

ภาคผนวก ค

ใบรับรองการสอบเทียบเครื่องมือ



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รายการเครื่องมือที่ใช้ในการวิเคราะห์ / ทดสอบ

Sample Name	Parameter	Equipment Name	ID No.	Calibrated Date	Next Cal	Freq. Calibrate (Months)
Ambient	Total Suspended Particulate	High Volume	RYG_FS0292	-	-	On site Calibration
Ambient	Total Suspended Particulate	High Volume	RYG_FS0175	-	-	On site Calibration
Ambient	Total Suspended Particulate	High Volume	RYG_FS0182	-	-	On site Calibration
Ambient	Total Suspended Particulate	Digital Balance	RYG_EN0001	22-Feb-24	22-Feb-25	12
Ambient	Nitrogen Dioxide	NO ₂ Analyzer	RYG_FS0463	4-Jan-24	4-Jul-24	6
Ambient	Nitrogen Dioxide	NO ₂ Analyzer	RYG_FS0535	4-Jan-24	4-Jul-24	6
Ambient	Nitrogen Dioxide	NO ₂ Analyzer	RYG_FS0455	4-Jan-24	4-Jul-24	6
Ambient	Sulfur Dioxide	SO ₂ Analyzer	RYG_FS0257	4-Jan-24	4-Jul-24	6
Ambient	Sulfur Dioxide	SO ₂ Analyzer	RYG_FS0534	4-Jan-24	4-Jul-24	6
Ambient	Sulfur Dioxide	SO ₂ Analyzer	RYG_FS0454	4-Jan-24	4-Jul-24	6
Ambient	Benzene	GC-MSD	RYG_EN0136	5-Jan-24	4-Jul-25	18
Ambient	Toluene	GC-MSD	RYG_EN0136	5-Jan-24	4-Jul-25	18
Ambient	Styrene	GC-MSD	RYG_EN0136	5-Jan-24	4-Jul-25	18
Ambient	Xylene	GC-MSD	RYG_EN0136	5-Jan-24	4-Jul-25	18
Ambient	1,3-Butadiene	GC-MSD	RYG_EN0136	5-Jan-24	4-Jul-25	18
Ambient	Ethyl Benzene	GC-MSD	RYG_EN0136	5-Jan-24	4-Jul-25	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0414	10-Feb-23	10-Aug-24	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0530	19-Jan-23	19-Jul-24	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0650	20-Jun-23	20-Dec-24	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0531	19-Jan-23	19-Jul-24	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0608	17-Nov-22	17-May-24	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0609	18-Nov-22	18-May-24	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	BKK_FS0141	5-Jan-23	5-Jul-24	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0531	19-Jan-23	19-Jul-24	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	BKK_FS0143	5-Jan-23	5-Jul-24	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	BKK_FS0165	4-Jan-24	4-Jul-25	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	BKK_FS0167	9-Dec-22	8-Jun-24	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	NKH_FS0054	11-Jan-23	11-Jul-24	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0530	19-Jan-23	19-Jul-24	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0650	20-Jun-23	20-Dec-24	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0414	10-Feb-23	10-Aug-24	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0089	19-Jan-23	19-Jul-24	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0087	19-Jan-23	19-Jul-24	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0611	17-Nov-22	17-May-24	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0545	21-Jul-23	21-Jan-25	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0328	18-Aug-23	18-Feb-25	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0544	21-Jul-23	21-Jan-25	18
Stack (CEMs)	Oxides of Nitrogen	Analyzer , System calibration, Standard gas	-	-	-	-
Stack (CEMs)	Sulfur Dioxide	Analyzer , System calibration, Standard gas	-	-	-	-
Stack (CEMs)	Oxygen	Analyzer , System calibration, Standard gas	-	-	-	-
Stack	Total Hydrocarbon as Propane	Console Control Unit	BKK_FS0496	4-Jan-24	4-Jul-24	6
Stack	Total Hydrocarbon as Propane	Console Control Unit	BKK_FS0507	4-Jan-24	4-Jul-24	6
Stack	Total Hydrocarbon as Propane	Pitot Tube	BKK_FS0453	3-Jan-24	3-Jul-24	6
Stack	Total Hydrocarbon as Propane	Pitot Tube	BKK_FS0541	16-Jan-24	16-Jul-24	6
Stack	Total Hydrocarbon as Propane	Pitot Tube	BKK_FS0501	4-Jan-24	4-Jul-24	6
Stack	Total Hydrocarbon as Propane	Total Hydrocarbon Analyzer	BKK_FS1068	11-Dec-23	11-Jun-25	18
Stack	Total Hydrocarbon as Propane	Total Hydrocarbon Analyzer	RYG_EN0038	10-Aug-23	10-Aug-24	12
Stack	Total Hydrocarbon as Propane	FID Analyzer	BKK_FS0758	3-Jan-24	3-Jul-24	6
Stack	Total Suspended Particulate	Console Control Unit	BKK_FS0496	4-Jan-24	4-Jul-24	6
Stack	Total Suspended Particulate	Console Control Unit	BKK_FS0507	4-Jan-24	4-Jul-24	6
Stack	Total Suspended Particulate	Pitot Tube	BKK_FS0453	3-Jan-24	3-Jul-24	6
Stack	Total Suspended Particulate	Pitot Tube	BKK_FS0541	16-Jan-24	16-Jul-24	6
Stack	Total Suspended Particulate	Digital Balance	BKK_EN0309	30-Nov-23	30-Nov-24	12
VOC Fugitive	Total VOC Fugitive	TVOC Analyzer	BKK_FS0819	19-Jan-24	19-Jul-25	18



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Sample Name	Parameter	Equipment Name	ID No.	Calibrated Date	Next Cal	Freq. Calibrate (Months)
Stack	Xylene	Dry Gas	BKK_FS0505	3-Jan-24	3-Jul-24	6
Stack	Xylene	GC-MSD	BKK_EN0119	18-Apr-23	18-Oct-24	18
Noise	Leq 24 hrs	Sound Calibrator	RYG_FS0215	20-Sep-23	20-Sep-24	12
Noise	Leq 24 hrs	Sound Level Meter	RYG_FS0627	22-Jan-24	21-Jan-25	12
Noise	Leq 24 hrs	Sound Level Meter	RYG_FS0629	22-Jan-24	21-Jan-25	12
Noise	Leq 24 hrs	Sound Level Meter	BKK_FS0135	10-May-23	10-May-24	12
Noise	Leq 24 hrs	Sound Level Meter	RYG_FS0622	22-Jan-24	21-Jan-25	12
Noise	Leq 24 hrs	Sound Level Meter	RYG_FS0624	22-Jan-24	21-Jan-25	12
Noise	Leq 24 hrs	Sound Level Meter	BKK_FS0133	10-May-23	10-May-24	12
Noise	Noise Annoyance	Sound Calibrator	RYG_FS0215	20-Sep-23	20-Sep-24	12
Noise	Noise Annoyance	Sound Level Meter	RYG_FS0627	22-Jan-24	21-Jan-25	12
Noise	Noise Annoyance	Sound Level Meter	RYG_FS0629	22-Jan-24	21-Jan-25	12
Noise	Noise Annoyance	Sound Level Meter	BKK_FS0135	10-May-23	10-May-24	12
Noise	Noise Annoyance	Sound Level Meter	RYG_FS0622	22-Jan-24	21-Jan-25	12
Noise	Noise Annoyance	Sound Level Meter	RYG_FS0624	22-Jan-24	21-Jan-25	12
Noise	Noise Annoyance	Sound Level Meter	BKK_FS0133	10-May-23	10-May-24	12
Noise	Noise Annoyance	Sound Level Meter	RYG_FS0628	22-Jan-24	21-Jan-25	12
Noise	Noise Annoyance	Sound Level Meter	RYG_FS0630	22-Jan-24	21-Jan-25	12
Noise	Noise Annoyance	Sound Level Meter	BKK_FS0134	10-May-23	10-May-24	12
Noise	Noise Annoyance	Sound Level Meter	RYG_FS0623	22-Jan-24	21-Jan-25	12
Noise	Noise Annoyance	Sound Level Meter	RYG_FS0625	22-Jan-24	21-Jan-25	12
Noise	Noise Annoyance	Sound Level Meter	BKK_FS0132	10-May-23	10-May-24	12
Noise	Leq 12 hrs	Sound Calibrator	RYG_FS0215	20-Sep-23	20-Sep-24	12
Noise	Leq 12 hrs	Sound Level Meter	RYG_FS0492	23-Feb-24	22-Feb-25	12
Noise	Leq 12 hrs	Sound Level Meter	RYG_FS0494	23-Feb-24	22-Feb-25	12
Noise	Leq 12 hrs	Sound Level Meter	RYG_FS0493	23-Feb-24	22-Feb-25	12
Noise	Noise Dose, TWA	Dose Badge Reader	RYG_FS0497	29-Jan-24	28-Jan-25	12
Noise	Noise Dose, TWA	Dose Badge Reader	RYG_FS0210	29-Jan-24	28-Jan-25	12
Noise	Noise Dose, TWA	Dose Badge Reader	RYG_FS0212	18-Aug-23	18-Aug-24	12
Noise	Noise Dose, TWA	Dose Badge Reader	RYG_FS0211	15-Dec-23	14-Dec-24	12
Workplace	1,3-Butadiene	Field Rotameter	RYG_FS0657	4-Jan-24	4-Apr-24	3
Workplace	1,3-Butadiene	DRYCAL FLOWMETER	BKK_FS1347	18-Aug-23	18-Aug-24	12
Workplace	1,3-Butadiene	GC-MSD	BKK_EN0119	18-Apr-23	18-Oct-24	18
Workplace	Benzene	Field Rotameter	RYG_FS0657	4-Jan-24	4-Apr-24	3
Workplace	Benzene	DRYCAL FLOWMETER	BKK_FS1347	18-Aug-23	18-Aug-24	12
Workplace	Benzene	GC-MSD	BKK_EN0119	18-Apr-23	18-Oct-24	18
Workplace	Ethyl Benzene	Field Rotameter	RYG_FS0657	4-Jan-24	4-Apr-24	3
Workplace	Ethyl Benzene	DRYCAL FLOWMETER	BKK_FS1347	18-Aug-23	18-Aug-24	12
Workplace	Ethyl Benzene	GC-MSD	BKK_EN0119	18-Apr-23	18-Oct-24	18
Workplace	Dimethyl Disulfide	Field Rotameter	RYG_FS0657	4-Jan-24	4-Apr-24	3
Workplace	Dimethyl Disulfide	DRYCAL FLOWMETER	BKK_FS1347	18-Aug-23	18-Aug-24	12
Workplace	Sulfide	Field Rotameter	RYG_FS0657	4-Jan-24	4-Apr-24	3
Workplace	Sulfide	DRYCAL FLOWMETER	BKK_FS1347	18-Aug-23	18-Aug-24	12
Workplace	Sulfide	SPECTROPHOTOMETER	RYG_EN0179	18-Sep-23	18-Mar-25	18
Workplace	Styrene	Field Rotameter	RYG_FS0657	4-Jan-24	4-Apr-24	3
Workplace	Styrene	DRYCAL FLOWMETER	BKK_FS1347	18-Aug-23	18-Aug-24	12
Workplace	Styrene	GC-MSD	BKK_EN0119	18-Apr-23	18-Oct-24	18
Workplace	Total Hydrocarbon	Total Hydrocarbon Analyzer	RYG_EN0038	10-Aug-23	10-Aug-24	12
Workplace	Toluene	Field Rotameter	RYG_FS0657	4-Jan-24	4-Apr-24	3
Workplace	Toluene	DRYCAL FLOWMETER	BKK_FS1347	18-Aug-23	18-Aug-24	12
Workplace	Toluene	GC-MSD	BKK_EN0119	18-Apr-23	18-Oct-24	18
Workplace	Xylene	Field Rotameter	RYG_FS0657	4-Jan-24	4-Apr-24	3
Workplace	Xylene	DRYCAL FLOWMETER	BKK_FS1347	18-Aug-23	18-Aug-24	12
Workplace	Xylene	GC-MSD	BKK_EN0119	18-Apr-23	18-Oct-24	18
Rayong Lab	BOD	DO meter with Sensor	RYG_EN0032	24-Jul-23	24-Jan-25	18
Rayong Lab	BOD	Incubator	RYG_EN0154	29-May-23	29-Nov-24	18
Rayong Lab	COD	Spectrophotometer	RYG_EN0037	18-Sep-23	18-Mar-25	18
Rayong Lab	Oil & Grease	Electronic Balance	RYG_EN0002	22-Feb-24	22-Feb-25	12
Rayong Lab	Oil & Grease	Hot Air Oven	RYG_EN0213	21-Mar-24	21-Mar-25	12
Rayong Lab	Oil & Grease	Water Bath	RYG_EN0061	21-Mar-24	21-Sep-25	18
Rayong Lab	pH at 25 °C	pH Meter	RYG_EN0152	14-Dec-23	14-Dec-24	12



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Sample Name	Parameter	Equipment Name	ID No.	Calibrated Date	Next Cal	Freq. Calibrate (Months)
Rayong Lab	Phenol	SPECTROPHOTOMETER	RYG_EN0179	18-Sep-23	18-Mar-25	18
Rayong Lab	Total Dissolved Solids 180°C	Electronic Balance	RYG_EN0002	22-Feb-24	22-Feb-25	12
Rayong Lab	Total Dissolved Solids 180°C	Hot Air Oven	RYG_EN0010	21-Mar-24	21-Sep-25	18
Rayong Lab	Temperature	pH meter	RYG_FS0594	3-Aug-23	3-Aug-24	12
Rayong Lab	Total Suspended Solids	Electronic Balance	RYG_EN0002	22-Feb-24	22-Feb-25	12
Rayong Lab	Total Suspended Solids	Hot Air Oven	RYG_EN0010	21-Mar-24	21-Sep-25	18
Water Lab	Toluene	Gas Chromatography (MSD)	BKK_EN0059	13-Dec-23	13-Jun-25	18
Water Lab	Benzene	Gas Chromatography (MSD)	BKK_EN0059	13-Dec-23	13-Jun-25	18
Water Lab	Ethylbenzene	Gas Chromatography (MSD)	BKK_EN0059	13-Dec-23	13-Jun-25	18
Water Lab	Total Xylene	Gas Chromatography (MSD)	BKK_EN0059	13-Dec-23	13-Jun-25	18
Water Lab	Methanol	Gas Chromatography	BKK_EN0041	26-Jun-23	26-Dec-24	18
Soil	Methanol	Gas Chromatography	BKK_EN0041	26-Jun-23	26-Dec-24	18
Soil	Benzene	Gas Chromatography (MSD)	BKK_EN0059	13-Dec-23	13-Jun-25	18
Soil	Toluene	Gas Chromatography (MSD)	BKK_EN0059	13-Dec-23	13-Jun-25	18
Soil	Total Xylene	Gas Chromatography (MSD)	BKK_EN0059	13-Dec-23	13-Jun-25	18
Soil	Ethylbenzene	Gas Chromatography (MSD)	BKK_EN0059	13-Dec-23	13-Jun-25	18

Certificate of Calibration

Model Number : LA130S-F Certificate No. : 24BCI0058
Description : Analytical Balance Issued Date : Friday, February 23, 2024
Serial Number : 25409554 Reference No. : 225195
ID No. : RYG_EN0001
Manufacturer : Sartorius Page No. : 2 of 2

Calibration Results : Without Adjustment

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

Nominal Value (Low Load)	10.0000	99.9999
10 g	10.0000	100.0000
Tolerance	10.0000	100.0001
0.0001 g	10.0000	100.0001
	9.9999	100.0000
Nominal Value (High Load)	10.0000	100.0001
100 g	10.0000	100.0000
Tolerance	10.0000	100.0001
0.0001 g	9.9999	100.0002
	9.9999	100.0001
Standard Deviation	0.00005	0.00008

Eccentricity (Off-center loading error)
The off-center loading error is yielded by the difference between the result of the load, i.e. 1/2 or 1/4 of maximum capacity, placed in the middle of the weighing pan and between each of four additional measurement points (positions defined according to OIML R76).

Nominal value	50 g
Tolerance	0.0004 g

Difference

1	-
2	-0.0001
3	0.0001
4	0.0002
5	0.0000
6	-

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

Tolerance	0.0002 g			
Nominal Value (g)	Conventional Mass Value (g)	Displayed Value (g)	Deviation (g)	Uncertainty (g)
0.01	0.0100	0.0100	0.0000	0.00020
0.05	0.0500	0.0500	0.0000	0.00021
0.1	0.1000	0.1000	0.0000	0.00021
0.5	0.5000	0.5000	0.0000	0.00021
1	1.0000	1.0000	0.0000	0.00021
2	2.0000	2.0000	0.0000	0.00022
5	5.0000	5.0000	0.0000	0.00021
10	10.0000	10.0001	0.0001	0.00024
20	20.0000	20.0001	0.0001	0.00021
100	100.0000	99.9999	-0.0001	0.00024

End of Report

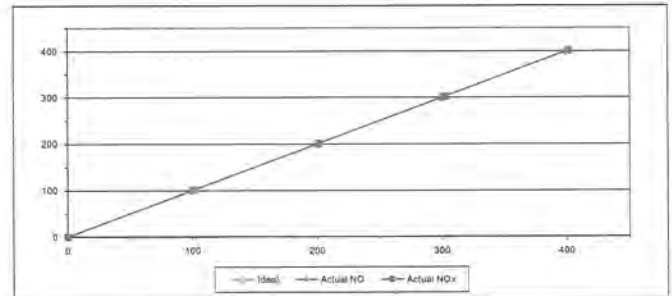
SOP FM 33-03 February 2022



MULTIPOINT CALIBRATION REPORT

Calibration Date : 4-Jan-24 Equipment Name : NOx Analyzer
Manufacturer : HORIBA Model : APNA-370
Serial No. : R08K0177 Equipment ID : RYG_FS0463
Calibrator Manufacturer : Teledyne API Model : 700
Serial No. : 947
Std. Gas Concentration (PPM) : 55.88 Cylinder No. : GN0027222
Cylinder Pressure (psi) : 1800 Certified By : Airgas Inc.
Certified Date : 9-Feb-22 Expired Date : 9-Feb-30

Point	CALIBRATION RESULTS						
	Ideal	Actual NO	Error NO	%Error NO	Actual NOx	Error NOx	%Error NOx
ZERO	0.00	0.10	0.10	0.10	0.10	0.10	0.10
1	100.00	98.80	-1.20	-1.20	101.10	1.10	1.10
2	200.00	201.30	1.30	0.65	201.20	1.20	0.60
3	300.00	299.40	-0.60	-0.20	302.60	2.60	0.87
4	400.00	398.70	-1.30	-0.33	401.50	1.50	0.38
AVERAGE (%)				-0.20			0.61



Calibrated By

(Mr. Jirawut Sakam)

Field Environmental Scientist (3)

Approved By

(Mr. Sarayuth Jitranont)

Assistant General Manager

ALS Laboratory Group

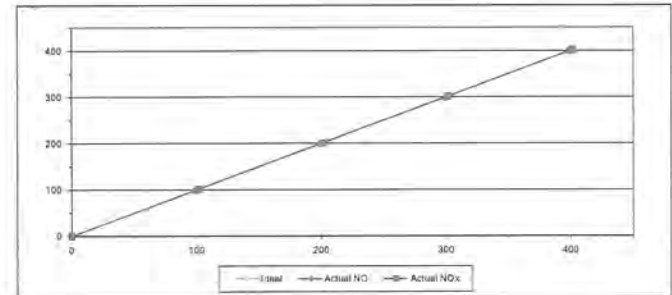
FORM NO. F-06-058 REVISION NO. - ISSUE DATE: 02/04/12



MULTIPOINT CALIBRATION REPORT

Calibration Date : 4-Jan-24 Equipment Name : NOx Analyzer
Manufacturer : HORIBA Model : APNA-370
Serial No. : ALP0VWY Equipment ID : RYG_FS0455
Calibrator Manufacturer : Teledyne API Model : 700
Serial No. : 947
Std. Gas Concentration (PPM) : 55.88 Cylinder No. : GN0027222
Cylinder Pressure (psi) : 1800 Certified By : Airgas Inc.
Certified Date : 9-Feb-22 Expired Date : 9-Feb-30

Point	CALIBRATION RESULTS						
	Ideal	Actual NO	Error NO	%Error NO	Actual NOx	Error NOx	%Error NOx
ZERO	0.00	0.10	0.10	0.10	0.10	0.10	0.10
1	100.00	98.60	-1.40	-1.40	101.60	1.60	1.60
2	200.00	198.80	-1.20	-0.60	201.20	1.20	0.60
3	300.00	301.00	1.00	0.33	301.80	1.80	0.60
4	400.00	398.50	-1.50	-0.38	401.30	1.30	0.33
AVERAGE (%)				-0.38			0.54



Calibrated By

(Mr. Jirawut Sakam)

Field Environmental Scientist (3)

Approved By

(Mr. Sarayuth Jitranont)

Assistant General Manager

ALS Laboratory Group

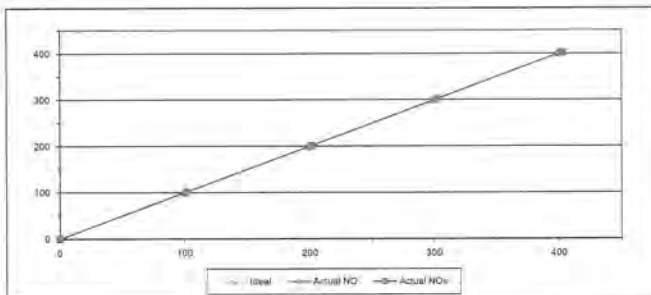
FORM NO. F-06-058 REVISION NO. - ISSUE DATE: 02/04/12



MULTIPOINT CALIBRATION REPORT

Calibration Date : 4-Jan-24 Equipment Name : NOx Analyzer
Manufacturer : Teledyne API Model : T200
Serial No. : 7239 Equipment ID : RYG_FS0535
Calibrator Manufacturer : Teledyne API Model : 700
Serial No. : 947
Std. Gas Concentration (PPM) : 55.88 Cylinder No. : GN0027222
Cylinder Pressure (psi) : 1800 Certified By : Airgas Inc.
Certified Date : 9-Feb-22 Expired Date : 9-Feb-30

Point	CALIBRATION RESULTS						
	Ideal	Actual NO	Error NO	%Error NO	Actual NOx	Error NOx	%Error NOx
ZERO	0.00	0.10	0.10	0.10	0.10	0.10	0.10
1	100.00	98.80	-1.20	-1.20	101.00	1.00	1.00
2	200.00	198.30	-1.70	-0.85	201.10	1.10	0.55
3	300.00	298.80	-1.20	-0.40	301.20	1.20	0.40
4	400.00	398.70	-1.30	-0.33	402.30	2.30	0.58
AVERAGE (%)				-0.33			0.52



Calibrated By

(Mr. Jirawut Sakam)

Field Environmental Scientist (3)

Approved By

(Mr. Sarayuth Jitranont)

Assistant General Manager

ALS Laboratory Group

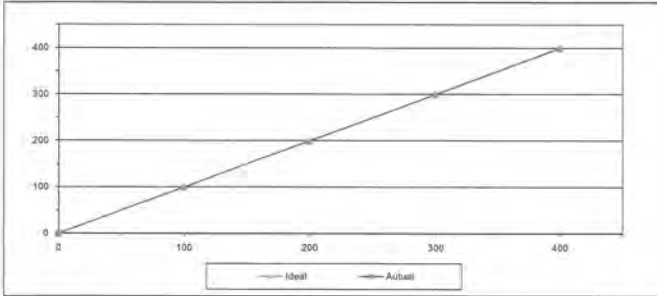
FORM NO. F-06-058 REVISION NO. - ISSUE DATE: 02/04/12



MULTIPOINT CALIBRATION REPORT

Calibration Date	4-Jan-24	Equipment Name	SO2 Analyzer
Manufacturer	HORIBA	Model	APSA-370
Serial No.	24PH0KNA	Equipment ID	RYG_FS0257
Calibrator Manufacturer	Teledyne API	Model	700
Serial No.	947		
Std. Gas Concentration (PPM)	56.3	Cylinder No.	GN0027222
Cylinder Pressure (psi)	1800	Certified By	Airgas Inc.
Certified Date	9-Feb-22	Expired Date	9-Feb-30

Point	CALIBRATION RESULTS			
	Ideal	Actual	Error	%Error
ZERO	0.00	0.10	0.10	0.10
1	100.00	99.40	-0.60	-0.60
2	200.00	198.30	-1.70	-0.85
3	300.00	299.50	-0.50	-0.17
4	400.00	398.90	-1.10	-0.28
AVERAGE (%)				-0.36



Calibrated By

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

Approved By

(Mr.Sarayuth Jitranont)
Assistant General Manager

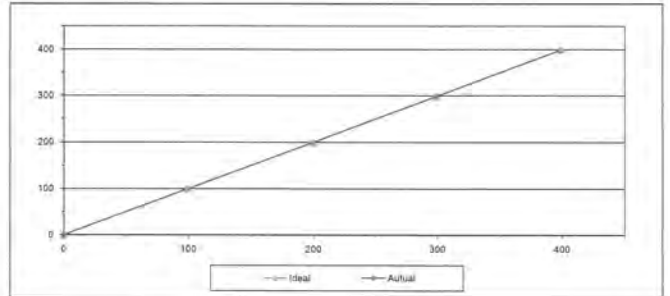
ALS Laboratory Group
FORM NO. F-06-056 REVISION NO. - ISSUE DATE: 02/04/12



MULTIPOINT CALIBRATION REPORT

Calibration Date	4-Jan-24	Equipment Name	SO2 Analyzer
Manufacturer	Teledyne API	Model	T100
Serial No.	8061	Equipment ID	RYG_FS0534
Calibrator Manufacturer	Teledyne API	Model	700
Serial No.	947		
Std. Gas Concentration (PPM)	56.3	Cylinder No.	GN0027222
Cylinder Pressure (psi)	1800	Certified By	Airgas Inc.
Certified Date	9-Feb-22	Expired Date	9-Feb-30

Point	CALIBRATION RESULTS			
	Ideal	Actual	Error	%Error
ZERO	0.00	0.10	0.10	0.10
1	100.00	98.80	-1.20	-1.20
2	200.00	198.70	-1.30	-0.65
3	300.00	298.30	-1.70	-0.57
4	400.00	398.70	-1.30	-0.33
AVERAGE (%)				-0.53



Calibrated By

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

Approved By

(Mr.Sarayuth Jitranont)
Assistant General Manager

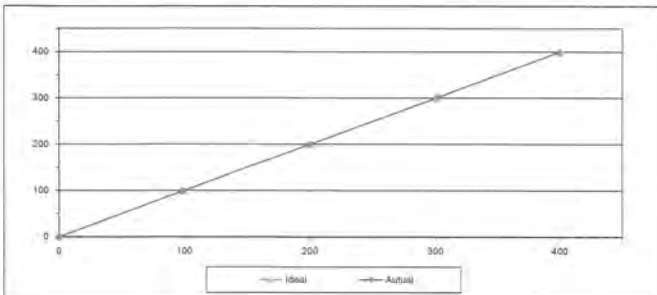
ALS Laboratory Group
FORM NO. F-06-056 REVISION NO. - ISSUE DATE: 02/04/12



MULTIPOINT CALIBRATION REPORT

Calibration Date	4-Jan-24	Equipment Name	SO2 Analyzer
Manufacturer	HORIBA	Model	APSA-370
Serial No.	H0S3D9FA	Equipment ID	RYG_FS0454
Calibrator Manufacturer	Teledyne API	Model	700
Serial No.	947		
Std. Gas Concentration (PPM)	56.3	Cylinder No.	GN0027222
Cylinder Pressure (psi)	1800	Certified By	Airgas Inc.
Certified Date	9-Feb-22	Expired Date	9-Feb-30

Point	CALIBRATION RESULTS			
	Ideal	Actual	Error	%Error
ZERO	0.00	0.10	0.10	0.10
1	100.00	98.30	-1.70	-1.70
2	200.00	200.80	0.80	0.40
3	300.00	301.90	1.90	0.63
4	400.00	399.70	-0.30	-0.08
AVERAGE (%)				-0.13



Calibrated By

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

Approved By

(Mr.Sarayuth Jitranont)
Assistant General Manager

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

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Agilent CrossLab Compliance Services

Certificate of System Qualification

GC-OQ + GCMS-OQ

System ID: RYG_EN0136
Organization Name: ALS Laboratory Group (Thailand) Co.Ltd.
Organization Location: 516/10, Moo 5, Tambol Mae Nam Khu, Phak Daeng, Rayong, 21140, Thailand

Date: January 5, 2024 10:53:24 AM
EQP Name: AgilentRecommended, AgilentRecommended
EQP Revision: GC.02.54, GCMS.02.54
Overall Qualification Status: Pass

REVIEW BY: Chontichol
APPROVED BY: [Signature]
NEXT CAL DATE: 11/09/2025

CDS Logon Verification - GC

Logon: chonl-cha.khunkaew

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 Accuracy

Name: 7890
Front: SSL
Setpoint Status: Pass
Setpoint: 25.0 psi
Actual: 25 psi
Inlet Pressure: 25.0 psi
Accuracy: 0.0 psi
Agilent Recommended: <= 1.2

Date: January 5, 2024 10:53:24 AM
System ID: RYG_EN0136

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Overall Inlet Pressure Accuracy Test Status

Pass

GC Oven Temperature Accuracy

Name: 7890

Setpoint Status: Pass

Zone: Oven

Setpoint/Actual

Temperature: 230.0 229 °C

Accuracy: -1.0 °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: 100.0 100.8 °C

Accuracy: 0.8 °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: 100.0 100.8167 °C

Stability: 0.1 °C

Agilent Recommended: ≤ 0.5

Overall GC Oven Temperature Stability Test Status

Pass

Date: January 5, 2024 10:53:24 AM

System ID: RYG_EN0136

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Log Amp

Tested Combination1 Front SSL / External SQ

Name: 5977B

Setpoint Status: Pass

Overall Log Amp Test Status

Pass

RPPA

Tested Combination1 Front SSL / External SQ

Name: 5977B

Setpoint Status: Pass

Amu: 1050 m/z Drift After Five Minutes: RPPA Voltage: 500 mV

Agilent Recommended: ≥ -100 and ≤ 100 ≤ 1100

Overall RPPA 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

Scouting Run

Date: January 5, 2024 10:53:24 AM

System ID: RYG_EN0136

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Tested Combination1 Front SSL / External SQ

Manual Injection

Name: Not applicable

Source: EI - Extractor

Setpoint Status: Completed

Injection Volume on Column: 1.0 µL

Overall Scouting Run Status

Completed

Signal to Noise EI

Tested Combination1 Front SSL / External SQ

Name: 5977B

Source: EI - Extractor Filament: 1

Setpoint Status: Pass

Signal to Noise: 5113

Agilent Recommended: ≥ 1200

Source: EI - Extractor Filament: 2

Setpoint Status: Pass

Signal to Noise: 4455

Agilent Recommended: ≥ 1200

Overall Signal to Noise EI Test Status

Pass

NOTE: This test's 2 comment(s) and 3 deviation(s) are available in the Attachments section.

Date: January 5, 2024 10:53:24 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

Flow Data Input Manual Data

Temperature Data Input Manual Data or Other Data Logging

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 CN16463238

Firmware Revision B.02.04.3

Component ID/Asset No. 081177000235

Over Type Standard

Date: January 5, 2024 10:53:24 AM

System ID: RYG_EN0136

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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
Detector 1	
Manufacturer	Agilent Technologies
Name	Mass Spectrometer
Type	Mass Spectrometer
Location	External
Mass Spectrometer 1	
Manufacturer	Agilent Technologies
Type	SQ
Name	5977B
Model Number	G7077B
Serial Number	US1701M008
Firmware Revision	5977 5.00.34
High Vacuum System	Turbo Pump
Scouting Run Standard	OFN Std
Component ID/Asset No.	081117000236
MS EI Source 1	
Manufacturer	Agilent Technologies
Source Type	EI - Extractor
Number of Filaments	2

Date: January 5, 2024 10:53:24 AM
System ID: RYG_EN0136

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_puangsoa@agilent.com
Signature Creation Date: January 5, 2024
Reason for Signature: Executed protocol and published this original version of document

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Date: January 5, 2024 10:53:24 AM
System ID: RYG_EN0136

User Name: eaknarin_puangsoa

Report Generated by Hostname: ASRYGWS074

System ID: RYG_EN0136

Print Date: January 5, 2024 10:51:25 AM

ALS_QO_RYG_EN0136 Transaction log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
January 4, 2024 10:37:31 AM	Auth	Server-Created	Session	None
January 4, 2024 10:37:31 AM	Start	Configuration	Session	None
January 4, 2024 10:37:31 AM	Auth	Ext Server	License	User is Field Engineer and does not require an unlock code
January 4, 2024 10:39:29 AM	Auth	EplLoaded	Session	EOP details for primary technique (SQ) - File path: (ProtocolPacks\GC\Configurations\02.54\GC_02.54.eop) EOP File Name: (GC_02.54.eop) EOP Name: (AgilentRecommended)\Protocol Revision: (SQ_02.54) EOP details for hyphenated technique (SQM) - File path: (ProtocolPacks\GCMS\Configurations\02.54\GCMS_02.54.eop) EOP File Name: (SQM_02.54.eop) EOP Name: (AgilentRecommended)
January 4, 2024 10:39:40 AM	End	Configuration	Session	None
January 4, 2024 10:39:44 AM	Start	Qualification	Session	QC
January 4, 2024 10:39:44 AM	Start	Execution	CO2 Lepton Verification - GC - 7890 - Qualitative test	None
January 4, 2024 10:40:00 AM	End	Execution	CO2 Lepton Verification - GC - 7890 - Qualitative test	Run Count: 1

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Date: January 5, 2024 10:53:24 AM
System ID: RYG_EN0136

User Name: eaknarin_puangsoa			System ID: RYG_EN0136	
Report Generated by Hostname: ASRYGWS074			Print Date: January 5, 2024 10:51:25 AM	
ALS_QO_RYG_EN0136 Transaction log:				
Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
January 4, 2024 10:40:05 AM	Start	Execution	System Inspection and Basic Safety and Operation - 7890 - Qualitative Test - No endpoints associated	None
January 4, 2024 10:40:18 AM	End	Execution	System Inspection and Basic Safety and Operation - 7890 - Qualitative Test - No endpoints associated	Run Count: 1
January 4, 2024 10:40:22 AM	Start	Execution	Inject Pressure Accuracy - Front SSL - Pressure Controlled Inlet - S: 25.0 psi - L: <= 1.2 psi	None
January 4, 2024 10:40:52 AM	End	Execution	Inject Pressure Accuracy - Front SSL - Pressure Controlled Inlet - S: 25.0 psi - L: <= 1.2 psi	Run Count: 1
January 4, 2024 10:48:54 AM	Start	Execution	GC Oven Temperature Accuracy - 7890 - Temperature - Oven - S: 230.0°C - L: <= -1.0 AND <= 1.0 % specified in K	None
January 4, 2024 10:51:05 AM	Auth	Data	GC Oven Temperature Accuracy - 7890 - Temperature - Oven - S: 230.0°C - L: <= -1.0 AND <= 1.0 % specified in K	Manual Data Entry
January 4, 2024 10:51:08 AM	End	Execution	GC Oven Temperature Accuracy - 7890 - Temperature - Oven - S: 230.0°C - L: <= -1.0 AND <= 1.0 % specified in K	Run Count: 1
January 4, 2024 10:51:43 AM	Start	Execution	GC Oven Temperature Accuracy - 7890 - Temperature - Oven - S: 160.0°C - L: <= -1.0 AND <= 1.0 % specified in K	None
January 4, 2024 10:58:45 AM	Auth	Data	GC Oven Temperature Accuracy - 7890 - Temperature - Oven - S: 160.0°C - L: <= -1.0 AND <= 1.0 % specified in K	Manual Data Entry

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Date: January 5, 2024 10:53:24 AM
System ID: RYG_EN0136

User Name: sakshini_jungappa

Report Generated by Hostname: ASRYGW0074

System ID: RYG_EN0136

Print Date: January 5, 2024 10:53:25 AM

ALS_OQ_RYG_EN0136 Transaction log

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
January 4, 2024 10:59:46 AM	End	Execution	GC Oven Temperature Accuracy - 7850 - Temperature Oven - 8: 100.0°C - L: +/- 1.0 AND +/- 1.0 % repeat in K	Run Count: 1
January 4, 2024 10:58:59 AM	Start	Execution	GC Oven Temperature Stability - 7850 - Temperature Oven - 8: 100.0°C - L: +/- 0.5°C	None
January 4, 2024 11:23:28 AM	Auto	Data	GC Oven Temperature Stability - 7850 - Temperature Oven - 8: 100.0°C - L: +/- 0.5°C	Manual Data Entry
January 4, 2024 11:23:25 AM	End	Execution	GC Oven Temperature Stability - 7850 - Temperature Oven - 8: 100.0°C - L: +/- 0.5°C	Run Count: 0
January 4, 2024 11:23:35 AM	Start	Execution	Log Amp - 59778 SQ - Source: None	Run Count: 1
January 4, 2024 11:43:23 AM	End	Execution	Log Amp - 59778 SQ - Source: EI - Extractor	Run Count: 1
January 4, 2024 11:43:26 AM	Start	Execution	RPPA - 59778 SQ - Source: EI - None	Run Count: 1
January 4, 2024 11:53:23 AM	End	Execution	RPPA - 59778 SQ - Source: EI - None	Run Count: 1
January 4, 2024 11:53:28 AM	Start	Execution	Tune EI - 59778 SQ - Source: EI - None	Run Count: 1
January 4, 2024 11:57:28 PM	End	Execution	Tune EI - 59778 SQ - Source: EI - None	Run Count: 1
January 4, 2024 11:57:23 PM	Start	Execution	Tune EI - 59778 SQ - Source: EI - None	Run Count: 1

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User Name: sakshini_jungappa

