure (mm Hg): 757.2  
Temperature (°C): 32.9  
High Volume ID: RYG\_FS0182  
High Volume Model: TE-5170D  
High Volume S/N: 5335  
Calibrator Slope: 1.48469  
Calibrator Intercept: -0.02523

Test No.	Delta H <sub>2</sub> O (Inch)	Q <sub>std</sub> (m <sup>3</sup> /min)	I: Chart (CFM)	Linear Regression
1	2.8	1.1356	42	Slope: 38.2710 Intercept: -1.7342 Correlation Coefficient: 0.9967
2	3.4	1.2488	46	
3	4.0	1.3523	50	
4	4.8	1.4790	54	
5	5.6	1.5955	60	



FORM NO.: F 06-073 REVISION NO.:2 ISSUE DATE: 20/11/23

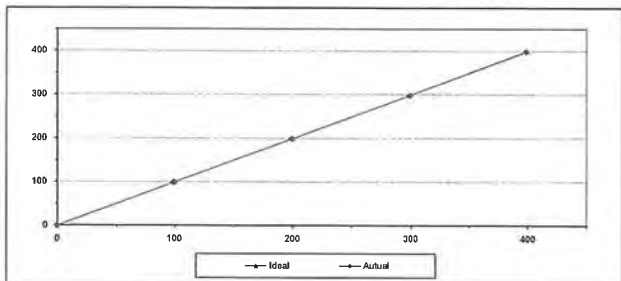




## MULTIPOINT CALIBRATION REPORT

Calibration Date 5-Jul-24 Equipment Name SO2 Analyzer  
Manufacturer Teledyne API Model T100  
Serial No. 6061 Equipment ID RYG\_FS0534  
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

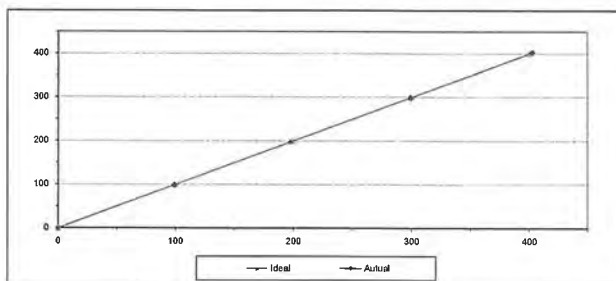
Point	CALIBRATION RESULTS			
	Ideal	Actual	Error	%Error
ZERO	0.00	0.10	0.10	0.10
1	100.00	98.90	-1.10	-1.10
2	200.00	198.70	-1.30	-0.65
3	300.00	298.30	-1.70	-0.57
4	400.00	398.70	-1.30	-0.33
AVERAGE (%)				-0.51



## MULTIPOINT CALIBRATION REPORT

Calibration Date 5-Jul-24 Equipment Name SO2 Analyzer  
Manufacturer HORIBA Model APSA-370  
Serial No. XL29Y65B Equipment ID RYG\_FS0482  
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

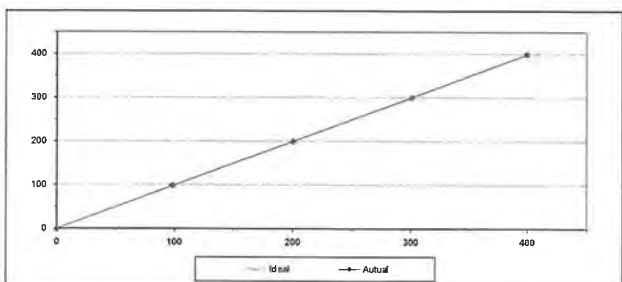
Point	CALIBRATION RESULTS			
	Ideal	Actual	Error	%Error
ZERO	0.00	0.10	0.10	0.10
1	100.00	99.10	-0.90	-0.90
2	200.00	198.00	-2.00	-1.00
3	300.00	299.90	-0.10	-0.03
4	400.00	403.20	3.20	0.80
AVERAGE (%)				-0.21



## MULTIPOINT CALIBRATION REPORT

Calibration Date 5-Jul-24 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

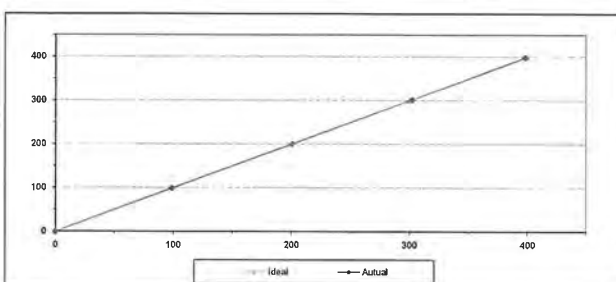
Point	CALIBRATION RESULTS			
	Ideal	Actual	Error	%Error
ZERO	0.00	0.10	0.10	0.10
1	100.00	98.30	-1.70	-1.70
2	200.00	200.80	0.80	0.40
3	300.00	301.20	1.20	0.40
4	400.00	399.70	-0.30	-0.08
AVERAGE (%)				-0.18



## MULTIPOINT CALIBRATION REPORT

Calibration Date 5-Jul-24 Equipment Name SO2 Analyzer  
Manufacturer HORIBA Model APSA-370  
Serial No. PAUY0T7A Equipment ID RYG\_FS0458  
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	98.90	-1.10	-1.10
2	200.00	201.00	1.00	0.50
3	300.00	302.30	2.30	0.77
4	400.00	398.50	-1.50	-0.38
AVERAGE (%)				-0.02

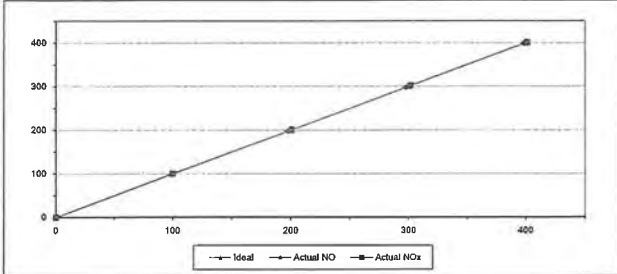




## MULTIPOINT CALIBRATION REPORT

Calibration Date 2-Jul-24 Equipment Name NOx Analyzer  
Manufacturer HORIBA Model APNA-370  
Serial No. SEEAWS3E Equipment ID RYG\_FS0261  
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

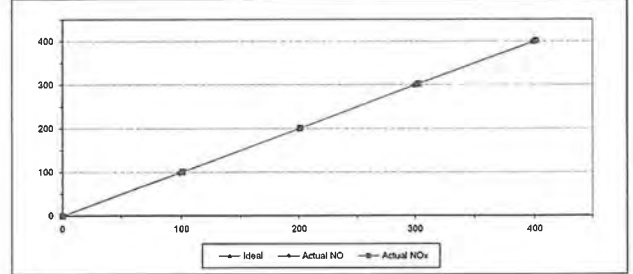
Point	CALIBRATION RESULTS						
	Ideal	Actual NO	Error NO	%Error NO	Actual NOx	Error NOx	%Error NOx
ZERO	0.00	0.10	0.10	0.10	0.10	0.10	0.10
1	100.00	98.70	-1.30	-1.30	100.20	0.20	0.20
2	200.00	197.70	-2.30	-1.15	201.20	1.20	0.60
3	300.00	298.10	-1.90	-0.63	302.00	2.00	0.67
4	400.00	398.50	-1.50	-0.38	401.40	1.40	0.35
AVERAGE (%)				-0.67			0.38



## MULTIPOINT CALIBRATION REPORT

Calibration Date 3-Jul-24 Equipment Name NOx Analyzer  
Manufacturer HORIBA Model APNA-370  
Serial No. R08K0177 Equipment ID RYG\_FS0463  
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

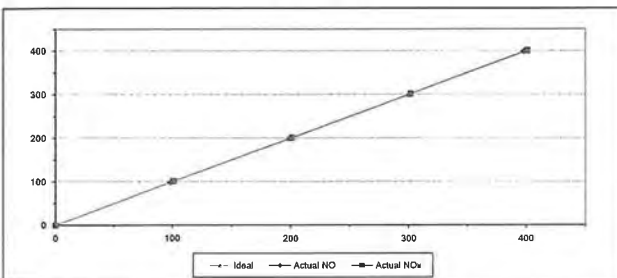
Point	CALIBRATION RESULTS						
	Ideal	Actual NO	Error NO	%Error NO	Actual NOx	Error NOx	%Error NOx
ZERO	0.00	0.10	0.10	0.10	0.10	0.10	0.10
1	100.00	98.80	-1.20	-1.20	101.30	1.30	1.30
2	200.00	201.30	1.30	0.65	201.20	1.20	0.60
3	300.00	299.40	-0.60	-0.20	302.60	2.60	0.87
4	400.00	398.70	-1.30	-0.33	401.50	1.50	0.38
AVERAGE (%)				-0.20			0.65



## MULTIPOINT CALIBRATION REPORT

Calibration Date 3-Jul-24 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

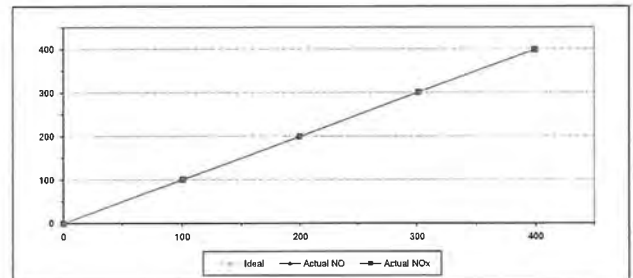
Point	CALIBRATION RESULTS						
	Ideal	Actual NO	Error NO	%Error NO	Actual NOx	Error NOx	%Error NOx
ZERO	0.00	0.10	0.10	0.10	0.10	0.10	0.10
1	100.00	98.60	-1.40	-1.40	101.60	1.60	1.60
2	200.00	198.80	-1.20	-0.60	201.30	1.30	0.65
3	300.00	301.00	1.00	0.33	301.80	1.80	0.60
4	400.00	398.50	-1.50	-0.38	401.30	1.30	0.33
AVERAGE (%)				-0.39			0.66

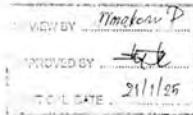


## MULTIPOINT CALIBRATION REPORT

Calibration Date 3-Jul-24 Equipment Name NOx Analyzer  
Manufacturer HORIBA Model APNA-370  
Serial No. NV0ER3YH Equipment ID RYG\_FS0459  
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	0.05	0.05	0.05	0.10	0.10	0.10
1	100.00	99.50	-0.50	-0.50	101.20	1.20	1.20
2	200.00	198.70	-1.30	-0.65	199.70	-0.30	-0.15
3	300.00	301.10	1.10	0.37	301.40	1.40	0.47
4	400.00	400.30	0.30	0.08	396.80	-1.20	-0.30
AVERAGE (%)				-0.13			0.28





Certificate Number

CWS 002-66

## CERTIFICATE OF CALIBRATION

Page 2 of 2 Pages

### MEASUREMENT ITEM MANUFACTURER MODEL/TYPE

1 Cup anemometer  
1 Novallisa  
Sensor: WS-02F  
Data logger: 110 WS-250L-D

### SERIAL NUMBER ID NUMBER CONDITION AS-RECEIVED CUSTOMER

Sensor: WSD AS816  
Data logger: AS816  
RYG\_F50545  
Used item  
ALS laboratory group (Thailand) Co., Ltd.  
104 Phatthanakan Rd, Phatthanakan Rd, Khwaeng Suan Luang,  
Khet Suan Luang, Bangkok 10250 Thailand

### RECEIVED DATE MEASUREMENT DATE ISSUE DATE

11 Jul 2023  
11 Jul 2023  
11 Jul 2023

### ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follow:

Temperature: 23.0 ± 0.5 °C  
Relative Humidity: 55.0 ± 1.0 %RH  
Atmospheric Pressure: 1010.0 ± 1.0 hPa

### PLACE OF CALIBRATION

Effel type wind tunnel of Jiranta Associates Co., Ltd.

### CALIBRATION CONDITIONS

1 Wind tunnel cross-section area<sup>1</sup>: 900 cm<sup>2</sup>  
2 Wind direction frontal area<sup>2</sup>: 100 cm<sup>2</sup>  
3 Diameter of mounting pipe<sup>3</sup>: mm  
4 Blockage ratio of test object<sup>4</sup>: 0.11 [-]

### Preconditioning Measurement Condition

24 hours at ambient conditions  
The average values during measurement are (23.9) °C, (45.7) %RH and (1008.2) hPa

### TABULATION OF RESULTS:

The table on next page give the measured values.

### Calibrated by

1 Mr. Sarawat Thirachai  
2 Miss. Jiraporn Lertsamphol

### Remarks:

<sup>1</sup> Actual cross-section area of the wind tunnel  
<sup>2</sup> Projected cross-section area of the tested object include mounting pipe  
<sup>3</sup> Diameter of mounting pipe  
<sup>4</sup> Ratio =  $\frac{A_o}{A_t}$

THIS CERTIFICATE OF CALIBRATION MAY NOT BE REPRODUCED EXCEPT IN FULL UNLESS PERMISSION FOR REPRODUCTION HAS BEEN OBTAINED IN WRITING FROM THE LABORATORY

Page 2 of 2 Pages

### MEASUREMENT RESULTS<sup>5</sup>

The cup anemometer, Unit Under Calibration (UUC) was exercise at 10 m/s for 5 minutes prior to calibration being performed. The standard air velocity 0.5 m/s to 5 m/s was calculated by a standard air velocity transducer and above 5 m/s to 10 m/s was calculated by a pitot tube with pressure differential pressure meter which was installed 60 mm and 300 mm respectively away from wind tunnel nozzle. UUC was installed at center of the test section. The calibration was carried out under both rising and falling air velocity in the range of 1 m/s to 10 m/s at calibration interval of 1 m/s. The results of calibration and associated measurement uncertainties are reported in the table below.

$V_{ref}$ (m/s)	Temp. wind tunnel (°C)	Temp. room (°C)	$V_{ref}$ (m/s)	Error (m/s)	$U$ (m/s) (m/s)
1.033	23.83	23.90	0.8	-0.2	0.31
2.078	24.00	23.90	1.8	-0.2	0.31
3.021	23.78	23.90	2.8	-0.2	0.31
4.145	23.92	23.90	3.9	-0.2	0.31
5.00	23.60	23.90	4.8	-0.2	0.31
5.99	23.68	23.90	5.8	-0.2	0.31
7.03	23.50	23.90	6.8	-0.2	0.31
8.16	23.60	23.90	7.9	-0.3	0.31
9.08	23.50	23.90	8.9	-0.2	0.31
10.06	23.78	23.90	9.8	-0.3	0.31
11.13	23.50	23.90	10.9	-0.2	0.31
12.11	23.78	23.90	12.0	0.1	0.31
13.16	23.50	23.90	12.9	-0.3	0.31
14.21	23.66	23.90	14.0	-0.2	0.31
15.18	23.50	23.90	15.0	-0.2	0.31
16.26	23.58	23.90	16.0	-0.3	0.31

### Remark:

<sup>5</sup> Calibration results only count for the tested circumstances and environmental conditions during which calibration took place.

<sup>6</sup> Velocity of standard

<sup>7</sup> Velocity of Unit Under Calibration

### PHOTO OF CALIBRATION SET UP



Calibration set up of the Cup anemometer calibration in the wind tunnel of Jiranta Associates Co., Ltd. The cup anemometer shown may differ from the calibrated one. The photograph of the set-up is not to be used for claiming accuracy.

Certificate Number

CWD 002-66

## CERTIFICATE OF CALIBRATION

Page 2 of 2 Pages

### MEASUREMENT ITEM MANUFACTURER MODEL/TYPE

1 Wind Direction Sensor  
1 Novallisa  
Sensor: WS-02F  
Data logger: 110 WS-250L-D

### SERIAL NUMBER ID NUMBER CONDITION AS-RECEIVED CUSTOMER

Sensor: WSD AS816  
Data logger: AS816  
RYG\_F50545  
Used item  
ALS laboratory group (Thailand) Co., Ltd.  
104 Phatthanakan Rd, Phatthanakan Rd, Khwaeng Suan Luang,  
Khet Suan Luang, Bangkok 10250 Thailand

### RECEIVED DATE MEASUREMENT DATE ISSUE DATE

11 Jul 2023  
11 Jul 2023  
11 Jul 2023

### ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follow:

Temperature: 23.0 ± 0.5 °C  
Relative Humidity: 55.0 ± 1.0 %RH  
Atmospheric Pressure: 1010.0 ± 1.0 hPa

### PLACE OF CALIBRATION

Effel type wind tunnel of Jiranta Associates Co., Ltd.

### CALIBRATION CONDITION

1 Wind tunnel cross-section area<sup>1</sup>: 900 cm<sup>2</sup>  
2 Wind direction frontal area<sup>2</sup>: 100 cm<sup>2</sup>  
3 Diameter of mounting pipe<sup>3</sup>: mm  
4 Blockage ratio of test object<sup>4</sup>: 0.143 [-]

### Preconditioning Measurement Condition

24 hours at ambient conditions  
The average values during measurement are (23.9) °C, (45.9) %RH and (1012.4) hPa

### TABULATION OF RESULTS:

The table on next page give the measured values.

### Calibrated by

1 Mr. Sarawat Thirachai  
2 Miss. Jiraporn Lertsamphol

### Remarks:

<sup>1</sup> Actual cross-section area of the wind tunnel  
<sup>2</sup> Projected cross-section area of the tested object include mounting pipe  
<sup>3</sup> Diameter of mounting pipe  
<sup>4</sup> Ratio =  $\frac{A_o}{A_t}$

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Certificate Number

CWD-002-66

Page 2 of 2 Pages

### MEASUREMENT RESULTS<sup>5</sup>

The wind direction sensor was calibrated against standard rotary encoder by comparison method. During calibration, the measurement was carried out at 45° intervals in clockwise and counter-clockwise direction after effort adjustment has been made. The flow speed of wind tunnel (usually 5 m/s) is kept constant while the sensor is rotated around its vertical axis. The results of calibration and associated measurement uncertainties are reported in the table below.

Air speed m/s	D <sub>ref</sub> Degree (°)	D <sub>ref</sub> Degree (°)	Error Degree (°)	U (m/s) Degree (°)
5.00	45.000	42	-3	1.0
	50.000	47	-3	1.0
	135.000	133	-2	1.0
	180.000	181	1	1.0
	225.000	229	4	1.0
	270.001	273	3	1.0
	315.000	317	2	1.0
	360.000	359	-1	1.0

### Remark:

<sup>5</sup> Calibration results only count for the tested circumstances and environmental conditions during which calibration took place.

<sup>6</sup> Direction of standard

<sup>7</sup> Direction of Unit Under Calibration

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





63/14 15,67/35 36, Soi Petchkasem 7/71, Petchkasem Rd,  
Walthapra, Bangkokyai, Bangkok 10600 Thailand.  
Tel: (66) 02-8680812#13 Fax: (66) 02-8680860 www.jiranalee.com



## CERTIFICATE OF CALIBRATION

Certificate No : CDT-038-66  
Page 1 of 2

Equipment Name Data logger with Temperature sensor  
Manufacturer: Nuvalynx  
Model: 110 WS 25DL D  
Serial No: A5816  
ID No.: RYG\_FS0545

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: 11 Jul 2023  
Calibration date: 21 Jul 2023  
Issue date: 21 Jul 2023

Reference Used During Calibration  
1 SI Indirect Temperature Probe Model: STS 100 A500,  
Serial No: 667682 09, Due date: 28 Mar 2024  
2 Digital Temperature Indicator Model: DTI 1000 A MK  
II, Serial No: 671407-00591 Due date: 22 July 2023

Calibration Condition  
Temperature: (23±3) °C  
Relative Humidity: (58±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 used 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 0038 23 Certificate number: ER 0092 22

Notes: This certificate is valid only for the item calibrated on date and place of calibration.

Calibrated by  
☐ Mr. Sorawit Thachalad  
☐ Miss Jitraporn Lertsomphol  
☐ Miss Ruangsiraporn Phoommit



THIS CERTIFICATE MAY NOT BE REPRODUCED EXCEPT IN FULL UNLESS PERMISSION FOR REPRODUCTION HAS BEEN OBTAINED IN WRITING FROM THE LABORATORY.



63/14 15,67/35-36, Soi Petchkasem 7/71, Petchkasem Rd,  
Walthapra, Bangkokyai, Bangkok 10600 Thailand.  
Tel: (66) 02-8680812#13 Fax: (66) 02-8680860 www.jiranalee.com



Certificate No : CDT-038-66  
Page 2 of 2

Result of Calibration: ☒ Without Adjustment : ☐ With Adjustment  
Calibration Range: 20-40 °C

### Function:

This equipment was connected with temperature sensor Model: HMP60 S/N: T2320595

Dimension : Diameter 12 mm, Length 80 mm.

Immersion Depth (mm)	Standard Reading (°C)	UUC Reading (°C)	Error (°C)	Uncertainty (°C)
70	20.050	19.6	-0.5	0.099
70	25.055	24.6	-0.4	0.14
70	30.050	29.7	-0.4	0.099
70	35.043	34.5	-0.5	0.099
70	40.036	39.5	-0.5	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 ★



63/14-15,67/35 36, Soi Petchkasem 7/71, Petchkasem Rd,  
Walthapra, Bangkokyai, Bangkok 10600 Thailand.  
Tel: (66) 02-8680812#13 Fax: (66) 02-8680860 www.jiranalee.com

## CERTIFICATE OF CALIBRATION

Calibration No : RH-02072023  
Page 1 of 1 Pages

Measurement Item Relative humidity with data logger  
Manufacturer: Nuvalynx  
Model/Type: 110-WS 25DL-D  
Serial Number: A5816  
ID No: RYG\_FS0545  
Customer: ALS laboratory group (Thailand) Co., Ltd  
104 Phatthanakan 40, Phatthanakan Rd, Khwaeng Suan Luang, Khet Suan Luang, Bangkok 10250 Thailand

### Environmental Condition:

The measurement was carried out in an ambient temperature of (25±3)°C and relative humidity of (60±15)%

### Measurement Method:

Unit Under Calibration (UUC) was calibrated by comparison method with standard chilled mirror hygrometer model 1860-3 in the humidity generator chamber to determine the errors.

### Traceability:

This instrument was calibrated using standard equipment whose accuracy is traceability through National Institute of Standards and Technology to the international system of units (SI) via MCS Calibration, Inc. Certificate number: 20926-601 Due date: Sep 26, 2024.

Measurement Date: Jul 21, 2023  
Issued Date: Jul 21, 2023

### Measurement Results:

This equipment was connected with Indoor air quality probe and Displayed (URI) on display Model: HMP60, Serial number: T2320595

Calibration was performed in the range of 20%RH to 80%RH

The results of calibration are reported in table below.

Determined (%RH)	Standard (%RH)	UUC reading (%RH)	Error (%RH)	Uncertainty (%RH)
20	20.07	17.5	-2.6	0.52
50	50.23	48.5	-1.7	0.51
80	80.25	75.5	-4.8	0.51

Performed by  
☐ Mr. Sorawit Thachalad  
☒ Miss Jitraporn Lertsomphol  
☐ Miss Ruangsiraporn Phoommit



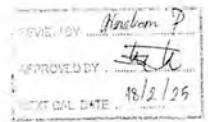
Approved by

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Accredited calibration laboratory  
ISO/IEC 17025:2017  
ASC-175-115.17025  
CALIBRATION 0367  
Air speed measurement laboratory  
Calibration services department

Accredited calibration laboratory  
ISO/IEC 17025:2017  
ASC-175-115.17025  
CALIBRATION 0367  
Air speed measurement laboratory  
Calibration services department



Certificate Number

CWS-003-66

## CERTIFICATE OF CALIBRATION

Page 1 of 2 Pages

### MEASUREMENT ITEM

MANUFACTURER: Nuvalynx  
MODEL/TYPE: Sensor: WS 038  
Data logger: 200 WS 25DL  
SERIAL NUMBER: Sensor: WSD-A5190  
Data logger: A5190  
ID NUMBER: NVC FS0329  
CONDITION AS-RECEIVED: Used item  
CUSTOMER: ALS laboratory group (Thailand) Co., Ltd  
104 Phatthanakan 40, Phatthanakan Rd, Khwaeng Suan Luang, Khet Suan Luang, Bangkok 10250 Thailand

RECEIVED DATE: 11 Aug 2023  
MEASUREMENT DATE: 18 Aug 2023  
ISSUE DATE: 21 Aug 2023

### ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follow:  
Temperature: 23.0 ± 3.0 °C  
Relative Humidity: 55.0 ± 15.0 %RH  
Atmospheric Pressure: 1010 ± 10 hPa

### PLACE OF CALIBRATION

Eiffel type wind tunnel of Jiranalee Associates Co., Ltd

### CALIBRATION CONDITIONS

Wind tunnel cross section area: 900 cm<sup>2</sup>  
Wind direction frontal area: 100 cm<sup>2</sup>  
Diameter of mounting pipe: 10 mm  
Blockage ratio of test object: 0.133 [-]

### Preconditioning

24 hours at ambient conditions.

### Measurement Condition

The average values during measurement are (24.31 °C, (43.2) %RH and (1005.59) hPa

### TABULATION OF RESULTS:

The table on next page give the results of the calibration.

Calibrated by  
☐ Mr. Sorawit Thachalad  
☒ Miss Jitraporn Lertsomphol  
☐ Miss Ruangsiraporn Phoommit



### Remarks:

\* Actual cross-section area of the wind tunnel  
\* Projected frontal area of the tested object include mounting pipe  
\* Diameter of mounting pipe  
\* Ratio to 1

THIS CERTIFICATE OF CALIBRATION MAY NOT BE REPRODUCED EXCEPT IN FULL UNLESS PERMISSION FOR REPRODUCTION HAS BEEN OBTAINED IN WRITING FROM THE LABORATORY.



Certificate Number

CWS-003-68

Page 2 of 2 Pages

MEASUREMENT RESULTS<sup>1</sup>

The cup anemometer, Link (sonar) Calib: (UUC) was exercised at 10 m/s for 5 minutes prior to calibration being performed. The standard air velocity 0.5 m/s to 5 m/s was calculated by a standard air velocity transducer and above 5 m/s to 30 m/s was calculated by a pitot tube with precision differential pressure meter which was installed 30 mm and 300 mm respectively away from wind tunnel nozzle. UUC was installed at center of the test section. The calibration was carried out under both steady and falling air velocity in the range of 1 m/s to 16 m/s at constant interval of 1 m/s. The results of calibration and associated measurement uncertainties are reported in the table below.

$V_{ref}$ (m/s)	Temp. wind tunnel (°C)	Temp. room (°C)	$V_{meas}$ (m/s)	Error (m/s)	$U$ (k=2) (m/s)
1.632	24.18	24.30	0.6	-0.1	0.31
2.095	24.54	24.30	1.9	-0.2	0.31
3.006	24.08	24.30	2.9	-0.1	0.31
4.220	24.04	24.30	4.0	-0.2	0.31
5.00	23.78	24.30	4.9	-0.1	0.31
5.97	23.22	24.30	5.9	-0.1	0.31
7.01	23.78	24.30	6.9	-0.1	0.31
8.13	24.00	24.30	8.0	-0.1	0.31
9.27	23.62	24.30	9.0	-0.1	0.31
10.07	23.50	24.30	9.9	-0.1	0.31
11.23	23.24	24.30	11.1	0.0	0.31
12.13	23.80	24.30	12.0	-0.1	0.31
13.16	23.82	24.30	13.2	0.0	0.31
14.24	22.74	24.30	14.1	-0.3	0.31
15.20	23.50	24.30	15.2	0.0	0.31
16.26	23.78	24.30	16.1	-0.2	0.31

## Remark:

Calibration results only count for the tested circumstances and environmental conditions during which calibration took place.

<sup>1</sup> Velocity of standard

Velocity of Unit Under Calibration

## PHOTO OF CALIBRATION SET-UP



Calibration set-up of the cup anemometer calibration in the wind tunnel of Jiraratree Associates Co., Ltd. The cup anemometer shown may differ from the calibrated one. Remark: The proportion of the set-up is not true to scale due to image compression.



Jiraratree Associates Co., Ltd.  
33/14 15, 07/15/36  
Plot 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000.

Accredited calibration laboratory  
ISO/IEC 17025:2017  
NSC-TIS-175 17025  
CALIBRATION 0367

Air speed measurement laboratory  
Calibration services department

Certificate Number

CWD-003-66

## CERTIFICATE OF CALIBRATION

Page 1 of 2 Pages

## MEASUREMENT ITEM

Wind Direction Sensor

## MANUFACTURER

Navalyma

## MODEL/TYPE

Sensor: WS-02F

## SERIAL NUMBER

Data logger: 200 WS-2XLB

## ID NUMBER

Sensor: WSD AS190

## CONDITION AS RECEIVED

Data logger: AS190

## CUSTOMER

ALS Laboratory Group (Thailand) Co., Ltd.  
104 Phatthanabon 40, Phatthanabon Rd, Khwaeng Suan Luang,  
Khet Suan Luang, Bangkok 10250 Thailand

## RECEIVED DATE

11 Aug 2023

## MEASUREMENT DATE

16 Aug 2023

## ISSUE DATE

21 Aug 2023

## ENVIRONMENTAL CONDITIONS:

Air ambient condition in the laboratory are as follows:

Temperature: 23.0 ± 3.0 °C  
Relative Humidity: 55.0 ± 15.0 %RH  
Atmospheric Pressure: 1010 ± 10 hPa

## PLACE OF CALIBRATION

Eifel type wind tunnel of Jiraratree Associates Co., Ltd

## CALIBRATION CONDITION

Wind tunnel cross-section area<sup>1</sup>: 900 cm<sup>2</sup>  
Wind direction frontal area<sup>2</sup>: 129 cm<sup>2</sup>  
Diameter of mounting pipe: 6 mm  
Blockage ratio of test object<sup>3</sup>: 0.143 [-]

## Preconditioning

24 hours at ambient conditions

## Measurement Condition

The average values during measurement are (23.8) °C, (44.9) %RH and (1009.7) hPa

## TABULATION OF RESULTS:

The table on next page give the measured values



## Remarks:

<sup>1</sup> Actual cross-section area of the wind tunnel

<sup>2</sup> Frontal cross-section area of the tested object include mounting pipe

<sup>3</sup> Diameter of mounting pipe

<sup>4</sup> Ratio [-]

THIS CERTIFICATE OF CALIBRATION MAY NOT BE REPRODUCED EXCEPT IN FULL UNLESS PERMISSION FOR REPRODUCTION HAS BEEN OBTAINED IN WRITING FROM THE LABORATORY

Certificate Number

CWD-003-65

Page 2 of 2 Pages

MEASUREMENT RESULTS<sup>1</sup>

The wind direction sensor was calibrated against standard rotary encoder by comparison method. During calibration, the measurement was carried out at 45° intervals in clockwise and counterclockwise directions after initial adjustment has been made. The flow speed of wind tunnel (usually 5 m/s) is kept constant while the sensor is rotated around its vertical axis. The results of calibration and associated measurement uncertainties are reported in the table below.

Air speed m/s	D <sub>ref</sub> Degree (°)	D <sub>meas</sub> Degree (°)	Error Degree (°)	U (k=2) Degree (°)
5.00	45.000	41	-4	1.0
	90.000	87	-3	1.0
	135.000	132	-3	1.0
	180.000	178	-2	1.0
	225.000	226	1	1.0
	270.000	272	2	1.0
	315.000	319	4	1.0
	360.000	359	-1	1.0

## Remark:

Calibration results only count for the tested circumstances and environmental conditions during which calibration took place.

