

ภาคผนวก ง

ใบรับรองการสอบเทียบเครื่องมือ



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รายการเครื่องมือที่ใช้ในการวิเคราะห์ / ทดสอบ

Sample Name	Parameter	Equipment Name	ID No.	Calibrated Date	Next Cal	Freq. Calibrate (Months)
Stack	Oxides of Nitrogen	Console Control Unit	BKK_FS0468	12-Jan-22	12-Jul-22	6
Stack	Oxides of Nitrogen	Console Control Unit	RYG_FS0315	12-Jan-22	12-Jul-22	6
Stack	Oxides of Nitrogen	Vacuum Gauge	BKK_FS0435	9-Apr-21	8-Oct-22	18
Stack	Oxides of Nitrogen	Vacuum Gauge	RYG_FS0333	6-Oct-21	6-Apr-23	18
Stack	Oxides of Nitrogen	SPECTROPHOTOMETER	RYG_EN0037	1-Apr-21	1-Oct-22	18
Stack	Non-Methane Hydrocarbon	Console Control Unit	BKK_FS0468	12-Jan-22	12-Jul-22	6
Stack	Non-Methane Hydrocarbon	Console Control Unit	RYG_FS0315	12-Jan-22	12-Jul-22	6
Stack	Non-Methane Hydrocarbon	Total Hydrocarbon Analyzer	RYG_EN0038	8-Jul-21	8-Jul-22	12
Stack	Total Hydrocarbon	Console Control Unit	BKK_FS0468	12-Jan-22	12-Jul-22	6
Stack	Total Hydrocarbon	Console Control Unit	RYG_FS0315	12-Jan-22	12-Jul-22	6
Stack	Total Hydrocarbon	Total Hydrocarbon Analyzer	RYG_EN0038	8-Jul-21	8-Jul-22	12
Ambient	Nitrogen Dioxide	NO ₂ Analyzer	RYG_FS0455	4-Jan-22	4-Jul-22	6
Ambient	Nitrogen Dioxide	NO ₂ Analyzer	RYG_FS0252	4-Jan-22	4-Jul-22	6
Ambient	Nitrogen Dioxide	NO ₂ Analyzer	BKK_FS1064	4-Jan-22	4-Jul-22	6
Ambient	Nitrogen Dioxide	NO ₂ Analyzer	BKK_FS0797	4-Jan-22	4-Jul-22	6
Ambient	Total Hydrocarbon	Total Hydrocarbon Analyzer	BKK_EN0057	9-Feb-21	9-Aug-22	18
Ambient	Volatile Organic Compounds	GC-MSD	RYG_EN0136	2-Feb-21	2-Aug-22	18
Ambient	Ethylene glycol	Field Rotameter	BKK_FS1006	4-Jan-22	4-Apr-22	3
Ambient	Ethylene glycol	Field Rotameter	RYG_FS0199	4-Jan-22	4-Apr-22	3
Ambient	Ethylene glycol	Field Rotameter	BKK_FS1044	1-Apr-22	1-Jul-22	3
Ambient	Ethylene glycol	Field Rotameter	RYG_FS0199	1-Apr-22	1-Jul-22	3
Ambient	Ethylene glycol	GC-FID	BKK_EN0133	27-Jan-22	27-Jul-23	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0329	31-Jan-22	29-Jul-23	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0411	29-Jul-21	27-Jan-23	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0413	29-Jul-21	27-Jan-23	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0412	29-Jul-21	27-Jan-23	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0085	8-Oct-21	8-Apr-23	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0412	29-Jul-21	27-Jan-23	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0081	5-Jul-21	3-Jan-23	18



รายการเครื่องมือที่ใช้ในการวิเคราะห์ / ทดสอบ

Sample Name	Parameter	Equipment Name	ID No.	Calibrated Date	Next Cal	Freq. Calibrate (Months)
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0545	14-Sep-21	15-Mar-23	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	BKK_FS0141	7-Jun-21	6-Dec-22	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0413	29-Jul-21	27-Jan-23	18
Workplace	n-Octane	Field Rotameter	RYG_FS0199	4-Jan-22	4-Apr-22	3
Workplace	n-Octane	Field Rotameter	RYG_FS0199	1-Apr-22	1-Jul-22	3
Workplace	n-Octane	GC-FID	BKK_EN0126	21-Oct-21	21-Apr-23	18
Noise	Leq 24 hrs	Sound Calibrator	RYG_FS0215	9-Aug-21	9-Aug-22	12
Noise	Leq 24 hrs	Sound Level Meter	RYG_FS0024	4-Oct-21	4-Oct-22	12
Noise	Leq 24 hrs	Sound Level Meter	RYG_FS0025	21-Jan-22	21-Jan-23	12
Noise	Leq 24 hrs	Sound Level Meter	RYG_FS0027	10-Jan-22	10-Jan-23	12
Noise	Leq 5 min	Sound Calibrator	RYG_FS0215	9-Aug-21	9-Aug-22	12
Noise	Leq 5 min	Sound Level Meter	RYG_FS0024	4-Oct-21	4-Oct-22	12
Noise	Leq 5 min	Sound Level Meter	RYG_FS0025	21-Jan-22	21-Jan-23	12
Noise	Leq 8 hrs	Sound Calibrator	RYG_FS0215	9-Aug-21	9-Aug-22	12
Noise	Leq 8 hrs	Sound Level Meter	RYG_FS0029	21-Apr-21	21-Apr-22	12
Noise	Leq 8 hrs	Sound Level Meter	RYG_FS0030	21-Jan-22	21-Jan-23	12
Noise	Leq 8 hrs	Sound Calibrator	RYG_FS0215	9-Aug-21	9-Aug-22	12
Noise	Leq 8 hrs	Sound Level Meter	RYG_FS0303	2-Jun-21	2-Jun-22	12
Noise	Leq 8 hrs	Sound Level Meter	RYG_FS0304	2-Jun-21	2-Jun-22	12
Noise	Octave Band	Sound Calibrator	RYG_FS0215	9-Aug-21	9-Aug-22	12
Noise	Octave Band	Sound Level Meter	RYG_FS0029	21-Apr-21	21-Apr-22	12
Noise	Octave Band	Sound Level Meter	RYG_FS0030	21-Jan-22	21-Jan-23	12
Noise	Octave Band	Sound Calibrator	RYG_FS0215	9-Aug-21	9-Aug-22	12
Noise	Octave Band	Sound Level Meter	RYG_FS0303	2-Jun-21	2-Jun-22	12
Noise	Octave Band	Sound Level Meter	RYG_FS0304	2-Jun-21	2-Jun-22	12
Rayong Lab	pH at 25 °C	pH meter	RYG_EN0183	17-Mar-22	17-Mar-23	12
Rayong Lab	BOD (5 days at 20°C)	DO meter with Sensor	RYG_EN0032	14-Feb-22	15-Aug-23	18
Rayong Lab	BOD (5 days at 20°C)	Incubator	RYG_EN0154	22-Apr-22	21-Oct-23	18
Rayong Lab	COD	Spectrophotometer	RYG_EN0037	1-Apr-21	1-Oct-22	18
Rayong Lab	Total Suspended Solids	Electronic Balance	RYG_EN0002	23-Mar-22	23-Mar-23	12
Rayong Lab	Total Suspended Solids	Hot Air Oven	RYG_EN0010	5-May-21	3-Nov-22	18
Rayong Lab	Total Dissolved Solids 180°C	Electronic Balance	RYG_EN0002	23-Mar-22	23-Mar-23	12
Rayong Lab	Total Dissolved Solids 180°C	Hot Air Oven	RYG_EN0010	5-May-21	3-Nov-22	18



รายการเครื่องมือที่ใช้ในการวิเคราะห์ / ทดสอบ

Sample Name	Parameter	Equipment Name	ID No.	Calibrated Date	Next Cal	Freq. Calibrate (Months)
Lab	Solids 180°C					
Rayong Lab	Oil & Grease	Electronic Balance	RYG_EN0002	23-Mar-22	23-Mar-23	12
Rayong Lab	Oil & Grease	Hot Air Oven	RYG_EN0006	5-May-21	3-Nov-22	18
Rayong Lab	Oil & Grease	Water Bath	RYG_EN0061	5-May-21	3-Nov-22	18
Rayong Lab	Temperature	Digital Thermometer	RYG_FS0467	7-Jul-21	7-Jul-22	18
Rayong Lab	Total Kjeldahl Nitrogen	Block Digestion Unit	RYG_EN0188	17-Mar-22	17-Mar-23	12
Rayong Lab	Total Kjeldahl Nitrogen	pH Meter	RYG_EN0152	23-Dec-21	23-Dec-22	12



CONSOLE CONTROL UNIT CALIBRATION TEST REPORT

Calibration of Date : 12 Jan 22
Next Cal. Date : 12 Jul 22

Barometric Pressure (mm.Hg) : 760
Relative Humidity (%) : 55.0
Temperature (°C) : 28.0

Console Control Meter Data

Calibration No. : C-120122-BKK_FS0468
Dry Gas Meter No. : BKK_FS0468
Console Serial No. : 1302005
Console Model No. : XC-572-V

Reference Dry Gas Meter Data

Serial No. : 1607009
Model No. : SK25EXSR-QC6
Correction Factor (Yr) : 1.0060
Next Calibration Date : 8 Apr 22

ΔH (mm.H ₂ O)	Θ Minutes	Reference Dry Gas Meter Calibration				Console Control ; Drygas Meter						Dry Gas Meter Correction Factor (Y)	Orifice Calibration Factor $\Delta H @$
		Vr (Liters)			Tr (°C)	Vm (Liters)			Ti (°C)	To (°C)	Avg.Tm (°C)		
		Final	Initial	Total		Final	Initial	Total					
15	12.38	150.00	0.00	150.00	30.0	2564504.0	2564355.0	149.00	29.0	29.0	29.0	1.0079	47.0425
25	9.33	150.00	0.00	150.00	31.0	2564661.0	2564510.0	151.00	30.0	30.0	30.0	0.9936	44.6773
50	6.57	150.00	0.00	150.00	31.0	2564821.0	2564670.0	151.00	31.0	31.0	31.0	0.9945	44.1625
80	5.14	150.00	0.00	150.00	31.0	2564983.0	2564830.0	153.00	32.0	32.0	32.0	0.9819	43.1065
120	4.18	150.00	0.00	150.00	32.0	2565149.0	2564995.0	154.00	32.0	32.0	32.0	0.9686	43.0440
										Avg.		0.9893	44.4066

Y : Ratio of reading of reference to dry gas meter : tolerance for individual values ± 0.02 from average .

$\Delta H @$: Orifice pressure differential that equates to 21.24 in of air @ 25 C and 760 mm of mercury , mmH₂O ; tolerance for individual values ± 5.08 from average .

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

Calibrated by:

Saksit Phaisanphisit

(Mr.Saksit Phaisanphisit)
Field Scientist (4)

Approved by:

Wichan Choonharat

(Mr.Wichan Choonharat)
Manager



DIGITAL TEMPERATURE CALIBRATION DATA SHEET

Calibration Date :	12-Jan-22	Ambient Temperature (°C)	28
Calibration sheet No. :	C-120122-BKK_FS0469	Relative Humidity (%) :	55
Digital Temperature ID	BKK_FS0469	Reference Temperature ID	BKK_FS0469
Serial No. :	1302005	Serial No. :	7688004
Model :	XC-672-V	Model :	FLUKE 714
		Next Calibrate :	13 Jan 22

Location	Reference Temperature °C	Digital Temperature °C	Error °C	Remark
Stack	0	0	0	
	25	24	-1	
	50	49	-1	
	100	98	-2	
	150	148	-2	
	200	197	-3	
	250	247	-3	
	300	297	-3	
	500	497	-3	
	1000	997	-3	
	1200	1197	-3	
Probe	100	99	-1	
	125	124	-1	
	150	149	-1	
Oven	100	99	-1	
	125	124	-1	
	150	149	-1	
Filter	100	100	0	
	125	125	0	
	150	149	-1	
Exit	0	0	0	
	10	11	1	
	20	21	1	
Meter	0	0	0	
	25	25	0	
	50	50	0	
AUX	0	0	0	
	25	25	0	
	50	50	0	

Calibrated by : Saksit Phaisanphisit Approved by : Wichan Choonharat
 (Mr.Saksit Phaisanphisit) (Mr.Wichan Choonharat)
 Field Scientist (4) Manager
 Form 281-048 (02/03/02)



Pitot Tube Calibration Data

Pitot Tube Identification Number : BKK_FS0472 Calibration Date : 12 Jan 22
 Lab test duct Number : 258-1-13-01 Standard Pitot ID : BKK_FS0441
 Calibration Sheet No. : C-120122-BKK_FS0472 Cp Standard : 0.99

Type S Pitot Tube Coefficient Data					
	Type s pitot tube Leg A,B	Standard pitot tube (ΔP, mm.H ₂ O)	Type s pitot tube (ΔP, mm.H ₂ O)	Cp (s) Leg A	Cp (s) Leg B
Test 1	A	12.00	16.60	0.842	-
	B	12.00	16.60	-	0.842
Test 2	A	12.00	16.60	0.842	-
	B	12.00	16.60	-	0.842
Test 3	A	12.00	16.60	0.842	-
	B	12.00	16.60	-	0.842
			C _p	0.842	0.842

$$C_p(s) = C_p \cdot \sqrt{\frac{\Delta P(s)}{\Delta P(s)}}$$

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

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

Calibrated by : Saksit Phaisanphisit Approved by : Wichan Choonharat
 (Mr.Saksit Phaisanphisit) (Mr.Wichan Choonharat)
 Field Scientist (4) Manager
 Form 281-048 (04/03/02)



Pitot Tube Calibration Data

Pitot Tube Identification Number : BKK_FS0473 Calibration Date : 12 Jan 22
 Lab test duct Number : 258-1-13-01 Standard Pitot ID : BKK_FS0441
 Calibration Sheet No. : C-120122-BKK_FS0473 Cp Standard : 0.99

Type S Pitot Tube Coefficient Data					
	Type s pitot tube Leg A,B	Standard pitot tube (ΔP, mm.H ₂ O)	Type s pitot tube (ΔP, mm.H ₂ O)	Cp (s) Leg A	Cp (s) Leg B
Test 1	A	12.00	16.60	0.842	-
	B	12.00	16.60	-	0.842
Test 2	A	12.00	16.60	0.842	-
	B	12.00	16.60	-	0.842
Test 3	A	12.00	16.60	0.842	-
	B	12.00	16.60	-	0.842
			C _p	0.842	0.842

$$C_p(s) = C_p \cdot \sqrt{\frac{\Delta P(s)}{\Delta P(s)}}$$

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

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

Calibrated by : Saksit Phaisanphisit Approved by : Wichan Choonharat
 (Mr.Saksit Phaisanphisit) (Mr.Wichan Choonharat)
 Field Scientist (4) Manager
 Form 281-048 (04/03/02)

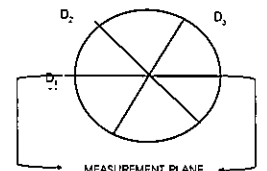


PROBE NOZZLE DIAMETER CALIBRATION DATA SHEET

Calibration Date : 12 Jan 22 Nozzle Set ID : BKK_FS0474
 Calibration Sheet No. : C-120122-BKK_FS0474 Vernier Caliper ID : BKK_FS0626

Nozzle ID #	Nozzle Diameter (cm.)			Hi - Lo ΔD	(D ₁ + D ₂ + D ₃) / 3 D _{avg}
	D ₁	D ₂	D ₃		
1	0.300	0.300	0.300	0.000	0.300
2	0.450	0.450	0.450	0.000	0.450
3	0.600	0.600	0.600	0.000	0.600
4	0.780	0.780	0.780	0.000	0.780
5	0.932	0.932	0.932	0.000	0.932
6	1.094	1.094	1.094	0.000	1.094
7	1.264	1.264	1.264	0.000	1.264

Where :
 D₁, D₂, D₃ = 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_{avg} = (D₁ + D₂ + D₃) / 3



Calibrated by : Saksit Phaisanphisit Approved by : Wichan Choonharat
 (Mr.Saksit Phaisanphisit) (Mr.Wichan Choonharat)
 Field Scientist (4) Manager
 Form No. 05 281-048 (13/01/03)



CONSOLE CONTROL UNIT CALIBRATION TEST REPORT

Calibration of Date : 12 Jan 22 Barometric Pressure (mm Hg) : 760

Next Cal. Date : 12 Jul 22 Relative Humidity (%) : 58.3

Temperature (°C) : 25.0

Reference Dry Gas Meter Data

Calibration No. : C-120122-RYG_FS0315

Dry Gas Meter No. : RYG_FS0315

Console Serial No. : 1706091

Console Model No. : XC-572-V

Serial No. : 1507009

Model No. : DGM-SK25RM-Q38

Correction Factor (Vf) : 1.0060

Next Calibration Date : 8 Apr 22

All	Q	Reference Dry Gas Meter Calibration				Console Control Dry Gas Meter				Dry Gas Meter Correction Factor (Vf)	Orifice Calibration Factor (Vf)	Avg. Trm (°C)
		Final	Initial	Total	Tr (°C)	Final	Initial	Total	Tr (°C)			
15	12.30	150.00	0.00	150.00	27.0	1274534.0	1274300.0	144.00	27.0	1.0464	45.8240	27.0
25	9.45	150.00	0.00	150.00	30.0	1274545.0	1274545.0	144.00	28.0	1.0066	45.8555	28.0
50	6.73	150.00	0.00	150.00	30.0	12744943.0	1274702.0	143.00	28.0	1.0432	46.8941	28.0
80	5.22	150.00	0.00	150.00	30.0	1275000.0	1274860.0	143.00	30.0	1.0471	44.5553	30.0
120	4.27	150.00	0.00	150.00	30.0	1275163.0	1275002.0	143.00	30.0	1.0431	44.6250	30.0
												Avg. 27.0

Y Ratio of reading of reference to dry gas meter : tolerance for individual values = 0.02 from average.

ΔVf Orifice pressure differential that equates to 21.24 in of air @ 25 °C and 760 mm of mercury, initial20 : tolerance for individual values = 5.08 from average.

Procedure: 40 CFR 60 APP A METH. SEC 5.3.4.7

Calibrated by :

(Mr. Warawut Pulpas)

Field Scientist (3)

Approved by :

(Mr. Wichan Choonharat)

Manager



PROBE NOZZLE DIAMETER CALIBRATION DATA SHEET

Calibration Date	12 Jan 22	Nozzle Set ID :	RYG_FS0319
Calibration Sheet No. :	C-120122-RYG_FS0319	Vernier Caliper ID :	BKK_FS0626

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

Where :

D₁, D₂, D₃

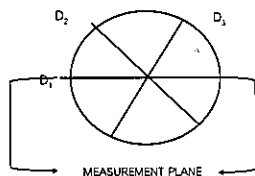
= Three different nozzle diameters at 60 degrees to each other, each measured the nearest 0.025 mm.

ΔD

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

D_{avg}

= (D₁ + D₂ + D₃) / 3



Calibrated by

(Mr. Warawut Pulpas)
Field Scientist (3)

Approved by

(Mr. Wichan Choonharat)
Manager

Form No. 03 281-029 (13/01/03)



Pitot Tube Calibration Data

Pitot Tube Identification Number : RYG_FS0320 Calibration Date : 12 Jan 22

Lab test duct Number : 258-1-13-01

Standard Pitot ID : BKK_FS0441

Calibration Sheet No. : C-120122-RYG_FS0320

Cp Standard : 0.99

Type S Pitot Tube Coefficient Data					
	Type s pitot tube Leg A, B	Standard pitot tube (ΔP, mm.H ₂ O)	Type s pitot tube (ΔP, mm.H ₂ O)	Cp (s) Leg A	Cp (s) Leg B
Test 1	A	12.00	16.60	0.842	-
	B	12.00	16.60	-	0.842
Test 2	A	12.00	16.60	0.842	-
	B	12.00	16.60	-	0.842
Test 3	A	12.00	16.60	0.842	-
	B	12.00	16.60	-	0.842
			Cp	0.842	0.842

$$C_p(S) = C_p \cdot \sqrt{\frac{\Delta P(s)}{\Delta P(s)}}$$

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

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

Calibrated by

(Mr. Warawut Pulpas)
Field Scientist (3)

Approved by

(Mr. Wichan Choonharat)
Manager

Form 281-04a-104/03/021



Pitot Tube Calibration Data

Pitot Tube Identification Number: RYG_FS0321 Calibration Date: 12 Jan 22
Lab test duct Number: 258-1-13-01 Standard Pitot ID: BKK_FS0441
Calibration Sheet No.: C-120122-RYG_FS0321 Cp Standard: 0.99

Type S Pitot Tube Coefficient Data					
	Type s pitot tube Leg A,B	Standard pitot tube (ΔP, mm.H ₂ O)	Type s pitot tube (ΔP, mm.H ₂ O)	Cp (s) Leg A	Cp (s) Leg B
Test 1	A	12.00	16.60	0.842	-
	B	12.00	16.60	-	0.842
Test 2	A	12.00	16.60	0.842	-
	B	12.00	16.60	-	0.842
Test 3	A	12.00	16.60	0.842	-
	B	12.00	16.60	-	0.842
Cp				0.842	0.842

$$C_p(s) = C_p \sqrt{\frac{\Delta P(s)}{\Delta P(r)}}$$

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

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

Calibrated by

(Mr.) Warawut Putpa
Field Scientist (3)

Approved by

Mr. Wichan Choonharat
Manager

Form 281-046 (04/03/02)



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



Certificate of Calibration

Certificate No.: 21P1350
Page: 1 of 2

Equipment: Digital Vacuum Gauge

Manufacturer: Dwyer

Model: DPGA-00

Serial No.: DVG03

ID No.: BKK_FS0435

Condition As-Received: Used Item

Received Date: 09 April 2021

Calibration Date: 20 April 2021

Reference: 2104-0323WSC

Ambient Temperature: (23 ± 2) °C

Relative Humidity: (50 ± 15) %

Atmospheric Pressure: 1010 mbar

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

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

Procedure used: The calibration was conducted by direct comparison method against Pressure Measuring Instruments Standard according to in-house calibration procedure CP-P06, using "DKO-R 6-1; Calibration of Pressure Gauges, Edition 03/2014" as a guidelines.

Condition of this result of calibration

1. Reference standards Instruments:

Instrument	Model	Serial No.	Certificate No.	Due Date
1) Pressure Calibrator	PC106P	1189	MP-0113-20	14 Jul 2021
2. This instrument was installed in vertical orientation and lower groove of pressure sensor was used as the reference level.				
3. This result of calibration was made on requested at the point specified by customer.				
4. Scale and conversion factor is 1 kPa = 0.2953 inHg				
5. This instrument was used clean air as pressure media.				
6. The certificate is valid only to the item calibrated on date and place of calibration.				
7. This Certification is traceable to the International System of Unit maintained at:- National Institute of Metrology Thailand (NIMT)				

REVIEW BY: *Phatthana P.*
APPROVED BY: *Phatthana P.*
NEXT CAL. DATE: 8/10/22

Calibrated by: Suwit Aussarree
Issue Date: 21 April 2021

Approved Signatory: *Attapol P.*
[] Phatinee Prabpai
[] Sura Suwannasri
[x] Attapol Panurech

B 0256843



Cert.No: 21P1350
Page: 2 of 2

Result of calibration: Without adjustment

Function: Vacuum Pressure Measurement

Increasing Pressure

Applied Pressure (inHg)	0.000	-4.998	-9.996	-14.994	-19.992	-24.987
UUC* Indication (inHg)	0.00	-5.05	-10.10	-15.20	-20.30	-25.40
Error (inHg)	0.000	-0.052	-0.104	-0.208	-0.308	-0.413

Decreasing Pressure

Applied Pressure (inHg)	-24.987	-19.992	-14.994	-9.996	-4.998	0.000
UUC* Indication (inHg)	-26.90	-20.30	-15.20	-10.10	-5.05	0.00
Error (inHg)	-0.413	-0.308	-0.208	-0.104	-0.052	0.000

The uncertainty of measurement was ± 0.080 inHg

* UUC = Unit Under Calibration

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 %.

-000-



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



Certificate of Calibration

Certificate No.: 21P3344
Page: 1 of 2

Equipment: Vacuum Gauge

Manufacturer: QualityWell

Model: F221AVD

Serial No.: VQ02

ID No.: RYG_FS0333

Condition As-Received: Used Item

Received Date: 01 October 2021

Calibration Date: 08 October 2021

Reference: 2110-0086WSC

Ambient Temperature: (23 ± 2) °C

Relative Humidity: (50 ± 15) %

Atmospheric Pressure: 1008 mbar

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

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

Procedure used: The calibration was conducted by direct comparison method against Pressure Measuring Instruments Standard according to in-house calibration procedure CP-P06, using "DKD-R 6-1; Calibration of Pressure Gauges, Edition 03/2014" as a guidelines.

Condition of this result of calibration

1. Reference standards Instruments:

Instrument	Model	Serial No.	Certificate No.	Due Date
1) Digital Pressure Gauge	15PSIXP21	158670	21P2929	03 Sep 2022

2. This instrument was installed in vertical orientation and center of the dial was used as the reference level.

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

4. Scale and conversion factor is 1 kPa = 0.2953 inHg

5. This instrument was used clean air as pressure media.

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

7. This Certification is traceable to the International System of Unit maintained at:-
National Institute of Metrology Thailand (NIMT)

REVIEW BY: *Phatthana P.*
APPROVED BY: *Phatthana P.*
NEXT CAL. DATE: 6/14/23

Calibrated by: Noppapol Phangam
Issue Date: 07 October 2021

Approved Signatory: *Attapol P.*
[] Phatinee Prabpai
[] Sura Suwannasri
[x] Attapol Panurech

Attapol P.

a 1046881

B 0270821



Certificate of Calibration

Equipment: SPECTROPHOTOMETER
 Model: DR5000
 Serial No. (or ID.): 1627845 (RYG_EN0037)
 Manufacturer: HACH
 Condition: In Condition

Certificate No.: C06210159
 Issued Date: 01 April 2021
 Job No.: KSPR2104738
 Page: 1 of 3

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

REVIEW BY: *M.Bamrit*
 APPROVED BY: *D.K.*
 NEXT CAL. DATE: 01/10/22

Environment Condition: Temperature 25.1 °C ± 0.4 °C
 Humidity 48.8 %RH ± 3.7 %RH

Calibration Place: ALS Laboratory Group (Thailand) Co., Ltd. (Rayong Branch) (Wet Chemistry Lab)
 618/10 Moo 5 T.Maenam Khu,
 A.Pluakdaeng, Rayong 21140, Thailand.

Calibration By: Mr. Chattaphon Folthong
 Calibration Date: 01 April 2021
 The Method used: In house method, SPCC-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. 87146 and 87152
 The standard for Photometric Certificate No. 87220 and 87139
 The standard for Stray light Certificate No. 87163 and 87161
 The standard for Spectral resolution Certificate No. 87173

[Signature]
 (Mr. Chattaphon Folthong)
 Person in charge

SERT
 บริษัท เซอร์ติฟายด์ เทคโนโลยี จำกัด
 SPC RT Co., Ltd.

[Signature]
 (Mr. Dumrong Boonsopon)
 Authorized signatory

This certificate is issued in the units of measurement according to the International System of Units (SI). It provides traceability of measurement to international or national standard or other recognized national standard laboratories.
 The measurement uncertainty stated is the expanded uncertainty which is obtained from the standard uncertainty multiplied by the coverage factor (k=2) to provide a level of confidence of approximately 95%. It is determined in accordance with the Guide to Expression of Uncertainty in Measurement (GUM).
 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 SPC RT Co., Ltd.

SEKI CERT. 01/15 6156
 101 RT CO., LTD.
 1154 หมู่ 5 ตำบลนาเกลือ 37 หมู่บ้าน 101 RT CO., LTD. ถนนสุขุมวิท กรุงเทพฯ 10260 Thailand
 1154 หมู่ 5 ตำบลนาเกลือ 37 หมู่บ้าน 101 RT CO., LTD. ถนนสุขุมวิท กรุงเทพฯ 10260 Thailand

Cert.No.: 21P3344
 Page: 2 of 2

Result of calibration: Without adjustment
 Function: Vacuum Pressure Measurement

Range: 0 inHg to -30 inHg
 Scale Interval: 0.5 inHg (The Fifth Estimate)

Increasing Pressure

Applied Pressure (inHg)	0.00	-4.97	-9.97	-14.97	-19.98	-25.02
UUC* Indication (inHg)	0.0	-5.0	-10.0	-15.0	-20.0	-25.0
Error (inHg)	0.00	-0.03	-0.03	-0.03	-0.01	0.02

Decreasing Pressure

Applied Pressure (inHg)	-26.00	-19.97	-14.95	-9.96	-4.97	0.00
UUC* Indication (inHg)	-26.0	-20.0	-15.0	-10.0	-5.0	0.0
Error (inHg)	0.00	-0.03	-0.05	-0.04	-0.03	0.00

The uncertainty of measurement was ± 0.12 inHg

* UUC = Unit Under Calibration

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 %.

-000-

Attopol P.

a 1075036

Certificate No.: C06210159 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	418.4	0.21	0.13
536.66	536.7	-0.04	0.13
637.98	638.3	-0.32	0.14
748.48	748.7	-0.22	0.14
807.03	807.4	-0.37	0.14

Photometric Accuracy (Absorbance)

Wavelength	Standard absorbance	Unit Under Calibration	Correction	Uncertainty
420 nm	0.0000	0.000	0.0000	0.0045
	0.5890	0.590	-0.0010	0.0045
	0.7616	0.762	-0.0004	0.0045
	1.0253	1.027	-0.0007	0.0045
440 nm	0.0000	0.000	0.0000	0.0045
	0.5787	0.579	-0.0003	0.0045
	0.7442	0.744	0.0002	0.0045
	1.0039	1.004	-0.0001	0.0045
465 nm	0.0000	0.000	0.0000	0.0045
	0.5292	0.530	-0.0008	0.0045
	0.6865	0.687	-0.0005	0.0045
	0.9534	0.954	-0.0006	0.0045
546.1 nm	0.0000	0.000	0.0000	0.0045
	0.5468	0.546	0.0008	0.0045
	0.6957	0.695	0.0007	0.0045
	0.9951	0.998	0.0011	0.0045
590 nm	0.0000	0.000	0.0000	0.0045
	0.5851	0.584	0.0011	0.0045
	0.7238	0.723	0.0008	0.0045
	1.0957	1.094	0.0017	0.0045
635 nm	0.0000	0.000	0.0000	0.0045
	0.5692	0.568	0.0012	0.0045
	0.6914	0.691	0.0004	0.0045
	1.0881	1.087	0.0011	0.0045

SEKI CERT. 01/15 6156
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 1154 หมู่ 5 ตำบลนาเกลือ 37 หมู่บ้าน 101 RT CO., LTD. ถนนสุขุมวิท กรุงเทพฯ 10260 Thailand
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Certificate No.: C06210159 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
	0.7307	0.730	0.0007	0.0080
257 nm	0.0000	0.000	0.0000	0.0080
	0.8516	0.850	0.0016	0.0080
313 nm	0.0000	0.000	0.0000	0.0080
	0.2636	0.285	-0.0014	0.0080
350 nm	0.0000	0.000	0.0000	0.0080
	0.6319	0.629	0.0029	0.0080

Stray light *

Standard: cut-off	UUC: Wavelength (nm)	UUC: Transmission (%)	Absorbance (A)
260.57 ± 0.11 nm	260.6	1.5	1.824
392.03 ± 0.11 nm	392.0	1.5	1.824

The stray light transmission reference is less than 1.0 T(%) and absorbance is greater than 2.0 (A)

Spectral Resolution *

Nominal Concentration 0.02 % v/v	Peak	Trough	Ratio	SBW
Standard Wavelength (nm)	268.72	266.76	1.39	2.00
UUC: Wavelength (nm)	268.2	266.1		
Std Absorbance (A)	0.4516	0.2797		
Absorbance (A)	0.416	0.300		

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

The End of Certificate

SEKI CERT. 01/15 6156
 101 RT CO., LTD.
 1154 หมู่ 5 ตำบลนาเกลือ 37 หมู่บ้าน 101 RT CO., LTD. ถนนสุขุมวิท กรุงเทพฯ 10260 Thailand
 1154 หมู่ 5 ตำบลนาเกลือ 37 หมู่บ้าน 101 RT CO., LTD. ถนนสุขุมวิท กรุงเทพฯ 10260 Thailand

เลขที่ใบงาน: KSPR2104738

ชนิดเครื่องมือ: SPECTROPHOTOMETER รุ่น: DR6000

หมายเลขเครื่อง: 1627845

ตรวจสอบ (รับ)		รายการตรวจเช็ค	ตรวจสอบ (ส่ง)		หมายเหตุ
01 Apr 2021			01 Apr 2021		
ปกติ	ไม่ปกติ		ปกติ	ไม่ปกติ	
		<i>General</i>			
<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"/>	
		<i>Spectrophotometer</i>			
<input type="checkbox"/>	<input type="checkbox"/>	6. แรงดันไฟฟ้า (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 type="checkbox"/>	656.1=656.1 nm
<input checked="" type="checkbox"/>	<input type="checkbox"/>	9. แหล่งกำเนิดแสง (UV $< 3,000$ hour)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	10. แหล่งกำเนิดแสง (Visible $< 5,000$ hour)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	11. ช่องวัดหลายตัวอย่าง (Carousel Module)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
		<i>pH Meter and Conductivity Meter</i>			
<input type="checkbox"/>	<input type="checkbox"/>	12. ขั้วไฟฟ้า (Electrode and Connection Cable)	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	<input type="checkbox"/>	ระดับสารละลายใน Electrode (Level KCl)	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	<input type="checkbox"/>	ฝาปิดกันฝุ่น Electrode (Dust Protection Hood)	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	<input type="checkbox"/>	ขาจับขั้วไฟฟ้า (Stand)	<input type="checkbox"/>	<input type="checkbox"/>	
		<i>Turbidimeter</i>			
<input type="checkbox"/>	<input type="checkbox"/>	ค่าความขุ่นที่ต่ำสุด (No Sample)	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	<input type="checkbox"/>	ระดับการส่องสว่างของแสง (≥ 2.5 ไม่นเกิน 3.0)	<input type="checkbox"/>	<input type="checkbox"/>	
		<i>Automatic titrator</i>			
<input type="checkbox"/>	<input type="checkbox"/>	สภาพ Piston Burettes	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	<input type="checkbox"/>	Function Rinsing and Dosing	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	<input type="checkbox"/>	ระบบท่อจ่ายยาและอุปกรณ์ประกอบ	<input type="checkbox"/>	<input type="checkbox"/>	

เพิ่มเติมข้อมูลแนะนำ :

Mr. Chattaphon Folthong
Service Engineer

สำนักงานส่งเสริมการค้าในต่างประเทศ
10 หมู่ 60, LTD.
เลขที่ 00003 1194 หมู่ 60/1 ถนนพหลโยธิน แขวงสามยุค กรุงเทพมหานคร 10260
โทรเลข 00003 1194 Sol Wachiraprasertine St, Suvarnabhumi 101/1 Road Bangkok, Phrasathong Bangkok 10260 Thailand