Report Generated by Hostname: ASRYGW0074

System ID: RYG_EN0136

Print Date: January 5, 2024 10:53:25 AM

ALS_OQ_RYG_EN0136 Transaction log

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
January 4, 2024 11:59:55 PM	End	Execution	Tune EI - 59778 SQ - Source: EI - None	Run Count: 1
January 4, 2024 11:59:02 PM	Start	Execution	Scouting Run - Manual Injection, Front SSI, SQ - Source: EI - Extractor Part of GCMS System Preparation	None
January 4, 2024 12:03:35 PM	Auto	AcqClosed	Session	None
January 5, 2024 8:28:18 AM	Auto	AcqRestarted	Session	None
January 5, 2024 8:28:18 AM	Auto	Session/Reloaded	Session	None
January 5, 2024 8:28:29 AM	Start	Qualification	Session	OQ
January 5, 2024 8:28:29 AM	Start	Execution	Scouting Run - Manual Injection, Front SSI, SQ - Source: EI - Extractor Part of GCMS System Preparation	None
January 5, 2024 9:21:28 AM	Auto	Data	Scouting Run - Manual Injection, Front SSI, SQ - Source: EI - Extractor Part of GCMS System Preparation	Data File Path: D:\OQ2024\ASRYGW0074.D
January 5, 2024 9:21:53 AM	End	Execution	Scouting Run - Manual Injection, Front SSI, SQ - Source: EI - Extractor Part of GCMS System Preparation	Run Count: 1
January 5, 2024 9:21:58 AM	Start	Execution	Signal to Noise EI - Liquid Injection, Front SSI, SQ - Source: EI - Extractor using Filament 2 - L: +/- 1200	None

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Date: January 5, 2024 10:53:24 AM
System ID: RYG_EN0136

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Date: January 5, 2024 10:53:24 AM
System ID: RYG_EN0136

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User Name: sakshini_jungappa

Report Generated by Hostname: ASRYGW0074

System ID: RYG_EN0136

Print Date: January 5, 2024 10:53:25 AM

ALS_OQ_RYG_EN0136 Transaction log

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
January 5, 2024 9:25:59 AM	End	Qualification	Session	OQ
January 5, 2024 9:25:38 AM	Start	Reporting	Session	None
January 5, 2024 9:27:46 AM	End	Reporting	Session	None
January 5, 2024 9:27:46 AM	Start	Qualification	Session	OQ
January 5, 2024 9:37:46 AM	Start	Execution	Signal to Noise EI - Liquid Injection, Front SSI, SQ - Source: EI - Extractor using Filament 1 - L: +/- 1200	None
January 5, 2024 9:33:18 AM	Auto	Data	Signal to Noise EI - Liquid Injection, Front SSI, SQ - Source: EI - Extractor using Filament 1 - L: +/- 1200	Data File Path: D:\OQ2024\ASRYGW0074.D
January 5, 2024 9:44:22 AM	End	Execution	Signal to Noise EI - Liquid Injection, Front SSI, SQ - Source: EI - Extractor using Filament 1 - L: +/- 1200	Run Count: 1
January 5, 2024 9:45:32 AM	Start	Execution	Signal to Noise EI - Liquid Injection, Front SSI, SQ - Source: EI - Extractor using Filament 2 - L: +/- 1200	None
January 5, 2024 9:55:15 AM	Auto	Data	Signal to Noise EI - Liquid Injection, Front SSI, SQ - Source: EI - Extractor using Filament 2 - L: +/- 1200	Data File Path: D:\OQ2024\ASRYGW0074.D
January 5, 2024 10:02:18 AM	End	Execution	Signal to Noise EI - Liquid Injection, Front SSI, SQ - Source: EI - Extractor using Filament 2 - L: +/- 1200	Run Count: 1

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User Name: sakshini_jungappa			System ID: RYG_EN0136	
Report Generated by Hostname: ASRYGW0074			Print Date: January 5, 2024 10:53:25 AM	
ALS_OQ_RYG_EN0136 Transaction log				
Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
January 5, 2024 10:03:53 AM	Auto	Test/Unlocked	Signal to Noise EI - Liquid Injection, Front SSI, SQ - Source: EI - Extractor using Filament 2 - L: +/- 1200	Deviation fixed for Run Count: 1
January 5, 2024 10:03:53 AM	Start	Execution	Signal to Noise EI - Liquid Injection, Front SSI, SQ - Source: EI - Extractor using Filament 2 - L: +/- 1200	None
January 5, 2024 10:13:43 AM	Auto	Data	Signal to Noise EI - Liquid Injection, Front SSI, SQ - Source: EI - Extractor using Filament 2 - L: +/- 1200	Data File Path: D:\OQ2024\ASRYGW0074.D
January 5, 2024 10:17:58 AM	End	Execution	Signal to Noise EI - Liquid Injection, Front SSI, SQ - Source: EI - Extractor using Filament 2 - L: +/- 1200	Run Count: 2
January 5, 2024 10:22:59 AM	Auto	Test/Unlocked	Signal to Noise EI - Liquid Injection, Front SSI, SQ - Source: EI - Extractor using Filament 2 - L: +/- 1200	Deviation fixed for Run Count: 2
January 5, 2024 10:22:04 AM	Start	Execution	Signal to Noise EI - Liquid Injection, Front SSI, SQ - Source: EI - Extractor using Filament 2 - L: +/- 1200	None
January 5, 2024 10:32:15 AM	Auto	Data	Signal to Noise EI - Liquid Injection, Front SSI, SQ - Source: EI - Extractor using Filament 2 - L: +/- 1200	Data File Path: D:\OQ2024\ASRYGW0074.D
January 5, 2024 10:35:57 AM	End	Execution	Signal to Noise EI - Liquid Injection, Front SSI, SQ - Source: EI - Extractor using Filament 2 - L: +/- 1200	Run Count: 3

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Date: January 5, 2024 10:53:24 AM
System ID: RYG_EN0136

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Date: January 5, 2024 10:53:24 AM
System ID: RYG_EN0136

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User Name: eaknarin_puangso
Report Generated by Hostname: ASRYGWIN274

System ID: RYG_EN0136
Print Date: January 5, 2024 16:33:25 AM

ALS_OO_RYG_EN0136 Transaction log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
January 5, 2024 10:29:11 AM	Auto	Test/Loaded	Signal to Noise E1 - Liquid Injection, Front S&L, SQ- Source: E1 - Extractor using Filament 2 - L >= 1200	De-ision tied for Run Count : 3
January 5, 2024 10:29:11 AM	Start	Erection	Signal to Noise E1 - Liquid Injection, Front S&L, SQ- Source: E1 - Extractor using Filament 2 - L >= 1200	None
January 5, 2024 10:42:05 AM	Auto	Data	Signal to Noise E1 - Liquid Injection, Front S&L, SQ- Source: E1 - Extractor using Filament 2 - L >= 1200	Data file Path: D:\Q0025\SM_F002.D
January 5, 2024 10:43:34 AM	End	Erection	Signal to Noise E1 - Liquid Injection, Front S&L, SQ- Source: E1 - Extractor using Filament 2 - L >= 1200	Run Count : 4
January 5, 2024 10:48:41 AM	End	Qualification	Session	OG
January 5, 2024 10:46:41 AM	Start	Reporting	Session	None
January 5, 2024 10:50:27 AM	Auto	Reporting	Session	Report Generated : Certificate
January 5, 2024 10:51:07 AM	Auto	Reporting	Session	Report Generated : Report
January 5, 2024 10:51:29 AM	Auto	Reporting	Session	Report Generated : Certificate
January 5, 2024 10:52:00 AM	Auto	Reporting	Session	Report Generated : Report

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Date: January 5, 2024 10:53:24 AM
System ID: RYG_EN0136

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MEASUREMENT RESULTS³

The cup anemometer, Unit Under Calibration (UUC) was exercised at 10 m/s for 5 minutes prior to calibration being performed. The standard air velocity 0.5 m/s to 5 m/s was calculated by a standard air velocity transducer and above 5 m/s to 10 m/s was calculated by a pitot tube with precision differential pressure meter which was installed 40 mm and 300 mm respectively away from wind tunnel nozzle. UUC was installed at center of the test section. The calibration was carried out under both rising and falling air velocity in the range of 1 m/s to 10 m/s at calibration interval of 1 m/s. The results of calibration and associated measurement uncertainties are reported in the table below.

V_{std} (m/s)	Temp. wind tunnel (°C)	Temp. room (°C)	V_{UUC} (m/s)	Error (m/s)	U (k=2) (m/s)
0.985	24.10	24.10	0.8	-0.2	0.36
2.033	24.10	24.10	1.9	-0.1	0.16
3.040	23.94	24.10	3.0	-0.1	0.23
4.134	24.10	24.10	4.0	-0.1	0.20
4.99	23.92	24.10	4.9	-0.1	0.44
5.98	24.10	24.10	6.0	0.0	0.18
7.05	23.90	24.10	7.0	-0.1	0.36
8.19	24.06	24.10	8.2	0.0	0.26
9.09	23.84	24.10	9.1	0.0	0.24
10.09	23.92	24.10	10.1	0.0	0.28
11.15	23.80	24.10	11.1	0.0	0.45
12.14	23.80	24.10	12.2	0.0	0.31
13.19	23.80	24.10	13.2	0.0	0.47
14.26	23.74	24.10	14.2	0.0	0.42
15.25	23.78	24.10	15.1	-0.1	0.66
16.26	23.70	24.10	16.3	0.0	0.56

Remark:

³ Calibration results only count for the tested circumstances and environmental conditions during which calibration took place.

⁴ Velocity of standard

Velocity of Unit Under Calibration

PHOTO OF CALIBRATION SET-UP



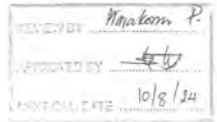
Calibration set-up of the cup anemometer calibration in the wind tunnel of Jiranatee Associates Co., Ltd. The cup anemometer shown may differ from the calibrated one. Remark: The proportion of the set-up is not true (some due to image geometry).



Jiranatee Associates Co., Ltd.
63/14-15, 67/35-36
Fetthasam 7/71, 86 Watthana, Bangkok,
Bangkok 10007 (Thailand)
Tel: +66(0)840812
Mobile: +66(0)959453
E-mail: nac-calibration@jiranatee.com
Web site: www.jiranatee.com

Accredited calibration laboratory
ISO/IEC 17025:2017
NSC-TIS-715 17025
CALIBRATION 0367

Air speed measurement laboratory
Calibration services department



Certificate Number

CL-021-66

CERTIFICATE OF CALIBRATION

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MEASUREMENT ITEM
MANUFACTURER
MODEL/TYPE

Cup anemometer
Novolytis
Sensor: WS-02F
Data logger: 200-WS-25L8

SERIAL NUMBER

Sensor: -
Data logger: AS376

ID NUMBER
CONDITION AS-RECEIVED
CUSTOMER

RYG_F50414
Used item
ALS laboratory group (Thailand) Co., Ltd.
104 Phatthanakan 40, Phatthanakan Rd, Khwaeng Suan Luang,
Khet Suan Luang, Bangkok 10250 Thailand.

RECEIVED DATE
MEASUREMENT DATE
ISSUE DATE

27 Jan 2023
10 Feb 2023
10 Feb 2023

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follow:

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

PLACE OF CALIBRATION

Effel-type wind tunnel of Jiranatee Associates Co., Ltd.

CALIBRATION CONDITIONS

Wind tunnel cross-section area¹ 900 cm²
Win direction frontal area² 100 cm²
Diameter of mounting pipe³ 129 mm
Blockage ratio of test object⁴ 0.143 [-]

Preconditioning

24 hours at ambient conditions.

Measurement Condition

The average values during measurement are (24.1) °C, (47.6) %RH and (1014.7) hPa.

TABULATION OF RESULTS:

The table on next page give the measured values.

Calibrated by:

☒ Mr. Sorawit Thuchaiad
☐ Miss Jitraporn Leptanaphol



Approved signatory:

Mr. Parinya Boonchroen
Mr. Parinya Boonchroen
Calibration Department Manager

Remark:

¹ Nozzle cross-section area of the wind tunnel

² Projected cross-section area of the tested object include mounting pipe

³ Diameter of mounting pipe

⁴ Ratio "a"

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

Jiranatee Associates Co., Ltd.
63/14-15, 67/35-36
Fetthasam 7/71, 86 Watthana, Bangkok,
Bangkok 10007 (Thailand)
Tel: +66(0)840812
Mobile: +66(0)959453
E-mail: nac-calibration@jiranatee.com
Web site: www.jiranatee.com

Accredited calibration laboratory
ISO/IEC 17025:2017
NSC-TIS-715 17025
CALIBRATION 0367

Air speed measurement laboratory
Calibration services department

Certificate Number

CL-019-66

CERTIFICATE OF CALIBRATION

Page 1 of 3 Pages

MEASUREMENT ITEM
MANUFACTURER
MODEL/TYPE

Wind Direction Sensor
Novolytis
Sensor: WS-02F
Data logger: 200-WS-25L8

SERIAL NUMBER

Sensor: -
Data logger: AS376

ID NUMBER
CONDITION AS-RECEIVED
CUSTOMER

RYG_F50414
Used item
ALS laboratory group (Thailand) Co., Ltd.
104 Phatthanakan 40, Phatthanakan Rd, Khwaeng Suan Luang,
Khet Suan Luang, Bangkok 10250 Thailand.

RECEIVED DATE
MEASUREMENT DATE
ISSUE DATE

27 Jan 2023
10 Feb 2023
10 Feb 2023

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follow:

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

PLACE OF CALIBRATION

Effel-type wind tunnel of Jiranatee Associates Co., Ltd.

CALIBRATION CONDITION

Wind tunnel cross-section area¹ 900 cm²
Win direction frontal area² 129 cm²
Diameter of mounting pipe³ 129 mm
Blockage ratio of test object⁴ 0.143 [-]

Preconditioning

24 hours at ambient conditions.

Measurement Condition

The average values during measurement are (24.0) °C, (49.0) %RH and (1014.3) hPa.

TABULATION OF RESULTS:

The table on next page give the measured values.

Calibrated by:

☒ Mr. Sorawit Thuchaiad
☐ Miss Jitraporn Leptanaphol



Approved signatory:

Mr. Parinya Boonchroen
Mr. Parinya Boonchroen
Calibration Department Manager

Remark:

¹ Nozzle cross-section area of the wind tunnel

² Projected cross-section area of the tested object include mounting pipe

³ Diameter of mounting pipe

⁴ Ratio "a"

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

Certificate Number
CL-019-66

Page 2 of 2 Pages

MEASUREMENT RESULTS¹

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

Air speed m/s	D _{180°} Degree (°)	D _{0°} Degree (°)	Error Degree (°)	U (k=2) Degree (°)
	0.000	0	0	0.58
	45.000	41	-4	0.58
	90.000	87	-3	0.64
4.98	135.001	133	-2	0.68
	180.000	179	-1	0.74
	225.000	227	2	0.91
	270.001	273	3	0.98
	315.000	318	3	0.74

Remark:

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

² Direction of standard.

³ Direction of Unit Under Calibration.



End of Certificate of Calibration



Jiranatee Associates Co., Ltd.
83/24-25, Srinakharin
Petchkasem 7/71 Rd. Watthana, Bangkok 10600 (Thailand)
Tel : +66888312
Mobile : +6688299543
E-mail : jnac-calibration@jiranatee.com
Web site : www.jiranatee.com

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

Air speed measurement laboratory
Calibration services department.



Certificate Number
CL-012-66

CERTIFICATE OF CALIBRATION

Page 1 of 2 Pages

MEASUREMENT ITEM MANUFACTURER MODEL/TYPE

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

SERIAL NUMBER

: Sensor: WSD-011

ID NUMBER

: Data logger: AS660

CONDITION AS-RECEIVED

: RYG_350330

CUSTOMER

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

RECEIVED DATE

: 16 Jan 2023

MEASUREMENT DATE

: 19 Jan 2023

ISSUE DATE

: 20 Jan 2023

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follows:

Temperature : 23.0 ± 3.0 °C
Relative Humidity : 55.0 ± 15.0 %RH
Atmospheric Pressure : 1010.0 ± 10 hPa

PLACE OF CALIBRATION

: Effel-type wind tunnel of Jiranatee Associates Co., Ltd.

CALIBRATION CONDITION

Wind tunnel cross-section area¹ : 900 cm²
Win direction frontal area² : 129 cm²
Diameter of mounting pipe³ : - mm
Blockage ratio of test object⁴ : 0.143 [-]

Preconditioning

: 24 hours at ambient conditions.

Measurement Condition

: The average values during measurement are (23.7) °C, (64.2) %RH and (1015.2) hPa.

TABULATION OF RESULTS:

The table on next page give the measured values.

Calibrated by:

☒ Mr. Sorawit Thachavadi
☐ Miss Jitraporn Lertsomphol

Approved signatory:

Mr. Pinyia Booncharoen
Calibration Department Manager

Remark:

¹ Nozzle cross-section area of the wind tunnel.

² Projected cross-section area of the tested object include mounting pipe.

³ Diameter of mounting pipe.

⁴ Ratio "a" to "b".

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

Certificate Number
CL-012-66

Page 2 of 2 Pages

MEASUREMENT RESULTS¹

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

Air speed m/s	D _{180°} Degree (°)	D _{0°} Degree (°)	Error Degree (°)	U (k=2) Degree (°)
	0.000	0	0	0.58
	45.000	42	-3	0.74
	90.000	88	-2	0.74
5.01	135.000	133	-2	0.68
	180.000	179	-1	0.74
	225.000	226	-1	0.74
	270.000	270	0	0.74
	315.000	316	-1	0.74

Remark:

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

² Direction of standard.

³ Direction of Unit Under Calibration.

End of Certificate of Calibration



Jiranatee Associates Co., Ltd.
83/24-25, Srinakharin
Petchkasem 7/71 Rd. Watthana, Bangkok 10600 (Thailand)
Tel : +66888312
Mobile : +6688299543
E-mail : jnac-calibration@jiranatee.com
Web site : www.jiranatee.com

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

Air speed measurement laboratory
Calibration services department.

Certificate Number
CL-012-66

CERTIFICATE OF CALIBRATION

Page 1 of 2 Pages

MEASUREMENT ITEM MANUFACTURER MODEL/TYPE

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

SERIAL NUMBER

: Sensor: WSD-011

ID NUMBER

: Data logger: AS660

CONDITION AS-RECEIVED

: RYG_350330

CUSTOMER

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

RECEIVED DATE

: 16 Jan 2023

MEASUREMENT DATE

: 18 Jan 2023

ISSUE DATE

: 20 Jan 2023

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follows:

Temperature : 23.0 ± 3.0 °C
Relative Humidity : 55.0 ± 15.0 %RH
Atmospheric Pressure : 1010.0 ± 10 hPa

PLACE OF CALIBRATION

: Effel-type wind tunnel of Jiranatee Associates Co., Ltd.

CALIBRATION CONDITIONS

Wind tunnel cross-section area¹ : 900 cm²
Win direction frontal area² : 100 cm²
Diameter of mounting pipe³ : - mm
Blockage ratio of test object⁴ : 0.111 [-]

Preconditioning

: 24 hours at ambient conditions.

Measurement Condition

: The average values during measurement are (23.7) °C, (50.2) %RH and (1017.1) hPa.

TABULATION OF RESULTS:

The table on next page give the measured values.

Calibrated by:

☒ Mr. Sorawit Thachavadi
☐ Miss Jitraporn Lertsomphol

Approved signatory:

Mr. Pinyia Booncharoen
Calibration Department Manager

Remark:

¹ Nozzle cross-section area of the wind tunnel.

² Projected cross-section area of the tested object include mounting pipe.

³ Diameter of mounting pipe.

⁴ Ratio "a" to "b".

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

Certificate Number
CL-012-66

Page 2 of 2 Pages

MEASUREMENT RESULTS¹

The cup anemometer, Unit Under Calibration (UUC) was exercised at 10 m/s for 5 minutes prior to calibration being performed. The standard air velocity 0.5 m/s to 5 m/s was calculated by a standard air velocity transducer and above 5 m/s to 30 m/s was calculated by a pitot tube with precision differential pressure meter which was installed 40 mm and 300 mm respectively away from wind tunnel nozzle. UUC was installed at center of the test section. The calibration was carried out under both rising and falling air velocity in the range of 1 m/s to 16 m/s at calibration interval of 1 m/s. The results of calibration and associated measurement uncertainties are reported in the table below.

V_{std} (m/s)	Temp. wind tunnel (°C)	Temp. room (°C)	V_{UUC} (m/s)	Error (m/s)	$M (k=2)$ (m/s)
0.979	23.56	23.70	0.8	-0.2	0.16
2.025	23.80	23.70	1.8	-0.2	0.16
3.045	23.50	23.70	2.8	-0.2	0.30
4.120	23.64	23.70	3.9	-0.3	0.20
5.01	23.44	23.70	4.8	-0.2	0.18
5.98	23.60	23.70	5.8	-0.2	0.18
7.05	23.28	23.70	6.9	-0.1	0.19
8.17	23.60	23.70	8.0	-0.2	0.19
9.08	23.20	23.70	9.0	0.0	0.22
10.09	23.52	23.70	9.9	-0.2	0.20
11.13	23.20	23.70	10.9	-0.2	0.21
12.13	23.50	23.70	11.9	-0.2	0.21
13.19	23.20	23.70	13.0	0.2	0.22
14.25	23.45	23.70	14.9	0.6	0.24
15.22	23.20	23.70	15.1	-0.1	0.34
16.31	23.30	23.70	16.1	-0.2	0.29

Remark:

¹ Calibration results only count for the tested circumstances and environmental conditions during which calibration took place

² Velocity of standard

³ Velocity of Unit Under Calibration

PHOTO OF CALIBRATION SET-UP



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

End of Certificate of Calibration



63/14-15,67/36-36, Soi Petchkasem 7/1, Petchkasem Rd,
Walthapra, Bangkokkhyai, Bangkok 10600 Thailand.
Tel: (66) 02-8680812#13 Fax: (66) 02-8680860 www.jiranatee.com



CERTIFICATE OF CALIBRATION

Certificate No.: CL-005-66
Page 1 of 2

Equipment Name: Data Logger with Temperature

Sensor

Manufacturer: Novolyns

Model: 110-WS-250L-D

Serial No.: A5660

ID No.: RYG_F80530

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: 16 Jan 2023
Calibration date: 18 Jan 2023
Issue date: 20 Jan 2023

Reference Used During Calibration

1. Standard Temperature Probe Model: STS-100 A500,
Serial No.: 667682-09, Due date: 23 Mar 2023
2. Digital Temperature Indicator Model: DTI-1000 A MK
II, Serial No.: 671407-00591 Due date: 22 July 2023

Calibration Condition

Temperature: (23±3)°C
Relative Humidity: (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-0034-22, Certificate number: ER-0092-22

Calibrated by
☐ Mr. Sorawit Thachalad
☒ Miss Jitraporn Lertsomphol



Approved Signatory:
Mr. Panyee 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.



63/14-15,67/36-36, Soi Petchkasem 7/1, Petchkasem Rd,
Walthapra, Bangkokkhyai, Bangkok 10600 Thailand.
Tel: (66) 02-8680812#13 Fax: (66) 02-8680860 www.jiranatee.com



Certificate No.: CL-005-66
Page 2 of 2

Result of Calibration: ☒ Without Adjustment ☐ With Adjustment

Calibration Range: 20-40 °C

Function:

This equipment was connected with temperature sensor Model: HMP60 S/N: S4620631.

Dimension : Diameter 12 mm. Length 80 mm.

Immersion Depth (mm)	Standard Reading (°C)	UUC Reading (°C)	Error (°C)	Uncertainty (°C)
60	20.066	19.8	-0.3	0.099
60	25.058	24.6	-0.5	0.14
60	30.052	29.5	-0.6	0.099
60	35.047	34.5	-0.5	0.099
60	40.038	39.4	-0.6	0.099

UUC*: Unit Under Calibration

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

★ End of Certificate ★



63/14-15,67/36-36, Soi Petchkasem 7/1, Petchkasem Rd,
Walthapra, Bangkokkhyai, Bangkok 10600 Thailand.
Tel: (66) 02-8680812#13 Fax: (66) 02-8680860 www.jiranatee.com

CERTIFICATE OF CALIBRATION

Calibration No.: RH-06012023
Page 1 of 1 Pages

Measurement Item : Relative humidity with data logger
Manufacturer : Novolyns
Model/Type : 110-WS-250L-D
Serial Number : A5660
ID No. : RYG_F80530
Customer : ALS laboratory group (Thailand) Co., Ltd.
: 104 Phatthanakan 40, Phatthanakan Rd., Khwaeng Suan Luang, Khet Suan Luang, Bangkok
10250 Thailand.

Environmental Condition:

The measurement was carried out in an ambient temperature of (25±3)°C, and relative humidity of (60±16)%.

Measurement Method:

Unit Under Calibration (UUC) was calibrated by comparison method with standard thermo hygrometer in the humidity generator chamber to determine the errors.

Traceability:

This instrument was calibrated using standard equipment whose accuracy is traceability through National Institute of Standards and Technology and the international system of units (SI) via MCS Calibration, Inc. Certificate number: 20314-101, Due date: Mar 14, 2023.

Measurement Date : Jan 18, 2023
Issued Date : Jan 20, 2023

Measurement Results:

This equipment was connected with indoor air quality probe and Displayed (RH) on display. Model: HMP60, Serial number: S4620631.

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

The results of calibration are reported in table below.

Determined (%RH)	Standard (%RH)	UUC (Reading) (%RH)	Error (%RH)	Uncertainty (%RH)
20	20.03	17.8	-2.2	0.68
50	50.28	48.6	-1.7	0.67
80	80.29	79.8	-0.6	0.68

Performed by
☐ Mr. Sorawit Thachalad
☒ Miss Jitraporn Lertsomphol



Approved Signatory:
Mr. Panyee Booncharoen
Calibration Department Manager

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

MEASUREMENT RESULTS¹

The cup anemometer, Link Under Calibration (LUC) was exercised at 10 m/s for 5 minutes prior to calibration being performed. The standard air velocity 0.5 m/s to 5 m/s was calculated by a standard air velocity transducer and above 5 m/s to 30 m/s was calculated by a pitot tube with precision differential pressure meter which was installed 40 mm and 300 mm respectively away from wind tunnel nozzle. LUC was installed at center of the test section. The calibration was carried out under both rising and falling air velocity in the range of 1 m/s to 16 m/s at calibration interval of 1 m/s. The results of calibration and associated measurement uncertainties are reported in the table below.

V_{ref} (m/s)	Temp. wind tunnel (°C)	Temp. room (°C)	V_{meas} (m/s)	Error (m/s)	U (k=2) (m/s)
1.025	24.16	24.30	0.9	-0.1	0.31
2.025	24.50	24.30	1.9	-0.1	0.31
3.013	24.08	24.30	2.8	-0.1	0.31
4.121	24.18	24.30	4.0	-0.1	0.31
5.02	24.00	24.30	4.9	-0.1	0.31
5.99	24.26	24.30	5.9	-0.1	0.31
7.04	23.90	24.30	7.0	-0.1	0.31
8.18	24.12	24.30	8.0	-0.2	0.31
9.09	23.90	24.30	9.0	-0.1	0.31
10.09	24.02	24.30	10.0	-0.1	0.31
11.14	23.86	24.30	11.0	-0.2	0.31
12.15	23.90	24.30	12.0	-0.1	0.31
13.19	23.80	24.30	13.0	-0.2	0.31
14.26	23.85	24.30	14.1	-0.2	0.31
15.23	23.80	24.30	15.0	-0.2	0.31
16.31	23.80	24.30	16.1	-0.2	0.31

Remarks:

¹ Calibration results only count for the tested circumstances and environmental conditions during which calibration took place

² Velocity of standard

Velocity of Link Under Calibration

PHOTO OF CALIBRATION SET-UP



Calibration set-up of the cup anemometer calibration in the wind tunnel of Jirantee Associates Co., Ltd. The cup anemometer shown may differ from the calibrated one. Remark: The position of the set-up is not true to scale and is for reference only.



MEASUREMENT ITEM

MANUFACTURER

MODEL/TYPE

SERIAL NUMBER

ID NUMBER

CONDITION AS-RECEIVED

CUSTOMER

Cup anemometer
Novalyne
Sensor: WS-02FA
Data logger: 110-WS-25DI-0
Sensor: WSD-A5088
Data logger: A5088
RYG, FS0650
New item
ALS laboratory group (Thailand) Co., Ltd.
104 Phatthanakan 40, Phatthanakan Rd, Khwaeng Suan Luang,
Khet Suan Luang, Bangkok 10250 Thailand.

Calibration procedure:

The cup anemometer was calibrated against standard air velocity transducer model: BASS-12 and pitot tube with precision differential pressure meter model: DP42500 in an open test-section of Effel-type wind tunnel with 900 cm² cross test section area. The WS-CL-902 based on IEC 61400-12-1, Wind energy generation systems - Part 12-1: Power performance measurements of electricity producing wind turbines, March 2017 was used as a calibration guideline.

Traceability:

This certificate provides a traceability of the measurement to recognize the national standards and to realization of the international system of units (SI) through the NIMT (National Metrology Institute of Thailand) via Certificate number: MW-0022-21 and MW-0066-22

Uncertainty of Measurement:

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

RECEIVED DATE

MEASUREMENT DATE

ISSUE DATE

16 Jun 2023
20 Jun 2023
20 Jun 2023

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follows:

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

PLACE OF CALIBRATION

Effel-type wind tunnel of Jirantee Associates Co., Ltd.

CALIBRATION CONDITIONS

Wind tunnel cross-section area¹: 900 cm²
Win direction frontal area²: 100 cm²
Diameter of mounting pipe³: mm
Blockage ratio of test object⁴: 0.113 [-]

Preconditioning

Measurement Condition

24 hours at ambient conditions
The average values during measurement are (24.3) °C, (44.7) %RH and (1009.5) hPa.

TABULATION OF RESULTS:

The table on next page give the measured values.

Calibrated by:

Mr. Sorawat Thachalad
Miss Jiragorn Lertsomphol



Approved signature:

[Signature]
Mr. Pannya Booncharoen
Calibration Department Manager

Remarks:

¹ Nozzle cross-section area of the wind tunnel
² Projected cross-section area of the tested object include mounting pipe
³ Diameter of mounting pipe
⁴ Ratio "a/b"

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

MEASUREMENT RESULTS¹

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

Air speed	D ¹ _{me} Degree (°)	D ² _{me} Degree (°)	Error Degree (°)	U (k=2) Degree (°)
	0.000	0	0	1.0
	45.000	42	-3	1.0
	90.000	87	-3	1.0
	135.000	132	-3	1.0
	180.000	178	-3	1.0
	225.000	227	-2	1.0
	270.000	273	3	1.0
	315.000	318	3	1.0

Remarks:

¹ Calibration results only count for the tested circumstances and environmental conditions during which calibration took place

² Direction of standard

³ Direction of Link Under Calibration



MEASUREMENT ITEM

MANUFACTURER

MODEL/TYPE

SERIAL NUMBER

ID NUMBER

CONDITION AS-RECEIVED

CUSTOMER

Wind Direction Sensor

Novalyne

Sensor: WS-02FA

Data logger: 110 WS-25DI-0

Sensor: WSD-A5088

Data logger: A5088

RYG, FS0650

New item

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

Calibration procedure:

The wind direction sensor was calibrated against Standard Rotary Encoder model: AX400TS-DMD4-P3-S-10 in an open test-section of Effel-type wind tunnel with 900 cm² cross test section area. The WS-CL-902 based on IEC 61400-12-1, Wind energy generation systems - Part 12-1: Power performance measurements of electricity producing wind turbines, March 2017 was used as a calibration guideline.

Traceability:

This certificate provides a traceability of the measurement to recognize the national standards and to realization of the international system of units (SI) through the NIMT (National Metrology Institute of Thailand) via Certificate number: DA-0045-22

Uncertainty of Measurement:

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

RECEIVED DATE

MEASUREMENT DATE

ISSUE DATE

16 Jun 2023
20 Jun 2023
20 Jun 2023

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follows:

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

PLACE OF CALIBRATION

Effel-type wind tunnel of Jirantee Associates Co., Ltd.

CALIBRATION CONDITION

Wind tunnel cross-section area¹: 900 cm²
Win direction frontal area²: 129 cm²
Diameter of mounting pipe³: mm
Blockage ratio of test object⁴: 0.143 [-]

Preconditioning

Measurement Condition

24 hours at ambient conditions
The average values during measurement are (24.3) °C, (51.8) %RH and (1008.5) hPa.

TABULATION OF RESULTS:

The table on next page give the measured values.

Calibrated by:

Mr. Sorawat Thachalad
Miss Jiragorn Lertsomphol



Approved signature:

[Signature]
Mr. Pannya Booncharoen
Calibration Department Manager

Remarks:

¹ Nozzle cross-section area of the wind tunnel
² Projected cross-section area of the tested object include mounting pipe
³ Diameter of mounting pipe
⁴ Ratio "a/b"

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



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



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



CERTIFICATE OF CALIBRATION

Certificate No.: CT-026-66
Page 1 of 2

Equipment Name: Data Logger with Temperature sensor
Manufacturer: Novolyx
Model: 110-WS-25DL-D
Serial No.: A5988
ID No.: RYG_FS0650

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: 16 Jun 2023
Calibration date: 20 Jun 2023
Issue date: 22 Jun 2023

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

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-0038-23, Certificate number: ER-0092-22

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

Calibrated by

- ☐ Mr. Sorawit Thachalad
☒ Miss Jitraporn Lertsomphol
☐ Miss Ruangrunjai Phoommit



Approved Signatory:

Mr. Parinya Booncharoen
Calibration Department Manager

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CERTIFICATE OF CALIBRATION

Calibration No.: PH-09062023
Page 1 of 1 Pages

Measurement Item: Relative humidity with data logger
Manufacturer: Novolyx
Model/Type: 110-WS-25DL-D
Serial Number: A5988
ID No.: RYG_FS0650
Customer: ALS laboratory group (Thailand) Co., Ltd.
104 Phatthanakan 40, Phatthanakan Rd., Khwaeng Suan Luang, Khet Suan Luang, Bangkok
10250 Thailand.

Environmental Condition:

The measurement was carried out in an ambient temperature of (25±3)°C, and relative humidity of (50±15)%.

Measurement Method:

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

Traceability:

This instrument was calibrated using standard equipment whose accuracy is traceability through National Institute of Standards and Technology to the international system of units (SI) via MCS Calibration, Inc. Certificate number: 20926-001. Due date: Sep 26, 2024.

Measurement Date: Jun 20, 2023
Issued Date: Jun 22, 2023

Measurement Results:

This equipment was connected with indoor air quality probe and Displayed (iIR) on display. Model: HMP60, Serial number: V1920215

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

The results of calibration are reported in table below:

Determined (%RH)	Standard (%RH)	UUC (%RH)	Error (%RH)	Uncertainty ±(%RH)
20	20.03	19.2	-0.9	0.62
50	50.24	49.5	-0.8	0.52
80	80.33	80.5	0.2	0.52

Performed by

- ☐ Mr. Sorawit Thachalad
☒ Miss Jitraporn Lertsomphol
☐ Miss Ruangrunjai Phoommit



Approved Signatory:

Mr. Parinya Booncharoen
Calibration Department Manager

THIS CALIBRATION 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 Range: 20 - 40 °C

Function:

This equipment was connected with temperature sensor Model: HMP60 S/N: V1920215.

Dimension: Diameter 12 mm. Length 80 mm.

Immersion Depth (mm)	Standard Reading (°C)	UUC Reading (°C)	Error (°C)	Uncertainty (°C)
70	20.058	20.0	-0.1	0.099
70	25.051	24.9	-0.2	0.099
70	30.044	29.8	-0.2	0.099
70	35.039	34.8	-0.2	0.099
70	40.034	39.7	-0.3	0.099

UUC* - Unit Under Calibration

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

★ End of Certificate ★



J NAC
JIRANATE ASSOCIATES CO., LTD.
Jiranatee Associates Co., Ltd.
10/14-15, 67/35-36,
Petchkasem 7/71, Rd. Wathapra, Bangkok,
Bangkok 10600 Thailand.
Tel: +6628680812
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E-mail: jiranatee@jiranatee.com
Web site: www.jiranatee.com

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

Pressure measurement laboratory:
Calibration services department



NSC - TIS - TIS 17025
CALIBRATION 0367

CERTIFICATE OF CALIBRATION

Certificate No.: CP-010-66

Page 1 of 2 Pages

MEASUREMENT ITEM
MANUFACTURER
MODEL/TYPE

Digital barometer
Novolyx
Sensor: 110-WS-25BP

SERIAL NUMBER

Data logger: 110-WS-25DL-D

ID NUMBER

Sensor: BP-A5988

CONDITION AS-RECEIVED

Data logger: A5988

CUSTOMER

RYG_FS0650

RECEIVED DATE

New Item

MEASUREMENT DATE

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

ISSUE DATE

16 Jun 2023
20 Jun 2023
20 Jun 2023

Calibration procedure:

The pressure calibration was done by in-house calibration method as WI-CL-003 according to comparison method with Digital pressure calibrator sold on OX-D-6-3

Traceability:

The measurement results are traceable to the international system of units (SI) through the NIMT (National Metrology Institute of Thailand) via Certificate number: MP-0205-22

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

CONDITION OF THIS RESULT OF CALIBRATION:

1. Reference Standard Instrument:

Instrument	Model	Serial No.	Certificate No.	Due Date
Absolute Pressure Transducer	CP62500	4100126R	MP-0205-22	03 Dec 2023

2. Calibration effort for calibration sequence C

3. The UUC* was installed in vertical orientation above reference standard instrument and center of UUC* was used as the reference level.

4. Calibration conditions:

5. Condition

Pressure transmitting medium

1.19 kg/m³

1.19 kg/m³

1.19 kg/m³

1.19 kg/m³

1.19 kg/m³

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1.19 kg/m³

1.19 kg/m³

CERTIFICATE OF CALIBRATION

Certificate No. : CP-010-66

Page 2 of 2 Pages

MEASUREMENT RESULTS : ☒ Without adjustment ☐ With adjustment
CALIBRATION IN THE RANGE OF : 950 mbar to 1050 mbar

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

STD (mbar)	UUC* (mbar)	Error (mbar)	Uncertainty (k=2) (mbar)
950.08	950.7	0.7	0.85
970.10	970.5	0.4	0.61
990.05	990.4	0.4	0.57
1010.10	1010.2	0.1	0.40
1030.07	1030.0	-0.1	0.38
1050.10	1049.8	-0.3	0.52

Note: UUC* Unit Under Calibration

* To convert the result in report unit to Pa should be multiply by 100

End of certificate



Page 1 of 2 Pages

MEASUREMENT ITEM
MANUFACTURER
MODEL/TYPE

Wind Direction Sensor
Novallma
Sensor: WS-02F

SERIAL NUMBER

Data logger: 110-WS-25DL-D

ID NUMBER
CONDITION AS-RECEIVED
CUSTOMER

Sensor: WSD-014
Data logger: AS789
RYG JS0531
Used item
A/S laboratory group (Thailand) Co., Ltd.
104 Phatthanakan Rd. Khwaeng Suan Luang,
Khet Suan Luang, Bangkok 10250 Thailand

RECEIVED DATE
MEASUREMENT DATE
ISSUE DATE

16 Jan 2023
19 Jan 2023
20 Jan 2023

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follows:

Temperature : 23.0 ± 3.0 °C
Relative Humidity : 55.0 ± 15.0 %RH
Atmospheric Pressure : 1010.0 ± 10 hPa

PLACE OF CALIBRATION

Effel-type wind tunnel of Jiranatee Associates Co., Ltd.