<sup>1</sup> Velocity of standard

Direction of Unit Under Calibration

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



Jiraratree Associates Co., Ltd.  
33/14 15, 07/15/36  
Plot 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490,

Certificate Number

CWS-026-67

Page 2 of 2 Pages

MEASUREMENT RESULTS<sup>1</sup>

<sup>1</sup> The Cup anemometer Unit Under Calibration (UUC) was warm-up at 10 m/s for 5 minutes prior to calibration being performed. The standard air velocity 0.5 m/s to 5 m/s was calculated by a standard air velocity transducer which was installed 50 mm away from wind tunnel nozzle and installed 40 mm away from tip of the test vector and the standard air velocity 5 m/s to 30 m/s was calculated by a Pitot tube with precision differential pressure meter which was installed 50 mm away from wind tunnel nozzle and installed 40 mm away from tip of the test section. UUC was mounted on a round vertical tube of the wall plate at center of test section. The calibration was carried out under both rising and falling air velocity in the range of 1 m/s to 16 m/s at calibration interval of 1 m/s. The results of calibration and associated measurement uncertainties are reported in the table below.

$V_{std}$ (m/s)	Temp. wind tunnel (°C)	Temp. room (°C)	$V_{std}$ (m/s)	Error (m/s)	$U$ (k=2) (m/s)
0.997	23.70	23.80	0.9	-0.1	0.11
2.021	23.90	23.80	1.8	0.2	0.11
2.990	23.70	23.80	2.9	-0.1	0.31
4.094	23.70	23.80	3.8	-0.3	0.31
4.97	23.72	23.80	5.0	0.0	0.31
5.97	23.60	23.80	6.0	0.0	0.31
7.04	23.80	23.80	7.0	0.0	0.31
7.98	23.62	23.80	8.0	0.0	0.31
9.00	23.72	23.90	9.1	0.1	0.31
9.96	23.50	23.80	10.1	0.1	0.31
10.97	22.70	23.80	11.1	0.1	0.31
12.04	23.50	23.80	12.1	0.1	0.31
12.96	23.80	23.80	13.1	0.1	0.31
14.10	23.50	23.80	14.2	0.1	0.31
15.04	23.70	23.80	15.2	0.2	0.31
15.97	23.60	23.80	16.2	0.2	0.31

## Remarks:

<sup>1</sup> Calibration results only count for the tested circumstances and environmental conditions during which calibration took place.

<sup>2</sup> Velocity of standard.

<sup>3</sup> Velocity of Unit Under Calibration.

## PHOTO OF CALIBRATION SET UP



Calibration set up of the Cup anemometer calibration in the wind tunnel of Jirapatt Associates Co., Ltd. The Cup anemometer shown may differ from the calibration one. Remarks: The position of the set up is not true to scale due to imaging geometry.



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

Certificate Number

CWD-026-67

Page 2 of 2 Pages

MEASUREMENT RESULTS<sup>1</sup>

<sup>1</sup> The wind direction sensor was calibrated against standard rotary encoder by comparison method. During calibration, the measurement was carried out at 45° intervals in clockwise and counterclockwise directions after offset adjustment has been made. The flow speed of wind tunnel (usually 5 m/s) is kept constant while the sensor is rotated around its vertical axis. The results of calibration and associated measurement uncertainties are reported in the table below.

Air speed m/s	$D'$ Degree (°)	$D''$ Degree (°)	Error Degree (°)	$U$ (k=2) Degree (°)
5.04	0.000	0	0	0.00
	45.000	44	-1	0.00
	90.000	87	-3	0.00
	135.000	131	-4	0.00
	180.000	176	-4	0.00
	225.000	222	-3	0.00
	270.000	272	2	0.00
	315.000	320	5	0.00

## Remarks:

<sup>1</sup> Calibration results only count for the tested circumstances and environmental conditions during which calibration took place.

<sup>2</sup> Direction of standard.

<sup>3</sup> Direction of Unit Under Calibration.

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



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

J NAC

JIRAPATT ASSOCIATES CO., LTD.

Jirapatt Associates Co., Ltd.  
104 Phatthanasak Rd.,  
Khuang Suan Luang, Bangkok 10250 Thailand  
(Tel: 02-010-4111)  
Fax: 02-010-4111  
E-mail: jirapatt@jirapatt.com  
Website: www.jirapatt.com

Accredited calibration laboratory  
ISO/IEC 17025:2017  
NAC-TISI-TIS 17025  
CALIBRATION 0367

Wind direction measurement laboratory  
Calibration services department



NAC-TISI-TIS 17025  
CALIBRATION 0367

Certificate Number

CWD 026-67

## CERTIFICATE OF CALIBRATION

Page 1 of 2 Pages

## MEASUREMENT ITEM

## MANUFACTURER

## MODEL/TYPE

## SERIAL NUMBER

## ID NUMBER

## CONDITION AS-RECEIVED

## CUSTOMER

Wind Direction Sensor

: Navalyne

Sensor WS-02F

Data logger: 110-WS-250L-D

Sensor: WSD-A5910

Data logger: AS910

RYS-F50609

: User item

ALS laboratory group (Thailand) Co., Ltd.

104 Phatthanasak Rd., Phatthanasak Rd., Khuang Suan Luang,

Khet Suan Luang, Bangkok 10250 Thailand

## RECEIVED DATE

08 Jul 2024

## MEASUREMENT DATE

18 Jul 2024

## ISSUE DATE

18 Jul 2024

## ENVIRONMENTAL CONDITIONS:

Ambient conditions in the laboratory are as follows:

Temperature: 23.0 ± 3.0 °C

Relative Humidity: 55.0 ± 15.0 %RH

Atmospheric Pressure: 1010 ± 10 hPa

## PLACE OF CALIBRATION

Effel type wind tunnel of Jirapatt Associates Co., Ltd.

## CALIBRATION CONDITION

Wind tunnel cross section area<sup>1</sup> 900 cm<sup>2</sup>Wind direction frontal area<sup>2</sup> 129 cm<sup>2</sup>Diameter of mounting plate<sup>3</sup> mmBlockage ratio of test object<sup>3</sup> 0.143 [-]

## Preconditioning

24 hours at ambient conditions.

## Measurement Condition

Average values during measurement are (22.2°C, (47.5) %RH and (1001.7) hPa

## TABULATION OF RESULTS:

<sup>1</sup> The table on next page give the measured values.

## Calibrated by:

Dr. Mr. Somchai Thairudol  
(Jirapatt Associates Co., Ltd.)



## Remarks:

<sup>1</sup> Image of calibration place of the wind tunnel.

<sup>2</sup> Mounted cross-section area of the tested object include mounting plate.

<sup>3</sup> Diameter of mounting plate.

<sup>4</sup> Blockage ratio.

THIS CERTIFICATE OF CALIBRATION MAY NOT BE REPRODUCED OR KEPT IN FULL UNLESS PERMISSION FOR REPRODUCTION HAS BEEN OBTAINED IN WRITING FROM THE LABORATORY

**Calibration procedure:**  
The wind direction sensor was calibrated against Standard Rotary Encoder by comparison method. During calibration, the measurement was carried out at 45° intervals in clockwise and counterclockwise directions after offset adjustment has been made. The flow speed of wind tunnel (usually 5 m/s) is kept constant while the sensor is rotated around its vertical axis. The results of calibration and associated measurement uncertainties are reported in the table below.

**Traceability:**  
This certificate provides a traceability of the measurement to the International System of Units (SI) through the National Institute of Metrology (NIM) of Thailand via Certificate number: CA-0036-23.

**Uncertainty of Measurement:**  
The reported uncertainty of measurement is based on the standard uncertainty multiplied by a coverage factor  $k=2$ , which for a normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty has been determined in accordance with the GUM (Evaluation of measurement data) Guide to the expression of uncertainty in measurement.

J NAC

JIRAPATT ASSOCIATES CO., LTD.

Jirapatt Associates Co., Ltd.  
104 Phatthanasak Rd.,  
Khuang Suan Luang, Bangkok 10250 Thailand  
(Tel: 02-010-4111)  
Fax: 02-010-4111  
E-mail: jirapatt@jirapatt.com  
Website: www.jirapatt.com

Accredited calibration laboratory  
ISO/IEC 17025:2017  
NAC-TISI-TIS 17025  
CALIBRATION 0367

Temperature measurement laboratory  
Calibration services department



NAC-TISI-TIS 17025  
CALIBRATION 0367

## CERTIFICATE OF CALIBRATION

Certificate No.: CDT-121-67

Page 1 of 2 Pages

## MEASUREMENT ITEM

## MANUFACTURER

## MODEL/TYPE

## SERIAL NUMBER

## ID NUMBER

## CONDITION AS-RECEIVED

## CUSTOMER

Data Logger with Temperature sensor

: Navalyne

110-WS-250L-D

AS910

: RYS-F50609

: User item

ALS laboratory group (Thailand) Co., Ltd.

104 Phatthanasak Rd., Phatthanasak Rd., Khuang Suan Luang,

Khet Suan Luang, Bangkok 10250 Thailand

## RECEIVED DATE

08 Jul 2024

## MEASUREMENT DATE

16 Jul 2024

## ISSUE DATE

18 Jul 2024

## ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follows

Temperature: 23.0 ± 3.0 °C

Relative Humidity: 55.0 ± 15.0 %RH

**NOTED:** The certificate is valid only to the item calibrated on date and place of calibration

## TABULATION OF RESULTS:

The table on next page give the measured values

## Calibrated by:

Dr. Mr. Somchai Thairudol  
(Jirapatt Associates Co., Ltd.)  
E: Somchai.Thairudol@jirapatt.com



THIS CERTIFICATE MAY NOT BE REPRODUCED EXCEPT IN FULL UNLESS PERMISSION FOR REPRODUCTION HAS BEEN OBTAINED IN WRITING FROM THE LABORATORY

Continuation of Certificate of Calibration Number CDT-121-67

Page 2 of 2 Pages

Result of Calibration: ☒ Without Adjustment ☐ With Adjustment

Calibration Range: 20 °C to 40 °C

**Function:**

Table 1: This equipment was connected with temperature sensor Model: HMP60 S/N: U3641223.  
Dimension: Diameter 12 mm, Length 80 mm

Immersion Depth (mm)	Standard Reading (°C)	UUC Reading (°C)	Error (°C)	Uncertainty (°C)
80	20.047	19.6	0.4	0.099
80	25.043	24.6	-0.4	0.099
80	30.034	29.7	-0.3	0.099
80	35.026	34.7	-0.3	0.099
80	40.018	39.5	-0.5	0.099

UUC\*: Unit Under Calibration

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



Accredited calibration laboratory  
ISO/IEC 17025:2017  
NSC-TIS-17025  
CALIBRATION 0367

Relative humidity and Air Temperature measurement laboratory  
Calibration services department

**CERTIFICATE OF CALIBRATION**

Certificate No.: CRT-023-67

Page 1 of 2 Pages

**MEASUREMENT ITEM**

MANUFACTURER

MODEL/TYPE

SERIAL NUMBER

ID NUMBER

CONDITION AS-RECEIVED

CUSTOMER

Relative humidity with data logger

Novelty

Data Logger: 110 WS 250L D

Sensor: HMP60

Data Logger: AS910

Sensor: U3641223

RHS\_F56000

Used item

ALS laboratory group (Thailand) Co., Ltd

104 Phatthanakan 40, Phatthanakan Rd, Khwaeng Suan Luang,

Khet Suan Luang, Bangkok 10250 Thailand

RECEIVED DATE

06 Jul 2024

MEASUREMENT DATE

18 Jul 2024

ISSUE DATE

18 Jul 2024

**ENVIRONMENTAL CONDITIONS:**

Ambient condition in the laboratory are as follow

Temperature: 23.0 ± 3.0 °C

Relative Humidity: 55.0 ± 15.0 %RH

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

**TABULATION OF RESULTS:**

The table on next page give the measured values

**Calibration procedure**

The Relative humidity and Air Temperature calibration was done by in Moist calibration method as WI 01-003 and WI 01-010 according in comparison method with Standard United Meter International from, measure within standard humidity generator chamber.

**Traceability:**

The calibrations are traceable to the international system of units (SI) through National Institute of Metrology Thailand (NIMT) Certificate number: TH051-22 and through provider: Apolonia Co., Ltd. Certificate number: CDT 003-03

**Uncertainty of Measurement:**

The reported uncertainty of measurement is based on the standard uncertainty multiplied by a coverage factor of 2, which for a normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty has been determined in accordance with the GUM Evaluation of measurement data Guide to the expression of uncertainty in measurement

Calibrated by

- ☐ Mr. Sorawat Thacholad
- ☒ Mr. Sorawat Thacholad
- ☐ Mr. Sorawat Thacholad



THIS CERTIFICATE REPORT MAY NOT BE REPRODUCED EXCEPT IN FULL UNLESS PERMISSION FOR REPRODUCTION HAS BEEN OBTAINED IN WRITING FROM THE LABORATORY

Continuation of Certificate of Calibration Number: CRT-023-67

Page 2 of 2 Pages

**Measurement Results:**

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

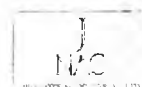
Result of Calibration: ☒ Without Adjustment ☐ With Adjustment

Table 1: The results of calibration of relative humidity at 20 °C are reported in table below  
Calibration Range: 20%RH to 80%RH

Air Temperature (°C)	Standard Reading (%RH)	UUC Reading (%RH)	Error (%RH)	Uncertainty (%RH)
25.78	50.57	47.7	-2.8	0.9
25.83	50.57	47.9	-2.7	1.3
25.90	50.57	48.0	-2.6	2.3

UUC\*: Unit Under Calibration

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



Accredited calibration laboratory  
ISO/IEC 17025:2017  
NSC-TIS-17025  
CALIBRATION 0367

Air speed measurement laboratory  
Calibration services department

**CERTIFICATE OF CALIBRATION**

Page 1 of 2 Pages

**MEASUREMENT ITEM**

MANUFACTURER

MODEL/TYPE

SERIAL NUMBER

ID NUMBER

CONDITION AS-RECEIVED

CUSTOMER

Cup anemometer

Novelty

Sensor: WS-020

Data Logger: 200 WS-250E

Sensor: WSD-AS101

Data Logger: AS191

RHS\_F50328

Used item

ALS laboratory group (Thailand) Co., Ltd

104 Phatthanakan 40, Phatthanakan Rd, Khwaeng Suan Luang,

Khet Suan Luang, Bangkok 10250 Thailand

RECEIVED DATE

11 Aug 2023

MEASUREMENT DATE

18 Aug 2023

ISSUE DATE

21 Aug 2023

**ENVIRONMENTAL CONDITIONS:**

Ambient condition in the laboratory are as follow

Temperature: 23.0 ± 3.0 °C

Relative Humidity: 55.0 ± 15.0 %RH

Atmospheric Pressure: 1010 ± 10 hPa

**PLACE OF CALIBRATION**

Elliptical type wind tunnel at Jirassatit Associate Co., Ltd

**CALIBRATION CONDITIONS**

Wind tunnel cross section area<sup>1</sup>

900 cm<sup>2</sup>

Wind direction frontal area<sup>2</sup>

100 cm<sup>2</sup>

Diameter of mounting pipe<sup>3</sup>

10 mm

Blockage ratio of test object<sup>4</sup>

0.112 [-]

**Preconditioning**

24 hours at ambient conditions

**Measurement Condition**

The average values during measurement are (34.1) °C, (44.3) %RH and (1005.4) hPa

**TABULATION OF RESULTS:**

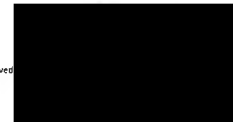
The table on next page give the measured values

Calibrated by

- ☒ Mr. Sorawat Thacholad
- ☐ Mr. Sorawat Thacholad
- ☐ Mr. Sorawat Thacholad



Approved



**Remarks:**

- <sup>1</sup> Available cross section area of the wind tunnel
- <sup>2</sup> Projected cross section area of the tested object include mounting pipe
- <sup>3</sup> Diameter of mounting pipe
- <sup>4</sup> Ratio [-]

THIS CERTIFICATE OF CALIBRATION MAY NOT BE REPRODUCED EXCEPT IN FULL UNLESS PERMISSION FOR REPRODUCTION HAS BEEN OBTAINED IN WRITING FROM THE LABORATORY







### DIGITAL TEMPERATURE CALIBRATION DATA SHEET

Calibration Date :	10 Jul 24	Ambient Temperature (°C)	28.2		
Calibration sheet No : C-100724-RYG_FS0315		Relative Humidity (%) :	64		
Digital Temperature ID :	RYG_FS0315	Reference Temperature ID	RYG_FS0315		
Serial No :	1708091	Serial No :	20109014918		
Model :	XC-572-V	Model :	Digicon-CC-VT-MS		
		Next Calibrate :	13 Nov 24		
Location	Reference Temperature °C	Digital Temperature °C	Error °C	MPE	Pass / Fail
Stack	0	0	0	±3	Pass
	25	25	0	±3	Pass
	50	50	0	±3	Pass
	100	101	1	±3	Pass
	150	151	1	±3	Pass
	200	200	0	±3	Pass
Probe	250	250	0	±3	Pass
	300	301	1	±3	Pass
	500	501	1	±3	Pass
	100	102	2	±3	Pass
	120	121	1	±3	Pass
	140	141	1	±3	Pass
Oven	100	101	1	±3	Pass
	120	120	0	±3	Pass
	140	141	1	±3	Pass
Filter	100	101	1	±3	Pass
	120	121	1	±3	Pass
	140	140	0	±3	Pass
Exit	0	0	0	±3	Pass
	10	10	0	±3	Pass
	20	20	0	±3	Pass
Meter	0	-1	-1	±3	Pass
	25	24	-1	±3	Pass
	50	49	-1	±3	Pass
AUX	0	0	0	±3	Pass
	25	25	0	±3	Pass
	50	50	0	±3	Pass

MPE : (Maximum permissible error of measurement) ค่าความคลาดเคลื่อนสูงสุดที่วัดได้



### PROBE NOZZLE DIAMETER CALIBRATION DATA SHEET

Calibration Date :	10 Jul 24	Nozzle Set ID :	RYG_FS0319
Calibration Sheet No. :	C-100724-RYG_FS0319	Vernier Caliper ID :	BKK_FS1123

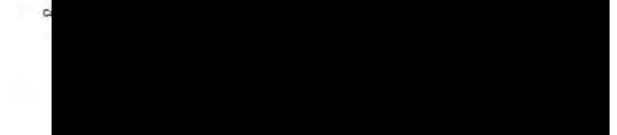
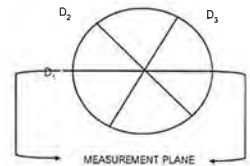
Nozzle ID #	Nozzle Diameter (cm.)			Hi - Lo	$(D_1 + D_2 + D_3)/3$
	D <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>	ΔD	D <sub>avg</sub>
1	0.298	0.300	0.305	0.007	0.301
2	0.465	0.475	0.465	0.010	0.468
3	0.605	0.605	0.605	0.000	0.605
4	0.770	0.760	0.765	0.010	0.765
5	0.930	0.928	0.930	0.002	0.929
6	1.062	1.080	1.085	0.005	1.082
7	1.240	1.230	1.235	0.010	1.235
8	1.594	1.558	1.551	0.043	1.568

Where :

D<sub>1</sub>, D<sub>2</sub>, D<sub>3</sub> = There different nozzle diameters at 60 degrees to each other, each measured the nearest 0.025 mm.

ΔD = Maximum distance between any two diameters, must be ≤ 0.100 mm

D<sub>avg</sub> = (D<sub>1</sub> + D<sub>2</sub> + D<sub>3</sub>) / 3



### Stopwatch Calibration Test Report

Calibration Date : 10 Jul 24      Next Cal. Date : 10 Jan 25  
Barometric Pressure (mmHg) : 749.1      Temperature (°C) : 33.8  
Relative Humidity (%) : 46.2

Reference Stopwatch Data      Console Control Meter Data  
Stopwatch ID No : RYG\_FS0540      Dry Gas Meter No : BKK\_FS0556  
Model : F608      Model : XC-572-V  
Serial No : E18061      Serial No : 1606041  
Calibration Date : 4 Jul 24  
Certificate No : E-2407022

Run No	Time Actual (m:ss.ms)	Time Reading (m:ss)	Diff. (ms)	Diff. (min)
1	5:00:03	5:00	3	0.00005
2	5:00:07	5:00	7	0.00012
3	5:00:07	5:00	7	0.00012
4	5:00:08	5:00	8	0.00013
5	5:00:05	5:00	5	0.00008
6	5:00:07	5:00	7	0.00012
7	5:00:06	5:00	6	0.00010
8	5:00:08	5:00	8	0.00013
9	5:00:08	5:00	8	0.00013
10	5:00:07	5:00	7	0.00012
Average			7	0.00011
SD				0.00003



### CONSOLE CONTROL UNIT CALIBRATION TEST REPORT

Calibration of Date : 10 Jul 24      Barometric Pressure (mmHg) : 749.1  
Next Cal. Date : 19 Jan 25      Relative Humidity (%) : 46.2  
Console Control Meter Data      Reference Dry Gas Meter Data  
Calibration No : C-100724-BKK\_FS0556      Reference Dry Gas Meter ID :  
Dry Gas Meter ID : BKK\_FS0556      Serial No :  
Serial No : 1606041      Correction Factor (F) :  
Model No : XC-572-V      Next Calibration Date :

ΔH (mm Hg)	θ (Min)	Reference Dry Gas Meter Calibration				Console Control Dry Gas Meter			
		Flow (mL/min)	Pressure (mmHg)	Temp (°C)	Flow (mL/min)	Pressure (mmHg)	Temp (°C)	Flow (mL/min)	Temp (°C)
10	15.75	150.00	0.90	150.00	250	300.00	1.40	300.00	30.0
20	9.24	150.00	0.90	150.00	250	300.00	1.40	300.00	30.0
30	6.53	150.00	0.90	150.00	250	300.00	1.40	300.00	30.0
40	5.19	150.00	0.90	150.00	250	300.00	1.40	300.00	30.0
50	4.20	150.00	0.90	150.00	250	300.00	1.40	300.00	30.0

F = Ratio of reading of reference to dry gas meter. Tolerance for individual values ± 0.02 from average





### DIGITAL TEMPERATURE CALIBRATION DATA SHEET

Calibration Date :	10 Jul 24	Ambient Temperature (°C)	33.8		
Calibration sheet No. : C-100724-BKK_FS0557		Relative Humidity (%) :	48.2		
Digital Temperature ID : BKK_FS0557		Reference Temperature ID	RYG_FS0681		
Serial No. : 1606041		Serial No. :	201090014818		
Model : XC-572-V		Model :	Digloco-CC-VT-MS		
		Next Calibrate :	13 Nov 24		
Location	Reference Temperature °C	Digital Temperature °C	Error °C	MPE	Pass / Fail
Stack	0	0	0	±3	Pass
	25	24	-1	±3	Pass
	50	49	-1	±3	Pass
	100	99	-1	±3	Pass
	150	149	-1	±3	Pass
	200	199	-1	±3	Pass
	250	249	-1	±3	Pass
	300	299	-1	±3	Pass
Probe	500	499	-1	±3	Pass
	100	99	-1	±3	Pass
	120	119	-1	±3	Pass
	140	139	-1	±3	Pass
Oven	100	99	-1	±3	Pass
	120	119	-1	±3	Pass
	140	139	-1	±3	Pass
Filter	100	100	0	±3	Pass
	120	120	0	±3	Pass
	140	141	1	±3	Pass
Exit	0	0	0	±3	Pass
	10	10	0	±3	Pass
	20	20	0	±3	Pass
Meter	0	0	0	±3	Pass
	25	25	0	±3	Pass
	50	50	0	±3	Pass
AUX	0	0	0	±3	Pass
	25	24	-1	±3	Pass
	50	49	-1	±3	Pass

MPE : (Maximum permissible error of measurement) ค่าความคลาดเคลื่อนสูงสุดที่อนุญาต



### PROBE NOZZLE DIAMETER CALIBRATION DATA SHEET

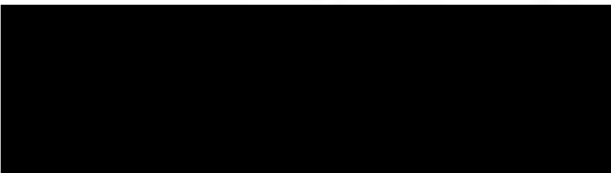
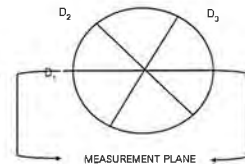
Calibration Date :		10 Jul 24		Nozzle Set ID. :		BKK_FS0562	
Calibration Sheet No. :		C-100724-BKK_FS0562		Vernier Caliper ID.:		BKK_FS1123	
Nozzle ID #	Nozzle Diameter (cm)			Hi - Lo	$(D_1 + D_2 + D_3) / 3$		
	D <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>	ΔD	D <sub>avg</sub>		
1	0.305	0.302	0.302	0.003	0.303		
2	0.485	0.475	0.485	0.010	0.482		
3	0.620	0.635	0.635	0.015	0.630		
4	0.765	0.765	0.765	0.000	0.765		
5	0.970	0.980	0.975	0.010	0.975		
6	1.085	1.085	1.081	0.004	1.084		
7	1.275	1.275	1.275	0.000	1.275		
8	1.610	1.610	1.615	0.005	1.612		

Where :

D<sub>1</sub>, D<sub>2</sub>, D<sub>3</sub> = Three different nozzle diameters at 60 degrees to each other, each measured the nearest 0.025 mm.

ΔD = Maximum distance between any two diameters must be ≤ 0.100 mm.

D<sub>avg</sub> = (D<sub>1</sub> + D<sub>2</sub> + D<sub>3</sub>) / 3



### Stopwatch Calibration Test Report

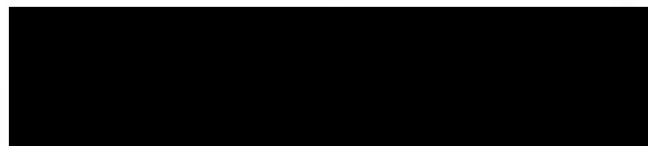
Calibration Date : 31 Jul 24  
Barometric Pressure (mmHg) : 754  
Relative Humidity (%) : 53.0

Next Cal. Date : 31 Jan 25  
Temperature (°C) : 27.0

Reference Stopwatch Data  
Stopwatch ID No. : RYG\_FS0540  
Model : F808  
Serial No. : E18061  
Calibration Date : 4 Jul 24  
Certificate No. : E-2407022

Console Control Meter Data  
Dry Gas Meter No. BKK\_FS0527  
Model : XC-572-V  
Serial No. : 1508053

Run No.	Time Actual (m:ss.ms)	Time Reading (m:ss)	Diff. (ms)	Diff. (min)
1	5:00:03	5:00	3	0.00005
2	5:00:09	5:00	9	0.00013
3	5:00:09	5:00	9	0.00015
4	5:00:11	5:00	11	0.00016
5	5:00:05	5:00	5	0.00008
6	5:00:06	5:00	6	0.00010
7	5:00:06	5:00	6	0.00010
8	5:00:08	5:00	8	0.00013
9	5:00:09	5:00	9	0.00015
10	5:00:07	5:00	7	0.00012
Average				0.00012
SD				0.00004



### CONSOLE CONTROL UNIT CALIBRATION TEST REPORT

Calibration Date : 31 Jul 24  
Next Cal. Date : 31 Jan 25

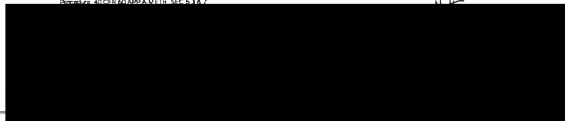
Barometric Pressure (mmHg) : 754  
Relative Humidity (%) : 53.0  
Temperature (°C) : 27.0

Console Control Meter Data  
Calibration ID : C-100724-BKK\_FS0527  
Dry Gas Meter ID : BKK\_FS0527  
Serial No. : 1508053  
Model : XC-572-V

Reference Dry Gas Meter Data  
Reference Dry Gas Meter ID : RYG\_FS0540  
Serial No. : E18061  
Correction Factor (1) : 1.00000  
Next Calibration Date : 4 Jul 24

ΔH	g	Reference Dry Gas Meter Calibration				Console Control Dry Gas Meter			
		Flow (m³/hr)	Flow (m³/hr)	Flow (m³/hr)	Flow (m³/hr)	Flow (m³/hr)	Flow (m³/hr)	Flow (m³/hr)	Flow (m³/hr)
1	11.80	150.00	0.00	150.00	25.0	150.00	0.00	150.00	25.0
2	9.02	150.00	0.00	150.00	25.0	150.00	0.00	150.00	25.0
3	6.93	150.00	0.00	150.00	25.0	150.00	0.00	150.00	25.0
4	5.02	150.00	0.00	150.00	25.0	150.00	0.00	150.00	25.0
5	4.12	150.00	0.00	150.00	25.0	150.00	0.00	150.00	25.0

ΔH : Rate of change of reference to dry gas meter. (tolerance for individual values ± 0.02 from average)  
Δg : (Dry gas pressure tolerance) not required. (0.21 m of w.c. @ 75°C and 750 mm of mercury) (tolerance for individual values ± 5 mmHg) (0.21 m of w.c. @ 75°C and 750 mm of mercury) (tolerance for individual values ± 5 mmHg)





### DIGITAL TEMPERATURE CALIBRATION DATA SHEET

Calibration Date :	31 Jul 24	Ambient Temperature (°C)	27		
Calibration sheet No. : C-310724-BKK_FS0527		Relative Humidity (%) :	53		
Digital Temperature ID : BKK_FS0527		Reference Temperature ID	RYG_FS0801		
Serial No. :		Serial No. :	201090014618		
Model : XC-572-V		Model :	Digicon-CC-VT-MS		
		Next Calibrate :	13 Nov 24		
Location	Reference Temperature °C	Digital Temperature °C	Error °C	MPE	Pass / Fail
Stack	0	0	0	±3	Pass
	25	25	0	±3	Pass
	50	50	0	±3	Pass
	100	100	0	±3	Pass
	150	150	0	±3	Pass
	200	200	0	±3	Pass
Probe	250	250	0	±3	Pass
	300	300	0	±3	Pass
	500	501	1	±3	Pass
	100	101	1	±3	Pass
	120	121	1	±3	Pass
	140	141	1	±3	Pass
Oven	100	101	-	±3	-
	120	121	-	±3	-
	140	142	-	±3	-
Filter	100	102	2	±3	Pass
	120	121	1	±3	Pass
	140	141	1	±3	Pass
Exit	0	1	1	±3	Pass
	10	9	-1	±3	Pass
	20	20	0	±3	Pass
Meter	0	-1	-1	±3	Pass
	25	24	-1	±3	Pass
	50	48	-2	±3	Pass
AUX	0	-1	-1	±3	Pass
	25	25	0	±3	Pass
	50	50	0	±3	Pass

MPE : (Maximum permissible error of measurement) ค่าความคลาดเคลื่อนสูงสุดที่วัดได้



### PROBE NOZZLE DIAMETER CALIBRATION DATA SHEET

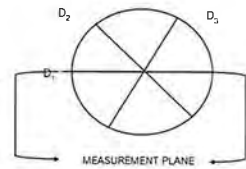
Calibration Date : 31 Jul 24		Nozzle Set ID. : BKK_FS0533			
Calibration Sheet No : C-310724-BKK_FS0533		Vernier Caliper ID. : BKK_FS1123			
Nozzle ID #	Nozzle Diameter (cm)			Hi - Lo	$(D_1 + D_2 + D_3) / 3$
	D <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>	ΔD	D <sub>avg</sub>
1	0.316	0.318	0.316	0.002	0.317
2	0.480	0.475	0.474	0.006	0.476
3	0.635	0.635	0.635	0.000	0.635
4	0.791	0.792	0.791	0.001	0.791
5	0.950	0.952	0.951	0.002	0.951
6	1.068	1.080	1.069	0.009	1.066
7	1.270	1.270	1.270	0.000	1.270
8	1.600	1.600	1.598	0.002	1.599

Where :

D<sub>1</sub>, D<sub>2</sub>, D<sub>3</sub> = There different nozzle diameters at 60 degrees to each other, each measured the nearest 0.025 mm.