**J
NAC**

CHECK LIST

CUSTOMER NAME : ALS Laboratory Group (Thailand) Co., Ltd. (บริษัท แอลเอส กรุ๊ป (ประเทศไทย) จำกัด)		
EQUIPMENT NAME : THC Analyzer		
MANUFACTURER : HORIBA	MODEL : APHA-370	SERIAL NO. : U430GTHB

TEST VALUES				
NO.	THC Analyzer (APHA-370)	UNIT	BEFORE	AFTER
1	Signal (THC)	mV	25.60	25.70
2	Signal (CH ₄)	mV	31.90	34.30
3	Detector	Temp °C , Standard Value : Ambient temp(5°C to 15°C) Pressure kPa , Standard Value : (Ambient/1013x100-20)±4kPa	49.50 81.10	47.80 80.80
4	Ambient	kPa current atmospheric pressure	100.70	100.40
5	Purifire	°C , Standard Value : 390 °C to 430 °C kPa , Normal value : 8 kPa to 25 kPa	419.90 10.30	420.00 10.30
6	NMHC	°C , Standard Value : 230 °C to 260 °C	242.90	243.50
7	DC 24 V	V , Standard Value : 24 V ± 0.5 V	23.90	23.90
8	DC 5 V	V , Standard Value : 5 V ± 0.5 V	5.00	5.00
9	Bypass (Optional)	L/min, Normal value : 0.9 L/min ± 0.3 L/min	-	-
10	Over Flow (Optional)	L/min, Standard Value 0.8 L/min or More	-	-
11	CH ₄ Sampling Reading	PPM	2.65	2.02
12	THC Sampling Reading	PPM	0.44	0.54
13	NMHC Sampling Reading	PPM	3.09	2.54
14	Zero Gas CH ₄ /THC	PPM	0.16/0.25	0.00/0.00
15	Sapn Gas	PPM	29.42/29.3	39.99/40.0
G	Gas H ₂ 20/1.300			

อาการที่ตรวจพบ

- เครื่องปอก

รายละเอียดการดำเนินการ

- ๑๓ Check list Analyzer , ใช้ปรับ calibrate Zero/Span และปรับ Calibrate ด้วย Multi Point

ผลการดำเนินงาน

- เครื่องใช้ภายในตู้แช่

CALIBRATED BY: นาย/นายหญิง ปิยะฉัตร
CHECKED BY: นาย/นายหญิง

J NAC DATE : 8/2/64
IRRAWADDI ASSOCIATES CO. LTD. DATE : 8/7/64

ต้องการข้อมูลทางด้านเทคนิคเพิ่มเติม : กรุณาติดต่อฝ่ายบริการลูกค้า โทร 02-868-0812 # 15-16 , E-Mail : Engineer@iransteel.com

เลขที่ 63/14-15 ชุดยพชรเกษม 7 ถนนพชรเกษม แขวงวัดป่าพระ เขตบางกอกใหญ่ กรุงเทพมหานคร 10600 โทร 02-868-0812-13 โทรสาร 02-868-1889

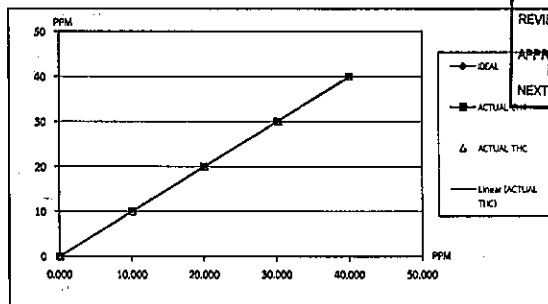


TEST REPORT

CUSTOMER NAME	: ALS Laboratory Group (Thailand) Co., Ltd. (บริษัท แอลเอส กรุ๊ปประเทศไทย จำกัด)		
EQUIPMENT NAME	: THC Analyzer		
MANUFACTURER	: HORIBA	MODEL	: APHA-370
		SERIAL NO	: U430GTH9
STANDARD GAS CONCENTRATION (PPM)	: 506.1 PPM	CYLINDER NO	: CC734373
CYLINDER PRESSURE (psig)	: 1,000 PSI	CERTIFIED DATE	: 12/05/2020
CERTIFIED BY	: AIRGAS	EXPIRED DATE	: 12/05/2028

TEST RESULTS

POINT NO	TEST RESULTS						
	IDEAL	ACTUAL CH4	ERROR CH4	MEANOR CH4	ACTUAL THC	ERROR THC	MEANOR THC
ZERO	0.000	0.000	0.000	-	0.000	0.000	-
1	10.000	10.040	0.040	0.40	10.090	0.090	0.90
2	20.000	20.080	0.080	0.40	20.200	0.200	1.00
3	30.000	30.120	0.120	0.40	30.320	0.320	1.07
4	40.000	39.990	-0.010	-0.02	40.020	0.020	0.05
AVERAGE (%)				0.29	0.75		



CALIBRATED BY: Erin J. [Signature] DATE: 8/2/16
CHECKED BY: [Signature] DATE: 8/7

ห้องการช่างอุตสาหกรรมเทคนิคเพิ่มเติม : เจ้าหน้าที่ฝ่ายบริการลูกค้าขาย, โทร 02-868-0812 พ 15,16 , E-Mail : Engineer@jiranteer.com
นางพ 63/14 15,67/35-36 ถนนเพชรเกษม 7,7/1 แขวงวัดบางพระ เขตดอนเมือง กรุงเทพฯ 10600 โทร 02-8680812-13 โทรสาร 02-868-1889

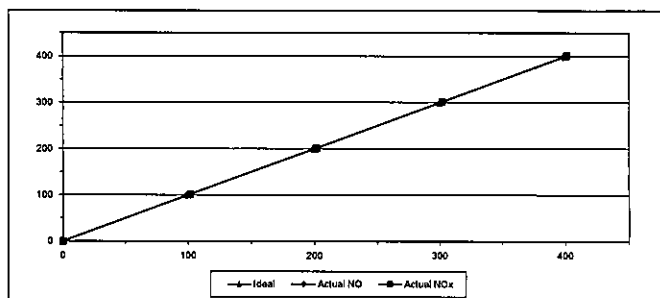
FO-EN-206 801/22-10-14



MULTIPOINT CALIBRATION REPORT

Calibration Date	4-Jan-22	Equipment Name	Nox Analyzer
Manufacturer	HORIBA	Model	APNA-370
Serial No.	ALP0V0WY	Equipment ID	RYQ_F80455
Calibrator Manufacturer	Teledyne API	Model	700
Serial No.	947		
Std. Gas Concentration (PPM)	51.33	Cylinder No.	LL36633
Cylinder Pressure (psi)	1200	Certified By	Airgas Inc.
Certified Date	18-Mar-14	Expired Date	18-Mar-22

Point	CALIBRATION RESULTS						
	Ideal	Actual NO	Error NO	%Error NO	Actual NOx	Error NOx	%Error NOx
ZERO	0.0	0.10	0.10	0.10	0.10	0.10	0.10
1	100.00	98.60	-1.40	-1.40	101.60	1.60	1.60
2	200.00	198.70	-1.30	-0.65	201.40	1.40	0.70
3	300.00	301.00	1.00	0.33	301.80	1.80	0.60
4	400.00	398.20	-1.80	-0.45	401.20	1.20	0.30
	AVERAGE (%)			-0.41			0.58



Calibrated By

Approved By _____

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

(Mr.Sarayuth Jittranont)
Assistant General Manager

EO-FN-207 R01/28-02-14

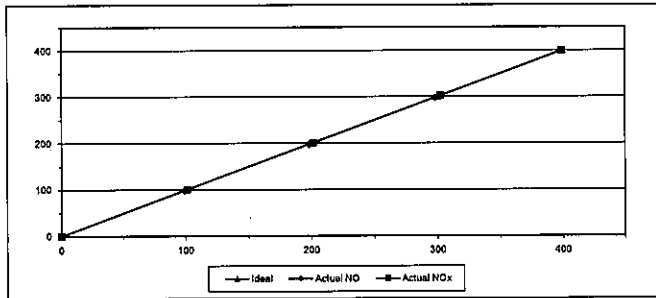
ALS Laboratory Group
FORM NO. F-06-058 REVISION NO. : ISSUE DATE: 02/04/12



MULTIPOINT CALIBRATION REPORT

Calibration Date	4-Jan-22	Equipment Name	NOx Analyzer
Manufacturer	Teledyne API	Model	T200
Serial No.	2198	Equipment ID	RYG_FS0252
Calibrator Manufacturer	Teledyne API	Model	700
Serial No.	947		
Std. Gas Concentration (PPM)	51.33	Cylinder No.	LL38633
Cylinder Pressure (psi)	1200	Certified By	Airgas Inc.
Certified Date	18-Mar-14	Expired Date	18-Mar-22

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



Calibrated By

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

Approved By

(Mr.Sarayuth Jittrantont)
Assistant General Manager

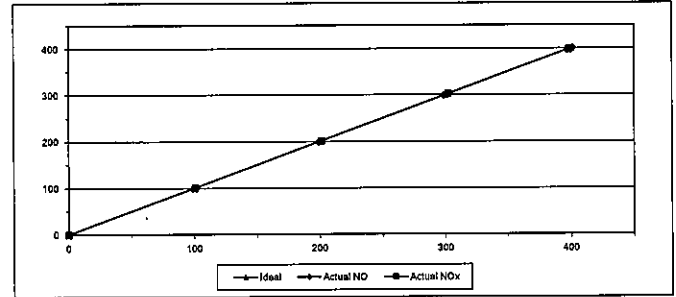
ALS Laboratory Group
FORM NO.: F 06-058 REVISION NO.: - ISSUE DATE: 02/04/12



MULTIPOINT CALIBRATION REPORT

Calibration Date	4-Jan-22	Equipment Name	NOx Analyzer
Manufacturer	HORIBA	Model	APNA-370
Serial No.	148EH0E0	Equipment ID	BKK_FS1084
Calibrator Manufacturer	Teledyne API	Model	700
Serial No.	947		
Std. Gas Concentration (PPM)	51.33	Cylinder No.	LL38633
Cylinder Pressure (psi)	1200	Certified By	Airgas Inc.
Certified Date	18-Mar-14	Expired Date	18-Mar-22

Point	CALIBRATION RESULTS						
	Ideal	Actual NO	Error NO	%Error NO	Actual NOx	Error NOx	%Error NOx
ZERO	0.00	0.10	0.10	0.10	0.10	0.10	0.10
1	100.00	99.00	-1.00	-1.00	100.70	0.70	0.70
2	200.00	199.40	-0.60	-0.30	201.50	1.50	0.75
3	300.00	298.60	-1.40	-0.47	302.30	2.30	0.77
4	400.00	401.40	1.40	0.35	398.00	-2.00	-0.50
AVERAGE (%)				-0.28			0.38



Calibrated By

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

Approved By

(Mr.Sarayuth Jittrantont)
Assistant General Manager

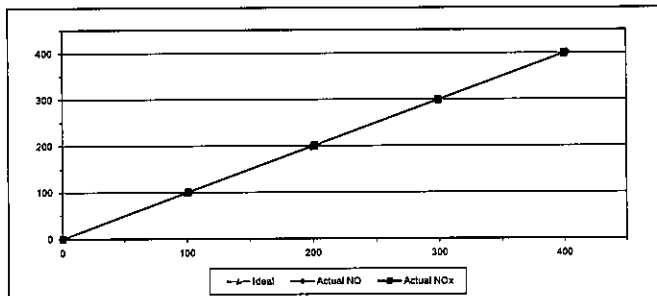
ALS Laboratory Group
FORM NO.: F 06-058 REVISION NO.: - ISSUE DATE: 02/04/12



MULTIPOINT CALIBRATION REPORT

Calibration Date	4-Jan-22	Equipment Name	NOx Analyzer
Manufacturer	HORIBA	Model	APNA-370
Serial No.	H73KYD1M	Equipment ID	BKK_FS0797
Calibrator Manufacturer	Teledyne API	Model	700
Serial No.	947		
Std. Gas Concentration (PPM)	51.33	Cylinder No.	LL38633
Cylinder Pressure (psi)	1200	Certified By	Airgas Inc.
Certified Date	18-Mar-14	Expired Date	18-Mar-22

Point	CALIBRATION RESULTS						
	Ideal	Actual NO	Error NO	%Error NO	Actual NOx	Error NOx	%Error NOx
ZERO	0.00	0.10	0.10	0.10	0.10	0.10	0.10
1	100.00	99.70	-0.30	-0.30	101.00	1.00	1.00
2	200.00	199.60	-1.40	-0.70	201.30	1.30	0.65
3	300.00	299.00	-1.00	-0.33	299.20	-0.80	-0.27
4	400.00	402.10	2.10	0.53	399.50	-0.50	-0.13
AVERAGE (%)				-0.14			0.27



Calibrated By

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

Approved By

(Mr.Sarayuth Jittrantont)
Assistant General Manager

ALS Laboratory Group
FORM NO.: F 06-058 REVISION NO.: - ISSUE DATE: 02/04/12

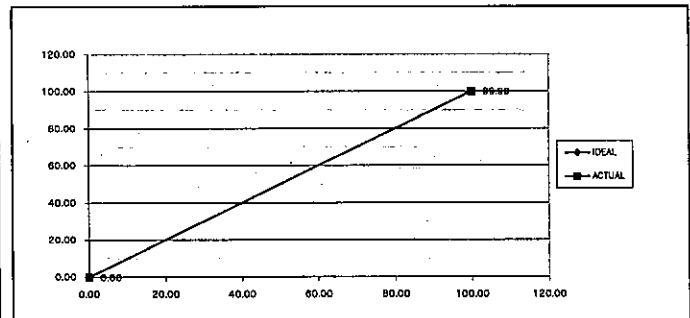


CALIBRATION REPORT

REVIEW BY: <u>Sirach T.</u>	
APPROVED BY: <u>Sirach T.</u>	
NEXT CAL. DATE: <u>01/05/25</u>	
CUSTOMER NAME: ALS Laboratory Group (Thailand) Co., Ltd.	
EQUIPMENT NAME: Total Hydrocarbon Analyzer	
MANUFACTURER: Baseline	MODEL: 9000 NMHC
SERIAL NO: 0314DR0170	
STANDARD GAS CONCENTRATION (PPM): 100 PPM (Methane)	CYLINDER NO: ND55981
CYLINDER PRESSURE (psig): 800 PSI	CERTIFIED DATE: 12/02/2019
CERTIFIED BY: AIRGAS	EXPIRED DATE: 12/02/2021

CALIBRATION RESULTS

POINT NO	CALIBRATION RESULTS			
	IDEAL	ACTUAL	ERROR	%ERROR
ZERO	0.00	0.00	0.00	-
1	100.00	99.80	-0.1	-0.10
AVERAGE (%)				0.02

CALIBRATED BY: สมชายDATE: 9/2/64CHECKED BY: สมชายDATE: 9/2/64

บริษัท นาค จำกัด (มหาชน) : สำนักงานใหญ่ อาคาร 10000 ถนนสุขุมวิท 10000 โทร 02-008-0812-13, E-Mail: Engineer@nacet.co.th
 สาขา 13/14-15, 67/35-36 ถนนสุขุมวิท 7, 7/1 และ 7/11 โทร 02-008-0812-13 โทรสาร 02-008-1888

FD-EN-208 R00/01-08-13

J NAC
JANANITE ASSOCIATES CO., LTD.

CALIBRATION REPORT

CUSTOMER NAME : ALS Laboratory Group (Thailand) Co., Ltd.
EQUIPMENT NAME : Total Hydrocarbon Analyzer
MANUFACTURER : Baseline MODEL : 8000 NMHC SERIAL NO : 0314DR0170
STANDARD GAS CONCENTRATION (PPM) : 100 PPM (Propane) CYLINDER NO : ND55981
CYLINDER PRESSURE (psig) : 800 PSI CERTIFIED DATE : 12/02/2019
CERTIFIED BY : AIRGAS EXPIRED DATE : 12/02/2021

CALIBRATION RESULTS

POINT NO	CALIBRATION RESULTS			
	IDEAL	ACTUAL	ERROR	%ERROR
ZERO	0.00	0.00	0.00	-
1	300.00	299.60	-0.2	-0.07
AVERAGE (%)				0.02

CALIBRATED BY : วิจิตร DATE : 9/2/14
CHECKED BY : Chai DATE : 9/2/14

J NAC
JANANITE ASSOCIATES CO., LTD.

สำหรับข้อมูลการสอบเทียบและใบรับรอง : กรุณาติดต่อฝ่ายบริการลูกค้า โทร 02-858-0812 หรือ E-Mail : Engineer@jnanate.com
เลขที่ 83/14-15, 87/35-36 ถนน เลียบคลอง 7/1 แขวง สีหราชูประสิทธิ์ เขต บางนา กรุงเทพมหานคร 10600 โทร 02-858-0812-13 โทรสาร 02858-1891

FO-EN-208 R00/01-08-13

J NAC
JANANITE ASSOCIATES CO., LTD.

FLOW CALIBRATE

CUSTOMER NAME : ALS Laboratory Group (Thailand) Co., Ltd.
EQUIPMENT NAME : Flow Calibrator
MANUFACTURER : Bios MODEL : 510 L SERIAL NO : 129549

Flow Parameter	Step	Set	Display	Flow Meter
Sample	Before	40	38	38 cc/min
	After	40	39	39 cc/min
Air	Before	175	160	160 cc/min
	After	175	175	175 cc/min
Fuel	Before	35	32	32 cc/min
	After	35	34	34 cc/min

CALIBRATED BY : วิจิตร DATE : 9/2/14
CHECKED BY : Chai DATE : 9/2/14

J NAC
JANANITE ASSOCIATES CO., LTD.

สำหรับข้อมูลการสอบเทียบและใบรับรอง : กรุณาติดต่อฝ่ายบริการลูกค้า โทร 02-858-0812 หรือ E-Mail : Engineer@jnanate.com
เลขที่ 83/14-15, 87/35-36 ถนน เลียบคลอง 7/1 แขวง สีหราชูประสิทธิ์ เขต บางนา กรุงเทพมหานคร 10600 โทร 02-858-0812-13 โทรสาร 02858-1891

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Agilent CrossLab Compliance Services

Certificate of System Qualification

GC-QQ + GCMS-QQ

System ID: RYG_EN0138
Organization Name: ALS Laboratory Group (Thailand) Co Ltd.
Organization Location: Tambol Pluak Daeng, Amphoe Pluak Daeng, Rayong, 21140, Thailand

Date: February 2, 2021 11:38:25 AM
EQP Name: AgilentRecommended, AgilentRecommended
EQP Revision: GC.02.50, GCMS.02.50
Overall Qualification Status: Pass

REVIEW BY: Wich
APPROVED BY: D. E.
NEXT CAL DATE: 02/08/2022

System Inspection and Basic Safety and Operation

Name: 7690
Setpoint Status: Pass

Overall System Inspection and Basic Safety and Operation Test Status
Pass

Inlet Pressure Accuracy

Name: 7690
Front SSL
Setpoint Status: Pass
Inlet Pressure: 25.0 psi Actual: 25.1 psi
Accuracy: 0.1 psi
Agilent Recommended: ≤ 1.2 psi
Overall Inlet Pressure Accuracy Test Status
Pass

GC Oven Temperature Accuracy

Name: 7690

Date: February 2, 2021 11:38:25 AM
System ID: RYG_EN0138

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Agilent CrossLab Compliance Services

Setpoint Status: Pass
Zone: Oven
Setpoint/Actual: 230.0 / 231.3 °C
Temperature: 230.0 231.3 °C
Accuracy: 1.3 °C
Agilent Recommended: ≥ -1.0 °C setpoint in K (-5.0 °C)
≤ 1.0 °C setpoint in K (5.0 °C)

Data for this setpoint was entered manually.

Reason: No Data Logging Software

Setpoint Status: Pass
Zone: Oven
Setpoint/Actual: 100.0 / 99.8 °C
Temperature: 100.0 99.8 °C
Accuracy: -0.2 °C
Agilent Recommended: ≥ -1.0 °C setpoint in K (-3.7 °C)
≤ 1.0 °C setpoint in K (3.7 °C)

Data for this setpoint was entered manually.

Reason: No Data Logging Software

Overall GC Oven Temperature Accuracy Test Status

Pass

GC Oven Temperature Stability

Name: 7690
Setpoint Status: Pass
Setpoint/Average: 100.0 / 99.8 °C
Temperature: 100.0 99.8 °C
Stability: 0.0 °C
Agilent Recommended: ≤ 0.5 °C

Data for this setpoint was entered manually.

Reason: No Data Logging Software

Date: February 2, 2021 11:38:25 AM
System ID: RYG_EN0138

Overall GC Oven Temperature Stability Test Status

Pass

Log Amp

Tested Combination1 Front SSL / External SQ
Name: 5977B
Setpoint Status: Pass

Overall Log Amp Test Status

Pass

RFPA

Tested Combination1 Front SSL / External SQ
Name: 5977B
Setpoint Status: Pass
Amu: 1050 m/z Drift After Five Minutes: 1 mV RFPA Voltage: 475 mV
Agilent Recommended: ≥ -100 and ≤ 100 ≤ 1100

Overall RFPA Test Status

Pass

Tune EI

Tested Combination1 Front SSL / External SQ
Name: 5977B
Setpoint Status: Pass
Filament: 1
Setpoint Status: Pass
Filament: 2

Overall Tune EI Test Status

Pass

Date: February 2, 2021 11:38:25 AM
System ID: RYG_EN0136

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Signal to Noise EI

Tested Combination1 Front SSL / External SQ
Name: 5977B
Source: EI - Extractor Filament: 1
Setpoint Status: Pass
Signal to Noise: 7105
Agilent Recommended: ≥ 1200
Source: EI - Extractor Filament: 2
Setpoint Status: Pass
Signal to Noise: 3440
Agilent Recommended: ≥ 1200

This test's 0 comment(s) and 1 deviation(s) are available in the Attachments section.

Overall Signal to Noise EI Test Status

Pass

Date: February 2, 2021 11:38:25 AM
System ID: RYG_EN0136

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Instrument Details

Purpose

This section describes the as found system configuration.

Details

System

System ID RYG_EN0136
Manufacturer Agilent Technologies
Name 7890

Tested Combination1

Injection Technique Manual Injection
Inlet Front
Detector External
LTM Included? No

Sampler 1

Manufacturer Agilent Technologies
Type Manual Injection
Usage Sample Injection
Syringe Volume (µL) 10

Mainframe 1

Manufacturer Agilent Technologies
Name 7890
Model Number G3442B
Serial Number CN16463236
Firmware Revision B.02.D4.3
Component ID/Asset No. 061117000236
Oven Type Standard

Inlet 1

Manufacturer Agilent Technologies
Name 7890
Type SSL
Location Front
Carrier Gas Helium
Control Type Electronic Pressure Control (EPC)
Purged Inlet Yes

Detector 1

Manufacturer Agilent Technologies
Name Mass Spectrometer
Type Mass Spectrometer
Location External

Mass Spectrometer 1

Manufacturer Agilent Technologies
Type SQ
Name 5977B
Serial Number US1701M009
Firmware Revision 5977 6.00.34
High Vacuum System Turbo Pump
Scouting Run Standard OFN Std
Component ID/Asset No. 061117000236

MS EI Source 1

Manufacturer Agilent Technologies
Source Type EI - Extractor
Number of filaments 2

Date: February 2, 2021 11:38:25 AM
System ID: RYG_EN0136

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Date: February 2, 2021 11:38:25 AM
System ID: RYG_EN0136

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Electronic Signature

Purpose

This signature page was created and published because the ACE sign-off action was executed, which is valid for the entire document, including attachments. The ACE sign-off is an electronic signature that requires two distinct identification components: unique username and personal password. The Agilent representative who has delivered this service understands the meaning and legal status of an electronic signature. As a trained official operator, the Agilent representative has a unique password and login to access ACE and electronically sign this document. (Other e-signatures can be applied to this document using a Document Content Management or other suitable method defined in your data access and control procedures.)

Details

Full Name of Signer: Eaknarin Puangsopa
 Logged On User Name: eaknarin_puangsope@agilent.com
 Signature Creation Date: February 2, 2021
 Reason for Signature: Executed protocol and published this original version of document

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User Name: eaknarin_puangsope
 Hostname: ASRYGHT002

System ID: RYG_EN0136
 Print Date: February 2, 2021 11:38:27 AM

ALS_US1701M008 Transaction log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
February 1, 2021 12:00:51 PM	Auth	Session Created	Session	None
February 1, 2021 12:00:51 PM	Start	Configuration	Session	None
February 1, 2021 12:00:51 PM	Auth	Entitlement	Licensing	User is FAME/Engineer and does not require an unlock code
February 1, 2021 12:00:57 PM	Auth	Ecploded	Session	EOP details for primary technique [GC] - File path: [ProtocolPacks\GC\Conf\G02.50\G02.50.ecp], EOP File Name: [G02.50.ecp], EOP Name: [AgilentRecommended], EOP details for hyphenated technique [GCMS] - File path: [ProtocolPacks\GCMS\Conf\G02.50\G02.50.ecp], EOP File Name: [G02.50.ecp], EOP Name: [AgilentRecommended]
February 1, 2021 12:09:02 PM	End	Configuration	Session	None
February 1, 2021 12:09:06 PM	Start	Qualification	Session	OQ
February 1, 2021 12:09:07 PM	Start	Execution	System Inspection and Basic Safety and Operation - 7890 - Qualitative Test - No setpoints associated	None

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Date: February 2, 2021 11:38:25 AM
 System ID: RYG_EN0136

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Date: February 2, 2021 11:38:25 AM
 System ID: RYG_EN0136

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User Name: eaknarin_puangsope
 Hostname: ASRYGHT002

System ID: RYG_EN0136
 Print Date: February 2, 2021 11:38:27 AM

ALS_US1701M008 Transaction log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
February 1, 2021 12:10:04 PM	End	Execution	System Inspection and Basic Safety and Operation - 7890 - Qualitative Test - No setpoints associated	Run Count: 1
February 1, 2021 12:10:07 PM	Start	Execution	Inlet Pressure Accuracy - Front SSL - Pressure Controlled Inlet - S: 25.0 psi - L: <= 1.2 psi	None
February 1, 2021 12:19:39 PM	End	Execution	Inlet Pressure Accuracy - Front SSL - Pressure Controlled Inlet - S: 25.0 psi - L: <= 1.2 psi	Run Count: 1
February 1, 2021 12:19:42 PM	Start	Execution	GC Oven Temperature Accuracy - 7890 - Temperature : Oven - S: 230.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	None
February 1, 2021 12:28:41 PM	Start	Execution	GC Oven Temperature Accuracy - 7890 - Temperature : Oven - S: 100.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	None
February 1, 2021 12:28:44 PM	Start	Execution	GC Oven Temperature Accuracy - 7890 - Temperature : Oven - S: 230.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	None
February 1, 2021 12:29:32 PM	Auth	Data	GC Oven Temperature Accuracy - 7890 - Temperature : Oven - S: 230.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	Manual Data Entry
February 1, 2021 12:29:38 PM	End	Execution	GC Oven Temperature Accuracy - 7890 - Temperature : Oven - S: 230.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	Run Count: 1
February 1, 2021 12:29:41 PM	Start	Execution	GC Oven Temperature Accuracy - 7890 - Temperature : Oven - S: 100.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	None

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Date: February 2, 2021 11:38:25 AM
 System ID: RYG_EN0136

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User Name: eaknarin_puangsope
 Hostname: ASRYGHT002

System ID: RYG_EN0136
 Print Date: February 2, 2021 11:38:27 AM

ALS_US1701M008 Transaction log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
February 1, 2021 12:37:42 PM	Auth	Data	GC Oven Temperature Accuracy - 7890 - Temperature : Oven - S: 100.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	Manual Data Entry
February 1, 2021 12:37:45 PM	End	Execution	GC Oven Temperature Accuracy - 7890 - Temperature : Oven - S: 100.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	Run Count: 1
February 1, 2021 12:37:51 PM	Start	Execution	GC Oven Temperature Stability - 7890 - Temperature : Oven - S: 100.0°C - L: <= 0.5°C	None
February 1, 2021 1:00:14 PM	Auth	Data	GC Oven Temperature Stability - 7890 - Temperature : Oven - S: 100.0°C - L: <= 0.5°C	Manual Data Entry
February 1, 2021 1:00:24 PM	End	Execution	GC Oven Temperature Stability - 7890 - Temperature : Oven - S: 100.0°C - L: <= 0.5°C	Run Count: 1
February 1, 2021 1:01:19 PM	Auth	AccClosed	Session	None
February 2, 2021 9:04:47 AM	Auth	AccRestricted	Session	None
February 2, 2021 9:04:48 AM	Auth	SessionReloaded	Session	None
February 2, 2021 9:04:51 AM	Start	Qualification	Session	OQ
February 2, 2021 9:05:00 AM	Start	Execution	Log Amp - 5977B SQ - Source: None EI - Extractor	None
February 2, 2021 9:15:19 AM	End	Execution	Log Amp - 5977B SQ - Source: None EI - Extractor	Run Count: 1
February 2, 2021 9:15:21 AM	Start	Execution	RIPA - 5977B SQ - Source: EI - None - Extractor	None

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Date: February 2, 2021 11:38:25 AM
 System ID: RYG_EN0136

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User Name: sahnarin_puangsope
 Hostname: ASRYQW7602
 System ID: RYG_EN0136
 Print Date: February 2, 2021 11:38:27 AM

ALS_U8191M008 Transaction log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
February 2, 2021 9:33:28 AM	End	Execution	RPPA - 58778 SQ - Source: EI - Run Count: 1 - Extractor	
February 2, 2021 9:33:30 AM	Start	Execution	Tune EI - 58778 SQ - Source: - None EI - Extractor Filament 1 (Qualitative - No setpoints associated)	
February 2, 2021 9:35:22 AM	End	Qualification	Session	OQ
February 2, 2021 9:35:32 AM	Start	Reporting	Session	None
February 2, 2021 9:35:31 AM	End	Reporting	Session	None
February 2, 2021 9:53:31 AM	Start	Qualification	Session	OQ
February 2, 2021 9:53:31 AM	Start	Execution	Tune EI - 58778 SQ - Source: - None EI - Extractor Filament 1 (Qualitative - No setpoints associated)	
February 2, 2021 9:53:55 AM	End	Execution	Tune EI - 58778 SQ - Source: - Run Count: 1 EI - Extractor Filament 1 (Qualitative - No setpoints associated)	
February 2, 2021 9:53:57 AM	Start	Execution	Tune EI - 58778 SQ - Source: - None EI - Extractor Filament 2 (Qualitative - No setpoints associated)	
February 2, 2021 9:54:15 AM	End	Qualification	Session	OQ
February 2, 2021 9:54:16 AM	Start	Reporting	Session	None
February 2, 2021 10:04:03 AM	End	Reporting	Session	None

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User Name: sahnarin_puangsope
 Hostname: ASRYQW7602
 System ID: RYG_EN0136
 Print Date: February 2, 2021 11:38:27 AM

ALS_U8191M008 Transaction log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
February 2, 2021 10:04:03 AM	Start	Qualification	Session	OQ
February 2, 2021 10:04:03 AM	Start	Execution	Tune EI - 58778 SQ - Source: - None EI - Extractor Filament 2 (Qualitative - No setpoints associated)	
February 2, 2021 10:04:12 AM	End	Execution	Tune EI - 58778 SQ - Source: - Run Count: 1 EI - Extractor Filament 2 (Qualitative - No setpoints associated)	
February 2, 2021 10:04:14 AM	Start	Execution	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 1 - L: >= 1200	None
February 2, 2021 10:10:50 AM	End	Qualification	Session	OQ
February 2, 2021 10:10:50 AM	Start	Reporting	Session	None
February 2, 2021 10:27:59 AM	End	Reporting	Session	None
February 2, 2021 10:27:59 AM	Start	Qualification	Session	OQ
February 2, 2021 10:27:59 AM	Start	Execution	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 1 - L: >= 1200	None
February 2, 2021 10:43:04 AM	End	Qualification	Session	OQ
February 2, 2021 10:43:04 AM	Start	Reporting	Session	None

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Date: February 2, 2021 11:38:25 AM
 System ID: RYG_EN0136

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Date: February 2, 2021 11:38:25 AM
 System ID: RYG_EN0136

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ROTA METER CALIBRATION RESULT JANUARY 2022

Rotameter ID.	Calibration Date	Regression Result	Coefficient (R ²)
BKK_FS0577	05 Jan 22	Y = 0.9890x + 0.9112	0.9999
BKK_FS0579	05 Jan 22	Y = 1.007x - 0.0269	1.0000
BKK_FS0583	05 Jan 22	Y = 1.0513x + 1.869	0.9997
BKK_FS0584	05 Jan 22	Y = 1.0048x - 1.069	1.0000
BKK_FS0585	05 Jan 22	Y = 1.0076x - 1.1036	0.9999
BKK_FS0586	05 Jan 22	Y = 0.9933x + 3.2655	1.0000
BKK_FS0587	05 Jan 22	Y = 1.0401x - 17.457	0.9996
BKK_FS0588	05 Jan 22	Y = 1.0154x + 4.8357	0.9999
BKK_FS0589	05 Jan 22	Y = 0.9918x + 4.8069	0.9999
BKK_FS0590	05 Jan 22	Y = 0.9881x + 10.07	0.9995
BKK_FS0591	05 Jan 22	Y = 1.0117x - 92.415	0.9995
BKK_FS0592	05 Jan 22	Y = 1.0031x - 69.305	0.9996
BKK_FS0593	05 Jan 22	Y = 1.0131x - 98.198	0.9996
BKK_FS0594	05 Jan 22	Y = 1.0075x - 7.0829	0.9999
BKK_FS0595	05 Jan 22	Y = 1.0249x - 98.162	0.9999
BKK_FS0596	05 Jan 22	Y = 0.9843x - 26.806	0.9991
BKK_FS0597	05 Jan 22	Y = 1.0203x - 122.14	0.9999
BKK_FS1004	04 Jan 22	Y = 0.9651x + 19.648	0.9989
BKK_FS1005	04 Jan 22	Y = 1.0096x + 4.6543	0.9997
BKK_FS1006	04 Jan 22	Y = 1.2188x - 7.1214	0.9994
BKK_FS1007	05 Jan 22	Y = 1.0583x - 1.0812	1.0000
BKK_FS1008	05 Jan 22	Y = 0.9689x + 1.8061	1.0000
BKK_FS1009	05 Jan 22	Y = 1.0132x + 1.1633	0.9990
BKK_FS1010	05 Jan 22	Y = 1.0033x + 0.5758	0.9999
BKK_FS1014	05 Jan 22	Y = 1.0021x + 0.3148	0.9998
BKK_FS1015	05 Jan 22	Y = 0.9994x + 1.768	1.0000
BKK_FS1016	05 Jan 22	Y = 1.0105x - 80.258	0.9998
BKK_FS1017	05 Jan 22	Y = 0.9995x + 0.649	1.0000
BKK_FS1018	05 Jan 22	Y = 1.0011x + 1.1786	1.0000
BKK_FS1019	05 Jan 22	Y = 1.0023x - 65.424	0.9996
BKK_FS1020	05 Jan 22	Y = 0.9887x + 2.8844	0.9999
BKK_FS1021	05 Jan 22	Y = 0.9659x + 1.4905	0.9978
BKK_FS1022	05 Jan 22	Y = 1.022x - 17.957	0.9997
BKK_FS1023	05 Jan 22	Y = 1.0094x + 0.0717	0.9999
BKK_FS1024	05 Jan 22	Y = 1.0042x + 0.4086	0.9997
BKK_FS1025	05 Jan 22	Y = 1.0132x - 88.507	0.9996
BKK_FS1026	05 Jan 22	Y = 0.9902x + 0.9554	1.0000
BKK_FS1027	05 Jan 22	Y = 1.0086x - 2.279	1.0000
BKK_FS1028	05 Jan 22	Y = 1.0105x - 81.055	0.9997