CALIBRATION CONDITION

Wind tunnel cross-section area¹ 900 cm²
Win direction frontal area² 129 cm²
Diameter of mounting pipe³ 1 mm
Blockage ratio of test object⁴ 0.143 [-]

Preconditioning
Measurement Condition

24 hours at ambient conditions.
The average values during measurement are (23.6) °C, (46.6) %RH and (1014.9) hPa.

TABULATION OF RESULTS:

The table on next page give the measured values.

Calibrated by:

☒ Mr. Sorawit Thachakul
☐ Miss Jitragorn Lertachonphol

Approved signatory

Mr. Parinya Booncharoen
Calibration Department Manager

Remarks:

¹ Nozzle cross-section area of the wind tunnel
² Projected cross-section area of the tested object include mounting pipe
³ Diameter of mounting pipe
⁴ Ratio = $\frac{A_2}{A_1}$

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Certificate Number

CL-013-46

Page 2 of 2 Pages

MEASUREMENT RESULTS¹

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

Air speed m/s	D ₁₀₀ Degree (°)	D ₁₀₀ Degree (°)	Error Degree (°)	U (k=2) Degree (°)
	0.000	0	0	0.58
	45.000	43	-2	0.74
	90.000	88	-2	0.74
	135.000	133	-2	0.74
	180.000	179	-1	0.74
	225.000	227	2	0.74
	270.000	272	2	0.74
	315.000	317	2	0.74

Remark:

¹ Calibration result is only count for the tested circumstances and environmental conditions during which calibration was performed

² Direction of standard

Direction of Unit Under Calibration

End of Certificate of Calibration

Page 1 of 2 Pages

MEASUREMENT ITEM
MANUFACTURER
MODEL/TYPE

Cup anemometer
Novallma
Sensor: WS-02F

SERIAL NUMBER

Data logger: 110-WS-25DL-D

ID NUMBER
CONDITION AS-RECEIVED
CUSTOMER

Sensor: WSD-014
Data logger: AS789
RYG JS0531
Used item
A/S laboratory group (Thailand) Co., Ltd.
104 Phatthanakan Rd. Khwaeng Suan Luang,
Khet Suan Luang, Bangkok 10250 Thailand

RECEIVED DATE
MEASUREMENT DATE
ISSUE DATE

16 Jan 2023
18 Jan 2023
20 Jan 2023

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follows:

Temperature : 23.0 ± 3.0 °C
Relative Humidity : 55.0 ± 15.0 %RH
Atmospheric Pressure : 1010.0 ± 10 hPa

PLACE OF CALIBRATION

Effel-type wind tunnel of Jiranatee Associates Co., Ltd.

CALIBRATION CONDITIONS

Wind tunnel cross-section area¹ 900 cm²
Win direction frontal area² 101 cm²
Diameter of mounting pipe³ 1 mm
Blockage ratio of test object⁴ 0.111 [-]

Preconditioning
Measurement Condition

24 hours at ambient conditions.
The average values during measurement are (23.7) °C, (44.5) %RH and (1018.3) hPa.

TABULATION OF RESULTS:

The table on next page give the measured values.

Calibrated by:

☒ Mr. Sorawit Thachakul
☐ Miss Jitragorn Lertachonphol

Approved signatory

Mr. Parinya Booncharoen
Calibration Department Manager

Remarks:

¹ Nozzle cross-section area of the wind tunnel
² Projected cross-section area of the tested object include mounting pipe
³ Diameter of mounting pipe
⁴ Ratio = $\frac{A_2}{A_1}$

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Certificate Number

CL-013-66

Page 2 of 2 Pages

MEASUREMENT RESULTS¹

The cup anemometer, Unit Under Calibration (UUC) was exercised at 10 m/s for 5 minutes prior to calibration being performed. The standard air velocity 0.5 m/s to 5 m/s was calculated by a standard air velocity transducer and above 5 m/s to 30 m/s was calculated by a pitot tube with precision differential pressure meter which was installed 40 mm and 300 mm respectively away from wind tunnel nozzle. UUC was installed at center of the test section. The calibration was carried out under both rising and falling air velocity in the range of 1 m/s to 16 m/s at calibration interval of 1 m/s. The results of calibration and associated measurement uncertainties are reported in the table below.

V _{std} (m/s)	Temp. wind tunnel (°C)	Temp. room (°C)	V _{uuc} (m/s)	Error (m/s)	U (k=2) (m/s)
0.983	23.60	23.70	0.7	-0.3	0.18
2.024	23.74	23.70	1.7	-0.3	0.16
3.044	23.50	23.70	2.8	-0.2	0.18
4.119	23.82	23.70	3.8	-0.2	0.19
5.02	23.50	23.70	4.9	-0.2	0.18
5.99	23.88	23.70	5.8	-0.2	0.18
7.08	23.50	23.70	6.9	-0.1	0.20
8.18	23.58	23.70	8.0	-0.2	0.18
9.11	23.50	23.70	9.0	-0.5	0.19
10.08	23.66	23.70	10.0	-0.7	0.25
11.15	23.32	23.70	11.0	-0.2	0.21
12.14	23.66	23.70	12.0	-0.2	0.20
13.20	23.32	23.70	13.2	0.0	0.25
14.25	23.50	23.70	14.5	-0.1	0.27
15.33	23.30	23.70	15.5	-0.2	0.27
16.29	23.40	23.70	16.2	-0.1	0.23

Remarks:

¹ Calibration results only count for the tested circumstances and environmental conditions during which calibration took place

² Velocity of standard

³ Velocity of Unit Under Calibration

PHOTO OF CALIBRATION SET-UP



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

End of Certificate of Calibration



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CERTIFICATE OF CALIBRATION

Certificate No.: CL-006-66
Page 1 of 2

Equipment Name: Data Logger with Temperature
Sensor

Manufacturer: Novalyx
Model: 110-WS-25DL-D
Serial No.: A5789
ID No.: RYG_FS0531

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: 16 Jan 2023
Calibration date: 18 Jan 2023
Issue date: 20 Jan 2023

Reference Used During Calibration

1. Standard Temperature Probe Model: STS-100 A500,
Serial No.: 687682-09, Due date: 23 Mar 2023
2. Digital Temperature Indicator Model: DTI-1000-A MK
II, Serial No.: 671407-00591 Due date: 22 July 2023

Calibration Condition

Temperature: (23±3) °C
Relative Humidity: (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-0034-22, Certificate number: ER-0092-22

Calibrated by
☐ Mr. Sorawit Thechalad
☒ Miss Jitraporn Lertsomphol



Approved Signatory: *28/Jan*
Mr. Parinya Booncharoen
Calibration Department Manager

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Certificate No.: CL-006-66
Page 2 of 2

Result of Calibration: ☒ Without Adjustment ☐ With Adjustment

Calibration Range: 20-40 °C

Function:

This equipment was connected with temperature sensor Model: HMP60 S/N: T0210901.

Dimension : Diameter 12 mm. Length 80 mm.

Immersion Depth (mm)	Standard Reading (°C)	UUC Reading (°C)	Error (°C)	Uncertainty (°C)
60	20.067	19.8	-0.3	0.099
60	25.058	24.6	-0.5	0.099
60	30.052	29.5	-0.6	0.099
60	35.047	34.5	-0.5	0.099
60	40.038	39.3	-0.7	0.099

UUC*: Unit Under Calibration

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

★ End of Certificate ★



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CERTIFICATE OF CALIBRATION

Calibration No.: RH-06012023
Page 1 of 1 Pages

Measurement Item : Relative humidity with data logger
Manufacturer : Novalyx
Model/Type : 110-WS-25DL-D
Serial Number : A5789
ID No. : RYG_FS0531
Customer : ALS laboratory group (Thailand) Co., Ltd.
104 Phatthanakan 40, Phatthanakan Rd, Khwaeng Suan Luang, Khet Suan Luang, Bangkok
10250 Thailand.

Environmental Condition:

The measurement was carried out in an ambient temperature of (25±3)°C, and relative humidity of (50±10)%

Measurement Method:

Unit Under Calibration (UUC) was calibrated by comparison method with standard thermo hygrometer in the humidity generator chamber to determine the errors.

Traceability:

This instrument was calibrated using standard equipment whose accuracy is traceability through National Institute of Standards and Technology to the international system of units (SI) via MCS Calibration, Inc. Certificate number: 20314-101. Due date: Mar 14, 2023.

Measurement Date : Jan 18, 2023
Issued Date : Jan 20, 2023

Measurement Results:

This equipment was connected with indoor air quality probe and Displayed (RH) on display. Model: HMP60, Serial number: T0210901.

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

The results of calibration are reported in table below.

Determined (%RH)	Standard reading (%RH)	UUC Reading (%RH)	Error (%RH)	Uncertainty ±(%RH)
20	20.03	18.0	-2.0	0.51
50	50.24	47.8	-2.4	0.51
80	80.19	77.3	-2.9	0.51

Performed by
☐ Mr. Sorawit Thechalad
☒ Miss Jitraporn Lertsomphol



Approved Signatory: *28/Jan*
Mr. Parinya Booncharoen
Calibration Department Manager

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

MEASUREMENT RESULTS¹

The wind direction sensor was calibrated against a standard rotary anemometer by comparison method. During calibration, the measurement was carried out at 85° intervals in clockwise and counter-clockwise directions after offset adjustment has been made. The flow speed of wind sensor (usually 5 m/s) is kept constant while the sensor is rotated around its vertical axis. The results of calibration and associated measurement uncertainties are reported in the table below.

Air speed m/s	D _{ref} Degree (°)	D _{meas} Degree (°)	Error Degree (°)	U (k=2) Degree (°)
0.000	0	0	0	0.58
45.000	42	42	-3	0.74
85.000	88	88	-2	0.68
135.000	133	133	-2	0.68
180.000	179	179	-1	0.68
225.000	225	225	0	0.68
270.000	271	271	1	0.68
315.000	318	318	3	0.74

Remarks:

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

Direction of standard

Direction of Unit Under Calibration

End of Certificate of Calibration



MEASUREMENT ITEM

MANUFACTURER

MODEL/TYPE

SERIAL NUMBER

ID NUMBER

CONDITION AS RECEIVED

CUSTOMER

RECEIVED DATE

MEASUREMENT DATE

ISSUE DATE

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follow:

Temperature	23.0 ± 0.5 °C
Relative Humidity	55.0 ± 15.0 %RH
Atmospheric Pressure	1010.0 hPa

PLACE OF CALIBRATION

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

CALIBRATION CONDITION

Wind tunnel cross section area ¹	900 cm ²
Win direction frontal area ²	129 cm ²
Diameter of mounting pipe ³	mm
Blockage ratio of test object ⁴	0.143 [-]

Preconditioning

Measurement Condition

24 hours at ambient conditions.
The average values during measurement are (24.0) °C, (50.6) %RH and (1009.4) hPa.

TABULATION OF RESULTS:

The table on next page give the measured values.

Calibrated by:

Mr. Sorasit Thuchakul
Miss Atsaraorn Lertsomphol



Approved signatory

Mr. Pongpoo Boonharum
Calibration Department Manager

Remarks:

1. Nozzle cross-section area of the wind tunnel
2. Projected cross-section area of the tested object include mounting pipe
3. Diameter of mounting pipe
4. Ratio "a/b"

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

MEASUREMENT RESULTS¹

The cup anemometer, Unit Under Calibration (UUC) was measured at 30 m/s for 5 minutes prior to calibration being performed. The standard air velocity 0.5 m/s to 5 m/s was estimated by a standard air velocity transducer and above 5 m/s to 30 m/s was calculated by a pitot tube with pressure differential pressure meter which was installed 40 mm and 300 mm respectively away from wind tunnel nozzle. UUC was installed at center of the test section. The calibration was carried out under both rising and falling air velocity in the range of 5 m/s to 16 m/s at calibration interval of 1 m/s. The results of calibration and associated measurement uncertainties are reported in the table below.

V _{ref} (m/s)	Temp. wind tunnel (°C)	Temp. room (°C)	V _{meas} (m/s)	Error (m/s)	U (k=2) (m/s)
0.988	23.90	23.80	0.8	-0.2	0.15
2.035	23.70	23.80	1.8	-0.2	0.16
3.043	23.90	23.80	2.8	0.1	0.15
4.104	23.60	23.80	3.8	-0.4	0.20
5.01	23.70	23.80	4.8	-0.2	0.17
6.00	23.78	23.80	5.8	-0.2	0.16
7.08	23.80	23.80	6.8	-0.2	0.17
8.18	23.62	23.80	8.0	-0.2	0.20
9.10	23.80	23.80	8.9	-0.2	0.20
10.08	23.64	23.80	9.9	-0.2	0.21
11.15	23.56	23.80	10.0	0.1	0.21
12.16	23.66	23.80	11.9	-0.3	0.22
13.20	23.52	23.80	12.9	-0.3	0.22
14.26	23.60	23.80	14.1	-0.2	0.22
15.25	23.58	23.80	15.0	-0.7	0.22
16.30	23.60	23.80	16.2	0.1	0.24

Remarks:

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

Velocity of standard

Velocity of Unit Under Calibration

PHOTO OF CALIBRATION SET-UP



Calibration set-up of the Cup Anemometer Calibration in the wind tunnel of Jirante Associates Co., Ltd. The cup anemometer (shown only after 500 mm) calibrated use. Remark: The position of the set-up is not true to scale due to imaging geometry.

End of Certificate of Calibration



MEASUREMENT ITEM

MANUFACTURER

MODEL/TYPE

SERIAL NUMBER

ID NUMBER

CONDITION AS RECEIVED

CUSTOMER

RECEIVED DATE

MEASUREMENT DATE

ISSUE DATE

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follow:

Temperature	23.0 ± 0.5 °C
Relative Humidity	55.0 ± 15.0 %RH
Atmospheric Pressure	1010.0 hPa

PLACE OF CALIBRATION

Effel-type wind tunnel of Jirante Associates Co., Ltd.

CALIBRATION CONDITIONS

Wind tunnel cross section area ¹	900 cm ²
Win direction frontal area ²	150 cm ²
Diameter of mounting pipe ³	mm
Blockage ratio of test object ⁴	0.111 [-]

Preconditioning

Measurement Condition

24 hours at ambient conditions.
The average values during measurement are (23.0) °C, (48.3) %RH and (1014.7) hPa.

TABULATION OF RESULTS:

The table on next page give the measured values.

Calibrated by:

Mr. Sorasit Thuchakul
Miss Atsaraorn Lertsomphol



Approved signatory

Mr. Pongpoo Boonharum
Calibration Department Manager

Remarks:

1. Nozzle cross-section area of the wind tunnel
2. Projected cross-section area of the tested object include mounting pipe
3. Diameter of mounting pipe
4. Ratio "a/b"

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

CERTIFICATE OF CALIBRATION

Certificate No. : CL 15145
Page: 1 of 2

Equipment Name: Data Logger with Temperature Sensor
Manufacturer: Novolyne
Model: 110 WS 250L (P)
Serial No.: A5909
ID No.: IYG 130608

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

Received date: 09 Nov 2022
Calibration date: 18 Nov 2022
Issue date: 23 Nov 2022

Reference Used During Calibration
1. Standard Temperature Probe Model: S15 100 A-MD,
Serial No.: 6676R2 09, Due date: 23 Mar 2023
2. Digital Temperature Indicator Model: D11 1000 A-MW
II, Serial No.: 671407 00501, Due date: 22 July 2023

Calibration Condition
Temperature: (23.13) °C
Relative Humidity: (55.15) %

Calibration Procedure
The temperature calibration was done by in-house calibration method as WtC 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 (NIM) Certificate number: 11.0034 22, Certificate number: ER 0039 22

Result of Calibration: - Without Adjustment - With Adjustment

Calibration Range: 20.00 °C

Function:

This equipment was connected with temperature sensor Model: HMP50 S/N: U3641220.

Dimension : Diameter 32 mm, Length 80 mm.

Immersion Depth (mm)	Standard Reading (°C)	UUC Reading (°C)	Error (°C)	Uncertainty (°C)
60	19.99	19.9	0.1	0.30
60	25.00	24.8	0.2	0.30
60	30.00	29.8	0.2	0.30
60	35.01	34.7	0.3	0.30
60	40.01	39.5	0.5	0.30

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 ★



Calibrated by
Mr. Sorawit Thachalad
Miss Jitraporn Leisomphol



Approved Signatory:
Mr. Parinya Booncharoen
Calibration Department Manager

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CONTAINED IN WRITING FROM THE LABORATORY.

CERTIFICATE OF CALIBRATION

Calibration No. : TH-02112022
Page 1 of 1 Pages

Measurement Item: Relative humidity with data logger
Manufacturer: Novolyne
Model/Type: 110 WS 250L (P)
Serial Number: A5909
ID No.: IYG 130608
Customer: ALS laboratory group (Thailand) Co., Ltd.
104 Phatthanakan 40, Phatthanakan Rd., Khwaeng Suan Luang, Ratcha Suan Luang, Bangkok 10250 Thailand

Environmental Condition:
The measurement was carried out in an ambient temperature of (26.13) °C, and relative humidity of (50.15) %.

Measurement Method:
Unit Under Calibration (UUC) was calibrated by comparison method with standard thermo hygrometer in the humidity generator chamber to determine the errors.

Traceability:
This instrument was calibrated using standard equipment whose accuracy is traceability through National Institute of Standards and Technology to the international system of units (SI) via MCS Calibration, Inc. Certificate number: 20314 101, Due date: Mar 14, 2023.

Measurement Date: Nov 18, 2022
Issued Date: Nov 23, 2022

Measurement Results:
This equipment was connected with indoor air quality probe and Displayed RH% on display. Model: HMP60, Serial num ber: U3641220.
Calibration was performed in the range of 20%RH to 80%RH
The results of calibration are reported in table below.

Determined (RH%)	Standard (RH%)	UUC (RH%)	Error (RH%)	Uncertainty Δ(RH%)
20	19.94	17.4	-2.5	0.67
50	50.31	47.1	-3.3	0.55
80	80.30	77.4	-2.9	0.67

Performed by
☒ Mr. Sorawit Thachalad
☐ Miss Jitraporn Leisomphol



Approved Signatory:
Mr. Parinya Booncharoen
Calibration Department Manager

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

Accredited calibration laboratory
ISO/IEC 17025:2017
ASC-151-15.17025
(CALIBRATION) 6362

An speed measurement laboratory
Calibration services department

Jiranatee Associates Co., Ltd.
63/14-15, 67/35-36,
Petchkasem 7/1, Rd Walthapa, Bangkok
Bangkok 10600 (Thailand)
Tel: +66(0)2-860812
Email: +66(0)2-860860
E-mail: jiranatee@jiranatee.com
Web site: www.jiranatee.com

CERTIFICATE OF CALIBRATION

Page 1 of 2 Pages

MEASUREMENT ITEM
MANUFACTURER
MODEL/TYPE

SERIAL NUMBER

ID NUMBER
CONDITION AS RECEIVED
CUSTOMER

RECEIVED DATE
MEASUREMENT DATE
ISSUE DATE

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follows:

Temperature: 23.0 ± 0.5 °C
Relative Humidity: 55.0 ± 1.5 %
Atmospheric Pressure: 1030 ± 10 hPa

PLACE OF CALIBRATION

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

CALIBRATION CONDITIONS

Wind tunnel cross section area¹: 900 cm²
Win direction frontal area²: 100 cm²
Diameter of mounting pipe³: — mm
Blockage ratio of test object⁴: 0.111 (-)

Preconditioning

Measurement Condition

24 hours at ambient conditions.

The average values during measurement are (28.7) °C, (49.5) %RH and (1011.2) hPa.

TABULATION OF RESULTS:

The table on next page give the measured values

Calibrated by:
☒ Mr. Sorawit Thachalad
☐ Miss Jitraporn Leisomphol



Approved signatory:
Mr. Parinya Booncharoen
Calibration Department Manager

Remarks:

¹ Nozzle cross section area of the wind tunnel
² Projected cross section area of the tested object include mounting pipe
³ Diameter of mounting pipe
⁴ Ratio 1 to 1

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

Certificate Number
CL-006-65

Page 2 of 2 Pages

MEASUREMENT RESULTS¹

The cup anemometer, Unit Under Calibration (UUC) was retrieved at 10 m/s for 5 minutes prior to calibration being performed. The standard air velocity 0.5 m/s to 5 m/s was calculated by a standard air velocity transducer and above 5 m/s to 40 m/s was calculated by a pitot tube with pressure differential pressure system which was installed at 40 mm and 300 mm respectively using flow wind tunnel nozzle. UUC was installed at center of the wind section. The calibration was carried out under both rising and falling air velocity in the range of 1 m/s to 16 m/s at calibration interval of 1 m/s. The results of calibration and associated measurement uncertainties are reported in the table below.

V_{ref} (m/s)	Temp. wind tunnel (°C)	Temp. room (°C)	V_{UUC} (m/s)	Error (m/s)	U (k=2) (m/s)
0.071	23.98	23.70	0.8	-0.2	0.15
2.042	23.46	23.70	1.8	-0.2	0.16
3.069	23.50	23.70	2.8	-0.2	0.21
4.221	23.60	23.70	3.9	-0.4	0.20
5.02	23.80	23.70	4.8	-0.2	0.20
5.99	23.84	23.70	5.8	-0.2	0.19
7.06	23.66	23.70	6.8	-0.2	0.18
8.17	23.78	23.70	7.9	-0.2	0.18
9.10	23.60	23.70	8.8	-0.3	0.22
10.05	23.74	23.70	9.9	-0.2	0.19
11.16	23.68	23.70	10.9	-0.2	0.22
12.14	23.94	23.70	11.8	-0.1	0.22
13.15	23.70	23.70	13.0	-0.2	0.22
14.27	23.94	23.70	13.8	-0.4	0.22
15.25	23.78	23.70	15.1	-0.2	0.26
16.30	23.84	23.70	15.9	-0.4	0.25

Remark:

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

Velocity of standard:

Velocity of Unit Under Calibration:

PHOTO OF CALIBRATION SET-UP



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



Certificate Number
CL-006-65

Page 2 of 2 Pages

MEASUREMENT RESULTS¹

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

Air speed m/s	D'_{ref} Degree (°)	D'_{UUC} Degree (°)	Error Degree (°)	U (k=2) Degree (°)
	0.000	0	0	0.58
	45.000	44	-2	0.76
	90.000	87	-3	0.56
	135.000	132	-3	0.68
	180.000	177	-3	0.68
	225.000	222	-3	0.58
	270.000	270	0	0.74
	315.000	318	3	0.58

Remark:

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

Direction of standard:

Direction of Unit Under Calibration:



Jiraratte Associates Co., Ltd.
Unit 15, 67/15, 16,
Tachakorn 7/11, 44 Petchkasom, Bangkok
Bangkok 10600 (Thailand)
Tel: (666) 02-8680811
Mobile: (666) 9999451
E-mail: jiraratte@jiraratte.com
Web: www.jiraratte.com

Accredited calibration laboratory
ISO/IEC 17025:2017
NAC 161-18 17025
CALIBRATION 0367

An agreed measurement laboratory
Calibration services department

Certificate Number
CL-006-65

CERTIFICATE OF CALIBRATION

Page 3 of 2 Pages

MEASUREMENT ITEM

MANUFACTURER

MODEL/TYPE

SERIAL NUMBER

ID NUMBER

CONDITION AS RECEIVED

CUSTOMER

RECEIVED DATE

MEASUREMENT DATE

ISSUE DATE

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follow:

Temperature:	23.0 ± 1.0	°C
Relative Humidity:	55.0 ± 15.0	%RH
Atmospheric Pressure:	1010 ± 10	hPa

PLACE OF CALIBRATION

CALIBRATION CONDITION

Preconditioning

Measurement Condition

TABULATION OF RESULTS:

The table on next page give the measured values.

Calibrated by:

1. Mr. Sorawit Thachakorn
2. Miss Jiraporn Lertsomphol



Approved signature:

Mr. Pinyaporn Booncharit
Calibration Department Manager

Remark:

¹ Nozzle cross section area of the wind tunnel

² Projected cross section area of the tested object include mounting pipe

³ Diameter of mounting pipe

⁴ Ratio 1/10

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63/14-15, 67/35 36, Soi Petchkasom 7/11, Petchkasom Rd.,
Wallhapra, Banghokkya, Bangkok 10600 Thailand.
Tel: (666) 02-8680812#13 Fax: (666) 02-8680860 www.jiraratte.com

CERTIFICATE OF CALIBRATION

Calibration No. J91-06112022

Page 1 of 1 Page

Measurement Item

Manufacturer

Model/Type

Serial Number

ID No.

Condition

(Relative humidity with data logger)

Novalys

110 WS 25DL D

A5011

HYD F50609

ALS laboratory group (Thailand) Co., Ltd.

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

Environmental Condition

The measurement was carried out in an ambient temperature of (25±3)°C and relative humidity of (50±10)%.

Measurement Method:

Unit Under Calibration (UUC) was calibrated by comparison method with standard thermohygrometer in the humidity generator chamber to determine the errors.

Traceability:

This instrument was calibrated using standard equipment whose accuracy is traceability through National Institute of Standards and Technology to the international system of units (SI) via NIST Calibration Inc. Certificate number: 20314-101. Due date: Mar 14, 2023.

Measurement Date

Nov 18, 2022

Issue Date: Nov 23, 2022

Measurement Results

This equipment was connected with indoor air quality probe and Displayed RH on display Model: TM246, Serial number: U3641223

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

The results of calibration are reported in table below.

Determined (%RH)	Standard (%RH)	UUC (%RH)	Error (%RH)	Uncertainty (%RH)
20	19.98	17.6	-2.4	0.56
50	50.28	47.3	-3.0	0.51
80	80.30	77.6	-2.7	0.52

Performed by

1. Mr. Sorawit Thachakorn
2. Miss Jiraporn Lertsomphol



Approved signature:

Mr. Pinyaporn Booncharit
Calibration Department Manager

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CERTIFICATE OF CALIBRATION

Certificate No. CL 161 65
Page 1 of 2

Equipment Name: Data Logger with Temperature
Sensor
Manufacturer: Novolyne
Model: T10 WS 2501 D
Serial No.: A5910
ID No.: RVG 130609

Customer
Name: Al S Laboratory pump (Hua Lam) Co., Ltd.
Address: 104 Phuthanank 40 Phuthanank
Rd., Khwaeng Suan Luang, Khet Suan Luang, Bangkok
10250 Thailand.

Received date: 09 Nov 2022
Calibration date: 18 Nov 2022
Issue date: 23 Nov 2022

Reference Used During Calibration
1. Standard Temperature Probe Model: S15 300 A500,
Serial No.: 667682 09, Due date: 25 Mar 2023
2. Digital Temperature Indicator Model: DTI 1000 A MH
II, Serial No.: 671407 00591 Due date: 22 July 2023

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 (NIM) Certificate
number: TF 0034 22, Certificate number: LR 0039
22

Calibrated by
Mr. Sorawit Thachitthai
Miss Jiraporn Loitsamphol



Approved Signatory:

Mr. Paitiya Booncharoan
Calibration Department Manager

Result of Calibration: Without Adjustment With Adjustment

Calibration Range: 20 40 °C

Function:

This equipment was connected with temperature sensor Model: HMI G05/R; U9841223.

Dimension: Diameter 12 mm, Length 80 mm

Immersion Depth (mm)	Standard Reading (°C)	UUC Reading (°C)	Error (°C)	Uncertainty (°C)
60	29.03	19.8	0.2	0.30
60	29.02	24.8	0.2	0.30
60	30.00	29.7	0.3	0.30
60	35.00	34.6	0.4	0.30
60	40.00	39.5	0.5	0.30

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%).

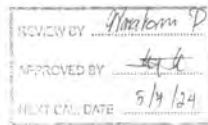


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IN WRITING FROM THE LABORATORY.

63/14-15, 67/35-36,
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Tel: (66) 02-8680812
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Email: jiranate@jiranate.com
www.jiranate.com

Accredited calibration laboratory
ISO/IEC 17025:2017
MSC-TS-TS 17025
CALIBRATION 0367

Air speed measurement laboratory
Calibration services department



Certificate Number

CL-001-66

Certificate Number

CL-001-66

CERTIFICATE OF CALIBRATION

Page 1 of 2 Pages

MEASUREMENT ITEM

MANUFACTURER

MODEL/TYPE

SERIAL NUMBER

ID NUMBER

CONDITION AS-RECEIVED

CUSTOMER

RECEIVED DATE

MEASUREMENT DATE

ISSUE DATE

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follow:

Temperature

Relative Humidity

Atmospheric Pressure

PLACE OF CALIBRATION

CALIBRATION CONDITIONS

Preconditioning

Measurement Condition

TABULATION OF RESULTS:

The table on next page give the measured values:

Calibrated by:

at Mr. Sorawit Thachitthai

Miss Jiraporn Loitsamphol

Remark:

1. Fully integration area of the wind tunnel

2. Properly cross section area of the tested object include mounting plate

3. Diameter of mounting pipe

4. Ratio 1 to 1

Cup anemometer

Novolyne

Sensor WS 03F

Data logger WS-2501

Sensor:

Data logger AA481

BAX 150141

Used item

Al S Laboratory group (Thailand) Co., Ltd

104 Phuthanank 40, Phuthanank Rd., Khwaeng Suan Luang,

Khet Suan Luang, Bangkok 10250 Thailand.

RECEIVED DATE

05 Jan 2023

MEASUREMENT DATE

09 Jan 2023

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follow:

Temperature

55.0 ± 3.0 °C

Relative Humidity

55.0 ± 3.0 %RH

Atmospheric Pressure

1010.9 ± 1.0 hPa

PLACE OF CALIBRATION

Tunnel type wind tunnel of Jiranate Associates Co., Ltd

CALIBRATION CONDITIONS

Wind tunnel cross-section area¹800 cm²Win direction frontal area²100 cm²Diameter of mounting pipe³

10 mm

Blockage ratio of test object⁴

0.111 [-]

Preconditioning

24 hours at ambient condition.

Measurement Condition

The average values during measurement are (23.9) °C, (47.3) %RH and (1015.6) hPa

Calibration procedure:

The cup anemometer was calibrated against

Standard air velocity transducer model: B45-22

and pitot tube with precision differential pressure

meter model: DPM2500 in an open test section of

Bifur type wind tunnel with 900 cm² cross test

section area. The WI CL 007 based on IEC 61450-

12-3. Wind energy generation systems - Part 12-

3. Power performance measurements of

velocity producing wind turbines. March 2017

was used as a calibration guideline.

Traceability:

This certificate provides a traceability of the

measurement to recognized the national

standards and to realization of the international

system of units (SI) through the NIM's National

Metrology Institute of Thailand via Certificate

number: MN-0052-21 and MN-0068-22

Uncertainty of Measurement:

The reported uncertainty of measurement is

based on the standard uncertainty multiplied by a

coverage factor k=2. Which for a normal

distribution corresponds to a coverage probability

of approximately 95%. The standard uncertainty

has been determined in accordance with the GUM

(Evaluation of measurement

data) - Guide to the expression of uncertainty in

measurement



Approved signatory:

Mr. Paitiya Booncharoan
Calibration Department Manager

Page 2 of 2 Pages

MEASUREMENT RESULTS¹

The cup anemometer, Unit Under Calibration (UUC) was exercise at 10 m/s for 5 minutes prior to calibration being performed. The standard air velocity 0.5 m/s to 5 m/s was calculated by a standard air velocity transducer and above 5 m/s to 30 m/s was calculated by a pitot tube with precision differential pressure meter which was installed 40 mm and 300 mm respectively away from wind tunnel nozzle. UUC was installed at center of the test section. The calibration was carried out under both rising and falling air velocity in the range of 1 m/s to 16 m/s at calibration interval of 1 m/s. The results of calibration and associated measurement uncertainties are reported in the table below.

V _{ref} (m/s)	Temp. wind tunnel (°C)	Temp. room (°C)	V _{uc} (m/s)	Error (m/s)	U (k=2) (m/s)
0.989	23.82	23.85	0.7	-0.3	0.16
2.031	23.90	23.85	1.7	-0.3	0.16
3.051	24.00	23.85	2.9	-0.2	0.20
4.132	23.84	23.85	3.9	-0.2	0.20
5.00	23.88	23.85	4.9	-0.1	0.24
5.38	23.94	23.85	5.9	-0.2	0.18
7.06	23.82	23.85	6.9	-0.2	0.19
8.17	23.90	23.85	8.0	-0.1	0.22
9.08	23.72	23.85	9.0	-0.1	0.21
10.09	23.86	23.85	9.9	-0.2	0.20
11.14	23.60	23.85	11.0	-0.1	0.26
12.14	23.74	23.85	12.1	-0.1	0.28
13.21	23.68	23.85	13.0	-0.2	0.21
14.28	23.70	23.85	14.1	-0.2	0.27
15.26	23.64	23.85	15.0	-0.3	0.26
16.30	23.80	23.85	16.1	-0.2	0.28

Remark:

¹ Calibration results only apply for the tested circumstances and environmental conditions during which calibration took place² Velocity of standard

Velocity of Unit Under Calibration

PHOTO OF CALIBRATION SET-UP



Calibration set-up of the cup anemometer calibration in the wind tunnel of Jiranate Associates Co., Ltd. The cup anemometer shown may differ from the calibrated one. Remark: The position of the set-up is not true to provide the best possible geometry.



CERTIFICATE OF CALIBRATION

Page 1 of 2 Pages

MEASUREMENT ITEM MANUFACTURER MODEL/TYPE

Wind Direction Sensor

Novelty

Sensor: WS-02F

Data logger: WS-25DL

Sensor: -

Data logger: A4481

BKX_750143

SERIAL NUMBER

ID NUMBER

CONDITION AS RECEIVED

CUSTOMER

ALS Laboratory group (Thailand) Co., Ltd.
104 Phatthanakan Rd, Phatthanakan Rd, Khwaeng Suan Luang,
Khet Suan Luang, Bangkok 10250 Thailand

RECEIVED DATE

28 Dec 2022

MEASUREMENT DATE

06 Jan 2023

ISSUE DATE

09 Jan 2023

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follow:

Temperature: 23.0 ± 3.0 °C
Relative Humidity: 55.0 ± 15.0 %RH
Atmospheric Pressure: 1010 to 1015 hPa

PLACE OF CALIBRATION

Efflu-type wind tunnel of Jirantee Associates Co., Ltd.

CALIBRATION CONDITION

Wind tunnel cross-section area¹ 900 cm²
Win direction frontal area² 139 cm²
Diameter of mounting pipe³ - mm
Blockage ratio of test object⁴ 0.143 [-]

Preconditioning

24 hours at ambient conditions

Measurement Condition

The average values during measurement are (23.5°C (48.8) °RH and (1015.8) hPa)

TABULATION OF RESULTS:

The table on next page give the measured values.

Calibrated by:

01 Mr. Soravit Thachakul
01 Miss Jittaporn Lertanongthai



Approved signatory:

Mr. Pinying Booncharoen
Calibration Department Manager

Remark:

- ¹ Nozzle cross-section area of the wind tunnel
- ² Projected cross-section area of the tested object include mounting pipe
- ³ Diameter of mounting pipe
- ⁴ Ratio %

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

Page 2 of 2 Pages

MEASUREMENT RESULTS¹

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

Air speed	D ₉₀	D ₉₀	Error	U (k=2)
m/s	Degree (°)	Degree (°)	Degree (°)	Degree (°)
	0.000	0	0	0.58
	45.000	41	-4	0.74
	90.000	87	-3	0.58
	135.000	134	-1	0.74
5.02	180.001	181	1	0.74
	225.000	228	3	0.74
	270.001	273	3	0.74
	315.000	318	3	0.88

Remark:

¹ Calibration results only count for the tested circumstances and environmental conditions during which calibration took place

² Direction of standard

Direction of Unit Under Calibration



End of Certificate of Calibration

CERTIFICATE OF CALIBRATION

Page 1 of 2 Pages

MEASUREMENT ITEM MANUFACTURER MODEL/TYPE

Cup anemometer

Novelty

Sensor: WS-02F

Data logger: WS-25DL

Sensor: -

Data logger: A4481

BKX_750143

SERIAL NUMBER

ID NUMBER

CONDITION AS RECEIVED

CUSTOMER

ALS Laboratory group (Thailand) Co., Ltd.
104 Phatthanakan Rd, Phatthanakan Rd, Khwaeng Suan Luang,
Khet Suan Luang, Bangkok 10250 Thailand

RECEIVED DATE

28 Dec 2022

MEASUREMENT DATE

05 Jan 2023

ISSUE DATE

09 Jan 2023

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follow:

Temperature: 23.0 ± 3.0 °C
Relative Humidity: 55.0 ± 15.0 %RH
Atmospheric Pressure: 1010 to 1015 hPa

PLACE OF CALIBRATION

Efflu-type wind tunnel of Jirantee Associates Co., Ltd.

CALIBRATION CONDITIONS

Wind tunnel cross-section area¹ 900 cm²
Win direction frontal area² 100 cm²
Diameter of mounting pipe³ - mm
Blockage ratio of test object⁴ 0.111 [-]

Preconditioning

24 hours at ambient conditions

Measurement Condition

The average values during measurement are (24.0) °C, (59.4) %RH and (1014.5) hPa

TABULATION OF RESULTS:

The table on next page give the measured values.