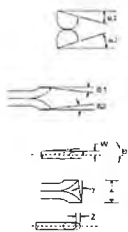
ΔD = Maximum distance between any two diameters, must be ≤ 0.100 mm

D<sub>avg</sub> = (D<sub>1</sub> + D<sub>2</sub> + D<sub>3</sub>) / 3



### Type S Pitot Tube Calibration

Date Calibration 10-Jul-24 Due Date 10-Jan-25  
Pitot ID RYG\_FS0321 Inclinator ID BKK\_FS1131  
Pitot SN - Vernier ID RYG\_FS0539



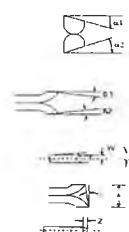
Parameter	Value	Allowable Range	Check
α1	-1.4	-10° < α1 < +10°	OK
α2	-0.2	-10° < α2 < +10°	OK
β1	0.8	-5° < β1 < +5°	OK
β2	-0.4	-5° < β2 < +5°	OK
γ	0.8	-	-
θ	0.5	-	-
Z = A tan γ	0.013	Z ≤ 0.125"	OK
W = A tan θ	0.008	W ≤ 0.031"	OK
Dt	0.310	0.188" to 0.375"	OK
A/2Dt	1.484	1.05 ≤ PA/Dt ≤ 1.5	OK
A	0.92	2.1Dt ≤ A ≤ 3Dt	OK

Certify that pitot tube/probe meets or exceeds all specifications, criteria and/or applicable design features and is hereby assigned a pitot tube certification fact of 0.84 . See 40 CFR Pt. 60, App. A, EPA Method 2.



### Type S Pitot Tube Calibration

Date Calibration 10-Jul-24 Due Date 10-Jan-25  
Pitot ID BKK\_FS0561 Inclinator ID BKK\_FS1131  
Pitot SN - Vernier ID RYG\_FS0539



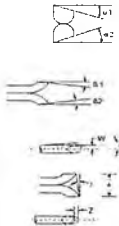
Parameter	Value	Allowable Range	Check
α1	-2.4	-10° < α1 < +10°	OK
α2	-1.2	-10° < α2 < +10°	OK
β1	-2.0	-5° < β1 < +5°	OK
β2	1.3	-5° < β2 < +5°	OK
γ	0.3	-	-
θ	0.2	-	-
Z = A tan γ	0.005	Z ≤ 0.125"	OK
W = A tan θ	0.003	W ≤ 0.031"	OK
Dt	0.310	0.188" to 0.375"	OK
A/2Dt	1.468	1.05 ≤ PA/Dt ≤ 1.5	OK
A	0.91	2.1Dt ≤ A ≤ 3Dt	OK

Certify that pitot tube/probe meets or exceeds all specifications, criteria and/or applicable design features and is hereby assigned a pitot tube certification fact of 0.84 . See 40 CFR Pt. 60, App. A, EPA Method 2.



## Type S Pitot Tube Calibration

Date Calibration 5-Jul-24 Due Date 3-Jan-25  
Pitot ID BKK\_FS0551 Inclinator ID BKK\_FS1131  
Pitot SN - Vernier ID BKK\_FS1405



Parameter	Value	Allowable Range	Check
$\alpha_1$	2.4	$-10^\circ < \alpha_1 < +10^\circ$	OK
$\alpha_2$	-3.1	$-10^\circ < \alpha_2 < +10^\circ$	OK
$\beta_1$	-0.4	$-5^\circ < \beta_1 < +5^\circ$	OK
$\beta_2$	9.3	$-5^\circ < \beta_2 < +5^\circ$	OK
$\gamma$	1.3	-	-
B	1.4	-	-
$Z = A \tan \gamma$	0.020	$Z \leq 0.125''$	OK
$W = A \tan \theta$	0.021	$W \leq 0.031''$	OK
Dt	0.375	$0.188'' \text{ to } 0.375''$	OK
A/2Dt	1.160	$1.05 \leq A/2Dt \leq 1.5$	OK
A	0.87	$2.1Dt \leq A \leq 3Dt$	OK

Certify that pitot tube/probe meets or exceeds all specifications, criteria and/or applicable design features and is hereby assigned a pitot tube certification factor of 0.84. See 40 CFR Pt. 60, App. A, EPA Method 2.

FORM NO.: F-05-124 REVISION NO.: 0 ISSUE DATE: 25/12/23

testo

## Calibration certificate Kalibrier-Zertifikat

5753561

Object: Control Unit 1350 Measuring Box testo 350  
Manufacturer: TESTO SE & Co. KGaA  
Type description: 0632 3511  
Serial no.: 64554897  
Inventory no.:  
Test equipment no.:  
Equipment no.: 15862485  
Location: Sianport  
Customer: ALS Laboratory Group (Thailand) Co., Ltd.  
Customer ID no.: 1031994  
Order no.: 12459724 / 0520 0055

Date of calibration: 16.07.2024  
Date of the recommended re-calibration: 16.07.2025  
Conformity statement: Pass

The expanded uncertainty of measurement was calculated according to EN ISO 9001:2015, and the uncertainty of the measurement is made according to the GUM (Guide to the Expression of Uncertainty in Measurement). The uncertainty is expressed as a percentage of the measured value. The uncertainty is calculated according to the GUM (Guide to the Expression of Uncertainty in Measurement). The uncertainty is expressed as a percentage of the measured value. The uncertainty is calculated according to the GUM (Guide to the Expression of Uncertainty in Measurement). The uncertainty is expressed as a percentage of the measured value.

REVIEW BY: [Signature]  
APPROVED BY: [Signature]  
NEXT CAL DATE: 16.07.2025

Testo Industrial Services GmbH

Gewerbestraße 3  
79189 Korbussen

Tel: +49 7801 90801-8000  
Fax: +49 7801 90801-8001

www.testo.de  
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testo

## Calibration certificate Kalibrier-Zertifikat

5753561

### Measuring equipment Messschiebungen

Reference	Traceability	Next cal.	Certificate no.	Eq. no.
1. Reference	Reference	Next cal.	Certificate no.	Eq. no.
2. Test gas medium 1 Propane Medium 1	2024-07-01	2025-07-01	5714402	12459724
3. Test gas medium 2 Propane Medium 2	2024-07-01	2025-07-01	5714402	12459724
4. Test gas medium 3 Propane Medium 3	2024-07-01	2025-07-01	5714402	12459724
5. Test gas medium 4 Propane Medium 4	2024-07-01	2025-07-01	5714402	12459724
6. Test gas medium 5 Propane Medium 5	2024-07-01	2025-07-01	5714402	12459724
7. Test gas medium 6 Propane Medium 6	2024-07-01	2025-07-01	5714402	12459724
8. Test gas medium 7 Propane Medium 7	2024-07-01	2025-07-01	5714402	12459724
9. Test gas medium 8 Propane Medium 8	2024-07-01	2025-07-01	5714402	12459724
10. Test gas medium 9 Propane Medium 9	2024-07-01	2025-07-01	5714402	12459724
11. Test gas medium 10 Propane Medium 10	2024-07-01	2025-07-01	5714402	12459724

Reference certificates are available at [www.primosonline.com](http://www.primosonline.com) and [www.primosonline.com](http://www.primosonline.com) and [www.primosonline.com](http://www.primosonline.com)

### Ambient conditions Umgebungsbedingungen

Temperature Temperatur (20...26) °C Humidity Feuchte (20...60) % RH % r.f.

### Measuring procedure Messverfahren

The calibration was carried out by comparison measurement with calibrated test gases. Die Kalibrierung erfolgte durch Vergleichsmessung mit kalibrierten Prüfgasen.

### Measuring results Messergebnisse

Channel Kanal

Reference value	Indicated measured value	Deviation	Allowed deviation	Measurement	Confirmation
Bezugswert	Angezeigter Messwert	Abweichung	Zulässige Abweichung	Messunsicherheit (k=2)	Bestätigung
ppm	Vol.-%	ppm	Vol.-%	ppm	Vol.-%
CO					
100.0	100.0	-0.6	± 1.1	3.3	pass
400.0	400.0	2.0	± 2.1	8.4	pass
700.0	700.0	2.0	± 3.6	14.4	pass
NO					
150.0	151.0	0.8	± 9.0	4.0	pass
300.0	302.0	2.0	± 16.0	6.9	pass
NO2					
100.0	102.3	1.9	± 5.1	3.20	pass
SO2					
97.0	96.0	-1.0	± 6.0	3.5	pass
O2					
0.02	0.09	0.09	± 0.21	0.027	pass
2.52	2.57	0.05	± 0.21	0.055	pass
5.01	5.17	0.16	± 0.21	0.107	pass

In accordance with the manufacturer's permit to use.

Remarks Bemerkungen

...

Testo Industrial Services GmbH

Gewerbestraße 3  
79189 Korbussen

Tel: +49 7801 90801-8000  
Fax: +49 7801 90801-8001

www.testo.de  
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Sartorius (Thailand) Co., Ltd.  
128 Rama 9 Road, Huaykwang, Huaykwang, Bangkok 10310  
Tel: +66 2543 8391-6, e-mail: service.thailand@sartorius.com



SARTORIUS

## Certificate of Calibration

REVIEW BY: [Signature]  
APPROVED BY: [Signature]  
NEXT CAL DATE: 02.02.2025

Model Number: MSU224S-100-DU Certificate No.: 24BC0073  
Description: Analytical Balance Issued Date: Friday, February 23, 2024  
Serial Number: 0031709552 Reference No.: 229196  
ID No.: RYG\_EN0003  
Manufacturer: Sartorius Page No.: 1 of 2

Customer Name: ALS Laboratory Group (Thailand) Co., Ltd. (Rayong Branch)  
616/10 Moo 5 T.Maenam Khw. A.Pluak Daeng, Rayong 21140, Thailand.

Calibrated Place: ALS Laboratory Group (Thailand) Co., Ltd. (Balance Room)  
616/10 Moo 5 T.Maenam Khw. A.Pluak Daeng, Rayong 21140, Thailand.

Calibrated By: Mr.Chonchai Inthana  
Calibration Date: Thursday, February 22, 2024  
Calibration Procedure No.: This calibration was conducted by Using in-house calibration procedure number (WI-003) Based on UKAS Lab 14: 2019

Metrological data:  
Capacity: 220 g Readability: 0.0001 g  
Ambients Conditions:  
Temperature: 23.7 °C ± 5.0 °C  
Humidity: 62.0 % RH ± 10.0 % RH  
Pressure: ±

Reasons for calibration

☐ New Installation ☐ Service / Repair ☒ Re-calibration / Maintenance

Equipment Condition: ☒ Good Operate ☐ Fair

### Measurement Method UKAS Publication Ref: Lab 14

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 the Expression of Uncertainty in Measurement (GUM). The calibration certificate documents the traceability to National Standards, which realise the unit of measurement according to the International Standard System of Units (SI). Report of Tolerance came from list of Sartorius Metrological Specifications.

### Traceability:

Model Number	Description	Traceability	Certificate No.	Due Date
YC5011-522-00	Sartorius weight set 1mg - 5000g E2 YC5011-522-00	TCS	M2308197S	23-Aug-2025
MHB-3825D	Humidity/Balometer/Temp. Lutron MHB-3825D	DKSH	C1923184S	23-Aug-2024

This certificate is valid and apply this equipment only.

This certificate may not be reproduced other than in full except the prior written approval of the Verification Operation Division Sartorius (Thailand) Co., Ltd.

SOP FM 33 03 February 2022





# Certificate of Calibration

Model Number : MSU224S-100-DU Certificate No : 24BCI0073  
Description : Analytical Balance Issued Date : Friday, February 23, 2024  
Serial Number : 0031708552 Reference No. : 229196  
ID No : RYG\_EN0003  
Manufacturer : Sartorius Page No : 2 of 2

## Calibration Results : Without Adjustment

### Repeatability

The reproducibility is the ability of a weighing instrument to display nearly identical readings under constant test conditions when the same load within a measurement range is placed repeatedly on the weighing pan in the same manner. The standard deviation is used to express reproducibility quantitatively.

Nominal Value : (Low Load)	20.0000	200.0001
20 g	20.0000	200.0000
Tolerance	20.0001	200.0001
0.0001 g	20.0000	200.0001
Nominal Value : (High Load)	20.0000	200.0001
200 g	19.9999	200.0001
Tolerance	20.0000	200.0000
0.0001 g	20.0000	200.0000
Standard Deviation	0.00005	0.00005

### Eccentricity (Off-center loading error)

The off-center loading error is yielded by the difference between the reading of the load, i.e. 1/3 or 1/4 of maximum capacity, placed in the middle of the weighing pan and between each of four additional measurement points (positions defined according to OIML R111).

Nominal value :	100 g	9
Tolerance	0.0004	9
		Difference
		1 -
		2 0.0000
		3 -0.0001
		4 0.0000
		5 0.0001
		6 -

### Linearity

The linearity, also called linearity error, describes the deviation of the characteristic curve of a weighing instrument from the linear slope.

Tolerance		0.0002 g		
Nominal Value	Conventional Mass Value	Displayed Value	Deviation	Uncertainty
(g)	(g)	(g)	(g)	(g)
0.01	0.0100	0.0100	0.0000	0.00013
0.1	0.1000	0.1000	0.0000	0.00013
0.5	0.5000	0.5000	0.0000	0.00013
1	1.0000	1.0000	0.0000	0.00013
5	5.0000	5.0000	0.0000	0.00013
10	10.0000	10.0000	0.0000	0.00013
20	20.0000	20.0000	0.0000	0.00013
50	50.0000	50.0000	0.0000	0.00024
100	100.0000	99.9999	-0.0001	0.00016
200	200.0000	199.9999	-0.0001	0.00029

End of Report

SOP FM 33 03 February 2022



Lot No. 2483307-1

## ANALYZER CALIBRATION DATA

Client : GLOW ENERGY PUBLIC CO., Ltd. Location : HRSG 41  
Date : 26 Oct 24 Test Operator : Usaree N.  
O<sub>2</sub> ANALYZER : TELEDYNE API T200H Serial No : 923  
Model : 25

	Cylinder Value (%)	Initial Analyzers Calibration Response (%)	Final Analyzers Calibration Response (%)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.00	0.00
Low-Level Gas	7.58	7.55	7.55	0.04
Span Gas	16.04	16.02	16.03	0.04

NO<sub>2</sub> ANALYZER : TELEDYNE API T200H Serial No : 923  
Model : 200  
Span (ppm) : 200

	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	55.80	55.37	55.42	0.03
Span Gas	162.90	162.94	162.75	0.09

SO<sub>2</sub> ANALYZER : TELEDYNE API T100H Serial No : 536  
Model : 200  
Span (ppm) : 200

	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	55.20	55.11	55.05	0.04
Span Gas	162.80	162.84	163.05	0.06

CO ANALYZER : TELEDYNE API T300M Serial No : 845  
Model : 200  
Span (ppm) : 200

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.01	0.02	0.01
Low-Level Gas	55.22	55.00	55.05	0.02
Span Gas	156.00	155.95	155.82	0.06

Calibrated by

FORM NO. F 06-002 REVISION NO. 4 ISSUE DATE 18/01/24

ALS Laboratory Group

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Lot No. 2483307-1

## SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client : GLOW ENERGY PUBLIC CO., Ltd. Location : HRSG 41  
Date : 26 Oct 24 Test Operator : Usaree N.  
O<sub>2</sub> ANALYZER : 16.04 Span (%) : 25  
Cylinder Conc. (%) : 25

	O <sub>2</sub> Analyzer Calibration Response	System Calibration Response	System Calibration Response	System Calibration Response	System Calibration Response	Drift (% of Span)
Zero Gas	0.00	0.00	0.00	0.00	0.00	0.00
Upscale Gas	16.02	16.00	0.00	16.02	0.00	0.12

NO<sub>2</sub> ANALYZER : 162.90 Span (ppm) : 200  
Cylinder Conc. (ppm) : 200

	NO <sub>2</sub> Analyzer Calibration Response	System Calibration Response	System Calibration Response	System Calibration Response	System Calibration Response	Drift (% of Span)
Zero Gas	0.00	0.02	0.01	0.00	0.03	0.02
Upscale Gas	162.94	163.16	0.11	162.92	0.01	0.12

SO<sub>2</sub> ANALYZER : 162.60 Span (ppm) : 200  
Cylinder Conc. (ppm) : 200

	SO <sub>2</sub> Analyzer Calibration Response	System Calibration Response	System Calibration Response	System Calibration Response	System Calibration Response	Drift (% of Span)
Zero Gas	0.00	0.02	0.01	0.01	0.01	0.00
Upscale Gas	162.94	161.26	0.84	161.00	0.97	0.13

CO ANALYZER : 156.00 Span (ppm) : 200  
Cylinder Conc. (ppm) : 200

	CO Analyzer Calibration Response	System Calibration Response	System Calibration Response	System Calibration Response	System Calibration Response	Drift (% of Span)
Zero Gas	0.01	0.02	0.01	0.05	0.02	0.02
Upscale Gas	155.95	155.22	0.36	155.68	0.43	0.07



## EMISSION TEST RESULT

Client : GLOW ENERGY PUBLIC CO., Ltd. Run # : 1  
Date : 26 Oct 24 Location : HRSG 41  
Start Time : 11:40 Test Operator : Usaree N.  
SO<sub>2</sub> Analyzer Model : TELEDYNE API T100H Serial No : 536  
NO<sub>2</sub>/O<sub>2</sub> Analyzer Model : TELEDYNE API T200H Serial No : 923  
CO/CO<sub>2</sub> Analyzer Model : TELEDYNE API T300M Serial No : 845

Time (min)	O <sub>2</sub> (%)	CO <sub>2</sub> (%)	NO <sub>x</sub> (ppm)	SO <sub>2</sub> (ppm)	CO (ppm)	Remark
11:40	13.29	4.18	22.00	0.09	1.03	
11:41	13.31	4.20	22.28	0.11	1.07	
11:42	13.32	4.19	22.26	0.13	0.99	
11:43	13.32	4.16	22.21	0.13	1.01	
11:44	13.30	4.18	22.23	0.10	1.06	
11:45	13.33	4.18	22.31	0.13	0.99	
11:46	13.31	4.19	22.30	0.11	1.04	
11:47	13.33	4.19	22.39	0.13	1.02	
11:48	13.32	4.18	22.38	0.12	1.03	
11:49	13.29	4.18	22.35	0.09	1.05	
11:50	13.27	4.20	22.48	0.07	1.04	
11:51	13.33	4.18	22.43	0.13	1.05	
11:52	13.31	4.18	22.29	0.11	0.97	
11:53	13.30	4.18	22.22	0.11	0.95	
11:54	13.28	4.21	22.38	0.09	0.93	
11:55	13.32	4.19	22.56	0.12	0.99	
11:56	13.32	4.19	22.64	0.12	0.99	
11:57	13.31	4.20	22.52	0.11	0.94	
11:58	13.31	4.21	22.35	0.12	0.90	
11:59	13.30	4.19	22.41	0.10	0.97	
12:00	13.31	4.19	22.52	0.11	0.98	
Average	13.31	4.18	22.36	0.11	1.00	

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## EMISSION TEST RESULT

Client	GLOW ENERGY PUBLIC CO., Ltd.	Run #	2
Date	26 Oct 24	Location	HRSG 41
Start Time	12:01	Test Operator	Uwasee N.
SO <sub>2</sub> Analyzer Model	TELEDYNE API T100H	Serial No.	538
NO <sub>x</sub> /CO Analyzer Model	TELEDYNE API T200H	Serial No.	923
CO/CO <sub>2</sub> Analyzer Model	TELEDYNE API T300M	Serial No.	845

Time (min)	O <sub>2</sub> (%)	CO <sub>2</sub> (%)	NO <sub>x</sub> (ppm)	SO <sub>2</sub> (ppm)	CO (ppm)	Remark
12:01	13.33	4.18	22.43	0.13	0.59	
12:02	13.31	4.18	22.31	0.11	0.57	
12:03	13.33	4.19	22.17	0.14	0.58	
12:04	13.34	4.19	22.08	0.14	0.57	
12:05	13.30	4.18	22.08	0.15	0.55	
12:06	13.25	4.19	22.22	0.25	0.56	
12:07	13.02	4.32	23.42	0.64	0.70	
12:08	12.87	4.43	22.76	0.19	0.44	
12:09	12.85	4.47	23.15	0.21	0.38	
12:10	12.90	4.46	23.58	0.16	0.41	
12:11	12.88	4.43	23.27	0.16	0.43	
12:12	12.95	4.41	23.22	0.11	0.49	
12:13	13.04	4.36	23.23	0.07	0.59	
12:14	13.18	4.31	22.97	0.01	0.70	
12:15	13.20	4.27	22.70	0.00	0.65	
12:16	13.28	4.25	22.52	0.08	0.90	
12:17	13.34	4.19	22.24	0.14	0.98	
12:18	13.32	4.18	22.14	0.13	1.01	
12:19	13.31	4.18	22.34	0.11	0.97	
12:20	13.34	4.21	22.58	0.14	1.05	
12:21	13.34	4.19	22.58	0.14	1.01	
Average	13.17	4.28	22.61	0.11	0.80	

FORM NO F 06-003 REVISION NO 1 ISSUE DATE 18/01/24

ALS Laboratory Group



## EMISSION TEST RESULT

Client	GLOW ENERGY PUBLIC CO., Ltd.	Run #	3
Date	26 Oct 24	Location	HRSG 41
Start Time	12:22	Test Operator	Uwasee N.
SO <sub>2</sub> Analyzer Model	TELEDYNE API T100H	Serial No.	836
NO <sub>x</sub> /CO Analyzer Model	TELEDYNE API T200H	Serial No.	923
CO/CO <sub>2</sub> Analyzer Model	TELEDYNE API T300M	Serial No.	845

Time (min)	O <sub>2</sub> (%)	CO <sub>2</sub> (%)	NO <sub>x</sub> (ppm)	SO <sub>2</sub> (ppm)	CO (ppm)	Remark
12:22	13.34	4.18	22.35	0.15	1.00	
12:23	13.33	4.17	22.25	0.13	1.07	
12:24	13.32	4.20	22.39	0.13	1.06	
12:25	13.35	4.19	22.52	0.16	1.04	
12:26	13.35	4.19	22.31	0.15	1.05	
12:27	13.33	4.20	22.32	0.13	1.07	
12:28	13.34	4.19	22.42	0.14	1.07	
12:29	13.32	4.19	22.33	0.12	1.06	
12:30	13.30	4.21	22.33	0.10	1.05	
12:31	13.35	4.19	22.40	0.15	1.04	
12:32	13.35	4.18	22.35	0.15	1.04	
12:33	13.34	4.18	22.25	0.15	1.12	
12:34	13.33	4.19	22.30	0.13	1.13	
12:35	13.33	4.19	22.33	0.13	1.04	
12:36	13.33	4.19	22.28	0.13	1.04	
12:37	13.33	4.20	22.23	0.13	1.02	
12:38	13.33	4.19	22.17	0.13	1.01	
12:39	13.32	4.20	22.21	0.12	1.05	
12:40	13.31	4.20	22.38	0.12	1.09	
12:41	13.33	4.19	22.44	0.13	1.08	
12:42	13.33	4.19	22.36	0.13	1.05	
Average	13.33	4.19	22.33	0.13	1.06	

FORM NO F 06-003 REVISION NO 1 ISSUE DATE 18/01/24

ALS Laboratory Group



## ANALYZER CALIBRATION DATA

Lot No. 2483308-1

Client	GLOW ENERGY PCL	Location	HRSG 42
Date	29 Oct 24	Test Operator	Sakell P.

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	-0.10	-0.05	0.20
Low-Level Gas	8.00	7.90	7.95	0.20
Span Gas	16.02	15.92	15.97	0.20

NO <sub>x</sub> ANALYZER Model	HORIBA PG-350	Serial No.	TDBARGKP
Span (ppm)	200		

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	-0.10	-0.03	0.04
Low-Level Gas	87.39	87.29	87.30	0.03
Span Gas	164.40	164.30	164.37	0.03

SO <sub>2</sub> ANALYZER Model	TELEDYNE API 100EH	Serial No.	437
Span (ppm)	200		

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	-0.04	-0.01	0.02
Low-Level Gas	78.75	78.71	78.74	0.02
Span Gas	159.80	159.65	159.89	0.01

CO ANALYZER Model	TELEDYNE API 300EM	Serial No.	451
Span (ppm)	500		

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	-0.05	-0.01	0.01
Low-Level Gas	76.28	76.13	76.17	0.01
Span Gas	407.40	407.35	407.39	0.01

FORM NO F 06-002 REVISION NO 4 ISSUE DATE 18/01/24

ALS Laboratory Group



## SYSTEM CALIBRATION BIAS AND DRIFT DATA

Lot No. 2483308-1

Client	GLOW ENERGY PCL	Location	HRSG 42
Date	29 Oct 24	Test Operator	Sakell P.

O <sub>2</sub> ANALYZER Cylinder Conc. (%)	16.02	Span (%)	25
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	O <sub>2</sub> Analyzer Calibration Response	Initial Values System Calibration Response (%)	System Cal Bias (%)	Final Values System Calibration Response (%)	System Cal Bias (%)	Drift (%)
Zero Gas	-0.10	-0.10	0.00	-0.05	0.20	0.20
Upscale Gas	15.92	15.92	0.00	15.97	0.20	0.20

NO <sub>x</sub> ANALYZER Cylinder Conc. (ppm)	164.40	Span (ppm)	200
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	NO <sub>x</sub> Analyzer Calibration Response	Initial Values System Calibration Response (%)	System Cal Bias (%)	Final Values System Calibration Response (%)	System Cal Bias (%)	Drift (%)
Zero Gas	-0.10	-0.10	0.00	-0.03	0.04	0.04
Upscale Gas	164.30	164.30	0.00	164.37	0.03	0.03

SO <sub>2</sub> ANALYZER Cylinder Conc. (ppm)	159.80	Span (ppm)	200
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	SO <sub>2</sub> Analyzer Calibration Response	Initial Values System Calibration Response (%)	System Cal Bias (%)	Final Values System Calibration Response (%)	System Cal Bias (%)	Drift (%)
Zero Gas	-0.04	-0.04	0.00	-0.01	0.02	0.02
Upscale Gas	159.80	159.80	0.00	159.89	0.01	0.01

CO ANALYZER Cylinder Conc. (ppm)	407.40	Span (ppm)	500
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	CO Analyzer Calibration Response	Initial Values System Calibration Response (%)	System Cal Bias (%)	Final Values System Calibration Response (%)	System Cal Bias (%)	Drift (%)
Zero Gas	-0.05	-0.05	0.00	-0.01	0.01	0.01
Upscale Gas	407.35	407.35	0.00	407.39	0.01	0.01

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## EMISSION TEST RESULT

Client	GLOW ENERGY PCL.	Run #	1
Date	28 Oct 24	Location	HRSG 42
Start Time	10:50	Test Operator	Sakshi P.
SO <sub>2</sub> Analyzer Model	TELEDYNE API 100EH	Finish Time	11:10
NO <sub>x</sub> /O <sub>2</sub> Analyzer Model	HORIBA PG-350	Serial No.	437
CO/CO <sub>2</sub> Analyzer Model	TELEDYNE API 300EM	Serial No.	TDAARGKP
		Serial No.	451

Time (min)	O <sub>2</sub> (%)	CO <sub>2</sub> (%)	NO <sub>x</sub> (ppm)	SO <sub>2</sub> (ppm)	CO (ppm)	Remark
10:50	13.14	4.54	20.26	0.11	0.34	
10:51	13.13	4.54	20.36	0.05	0.28	
10:52	13.13	4.54	20.34	0.07	0.24	
10:53	13.11	4.56	20.30	0.09	0.29	
10:54	13.11	4.57	20.50	0.08	0.20	
10:55	13.10	4.59	20.38	0.07	0.29	
10:56	13.11	4.58	20.50	0.07	0.12	
10:57	13.11	4.58	20.65	0.08	0.18	
10:58	13.09	4.58	20.74	0.09	0.30	
10:59	13.09	4.58	20.80	0.10	0.27	
10:59	13.09	4.58	20.82	0.12	0.26	
11:00	13.10	4.58	20.90	0.12	0.29	
11:01	13.08	4.59	20.14	0.08	0.33	
11:02	13.07	4.59	21.03	0.09	0.36	
11:03	13.07	4.60	21.09	0.08	0.38	
11:04	13.09	4.60	21.15	0.07	0.25	
11:05	13.08	4.59	20.69	0.07	0.24	
11:06	13.10	4.59	21.01	0.07	0.28	
11:07	13.10	4.57	21.05	0.07	0.28	
11:08	13.10	4.57	20.94	0.09	0.32	
11:09	13.10	4.54	21.07	0.10	0.32	
11:10	13.08	4.57	20.75	0.08	0.28	
Average	13.09	4.57	20.75	0.08	0.28	

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## EMISSION TEST RESULT

Client	GLOW ENERGY PCL.	Run #	2
Date	29 Oct 24	Location	HRSG 42
Start Time	11:11	Test Operator	Sakshi P.
SO <sub>2</sub> Analyzer Model	TELEDYNE API 100EH	Finish Time	11:31
NO <sub>x</sub> /O <sub>2</sub> Analyzer Model	HORIBA PG-350	Serial No.	437
CO/CO <sub>2</sub> Analyzer Model	TELEDYNE API 300EM	Serial No.	TDAARGKP
		Serial No.	451

Time (min)	O <sub>2</sub> (%)	CO <sub>2</sub> (%)	NO <sub>x</sub> (ppm)	SO <sub>2</sub> (ppm)	CO (ppm)	Remark
11:11	13.09	4.58	21.19	0.10	0.31	
11:12	13.11	4.57	21.23	0.12	0.31	
11:13	13.09	4.58	21.19	0.11	0.31	
11:14	13.08	4.57	24.78	0.08	0.44	
11:15	13.10	4.56	21.78	0.08	0.45	
11:16	13.09	4.57	21.40	0.07	0.49	
11:17	13.08	4.57	21.24	0.05	0.55	
11:18	13.08	4.58	21.23	0.05	0.50	
11:19	13.08	4.57	21.15	0.07	0.58	
11:20	13.09	4.56	21.15	0.08	0.57	
11:21	13.10	4.56	20.92	0.07	0.58	
11:22	13.10	4.56	20.50	0.09	0.59	
11:23	13.10	4.58	20.71	0.10	0.61	
11:24	13.12	4.55	20.80	0.12	0.67	
11:25	13.12	4.54	20.84	0.11	0.37	
11:26	13.11	4.54	20.92	0.09	0.38	
11:27	13.10	4.55	20.84	0.05	0.37	
11:28	13.10	4.57	20.84	0.05	0.39	
11:29	13.09	4.57	21.11	0.07	0.38	
11:30	13.08	4.59	21.12	0.08	0.39	
11:31	13.08	4.60	21.14	0.08	0.49	
Average	13.09	4.58	21.28	0.07	0.48	

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## EMISSION TEST RESULT

Client	GLOW ENERGY PCL.	Run #	3
Date	29 Oct 24	Location	HRSG 42
Start Time	11:32	Test Operator	Sakshi P.
SO <sub>2</sub> Analyzer Model	TELEDYNE API 100EH	Finish Time	11:52
NO <sub>x</sub> /O <sub>2</sub> Analyzer Model	HORIBA PG-350	Serial No.	437
CO/CO <sub>2</sub> Analyzer Model	TELEDYNE API 300EM	Serial No.	TDAARGKP
		Serial No.	451