ROTA METER CALIBRATION RESULT JANUARY 2022

Rotameter ID.	Calibration Date	Regression Result	Coefficient (R ²)
BKK_FS1029	05 Jan 22	Y = 0.9935x + 0.8234	1.0000
BKK_FS1030	05 Jan 22	Y = 1.0039x + 0.515	0.9999
BKK_FS1031	05 Jan 22	Y = 1.009x - 79.295	0.9998
BKK_FS1039	04 Jan 22	Y = 0.9916x + 6.1524	0.9998
BKK_FS1040	04 Jan 22	Y = 1.0133x - 10.177	0.9995
BKK_FS1041	04 Jan 22	Y = 1.0805x - 1.7381	0.9998
BKK_FS1042	04 Jan 22	Y = 1.0061x + 1.3405	0.9994
BKK_FS1043	04 Jan 22	Y = 1.0112x - 10.393	0.9999
BKK_FS1044	04 Jan 22	Y = 1.0495x - 1.0136	0.9996
BKK_FS1161	05 Jan 22	Y = 0.9812x + 15571	1.0000
BKK_FS1162	05 Jan 22	Y = 0.9932x + 5.0014	0.9997
BKK_FS1163	05 Jan 22	Y = 1.0082x - 82.062	0.9998
BKK_FS1164	05 Jan 22	Y = 0.9914x + 0.8427	0.9997
BKK_FS1165	05 Jan 22	Y = 0.9893x + 6.5919	0.9999
BKK_FS1166	05 Jan 22	Y = 1.0031x - 77.891	0.9999
RYG_FS0197	04 Jan 22	Y = 1.0088x + 1.7152	0.9998
RYG_FS0198	04 Jan 22	Y = 0.9986x + 18.196	0.9995
RYG_FS0199	04 Jan 22	Y = 1.1202x - 3.5782	0.9999

Review By: Wichan Choonharat
 (Mr. Wichan Choonharat)
 Enviro Field Services Manager

Approved By: (Signature)
 (Mr. Sarayuth Jitranonit)
 Assistant General Manager



ROTA METER CALIBRATION RESULT APRIL 2022

Rotameter ID.	Calibration Date	Regression Result	Coefficient (R ²)
BKK_FS0577	01 Apr 22	$Y = 1.0202x + 0.1876$	1.0000
BKK_FS0579	01 Apr 22	$Y = 1.0076x + 0.4789$	0.9998
BKK_FS0583	01 Apr 22	$Y = 1.016x + 0.3922$	1.0000
BKK_FS0584	01 Apr 22	$Y = 1.0036x + 2.2262$	0.9997
BKK_FS0585	01 Apr 22	$Y = 1.0189x - 5.6476$	0.9997
BKK_FS0588	01 Apr 22	$Y = 1.0095x + 1.1524$	0.9995
BKK_FS0587	01 Apr 22	$Y = 1.013x - 3.6619$	0.9996
BKK_FS0588	01 Apr 22	$Y = 1.0154x + 4.8357$	0.9999
BKK_FS0589	01 Apr 22	$Y = 0.9918x + 4.8069$	0.9999
BKK_FS0590	01 Apr 22	$Y = 1.0038x - 0.4857$	0.9996
BKK_FS0591	01 Apr 22	$Y = 0.9705x - 52.174$	0.9986
BKK_FS0592	01 Apr 22	$Y = 0.9646x - 37.642$	0.9985
BKK_FS0593	01 Apr 22	$Y = 0.9767x - 58.445$	0.9988
BKK_FS0594	01 Apr 22	$Y = 0.9902x - 62.87$	0.9999
BKK_FS0595	01 Apr 22	$Y = 1.0249x - 98.162$	0.9999
BKK_FS0596	01 Apr 22	$Y = 0.9843x - 28.806$	0.9991
BKK_FS0597	01 Apr 22	$Y = 0.9802x - 61.653$	0.9978
BKK_FS1004	01 Apr 22	$Y = 0.9696x + 17.69$	0.9990
BKK_FS1005	01 Apr 22	$Y = 1.0065x + 5.6786$	0.9997
BKK_FS1006	01 Apr 22	$Y = 1.2142x - 7.1037$	0.9993
BKK_FS1007	01 Apr 22	$Y = 0.9917x + 1.6592$	1.0000
BKK_FS1008	01 Apr 22	$Y = 1.0132x + 0.7287$	1.0000
BKK_FS1009	01 Apr 22	$Y = 1.0132x + 1.1633$	0.9960
BKK_FS1010	01 Apr 22	$Y = 1.0033x + 0.5758$	0.9999
BKK_FS1011	01 Apr 22	$Y = 1.0234x + 0.1759$	0.9996
BKK_FS1012	01 Apr 22	$Y = 1.0106x - 2.0048$	0.9997
BKK_FS1013	01 Apr 22	$Y = 0.9677x - 35.851$	0.9997
BKK_FS1014	01 Apr 22	$Y = 1.0021x + 0.3148$	0.9998
BKK_FS1015	01 Apr 22	$Y = 0.9994x + 1.788$	1.0000
BKK_FS1016	01 Apr 22	$Y = 1.0105x - 80.256$	0.9998
BKK_FS1017	01 Apr 22	$Y = 0.9995x + 0.649$	1.0000
BKK_FS1018	01 Apr 22	$Y = 1.0011x + 1.1786$	1.0000
BKK_FS1019	01 Apr 22	$Y = 1.0023x - 68.424$	0.9996
BKK_FS1020	01 Apr 22	$Y = 1.0547x - 0.666$	0.9998
BKK_FS1021	01 Apr 22	$Y = 1.018x - 3.3286$	0.9998
BKK_FS1022	01 Apr 22	$Y = 0.9932x - 57.035$	0.9998
BKK_FS1023	01 Apr 22	$Y = 1.0094x + 0.0717$	0.9999
BKK_FS1024	01 Apr 22	$Y = 1.0042x + 0.4086$	0.9997



ROTA METER CALIBRATION RESULT APRIL 2022

Rotameter ID.	Calibration Date	Regression Result	Coefficient (R ²)
BKK_FS1025	01 Apr 22	$Y = 1.0132x - 88.507$	0.9996
BKK_FS1026	01 Apr 22	$Y = 1.0018x + 1.0776$	0.9997
BKK_FS1027	01 Apr 22	$Y = 1.0053x + 0.231$	0.9995
BKK_FS1028	01 Apr 22	$Y = 0.9792x - 60.312$	0.9982
BKK_FS1029	01 Apr 22	$Y = 0.9935x + 0.8234$	1.0000
BKK_FS1030	01 Apr 22	$Y = 1.0039x + 0.515$	0.9999
BKK_FS1031	01 Apr 22	$Y = 1.008x - 79.295$	0.9998
BKK_FS1039	01 Apr 22	$Y = 0.9868x + 7.8110$	0.9993
BKK_FS1040	01 Apr 22	$Y = 1.0096x - 7.2805$	0.9990
BKK_FS1041	01 Apr 22	$Y = 1.076x - 2.0503$	0.9999
BKK_FS1042	01 Apr 22	$Y = 1.0054x + 1.6095$	0.9995
BKK_FS1043	01 Apr 22	$Y = 1.0108x - 11.048$	0.9999
BKK_FS1044	01 Apr 22	$Y = 1.0468x - 0.9391$	0.9997
BKK_FS1161	01 Apr 22	$Y = 1.0126x + 0.7738$	0.9999
BKK_FS1162	01 Apr 22	$Y = 0.9994x + 2.6357$	0.9995
BKK_FS1163	01 Apr 22	$Y = 0.877x - 55.03$	0.9987
BKK_FS1164	01 Apr 22	$Y = 0.9914x + 0.8427$	0.9997
BKK_FS1165	01 Apr 22	$Y = 0.9893x + 6.5918$	0.9998
BKK_FS1166	01 Apr 22	$Y = 1.0031x - 77.881$	0.9996
RYG_FS0197	01 Apr 22	$Y = 1.0055x + 1.1914$	0.9999
RYG_FS0198	01 Apr 22	$Y = 0.996x + 23.788$	0.9996
RYG_FS0199	01 Apr 22	$Y = 1.1166x - 3.3942$	0.9998

Review By: Wichan Choonharat
(Mr. Wichan Choonharat)
Enviro Field Services Manager

Approved By: (Signature)
(Mr. Sarayuth Jitranont)
Assistant General Manager

Certificate of System Qualification
GC-DQ

System ID: GC-7
Organization Name: ALS Laboratory Groups (Thailand) Co., Ltd.
Organization Location: 104 Phattanakarn 40, Phattanakarn Rd., Suan Luang, Bangkok 10250
Date: January 27, 2022 4:43:18 PM
EQP Name: Agilent Recommended
EQP Revision: GC.02.62
Overall Qualification Status: Pass

REVIEW BY: Suchada T.
APPROVED BY: Saranyat N.
NEXT CAL DATE: 22 Jul 23

CDS Logon Verification - GC

Logon: suchada

Overall CDS Logon Verification - GC Test Status

Pass

System Inspection and Basic Safety and Operation

Name: 7890

Setpoint Status: Pass

Overall System Inspection and Basic Safety and Operation Test Status

Pass

Inlet Pressure Decay

Name: 7890
Front SSL

Setpoint Status: Pass
Pressure: 25.0 psi
Pressure Change: -0.1 psi / 5 minutes
Agilent Recommended: ≥ -2.0 and ≤ 0.5

Overall Inlet Pressure Decay Test Status

Pass

Inlet Pressure Accuracy

Name: 7890
Front SSL
Setpoint Status: Pass
Setpoint: 25.0 psi Actual: 24.9 psi
Accuracy: 0.1 psi
Agilent Recommended: ≤ 1.2

Overall Inlet Pressure Accuracy Test Status

Pass

Inlet Pressure Decay

Name: 7890
Back SSL
Setpoint Status: Pass
Pressure: 25.0 psi
Pressure Change: -0.1 psi / 5 minutes
Agilent Recommended: ≥ -2.0 and ≤ 0.5

Overall Inlet Pressure Decay Test Status

Pass

Inlet Pressure Accuracy

Name: 7890
Back SSL

Setpoint Status: Pass

Inlet Pressure: Setpoint 25.0 psi Actual 25.2 psi
Accuracy: 0.2 psi
Agilent Recommended: ≤ 1.2 psi

Overall Inlet Pressure Accuracy Test Status

Pass

Detector Flow Accuracy

Name: 7890

Front FID

Setpoint Status: Pass

Flow Type: Fuel
Setpoint: 30.0 mL/min Measured Flow: 30.8 mL/min
Accuracy: 0.8 mL/min
Agilent Recommended: ≤ 10.0 % setpoint (3.0 mL/min)
Limit is percentage of setpoint or 0.5 mL/min, whichever is largest.

Setpoint Status: Pass

Flow Type: Oxidizer
Setpoint: 400.0 mL/min Measured Flow: 402.2 mL/min
Accuracy: 2.2 mL/min
Agilent Recommended: ≤ 10.0 % setpoint (40.0 mL/min)
Limit is percentage of setpoint or 0.5 mL/min, whichever is largest.

Setpoint Status: Pass

Flow Type: Makeup
Setpoint: 25.0 mL/min Measured Flow: 24.2 mL/min
Accuracy: 0.8 mL/min
Agilent Recommended: ≤ 10.0 % setpoint (2.5 mL/min)
Limit is percentage of setpoint or 0.5 mL/min, whichever is largest.

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Overall Detector Flow Accuracy Test Status

Pass

Detector Flow Accuracy

Name: 7890

Back FID

Setpoint Status: Pass

Flow Type: Fuel
Setpoint: 30.0 mL/min Measured Flow: 30.3 mL/min
Accuracy: 0.3 mL/min
Agilent Recommended: ≤ 10.0 % setpoint (3.0 mL/min)
Limit is percentage of setpoint or 0.5 mL/min, whichever is largest.

Setpoint Status: Pass

Flow Type: Oxidizer
Setpoint: 400.0 mL/min Measured Flow: 401.3 mL/min
Accuracy: 1.3 mL/min
Agilent Recommended: ≤ 10.0 % setpoint (40.0 mL/min)
Limit is percentage of setpoint or 0.5 mL/min, whichever is largest.

Setpoint Status: Pass

Flow Type: Makeup
Setpoint: 25.0 mL/min Measured Flow: 25.1 mL/min
Accuracy: 0.1 mL/min
Agilent Recommended: ≤ 10.0 % setpoint (2.5 mL/min)
Limit is percentage of setpoint or 0.5 mL/min, whichever is largest.

Overall Detector Flow Accuracy Test Status

Pass

GC Oven Temperature Accuracy

Name: 7890

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Setpoint Status: Pass

Zone: Oven

Temperature: Setpoint/Actual 230.0 / 229.6 °C
Accuracy: 0.5 °C
Agilent Recommended: ≥ -1.0 °C (-5.0 °C)
≤ 1.0 °C (5.0 °C)

Setpoint Status: Pass

Zone: Oven

Temperature: Setpoint/Actual 100.0 / 100.8 °C
Accuracy: 0.8 °C
Agilent Recommended: ≥ -1.0 °C (-3.7 °C)
≤ 1.0 °C (3.7 °C)

Overall GC Oven Temperature Accuracy Test Status

Pass

GC Oven Temperature Stability

Name: 7890

Setpoint Status: Pass

Temperature: Setpoint/Average 100.0 / 100.7887 °C
Stability: 0.3 °C
Agilent Recommended: ≤ 0.5 °C

Overall GC Oven Temperature Stability Test Status

Pass

Scouting Run

Tested Combination1 Front SSL / Front FID

Name: 7693A

Date: January 27, 2022 4:43:16 PM
System ID: GC-7

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Setpoint Status: Completed

Injection Volume on Column: 1.0 µL

Overall Scouting Run Status

Completed

Noise and Drift

Tested Combination1 Front SSL / Front FID

Name: 7890

Setpoint Status: Pass

Base Signal: 13.7 pA

ASTM Noise pA 0.05
Drift pA/hr 0.07
Agilent Recommended: ≤ 0.10 (-3.7 °C)
Status: Pass (3.7 °C)

Overall Noise and Drift Test Status

Pass

Injection Precision

Tested Combination1 Front SSL / Front FID

Name: 7693A

Setpoint Status: Pass

Injection Volume on Column: 1.0 µL

Area RSD: 1.22 % Retention Time RSD: 0.16 %
Agilent Recommended: ≤ 3.00 (-3.7 °C)

Overall Injection Precision Test Status

Pass

Signal to Noise

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Tested Combination1 Front SSL / Front FID

Injection Tower

Name: 7890

Setpoint Status: Pass

Signal to Noise: 828858

Agilent Recommended: >= 300000

Overall Signal to Noise Test Status: Pass

Scouting Run

Tested Combination2 Back SSL / Back FID

Injection Tower

Name: 7693A

Setpoint Status: Completed

Injection Volume on Column: 1.0 uL

Overall Scouting Run Status: Completed

Noise and Drift

Tested Combination2 Back SSL / Back FID

Name: 7890

Setpoint Status: Pass

Base Signal: 12.0 pA

ASTM Noise pA

0.07

Agilent Recommended: <= 0.10

Pass

Drift pA/hr

0.56

Agilent Recommended: <= 2.50

Pass

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Overall Noise and Drift Test Status

Pass

Injection Precision

Tested Combination2 Back SSL / Back FID

Name: 7693A

Setpoint Status: Pass

Injection Volume on Column: 1.0 uL

Area RSD: 0.46 %

Retention Time RSD: 0.00 %

Agilent Recommended: <= 3.00

<= 1.00

Overall Injection Precision Test Status

Pass

Signal to Noise

Tested Combination2 Back SSL / Back FID

Injection Tower

Name: 7890

Setpoint Status: Pass

Signal to Noise: 886824

Agilent Recommended: >= 300000

Overall Signal to Noise Test Status: Pass

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Instrument Details

Purpose

This section describes the as found system configuration.

Details

System

System ID	GC-7
Manufacturer	Agilent Technologies
Name	7890
Flow Data Input	Manual Data
Temperature Data Input	Manual Data or Other Data Logging

Tested Combination1	Injection Tower
Injection Technique	Injection Tower
Sampler Identifier	Sampler 1
Inlet	Front
Detector	Front
LTM Included?	No
Tested Combination2	Injection Tower
Injection Technique	Injection Tower
Sampler Identifier	Sampler 2
Inlet	Back
Detector	Back
LTM Included?	No

Sampler 1	Agilent Technologies
Manufacturer	Agilent Technologies
Type	Injection Tower
Name	7693A
Model Number	G4513A
Serial Number	CN16310209
Firmware Revision	A.11.02
Usage	Sample Injection
Location	Front
Syringe Volume (uL)	10

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Sampler 2

Manufacturer	Agilent Technologies
Type	Injection Tower
Name	7693A
Model Number	G4513A
Serial Number	CN16310204
Firmware Revision	A.11.02
Usage	Sample Injection
Location	Back
Syringe Volume (uL)	10

Sampler 3

Manufacturer	Agilent Technologies
Type	Tray
Name	7693A
Model Number	G4514A
Serial Number	CN13440001
Firmware Revision	A.11.03
Vial Heater	Not installed

Mainframe 1

Manufacturer	Agilent Technologies
Name	7890
Model Number	G3440B
Serial Number	CN16363138
Firmware Revision	B.02.04.2
Component ID/Assat No.	GC-7
Oven Type	Standard

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Inlet 1

Manufacturer: Agilent Technologies
Name: 7890
Type: SSL
Location: Front
Carrier Gas: Helium
Control Type: Electronic Pressure Control (EPC)
Purged Inlet: Yes

Inlet 2

Manufacturer: Agilent Technologies
Name: 7890
Type: SSL
Location: Back
Carrier Gas: Helium
Control Type: Electronic Pressure Control (EPC)
Purged Inlet: Yes

Detector 1

Manufacturer: Agilent Technologies
Name: 7890
Type: FID
Adapter: Capillary
Control Type: Electronic Pressure Control (EPC)
Location: Front
Makeup Gas: Nitrogen

Detector 2

Manufacturer: Agilent Technologies
Name: 7890
Type: FID
Adapter: Capillary
Control Type: Electronic Pressure Control (EPC)
Location: Back
Makeup Gas: Nitrogen

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Electronic Signature

Purpose

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Details

Full Name of Signer: Yarin-ek Sriwitool
Logged On User Name: yarin-ek.sriwitool@agilent.com
Signature Creation Date: January 27, 2022
Reason for Signature: Executed protocol and published this original version of document

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System ID: GC-7

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User Name: yarin-ek.sriwitool
Host Name: A3BKKW1007
Print Date: January 27, 2022 4:43:21 PM
System ID: GC-7

GC-QG Transaction log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
January 27, 2022 2:59:28 PM	Auto	Session Created	Session	None
January 27, 2022 2:59:28 PM	Start	Configuration	Session	None
January 27, 2022 2:59:28 PM	Auto	Entrainment	Licensing	User is Field Engineer and does not require an unlock code
January 27, 2022 3:08:32 PM	Auto	Exp. loaded	Session	EOP details for primary installation (GC) - File path: [Protocol Packs\GC\Config\Instal02.S2\GC_02.S2.asp], EOP File Name: [GC_02.S2.asp], EOP Name: [AgilentRecommended]
January 27, 2022 3:08:41 PM	End	Configuration	Session	None
January 27, 2022 4:00:12 PM	End	Configuration	Session	None
January 27, 2022 4:00:18 PM	Start	Qualification	Session	QC
January 27, 2022 4:00:18 PM	Start	Execution	GC6 Logon Verification - GC 1 - Qualitative test	None
January 27, 2022 4:04:23 PM	End	Execution	GC6 Logon Verification - GC 1 - Qualitative test	Run Count: 1
January 27, 2022 4:04:28 PM	Start	Execution	System Inspection and Basic Safety and Operation - 7890 - Qualitative Test - No sample associated	None
January 27, 2022 4:04:41 PM	End	Execution	System Inspection and Basic Safety and Operation - 7890 - Qualitative Test - No sample associated	Run Count: 1

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Date: January 27, 2022 4:43:18 PM
System ID: GC-7

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User Name: yarin-ek.sriwitool
Host Name: A3BKKW1007
Print Date: January 27, 2022 4:43:21 PM
System ID: GC-7

GC-QG Transaction log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
January 27, 2022 4:04:43 PM	Start	Execution	Inlet Pressure Decay - Front SSL - Pressure Controlled Inlet - S: 25.0 psi - L: >= -2.0 psi and <= 0.5 psi	None
January 27, 2022 4:05:29 PM	Start	Execution	Inlet Pressure Accuracy - Front SSL - Pressure Controlled Inlet - S: 25.0 psi - L: <= 1.2 psi	None
January 27, 2022 4:05:38 PM	Start	Execution	Inlet Pressure Decay - Front SSL - Pressure Controlled Inlet - S: 25.0 psi - L: >= -2.0 psi and <= 0.5 psi	None
January 27, 2022 4:05:51 PM	End	Execution	Inlet Pressure Decay - Front SSL - Pressure Controlled Inlet - S: 25.0 psi - L: >= -2.0 psi and <= 0.5 psi	Run Count: 1
January 27, 2022 4:05:58 PM	Start	Execution	Inlet Pressure Accuracy - Front SSL - Pressure Controlled Inlet - S: 25.0 psi - L: <= 1.2 psi	None
January 27, 2022 4:06:14 PM	End	Execution	Inlet Pressure Accuracy - Front SSL - Pressure Controlled Inlet - S: 25.0 psi - L: <= 1.2 psi	Run Count: 1
January 27, 2022 4:06:17 PM	Start	Execution	Inlet Pressure Decay - Back SSL - Pressure Controlled Inlet - S: 25.0 psi - L: >= -2.0 psi and <= 0.5 psi	None
January 27, 2022 4:06:30 PM	End	Execution	Inlet Pressure Decay - Back SSL - Pressure Controlled Inlet - S: 25.0 psi - L: >= -2.0 psi and <= 0.5 psi	Run Count: 1
January 27, 2022 4:06:32 PM	Start	Execution	Inlet Pressure Accuracy - Back SSL - Pressure Controlled Inlet - S: 25.0 psi - L: <= 1.2 psi	None

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Date: January 27, 2022 4:43:18 PM
System ID: GC-7

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User Name: tam@sk.arkwood
Host Name: ASBKW007
System ID: GC-7
Print Date: January 27, 2022 4:43:21 PM

GC-QC Transaction log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
January 27, 2022 4:06:38 PM	End	Execution	Inlet Pressure Accuracy - Back SBL - Pressure Controlled Inlet - S: 25.0 psi - L: <= 1.2 psi	Run Count: 1
January 27, 2022 4:06:40 PM	Start	Execution	Detector Flow Accuracy - Front FID - Type: Fuel - S: 30.0 mL/min - L: <= 10.0% setpoint	None
January 27, 2022 4:07:18 PM	Audit	Data	Detector Flow Accuracy - Front FID - Type: Fuel - S: 30.0 mL/min - L: <= 10.0% setpoint	Manual Data Entry
January 27, 2022 4:07:20 PM	End	Execution	Detector Flow Accuracy - Front FID - Type: Fuel - S: 30.0 mL/min - L: <= 10.0% setpoint	Run Count: 1
January 27, 2022 4:07:21 PM	Start	Execution	Detector Flow Accuracy - Front FID - Type: Galdizer - S: 400.0 mL/min - L: <= 10.0% setpoint	None
January 27, 2022 4:08:07 PM	Audit	Data	Detector Flow Accuracy - Front FID - Type: Galdizer - S: 400.0 mL/min - L: <= 10.0% setpoint	Manual Data Entry
January 27, 2022 4:08:14 PM	End	Execution	Detector Flow Accuracy - Front FID - Type: Galdizer - S: 400.0 mL/min - L: <= 10.0% setpoint	Run Count: 1
January 27, 2022 4:08:20 PM	Start	Execution	Detector Flow Accuracy - Front FID - Type: Makeup - S: 23.0 mL/min - L: <= 10.0% setpoint	None
January 27, 2022 4:08:37 PM	Audit	Data	Detector Flow Accuracy - Front FID - Type: Makeup - S: 23.0 mL/min - L: <= 10.0% setpoint	Manual Data Entry
January 27, 2022 4:08:47 PM	End	Execution	Detector Flow Accuracy - Front FID - Type: Makeup - S: 23.0 mL/min - L: <= 10.0% setpoint	Run Count: 1
January 27, 2022 4:08:58 PM	Start	Execution	Detector Flow Accuracy - Back FID - Type: Fuel - S: 30.0 mL/min - L: <= 10.0% setpoint	None

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Date: January 27, 2022 4:43:18 PM
System ID: GC-7

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User Name: tam@sk.arkwood
Host Name: ASBKW007
System ID: GC-7
Print Date: January 27, 2022 4:43:21 PM

GC-QC Transaction log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
January 27, 2022 4:09:26 PM	Audit	Data	Detector Flow Accuracy - Back FID - Type: Fuel - S: 30.0 mL/min - L: <= 10.0% setpoint	Manual Data Entry
January 27, 2022 4:09:32 PM	End	Execution	Detector Flow Accuracy - Back FID - Type: Fuel - S: 30.0 mL/min - L: <= 10.0% setpoint	Run Count: 1
January 27, 2022 4:09:34 PM	Start	Execution	Detector Flow Accuracy - Back FID - Type: Galdizer - S: 400.0 mL/min - L: <= 10.0% setpoint	None
January 27, 2022 4:10:01 PM	Audit	Data	Detector Flow Accuracy - Back FID - Type: Galdizer - S: 400.0 mL/min - L: <= 10.0% setpoint	Manual Data Entry
January 27, 2022 4:10:05 PM	End	Execution	Detector Flow Accuracy - Back FID - Type: Galdizer - S: 400.0 mL/min - L: <= 10.0% setpoint	Run Count: 1
January 27, 2022 4:10:06 PM	Start	Execution	Detector Flow Accuracy - Back FID - Type: Makeup - S: 23.0 mL/min - L: <= 10.0% setpoint	None
January 27, 2022 4:10:35 PM	Audit	Data	Detector Flow Accuracy - Back FID - Type: Makeup - S: 23.0 mL/min - L: <= 10.0% setpoint	Manual Data Entry
January 27, 2022 4:10:39 PM	End	Execution	Detector Flow Accuracy - Back FID - Type: Makeup - S: 23.0 mL/min - L: <= 10.0% setpoint	Run Count: 1
January 27, 2022 4:10:42 PM	Start	Execution	GC Oven Temperature Accuracy - 7890 - Temperature : Oven - S: 230.0°C - L: <= +1.0 AND <= 1.0 % setpoint in K	None
January 27, 2022 4:11:22 PM	Audit	Data	GC Oven Temperature Accuracy - 7890 - Temperature : Oven - S: 230.0°C - L: <= +1.0 AND <= 1.0 % setpoint in K	Manual Data Entry

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Date: January 27, 2022 4:43:18 PM
System ID: GC-7

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User Name: tam@sk.arkwood
Host Name: ASBKW007
System ID: GC-7
Print Date: January 27, 2022 4:43:21 PM

GC-QC Transaction log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
January 27, 2022 4:11:26 PM	End	Execution	GC Oven Temperature Accuracy - 7890 - Temperature : Oven - S: 230.0°C - L: <= +1.0 AND <= 1.0 % setpoint in K	Run Count: 1
January 27, 2022 4:11:28 PM	Start	Execution	GC Oven Temperature Accuracy - 7890 - Temperature : Oven - S: 100.0°C - L: <= +1.0 AND <= 1.0 % setpoint in K	None
January 27, 2022 4:12:05 PM	Audit	Data	GC Oven Temperature Accuracy - 7890 - Temperature : Oven - S: 100.0°C - L: <= +1.0 AND <= 1.0 % setpoint in K	Manual Data Entry
January 27, 2022 4:12:07 PM	End	Execution	GC Oven Temperature Accuracy - 7890 - Temperature : Oven - S: 100.0°C - L: <= +1.0 AND <= 1.0 % setpoint in K	Run Count: 1
January 27, 2022 4:12:09 PM	Start	Execution	GC Oven Temperature Stability - 7890 - Temperature : Oven - S: 100.0°C - L: <= 0.5°C	None
January 27, 2022 4:13:36 PM	Audit	Data	GC Oven Temperature Stability - 7890 - Temperature : Oven - S: 100.0°C - L: <= 0.5°C	Manual Data Entry
January 27, 2022 4:13:41 PM	End	Execution	GC Oven Temperature Stability - 7890 - Temperature : Oven - S: 100.0°C - L: <= 0.5°C	Run Count: 1
January 27, 2022 4:13:47 PM	Start	Execution	GC Scouting Run - Injection Tower, Front SBL, Front FID - Part of System Preparation - No limits associated	None

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Date: January 27, 2022 4:43:18 PM
System ID: GC-7

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User Name: tam@sk.arkwood
Host Name: ASBKW007
System ID: GC-7
Print Date: January 27, 2022 4:43:21 PM

GC-QC Transaction log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
January 27, 2022 4:14:45 PM	Audit	Data	GC Scouting Run - Injection Tower, Front SBL, Front FID - Part of System Preparation - No limits associated	Data File Path: C:\Users\Public\Documents\GC-SCOUTING 2022-01-27 14-34-42\SCOUT_F_ID\FID1A.d
January 27, 2022 4:15:36 PM	End	Execution	GC Scouting Run - Injection Tower, Front SBL, Front FID - Part of System Preparation - No limits associated	Run Count: 1
January 27, 2022 4:15:18 PM	Start	Execution	GC Scouting Run - Injection Tower, Back SBL, Back FID - Part of System Preparation - No limits associated	None
January 27, 2022 4:15:25 PM	Audit	Data	GC Scouting Run - Injection Tower, Back SBL, Back FID - Part of System Preparation - No limits associated	Data File Path: C:\Users\Public\Documents\GC-SCOUTING 2022-01-27 14-34-42\SCOUT_B_ID\FID1B.d
January 27, 2022 4:15:38 PM	End	Execution	GC Scouting Run - Injection Tower, Back SBL, Back FID - Part of System Preparation - No limits associated	Run Count: 1
January 27, 2022 4:15:43 PM	Start	Execution	Noise and Drift - Front FID - Detector FID - L (Noise) <= 0.10 pA - L (Drift) <= 2.50 pA/Hz	None
January 27, 2022 4:16:20 PM	Audit	Data	Noise and Drift - Front FID - Detector FID - L (Noise) <= 0.10 pA - L (Drift) <= 2.50 pA/Hz	Data File Path: C:\Users\Public\Documents\GC-SCOUTING 2022-01-27 14-45-01\NOISE_F_ID\FID1A.d

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Date: January 27, 2022 4:43:18 PM
System ID: GC-7

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User Name: jatin@kshilool
Host Name: ASBKKW007
System ID: GC-7
Print Date: January 27, 2022 4:43:21 PM

GC-OQ Transaction Log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
January 27, 2022 4:18:32 PM	End	Execution	Noise and Drift - Front FID - Detector FID - L (Noise) <= 0.10 pA - L (Drift) <= 2.50 pA/hour	Run Count: 1
January 27, 2022 4:18:36 PM	Start	Execution	Noise and Drift - Back FID - Detector FID - L (Noise) <= 0.10 pA - L (Drift) <= 2.50 pA/hour	None
January 27, 2022 4:18:55 PM	Audit	Data	Noise and Drift - Back FID - Detector FID - L (Noise) <= 0.10 pA - L (Drift) <= 2.50 pA/hour	Data File Path: C:\Users\Public\Documents\hensStation\QData\GC02022\NUPRE 2022-01-27 15-15-S1\NUPRE_F3.D\FID 3B.ch
January 27, 2022 4:17:13 PM	End	Execution	Noise and Drift - Back FID - Detector FID - L (Noise) <= 0.10 pA - L (Drift) <= 2.50 pA/hour	Run Count: 1
January 27, 2022 4:17:17 PM	Start	Execution	Injection Precision - Injection Tower, Front SSL, Front FID - GC - L (Area) <= 3.00% - L (Rel. Time) <= 1.00%	None
January 27, 2022 4:19:27 PM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Front FID - GC - L (Area) <= 3.06% - L (Rel. Time) <= 1.00%	Data File Path: C:\Users\Public\Documents\hensStation\QData\GC02022\NUPRE 2022-01-27 15-15-S1\NUPRE_F3.D\FID 1A.ch
January 27, 2022 4:19:27 PM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Front FID - GC - L (Area) <= 3.00% - L (Rel. Time) <= 1.00%	Data File Path: C:\Users\Public\Documents\hensStation\QData\GC02022\NUPRE 2022-01-27 15-15-S1\NUPRE_F3.D\FID 1A.ch

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User Name: jatin@kshilool
Host Name: ASBKKW007
System ID: GC-7
Print Date: January 27, 2022 4:43:21 PM

GC-OQ Transaction Log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
January 27, 2022 4:19:27 PM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Front FID - GC - L (Area) <= 3.00% - L (Rel. Time) <= 1.00%	Data File Path: C:\Users\Public\Documents\hensStation\QData\GC02022\NUPRE 2022-01-27 15-15-S1\NUPRE_F4.D\FID 1A.ch
January 27, 2022 4:19:27 PM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Front FID - GC - L (Area) <= 3.00% - L (Rel. Time) <= 1.00%	Data File Path: C:\Users\Public\Documents\hensStation\QData\GC02022\NUPRE 2022-01-27 15-15-S1\NUPRE_F3.D\FID 1A.ch
January 27, 2022 4:19:27 PM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Front FID - GC - L (Area) <= 3.00% - L (Rel. Time) <= 1.00%	Data File Path: C:\Users\Public\Documents\hensStation\QData\GC02022\NUPRE 2022-01-27 15-15-S1\NUPRE_F4.D\FID 1A.ch
January 27, 2022 4:19:27 PM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Front FID - GC - L (Area) <= 3.00% - L (Rel. Time) <= 1.00%	Data File Path: C:\Users\Public\Documents\hensStation\QData\GC02022\NUPRE 2022-01-27 15-15-S1\NUPRE_F3.D\FID 1A.ch
January 27, 2022 4:19:49 PM	End	Execution	Injection Precision - Injection Tower, Front SSL, Front FID - GC - L (Area) <= 3.03% - L (Rel. Time) <= 1.00%	Run Count: 1
January 27, 2022 4:20:06 PM	Start	Execution	Injection Precision - Injection Tower, Back SSL, Back FID - GC - L (Area) <= 3.00% - L (Rel. Time) <= 1.00%	None

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Date: January 27, 2022 4:43:18 PM
System ID: GC-7

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Date: January 27, 2022 4:43:15 PM
System ID: GC-7