Calibrated by:

01 Mr. Soravit Thachakul
01 Miss Jittaporn Lertanongthai



Approved signatory:

Mr. Pinying Booncharoen
Calibration Department Manager

Remark:

- ¹ Nozzle cross-section area of the wind tunnel
- ² Projected cross-section area of the tested object include mounting pipe
- ³ Diameter of mounting pipe
- ⁴ Ratio %

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

Page 2 of 2 Pages

MEASUREMENT RESULTS¹

The cup anemometer, Unit Under Calibration (UUC) was exercised at 30 m/s for 5 minutes prior to calibration being performed. The standard air velocity 0.5 m/s to 3 m/s was calculated by a standard air velocity transducer; and above 3 m/s to 30 m/s was calculated by a pitot tube with precision differential pressure meter which was installed 40 mm and 300 mm respectively away from wind tunnel nozzle. UUC was installed at center of the test section. The calibration was carried out under both rising and falling air velocity in the range of 1 m/s to 16 m/s at calibration interval of 5 m/s. The results of calibration and associated measurement uncertainties are reported in the table below.

V _{ref} ²	Temp. wind tunnel	Temp. room	V _{uuc}	Error	U (k=2)
(m/s)	(°C)	(°C)	(m/s)	(m/s)	(m/s)
0.889	24.10	24.00	0.7	-0.3	0.13
2.034	23.96	24.00	1.7	-0.8	0.16
3.051	24.06	24.00	2.9	-0.7	0.29
4.138	24.00	24.00	3.9	-0.2	0.19
4.99	24.00	24.00	4.8	-0.1	0.26
5.96	24.00	24.00	5.9	-0.1	0.18
7.05	23.90	24.00	6.9	-0.1	0.21
8.18	23.90	24.00	8.0	-0.2	0.21
9.09	23.72	24.00	9.1	0.0	0.30
10.09	23.80	24.00	9.9	-0.1	0.24
11.16	23.80	24.00	11.1	-0.1	0.28
12.13	23.80	24.00	12.1	0.0	0.26
13.21	23.90	24.00	13.2	0.0	0.34
14.27	23.95	24.00	14.4	0.1	0.22
15.26	23.88	24.00	15.1	-0.1	0.27
16.32	24.00	24.00	16.4	0.1	0.28

Remark:

¹ Calibration results only count for the tested circumstances and environmental conditions during which calibration took place

² Velocity of standard

Velocity of Unit Under Calibration

PHOTO OF CALIBRATION SET-UP



Calibration set-up of the cup anemometer (UUC) in the wind tunnel of Jirantee Associates Co., Ltd. The cup anemometer (UUC) was exercised at 30 m/s for 5 minutes prior to calibration being performed. The standard air velocity 0.5 m/s to 3 m/s was calculated by a standard air velocity transducer; and above 3 m/s to 30 m/s was calculated by a pitot tube with precision differential pressure meter which was installed 40 mm and 300 mm respectively away from wind tunnel nozzle. UUC was installed at center of the test section. The calibration was carried out under both rising and falling air velocity in the range of 1 m/s to 16 m/s at calibration interval of 5 m/s. The results of calibration and associated measurement uncertainties are reported in the table below.



End of Certificate of Calibration

CERTIFICATE OF CALIBRATION

Page 2 of 2 Pages

MEASUREMENT ITEM MANUFACTURER MODEL/TYPE

Wind Direction Sensor
Novalyis
Sensor: WS-02F

SERIAL NUMBER

Data logger: WS-250L

ID NUMBER CONDITION AS-RECEIVED CUSTOMER

Sensor: WS-02F
Data logger: WS-250L
BKK, 550143

RECEIVED DATE MEASUREMENT DATE ISSUE DATE

Used Item
ALS laboratory group (Thailand) Co., Ltd.
104 Phatthanakan 40, Phatthanakan Rd., Khwaeng Suan Luang,
Khet Suan Luang, Bangkok 10250 Thailand

ENVIRONMENTAL CONDITIONS:

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

PLACE OF CALIBRATION

Effel-type wind tunnel of Jirantee Associates Co., Ltd.

CALIBRATION CONDITIONS

Wind tunnel cross-section area¹ 900 cm²
Wind direction frontal area² 129 cm²
Diameter of mounting pipe³ mm
Blockage ratio of test object⁴ 0.148 [-]

Preconditioning Measurement Condition

24 hours at ambient conditions.
The average values during measurement are (23.0) °C, (50.1) %RH and (1015.7) hPa

TABULATION OF RESULTS:

The table on next page give the measured values.

Calibrated by:
[X] Mr. Sorawit Thachitad
[X] Miss Jiraporn Lertsomphol



Approved signature:

Mr. Parinya Booncharoen

Mr. Parinya Booncharoen
Calibration Department Manager

Remark:

¹ Nozzle cross-section area of the wind tunnel
² Projected cross-section area of the tested object include mounting pipe
³ Diameter of mounting pipe
⁴ Ratio $\frac{A_o}{A_t}$

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

Certificate Number

CL-002-66

Page 2 of 2 Pages

MEASUREMENT RESULTS¹

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

Air speed	D ₁ ²	D ₂ ²	Error	U (k=2)
m/s	Degree (°)	Degree (°)	Degree (°)	Degree (°)
0.000	0	0	0	0.58
45.000	41	41	4	0.74
90.000	87	87	-5	0.74
135.000	134	134	-1	0.74
180.000	182	182	2	0.74
225.000	229	229	3	0.66
270.000	272	272	2	0.74
315.000	318	318	3	0.74

Remark:

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

² Direction of standard

³ Direction of Unit Under Calibration



End of Certificate of Calibration



CERTIFICATE OF CALIBRATION

Page 2 of 2 Pages

MEASUREMENT ITEM MANUFACTURER MODEL/TYPE

Cup anemometer
Novalyis
Sensor: WS-02F

SERIAL NUMBER

Data logger: WS-250L

ID NUMBER CONDITION AS-RECEIVED CUSTOMER

Sensor: WS-02F
Data logger: WS-250L
BKK, 550143

RECEIVED DATE MEASUREMENT DATE ISSUE DATE

Used Item
ALS laboratory group (Thailand) Co., Ltd.
104 Phatthanakan 40, Phatthanakan Rd., Khwaeng Suan Luang,
Khet Suan Luang, Bangkok 10250 Thailand

ENVIRONMENTAL CONDITIONS:

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

PLACE OF CALIBRATION

Effel-type wind tunnel of Jirantee Associates Co., Ltd.

CALIBRATION CONDITIONS

Wind tunnel cross-section area¹ 900 cm²
Wind direction frontal area² 100 cm²
Diameter of mounting pipe³ mm
Blockage ratio of test object⁴ 0.111 [-]

Preconditioning Measurement Condition

24 hours at ambient conditions.
The average values during measurement are (23.0) °C, (50.5) %RH and (1015.3) hPa

TABULATION OF RESULTS:

The table on next page give the measured values.

Calibrated by:
[X] Mr. Sorawit Thachitad
[X] Miss Jiraporn Lertsomphol



Approved signature:

Mr. Parinya Booncharoen

Mr. Parinya Booncharoen
Calibration Department Manager

Remark:

¹ Nozzle cross-section area of the wind tunnel
² Projected cross-section area of the tested object include mounting pipe
³ Diameter of mounting pipe
⁴ Ratio $\frac{A_o}{A_t}$

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

Certificate Number

CWS-003-67

Page 2 of 2 Pages

MEASUREMENT RESULTS¹

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

V _{ref} ¹	Temp. wind tunnel	Temp. room	V _{unc} ²	Error	U (k=2)
(m/s)	(°C)	(°C)	(m/s)	(m/s)	(m/s)
1.018	23.82	23.85	0.9	-0.1	0.31
2.083	23.80	23.85	1.9	-0.2	0.31
2.993	23.78	23.85	2.9	-0.1	0.31
4.164	23.80	23.85	3.9	-0.2	0.31
5.066	23.84	23.85	5.0	0.0	0.31
6.000	23.98	23.85	6.0	0.0	0.31
7.020	23.30	23.85	7.0	0.0	0.31
7.970	23.88	23.85	8.0	0.0	0.31
8.970	23.20	23.85	9.1	0.1	0.31
10.020	23.50	23.85	10.1	0.1	0.31
11.040	23.30	23.85	11.2	0.2	0.31
12.020	23.60	23.85	12.2	0.2	0.31
13.040	23.40	23.85	13.2	0.2	0.31
14.030	23.64	23.85	14.2	0.2	0.31
15.030	23.50	23.85	15.3	0.3	0.31
16.030	23.60	23.85	16.3	0.3	0.31

Remark:

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

² Velocity of standard

³ Velocity of Unit Under Calibration

PHOTO OF CALIBRATION SET-UP



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



End of Certificate of Calibration

Certificate Number

CWD-003-67

CERTIFICATE OF CALIBRATION

Page 1 of 2 Pages

MEASUREMENT ITEM

MANUFACTURER

MODEL/TYPE

SERIAL NUMBER

ID NUMBER

CONDITION AS-RECEIVED

CUSTOMER

Wind Direction Sensor
Novelins
Sensor: WS-02F
Data logger: 200 WS-25DL
Sensor: WSD-A4840
Data logger: A4840
BKK_F50165
Used item
ALS laboratory group (Thailand) Co., Ltd.
104 Phatthanakan 40, Phatthanakan Rd, Khwaeng Suan Luang,
Khet Suan Luang, Bangkok 10250 Thailand

Calibration procedure:
The wind direction sensor was calibrated against
Standard Rotary Encoder model: AX4039T5-
DM04-P3-S-LO in an on close test-section of Effel-
type wind tunnel with 900 cm² cross test section
area. The WI-CL-008 based on IEC 61400-12-1,
Wind energy generation systems - Part 12-1,
Power performance measurements of electricity
producing wind turbines, March 2017 was used as
a calibration guideline.

Traceability:
This certificate provides a traceability of the
measurement to the recognized national
standards, and to realization of the international
system of units (SI) through the NIMT (National
Metrology Institute of Thailand) via Certificate
number: DA-0026-23.

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

RECEIVED DATE

MEASUREMENT DATE

ISSUE DATE

25 Dec 2023
04 Jan 2024
05 Jan 2024

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follow:

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

PLACE OF CALIBRATION

Effel-type wind tunnel of Jiranatee Associates Co., Ltd.

CALIBRATION CONDITION

Wind tunnel cross-section area¹ 900 cm²
Wind direction frontal area² 129 cm²
Diameter of mounting pipe³ mm
Blockage ratio of test object⁴ 0.143 [-]

Preconditioning

Measurement Condition

24 hours at ambient conditions.
The average values during measurement are $(23.6)^\circ\text{C}$, $(54.1)\%$ RH and (1010.9) hPa.

TABULATION OF RESULTS:

The table on next page give the measured values.

Calibrated by:
[X] Mr. Sorawit Thachalad
[X] Miss Jiraporn Lerttongphol



Approved signature

Mr. Panyee Booncharoen
Calibration Department Manager

Remark:

¹ Inside cross-section area of the wind tunnel
² Projected cross-section area of the tested object include mounting pipe
³ Diameter of mounting pipe
⁴ Ratio $\frac{A_2}{A_1}$

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

Certificate Number

CWD-003-67

Page 2 of 2 Pages

MEASUREMENT RESULTS¹

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

Air speed m/s	D _{in} Degree (°)	D _{out} Degree (°)	Error Degree (°)	U (k=2) Degree (°)
45.000	41	41	-4	0.80
89.999	87	87	-3	0.80
135.000	133	133	-2	0.80
180.000	182	182	2	0.80
225.000	230	230	5	0.80
270.000	275	275	5	0.80
315.000	320	320	5	0.80
360.000	359	359	-1	0.80

Remark:

¹ Calibration results only count for the tested circumstances and environmental conditions during which calibration took place

² Direction of standard

Direction of Unit Under Calibration

End of Certificate of Calibration



Certificate Number

CL-015-65

CERTIFICATE OF CALIBRATION

Page 1 of 2 Pages

MEASUREMENT ITEM

MANUFACTURER

MODEL/TYPE

SERIAL NUMBER

ID NUMBER

CONDITION AS-RECEIVED

CUSTOMER

Cup anemometer
Novelins
Sensor: WS-02F
Data logger: 200 WS-25DL
Sensor: A4840
Data logger: A4840
BKK_F50167
Used item
ALS laboratory group (Thailand) Co., Ltd.
104 Phatthanakan 40, Phatthanakan Rd, Khwaeng Suan Luang,
Khet Suan Luang, Bangkok 10250 Thailand

Calibration procedure:
The cup anemometer was calibrated against
Standard air velocity transducer model: P455-32
and pitot tube with precision differential pressure
meter model: DPM2500 in an on close test-section of
Effel-type wind tunnel with 900 cm² cross test
section area. The WI-CL-007 based on IEC 61400-
12-1, Wind energy generation systems - Part 12-1,
Power performance measurements of electricity
producing wind turbines, March 2017
was used as a calibration guideline.

Traceability:
This certificate provides a traceability of the
measurement to the recognized national
standards, and to realization of the international
system of units (SI) through the NIMT (National
Metrology Institute of Thailand) via Certificate
number: MW-0052-23 and MW-0056-22.

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

RECEIVED DATE

MEASUREMENT DATE

ISSUE DATE

02 Dec 2022
06 Dec 2022
12 Dec 2022

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follow:

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

PLACE OF CALIBRATION

Effel-type wind tunnel of Jiranatee Associates Co., Ltd.

CALIBRATION CONDITIONS

Wind tunnel cross-section area¹ 900 cm²
Wind direction frontal area² 100 cm²
Diameter of mounting pipe³ mm
Blockage ratio of test object⁴ 0.111 [-]

Preconditioning

Measurement Condition

24 hours at ambient conditions.
The average values during measurement are $(23.9)^\circ\text{C}$, $(47.5)\%$ RH and (1008.9) hPa.

TABULATION OF RESULTS:

The table on next page give the measured values

Calibrated by:
[X] Mr. Sorawit Thachalad
[X] Miss Jiraporn Lerttongphol



Approved signature

Mr. Panyee Booncharoen
Calibration Department Manager

Remark:

¹ Inside cross-section area of the wind tunnel
² Projected cross-section area of the tested object include mounting pipe
³ Diameter of mounting pipe
⁴ Ratio $\frac{A_2}{A_1}$

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

Certificate Number

CL-015-65

Page 2 of 2 Pages

MEASUREMENT RESULTS¹

The cup anemometer, Unit Under Calibration (UUC) was exercise at 10 m/s for 5 minutes prior to calibration being performed. The standard air velocity 0.5 m/s to 5 m/s was calculated by a standard air velocity transducer and above 5 m/s to 30 m/s was calculated by a pitot tube with precision differential pressure meter which was installed 40 mm and 300 mm respectively away from wind tunnel nozzle. UUC was installed at center of the test section. The calibration was carried out under both rising and falling air velocity in the range of 1 m/s to 36 m/s at calibration interval of 1 m/s. The results of calibration and associated measurement uncertainties are reported in the table below.

V _{ref} (m/s)	Temp. wind tunnel (°C)	Temp. room (°C)	V _{meas} (m/s)	Error (m/s)	U (k=2) (m/s)
0.990	23.80	23.85	0.8	-0.2	0.15
2.045	23.84	23.85	1.9	-0.2	0.16
3.091	23.90	23.85	2.9	-0.1	0.26
4.221	24.10	23.85	4.1	-0.2	0.30
5.01	23.66	23.85	4.9	-0.1	0.19
6.00	24.10	23.85	6.0	0.0	0.21
7.06	23.54	23.85	6.9	0.2	0.21
8.16	24.10	23.85	8.1	-0.1	0.19
9.10	23.60	23.85	9.1	0.0	0.27
10.10	24.06	23.85	10.0	-0.1	0.23
11.16	23.64	23.85	11.0	-0.1	0.22
12.15	23.96	23.85	12.0	-0.1	0.28
13.20	23.70	23.85	13.0	-0.2	0.45
14.28	23.50	23.85	14.1	-0.2	0.28
15.27	23.74	23.85	15.2	-0.1	0.29
16.32	23.74	23.85	16.3	-0.1	0.49

Remark:

¹ Calibration results only count for the tested circumstances and environmental conditions during which calibration took place

² Velocity of standard

³ Velocity of Unit Under Calibration

PHOTO OF CALIBRATION SET-UP



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

End of Certificate of Calibration

Certificate Number
CL-015-65

CERTIFICATE OF CALIBRATION

Page 1 of 2 Pages

MEASUREMENT ITEM	Wind Direction Sensor
MANUFACTURER	Novatym
MODEL/TYPE	Sensor: WS-02F Data logger: 200-WS-25DL
SERIAL NUMBER	Sensor: Data logger: A4884
ID NUMBER	BKK_F50167
CONDITION AS-RECEIVED	Used item
CUSTOMER	ALS laboratory group (Thailand) co., Ltd. 104 Phatthanakan 40, Phatthanakan Rd, Khwaeng Suan Luang, Khet Suan Luang, Bangkok 10250 Thailand.
RECEIVED DATE	07 Dec 2022
MEASUREMENT DATE	12 Dec 2022
ISSUE DATE	12 Dec 2022

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

PLACE OF CALIBRATION	Eiffel-type wind tunnel of Jiranatee Associates Co., Ltd.
-----------------------------	---

CALIBRATION CONDITION	Wind tunnel cross-section area ¹	900	cm ²
	Win direction frontal area ²	128	cm ²
	Diameter of mounting pipe ³	-	mm
	Blockage ratio of test object ⁴	0.143	[-]

Preconditioning	24 hours at ambient conditions.
Measurement Condition	The average values during measurement are (24.3) °C, (49.4) %RH and (1006.8) hPa.

TABULATION OF RESULTS:
The table on next page give the measured values.

Calibrated by:
[] Mr. Sorawit Thakhalad
[] Miss Jitraporn Lertbumpol



Approved signatory:
Mr. Parinya Booncharoen
Calibration Department Manager

Remarks:
1. Suitable cross-section area of the wind tunnel
2. Projected cross-section area of the tested object include mounting pipe
3. Diameter of mounting pipe
4. Ratio $\frac{A_o}{A_t}$

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

REVIEW BY	Parinya P.
APPROVED BY	[Signature]
CAL DATE	11/13/24

Certificate Number
CL-006-66

CERTIFICATE OF CALIBRATION

Page 1 of 2 Pages

MEASUREMENT ITEM	Cup anemometer
MANUFACTURER	Novatym
MODEL/TYPE	Sensor: WS-02F Data logger: 130 WS-25DLN
SERIAL NUMBER	Sensor: WSD-008 Data logger: AS488
ID NUMBER	NKH_F50054
CONDITION AS-RECEIVED	Used item
CUSTOMER	ALS laboratory group (Thailand) co., Ltd. 104 Phatthanakan 40, Phatthanakan Rd, Khwaeng Suan Luang, Khet Suan Luang, Bangkok 10250 Thailand.
RECEIVED DATE	09 Jan 2023
MEASUREMENT DATE	11 Jan 2023
ISSUE DATE	13 Jan 2023

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

PLACE OF CALIBRATION	Eiffel-type wind tunnel of Jiranatee Associates Co., Ltd.
-----------------------------	---

CALIBRATION CONDITIONS	Wind tunnel cross-section area ¹	900	cm ²
	Win direction frontal area ²	100	cm ²
	Diameter of mounting pipe ³	-	mm
	Blockage ratio of test object ⁴	0.111	[-]

Preconditioning	24 hours at ambient conditions.
Measurement Condition	The average values during measurement are (23.5) °C, (57.4) %RH and (1011.3) hPa.

TABULATION OF RESULTS:
The table on next page give the measured values.

Calibrated by:
[] Mr. Sorawit Thakhalad
[] Miss Jitraporn Lertbumpol



Approved signatory:
Mr. Parinya Booncharoen
Calibration Department Manager

Remarks:
1. Suitable cross-section area of the wind tunnel
2. Projected cross-section area of the tested object include mounting pipe
3. Diameter of mounting pipe
4. Ratio $\frac{A_o}{A_t}$

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

Certificate Number

CL-015-65

Page 2 of 2 Pages

MEASUREMENT RESULTS¹

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

Air speed m/s	D ⁺ _{std} Degree (°)	D ⁻ _{std} _{std} Degree (°)	Error Degree (°)	U (k=2) Degree (°)
0.001	0	0	0	0.58
45.000	43	43	-2	0.76
90.000	87	87	-3	0.88
135.000	133	133	-2	0.66
180.000	179	179	-1	0.68
225.001	227	227	2	0.58
270.000	274	274	4	0.68
315.000	319	319	4	0.74

Remark:

¹ Calibration results only count for the tested circumstances and environmental conditions during which calibration took place

² Direction of standard

³ Direction of Unit Under Calibration

End of Certificate of Calibration



Certificate Number

CL-006-66

Page 2 of 2 Pages

MEASUREMENT RESULTS¹

The cup anemometer, Unit Under Calibration (UUC) was exercise at 10 m/s for 5 minutes prior to calibration being performed. The standard air velocity 0.5 m/s to 5 m/s was calculated by a standard air velocity transducer and above 5 m/s to 30 m/s was calculated by a pitot tube with precision differential pressure meter which was installed 40 mm and 300 mm respectively away from wind tunnel nozzle. UUC was installed at center of the test section. The calibration was carried out under both rising and falling air velocity in the range of 1 m/s to 16 m/s at calibration interval of 1 m/s. The results of calibration and associated measurement uncertainties are reported in the table below.

V _{std} (m/s)	Temp. wind tunnel (°C)	Temp. room (°C)	V _{std} (m/s)	Error (m/s)	U (k=2) (m/s)
0.981	23.36	23.45	0.8	-0.2	0.16
2.040	23.50	23.45	1.9	0.2	0.18
3.049	23.30	23.45	2.9	-0.1	0.20
4.147	23.50	23.45	3.9	-0.2	0.20
4.99	23.30	23.45	4.9	-0.1	0.19
5.99	23.48	23.45	5.9	-0.1	0.18
7.03	23.16	23.45	6.9	-0.1	0.21
8.16	23.40	23.45	7.9	-0.3	0.19
9.09	23.10	23.45	8.9	-0.3	0.21
10.07	23.36	23.45	9.9	-0.1	0.19
11.14	23.14	23.45	11.0	-0.2	0.21
12.14	23.28	23.45	12.0	-0.1	0.22
13.20	23.28	23.45	13.0	-0.2	0.26
14.26	23.16	23.45	14.0	-0.2	0.35
15.24	23.14	23.45	15.0	-0.2	0.27
16.30	23.10	23.45	16.1	-0.2	0.44

Remark:

¹ Calibration results only count for the tested circumstances and environmental conditions during which calibration took place

² Velocity of standard

³ Velocity of Unit Under Calibration

PHOTO OF CALIBRATION SET-UP



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



End of Certificate of Calibration
JIRANATEE ASSOCIATES CO., LTD.

CERTIFICATE OF CALIBRATION

Page 1 of 2 Pages

MEASUREMENT ITEM MANUFACTURER MODEL/TYPE

Wind Direction Sensor
Novalyne
Sensor: WS-021
Data logger: 110-WS-25DL-N

SERIAL NUMBER

Sensor: WS0-008
Data logger: AS488

ID NUMBER CONDITION AS RECEIVED CUSTOMER

NKH_FS0054
Used item
ALS laboratory group (Thailand) Co., Ltd.
104 Phatthanasak 40, Phatthanasak Rd, Khwaeng Suan Luang,
Khet Suan Luang, Bangkok 10250 Thailand

RECEIVED DATE MEASUREMENT DATE ISSUE DATE

09 Jan 2023
13 Jan 2023
13 Jan 2023

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follow:

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

PLACE OF CALIBRATION

Effel-type wind tunnel of Jirantee Associates Co., Ltd.

CALIBRATION CONDITION

Wind tunnel cross-section area: 900 cm²
Win direction frontal area: 129 cm²
Diameter of measuring pipe: mm
Blockage ratio of test object: 0.143 [-]

Preconditioning

24 hours at ambient conditions.

Measurement Condition

The average values during measurement are (23.5 ± 3.0) °C, (49.0) %RH and (1011.5) hPa.

TABULATION OF RESULTS:

The table on next page give the measured values.

Calibrated by:

☒ Mr. Soravit Thachalad
☐ Miss Jittreem Lertsomphol

Remarks:

* Validity cross-section area of the wind tunnel.
* Precipitation cross-section area of the tested object include mounting pipe.
* Diameter of measuring pipe.
* Ratio "a" = 1

Calibration procedure:
The wind direction sensor was calibrated against
Standard Rotary Encoder, model: 42000750
DIA04-P3-S-10 in an open test section of Effel-
type wind tunnel with 900 cm² cross section
area. The WI-CL-008 based on RD-60400-12-1,
Wind energy generation systems, - Part 12-1-1,
Power performance measurement of electricity
producing wind turbines, March 2017 was used as
a calibration guideline.

Traceability:

This certificate provides a traceability of the
measurement to recognized the national
standards, and to realization of the international
system of units (SI) through the NIMT (National
Metrology Institute of Thailand) via Certificate
Number: DA-0043-22

Uncertainty of Measurement:

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

Page 2 of 2 Pages

MEASUREMENT RESULTS¹

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

Air speed m/s	D ₁₀₀ Degree (°)	D ₁₀₀ Degree (°)	Error Degree (°)	U (k=2) Degree (°)
0.000	0	0	0	0.58
45.000	42	42	-3	0.74
90.000	87	87	-3	0.74
135.000	134	134	-1	0.74
180.000	182	182	1	0.75
225.000	228	228	3	0.74
270.000	273	273	3	0.74
315.000	319	319	4	0.74

Remarks:

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

² Direction of standard

³ Direction of Unit Under Calibration

End of Certificate of Calibration



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

CERTIFICATE OF CALIBRATION

Calibration No.: RH-D4012023

Page 1 of 1 Pages

Measurement Item

Relative humidity with data logger

Manufacturer

Novalyne

Model/Type

110-WS-25DL-N

Serial Number

AS488

ID No.

NKH_FS0054

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 (25 ± 3) °C, and relative humidity of (55 ± 15) %.

Measurement Method:

Unit Under Calibration (UUC) was calibrated by comparison method with standard thermo hygrometer in the humidity generator chamber to determine the errors.

Traceability:

This instrument was calibrated using standard equipment whose accuracy is traceability through National Institute of Standards and Technology to the international system of units (SI) via MCS Calibration Inc. Certificate number: 20314-101. Due date Mar 14, 2023.

Measurement Date

Jan 13, 2023

Issued Date

Jan 13, 2023

Measurement Results:

This equipment was connected with indoor air quality probe and Displayed (DR) on display. Model: HMR60, Serial number: R3140637.

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

The results of calibration are reported in table below:

Determined (%RH)	Standard (%RH)	UUC (%RH)	Error (%RH)	Uncertainty (%RH)
20	20.05	18.9	-1.1	0.66
50	50.33	48.7	-1.6	0.66
80	80.26	79.7	-0.5	0.66

Performed by

☐ Mr. Soravit Thachalad
☒ Miss Jittreem Lertsomphol



Approved Signatory

Mr. Parinya Booncharoen
Calibration Department Manager

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

CERTIFICATE OF CALIBRATION

Certificate No.: CL-003-66

Page 1 of 2

Equipment Name: Data Logger with Temperature

Sensor

Manufacturer: Novalyne

Model: 110-WS-25DL-N

Serial No.: AS488

ID No.: NKH_FS0054

Customer

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

Received date: 09 Jan 2023

Calibration date: 13 Jan 2023

Issue date: 13 Jan 2023

Reference Used During Calibration

1. Standard Temperature Probe Model: STS-100 AS00,
Serial No.: 667682-09, Due date: 23 Mar 2023
2. Digital Temperature Indicator Model: DTI-1000-A MK
II, Serial No.: 671407-00591 Due date: 22 July 2023

Calibration Condition

Temperature: (23 ± 3) °C
Relative Humidity: (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 used was based on ITS-90.

Traceability

The measurement results are traceable to the
international system of units (SI) through National
Institute of Metrology Thailand (NIMT) Certificate
number: TT-0034-22, Certificate number: ER-0092-
22

Calibrated by

☐ Mr. Soravit Thachalad
☒ Miss Jittreem Lertsomphol



Approved Signatory

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 No.: CL-003-66
Page 2 of 2

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

Function:
This equipment was connected with temperature sensor Model: HMP60 S/N: R3140637.
Dimension : Diameter 12 mm. Length 80 mm.

Immersion Depth (mm)	Standard Reading (°C)	UUC Reading (°C)	Error (°C)	Uncertainty (°C)
60	20.067	20.1	0.0	0.099
60	25.058	25.1	0.0	0.099
60	30.052	30.0	-0.1	0.099
60	35.047	34.8	-0.2	0.099
60	40.038	39.6	-0.4	0.099

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

★ End of Certificate ★



Page 1 of 2 Pages

MEASUREMENT ITEM
MANUFACTURER
MODEL/TYPE
SERIAL NUMBER
ID NUMBER
CONDITION AS-RECEIVED
CUSTOMER
RECEIVED DATE
MEASUREMENT DATE
ISSUE DATE

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

PLACE OF CALIBRATION : Effel-type wind tunnel of Jiranatee Associates Co., Ltd.

CALIBRATION CONDITION : Wind tunnel cross-section area* 900 cm²
Win direction frontal area* 129 cm²
Diameter of mounting pipe* mm
Blockage ratio of test object* 0.143 [-]

Preconditioning : 24 hours at ambient conditions.
Measurement Condition : The average values during measurement are (24.1)°C, (54.3) %RH and (1015.2) hPa.

TABULATION OF RESULTS:
The table on next page give the measured values.

Calibrated by:
☒ Mr. Sorawit Thakuldee
☐ Miss Jitragorn Jiratanachol

Approved signature:
Mr. Panyia Booncharoen
Calibration Department Manager

Remarks:
* Nozzle cross-section area of the wind tunnel.
* Projected cross-section area of the tested object include mounting pipe.
* Diameter of mounting pipe.
* Ratio "to 1"

Calibration procedure:
The wind direction sensor was calibrated against Standard Rotary Encoder, model: AX40095-DH04 P3-5-UD in an open section of Effel-type wind tunnel with 900 cm² cross flow section area. The WI-CL-008 based on IEC 61400-12-1, Wind energy generation systems - Part 12-1: Power performance measurements of electricity producing wind turbines. March 2017 was used as a calibration guideline.

Traceability:
This certificate provides a traceability of the measurement to recognized the national standards and to realization of the international system of units (SI) through the NIMT (National Metrology Institute of Thailand) via Certificate Number: GA-G045-22.

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

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

Certificate Number

CL-011-66

Page 2 of 2 Pages

MEASUREMENT RESULTS¹

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

Air speed m/s	D _{ref} Degree (°)	D _{meas} Degree (°)	Error Degree (°)	U (k=2) Degree (°)
5.03	0.000	0	0	0.58
	45.000	41	-4	0.68
	90.000	88	-2	0.74
	135.000	133	-2	0.58
	180.000	180	0	0.74
	225.000	228	3	0.74
	270.000	273	3	0.68
	315.000	316	1	0.74

Remarks:
¹ Calibration results only count for the tested circumstances and environmental conditions during which calibration took place.
² Direction of standard.
³ Direction of Unit Under Calibration.

End of Certificate of Calibration

Certificate Number

CL-011-66

CERTIFICATE OF CALIBRATION

Page 1 of 2 Pages

MEASUREMENT ITEM
MANUFACTURER
MODEL/TYPE
SERIAL NUMBER
ID NUMBER
CONDITION AS-RECEIVED
CUSTOMER
RECEIVED DATE
MEASUREMENT DATE
ISSUE DATE

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

PLACE OF CALIBRATION : Effel-type wind tunnel of Jiranatee Associates Co., Ltd.

CALIBRATION CONDITIONS : Wind tunnel cross-section area* 900 cm²
Win direction frontal area* 129 cm²
Diameter of mounting pipe* mm
Blockage ratio of test object* 0.111 [-]

Preconditioning : 24 hours at ambient conditions.
Measurement Condition : The average values during measurement are (23.3)°C, (52.3) %RH and (1014.3) hPa.

TABULATION OF RESULTS:
The table on next page give the measured values.

Calibrated by:
☒ Mr. Sorawit Thakuldee
☐ Miss Jitragorn Jiratanachol

Approved signature:
Mr. Panyia Booncharoen
Calibration Department Manager

Remarks:
* Nozzle cross-section area of the wind tunnel.
* Projected cross-section area of the tested object include mounting pipe.
* Diameter of mounting pipe.
* Ratio "to 1"

Calibration procedure:
The cup anemometer was calibrated against Standard air velocity transducer model: 8455B2 and pilot tube with precision differential pressure meter model: DPA1550 in an open section of Effel-type wind tunnel with 900 cm² cross flow section area. The WI-CL-007 based on IEC 61400-12-1, Wind energy generation systems - Part 12-1: Power performance measurements of electricity producing wind turbines. March 2017 was used as a calibration guideline.

Traceability:
This certificate provides a traceability of the measurement to recognized the national standards and to realization of the international system of units (SI) through the NIMT (National Metrology Institute of Thailand) via Certificate Number: MW-0307-21 and MW-0306-22.

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

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

Certificate Number
CL-010-66

Page 2 of 2 Pages

MEASUREMENT RESULTS¹

The cup anemometer, Unit Under Calibration (UUC) was exercised at 10 m/s for 5 minutes prior to calibration being performed. The standard air velocity 0.5 m/s to 5 m/s was calculated by a standard air velocity transducer and above 5 m/s to 30 m/s was calculated by a pitot tube with precision differential pressure meter which was installed 40 mm and 300 mm respectively away from wind tunnel nozzle. UUC was operated at center of the test section. The calibration was carried out under both rising and falling air velocity in the range of 1 m/s to 16 m/s at calibration interval of 1 m/s. The results of calibration and associated measurement uncertainties are reported in the table below.

V_{ref} (m/s)	Temp. wind tunnel (°C)	Temp. room (°C)	V_{UUC} (m/s)	Error (m/s)	U (k=2) (m/s)
0.983	23.50	23.45	0.8	-0.2	0.17
2.035	23.44	23.45	1.9	-0.1	0.16
3.049	23.50	23.45	2.9	-0.2	0.19
4.136	23.50	23.45	3.9	-0.2	0.20
5.01	23.40	23.45	4.9	-0.1	0.18
6.00	23.30	23.45	5.9	-0.1	0.19
7.07	23.40	23.45	7.0	-0.1	0.19
8.18	23.50	23.45	8.0	-0.2	0.19
9.10	23.26	23.45	9.0	-0.1	0.20
10.09	23.44	23.45	9.9	-0.1	0.21
11.15	23.30	23.45	11.0	-0.1	0.21
12.14	23.42	23.45	12.0	-0.1	0.25
13.20	23.23	23.45	13.1	-0.1	0.26
14.25	23.34	23.45	14.0	-0.1	0.24
15.24	23.24	23.45	15.0	-0.3	0.26
16.31	23.24	23.45	16.1	-0.2	0.24

Remark:

¹ Calibration results only count for the tested circumstances and environmental conditions during which calibration took place

² Velocity of standard

³ Velocity of Unit Under Calibration

PHOTO OF CALIBRATION SET-UP



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

End of Certificate of Calibration

Jiranatee Associates Co., Ltd.
63/24-15, 67/25-16,
Pattana 7, 7/1, Rd. Wattana, Bangkok
Bangkok 10002 (Thailand)
Tel: +6628860012
Fax: +6628860013
E-mail: jnac-ca-br@jiranatee.com
Web site: www.jiranatee.com

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

Air speed measurement laboratory
Calibration services department.

Handwritten signature and date: 19/1/24

Certificate Number
CL-010-66

CERTIFICATE OF CALIBRATION

Page 1 of 2 Pages

MEASUREMENT ITEM

Wind Direction Sensor

MANUFACTURER

Novalyte

MODEL/TYPE

Sensor: WS-02F

SERIAL NUMBER

Data logger: 200-WS-25DL

ID NUMBER

Sensor: -

CONDITION AS-RECEIVED

Data logger: A4886

CUSTOMER

RYG, FS0087

Used item

ALS laboratory group (Thailand) Co., Ltd.

104 Phatthanakan Rd, Phatthanakan Rd, Khwaeng Suan Luang,

Khut Suan Luang, Bangkok 10250 Thailand

RECEIVED DATE

16 Jan 2023

MEASUREMENT DATE

19 Jan 2023

ISSUE DATE

20 Jan 2023

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follows:

Temperature: 23.0 ± 3.0 °C

Relative Humidity: 55.0 ± 15.0 NRH

Atmospheric Pressure: 1010 ± 10 hPa

PLACE OF CALIBRATION

Elfel-type wind tunnel of Jiranatee Associates Co., Ltd.

CALIBRATION CONDITION

Wind tunnel cross-section area¹ 900 cm²

Win direction frontal area² 129 cm²

Diameter of mounting pipe³ 129 mm

Blockage ratio of test object⁴ 0.143 [-]

Preconditioning

24 hours at ambient conditions.

Measurement Condition

The average values during measurement are (23.5) °C, (47.4) NRH and (1013.5) hPa.

TABULATION OF RESULTS:

The table on next page give the measured values.

Calibrated by:

Mr. Sorawit Thachabud

Miss Jittraorn Jiratanaporn

Approved signatory:

Handwritten signature

Mr. Parinya Booncharoen
Calibration Department Manager

Remark:

¹ Nozzle cross-section area of the wind tunnel

² Projected cross-section area of the tested object include mounting pipe

³ Diameter of mounting pipe

⁴ Ratio "a/b"

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

Jiranatee Associates Co., Ltd.
63/24-15, 67/25-16,
Pattana 7, 7/1, Rd. Wattana, Bangkok
Bangkok 10002 (Thailand)
Tel: +6628860012
Fax: +6628860013
E-mail: jnac-ca-br@jiranatee.com
Web site: www.jiranatee.com

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

Air speed measurement laboratory
Calibration services department.

Certificate Number
CL-010-66

CERTIFICATE OF CALIBRATION

Page 1 of 2 Pages

MEASUREMENT ITEM

Cup anemometer

MANUFACTURER

Novalyte

MODEL/TYPE

Sensor: WS-02F

SERIAL NUMBER

Data logger: 200-WS-25DL

ID NUMBER

Sensor: -

CONDITION AS-RECEIVED

Data logger: A4886

CUSTOMER

RYG, FS0087

Used item

ALS laboratory group (Thailand) Co., Ltd.

104 Phatthanakan Rd, Phatthanakan Rd, Khwaeng Suan Luang,

Khut Suan Luang, Bangkok 10250 Thailand

RECEIVED DATE

16 Jan 2023

MEASUREMENT DATE

19 Jan 2023

ISSUE DATE

20 Jan 2023

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follows:

Temperature: 23.0 ± 3.0 °C

Relative Humidity: 55.0 ± 15.0 NRH

Atmospheric Pressure: 1010 ± 10 hPa

PLACE OF CALIBRATION

Elfel-type wind tunnel of Jiranatee Associates Co., Ltd.