Time (min)	O <sub>2</sub> (%)	CO <sub>2</sub> (%)	NO <sub>x</sub> (ppm)	SO <sub>2</sub> (ppm)	CO (ppm)	Remark
11:32	13.10	4.57	21.10	0.07	0.30	
11:33	13.11	4.58	21.12	0.06	0.30	
11:34	13.08	4.55	21.03	0.09	0.29	
11:35	13.07	4.57	21.08	0.09	0.30	
11:36	13.08	4.57	21.06	0.09	0.19	
11:37	13.07	4.56	21.20	0.06	0.31	
11:38	13.08	4.57	21.23	0.05	0.29	
11:39	13.07	4.58	21.10	0.08	0.25	
11:40	13.09	4.57	21.29	0.09	0.31	
11:41	13.09	4.57	21.42	0.09	0.29	
11:42	13.09	4.57	21.44	0.09	0.23	
11:43	13.10	4.56	21.23	0.09	0.23	
11:44	13.11	4.55	21.25	0.11	0.31	
11:45	13.13	4.54	21.10	0.12	0.24	
11:46	13.13	4.55	21.16	0.12	0.27	
11:47	13.18	4.53	20.93	0.06	0.30	
11:48	13.18	4.51	20.85	0.06	0.30	
11:49	13.19	4.52	20.83	0.05	0.29	
11:50	13.14	4.54	21.23	0.06	0.32	
11:51	13.11	4.56	21.29	0.05	0.58	
11:52	13.09	4.58	21.33	0.07	0.38	
Average	13.10	4.55	21.16	0.07	0.29	

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## ANALYZER CALIBRATION DATA

Lot No. 2483308-1

Client	GLOW ENERGY PCL.	Location	HRSG 61
Date	28 Oct 24	Test Operator	Sakshi P.
O <sub>2</sub> ANALYZER Model	TELEDYNE API 200EH	Serial No.	735
Span (%)	25		

	Cylinder Value (%)	Initial Analyzers Calibration Response (%)	Final Analyzers Calibration Response (%)	Difference (Percent of Span)
Zero Gas	0.00	0.01	0.01	0.00
Low-Level Gas	8.19	8.20	8.21	0.04
Span Gas	16.07	16.08	16.09	0.04

NO <sub>2</sub> ANALYZER Model	TELEDYNE API 200EH	Serial No.	735
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	0.02	0.01
Low-Level Gas	54.95	54.95	54.95	0.00
Span Gas	82.51	82.51	82.45	0.03

SO <sub>2</sub> ANALYZER Model	TELEDYNE API 100EH	Serial No.	439
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	55.55	55.53	55.52	0.01
Span Gas	79.70	79.75	79.75	0.00

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	0.02	0.03	0.01
Low-Level Gas	54.84	54.82	54.81	0.01
Span Gas	79.74	79.72	79.72	0.00

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Lot No. 2483309-1

## SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client : GLOW ENERGY PCL. Location : HRSG 61  
Date : 28 Oct 24 Test Operator : Sathaporn T.O<sub>2</sub> ANALYZER  
Cylinder Conc. (%) : 18.07 Span (%) : 25

	O <sub>2</sub> Analyzer Calibration Response	Initial Values		Final Values		Drift (% of Span)
		System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	
Zero Gas	0.01	0.02	0.04	0.01	0.04	0.00
Up-scale Gas	18.08	18.10	0.08	18.10	0.08	0.00

NO<sub>2</sub> ANALYZER  
Cylinder Conc. (ppm) : 82.51 Span (ppm) : 100

	NO <sub>2</sub> Analyzer Calibration Response	Initial Values		Final Values		Drift (% of Span)
		System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	
Zero Gas	0.01	0.03	0.02	0.03	0.02	0.00
Up-scale Gas	82.51	82.45	0.08	82.45	0.06	0.00

SO<sub>2</sub> ANALYZER  
Cylinder Conc. (ppm) : 78.76 Span (ppm) : 100

	SO <sub>2</sub> Analyzer Calibration Response	Initial Values		Final Values		Drift (% of Span)
		System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	
Zero Gas	0.00	0.00	0.00	0.00	0.00	0.00
Up-scale Gas	78.75	78.72	0.03	78.72	0.03	0.00

CO ANALYZER  
Cylinder Conc. (ppm) : 79.74 Span (ppm) : 100

	CO Analyzer Calibration Response	Initial Values		Final Values		Drift (% of Span)
		System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	
Zero Gas	0.02	0.04	0.02	0.04	0.02	0.00
Up-scale Gas	79.72	79.70	0.02	79.70	0.02	0.00

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## EMISSION TEST RESULT

Client : GLOW ENERGY PCL.  
Date : 28 Oct 24  
Start Time : 11:20  
SO<sub>2</sub> Analyzer Model : TELEDYNE API 100EH  
NO<sub>x</sub>/O<sub>2</sub> Analyzer Model : TELEDYNE API 200EH  
CO/CO<sub>2</sub> Analyzer Model : TELEDYNE API 300EMRun # : 1  
Location : HRSG 61  
Test Operator : Sathaporn T.  
Finish Time : 11:40  
Serial No. : 410  
Serial No. : 735  
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
11:20	12.50	4.80	20.78	0.07	2.77	
11:21	12.53	4.81	20.88	0.09	2.80	
11:22	12.53	4.80	20.52	0.07	2.69	
11:23	12.58	4.78	20.41	0.01	2.65	
11:24	12.63	4.78	20.29	0.08	2.75	
11:25	12.63	4.78	20.19	0.07	2.73	
11:26	12.59	4.78	20.17	0.08	2.57	
11:27	12.55	4.79	20.20	0.05	2.57	
11:28	12.61	4.75	20.27	0.08	2.57	
11:29	12.68	4.74	20.11	0.02	2.66	
11:30	12.68	4.88	19.97	0.08	2.61	
11:31	12.64	4.77	20.00	0.07	2.76	
11:32	12.65	4.74	20.12	0.01	2.62	
11:33	12.73	4.75	20.04	0.08	2.58	
11:34	12.75	4.70	19.68	0.04	2.58	
11:35	12.73	4.72	19.70	0.05	2.55	
11:36	12.72	4.66	19.73	0.09	2.54	
11:37	12.77	4.64	19.70	0.08	2.58	
11:38	12.82	4.65	19.53	0.05	2.58	
11:39	12.88	4.64	19.44	0.03	2.63	
11:40	12.88	4.57	19.30	0.07	2.69	
Average	12.67	4.73	20.07	0.06	2.63	

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## EMISSION TEST RESULT

Client : GLOW ENERGY PCL. Run # : 2  
Date : 28 Oct 24 Location : HRSG 61  
Start Time : 11:41 Test Operator : Sathaporn T.  
SO<sub>2</sub> Analyzer Model : TELEDYNE API 100EH Serial No. : 410  
NO<sub>x</sub>/O<sub>2</sub> Analyzer Model : TELEDYNE API 200EH Serial No. : 735  
CO/CO<sub>2</sub> Analyzer Model : TELEDYNE API 300EM 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
11:41	12.91	4.84	19.39	0.08	2.73	
11:42	12.93	4.59	19.22	0.08	2.73	
11:43	12.92	4.53	19.14	0.00	2.74	
11:44	12.86	4.61	19.28	0.02	2.60	
11:45	12.82	4.68	19.42	0.01	2.53	
11:46	12.75	4.70	19.59	0.03	2.40	
11:47	12.72	4.76	19.68	0.05	2.38	
11:48	12.72	4.70	19.70	0.08	2.44	
11:49	12.70	4.72	19.57	0.02	2.41	
11:50	12.68	4.74	19.94	0.04	2.32	
11:51	12.59	4.76	20.02	0.06	2.29	
11:52	12.59	4.80	20.13	0.07	2.10	
11:53	12.65	4.70	20.16	0.03	2.04	
11:54	12.72	4.74	20.08	0.02	2.18	
11:55	12.77	4.67	19.87	0.03	2.16	
11:56	12.79	4.65	19.77	0.02	2.17	
11:57	12.81	4.63	19.74	0.04	2.21	
11:58	12.85	4.64	19.69	0.07	2.16	
11:59	12.97	4.55	19.51	0.04	2.25	
12:00	13.07	4.50	19.20	0.02	2.31	
12:01	13.03	4.53	19.02	0.03	2.27	
Average	12.80	4.67	19.84	0.04	2.35	

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## EMISSION TEST RESULT

Client : GLOW ENERGY PCL. Run # : 3  
Date : 28 Oct 24 Location : HRSG 61  
Start Time : 12:02 Test Operator : Sathaporn T.  
SO<sub>2</sub> Analyzer Model : TELEDYNE API 100EH Serial No. : 410  
NO<sub>x</sub>/O<sub>2</sub> Analyzer Model : TELEDYNE API 200EH Serial No. : 735  
CO/CO<sub>2</sub> Analyzer Model : TELEDYNE API 300EM 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
12:02	12.97	4.60	19.05	0.05	2.32	
12:03	12.98	4.56	19.18	0.08	2.29	
12:04	12.94	4.61	19.25	0.01	2.30	
12:05	12.90	4.60	19.37	0.02	2.24	
12:06	12.89	4.62	19.46	0.02	2.22	
12:07	12.91	4.60	19.48	0.09	2.24	
12:08	12.94	4.57	19.44	0.07	2.22	
12:09	12.96	4.58	19.35	0.06	2.29	
12:10	13.00	4.55	19.29	0.05	2.30	
12:11	12.98	4.58	19.07	0.07	2.11	
12:12	12.93	4.59	18.88	0.07	2.19	
12:13	12.91	4.59	18.66	0.01	2.11	
12:14	12.94	4.55	18.72	0.04	2.10	
12:15	12.96	4.58	18.70	0.09	2.18	
12:16	12.98	4.56	18.58	0.08	2.22	
12:17	13.01	4.60	18.41	0.03	2.23	
12:18	12.98	4.56	18.32	0.06	2.17	
12:19	12.94	4.57	18.36	0.05	2.11	
12:20	12.96	4.55	18.47	0.07	2.20	
12:21	12.99	4.58	18.50	0.09	2.20	
12:22	12.92	4.61	18.47	0.09	2.01	
Average	12.95	4.58	18.91	0.06	2.20	

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Lot No. 2483310-1

## ANALYZER CALIBRATION DATA

Client : GLOW ENERGY PCL Location : HRSG 62  
Date : 28 Oct 24 Test Operator : Sakalt P.  
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	-0.10	-0.05	0.20
Low-Level Gas	8.00	7.90	7.95	0.20
Span Gas	16.02	15.92	15.97	0.20

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

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	-0.15	-0.05	0.05
Low-Level Gas	82.39	82.24	82.34	0.05
Span Gas	164.40	164.25	164.35	0.05

SO<sub>2</sub> ANALYZER :  
Model : TELEDYNE API 100EH Serial No. : 437  
Span (ppm) : 200

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	-0.04	-0.01	0.02
Low-Level Gas	78.75	78.71	78.74	0.02
Span Gas	159.90	159.86	159.89	0.01

CO ANALYZER :  
Model : TELEDYNE API 300EM Serial No. : 451  
Span (ppm) : 500

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	-0.05	-0.01	0.01
Low-Level Gas	76.48	76.43	76.47	0.01
Span Gas	407.40	407.35	407.39	0.01

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Lot No. 2483310-1

## SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client : GLOW ENERGY PCL Location : HRSG 62  
Date : 28 Oct 24 Test Operator : Sakalt P.  
O<sub>2</sub> ANALYZER :  
Cylinder Conc. (%) : 16.02 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	-0.10	-0.10	0.00	-0.05	-0.05	0.00	0.20	0.20
Upscale Gas	15.92	15.92	0.00	15.97	15.97	0.00	0.20	0.20

NO<sub>x</sub> ANALYZER :  
Cylinder Conc. (ppm) : 164.40 Span (ppm) : 200

	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	-0.15	-0.15	0.00	-0.05	-0.05	0.00	0.05	0.05
Upscale Gas	164.25	164.25	0.00	164.35	164.35	0.00	0.05	0.05

SO<sub>2</sub> ANALYZER :  
Cylinder Conc. (ppm) : 159.90 Span (ppm) : 200

	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	-0.04	-0.04	0.00	-0.01	-0.01	0.00	0.02	0.02
Upscale Gas	159.86	159.86	0.00	159.89	159.89	0.00	0.01	0.01

CO ANALYZER :  
Cylinder Conc. (ppm) : 407.40 Span (ppm) : 500

	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	-0.05	-0.05	0.00	-0.01	-0.01	0.00	0.01	0.01
Upscale Gas	407.35	407.35	0.00	407.39	407.39	0.00	0.01	0.01

FORM NO F-06-003 REVISION NO 4 ISSUE DATE 18/10/24

ALS Laboratory Group

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## EMISSION TEST RESULT

Client : GLOW ENERGY PCL Run # : 1  
Date : 28 Oct 24 Location : HRSG 62  
Start Time : 11:10 Test Operator : Sakalt P.  
Finish Time : 11:30  
SO<sub>2</sub> Analyzer Model : TELEDYNE API 100EH Serial No. : 437  
NO<sub>x</sub>/O<sub>2</sub> Analyzer Model : TELEDYNE API 200EH Serial No. : 774  
CO/CO<sub>2</sub> Analyzer Model : TELEDYNE API 300EM Serial No. : 451

Time (min)	O <sub>2</sub> (%)	CO <sub>2</sub> (%)	NO <sub>x</sub> (ppm)	SO <sub>2</sub> (ppm)	CO (ppm)	Remark
11:10	13.02	4.87	20.77	0.12	0.49	
11:11	13.03	4.85	20.68	0.11	0.49	
11:12	13.01	4.64	20.73	0.10	0.48	
11:13	13.10	4.61	20.68	0.12	0.57	
11:14	13.26	4.52	20.69	0.11	0.28	
11:15	13.35	4.46	20.56	0.11	0.29	
11:16	13.34	4.45	20.46	0.09	0.28	
11:17	13.25	4.48	20.58	0.09	0.59	
11:18	13.13	4.57	20.80	0.08	0.78	
11:19	13.03	4.64	21.19	0.09	0.64	
11:20	13.03	4.65	21.41	0.10	0.62	
11:21	13.09	4.61	21.37	0.11	0.67	
11:22	13.09	4.60	21.22	0.10	0.61	
11:23	13.12	4.57	21.10	0.12	0.65	
11:24	13.19	4.55	21.01	0.11	0.57	
11:25	13.22	4.52	20.78	0.14	0.71	
11:26	13.19	4.53	20.81	0.13	0.66	
11:27	13.14	4.54	20.97	0.13	0.57	
11:28	13.14	4.55	21.07	0.13	0.49	
11:29	13.22	4.50	20.69	0.13	0.61	
11:30	13.27	4.50	20.76	0.15	0.73	
Average	13.15	4.56	20.88	0.11	0.56	

FORM NO F-06-000 REVISION NO 1 ISSUE DATE 18/10/24

ALS Laboratory Group

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## EMISSION TEST RESULT

Client : GLOW ENERGY PCL Run # : 2  
Date : 28 Oct 24 Location : HRSG 62  
Start Time : 11:31 Test Operator : Sakalt P.  
Finish Time : 11:51  
SO<sub>2</sub> Analyzer Model : TELEDYNE API 100EH Serial No. : 437  
NO<sub>x</sub>/O<sub>2</sub> Analyzer Model : TELEDYNE API 200EH Serial No. : 774  
CO/CO<sub>2</sub> Analyzer Model : TELEDYNE API 300EM Serial No. : 451

Time (min)	O <sub>2</sub> (%)	CO <sub>2</sub> (%)	NO <sub>x</sub> (ppm)	SO <sub>2</sub> (ppm)	CO (ppm)	Remark
11:31	13.23	4.51	20.47	0.12	0.58	
11:32	13.22	4.53	20.54	0.12	0.56	
11:33	13.29	4.49	20.68	0.11	0.62	
11:34	13.36	4.44	20.59	0.12	0.69	
11:35	13.34	4.43	20.36	0.13	0.61	
11:36	13.31	4.46	20.35	0.13	0.55	
11:37	13.34	4.45	20.43	0.10	0.58	
11:38	13.40	4.41	20.31	0.10	0.64	
11:39	13.44	4.37	20.16	0.12	0.70	
11:40	13.49	4.34	19.90	0.11	0.71	
11:41	13.50	4.34	19.84	0.13	0.69	
11:42	13.54	4.33	19.84	0.13	0.59	
11:43	13.54	4.33	19.70	0.13	0.75	
11:44	13.49	4.34	19.84	0.12	0.55	
11:45	13.45	4.37	19.83	0.11	0.35	
11:46	13.39	4.42	19.49	0.11	0.38	
11:47	13.32	4.45	20.04	0.12	0.38	
11:48	13.31	4.47	20.17	0.10	0.62	
11:49	13.30	4.47	20.27	0.10	0.72	
11:50	13.27	4.48	20.35	0.11	0.71	
11:51	13.22	4.50	20.32	0.11	0.68	
Average	13.38	4.42	20.18	0.11	0.63	

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## EMISSION TEST RESULT

Client	OLOW ENERGY PCL	Run #	3
Date	26 Oct 24	Location	KRSG 62
Start Time	11:52	Test Operator	Sekait P.
SO <sub>2</sub> Analyzer Model	TELEDYNE API 100EH	Finish Time	12:12
NO <sub>x</sub> Analyzer Model	TELEDYNE API 200EH	Serial No.	437
CO/CO <sub>2</sub> Analyzer Model	TELEDYNE API 300EM	Serial No.	774
		Serial No.	451

Time (min)	O <sub>2</sub> (%)	CO <sub>2</sub> (%)	NO <sub>x</sub> (ppm)	SO <sub>2</sub> (ppm)	CO (ppm)	Remark
11:52	13.17	4.55	20.39	0.10	0.79	
11:53	13.19	4.54	20.48	0.13	0.88	
11:54	13.26	4.49	20.58	0.13	0.88	
11:55	13.32	4.44	20.40	0.12	0.71	
11:56	13.37	4.41	20.22	0.09	0.53	
11:57	13.39	4.39	20.16	0.10	0.54	
11:58	13.41	4.39	20.11	0.11	0.53	
11:59	13.50	4.36	20.09	0.11	0.71	
12:00	13.61	4.27	19.16	0.12	0.90	
12:01	13.62	4.26	19.69	0.12	1.10	
12:02	13.58	4.28	19.51	0.13	1.21	
12:03	13.56	4.30	19.70	0.13	1.11	
12:04	13.66	4.31	19.51	0.13	1.16	
12:05	13.51	4.33	19.84	0.13	1.11	
12:06	13.59	4.35	19.16	0.13	1.11	
12:07	13.68	4.34	19.83	0.12	1.03	
12:08	13.50	4.33	19.79	0.11	1.01	
12:09	13.50	4.34	19.87	0.10	0.99	
12:10	13.55	4.31	19.16	0.10	1.04	
12:11	13.58	4.30	19.73	0.09	0.89	
12:12	13.52	4.33	19.55	0.13	1.02	
Average	13.45	4.36	19.87	0.11	0.92	

FORM NO. F-96-080 REVISED NO. 1 ISSUE DATE: 18/01/24  
ALS Laboratory Group



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

## CERTIFICATE OF ANALYSIS

Grade of Product: EPA PROTOCOL STANDARD

Customer:	AIR LIQUIDE (THAILAND) LTD E04N19E3HAD086	Reference Number:	160-402340012-1
Part Number:	GN0027222	Cylinder Volume:	247.2 CF
Cylinder Number:	124 - Plumsteadville - PA	Cylinder Pressure:	2215 PSIG
Laboratory:	A12022	Valve Outlet:	660
PGVP Number:	CO,NO,NOX,SO2,BALN	Certification Date:	Feb 09, 2022
Gas Code:			

Expiration Date: Feb 09, 2030

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gasometer Calibration Standards (May 2012)" document EPA 820R-12-031, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analysis 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 nitrogen basis unless otherwise noted.  
Do Not Use This Cylinder Below 100 psig, i.e. 6.7 megapascals.

ANALYTICAL RESULTS					
Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Date
NOX	55.00 PPM	55.18 PPM	G1	+/- 1.0% NIST Traceable	02/09/2022, 02/09/2022
CARBON MONOXIDE	55.00 PPM	55.22 PPM	G1	+/- 0.6% NIST Traceable	02/02/2022
NITRIC OXIDE	55.00 PPM	55.88 PPM	G1	+/- 1.0% NIST Traceable	02/09/2022, 02/09/2022
SULFUR DIOXIDE	55.00 PPM	55.39 PPM	G1	+/- 0.8% NIST Traceable	02/02/2022, 02/06/2022
NITROGEN	Balance				
CALIBRATION STANDARDS					
Type	Lot ID	Cylinder No.	Concentration	Uncertainty	Expiration Date
NTRM	20010212	KAL004771	8% 48 PPM CARBON MONOXIDE/NITROGEN	+/- 0.5%	Oct 16, 2024
NTRM	200610-15	CC233108	10% 61 PPM NITRIC OXIDE/NITROGEN	+/- 0.8%	Oct 01, 2026
GMIS	12420689	CC233767	4.057 PPM NITROGEN DIOXIDE/NITROGEN	+/- 2.0%	Sep 03, 2024
NTRM	11010416	KAL004913	89.6 PPM SULFUR DIOXIDE/NITROGEN	+/- 0.8%	Jul 28, 2023
ANALYTICAL EQUIPMENT					
Instrument/Make/Model	Analytical Principle		Last Multipoint Calibration		
Nicodem 550 FTIR ALP2010245 CO	FTIR		Jan 06, 2022		
Nicodem 550 FTIR ALP2010245 NO	FTIR		Jan 12, 2022		
Nicodem 550 FTIR ALP2010245 NO2	FTIR		Jan 27, 2022		
Nicodem 550 FTIR ALP2010245 SO2	FTIR		Jan 20, 2022		

Triad Data Available Upon Request

NOTES: Gross Weight: 49.4 Kg  
Net Weight: 8.4 Kg



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

## CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Part Number:	E04N19E3HAD0021	Reference:	160-402138466-1
Cylinder Number:	ND11221	Cylinder Volume:	247.2 CF
Laboratory:	124 - Plumsteadville - PA	Cylinder Pressure:	2215 PSIG
PGVP Number:	A12021	Valve Outlet:	660
Gas Code:	CO,NO,NOX,SO2,BALN	Certification Date:	Jul 15, 2021

Expiration Date: Jul 15, 2028

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gasometer Calibration Standards (May 2012)" document EPA 820R-12-031, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analysis 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 nitrogen basis unless otherwise noted.  
Do Not Use This Cylinder Below 100 psig, i.e. 6.7 megapascals.

ANALYTICAL RESULTS					
Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Date
NOX	180.0 PPM	182.9 PPM	G1	+/- 1.4% NIST Traceable	07/08/2021, 07/15/2021
CARBON MONOXIDE	180.0 PPM	158.0 PPM	G1	+/- 0.8% NIST Traceable	07/09/2021
NITRIC OXIDE	180.0 PPM	152.9 PPM	G1	+/- 1.0% NIST Traceable	07/08/2021, 07/15/2021
SULFUR DIOXIDE	180.0 PPM	162.5 PPM	G1	+/- 1.0% NIST Traceable	07/08/2021, 07/15/2021
NITROGEN	Balance				
CALIBRATION STANDARDS					
Type	Lot ID	Cylinder No.	Concentration	Uncertainty	Expiration Date
NTRM	200103-29	KAL004559	970.0 PPM CARBON MONOXIDE	+/- 0.4%	Dec 21, 2025
PRM	12386	D685025	9.81 PPM AIR/NITROGEN DIOXIDE	2.0%	Feb 20, 2026
NTRM	13010312	KAL003449	243.4 PPM NITRIC OXIDE/NITROGEN	+/- 0.5%	May 04, 2028
GMIS	12420689	CC233767	4.028 PPM NITROGEN DIOXIDE/NITROGEN	2.1%	Aug 15, 2021
NTRM	10010254	KAL023227	255.3 PPM SULFUR DIOXIDE/NITROGEN	+/- 0.8%	Apr 25, 2022
ANALYTICAL EQUIPMENT					
Instrument/Make/Model	Analytical Principle		Last Multipoint Calibration		
Nicodem 550 FTIR ALP2010245 CO	FTIR		Jun 24, 2021		
Nicodem 550 FTIR ALP2010245 NO	FTIR		Jul 01, 2021		
Nicodem 550 FTIR ALP2010245 NO2	FTIR		Jan 30, 2021		
Nicodem 550 FTIR ALP2010245 SO2	FTIR		Jul 09, 2021		

Triad Data Available Upon Request

NOTES:  
Gross Weight: 48.8 Kg  
Net Weight: 6.5 Kg



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

## CERTIFICATE OF ANALYSIS

Grade of Product: EPA PROTOCOL STANDARD

Customer:	AIR LIQUIDE (THAILAND) LTD E02N19E3HAD0000	Reference Number:	160-402340009-1
Part Number:	GN0027033	Cylinder Volume:	248.4 CF
Cylinder Number:	124 - Plumsteadville - PA	Cylinder Pressure:	2214 PSIG
Laboratory:	A12022	Valve Outlet:	660
PGVP Number:	O2,BALN	Certification Date:	Feb 10, 2022
Gas Code:			

Expiration Date: Feb 10, 2030

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gasometer Calibration Standards (May 2012)" document EPA 820R-12-031, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analysis 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 nitrogen basis unless otherwise noted.  
Do Not Use This Cylinder Below 100 psig, i.e. 6.7 megapascals.

ANALYTICAL RESULTS					
Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Date
OXYGEN	8.000 %	7.875 %	G1	+/- 0.4% NIST Traceable	02/10/2022
NITROGEN	Balance				
CALIBRATION STANDARDS					
Type	Lot ID	Cylinder No.	Concentration	Uncertainty	Expiration Date
NTRM	10010635	K022176	6.967 % OXYGEN/NITROGEN	+/- 0.3%	Apr 19, 2022
ANALYTICAL EQUIPMENT					
Instrument/Make/Model	Analytical Principle		Last Multipoint Calibration		
SIEMENS OXYMAT 6 - N1-WS-951 - O2	PARAMAGNETIC		Jan 27, 2022		

Triad Data Available Upon Request

NOTES: Gross Weight: 48.3 Kg  
Net Weight: 8.1 Kg



## CERTIFICATE OF ANALYSIS

### Grade of Product: EPA PROTOCOL STANDARD

Customer: AIR LIQUIDE  
(THAILAND) LTD  
Part Number: E02N184E3HA0001  
Cylinder Number: GN0027201  
Laboratory: 124 - Plumsteadville - PA  
PGVP Number: A12022  
Gas Code: O2,BALN

Reference Number: 160-402340010-1  
Cylinder Volume: 249.8 CF  
Cylinder Pressure: 2214 PSIG  
Valve Outlet: 590  
Certification Date: Feb 02, 2022

Expiration Date: Feb 02, 2030

Certification performed in accordance with ISO 9001:2015. Traceability Protocol for Assay and Certification of Gasous Calibration Standards (May 2012) document EPA 600/6-12/031, 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	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Date
OXYGEN	16.00 %	16.04 %	G1	+/- 0.4% NIST Traceable	02/02/2022
NITROGEN	Balance				

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	09010230	K003228	23.20 % OXYGEN/NITROGEN	+/- 0.4%	Jun 01, 2022

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
SIEMENS OXYMAT 6 - N1-N5-951 - Q2	PARAMAGNETIC	Jan 27, 2022

Triad Data Available Upon Request

NOTES: Gross Weight: 48.8 Kg  
Net Weight: 8.2 Kg



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## SITHIPORN ASSOCIATES CO., LTD. CALIBRATION LABORATORY

45B-45B/1 Sinitthorn Road, Bangbunru, Bangkok 10700 Thailand  
Tel: +66 2432 8331 Email: calibration@sithiporn.com

SITHIPORN  
ASSOCIATES



Cert. No. : ACC24008  
Pages : 1 of 3

## Calibration Certificate

Equipment : SOUND CALIBRATOR  
Manufacturer : RION  
Model : NC-75  
Serial No. : 35002736  
ID No. : RYG FS0496

Condition As Found : GOOD

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

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

Received Date : 19 JANUARY 2024  
Calibration Date : 26 JANUARY 2024  
Date of Issue : 29 JANUARY 2024

Calibrated by : Natlakorn Pisutpaan



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.

## SITHIPORN ASSOCIATES CO., LTD. CALIBRATION LABORATORY

45B-45B/1 Sinitthorn Road, Bangbunru, Bangkok 10700 Thailand  
Tel: +66 2432 8331 Email: calibration@sithiporn.com

SITHIPORN  
ASSOCIATES



Cert. No. : ACC24008  
Job No. : VC67AC0058  
Pages : 2 of 3

Calibration Procedure : CP-AC-03

### Calibration Method :

This equipment was calibrated by follow 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	ET-0010-23	07-FEB-24
Digital Multimeter	33461A	MY53220104	EEL-BP 30/0266	13-FEB-24
Digital Multimeter	33461A	MY53220076	EEL-BP 30/0267	13-FEB-24
Digital Multimeter	33461A	MY60024273	EEL-BP 31/0266	14-FEB-24
Programmable Attenuator	MAT-1070	62100114	ET-0011-23	08-FEB-24
Condenser Microphone	4180	2977900	AA-1001-23	14-FEB-24
Measuring Amplifier	NA-42KAI	34560495	AA-3002-23	14-FEB-24
Audio Analyzer	AVR-3360A	V744R6069	ET-0012-23	10-FEB-24

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)

## SITHIPORN ASSOCIATES CO., LTD. CALIBRATION LABORATORY

45B-45B/1 Sinitthorn Road, Bangbunru, Bangkok 10700 Thailand  
Tel: +66 2432 8331 Email: calibration@sithiporn.com

SITHIPORN  
ASSOCIATES



Cert. No. : ACC24008  
Job No. : VC67AC0058  
Pages : 3 of 3

### Result of calibration :

#### 1. Sound pressure level

Specified sound pressure level (dB)	Measured value (dB)	Deviated value (dB)	Uncertainty (dB)	Acceptance limit (dB)
94	93.98	-0.02	0.14	0.40

#### 2. Frequency

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

#### 3. Total distortion

Measured value (%)	Uncertainty (%)	Acceptance limit (%)
0.83	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

*T. Petch*

*T. Petch*

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

451-4511 Srinthorn Road, Bangbunru, Bangpu, Bangkok 10700 Thailand  
Tel : +66 2433 8331 Email : cal@calibration@hph.com

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Cert. No. : ACL24307  
Pages : 1 of 8

**Calibration Certificate**

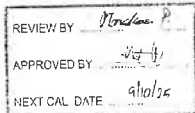
**Equipment :** SOUND LEVEL METER  
**Manufacturer :** RION  
**Model :** NL-42 / Microphone UC-52 / Preamplifier NH-24  
**Serial No.:** 01073423 / 169513 / 73684  
**ID No.:** RYG JS0386

**Condition As Found :** GOOD

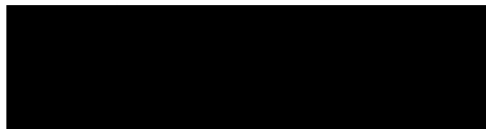
**Customer :** A.I.S. LABORATORY GROUP (THAILAND) CO., LTD.  
104 PHATTHANAKAN 40, PHATTHANAKAN ROAD,  
KHWAENG PHATTHANAKAN, KHEET SUAN LUANG,  
BANGKOK, 10250 THAILAND.

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

**Received Date :** 23 SEPTEMBER 2024  
**Calibration Date :** 09 OCTOBER 2024  
**Date of Issue :** 09 OCTOBER 2024



**Calibrated by :** Nathakorn Pisanpaisan



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.