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User Name: jatin@kshilool
Host Name: ASBKKW007
System ID: GC-7
Print Date: January 27, 2022 4:43:21 PM

GC-OQ Transaction Log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
January 27, 2022 4:20:29 PM	Audit	Data	Injection Precision - Injection Tower, Back SSL, Back FID - GC - L (Area) <= 3.00% - L (Rel. Time) <= 1.00%	Data File Path: C:\Users\Public\Documents\hensStation\QData\GC02022\NUPRE 2022-01-27 15-15-S1\NUPRE_B3.D\FID 3B.ch
January 27, 2022 4:20:26 PM	Audit	Data	Injection Precision - Injection Tower, Back SSL, Back FID - GC - L (Area) <= 3.00% - L (Rel. Time) <= 1.00%	Data File Path: C:\Users\Public\Documents\hensStation\QData\GC02022\NUPRE 2022-01-27 15-15-S1\NUPRE_B3.D\FID 3B.ch
January 27, 2022 4:20:26 PM	Audit	Data	Injection Precision - Injection Tower, Back SSL, Back FID - GC - L (Area) <= 3.00% - L (Rel. Time) <= 1.00%	Data File Path: C:\Users\Public\Documents\hensStation\QData\GC02022\NUPRE 2022-01-27 15-15-S1\NUPRE_B4.D\FID 3B.ch
January 27, 2022 4:20:29 PM	Audit	Data	Injection Precision - Injection Tower, Back SSL, Back FID - GC - L (Area) <= 3.00% - L (Rel. Time) <= 1.00%	Data File Path: C:\Users\Public\Documents\hensStation\QData\GC02022\NUPRE 2022-01-27 15-15-S1\NUPRE_B5.D\FID 3B.ch
January 27, 2022 4:20:29 PM	Audit	Data	Injection Precision - Injection Tower, Back SSL, Back FID - GC - L (Area) <= 3.00% - L (Rel. Time) <= 1.00%	Data File Path: C:\Users\Public\Documents\hensStation\QData\GC02022\NUPRE 2022-01-27 15-15-S1\NUPRE_B5.D\FID 3B.ch
January 27, 2022 4:20:29 PM	Audit	Data	Injection Precision - Injection Tower, Back SSL, Back FID - GC - L (Area) <= 3.00% - L (Rel. Time) <= 1.00%	Data File Path: C:\Users\Public\Documents\hensStation\QData\GC02022\NUPRE 2022-01-27 15-15-S1\NUPRE_B7.D\FID 3B.ch

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User Name: jatin@kshilool
Host Name: ASBKKW007
System ID: GC-7
Print Date: January 27, 2022 4:43:21 PM

GC-OQ Transaction Log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
January 27, 2022 4:20:45 PM	End	Execution	Injection Precision - Injection Tower, Back SSL, Back FID - GC - L (Area) <= 3.00% - L (Rel. Time) <= 1.00%	Run Count: 1
January 27, 2022 4:20:51 PM	Start	Execution	Signal to Noise - Injection Tower, Front SSL, Front FID - Detector FID - L >= 30000	None
January 27, 2022 4:21:16 PM	Audit	Data	Signal to Noise - Injection Tower, Front SSL, Front FID - Detector FID - L >= 30000	Data File Path: C:\Users\Public\Documents\hensStation\QData\GC02022\NUPRE 2022-01-27 15-15-S1\NUPRE_F1.D\FID 1A.ch
January 27, 2022 4:21:33 PM	End	Execution	Signal to Noise - Injection Tower, Front SSL, Front FID - Detector FID - L >= 30000	Run Count: 1
January 27, 2022 4:21:59 PM	Start	Execution	Signal to Noise - Injection Tower, Back SSL, Back FID - Detector FID - L >= 30000	None
January 27, 2022 4:21:50 PM	Audit	Data	Signal to Noise - Injection Tower, Back SSL, Back FID - Detector FID - L >= 30000	Data File Path: C:\Users\Public\Documents\hensStation\QData\GC02022\NUPRE 2022-01-27 15-15-S1\NUPRE_F1.D\FID 3B.ch
January 27, 2022 4:22:15 PM	End	Execution	Signal to Noise - Injection Tower, Back SSL, Back FID - Detector FID - L >= 30000	Run Count: 1
January 27, 2022 4:22:52 PM	End	Qualification	Session	OQ
January 27, 2022 4:22:52 PM	Start	Reporting	Session	None

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Date: January 27, 2022 4:43:18 PM
System ID: GC-7

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Date: January 27, 2022 4:43:18 PM
System ID: GC-7

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User Name: tanwuk.s@ranatee.com System ID: GC-7
 Host Name: A58KXW007 Print Date: January 27, 2022 4:43:21 PM

GC-00 Transaction log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
January 27, 2022 4:27:19 PM	Audit	Reporting	Session	Report Generated: Certificate
January 27, 2022 4:27:47 PM	End	Reporting	Session	None
January 27, 2022 4:27:47 PM	Start	Configuration	Session	None
January 27, 2022 4:37:50 PM	End	Configuration	Session	None
January 27, 2022 4:37:50 PM	Start	Qualification	Session	00
January 27, 2022 4:38:41 PM	End	Qualification	Session	00
January 27, 2022 4:38:41 PM	Start	Reporting	Session	None
January 27, 2022 4:41:57 PM	Audit	Reporting	Session	Report Generated: Report
January 27, 2022 4:42:58 PM	Audit	Reporting	Session	Report Signed: Report PDF Name: GC-00_2022127_00 Report_1.pdf User Name: tanwuk.s@ranatee.com Full Name of Signer: Tanwuk Sathit Reason for signature: Essential protocol and published the original version of document

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 Date: January 27, 2022 4:43:18 PM
 System ID: GC-7

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Continuation of Certificate of Calibration Number

 Certificate No: W9-05012022
 Page 2 of 2 Pages
Result of calibration: ☒ Without adjustment ☐ With adjustment
 Calibration in the range of 1 - 10 m/s at a calibration interval of 1 m/s.
 The results of calibration and associated measurement uncertainties are reported in the table below.

V _{ref} Reading m/s	V _{ref} Reading m/s	Error (m/s)	Uncertainty (%)
2.076	2.0	0.1	2.4
4.101	4.1	0.0	1.2
6.099	6.0	0.0	0.95
8.01	8.0	0.0	0.83
10.01	10.1	0.1	0.79
12.01	12.1	0.1	0.67
13.99	14.1	0.1	0.70
15.99	16.4	0.4	0.43
15.00	15.2	0.2	0.79
13.01	13.0	0.0	0.83
11.02	11.2	0.0	0.76
9.03	9.0	0.0	0.81
7.02	7.0	0.0	0.82
5.130	5.1	0.0	0.86
3.091	3.0	0.0	1.5
1.036	0.9	-0.1	4.6

UUC: Unit Under Calibration

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

Appendix 1: Instrumentations

NO	Sensor	Manufacturer	Model/Type	Calibration Date	Certificate Report Number	Range
1	Profi basic	ICSI INC.	CS352143	Aug 07, 2021	MW-0034-21	5 - 30 m/s
2	Precision Differential Pressure Meter	Zorglab	DPW2000	Aug 07, 2021	MW-0034-21	5 - 30 m/s
3	Air velocity transducer (hot wire)	TSI INC.	8450-12	Aug 08, 2021	MW-0035-21	0 - 3 m/s
4	Temperature	Zorglab	DSH-118*	March 30, 2021	CL-027-64	-30 - 70°C
5	Relative humidity	Zorglab	DSH-118*	March 30, 2021	RH-030312021	0 - 100 %RH
6	Atmospheric pressure	Zorglab	DSH-118*	March 30, 2021	DP-010102021	860 - 1100 mPa
7	Wind tunnel	CSSOW	MP3300	-	-	0 - 50 Hz

End of certificate of calibration

CERTIFICATE OF CALIBRATION

 Certificate No: W9-05012022
 Page 1 of 2 pages

Measurement Item : Cup anemometer with data logger.

Manufacturer : Data logger: Novolyne
: Cup anemometer: Novolyne

Model/Type : Data logger: 200-WS-26LB
: Cup anemometer: WS-02F

Serial Number : Data logger: AS190
: Cup anemometer: -

ID No : Data logger: RFD_FS0320
: Cup anemometer: -

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

Test Conditions : Wind tunnel cross test section area 900 cm²
: Anemometer frontal area 100 cm²
: Diameter of mounting pipe 1 mm
: Blockage ratio of test object 0.111 [1]

Test Conditions : Air temperature 23.6 ±0.8 °C
: Air pressure 1014.6 ±0.4 hPa
: Relative air humidity 53.4 ±3.5 %RH

Calibration Procedure : Calibration was carried out base on:
: ISO 61403-12-1 (2011): 2005-POWER Performance Measurements of Electricity Producing Wind Turbines;
: MIDASNET Anemometer Calibration Procedure - Version 2: 2009;

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

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

REVIEW BY: *Manom P.*
 APPROVED BY: *[Signature]*
 NEXT CAL. DATE: *29/4/23*

 Calibrated by
☒ Mr. Soravit Thachalad
☐ Miss Orathai Wasthaisay

 Approved Signatory: *[Signature]*
 Mr. Parinya Booncharoen
 Calibration Department Manager

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

CERTIFICATE OF CALIBRATION

 Certificate No: W9-05012022
 Page 1 of 2 pages

Measurement Item : Wind direction sensor with data logger.

Manufacturer : Data logger: Novolyne
: Wind direction sensor: Novolyne

Model/Type : Data logger: 200-WS-26LB
: Wind direction sensor: WS-02F

Serial Number : Data logger: AS190
: Wind direction sensor: -

ID No : Data logger: RFD_FS0320
: Wind direction sensor: -

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 (23±3) °C and relative humidity of (40±10) %.

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

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

Traceability: The measurement results are traceable to the international system of units (SI) through Certificate No: Q21060014, Certificate No: KW56-4/0026.

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

 Performed by
☒ Mr. Soravit Thachalad
☐ Miss Orathai Wasthaisay

 Approved Signatory: *[Signature]*
 Mr. Parinya Booncharoen
 Calibration Department Manager

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

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

NO	Turning Direction	Nominal Angle (°)	Standard Reading (°)	UUC* Reading (°)	Error (°)	Uncertainty (°)
1	Clockwise	0/360	0	0	0	3.0
2		45	45	43	-2	3.0
3		90	90	90	0	3.0
4		135	135	135	0	3.0
5		180	180	181	1	3.0
6		225	225	227	2	3.0
7		270	270	273	3	3.0
8		315	315	318	3	3.0
9	Counter Clockwise	0/360	0	0	0	3.0
10		45	45	43	-2	3.0
11		90	90	90	0	3.0
12		135	135	136	1	3.0
13		180	180	181	1	3.0
14		225	225	227	2	3.0
15		270	270	273	3	3.0
16		315	315	318	3	3.0

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

End of Certificate of Calibration



CERTIFICATE OF CALIBRATION

Certificate No: WS-11072021
Page 1 of 2 pages

Measurement Item	: Cup anemometer with data logger.
Manufacturer	: Data logger: Novolyne. : Cup anemometer: Novolyne.
Model/Type	: Data logger: 200-WS-20LB. : Cup anemometer: WS-02P.
Serial Number	: Data logger: A5369. : Cup anemometer: -
ID No	: Data logger: RYD_FSD411. : Cup anemometer: -
Customer	: ALS laboratory group (Thailand) Co., Ltd. : 104 Phatthanasak 40, Phatthanasak Rd, Khwaeng Suan Luang, Khet Suan Luang, Bangkok 10250 Thailand.
Test Conditions	: Wind tunnel cross test section area: 900 cm ² : Anemometer frontal area: 100 cm ² : Diameter of mounting pipe: - mm : Blockage ratio of test object: 0.111 [-]
Test Conditions	: Air temperature: 24.5 ±0.5 °C : Air pressure: 1009.3 ±0.4 hPa : Relative air humidity: 55.5 ±3.0 %RH
Calibration Procedure	: Calibration was carried out based on ISO 91400-12-1 (G1): 2005 Power Performance Measurements of Electricity Producing Wind Turbines. : ICAASNET Anemometer Calibration Procedure - Version 2: 2009.
Traceability	: This calibration documents the traceability to national standard, which realize the unit of measurement according to the International system of units (SI) through National Institute of Metrology Thailand (NIMT).
Measurement Date	: Jul 29, 2021.
Issued Date	: Jul 29, 2021.
Calibrated by	<input checked="" type="checkbox"/> Mr. Sorawat Thachetel <input type="checkbox"/> Miss Oranai Witsakulchai
Approved Signatory	 Mr. Panyia Booncharoen Technical Support and Calibration Manager

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

Result of calibration: ☒ Without adjustment ☐ With adjustment.
Calibration in the range of 1 - 10 m/s at a calibration interval of 1 m/s.
The results of calibration and associated measurement uncertainties are reported in table below.

V _{ref} Reading m/s	V _{UUC} Reading m/s	Error (m/s)	Uncertainty (%)
2.064	1.9	-0.2	2.5
4.102	4.1	0.0	1.2
5.97	6.1	0.1	0.97
8.03	8.0	0.0	0.73
10.02	10.1	0.1	0.63
11.99	12.2	0.2	0.52
13.98	14.3	0.3	0.42
15.99	16.3	0.3	0.49
18.00	18.4	0.4	0.45
19.99	20.1	0.1	0.67
21.99	22.1	0.1	0.51
23.99	24.1	0.1	0.63
25.99	26.0	0.0	0.64
27.99	28.1	0.1	1.1
29.99	30.0	0.0	1.9
31.99	32.0	0.0	3.4

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

Appendix 1: Instruments

NO	Sensor	Manufacturer	Model/Type	Calibration Date	Certificate Report Number	Range
1	Pinot glass	TESCO INC.	C632145	July 16, 2020	WW-0035-20	5 - 30 m/s
2	Precision Differential Pressure Meter	Zorgab	DPM25CD	July 16, 2020	WW-0035-20	5 - 30 m/s
3	Air velocity transducer (hot wire)	TB INC.	8455-12	July 20, 2020	WW-0035A-20	0 - 5 m/s
4	Temperature	Zorgab	DSR-THP	March 30, 2021	OL-027-e4	-30 - 70 °C
5	Relative humidity	Zorgab	DSR-THP	March 30, 2021	HA-03032021	0 - 100 %RH
6	Atmospheric pressure	Zorgab	DSR-THP	March 30, 2021	BP-01037021	900 - 1100 hPa
7	Wind tunnel	CSSOV	MP3300	-	-	0 - 50 m/s

End of certificate of calibration



CERTIFICATE OF CALIBRATION

Certificate No: WD-11072021
Page 1 of 2 pages

Measurement Item	: Wind direction sensor with data logger.
Manufacturer	: Data logger: Novolyne. : Wind direction sensor: Novolyne.
Model/Type	: Data logger: 200-WS-20LB. : Wind direction sensor: WS-02P.
Serial Number	: Data logger: A5369. : Wind direction sensor: -
ID No	: Data logger: RYD_FSD411. : Wind direction sensor: -
Customer	: ALS laboratory group (Thailand) Co., Ltd. : 104 Phatthanasak 40, Phatthanasak Rd, Khwaeng Suan Luang, Khet Suan Luang, Bangkok 10250 Thailand.
Environmental Condition	: The measurement was carried out in an ambient temperature of (23±3) °C, and relative humidity of (40±10)%.
Measurement Method	: The wind direction sensor calibration according to comparison method with reference angle measurement electronic theodolite and line laser is used for axis control. The measurement were taken at 45° intervals in clockwise and counterclockwise directions.
Note	: The UUC was waited up for 1 hour prior to the calibration being performed.
Traceability	: The measurement results are traceable to the international system of units (SI) through Certificate No: CC563-07-0045, Certificate No: RW963/0044.
Measurement Date	: Jul 29, 2021.
Issued Date	: Jul 29, 2021.
Performed by	<input checked="" type="checkbox"/> Mr. Sorawat Thachetel <input type="checkbox"/> Miss Oranai Witsakulchai
Approved Signatory	 Mr. Panyia Booncharoen Technical Support and Calibration Manager

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Continuation of Certificate of Calibration Number

Certificate No: WD-11072021
Page 2 of 2 pages

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

NO	Turning Direction	Nominal Angle (°)	Standard Reading (°)	UUC* Reading (°)	Error (°)	Uncertainty ±(°)
1	Clockwise	0/360	360	359	-1	3.0
2		45	45	42	-3	3.0
3		90	90	87	-3	3.0
4		135	135	132	-3	3.0
5		180	180	180	0	3.0
6		225	225	228	3	3.0
7		270	270	273	3	3.0
8		315	315	318	3	3.0
9	Counter Clockwise	0/360	360	359	-1	3.0
10		45	45	42	-3	3.0
11		90	90	87	-3	3.0
12		135	135	132	-3	3.0
13		180	180	180	0	3.0
14		225	225	228	3	3.0
15		270	270	273	3	3.0
16		315	315	318	3	3.0

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

End of Certificate of Calibration



CERTIFICATE OF CALIBRATION

Certificate No: WS-13072021
Page 1 of 2 pages

Measurement Item	: Cup anemometer with data logger.
Manufacturer	: Data logger: Novolyne. : Cup anemometer: Novolyne.
Model/Type	: Data logger: 200-WS-25LB. : Cup anemometer: WS-02P.
Serial Number	: Data logger: A5375. : Cup anemometer: -
ID No	: Data logger: RY0_F80413. : Cup anemometer: -
Customer	: A/S laboratory group (Thailand) Co. Ltd. : 104 Phatthanakan 40, Phatthanakan Rd, Khwaeng Suan Luang, Khet Suan Luang, Bangkok 10250 Thailand.
Test Conditions	: Wind tunnel cross test section area: 900 cm ² : Anemometer frontal area: 100 cm ² : Diameter of mounting pipe: - mm : Rackage ratio of test object: 0.111 [-]
Test Conditions	: Air temperature: 24.6 ±0.6 °C : Air pressure: 1007.4 ±0.4 hPa : Relative air humidity: 62.4 ±3.5 %RH

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

Calibration Procedure: Calibration was carried out base on:
ISO 91400-12-1 Ed.1: 2005-Performance Measurements of Directly Producing Wind Turbines
JAS-NDT Anemometer Calibration Procedure - Version 2: 2009.

Traceability: This calibration documents are traceable to national standard, which realize the unit of measurements according to the International system of units (SI) through National Institute of Metrology Thailand (NIMT).

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

Calibrated by:
☒ Mr. Sornchai Thachetad
☐ Miss Orathai Witsakanya



Approved Signatory: *[Signature]*
Mr. Parinya Booncharoen
Technical Support
and Calibration Manager

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Continuation of Certificate of Calibration Number

Certificate No: WS-13072021
Page 2 of 2 Pages

Result of calibration: ☒ Without adjustment ☐ With adjustment
Calibration in the range of 1 - 16 m/s at a calibration interval of 1 m/s.
The results of calibration and associated measurement uncertainties are reported in the table below.

Velo Reading m/s	VUC* Reading m/s	Error (m/s)	Uncertainty (m/s)
2.067	2.0	-0.1	2.4
4.138	4.1	0.0	1.2
6.03	6.1	0.1	0.97
7.99	8.0	0.0	0.84
10.00	10.1	0.1	0.69
12.03	12.2	0.2	0.79
13.99	14.3	0.3	0.47
15.98	16.4	0.4	0.35
16.03	16.3	0.3	0.38
12.29	13.1	0.1	0.69
11.01	11.1	0.1	0.57
9.01	9.0	0.0	0.67
6.99	7.1	0.1	0.81
5.177	5.1	-0.1	0.97
2.072	2.1	0.1	1.6
1.044	0.9	-0.1	5.3

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

Appendix 1: Instrumentation

NO	Sensor	Manufacturer	Model/Type	Calibration Date	Certificate Report Number	Range
1	Flow wire	TECOT INC	06302145	July 16, 2020	MY-0035-20	5 - 30 m/s
2	Precision Differential Pressure Meter	Zorgat	DPA2500	July 16, 2020	MY-0035-20	5 - 30 m/s
3	Air velocity transducer (hot wire)	TSI INC	8435-12	July 20, 2020	MY-0036A4-20	0 - 5 m/s
4	Temperature	Zorgat	DC1011H	March 30, 2021	CL-027-04	-30 - 70 °C
5	Relative humidity	Zorgat	DS50-10P	March 30, 2021	RI-0333-2021	0 - 100 %RH
6	Atmospheric pressure	Zorgat	DCA-TM	March 30, 2021	RI-0105-2021	500 - 1100 mPa
7	Wind tunnel	CS50V	WFS300			0 - 30 m/s

End of certificate of calibration



CERTIFICATE OF CALIBRATION

Certificate No: WD-13072021
Page 1 of 2 pages

Measurement Item	: Wind direction sensor with data logger.
Manufacturer	: Data logger: Novolyne. : Wind direction sensor: Novolyne.
Model/Type	: Data logger: 200-WS-25LB. : Wind direction sensor: WS-02P.
Serial Number	: Data logger: A5375. : Wind direction sensor: -
ID No	: Data logger: RY0_F80413. : Wind direction sensor: -
Customer	: A/S 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 (23±3)°C, and relative humidity of (40±10)%.

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

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

Traceability: The measurement results are traceable to the International system of units (SI) through Certificate No: DC563-07-0045.
Certificate No: KWS63/0044.

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

Performed by:
☒ Mr. Sornchai Thachetad
☐ Miss Orathai Witsakanya



Approved Signatory: *[Signature]*
Mr. Parinya Booncharoen
Technical Support
and Calibration Manager

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Continuation of Certificate of Calibration Number

Certificate No: WD-13072021
Page 2 of 2 pages

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

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

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

End of Certificate of Calibration



CERTIFICATE OF CALIBRATION

Certificate No: WS-12072021
Page 1 of 2 pages

Measurement Item	: Cup anemometer with data logger.
Manufacturer	: Data logger: Novalyx. : Cup anemometer: Novalyx.
Model/Type	: Data logger: 200-WS-25LB. : Cup anemometer: WS-02F.
Serial Number	: Data logger: A5374. : Cup anemometer: -
ID No	: Data logger: RY0_F50412 : Cup anemometer: -
Customer	: ALS laboratory group (Thailand) Co., Ltd. : 104 Phatthanakan 43, Phatthanakan Rd, Khwaeng Suan Luang, Khet Suan Luang, Bangkok 10250 Thailand.
Test Conditions	: Wind tunnel cross test section area: 900 cm ² : Anemometer frontal area: 100 cm ² : Diameter of mounting pipe: - mm : Blockage ratio of test object: 0.111 H
Test Conditions	: Air temperature: 23.9 ±0.8 °C : Air pressure: 1037.7 ±0.4 hPa : Relative air humidity: 57.7 ±3.5 %RH

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

Calibration Procedure : Calibration was carried out base on:
IEC 61400-12-1 ED.1: 2005 Power Performance Measurements of Electricity Producing Wind Turbines
MIDASNET Anemometer Calibration Procedure - Version 2: 2009.

Traceability : This calibration documents the traceable to national standard, which realize the unit of measurements according to the international system of units (SI) through National Institute of Metrology Thailand (NIMT).

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

Calibrated by:
☒ Mr. Sorawit Thachwad
☐ Miss Orathai Waiwattayee



Approved Signatory: *[Signature]*
Mr. Parinya Booncharoen
Technical Support
and Calibration Manager

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Continuation of Certificate of Calibration Number

Certificate No: WS-12072021
Page 2 of 2 Pages

Result of calibration: ☒ Without adjustment ☐ With adjustment
Calibration in the range of 1 - 16 m/s at a calibration interval of 1 m/s.
The results of calibration and associated measurement uncertainties are reported in the table below.

V _{ref} Reading m/s	V _{UUC} Reading m/s	Error (m/s)	Uncertainty (m/s)
2.075	2.0	-0.1	2.6
4.160	4.1	-0.1	1.3
6.245	6.2	0.0	0.8
8.330	8.3	0.1	0.65
10.415	10.4	0.1	0.77
12.500	12.5	0.2	0.65
14.585	14.5	0.3	0.41
16.670	16.4	0.4	0.59
18.755	18.3	0.5	0.49
20.840	20.2	0.6	0.51
22.925	22.1	0.1	0.52
25.010	25.0	0.0	0.97
27.095	27.0	0.0	0.81
29.180	29.1	-0.1	0.68
31.265	31.1	0.1	1.7
33.350	33.0	-0.1	5.4

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

Appendix 1: Instrumentations

NO	Sensor	Manufacturer	Model/Type	Calibration Date	Certificate Report Number	Range
1	Flow static	TEBTO INC.	06352143	July 16, 2020	MX-0035-20	5 - 30 m/s
2	Precision Differential Pressure Meter	Zepab	CPM2500	July 16, 2020	MX-0035-20	5 - 30 m/s
3	Air velocity transducer (hot wire)	TGI INC.	8455-12	July 20, 2020	MX-0035A-20	0 - 5 m/s
4	Temperature	Zepab	DPR-TMP	March 30, 2021	OL-027-64	30 - 70°C
5	Relative humidity	Zepab	DGR-TMP	March 30, 2021	RH-03032021	0 - 100 %RH
6	Atmospheric pressure	Zepab	DGR-TMP	March 30, 2021	BPG1032021	500 - 1100 mPa
7	Wind tunnel	CSSOM	MP33CD	-	-	0 - 20 Hz

End of certificate of calibration



CERTIFICATE OF CALIBRATION

Certificate No: WD-12072021
Page 1 of 2 pages

Measurement Item	: Wind direction sensor with data logger.
Manufacturer	: Data logger: Novalyx. : Wind direction sensor: Novalyx.
Model/Type	: Data logger: 200-WS-25LB. : Wind direction sensor: WS-02F.
Serial Number	: Data logger: A5374. : Wind direction sensor: -
ID No	: Data logger: RY0_F50412. : Wind direction sensor: -
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 (23±3)°C and relative humidity of (60±10)%.

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

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

Traceability:
The measurement results are traceable to the international system of units (SI) through Certificate No: C0563-07-0045, Certificate No: KWS63/0044.

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

Performed by:
☒ Mr. Sorawit Thachwad
☐ Miss Orathai Waiwattayee



Approved Signatory: *[Signature]*
Mr. Parinya Booncharoen
Technical Support
and Calibration Manager

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Continuation of Certificate of Calibration Number

Certificate No: WD-12072021
Page 2 of 2 pages

Result of calibration: ☐ Without adjustment ☒ With adjustment.

Calibration in the range of 0 - 360 ° at a calibration interval of 45°.

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

NO	Turning Direction	Nominal Angle (°)	Standard Reading (°)	UUC* Reading (°)	Error (°)	Uncertainty ±(°)
1	Clockwise	0/360	360	359	-1	3.0
2		45	45	42	-3	3.0
3		90	90	87	-3	3.0
4		135	135	133	-2	3.0
5		180	180	178	-2	3.0
6		225	225	226	1	3.0
7		270	270	273	3	3.0
8		315	315	316	1	3.0
9	Counter Clockwise	0/360	360	359	-1	3.0
10		45	45	42	-3	3.0
11		90	90	87	-3	3.0
12		135	135	133	-2	3.0
13		180	180	178	-2	3.0
14		225	225	226	1	3.0
15		270	270	273	3	3.0
16		315	315	316	1	3.0

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

End of Certificate of Calibration



CERTIFICATE OF CALIBRATION

Certificate No: WS-01102021
Page 1 of 2 pages

Measurement Item : Cup anemometer with data logger.

Manufacturer : Data logger: Novatyns.
Cup anemometer: Novatyns.

Model/Type : Data logger: 200-WS-250L
Cup anemometer: WS-02P

Serial Number : Data logger: A4985
Cup anemometer: -

ID No : Data logger: RFD_F50085
Cup anemometer: -

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

Test Conditions : Wind tunnel cross test section area 900 cm²
Anemometer frontal area 100 cm²
Diameter of mounting pipe - mm
Blockage ratio of test object 0.111 [-]

Test Conditions : Air temperature 24.0 ±0.8 °C
Air pressure 1008.1 ±0.4 hPa
Relative air humidity 58.1 ±3.5 %RH

Calibration Procedure : Calibration was carried out base on:
ISO 91400-12-1 GDI: 2005 Power Performance Measurements of Directly Producing Wind Turbines.
MGSNET Anemometer Calibration Procedure - Version 2: 2009.

Traceability : This calibration documents the traceable to national standard, which realize the unit of measurements according to the international system of units (SI) through National Institute of Metrology Thailand (NIMT).

Measurement Date : Oct 08, 2021.
Issued Date : Oct 11, 2021.

Calibrated by:
☒ Mr. Sorawat Thachad
☐ Miss Orathai Wathakulwong



Approved Signatory:
Mr. Perinya Booncharoen
Technical Support
and Calibration Manager

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Continuation of Certificate of Calibration Number

Certificate No: WS-01102021
Page 2 of 2 pages

Result of calibration: ☒ Without adjustment ☐ With adjustment.

Calibration in the range of 3 - 16 m/s at a calibration interval of 1 m/s.

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

V _{ref} Reading m/s	V _{unc} Reading m/s	Error (m/s)	Uncertainty (K)
2.049	1.9	-0.1	2.7
4.103	4.0	-0.1	1.3
6.01	6.0	0.0	1.1
8.01	8.0	0.0	0.99
9.99	10.0	0.0	1.0
11.99	12.1	0.1	0.64
13.98	14.1	0.1	0.55
16.02	16.2	0.2	0.40
18.03	18.2	0.2	0.78
19.99	19.1	-0.1	0.61
21.03	21.0	0.0	1.1
23.03	23.0	0.0	0.70
25.02	25.0	0.0	0.84
27.02	27.0	0.0	0.98
29.04	29.0	0.0	1.7
31.03	31.0	0.0	4.5

UUC*: Unit Under Calibration

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

Appendix 1: Instrumentation

NO	Sensor	Manufacturer	Model/Type	Calibration Date	Certificate Report Number	Range
1	Plot scale	TCSTO INC	03302145	Aug 07, 2021	MM-0034-21	5 - 30 m/s
2	Precision Differential Pressure Meter	Zepha	DPW2500	Aug 07, 2021	MM-0034-21	5 - 30 m/s
3	AI velocity transducer (hot wire)	TB INC	8455-12	Aug 08, 2021	MM-0035-21	0 - 5 m/s
4	Temperature	Zepha	DSN-T10	March 30, 2021	CL-027-04	30 - 70°C
5	Relative humidity	Zepha	DSN-T10	March 30, 2021	PL-03032021	0 - 100 %RH
6	Atmospheric pressure	Zepha	DSN-T10	March 30, 2021	PL-03032021	500 - 1100 hPa
7	Wind tunnel	CSOOW	WP3200	-	-	0 - 80 Hz

End of certificate of calibration



CERTIFICATE OF CALIBRATION

Certificate No: WD-01102021
Page 1 of 2 pages

Measurement Item : Wind direction sensor with data logger.

Manufacturer : Data logger: Novatyns.
Wind direction sensor: Novatyns.

Model/Type : Data logger: 200-WS-250L
Wind direction sensor: WS-02P

Serial Number : Data logger: A4985
Wind direction sensor: -

ID No : Data logger: RFD_F50085
Wind direction sensor: -

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 (23±3) °C, and relative humidity of (40±10) %.

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

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

Traceability:
The measurement results are traceable to the international system of units (SI) through Certificate No: CC563-07-0045, Certificate No: KW564/0025.

Measurement Date : Oct 08, 2021.
Issued Date : Oct 11, 2021.

Performed by:
☒ Mr. Sorawat Thachad
☐ Miss Orathai Wathakulwong



Approved Signatory:
Mr. Perinya Booncharoen
Technical Support
and Calibration Manager

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Continuation of Certificate of Calibration Number

Certificate No: WD-01102021
Page 2 of 2 pages

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

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

NO	Turning Direction	Nominal Angle (°)	Standard Reading (°)	UUC* Reading (°)	Error (°)	Uncertainty ±(°)
1	Clockwise	0/360	360	359	-1	3.0
2		45	45	42	-3	3.0
3		90	90	88	-2	3.0
4		135	135	135	0	3.0
5		180	180	182	2	3.0
6		225	225	226	1	3.0
7		270	270	273	3	3.0
8		315	315	318	3	3.0
9	Counter Clockwise	0/360	360	359	-1	3.0
10		45	45	42	-3	3.0
11		90	90	88	-2	3.0
12		135	135	135	0	3.0
13		180	180	182	2	3.0
14		225	225	226	1	3.0
15		270	270	273	3	3.0
16		315	315	318	3	3.0

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

End of Certificate of Calibration



CERTIFICATE OF CALIBRATION

Certificate No: WS-12072021
Page 1 of 2 pages

Measurement Item : Cup anemometer with data logger.

Manufacturer : Data logger Novalyx
: Cup anemometer Novalyx.

Model/Type : Data logger: 200-WB-25LB
: Cup anemometer: WS-02F.

Serial Number : Data logger: A5374.
: Cup anemometer: -

ID No : Data logger: RY0_F50412.
: Cup anemometer: -

Customer : ALS laboratory group (Thailand) co., Ltd.
: 104 Phatthana 43, Phatthana Rd, Khwaeng Suan Luang, Khet Suan Luang, Bangkok 10250 Thailand.

Test Conditions : Wind tunnel cross test section area 900 cm²
: Anemometer frontal area 100 cm²
: Diameter of mounting pipe 1 mm
: Blockage ratio of test object 0.111 [%]

Test Conditions : Air temperature 23.9 ±0.8 °C
: Air pressure 1007.7 ±0.4 hPa
: Relative air humidity 57.7 ±3.5 %RH

Calibration Procedure : Calibration was carried out base on:
: IEC 61403-12-1 Ed.1: 2008 Power Performance Measurements of Electricity Producing Wind Turbines
: IECASCT Anemometer Calibration Procedure - Version 2: 2009.

Traceability : This calibration documents the traceable to national standard, which realize the unit of measurement according to the International system of units (SI) through National Institute of Metrology Thailand (NIMT).

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

Calculated by :
☒ Mr. Sorawit Thachad
☐ Miss Ornlha Witsakulchai



Approved Signatory:
Mr. Parinya Booncharoen
Technical Support
and Calibration Manager

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Continuation of Certificate of Calibration Number

Certificate No: WD-12072021
Page 2 of 2 Pages

Result of calibration: ☒ Without adjustment ☐ With adjustment
Calibration in the range of 1 - 16 m/s at a calibration interval of 1 m/s.