CALIBRATION CONDITIONS

Wind tunnel cross-section area¹ 900 cm²

Win direction frontal area² 100 cm²

Diameter of mounting pipe³ 100 mm

Blockage ratio of test object⁴ 0.111 [-]

Preconditioning

24 hours at ambient conditions.

Measurement Condition

The average values during measurement are (23.8) °C, (55.3) NRH and (1013.5) hPa.

TABULATION OF RESULTS:

The table on next page give the measured values.

Calibrated by:

Mr. Sorawit Thachabud

Miss Jittraorn Jiratanaporn

Approved signatory:

Handwritten signature

Mr. Parinya Booncharoen
Calibration Department Manager

Remark:

¹ Nozzle cross-section area of the wind tunnel

² Projected cross-section area of the tested object include mounting pipe

³ Diameter of mounting pipe

⁴ Ratio "a/b"

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

Certificate Number
CL-010-66

Page 2 of 2 Pages

MEASUREMENT RESULTS¹

The cup anemometer, Uno Under Calibration (UUC) was exercised at 10 m/s for 5 minutes prior to calibration being performed. The standard air velocity 0.5 m/s to 5 m/s was calculated by a standard air velocity transducer and above 5 m/s to 30 m/s was calculated by a pitot tube with precision differential pressure meter which was installed 40 mm and 300 mm respectively away from wind tunnel nozzle, UUC was installed at center of the test section. The calibration was carried out under both rising and falling air velocity in the range of 1 m/s to 16 m/s at calibration interval of 1 m/s. The results of calibration and associated measurement uncertainties are reported in the table below.

V_{std} (m/s)	Temp. wind tunnel (°C)	Temp. room (°C)	V_{UUC} (m/s)	Error (m/s)	U (k=2) (m/s)
0.985	23.68	23.60	0.8	-0.2	0.15
2.033	23.54	23.50	1.8	-0.2	0.16
3.046	23.68	23.60	2.9	-0.1	0.19
4.136	23.66	23.60	3.9	-0.2	0.20
5.03	23.50	23.60	4.9	-0.1	0.20
5.98	23.50	23.60	5.9	-0.1	0.18
7.09	23.36	23.60	7.0	-0.1	0.18
8.18	23.54	23.60	8.0	-0.2	0.20
9.10	23.30	23.60	8.9	-0.2	0.20
10.10	23.50	23.60	10.0	-0.1	0.19
11.14	23.28	23.60	11.1	-0.1	0.22
12.12	23.40	23.60	11.9	-0.2	0.21
13.19	23.10	23.60	13.0	-0.2	0.26
14.23	23.48	23.60	14.0	-0.2	0.32
15.26	23.10	23.60	15.0	-0.2	0.33
16.31	23.26	23.60	16.2	-0.1	0.29

Remark:

¹ Calibration results only count for the tested circumstances and environmental conditions during which calibration took place

² Velocity of standard

³ Velocity of Unit Under Calibration

PHOTO OF CALIBRATION SET-UP



Calibration setup of the cup anemometer calibration in the wind tunnel of Jiranatee Associates Co., Ltd. The cup anemometer always may differ from the calibrated one. Remark: The proportion of the set-up is not true to scale due to imaging geometry.

End of Certificate of Calibration

J NAC
JIRANATEE ASSOCIATES CO., LTD.
1 Lametee Road, Soi 310,
KJ134 10, KJ 13 15,
Pattana 1 J/1, 1st Floor, Bangkok 10110
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Tel: +662 000011
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Accredited calibration laboratory
ISO/IEC 17025:2017
MSC-150-15 17025
CALIBRATION 0367

Air speed measurement laboratory
Calibration services department

Handwritten: 17/9/24
Certificate Number
CL-004-65

CERTIFICATE OF CALIBRATION

Page 2 of 2 Pages

MEASUREMENT ITEM MANUFACTURER MODEL/TYPE

Wind Direction Sensor
Novolyne
Sensor: WS-027
Data logger: 110 WS-250L-D

SERIAL NUMBER

Sensor: WSD-014
Data logger: AS912

ID NUMBER

RVL_150611

CONDITION AS RECEIVED

New item

CUSTOMER

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

RECEIVED DATE

09 Nov 2022

MEASUREMENT DATE

17 Nov 2022

ISSUE DATE

23 Nov 2022

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follows:

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

PLACE OF CALIBRATION

Effel-type wind tunnel of Jiranatee Associates Co., Ltd.

CALIBRATION CONDITION

Wind tunnel cross section area ¹	900	cm ²
Wind direction frontal area ²	129	cm ²
Diameter of mounting pipe ³	—	mm
Blockage ratio of test object ⁴	0.143	%

Preconditioning

24 hours at ambient conditions

Measurement Condition

The average values during measurement are (24.5) °C, (48.3) %RH and (1012.4) hPa.

TABULATION OF RESULTS:

The table on next page give the measured values.

Calibrated by:

Mr. Sorawat Thirachai
Miss Jiraporn Jiratanaporn



Approved laboratory

Handwritten signature: Mr. Panyapa Boonchaisri
Mr. Panyapa Boonchaisri
Calibration Department Manager

Remark:

¹ Nozzle cross section area of the wind tunnel

² Projected cross section area of the tested object include mounting pipe

³ Diameter of mounting pipe

⁴ Ratio (%)

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

Certificate Number
CL-004-65

Page 2 of 2 Pages

MEASUREMENT RESULTS¹

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

Air speed m/s	D'_{cal} Degree (°)	D'_{std} Degree (°)	Error Degree (°)	U (k=2) Degree (°)
5.01	0.001	0	0	0.58
	45.000	45	0	0.74
	90.001	89	-1	0.68
	135.000	134	-1	0.74
	180.000	180	0	0.74
	225.000	227	2	0.74
	270.001	272	2	0.74
	315.000	318	3	0.68

Remark:

¹ Calibration results only count for the tested circumstances and environmental conditions during which calibration took place

² Direction of standard

³ Direction of Unit Under Calibration

End of Certificate of Calibration



J NAC
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Tel: +662 000011
Email: info@jiranatee.com
Fax: +662 000011
Website: www.jiranatee.com

Accredited calibration laboratory
ISO/IEC 17025:2017
MSC-150-15 17025
CALIBRATION 0367

Air speed measurement laboratory
Calibration services department

Certificate Number
CL-004-65

CERTIFICATE OF CALIBRATION

Page 1 of 2 Pages

MEASUREMENT ITEM MANUFACTURER MODEL/TYPE

Cup anemometer
Novolyne
Sensor: WS-027
Data logger: 110 WS-250L-D

SERIAL NUMBER

Sensor: WSD-014
Data logger: AS912

ID NUMBER

RVL_150611

CONDITION AS RECEIVED

New item

CUSTOMER

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

RECEIVED DATE

09 Nov 2022

MEASUREMENT DATE

17 Nov 2022

ISSUE DATE

23 Nov 2022

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follows:

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

PLACE OF CALIBRATION

Effel-type wind tunnel of Jiranatee Associates Co., Ltd.

CALIBRATION CONDITIONS

Wind tunnel cross-section area ¹	900	cm ²
Wind direction frontal area ²	180	cm ²
Diameter of mounting pipe ³	—	mm
Blockage ratio of test object ⁴	0.111	%

Preconditioning

24 hours at ambient conditions

Measurement Condition

The average values during measurement are (23.8) °C, (50.3) %RH and (1011.3) hPa.

TABULATION OF RESULTS:

The table on next page give the measured values.

Calibrated by:

Mr. Sorawat Thirachai
Miss Jiraporn Jiratanaporn



Approved laboratory

Handwritten signature: Mr. Panyapa Boonchaisri
Mr. Panyapa Boonchaisri
Calibration Department Manager

Remark:

¹ Nozzle cross-section area of the wind tunnel

² Projected cross section area of the tested object include mounting pipe

³ Diameter of mounting pipe

⁴ Ratio (%)

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Certificate Number
CL-004-45

Page 2 of 2 Pages

MEASUREMENT RESULTS¹

The cup anemometer, Unit Under Calibration (UUC) was calibrated at 10 m/s for 5 minutes prior to calibration being performed. The standard for velocity 0.5 m/s to 5 m/s was calculated by a standard air velocity transducer and above 5 m/s to 40 m/s was calculated by a pitot tube with precision differential pressure meter which was installed 40 mm and 100 mm respectively away from wind tunnel nozzle. UUC was installed at center of the test section. The calibration was carried out under both rising and falling air velocity in the range of 1 m/s to 16 m/s at calibration interval of 3 m/s. The results of calibration and associated measurement uncertainties are reported in the table below.

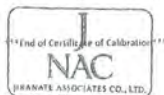
v_a^2 (m/s)	Temp. wind tunnel (°C)	Temp. room (°C)	V_{ref} (m/s)	Error (m/s)	$U(1-2)$ (m/s)
0.588	23.70	23.80	0.8	-0.2	0.15
2.053	23.90	23.80	1.8	-0.2	0.16
3.040	23.84	23.80	2.8	-0.2	0.18
4.227	23.86	23.80	3.8	-0.4	0.19
5.03	23.70	23.80	4.8	-0.2	0.19
6.02	23.94	23.80	5.8	-0.3	0.18
7.07	23.70	23.80	6.8	-0.2	0.18
8.19	23.90	23.80	7.9	-0.3	0.20
9.12	23.66	23.80	8.9	-0.2	0.20
10.12	23.82	23.80	9.9	-0.3	0.20
11.16	23.50	23.80	10.9	-0.3	0.21
12.15	23.90	23.80	11.8	-0.4	0.23
13.21	23.48	23.80	12.9	-0.3	0.23
14.27	23.74	23.80	13.9	-0.4	0.23
15.26	23.56	23.80	14.9	-0.3	0.23
16.32	23.62	23.80	16.0	-0.3	0.26

Remark:
Calibration results only count for the tested circumstances and environmental conditions during which calibration took place.
Velocity of standard
Velocity of Unit Under Calibration

PHOTO OF CALIBRATION SET-UP



Calibration set-up of the cup anemometer calibration in the wind tunnel of Jiranatee Associates Co., Ltd. The cup anemometer shows only differ from the calibration one. Remark: The proportion of the set-up is not true to scale due to imaging geometry.



63/14-15,67/35-36, Soi Petchhasem 7/71, Petchhasem Rd,
Walthapa, Banghokya, Bangkok 10600 Thailand.
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CERTIFICATE OF CALIBRATION

Calibration No. PH-04112022
Page 1 of 1 Pages

Measurement Item: Relative humidity with data logger
Manufacturer: Novalprok
Model/Type: 110 WS 25TR 11
Serial Number: AN212
ID No: 11001201611
Customer: NIS Laboratory Group (Thailand) Co., Ltd.
104 Phatthanasiri 40, Phatthanasiri Rd, Khwaeng Suan Luang, Khet Suan Luang, Bangkok
10250 Thailand

Environmental Condition:
The measurement was carried out in an ambient temperature of (25.3) °C, and relative humidity of (50.1) %.

Measurement Method:
Unit Under Calibration (UUC) was calibrated by comparison method with standard thermal hygrometer in the humidity generator chamber to determine the errors.

Traceability:
This instrument was calibrated using standard equipment whose accuracy is traceable through National Institute of Standards and Technology to the international system of units (SI) via JACS Calibration, Inc. Certificate number: 20314 101 Due date: Mar 14, 2023

Measurement Date: Nov 18, 2022
Issued Date: Nov 23, 2022

Measurement Results:
This equipment was connected with indoor air quality probe and displayed 50% RH on display. Model: 110 WS 25TR 11, Serial number: 03911247

Calibration was performed in the range of 20%RH to 80%RH
The results of calibration are reported in table below

Determined (%RH)	Standard setting (%RH)	UUC Reading (%RH)	Error (%RH)	Uncertainty ±(%RH)
20	19.97	18.5	1.5	0.51
50	50.75	48.0	2.3	0.51
80	80.30	78.3	2.0	0.52

Performed by
☒ Mr. Somsak Thaisakul
☐ Miss Jiraporn Lertsomphon



Approved Signatory:
Mr. Panyas Booncharoen
Calibration Department Manager

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



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Verification of Calibration of Calibration Number

Calibration Number: PH-04112022
Page 2 of 2 Pages

Result of Calibration: ☒ Within Acceptable Limit ☐ Not Acceptable
The result is in good agreement with the data below

Quantity of H ₂ O (ml)	Determined Tipping (ml)	Tipping count	Acceptable Tipping count
200	202	63	60 - 64
500	502	63	60 - 64
500	502	63	60 - 64
500	502	60	60 - 64
500	502	63	60 - 64

Remark: The procedure is made to verify the accuracy of the Unit Under Calibration (UUC) against a standard which is used for verification. We suggest that the number of tipping should be within ±2% difference from the full tipping bucket capacity. A good tipping accuracy that the unit should verify the measurement acceptable limit.

End of calibration report



Measurement Date: Nov 18, 2022
Issued Date: Nov 23, 2022

Performed by
☒ Mr. Somsak Thaisakul
☐ Miss Jiraporn Lertsomphon



Approved Signatory:
Mr. Panyas Booncharoen
Calibration Department Manager

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CERTIFICATE OF CALIBRATION

Certificate No.: CL-159-65
Page 2 of 2

Equipment Name: Data Logger with Temperature
Sensor

Manufacturer: Novolyne
Model: 130 WS 25DL D
Serial No.: A5932
ID No.: RYG_150611

Certificate No.: CL-159-65
Page 1 of 2

Received date: 09 Nov 2022
Calibration date: 18 Nov 2022
Issue date: 23 Nov 2022

Customer
Name: A.S. Laboratory group (Thailand) Co., Ltd.
Address: 104 Phatthanakan 40, Phatthanakan Rd,
Khwang Suan Luang, Khut Suan Luang, Bangkok
10250 Thailand.

Reference Used During Calibration
1. Standard Temperature Probe Model: STS 100 A500;
Serial No.: 657687-09, Due date: 23 Mar 2023
2. Digital Temperature Indicator Model: D11 1000 A MK II,
Serial No.: 671407-60591 Due date: 22 July 2023.

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 tested on ITS 90.

Traceability

The measurement results are traceable to the
international system of units (SI) through National
Institute of Metrology (NIMT) Certificate
number: TT-0034-22, Certificate number: ET-0002
22.

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

Function

This equipment was connected with temperature sensor Model: HMP60 S/N: 139131247.

Dimension: Diameter 12 mm, Length 80 mm.

Immersion Depth (mm)	Standard Reading (°C)	UUC Reading (°C)	Error (°C)	Uncertainty (°C)
60	19.99	19.9	-0.1	0.30
60	24.99	24.7	-0.2	0.30
60	30.00	29.8	-0.2	0.30
60	35.01	34.6	-0.4	0.30
60	39.99	39.5	-0.5	0.30

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 ★



Calibrated by
Mr. Sorawat Thachalad
Miss Jitraporn Lertsamphol



Approved Signatory:
Mr. Panyo Booncharoen
Calibration Department Manager

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



J NAC
J NAC Associates Co., Ltd.
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Fax: (66) 02-8680860
E-mail: jranateco@jranateco.com
Website: www.jranateco.com

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



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



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CALIBRATION 0367

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ISO/IEC 17025:2017
NSC-TISI-TIS 17025
CALIBRATION 0367

Pressure measurement laboratory
Calibration services department

CERTIFICATE OF CALIBRATION

Certificate No.: CL-017-65

Page 1 of 2 Pages

MEASUREMENT ITEM: Digital barometer
MANUFACTURER: Novolyne
MODEL/TYPE: 130 WS-25BP
SERIAL NUMBER: A5932
ID NUMBER: RYG_150611
CONDITION AS RECEIVED: Newton
CUSTOMER: A.S. Laboratory group (Thailand) Co., Ltd.
104 Phatthanakan 40, Phatthanakan Rd,
Khwang Suan Luang, Khut Suan Luang,
Bangkok 10250 Thailand.
RECEIVED DATE: 09 Nov 2022
MEASUREMENT DATE: 22 Nov 2022
ISSUE DATE: 23 Nov 2022

Calibration procedure:

The pressure calibration was done by In-house
calibration method as WI CL 001
according to comparison method with Digital
pressure calibrator Interfac DKO R 6-1.

Traceability:

The measurement results are traceable to the
international system of units (SI) through
NIMT which complies with the
requirements of ISO/IEC 17025:2017,
ANSI/NCSL Z540-1 via Certificate number:
201479.

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

CONDITION OF THIS RESULT OF CALIBRATION:

- Reference standard instrument:
Instrument: Model: Serial No.: Certificate No.: Due Date:
Absolute Pressure transducer: CPG7500: 41001811: 201479: 13 Sep 2022
- Calibration effort for calibration sequence A
- The UUC* was installed in vertical orientation above reference standard instrument and center of UUC* was used as the reference level.
- Calibration conditions:
a. Condition: ☒ Normal ☐ Abnormal
Pressure transmitting medium: Air
 p_{ref} (20°C, 1 bar): 3.19 kg/m³
 p_{max} : (55±15) %
 t_{amb} : (23±3) °C
 p_{max} : (1010±10) mbar
- The certificate is valid only to the item calibrated on date and place of calibration.

Calibrated by:
Mr. Sorawat Thachalad
Miss Jitraporn Lertsamphol



Approved signatory:
Mr. Panyo 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

CERTIFICATE OF CALIBRATION

Certificate No.: CL-017-65

Page 2 of 2 Pages

MEASUREMENT RESULTS: ☒ Without adjustment ☐ With adjustment
CALIBRATION IN THE RANGE OF: 950 - 1050 mbar

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

STD (mbar)	UUC* (mbar)	Error (mbar)	Uncertainty (k=2) (mbar)
950.00	950.6	0.6	0.83
970.00	970.4	0.4	0.55
990.00	990.1	0.1	0.45
1010.00	1010.0	0.0	0.38
1030.00	1029.8	-0.2	0.46
1050.00	1049.6	-0.4	0.59

Note: UUC* Unit Under Calibration

To convert, the result in report unit to Pa should be multiply by 100

End of certificate



MEASUREMENT RESULTS¹

The cup anemometer, Unit Under Calibration (UUC) was exercised at 10 m/s for 5 minutes prior to calibration being performed. The standard air velocity 0.5 m/s to 5 m/s was calculated by a standard air velocity transducer model: B453-32 and pitot tube with precision differential pressure meter model: DPM2500 in an open test section of Eiffel-type wind tunnel with 900 cm² cross test section area. The W-L-007 based on IEC 61400-12-3, Wind energy generation systems - Part 12-3, Power performance measurements of electricity producing wind turbines, March 2017 was used as a calibration guideline.

V_{ref} (m/s)	Temp. wind tunnel (°C)	Temp. room (°C)	V_{UUC} (m/s)	Error (m/s)	U (k=2) (m/s)
1.023	23.80	23.90	0.8	-0.2	0.31
2.078	24.00	23.90	1.8	-0.2	0.31
3.023	23.78	23.90	2.8	-0.2	0.31
4.148	23.92	23.90	3.9	-0.2	0.31
5.00	23.60	23.90	4.8	-0.2	0.31
5.99	23.68	23.90	5.8	-0.2	0.31
7.03	23.50	23.90	6.8	-0.2	0.31
8.16	23.60	23.90	7.9	-0.3	0.31
9.08	23.50	23.90	8.9	-0.2	0.31
10.06	23.78	23.90	9.8	-0.3	0.31
11.18	23.50	23.90	10.9	-0.2	0.31
12.11	23.78	23.90	12.0	-0.2	0.31
13.16	23.50	23.90	12.9	-0.3	0.31
14.21	23.68	23.90	14.0	-0.2	0.31
15.18	23.50	23.90	15.0	-0.2	0.31
16.26	23.58	23.90	16.0	-0.3	0.31

Remark:

¹ Calibration results only cover for the tested circumstances and environmental conditions during which calibration took place

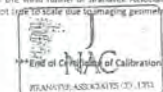
² Velocity of standard

³ Velocity of Unit Under Calibration

PHOTO OF CALIBRATION SET-UP



Calibration set-up of the cup anemometer calibration in the wind tunnel of Jirantee Associates Co., Ltd. The cup anemometer shown may differ from the calibrated one. Remark: The proportion of the set-up is not 1:1 scale due to imaging geometry.



MEASUREMENT ITEM MANUFACTURER MODEL/TYPE

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

SERIAL NUMBER

Sensor: WSO-AS816
Data logger: AS816

ID NUMBER

RYG_F50245

CONDITION AS RECEIVED

Used item

CUSTOMER

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

RECEIVED DATE

11 Jul 2023

MEASUREMENT DATE

21 Jul 2023

ISSUE DATE

21 Jul 2023

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follow:

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

PLACE OF CALIBRATION

Eiffel-type wind tunnel of Jirantee Associates Co., Ltd

CALIBRATION CONDITIONS

Wind tunnel cross-section area¹: 900 cm²
Win direction frontal area²: 100 cm²
Diameter of mounting pipe³: - mm
Blockage ratio of test object⁴: 0.111 [-]

Preconditioning

24 hours at ambient conditions

Measurement Condition

The average values during measurement are (23.9) °C, (45.7) %RH and (1008.3) hPa.

TABULATION OF RESULTS:

The table on next page give the measured values.

Calibrated by:

☒ Mr. Sorawit Thachalad
☐ Miss Jitraporn Lertsamphol



Approved signatory

Mr. Pannave Booncharoen
Calibration Department Manager

Remark:

¹ Nuclei cross-section area of the wind tunnel

² Projected cross-section area of the tested object include mounting pipe

³ Diameter of mounting pipe

⁴ Ratio 1 to 1

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

MEASUREMENT RESULTS¹

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

Air speed m/s	D ¹ ₉₀ Degree (°)	D ² ₉₀ Degree (°)	Error Degree (°)	U (k=2) Degree (°)
5.00	45.000	42	-3	1.0
	90.000	87	-3	1.0
	135.000	133	-2	1.0
	180.000	181	1	1.0
	225.000	229	4	1.0
	270.000	273	3	1.0
	315.000	317	2	1.0
	360.000	359	-1	1.0

Remark:

¹ Calibration results only cover for the tested circumstances and environmental conditions during which calibration took place

² Direction of standard

³ Direction of Unit Under Calibration



MEASUREMENT ITEM MANUFACTURER MODEL/TYPE

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

SERIAL NUMBER

Sensor: WSO-AS816
Data logger: AS816

ID NUMBER

RYG_F50245

CONDITION AS RECEIVED

Used item

CUSTOMER

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

RECEIVED DATE

11 Jul 2023

MEASUREMENT DATE

21 Jul 2023

ISSUE DATE

21 Jul 2023

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follow:

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

PLACE OF CALIBRATION

Eiffel-type wind tunnel of Jirantee Associates Co., Ltd

CALIBRATION CONDITION

Wind tunnel cross-section area¹: 900 cm²
Win direction frontal area²: 129 cm²
Diameter of mounting pipe³: - mm
Blockage ratio of test object⁴: 0.143 [-]

Preconditioning

24 hours at ambient conditions

Measurement Condition

The average values during measurement are (23.8) °C, (46.9) %RH and (1012.4) hPa

TABULATION OF RESULTS:

The table on next page give the measured values.

Calibrated by:

☒ Mr. Sorawit Thachalad
☐ Miss Jitraporn Lertsamphol



Approved signatory

Mr. Pannave Booncharoen
Calibration Department Manager

Remark:

¹ Nuclei cross-section area of the wind tunnel

² Projected cross-section area of the tested object include mounting pipe

³ Diameter of mounting pipe

⁴ Ratio 1 to 1

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



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



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



CERTIFICATE OF CALIBRATION

Certificate No.: GDT-038-66
Page 1 of 2

Equipment Name: Data Logger with Temperature sensor
Manufacturer: Novatex
Model: 110-WS-25DL-D
Serial No.: AS816
ID No.: RYG_FS0545

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

Reference Used During Calibration
1. Standard Temperature Probe Model: STS-100 A500.
Serial No.: 667682-08, Due date: 28 Mar 2024
2. Digital Temperature Indicator Model: DTI-1000-A MK
II, Serial No.: 671407-00591 Due date: 22 Jul 2023

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

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 (NIMT) Certificate
number: TT-0038-23. Certificate number: ER-0092-
22

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

Calibrated by

- ☐ Mr. Sorawat Thachalad
☒ Miss Jitraporn Lertsomphol
☐ Miss Ruangrumpai Poommit



Approved Signatory:

Mr. Parinya Booncharoen
Calibration Department Manager

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

CERTIFICATE OF CALIBRATION

Calibration No.: RH-02072023
Page 1 of 1 Pages

Measurement Item: Relative humidity with data logger
Manufacturer: Novatex
Model/Type: 110-WS-25DL-D
Serial Number: A5816
ID No.: RYG_FS0545
Customer: ALS Laboratory group (Thailand) Co., Ltd.
104 Phatthanakan 40, Phatthanakan Rd., Khwaeng Suan Luang, Khet Suan Luang, Bangkok
10250 Thailand

Environmental Condition:

The measurement was carried out in an ambient temperature of (25±3)°C, and relative humidity of (50±15)%.

Measurement Method:

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

Traceability:

This instrument was calibrated using standard equipment whose accuracy is traceability through National Institute of
Standards and Technology to the international system of units (SI) via MCS Calibration, Inc. Certificate number: 20920-
601. Due date: Sep 26, 2024.

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

Measurement Results:

This equipment was connected with indoor air quality probe and Displayed (UR) on display. Model: HMP60. Serial num-
ber: T2320595.

Calibration was performed in the range of 20%RH to 80%RH
The results of calibration are reported in table below.

Determined (%RH)	Standard Reading (%RH)	UUC Reading (%RH)	Error (%RH)	Uncertainty (%RH)
20	20.05	17.5	-2.6	0.52
50	50.23	46.5	-3.7	0.51
80	80.25	75.5	-4.8	0.51

Performed by

- ☒ Mr. Sorawat Thachalad
☒ Miss Jitraporn Lertsomphol
☐ Miss Ruangrumpai Poommit



Approved Signatory:

Mr. Parinya Booncharoen
Calibration Department Manager

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



Jiranatee Associates Co., Ltd.
63/14-15, 67/35-36, Soi Petchkasem 7/71, Wathapra, Bangkok
Bangkok 10600 Thailand
Tel: +66(0)2-8680812
Mobile: +66(0)2-8680860
E-mail: jiranatee@jiranatee.com
Web: www.jiranatee.com

Accredited calibration laboratory
ISO/IEC 17025:2017
MSC-TS-715-17025
CALIBRATION 0367

Air speed measurement laboratory
Calibration services department.

CERTIFICATE OF CALIBRATION

Page 1 of 2 Pages

MEASUREMENT ITEM
MANUFACTURER
MODEL/TYPE

SERIAL NUMBER

ID NUMBER
CONDITION AS-RECEIVED
CUSTOMER

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

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follow:

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

PLACE OF CALIBRATION

Effel-type wind tunnel of Jiranatee Associates Co., Ltd.

CALIBRATION CONDITIONS

Wind tunnel cross-section area¹: 900 cm²
Win direction frontal area²: 100 cm²
Diameter of mounting pipe³: -
Blockage ratio of test object⁴: 0.111 [1]

Preconditioning

24 hours at ambient conditions.

Measurement Condition

The average values during measurement are (24.1) °C, (44.3) %RH and (1005.44) hPa.

TABULATION OF RESULTS:

The table on next page give the measured values.

Calibrated by:

- ☒ Mr. Sorawat Thachalad
☒ Miss Jitraporn Lertsomphol



Approved signatory:

Mr. Parinya Booncharoen
Calibration Department Manager

Remarks:

- ¹ Nozzle cross-section area of the wind tunnel
² Projected cross-section area of the tested object include mounting pipe
³ Diameter of mounting pipe
⁴ Ratio [1]

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IN WRITING FROM THE LABORATORY

Certificate Number

CWD-004-66

CERTIFICATE OF CALIBRATION

Page 1 of 2 Pages

MEASUREMENT ITEM
MANUFACTURER
MODEL/TYPE

Wind Direction Sensor
Novelins
Sensor: WS-02F

SERIAL NUMBER

Data logger: Z00-WS-25L8

ID NUMBER

Sensor: WSD-A5191

CONDITION AS-RECEIVED

Data logger: AS191

CUSTOMER

RYG_F50328

Used item

ALS laboratory group (Thailand) Co., Ltd.

104 Phatthanakan 40, Phatthanakan Rd, Khwaeng Suan Luang,

Khet Suan Luang, Bangkok 10250 Thailand.

RECEIVED DATE

11 Aug 2023

MEASUREMENT DATE

18 Aug 2023

ISSUE DATE

21 Aug 2023

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follow:

Temperature: 23.0 ± 3.0 °C

Relative Humidity: 55.0 ± 15.0 %RH

Atmospheric Pressure: 1010 ± 10 hPa

PLACE OF CALIBRATION

Effel-type wind tunnel of Jiranatee Associates Co., Ltd.

CALIBRATION CONDITION

Wind tunnel cross-section area¹ 900 cm²

Win direction frontal area² 329 cm²

Diameter of mounting pipe³ - mm

Blockage ratio of test object⁴ 0.143 [-]

Preconditioning

24 hours at ambient conditions.

Measurement Condition

The average values during measurement are (23.9)°C, (41.2) %RH and (1009.3) hPa.

TABULATION OF RESULTS:

The table on next page give the measured values

Calibrated by:

Mr. Sorawat Thachalad

Miss Jitraporn Lertsomphol



Approved signatory:

Mr. Panyas Booncharoen
Calibration Department Manager

Remark:

¹ Nozzle cross-section area of the wind tunnel

² Projected cross-section area of the tested object include mounting pipe

³ Diameter of mounting pipe

⁴ Ratio "to"

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Page 2 of 2 Pages

MEASUREMENT RESULTS⁵

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

Air speed	D _{ref} Degree (°)	D _{meas} Degree (°)	Error Degree (°)	U (k=2) Degree (°)
m/s				
5.01	45.000	42	-3	1.0
	90.000	87	-3	1.0
	135.000	133	-2	1.0
	180.000	182	2	1.0
	225.000	229	4	1.0
	270.000	275	5	1.0
	315.000	320	5	1.0
	360.000	359	-1	1.0

Remark:

⁵ Calibration results only count for the tested circumstances and environmental conditions during which calibration took place

⁶ Direction of standard

⁷ Direction of Unit Under Calibration



Certificate Number

CWS-001-66

CERTIFICATE OF CALIBRATION

Page 1 of 2 Pages

MEASUREMENT ITEM
MANUFACTURER
MODEL/TYPE

Cup anemometer
Novelins
Sensor: WS-02F

SERIAL NUMBER

Data logger: Z00-WS-25L8-D

ID NUMBER

Sensor: WSD-A5662

CONDITION AS-RECEIVED

Data logger: AS662

CUSTOMER

RYG_F50544

Used item

ALS laboratory group (Thailand) Co., Ltd.

104 Phatthanakan 40, Phatthanakan Rd, Khwaeng Suan Luang,

Khet Suan Luang, Bangkok 10250 Thailand.

RECEIVED DATE

11 Jul 2023

MEASUREMENT DATE

21 Jul 2023

ISSUE DATE

21 Jul 2023

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follow:

Temperature: 23.0 ± 3.0 °C

Relative Humidity: 55.0 ± 15.0 %RH

Atmospheric Pressure: 1010 ± 10 hPa

PLACE OF CALIBRATION

Effel-type wind tunnel of Jiranatee Associates Co., Ltd.

CALIBRATION CONDITIONS

Wind tunnel cross-section area¹ 900 cm²

Win direction frontal area² 100 cm²

Diameter of mounting pipe³ - mm

Blockage ratio of test object⁴ 0.111 [-]

Preconditioning

24 hours at ambient conditions.

Measurement Condition

The average values during measurement are (24.0) °C, (41.7) %RH and (1009.1) hPa.

TABULATION OF RESULTS:

The table on next page give the measured values

Calibrated by:

Mr. Sorawat Thachalad

Miss Jitraporn Lertsomphol



Approved signatory:

Mr. Panyas Booncharoen
Calibration Department Manager

Remark:

¹ Nozzle cross-section area of the wind tunnel

² Projected cross-section area of the tested object include mounting pipe

³ Diameter of mounting pipe

⁴ Ratio "to"

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Certificate Number

CWS-001-66

Page 2 of 2 Pages

MEASUREMENT RESULTS⁵

The cup anemometer, Unit Under Calibration (UUC) was exercise at 30 m/s for 5 minutes prior to calibration being performed. The standard air velocity 0.5 m/s to 5 m/s was calculated by a standard air velocity transducer and above 5 m/s to 30 m/s was calculated by a pitot tube with precision differential pressure meter which was installed 40 mm and 800 mm respectively away from wind tunnel nozzle. UUC was installed at center of the test section. The calibration was carried out under both rising and falling air velocity in the range of 1 m/s to 16 m/s at calibration interval of 1 m/s. The results of calibration and associated measurement uncertainties are reported in the table below.

V _{ref} (m/s)	Temp. wind tunnel (°C)	Temp. room (°C)	V _{meas} (m/s)	Error (m/s)	U (k=2) (m/s)
0.024	23.84	23.95	0.8	-0.2	0.31
2.079	24.06	23.95	1.8	-0.3	0.31
3.019	24.04	23.95	2.8	-0.2	0.31
4.150	24.12	23.95	3.8	-0.3	0.31
5.00	23.72	23.95	4.8	0.2	0.31
5.99	23.88	23.95	5.8	-0.2	0.31
7.04	23.68	23.95	6.9	0.2	0.31
8.15	23.64	23.95	7.9	-0.2	0.31
9.09	23.30	23.95	9.0	-0.1	0.31
10.05	23.40	23.95	9.9	-0.1	0.31
11.13	23.48	23.95	11.0	-0.2	0.31
12.11	23.40	23.95	12.0	-0.1	0.31
13.16	23.50	23.95	13.0	-0.1	0.31
14.22	23.40	23.95	14.0	-0.2	0.31
15.22	23.50	23.95	15.0	-0.2	0.31
16.27	23.44	23.95	16.1	-0.2	0.31

Remark:

⁵ Calibration results only count for the tested circumstances and environmental conditions during which calibration took place

⁶ Velocity of standard

⁷ Velocity of Unit Under Calibration

PHOTO OF CALIBRATION SET-UP



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



Certificate Number

CWD-001-66

CERTIFICATE OF CALIBRATION

Page 1 of 2 Pages

MEASUREMENT ITEM MANUFACTURER MODEL/TYPE

Wind Direction Sensor
Novallmx
Sensor: WS-02F
Data logger: 110-WS-25DL-D

SERIAL NUMBER

Sensor: WSD-A5662
Data logger: A5662

ID NUMBER CONDITION AS-RECEIVED CUSTOMER

RYG_FS0544
Used item
ALS laboratory group (Thailand) Co., Ltd.
104 Phatthanakan 40, Phatthanakan Rd, Khwaeng Suan Luang,
Khet Suan Luang, Bangkok 10250 Thailand.

RECEIVED DATE

11 Jul 2023

MEASUREMENT DATE

21 Jul 2023

ISSUE DATE

21 Jul 2023

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follow:

Temperature: 23.0 ± 3.0 °C
Relative Humidity: 55.0 ± 15.0 %RH
Atmospheric Pressure: 1010.1 hPa

PLACE OF CALIBRATION

Effel-type wind tunnel of Jiranatee Associates Co., Ltd.

CALIBRATION CONDITION

Wind tunnel cross-section area¹ 500 cm²
Win direction frontal area² 129 cm²
Diameter of mounting pipe³ - mm
Blockage ratio of test object⁴ 0.143 [-]

Calibration procedure:

The wind direction sensor was calibrated against Standard Rotary Encoder model: AX009751 DM04-PJ-S-U0 in an open top section of Effel-type wind tunnel with 800 cm² open test section area. The WI-CL-008 based on IEC 61400-12-1, Wind energy generation systems - Part 12-1: Power performance measurements of electricity producing wind turbines, March 2017 was used as a calibration guideline.

Traceability:

This certificate provides a traceability of the measurement to recognized the national standards, and to realization of the international system of units (SI) through the NIMT (National Metrology Institute of Thailand) via Certificate number: GA-0049-22

Uncertainty of Measurement:

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

Preconditioning

24 hours at ambient conditions.

Measurement Condition

The average values during measurement are (23.8) °C, (43.0) %RH and (1011.6) hPa.

TABULATION OF RESULTS:

The table on next page give the measured values.

Calibrated by:

☒ Mr. Sorawit Thachalad
☐ Miss Jitraporn Lertsomphol



Approved signatory

Mr. Parinya Booncharoen
Calibration Department Manager

Remarks:

¹ Net open cross-section area of the wind tunnel
² Projected cross-section area of the tested object include mounting pipe
³ Diameter of mounting pipe
⁴ Ratio [-]

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CERTIFICATE OF CALIBRATION

Certificate No.: CDT-037-66
Page 1 of 2

Equipment Name: Data Logger with Temperature sensor

Manufacturer: Novallmx

Model: 110-WS-25DL-D

Serial No.: A5662

ID No.: RYG_FS0544

Customer

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

Received date: 11 Jul 2023

Calibration date: 21 Jul 2023

Issue date: 21 Jul 2023

Reference Used During Calibration

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

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-0038-23, Certificate number: ER-0092-22

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

Calibrated by

☐ Mr. Sorawit Thachalad
☒ Miss Jitraporn Lertsomphol
☐ Miss Ruangrumpai Phoommit



Approved Signatory:

Mr. Parinya Booncharoen
Calibration Department Manager

Certificate Number

CWD-001-66

Page 2 of 2 Pages

MEASUREMENT RESULTS⁵

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

Air speed	D _{ref}	D _{meas}	Error	U (k=2)
m/s	Degree (°)	Degree (°)	Degree (°)	Degree (°)
5.00	45.000	41	-4	1.0
	90.000	37	-3	1.0
	135.000	132	-3	1.0
	180.000	180	0	1.0
	225.000	228	3	1.0
	270.000	273	3	1.0
	315.000	318	3	1.0
	360.000	359	-1	1.0

Remark:

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

⁶ Division of standard

⁷ Division of Unit Under Calibration

End of Certificate of Calibration



Certificate No.: CDT-037-66
Page 2 of 2

Result of Calibration: ☒ Without Adjustment ☐ With Adjustment

Calibration Range: 20 - 40 °C

Function:

This equipment was connected with temperature sensor Model: HMP60 S/N: T2320591.