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

451-4511 Srinthorn Road, Bangbunru, Bangpu, Bangkok 10700 Thailand  
Tel : +66 2433 8331 Email : cal@calibration@hph.com

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Cert. No. : ACL24307  
Job No. : VC67AC0164  
Pages : 2 of 8

**Calibration Procedure :** CP-AC-01

**Calibration Method :**

This equipment was calibrated by follow 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-0009-24	05-FEB-25
Waveform Generator	33511B	MY53202742	EF-0007-24	05-FEB-25
Digital Multimeter	33461A	MY53220104	EELBP 21/0267	13-FEB-25
Digital Multimeter	33461A	MY53220076	EELBP 20/0267	15-FEB-25
Digital Multimeter	34461A	MY60024273	EELBP 22/0267	15-FEB-25
Programmable Attenuator	MAT-1070	62100114	EF-0008-24	05-FEB-25
Condenser Microphone	4180	2977900	AA-1001-24	12-FEB-25
Measuring Amplifier	NA-42KA1	34560495	AA-3001-24	05-FEB-25

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).

*Signature*

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

451-4511 Srinthorn Road, Bangbunru, Bangpu, Bangkok 10700 Thailand  
Tel : +66 2433 8331 Email : cal@calibration@hph.com

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Job No. : VC67AC0164  
Pages : 3 of 8

**Summary of Measurement Result :**

Parameter	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	0.3	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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**Result of calibration :**

**1. Absolute sensitivity**

Reference Acoustic Signal (dB)	Measured Value (dB)	Deviation (dB)	Acceptance Limit (dB)
93.9 (93.94)	93.9	0.0	±0.3

**2. Self-generated noise**

**2.1 Normal test**

Measured Value (dB)
15.7

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

Frequency Weighting	Weighting (dB)
A-weight	14.8
C-weight	21.2
Flat	26.6

**3. Acoustical signal tests of frequency weightings**

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

Frequency (Hz)	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	0.3	0.4	0.4	± 5.0

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

451-451/1 Srinthorn Road Bangbunru, Bangkok Bangkok 10700 Thailand  
Tel : +66 2433 8331 Email : calibration@sithiporn.com

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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	0.0	0.0	-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	-0.1	±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	Anticipated Value ( dB )	Measured Value ( dB )	Deviated Value ( dB )	Acceptance Limits ( dB )
A-weight	94.0	94.0	0.0	±0.2
C-weight	94.0	94.0	0.0	±0.2
Flat	94.0	94.0	0.0	±0.2

**5.2 Time weighting at 1 kHz**

Frequency Weighting	Anticipated Value ( dB )	Measured Value ( dB )	Deviated Value ( dB )	Acceptance Limits ( dB )
Fast	94.0	94.0	0.0	±0.1
Slow	94.0	94.0	0.0	±0.1
Leq	94.0	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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**SITHIPORN ASSOCIATES CO., LTD.**  
**CALIBRATION LABORATORY**

451-451/1 Srinthorn Road Bangbunru, Bangkok Bangkok 10700 Thailand  
Tel : +66 2433 8331 Email : calibration@sithiporn.com

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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	135.0	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	39.0	0.0	±1.1
34.0	34.1	0.1	±1.1
30.0	30.0	0.0	±1.1
29.0	29.1	0.1	±1.1
28.0	28.1	0.1	±1.1
27.0	27.2	0.2	±1.1
26.0	26.2	0.2	±1.1
25.0	25.3	0.3	±1.1

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

451-451/1 Srinthorn Road Bangbunru, Bangkok Bangkok 10700 Thailand  
Tel : +66 2433 8331 Email : calibration@sithiporn.com

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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 )
130	94.0	94.0	0.0	±1.1

Range	Anticipated Value ( dB )	Measured Value ( dB )	Deviated Value ( dB )	Acceptance Limits ( dB )
130	30.0	29.9	-0.1	±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

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**CALIBRATION LABORATORY**

451-451/1 Srinthorn Road Bangbunru, Bangkok Bangkok 10700 Thailand  
Tel : +66 2433 8331 Email : calibration@sithiporn.com

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**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	±3.0
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	±2.0
Positive half cycle	135.4	135.2	-0.2	±2.0
Negative half cycle	135.4	135.2	-0.2	±2.0

**11. Overload Indication**

Measured value ( dB )		Deviated Value ( dB )	Acceptance Limits ( dB )
Positive one-half cycle	Negative one-half cycle		
89.5	89.5	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	127.0	127.0	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

*T. Petch*



THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No.21-67/0232

MTC No. EEL BP 172-0167

### CALIBRATION CERTIFICATE

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

Address : 104 Phatthananakan 40, Phatthananakan Rd., Khwaeng Phatthananakan, Khet Suan Luang, Bangkok 10250.

Calibrated at : Electrical and Electronic Standards Laboratory, Industrial Metrology and Testing Service Centre,  
Sri 1C, Bangpoo Industrial Estate, Sukhumvit Rd., A.Muang, Samutprakan 10280.

#### Instrument Calibrated :

Description : Sound Level Meter

Manufacturer : Rion

Model : NL-42

Serial No. : 00296515 (ID: RYG\_FS0432)

Microphone : Type UC-52 No.179119

Preamplifier : Type NH-24 No.87526

#### Standards used :

1. Band Pass Filter Wavelet 752A S/N 90010494
2. Condenser Microphone Brüel&Kjær 4180 S/N 289871
3. Decade Attenuator Ando AI-205 S/N 00464602
4. Function/Arbitrary Waveform Generator Agilent 33220A S/N MY44042668
5. Digital Function Synthesizer NF Electronic Instruments DT-193A S/N 123037
6. Digital Multimeter Fluke 8520A S/N 4985007
7. Pistonphone Rion NC-72 S/N 00402446
8. Measuring Amplifier Brüel&Kjær 2636 S/N 1537484

#### Ambient Environment

Temperature : (23 ± 3) °C

Relative Humidity : (50 ± 15) %

Ambient Pressure : (101.325 ± 1.5) kPa

Date of Receipt : 24 Jan 2024

Date of Calibration : 22-28 Feb 2024

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Head Office  
15 Mu, 3 Tambon Khlongkro, Amphoe Khlongkro, Bangkok 10110, Thailand  
Tel: 06619 2577 9000  
Fax: 06619 2577 9006  
E-mail: hampoo@tistr.go.th

Office/Laboratory  
15/1C, Bangpoo Industrial Estate, Sukhumvit Road, Bangpoo, Bangkok 10280, Thailand  
Tel: 06619 2577 9000  
Fax: 06619 2577 9006  
E-mail: hampoo@tistr.go.th

Office  
15/1C, Bangpoo Industrial Estate, Sukhumvit Road, Bangkok 10280, Thailand  
Tel: 06619 2577 9000  
Fax: 06619 2577 9006  
E-mail: hampoo@tistr.go.th

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9. Power Amplifier Brüel&Kjær 2706 S/N 1517650

10. Speaker Tannoy Limited, Great Britain British Patent No. 215300.

11. Digital Multimeter Agilent 34401A S/N MY44005560

12. Programmable Attenuator Tamagawa TPA-103A S/N 2212

#### Calibration Procedure

This instrument was calibrated by using calibration procedures no CP-102-02 and CP-102-03, which were based on IEC 61672-3 Electroacoustics - Sound Level Meters - Part 3: Periodic tests (2013). These calibration procedures were related to the electrical and acoustic signal tests. The electrical signal test was carried out with the direct measurement method. The acoustic signal test was performed in an anechoic room with the comparison measurement method.

This instrument has been calibrated against standards maintained at the Electrical and Electronic Standards Laboratory (EEL), which are traceable to the International System of Units through the National Institute of Metrology (Thailand).

The information on actual reading is attached herewith and the uncertainty limits quoted refer to the measured values only.

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

Date of Calibration : 22-28 Feb 2024

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Head Office  
15 Mu, 3 Tambon Khlongkro, Amphoe Khlongkro, Bangkok 10110, Thailand  
Tel: 06619 2577 9000  
Fax: 06619 2577 9006  
E-mail: hampoo@tistr.go.th

Office/Laboratory  
15/1C, Bangpoo Industrial Estate, Sukhumvit Road, Bangpoo, Bangkok 10280, Thailand  
Tel: 06619 2577 9000  
Fax: 06619 2577 9006  
E-mail: hampoo@tistr.go.th

Office  
15/1C, Bangpoo Industrial Estate, Sukhumvit Road, Bangkok 10280, Thailand  
Tel: 06619 2577 9000  
Fax: 06619 2577 9006  
E-mail: hampoo@tistr.go.th

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#### 1. Absolute Sensitivity

Reference Acoustic Signal (dB)	Measured value (dB)		Deviation value (dB)	Acceptance limit Class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	Before adjust	After adjust				
113.96	114.1	113.9	-0.1	1.0	0.30	N/A

Note: The external calibration adjustment was firstly performed. The internal calibration adjustment was then completed at the display of 123.6 dB.

#### 2. Self-generated noise

##### 2.1 Normal test

Measured value (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
19.1	0.10	N/A

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

Frequency Weighting	Measured value (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
A-Weight	11.9	0.10	N/A
C-Weight	17.4	0.10	N/A
Flat	23.2	0.10	N/A

Date of Calibration : 22-28 Feb 2024

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Head Office  
15 Mu, 3 Tambon Khlongkro, Amphoe Khlongkro, Bangkok 10110, Thailand  
Tel: 06619 2577 9000  
Fax: 06619 2577 9006  
E-mail: hampoo@tistr.go.th

Office/Laboratory  
15/1C, Bangpoo Industrial Estate, Sukhumvit Road, Bangpoo, Bangkok 10280, Thailand  
Tel: 06619 2577 9000  
Fax: 06619 2577 9006  
E-mail: hampoo@tistr.go.th

Office  
15/1C, Bangpoo Industrial Estate, Sukhumvit Road, Bangkok 10280, Thailand  
Tel: 06619 2577 9000  
Fax: 06619 2577 9006  
E-mail: hampoo@tistr.go.th

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#### 3. Acoustical signal test of frequency weightings

Frequency (Hz)	Deviation from frequency response (dB)			Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	A-weight	C-weight	Flat			
125	0.1	0.2	0.2	1.5	0.45	0.6
1 000	-0.1	-0.1	-0.1	1.0	0.45	0.6
8 000	0.0	0.0	-0.1	5.0	0.45	0.7

#### 4. Electrical signal test of frequency weightings

Frequency (Hz)	Deviation from frequency response (dB)			Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	A-weight	C-weight	Flat			
63	-0.1	0.0	0.0	2.0	0.20	0.6
125	-0.1	0.0	0.0	1.5	0.20	0.6
250	-0.1	0.0	0.0	1.5	0.20	0.6
500	0.0	0.0	0.0	1.5	0.20	0.6
1 000	0.0	0.0	0.0	1.0	0.20	0.6
2 000	0.0	0.0	0.0	2.0	0.20	0.6
4 000	0.0	0.0	0.0	3.0	0.20	0.6
8 000	0.0	0.0	0.0	5.0	0.20	0.7

Date of Calibration : 22-28 Feb 2024

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15 Mu, 3 Tambon Khlongkro, Amphoe Khlongkro, Bangkok 10110, Thailand  
Tel: 06619 2577 9000  
Fax: 06619 2577 9006  
E-mail: hampoo@tistr.go.th

Office/Laboratory  
15/1C, Bangpoo Industrial Estate, Sukhumvit Road, Bangpoo, Bangkok 10280, Thailand  
Tel: 06619 2577 9000  
Fax: 06619 2577 9006  
E-mail: hampoo@tistr.go.th

Office  
15/1C, Bangpoo Industrial Estate, Sukhumvit Road, Bangkok 10280, Thailand  
Tel: 06619 2577 9000  
Fax: 06619 2577 9006  
E-mail: hampoo@tistr.go.th

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## 5. Long-term stability

Time	Measured Value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Begin	94.0	0.0	0.3	0.10	0.1
End	94.0				

## 6. Frequency and time weightings at 1 kHz

## 6.1 Frequency weightings at 1 kHz

Frequency Weighting	Measured Value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
A-weight	94.0	0.0	0.2	0.20	0.2
C-weight	94.0	0.0	0.2	0.20	0.2
Flat	94.1	0.1	0.2	0.20	0.2

## 6.2 Time weightings at 1 kHz

Frequency Weighting	Measured Value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Fast	94.0	0.0	0.1	0.20	0.2
Slow	94.0	0.0	0.1	0.20	0.2
Leq	94.0	0.0	0.1	0.20	0.2

Date of Calibration 22-28 Feb 2024

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Head Office  
35 Moo 3 Tambon Bang Mo Amphoe Bang Mo  
Changwat Pathum Thani 12130, Thailand  
Tel: +66 2577 9000  
Fax: +66 2577 9001  
E-mail: info@tistr.go.th

Office/Laboratory  
No. 111, Bang Mo Industrial Estate, Bang Mo  
Amphoe Bang Mo, Changwat Pathum Thani 12130, Thailand  
Tel: +66 2577 9000  
Fax: +66 2577 9001  
E-mail: info@tistr.go.th

Office  
111 Moo 3 Tambon Bang Mo, Amphoe Bang Mo  
Changwat Pathum Thani 12130, Thailand  
Tel: +66 2577 9000  
Fax: +66 2577 9001  
E-mail: info@tistr.go.th



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## 7. Level linearity on the reference level range

Anticipated value (dB)	Measured Value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
137	137.1	0.1	1.1	0.30	0.3
136	136.1	0.1	1.1	0.30	0.3
135	135.1	0.1	1.1	0.30	0.3
133	133.1	0.1	1.1	0.30	0.3
132	132.1	0.1	1.1	0.30	0.3
131	131.1	0.1	1.1	0.30	0.3
130	130.1	0.1	1.1	0.30	0.3
129	129.1	0.1	1.1	0.30	0.3
124	124.0	0.0	1.1	0.30	0.3
119	119.1	0.1	1.1	0.30	0.3
114	114.1	0.1	1.1	0.30	0.3
109	109.0	0.0	1.1	0.30	0.3
104	104.1	0.1	1.1	0.30	0.3
99	99.0	0.0	1.1	0.30	0.3
94	94.0	0.0	1.1	0.30	0.3
89	89.0	0.0	1.1	0.30	0.3
84	84.1	0.1	1.1	0.30	0.3
79	79.1	0.1	1.1	0.30	0.3
74	74.0	0.0	1.1	0.30	0.3
69	69.0	0.0	1.1	0.30	0.3
64	64.0	0.0	1.1	0.30	0.3
59	59.0	0.0	1.1	0.30	0.3

Date of Calibration 22-28 Feb 2024

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Head Office  
35 Moo 3 Tambon Bang Mo Amphoe Bang Mo  
Changwat Pathum Thani 12130, Thailand  
Tel: +66 2577 9000  
Fax: +66 2577 9001  
E-mail: info@tistr.go.th

Office/Laboratory  
No. 111, Bang Mo Industrial Estate, Bang Mo  
Amphoe Bang Mo, Changwat Pathum Thani 12130, Thailand  
Tel: +66 2577 9000  
Fax: +66 2577 9001  
E-mail: info@tistr.go.th

Office  
111 Moo 3 Tambon Bang Mo, Amphoe Bang Mo  
Changwat Pathum Thani 12130, Thailand  
Tel: +66 2577 9000  
Fax: +66 2577 9001  
E-mail: info@tistr.go.th



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MTC No. EEL, BP. 172-0167

## 7. Level linearity on the reference level range (cont.)

Anticipated value (dB)	Measured Value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
54	54.0	0.0	1.1	0.30	0.3
49	49.0	0.0	1.1	0.30	0.3
44	44.0	0.0	1.1	0.30	0.3
39	39.0	0.0	1.1	0.30	0.3
34	34.0	0.0	1.1	0.30	0.3
29	28.9	-0.1	1.1	0.30	0.3
28	28.0	0.0	1.1	0.30	0.3
27	27.0	0.0	1.1	0.30	0.3
26	26.0	0.0	1.1	0.30	0.3
25	25.0	0.0	1.1	0.30	0.3

## 8. Level linearity including the level range control

At reference sound level on the reference level range

Range	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
30-130	94.0	94.0	0.0	1.1	0.30	0.3

Date of Calibration 22-28 Feb 2024

7/9

This report was prepared by the laboratory and is subject to the terms and conditions of the contract. The laboratory is not responsible for the accuracy of the data provided by the customer. The laboratory is not responsible for the accuracy of the data provided by the customer. The laboratory is not responsible for the accuracy of the data provided by the customer.

FMELMTC.002 Rev.4

Head Office  
35 Moo 3 Tambon Bang Mo Amphoe Bang Mo  
Changwat Pathum Thani 12130, Thailand  
Tel: +66 2577 9000  
Fax: +66 2577 9001  
E-mail: info@tistr.go.th

Office/Laboratory  
No. 111, Bang Mo Industrial Estate, Bang Mo  
Amphoe Bang Mo, Changwat Pathum Thani 12130, Thailand  
Tel: +66 2577 9000  
Fax: +66 2577 9001  
E-mail: info@tistr.go.th

Office  
111 Moo 3 Tambon Bang Mo, Amphoe Bang Mo  
Changwat Pathum Thani 12130, Thailand  
Tel: +66 2577 9000  
Fax: +66 2577 9001  
E-mail: info@tistr.go.th



THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-67-0232

MTC No. EEL, BP. 172-0167

## 8. Level linearity including the level range control

At reference level at 5 dB greater than the under-range on a level range

Range	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
30-130	25	25.0	0.0	1.1	0.30	0.3

## 9. Tone burst response

Time Weighting	Toneburst Duration, Tb (ms)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Fast	200	126.0	0.0	±1.0	0.20	0.3
	2	108.9	+0.1	+1.0; -2.5	0.20	0.3
	0.25	100.0	0.0	+1.5; -5.0	0.20	0.3
Slow	200	119.5	+0.1	±1.0	0.20	0.3
	2	100.0	0.0	+1.0; -5.0	0.20	0.3

Date of Calibration 22-28 Feb 2024

8/9

This report was prepared by the laboratory and is subject to the terms and conditions of the contract. The laboratory is not responsible for the accuracy of the data provided by the customer. The laboratory is not responsible for the accuracy of the data provided by the customer. The laboratory is not responsible for the accuracy of the data provided by the customer.

FMELMTC.002 Rev.4

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Office  
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Changwat Pathum Thani 12130, Thailand  
Tel: +66 2577 9000  
Fax: +66 2577 9001  
E-mail: info@tistr.go.th



THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (ISTR)

Request No.21-67/0232

MTC No. EEL BP. 172.0167

#### 10. Peak C sound level

Number of cycles in test signal	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Complete cycle	125.4	125.5	0.1	2.0	0.20	0.35
Positive half cycle	124.4	124.3	-0.3	2.0	0.20	0.35
Negative half cycle	124.4	124.1	-0.3	2.0	0.20	0.35

#### 11. Overload indication

Measured value (dB)		Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Positive one-half cycle	Negative one-half cycle				
135.4	135.4	0.0	1.5	0.55	0.25

#### 12. High-level stability

Time	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Begin	129.0	0.0	0.3	0.10	0.1
End	129.0				

Date of Issue : 29 Feb 2024

Ref: 2011267012400347002

End of Certificate

## SITHIPORN ASSOCIATES CO., LTD. CALIBRATION LABORATORY

451-451/1 Sirthiporn Road, Bangh, rnu Bangplad, Bangkok 10700 Thailand  
Tel : +66 2433 8331 Email : calibration@sithiporn.com

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Cert. No. : ACL24033  
Pages : 1 of 8

## Calibration Certificate

**Equipment :** SOUND LEVEL METER  
**Manufacturer :** RION  
**Model :** NL-42A / Microphone UC-52 / Preamplifier NH-24  
**Serial No.:** 00623392 / 198639 / 26420  
**ID No.:** RYG\_FS0617

**Condition As Found :** GOOD

**Customer :** ALS LABORATORY GROUP (THAILAND) CO., LTD.  
104 PHATTHANAKAN 40, PHATTHANAKAN ROAD,  
KHAENG PHATTHANAKAN, KJIEY 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 2024  
**Calibration Date :** 12-15 JANUARY 2024  
**Date of Issue :** 16 JANUARY 2024

**Calibrated by :** Nuthakorn Pisulpaisan

**Approved by :**

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.

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451-451/1 Sirthiporn Road, Bangh, rnu Bangplad, Bangkok 10700 Thailand  
Tel : +66 2433 8331 Email : calibration@sithiporn.com

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Cert. No. : ACL24033  
Job No. : VC67AC0052  
Pages : 2 of 8

**Calibration Procedure :** CP-AC-01

#### Calibration Method :

This equipment was calibrated by follow 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-0009-23	07-FEB-24
Waveform Generator	33511B	MY53202742	EF-0010-23	07-FEB-24
Digital Multimeter	33461A	MY53220104	EELBP 30/0266	13-FEB-24
Digital Multimeter	33461A	MY53220076	EELBP 29/0266	13-FEB-24
Digital Multimeter	34461A	MY60024273	EELBP 31/0266	14-FEB-24
Programmable Attenuator	MAT-1070	62100114	EF-0011-23	08-FEB-24
Condenser Microphone	4180	2977900	AA-1001-23	14-FEB-24
Measuring Amplifier	NA-42KAI	34560495	AA-3002-23	14-FEB-24

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 (ISTR).

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Cert. No. : ACL24033  
Job No. : VC67AC0052  
Pages : 3 of 8

#### Summary of Measurement Result :

Parameter	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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Pages : 4 of 8

**Result of calibration :**

**1. Absolute sensitivity**

Reference Acoustic Signal ( dB )	Measured Value ( dB )	Deviation ( dB )	Acceptance Limit ( dB )
93.9 (93.98)	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	13.8
C - weight	20.6
Flat	26.1

**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	0.1	0.1	0.1	± 1.5
1000	0.0	0.0	0.0	± 1.0
8000	1.2	1.3	1.3	±5.0

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Job No. : VC67AC0052  
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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	0.0	0.0	0.0	±2.0
125	0.0	0.1	0.1	±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	Anticipated Value ( dB )	Measured Value ( dB )	Deviated Value ( dB )	Acceptance Limits ( dB )
A - weight	94.0	94.0	0.0	± 0.2
C - weight	94.0	94.0	0.0	± 0.2
Flat	94.0	94.0	0.0	± 0.2

**5.2 Time weighting at 1 kHz**

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

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Cert. No. : ACL24033  
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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	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	27.1	0.1	± 1.1
26.0	26.1	0.1	± 1.1
25.0	25.1	0.1	± 1.1

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451-451/1 Srinthorn Road Bangbunru Bangkok 10700 Thailand  
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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	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
	0.25	1	99.0	98.9	-0.1	1.5 ; -5.0
SEL	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, L <sub>peak</sub> ( dB )	Deviated Value ( dB )	Acceptance Limits ( dB )
Continuous	133.0	133.0	0.0	±3.0
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	±2.0
Positive half cycle	135.4	135.1	-0.3	±2.0
Negative half cycle	135.4	135.1	-0.3	±2.0

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**CALIBRATION LABORATORY**

451-451/1 Sinitporn Road, Bangbunmu, Bangkok, 10700 Thailand  
Tel : +66 2433 8331 Email : calibration@sithiporn.com

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Job No. : VC67AC0052  
Pages : 8 of 8

**11. Overload Indication**

Measured value ( dB )		Deviated Value ( dB )	Acceptance Limits ( dB )
Positive one-half cycle	Negative one-half cycle		
89.7	89.7	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

T. Petchu.

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Cert. No. : ACL24305  
Pages : 1 of 8

**Calibration Certificate**

**Equipment :** SOUND LEVEL METER  
**Manufacturer :** RION  
**Model :** NL-42 / Microphone UC-52 / Preamplifier NH-24  
**Serial No. :** 00873109 / 171842 / 73485  
**ID No. :** RYG\_TS0384

**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 :** 23 SEPTEMBER 2024  
**Calibration Date :** 09 OCTOBER 2024  
**Date of Issue :** 09 OCTOBER 2024

REVIEW BY	<i>Natthakorn</i>
APPROVED BY	<i>T. Petchu.</i>
NEXT CAL DATE	01/10/25

**Calibrated by :** Natthakorn Pitsutpaivan

**Approved by :** *T. Petchu.*  
( 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.

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Tel : +66 2433 8331 Email : calibration@sithiporn.com

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Cert. No. : ACL24305  
Job No. : VC67AC0164  
Pages : 2 of 8

**Calibration Procedure :** CP-AC-01

**Calibration Method :**

This equipment was calibrated by following 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-0009-24	05-FEB-25
Waveform Generator	33511B	MY52302742	EF-0007-24	05-FEB-25
Digital Multimeter	33461A	MY53220104	EEL BP 21/0267	13-FEB-25
Digital Multimeter	33461A	MY53220076	EEL BP 20/0267	15-FEB-25
Digital Multimeter	34461A	MY60024273	EEL BP 22/0267	15-FEB-25
Programmable Attenuator	MA11-1070	62100114	EF-0008-24	05-FEB-25
Condenser Microphone	4180	2977900	AA-1001-24	12-FEB-25
Measuring Amplifier	NA-42KAI	34560495	AA-3001-24	05-FEB-25

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).

T. Petchu.

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451-451/1 Sinitporn Road, Bangbunmu, Bangkok, 10700 Thailand  
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Cert. No. : ACL24305  
Job No. : VC67AC0164  
Pages : 3 of 8

**Summary of Measurement Result :**

Parameter	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	0.3	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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Cert. No. : ACL24305  
Job No. : VC67AC0164  
Page : 4 of 8

**Result of calibration :**

**1. Absolute sensitivity**

Reference Acoustic Signal ( dB )	Measured Value ( dB )	Deviation ( dB )	Acceptance Limits ( dB )
93.9 (93.94)	93.9	0.0	±0.3

**2. Self-generated noise**

**2.1 Normal test**

Measured Value ( dB )
16.1

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

Frequency Weighting	Weighting ( dB )
A - weight	13.1
C - weight	19.8
Flat	25.1

**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	0.4	0.5	0.5	± 1.5
1000	0.0	0.0	0.0	± 1.0
8000	-1.4	-1.3	-1.3	±5.0

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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	0.1	0.1	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	Anticipated Value ( dB )	Measured Value ( dB )	Deviated Value ( dB )	Acceptance Limits ( dB )
A - weight	94.0	94.0	0.0	± 0.2
C - weight	94.0	94.0	0.0	± 0.2
Flat	94.0	94.0	0.0	± 0.2

**5.2 Time weighting at 1 kHz**

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

*T. Petch.*

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

451-451/1 Srinthorn Road, Bangbunmu Bangkok 10700 Thailand  
Tel : +66 2433 8331 Email : calibration@sithiporn.com

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Cert. No. : ACL24305  
Job No. : VC67AC0164  
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	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	28.1	0.1	± 1.1
27.0	27.2	0.2	± 1.1
26.0	26.2	0.2	± 1.1
25.0	25.2	0.2	± 1.1

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**CALIBRATION LABORATORY**

451-451/1 Srinthorn Road, Bangbunmu Bangkok 10700 Thailand  
Tel : +66 2433 8331 Email : calibration@sithiporn.com

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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 )
130	94.0	94.0	0.0	±1.1

Range	Anticipated Value ( dB )	Measured Value ( dB )	Deviated Value ( dB )	Acceptance Limits ( dB )
130	30.0	30.1	0.1	±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
SIL	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

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451/451/1 Srinthorn Road Banglamung Bangkok 10700 Thailand  
Tel: +66 2423 0381 Email: calibration@sithiporn.com

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Cert. No. : ACL24305  
Job No. : VC67AC0164  
Pages : 8 of 8

## 10. Peak C sound level

Number of cycle in test signal	Anticipated Value (dB)	Measured Value, Lepen (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Continuous	133.0	133.0	0.0	±3.0
One	136.4	136.2	-0.2	±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	±2.0
Positive half cycle	135.4	135.1	-0.3	±2.0
Negative half cycle	135.4	135.1	-0.3	±2.0

## 11. Overload indication

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

*T. Petch*



THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-67-0232

MTC No. FEL BP. 171-0167

## CALIBRATION CERTIFICATE

Submitted by : ALS Laboratory Group (Thailand) Co., Ltd.  
Address : 104 Phatthanakan 40 Phatthanakan Rd. Khwaeng Phatthanakan, Khet Sunn Lunnag, Bangkok 10250  
Calibrated at : Electrical and Electronic Standards Laboratory, Industrial Metrology and Testing Service Centre,  
Sor 1C, Bangpoo Industrial Estate, Sukhumvit Rd., A Muang, Samutprakan 10280.

### Instrument Calibrated :

Description : Sound Level Meter  
Manufacturer : Rion  
Model : NL-42  
Serial No. : 00296518 (ID: RYG FS0431)  
Microphone : Type UC-52 No.66239  
Preamplifier : Type NH-24 No.34375

### Ambient Environment

Temperature : (23 ± 3) °C  
Relative Humidity : (50 ± 15) %  
Ambient Pressure : (101.325 ± 1.5) kPa

### Standards used :

1. Band Pass Filter Wavelet 752A S/N 90010494
2. Condenser Microphone Brüel&Kjær 4180 S/N 2889871
3. Decade Attenuator Ando AL-205 S/N 00464602
4. Function/Arbitrary Waveform Generator Agilent 33220A S/N MY44042668
5. Digital Function Synthesizer NF Electronic Instruments DF-193A S/N 122037
6. Digital Multimeter Fluke 8520A S/N 49K5007
7. Pistophone Ram NC-72 S/N 00402446
8. Measuring Amplifier Brüel&Kjær 2636 S/N 1537481

Date of Receipt : 24 Jan. 2024

Date of Calibration : 22-28 Feb. 2024

1.0

The results of this calibration are valid only for the conditions stated on this certificate. The user is responsible for ensuring that the conditions of use are within the scope of the calibration.

FM/SLMTC 002 Rev.4

Head Office:  
451/451/1 Srinthorn Road Banglamung Bangkok 10700 Thailand  
Tel: +66 2423 0381  
Fax: +66 2423 0382  
Email: info@sithiporn.com

Office/Laboratory:  
451/451/1 Srinthorn Road Banglamung Bangkok 10700 Thailand  
Tel: +66 2423 0381  
Fax: +66 2423 0382  
Email: info@sithiporn.com

Office:  
451/451/1 Srinthorn Road Banglamung Bangkok 10700 Thailand  
Tel: +66 2423 0381  
Fax: +66 2423 0382  
Email: info@sithiporn.com



THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-67-0232

MTC No. FEL BP. 171-0167

9. Power Amplifier Brüel&Kjær 2706 S/N 1517650
10. Speaker Tannoy Limited, Great Britain British Patent No. 215300
11. Digital Multimeter Agilent 34401A S/N MY44005560
12. Programmable Attenuator Tammigawa TPA-302A S/N 2212

### Calibration Procedure

This instrument was calibrated by using calibration procedures no CP-102-02 and CP-102-03, which were based on IEC 61672-3 Electroacoustics - Sound Level Meters - Part 3 : Periodic tests (2013). These calibration procedures were related to the electrical and acoustic signal tests. The electrical signal test was carried out with the direct measurement method. The acoustic signal test was performed in an anechoic room with the comparison measurement method.

This instrument has been calibrated against standards maintained at the Electrical and Electronic Standards Laboratory (EEL), which are traceable to the International System of Units through the National Institute of Metrology (Thailand).

The information on actual reading is attached herewith and the uncertainty limits quoted refer to the measured values only.

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

Date of Calibration : 22-28 Feb. 2024

2.0

The results of this calibration are valid only for the conditions stated on this certificate. The user is responsible for ensuring that the conditions of use are within the scope of the calibration.