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

V _{std} Reading m/s	V _{UUC} Reading m/s	Error (m/s)	Uncertainty (m/s)
2.075	2.0	-0.1	2.5
4.150	4.1	-0.1	1.3
5.98	6.0	0.0	0.98
8.01	8.1	0.1	0.66
10.03	10.1	0.1	0.77
12.02	12.2	0.2	0.65
13.96	14.3	0.3	0.41
16.03	16.4	0.4	0.59
14.98	15.3	0.3	0.49
13.00	13.2	0.2	0.51
11.01	11.1	0.1	0.52
8.97	9.0	0.0	0.97
7.01	7.0	0.0	0.51
5.195	5.1	-0.1	0.98
2.980	3.1	0.1	1.7
1.037	0.9	-0.1	5.4

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

Appendix 1: Instrumentation

NO	Sensor	Manufacturer	Model/Type	Calibration Date	Certificate Report Number	Range
1	Pressure	TECOT INC	DS352143	July 16, 2020	MA-0035-20	5 - 30 mPa
2	Precision Differential Pressure Meter	Zorgab	DM42500	July 16, 2020	MA-0035-20	5 - 30 mPa
3	Air velocity transducer (hot wire)	TGI INC	6455-12	July 20, 2020	MA-0035-20	0 - 5 m/s
4	Temperature	Zorgab	DSR-RTP	March 30, 2021	CL-027-04	-30 - 70°C
5	Relative Humidity	Zorgab	DSR-RTP	March 30, 2021	RI-03032021	0 - 100 %RH
6	Atmospheric pressure	Zorgab	DSR-RTP	March 30, 2021	BP-01032021	500 - 1100 hPa
7	Wind tunnel	PSDOM	MP33CD			0 - 80 Hz

End of certificate of calibration



CERTIFICATE OF CALIBRATION

Certificate No: WD-12072021
Page 1 of 2 pages

Measurement Item : Wind direction sensor with data logger.

Manufacturer : Data logger Novalyx
: Wind direction sensor: Novalyx.

Model/Type : Data logger: 200-WB-25LB
: Wind direction sensor: WS-02F.

Serial Number : Data logger: A5374.
: Wind direction sensor: -

ID No : Data logger: RY0_F50412.
: Wind direction sensor: -

Customer : ALS laboratory group (Thailand) Co.Ltd.
: 104 Phatthana 43, Phatthana Rd, Khwaeng Suan Luang, Khet Suan Luang, Bangkok 10250 Thailand.

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

Measurement Method:

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

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

Traceability:

The measurement results are traceable to the International system of units (SI) through Certificate No: 00563-07-0045, Certificate No: KWS63/0044.

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

Performed by :
☒ Mr. Sorawit Thachad
☐ Miss Ornlha Witsakulchai



Approved Signatory:
Mr. Parinya Booncharoen
Technical Support
and Calibration Manager

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Continuation of Certificate of Calibration Number

Certificate No: WD-12672021
Page 2 of 2 pages

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

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

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

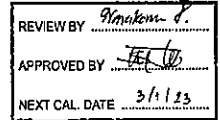
End of Certificate of Calibration



CERTIFICATE OF CALIBRATION

Certificate No: WS 01072021
Page 1 of 2 pages

Measurement Item	: Cup anemometer with data logger.	
Manufacturer	: Data logger: Novatynx. : Cup anemometer: Novatynx.	
Model/Type	: Data logger: I1D-WS-16N. : Cup anemometer: WS-02C.	
Serial Number	: Data logger: I155. : Cup anemometer: -.	
ID No	: Data logger: RYD_F800B1. : Cup anemometer: -.	
Customer	: ALS laboratory group (Thailand) Co. Ltd. : 104 Phatthanasen 40, Phatthanasen Rd, Khwaeng Suan Luang, Khet Suan Luang, Bangkok 10250 Thailand.	
Test Conditions	: Wind tunnel cross test section area	900 cm ²
	: Anemometer frontal area	100 cm ²
	: Diameter of mounting pipe	- mm
	: Blockage ratio of test object	0.111 [-]
Test Conditions	: Air temperature	23.9 ±0.8 °C
	: Air pressure	1010.5 ±0.4 hPa
	: Relative air humidity	52.8 ±3.5 %RH



Calibration Procedure: Calibration was carried out base on:
ISO 91403-12-1 (G.1): 2005-Power Performance Measurements of Electricity Producing Wind Turbines.
MEASNET Anemometer Calibration Procedure - Version 2: 2009;

Traceability: This calibration documents the traceable to national standard, which realize the unit of measurements according to the international system of units (SI) through National Institute of Metrology Thailand (NIMT).

Measurement Date: : Jul 05, 2021.
Issued Date: : Jul 08, 2021.

Calibrated by:
☒ Mr. Soravit Thachad
☐ Miss Orathai Witsakulaya



Approved Signatory:
Mr. Parinya Booncharoen
Technical Support
and Calibration Manager

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Continuation of Certificate of Calibration Number

Certificate No: WS-01072021
Page 2 of 2 Pages

Result of calibration: ☒ Without adjustment ☐ With adjustment
Calibration in the range of 2 - 16 m/s at a calibration interval of 1 m/s.
The results of calibration and associated measurement uncertainties are reported in the table below.

V _{ref} Reading m/s	V _{cup} Reading m/s	Error (m/s)	Uncertainty (%)
2.071	1.8	-0.3	2.7
4.089	3.8	-0.3	1.1
6.01	5.9	-0.1	1.03
8.01	7.8	-0.2	0.74
10.03	10.0	0.0	0.60
12.03	12.0	0.0	0.48
14.05	14.2	0.1	0.39
16.04	16.3	0.3	0.33
14.00	13.2	-0.2	0.39
12.99	13.1	0.1	0.46
10.98	11.0	0.0	0.49
9.03	8.9	-0.1	0.55
7.01	6.9	-0.1	0.68
5.165	4.9	-0.3	1.00
3.011	2.7	-0.3	1.9

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

Appendix 1: Instrumentations

NO	Sensor	Manufacturer	Model/Type	Calibration Date	Certificate Report Number	Range
1	Photo klac	10810 INC	60352145	July 16, 2020	IMW0035-20	0 - 30 m/s
2	Precision Differential Pressure Meter	Zorgas	DP442500	July 16, 2020	IMW0035-20	0 - 30 m/s
3	Air velocity transducer (hot wire)	TS INC	8435-12	July 20, 2020	IMW0035-20	0 - 5 m/s
4	Temperature	Zorgas	DS9-TMP	March 30, 2021	CL-027-24	-30 - 70 °C
5	Relative humidity	Zorgas	DS9-TMP	March 30, 2021	IM-03032021	0 - 100 %RH
6	Atmospheric pressure	Zorgas	DS9-TMP	March 30, 2021	BP-01032021	500 - 1100 hPa
7	Wind tunnel	ESSOM	MP3300	-	-	0 - 50 m/s

End of certificate of calibration



CERTIFICATE OF CALIBRATION

Certificate No: WD-01072021
Page 1 of 2 pages

Measurement Item	: Wind direction sensor with data logger.	
Manufacturer	: Data logger: Novatynx. : Wind direction sensor: Novatynx.	
Model/Type	: Data logger: I1D-WS-16N. : Wind direction sensor: WS-02C.	
Serial Number	: Data logger: I155. : Wind direction sensor: -.	
ID No	: Data logger: RYD_F800B1. : Cup anemometer: -.	
Customer	: ALS laboratory group (Thailand) Co. Ltd. : 104 Phatthanasen 40, Phatthanasen Rd, Khwaeng Suan Luang, Khet Suan Luang, Bangkok 10250 Thailand.	
Environmental Condition:	The measurement was carried out in an ambient temperature of (23±3)°C, and relative humidity of (40±10)%.	
Measurement Method:	The wind direction sensor calibration according to comparison method with reference angle measurement electronic theodolite and the laser is used for axis control. The measurement were taken at 45° intervals in clockwise and counter-clockwise directions.	
Note:	Note: The UUC was warmed up for 1 hour prior to the calibration being performed	
Traceability:	The measurement results are traceable to the international system of units (SI) through Certificate No: GC563-07-0045. Certificate No: KWS63/0044.	
Measurement Date	: Jul 05, 2021.	
Issued Date	: Jul 08, 2021.	

Performed by:
☒ Mr. Soravit Thachad
☐ Miss Orathai Witsakulaya



Approved Signatory:
Mr. Parinya Booncharoen
Technical Support
and Calibration Manager

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Continuation of Certificate of Calibration Number

Certificate No: WD-01072021
Page 2 of 2 pages

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

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

NO	Turning Direction	Nominal Angle (°)	Standard Reading (°)	UUC ^a Reading (°)	Error (°)	Uncertainty ±(°)
1	Clockwise	0/360	360	359	-1	3.0
2		45	45	41	-4	3.0
3		90	90	87	-3	3.0
4		135	135	132	-3	3.0
5		180	180	179	-1	3.0
6		225	225	227	2	3.0
7		270	270	273	3	3.0
8		315	315	317	2	3.0
9	Counter Clockwise	0/360	360	359	-1	3.0
10		45	45	41	-4	3.0
11		90	90	87	-3	3.0
12		135	135	132	-3	3.0
13		180	180	179	-1	3.0
14		225	225	227	2	3.0
15		270	270	273	3	3.0
16		315	315	317	2	3.0

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

End of Certificate of Calibration



CERTIFICATE OF CALIBRATION

Certificate No: WS-02092021
Page 1 of 2 pages

Measurement Item : Cup anemometer with data logger.

Manufacturer : Data logger: Novolyne,
: Cup anemometer: Novolyne.

Model/Type : Data logger: 110-WS-25DL-D
: Cup anemometer: WS-02P

Serial Number : Data logger: A5816
: Cup anemometer: WSD-016

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

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

Test Conditions : Wind tunnel cross test section area : 600 cm²
: Anemometer frontal area : 100 cm²
: Diameter of mounting pipe : mm
: Blockage ratio of test object : 0.111 %

Test Conditions : Air temperature : 23.6 ±0.8 °C
: Air pressure : 1012.9 ±0.4 hPa
: Relative humidity : 57.8 ±3.5 %RH

Calibration Procedure : Calibration was carried out based on:
: IEC 61400-12-1: 2013-Power Performance Measurements of Electricity Producing Wind Turbines.
: MDAQNET Anemometer Calibration Procedure - Version 2: 2009.

Traceability : This calibration documents the traceability to national standards, which realize the unit of measurement according to the International system of units (SI) through National Institute of Metrology (NIMT).

Measurement Date : Sep 14, 2021.
Issued Date : Sep 15, 2021.

Calibrated by
☒ Mr. Sorawit Thachalad
☐ Miss Orachai Wuthitaya



Approved Signatory :
Mr. Panyia Booncharoen
Technical Support
and Calibration Manager

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Continuation of Certificate of Calibration Number

Certificate No: WS-02092021
Page 2 of 2 Pages

Result of calibration: ☒ Without adjustment ☐ With adjustment
Calibration in the range of 1 - 16 m/s at a calibration interval of 1 m/s.

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

V _{ref} Reading m/s	V _{unc} Reading m/s	Error (m/s)	Uncertainty (%)
2.046	2.0	0.0	2.4
4.087	4.0	-0.1	1.5
6.09	6.0	0.0	1.2
8.01	8.0	0.0	0.84
10.02	10.1	0.1	0.67
12.02	12.2	0.2	0.63
14.00	14.2	0.2	0.42
15.09	15.2	0.2	0.76
14.99	15.2	0.2	0.49
13.01	13.1	0.1	0.51
11.02	11.1	0.1	0.66
9.02	9.0	0.0	0.66
7.00	7.0	0.0	0.90
5.122	5.1	0.0	1.3
3.078	3.0	0.0	1.9
1.023	1.0	0.0	4.8

UUC^a: Unit Under Calibration

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

Appendix 1: Instrumentation

NO	Sensor	Manufacturer	Model/Type	Calibration Date	Certificate Report Number	Range
1	Pilot static	TECSTO INC.	06352145	Aug 07, 2021	MY-C034-21	5 - 30 m/s
2	Precision Differential Pressure Meter	Zepac	DPH2500	Aug 07, 2021	MY-C034-21	5 - 30 m/s
3	Air velocity transducer (hot wire)	TSI INC.	8445-12	Aug 08, 2021	MY-C035-21	0 - 5 m/s
4	Temperature	Zepac	DSR-T1P	March 30, 2021	CL-027-21	-30 - 70 °C
5	Relative humidity	Zepac	DSR-T1P	March 30, 2021	RI-C030-2021	0 - 100 %RH
6	Atmospheric pressure	Zepac	DSR-T1P	March 30, 2021	BP-C1032-2021	500 - 1100 hPa
7	Wind Tunnel	CS&S	WT3300	-	-	0 - 90 m/s

End of certificate of calibration



CERTIFICATE OF CALIBRATION

Certificate No: WD-02092021
Page 1 of 2 pages

Measurement Item : Wind direction sensor with data logger.

Manufacturer : Data logger: Novolyne,
: Wind direction sensor: Novolyne.

Model/Type : Data logger: 110-WS-25DL-D
: Wind direction sensor: WS-02P.

Serial Number : Data logger: A5816
: Wind direction sensor: WSD-016.

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

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

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

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

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

Traceability:
The measurement results are traceable to the international system of units (SI) through Certificate No: CC563-07-0045.
Certificate No: KWS63/0044

Measurement Date : Sep 15, 2021.
Issued Date : Sep 15, 2021.

Performed by
☒ Mr. Sorawit Thachalad
☐ Miss Orachai Wuthitaya



Approved Signatory :
Mr. Panyia Booncharoen
Technical Support
and Calibration Manager

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Continuation of Certificate of Calibration Number

Certificate No: WD-02092021
Page 2 of 2 pages

Result of calibration: ☐ Without adjustment ☒ With adjustment

Calibration in the range of 0 - 360 ° at a calibration interval of 45°.

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

NO	Turning Direction	Nominal Angle (°)	Standard Reading (°)	UUC* Reading (°)	Error (°)	Uncertainty ±(°)
1	Clockwise	0/360	360	359	-1	3.0
2		45	45	44	-1	3.0
3		90	90	87	-3	3.0
4		135	135	133	-2	3.0
5		180	180	180	0	3.0
6		225	225	225	0	3.0
7		270	270	273	3	3.0
8		315	315	317	2	3.0
9	Counter Clockwise	0/360	360	359	-1	3.0
10		45	45	44	-1	3.0
11		90	90	87	-3	3.0
12		135	135	133	-2	3.0
13		180	180	180	0	3.0
14		225	225	225	0	3.0
15		270	270	273	3	3.0
16		315	315	317	2	3.0

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

End of Certificate of Calibration



CERTIFICATE OF CALIBRATION

Certificate No.: CL-068-64
Page 1 of 2

Equipment Name: Data Logger with Temperature Sensor

Manufacturer: Novolynx
Model: 110-WS-25 DL-D
Serial No.: A5616
ID No.: -

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: 1 SEP 2021
Calibration date: 13 SEP 2021
Issue date: 15 SEP 2021

Reference Used During Calibration
1. Standard Temperature Probe Model: STS-100 A500, Serial No.: 687682-09, Due date: 25 Mar 2022
2. Digital Temperature Indicator Model: DTI 1000 A MK II, Serial No.: 671407-00591 Due date: 04 June 2022

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

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

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

Calibrated by
☐ Mr. Sorawit Thachalad
☒ Miss Orathai Wiwatwittaya



Approved Signatory: *[Signature]*
Mr. Parinya Booncharoen
Technical Support
and Calibration Manager

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Certificate No.: CL-068-64
Page 2 of 2

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

Function:

This equipment was connected with temperature sensor Model: HMP60 S/N: T2320595
Dimension: Diameter 12mm, Length 80 mm.

Immersion Depth (mm)	Standard Reading (°C)	UUC Reading (°C)	Error (°C)	Uncertainty (°C)
60	20.050	19.6	-0.4	0.080
60	24.878	24.5	-0.4	0.080
60	29.857	29.4	-0.4	0.13
60	34.848	34.3	-0.5	0.080
60	39.842	39.3	-0.5	0.080

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 ★



CALIBRATION REPORT

Calibration No.: RH-02092021
Page 1 of 1 Pages

Measurement Item: Relative humidity with data logger.

Manufacturer: Data logger: Novolynx.
Relative humidity sensor: Novolynx.

Model/Type: Data logger: 110-WS-25 DL-D.
Relative humidity sensor: HMP60.

Serial Number: Data logger: A5616.
Relative humidity sensor: T2320595.

ID No: Data logger: -
Relative humidity sensor: -

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 (26±3)°C, and relative humidity of (50±15)%.

Measurement Method:

The Relative humidity with data logger, Unit Under Calibration (UUC) was calibrated by comparison method with the equilibrium of standard salt solution CH₃COOK: Potassium Acetate, Mg(NO₃)₂: Magnesium Nitrate, KCl: Potassium Chloride to determine the errors.

Measurement Date: Sep 13, 2021
Issued Date: Sep 15, 2021

Measurement Results:

The results of calibration are reported in table below.

Standard salt solution	Standard (RH)	UUC Reading	Error
CH ₃ COOK: Potassium Acetate	22.51	23.6	1.1
Mg(NO ₃) ₂ : Magnesium Nitrate	52.89	53.1	0.2
KCl: Potassium Chloride	84.34	85.4	1.0

Performed by
☐ Mr. Sorawit Thachalad
☒ Miss Orathai Wiwatwittaya



Approved Signatory: *[Signature]*
Mr. Parinya Booncharoen
Technical Support
and Calibration Manager

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CERTIFICATE OF CALIBRATION

Certificate No: WS-01062021
Page 1 of 2 pages

Measurement Item : Cup anemometer with data logger.

Manufacturer : Data logger: Novelynx.
: Cup anemometer: Novelynx.

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

Serial Number : Data logger: A4481.
: Cup anemometer: -

ID No : Data logger: BKH_F90141.
: Cup anemometer: -

Customer : ALS laboratory group (Thailand) co. Ltd.
: 104 Phatthanakan 40, Phatthanakan Rd, Khwaeng Suan Luang, Khiet Suan Luang, Bangkok 10250
Thailand.

Test Conditions : Wind tunnel, cross test section area 900 cm²
: Anemometer frontal area 100 cm²
: Diameter of mounting pipe 1mm
: Blockage ratio of test object 0.111 [-]

Test Conditions : Air temperature 23.7 ±0.8 °C
: Air pressure 1010.3 ±0.4 hPa
: Relative air humidity 53.7 ±3.5 %RH

Calibration Procedure : Calibration was carried out based on:
ISO 91400-12-1 (D1): 2005-Performance Measurements of Electricity Producing Wind
Turbines.
MEASNET Anemometer Calibration Procedure - Version 2: 2009.

Traceability : This calibration documents the traceability to national standard, which realize the unit of
measurements according to the International system of units (SI) through National Institute of
Metrology Thailand (NIMT).

Measurement Date : Jun 07, 2021.
Issued Date : Jun 07, 2021.

Calibrated by
☒ Mr. Sorawit Theachad
☐ Miss Orathai Waiwitlaya



Approved Signatory:
Mr. Parinya Booncharoen
Technical Support
and Calibration Manager

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OBTAINED IN WRITING FROM THE LABORATORY.

CERTIFICATE OF CALIBRATION

Certificate No: WD-01062021
Page 1 of 2 pages

Measurement Item : Wind direction sensor with data logger.

Manufacturer : Data logger: Novelynx.
: Wind direction sensor: Novelynx.

Model/Type : Data logger: WS-25DL
: Wind direction sensor: WS-02P.

Serial Number : Data logger: A4481.
: Wind direction sensor: -

ID No : Data logger: BKH_FS0141.
: Cup anemometer: -

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

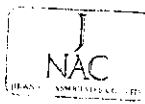
Environmental Condition:
The measurement was carried out in an ambient temperature of (23±3)°C, and relative humidity of (40±10)%.
Measurement Method:
The wind direction sensor calibration according to comparison method with reference angle measurement electronic theodolite and
line laser is used for axis control. The measurement were taken at 45° intervals in clockwise and counterclockwise
directions.

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

Traceability:
The measurement results are traceable to the International system of units (SI) through Certificate No: DC563-07-0045,
Certificate No: KWS63/0344.

Measurement Date : Jun 07, 2021.
Issued Date : Jun 07, 2021.

Performed by
☒ Mr. Sorawit Theachad
☐ Miss Orathai Waiwitlaya



Approved Signatory:
Mr. Parinya Booncharoen
Technical Support
and Calibration Manager

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Continuation of Certificate of Calibration Number

Certificate No: WS-01062021
Page 2 of 2 Pages

Result of calibration: ☒ Without adjustment ☐ With adjustment
Calibration in the range of 1 - 16 m/s at a calibration interval of 1 m/s.
The results of calibration and associated measurement uncertainties are reported in the table below.

V _{ref} Reading m/s	V _{act} Reading m/s	Error (m/s)	Uncertainty (%)
2.055	2.0	-0.1	2.6
4.124	4.0	-0.1	1.2
5.59	6.0	0.0	1.01
8.00	8.0	0.0	0.74
9.99	10.1	0.1	0.60
11.56	12.2	0.2	0.67
14.02	14.4	0.4	0.45
16.03	16.6	0.6	0.36
15.01	15.3	0.3	2.8
12.99	13.3	0.3	0.41
10.99	11.2	0.2	0.53
9.01	9.3	0.3	1.2
7.05	7.0	0.0	0.77
5.121	5.0	-0.1	0.88
3.048	3.0	0.0	1.8
1.088	1.0	-0.1	5.3

UUC: Unit Under Calibration

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

Appendix 1: Instrumentations

NO	Sensor	Manufacturer	Model/Type	Calibration Date	Certificate Report Number	Range
1	Flat plate	TOSTO INC.	Q5352145	July 16, 2020	MY-0035-20	0 - 30 m/s
2	Precision Differential Pressure Meter	Zephe	DPW2500	July 16, 2020	MY-0035-20	0 - 30 m/s
3	Air velocity transducer (hot wire)	TSP INC.	RA5512	July 20, 2020	MY-0035-20	0 - 5 m/s
4	Temperature	Zephe	DSR-TMP	March 30, 2021	Q-027-24	-30 - 70°C
5	Relative humidity	Zephe	DSR-TMP	March 30, 2021	IRAC3032021	0 - 100 %RH
6	Atmospheric pressure	Zephe	DSR-TMP	March 30, 2021	IRAC3032021	600 - 1100 hPa
7	Wind tunnel	CSCM	MP3000			0 - 30 m/s

End of certificate of calibration



Continuation of Certificate of Calibration Number

Certificate No: WD-01062021
Pages 2 of 2 pages

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

NO	Turning Direction	Nominal Angle (°)	Standard Reading (°)	UUC* Reading (°)	Error (°)	Uncertainty ±(°)
1	Clockwise	0/360	0	0	0	3.0
2		45	45	42	-3	3.0
3		90	90	90	0	3.0
4		135	135	130	-5	3.0
5		180	180	182	2	3.0
6		225	225	227	2	3.0
7		270	270	273	3	3.0
8		315	315	314	-1	3.0
9	Counter Clockwise	0/360	0	0	0	3.0
10		45	45	47	+3	3.0
11		90	90	90	0	3.0
12		135	135	136	1	3.0
13		180	180	182	2	3.0
14		225	225	227	2	3.0
15		270	270	273	3	3.0
16		315	315	314	-1	3.0

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

End of Certificate of Calibration



CERTIFICATE OF CALIBRATION

Certificate No: WS-13072021
Page 1 of 2 pages

Measurement Item : Cup anemometer with data logger.
Manufacturer : Data logger: Novatynx.
: Cup anemometer: Novatynx.
Model/Type : Data logger: 200-WS-25LB.
: Cup anemometer: WS-02P.
Serial Number : Data logger: A5375.
: Cup anemometer: -.
ID No : Data logger: RY0_F80413.
: Cup anemometer: -.
Customer : ALS laboratory group (Thailand) co., Ltd.
: 104 Phatthanakan 40, Phatthanakan Rd, Khwaeng Suan Luang, Khet Suan Luang, Bangkok 10250 Thailand.
Test Conditions : Wind tunnel cross test section area 900 cm²
: Anemometer frontal area 100 cm²
: Diameter of mounting pipe mm
: Blockage ratio of test object 0.111 [%]
Test Conditions : Air temperature 24.5 ±0.5 °C
: Air pressure 1007.4 ±0.4 hPa
: Relative air humidity 52.4 ±3.5 %RH
Calibration Procedure : Calibration was carried out base on:
IEC 61402-12-1 ED1: 2005: Power Performance Measurements of Electricity Producing Wind Turbines;
MCASNDT Anemometer Calibration Procedure - Version 2: 2009;
Traceability : This calibration documents the traceable to national standard, which realize the unit of measurements according to the international system of units (SI) through National Institute of Metrology Thailand (NIMT)
Measurement Date : Jul 29, 2021.
Issued Date : Jul 29, 2021.

REVIEW BY *Mr. P. P.*
APPROVED BY *Mr. P.*
NEXT CAL DATE 27/1/23

Calibrated by
☒ Mr. Sorawit Thachalad
☐ Miss Orathai Witsatitaya



Approved Signatory: *Mr. P.*
Mr. Pinyas Booncharoen
Technical Support
and Calibration Manager

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Continuation of Certificate of Calibration Number

Certificate No: WS-13072021
Page 2 of 2 pages

Result of calibration: ☒ Without adjustment ☐ With adjustment
Calibration in the range of 1 - 16 m/s at a calibration interval of 1 m/s.
The results of calibration and associated measurement uncertainties are reported in the table below.

Wind Reading m/s	Wind Reading m/s	Error m/s	Uncertainty m/s
2.067	2.0	-0.1	2.4
4.136	4.1	0.0	1.2
6.03	6.1	0.1	0.7
7.99	8.0	0.0	0.64
10.00	10.1	0.1	0.59
12.03	12.2	0.2	0.72
13.99	14.0	0.0	0.47
15.98	16.4	0.4	0.55
16.03	16.3	0.3	0.38
12.99	13.1	0.1	0.69
11.01	11.1	0.1	0.67
9.01	9.0	0.0	0.87
6.99	7.1	0.1	0.81
5.177	5.1	-0.1	0.97
2.072	2.1	0.1	1.6
1.044	0.9	-0.1	5.3

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

Appendix 1: Instrumentations

NO	Sensor	Manufacturer	Model/Type	Calibration Date	Certificate Report Number	Range
1	Pitot static	IC810 INC.	06352143	July 16, 2020	MY-0035-20	0 - 30 m/s
2	Precision Differential Pressure Meter	ZepLab	D-PR2500	July 16, 2020	MY-0035-20	0 - 30 m/s
3	Air velocity transducer (Pitot-static)	TSS INC.	8455-12	July 20, 2020	MY-0035-20	0 - 5 m/s
4	Temperature	ZepLab	DGR-TMP	March 30, 2021	CL-027-04	-30 - 70 °C
5	Relative humidity	ZepLab	DGR-RHP	March 30, 2021	PH-0333-2021	0 - 100 %RH
6	Atmospheric pressure	ZepLab	DGR-HP	March 30, 2021	BP-0103-2021	500 - 1100 hPa
7	Wind tunnel	CSGOW	MP3300			0 - 60 m/s

End of certificate of calibration



CERTIFICATE OF CALIBRATION

Certificate No: WD-13072021
Page 1 of 2 pages

Measurement Item : Wind direction sensor with data logger.
Manufacturer : Data logger: Novatynx.
: Wind direction sensor: Novatynx.
Model/Type : Data logger: 200-WS-25LB.
: Wind direction sensor: WS-02P.
Serial Number : Data logger: A5375.
: Wind direction sensor: -.
ID No : Data logger: RY0_F80413.
: Wind direction sensor: -.
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 (23±3)°C, and relative humidity of (40±10%).
Measurement Method : The wind direction sensor calibration according to comparison method with reference angle measurement electronic theodolite and line laser is used for axis control. The measurement were taken at 45° intervals in clockwise and counterclockwise directions.
Note : The UUC was warmed up for 1 hour prior to the calibration being performed.
Traceability : The measurement results are traceable to the international system of units (SI) through Certificate No: CC563-07-0045.
Certificate No: KWS63/0044.
Measurement Date : Jul 29, 2021.
Issued Date : Jul 29, 2021.

Continuation of Certificate of Calibration Number

Certificate No: WD-13072021
Page 2 of 2 pages

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

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

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

End of Certificate of Calibration



Performed by
☒ Mr. Sorawit Thachalad
☐ Miss Orathai Witsatitaya



Approved Signatory: *Mr. P.*
Mr. Pinyas Booncharoen
Technical Support
and Calibration Manager

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Certificate of System Qualification

GC-OQ

System ID: GC-6
Organization Name: ALS Laboratory Group (Thailand) Co., Ltd.
Organization Location: 104 Phattanakarn 40, Phattanakarn Rd., Suan Luang, Bangkok 10250

Date: October 21, 2021 10:05:40 AM
EQP Name: Agilent Recommended
EQP Revision: GC.02.50
Overall Qualification Status: Pass

REVIEW BY: Suchada T.
APPROVED BY: SATYAN M.
NEXT CAL DATE: 21 Apr 2023

System Inspection and Basic Safety and Operation

Name: 7890
Setpoint Status: Pass

Overall System Inspection and Basic Safety and Operation Test Status
Pass

Inlet Pressure Decay

Name: 7890
Front SSL

Setpoint Status: Pass
Pressure: 25.0 psi
Pressure Change: 0.0 psi / 5 minutes
Agilent Recommended: ≥ -2.0 and ≤ 0.5

Overall Inlet Pressure Decay Test Status
Pass

Inlet Pressure Accuracy

Name: 7890
Front SSL

Date: October 21, 2021 10:05:40 AM
System ID: GC-6

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Setpoint Status: Pass
Inlet Pressure: Setpoint 25.0 psi Actual 24.9 psi
Accuracy: 0.1 psi
Agilent Recommended: ≤ 1.2

Overall Inlet Pressure Accuracy Test Status
Pass

Inlet Pressure Decay

Name: 7890
Back SSL
Setpoint Status: Pass
Pressure: 25.0 psi
Pressure Change: 0.0 psi / 5 minutes
Agilent Recommended: ≥ -2.0 and ≤ 0.5

Overall Inlet Pressure Decay Test Status
Pass

Inlet Pressure Accuracy

Name: 7890
Back SSL
Setpoint Status: Pass
Inlet Pressure: Setpoint 25.0 psi Actual 24.9 psi
Accuracy: 0.1 psi
Agilent Recommended: ≤ 1.2

Overall Inlet Pressure Accuracy Test Status
Pass

Detector Flow Accuracy

Date: October 21, 2021 10:05:40 AM
System ID: GC-6

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Name: 7890
Front FID
Setpoint Status: Pass
Flow Type: Fuel
Setpoint: 30.0 mL/min Measured Flow: 30.5 mL/min
Accuracy: 0.5 mL/min
Agilent Recommended: ≤ 10.0 % setpoint (3.0 mL/min)
Limit is percentage of setpoint or 0.5 mL/minute, whichever is largest.

Setpoint Status: Pass
Flow Type: Oxidizer
Setpoint: 400.0 mL/min Measured Flow: 394.0 mL/min
Accuracy: 8.0 mL/min
Agilent Recommended: ≤ 10.0 % setpoint (40.0 mL/min)
Limit is percentage of setpoint or 0.5 mL/minute, whichever is largest.

Setpoint Status: Pass
Flow Type: Makeup
Setpoint: 25.0 mL/min Measured Flow: 24.2 mL/min
Accuracy: 0.8 mL/min
Agilent Recommended: ≤ 10.0 % setpoint (2.5 mL/min)
Limit is percentage of setpoint or 0.5 mL/minute, whichever is largest.

Overall Detector Flow Accuracy Test Status
Pass

Detector Flow Accuracy

Name: 7890
Back FID

Date: October 21, 2021 10:05:40 AM
System ID: GC-6

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Setpoint Status: Pass
Flow Type: Fuel
Setpoint: 30.0 mL/min Measured Flow: 29.1 mL/min
Accuracy: 0.9 mL/min
Agilent Recommended: ≤ 10.0 % setpoint (3.0 mL/min)
Limit is percentage of setpoint or 0.5 mL/minute, whichever is largest.

Setpoint Status: Pass
Flow Type: Oxidizer
Setpoint: 400.0 mL/min Measured Flow: 397.3 mL/min
Accuracy: 2.7 mL/min
Agilent Recommended: ≤ 10.0 % setpoint (40.0 mL/min)
Limit is percentage of setpoint or 0.5 mL/minute, whichever is largest.

Setpoint Status: Pass
Flow Type: Makeup
Setpoint: 25.0 mL/min Measured Flow: 24.4 mL/min
Accuracy: 0.6 mL/min
Agilent Recommended: ≤ 10.0 % setpoint (2.5 mL/min)
Limit is percentage of setpoint or 0.5 mL/minute, whichever is largest.

Overall Detector Flow Accuracy Test Status
Pass

GC Oven Temperature Accuracy

Name: 7890

Date: October 21, 2021 10:05:40 AM
System ID: GC-6

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Setpoint Status: **Pass**
 Zone: **Oven**
 Setpoint/Actual
 Temperature: **230.0** | **231.5** °C
 Accuracy: **1.5** °C
 Agilent Recommended: **>= -1.0** % setpoint in K (**-5.0** °C)
<= 1.0 % setpoint in K (**5.0** °C)

Setpoint Status: **Pass**
 Zone: **Oven**
 Setpoint/Actual
 Temperature: **100.0** | **100.5** °C
 Accuracy: **0.5** °C
 Agilent Recommended: **>= -1.0** % setpoint in K (**-3.7** °C)
<= 1.0 % setpoint in K (**3.7** °C)

Overall GC Oven Temperature Accuracy Test Status
Pass

GC Oven Temperature Stability

Name: **7890**
 Setpoint Status: **Pass**
 Setpoint/Average
 Temperature: **100.0** | **100.4667** °C
 Stability: **0.1** °C
 Agilent Recommended: **<= 0.5**

Overall GC Oven Temperature Stability Test Status
Pass

Scouting Run

Tested Combination1 **Front** **SSL** / **Front** **FID**
 Injection Tower
 Name: **7693A**

Date: **October 21, 2021 10:05:40 AM**
 System ID: **GC-6**

Setpoint Status: **Completed**
 Injection Volume on Column: **1.0** uL
 Overall Scouting Run Status
Completed

Noise and Drift

Tested Combination1 **Front** **SSL** / **Front** **FID**
 Name: **7890**
 Setpoint Status: **Pass**
 Base Signal: **12.7** pA
 ASTM Noise **0.06** pA
 Drift **0.10** pA/hr
 Agilent Recommended: **<= 0.10** pA
 Status: **Pass**

Overall Noise and Drift Test Status

Pass

Injection Precision

Tested Combination1 **Front** **SSL** / **Front** **FID**
 Name: **7693A**
 Setpoint Status: **Pass**
 Injection Volume on Column: **1.0** uL
 Area RSD: **0.42** %
 Retention Time RSD: **0.16** %
 Agilent Recommended: **<= 3.00** %
<= 1.00 %

Overall Injection Precision Test Status

Pass

Signal to Noise

Date: **October 21, 2021 10:05:40 AM**
 System ID: **GC-6**

Tested Combination1 **Front** **SSL** / **Front** **FID**
 Injection Tower
 Name: **7890**
 Setpoint Status: **Pass**
 Signal to Noise: **1174861**
 Agilent Recommended: **>= 300000**

Overall Signal to Noise Test Status
Pass

Scouting Run

Tested Combination2 **Back** **SSL** / **Back** **FID**
 Injection Tower
 Name: **7693A**

Setpoint Status: **Completed**
 Injection Volume on Column: **1.0** uL
 Overall Scouting Run Status
Completed

Noise and Drift

Tested Combination2 **Back** **SSL** / **Back** **FID**
 Name: **7890**
 Setpoint Status: **Pass**
 Base Signal: **10.4** pA
 ASTM Noise **0.05** pA
 Drift **0.00** pA/hr
 Agilent Recommended: **<= 0.10** pA
 Status: **Pass**

Date: **October 21, 2021 10:05:40 AM**
 System ID: **GC-6**

Overall Noise and Drift Test Status
Pass

Injection Precision

Tested Combination2 **Back** **SSL** / **Back** **FID**
 Name: **7693A**
 Setpoint Status: **Pass**
 Injection Volume on Column: **1.0** uL
 Area RSD: **1.16** %
 Retention Time RSD: **0.12** %
 Agilent Recommended: **<= 3.00** %
<= 1.00 %

Overall Injection Precision Test Status

Pass

Signal to Noise

Tested Combination2 **Back** **SSL** / **Back** **FID**
 Injection Tower
 Name: **7890**
 Setpoint Status: **Pass**
 Signal to Noise: **805468**
 Agilent Recommended: **>= 300000**

Overall Signal to Noise Test Status

Pass

Date: **October 21, 2021 10:05:40 AM**
 System ID: **GC-6**

Instrument Details

Purpose

This section describes the as found system configuration.