Dimension : Diameter 12 mm. Length 80 mm.

Immersion Depth (mm)	Standard Reading (°C)	UUC Reading (°C)	Error (°C)	Uncertainty (°C)
70	20.060	19.6	-0.5	0.099
70	25.054	24.6	-0.5	0.099
70	30.050	29.7	-0.3	0.14
70	35.043	34.5	-0.5	0.099
70	40.036	39.5	-0.5	0.14

UUC* : Unit Under Calibration

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

★ End of Certificate ★





63/14-15,67/35-36, Soi Petchkasem 7/1, Petchkasem Rd,
Wetthepara, Bangkokyai, Bangkok 10600 Thailand.
Tel: (66) 02-8680812#13 Fax: (66) 02-8680860 www.jiranalee.com

CERTIFICATE OF CALIBRATION

Calibration No. : RH-01072023
Page 1 of 1 Pages

Measurement Item : Relative humidity with data logger
Manufacturer : Novalyox
Model/Type : 110-WS-25ULC
Serial Number : A5652
ID No. : RY0_F80544
Customer : ALS Laboratory Group (Thailand) Co., Ltd.
104 Phatthanahat 40, Phatthanahat Rd., Khwaeng Suan Luang, Khet Suan Luang, Bangkok
10250 Thailand.

Environmental Condition:
The measurement was carried out in an ambient temperature of (25±3)°C, and relative humidity of (50±5)%.

Measurement Method:
Unit Under Calibration (UUC) was calibrated by comparison method with standard certified metro hygrometer model: 1860-3 in the humidity generator chamber to determine the errors.

Traceability:
This instrument was calibrated using standard equipment whose accuracy is traceability through National Institute of Standards and Technology to the International system of units (SI) via MCS Calibration, Inc. Certificate number: 20P26-601. Due date: Sep 26, 2024.

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

Measurement Results:
This equipment was connected with indoor air quality probe and Displayed (MR) on display. Model: HMP50, Serial number: T232059.
Calibration was performed in the range of 20%RH to 80%RH.
The results of calibration are reported in table below.

Determined (%RH)	Standard Reading (%RH)	UUC Reading (%RH)	Error (%RH)	Uncertainty ±(%RH)
20	20.07	14.3	-3.8	0.51
50	50.23	45.0	-5.2	0.51
80	80.23	73.5	-6.7	0.51

Reviewed by:
☒ Mr. Sornwitt Thachalad
☒ Miss Jitraporn Lertsamphol
☒ Miss Ruangsri Phoommit



Approved Signature:
Mr. Pannys Boontachorn
Calibration Department Manager

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



Lot No. 2432596-1

ANALYZER CALIBRATION DATA

Client : Map Ta Phut Olefins Co., Ltd. Location : Utility Boiler Stack 1 Boiler A
Date : 04 Apr 24 Test Operator : Worawich T.

O ₂ ANALYZER		Serial No.	991	
Model	TELEDYNE API T200H			
Span (%)	25			
	Cylinder Value (%)	Initial Analyzers Calibration Response (%)	Final Analyzers Calibration Response (%)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.00	0.00
Low-Level Gas	8.02	8.00	7.99	0.04
Span Gas	16.02	16.01	16.04	0.12

NO _x ANALYZER	TELEDYNE API T200H	Serial No.	991	
Model				
Span (ppm)	100			
	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.01	0.00	0.01
Low-Level Gas	58.18	55.97	58.10	0.13
Span Gas	79.77	79.75	79.58	0.17

SO ₂ ANALYZER	TELEDYNE API T100H	Serial No.	553	
Model				
Span (ppm)	100			
	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.01	0.01
Low-Level Gas	55.55	55.39	55.43	0.04
Span Gas	79.99	79.92	79.99	0.03

CO ANALYZER	TELEDYNE API T300M	Serial No.	924	
Model				
Span (ppm)	100			
	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.05	0.05
Low-Level Gas	54.22	54.19	54.08	0.11
Span Gas	79.90	79.34	79.90	0.14

Calibrated by

(Mr. Worawich Tongpoom)

Environmental Field Scientist (2)

FORM NO. : 06-002 REVISION NO. : 4 ISSUE DATE : 18/01/24
ALS Laboratory Group

Page 1 of 5



Lot No. 2432596-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client : Map Ta Phut Olefins Co., Ltd. Location : Utility Boiler Stack 1 Boiler A
Date : 04 Apr 24 Test Operator : Worawich T.

O ₂ ANALYZER		Span (%) : 25			
Cylinder Conc. (%)		16.02			
O ₂ Analyzer Calibration Response	Initial Values		Final Values	Drift (% of Span)	
	System Calibration Response	System Cal Bias (% of Span)	System Calibration Response		System Cal Bias (% of Span)
Zero Gas	0.00	0.01	0.04	0.04	
Upscale Gas	16.01	16.03	0.08	0.12	0.04

NO _x ANALYZER		Cylinder Conc. (ppm)		79.77	Span (ppm) : 100	
	NO _x Analyzer Calibration Response	Initial Values		Final Values		Drift (% of Span)
		System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	
Zero Gas	0.01	0.00	0.05	0.04	0.03	0.02
Upscale Gas	79.75	79.13	0.62	75.89	0.85	0.24

SO ₂ ANALYZER		Cylinder Conc. (ppm) : 79.09		Span (ppm) : 100		
	SO ₂ Analyzer Calibration Response	Initial Values		Final Values		Drift (% of Span)
		System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	
Zero Gas	0.00	0.01	0.01	0.01	0.01	0.00
Upscale Gas	79.02	79.02	0.00	79.11	0.09	0.00

CO ANALYZER		Cylinder Conc (ppm)		Span (ppm)	
		79.90		100	
CO Analyzer Calibration Responses	Initial Values		Final Values		Drift (% of Span)
	System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	
	Zero Gas	0.00	0.02	0.10	
	Upscale Gas	79.94	79.71	0.23	
			79.52	0.42	

Calibrated by

(Mr. Worawich Tongpoom)

Environmental Field Scientist (2)



EMISSION TEST RESULT

Client : Map Ta Phut Olefins Co., Ltd.	Run # : 1
Date : 04 Apr 24	Location : Utility Boiler Stack 1 Boiler A
Start Time : 11:10	Test Operator : Worawich T.
SO ₂ Analyzer Model : TELEDYNE API T100H	Finish Time : 11:30
NO _x /O ₂ Analyzer Model : TELEDYNE API T200H	Serial No. : 553
CO/CO ₂ Analyzer Model : TELEDYNE API T300M	Serial No. : 991
	Serial No. : 924

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:10	4.46	10.09	63.42	8.33	0.07	
11:11	4.42	10.28	63.57	8.77	0.07	
11:12	4.54	10.26	63.97	8.82	0.07	
11:13	4.55	10.17	63.82	8.84	0.10	
11:14	4.75	10.11	63.55	8.96	0.11	
11:15	4.80	10.01	63.22	8.90	0.10	
11:16	4.80	10.00	62.84	8.94	0.11	
11:17	4.79	10.00	62.59	8.96	0.10	
11:18	4.75	10.02	62.53	8.89	0.12	
11:19	4.68	10.06	62.66	8.79	0.07	
11:20	4.70	10.07	63.16	8.81	0.06	
11:21	4.74	10.07	63.73	8.71	0.09	
11:22	4.82	10.08	63.68	8.82	0.11	
11:23	4.61	10.09	64.11	8.43	0.08	
11:24	4.58	10.13	64.24	8.49	0.11	
11:25	4.58	10.17	64.23	8.51	0.10	
11:26	4.42	10.17	64.13	8.40	0.06	
11:27	4.45	10.17	64.34	8.30	0.09	
11:28	4.46	10.18	65.01	8.19	0.10	
11:29	4.47	10.18	65.35	8.25	0.13	
11:30	4.46	10.19	65.40	8.29	0.09	
Average	4.51	10.12	63.81	8.83	0.09	

(Mr. Worawich Tongpoom)

Environmental Field Scientist (2)

FORM NO. : 06-003 REVISION NO. : 4 ISSUE DATE : 18/01/24

ALS Laboratory Group

FORM NO. : 06-005 REVISION NO. : 3 ISSUE DATE : 18/01/24

ALS Laboratory Group



EMISSION TEST RESULT

Client	Map Ta Phut Olefins Co., Ltd.	Run #	2
Date	04 Apr 24	Location	Utility Boiler Stack 1 Boiler A
Start Time	11:31	Test Operator	Worawich T.
SO ₂ Analyzer Model	TELEDYNE API T100H	Finish Time	11:51
NO _x /O ₂ Analyzer Model	TELEDYNE API T200H	Serial No.	553
CO/CO ₂ Analyzer Model	TELEDYNE API T300M	Serial No.	991
		Serial No.	924

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:31	4.52	10.19	65.44	8.31	0.07	
11:32	4.49	10.17	65.00	8.23	0.11	
11:33	4.50	10.18	64.50	8.29	0.10	
11:34	4.51	10.16	64.41	8.35	0.12	
11:35	4.49	10.10	64.48	8.27	0.16	
11:36	4.48	10.18	64.75	8.28	0.10	
11:37	4.43	10.19	65.04	8.31	0.15	
11:38	4.42	10.20	65.12	8.38	0.17	
11:39	4.45	10.20	65.28	8.31	0.16	
11:40	4.50	10.20	65.37	8.29	0.13	
11:41	4.54	10.17	65.16	8.30	0.14	
11:42	4.49	10.16	64.65	8.47	0.15	
11:43	4.46	10.19	65.31	8.67	0.13	
11:44	4.48	10.19	65.50	8.71	0.15	
11:45	4.46	10.18	65.30	8.64	0.14	
11:46	4.49	10.12	65.19	8.70	0.16	
11:47	4.52	10.18	65.03	8.83	0.17	
11:48	4.50	10.17	64.77	8.81	0.21	
11:49	4.52	10.17	64.50	8.84	0.20	
11:50	4.57	10.15	64.86	8.95	0.19	
11:51	4.51	10.11	65.09	8.98	0.19	
Average	4.49	10.18	65.01	8.53	0.16	

Worawich T.
(Mr. Worawich Tongpoom)

Environmental Field Scientist (2)

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EMISSION TEST RESULT

Client	Map Ta Phut Olefins Co., Ltd.	Run #	3
Date	04 Apr 24	Location	Utility Boiler Stack 1 Boiler A
Start Time	11:52	Test Operator	Worawich T.
SO ₂ Analyzer Model	TELEDYNE API T100H	Finish Time	12:12
NO _x /O ₂ Analyzer Model	TELEDYNE API T200H	Serial No.	553
CO/CO ₂ Analyzer Model	TELEDYNE API T300M	Serial No.	991
		Serial No.	924

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:52	4.51	10.18	64.84	8.81	0.18	
11:53	4.53	10.17	64.79	8.13	0.16	
11:54	4.55	10.13	64.87	8.78	0.19	
11:55	4.61	10.11	64.42	8.05	0.19	
11:56	4.58	10.08	64.00	9.24	0.20	
11:57	4.57	10.11	63.99	9.40	0.17	
11:58	4.55	10.10	64.11	9.42	0.19	
11:59	4.56	10.17	64.17	9.59	0.22	
12:00	4.52	10.14	64.30	9.63	0.21	
12:01	4.57	10.14	64.42	9.08	0.23	
12:02	4.60	10.13	64.54	9.05	0.24	
12:03	4.58	10.13	64.88	9.79	0.22	
12:04	4.50	10.10	65.04	9.95	0.17	
12:05	4.44	10.15	64.91	10.20	0.18	
12:06	4.41	10.20	64.80	10.18	0.24	
12:07	4.50	10.22	65.11	10.24	0.22	
12:08	4.47	10.18	65.40	10.26	0.25	
12:09	4.43	10.19	65.32	10.31	0.26	
12:10	4.51	10.21	65.17	10.25	0.25	
12:11	4.51	10.17	65.27	10.29	0.21	
12:12	4.50	10.15	65.41	10.35	0.25	
Average	4.52	10.18	64.75	9.73	0.21	

Worawich T.
(Mr. Worawich Tongpoom)

Environmental Field Scientist (2)

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ANALYZER CALIBRATION DATA

Client	Map Ta Phut Olefins Co., Ltd.	Location	Utility Boiler Stack 2 Boiler B
Date	03 Apr 24	Test Operator	Worawich T.
O ₂ ANALYZER Model	TELEDYNE API T200H	Serial No.	991
Span (%)	25		

	Cylinder Value (%)	Initial Analyzers Calibration Response (%)	Final Analyzers Calibration Response (%)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.01	0.04
Low-Level Gas	8.02	8.03	8.01	0.08
Span Gas	16.02	16.02	16.04	0.06

NO _x ANALYZER Model	TELEDYNE API T200H	Serial No.	991
Span (ppm)	100		

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.01	0.02	0.01
Low-Level Gas	56.16	56.47	56.56	0.11
Span Gas	78.77	79.80	79.55	0.25

SO ₂ ANALYZER Model	TELEDYNE API T100H	Serial No.	553
Span (ppm)	100		

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.01	0.01
Low-Level Gas	55.55	55.53	55.87	0.04
Span Gas	79.09	79.10	79.29	0.19

CO ANALYZER Model	TELEDYNE API T300M	Serial No.	924
Span (ppm)	100		

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.00	0.00
Low-Level Gas	54.22	55.08	54.87	0.21
Span Gas	79.90	79.88	79.71	0.17

Calibrated by

Worawich T.
(Mr. Worawich Tongpoom)

Environmental Field Scientist (2)

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SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client	Map Ta Phut Olefins Co., Ltd.	Location	Utility Boiler Stack 2 Boiler B
Date	03 Apr 24	Test Operator	Worawich T.

O ₂ ANALYZER Cylinder Conc. (%)	16.02	Span (%)	25
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	O ₂ Analyzer Calibration Response	System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.00	0.01	0.04	0.03	0.12	0.08
Up-scale Gas	16.02	16.05	0.12	16.08	0.24	0.12

NO _x ANALYZER Cylinder Conc. (ppm)	79.77	Span (ppm)	100
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	NO _x Analyzer Calibration Response	System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.01	0.11	0.10	0.00	0.08	0.02
Up-scale Gas	79.80	78.77	1.03	79.04	0.76	0.27

SO ₂ ANALYZER Cylinder Conc. (ppm)	79.09	Span (ppm)	100
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	SO ₂ Analyzer Calibration Response	System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.00	0.00	0.00	0.01	0.01	0.01
Up-scale Gas	79.10	78.84	0.26	78.87	0.23	0.12

CO ANALYZER Cylinder Conc. (ppm)	79.90	Span (ppm)	100
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	CO Analyzer Calibration Response	System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.00	0.00	0.00	0.00	0.00	0.00
Up-scale Gas	79.88	78.88	0.90	78.88	1.00	0.10

Calibrated by

Worawich T.
(Mr. Worawich Tongpoom)

Environmental Field Scientist (2)

FORM NO. F-06-003 REVISION NO. 4 ISSUE DATE 16/01/24

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EMISSION TEST RESULT

Client	Map Ta Phut Olefins Co., Ltd.	Run #	1
Date	03 Apr 24	Location	Utility Boiler Stack 2 Boiler B
Start Time	14:25	Test Operator	Worawich T.
SO ₂ Analyzer Model	TELEDYNE API T100H	Finish Time	14:45
NO _x /O ₂ Analyzer Model	TELEDYNE API T200H	Serial No.	553
CO/CO ₂ Analyzer Model	TELEDYNE API T300M	Serial No.	991
		Serial No.	924

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
14:25	5.00	9.97	65.56	7.57	0.08	
14:26	5.00	9.98	66.09	7.72	0.10	
14:27	4.98	9.93	66.30	7.67	0.15	
14:28	5.05	9.93	66.18	7.69	0.12	
14:29	5.04	9.93	65.62	7.76	0.10	
14:30	5.07	9.93	65.62	7.87	0.09	
14:31	5.08	9.99	65.56	7.94	0.05	
14:32	5.14	9.88	65.55	7.90	0.00	
14:33	5.13	9.87	65.43	7.97	0.08	
14:34	5.14	9.89	65.30	7.91	0.07	
14:35	5.13	9.87	65.34	7.87	0.10	
14:36	5.08	9.88	65.42	7.95	0.09	
14:37	5.10	9.87	65.72	7.94	0.02	
14:38	5.10	9.86	65.99	8.03	0.00	
14:39	5.08	9.87	65.82	8.04	0.10	
14:40	5.10	9.83	65.71	8.00	0.06	
14:41	5.11	9.85	65.86	8.00	0.00	
14:42	5.20	9.84	66.12	8.08	0.07	
14:43	5.25	9.81	66.01	8.11	0.06	
14:44	5.23	9.78	65.70	8.08	0.06	
14:45	5.23	9.78	65.43	8.00	0.06	
Average	5.11	9.88	65.75	7.92	0.08	

Noranich T.

(Mr. Worawich Tongpoom)

Environmental Field Scientist (2)

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EMISSION TEST RESULT

Client	Map Ta Phut Olefins Co., Ltd.	Run #	2
Date	03 Apr 24	Location	Utility Boiler Stack 2 Boiler B
Start Time	14:45	Test Operator	Worawich T.
SO ₂ Analyzer Model	TELEDYNE API T100H	Finish Time	15:05
NO _x /O ₂ Analyzer Model	TELEDYNE API T200H	Serial No.	553
CO/CO ₂ Analyzer Model	TELEDYNE API T300M	Serial No.	991
		Serial No.	924

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
14:45	5.25	9.77	65.19	8.08	0.09	
14:47	5.21	9.77	65.10	8.07	0.10	
14:48	5.21	9.79	65.28	8.16	0.11	
14:49	5.21	9.78	65.30	8.18	0.12	
14:50	5.26	9.80	65.28	8.12	0.14	
14:51	5.22	9.77	65.19	8.04	0.13	
14:52	5.26	9.80	65.25	8.08	0.08	
14:53	5.21	9.77	65.40	8.02	0.12	
14:54	5.18	9.79	65.75	8.06	0.13	
14:55	5.13	9.83	65.88	8.14	0.10	
14:56	5.17	9.84	65.70	8.20	0.07	
14:57	5.16	9.83	65.38	8.11	0.11	
14:58	5.20	9.81	64.95	8.16	0.08	
14:59	5.23	9.80	64.83	8.17	0.11	
15:00	5.28	9.76	64.80	8.30	0.09	
15:01	5.24	9.78	64.95	8.29	0.10	
15:02	5.21	9.78	65.08	8.27	0.06	
15:03	5.21	9.81	65.11	8.31	0.08	
15:04	5.21	9.78	65.06	8.15	0.07	
15:05	5.21	9.77	64.78	8.24	0.08	
15:06	5.25	9.77	64.73	8.22	0.09	
Average	5.21	9.79	65.20	8.18	0.10	

Noranich T.

(Mr. Worawich Tongpoom)

Environmental Field Scientist (2)

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EMISSION TEST RESULT

Client	Map Ta Phut Olefins Co., Ltd.	Run #	3
Date	03 Apr 24	Location	Utility Boiler Stack 2 Boiler B
Start Time	15:07	Test Operator	Worawich T.
SO ₂ Analyzer Model	TELEDYNE API T100H	Finish Time	15:27
NO _x /O ₂ Analyzer Model	TELEDYNE API T200H	Serial No.	553
CO/CO ₂ Analyzer Model	TELEDYNE API T300M	Serial No.	991
		Serial No.	924

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
15:07	5.25	9.78	64.77	8.16	0.04	
15:08	5.24	9.78	64.86	8.17	0.11	
15:09	5.27	9.77	64.96	8.07	0.10	
15:10	5.35	9.74	64.52	8.03	0.10	
15:11	5.41	9.70	63.86	8.04	0.08	
15:12	5.37	9.69	63.85	7.76	0.07	
15:13	5.35	9.71	63.91	7.59	0.08	
15:14	5.30	9.75	64.18	7.77	0.03	
15:15	5.27	9.78	64.25	7.82	0.08	
15:16	5.28	9.78	63.98	8.03	0.00	
15:17	5.32	9.75	63.77	7.98	0.06	
15:18	5.30	9.74	63.93	7.90	0.08	
15:19	5.33	9.75	64.03	7.80	0.08	
15:20	5.28	9.72	63.85	7.99	0.10	
15:21	5.29	9.75	63.34	8.07	0.08	
15:22	5.28	9.74	63.36	8.19	0.05	
15:23	5.24	9.76	63.70	8.27	0.06	
15:24	5.26	9.79	64.12	8.40	0.07	
15:25	5.31	9.76	64.42	8.48	0.09	
15:26	5.28	9.76	64.52	8.55	0.08	
15:27	5.11	9.76	65.86	8.56	0.07	
Average	5.28	9.76	64.17	8.09	0.07	

Noranich T.

(Mr. Worawich Tongpoom)

Environmental Field Scientist (2)

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ANALYZER CALIBRATION DATA

Client	Map Ta Phut Olefins Co., Ltd.	Location	Utility Boiler Stack 3 Boiler C
Date	02 Apr 24	Test Operator	Worawich T.
O ₂ ANALYZER			
Model	TELEDYNE API T200H	Serial No.	991
Span (%)	25		

	Cylinder Value (%)	Initial Analyzers Calibration Response (%)	Final Analyzers Calibration Response (%)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.01	0.04
Low-Level Gas	8.02	7.99	8.02	0.12
Span Gas	16.82	16.03	16.05	0.08

NO _x ANALYZER			
Model	TELEDYNE API T200H	Serial No.	991
Span (ppm)	100		

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.30	0.01	0.03	0.02
Low-Level Gas	56.16	56.89	56.92	0.03
Span Gas	79.77	79.79	79.59	0.10

SO ₂ ANALYZER			
Model	TELEDYNE API T100H	Serial No.	553
Span (ppm)	100		

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.00	0.00
Low-Level Gas	55.55	55.38	55.41	0.03
Span Gas	79.09	79.12	79.31	0.16

CO ANALYZER			
Model	TELEDYNE API T300M	Serial No.	924
Span (ppm)	100		

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.01	0.06	0.05
Low-Level Gas	54.22	54.17	54.20	0.03
Span Gas	79.90	79.92	79.95	0.03

Calibrated by

Noranich T.

(Mr. Worawich Tongpoom)

Environmental Field Scientist (2)

FORM NO. F-06-082 REVISION NO. 4 ISSUE DATE 18/01/24

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Lot No. 2432602-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client: Map Ta Phut Olefins Co., Ltd. Location: Utility Boiler Stack 3 Boiler C
Date: 02 Apr 24 Test Operator: Worawich T.O₂ ANALYZER
Cylinder Conc. (%) 16.62 Span (%) 25

	O ₂ Analyzer Calibration Response	Initial Values	System Calibration Response	System Cal Bias (% of Span)	Final Values	System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.00	0.02	0.03	0.01	0.01	0.04	0.04	0.04
Upscale Gas	16.03	16.07	0.18	0.05	16.05	0.08	0.08	0.08

NO_x ANALYZER
Cylinder Conc. (ppm) 79.77 Span (ppm) 160

	NO _x Analyzer Calibration Response	Initial Values	System Calibration Response	System Cal Bias (% of Span)	Final Values	System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.01	0.11	0.10	0.15	0.14	0.04	0.04	0.04
Upscale Gas	79.79	79.58	0.21	0.27	79.47	0.32	0.32	0.32

SO₂ ANALYZER
Cylinder Conc. (ppm) 78.69 Span (ppm) 160

	SO ₂ Analyzer Calibration Response	Initial Values	System Calibration Response	System Cal Bias (% of Span)	Final Values	System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Upscale Gas	78.12	78.03	0.09	0.09	78.08	0.14	0.05	0.05

CO ANALYZER
Cylinder Conc. (ppm) 79.96 Span (ppm) 160

	CO Analyzer Calibration Response	Initial Values	System Calibration Response	System Cal Bias (% of Span)	Final Values	System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.01	0.06	0.05	0.08	0.07	0.02	0.02	0.02
Upscale Gas	79.92	79.88	0.04	0.04	79.79	0.13	0.09	0.09

Calibrated by

Worawich T.

(Mr. Worawich Tongpoom)

Environmental Field Scientist (2)

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EMISSION TEST RESULT

Client: Map Ta Phut Olefins Co., Ltd.
Date: 02 Apr 24
Start Time: 11:10
SO₂ Analyzer Model: TELEDYNE API T100H
NO_x/O₂ Analyzer Model: TELEDYNE API T200H
CO/CO₂ Analyzer Model: TELEDYNE API T300MRun # 1
Location: Utility Boiler Stack 3 Boiler C
Test Operator: Worawich T.
Finish Time: 11:30
Serial No.: 553
Serial No.: 991
Serial No.: 924

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:10	4.93	10.22	67.46	12.36	0.89	
11:11	4.67	10.22	67.84	13.03	0.11	
11:12	4.62	10.20	68.09	13.40	0.04	
11:13	4.54	10.19	68.12	13.74	0.12	
11:14	4.58	10.16	68.50	13.62	0.12	
11:15	4.83	10.13	67.88	14.21	0.10	
11:16	4.65	10.17	67.62	14.13	0.05	
11:17	4.68	10.18	67.81	14.31	0.09	
11:18	4.57	10.16	67.60	14.47	0.12	
11:19	4.61	10.17	67.81	14.60	0.08	
11:20	4.58	10.19	67.82	14.72	0.00	
11:21	4.50	10.21	67.89	14.82	0.11	
11:22	4.51	10.20	68.09	14.74	0.09	
11:23	4.54	10.21	68.29	14.80	0.11	
11:24	4.67	10.18	68.38	14.76	0.10	
11:25	4.67	10.17	68.29	14.79	0.08	
11:26	4.61	10.16	68.07	14.57	0.05	
11:27	4.83	10.22	68.14	14.53	0.11	
11:28	4.93	10.21	68.36	14.61	0.12	
11:29	4.61	10.19	68.40	14.71	0.11	
11:30	4.62	10.19	68.49	14.54	0.16	
Average	4.63	10.19	68.05	14.27	0.10	

Worawich T.

(Mr. Worawich Tongpoom)

Environmental Field Scientist (2)

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EMISSION TEST RESULT

Client: Map Ta Phut Olefins Co., Ltd.
Date: 02 Apr 24
Start Time: 11:31
SO₂ Analyzer Model: TELEDYNE API T100H
NO_x/O₂ Analyzer Model: TELEDYNE API T200H
CO/CO₂ Analyzer Model: TELEDYNE API T300MRun # 3
Location: Utility Boiler Stack 3 Boiler C
Test Operator: Worawich T.
Finish Time: 11:51
Serial No.: 553
Serial No.: 991
Serial No.: 924

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:31	4.66	10.20	68.71	14.42	0.17	
11:32	4.59	10.18	68.76	14.61	0.17	
11:33	4.61	10.23	68.71	14.73	0.16	
11:34	4.58	10.21	68.70	14.68	0.16	
11:35	4.58	10.19	68.48	14.68	0.15	
11:36	4.62	10.20	68.37	14.65	0.15	
11:37	4.59	10.21	68.41	14.75	0.13	
11:38	4.61	10.22	68.28	14.79	0.16	
11:39	4.56	10.23	68.20	14.78	0.21	
11:40	4.53	10.24	68.18	14.68	0.12	
11:41	4.55	10.27	68.21	14.80	0.17	
11:42	4.64	10.23	68.27	14.91	0.19	
11:43	4.61	10.19	68.20	14.83	0.17	
11:44	4.62	10.19	68.07	14.82	0.19	
11:45	4.67	10.19	67.88	14.76	0.14	
11:46	4.60	10.14	68.02	14.64	0.16	
11:47	4.67	10.14	67.99	14.63	0.21	
11:48	4.63	10.15	67.90	14.62	0.21	
11:49	4.58	10.20	67.94	14.65	0.20	
11:50	4.53	10.20	68.26	14.60	0.18	
11:51	4.61	10.28	68.37	14.65	0.16	
Average	4.60	10.21	68.29	14.71	0.17	

Worawich T.

(Mr. Worawich Tongpoom)

Environmental Field Scientist (2)

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EMISSION TEST RESULT

Client: Map Ta Phut Olefins Co., Ltd.
Date: 02 Apr 24
Start Time: 11:52
SO₂ Analyzer Model: TELEDYNE API T100H
NO_x/O₂ Analyzer Model: TELEDYNE API T200H
CO/CO₂ Analyzer Model: TELEDYNE API T300MRun # 3
Location: Utility Boiler Stack 3 Boiler C
Test Operator: Worawich T.
Finish Time: 12:12
Serial No.: 553
Serial No.: 991
Serial No.: 924

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:52	4.55	10.24	68.36	14.77	0.15	
11:53	4.60	10.23	68.35	14.71	0.16	
11:54	4.65	10.21	68.39	14.75	0.10	
11:55	4.68	10.19	68.41	14.77	0.21	
11:56	4.65	10.19	68.07	14.72	0.23	
11:57	4.60	10.18	68.23	14.76	0.17	
11:58	4.57	10.19	68.48	14.69	0.17	
11:59	4.55	10.21	68.55	14.65	0.21	
12:00	4.50	10.25	68.46	14.64	0.22	
12:01	4.55	10.28	68.24	14.48	0.22	
12:02	4.53	10.24	67.99	14.56	0.21	
12:03	4.54	10.24	67.83	14.61	0.25	
12:04	4.55	10.25	67.92	14.59	0.23	
12:05	4.53	10.26	67.89	14.72	0.25	
12:06	4.55	10.25	67.82	14.62	0.13	
12:07	4.53	10.24	68.05	14.53	0.11	
12:08	4.52	10.26	68.27	14.61	0.04	
12:09	4.55	10.23	68.55	14.73	0.23	
12:10	4.57	10.24	68.74	14.81	0.30	
12:11	4.58	10.23	68.54	14.80	0.29	
12:12	4.63	10.22	68.58	14.71	0.29	
Average	4.57	10.23	68.27	14.68	0.20	

Worawich T.

(Mr. Worawich Tongpoom)

Environmental Field Scientist (2)

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Lot No: 2432603-1

ANALYZER CALIBRATION DATA

Client: Map Ta Phut Olefins Co., Ltd. Location: Naphtha Cracking Heater Stack 8 (H-100H)
Date: 03 Apr 24 Test Operator: Ussaree N.O₂ ANALYZER Model: TELEDYNE API 200EH Serial No: 549
Span (%): 25

	Cylinder Value (%)	Initial Analyzers Calibration Response (%)	Final Analyzers Calibration Response (%)	Difference (Percent of Span)
Zero Gas	0.00	0.01	0.01	0.00
Low-Level Gas	8.00	8.00	8.00	0.00
Span Gas	16.00	16.04	16.03	0.04

NO_x ANALYZER Model: TELEDYNE API 200EH Serial No: 549
Span (ppm): 200

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.03	0.03	0.00
Low-Level Gas	54.04	54.35	54.22	0.07
Span Gas	158.20	158.13	158.00	0.06

SO₂ ANALYZER Model: TELEDYNE API 100EH Serial No: 282
Span (ppm): 200

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.02	0.04	0.00
Low-Level Gas	54.34	54.05	54.12	0.03
Span Gas	161.50	161.30	161.20	0.05

CO ANALYZER Model: TELEDYNE API 300EM Serial No: 300
Span (ppm): 200

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.03	0.03	0.00
Low-Level Gas	54.42	54.12	54.10	0.01
Span Gas	157.50	157.38	157.30	0.04

Calibrated by

(Mr. Ussaree Namburee)

Environmental Field Scientist (4)

FORM NO: F-0606 REVISION NO: 4 ISSUE DATE: 18/01/24
ALS Laboratory Group

Lot No: 2432603-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client: Map Ta Phut Olefins Co., Ltd. Location: Naphtha Cracking Heater Stack 8 (H-100H)
Date: 03 Apr 24 Test Operator: Ussaree N.O₂ ANALYZER Cylinder Conc. (%): 16.06 Span (%): 25

	O ₂ Analyzer Calibration Response	Initial Values		Final Values		Drift (% of Span)
		System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	
Zero Gas	0.01	0.02	0.04	0.02	0.04	0.00
Upscale Gas	16.04	16.00	0.16	15.98	0.24	0.08

NO_x ANALYZER Cylinder Conc. (ppm): 158.20 Span (ppm): 200

	NO _x Analyzer Calibration Response	Initial Values		Final Values		Drift (% of Span)
		System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	
Zero Gas	0.03	0.03	0.00	0.03	0.00	0.00
Upscale Gas	158.13	157.63	0.26	157.40	0.38	0.11

SO₂ ANALYZER Cylinder Conc. (ppm): 161.50 Span (ppm): 200

	SO ₂ Analyzer Calibration Response	Initial Values		Final Values		Drift (% of Span)
		System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	
Zero Gas	0.02	0.03	0.01	0.03	0.01	0.00
Upscale Gas	161.30	160.15	0.58	160.40	0.45	0.13

CO ANALYZER Cylinder Conc. (ppm): 157.50 Span (ppm): 200

	CO Analyzer Calibration Response	Initial Values		Final Values		Drift (% of Span)
		System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	
Zero Gas	0.03	0.04	0.01	0.04	0.01	0.00
Upscale Gas	157.30	156.80	0.26	156.76	0.30	0.04

Calibrated by

(Mr. Ussaree Namburee)

Environmental Field Scientist (4)

FORM NO: F-03483 REVISION NO: 4 ISSUE DATE: 18/01/24
ALS Laboratory Group

EMISSION TEST RESULT

Client: Map Ta Phut Olefins Co., Ltd. Run #: 1
Date: 03 Apr 24 Location: Naphtha Cracking Heater Stack 8 (H-100H)
Start Time: 11:30 Test Operator: Ussaree N.
SO₂ Analyzer Model: TELEDYNE API 100EH Finish Time: 11:50
NO_x/O₂ Analyzer Model: TELEDYNE API 200EH Serial No: 549
CO/CO₂ Analyzer Model: TELEDYNE API 300EM Serial No: 300

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:30	8.10	7.24	26.67	0.10	0.62	
11:31	8.16	7.18	26.48	0.12	0.68	
11:32	8.31	7.18	26.61	0.10	0.74	
11:33	8.35	7.08	26.35	0.11	0.64	
11:34	8.23	7.19	26.17	0.11	0.74	
11:35	8.12	7.24	26.22	0.09	0.66	
11:36	8.09	7.22	26.17	0.11	0.69	
11:37	8.16	7.22	26.16	0.11	0.58	
11:38	8.17	7.16	26.20	0.15	0.60	
11:39	8.30	7.11	26.37	0.11	0.47	
11:40	8.41	7.02	26.49	0.13	0.65	
11:41	8.19	7.15	26.40	0.11	0.67	
11:42	8.02	7.21	26.42	0.13	0.49	
11:43	8.88	7.27	26.59	0.14	0.61	
11:44	8.67	7.43	26.97	0.15	0.63	
11:45	8.24	7.11	26.94	0.14	0.53	
11:46	8.14	7.13	26.69	0.12	0.53	
11:47	8.00	7.31	26.75	0.13	0.52	
11:48	8.09	7.16	26.74	0.11	0.45	
11:49	8.80	7.32	26.72	0.13	0.44	
11:50	8.40	7.32	26.95	0.14	0.46	
Average	8.09	7.21	26.54	0.12	0.59	

(Mr. Ussaree Namburee)

Environmental Field Scientist (4)

FORM NO: F-0606 REVISION NO: 4 ISSUE DATE: 18/01/24
ALS Laboratory Group

EMISSION TEST RESULT

Client: Map Ta Phut Olefins Co., Ltd. Run #: 2
Date: 03 Apr 24 Location: Naphtha Cracking Heater Stack 8 (H-100H)
Start Time: 11:51 Test Operator: Ussaree N.
SO₂ Analyzer Model: TELEDYNE API 100EH Finish Time: 12:11
NO_x/O₂ Analyzer Model: TELEDYNE API 200EH Serial No: 549
CO/CO₂ Analyzer Model: TELEDYNE API 300EM Serial No: 300

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:51	8.51	7.54	27.53	0.13	0.41	
11:52	8.18	7.21	27.44	0.10	0.45	
11:53	8.28	7.15	26.83	0.12	0.45	
11:54	8.04	7.48	26.74	0.13	0.48	
11:55	8.61	7.46	27.08	0.12	0.47	
11:56	8.90	7.30	27.09	0.12	0.45	
11:57	8.66	7.27	26.93	0.12	0.62	
11:58	8.06	7.20	26.76	0.13	0.49	
11:59	8.16	7.13	26.56	0.11	0.47	
12:00	8.58	7.03	26.42	0.14	0.52	
12:01	8.21	7.10	26.42	0.14	0.54	
12:02	8.64	7.49	26.80	0.14	0.55	
12:03	8.40	7.53	27.24	0.15	0.52	
12:04	8.41	7.51	27.77	0.17	0.42	
12:05	8.02	7.44	27.86	0.15	0.55	
12:06	8.73	7.43	27.77	0.13	0.64	
12:07	8.91	7.24	27.41	0.18	0.57	
12:08	8.51	7.28	27.62	0.15	0.55	
12:09	8.06	7.20	26.83	0.12	0.54	
12:10	8.13	7.28	26.83	0.13	0.53	
12:11	8.74	7.27	26.29	0.13	0.50	
Average	8.59	7.31	27.02	0.13	0.51	

(Mr. Ussaree Namburee)

Environmental Field Scientist (4)

FORM NO: F-0606 REVISION NO: 4 ISSUE DATE: 18/01/24
ALS Laboratory Group



EMISSION TEST RESULT

Client	Map Ta Phut Olefins Co., Ltd.	Run #	3
Date	02 Apr 24	Location	Naphtha Cracking Heater Stack 8 (H-100H)
Start Time	12:12	Test Operator	Ussaree N.
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	12:32
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	282
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	548
		Serial No.	300

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
12:12	5.80	7.39	26.32	0.14	0.69	
12:13	5.86	7.27	26.80	0.15	0.58	
12:14	6.20	7.26	26.91	0.12	0.52	
12:15	6.10	7.23	26.47	0.14	0.48	
12:16	6.02	7.34	25.88	0.13	0.49	
12:17	6.06	7.24	25.92	0.14	0.66	
12:18	5.66	7.41	26.31	0.15	0.45	
12:19	5.60	7.56	26.61	0.13	0.48	
12:20	6.14	7.16	27.02	0.12	0.52	
12:21	6.28	7.12	26.68	0.12	0.49	
12:22	6.14	7.18	26.03	0.13	0.45	
12:23	6.10	7.14	26.07	0.13	0.44	
12:24	5.63	7.42	26.44	0.15	0.44	
12:25	5.69	7.43	26.68	0.13	0.53	
12:26	5.97	7.26	27.09	0.14	0.56	
12:27	6.14	7.17	26.69	0.15	0.50	
12:28	5.67	7.51	26.46	0.13	0.58	
12:29	5.72	7.38	26.76	0.13	0.53	
12:30	6.06	7.16	26.88	0.14	0.42	
12:31	6.27	7.15	26.15	0.15	0.48	
12:32	6.33	7.16	25.39	0.14	0.54	
Average	5.98	7.28	26.50	0.14	0.52	

(Mr. Ussaree Namborae)

Environmental Field Scientist (4)



ANALYZER CALIBRATION DATA

Client	Map Ta Phut Olefins Co., Ltd.	Location	Naphtha Cracking Heater Stack 1 H-100A
Date	02 Apr 24	Test Operator	Anuvat M.
O ₂ ANALYZER		Serial No.	922
Model	TELEDYNE API T200H		
Span (%)	25		

	Cylinder Value (%)	Initial Analyzers Calibration Response (%)	Final Analyzers Calibration Response (%)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.00	0.00
Low-Level Gas	8.00	7.90	8.10	0.20
Span Gas	16.00	15.80	15.90	0.40

NO _x ANALYZER		Serial No.	922
Model	TELEDYNE API T200H		
Span (ppm)	100		

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.00	0.00
Low-Level Gas	54.98	55.60	55.30	0.30
Span Gas	80.73	80.20	80.00	0.20

CO ANALYZER		Serial No.	844
Model	TELEDYNE API T300M		
Span (ppm)	100		

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.10	0.08	0.02
Low-Level Gas	54.84	55.80	54.80	1.00
Span Gas	79.82	80.20	80.00	0.40

Calibrated by

Anuvat M.