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Head Office:  
451/451/1 Srinthorn Road Banglamung Bangkok 10700 Thailand  
Tel: +66 2423 0381  
Fax: +66 2423 0382  
Email: info@sithiporn.com

Office/Laboratory:  
451/451/1 Srinthorn Road Banglamung Bangkok 10700 Thailand  
Tel: +66 2423 0381  
Fax: +66 2423 0382  
Email: info@sithiporn.com

Office:  
451/451/1 Srinthorn Road Banglamung Bangkok 10700 Thailand  
Tel: +66 2423 0381  
Fax: +66 2423 0382  
Email: info@sithiporn.com



THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-67-0232

MTC No. FEL BP. 171-0167

### 1. Absolute Sensitivity

Reference Acoustic Signal (dB)	Measured value (dB)	Deviation value (dB)	Acceptance limit Class 2 (±dB)	Uncertainty (±dB)	Maximum permitted uncertainty of measurement (±dB)
113.96	Before adjust: 114.3 After adjust: 113.9	-0.1	1.0	0.30	N/A

Note: The external calibration adjustment was firstly performed. The internal calibration adjustment was then completed at the display of 125.1 dB

### 2. Self-generated noise

#### 2.1 Normal test

Measured value (dB)	Uncertainty (±dB)	Maximum permitted uncertainty of measurement (±dB)
20.2	0.10	N/A

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

Frequency Weighting	Measured value (dB)	Uncertainty (±dB)	Maximum permitted uncertainty of measurement (±dB)
A-Weight	14.4	0.10	N/A
C-Weight	19.9	0.10	N/A
Flat	25.3	0.10	N/A

Date of Calibration : 22-28 Feb. 2024

3.0

The results of this calibration are valid only for the conditions stated on this certificate. The user is responsible for ensuring that the conditions of use are within the scope of the calibration.

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Head Office:  
451/451/1 Srinthorn Road Banglamung Bangkok 10700 Thailand  
Tel: +66 2423 0381  
Fax: +66 2423 0382  
Email: info@sithiporn.com

Office/Laboratory:  
451/451/1 Srinthorn Road Banglamung Bangkok 10700 Thailand  
Tel: +66 2423 0381  
Fax: +66 2423 0382  
Email: info@sithiporn.com

Office:  
451/451/1 Srinthorn Road Banglamung Bangkok 10700 Thailand  
Tel: +66 2423 0381  
Fax: +66 2423 0382  
Email: info@sithiporn.com





THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-67/0232

MTC No. EEL BP. 171/0167

3. Acoustical signal test of frequency weightings

Frequency (Hz)	Deviation from frequency response (dB)			Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	A-weight	C-weight	Flat			
125	+0.1	0.2	0.1	1.5	0.45	0.6
1 000	0.0	0.0	0.0	1.0	0.45	0.6
8 000	+1.7	+1.7	+1.7	5.0	0.45	0.7

4. Electrical signal test of frequency weightings

Frequency (Hz)	Deviation from frequency response (dB)			Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	A-weight	C-weight	Flat			
63	+0.1	+0.1	+0.1	2.0	0.20	0.6
125	+0.1	0.0	0.0	1.5	0.20	0.6
250	+0.1	0.0	0.0	1.5	0.20	0.6
500	+0.1	0.0	0.0	1.5	0.20	0.6
1 000	0.0	0.0	0.0	1.0	0.20	0.6
2 000	+0.1	0.0	+0.1	2.0	0.20	0.6
4 000	+0.1	0.0	0.0	3.0	0.20	0.6
8 000	0.0	0.0	0.0	5.0	0.20	0.7

Date of Calibration 22-28 Feb 2024

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Pm

This report is valid only for the test results and does not cover the calibration of the equipment used in the test. The user is responsible for the calibration of the equipment used in the test.

THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Head Office  
35 Mu 3 Tambon Khwaeng Amphoe Nong Chok  
Chonburi Province 26100, Thailand  
Tel. 0372 2577 9100  
Fax. 0372 2577 9101  
E-mail: tistr@tistr.go.th

Office/Laboratory  
35 Mu 3 Tambon Khwaeng Amphoe Nong Chok  
Chonburi Province 26100, Thailand  
Tel. 0372 2577 9100  
Fax. 0372 2577 9101  
E-mail: tistr@tistr.go.th

Office  
35 Mu 3 Tambon Khwaeng Amphoe Nong Chok  
Chonburi Province 26100, Thailand  
Tel. 0372 2577 9100  
Fax. 0372 2577 9101  
E-mail: tistr@tistr.go.th



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Request No. 21-67/0232

MTC No. EEL BP. 171/0167

5. Long-term stability

Time	Measured Value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Begin	94.0	0.0	0.3	0.10	0.1
End	94.0				

6. Frequency and time weightings at 1 kHz

6.1 Frequency weightings at 1 kHz

Frequency Weighting	Measured Value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
A-weight	94.0	0.0	0.2	0.20	0.2
C-weight	94.0	0.0	0.2	0.20	0.2
Flat	94.1	0.1	0.2	0.20	0.2

6.2 Time weightings at 1 kHz

Frequency Weighting	Measured Value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Fast	94.0	0.0	0.1	0.20	0.2
Slow	94.0	0.0	0.1	0.20	0.2
Leq	94.0	0.0	0.1	0.20	0.2

Date of Calibration 22-28 Feb 2024

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Pm

This report is valid only for the test results and does not cover the calibration of the equipment used in the test. The user is responsible for the calibration of the equipment used in the test.

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Head Office  
35 Mu 3 Tambon Khwaeng Amphoe Nong Chok  
Chonburi Province 26100, Thailand  
Tel. 0372 2577 9100  
Fax. 0372 2577 9101  
E-mail: tistr@tistr.go.th

Office/Laboratory  
35 Mu 3 Tambon Khwaeng Amphoe Nong Chok  
Chonburi Province 26100, Thailand  
Tel. 0372 2577 9100  
Fax. 0372 2577 9101  
E-mail: tistr@tistr.go.th

Office  
35 Mu 3 Tambon Khwaeng Amphoe Nong Chok  
Chonburi Province 26100, Thailand  
Tel. 0372 2577 9100  
Fax. 0372 2577 9101  
E-mail: tistr@tistr.go.th



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MTC No. EEL BP. 171/0167

7. Level linearity on the reference level range

Anticipated value (dB)	Measured Value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
137	137.0	0.0	1.1	0.30	0.3
136	136.0	0.0	1.1	0.30	0.3
135	135.0	0.0	1.1	0.30	0.3
133	133.0	0.0	1.1	0.30	0.3
132	132.0	0.0	1.1	0.30	0.3
131	131.0	0.0	1.1	0.30	0.3
130	130.0	0.0	1.1	0.30	0.3
129	129.0	0.0	1.1	0.30	0.3
124	124.0	0.0	1.1	0.30	0.3
119	119.0	0.0	1.1	0.30	0.3
114	114.0	0.0	1.1	0.30	0.3
109	109.0	0.0	1.1	0.30	0.3
104	104.0	0.0	1.1	0.30	0.3
99	99.0	0.0	1.1	0.30	0.3
94	94.0	0.0	1.1	0.30	0.3
89	89.0	0.0	1.1	0.30	0.3
84	84.0	0.0	1.1	0.30	0.3
79	79.0	0.0	1.1	0.30	0.3
74	74.0	0.0	1.1	0.30	0.3
69	69.0	0.0	1.1	0.30	0.3
64	63.9	-0.1	1.1	0.30	0.3
59	59.0	0.0	1.1	0.30	0.3

Date of Calibration 22-28 Feb 2024

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Pm

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Head Office  
35 Mu 3 Tambon Khwaeng Amphoe Nong Chok  
Chonburi Province 26100, Thailand  
Tel. 0372 2577 9100  
Fax. 0372 2577 9101  
E-mail: tistr@tistr.go.th

Office/Laboratory  
35 Mu 3 Tambon Khwaeng Amphoe Nong Chok  
Chonburi Province 26100, Thailand  
Tel. 0372 2577 9100  
Fax. 0372 2577 9101  
E-mail: tistr@tistr.go.th

Office  
35 Mu 3 Tambon Khwaeng Amphoe Nong Chok  
Chonburi Province 26100, Thailand  
Tel. 0372 2577 9100  
Fax. 0372 2577 9101  
E-mail: tistr@tistr.go.th



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Request No. 21-67/0232

MTC No. EEL BP. 171/0167

7. Level linearity on the reference level range (cont.)

Anticipated value (dB)	Measured Value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
54	53.9	-0.1	1.1	0.30	0.3
49	49.0	0.0	1.1	0.30	0.3
44	43.9	-0.1	1.1	0.30	0.3
39	39.0	0.0	1.1	0.30	0.3
34	33.9	-0.1	1.1	0.30	0.3
29	28.9	-0.1	1.1	0.30	0.3
28	27.9	-0.1	1.1	0.30	0.3
27	26.9	-0.1	1.1	0.30	0.3
26	25.9	-0.1	1.1	0.30	0.3
25	24.8	-0.2	1.1	0.30	0.3

8. Level linearity including the level range control

At reference sound level on the reference level range

Range	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
30-130	94.0	94.0	0.0	1.1	0.30	0.3

Date of Calibration 22-28 Feb 2024

7/9  
Pm

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Head Office  
35 Mu 3 Tambon Khwaeng Amphoe Nong Chok  
Chonburi Province 26100, Thailand  
Tel. 0372 2577 9100  
Fax. 0372 2577 9101  
E-mail: tistr@tistr.go.th

Office/Laboratory  
35 Mu 3 Tambon Khwaeng Amphoe Nong Chok  
Chonburi Province 26100, Thailand  
Tel. 0372 2577 9100  
Fax. 0372 2577 9101  
E-mail: tistr@tistr.go.th

Office  
35 Mu 3 Tambon Khwaeng Amphoe Nong Chok  
Chonburi Province 26100, Thailand  
Tel. 0372 2577 9100  
Fax. 0372 2577 9101  
E-mail: tistr@tistr.go.th



MTC No. EEL BP 171/0167

At reference level at 5 dB greater than the under-range on a level range

### 9. Tone burst response



MTC No. EEL BP 171/0167

Number of cycles in test = $g_{\text{test}}$	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class = $2 \pm 2(g_{\text{test}})$	Uncertainty ( $\pm$ dB)	Maximum-permitted uncertainty of measurement ( $\pm$ dB)
Complete cycle	125.4	125.5	0.1	3.0	0.20	0.35
Positive half cycle	124.4	124.1	-0.3	2.0	0.20	0.35
Negative half cycle	124.4	124.1	-0.3	2.0	0.20	0.35

Measured value (dB)		Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Positive one-half cycle	Negative one-half cycle				
135.4	135.4	0.0	1.5	0.55	0.25

Time	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Begin	129.0	0,0	0,3	0,10	0,1
End	129.0				

 $\gamma : \mathbb{R} \rightarrow \mathbb{R}$ 

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Office/Laboratory  
 100, Bangsara Road, Jatiwaringin, Suburhan Raya  
 Komplek Korpri 5, Cawang, Jakarta Timur 13131  
 Tel: +62 21 6721 30 ext. 115, 116  
 Fax: +62 21 6721 9165  
 E-mail: [info@ictp.ac.id](mailto:info@ictp.ac.id)

**Office**  
166 West 12th Street, Cincinnati, OH 45202  
Tel: 513/251-1221 ext. 5219, 5225, 5217  
Fax: 513/251-1222  
E-mail: [journal@mc.manuscriptcentral.com](mailto:journal@mc.manuscriptcentral.com)

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Office/Laboratory  
 5010 Ewing Rd., York, PA 17403, United States  
 Telephone: 717-337-1200 Fax: 717-337-1200  
 E-mail: [john@york.edu](mailto:john@york.edu)

**Office**  
14, Protektoratowa 100, 01-600 Warszawa, Poland  
Tel: +48 6 71 3 11 21 • Fax: +48 22 5225 5217  
E-mail: [info@summaonline.pl](mailto:info@summaonline.pl)

FM 9-87C-002 Rev A



MTC No. EEL BP 173/0167

Soi 10, Bangna Industrial Estate, Sukhumvit Rd., A Muang, Samutprakan 10260.

### Ambient Environment

**Standards used :**



MTC No. E1:L BP: 173/0167

12. Programmable Attenuator Tamugawa TPA-303A S/N 2212

#### Calibration Procedure :

This instrument was calibrated by using calibration procedures no CP-102-02 and CP-102-03, which were based on IEC 61672-3: Electroacoustics - Sound Level Meters - Part 3: Periodic tests (2013). These calibration procedures were related to the electrical and acoustic signal tests. The electrical signal test was carried out with the direct measurement method. The acoustic signal test was performed in an anechoic room with the comparison measurement method.

This instrument has been calibrated against standards maintained at the Electrical and Electronic Standards Laboratory (EEL), which are traceable to the International System of Units through the National Institute of Metrology (Thailand).

The information on actual reading is attached herewith and the uncertainty limits quoted refer to the measured values only.

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

Date of Calibration 22-28 Feb 2024

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**Head Office**  
 25 - 1, Furber Kiln Road, Broomfield, Essex, UK  
 2 - 1, Furber Kiln Road, Broomfield, Essex, UK  
 Tel: 01274 251111  
 Fax: 01274 251112  
 E-mail: [enquiries@broomfield.co.uk](mailto:enquiries@broomfield.co.uk)

Office Laboratory  
1500 12th Avenue East  
Aurora, IL 60018  
Tel: 708/441-1100  
Fax: 708/441-1101

Office  
10000 Highway 100, Suite 100, Dallas, TX 75243  
Phone: 214-343-1111  
Fax: 214-343-1112  
E-mail: [info@houston.com](mailto:info@houston.com)

Table 1. ITC data for 1998-1999.

Head Office  
25th, The Light House, 200px (200x), 200px  
The Light House, 200px (200x), 200px  
The Light House, 200px (200x), 200px  
The Light House, 200px (200x), 200px  
The Light House, 200px (200x), 200px

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Office:  
111 Maple Street, Apt. 176, New Haven, CT 06510  
Tel: 203.333.1122 Fax: 203.333.1123  
E-mail: [info@21stcentury.com](mailto:info@21stcentury.com)

FIM, MIC, CO2 R<sub>0</sub>



THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-67/0232

MTC No. EEL BP. 173/0167

## 1. Absolute Sensitivity

Reference Acoustic Signal (dB)	Measured value (dB)		Deviation value (dB)	Acceptance limit Class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	Before adjust	After adjust				
113.96	114.1	113.9	-0.1	1.0	0.30	N/A

Note: The external calibration adjustment was firstly performed. The internal calibration adjustment was then completed at the display of 124.1 dB.

## 2. Self-generated noise

## 2.1 Normal test

Measured value (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
18.9	0.10	N/A

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

Frequency Weighting	Measured value (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
A-Weight	12.3	0.10	N/A
C-Weight	17.7	0.10	N/A
Flat	23.1	0.10	N/A

Date of Calibration : 22-28 Feb 2024

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The results were only for the purpose of comparison and not for legal use. The results were only for the purpose of comparison and not for legal use. The results were only for the purpose of comparison and not for legal use.

PMSE-MTC-002 Rev.4

Head Office  
25/62 Tambon Krungthai, Amphur Krungthai, Bangkok 10110, Thailand  
Tel: (662) 2577 9000  
Fax: (662) 2577 9009  
E-mail: kumpu@tistr.go.th

Office/Laboratory  
25/62 Tambon Krungthai, Amphur Krungthai, Bangkok 10110, Thailand  
Tel: (662) 2577 9000  
Fax: (662) 2577 9009  
E-mail: kumpu@tistr.go.th

Office  
106/9 Phrayothai Road, Bangkok 10110, Thailand  
Tel: (662) 2577 9000  
Fax: (662) 2577 9009  
E-mail: kumpu@tistr.go.th



THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-67/0232

MTC No. EEL BP. 173/0167

## 3. Acoustical signal test of frequency weightings

Frequency (Hz)	Deviation from frequency response (dB)			Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	A-weight	C-weight	Flat			
125	0.0	0.2	0.1	1.5	0.45	0.6
1 000	0.0	0.0	0.0	1.0	0.45	0.6
8 000	-0.3	-0.3	-0.3	3.0	0.45	0.7

## 4. Electrical signal test of frequency weightings

Frequency (Hz)	Deviation from frequency response (dB)			Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	A-weight	C-weight	Flat			
63	-0.1	0.0	0.0	2.0	0.20	0.6
125	-0.1	0.0	0.0	1.5	0.20	0.6
250	0.0	0.0	0.0	1.5	0.20	0.6
500	0.0	0.0	0.0	1.5	0.20	0.6
1 000	0.0	0.0	0.0	1.0	0.20	0.6
2 000	0.0	0.0	0.0	2.0	0.20	0.6
4 000	0.0	0.0	0.0	3.0	0.20	0.6
8 000	0.0	0.0	0.0	5.0	0.20	0.7

Date of Calibration : 22-28 Feb 2024

4-9

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E-mail: kumpu@tistr.go.th

Office/Laboratory  
25/62 Tambon Krungthai, Amphur Krungthai, Bangkok 10110, Thailand  
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Fax: (662) 2577 9009  
E-mail: kumpu@tistr.go.th

Office  
106/9 Phrayothai Road, Bangkok 10110, Thailand  
Tel: (662) 2577 9000  
Fax: (662) 2577 9009  
E-mail: kumpu@tistr.go.th



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Request No. 21-67/0232

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## 5. Long-term stability

Time	Measured Value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Begin	94.0	0.0	0.3	0.10	0.1
End	94.0				

## 6. Frequency and time weightings at 1 kHz

## 6.1 Frequency weightings at 1 kHz

Frequency Weighting	Measured Value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
A-weight	94.0	0.0	0.2	0.20	0.2
C-weight	94.0	0.0	0.2	0.20	0.2
Flat	94.1	0.1	0.2	0.20	0.2

## 6.2 Time weightings at 1 kHz

Frequency Weighting	Measured Value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Fast	94.0	0.0	0.1	0.20	0.2
Slow	94.0	0.0	0.1	0.20	0.2
Imp	94.0	0.0	0.1	0.20	0.2

Date of Calibration : 22-28 Feb 2024

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Office/Laboratory  
25/62 Tambon Krungthai, Amphur Krungthai, Bangkok 10110, Thailand  
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Tel: (662) 2577 9000  
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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-67/0232

MTC No. EEL BP. 173/0167

## 7. Level linearity on the reference level range

Anticipated value (dB)	Measured Value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
137	137.1	0.1	1.1	0.30	0.3
136	136.1	0.1	1.1	0.30	0.3
135	135.1	0.1	1.1	0.30	0.3
133	133.1	0.1	1.1	0.30	0.3
132	132.1	0.1	1.1	0.30	0.3
131	131.0	0.0	1.1	0.30	0.3
130	130.0	0.0	1.1	0.30	0.3
129	129.0	0.0	1.1	0.30	0.3
124	124.0	0.0	1.1	0.30	0.3
119	119.0	0.0	1.1	0.30	0.3
114	114.0	0.0	1.1	0.30	0.3
109	109.0	0.0	1.1	0.30	0.3
104	104.0	0.0	1.1	0.30	0.3
99	99.0	0.0	1.1	0.30	0.3
94	94.0	0.0	1.1	0.30	0.3
89	89.0	0.0	1.1	0.30	0.3
84	84.1	0.1	1.1	0.30	0.3
79	79.0	0.0	1.1	0.30	0.3
74	74.0	0.0	1.1	0.30	0.3
69	69.0	0.0	1.1	0.30	0.3
64	64.0	0.0	1.1	0.30	0.3
59	59.0	0.0	1.1	0.30	0.3

Date of Calibration : 22-28 Feb 2024

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Fax: (662) 2577 9009  
E-mail: kumpu@tistr.go.th

Office/Laboratory  
25/62 Tambon Krungthai, Amphur Krungthai, Bangkok 10110, Thailand  
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Request No. 21-67-0232

MTC No. EEL BP. 173-0167

## 7. Level linearity on the reference level range (cont.)

Anticipated value (dB)	Measured Value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
54	54.0	0.0	1.1	0.30	0.3
49	48.9	-0.1	1.1	0.30	0.3
44	44.0	0.0	1.1	0.30	0.3
39	38.9	-0.1	1.1	0.30	0.3
34	33.9	-0.1	1.1	0.30	0.3
29	28.8	-0.2	1.1	0.30	0.3
28	27.8	-0.2	1.1	0.30	0.3
27	26.9	-0.1	1.1	0.30	0.3
26	25.9	-0.1	1.1	0.30	0.3
25	24.8	-0.2	1.1	0.30	0.3

## 8. Level linearity including the level range control

At reference sound level on the reference level range

Range	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
30-130	94.0	94.0	0.0	1.1	0.30	0.3

Date of Calibration : 22-28 Feb. 2024

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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-67-0232

MTC No. EEL BP. 173-0167

## 8. Level linearity including the level range control

At reference level at 5 dB greater than the under-range on a level range

Range	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
30-130	25	25.0	0.0	1.1	0.30	0.3

## 9. Tone burst response

Time Weighting	Duration, T <sub>b</sub> (ms)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Fast	200	126.0	0.0	±1.0	0.20	0.3
	2	108.9	-0.1	-1.0; -2.5	0.20	0.3
	0.25	100.0	0.0	+1.5; -5.0	0.20	0.3
Slow	200	119.5	-0.1	±1.0	0.20	0.3
	2	100.0	0.0	+1.0; -5.0	0.20	0.3

Date of Calibration : 22-28 Feb. 2024

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Request No. 21-67-0232

MTC No. EEL BP. 173-0167

## 10. Peak C sound level

Number of cycles in test signal	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Complete cycle	125.4	125.5	0.1	3.0	0.20	0.35
Positive half cycle	124.4	124.1	-0.3	2.0	0.20	0.35
Negative half cycle	124.4	124.1	-0.3	2.0	0.20	0.35

## 11. Overload indication

Measured value (dB)		Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Positive one-half cycle	Negative one-half cycle	0.0	1.5	0.55	0.25
135.4	135.4				

## 12. High-level stability

Time	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Begin	129.0	0.0	0.3	0.10	0.1
End	129.0				

Request No. 21-67-0292

MTC No. EEL BP. 173-0267

## CALIBRATION CERTIFICATE

Submitted by : A1 S Laboratory Group (Thailand) Co., Ltd.  
Address : 104 Phatthanakan Rd., Phatthanakan Rd., Khwaeng Phatthanakan, Khet Suan Luang, Bangkok, 10250  
Calibrated at : Electrical and Electronic Standards Laboratory, Industrial Metrology and Testing Service Centre,  
Soi 1C, Bangpoo Industrial Estate, Sukhumvit Rd., Muang, Samprakan 10280.  
Instrument Calibrated : Ambient Environment  
Description : Sound Calibrator  
Temperature : (23 ± 3) °C  
Manufacturer : Rion  
Relative Humidity : (50 ± 15) %  
Model : NC-74  
Ambient Pressure : (101.325 ± 1.500) kPa  
Serial No. : 34178121 (ID RYG FS0213)  
Standards used : 1. Digital Function Synthesizer NF Electronic DF-193A S/N 122037.  
2. Measuring Amplifier Brüel & Kjær 2636 S/N 1537484.  
3. Programmable Attenuator Tamagawa TPA-303A S/N OF 2214.  
4. Digital Multimeter Agilent 34401A S/N MY44005560.  
5. Pressure Transmitter Vaisala PTB202AD S/N T0650001.  
6. Audio Analyzer Keithley 2015-P S/N 4106495.  
7. Condenser Microphone B&K 4180 S/N 289871.

Calibration Procedure: CIP-102-04 based on IEC 60942-2003: The sound pressure level generated by sound calibrator under test shall be measured by standard microphone using an insert voltage technique.

This instrument has been calibrated against standards maintained at Electrical and Electronic Standards Laboratory (EEL), which are traceable to the International System of Units through the National Institute of Metrology (Thailand).

The information on actual reading is attached herewith and the uncertainty limits quoted refer to the measured values only.

Date of Receipt : 19 Feb. 2024  
Date of Calibration : 28 Feb. 2024

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Head Office  
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Office  
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FMEL/MTC 002 Rev.4



THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-67-0292

MTC No. EEL BP. 173-0267

## CALIBRATION CERTIFICATE

Submitted by : A1 S Laboratory Group (Thailand) Co., Ltd.  
Address : 104 Phatthanakan Rd., Phatthanakan Rd., Khwaeng Phatthanakan, Khet Suan Luang, Bangkok, 10250  
Calibrated at : Electrical and Electronic Standards Laboratory, Industrial Metrology and Testing Service Centre,  
Soi 1C, Bangpoo Industrial Estate, Sukhumvit Rd., Muang, Samprakan 10280.  
Instrument Calibrated : Ambient Environment  
Description : Sound Calibrator  
Temperature : (23 ± 3) °C  
Manufacturer : Rion  
Relative Humidity : (50 ± 15) %  
Model : NC-74  
Ambient Pressure : (101.325 ± 1.500) kPa  
Serial No. : 34178121 (ID RYG FS0213)  
Standards used : 1. Digital Function Synthesizer NF Electronic DF-193A S/N 122037.  
2. Measuring Amplifier Brüel & Kjær 2636 S/N 1537484.  
3. Programmable Attenuator Tamagawa TPA-303A S/N OF 2214.  
4. Digital Multimeter Agilent 34401A S/N MY44005560.  
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This instrument has been calibrated against standards maintained at Electrical and Electronic Standards Laboratory (EEL), which are traceable to the International System of Units through the National Institute of Metrology (Thailand).

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Date of Calibration : 28 Feb. 2024

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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-67/0292 MTC No. EEL, BP, 63/0267

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

Nominal Output of Unit Under Test = 94 dB re 20  $\mu$ Pa at 1000 Hz

Acoustic Output in dB re 20  $\mu$ Pa, Corrected to Reference Conditions: 101.325 kPa, 23.0 °C and 50 % RH.

#### 1. Sound Pressure Level

Standard Microphone Type	Measured Sound Pressure Level (dB)	Deviated value (dB)	Uncertainty (dB)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Brüel&Kjaer 4180	94.01	0.01	$\pm 0.10$	$\pm 0.40$ dB

#### 2. Frequency

Standard Microphone Type	Measured Frequency (Hz)	Deviated value (Hz)	Uncertainty (Hz)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Brüel&Kjaer 4180	1003.1	3.1	$\pm 1.5$	$\pm 1.0\%$

#### 3. Total Distortion

Standard Microphone Type	Measured Total Distortion (%)	Uncertainty (%)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Brüel&Kjaer 4180	1.80	$\pm 0.50$	$\pm 3.0\%$

Note : 1. No adjustment.

2. The calibrator pressure correction was not included.

Date of Calibration : 28 Feb. 2024 Industrial Metrology and Testing Service Centre  
Date of Issue : 29 Feb. 2024 Ref: 2011267021900719001

Kind of Certificate

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The results refer only to the data provided and based on measurements.

Head Office  
25/45/1 Srinthorn Road Bangbunmu, Bangkok 10700 Thailand  
Tel: +66 2 243 8331 Fax: +66 2 243 8331  
E-mail: sithiporn@accreditation.com

Office/Laboratory  
25/45/1 Srinthorn Road Bangbunmu, Bangkok 10700 Thailand  
Tel: +66 2 243 8331 Fax: +66 2 243 8331  
E-mail: sithiporn@accreditation.com

Office  
25/45/1 Srinthorn Road Bangbunmu, Bangkok 10700 Thailand  
Tel: +66 2 243 8331 Fax: +66 2 243 8331  
E-mail: sithiporn@accreditation.com

FM/BL/MTC/002 Rev.4

## SITHIPORN ASSOCIATES CO., LTD. CALIBRATION LABORATORY

45/1-45/1 Srinthorn Road Bangbunmu, Bangkok 10700 Thailand  
Tel: +66 2 433 8331 Email: calibration@sithiporn.com

SITHIPORN ASSOCIATES



Cert. No. : ACL24072

Pages : 1 of 8

## Calibration Certificate

Equipment : SOUND LEVEL METER  
Manufacturer : RION  
Model : NL-42 / Microphone UC-52 / Preamplifier NH-24  
Serial No. : 01122578 / 143842 / 22771  
ID No. : RYG\_FS0017

Condition As Found : GOOD

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

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

Received Date : 11 JANUARY 2024  
Calibration Date : 22-24 JANUARY 2024  
Date of Issue : 24 JANUARY 2024

Calibrated by : Nathakorn Pisutpaisan

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.

## SITHIPORN ASSOCIATES CO., LTD. CALIBRATION LABORATORY

45/1-45/1 Srinthorn Road Bangbunmu, Bangkok 10700 Thailand  
Tel: +66 2 433 8331 Email: calibration@sithiporn.com

SITHIPORN ASSOCIATES



Cert. No. : ACL24072  
Job No. : VC67AC0054  
Pages : 2 of 8

Calibration Procedure : CP-AC-01

#### Calibration Method :

This equipment was calibrated by follow 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-0009-23	07-FEB-24
Waveform Generator	33511B	MY52302742	EF-0010-23	07-FEB-24
Digital Multimeter	33461A	MY53220104	EEL-BP 30/0266	13-FEB-24
Digital Multimeter	33461A	MY53220076	EEL-BP 29/0266	13-FEB-24
Digital Multimeter	34461A	MY60024273	EEL-BP 31/0266	14-FEB-24
Programmable Attenuator	MAT-1070	62100114	EF-0011-23	08-FEB-24
Condenser Microphone	4180	2977900	AA-1001-23	14-FEB-24
Measuring Amplifier	NA-42KAI	34560495	AA-3002-23	14-FEB-24

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).

## SITHIPORN ASSOCIATES CO., LTD. CALIBRATION LABORATORY

45/1-45/1 Srinthorn Road Bangbunmu, Bangkok 10700 Thailand  
Tel: +66 2 433 8331 Email: calibration@sithiporn.com

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Cert. No. : ACL24072  
Job No. : VC67AC0054  
Pages : 3 of 8

#### Summary of Measurement Result :

Parameter	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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Cert. No. : ACL24072  
Job No. : VC67AC0054  
Pages : 4 of 8

**Result of calibration :**

**1. Absolute sensitivity**

Reference Acoustic Signal ( dB )	Measured Value ( dB )	Deviation ( dB )	Acceptance Limit ( dB )
93.9 (93.98)	93.9	0.0	±0.3

**2. Self-generated noise**

**2.1 Normal test**

Measured Value ( dB )
16.7

**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	17.7
Flat	23.4

**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	0.5	± 1.5
1000	0.0	0.0	0.0	± 1.0
8000	0.0	0.1	0.1	±5.0

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Job No. : VC67AC0054  
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	0.1	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	0.1	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	Anticipated Value ( dB )	Measured Value ( dB )	Deviated Value ( dB )	Acceptance Limits ( dB )
A - weight	94.0	94.0	0.0	± 0.2
C - weight	94.0	94.0	0.0	± 0.2
Flat	94.0	94.0	0.0	± 0.2

**5.2 Time weighting at 1 kHz**

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

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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	135.0	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	119.1	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	28.9	-0.1	± 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

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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
	0.25	1	99.0	98.9	-0.1	1.5 ; -5.0
SEL	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	±3.0
One	136.4	135.3	-1.1	±3.0

Number of cycle in test signal	Anticipated Value ( dB )	Measured Value ( dB )	Deviated Value ( dB )	Acceptance Limits ( dB )
Continuous	133.0	132.9	-0.1	±2.0
Positive half cycle	135.4	135.1	-0.3	±2.0
Negative half cycle	135.4	135.1	-0.3	±2.0

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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

*T. Petch*

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Cert. No. : ACL24090  
Pages : 1 of 8

**Calibration Certificate**

Equipment : SOUND LEVEL METER  
Manufacturer : RION  
Model : NL-42 / Microphone UC-52 / Preamplifier NH-24  
Serial No.: 00233183 / 144835 / 23230  
ID No.: RYG\_FS0024

Condition As Found : GOOD

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

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

Received Date : 19 JANUARY 2024  
Calibration Date : 25-26 JANUARY 2024  
Date of Issue : 29 JANUARY 2024

Calibrated by : Nathakorn Pisutpaivan

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.