Details

System

System ID	GC-6
Manufacturer	Agilent Technologies
Name	7890
Flow Data Input	Manual Data
Temperature Data Input	Manual Data or Other Data Logging

Tested Combination1

Injection Technique	Injection Tower
Sampler Identifier	Sampler 2
Inlet	Front
Detector	Front
LTM Included?	No

Tested Combination2

Injection Technique	Injection Tower
Sampler Identifier	Sampler 3
Inlet	Back
Detector	Back
LTM Included?	No

Sampler 1

Manufacturer	Agilent Technologies
Type	Tray
Name	7893A
Model Number	G4514A
Serial Number	CN15380030
Firmware Revision	A.11.01
Vial Heater	Not Installed

Date: October 21, 2021 10:05:40 AM
System ID: GC-6

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Sampler 2

Manufacturer	Agilent Technologies
Type	Injection Tower
Name	7893A
Model Number	G4513A
Serial Number	CN10340103
Firmware Revision	A.10.09
Usage	Sample Injection
Location	Front
Syringe Volume (µL)	10

Sampler 3

Manufacturer	Agilent Technologies
Type	Injection Tower
Name	7893A
Model Number	G4513A
Serial Number	CN16280128
Firmware Revision	A.10.09
Usage	Sample Injection
Location	Back
Syringe Volume (µL)	10

Mainframe 1

Manufacturer	Agilent Technologies
Name	7890
Model Number	G3440A
Serial Number	CN11481066
Firmware Revision	Version 4.27
Component ID/Asset No.	GC-6
Oven Type	Standard

Date: October 21, 2021 10:05:40 AM
System ID: GC-6

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Inlet 1

Manufacturer	Agilent Technologies
Name	7890
Type	SSL
Location	Front
Carrier Gas	Helium
Control Type	Electronic Pressure Control (EPC)
Purged Inlet	Yes

Inlet 2

Manufacturer	Agilent Technologies
Name	7890
Type	SSL
Location	Back
Carrier Gas	Helium
Control Type	Electronic Pressure Control (EPC)
Purged Inlet	Yes

Detector 1

Manufacturer	Agilent Technologies
Name	7890
Type	FID
Adapter	Capillary
Control Type	Electronic Pressure Control (EPC)
Location	Front
Makeup Gas	Nitrogen

Detector 2

Manufacturer	Agilent Technologies
Name	7890
Type	FID
Adapter	Capillary
Control Type	Electronic Pressure Control (EPC)
Location	Back
Makeup Gas	Nitrogen

Date: October 21, 2021 10:05:40 AM
System ID: GC-6

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Electronic Signature

Purpose

This signature page was created and published because the ACE sign-off action was executed, which is valid for the entire document, including attachments. The ACE sign-off is an electronic signature that requires two distinct identification components: unique username and personal password. The Agilent representative who has delivered this service understands the meaning and legal status of an electronic signature. As a trained official operator, the Agilent representative has a unique password and login to access ACE and electronically sign this document. (Other e-signatures can be applied to this document using a Document Content Management or other suitable method defined in your data access and control procedures.)

Details

Full Name of Signer:	Suriya Thongkaew
Logged On User Name:	suriya.thongkaew@non.agilent.com
Signature Creation Date:	October 21, 2021
Reason for Signature:	Executed protocol and published this original version of document

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Date: October 21, 2021 10:05:40 AM
System ID: GC-6

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User Name: surya.thongkiew
Host Name: ASBKKW7015
Print Date: October 21, 2021 10:05:48 AM
System ID: GC-6

QC GC ALS CH11461968 Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
October 20, 2021 12:18:50 PM	Audit	SessionCreated	Session	None
October 20, 2021 12:18:50 PM	Start	Configuration	Session	None
October 20, 2021 12:18:50 PM	Audit	Entitlement	Licensing	User is Nonpaying and does not require an unlock code
October 20, 2021 12:24:57 PM	Audit	EqlLoaded	Session	EQP details for primary technique [GC] - File path: (ProtocolPkg\GCConfig\smv2.5\GC 02 51.ewg) EQP File Name: (GC 02 51.ewg) EQP Name: (AgilentRecommended)
October 20, 2021 12:25:02 PM	End	Configuration	Session	None
October 20, 2021 12:25:09 PM	Start	Qualification	Session	QC
October 20, 2021 12:25:09 PM	Start	Execution	System Inspection and Basic Safety and Operation - 7890 - Qualitative Test - No setpoints associated	None
October 20, 2021 12:30:35 PM	End	Execution	System Inspection and Basic Safety and Operation - 7890 - Qualitative Test - No setpoints associated	Run Count : 1
October 20, 2021 12:56:29 PM	Start	Execution	Inlet Pressure Decay - Front SSL - Pressure Controlled Inlet - S: 25.0 psi - L: >= -2.0 psi and <= 0.5 psi	None

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Date: October 21, 2021 10:05:40 AM
System ID: GC-6

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User Name: surya.thongkiew
Host Name: ASBKKW7015
Print Date: October 21, 2021 10:05:48 AM
System ID: GC-6

QC GC ALS CH11461968 Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
October 20, 2021 1:02:16 PM	End	Execution	Inlet Pressure Decay - Front SSL - Pressure Controlled Inlet - S: 25.0 psi - L: >= -2.0 psi and <= 0.5 psi	Run Count : 1
October 20, 2021 1:02:16 PM	Start	Execution	Inlet Pressure Accuracy - Front SSL - Pressure Controlled Inlet - S: 25.0 psi - L: <= 1.2 psi	None
October 20, 2021 1:02:26 PM	End	Execution	Inlet Pressure Accuracy - Front SSL - Pressure Controlled Inlet - S: 25.0 psi - L: <= 1.2 psi	Run Count : 1
October 20, 2021 1:02:29 PM	Start	Execution	Inlet Pressure Decay - Back SSL - Pressure Controlled Inlet - S: 25.0 psi - L: >= -2.0 psi and <= 0.5 psi	None
October 20, 2021 1:04:21 PM	End	Execution	Inlet Pressure Decay - Back SSL - Pressure Controlled Inlet - S: 25.0 psi - L: >= -2.0 psi and <= 0.5 psi	Run Count : 1
October 20, 2021 1:07:53 PM	Start	Execution	Inlet Pressure Accuracy - Back SSL - Pressure Controlled Inlet - S: 25.0 psi - L: <= 1.2 psi	None
October 20, 2021 1:08:11 PM	End	Execution	Inlet Pressure Accuracy - Back SSL - Pressure Controlled Inlet - S: 25.0 psi - L: <= 1.2 psi	Run Count : 1
October 20, 2021 1:08:15 PM	Start	Execution	Detector Flow Accuracy - Front FID - Type: Fuel - S: 30.0 mL/min - L: <= 10.0% setpoint	None
October 20, 2021 1:20:23 PM	Audit	Data	Detector Flow Accuracy - Front FID - Type: Fuel - S: 30.0 mL/min - L: <= 10.0% setpoint	Manual Data Entry
October 20, 2021 1:20:26 PM	End	Execution	Detector Flow Accuracy - Front FID - Type: Fuel - S: 30.0 mL/min - L: <= 10.0% setpoint	Run Count : 1

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Date: October 21, 2021 10:05:40 AM
System ID: GC-6

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User Name: surya.thongkiew
Host Name: ASBKKW7015
Print Date: October 21, 2021 10:05:48 AM
System ID: GC-6

QC GC ALS CH11461968 Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
October 20, 2021 1:30:29 PM	Start	Execution	Detector Flow Accuracy - Front FID - Type: Fuel - S: 400.0 mL/min - L: <= 10.0% setpoint	None
October 20, 2021 1:33:27 PM	Audit	Data	Detector Flow Accuracy - Front FID - Type: Fuel - S: 400.0 mL/min - L: <= 10.0% setpoint	Manual Data Entry
October 20, 2021 1:33:29 PM	End	Execution	Detector Flow Accuracy - Front FID - Type: Fuel - S: 400.0 mL/min - L: <= 10.0% setpoint	Run Count : 1
October 20, 2021 1:33:31 PM	Start	Execution	Detector Flow Accuracy - Front FID - Type: Makeup - S: 25.0 mL/min - L: <= 10.0% setpoint	None
October 20, 2021 1:37:40 PM	Audit	Data	Detector Flow Accuracy - Front FID - Type: Makeup - S: 25.0 mL/min - L: <= 10.0% setpoint	Manual Data Entry
October 20, 2021 1:37:42 PM	End	Execution	Detector Flow Accuracy - Front FID - Type: Makeup - S: 25.0 mL/min - L: <= 10.0% setpoint	Run Count : 1
October 20, 2021 1:37:46 PM	Start	Execution	Detector Flow Accuracy - Back FID - Type: Fuel - S: 30.0 mL/min - L: <= 10.0% setpoint	None
October 20, 2021 1:32:10 PM	Audit	Data	Detector Flow Accuracy - Back FID - Type: Fuel - S: 30.0 mL/min - L: <= 10.0% setpoint	Manual Data Entry
October 20, 2021 1:32:12 PM	End	Execution	Detector Flow Accuracy - Back FID - Type: Fuel - S: 30.0 mL/min - L: <= 10.0% setpoint	Run Count : 1
October 20, 2021 1:32:14 PM	Start	Execution	Detector Flow Accuracy - Back FID - Type: Makeup - S: 400.0 mL/min - L: <= 10.0% setpoint	None
October 20, 2021 1:34:13 PM	Audit	Data	Detector Flow Accuracy - Back FID - Type: Makeup - S: 400.0 mL/min - L: <= 10.0% setpoint	Manual Data Entry

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Date: October 21, 2021 10:05:40 AM
System ID: GC-6

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User Name: surya.thongkiew
Host Name: ASBKKW7015
Print Date: October 21, 2021 10:05:48 AM
System ID: GC-6

QC GC ALS CH11461968 Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
October 20, 2021 1:34:16 PM	End	Execution	Detector Flow Accuracy - Back FID - Type: Makeup - S: 400.0 mL/min - L: <= 10.0% setpoint	Run Count : 1
October 20, 2021 1:34:46 PM	Start	Execution	Detector Flow Accuracy - Back FID - Type: Makeup - S: 25.0 mL/min - L: <= 10.0% setpoint	None
October 20, 2021 1:36:33 PM	Audit	Data	Detector Flow Accuracy - Back FID - Type: Makeup - S: 25.0 mL/min - L: <= 10.0% setpoint	Manual Data Entry
October 20, 2021 1:36:36 PM	End	Execution	Detector Flow Accuracy - Back FID - Type: Makeup - S: 25.0 mL/min - L: <= 10.0% setpoint	Run Count : 1
October 20, 2021 1:36:38 PM	Start	Execution	GC Oven Temperature Accuracy - 7890 - Temperature - Oven - S: 230.0°C - L: >= -1.0 AND <= 1.0% setpoint in K	None
October 20, 2021 2:04:51 PM	Audit	Data	GC Oven Temperature Accuracy - 7890 - Temperature - Oven - S: 230.0°C - L: >= -1.0 AND <= 1.0% setpoint in K	Manual Data Entry
October 20, 2021 2:04:52 PM	End	Execution	GC Oven Temperature Accuracy - 7890 - Temperature - Oven - S: 230.0°C - L: >= -1.0 AND <= 1.0% setpoint in K	Run Count : 1
October 20, 2021 2:04:54 PM	Start	Execution	GC Oven Temperature Accuracy - 7890 - Temperature - Oven - S: 100.0°C - L: >= -1.0 AND <= 1.0% setpoint in K	None
October 20, 2021 2:10:47 PM	Audit	Data	GC Oven Temperature Accuracy - 7890 - Temperature - Oven - S: 100.0°C - L: >= -1.0 AND <= 1.0% setpoint in K	Manual Data Entry

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Date: October 21, 2021 10:05:40 AM
System ID: GC-6

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User Name: suriya.thongkiew

Hostname: ASBKKW7915

System ID: GC-4

Print Date: October 21, 2021 10:05:48 AM

OQ GC ALS CN11461066 Transaction log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
October 20, 2021 2:10:49 PM	End	Execution	GC Oven Temperature Accuracy +7860 - Temperature : Oven - 8: 100.0°C - L: <= +1.0 AND <= 1.0 % setpoint in K	Run Count: 1
October 20, 2021 2:10:51 PM	Start	Execution	GC Oven Temperature Stability - 7860 - Temperature : Oven - 8: 100.0°C - L: <= 0.5°C	None
October 20, 2021 2:31:38 PM	Audit	Data	GC Oven Temperature Stability - 7860 - Temperature : Oven - 8: 100.0°C - L: <= 0.5°C	Manual Data Entry
October 20, 2021 2:31:41 PM	End	Execution	GC Oven Temperature Stability - 7860 - Temperature : Oven - 8: 100.0°C - L: <= 0.5°C	Run Count: 1
October 20, 2021 2:31:44 PM	Start	Execution	GC Scouting Run - Injection Tower, Front SSL, Front FID - Part of System Preparation - No limits associated	None
October 20, 2021 2:43:08 PM	Audit	AccClosed	Session	None
October 21, 2021 8:18:59 AM	Audit	AccRestarted	Session	None
October 21, 2021 9:18:02 AM	Audit	SessionReloaded	Session	None
October 21, 2021 9:19:00 AM	Start	Qualification	Session	OQ
October 21, 2021 9:19:09 AM	Start	Execution	GC Scouting Run - Injection Tower, Front SSL, Front FID - Part of System Preparation - No limits associated	None
October 21, 2021 9:19:41 AM	Audit	AccClosed	Session	None

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User Name: suriya.thongkiew
 Hostname: ASBKKW7915

System ID: GC-4
 Print Date: October 21, 2021 10:05:48 AM

OQ GC ALS CN11461066 Transaction log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
October 21, 2021 9:20:08 AM	Audit	AccRestarted	Session	None
October 21, 2021 9:20:09 AM	Audit	SessionReloaded	Session	None
October 21, 2021 9:20:13 AM	Start	Qualification	Session	OQ
October 21, 2021 9:20:13 AM	Start	Execution	GC Scouting Run - Injection Tower, Front SSL, Front FID - Part of System Preparation - No limits associated	None
October 21, 2021 9:29:45 AM	Audit	Data	GC Scouting Run - Injection Tower, Front SSL, Front FID - Part of System Preparation - No limits associated	Data File Path : C:\Chem321\DATA\OQPV20 21\OQPV2021_F_2021-10-20 15-49-01\ONSIDRF_F001.D\FID1A.ch
October 21, 2021 9:30:06 AM	End	Execution	GC Scouting Run - Injection Tower, Front SSL, Front FID - Part of System Preparation - No limits associated	Run Count: 1
October 21, 2021 9:30:06 AM	Start	Execution	Noise and Drift - Front FID - Detector FID - L (Noise) <= 0.10 pA - L (Drift) <= 2.50 pA/hour	None
October 21, 2021 9:30:41 AM	Audit	Data	Noise and Drift - Front FID - Detector FID - L (Noise) <= 0.10 pA - L (Drift) <= 2.50 pA/hour	Data File Path : C:\Chem321\DATA\OQPV20 21\OQPV2021_F_2021-10-20 15-49-01\ONSIDRF_F001.D\FID1A.ch
October 21, 2021 9:31:10 AM	End	Execution	Noise and Drift - Front FID - Detector FID - L (Noise) <= 0.10 pA - L (Drift) <= 2.50 pA/hour	Run Count: 1

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Date: October 21, 2021 10:05:40 AM
System ID: GC-5

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Date: October 21, 2021 10:05:40 AM
System ID: GC-6

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User Name: suriya.thongkiew

Hostname: ASBKKW7915

System ID: GC-4

Print Date: October 21, 2021 10:05:48 AM

OQ GC ALS CN11461066 Transaction log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
October 21, 2021 9:31:42 AM	Start	Execution	Injection Precision - Injection Tower, Front SSL, Front FID - GC - L (Area) <= 3.00% - L (Ret. Time) <= 1.00%	None
October 21, 2021 9:32:56 AM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Front FID - GC - L (Area) <= 3.00% - L (Ret. Time) <= 1.00%	Data File Path : C:\Chem321\DATA\OQPV20 21\OQPV2021_F_2021-10-20 16-51-16\NUPREC_F002.D\FID1A.ch
October 21, 2021 9:32:56 AM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Front FID - GC - L (Area) <= 3.00% - L (Ret. Time) <= 1.00%	Data File Path : C:\Chem321\DATA\OQPV20 21\OQPV2021_F_2021-10-20 16-51-16\NUPREC_F003.D\FID1A.ch
October 21, 2021 9:32:58 AM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Front FID - GC - L (Area) <= 3.00% - L (Ret. Time) <= 1.00%	Data File Path : C:\Chem321\DATA\OQPV20 21\OQPV2021_F_2021-10-20 16-51-16\NUPREC_F004.D\FID1A.ch
October 21, 2021 9:32:58 AM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Front FID - GC - L (Area) <= 3.00% - L (Ret. Time) <= 1.00%	Data File Path : C:\Chem321\DATA\OQPV20 21\OQPV2021_F_2021-10-20 16-51-16\NUPREC_F005.D\FID1A.ch
October 21, 2021 9:32:58 AM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Front FID - GC - L (Area) <= 3.00% - L (Ret. Time) <= 1.00%	Data File Path : C:\Chem321\DATA\OQPV20 21\OQPV2021_F_2021-10-20 16-51-16\NUPREC_F006.D\FID1A.ch
October 21, 2021 9:32:58 AM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Front FID - GC - L (Area) <= 3.00% - L (Ret. Time) <= 1.00%	Data File Path : C:\Chem321\DATA\OQPV20 21\OQPV2021_F_2021-10-20 16-51-16\NUPREC_F007.D\FID1A.ch

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User Name: suriya.thongkiew Hostname: ASBKKW7915		System ID: GC-4 Print Date: October 21, 2021 10:05:48 AM		
OQ GC ALS CN11461066 Transaction log:				
Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
October 21, 2021 9:33:07 AM	End	Execution	Injection Precision - Injection Tower, Front SSL, Front FID - GC - L (Area) <= 3.00% - L (Ret. Time) <= 1.00%	Run Count: 1
October 21, 2021 9:33:23 AM	Start	Execution	Signal to Noise - Injection Tower, Front SSL, Front FID - Detector FID - L >= 300000	None
October 21, 2021 9:34:01 AM	Audit	Data	Signal to Noise - Injection Tower, Front SSL, Front FID - Detector FID - L >= 300000	Data File Path : C:\Chem321\DATA\OQPV20 21\OQPV2021_F_2021-10-20 16-51-16\SIGTONS_F001.D\FID1A.ch
October 21, 2021 9:34:15 AM	End	Execution	Signal to Noise - Injection Tower, Front SSL, Front FID - Detector FID - L >= 300000	Run Count: 1
October 21, 2021 9:34:18 AM	Start	Execution	GC Scouting Run - Injection Tower, Back SSL, Back FID - Part of System Preparation - No limits associated	None
October 21, 2021 9:35:04 AM	Audit	Data	GC Scouting Run - Injection Tower, Back SSL, Back FID - Part of System Preparation - No limits associated	Data File Path : C:\Chem321\DATA\OQPV20 21\OQPV2021_B_2021-10-20 17-13-49\SCOUT_B001.D\FID1A.ch
October 21, 2021 9:35:32 AM	End	Execution	GC Scouting Run - Injection Tower, Back SSL, Back FID - Part of System Preparation - No limits associated	Run Count: 1
October 21, 2021 9:35:32 AM	Start	Execution	Noise and Drift - Back FID - Detector FID - L (Noise) <= 0.10 pA - L (Drift) <= 2.50 pA/hour	None

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Date: October 21, 2021 10:05:40 AM
System ID: GC-5

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Date: October 21, 2021 10:05:40 AM
System ID: GC-6

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User Name: surya.jhonghajer		System Id: GC 4	
Host Name: ABBKKW7013		Print Date: October 21, 2021 19:05:48 AM	
GC GC ALS CH11491068 Transaction log :			
Time	Transaction State	Activity Performed	Optional Information
October 21, 2021 9:36:06 AM	Audit	Data	Noise and DR% - Back FID: - Detector FID - L (Noise) == 0.18 µA - L (DR%) == 2.80 µAhour Data File Path : C:\GCMS321\DATA\AQGPV20 210QPV2021_B 2021-10-20 17-15-45\NP\PREC_80051.D DFID28.ch
October 21, 2021 9:36:18 AM	End	Execution	Noise and DR% - Back FID: - Detector FID - L (Noise) == 0.18 µA - L (DR%) == 2.80 µAhour Run Count : 1
October 21, 2021 9:36:20 AM	Start	Execution	Injection Prediction - Injection Tower, Back SSI, Back FID: - GC - L (Area%) == 3.00% - L (Rel. Time) == 1.00%
October 21, 2021 9:36:57 AM	Audit	Data	Injection Prediction - Injection Tower, Back SSI, Back FID: - GC - L (Area) == 3.00% - L (Rel. Time) == 1.00%
October 21, 2021 9:36:57 AM	Audit	Data	Data File Path : C:\GCMS321\DATA\AQGPV20 210QPV2021_B 2021-10-20 17-15-45\NP\PREC_80052.D FID28.ch
October 21, 2021 9:36:57 AM	Audit	Data	Injection Prediction - Injection Tower, Back SSI, Back FID: - GC - L (Area) == 3.00% - L (Rel. Time) == 1.00%
October 21, 2021 9:36:57 AM	Audit	Data	Data File Path : C:\GCMS321\DATA\AQGPV20 210QPV2021_B 2021-10-20 17-15-45\NP\PREC_80053.D FID28.ch
October 21, 2021 9:36:57 AM	Audit	Data	Injection Prediction - Injection Tower, Back SSI, Back FID: - GC - L (Area) == 3.00% - L (Rel. Time) == 1.00%
October 21, 2021 9:36:57 AM	Audit	DMA	Injection Prediction - Injection Tower, Back SSI, Back FID: - GC - L (Area) == 3.00% - L (Rel. Time) == 1.00%
October 21, 2021 9:36:57 AM	Audit	DMA	Data File Path : C:\GCMS321\DATA\AQGPV20 210QPV2021_B 2021-10-20 17-15-45\NP\PREC_80055.D FID28.ch

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Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
October 21, 2021 9:38:57 AM	Audit	Data	Injection Precision - Injection Tower, Back SSL, Back FID - GC - L (Area) <= 3.00% - L (Rel. Time) <= 1.00%	Data File Path : C:\chem\3211DATA\AQGPV20 2100QPV2021_9 2021-10-20 17-13-45\NUPREC_8007.D\FID28.ch
October 21, 2021 9:38:57 AM	Audit	Data	Injection Precision - Injection Tower, Back SSL, Back FID - GC - L (Area) <= 3.00% - L (Rel. Time) <= 1.00%	Data File Path : C:\chem\3211DATA\AQGPV20 2100QPV2021_9 2021-10-20 17-13-45\NUPREC_8007.D\FID28.ch
October 21, 2021 9:39:06 AM	End	Execution	Injection Precision - Injection Tower, Back SSL, Back FID - GC - L (Area) <= 3.00% - L (Rel. Time) <= 1.00%	Run Count : 1
October 21, 2021 9:38:11 AM	Start	Execution	Signal to Noise - Injection Tower, Back SSL, Back FID - Detector FID - L : >= 300000	None
October 21, 2021 9:39:29 AM	Audit	Data	Injection Precision - Injection Tower, Back SSL, Back FID - Detector FID - L : >= 300000	Data File Path : C:\chem\3211DATA\AQGPV20 2100QPV2021_8 2021-10-20 17-13-45\SIGQ10-H_8001.D\FID28.ch
October 21, 2021 9:38:38 AM	End	Execution	Signal to Noise - Injection Tower, Back SSL, Back FID - Detector FID - L : >= 300000	Run Count : 1
October 21, 2021 9:39:43 AM	End	Qualification	Session	OQ
October 21, 2021 9:39:43 AM	Start	Reporting	Session	None
October 21, 2021 10:04:15 AM	Audit	Reporting	Session	Report Generated : Certificate

SITHIPORN ASSOCIATES CO.,LTD.
CALIBRATION LABORATORY

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



Cert. No. : ACC21009
Pages : 1 of 3

Calibration Certificate

Equipment :	SOUND CALIBRATOR
Manufacturer :	RJON
Model :	NC-74
Serial No.:	34178123
ID No.:	RYG_FS0215

Condition As Found : GOOD

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

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

Received Date : 05 AUGUST 2021
 Callbration Date : 09 AUGUST 2021
 Date of Issue : 11 AUGUST 2021

Calibrated by : Nathakorn Pisutpaisan

Approved by :

T. Petchuraj
(Thanakul Petchuraj)

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

Continuation of Calibration Certificate

Cert. No. : ACC21009
Job No. : VC64AC0058
Pages : 2 of 3

Calibration Procedure : CP-AC-03

Calibration Method :

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

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

Condition of this result of calibration :

1. Reference Standard Instruments :

Instrument	Model	Serial No.	Cert. No.	Due Date
Waveform Generator	33511B	MY52302742	EP-0011-21	10-Feb-22
Digital Multimeter	33461A	MY53220104	EEL.BP. 05/0264	10-Feb-22
Digital Multimeter	8846A	1997025	EEL.BP. 06/0264	05-Feb-22
Digital Multimeter	33461A	MY53220116	EEL.BP. 04/0264	10-Feb-22
Programmable Attenuator	MAT-1070	62100114	1500-07774E	08-Mar-22
Condenser Microphone	4180	2977900	AA-1008-21	05-Feb-22
Measuring Amplifier	NA-42K41	35460495	EA-3003-21	16-Feb-22
Audio Analyzer	AVR-3360A	V744B6069	EP-001-21	10-Feb-22

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

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

3.1 National Institute of Metrology (Thailand).

3.2 Thailand Institute of Scientific and Technological Research (TISTR)

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Continuation of Calibration Certificate

Cert. No. : ACC21009
Job No. : VC64AC0058
Pages : 3 of 3

Result of calibration :

1. Sound pressure level

Specified sound pressure level (dB)	Measured value (dB)	Deviated value (dB)	Uncertainty (dB)	Tolerance limit (dB)
94	94.06	0.06	0.14	0.40

2. Frequency

Specified Frequency (Hz)	Measured value (Hz)	Deviated value (%)	Uncertainty (%)	Tolerance limit (%)
1000	1001.5	0.1	0.1	1.0

3. Total distortion

Measured value (%)	Uncertainty (%)	Tolerance limit (%)
1.67	0.10	3.0

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

End of Calibration Certificate

QF-TS12-04-04-020664

Continuation of Calibration Certificate

Cert. No. : ACL21117
Job No. : VC64AC0070
Pages : 2 of 8

Calibration Procedure : CP-AC-01

Calibration Method :

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

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

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

Condition of this result of calibration :

1. Reference Standard Instruments :

Instrument	Model	Serial No.	Cert. No.	Due Date
Waveform Generator	33210A	MY48017076	EF-0012-21	10-Feb-22
Waveform Generator	33511B	MY52302742	EF-0011-21	10-Feb-22
Digital Multimeter	33461A	MY53220104	EEL.BP. 05/0264	10-Feb-22
Digital Multimeter	33461A	MY53220076	EEL.BP. 03/0264	08-Feb-22
Digital Multimeter	8846A	1997025	EEL.BP. 06/0264	05-Feb-22
Programmable Attenuator	MAT-1070	62100114	1500-07774E	08-Mar-22
Condenser Microphone	4180	2977900	AA-1008-21	05-Feb-22
Measuring Amplifier	NA-42KA1	34560495	AA-3003-21	16-Feb-22

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

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

3.1 National Institute of Metrology (Thailand).

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

QF-TS12-04-04-020664

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



Cert. No. : ACL21117
Pages : 1 of 8

Calibration Certificate

Equipment : SOUND LEVEL METER
Manufacturer : RION
Model : NL-42/ Microphone UC-52 / Preamplifier NH-24
Serial No. : 0023183 / 144835 / 23230
ID No. : RYG_FS0024

Condition As Found : GOOD

Customer : ALS LABORATORY GROUP (THAILAND) CO., LTD.
104 PHATTHANAKAN 40, PHATTHANAKAN ROAD,
KHWANG 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 : 21 SEPTEMBER 2021
Calibration Date : 04-06 OCTOBER 2021
Date of Issue : 11 OCTOBER 2021

REVIEW BY : *Nathakorn Pisutpaisan*
APPROVED BY : *T. Petchurai*
NEXT CAL DATE : 4/10/22

Calibrated by : Nathakorn Pisutpaisan

Approved by :

T. Petchurai
(Thanakul Petchurai)

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

QF-TS12-04-04-020664

Continuation of Calibration Certificate

Cert. No. : ACL21117
Job No. : VC64AC0070
Pages : 3 of 8

Summary of Measurement Result :

Parameter	Pass	Fail	Uncertainty (dB)	Maximum-permitted uncertainty of measurement (dB)
1. Absolute sensitivity	✓	-	0.2	N/A
2. Self-generated noise	✓	-	0.2	N/A
3. Acoustical signal tests of frequency weightings				
125 Hz	✓	-	0.3	0.6
1000 Hz	✓	-	0.3	0.6
8000 Hz	✓	-	0.4	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

QF-TS12-04-04-020664

Continuation of Calibration Certificate

Cert. No. : ACL21117
Job No. : VC64AC0070
Pages : 4 of 8

Result of calibration :

1. Absolute sensitivity

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

2. Self-generated noise

2.1 Normal test

Measured Value (dB)
22.9

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	19.7
Flat	25.4

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	-0.1	-0.1	-0.1	± 1.5
1000	0.0	-0.1	0.0	± 1.0
8000	0.3	0.4	0.4	±5.0

Continuation of Calibration Certificate

Cert. No. : ACL21117
Job No. : VC64AC0070
Pages : 5 of 8

4. Electrical signal tests of frequency weightings

Weighting network response with relative to 1 kHz.

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

5. Frequency and time weightings at 1 kHz

5.1 Frequency weightings at 1 kHz

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

5.2 Time weighting at 1 kHz

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

6. Long-term stability

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

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Continuation of Calibration Certificate

Cert. No. : ACL21117
Job No. : VC64AC0070
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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	34.0	0.0	±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	27.1	0.1	±1.1
26.0	26.1	0.1	±1.1
25.0	25.2	0.2	±1.1

Continuation of Calibration Certificate

Cert. No. : ACL21117
Job No. : VC64AC0070
Pages : 7 of 8

8. Level linearity including the level range control

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

9. Tone burst response

Time Weighting	Tone burst duration, Tb (ms)	Cycle	Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Fast	0.25	1	108.0	107.9	-0.1	1.5 ; -5.0
	2	8	117.0	117.0	0.0	1.0 ; -2.5
	200	800	134.0	134.1	0.1	±1.0
Slow	2	8	108.0	108.0	0.0	1.5 ; -5.0
	200	800	127.6	127.6	0.0	±1.0
	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 _{peak} (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Continuous	133.0	133.0	0.0	-
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	133.1	0.1	-
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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Continuation of Calibration Certificate

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11. Overload Indication

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

12. High level stability

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

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

End of Calibration Certificate

451-451/1 Sridinthorn Rd, Bangbunru, Bangkok Bangkok 10700 THAILAND.
Tel:0-2435-8800 Fax:0-2433-1579 e-mail:cal-center@sithiporn.com http://www.sithiporn.comCert. No. : ACL22054
Pages : 1 of 8

Calibration Certificate

Equipment : SOUND LEVEL METER
Manufacturer : RION
Model : NL-42/ Microphone UC-52 / Preamplifier NH-24
Serial No. : 00233184 / 144837 / 23232
ID No. : RYQ_FS0025

Condition As Found : GOOD

Customer : ALS LABORATORY GROUP (THAILAND) CO., LTD.
104 PHATTHANAKAN 40, PHATTHANAKAN ROAD,
KHWANG 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 : 14 JANUARY 2022
Calibration Date : 21-24 JANUARY 2022
Date of Issue : 25 JANUARY 2022

REVIEW BY	<i>Nathakorn P.</i>
APPROVED BY	<i>T. Petchur</i>
NEXT CAL. DATE	01/1/23

Calibrated by : Nathakorn Pisurpaian

Approved by :

T. Petchur
(Thanakul Petchur)

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Continuation of Calibration Certificate

Cert. No. : ACL22054
Job No. : VC65AC0043
Pages : 2 of 8

Calibration Procedure : CP-AC-01

Calibration Method :

This equipment was calibrated by based on IEC-61672-3 (2013) Standard for sound level meter (SLM).
The SLM had tests to Acoustical and Electrical signal tests of frequency weighting with Anechoic chamber and Reference Standard Instruments.