(Mr. Anuvat Moungpair)

Environmental Field Scientist (2)



SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client	Map Ta Phut Olefins Co., Ltd.	Location	Naphtha Cracking Heater Stack 1 H-100A
Date	02 Apr 24	Test Operator	Anuvat M.
O ₂ ANALYZER		Span (%)	25
Cylinder Conc. (%)	16.08		

	O ₂ Analyzer Calibration Response	Initial Values	System Calibration Response	System Cal Bias (% of Span)	Final Values	System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Upscale Gas	16.08	16.00	0.80	16.10	1.20	0.40		

NO _x ANALYZER		Span (ppm)	100
Cylinder Conc. (ppm)	80.73		

	NO _x Analyzer Calibration Response	Initial Values	System Calibration Response	System Cal Bias (% of Span)	Final Values	System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Upscale Gas	80.70	79.60	0.40	80.00	0.20	0.20		

CO ANALYZER		Span (ppm)	100
Cylinder Conc. (ppm)	79.82		

	CO Analyzer Calibration Response	Initial Values	System Calibration Response	System Cal Bias (% of Span)	Final Values	System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.10	0.00	0.10	0.00	0.10	0.00	0.00	0.00
Upscale Gas	80.20	79.40	0.80	79.10	1.10	0.30		

Calibrated by

Anuvat M.

(Mr. Anuvat Moungpair)

Environmental Field Scientist (2)



EMISSION TEST RESULT

Client	Map Ta Phut Olefins Co., Ltd.	Run #	1
Date	02 Apr 24	Location	Naphtha Cracking Heater Stack 1 H-100A
Start Time	12:00	Test Operator	Anuvat M.
SO ₂ Analyzer Model		Finish Time	12:30
NO _x /O ₂ Analyzer Model	TELEDYNE API T200H	Serial No.	922
CO/CO ₂ Analyzer Model	TELEDYNE API T300M	Serial No.	844

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
12:00	4.53	8.51	39.37	-	2.50	
12:01	4.44	8.80	39.25	-	2.45	
12:02	4.54	8.60	39.23	-	2.50	
12:03	4.56	8.54	39.43	-	2.50	
12:04	4.58	8.53	39.48	-	2.53	
12:05	4.61	8.51	39.49	-	2.55	
12:06	4.46	8.54	39.53	-	2.48	
12:07	4.67	8.56	39.48	-	2.55	
12:08	4.50	8.57	39.40	-	2.51	
12:09	4.58	8.58	39.52	-	2.50	
12:10	4.44	8.54	39.60	-	2.51	
12:11	4.37	8.50	39.46	-	2.52	
12:12	4.40	8.62	39.35	-	2.56	
12:13	4.55	8.60	39.52	-	2.50	
12:14	4.59	8.55	39.65	-	2.51	
12:15	4.66	8.45	39.63	-	2.56	
12:16	4.55	8.46	39.63	-	2.54	
12:17	4.40	8.54	39.56	-	2.57	
12:18	4.60	8.55	39.49	-	2.52	
12:19	4.63	8.54	39.54	-	2.55	
12:20	4.45	8.54	39.50	-	2.60	
Average	4.52	8.55	39.48	-	2.52	

Anuvat M.

(Mr. Anuvat Moungpair)

Environmental Field Scientist (2)



EMISSION TEST RESULT

Client: Map Ta Phut Olefina Co., Ltd.
Date: 02 Apr 24
Start Time: 12:21
SO₂ Analyzer Model: -
NO_x/O₂ Analyzer Model: TELEDYNE API T200H
CO/CO₂ Analyzer Model: TELEDYNE API T300M

Run # 2
Location: Naphtha Cracking Heater Stack 1 H-100A
Test Operator: Anuvut M.
Finish Time: 12:41
Serial No.: -
Serial No.: 922
Serial No.: 944

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
12:21	4.40	8.57	39.36	-	2.60	
12:22	4.52	8.54	39.26	-	2.68	
12:23	4.46	8.56	39.36	-	2.67	
12:24	4.48	8.56	39.36	-	2.61	
12:25	4.40	8.56	39.28	-	2.60	
12:26	4.42	8.62	39.25	-	2.55	
12:27	4.59	8.58	39.32	-	2.62	
12:28	4.44	8.56	39.38	-	2.60	
12:29	4.50	8.54	39.40	-	2.63	
12:30	4.51	8.55	39.57	-	2.62	
12:31	4.53	8.67	39.81	-	2.62	
12:32	4.45	8.56	39.59	-	2.64	
12:33	4.48	8.58	39.43	-	2.64	
12:34	4.55	8.52	39.53	-	2.65	
12:35	4.59	8.48	39.65	-	2.63	
12:36	4.50	8.48	39.60	-	2.62	
12:37	4.57	8.48	39.76	-	2.60	
12:38	4.58	8.47	39.79	-	2.59	
12:39	4.56	8.48	39.70	-	2.64	
12:40	4.60	8.46	39.67	-	2.64	
12:41	4.51	8.47	39.99	-	2.63	
Average	4.50	8.54	39.54	-	2.62	

(Mr. Anuvut Mungpair)

Environmental Field Scientist (2)

FORM NO. F-08-118 REVISION NO. 0 ISSUE DATE 2011/09
ALS Laboratory Group

EMISSION TEST RESULT

Client: Map Ta Phut Olefina Co., Ltd.
Date: 02 Apr 24
Start Time: 12:42
SO₂ Analyzer Model: -
NO_x/O₂ Analyzer Model: TELEDYNE API T200H
CO/CO₂ Analyzer Model: TELEDYNE API T300M

Run # 3
Location: Naphtha Cracking Heater Stack 1 H-100A
Test Operator: Anuvut M.
Finish Time: 13:02
Serial No.: -
Serial No.: 922
Serial No.: 944

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
12:42	4.51	8.53	39.05	-	2.61	
12:43	4.58	8.52	39.92	-	2.67	
12:44	4.42	8.47	39.84	-	2.63	
12:45	4.51	8.51	39.78	-	2.68	
12:46	4.54	8.50	39.82	-	2.60	
12:47	4.39	8.57	39.64	-	2.56	
12:48	4.50	8.54	39.78	-	2.59	
12:49	4.54	8.50	39.87	-	2.62	
12:50	4.48	8.50	40.05	-	2.59	
12:51	4.47	8.52	40.02	-	2.66	
12:52	4.51	8.52	39.97	-	2.62	
12:53	4.40	8.49	39.89	-	2.61	
12:54	4.48	8.58	39.62	-	2.65	
12:55	4.50	8.48	39.62	-	2.66	
12:56	4.55	8.48	39.94	-	2.64	
12:57	4.45	8.62	39.90	-	2.67	
12:58	4.46	8.58	39.83	-	2.72	
12:59	4.49	8.53	40.03	-	2.57	
13:00	4.51	8.53	40.12	-	2.69	
13:01	4.51	8.50	40.10	-	2.62	
13:02	4.40	8.50	40.03	-	2.64	
Average	4.48	8.52	39.80	-	2.63	

(Mr. Anuvut Mungpair)

Environmental Field Scientist (2)

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ANALYZER CALIBRATION DATA

Lot No. 2432713-1

Client: Map Ta Phut Olefina Co., Ltd.
Date: 04 Apr 24
Location: Naphtha Cracking Heater Stack 2 H-100B
Test Operator: Anuvut M.
O₂ ANALYZER Model: TELEDYNE API T200H
Span (%): 25
Serial No.: 922

	Cylinder Value (%)	Initial Analyzers Calibration Response (%)	Final Analyzers Calibration Response (%)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.00	0.00
Low-Level Gas	8.00	7.90	8.10	0.80
Span Gas	16.00	15.80	16.00	0.40

NO_x ANALYZER Model: TELEDYNE API T200H
Span (ppm): 100
Serial No.: 922

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.00	0.00
Low-Level Gas	54.06	55.60	55.30	0.90
Span Gas	80.73	80.20	80.00	0.20

CO ANALYZER Model: TELEDYNE API T300M
Span (ppm): 100
Serial No.: 944

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.10	0.08	0.02
Low-Level Gas	54.64	55.60	54.80	1.00
Span Gas	79.82	80.20	80.80	0.40

Calibrated by

(Mr. Anuvut Mungpair)
Environmental Field Scientist (2)FORM NO. F-08-061 REVISION NO. 0 ISSUE DATE 2011/09
ALS Laboratory Group

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Lot No. 2432713-1

Client: Map Ta Phut Olefina Co., Ltd.
Date: 04 Apr 24
Location: Naphtha Cracking Heater Stack 2 H-100B
Test Operator: Anuvut M.

O₂ ANALYZER Cylinder Conc. (%): 16.06 Span (%): 25

	O ₂ Analyzer Calibration Response	Initial Values System Calibration Response	System Cal Bias (% of Span)	Final Values System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.00	0.00	0.00	0.00	0.00	0.00
Upscale Gas	15.80	16.00	0.60	16.10	1.20	0.40

NO_x ANALYZER Cylinder Conc. (ppm): 80.73 Span (ppm): 100

	NO _x Analyzer Calibration Response	Initial Values System Calibration Response	System Cal Bias (% of Span)	Final Values System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.00	0.00	0.00	0.00	0.00	0.00
Upscale Gas	80.20	79.60	0.40	80.00	0.20	0.20

CO ANALYZER Cylinder Conc. (ppm): 79.82 Span (ppm): 100

	CO Analyzer Calibration Response	Initial Values System Calibration Response	System Cal Bias (% of Span)	Final Values System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.10	0.00	0.10	0.00	0.10	0.00
Upscale Gas	80.20	79.40	0.80	79.10	1.10	0.30

Calibrated by

(Mr. Anuvut Mungpair)
Environmental Field Scientist (2)FORM NO. F-08-061 REVISION NO. 0 ISSUE DATE 2011/09
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EMISSION TEST RESULT

Client	Map Ta Phut Olefina Co., Ltd.	Run #	1
Date	04 Apr 24	Location	Naphtha Cracking Heater Stack 2 H-100B
Start Time	10:20	Test Operator	Anuvut M.
SO ₂ Analyzer Model	-	Finish Time	-
NO _x /O ₂ Analyzer Model	TELEDYNE API T200H	Serial No.	-
CO/CO ₂ Analyzer Model	TELEDYNE API T300M	Serial No.	922
		Serial No.	844

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
10:20	4.77	8.33	44.52	-	0.79	
10:21	4.65	8.35	44.54	-	0.81	
10:22	4.66	8.37	44.49	-	0.80	
10:23	4.66	8.32	44.48	-	0.88	
10:24	4.74	8.34	44.55	-	0.87	
10:25	4.82	8.28	44.50	-	0.78	
10:26	4.78	8.30	44.61	-	0.84	
10:27	4.64	8.33	44.08	-	0.84	
10:28	4.66	8.37	44.77	-	0.80	
10:29	4.73	8.32	44.01	-	0.92	
10:30	4.76	8.29	45.29	-	0.77	
10:31	4.71	8.31	45.45	-	0.79	
10:32	4.54	8.39	45.28	-	0.82	
10:33	4.67	8.39	44.94	-	0.77	
10:34	4.73	8.37	44.92	-	0.78	
10:35	4.74	8.32	45.01	-	0.78	
10:36	4.72	8.30	45.18	-	0.82	
10:37	4.67	8.39	45.20	-	0.82	
10:38	4.64	8.36	45.05	-	0.75	
10:39	4.69	8.39	44.81	-	0.80	
10:40	4.65	8.40	44.45	-	0.78	
Average	4.70	8.34	44.84	-	0.81	

Anuvut M.

(Mr. Anuvut Moungpair)

Environmental Field Scientist (2)

FORM NO. F-05-118 REVISION NO. 0 ISSUE DATE 2011/01
ALS Laboratory Group



EMISSION TEST RESULT

Client	Map Ta Phut Olefina Co., Ltd.	Run #	2
Date	04 Apr 24	Location	Naphtha Cracking Heater Stack 2 H-100B
Start Time	10:41	Test Operator	Anuvut M.
SO ₂ Analyzer Model	-	Finish Time	11:01
NO _x /O ₂ Analyzer Model	TELEDYNE API T200H	Serial No.	-
CO/CO ₂ Analyzer Model	TELEDYNE API T300M	Serial No.	922
		Serial No.	844

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
10:41	4.71	8.41	44.35	-	0.80	
10:42	4.71	8.40	44.53	-	0.78	
10:43	4.75	8.40	44.55	-	0.82	
10:44	4.71	8.40	44.81	-	0.77	
10:45	4.75	8.39	44.92	-	0.82	
10:46	4.74	8.39	44.99	-	0.81	
10:47	4.73	8.38	44.83	-	0.83	
10:48	4.68	8.40	44.54	-	0.78	
10:49	4.68	8.40	44.54	-	0.78	
10:50	4.70	8.43	44.69	-	0.79	
10:51	4.70	8.38	44.87	-	0.82	
10:52	4.64	8.43	44.83	-	0.82	
10:53	4.64	8.43	44.59	-	0.84	
10:54	4.67	8.45	44.45	-	0.95	
10:55	4.76	8.42	44.51	-	0.84	
10:56	4.66	8.41	44.43	-	0.83	
10:57	4.67	8.46	44.47	-	0.84	
10:58	4.61	8.50	44.47	-	0.83	
10:59	4.69	8.49	44.55	-	0.81	
11:00	4.76	8.44	44.75	-	0.86	
11:01	4.72	8.39	44.87	-	0.79	
Average	4.70	8.42	44.66	-	0.82	

Anuvut M.

(Mr. Anuvut Moungpair)

Environmental Field Scientist (2)

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EMISSION TEST RESULT

Client	Map Ta Phut Olefina Co., Ltd.	Run #	3
Date	04 Apr 24	Location	Naphtha Cracking Heater Stack 2 H-100B
Start Time	11:02	Test Operator	Anuvut M.
SO ₂ Analyzer Model	-	Finish Time	11:22
NO _x /O ₂ Analyzer Model	TELEDYNE API T200H	Serial No.	-
CO/CO ₂ Analyzer Model	TELEDYNE API T300M	Serial No.	922
		Serial No.	844

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:02	4.68	8.45	44.85	-	0.79	
11:03	4.73	8.45	44.86	-	0.78	
11:04	4.70	8.44	44.95	-	0.82	
11:05	4.67	8.45	44.61	-	0.82	
11:06	4.71	8.46	44.44	-	0.83	
11:07	4.70	8.45	44.47	-	0.81	
11:08	4.69	8.45	44.50	-	0.77	
11:09	4.71	8.47	44.84	-	0.73	
11:10	4.72	8.44	44.81	-	0.77	
11:11	4.66	8.58	44.94	-	0.78	
11:12	4.70	8.45	44.79	-	0.85	
11:13	4.62	8.48	44.78	-	0.84	
11:14	4.70	8.45	44.89	-	0.83	
11:15	4.74	8.41	45.04	-	0.87	
11:16	4.67	8.41	45.06	-	0.88	
11:17	4.67	8.41	45.05	-	0.81	
11:18	4.68	8.41	45.11	-	0.74	
11:19	4.74	8.42	45.00	-	0.73	
11:20	4.75	8.37	45.09	-	0.75	
11:21	4.71	8.36	45.20	-	0.79	
11:22	4.69	8.35	45.30	-	0.81	
Average	4.70	8.44	44.86	-	0.80	

Anuvut M.

(Mr. Anuvut Moungpair)

Environmental Field Scientist (2)

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ANALYZER CALIBRATION DATA

Client	Map Ta Phut Olefina Co., Ltd.	Location	Naphtha Cracking Heater Stack 3 H-100C
Date	03 Apr 24	Test Operator	Anuvut M.
O ₂ ANALYZER Model	TELEDYNE API T200H	Serial No.	923
Span (%)	25		

	Cylinder Value (%)	Initial Analyzers Calibration Response (%)	Final Analyzers Calibration Response (%)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.00	0.00
Low-Level Gas	8.00	7.90	8.10	0.80
Span Gas	10.00	15.80	15.00	0.40

NO _x ANALYZER Model	TELEDYNE API T200H	Serial No.	923
Span (ppm)	100		

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.00	0.00
Low-Level Gas	54.00	55.10	56.30	0.20
Span Gas	80.73	80.20	79.20	1.00

CO ANALYZER Model	TELEDYNE API T300M	Serial No.	845
Span (ppm)	100		

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.10	0.05	0.02
Low-Level Gas	54.84	55.80	54.80	1.00
Span Gas	79.82	80.20	80.60	0.40

Calibrated by

Anuvut M.

(Mr. Anuvut Moungpair)

Environmental Field Scientist (2)

FORM NO. F-05-053 REVISION NO. 3 ISSUE DATE 2011/01
ALS Laboratory Group

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Lot No. 2432714-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client: Map Ta Phut Olefina Co., Ltd. Location: Naphtha Cracking Heater Stack 3 H-100C
Date: 03 Apr 24 Test Operator: Anuvat M.

	O ₂ Analyzer Calibration Response	Initial Values		Final Values		Drift (% of Span)
		System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	
Zero Gas	0.00	0.00	0.00	0.00	0.00	0.00
Upscale Gas	15.80	15.00	0.80	15.10	1.20	0.40

NO_x ANALYZER
Cylinder Conc. (ppm) 80.73 Span (ppm) : 100

	NO _x Analyzer Calibration Response	Initial Values		Final Values		Drift (% of Span)
		System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	
Zero Gas	0.00	0.00	0.00	0.00	0.00	0.00
Upscale Gas	80.73	80.90	0.20	79.40	0.60	0.30

CO ANALYZER
Cylinder Conc. (ppm) 79.62 Span (ppm) : 100

	CO Analyzer Calibration Response	Initial Values		Final Values		Drift (% of Span)
		System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	
Zero Gas	0.10	0.00	0.10	0.00	0.10	0.00
Upscale Gas	80.20	79.40	0.80	79.10	1.10	0.30

Calibrated by

(Mr. Anuvat Mungpair)

Environmental Field Scientist (2)

FORM NO. E-2503, REVISION NO. 3, ISSUE DATE 2011/03

ALS Laboratory Group



EMISSION TEST RESULT

Client: Map Ta Phut Olefina Co., Ltd.
Date: 03 Apr 24
Start Time: 12:00
SO₂ Analyzer Model: -
NO_x/O₂ Analyzer Model: TELEDYNE API T200H
CO/CO₂ Analyzer Model: TELEDYNE API T300MRun # 1
Location: Naphtha Cracking Heater Stack 3 H-100C
Test Operator: Anuvat M.
Finish Time: 12:26
Serial No.: 923
Serial No.: 845

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
12:00	6.59	7.21	36.44	-	0.31	
12:01	6.67	7.20	36.50	-	0.34	
12:02	6.65	7.20	36.53	-	0.30	
12:03	6.66	7.20	36.51	-	0.26	
12:04	6.69	7.19	36.50	-	0.26	
12:05	6.69	7.19	36.52	-	0.24	
12:06	6.67	7.18	36.55	-	0.23	
12:07	6.58	7.15	36.59	-	0.23	
12:08	6.74	7.19	36.64	-	0.26	
12:09	6.69	7.20	36.64	-	0.24	
12:10	6.70	7.21	36.62	-	0.24	
12:11	6.72	7.19	36.62	-	0.23	
12:12	6.73	7.19	36.37	-	0.27	
12:13	6.79	7.19	36.31	-	0.26	
12:14	6.65	7.20	36.16	-	0.25	
12:15	6.70	7.23	36.07	-	0.27	
12:16	6.72	7.22	36.07	-	0.27	
12:17	6.75	7.20	36.02	-	0.27	
12:18	6.78	7.18	36.09	-	0.21	
12:19	6.81	7.17	36.02	-	0.21	
12:20	6.82	7.21	35.98	-	0.19	
Average	6.76	7.19	36.38	-	0.26	

(Mr. Anuvat Mungpair)

Environmental Field Scientist (2)

FORM NO. E-2503, REVISION NO. 3, ISSUE DATE 2011/03

ALS Laboratory Group



EMISSION TEST RESULT

Client: Map Ta Phut Olefina Co., Ltd.
Date: 03 Apr 24
Start Time: 12:21
SO₂ Analyzer Model: -
NO_x/O₂ Analyzer Model: TELEDYNE API T200H
CO/CO₂ Analyzer Model: TELEDYNE API T300M
Run # 2
Location: Naphtha Cracking Heater Stack 3 H-100C
Test Operator: Anuvat M.
Finish Time: 12:41
Serial No.: 923
Serial No.: 845

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
12:21	6.64	7.26	36.82	-	0.21	
12:22	6.66	7.21	35.83	-	0.29	
12:23	6.72	7.19	35.62	-	0.29	
12:24	6.78	7.17	35.66	-	0.29	
12:25	6.73	7.16	35.97	-	0.25	
12:26	6.66	7.22	35.69	-	0.26	
12:27	6.64	7.25	36.01	-	0.26	
12:28	6.70	7.22	35.14	-	0.23	
12:29	6.68	7.21	36.19	-	0.25	
12:30	6.60	7.20	36.16	-	0.26	
12:31	6.64	7.23	36.17	-	0.25	
12:32	6.65	7.24	36.24	-	0.27	
12:33	6.63	7.23	36.29	-	0.26	
12:34	6.58	7.24	36.25	-	0.27	
12:35	6.59	7.24	36.35	-	0.27	
12:36	6.62	7.25	36.39	-	0.33	
12:37	6.60	7.25	36.37	-	0.35	
12:38	6.57	7.27	36.35	-	0.31	
12:39	6.61	7.27	36.31	-	0.29	
12:40	6.58	7.27	36.26	-	0.30	
12:41	6.55	7.26	36.30	-	0.30	
Average	6.64	7.23	36.18	-	0.28	

(Mr. Anuvat Mungpair)

Environmental Field Scientist (2)

FORM NO. E-2503, REVISION NO. 3, ISSUE DATE 2011/03

ALS Laboratory Group



EMISSION TEST RESULT

Client: Map Ta Phut Olefina Co., Ltd.
Date: 03 Apr 24
Start Time: 12:42
SO₂ Analyzer Model: -
NO_x/O₂ Analyzer Model: TELEDYNE API T200H
CO/CO₂ Analyzer Model: TELEDYNE API T300MRun # 3
Location: Naphtha Cracking Heater Stack 3 H-100C
Test Operator: Anuvat M.
Finish Time: 13:02
Serial No.: 923
Serial No.: 845

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
12:42	6.62	7.27	36.33	-	0.27	
12:43	6.65	7.27	36.35	-	0.28	
12:44	6.58	7.23	36.43	-	0.32	
12:45	6.57	7.24	36.46	-	0.31	
12:46	6.56	7.28	36.47	-	0.29	
12:47	6.58	7.29	36.43	-	0.27	
12:48	6.61	7.27	36.46	-	0.29	
12:49	6.63	7.26	36.57	-	0.30	
12:50	6.62	7.24	36.55	-	0.28	
12:51	6.57	7.24	36.67	-	0.29	
12:52	6.65	7.25	36.66	-	0.26	
12:53	6.64	7.25	36.72	-	0.28	
12:54	6.66	7.22	36.71	-	0.27	
12:55	6.64	7.23	36.70	-	0.32	
12:56	6.60	7.24	36.71	-	0.28	
12:57	6.60	7.21	36.72	-	0.24	
12:58	6.62	7.22	36.77	-	0.28	
12:59	6.58	7.22	36.83	-	0.29	
13:00	6.63	7.22	36.84	-	0.28	
13:01	6.65	7.23	36.79	-	0.31	
13:02	6.61	7.22	36.64	-	0.30	
Average	6.61	7.24	36.62	-	0.29	

(Mr. Anuvat Mungpair)

Environmental Field Scientist (2)

FORM NO. E-2503, REVISION NO. 3, ISSUE DATE 2011/03

ALS Laboratory Group



Lot No 2432715-1

ANALYZER CALIBRATION DATA

Client : Map Ta Phut Olefins Co., Ltd. Location : Naphtha Cracking Heater Stack 4 H-100D
Date : 02 Apr 24 Test Operator : Anuvatt M.O₂ ANALYZER
Model : TELEDYNE API T200H Serial No. : 922
Span (%) : 25

	Cylinder Value (%)	Initial Analyzers Calibration Response (%)	Final Analyzers Calibration Response (%)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.00	0.00
Low-Level Gas	8.00	7.90	8.10	0.80
Span Gas	10.00	10.00	10.00	0.40

NO_x ANALYZER
Model : TELEDYNE API T200H Serial No. : 922
Span (ppm) : 100

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.00	0.00
Low-Level Gas	54.96	55.10	55.30	0.20
Span Gas	80.73	80.20	79.20	1.00

CO ANALYZER
Model : TELEDYNE API T300M Serial No. : 844
Span (ppm) : 100

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.10	0.05	0.02
Low-Level Gas	54.84	55.80	54.80	1.00
Span Gas	79.82	80.20	80.80	0.40

Calibrated by

(Mr. Anuvatt Moungpair)

Environmental Field Scientist (2)

FORM NO. F-06-002 REVISION NO. 3 ISSUE DATE 2011/03
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Lot No 2432715-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client : Map Ta Phut Olefins Co., Ltd. Location : Naphtha Cracking Heater Stack 4 H-100D
Date : 02 Apr 24 Test Operator : Anuvatt M.O₂ ANALYZER
Cylinder Conc. (%) : 10.00 Span (%) : 25

	O ₂ Analyzer Calibration Response	Initial Values		Final Values		Drift (% of Span)
		System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	
Zero Gas	0.00	0.00	0.00	0.00	0.00	0.00
Upscale Gas	10.00	10.00	0.80	10.10	1.20	0.40

NO_x ANALYZER
Cylinder Conc. (ppm) : 80.73 Span (ppm) : 100

	NO _x Analyzer Calibration Response	Initial Values		Final Values		Drift (% of Span)
		System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	
Zero Gas	0.00	0.00	0.00	0.00	0.00	0.00
Upscale Gas	80.20	80.00	0.20	79.40	0.80	0.80

CO ANALYZER
Cylinder Conc. (ppm) : 79.82 Span (ppm) : 100

	CO Analyzer Calibration Response	Initial Values		Final Values		Drift (% of Span)
		System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	
Zero Gas	0.10	0.00	0.10	0.00	0.10	0.00
Upscale Gas	80.20	79.40	0.80	79.10	1.10	0.30

Calibrated by

(Mr. Anuvatt Moungpair)

Environmental Field Scientist (2)

FORM NO. F-06-003 REVISION NO. 3 ISSUE DATE 2011/03
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EMISSION TEST RESULT

Client : Map Ta Phut Olefins Co., Ltd. Run # : 1
Date : 02 Apr 24 Location : Naphtha Cracking Heater Stack 4 H-100D
Start Time : 13:20 Test Operator : Anuvatt M.
Finish Time : 13:40
SO_x Analyzer Model : TELEDYNE API T200H Serial No. : 922
CO/CO₂ Analyzer Model : TELEDYNE API T300M Serial No. : 844

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO _x (ppm)	CO (ppm)	Remark
13:20	3.85	8.56	37.27	-	0.20	
13:21	3.82	8.56	37.32	-	0.20	
13:22	3.86	8.55	37.33	-	0.19	
13:23	3.53	8.51	37.48	-	0.15	
13:24	3.87	8.46	37.64	-	0.15	
13:25	3.66	8.55	37.09	-	0.16	
13:26	3.77	8.50	37.66	-	0.21	
13:27	3.85	8.57	37.56	-	0.21	
13:28	3.91	8.54	37.48	-	0.19	
13:29	3.86	8.50	37.38	-	0.16	
13:30	3.81	8.50	37.37	-	0.20	
13:31	3.54	8.57	37.42	-	0.21	
13:32	3.95	8.53	37.57	-	0.18	
13:33	3.67	8.50	37.64	-	0.15	
13:34	3.85	8.52	37.58	-	0.16	
13:35	3.82	8.51	37.43	-	0.19	
13:36	3.50	8.55	37.47	-	0.20	
13:37	3.87	8.58	37.68	-	0.19	
13:38	3.89	8.50	37.75	-	0.16	
13:39	3.88	8.48	37.77	-	0.11	
13:40	3.82	8.52	37.87	-	0.17	
Average	3.86	8.53	37.53	-	0.18	

(Mr. Anuvatt Moungpair)

Environmental Field Scientist (2)

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EMISSION TEST RESULT

Client : Map Ta Phut Olefins Co., Ltd. Run # : 2
Date : 02 Apr 24 Location : Naphtha Cracking Heater Stack 4 H-100D
Start Time : 13:41 Test Operator : Anuvatt M.
Finish Time : 14:01
SO_x Analyzer Model : TELEDYNE API T200H Serial No. : 922
CO/CO₂ Analyzer Model : TELEDYNE API T300M Serial No. : 844

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO _x (ppm)	CO (ppm)	Remark
13:41	3.78	8.58	37.52	-	0.20	
13:42	3.60	8.50	37.48	-	0.20	
13:43	3.94	8.54	37.50	-	0.18	
13:44	3.84	8.52	37.84	-	0.17	
13:45	3.79	8.57	37.89	-	0.21	
13:46	3.82	8.55	37.85	-	0.19	
13:47	3.83	8.58	37.84	-	0.20	
13:48	3.88	8.58	37.86	-	0.22	
13:49	3.85	8.57	38.00	-	0.21	
13:50	3.92	8.54	37.61	-	0.18	
13:51	3.92	8.52	37.83	-	0.17	
13:52	3.91	8.50	37.84	-	0.15	
13:53	3.82	8.52	37.79	-	0.11	
13:54	3.85	8.58	37.67	-	0.20	
13:55	3.81	8.59	37.57	-	0.23	
13:56	3.80	8.57	37.51	-	0.21	
13:57	3.80	8.53	37.50	-	0.18	
13:58	3.85	8.56	37.54	-	0.20	
13:59	3.89	8.58	37.62	-	0.20	
14:00	3.81	8.58	37.57	-	0.20	
14:01	3.90	8.54	37.40	-	0.18	
Average	3.85	8.55	37.78	-	0.18	

(Mr. Anuvatt Moungpair)

Environmental Field Scientist (2)

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EMISSION TEST RESULT

Client: Map Ta Phut Olefins Co., Ltd.
 Date: 02 Apr 24
 Start Time: 14:02
 SO₂ Analyzer Model: -
 NO_x/O₂ Analyzer Model: TELEDYNE API T200H
 CO/CO₂ Analyzer Model: TELEDYNE API T300M

Run # 3
 Location: Naphtha Cracking Heater Stack 4 H-100D
 Test Operator: Anuvat M.
 Finish Time: 14:22
 Serial No.: -
 Serial No.: 922
 Serial No.: 844

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
14:02	3.90	8.51	37.27	-	0.15	
14:03	3.80	8.53	37.27	-	0.17	
14:04	3.72	8.61	37.26	-	0.25	
14:05	3.79	8.62	37.37	-	0.25	
14:06	3.87	8.52	37.39	-	0.17	
14:07	3.81	8.57	37.68	-	0.21	
14:08	3.85	8.52	37.79	-	0.18	
14:09	3.91	8.52	37.83	-	0.18	
14:10	3.89	8.58	37.82	-	0.20	
14:11	3.82	8.58	37.87	-	0.21	
14:12	3.87	8.57	37.95	-	0.21	
14:13	3.80	8.54	37.99	-	0.18	
14:14	3.80	8.57	37.89	-	0.21	
14:15	3.86	8.53	37.78	-	0.17	
14:16	3.81	8.54	37.65	-	0.18	
14:17	3.89	8.53	37.60	-	0.18	
14:18	3.89	8.52	37.71	-	0.16	
14:19	3.81	8.53	38.00	-	0.17	
14:20	3.77	8.57	38.09	-	0.22	
14:21	3.93	8.58	38.10	-	0.22	
14:22	3.94	8.46	38.13	-	0.13	
Average	3.85	8.55	37.73	-	0.19	

Anuvat M.

(Mr. Anuvat Mounpair)

Environmental Field Scientist (2)



Lot No. 2432710-1

ANALYZER CALIBRATION DATA

Client: Map Ta Phut Olefins Co., Ltd.
 Date: 04 Apr 24
 Location: Naphtha Cracking Heater Stack 5 H-100E
 Test Operator: Anuvat M.
 O₂ ANALYZER Model: TELEDYNE API T200H
 Span (%): 25
 Serial No.: 923

	Cylinder Value (%)	Initial Analyzers Calibration Response (%)	Final Analyzers Calibration Response (%)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.00	0.00
Low-Level Gas	8.00	7.90	8.10	0.80
Span Gas	16.00	16.80	15.90	0.40

NO_x ANALYZER Model: TELEDYNE API T200H
 Span (ppm): 100
 Serial No.: 923

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.00	0.00
Low-Level Gas	54.98	55.80	55.30	0.30
Span Gas	80.73	80.20	80.00	0.20

CO ANALYZER Model: TELEDYNE API T300M
 Span (ppm): 100
 Serial No.: 845

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.10	0.08	0.02
Low-Level Gas	54.84	55.80	54.80	1.00
Span Gas	79.83	80.20	80.00	0.40

Calibrated by

Anuvat M.

(Mr. Anuvat Mounpair)

Environmental Field Scientist (2)

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Lot No. 2432710-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client: Map Ta Phut Olefins Co., Ltd.
 Date: 04 Apr 24
 Location: Naphtha Cracking Heater Stack 5 H-100E
 Test Operator: Anuvat M.

O₂ ANALYZER Cylinder Conc. (%): 10.00
 Span (%): 25

	O ₂ Analyzer Calibration Response	Initial Values System Calibration Response	System Cal Bias (% of Span)	Final Values System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.00	0.00	0.00	0.00	0.00	0.00
Upscale Gas	15.80	16.00	0.80	16.10	1.20	0.40

NO_x ANALYZER Cylinder Conc. (ppm): 80.73
 Span (ppm): 100

	NO _x Analyzer Calibration Response	Initial Values System Calibration Response	System Cal Bias (% of Span)	Final Values System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.00	0.00	0.00	0.00	0.00	0.00
Upscale Gas	80.20	79.80	0.40	80.00	0.20	0.20

CO ANALYZER Cylinder Conc. (ppm): 79.82
 Span (ppm): 100

	CO Analyzer Calibration Response	Initial Values System Calibration Response	System Cal Bias (% of Span)	Final Values System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.10	0.10	0.00	0.00	0.10	0.00
Upscale Gas	80.20	79.40	0.80	79.10	1.10	0.30

Calibrated by

Anuvat M.

(Mr. Anuvat Mounpair)

Environmental Field Scientist (2)



EMISSION TEST RESULT

Client: Map Ta Phut Olefins Co., Ltd.
 Date: 04 Apr 24
 Location: Naphtha Cracking Heater Stack 5 H-100E
 Test Operator: Anuvat M.
 Start Time: 11:45
 Finish Time: 12:00
 SO₂ Analyzer Model: -
 NO_x/O₂ Analyzer Model: TELEDYNE API T200H
 CO/CO₂ Analyzer Model: TELEDYNE API T300M
 Serial No.: 923
 Serial No.: 845

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:40	8.10	8.88	35.32	-	0.39	
11:41	8.12	8.99	35.30	-	0.40	
11:42	8.18	8.96	35.24	-	0.38	
11:43	8.19	8.93	35.10	-	0.42	
11:44	8.17	8.94	34.97	-	0.45	
11:45	8.16	8.96	35.01	-	0.49	
11:46	8.20	8.95	34.91	-	0.54	
11:47	8.21	8.93	34.81	-	0.45	
11:48	8.20	8.92	34.75	-	0.48	
11:49	8.25	8.91	34.77	-	0.48	
11:50	8.25	8.91	34.64	-	0.53	
11:51	8.28	8.92	35.01	-	0.42	
11:52	8.20	8.92	34.99	-	0.49	
11:53	8.21	8.91	34.95	-	0.46	
11:54	8.24	8.90	34.86	-	0.35	
11:55	8.22	8.93	34.76	-	0.40	
11:56	8.23	8.94	34.77	-	0.35	
11:57	8.20	8.91	34.81	-	0.34	
11:58	8.19	8.92	34.77	-	0.29	
11:59	8.20	8.91	34.61	-	0.33	
12:00	8.23	8.89	34.51	-	0.37	
Average	8.20	8.93	34.81	-	0.42	

Anuvat M.