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Cert. No. : ACL24090  
Job No. : VC67AC0058  
Pages : 2 of 8

Calibration Procedure : CP-AC-01

**Calibration Method :**

This equipment was calibrated by follow 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-0009-23	07-FEB-24
Waveform Generator	33511B	MY52302742	EF-0010-23	07-FEB-24
Digital Multimeter	33461A	MY53220104	EEL-BP 30/0266	13-FEB-24
Digital Multimeter	33461A	MY53220076	EEL-BP 29/0266	13-FEB-24
Digital Multimeter	33461A	MY60024273	EEL-BP 31/0266	14-FEB-24
Programmable Attenuator	MAT-1070	62100114	EF-0011-23	08-FEB-24
Condenser Microphone	4180	2977900	AA-1001-23	14-FEB-24
Measuring Amplifier	NA-42KAI	34560495	AA-3002-23	14-FEB-24

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

451-451/1 Sirinthorn Road, Bangbunru Bangkok, Bangkok, 10700 Thailand  
Tel : +66 2433 8331 Email : calibration@sithiporn.com

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Job No. : VC67AC0058  
Pages : 3 of 8

**Summary of Measurement Result :**

Parameter	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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451-451/1 Srinithorn Road, Bangbunmu, Bangkok 10700 Thailand  
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Cert. No. : ACL24090  
Job No. : VC67AC0058  
Pages : 4 of 8

## Result of calibration :

### 1. Absolute sensitivity

Reference Acoustic Signal ( dB )	Measured Value ( dB )	Deviation ( dB )	Acceptance Limit ( dB )
93.9 (93.98)	93.9	0.0	±0.3

### 2. Self-generated noise

#### 2.1 Normal test

Measured Value ( dB )
18.3

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

Frequency Weighting	Measured value ( dB )
A - weight	14.2
C - weight	20.0
Flat	25.6

### 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	0.2	0.2	0.2	± 1.5
1000	0.1	0.1	0.1	± 1.0
8000	0.3	0.3	0.3	± 5.0

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Job No. : VC67AC0058  
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	0.0	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	Anticipated Value ( dB )	Measured Value ( dB )	Deviated Value ( dB )	Acceptance Limits ( dB )
A - weight	94.0	94.0	0.0	± 0.2
C - weight	94.0	94.0	0.0	± 0.2
Flat	94.0	94.0	0.0	± 0.2

#### 5.2 Time weighting at 1 kHz

Frequency Weighting	Anticipated Value ( dB )	Measured Value ( dB )	Deviated Value ( dB )	Acceptance Limits ( dB )
Fast	94.0	94.0	0.0	± 0.1
Slow	94.0	94.0	0.0	± 0.1
Leq	94.0	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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### 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	74.1	0.1	± 1.1
69.0	69.0	0.0	± 1.1
64.0	64.0	0.0	± 1.1
59.0	59.1	0.1	± 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	34.1	0.1	± 1.1
30.0	30.1	0.1	± 1.1
29.0	29.2	0.2	± 1.1
28.0	28.3	0.3	± 1.1
27.0	27.3	0.3	± 1.1
26.0	26.4	0.4	± 1.1
25.0	25.4	0.4	± 1.1

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451-451/1 Srinithorn Road, Bangbunmu, Bangkok 10700 Thailand  
Tel : +66 2433 8331 Email : calibration@sithiporn.com

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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	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, Lepeak ( dB )	Deviated Value ( dB )	Acceptance Limits ( dB )
Continuous	133.0	133.0	0.0	± 3.0
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	± 2.0
Positive half cycle	135.4	135.2	-0.2	± 2.0
Negative half cycle	135.4	135.2	-0.2	± 2.0

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451-451/1 Srinithorn Road Banglamung Bangkok 10700 Thailand  
Tel : +66 2133 8331 E-mail : calibration@sithiporn.com

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11. Overload indication

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

7. P. 10/11



SITHIPORN ASSOCIATES CO., LTD.  
451-451/1 Srinithorn Road Banglamung Bangkok 10700 Thailand  
Tel : +66 2133 8331 E-mail : calibration@sithiporn.com  
Web site : www.sithiporn.com

Accredited calibration laboratory  
ISO/IEC 17025:2017  
NSC-TISI-TIS 17025  
CALIBRATION 0367  
Temperature measurement laboratory  
Calibration services department



NSC - TISI - TIS 17025  
CALIBRATION 0367

CERTIFICATE OF CALIBRATION

Certificate No. : CDT-054-67

Page 1 of 2 Pages

MEASUREMENT ITEM : Heat Stress Monitor  
MANUFACTURER : Delta OHM  
MODEL/TYPE : HD32 2  
SERIAL NUMBER : 15006713  
ID NUMBER : RYG\_F50218  
CONDITION AS-RECEIVED : Used item  
CUSTOMER : ALS laboratory group (thailand) Co., Ltd  
104 Phatthanakan 40, Phatthanakan Rd.,  
Khuang Suan Luang, Khet Suan Luang,  
Bangkok 10250 Thailand

RECEIVED DATE : 12 Feb 2024  
MEASUREMENT DATE : 15 Feb 2024  
ISSUE DATE : 20 Feb 2024

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follow:  
Temperature : 23.0 ± 3.0 °C  
Relative Humidity : 55.0 ± 15.0 %RH

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

TABULATION OF RESULTS:

The table on next page give the measured values.

Calibration procedure:  
The temperature calibration was done by  
In House calibration method as WH-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-0038-23, Certificate  
number: ER-0101-23

Reference Used During Calibration:  
1. Standard Temperature Probe  
Model: STS-100 A500, Serial No: 667682 09,  
Due date: 28 Mar 2024  
2. Digital Temperature Indicator  
Model: DTI-1000-A MK II, Serial No: 671407,  
00591 Due date: 14 Sep 2024

Uncertainty of Measurement:  
The reported uncertainty of measurement is  
based on the standard uncertainty multiplied by  
a coverage factor  $k=2$ . Which for a normal  
distribution corresponds to a coverage  
probability of approximately 95%. The standard  
uncertainty has been determined in accordance  
with the GUM Evaluation of measurement data  
- Guide to the expression of uncertainty in  
measurement

THIS CERTIFICATE MAY NOT BE REPRODUCED EXCEPT IN FULL UNLESS PERMISSION FOR REPRODUCTION HAS BEEN OBTAINED  
IN WRITING FROM THE LABORATORY



Continuation of Certificate of Calibration Number CDT-054-67

Page 2 of 2 Pages

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: 22035270  
Dimension: Diameter 3.3 mm Length 170 mm.

Immersion Depth (mm)	Standard Reading (°C)	UUC Reading (°C)	Error (°C)	Uncertainty (°C)
80	20.054	20.1	0.046	0.069
80	25.053	25.1	0.046	0.069
80	30.043	30.1	0.056	0.069
80	35.033	35.1	0.066	0.069
80	40.018	40.1	0.082	0.099

Table 2: This equipment was connected with Globe thermometer probe Model: TP3276 2 S/N: 22035462  
Dimension: Diameter 3.3 mm Length 205 mm.

Immersion Depth (mm)	Standard Reading (°C)	UUC Reading (°C)	Error (°C)	Uncertainty (°C)
110	20.064	20.1	0.036	0.099
110	25.053	25.1	0.046	0.16
110	30.043	30.1	0.056	0.099
110	35.033	35.2	0.166	0.099
110	40.018	40.2	0.182	0.099

Table 3: This equipment was connected with temperature probe Model: TP3207.2 S/N: 15015499  
Dimension: Diameter 14 mm Length 150 mm.

Immersion Depth (mm)	Standard Reading (°C)	UUC Reading (°C)	Error (°C)	Uncertainty (°C)
75	20.064	20.3	0.236	0.099
75	25.053	25.2	0.146	0.099
75	30.043	30.0	0.046	0.099
75	35.033	35.0	0.036	0.099
75	40.018	39.8	-0.218	0.099

UUC\*: UUC Under Calibration

Remark: The reported uncertainty of measurement is 0.16, based on standard uncertainty multiplied by a coverage factor  $k=2$  21  
providing a level of confidence of approximately 95%

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



SITHIPORN ASSOCIATES CO., LTD.  
451-451/1 Srinithorn Road Banglamung Bangkok 10700 Thailand  
Tel : +66 2133 8331 E-mail : calibration@sithiporn.com  
Web site : www.sithiporn.com

Accredited calibration laboratory  
ISO/IEC 17025:2017  
NSC-TISI-TIS 17025  
CALIBRATION 0367  
Temperature measurement laboratory  
Calibration services department



NSC - TISI - TIS 17025  
CALIBRATION 0367

CERTIFICATE OF CALIBRATION

Certificate No. : CDT-015-67

Page 1 of 2 Pages

MEASUREMENT ITEM : Heat Stress Monitor  
MANUFACTURER : Delta OHM  
MODEL/TYPE : HD32 2  
SERIAL NUMBER : 15006715  
ID NUMBER : RYG\_F50210  
CONDITION AS-RECEIVED : Used item  
CUSTOMER : ALS laboratory group (thailand) Co., Ltd  
104 Phatthanakan 40, Phatthanakan Rd.,  
Khuang Suan Luang, Khet Suan Luang,  
Bangkok 10250 Thailand

RECEIVED DATE : 11 Jan 2024  
MEASUREMENT DATE : 11 Jan 2024  
ISSUE DATE : 17 Jan 2024

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follow:  
Temperature : 23.0 ± 3.0 °C  
Relative Humidity : 55.0 ± 15.0 %RH

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

TABULATION OF RESULTS:

The table on next page give the measured values.

Calibration procedure:  
The temperature calibration was done by  
In House calibration method as WH-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-0038 23, Certificate  
number: ER-0101-23

Reference Used During Calibration:  
1. Standard Temperature Probe  
Model: STS-100 A500, Serial No: 667682 09,  
Due date: 28 Mar 2024  
2. Digital Temperature Indicator  
Model: DTI-1000-A MK II, Serial No: 671407,  
00593 Due date: 14 Sep 2024

Uncertainty of Measurement:  
The reported uncertainty of measurement is  
based on the standard uncertainty multiplied by  
a coverage factor  $k=2$ . Which for a normal  
distribution corresponds to a coverage  
probability of approximately 95%. The standard  
uncertainty has been determined in accordance  
with the GUM Evaluation of measurement data  
- Guide to the expression of uncertainty in  
measurement

Calibrated by:  
☒ Mr. Sorawit Thachalad  
☒ Miss Jitraporn Lertsomphol  
☒ Mrs. Ruangrunpa Phoommit

THIS CERTIFICATE MAY NOT BE REPRODUCED EXCEPT IN FULL UNLESS PERMISSION FOR REPRODUCTION HAS BEEN OBTAINED  
IN WRITING FROM THE LABORATORY







Cert. No : 23E3924  
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 )	( ± µV )	
-200 0000	-199.9	0.1	68	
-150 0000	-150.0	0.0	65	
-100 0000	-100.0	0.0	63	
-50 0000	-50.0	0.0	61	
0 0000	0.0	0.0	58	
50 0000	50.0	0.0	61	
100 0000	100.0	0.0	63	
150 0000	150.0	0.0	65	
200 0000	199.9	-0.1	68	

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.

-000-

a 1193422



TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)  
CORPORATE SERVICES EQUIPMENT CALIBRATION AND TESTING SERVICES  
316 PATTANAKARN ROAD SUKHUMVIT 21, SUKHUMVIT 21, SUKHUMVIT 21, SUKHUMVIT 21  
TEL: 0-2717-9600 FAX: 0-2717-9184



Cert.No.: 23CH1574  
Page: 1 of 3

## Certificate of Calibration

Equipment : pH Meter  
Manufacturer : Mettler Toledo  
Model : SevenExcellence  
Serial No : B834291445  
ID No : RYG\_EN0152  
Condition As-Received: Used Item  
Received Date : 08 December 2023  
Calibration Date : 15 December 2023  
Reference : 2312-0151DSC-3  
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-CH5 by comparison with standard thermometer

Calibrated by : Warakorn Lernagatrakul

Approved by :

( ) Saitip Meangma  
( ) Warakorn Lernagatrakul  
(✓) Ponpan Palpin

Issue Date : 19 December 2023

The Uncertainties are for a confidence probability of approximately 95 %

This certificate is valid only for the item calibrated on the date and place of calibration.  
It is not valid for use as evidence of conformity with a specification or standard.

A 0061696



Cert No : 23CH1574  
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	23E2802	27 Aug 2024
2) Ref. Standard Thermometer	4982054	110RC044	23I908	26 July 2024

This certification is traceable to the International System of Unit maintained through -  
- Technology Promotion Association (Thailand-Japan)

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	913598	14 July 2025
pH 6.996	CPA chem	931959	01 Oct 2024
pH 9.997	CPA chem	940105	02 Nov 2024

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	Coverage factor
	pH	mV	mV	( mV )	k
pH Meter	4.000	177.48	177.3	0.058	2.00
S/N B834291445	7.000	0.00	-0.1	0.058	2.00
	10.000	-177.48	-177.5	0.058	2.00

a 1193852



Cert.No : 23CH1574  
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	Uncertainty of pH Measurement	Coverage factor
pH Electrode	4.008	4.013	184.1	0.0045	2.00
S/N : 3225368	6.986	6.998	8.7	0.0084	2.00
	9.997	10.002	-164.7	0.0088	2.11

**Function : Temperature Measurement**

( \* ) Without adjustment

This equipment was connected with Temperature Probe;

- Model : InLab®Expert Pro-ISM

- Serial No : 3225368

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 (± °C)	Coverage factor k
25.0	25.003	24.3	-0.703	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 %

-000-

a 1193851



## Certificate of Calibration

Equipment: SPECTROPHOTOMETER  
Model: DR6000  
Serial No. (or ID): 1627845 (RYG\_EN0037)  
Manufacturer: HACH  
Condition: In Condition

Certificate No.: C06230441  
Issued Date: 19 September 2023  
Job No.: WO-00005382  
Page: 1 of 3

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

Environment Condition: Temperature 23.9 °C ± 0.2  
Humidity 65.3 %RH ± 1.4

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

Calibration By: Mr. Nattapat Rungrueang  
Calibration Date: 18 September 2023  
The Method used: In house method, CAL-WI-24, base on ASTM E 275-08 and ASTM E 387-04  
Traceability: This certificate is traceable to the CRM maintained by National Institute of Standards and Technology (NIST) through Stama Scientific Limited.

The standard for Wavelength Certificate No. 111583 and 111584  
The standard for Photometric Certificate No. 9114984 and 111588  
The standard for Stray light Certificate No. 111586 and 111585  
The standard for Spectral resolution Certificate No. 111587

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).  
These results may be affected by deviations from specified conditions. The results relate only to the items tested, calibrated or sampled. The report shall not be reproduced except in full without approval of DKSH Technology Limited.  
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CAL-FM-C06-15: 12 Sep 2022



Certificate No.: C06230441 Page 2 of 3

### Calibration Results: Without Adjustment

Wavelength Accuracy (nm), The spectral bandwidth of Std at 2 nm and UUC at 2 nm				
Standard Wavelength	Unit Under Calibration	Correction	Uncertainty	
418.61	418.3	0.31	0.13	
536.66	536.6	0.06	0.13	
637.98	638.3	-0.32	0.13	
748.48	748.7	-0.22	0.13	
807.03	807.4	-0.37	0.13	

Photometric Accuracy (Absorbance)				
Wavelength	Standard absorbance	Unit Under Calibration	Correction	Uncertainty
420 nm	0.0000	0.000	0.0000	0.0045
	0.2930	0.289	0.0040	0.0045
	0.5168	0.519	-0.0022	0.0045
	1.0298	1.028	0.0008	0.0045
440 nm	0.0000	0.000	0.0000	0.0045
	0.2867	0.283	0.0037	0.0045
	0.5073	0.509	-0.0017	0.0045
	1.0083	1.007	0.0013	0.0045
465 nm	0.0000	0.000	0.0000	0.0045
	0.2516	0.250	0.0016	0.0045
	0.4595	0.462	-0.0025	0.0045
	0.9334	0.933	0.0004	0.0045
546.1 nm	0.0000	0.000	0.0000	0.0045
	0.2481	0.245	0.0011	0.0045
	0.4652	0.466	-0.0008	0.0045
	0.9468	0.946	0.0008	0.0045
590 nm	0.0000	0.000	0.0000	0.0045
	0.2584	0.259	0.0004	0.0045
	0.5040	0.505	-0.0010	0.0045
	1.0032	1.002	0.0012	0.0045
635 nm	0.0000	0.000	0.0000	0.0045
	0.2579	0.257	0.0009	0.0045
	0.4971	0.497	0.0001	0.0045
	0.9720	0.971	0.0010	0.0045

บริษัท ดิเคช เทคโนโลยี จำกัด  
DKSH Technology Limited  
2533 หมู่ 5 ตำบลนาเกลือ อำเภอนาเกลือ จังหวัดสมุทรสาคร 10280  
2533 Subthorn Road, Bangkok, Prachinburi, Bangkok 10280  
Phone: +66 2639 7300 Email: info.calibration@dksh.com Website: www.dksh.com/calibration-thailand

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CAL-FM-C06-15: 12 Sep 2022



Certificate No.: C06230441 Page 3 of 3

### Calibration Results: Without Adjustment

Photometric Accuracy (Absorbance)				
Wavelength	Standard absorbance	Unit Under Calibration	Correction	Uncertainty
235 nm	0.0000	0.000	0.0000	0.0080
	0.7355	0.737	-0.0015	0.0080
257 nm	0.0000	0.000	0.0000	0.0080
	0.8574	0.857	0.0004	0.0080
313 nm	0.0000	0.000	0.0000	0.0080
	0.2864	0.290	-0.0036	0.0080
350 nm	0.0000	0.000	0.0000	0.0080
	0.6374	0.637	0.0004	0.0080

Stray light *			
Standard: cut-off	UUC: Wavelength (nm)	UUC: Transmission (%)	Absorbance (A)
260.62 ± 0.11 nm	260.6	1.3	1.886
391.44 ± 0.11 nm	391.4	1.3	1.886

Spectral Resolution *				
Nominal Concentration 0.02 % v/v	Peak	Trough	Ratio	SBW
Standard Wavelength (nm)	268.66	266.69	1.38	2.00
UUC: Wavelength (nm)	268.2	266.1		
Std Absorbance (A)	0.4566	0.2780		
Absorbance (A)	0.413	0.300		

\* Calibration Marked \* Not TISI Accredited \* in this Certificate have been included for completeness.

The End of Certificate

บริษัท ดิเคช เทคโนโลยี จำกัด  
DKSH Technology Limited  
2533 หมู่ 5 ตำบลนาเกลือ อำเภอนาเกลือ จังหวัดสมุทรสาคร 10280  
2533 Subthorn Road, Bangkok, Prachinburi, Bangkok 10280  
Phone: +66 2639 7300 Email: info.calibration@dksh.com Website: www.dksh.com/calibration-thailand

Delivering Growth - In Asia and Beyond

CAL-FM-C06-15: 12 Sep 2022



## ใบตรวจสอบสภาพเครื่องวัดสิ่งแวดล้อม

เลขที่ใบงาน: WO-00005382

ชนิดเครื่องมือ: SPECTROPHOTOMETER		รุ่น: DR6000	หมายเลขเครื่อง: 1627845	
ตรวจสอบ (รับ)		ตรวจสอบ (ส่ง)		หมายเหตุ
18 Sep 2023		18 Sep 2023		
ปกติ	ไม่ปกติ	ปกติ	ไม่ปกติ	
General				
<input checked="" type="checkbox"/>	<input type="checkbox"/>	1. ความสมบูรณ์เครื่อง	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/>	<input type="checkbox"/>	2. ความสะอาด ( ช่องใส่ตัวอย่าง, ภายใน-นอกเครื่อง)	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/>	<input type="checkbox"/>	3. สวิทช์ ปิด - เปิด เครื่อง (On-Off Switch)	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/>	<input type="checkbox"/>	4. ปุ่มกด (Keypad)	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/>	<input type="checkbox"/>	5. หน้าจอ (Display, Screen Contrast)	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Spectrophotometer				
<input type="checkbox"/>	<input type="checkbox"/>	6. แบตเตอรี่สำรอง (Battery Backup) >= 2.5 VDC	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	7. ตัวหมุนเลือกความยาวคลื่น (Wavelength Control)	<input type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/>	<input type="checkbox"/>	8. ความยาวคลื่น (Wavelength Check)	<input checked="" type="checkbox"/>	*
<input checked="" type="checkbox"/>	<input type="checkbox"/>	9. แหล่งกำเนิดแสง (UV < 3,000 hour)	<input checked="" type="checkbox"/>	9.2 Hours
<input checked="" type="checkbox"/>	<input type="checkbox"/>	10. แสงที่มองเห็น (Visible < 5,000 hour)	<input checked="" type="checkbox"/>	741.5 Hours
<input checked="" type="checkbox"/>	<input type="checkbox"/>	11. ช่องใส่หลอดตัวอย่าง (Carousel Module)	<input checked="" type="checkbox"/>	<input type="checkbox"/>
pH Meter and Conductivity Meter				
<input type="checkbox"/>	<input type="checkbox"/>	12. อิเล็กโทรด ( Electrode and Connection Cable )	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	13. ระดับสารละลายใน Electrode (Level KCl )	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	14. ฝาปิดกันฝุ่น Electrode (Dust Protection Hood)	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	15. ขาจับอิเล็กโทรด (Stand)	<input type="checkbox"/>	<input type="checkbox"/>
Turbidimeter				
<input type="checkbox"/>	<input type="checkbox"/>	16. ค่าความทึบที่ต่ำสุด (No Sample)	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	17. ระดับการส่องสว่างของแสง (>= 2.5 ไม่น้อย 3.0)	<input type="checkbox"/>	<input type="checkbox"/>
Automatic titrator				
<input type="checkbox"/>	<input type="checkbox"/>	18. สภาพ Piston Burettes	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	19. Function Rinsing and Dosing	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	20. ระบบท่อสายยางและอุปกรณ์ประกอบ	<input type="checkbox"/>	<input type="checkbox"/>

เพิ่มเครื่องมือและน้ำ: \*656.1nm=656.1nm

\*486.0nm=485.5nm

Mr. Nattapat Rungrueang  
Service Engineer

บริษัท ดิเคช เทคโนโลยี จำกัด  
DKSH Technology Limited  
2533 หมู่ 5 ตำบลนาเกลือ อำเภอนาเกลือ จังหวัดสมุทรสาคร 10280  
2533 Subthorn Road, Bangkok, Prachinburi, Bangkok 10280  
Phone: +66 2639 7300 Email: info.calibration@dksh.com Website: www.dksh.com/calibration-thailand

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CAL-FM-R31-03: 20 Jul 2022



TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)  
CORPORATE SERVICES 3 : EQUIPMENT CALIBRATION AND TESTING SERVICES  
534/4 PATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG BANGKOK 10250  
TEL. 0-2717-3000 FAX 0-2719-9484

Cert.No.: 23TW168  
Page.: 1 of 2

## Certificate of Testing

Equipment : DO Meter  
Manufacturer : YSI  
Model : 5000-115V  
Serial No. : 15E102796  
ID No. : RYG\_EN0032  
Received Date : 21 July 2023  
Test Date : 24 July 2023  
Reference : 2307-0713DSC-1  
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 (  $25 \pm 5$  ) °C  
Humidity (  $50 \pm 20$  ) %  
Test Procedure : In - house method : CP-CH9  
by Comparison Technique with Azide Modification Method  
Tested by : Walelak Sirthean  
Approved by :  
( ) Malee Bulkruea  
(✓) Saithip Meangmai  
( ) Warakorn Lemgagrakul  
Issue Date : 26 July 2023

B 0320211



Cert.No.: 23TW168  
Page.: 2 of 2

### Condition of this result of calibration

#### 1. Reference Standard Instruments :

This certification is traceable to the International System of Unit through the reference standards laboratory of Industrial Calibration Center, Technology Promotion Association (Thailand-Japan).

Instruments	Serial No.	ID No.	Certificate No.	Due Date
1) Burette	-	130BU10	23CG1172	22 Mar 2025
2) Balance	1126143764	140RC004	22MM50	20 Sep 2023

#### 2. Standard Material :-

Material	Manufacturer	Lot.No.	Assay
Sodium Thiosulfate pentahydrate	Merck	AM1763316	100.2%

Result : Dissolved Oxygen Meter Adjustment With Air 100 %

Dissolved Oxygen Probe No.: 15E100464

Titration Method (Azide Modification Method) (mg/L)	DO Meter Reading (mg/L)	Standard Deviation (mg/L)
8.18	8.17	0.0055

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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Saithip

a 1172155



TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)  
CORPORATE SERVICES 3 : EQUIPMENT CALIBRATION AND TESTING SERVICES  
534/4 PATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG BANGKOK 10250  
TEL. 0-2717-3000 FAX 0-2719-9484



Cert.No.: 23LM125  
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 : 25 July 2023  
Calibrated Date : 27 July 2023  
Ambient Temperature : (  $26 \pm 10$  ) °C  
Relative Humidity : (  $50 \pm 30$  ) %  
AC Line Voltage : (  $220 \pm 22$  ) V  
Calibrated by :  
Approved by :  
( ) Ponthippa Tamayakul  
( ) Malee Bulkruea  
(✓) Suwit Imjai  
Issue Date : 31 July 2023

The Uncertainties are for a confidence probability of approximately 95%

This certificate may not be reproduced or altered in full, except with the prior written approval of the Technology Promotion Association (Thailand-Japan) Calibration and Testing Service

A 0053616



Equipment : DO Meter with Sensor  
Condition As-Received : Used Item  
Reference : 2307-0713DSC-2

Cert.No.: 23LM125  
Page.: 2 of 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	Serial No.	Cert. No.	Traceable	Due Date
1) Digital Thermometer	2188080	221285	TPA	21 Oct 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.

Remark : TPA : Technology Promotion Association ( Thailand - Japan )

Result of Calibration :- ( ° ) Without Adjustment

Function : Temperature measurement.

This instrument was connected with temperature sensor, S/N.: 1228475367

Calibration Point ( °C )	Immersion Depth ( mm )	Standard Temperature ( °C )	UUC* Reading ( °C )	Error ( °C )	Uncertainty ( ± °C )	Coverage Factor k
20.00	100	20.011	19.91	-0.101	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 %.

-o-o-

9.1

a 1159515



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Cert. No.: 23TM962  
Page: 1 of 3

## Certificate of Calibration

Equipment : Low Temp. Incubator  
Manufacturer : Memmert  
Model : IPP750  
Serial No. : V818 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 : 29 May 2023  
Calibration Date : 29 May 2023  
Ambient Temperature :  $(26 \pm 10) ^\circ\text{C}$   
Relative Humidity :  $(50 \pm 30) \%$   
Calibrated by : Man Pattanapongpaiboon  
Approved by :  
( ) Pornthippa Tameyakul  
( ) Malee Bulkruea  
(✓) Suwili Imjai

Issue Date : 7 June 2023

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 0054967



Equipment : Low Temp. Incubator  
Condition As-Received : Used Item  
Reference : 2305-0898OC-2  
Procedure Used :-

Cert. No.: 23TM962  
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).

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	MY57013711	22LM93	02 Jul 2023

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

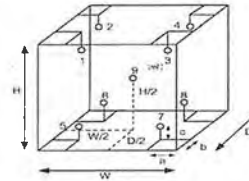
3. This certificate is traceable to the International System of Unit

#### Result of Calibration :-

Function of UUC\* : Temperature Source

Fresh air setting : Close

Environment during calibration		
	Beginning	Finished
Temp. ( °C )	23	23
REL Humid. ( % )	54	56
AC Supply ( Volt )	223	222



#### 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>

Position :	Ref. Std. ID No. :
1	18-18RTD-01
2	18-18RTD-02
3	18-18RTD-03
4	18-18RTD-04
5	18-18RTD-05
6	18-18RTD-10
7	18-18RTD-07
8	22-18RTD-08
9 (ref.)	18-18RTD-09

a 1165130



Equipment : Low Temp. Incubator  
Condition As-Received : Used Item  
Reference : 2305-0898OC-2  
Result of Calibration :- ( \* ) Without Adjustment  
Function of UUC\* : Temperature Source  
Fresh air setting : Close

Cert. No.: 23TM962  
Page: 3 of 3

Calibration Point ( °C )	UUC* Setting ( °C )	UUC* Reading ( °C )	Temperature stability ( ± °C )	Temperature uniformity ( °C )	Overall Variation ( °C )	Coverage Factor k
20.0	20.0	20.0	0.019	0.72	1.0	2

Calibration Point ( °C )	Measured Temperature ( °C )									Uncertainty ( ± °C )
	1	2	3	4	5	6	7	8	9 (ref.)	
20.0	19.547	19.780	19.487	19.529	19.408	20.139	20.112	20.406	20.116	0.30

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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a 1165129



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## Certificate of Calibration

Cert. No.: 24TM1663  
Page: 1 of 3

Equipment : Low Temp. Incubator  
Manufacturer : Memmert  
Model : IPP750  
Serial No. : V818 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 : 01 November 2024  
Calibration Date : 01 November 2024  
Ambient Temperature :  $(26 \pm 10) ^\circ\text{C}$   
Relative Humidity :  $(50 \pm 30) \%$   
AC Line Voltage :  $(220 \pm 22) \text{ V}$

Calibrated by : Krisda Malee

Approved by :

( ) Ponpan Palpim  
( ) Suwili Imjai  
(✓) Kunchit Prompratt

Issue Date : 07 November 2024

REVIEW BY : *Tharitat*

APPROVED BY : *D. P.*

NEXT CAL DATE : 01/05/26

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







## Certificate of Calibration

Cert. No.: 24TM632  
Page : 1 of 3

Equipment : Hot Air Oven  
Manufacturer : Memmert  
Model : UFE 500  
Serial No. : GS11,1572  
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 : 21 March 2024  
Calibration Date : 21 March 2024  
Ambient Temperature : ( 26 ± 10 ) °C  
Relative Humidity : ( 50 ± 30 ) %  
Calibrated by : Man Pattanapongpaiboon  
Approved by :   
( ) Ponthippa Tameyakul  
( ) Unnopphol Harachai  
(✓) Suwit Imjai  
Issue Date : 22 March 2024

The Uncertainties are for a confidence probability of approximately 95%

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Equipment : Hot Air Oven  
Condition As-Received : Used Item  
Reference : 2403-0563OC-1  
Procedure Used :-

Cert. No.: 24TM632  
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	Serial No.	Cert. No.	Traceable	Due Date
1 ) Data Acquisition	MY57013711	23LM115	TPA	11 Jul 2024

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

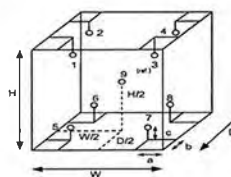
3. This certification is traceable to the International System of Unit.