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

Condition of this result of calibration :

1. Reference Standard Instruments :

Instrument	Model	Serial No.	Cert. No.	Due Date
Waveform Generator	33210A	MY48017076	EF-0012-21	10-Feb-22
Waveform Generator	33511B	MY52302742	EF-0011-21	10-Feb-22
Digital Multimeter	33461A	MY53220104	EEL-BP_05/0264	10-Feb-22
Digital Multimeter	33461A	MY53220076	EEL-BP_03/0264	08-Feb-22
Digital Multimeter	34461A	MY60024273	I-15180725251-1	15-Sep-22
Programmable Attenuator	MAT-1070	62100114	1500-07774E	08-Mar-22
Condenser Microphone	4180	2977900	AA-1008-21	05-Feb-22
Measuring Amplifier	NA-42KA1	34560495	AA-3003-21	16-Feb-22

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

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

3.1 National Institute of Metrology (Thailand).

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

Continuation of Calibration Certificate

Cert. No. : ACL22054
Job No. : VC65AC0043
Pages : 3 of 8

Summary of Measurement Result :

Parameter	Pass	Fail	Uncertainty (dB)	Maximum-permitted uncertainty of measurement (dB)
1. Absolute sensitivity	✓	-	0.2	N/A
2. Self-generated noise	✓	-	0.2	N/A
3. Acoustical signal tests of frequency weightings				
125 Hz	✓	-	0.3	0.6
1000 Hz	✓	-	0.3	0.6
8000 Hz	✓	-	0.4	0.7
4. Electrical signal tests of frequency weightings				
For 10 Hz to 4 kHz	✓	-	0.3	0.6
For > 4 kHz to 10 kHz	✓	-	0.3	0.7
For > 10 kHz to 20 kHz	-	-	-	1.0
5. Frequency and time weightings at 1 kHz	✓	-	0.2	0.2
6. Long-term stability	✓	-	0.1	0.1
7. Level linearity on the reference level range	✓	-	0.2	0.3
8. Level linearity including the level range control	✓	-	0.2	0.3
9. Tone burst response	✓	-	0.2	0.3
10. Peak C' sound level	✓	-	0.2	0.35
11. Overload indication	✓	-	0.2	0.25
12. High level stability	✓	-	0.1	0.1

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Continuation of Calibration Certificate

Cert. No. : ACL22054
Job No. : VC65AC0043
Pages : 4 of 8

Result of calibration :

1. Absolute sensitivity

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

2. Self-generated noise

2.1 Normal test

Measured Value (dB)
14.2

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

Frequency Weighting	Measured value (dB)
A - weight	10.8
C - weight	17.0
Flat	22.8

3. Acoustical signal tests of frequency weightings

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

Frequency (Hz)	Deviation from various frequency weighting response curve (dB)			
	Flat	C-weight	A-weight	Acceptance Limits
125	0.2	0.2	0.2	± 1.5
1000	0.0	0.0	0.0	± 1.0
8000	-0.9	-0.8	-0.8	±5.0

Continuation of Calibration Certificate

Cert. No. : ACL22054
Job No. : VC65AC0043
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	-0.1	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	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
A - weight	94.0	0.0	-
C - weight	94.0	0.0	± 0.2
Flat	94.0	0.0	± 0.2

5.2 Time weighting at 1 kHz

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

6. Long - term stability

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

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Continuation of Calibration Certificate

Cert. No. : ACL22054
Job No. : VC65AC0043
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	131.9	-0.1	± 1.1
131.0	130.9	-0.1	± 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

Continuation of Calibration Certificate

Cert. No. : ACL22054
Job No. : VC65AC0043
Pages : 7 of 8

8. Level linearity including the level range control

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

9. Tone burst response

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

10. Peak C sound level

Number of cycle in test signal	Anticipated Value (dB)	Measured Value, L _{peak} (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Continuous	133.0	133.0	0.0	-
One	136.4	136.4	0.0	±3.0

Number of cycle in test signal	Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Continuous	133.0	133.0	0.0	-
Positive half cycle	135.4	135.1	-0.3	±2.0
Negative half cycle	135.4	135.2	-0.2	±2.0

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Continuation of Calibration Certificate

Cert. No. : ACL22054
Job No. : VC65AC0043
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	89.5	-0.1	±1.5

12. High level stability

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

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

End of Calibration Certificate

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



Cert. No. : ACL22025
Pages : 1 of 8

Calibration Certificate

Equipment : SOUND LEVEL METER
Manufacturer : RION
Model : NL-42/ Microphone UC-52 / Preamp. NH-24
Serial No. : 00734221 / 145286 / 34371
ID No. : RYG_FS0027

Condition As Found : GOOD

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

Location : -
Ambient Temperature : (23.0 ± 3) °C
Pressure : (101.3 ± 3) kPa
Relative Humidity : (50.0 ± 20) %
Received Date : 05 JANUARY 2022
Calibration Date : 10-12 JANUARY 2022
Date of Issue : 13 JANUARY 2022

REVIEW BY : *Nathakorn P.*
APPROVED BY : *[Signature]*
NEXT CAL DATE : 10/1/23

Calibrated by : Nathakorn Pisutpaisan

Approved by :

[Signature]
(Thanakul Petchurai)

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Continuation of Calibration Certificate

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

Calibration Procedure : CP-AC-01

Calibration Method :

This equipment was calibrated by based on IEC-61672-3 (2013) Standard for sound level meter (SLM).
The SLM had tests to Acoustical and Electrical signal tests of frequency weighting with Anechoic chamber and Reference Standard Instruments.

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

Condition of this result of calibration :

1. Reference Standard Instruments :

Instrument	Model	Serial No.	Cert. No.	Due Date
Waveform Generator	33210A	MY48017076	EF-0012-21	10-Feb-22
Waveform Generator	33511B	MY52302742	EP-0011-21	10-Feb-22
Digital Multimeter	33461A	MY53220104	EEL.BP.03/0264	10-Feb-22
Digital Multimeter	33461A	MY53220076	EEL.BP.03/0264	08-Feb-22
Digital Multimeter	34461A	MY60024273	1-15180725251-1	15-Sep-22
Programmable Attenuator	MAT-1070	62100114	1500-07774E	08-Mar-22
Condenser Microphone	4180	2977900	AA-1008-21	05-Feb-22
Measuring Amplifier	NA-42KA1	34560495	AA-3003-21	16-Feb-22

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

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

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

Continuation of Calibration Certificate

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

Summary of Measurement Result :

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

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Continuation of Calibration Certificate

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

Result of calibration :

1. Absolute sensitivity

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

2. Self-generated noise

2.1 Normal test

Measured Value (dB)
16.2

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

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

3. Acoustical signal tests of frequency weightings

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

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

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T P.T.A.

Continuation of Calibration Certificate

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

7. Level linearity on the reference level range

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

QF-TS12-04-04-020664

T P.T.A.

Continuation of Calibration Certificate

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

4. Electrical signal tests of frequency weightings

Weighting network response with relative to 1 kHz.

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

5. Frequency and time weightings at 1 kHz

5.1 Frequency weightings at 1 kHz

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

5.2 Time weighting at 1 kHz

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

6. Long-term stability

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

QF-TS12-04-04-020664

T P.T.A.

Continuation of Calibration Certificate

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

8. Level linearity including the level range control

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

9. Tone burst response

Time Weighting	Tone burst duration, Tb (ms)	Cycle	Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Fast	0.25	1	108.0	108.0	0.0	1.5; -5.0
	2	8	117.0	117.0	0.0	1.0; -2.5
	200	800	134.0	134.1	0.1	±1.0
Slow	2	8	108.0	108.0	0.0	1.5; -5.0
	200	800	127.6	127.6	0.0	±1.0
SEL	0.25	1	99.0	98.9	-0.1	1.5; -5.0
	2	8	108.0	108.0	0.0	1.0; -2.5
	200	800	128.0	128.1	0.1	±1.0

10. Peak C sound level

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

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

QF-TS12-04-04-020664

T P.T.A.

Continuation of Calibration Certificate

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

11. Overload indication

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


12. High level stability

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


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

End of Calibration Certificate

QF-TS12-04-04-020664



**ELECTRICAL AND ELECTRONICS INSTITUTE
FOUNDATION FOR INDUSTRIAL DEVELOPMENT**
975 Moo 4, Bangpoo Industrial Estate, Soi 8, Sukhumvit Road km 37,
Phraek Sa, Mueang Samut Prakan, Samut Prakan 10280
Tel: +66 2709 4860-8 Fax: +66 2324 0917-8



Certificate No.: 0168SV21
Operation No.: CP2021040004

Certificate of Calibration

Equipment: Sound Level Meter
Manufacturer: RION
Model/Type: NL-42 (Meter), UC-52 (Microphone), NH-24 (Preamplifier)
Serial No.: 00734223 (Meter), 157777 (Microphone), 22653 (Preamplifier)
ID No.: RYG_FS0029
Customer: ALS Laboratory Group (Thailand) Co., Ltd.
Address: 104 Phatthanakan 40, Phatthanakan Rd., Khwaeng Phatthanakan
Khet Suan Luang, Bangkok 10250 Thailand

Received Date: 7 April 2021
Calibrated Date: 21 - 27 April 2021
Issued Date: 28 April 2021
Calibrated by: Ms. Juntaporn Kunhakom

REVIEW BY: *M. P.*
APPROVED BY: *[Signature]*
NEXT CAL. DATE: 21/12/22

Approved by: *[Signature]*
(Mr. Sittichai Swaksuriyawong)
Group Manager

The reported uncertainty of measurement was based on standard uncertainty multiplied by a coverage factor $k = 2.00$, providing a level of confidence of approximately 95%. This certificate may not be reproduced other than in full except with the prior written approval of the Electrical and Electronics Institute, Foundation for Industrial Development.

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F-CAL-004 Ed.0



ELECTRICAL AND ELECTRONICS INSTITUTE
FOUNDATION FOR INDUSTRIAL DEVELOPMENT

Certificate No.: 0168SV21

Calibration Report

Equipment: Sound Level Meter
Manufacturer: RION
Model/Type: NL-42 (Meter), UC-52 (Microphone), NH-24 (Preamplifier)
Serial No.: 00734223 (Meter), 157777 (Microphone), 22653 (Preamplifier)
ID No.: RYG_FS0029
Ambient Temperature: (23 ± 2) °C
Relative Humidity: (50 ± 15) %
Pressure: (101.3 ± 1.5) kPa

Method of Calibration :-

IEC61672-3:2013.

Condition of this result of calibration

1. Reference standards Instrument :-

Instrument	Model	Serial No.	Cert. No.	Due Date
1) Standard microphone	4180	2661000	AA-1013-20	12 May 2021
2) Sine generator	1051	1501442	0151RF20	21 September 2021
3) Arbitrary Function Generator	AFG2021	C010063	0099RF20	17 June 2021
4) Programmable Attenuator	PA5	2755	EF-0034-20	10 November 2021
5) 6.5 Digit precision multimeter	8846A	9609027	0498EL20	10 August 2021
6) 6.5 Digit precision multimeter	8846A	9610014	0669EL20	27 October 2021
7) Pressure humidity and Temperature Transmitter	PTU301	F0640002	CL1-P2000051	31 May 2021
8) Pressure humidity and Temperature Transmitter	PTU301	F0640003	CL1-P2000052	28 June 2021
			0305TE20	28 June 2021

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

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

- Reference standards Instrument for Acoustic function
- National Institute of Metrology (Thailand)
- Reference standards Instrument for Electrical function
- National Institute of Metrology (Thailand)
- Electrical and Electronics Institute; ONSC Accredited Calibration No.0119

Result of Calibration:-

Function : 1. Indication at the calibration check frequency

Reference Acoustic Signal (dB)	Measured value (dB)	Deviation (dB)	Acceptance Limits (dB)
94.0	94.0	0.0	±1.0

Note : Absolute sensitivity was established by the use of the Sound Calibrator RION Type NC-74 S/N : 34615278.



ELECTRICAL AND ELECTRONICS INSTITUTE
FOUNDATION FOR INDUSTRIAL DEVELOPMENT

Certificate No.: 0168SV21

Calibration Report

Function : 2. Self-generated Noise

2.1 Microphone installed

Measured value (dB)
19.1

2.2 Microphone replaced by the electrical input signal device

Frequency Weighting	Measured value (dB)
A-weighting	12.0
C-weighting	18.5
Z-weighting	23.8

Function : 3. Acoustical signal tests of frequency weightings (Without Windscreen)

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

Frequency (Hz)	Deviation from various Frequency Weighting Response Curve			
	C-Weighting (dB)	A-Weighting (dB)	Z-Weighting (dB)	Acceptance Limits (dB)
125	0.6	0.7	0.6	±1.5
1000	0.0	0.0	0.0	±1.0
8000	-2.4	-2.4	-2.4	±5.0

Function : 4. Electrical signal tests of frequency weightings

Weighting network response with relative to 1 kHz.

Frequency (Hz)	Deviation from various Frequency Weighting Response Curve			
	C-Weighting (dB)	A-Weighting (dB)	Z-Weighting (dB)	Acceptance Limits (dB)
63	-0.1	-0.1	0.0	±2.0
125	0.0	-0.1	0.0	±1.5
250	0.0	-0.1	0.0	±1.5
500	0.0	0.0	0.0	±1.5
1000	0.0	0.0	0.0	±1.0
2000	0.1	0.1	0.0	±2.0
4000	0.1	0.0	0.0	±3.0
8000	0.1	0.1	0.0	±5.0

Function : 5. Frequency and time weighting at 1 kHz

5.1 Frequency weighting at 1 kHz

Frequency Weighting	Measured value (dB)	Deviated value (dB)	Acceptance Limits (dB)
C-weighting	94.0	0.0	±0.2
A-weighting	94.0	0.0	±0.2
Z-weighting	94.0	0.0	±0.2



Certificate No.: 0168SV21

Calibration Report

5.2 Time weighting at 1 kHz

Time Weighting	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
Fast	94.0	0.0	±0.1
Slow	94.0	0.0	±0.1
LAeq	94.0	0.0	±0.1

Function : 6. Long-Term Stability

Long-term stability over 30 minutes, with steady 1 kHz signal at reference level.

Time Period to Apply Signal (min)	Reference SPL (dB)	Record SPL at Conclusion of Time Period (dB)	Deviated value (dB)	Acceptance limits (dB)
30	94.0	94.0	0.0	±0.3

Function : 7. Level Linearity on the reference level range

7.1 Level Linearity on the reference level range, Upper

Anticipated Value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
94.0	94.0	0.0	±1.1
99.0	99.0	0.0	±1.1
104.0	104.0	0.0	±1.1
109.0	109.0	0.0	±1.1
114.0	114.0	0.0	±1.1
119.0	119.0	0.0	±1.1
124.0	124.0	0.0	±1.1
129.0	129.0	0.0	±1.1
130.0	130.0	0.0	±1.1
131.0	131.0	0.0	±1.1
132.0	132.0	0.0	±1.1
133.0	133.0	0.0	±1.1
134.0	134.0	0.0	±1.1
135.0	135.0	0.0	±1.1
136.0	136.0	0.0	±1.1
137.0	137.0	0.0	±1.1

7.2 Level Linearity on the reference level range, Lower

Anticipated Value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
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

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Certificate No.: 0168SV21

Calibration Report

7.2 Level Linearity on the reference level range, Lower (Cont.)

Anticipated Value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
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
29.0	29.0	0.0	±1.1
24.0	24.0	0.0	±1.1

Function : 8. Tone burst response

Time Weighting	Tone burst duration, Tb (ms)	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
Fast	200	126.0	0.0	±1.0
	2	109.0	0.0	+1.0; -2.5
	0.25	99.9	-0.1	+1.5; -5.0
Slow	200	119.6	0.0	±1.0
	2	100.0	0.0	+1.0; -5.0
	200	120.0	0.0	±1.0
LAE	2	100.0	0.0	+1.0; -2.5
	0.25	90.9	-0.1	+1.5; -5.0

Function : 9. Peak C sound level

Number of cycles in test signal	Anticipated Value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
Complete cycle	125.4	125.2	-0.2	±3.0
Positive half cycle	124.4	124.1	-0.3	±2.0
Negative half cycle	124.4	124.1	-0.3	±2.0

Function : 10. Overload Indication

Measured value (dB)		Deviated value (dB)	Acceptance limits (dB)
Positive one-half cycle	Negative one-half cycle		
139.5	139.4	-0.1	±1.5

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Certificate No.: 0168SV21

Calibration Report

Function : 11. High-Level Stability

High-level stability over 5 minutes, with steady 1 kHz signal, 1 dB below upper boundary.

Time Period to Apply Signal (min)	Reference SPL (dB)	Record SPL at Conclusion of Time Period (dB)	Deviated value (dB)	Acceptance limits (dB)
5	129.0	129.0	0.0	±0.3

Uncertainty of measurement

Function	Uncertainty (dB)	Maximum-permitted uncertainty of measurement (dB)
1) Indication at the calibration check frequency	0.30	Not applicable
2) Self-generated Noise	0.10	Not applicable
3) Acoustical signal tests of frequency weightings - Free-field sound pressure response level	0.30	0.60 (10Hz to 4kHz) 0.70 (>4kHz to 10kHz)
4) Electrical signal tests of frequency weightings	0.20	0.20
5) Frequency and time weighting at 1 kHz	0.20	0.20
6) Long-Term Stability	0.10	0.10
7) Level Linearity on the reference level range	0.30	0.30
8) Tone burst response	0.20	0.30
9) Peak C sound level	0.20	0.35
10) Overload indication	0.20	0.25
11) High-Level Stability	0.10	0.10

Remarks: 1. The acceptance limit is for the deviated value.
2. Acceptance limits was IEC61672-3:2013 Class 2.

-- End of Report --

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SITHIPORN ASSOCIATES CO.,LTD. CALIBRATION LABORATORY

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



Cert. No.: ACL22060
Pages : 1 of 8

Calibration Certificate

Equipment : SOUND LEVEL METER
Manufacturer : RION
Model : NL-42/ Microphone UC-52 / Preamplifier NH-24
Serial No.: 00734225 / 169439 / 72460
ID No.: RYG_FS0030

Condition As Found : GOOD

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

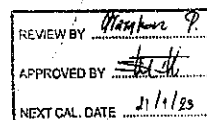
Location :
Ambient Temperature : (23.0 ± 3) °C
Pressure : (101.3 ± 3) kPa
Relative Humidity : (50.0 ± 20) %

Received Date : 14 JANUARY 2022
Calibration Date : 21-24 JANUARY 2022
Date of Issue : 25 JANUARY 2022

Calibrated by : Nathakorn Pisutpaisan

Approved by :

(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.

QP-TS12-14-04-020664

Continuation of Calibration Certificate

Cert. No. : ACL22060
Job No. : VC65AC0043
Pages : 2 of 8

Calibration Procedure : CP-AC-01

Calibration Method :

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

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

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

Condition of this result of calibration :

1. Reference Standard Instruments :

Instrument	Model	Serial No.	Cert. No.	Due Date
Waveform Generator	33210A	MY48017076	EP-0012-21	10-Feb-22
Waveform Generator	33511B	MY52302742	EP-0011-21	10-Feb-22
Digital Multimeter	33461A	MY53220104	EEL.BP. 05/0264	10-Feb-22
Digital Multimeter	33461A	MY53220076	EEL.BP. 03/0264	08-Feb-22
Digital Multimeter	34461A	MY60024273	1-15180725251-1	15-Sep-22
Programmable Attenuator	MAT-1070	62100114	1500-07774E	08-Mar-22
Condenser Microphone	4180	2977900	AA-1008-21	05-Feb-22
Measuring Amplifier	NA-42KA1	34560495	AA-3003-21	16-Feb-22

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

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

3.1 National Institute of Metrology (Thailand).

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

QF-TS12-04-04-020664

T. Ratan.

Continuation of Calibration Certificate

Cert. No. : ACL22060
Job No. : VC65AC0043
Pages : 4 of 8

Result of calibration :

1. Absolute sensitivity

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

2. Self-generated noise

2.1 Normal test

Measured Value (dB)
14.2

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

Frequency Weighting	Measured value (dB)
A-weight	10.8
C-weight	17.2
Flat	23.0

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	-0.1	-0.1	-0.1	± 1.0
8000	-1.6	-1.5	-1.5	±5.0

QF-TS12-04-04-020664

T. Ratan.

Continuation of Calibration Certificate

Cert. No. : ACL22060
Job No. : VC65AC0043
Pages : 3 of 8

Summary of Measurement Result :

Parameter	Pass	Fail	Uncertainty (dB)	Maximum-permitted uncertainty of measurement (dB)
1. Absolute sensitivity	✓	-	0.2	N/A
2. Self-generated noise	✓	-	0.2	N/A
3. Acoustical signal tests of frequency weightings				
125 Hz	✓	-	0.3	0.6
1000 Hz	✓	-	0.3	0.6
8000 Hz	✓	-	0.4	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

QF-TS12-04-04-020664

T. Ratan.

Continuation of Calibration Certificate

Cert. No. : ACL22060
Job No. : VC65AC0043
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	-0.1	0.0	±2.0
125	0.0	0.0	0.0	±1.5
250	0.0	0.0	-0.1	±1.5
500	0.0	0.0	-0.1	±1.5
1000	0.0	0.0	0.0	±1.0
2000	0.0	0.0	0.0	±2.0
4000	0.0	0.0	0.0	±3.0
8000	0.0	0.1	0.1	±5.0

5. Frequency and time weightings at 1 kHz

5.1 Frequency weightings at 1 kHz

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

5.2 Time weighting at 1 kHz

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

6. Long-term stability

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

QF-TS12-04-04-020664

T. Ratan.

Continuation of Calibration Certificate

Cert. No. : ACL22060
Job No. : VC65AC0043
Pages : 6 of 8

7. Level linearity on the reference level range

Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
137.0	137.0	0.0	±1.1
136.0	136.0	0.0	±1.1
135.0	135.0	0.0	±1.1
134.0	134.0	0.0	±1.1
133.0	132.9	-0.1	±1.1
132.0	131.9	-0.1	±1.1
131.0	130.9	-0.1	±1.1
129.0	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	27.0	0.0	±1.1
26.0	26.1	0.1	±1.1
25.0	25.1	0.1	±1.1

QF-TS12-04-04-020604

T. R. R.

Continuation of Calibration Certificate

Cert. No. : ACL22060
Job No. : VC65AC0043
Pages : 7 of 8

8. Level linearity including the level range control

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

9. Tone burst response

Time Weighting	Tone burst duration, Tb (ms)	Cycle	Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Fast	0.25	1	108.0	107.9	-0.1	1.5 ; -5.0
	2	8	117.0	117.0	0.0	1.0 ; -2.5
	200	800	134.0	134.0	0.0	±1.0
Slow	2	8	108.0	108.0	0.0	1.5 ; -5.0
	200	800	127.6	127.6	0.0	±1.0
	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, Lepeak (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Continuous	133.0	133.0	0.0	-
One	136.4	135.8	-0.6	±3.0

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

QF-TS12-04-04-020604

T. R. R.

Continuation of Calibration Certificate

Cert. No. : ACL22060
Job No. : VC65AC0043
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	89.5	-0.1	±1.5

12. High level stability

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

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

End of Calibration Certificate



ELECTRICAL AND ELECTRONICS INSTITUTE
FOUNDATION FOR INDUSTRIAL DEVELOPMENT
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Phraek Sa, Mueang Samut Prakan, Samut Prakan 10280
Tel: +66 2709 4860-8 Fax: +66 2324 0917-8

Certificate No.: 02245V21
Operation No.: CP2021050034

Certificate of Calibration

Equipment: Sound Level Meter
Manufacturer: RION
Model/Type: NL-42 (Meter), UC-52 (Microphone), NH-24 (Preamplifier)
Serial No.: 00472130 (Meter), 157774 (Microphone), 72464 (Preamp) (Preamplifier)
ID No.: RYG_F50303
Customer: ALS Laboratory Group (Thailand) Co., Ltd.
Address: 104 Phatthanakan 40, Phatthanakan Rd., Khwaeng Phatthanakan Khet Suan Luang, Bangkok 10250 Thailand
Received Date: 28 May 2021
Calibrated Date: 2 - 9 June 2021
Issued Date: 11 June 2021
Calibrated by: Ms. Juntaporn Kunhakom

REVIEW BY: [Signature]
APPROVED BY: [Signature]
NEXT CAL DATE: 2/6/22

Approved by:

[Signature]
(Mr. Sittichai Svanthong)
Group Manager, Electrical and Electronics Institute

The reported uncertainty of measurement was based on standard uncertainty multiplied by a coverage factor $k = 2.00$, providing a level of confidence of approximately 95%. This certificate may not be reproduced other than in full except with the prior written approval of the Electrical and Electronics Institute, Foundation for Industrial Development.



Certificate No.: 02245V21

Calibration Report

Equipment: Sound Level Meter
Manufacturer: RION
Model/Type: NL-42 (Meter), UC-52 (Microphone), NH-24 (Preamplifier)
Serial No.: 00472130 (Meter), 157774 (Microphone), 72464 (Preamplifier)
ID No.: RYG_FS0303
Ambient Temperature: (23 ± 2) °C
Relative Humidity: (50 ± 15) %
Pressure: (101.3 ± 1.5) kPa

Method of Calibration :-

IEC 61672-3:2013.

Condition of this result of calibration

1. Reference standards instrument :-

Instrument	Model	Serial No.	Cert. No.	Due Date
1) Standard microphone	4180	2787490	AA-1001-21	12 January 2022
2) Sine generator	1051	1501442	0151RF20	21 September 2021
3) Arbitrary Function Generator	AFG2021	C010063	0099RF20	17 June 2021
4) Programmable Attenuator	PA5	2913	EF-0017-21	1 April 2022
5) Programmable Attenuator	PA5	2755	EF-0034-20	10 November 2021
6) 6.5 Digit precision multimeter	8846A	9609027	0498EL20	10 August 2021
7) 6.5 Digit precision multimeter	8846A	9610014	0669EL20	27 October 2021
8) Pressure humidity and Temperature Transmitter	PTU301	L3950484	CL1-P210020	22 March 2022
			0176TE21	1 April 2022

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

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

Reference standards instrument for Acoustic function

- National Institute of Metrology (Thailand)

Reference standards instrument for Electrical function

- National Institute of Metrology (Thailand)

- Electrical and Electronics Institute, ONSC Accredited Calibration No.0119

Result of Calibration:-

Function : 1. Indication at the calibration check frequency

Reference Acoustic Signal (dB)	Measured value (dB)	Deviation (dB)	Acceptance Limits (dB)
94.0	94.0	0.0	±1.0

Note : Absolute sensitivity was established by the use of the Sound Calibrator RION Type NC-74 S/N : 34615278.



Certificate No.: 02245V21

Calibration Report

Function : 2. Self-generated Noise

2.1 Microphone Installed

Measured value (dB)
19.6

2.2 Microphone replaced by the electrical input signal device

Frequency Weighting	Measured value (dB)
A-weighting	15.8
C-weighting	21.5
Z-weighting	27.7

Function : 3. Acoustical signal tests of frequency weightings (Without Windscreen)

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

Frequency (Hz)	Deviation from various Frequency Weighting Response Curve			
	C-Weighting (dB)	A-Weighting (dB)	Z-Weighting (dB)	Acceptance Limits (dB)
125	0.3	0.7	0.3	±1.5
1000	0.0	0.0	0.0	±1.0
8000	-0.9	-0.9	-1.0	±5.0

Function : 4. Electrical signal tests of frequency weightings

Weighting network response with relative to 1 kHz.

Frequency (Hz)	Deviation from various Frequency Weighting Response Curve			
	C-Weighting (dB)	A-Weighting (dB)	Z-Weighting (dB)	Acceptance Limits (dB)
63	0.0	-0.1	0.0	±2.0
125	0.0	-0.2	0.0	±1.5
250	0.0	-0.1	0.0	±1.5
500	0.0	-0.1	0.0	±1.5
1000	0.0	0.0	0.0	±1.0
2000	0.1	0.0	0.0	±2.0
4000	0.0	0.0	0.0	±3.0
8000	0.1	0.1	0.0	±5.0

Function : 5. Frequency and time weighting at 1 kHz

5.1 Frequency weighting at 1 kHz

Frequency Weighting	Measured value (dB)	Deviated value (dB)	Acceptance Limits (dB)
C-weighting	94.0	0.0	±0.2
A-weighting	94.0	0.0	±0.2
Z-weighting	94.0	0.0	±0.2



Certificate No.: 02245V21

Calibration Report

5.2 Time weighting at 1 kHz

Time Weighting	Measured value (dB)	Deviated value (dB)	Acceptance Limits (dB)
Fast	94.0	0.0	±0.1
Slow	94.0	0.0	±0.1
Laeq	94.0	0.0	±0.1

Function : 6. Long-Term Stability

Long-term stability over 30 minutes, with steady 1 kHz signal at reference level.

Time Period to Apply Signal (min)	Reference SPL (dB)	Record SPL at Conclusion of Time Period (dB)	Deviated value (dB)	Acceptance limits (dB)
30	94.0	94.0	0.0	±0.3

Function : 7. Level Linearity on the reference level range

7.1 Level Linearity on the reference level range, Upper

Anticipated Value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
94.0	94.0	0.0	±1.1
99.0	99.0	0.0	±1.1
104.0	104.0	0.0	±1.1
109.0	109.0	0.0	±1.1
114.0	114.0	0.0	±1.1
119.0	119.0	0.0	±1.1
124.0	124.0	0.0	±1.1
129.0	129.0	0.0	±1.1
130.0	130.0	0.0	±1.1
131.0	131.0	0.0	±1.1
132.0	132.0	0.0	±1.1
133.0	133.0	0.0	±1.1
134.0	134.0	0.0	±1.1
135.0	135.0	0.0	±1.1
136.0	136.0	0.0	±1.1
137.0	137.0	0.0	±1.1

7.2 Level Linearity on the reference level range, Lower

Anticipated Value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
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



Certificate No.: 02245V21

Calibration Report

7.2 Level Linearity on the reference level range, Lower (Cont.)

Anticipated Value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance Limits (dB)
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	33.9	-0.1	±1.1
29.0	29.0	0.0	±1.1
24.0	24.1	0.1	±1.1

Function : 8. Tone burst response

Time Weighting	Tone burst duration, Tb (ms)	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
Fast	200	126.0	0.0	±1.0
	2	108.9	-0.1	+1.0 ; -2.5
	0.25	99.9	-0.1	+1.5 ; -5.0
Slow	200	119.6	0.0	±1.0
	2	100.0	0.0	+1.0 ; -5.0
	0.25	100.0	0.0	+1.0 ; -5.0

Function : 9. Peak C sound level

Number of cycles in test signal	Anticipated Value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
Complete cycle	125.4	125.2	-0.2	±3.0
Positive half cycle	124.4	124.1	-0.3	±2.0
Negative half cycle	124.4	124.1	-0.3	±2.0

Function : 10. Overload Indication

Measured value (dB)		Deviated value (dB)	Acceptance limits (dB)
Positive one-half cycle	Negative one-half cycle		
139.5	139.5	0.0	±1.5



ELECTRICAL AND ELECTRONICS INSTITUTE
FOUNDATION FOR INDUSTRIAL DEVELOPMENT

Certificate No.: 0224SV21

Calibration Report

Function : 11. High-Level Stability

High-level stability over 5 minutes, with steady 1 kHz signal, 1 dB below upper boundary.

Time Period to Apply Signal (min)	Reference SPL (dB)	Record SPL at Conclusion of Time Period (dB)	Deviated value (dB)	Acceptance limits (dB)
5	129.0	129.0	0.0	±0.3

Uncertainty of measurement

Function	Uncertainty (dB)	Maximum-permitted uncertainty of measurement (dB)
1) Indication at the calibration check frequency	0.30	Not applicable
2) Self-generated Noise	0.10	Not applicable
3) Acoustical signal tests of frequency weightings - Free-field sound pressure response level	0.30	0.60 (10Hz to 4kHz) 0.70 (>4kHz to 10kHz)
4) Electrical signal tests of frequency weightings	0.20	0.20
5) Frequency and time weighting at 1 kHz	0.20	0.20
6) Long-Term Stability	0.10	0.10
7) Level Linearity on the reference level range	0.30	0.30
8) Tone burst response	0.20	0.30
9) Peak C sound level	0.20	0.35
10) Overload indication	0.20	0.25
11) High-Level Stability	0.10	0.10

Remarks: 1. The acceptance limit is for the deviated value.
2. Acceptance limits was IEC61672-3:2013 Class 2.

-- End of Report --



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Phraek Sa, Muang Samut Prakan, Samut Prakan 10280

Tel: +66 2709 4860-8 Fax: +66 2324 0917-8



Certificate No.: 0225SV21

Operation No.: CP2021050035

Certificate of Calibration

Equipment: Sound Level Meter

Manufacturer: RION

Model/Type: NL-42 (Meter), UC-52 (Microphone), NH-24 (Preamplifier)

Serial No.: 00472132 (Meter), 169445 (Microphone), 72466 (Preamplifier)

ID No.: RYG_FS0304

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

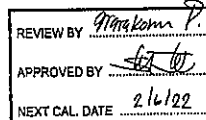
Address: 104 Phatthanakan 40, Phatthanakan Rd., Khwaeng Phatthanakan
Khet Suan Luang, Bangkok 10250 Thailand

Received Date: 28 May 2021

Calibrated Date: 2 - 9 June 2021

Issued Date: 11 June 2021

Calibrated by: Ms. Juntapom Kunhakom



Approved by:

(Mr. Sittichai Srinakulchai)
Group Manager, Calibration Institute

The reported uncertainty of measurement was based on standard uncertainty multiplied by a coverage factor $k = 2.00$, providing a level of confidence of approximately 95%. This certificate may not be reproduced other than in full except with the prior written approval of the Electrical and Electronics Institute, Foundation for Industrial Development.



ELECTRICAL AND ELECTRONICS INSTITUTE
FOUNDATION FOR INDUSTRIAL DEVELOPMENT

Certificate No.: 0225SV21

Calibration Report

Equipment: Sound Level Meter
Manufacturer: RION
Model/Type: NL-42 (Meter), UC-52 (Microphone), NH-24 (Preamplifier)
Serial No.: 00472132 (Meter), 169445 (Microphone), 72466 (Preamplifier)
ID No.: RYG_FS0304
Ambient Temperature: (23 ± 2) °C
Relative Humidity: (50 ± 15) %
Pressure: (101.3 ± 1.5) kPa
Method of Calibration :-
IEC 61672-3:2013.

Condition of this result of calibration

1. Reference standards instrument :-

Instrument	Model	Serial No.	Cert. No.	Due Date
1) Standard microphone	4180	2787490	AA-1001-21	12 January 2022
2) Sine generator	1051	1501442	0151RF20	21 September 2021
3) Arbitrary Function Generator	AFG2021	C010063	0099RF20	17 June 2021
4) Programmable Attenuator	PA5	2913	EF-0017-21	1 April 2022
5) Programmable Attenuator	PA5	2755	EF-0034-20	10 November 2021
6) 6.5 Digit precision multimeter	8846A	9609027	0498EL20	10 August 2021
7) 6.5 Digit precision multimeter	8846A	9610014	0669EL20	27 October 2021
8) Pressure humidity and Temperature Transmitter	PTU301	L3950484	CL1-P210020 0176TE21	22 March 2022 1 April 2022

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

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

- Reference standards instrument for Acoustic function
- National Institute of Metrology (Thailand)
- Reference standards instrument for Electrical function
- National Institute of Metrology (Thailand)
- Electrical and Electronics Institute; ONSC Accredited Calibration No.0119

Result of Calibration:-

Function : 1. Indication at the calibration check frequency

Reference Acoustic Signal (dB)	Measured value (dB)	Deviation (dB)	Acceptance limits (dB)
94.0	94.0	0.0	±1.0

Note : Absolute sensitivity was established by the use of the Sound Calibrator RION Type NC-74 S/N : 34515278.



ELECTRICAL AND ELECTRONICS INSTITUTE
FOUNDATION FOR INDUSTRIAL DEVELOPMENT

Certificate No.: 0225SV21

Calibration Report

Function : 2. Self-generated Noise

2.1 Microphone Installed

Measured value (dB)
14.5

2.2 Microphone replaced by the electrical input signal device

Frequency Weighting (dB)	Measured value (dB)
A-weighting	10.4
C-weighting	17.5
Z-weighting	23.1

Function : 3. Acoustical signal tests of frequency weightings (Without Windscreen)

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

Frequency (Hz)	Deviation from various Frequency Weighting Response Curve				Acceptance limits (dB)
	C-Weighting (dB)	A-Weighting (dB)	Z-Weighting (dB)		
125	0.3	0.6	0.3		±1.5
1000	0.1	0.1	0.1		±1.0
8000	-0.9	-0.9	-1.0		±5.0

Function : 4. Electrical signal tests of frequency weightings

Weighting network response with relative to 1 kHz

Frequency (Hz)	Deviation from various Frequency Weighting Response Curve				Acceptance limits (dB)
	C-Weighting (dB)	A-Weighting (dB)	Z-Weighting (dB)		
63	-0.1	-0.1	0.0		±2.0
125	0.0	-0.1	0.0		±1.5
250	0.0	-0.1	0.0		±1.5
500	0.1	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	0.1	0.1	0.0		±5.0

Function : 5. Frequency and time weighting at 1 kHz

5.1 Frequency weighting at 1 kHz

Frequency Weighting	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
C-weighting	94.0	0.0	±0.2
A-weighting	94.0	0.0	±0.2
Z-weighting	94.0	0.0	±0.2



Certificate No.: 0225SV21

Calibration Report

5.2 Time weighting at 1 kHz

Time Weighting	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
Fast	94.0	0.0	±0.1
Slow	94.0	0.0	±0.1
Laeq	94.0	0.0	±0.1

Function : 6. Long-Term Stability

Long-term stability over 30 minutes, with steady 1 kHz signal at reference level.