Remark : TPA : Technology Promotion Association ( Thailand - Japan )

### Result of Calibration :-

Function of UUC\* : ( \* ) Without Adjustment

Fresh air setting : Temperature Source  
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 m <sup>3</sup>

Environment during calibration		
	Beginning	Finished
Temp. ( °C )	27	27
REL.Humid. ( % )	57	59
AC Supply ( Volt )	222	224

Ref. Std. ID No. : @ Calibration Point		
Position :	( 180 ) °C	( 104 ) °C
1	18-18TC-01	18-18RTD-01
2	18-18TC-02	18-18RTD-02
3	18-18TC-03	18-18RTD-03
4	18-18TC-04	18-18RTD-04
5	18-18TC-05	18-18RTD-05
6	18-18TC-06	23-18RTD-06
7	18-18TC-07	18-18RTD-07
8	18-18TC-08	22-18RTD-08
9 (ref.)	18-18TC-09	18-18RTD-09



Equipment : Hot Air Oven  
Condition As-Received : Used Item  
Reference : 2403-0563OC-1  
Result of Calibration :- ( \* ) Without Adjustment  
Function of UUC\* : Temperature Source  
Fresh air setting : Close

Cert. No.: 24TM632  
Page : 3 of 3

Calibration Point ( °C )	UUC* Setting ( °C )	UUC* Reading ( °C )	Temperature stability ( ± °C )	Temperature uniformity ( °C )	Overall Variation ( °C )	Coverage Factor
104.0	104.0	104.0	0.051	0.59	0.62	2
180.0	180.0	180.0	0.15	1.3	1.7	2

Calibration Point ( °C )	Measured Temperature ( °C )									Uncertainty ( ± °C )
	1	2	3	4	5	6	7	8	9 (ref.)	
104.0	103.921	103.786	103.757	103.758	103.950	103.817	104.213	103.672	103.673	0.42
180.0	179.614	179.270	179.145	179.599	180.001	180.423	180.293	180.629	179.429	1.1

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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## Certificate of Calibration

Cert. No.: 24TM634  
Page : 1 of 3

Equipment : Hot Air Oven  
Manufacturer : Memmert  
Model : UF 110  
Serial No. : B423.0853  
ID No. : RYG\_EN0213  
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 : 21 March 2024  
Calibration Date : 21 - 22 March 2024  
Ambient Temperature : ( 26 ± 10 ) °C  
Relative Humidity : ( 50 ± 30 ) %  
Calibrated by : Man Pattanapongpaiboon  
Approved by :   
( ) Ponthippa Tameyakul  
( ) Unnopphol Harachai  
(✓) Suwit Imjai  
Issue Date : 23 March 2024

The Uncertainties are for a confidence probability of approximately 95%

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Equipment : Hot Air Oven  
Condition As-Received : Used Item  
Reference : 2403-0563OC-3  
Procedure Used :-

Cert. No.: 24TM634  
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	Serial No.	Cert. No.	Traceable	Due Date
1) Data Acquisition	MY57013711	23LM115	TPA	11 Jul 2024

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

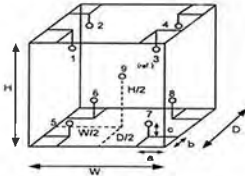
3. This certification is traceable to the International System of Unit.

Remark : TPA : Technology Promotion Association ( Thailand - Japan )

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 m<sup>3</sup>

Environment during calibration		
	Beginning	Finished
Temp. ( °C )	27	27
REL.Humid. ( % )	59	59
AC Supply ( Volt )	224	223

Ref. Std. ID No. : @ Calibration Point		
Position :	( 180 ) °C	( 104 ) °C
1	18-18TC-01	18-18RTD-01
2	18-18TC-02	18-18RTD-02
3	18-18TC-03	18-18RTD-03
4	18-18TC-04	18-18RTD-04
5	18-18TC-05	18-18RTD-05
6	18-18TC-06	23-18RTD-06
7	18-18TC-07	18-18RTD-07
8	18-18TC-08	22-18RTD-08
9 (ref.)	18-18TC-09	18-18RTD-09



Equipment : Hot Air Oven  
Condition As-Received : Used Item  
Reference : 2403-0563OC-3  
Result of Calibration :- ( \* ) Without Adjustment  
Function of UUC\* : Temperature Source  
Fresh air setting : Close

Cert. No.: 24TM634  
Page : 3 of 3

Calibration Point ( °C )	UUC* Setting ( °C )	UUC* Reading ( °C )	Temperature stability ( ± °C )	Temperature uniformity ( °C )	Overall Variation ( °C )	Coverage Factor
104.0	104.0	104.0	0.065	0.52	0.90	2
180.0	180.0	180.0	0.20	1.2	2.0	2

Calibration Point ( °C )	Measured Temperature ( °C )									Uncertainty ( ± °C )
	1	2	3	4	5	6	7	8	9 (ref.)	
104.0	104.169	103.506	103.898	103.712	103.772	103.730	104.289	103.805	103.798	0.42
180.0	180.701	179.239	179.935	179.999	180.127	180.138	180.895	179.313	180.211	1.1

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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## Certificate of Calibration

Cert. No.: 24TM635  
Page : 1 of 3

Equipment : Water Bath  
Manufacturer : Memmert  
Model : WNB22  
Serial No. : L513.0648  
ID No. : RYG\_EN0061

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

Received Order : 21 March 2024  
Calibration Date : 21 March 2024  
Ambient Temperature : ( 26 ± 10 ) °C  
Relative Humidity : ( 50 ± 30 ) %

Calibrated by :

Approved by :

( ) Pomthippa Tanayakul  
( ) Unnopphol Harachai  
(✓) Suwit Imjai

Issue Date : 23 March 2024

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

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Equipment : Water Bath  
Condition As-Received : Used Item  
Reference : 2403-0563OC-4  
Procedure Used :-

Cert. No.: 24TM635  
Page : 2 of 3

Calibration were conducted using in-house calibration procedure CP-OT04 Based on ASTM E715 according to direct measurement method with Data Acquisition which connected with Industrial Platinum Resistance Thermometer ( IPT ) .

The temperature scale used was based on ITS-90.

#### Condition of this result of calibration

##### 1. Reference standard instrument:-

Instrument	Serial No.	Cert. No.	Traceable	Due Date
1) Data Acquisition	MY57013711	23LM115	TPA	11 Jul 2024

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.

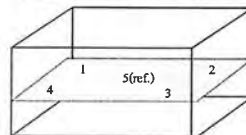
Remark : TPA : Technology Promotion Association ( Thailand - Japan )

Result of Calibration :- ( \* ) Without Adjustment

Function of UUC\* : Temperature Source

Heat transfer medium used : Water

	Environmental		AC Voltage Supply
	( °C )	( %R.H. )	( Volt )
Beginning of Calibration	25	55	222
Finished of Calibration	25	57	223



Front

Position :	Ref. Std. ID No. :
1	4803988-001
2	4803988-002
3	4803988-003
4	4803988-004
5(ref.)	4803988-005



Equipment : Water Bath  
Condition As-Received : Used Item  
Reference : 2403-0563OC-4  
Result of Calibration : ( \* ) Without Adjustment  
Function of UUC\* : Temperature Source

Cert. No.: 24TM635  
Page : 3 of 3

Calibration point (°C)	UUC* Setting (°C)	UUC* Reading (°C)	Average* Standard Reading (°C)					Uncertainty (± °C)
			1	2	3	4	5 (ref.)	
85.0	85.0	85.0	84.428	84.424	84.489	84.507	84.477	0.18

Calibration point (°C)	Uniformity (°C)	Stability (± °C)	Coverage Factor k
85.0	0.19	0.11	2

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

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.

Stability : One-half of the greatest maximum difference of measured temperature at any one probe.

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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## Certificate of Calibration

Cert.No.: 24CH773  
Page.: 1 of 2

Equipment : pH Meter  
Manufacturer : Mettler Toledo  
Model : Seven2Go S2  
Serial No. : C222171773  
ID No. : RYG\_FS0595  
Condition As-Received : Used Item  
Received Date : 28 June 2024  
Calibration Date : 01 July 2024  
Reference : 2405-0969DSC-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 DC voltage standard and direct measurement with certified reference material (CRM)

Calibrated by :

Approved by :

( ) Unnophol Harachai  
( ) Ponpan Paipim  
(✓) Sathip Meangmai

Issue Date :

03 July 2024

The Uncertainties are for a confidence probability of approximately 95%

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Cert.No.: 24CH773  
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	23E2802	27 Aug 2024

- This Certification is traceable to SI Through Technology Promotion Association (Thailand - Japan)

#### 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	970851	25 Apr 2026
pH 6.985	CPA chem	970852	25 Apr 2025
pH 9.997	CPA chem	970853	25 Apr 2025

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 Document Process Calibrator at pH (4,7,10)

Unit Under Calibration	Nominal Value	Standard Voltage Input	Actual Reading		Uncertainty of Measurement (± mV)	Coverage factor k
	pH	mV	mV	pH		
pH Meter S/N.: C222171773	4.00	177.48	178	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 (±)	Coverage factor k
pH Electrode S/N.: 2465853	4.008	4.01	169	0.0085	2.05
	6.986	7.00	-7	0.0099	2.00
	9.997	10.00	-182	0.0085	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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## Certificate of Calibration

Cert. No.: 24LM107  
Page.: 1 of 2

Equipment : pH Meter with Sensor  
Manufacturer : Mettler Toledo  
Model : Seven2Go S2  
Serial No. : C222171773  
ID No. : RYG\_FS0595  
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 : 28 June 2024  
Calibrated Date : 01 July 2024  
Ambient Temperature : (26 ± 10) °C  
Relative Humidity : (50 ± 30) %  
AC Line Voltage : (220 ± 22) V

Calibrated by :

Approved by :

( ) Ponpan Paipim  
(✓) Suwit Imjai  
( ) Kunchit Promprut

Issue Date :

03 July 2024

The Uncertainties are for a confidence probability of approximately 95%

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Equipment : pH Meter with Sensor  
Condition As-Received : Used Item  
Reference : 2406-0969DSC-5

Cert. No.: 24LM107  
Page: 2 of 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	Serial No.	Cert. No.	Traceable	Due Date
1) Digital Thermometer	2188080	2311216	TPA	11 Oct 2024

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.

Remark : TPA : Technology Promotion Association ( Thailand - Japan )

Result of Calibration :- ( \* ) Without Adjustment

Function : Temperature measurement.

This instrument was connected with temperature sensor, S/N: 2465853

Calibration Point (°C)	Immersion Depth (mm)	Standard Temperature (°C)	UUC* Reading (°C)	Error (°C)	Uncertainty (± °C)	Coverage Factor k
25.0	100	25.001	25.2	0.199	0.16	2.00
30.0	100	30.005	30.2	0.195	0.16	2.00
40.0	100	40.002	40.3	0.298	0.16	2.00
50.0	100	50.004	50.3	0.296	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 %.

-00-



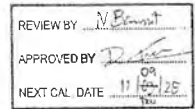
## Certificate of Calibration

Represent to Certificate of Calibration No C29240007

Equipment:	Block Digestion Unit	Certificate No	C29240011
Model:	KT-20s	Issued Date:	22 March 2024
Serial No. (or ID.):	5720210009/5770200073	Job No.:	WO-00020429
Manufacturer:	Gerhardt	Page:	1 of 4
Condition:	In Condition	Digestion Block:	20 holes

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

Environment Condition: Temperature: 25 °C ± 0.7 °C  
Humidity: 54 %RH ± 4.1 %RH  
Voltage: 225 VAC ± 1.7 VAC



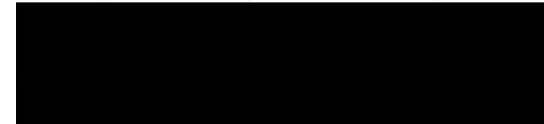
Calibration Place: ALS Laboratory Group (Thailand) Co., Ltd. (Rayong Branch)  
( Wet Chemistry Lab )  
616/10 Moo 5 T Maenam Khu, A Pluakdaeng, Rayong 21140, Thailand.

Calibration By: Mr. Thanathorn Phunook

Calibration Date: 11 March 2024

The Method used: In house method, base on by comparison with standard

Traceability: This certificate is traceable to the SI Units maintained by National Institute of Metrology (NIMT) Thailand through NIM Technical Center Laboratory (NTL)



Person in charge

Authorized signatory

This certificate is issued in the units of measurement according to the International System of Units (SI). It is provided in duplicate by DKSH Technology Limited.

The measurement uncertainty stated is the expanded uncertainty  $k=2$  based on 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 GUM (Guide to the Expression of Uncertainty in Measurement) (GUM).

This certificate may be affected by deviations from stated conditions. The results are valid only for the intended application and use. The report shall not be reproduced except in full without approval of DKSH Technology Limited.

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2533 Maenam Road, Rayong, Thailand 21140  
2533 Maenam Road, Rayong, Thailand 21140  
Phone: +66 20 21 0009 Email: info@dksh.com Website: www.dksh.com

Delivering Growth - in Asia and Beyond

CAL-FM-C29-07: 20 Jul 2022

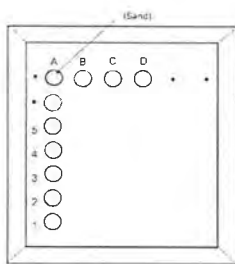


Certificate No : C29240011

Page: 2 of 4



Fig. 1 Front view



Location of standard

Fig. 2 Digestion block

#### Definitions

Indicating Temperature: The average reading of indicating device which forms the integral part of the Digestion block.

Measured Temperature: The averaging of working standard at any position or location.

DKSH Technology Limited  
2533 Maenam Road, Rayong, Thailand 21140  
2533 Maenam Road, Rayong, Thailand 21140  
Phone: +66 20 21 0009 Email: info@dksh.com Website: www.dksh.com

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Page: 3 of 4

#### Calibration Results:

##### Pre Calibration

Locations	Desired (°C)	Setting (°C)	Indicating (°C)	Measured Temperature (°C)	Correction of UUC (°C)	Uncertainty (± °C)
A1	380	380	380	401.5	21.5	1.5
A2				401.2	21.2	1.5
A3				399.1	19.1	1.5
A4				397.8	17.8	1.5
A5				395.1	15.1	1.5
B1				396.6	16.6	1.5
B2				396.1	16.1	1.5
B3				392.9	12.9	1.5
B4				391.6	11.6	1.5
B5				390.7	10.7	1.5
C1				395.3	15.3	1.5
C2				395.6	15.6	1.5
C3				392.8	12.8	1.5
C4				391.7	11.7	1.5
C5				390.3	10.3	1.5
D1				397.6	17.6	1.5
D2				396.6	16.6	1.5
D3				395.0	15.0	1.5
D4				394.2	14.2	1.5
D5				393.6	13.6	1.5

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2533 Maenam Road, Rayong, Thailand 21140  
2533 Maenam Road, Rayong, Thailand 21140  
Phone: +66 20 21 0009 Email: info@dksh.com Website: www.dksh.com

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CAL-FM-C29-07: 20 Jul 2022

Calibration Results  
Without adjustment

Locations	Desired (°C)	Setting (°C)	Indicating (°C)	Measured Temperature (°C)	Correction of UUC (°C)	Uncertainty (± °C)
A1	360	360	365	362.5	17.5	1.5
A2				362.4	17.4	1.5
A3				362.1	17.1	1.5
A4				379.7	14.7	1.5
A5				378.3	13.3	1.5
B1				380.1	15.1	1.5
B2				380.1	15.1	1.5
B3				378.5	13.5	1.5
B4				378.3	13.3	1.5
B5				379.1	14.1	1.5
C1				380.1	15.1	1.5
C2				380.1	15.1	1.5
C3				378.9	13.9	1.5
C4				378.2	13.2	1.5
C5				377.3	12.3	1.5
D1				380.5	15.5	1.5
D2				380.6	15.6	1.5
D3				378.1	13.1	1.5
D4				378.7	13.7	1.5
D5				377.7	12.7	1.5

The End of Certificate

Agilent Technologies (Thailand) Limited  
2533 ถนนพหลโยธิน แขวงจตุจักร เขตจตุจักร กรุงเทพฯ 10210  
Phone: +66 2556 1111 Email: info.thailand@agilent.com Website: www.agilent.com/thailand

Delivering Growth - in Asia and Beyond

CAL-FM-C29-07 20 Jul 2022

## ใบตรวจสอบสภาพเครื่องควบคุมอุณหภูมิ

เลขที่ใบงาน WO-00020429

ชนิดเครื่องมือ Block Digestion Unit

รุ่น KT-20s

หมายเลขเครื่อง S720210009/S770200073

ตรวจสอบ (รับ)		รายการตรวจเช็ค	ตรวจสอบ (ส่ง)		หมายเหตุ
11 Mar 2024			11 Mar 2024		
ปกติ	ไม่ปกติ		ปกติ	ไม่ปกติ	
		General			
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	1	สายไฟ	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	2	การทำงานของ Main Switch	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	3	การทำงานของ Selector Key	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	4	การแสดงผล Display	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	5	สภาพ Hole	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	6	สภาพฝาปิด	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	7	สภาพตัวเครื่อง	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	8	สภาวะแวดล้อม ณ สถานที่ตั้งเครื่อง	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

ชื่อนามนำ

Mr. Thanathorn Phunook  
Service Engineer

Agilent Technologies (Thailand) Limited  
2533 ถนนพหลโยธิน แขวงจตุจักร เขตจตุจักร กรุงเทพฯ 10210  
Phone: +66 2556 1111 Email: info.thailand@agilent.com Website: www.agilent.com/thailand

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BKK\_EL0043

## Agilent Technologies

Agilent Technologies (Thailand) Limited  
104 Phatthanakan 40 Phatthanakan Rd  
Klongkiet Phatthanakan Khet Suan  
Bangkok 10550 Thailand

Tel: +66 2 671 8100  
Fax: +66 2 372 4346  
Email: ccc.smt@agilent.com  
Website: www.agilent.com/thailand

## Customer Contact:

ALS Laboratory Group (Thailand) Co.  
Ltd Head Office104 Phatthanakan 40 Phatthanakan Rd  
Klongkiet Phatthanakan Khet Suan  
TAX ID: 0105540004859chanatagarn.kitichan@agilent.com  
227158760

## Invoice To:

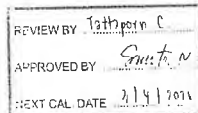
ALS Laboratory Group (Thailand) Co.  
Ltd Head Office104 Phatthanakan 40 Phatthanakan Rd  
Klongkiet Phatthanakan Khet Suan

## Delivery Site:

ALS Laboratory Group (Thailand) Co.  
Ltd Head Office104 Phatthanakan 40 Phatthanakan Rd  
Klongkiet Phatthanakan Khet SuanLocation  
Room  
Bldg  
Lab  
Dept

## SERVICE REPORT

Customer Purchase Order Number: 70371013	Customer Number: 70371013
Service Request:	Service Request Date:
Service Order: 00066/5000	Service Confirmation: 6905905441



## Direct Inquiries to:

Contact Name:  
Contact Email:  
Contact Telephone:  
Contact Fax:Customer Contact Center  
ccc.smt@agilent.com  
+66 2 671 8100  
+66 2 372 4346

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390 Interchange 21 Building, Sukhumvit Road, Klongkiet  
Sub-district, Watthana District, Bangkok 10110 Thailand  
Tel: +66 2 372 4350 (00)  
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Agilent Service Bldg, 119/12 Rama 9 Rd, Phatthanakan, Bangkok 10550  
Thailand

Page 1 of 2

Service Confirmation Number: 6905905441

Service Confirmation Date: 08.10.2024

## Service Instrument:

Model Number	Model Description	Serial Number	System Handle	Parent Asset
SYS-IM-7900	ICP-MS 7900 System			
G8410A	SPS 4 Autosampler	AU15430722	ICP MS 7900	SYS-IM-7900
G8411A	ISIS 3 for Agilent 7900/7900/8900	JP16510227	ICP MS 7900	SYS-IM-7900
G3292A	PSC 610BT Chiller	2U16A1948	ICP MS 7900	SYS-IM-7900
G8403A	Agilent 7900 ICP-MS	JP16471169	ICP MS 7900	SYS-IM-7900

## Service Items:

Item	Service/Part #	Description	Qty	Entitlement	Service Start	Service End
1000	EQC	Enterprise Operational Qualification	1.00	Agreement Entitlement 100 % covered	04.10.2024	04.10.2024
1010	5185-5950	ICP-MS Checkout Solutions	1.00	Agreement Entitlement 100 % covered		

## Additional Information:

Page 2 of 3



Service Information:

Problem Description:  
WU-EDQ-IM-7900-5001253855

Service Provided:  
Perform OQ Hardware. Test CDS' logon, auto sampler, Auto tune, BG and 20 Min stability.  
I calibrate the instrument No BKK\_EL0043 test all pass.

Service Overview Code:  
Reason Code: Scheduled Service  
Diagnosis Code: Scheduled Service  
Resolution Code: Scheduled Service

Reported Hours: 7.0  
Travel Hours: 2.0

Customer Field Service  
Representative Name:  
Panthep Kurasathain

Customer Name:  
Supakwan Mak

Additional Comments:



Metrological Center

SCI ECO Services Company Limited

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

Telephone : +66 2 586 5792-4 Fax : +66 2 586 5109

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

Certificate No. T231676

Page 1 of 6

Certificate of Calibration

Equipment : HEATING BLOCK

Manufacturer : Environmental Express

Model : SC 196

Serial No. : 6974CECW3285

Customer Code : BKK\_EL0054

ID No. : T5306A3

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

104 Phatthanakan 40, Phatthanakan Rd., Khwaeng Phatthanakan,

Khet Suan Luang, Bangkok 10250

Customer Location : Acid Digestion Lab

Date of Receipt : 13 September 2023

Calibrated By : Sane Musikawan (Site Calibration Manager)

Approved By : [Redacted] Nakkred (Site Calibration Manager)

Date of Issue

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-L13 109/30-05-57



Metrological Center

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Telephone : +66 2 586 5792-4 Fax : +66 2 586 5109

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Page 2 of 6

Calibration Report

Equipment : HEATING BLOCK

Date of Calibration : 22 September 2023

Environment : Temperature : 21.8-23.1 °C

Line Voltage : 221.6-226.3 V

Relative Humidity : 55 - 65 %RH

Condition of this results of calibration :

1. This equipment was calibrated by insert 20 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

All data show below were final values and the initial data from customer request. The temperature scale used was based on ITS - 90.

2. Reference Standard Instrument :

Instrument	Model	Instrument No	Certificate No	Due Date
TC	TYPE T	TN21-TN30	T230014	17 January 2024
TC	TYPE T	TN31-TN40	T230014	17 January 2024
DATA LOGGER	34970A	TI51	T230014	17 January 2024

3. This certificate is traceable to :

National Institute of Metrology ( Thailand ) through Metrological Center ( NSC-TISI-115 17025 CALIBRATION 0244 )

4. Condition of calibrated item : good

Equipment Description :

Time Constant : 2 Hour 20 Minute At 95 °C  
Fresh Air Damper : ☐ Open ☐ Min ☐ Medium ☐ Max  
☐ Close  
☒ Not Available

5. Adjustment :

( ) without adjustment



Metrological Center

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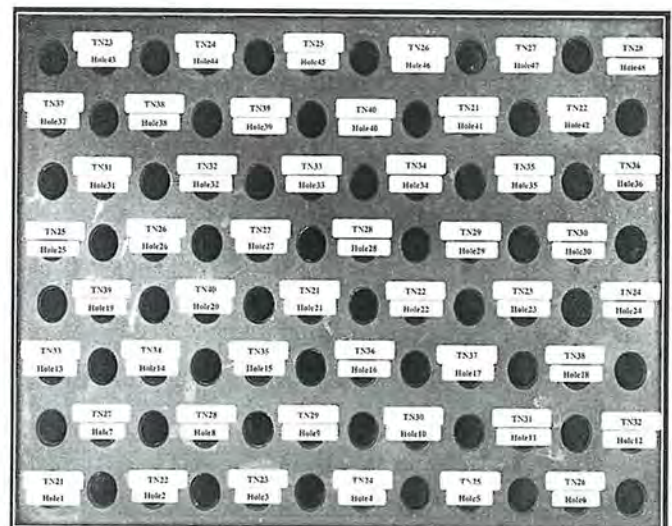
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Certificate No. T231676

Page 3 of 6

Calibration Report





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Certificate No T231676

Page 4 of 6

### Calibration Report

Measurement Results						
Calibration Point	Average Standard Reading at each position (°C)					
R1 Hole1-Hole6	TN21	TN22	TN23	TN24	TN25	TN26
CAL POINT 95	Max	95.01	94.41	95.20	95.41	94.51
	Min	94.57	93.95	94.75	94.92	94.00
	Average	94.79	94.18	94.98	95.17	94.26
R2 Hole7-Hole12	TN27	TN28	TN29	TN30	TN31	TN32
CAL POINT 105	Max	95.36	95.43	95.19	95.16	95.35
	Min	94.54	94.95	94.72	94.71	94.90
	Average	95.15	95.19	94.96	94.94	95.13
R3 Hole13-Hole18	TN33	TN34	TN35	TN36	TN37	TN38
CAL POINT 105	Max	95.37	95.50	95.22	95.21	95.33
	Min	94.99	95.09	94.78	94.82	94.84
	Average	95.18	95.30	95.00	95.02	95.11
R4 Hole19-Hole24	TN39	TN40	TN21	TN22	TN23	TN24
CAL POINT 105	Max	95.59	94.42	94.52	94.24	91.62
	Min	95.21	94.06	94.13	95.85	94.28
	Average	95.40	94.24	94.33	95.06	94.45
R5 Hole25-Hole30	TN25	TN26	TN27	TN28	TN29	TN30
CAL POINT 105	Max	95.19	95.13	92.93	95.30	95.14
	Min	94.83	95.03	92.56	94.95	94.79
	Average	95.01	95.20	92.75	95.12	94.96
R6 Hole31-Hole36	TN31	TN32	TN33	TN34	TN35	TN36
CAL POINT 105	Max	94.63	94.90	94.77	94.31	94.24
	Min	94.24	94.55	94.44	93.98	93.92
	Average	94.43	94.72	94.60	94.14	94.09
R7 Hole37-Hole42	TN37	TN38	TN39	TN40	TN21	TN22
CAL POINT 105	Max	94.30	94.44	94.04	93.81	94.89
	Min	93.95	94.05	93.67	92.48	94.39
	Average	94.13	94.24	93.86	93.65	94.64
R8 Hole43-Hole48	TN23	TN24	TN25	TN26	TN27	TN28
CAL POINT 105	Max	95.99	95.63	95.28	95.29	95.45
	Min	95.57	95.15	94.82	94.84	94.99
	Average	95.78	95.39	95.05	95.07	95.22



## Metrological Center

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

Telephone : +66 2 586 5792-4 Fax : +66 2 586 5109

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

Certificate No T231676

Page 5 of 6

### Calibration Report

Measurement Results						
Calibration Point	Average Standard Reading at each position (°C)					
R1 Hole1-Hole6	TN21	TN22	TN23	TN24	TN25	TN26
CAL POINT 105	Max	105.23	104.32	105.43	105.25	104.44
	Min	104.94	103.95	105.15	105.04	104.11
	Average	105.09	104.13	105.29	105.15	104.28
R2 Hole7-Hole12	TN27	TN28	TN29	TN30	TN31	TN32
CAL POINT 105	Max	105.30	105.12	105.18	105.22	105.12
	Min	105.11	104.92	104.96	105.00	104.92
	Average	105.20	105.02	105.07	105.11	105.02
R3 Hole13-Hole18	TN33	TN34	TN35	TN36	TN37	TN38
CAL POINT 105	Max	105.37	105.63	105.02	104.80	104.69
	Min	105.17	105.37	104.75	104.59	104.50
	Average	105.27	105.50	104.88	104.69	104.60
R4 Hole19-Hole24	TN39	TN40	TN21	TN22	TN23	TN24
CAL POINT 105	Max	105.31	104.43	106.41	104.71	105.63
	Min	105.08	104.22	106.15	104.41	105.37
	Average	105.19	104.33	106.28	104.56	105.50
R5 Hole25-Hole30	TN25	TN26	TN27	TN28	TN29	TN30
CAL POINT 105	Max	104.95	106.26	103.33	105.78	105.59
	Min	104.67	105.96	103.05	105.56	105.36
	Average	104.81	106.11	103.21	105.67	105.48
R6 Hole31-Hole36	TN31	TN32	TN33	TN34	TN35	TN36
CAL POINT 105	Max	104.75	104.86	104.80	105.20	104.50
	Min	104.54	104.63	104.59	105.00	104.32
	Average	104.65	104.75	104.69	105.10	104.41
R7 Hole37-Hole42	TN37	TN38	TN39	TN40	TN21	TN22
CAL POINT 105	Max	104.30	104.90	104.85	104.65	104.88
	Min	104.09	104.72	104.66	104.49	104.63
	Average	104.19	104.81	104.75	104.57	104.76
R8 Hole43-Hole48	TN23	TN24	TN25	TN26	TN27	TN28
CAL POINT 105	Max	105.71	105.85	105.39	105.61	105.42
	Min	105.45	105.61	105.14	105.27	105.18
	Average	105.58	105.73	105.27	105.44	105.30



## Metrological Center

SCI ECO Services Company Limited

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

Telephone : +66 2 586 5792-4 Fax : +66 2 586 5109

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

Certificate No. T231676

Page 6 of 6

### Calibration Report

#### Measurement Results:

HEATING BLOCK			Temperature Distribution	
Setting (°C)	Reading (°C)		Stability (°C)	Uncertainty (±°C)
	Min, Max	Average		
100.0	100.3, 100.5	100.4	0.26	0.81
107.0	107.0, 107.1	107.1	0.19	0.78

\* The quoted 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: \_\_\_\_\_



## Metrology

SCI ECO Services Company Limited

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

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

Bangkok Tel : +668 9205 6851, +669 8247 2360

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



Certificate No. T232160

Page 1 of 4

### Certificate of Calibration

Equipment : Chamber (Cooling Room)

Manufacturer : KOLDTECH

Model : KM 320

Serial No. : TBN-1012061/05

Customer Code : BKK\_EN0167

ID No. : T2463A3

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

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

Customer Location : Laboratory

Date of Receipt : 29 November 2023

Calibrated By : Atinpong Ronprat (Technician)

Approved By : \_\_\_\_\_ (Site Calibration Manager)

Date of Issue : \_\_\_\_\_

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 Metrology.

Certificate No. T232160

Page 2 of 4

## Calibration Report

Equipment : Chamber (Cooling Room)  
Date of Calibration : 6 December 2023  
Environment : Temperature : 23.4-24.9 °C  
Line Voltage : 221.4-230.2 V  
Relative Humidity : 55 - 65 %RH

## Condition of this results of calibration :

1. 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 W1-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.

## 2. Reference Standard Instrument :

Instrument	Model	Instrument No.	Certificate No.	Due Date
TC	TYPE T	TN161-TN170	T230773	10 April 2024
TC	TYPE T	TN171-TN180	T230773	10 April 2024
DATA LOGGER	34970A	T149	T230773	10 April 2024

## 3. This certificate is traceable to :

National Institute of Metrology (Thailand) through Metrological Center (NSC-TIS-TIS 17025 CALIBRATION 0244)

## 4. Condition of calibrated item : good

## Equipment Description :

Time Constant 1 Hour 30 Minute At 3 °C  
Fresh Air Damper ☐ Open ☐ Min ☐ Medium ☐ Max  
☐ Close  
☒ Not Available

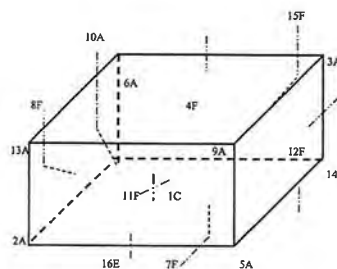
## 5. Adjustment :

( X ) without adjustment ( ) after adjustment

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## Calibration Report



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

1C = TN161	12F = TN172
2A = TN162	13A = TN173
3A = TN163	14A = TN174
4F = TN164	15F = TN175
5A = TN165	16E = TN176
6A = TN166	
7F = TN167	
8F = TN168	
9A = TN169	
10A = TN170	
11F = TN171	

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## Calibration Report

## Measurement Results

Calibration Point	Average Standard Reading at each position (°C)											
	TN161	TN162	TN163	TN164	TN165	TN166	TN167	TN168	TN169	TN170	TN171	TN172
3.0	2.83	3.34	2.95	3.46	3.45	3.76	3.25	3.46	3.39	3.50	3.58	3.42
	TN173	TN174	TN175	TN176								
	3.33	3.39	3.15	3.43								

Chamber (Cooling Room)			Temperature Distribution				
Setting (°C)	Reading (°C)		Average (°C)	Stability (± °C)	Uniformity (°C)	Uncertainty (± °C)	Coverage Factor k
	Min	Max					
3.0	2.8	4.1	3.5	1.10	2.00	1.90	2.09

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 118/18-08-66