Time Period to Apply Signal (min)	Reference SPL (dB)	Record SPL at Conclusion of Time Period (dB)	Deviated value (dB)	Acceptance limits (dB)
30	94.0	94.0	0.0	±0.3

Function : 7. Level Linearity on the reference level range

7.1 Level Linearity on the reference level range, Upper

Anticipated Value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
94.0	94.0	0.0	±1.1
99.0	99.0	0.0	±1.1
104.0	104.0	0.0	±1.1
109.0	109.0	0.0	±1.1
114.0	114.0	0.0	±1.1
119.0	119.0	0.0	±1.1
124.0	124.0	0.0	±1.1
129.0	129.0	0.0	±1.1
130.0	130.0	0.0	±1.1
131.0	131.0	0.0	±1.1
132.0	132.0	0.0	±1.1
133.0	133.0	0.0	±1.1
134.0	134.0	0.0	±1.1
135.0	135.0	0.0	±1.1
136.0	136.0	0.0	±1.1
137.0	137.0	0.0	±1.1

7.2 Level Linearity on the reference level range, Lower

Anticipated Value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
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

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Certificate No.: 0225SV21

Calibration Report

7.2 Level Linearity on the reference level range, Lower (Cont.)

Anticipated Value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
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	33.9	-0.1	±1.1
29.0	28.8	-0.2	±1.1
24.0	23.9	-0.1	±1.1

Function : 8. Tone burst response

Time Weighting	Tone burst duration, Tb (ms)	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
Fast	200	126.0	0.0	±1.0
	2	109.0	0.0	+1.0 ; -2.5
	0.25	99.9	-0.1	+1.5 ; -5.0
Slow	200	119.6	0.0	±1.0
	2	100.0	0.0	+1.0 ; -5.0
	200	120.0	0.0	±1.0
LAE	2	100.0	0.0	+1.0 ; -2.5
	0.25	90.9	-0.1	+1.5 ; -5.0

Function : 9. Peak C sound level

Number of cycles in test signal	Anticipated Value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
Complete cycle	125.4	125.4	0.0	±3.0
Positive half cycle	124.4	124.1	-0.3	±2.0
Negative half cycle	124.4	124.1	-0.3	±2.0

Function : 10. Overload indication

Measured value (dB)		Deviated value (dB)	Acceptance limits (dB)
Positive one-half cycle	Negative one-half cycle		
139.5	139.4	-0.1	±1.5

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Certificate No.: 0225SV21

Calibration Report

Function : 11. High-Level Stability

High-level stability over 5 minutes, with steady 1 kHz signal, 1 dB below upper boundary.

Time Period to Apply Signal (min)	Reference SPL (dB)	Record SPL at Conclusion of Time Period (dB)	Deviated value (dB)	Acceptance limits (dB)
5	129.0	129.0	0.0	±0.3

Uncertainty of measurement

Function	Uncertainty (dB)	Maximum-permitted uncertainty of measurement (dB)
1) Indication at the calibration check frequency	0.30	Not applicable
2) Self-generated Noise	0.10	Not applicable
3) Acoustical signal tests of frequency weightings - Free-field sound pressure response level	0.30	0.60 (10Hz to 4kHz) 0.70 (>4kHz to 10kHz)
4) Electrical signal tests of frequency weightings	0.20	0.20
5) Frequency and time weighting at 1 kHz	0.20	0.20
6) Long-Term Stability	0.10	0.10
7) Level Linearity on the reference level range	0.30	0.30
8) Tone burst response	0.20	0.30
9) Peak C sound level	0.20	0.35
10) Overload indication	0.20	0.25
11) High-Level Stability	0.10	0.10

Remarks: 1. The acceptance limit is for the deviated value.
2. Acceptance limits was IEC61672-3:2013 Class 2.

-- End of Report --

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TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)
CORPORATE SERVICES & EQUIPMENT CALIBRATION AND TESTING SERVICES
5344 PATTANAKARN ROAD SRI IL SUANLUANG, SUANLUANG BANGKOK 10350
TEL. 0-2717-3000-27 FAX. 0-2719-9484



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

Certificate of Calibration

Equipment : pH Meter
Manufacturer : Mettler Toledo
Model : Seven Compact S220
Serial No. : C104059450
ID No. : RYG_EN0183
Condition As-Received : Used Item
Received Date : 16 March 2022
Calibration Date : 17 March 2022
Reference : 2203-0611DSC-4
Submitted by : ALS Laboratory Group (Thailand) Co., Ltd.
Rayong Branch
616/10 Moo 5 T.Maenam Khu,
A.Plusdaeng, Rayong 21140, Thailand
Ambient Temperature : (25 ± 2.5) °C
Relative Humidity : (50 ± 15) %
Calibration Procedure : In - house method :
- CP-CH5 by direct measurement with standard voltage calibrator and direct measurement with certified reference material (CRM)
- CP-CH8 by comparison with standard thermometer

Calibrated by : Warakorn Lengagrakul

Approved by :
Approved Signatory

(✓) Malee Butkruea
() Sathip Meangmai
() Warakorn Lengagrakul

Issue Date : 22 March 2022

The Uncertainties are for a confidence probability of approximately 95%

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

A 0037307



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

Condition of this calibration result

1. Reference Standard Instrument :-

Instrument	Serial No.	ID No.	Cert. No.	Due Date
1) Document Process Calibrator	54030049	130RC118	21E2682	25 Aug 2022
2) Ref. Standard Thermometer	4982054	110RC044	2111201	26 Oct 2022

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

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

Buffer Solution	Manufacturer	Lot No.	Exp. date
pH 4.008	CPA chem	788995	01 Jan 2024
pH 6.982	CPA chem	781017	02 Aug 2022
pH 10.015	CPA chem	766824	04 Sep 2022

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

Calibration Results

Function : mV Measurement

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

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



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

Calibration Results

Function : pH Measurement

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

Unit Under Calibration	Standard pH Buffer Solution	Actual pH Reading	Actual mV Reading (mV)	Uncertainty of pH measurement (\pm)	Coverage factor k
pH Electrode	4.008	4.010	177.7	0.0048	2.00
S/N.: 1453404	6.982	6.988	3.6	0.0084	2.00
	10.015	10.010	-172.9	0.0073	2.05

Function : Temperature Measurement

(*) Without adjustment

This equipment was connected with Temperature Probe;

- Model : InLab Expert Pro-ISM

- Serial No. : 1453404

Dimension of probe;

- Length : 120 mm.

- Diameter : 12 mm.

- Immersion Depth : 100 mm.

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

Remark : - UUC* = Unit Under Calibration

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

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a 1100955

a 1100954



TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)
CORPORATE SERVICES 3: EQUIPMENT CALIBRATION AND TESTING SERVICES
3344 TATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG, BANGKOK 10250
TEL 0-2717-3000-34 FAX: 0-2719-9484



Certificate of Calibration

Certificate No.: 22E888
Page: 1 of 2

Equipment : pH Meter
Manufacturer: Mettler Toledo
Model : SevenCompact S220
Serial No.: C104059460
ID No.: RYQ_EN0183
Condition As-Received: Used Item
Received Date: 16 March 2022
Calibration Date: 21 March 2022
Reference: 2203-0611DSC
Ambient Temperature: (23 \pm 2) °C
Relative Humidity: (50 \pm 10) %

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Submitted by: ALS Laboratory Group (Thailand) Co., Ltd. Rayong Branch
618/10 Moo 5 T.Meenam Khu, A.Pluakdaeng, Rayong
21140, Thailand

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

Condition of this result of calibration

1. Reference standards Instruments :

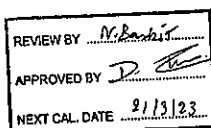
Instrument	Model	Serial No.	Certificate No.	Due Date
1) Multi-Product Calibrator	5500A	6440007	21E1444	07 May 2022

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

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

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

- National Institute of Metrology Thailand (NIMT)



Calibrated by: Pongsagom Boonyasom
Issue Date: 22 March 2022

Approved Signatory :
[] Phatinee Preebpaipal
[] Nuntawat Khanchai
[] Pornthipha Tameyakul

B 0284414



Cert. No.: 22E888
Page: 2 of 2

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

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

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

*UUC= Unit Under Calibration.

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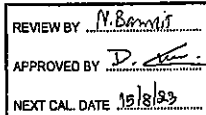
a 1101070



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

Certificate of Testing

Equipment : DO Meter
Manufacturer : YSI
Model : 5000-115V
Serial No. : 15E102796
ID No. : RYG_EN0032
Received Date : 11 February 2022
Test Date : 14 February 2022
Reference : 2202-0404DSC-4
Submitted by : ALS Laboratory Group (Thailand) Co., Ltd.
(Rayong Branch)
616/10 Moo 5 T.Maenam Khu, A.Pluakdaeng,
Rayong 21140, Thailand
Laboratory Condition : Temperature (25 ± 5) °C
Humidity (50 ± 20) %
Test Procedure : In - house method : CP-CH9
by Comparison Technique with Azide Modification Method
Tested by : Walalak Sirithean
Approved by : Sathip
Approved Signatory
() Malee Butkruea
(✓) Sathip Meangmal
() Warakorn Lemgagrakul
Issue Date : 18 February 2022



B 0281265



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

Result : Dissolved Oxygen Meter Adjustment With Air 100 %
Dissolved Oxygen Probe No.: 15E100454

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

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

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Sathip

a 1094744



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

Certificate of Calibration

Equipment : DO Meter with Sensor
Manufacturer : YSI
Model : 5000-115V
Serial No. : 15E102796
ID No. : RYG_EN0032
Submitted by : ALS Laboratory Group (Thailand) Co., Ltd. (Rayong Branch)
616/10 Moo 5 T.Maenam Khu, A.Pluakdaeng,
Rayong 21140, Thailand
Location : TPA On Site Calibration Laboratory
Received Order : 11 February 2022
Calibrated Date : 21 February 2022
Ambient Temperature : (26 ± 10) °C
Relative Humidity : (50 ± 30) %
AC Line Voltage : (220 ± 22) V
Calibrated by : Kunchit Promprat
Approved by : Malee
Approved Signatory
() Pornthipha Tameysakul
(✓) Malee Butkruea
() Suwit Imjai
Issue Date : 21 February 2022



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

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

Calibration were conducted using in-house calibration procedure CP-OT01 according to comparison with Industrial Platinum Resistance Thermometer (IPT) into Temperature Bath.
The temperature scale used was based on ITS-90.

Condition of this result of calibration

1. Reference standard Instrument:-

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

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

Result of Calibration :- (°) Without Adjustment

Function : Temperature measurement.

This instrument was connected with temperature sensor, S/N.: 15E100454

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

UUC* : Unit Under Calibration

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

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The Uncertainties are for a confidence probability of approximately 95%

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A 0038008

a 1095714



TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)
CORPORATE SERVICES 3: EQUIPMENT CALIBRATION AND TESTING SERVICES
5144 PATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG BANGKOK 10250
TEL. 0-2717-3000-27 FAX. 0-2719-9484



Certificate of Calibration

Cert. No.: 22TM317
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 : 22 April 2022
Calibration Date : 22 April 2022
Ambient Temperature : $(26 \pm 10) ^\circ\text{C}$
Relative Humidity : $(50 \pm 30) \%$
Calibrated by : Man Pattansongpaiboon

Approved by :
Approved Signatory

() Pomthippa Tamayakul
() Malee Bulkruea
() Suwit Imjai

Issue Date : 3 May 2022

The Uncertainties are for a confidence probability of approximately 95%

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

A 0040735



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

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

Procedure Used :-

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

Condition of this result of calibration

1. Reference standard instrument:-

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

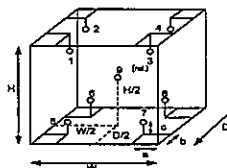
2. This certificate is valid only to the item calibrated on date and place of calibration.
3. This certification is traceable to the International System of Unit.

Result of Calibration : (*) Without Adjustment

Function of UUC : Temperature Source

Fresh air setting : Close

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



Probe Installation Details : Dimension of Chamber :

a = 10 cm	D = 0.50 m
b = 10 cm	W = 1.0 m
c = 10 cm	H = 1.2 m
	Capacity = 0.75 m ³

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

Malee

a 1105485

RYG_EN0002



PENTA
CALIBRATION

PENTA CALIBRATION CO., LTD.
86/124 The Connect 33 Village Kanchanaphisek Road
Dokmai Ploewet Bangkok 10250
Tel: +66 (0) 2059-9719
www.pentalab.co.th

Certificate of Calibration

Represent to Certificate of Calibration /PTC07/22103

Certificate No.:	PTC07/22103	Page:	1 of 2
Equipment:	Digital Balance	Condition:	Normal
Manufacturer:	Sartorius	Serial No.:	26207038
Model:	MSE224S-100-DU	ID No.:	RYG_EN0002
Type of Balance:	Single interval		

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

Environment Condition: Temperature 23.9 °C ± 0.3 °C
Humidity 58.1 %RH ± 4.4 %RH
Air density 1.17 kg/m³

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

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

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

Date Received: March 23, 2022

Calibration Date: March 23, 2022

Issued Date: March 25, 2022

Calibration By: Mr. Rungroj Motakul



REVIEW BY
APPROVED BY
NEXT CAL DATE 09/10/25



Approved By :
(Mr. Keetisak Kerdto)
Laboratory Manager

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

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

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

PTC-TAC-07-02 2 Feb 2020

a 1105484



PENTA CALIBRATION CO., LTD.
56/124 The Connect 33 Village Kanchanaphisek Road
Dokmai Praset Bangkok 10250
Tel: +66 (0) 2059-6173
www.pentacal.com

Represent to Certificate of Calibration PTC07/22103

Certificate No.: PTC07/22103

Page: 2 of 2

Measurement Results:

Without Adjustment:

Function Calibration: Non Adjustment

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

The figure illustrates two methods for eccentricity testing. On the left, a rectangular plate is shown with five points labeled 1 through 5. Point 1 is at the center, and points 2, 3, 4, and 5 are positioned at the corners. On the right, a circular plate is shown with five points labeled 1 through 5. Point 1 is at the center, and points 2, 3, 4, and 5 are positioned at the edges of the circle.

Eccentricity test 100 (g)

Position (g)				
1	2	3	4	5
0.0000	0.0000	-0.0002	0.0002	0.0002

Maximum deviation: 0.0002

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

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

Nominal test value (g)	Standard Deviation
200	0.0003

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

Nominal Value (g)	Conventional Mass (g)	Indication (g)	Correction of Balance (g)	Uncertainty (g)	k
0	0.00000	0.0000	0.0000	0.000086	2.16
0.01	0.01000	0.0100	0.0000	0.00010	2.06
0.1	0.10000	0.1000	0.0000	0.00010	2.06
1	1.00000	1.0000	0.0000	0.00010	2.06
2	2.00000	1.9999	0.0001	0.00010	2.06
5	5.00001	5.0000	0.0000	0.00010	2.06
10	10.00000	10.0000	0.0000	0.00010	2.06
20	20.00003	19.9999	0.0001	0.00011	2.05
50	50.00004	49.9999	0.0001	0.00012	2.00
100	100.00004	100.0001	-0.0001	0.00017	2.00
200	200.00011	200.0000	0.0001	0.00027	2.00

Note: Weight of adjust (g)

The End of Certificate

PTC-FMC 07/2017/10/2018



TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)
CORPORATE SERVICES & EQUIPMENT CALIBRATION AND TESTING SERVICES
33/44 PATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG BANGKOK 10259
TEL: 0-2717-3000-21 FAX: 0-2719-9484



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

Certificate of Calibration

Equipment: Hot Air Oven
Manufacturer: Memmert
Model: UFE 500
Serial No.: G511.1572
ID No.: RYG_EN0010
Submitted by: ALS Laboratory Group (Thailand) Co., Ltd. (Rayong Branch)
618/10 Moo 5 T. Maenam Khu,
A. Pluakdaeng,
Rayong 21140 Thailand
Location: Oven Room
Received Order: 5 May 2021
Calibration Date: 5 May 2021
Ambient Temperature: (26 ± 10) °C
Relative Humidity: (50 ± 30) %
Calibrated by: Khit Ruttanaprapachal
Approved by:
() Pornthippa Tameyakul
() Malee Sutkrua
() Suwit Imjai
Issue Date: 14 May 2021

The Uncertainties are for a confidence probability of approximately 95%

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

A 0028099



Equipment: Hot Air Oven
Condition As-Received: Used Item
Reference: 2105-00050C-4
Procedure Used:-

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

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

The temperature scale used was based on ITS-90.

Condition of this result of calibration

1. Reference standard instrument:-

Instrument	Model	Serial No.	Cert. No.	Due Date
1) Data Acquisition	34872A	MY57013823	21LM3	26 Feb 2022

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

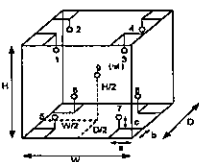
3. This certification is traceable to the International System of Unit.

Result of Calibration: (*) Without Adjustment

Function of UUC: Temperature Source

Fresh air setting: Close

Environment during calibration		
	Beginning	Finished
Temp. (°C)	28	29
REL.Humid. (%)	59	58
AC Supply (Volt)	220	221



Probe Installation Details: Dimension of Chamber:
a = 5.0 cm D = 0.40 m
b = 5.0 cm W = 0.58 m
c = 5.0 cm H = 0.48 m
Capacity = 0.11 m³

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



Equipment: Hot Air Oven
Condition As-Received: Used Item
Reference: 2105-00050C-4
Result of Calibration: (*) Without Adjustment
Function of UUC: Temperature Source

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

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

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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TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)
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TEL. 0-2717-3000-27 FAX. 0-2719-0484



Cert. No.: 21TM829
Page.: 1 of 3

Certificate of Calibration

Equipment : Hot Air Oven
Manufacturer : Memmert
Model : UM 400
Serial No. : b495.0899
ID No. : RYG_EN0006
Submitted by : ALS Laboratory Group (Thailand) Co., Ltd. (Rayong Branch)
616/10 Moo 5 T. Maenam Khu,
A. Pluekdaeng,
Rayong 21140 Thailand
Location : Oven Room
Received Order : 5 May 2021
Calibration Date : 5 - 6 May 2021
Ambient Temperature : (26 ± 10) °C
Relative Humidity : (50 ± 30) %
Calibrated by : Khitt Rutnanapachal

REVIEW BY *Thank*
APPROVED BY *D. K.*
NEXT CAL. DATE *3/1/22*

Approved by : *Khitt Rutnanapachal*
Approved Signatory

() Ponthippa Tamoyakul
() Malee Butkusa
() Suwit Imjai

Issue Date : 14 May 2021

The Uncertainties are for a confidence probability of approximately 95%

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A 0028096

Cert. No.: 21TM829
Page.: 2 of 3

Equipment : Hot Air Oven
Condition As-Received : Used Item
Reference : 2105-0005OC-1
Procedure Used :-

Calibration were conducted using calibration procedure CP-OT02 according to direct measurement method with Data Acquisition which connected with Resistance Temperature Detector (RTD).
The temperature scale used was based on ITS-90.

Condition of this result of calibration

1. Reference standard instrument:-

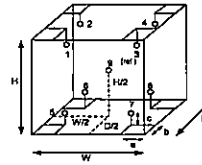
Instrument	Model	Serial No.	Cert. No.	Due Date
1) Data Acquisition	34972A	MY57013823	21LM3	26 Feb 2022

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

Result of Calibration :- (*) Without Adjustment

Function of UUC* : Temperature Source

Fresh air setting : Close



Probe Installation Details : Dimension of Chamber :
a = 5.0 cm D = 0.33 m
b = 5.0 cm W = 0.40 m
c = 5.0 cm H = 0.40 m
Capacity = 0.053 m³

Environment during calibration		
	Beginning	Finished
Temp. (°C)	29	30
REL.Humid. (%)	56	58
AC Supply (Volt)	221	222

Position :	Ref. Std. ID No.:
1	21-17RTD-01
2	21-17RTD-02
3	17RTD-03
4	17RTD-04
5	17RTD-05
6	17RTD-06
7	17RTD-07
8	17RTD-08
9 (ref.)	17RTD-09

Equipment : Hot Air Oven
Condition As-Received : Used Item
Reference : 2105-0005OC-1

Cert. No.: 21TM829
Page.: 3 of 3

Result of Calibration :- (*) Without Adjustment
Function of UUC* : Temperature Source

Calibration Point (°C)	UUC* Setting (°C)	UUC* Reading (°C)	Temperature stability (± °C)	Temperature uniformity (°C)	Overall Variation (°C)	Uncertainty (± °C)	Coverage Factor k
70.0	70.0	70.0	0.21	1.8	2.0	0.55	2

Calibration Point (°C)	Measured Temperature (°C)								
	Position								
	1	2	3	4	5	6	7	8	9 (ref.)
70.0	70.404	70.277	70.607	70.307	68.789	69.257	68.846	69.331	70.495

Average* : The average of 30 values in each position.
Temperature stability : One-half of the greatest maximum difference of measured temperature at any one sensor.
Temperature uniformity : The maximum difference of measured temperatures at any sensors and the measured temperature at the reference location which are observed at the same time or at as close an observation time as possible to determine the temperature pattern or homogeneity within the chamber under steady-state conditions.
Overall Variation : The Difference of the maximum and minimum measured temperatures throughout observation.
UUC* : Unit Under Calibration
Note : The reported uncertainty of measurement was included stability and excluded uniformity .

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

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TEL. 0-2717-3000-27 FAX. 0-2719-0484



Cert. No.: 21TM873
Page.: 1 of 3

Certificate of Calibration

Equipment : Water Bath
Manufacturer : Memmert
Model : WNB22
Serial No. : L513.0646
ID No. : RYG_EN0081
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 : 5 May 2021
Calibration Date : 5 May 2021
Ambient Temperature : (26 ± 10) °C
Relative Humidity : (50 ± 30) %
Calibrated by : Tawatchai Pama
Approved by : *Khitt Rutnanapachal*
Approved Signatory
() Ponthippa Tamoyakul
() Malee Butkusa
() Suwit Imjai
Issue Date : 14 May 2021

REVIEW BY *Thank*
APPROVED BY *D. K.*
NEXT CAL. DATE *3/1/22*

The Uncertainties are for a confidence probability of approximately 95%

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

a 1054309

A 0028098



Equipment : Water Bath
 Condition As-Received : Used Item
 Reference : 2105-0005OC-3
 Procedure Used :-

Cert. No.: 21TM673
 Page: 2 of 3

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

The temperature scale used was based on ITS-90.

Condition of this result of calibration

1. Reference standard instrument:-

Instrument	Model	Serial No.	Cert. No.	Due Date
1) Data Acquisition	34970A	MY44060450	21LM4	08 Mar 2022

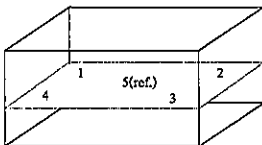
2. This certificate is valid only to the item calibrated on date and place of calibration.

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

Result of Calibration :- () Without Adjustment

Function of UUC* : Temperature Source

	Environmental		AC Voltage Supply
	(°C)	(%R.H.)	(Volt)
Beginning of Calibration	22	68	230
Finished of Calibration	20	64	231



Front

Position :	Ref. Std. S/N:
1	4803988-001
2	4803988-002
3	4803988-003
4	4803988-004
S(ref.)	4803988-005



Equipment : Water Bath
 Condition As-Received : Used Item
 Reference : 2105-0005OC-3
 Result of Calibration :- () Without Adjustment
 Function of UUC* : Temperature Source

Cert. No.: 21TM673
 Page: 3 of 3

Calibration point (°C)	UUC* Setting (°C)	UUC* Reading (°C)	Average* Standard Reading (°C)				
			Position				
85.0	85.0	85.0	1	2	3	4	5 (ref.)
			84.891	84.893	84.880	84.882	84.917

Calibration point (°C)	Uniformity (°C)	Stability (±°C)	Uncertainty (±°C)	Coverage Factor k
85.0	0.089	0.052	0.22	2

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

Uniformity : The maximum difference of measured temperatures of 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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Mak.

a 1054289

Mak.

a 1054288



TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)
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 TEL. 0-2717-3000-24 FAX. 0-2719-9484



Certificate of Calibration

Certificate No.: 21T1200
 Page: 1 of 2



Cert. No.: 21T1200
 Page: 2 of 2

Equipment : Digital Thermometer With Sensor
 Manufacturer : Testo
 Model : 108
 Serial No. : 31281494/504
 ID No. : RYG_FS0457

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Condition As-Received: Used Item

Received Date: 02 July 2021

Calibration Date: 07 July 2021 to 08 July 2021

Reference: 2107-0068DSC

Ambient Temperature: (25 ± 3) °C

Relative Humidity: (50 ± 20) %

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

618/10 Moo 5 T.Maenam Khu, A.Pluakdaeng, Rayong

21140, Thailand

Procedure used: Calibration were conducted using in-house calibration procedure CP-T01 according to comparison with Platinum Resistance Thermometer (PRT) into liquid bath temperature controller. The temperature scale used was based on ITS-90.

Condition of this result of calibration

1. Reference standard instruments :

Instrument	Model	Serial No.	Certificate No.	Due Date
1) Digital Thermometer	1529-R	B18520	21680	28 Jun 2022
2) Platinum Resistance Thermometer	935-14-95	251589/1	21680	28 Jun 2022

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

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

National Institute of Metrology Thailand (NIMT)

REVIEW BY	Torwisit
APPROVED BY	Sut S
NEXT CAL. DATE	7/12/22

Calibrated by : Yossapon Poljorn
 Issue Date : 09 July 2021

Approved Signatory :
☐ Phatinee Prapaisai
☐ Chatchawan Khunpikuluek
☒ Wanlop Larpkum

B 0265214

a 1063351

Certificate of Calibration

Equipment: Block Digestion Unit Certificate No.: C29220011
 Model: KT-20s Issued Date: 18 March 2022
 Serial No. (or ID.): 5720210009/5770200073 Job No.: KSPR2203623
 Manufacturer: Gerhardt Page: 1 of 3
 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: 24 °C ± 0.8 °C
 Humidity: 67 %RH ± 2.2 %RH
 Voltage: 226 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. Worachai Hongkaew

Calibration Date: 17 March 2022

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 N.M. Technical Center Laboratory (NTL)
 Certificate No.: TC21/0075

REVIEW BY: N. Sarnit
 APPROVED BY: D. Sarnit
 NEXT CAL. DATE: 17/3/23

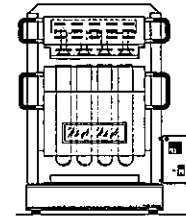
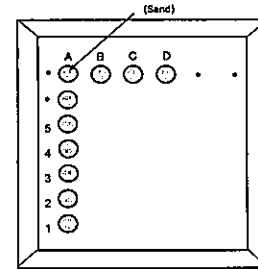


Fig. 1.: Front view



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 average reading of working standard at any positions or location.



(Mr. Worachai Hongkaew)
 Person in charge



บริษัท เอสพีซี จำกัด
 SPC RT CO., LTD.



(Mr. Udon Srichana)
 Authorized signatory

This certificate is issued the units of measurement according to the International System of Units (SI). It provides traceability of measurement to international or national standard or other recognized national standard laboratories.
 The measurement uncertainty stated is the expanded uncertainty 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 SPC RT CO., LTD.

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SPCC-FM-C29-05: 23 Nov 2020

SPCC-FM-C29-05: 23 Nov 2020

Calibration Results:
Without adjustment

Locations	Desired (°C)	Setting (°C)	Indicating (°C)	Measured Temperature (°C)	Correction of UUC (°C)	Uncertainty (± °C)
A1	380	380	380	378.6	-1.4	1.5
A2				382.2	2.2	1.5
A3				380.2	0.2	1.5
A4				381.5	1.5	1.5
A5				381.2	1.2	1.5
B1				378.8	-1.2	1.5
B2				381.8	1.8	1.5
B3				379.4	-0.6	1.5
B4				382.1	2.1	1.5
B5				380.9	0.9	1.5
C1				378.2	-1.8	1.5
C2				380.0	0.0	1.5
C3				377.4	-2.6	1.5
C4				381.8	1.8	1.5
C5				382.3	2.3	1.5
D1				379.7	-0.3	1.5
D2				378.3	-1.7	1.5
D3				378.6	-1.2	1.5
D4				379.0	-1.0	1.5
D5				379.4	-0.6	1.5

The End of Certificate

ใบตรวจสอบสภาพเครื่องควบคุมอุณหภูมิ

เลขที่ใบงาน: KSPR2203623

ชนิดเครื่องวัด: Block Digestion Unit รุ่น: KT-20s
 หมายเลขเครื่อง: 5720210009/5770200073

ตรวจสอบ (รับ)	ตรวจสอบ (ส่ง)	หมายเหตุ
17 Mar 2022	17 Mar 2022	
ปกติ	ปกติ	
ไม่ปกติ	ไม่ปกติ	
General		
<input checked="" type="checkbox"/>	<input type="checkbox"/>	1. สายไฟ
<input checked="" type="checkbox"/>	<input type="checkbox"/>	2. การทำงาน Main Switch
<input checked="" type="checkbox"/>	<input type="checkbox"/>	3. การทำงาน Selector Key
<input checked="" type="checkbox"/>	<input type="checkbox"/>	4. การแสดงผล Display
<input checked="" type="checkbox"/>	<input type="checkbox"/>	5. สภาพ Hole
<input type="checkbox"/>	<input type="checkbox"/>	6. สภาพฝาปิด
<input type="checkbox"/>	<input type="checkbox"/>	7. สภาพตัวเครื่อง
<input checked="" type="checkbox"/>	<input type="checkbox"/>	8. สภาพแวดล้อม ณ สถานที่ตั้งเครื่อง

ลงนามเรา:

Mr. Worachai Hongkaew
 Service Engineer

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Cert.No.: 21CH1733
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 : 22 December 2021
Calibration Date : 23 December 2021
Reference : 2112-0636DSC-2
Submitted by : ALS Laboratory Group (Thailand) Co., Ltd. Rayong Branch
618/10 Moo 5 T.Maenam Khu, A.Pluakdaeng,
Rayong 21140, Thailand

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

Calibrated by : Warakorn Lemgagrakul

Approved by :
Approved Signatory

(/) Malee Butkruea
() Sathip Meangmai
() Warakorn Lemgagrakul

Issue Date : 24 December 2021

The Uncertainties are for a confidence probability of approximately 95%

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A 0036356



Cert.No.: 21CH1733
Page: 2 of 3

Condition of this calibration result

1. Reference Standard Instrument :-

Instrument	Serial No.	ID No.	Cert. No.	Due Date
1) Document Process Calibrator	54030049	130RC116	21E2682	25 Aug 2022
2) Ref. Standard Thermometer	4982054	110RC044	2111201	26 Oct 2022

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

2. Certified Reference Materials : The measurement results are traceable to SI through CPA chem Ltd.,
ANSI-ASQ National Accreditation Board, Accredited No. AR-1635

Buffer Solution	Manufacturer	Lot No.	Exp. date
pH 4.008	CPA chem	781016	02 Aug 2023
pH 6.982	CPA chem	761017	02 Aug 2022
pH 10.015	CPA chem	761018	02 Aug 2022

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

Calibration Results

Function : mV Measurement

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

Unit Under Calibration	Nominal Value	Standard Voltage Input	Actual Reading		Uncertainty of Measurement (\pm mV)	Coverage factor k
	pH	mV	mV	pH		
pH Meter S/N: B834291445	4.000	177.48	177.3	4.000	0.058	2.00
	7.000	0.00	-0.1	7.000	0.058	2.00
	10.000	-177.48	-177.5	10.000	0.058	2.00

a 1087319



Cert.No.: 21CH1733
Page: 3 of 3

Calibration Results

Function : pH Measurement

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

Unit Under Calibration	Standard pH Buffer Solution	Actual pH Reading	Actual mV Reading (mV)	Uncertainty of pH measurement (\pm)	Coverage factor k
pH Electrode S/N: 1475518	4.008	4.011	180.6	0.0049	2.05
	6.982	6.984	5.3	0.0077	2.00
	10.015	10.014	-171.3	0.0065	2.00

Function : Temperature Measurement

(*) Without adjustment

This equipment was connected with Temperature Probe;

- Model : InLab Expert Pro-ISM
- Serial No. : 1475518
Dimension of probe:
- Length : 120 mm.
- Diameter : 12 mm.
- Immersion Depth : 100 mm.

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

Remark : - UUC* = Unit Under Calibration

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

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a 1087180



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Certificate of Calibration

Certificate No.: 21E4151
Page: 1 of 2

Equipment : pH Meter
Manufacturer : Mettler Toledo
Model : SevenExcellence
Serial No. : B834291445
ID No. : RYG_EN0152
Condition As-Received: Used Item
Received Date : 22 December 2021
Calibration Date : 28 December 2021

Reference : 2112-0636DSC
Submitted by : ALS Laboratory Group (Thailand) Co., Ltd. Rayong Branch
618/10 Moo 5 T.Maenam Khu, A.Pluakdaeng, Rayong
21140, Thailand

Ambient Temperature : (23 ± 2) °C
Relative Humidity : (50 ± 10) %

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

Condition of this result of calibration

1. Reference standards Instruments :

Instrument	Model	Serial No.	Certificate No.	Due Date
1) Multi-Product Calibrator	5500A	6440007	21E1444	07 May 2022

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

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

4. This Certification is traceable to the International System of Unit maintained at:-
- National Institute of Metrology Thailand (NIMT)

Calibrated by : Wuthareeporn Wongchutikrane Approved Signatory :
Issue Date : 07 January 2022

(/) Phaiinee Pradapipat
() Nuntawat Khanchal
() Pornthipha Tanayakul

B 0278122



Cert. No.: 21E4151

Page: 2 of 2

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

Function:	DC voltage measurement	Range:	2000	mV
	<u>Standard Value</u>	<u>UUC* Reading</u>	<u>Error</u>	<u>Uncertainty</u>
	(mV)	(mV)	(mV)	(\pm μ V)
	-100.0000	-100.0	0.0	65
	-50.0000	-50.0	0.0	62
	0.0000	0.0	0.0	58
	50.0000	50.0	0.0	62
	100.0000	100.0	0.0	65
	150.0000	150.0	0.0	69
	200.0000	199.9	-0.1	72

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

*UUC= Unit Under Calibration.

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