(Mr. Anuvat Mounpair)

Environmental Field Scientist (2)

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EMISSION TEST RESULT

Client	Map Ta Phut Olefins Co., Ltd.	Run #	2
Date	04 Apr 24	Location	Naphtha Cracking Heater Stack 5 H-100E
Start Time	12:01	Test Operator	Anuvut M.
SO ₂ Analyzer Model	TELEDYNE API 200EH	Finish Time	12:21
NO _x Analyzer Model	TELEDYNE API T200H	Serial No.	923
CO/CO ₂ Analyzer Model	TELEDYNE API T300M	Serial No.	845

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
12:01	0.22	0.02	34.43	-	0.42	
12:02	0.18	0.03	34.41	-	0.39	
12:03	0.23	0.03	34.28	-	0.34	
12:04	0.17	0.02	34.22	-	0.39	
12:05	0.18	0.03	34.24	-	0.32	
12:06	0.23	0.02	34.29	-	0.37	
12:07	0.17	0.03	34.41	-	0.29	
12:08	0.23	0.03	34.43	-	0.35	
12:09	0.21	0.03	34.54	-	0.35	
12:10	0.17	0.03	34.57	-	0.37	
12:11	0.20	0.02	34.61	-	0.37	
12:12	0.14	0.02	34.74	-	0.40	
12:13	0.14	0.05	34.92	-	0.36	
12:14	0.13	0.05	34.91	-	0.32	
12:15	0.22	0.04	34.76	-	0.31	
12:16	0.19	0.03	34.73	-	0.31	
12:17	0.21	0.01	34.77	-	0.31	
12:18	0.19	0.01	34.69	-	0.31	
12:19	0.18	0.05	34.93	-	0.31	
12:20	0.19	0.05	34.89	-	0.32	
12:21	0.12	0.05	34.76	-	0.29	
Average	0.19	0.03	34.61	-	0.34	

Anuvut M.
(Mr Anuvut Moungpair)

Environmental Field Scientist (2)



EMISSION TEST RESULT

Client	Map Ta Phut Olefins Co., Ltd.	Run #	3
Date	04 Apr 24	Location	Naphtha Cracking Heater Stack 5 H-100E
Start Time	12:22	Test Operator	Anuvut M.
SO ₂ Analyzer Model	TELEDYNE API T200H	Finish Time	12:42
NO _x Analyzer Model	TELEDYNE API T200H	Serial No.	923
CO/CO ₂ Analyzer Model	TELEDYNE API T300M	Serial No.	845

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
12:22	0.10	0.08	34.74	-	0.29	
12:23	0.15	0.07	34.85	-	0.35	
12:24	0.14	0.05	34.94	-	0.34	
12:25	0.18	0.03	34.95	-	0.39	
12:26	0.23	0.03	35.00	-	0.35	
12:27	0.20	0.02	35.08	-	0.36	
12:28	0.21	0.02	35.00	-	0.42	
12:29	0.22	0.09	35.14	-	0.37	
12:30	0.17	0.01	35.12	-	0.37	
12:31	0.11	0.04	35.10	-	0.42	
12:32	0.15	0.06	35.10	-	0.40	
12:33	0.14	0.04	35.10	-	0.43	
12:34	0.16	0.05	35.09	-	0.43	
12:35	0.12	0.04	35.14	-	0.40	
12:36	0.14	0.05	35.18	-	0.38	
12:37	0.14	0.04	35.23	-	0.38	
12:38	0.14	0.02	35.27	-	0.43	
12:39	0.17	0.04	35.36	-	0.39	
12:40	0.14	0.04	35.30	-	0.41	
12:41	0.18	0.05	35.28	-	0.39	
12:42	0.14	0.05	35.22	-	0.36	
Average	0.16	0.04	35.11	-	0.39	

Anuvut M.
(Mr Anuvut Moungpair)

Environmental Field Scientist (2)

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ANALYZER CALIBRATION DATA

Client	Map Ta Phut Olefins Co., Ltd.	Location	Naphtha Cracking Heater Stack 5 H-100F
Date	02 Apr 24	Test Operator	Ussaree N.

O ₂ ANALYZER			
Model	TELEDYNE API 200EH	Serial No.	549
Span (%)	25		

	Cylinder Value (%)	Initial Analyzers Calibration Response (%)	Final Analyzers Calibration Response (%)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.01	0.04
Low-Level Gas	8.00	7.99	8.00	0.01
Span Gas	10.05	10.04	10.02	0.06

NO _x ANALYZER			
Model	TELEDYNE API 200EH	Serial No.	549
Span (ppm)	200		

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.03	0.03	0.00
Low-Level Gas	54.84	54.23	54.17	0.03
Span Gas	158.20	158.38	158.01	0.10

SO ₂ ANALYZER			
Model	TELEDYNE API 100EH	Serial No.	282
Span (ppm)	200		

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.04	0.04	0.00
Low-Level Gas	54.34	54.05	53.97	0.02
Span Gas	161.00	161.38	161.40	0.02

CO ANALYZER			
Model	TELEDYNE API 300EM	Serial No.	306
Span (ppm)	200		

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.03	0.03	0.00
Low-Level Gas	54.42	54.12	54.00	0.05
Span Gas	157.50	157.72	157.30	0.21

Calibrated by

Ussaree N.

(Mr. Ussaree Namburee)
Environmental Field Scientist (4)

FORM NO. E-06-118 REVISION NO. 4 ISSUE DATE 18/10/26

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SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client	Map Ta Phut Olefins Co., Ltd.	Location	Naphtha Cracking Heater Stack 5 H-100F
Date	02 Apr 24	Test Operator	Ussaree N.

O ₂ ANALYZER			
Cylinder Conc. (%)	16.08	Span (%)	25

	O ₂ Analyzer Calibration Response	Initial Values	System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Upscale Gas	16.08	16.00	0.16	15.98	0.24	0.08	0.08

NO _x ANALYZER			
Cylinder Conc. (ppm)	158.20	Span (ppm)	200

	NO _x Analyzer Calibration Response	Initial Values	System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.03	0.03	0.00	0.00	0.00	0.00	0.00
Upscale Gas	158.38	157.77	0.30	157.43	0.47	0.17	0.17

SO ₂ ANALYZER			
Cylinder Conc. (ppm)	161.80	Span (ppm)	200

	SO ₂ Analyzer Calibration Response	Initial Values	System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.04	0.04	0.00	0.00	0.01	0.01	0.01
Upscale Gas	161.38	160.28	0.55	160.43	0.47	0.09	0.09

CO ANALYZER			
Cylinder Conc. (ppm)	157.50	Span (ppm)	200

	CO Analyzer Calibration Response	Initial Values	System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.03	0.04	0.01	0.04	0.01	0.00	0.00
Upscale Gas	157.72	157.50	0.36	156.76	0.47	0.11	0.11

Calibrated by

Ussaree N.

(Mr. Ussaree Namburee)
Environmental Field Scientist (4)

FORM NO. E-06-118 REVISION NO. 4 ISSUE DATE 18/10/26

ALS Laboratory Group



EMISSION TEST RESULT

Client	Map Ta Phut Olefins Co., Ltd.	Run #	1
Date	02 Apr 24	Location	Naphtha Cracking Heater Stack 6 H-100F
Start Time	13:10	Test Operator	Ussaree N.
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	13:30
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	282
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	548
		Serial No.	300

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
13:10	4.40	7.79	39.33	0.27	0.32	
13:11	4.32	7.88	39.12	0.27	0.48	
13:12	4.36	7.79	38.64	0.28	0.30	
13:13	4.41	7.83	39.03	0.30	0.48	
13:14	4.42	7.74	39.00	0.30	0.42	
13:15	4.46	7.72	38.86	0.30	0.39	
13:16	4.45	7.77	38.93	0.30	0.40	
13:17	4.46	7.84	39.02	0.29	0.56	
13:18	4.43	7.48	38.96	0.32	0.44	
13:19	4.44	7.76	38.70	0.31	0.37	
13:20	4.48	7.71	38.63	0.28	0.44	
13:21	4.47	7.79	38.60	0.32	0.41	
13:22	4.48	7.88	38.55	0.30	0.42	
13:23	4.51	7.75	38.71	0.30	0.50	
13:24	4.50	7.68	38.85	0.30	0.50	
13:25	4.43	7.78	39.02	0.30	0.58	
13:26	4.39	7.67	39.05	0.30	0.64	
13:27	4.40	7.78	38.97	0.28	0.55	
13:28	4.45	7.78	38.78	0.29	0.50	
13:29	4.48	7.76	38.71	0.31	0.45	
13:30	4.46	7.82	38.82	0.30	0.58	
Average	4.44	7.77	38.87	0.29	0.48	

(Mr. Ussaree Namburee)

Environmental Field Scientist (4)

FORM NO. F-04-02 REVISION NO. 1 ISSUE DATE 18/01/24

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EMISSION TEST RESULT

Client	Map Ta Phut Olefins Co., Ltd.	Run #	2
Date	02 Apr 24	Location	Naphtha Cracking Heater Stack 6 H-100F
Start Time	13:31	Test Operator	Ussaree N.
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	13:51
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	282
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	548
		Serial No.	300

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
13:31	4.41	7.83	38.85	0.31	0.40	
13:32	4.47	7.80	38.78	0.30	0.50	
13:33	4.51	7.79	38.03	0.31	0.55	
13:34	4.47	7.78	39.13	0.29	0.58	
13:35	4.47	7.73	39.07	0.30	0.48	
13:36	4.49	7.76	38.87	0.32	0.48	
13:37	4.49	7.67	38.76	0.31	0.48	
13:38	4.51	7.76	38.95	0.32	0.45	
13:39	4.50	7.70	39.00	0.32	0.33	
13:40	4.44	7.79	38.94	0.34	0.41	
13:41	4.41	7.62	38.70	0.34	0.38	
13:42	4.50	7.69	38.95	0.35	0.47	
13:43	4.55	7.76	38.68	0.34	0.36	
13:44	4.51	7.71	38.91	0.37	0.54	
13:45	4.41	7.82	39.07	0.35	0.44	
13:46	4.39	7.68	38.98	0.36	0.54	
13:47	4.44	7.74	38.98	0.36	0.40	
13:48	4.45	7.74	38.94	0.38	0.44	
13:49	4.44	7.72	38.85	0.34	0.45	
13:50	4.47	7.75	38.93	0.36	0.50	
13:51	4.50	7.71	38.82	0.34	0.47	
Average	4.47	7.76	38.88	0.33	0.48	

(Mr. Ussaree Namburee)

Environmental Field Scientist (4)

FORM NO. F-04-02 REVISION NO. 1 ISSUE DATE 18/01/24

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EMISSION TEST RESULT

Client	Map Ta Phut Olefins Co., Ltd.	Run #	3
Date	02 Apr 24	Location	Naphtha Cracking Heater Stack 6 H-100F
Start Time	13:52	Test Operator	Ussaree N.
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	14:12
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	282
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	548
		Serial No.	300

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
13:52	4.52	7.75	38.99	0.33	0.44	
13:53	4.48	7.74	38.73	0.34	0.42	
13:54	4.45	7.85	38.74	0.35	0.51	
13:55	4.44	7.74	38.69	0.33	0.49	
13:56	4.42	7.78	38.50	0.36	0.37	
13:57	4.45	7.70	38.50	0.33	0.48	
13:58	4.48	7.77	38.53	0.36	0.53	
13:59	4.52	7.86	38.83	0.36	0.42	
14:00	4.48	7.70	38.55	0.33	0.47	
14:01	4.51	7.76	39.68	0.38	0.44	
14:02	4.53	7.73	38.78	0.34	0.40	
14:03	4.48	7.77	38.79	0.36	0.40	
14:04	4.40	7.79	38.65	0.36	0.44	
14:05	4.40	7.76	38.61	0.33	0.55	
14:06	4.44	7.75	38.58	0.37	0.46	
14:07	4.43	7.81	38.03	0.37	0.47	
14:08	4.45	7.78	38.61	0.38	0.45	
14:09	4.48	7.77	39.02	0.34	0.45	
14:10	4.52	7.75	39.09	0.36	0.54	
14:11	4.49	7.80	39.03	0.36	0.48	
14:12	4.55	7.72	39.07	0.38	0.32	
Average	4.47	7.76	38.72	0.35	0.45	

(Mr. Ussaree Namburee)

Environmental Field Scientist (4)

FORM NO. F-04-02 REVISION NO. 1 ISSUE DATE 18/01/24

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ANALYZER CALIBRATION DATA

Client	Map Ta Phut Olefins Co., Ltd.	Location	Naphtha Cracking Heater Stack 7 H-100G
Date	27 Jun 24	Test Operator	Ussaree N.
O ₂ ANALYZER Model	TELEDYNE API T200H	Serial No.	923
Span (%)	25		

	Cylinder Value (%)	Initial Analyzers Calibration Response (%)	Final Analyzers Calibration Response (%)	Difference (Percent of Span)
Zero Gas	0.00	0.02	0.02	0.00
Low-Level Gas	7.06	8.00	8.01	0.04
Span Gas	16.04	16.02	16.05	0.12

NO _x ANALYZER Model	TELEDYNE API T200H	Serial No.	923
Span (ppm)	100		

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.05	0.05	0.00
Low-Level Gas	55.85	55.53	55.48	0.05
Span Gas	66.46	66.72	66.80	0.12

SO ₂ ANALYZER Model	TELEDYNE API T100H	Serial No.	526
Span (ppm)	100		

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.00	0.00
Low-Level Gas	56.30	56.00	55.99	0.14
Span Gas	79.51	79.68	79.35	0.33

CO ANALYZER Model	TELEDYNE API T300M	Serial No.	845
Span (ppm)	100		

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.06	0.06	0.00
Low-Level Gas	55.23	55.05	55.05	0.05
Span Gas	79.95	79.87	79.72	0.05

Calibrated by

(Mr. Ussaree Namburee)

Environmental Field Scientist (4)

FORM NO. F-04-02 REVISION NO. 4 ISSUE DATE 18/01/24

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Lot No: 2432718-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client: Map Ta Phut Olefins Co., Ltd. Location: Naphtha Cracking Heater Stack 7 H-100G
Date: 27 Jun 24 Test Operator: Usaree N.

	O ₂ Analyzer Calibration Response	Initial Values		Final Values		Drift (% of Span)
		System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	
Zero Gas	0.02	0.04	0.06	0.06	0.16	0.08
Upscale Gas	16.02	16.06	0.16	16.11	0.35	0.20

NO_x ANALYZER
Cylinder Conc. (ppm): 80.49 Span (ppm): 166

	NO _x Analyzer Calibration Response	Initial Values		Final Values		Drift (% of Span)
		System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	
Zero Gas	0.05	0.07	0.02	0.10	0.55	0.03
Upscale Gas	80.72	80.00	0.72	79.84	0.88	0.10

SO₂ ANALYZER
Cylinder Conc. (ppm): 79.51 Span (ppm): 166

	SO ₂ Analyzer Calibration Response	Initial Values		Final Values		Drift (% of Span)
		System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	
Zero Gas	0.00	0.00	0.00	0.00	0.00	0.00
Upscale Gas	79.08	79.02	0.06	78.84	0.84	0.16

CO ANALYZER
Cylinder Conc. (ppm): 79.85 Span (ppm): 166

	CO Analyzer Calibration Response	Initial Values		Final Values		Drift (% of Span)
		System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	
Zero Gas	0.00	0.00	0.00	0.00	0.00	0.00
Upscale Gas	79.87	79.37	0.30	79.12	0.55	0.25

Calibrated by

(Mr. Usaree Namburee)

Environmental Field Scientist (4)

FORM NO. F-04-003 REVISION NO. 1 ISSUE DATE 18/01/24

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EMISSION TEST RESULT

Client: Map Ta Phut Olefins Co., Ltd.
Date: 27 Jun 24
Start Time: 11:40
SO₂ Analyzer Model: TELEDYNE API T100H
NO_x/O₂ Analyzer Model: TELEDYNE API T200H
CO/CO₂ Analyzer Model: TELEDYNE API T300MRun # 1
Location: Naphtha Cracking Heater Stack 7 H-100G
Test Operator: Usaree N.
Finish Time: 12:06
Serial No.: 536
Serial No.: 923
Serial No.: 845

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:40	3.28	8.82	40.90	0.02	0.20	
11:41	3.37	8.72	40.86	0.08	0.20	
11:42	3.37	8.76	40.93	0.02	0.19	
11:43	3.24	8.66	40.55	0.05	0.22	
11:44	3.08	8.65	40.61	0.06	0.20	
11:45	3.40	8.77	40.37	0.04	0.15	
11:46	3.29	8.64	40.48	0.08	0.11	
11:47	3.21	8.91	40.66	0.11	0.14	
11:48	3.47	8.78	40.63	0.14	0.15	
11:49	3.32	8.79	40.67	0.19	0.11	
11:50	3.31	8.66	40.59	0.02	0.14	
11:51	3.15	8.66	40.53	0.08	0.12	
11:52	3.22	8.68	40.47	0.22	0.09	
11:53	3.44	8.60	40.46	0.20	0.09	
11:54	3.10	8.90	40.40	0.01	0.12	
11:55	3.26	8.83	40.23	0.06	0.14	
11:56	3.17	8.83	40.17	0.07	0.10	
11:57	3.17	8.69	40.16	0.10	0.10	
11:58	3.40	8.76	40.25	0.18	0.08	
11:59	3.22	8.65	40.28	0.20	0.11	
12:00	3.05	8.61	40.14	0.16	0.10	
Average	3.27	8.84	40.51	0.10	0.14	

(Mr. Usaree Namburee)

Environmental Field Scientist (4)

FORM NO. F-04-003 REVISION NO. 1 ISSUE DATE 18/01/24

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EMISSION TEST RESULT

Client: Map Ta Phut Olefins Co., Ltd. Run # 2
Date: 27 Jun 24 Location: Naphtha Cracking Heater Stack 7 H-100G
Start Time: 12:31 Test Operator: Usaree N.
SO₂ Analyzer Model: TELEDYNE API T100H Finish Time: 12:21
NO_x/O₂ Analyzer Model: TELEDYNE API T200H Serial No.: 536
CO/CO₂ Analyzer Model: TELEDYNE API T300M Serial No.: 923
Serial No.: 845

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
12:01	3.24	8.86	39.65	0.02	0.09	
12:02	3.36	8.80	39.93	0.24	0.11	
12:03	3.20	8.87	39.69	0.29	0.11	
12:04	3.24	8.66	40.01	0.32	0.08	
12:05	3.25	8.83	40.12	0.35	0.08	
12:06	3.23	8.85	40.10	0.39	0.07	
12:07	3.00	8.96	39.84	0.38	0.05	
12:08	3.16	8.94	39.40	0.21	0.10	
12:09	3.27	8.83	39.44	0.16	0.08	
12:10	3.09	8.98	39.62	0.19	0.07	
12:11	3.50	8.76	39.50	0.21	0.10	
12:12	3.16	8.67	39.63	0.24	0.12	
12:13	2.44	8.82	39.73	0.23	0.07	
12:14	3.22	8.64	39.76	0.24	0.13	
12:15	3.07	8.64	39.55	0.30	0.09	
12:16	3.14	8.94	39.33	0.29	0.10	
12:17	3.12	8.83	39.23	0.35	0.11	
12:18	3.26	8.88	39.19	0.39	0.07	
12:19	3.20	8.90	39.16	0.32	0.08	
12:20	3.14	8.92	39.25	0.30	0.09	
12:21	3.14	8.93	39.21	0.31	0.01	
Average	3.21	8.88	39.62	0.28	0.09	

(Mr. Usaree Namburee)

Environmental Field Scientist (4)

FORM NO. F-04-003 REVISION NO. 1 ISSUE DATE 18/01/24

ALS Laboratory Group



EMISSION TEST RESULT

Client: Map Ta Phut Olefins Co., Ltd.
Date: 27 Jun 24
Start Time: 12:22
SO₂ Analyzer Model: TELEDYNE API T100H
NO_x/O₂ Analyzer Model: TELEDYNE API T200H
CO/CO₂ Analyzer Model: TELEDYNE API T300MRun # 3
Location: Naphtha Cracking Heater Stack 7 H-100G
Test Operator: Usaree N.
Finish Time: 12:42
Serial No.: 536
Serial No.: 923
Serial No.: 845

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
12:22	3.17	8.91	39.24	0.29	0.07	
12:23	2.97	9.02	39.19	0.31	0.07	
12:24	3.48	8.85	39.11	0.03	0.07	
12:25	3.01	8.89	39.13	0.03	0.09	
12:26	3.38	8.85	39.24	0.06	0.09	
12:27	2.69	8.95	39.00	0.04	0.08	
12:28	3.30	8.87	38.84	0.09	0.03	
12:29	3.12	8.89	38.84	0.11	0.05	
12:30	3.21	8.91	39.06	0.12	0.14	
12:31	3.25	8.86	39.14	0.08	0.10	
12:32	2.98	8.95	39.08	0.14	0.11	
12:33	3.24	8.86	38.88	0.18	0.10	
12:34	3.17	8.69	38.67	0.17	0.11	
12:35	3.00	9.02	38.91	0.14	0.12	
12:36	2.97	8.95	38.65	0.15	0.08	
12:37	3.23	8.87	38.52	0.20	0.08	
12:38	2.69	8.88	38.64	0.18	0.08	
12:39	2.95	9.01	38.65	0.20	0.11	
12:40	2.94	9.03	38.46	0.21	0.08	
12:41	2.66	9.03	38.27	0.21	0.09	
12:42	3.07	8.92	38.21	0.27	0.14	
Average	3.11	8.94	38.65	0.15	0.09	

(Mr. Usaree Namburee)

Environmental Field Scientist (4)

FORM NO. F-04-003 REVISION NO. 1 ISSUE DATE 18/01/24

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Lot No. 2432719-1

ANALYZER CALIBRATION DATA

Client: Map Ta Phut Olefins Co., Ltd. Location: Recycle Cracking Heater (H-120R)
Date: 03 Apr 24 Test Operator: Anuvat M.O₂ ANALYZER Model: TELEDYNE API T200H Serial No.: 922
Span (%): 25

	Cylinder Value (%)	Initial Analyzers Calibration Response (%)	Final Analyzers Calibration Response (%)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.00	0.00
Low-Level Gas	8.00	7.90	8.10	0.20
Span Gas	16.00	15.80	16.20	0.40

NO_x ANALYZER Model: TELEDYNE API T200H Serial No.: 922
Span (ppm): 100

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.00	0.00
Low-Level Gas	54.50	55.00	53.50	0.50
Span Gas	80.75	80.20	80.00	0.20

CO ANALYZER Model: TELEDYNE API T300M Serial No.: 844
Span (ppm): 100

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.00	0.00
Low-Level Gas	54.84	55.60	54.80	1.00
Span Gas	79.82	80.20	80.60	0.40

Calibrated by

(Mr. Anuvat Moungpair)

Environmental Field Scientist (2)



Lot No. 2432719-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client: Map Ta Phut Olefins Co., Ltd. Location: Recycle Cracking Heater (H-120R)
Date: 03 Apr 24 Test Operator: Anuvat M.O₂ ANALYZER Cylinder Conc. (%): 16.05 Span (%): 25

	O ₂ Analyzer Calibration Response	Initial Values System Calibration Response	System Cal Bias (% of Span)	Final Values System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.00	0.00	0.00	0.00	0.00	0.00
Upscale Gas	16.00	16.00	0.00	16.10	1.20	0.40

NO_x ANALYZER Cylinder Conc. (ppm): 80.73 Span (ppm): 100

	NO _x Analyzer Calibration Response	Initial Values System Calibration Response	System Cal Bias (% of Span)	Final Values System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.00	0.00	0.00	0.00	0.00	0.00
Upscale Gas	80.20	79.80	0.40	80.00	0.20	0.20

CO ANALYZER Cylinder Conc. (ppm): 79.82 Span (ppm): 100

	CO Analyzer Calibration Response	Initial Values System Calibration Response	System Cal Bias (% of Span)	Final Values System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.00	0.00	0.00	0.00	0.00	0.00
Upscale Gas	80.20	79.40	0.80	79.10	1.10	0.30

Calibrated by

(Mr. Anuvat Moungpair)

Environmental Field Scientist (2)

FORM INC. F-08-027 REVISION NO. 3 ISSUE DATE 2011/03

ALS Laboratory Group

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FORM INC. F-08-028 REVISION NO. 3 ISSUE DATE 2011/03

ALS Laboratory Group



EMISSION TEST RESULT

Client: Map Ta Phut Olefins Co., Ltd. Run #: 1
Date: 03 Apr 24 Location: Recycle Cracking Heater (H-120R)
Start Time: 10:29 Test Operator: Anuvat M.
Finish Time: 10:40
SO₂ Analyzer Model: - Serial No.: -
NO_x/O₂ Analyzer Model: TELEDYNE API T200H Serial No.: 922
CO/CO₂ Analyzer Model: TELEDYNE API T300M Serial No.: 844

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
10:20	1.85	9.62	41.49	-	0.55	-
10:21	1.96	9.81	41.74	-	0.59	-
10:22	2.00	9.81	41.81	-	0.58	-
10:23	1.92	9.64	41.47	-	0.59	-
10:24	1.92	9.64	41.44	-	0.57	-
10:25	1.88	9.63	41.52	-	0.52	-
10:26	1.79	9.66	41.32	-	0.53	-
10:27	2.00	9.65	40.98	-	0.51	-
10:28	2.04	9.62	40.90	-	0.57	-
10:29	2.00	9.62	41.18	-	0.56	-
10:30	2.05	9.80	41.19	-	0.57	-
10:31	1.96	9.62	41.13	-	0.53	-
10:32	1.90	9.64	41.05	-	0.58	-
10:33	1.86	9.68	41.18	-	0.55	-
10:34	1.76	9.74	41.33	-	0.54	-
10:35	1.79	9.78	41.23	-	0.58	-
10:36	1.90	9.80	41.17	-	0.55	-
10:37	1.91	9.67	41.24	-	0.56	-
10:38	1.84	9.65	41.13	-	0.58	-
10:39	1.94	9.83	41.09	-	0.55	-
10:40	2.00	9.85	41.30	-	0.53	-
Average	1.93	9.65	41.20	-	0.57	-

(Mr. Anuvat Moungpair)

Environmental Field Scientist (2)



EMISSION TEST RESULT

Client: Map Ta Phut Olefins Co., Ltd. Run #: 2
Date: 03 Apr 24 Location: Recycle Cracking Heater (H-120R)
Start Time: 10:41 Test Operator: Anuvat M.
Finish Time: 11:01
SO₂ Analyzer Model: - Serial No.: -
NO_x/O₂ Analyzer Model: TELEDYNE API T200H Serial No.: 922
CO/CO₂ Analyzer Model: TELEDYNE API T300M Serial No.: 844

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
10:41	1.94	9.63	41.63	-	0.59	-
10:42	1.83	9.68	41.64	-	0.58	-
10:43	1.91	9.60	41.65	-	0.54	-
10:44	1.92	9.65	41.63	-	0.52	-
10:45	1.78	9.69	41.62	-	0.49	-
10:46	1.75	9.77	41.21	-	0.54	-
10:47	1.90	9.77	40.82	-	0.54	-
10:48	1.87	9.68	40.82	-	0.54	-
10:49	1.74	9.60	40.91	-	0.52	-
10:50	1.80	9.74	41.03	-	0.56	-
10:51	1.85	9.67	41.36	-	0.54	-
10:52	1.90	9.63	41.61	-	0.55	-
10:53	2.03	9.62	41.08	-	0.57	-
10:54	2.01	9.60	41.76	-	0.55	-
10:55	1.87	9.64	41.60	-	0.55	-
10:56	1.72	9.70	41.31	-	0.53	-
10:57	1.75	9.78	41.00	-	0.56	-
10:58	1.92	9.68	41.05	-	0.55	-
10:59	1.90	9.65	41.60	-	0.52	-
11:00	1.90	9.65	41.60	-	0.51	-
11:01	1.81	9.70	41.44	-	0.53	-
Average	1.87	9.68	41.38	-	0.54	-

(Mr. Anuvat Moungpair)

Environmental Field Scientist (2)

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EMISSION TEST RESULT

Run # 3
Location Recycle Cracking Heater (H-120R)
Test Operator Anuvat M.
Finish Time 11:22
Serial No. 922
Serial No. 844

Client Map Ta Phut Olefins Co., Ltd.
Date 03 Apr 24
Start Time 11:02
SO₂ Analyzer Model -
NO_x/O₂ Analyzer Model TELEDYNE API T200H
CO/CO₂ Analyzer Model TELEDYNE API T300M

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:02	1.89	0.88	41.43	--	0.51	
11:03	1.73	0.78	41.37	--	0.54	
11:04	1.77	0.74	41.18	--	0.54	
11:05	2.07	0.64	41.02	--	0.50	
11:06	1.89	0.58	41.22	--	0.55	
11:07	2.00	0.60	41.30	--	0.54	
11:08	1.85	0.61	41.75	--	0.51	
11:09	1.84	0.63	42.09	--	0.46	
11:10	1.84	0.68	42.13	--	0.50	
11:11	1.91	0.69	42.03	--	0.50	
11:12	1.90	0.67	42.06	--	0.50	
11:13	2.08	0.58	42.29	--	0.50	
11:14	2.04	0.55	42.48	--	0.50	
11:15	2.00	0.55	42.33	--	0.50	
11:16	2.08	0.55	42.02	--	0.40	
11:17	1.98	0.53	41.82	--	0.40	
11:18	1.97	0.50	41.92	--	0.50	
11:19	1.91	0.62	41.96	--	0.47	
11:20	1.89	0.66	41.63	--	0.45	
11:21	1.99	0.61	41.80	--	0.48	
11:22	2.02	0.58	41.90	--	0.45	
Average	1.84	0.62	41.81	--	0.50	

(Mr. Anuvat Mungpair)
Environmental Field Scientist (2)



ANALYZER CALIBRATION DATA

Client Map Ta Phut Olefins Co., Ltd. Location GHU II
Date 05 Apr 24 Test Operator Anuvat M.
Start Time 15:20
SO₂ Analyzer Model -
NO_x/O₂ Analyzer Model TELEDYNE API T200H
CO/CO₂ Analyzer Model TELEDYNE API T300M

	Cylinder Value (%)	Initial Analyzers Calibration Response (%)	Final Analyzers Calibration Response (%)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.00	0.00
Low-Level Gas	8.00	7.90	8.10	0.20
Span Gas	15.00	15.80	15.50	0.40

NO_x ANALYZER
Model TELEDYNE API T200H
Span (ppm) 100
Serial No. 922

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.00	0.00
Low-Level Gas	54.30	55.60	55.30	0.30
Span Gas	80.73	80.20	80.00	0.20

CO ANALYZER
Model TELEDYNE API T300M
Span (ppm) 100
Serial No. 844

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.10	0.08	0.02
Low-Level Gas	54.84	55.90	54.80	1.00
Span Gas	79.32	80.20	80.00	0.40

Calibrated by

(Mr. Anuvat Mungpair)
Environmental Field Scientist (2)



SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client Map Ta Phut Olefins Co., Ltd. Location GHU II
Date 05 Apr 24 Test Operator Anuvat M.

O₂ ANALYZER
Cylinder Conc. (%) 16.06 Span (%) : 25

	O ₂ Analyzer Calibration Response	Initial Values	System Calibration Response	System Cal Bias (% of Span)	Final Values	System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Up-scale Gas	15.80	16.00	0.80	0.00	16.10	1.20	0.40	0.40

NO_x ANALYZER
Cylinder Conc. (ppm) 89.73 Span (ppm) : 100

	NO _x Analyzer Calibration Response	Initial Values	System Calibration Response	System Cal Bias (% of Span)	Final Values	System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Up-scale Gas	80.20	79.50	0.40	0.00	80.00	0.20	0.20	0.20

CO ANALYZER
Cylinder Conc. (ppm) 79.82 Span (ppm) : 100

	CO Analyzer Calibration Response	Initial Values	System Calibration Response	System Cal Bias (% of Span)	Final Values	System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.10	0.05	0.10	0.10	0.10	0.10	0.00	0.00
Up-scale Gas	80.20	79.40	0.60	0.00	79.10	1.10	0.30	0.30

Calibrated by

(Mr. Anuvat Mungpair)
Environmental Field Scientist (2)



EMISSION TEST RESULT

Client Map Ta Phut Olefins Co., Ltd. Location GHU II
Date 05 Apr 24 Test Operator Anuvat M.
Start Time 15:20
SO₂ Analyzer Model -
NO_x/O₂ Analyzer Model TELEDYNE API T200H
CO/CO₂ Analyzer Model TELEDYNE API T300M

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
15:20	13.28	4.01	15.08	--	22.47	
15:21	13.25	4.01	14.97	--	22.17	
15:22	13.28	4.01	14.95	--	21.66	
15:23	13.23	4.02	15.01	--	21.31	
15:24	13.20	4.00	15.02	--	20.82	
15:25	13.21	4.05	15.10	--	22.01	
15:26	13.23	4.05	15.07	--	21.73	
15:27	13.18	4.05	15.05	--	22.72	
15:28	13.19	4.05	15.08	--	22.60	
15:29	13.21	4.05	15.02	--	22.71	
15:30	13.17	4.05	14.95	--	22.57	
15:31	13.17	4.05	14.91	--	23.37	
15:32	13.24	4.00	14.95	--	21.72	
15:33	13.34	3.98	15.01	--	21.48	
15:34	13.36	3.98	15.10	--	21.53	
15:35	13.38	3.96	15.16	--	21.30	
15:36	13.30	3.94	15.12	--	20.67	
15:37	13.42	3.93	15.10	--	20.76	
15:38	13.38	3.95	15.10	--	20.91	
15:39	13.32	4.02	15.10	--	20.64	
15:40	13.25	4.05	15.24	--	20.54	
Average	13.27	4.02	15.05	--	21.71	

(Mr. Anuvat Mungpair)
Environmental Field Scientist (2)



EMISSION TEST RESULT

Client	Map Ta Phut Olefins Co., Ltd.	Run #	2
Date	05 Apr 24	Location	GHU II
Start Time	15:41	Test Operator	Anuvat M.
SO ₂ Analyzer Model	-	Finish Time	16:01
NO _x /O ₂ Analyzer Model	TELEDYNE API T200H	Serial No.	-
CO/CO ₂ Analyzer Model	TELEDYNE API T300M	Serial No.	922
		Serial No.	644

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
15:41	13.21	4.05	15.28	-	22.37	
15:42	13.10	4.03	15.21	-	21.72	
15:43	13.10	4.05	15.11	-	22.77	
15:44	13.21	4.04	15.09	-	21.77	
15:45	13.21	4.05	15.09	-	23.97	
15:46	13.20	4.05	15.06	-	22.73	
15:47	13.22	4.02	15.08	-	21.10	
15:48	13.28	3.99	15.13	-	22.57	
15:49	13.35	3.97	15.09	-	21.28	
15:50	13.38	3.95	15.02	-	21.71	
15:51	13.39	3.95	14.99	-	20.51	
15:52	13.39	3.94	14.93	-	20.84	
15:53	13.40	3.94	14.83	-	20.90	
15:54	13.33	3.99	14.99	-	20.54	
15:55	13.25	4.04	15.02	-	21.37	
15:56	13.16	4.00	15.03	-	22.32	
15:57	13.21	4.04	14.99	-	21.18	
15:58	13.25	4.02	15.00	-	21.30	
15:59	13.21	4.02	15.03	-	21.84	
16:00	13.23	4.01	15.04	-	20.90	
16:01	13.24	4.02	15.03	-	21.49	
Average	13.28	4.01	15.05	-	21.83	

(Mr. Anuvat Moungpair)

Environmental Field Scientist (2)



EMISSION TEST RESULT

Client	Map Ta Phut Olefins Co., Ltd.	Run #	3
Date	05 Apr 24	Location	GHU II
Start Time	16:02	Test Operator	Anuvat M.
SO ₂ Analyzer Model	-	Finish Time	16:22
NO _x /O ₂ Analyzer Model	TELEDYNE API T200H	Serial No.	-
CO/CO ₂ Analyzer Model	TELEDYNE API T300M	Serial No.	922
		Serial No.	644

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
16:02	13.25	4.03	15.00	-	22.94	
16:03	13.32	3.98	14.94	-	22.01	
16:04	13.35	3.97	14.92	-	20.76	
16:05	13.38	3.94	14.88	-	20.95	
16:06	13.43	3.99	15.02	-	20.30	
16:07	13.39	3.95	14.98	-	22.04	
16:08	13.35	3.99	14.88	-	21.64	
16:09	13.29	4.01	14.81	-	21.97	
16:10	13.28	4.04	14.84	-	22.14	
16:11	13.20	4.05	14.91	-	22.85	
16:12	13.21	4.05	14.90	-	22.10	
16:13	13.20	4.05	14.85	-	22.31	
16:14	13.21	4.06	14.89	-	22.53	
16:15	13.20	4.05	14.79	-	23.85	
16:16	13.20	4.04	14.81	-	23.34	
16:17	13.24	4.04	14.83	-	21.80	
16:18	13.24	4.02	14.87	-	21.89	
16:19	13.27	4.02	14.92	-	21.80	
16:20	13.32	3.97	14.94	-	21.62	
16:21	13.40	3.94	14.89	-	20.82	
16:22	13.34	3.95	14.88	-	20.80	
Average	13.29	4.01	14.90	-	21.81	

(Mr. Anuvat Moungpair)

Environmental Field Scientist (2)

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ANALYZER CALIBRATION DATA

Client	Map Ta Phut Olefins Co., Ltd.	Location	OCU Feed Heater (H-760)
Date	05 Apr 24	Test Operator	Anuvat M.
O ₂ ANALYZER Model	TELEDYNE API T200H	Serial No.	922
Span (%)	25		

	Cylinder Value (%)	Initial Analyzers Calibration Response (%)	Final Analyzers Calibration Response (%)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.00	0.00
Low-Level Gas	8.00	7.90	8.10	0.80
Span Gas	16.00	15.80	15.90	0.40

NO _x ANALYZER Model	TELEDYNE API T200H	Serial No.	923
Span (ppm)	100		

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.00	0.00
Low-Level Gas	54.96	55.16	55.30	0.20
Span Gas	80.73	80.20	79.20	1.00

CO ANALYZER Model	TELEDYNE API T300M	Serial No.	645
Span (ppm)	160		

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.10	0.08	0.02
Low-Level Gas	54.84	55.80	54.80	1.00
Span Gas	79.82	80.20	80.60	0.40

Calibrated by

(Mr. Anuvat Moungpair)

Environmental Field Scientist (2)



SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client	Map Ta Phut Olefins Co., Ltd.	Location	OCU Feed Heater (H-760)
Date	05 Apr 24	Test Operator	Anuvat M.

O ₂ ANALYZER Cylinder Conc. (%)	16.96	Span (%)	25
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	O ₂ Analyzer Calibration Response	Initial Values System Calibration Response	System Cal Bias (% of Span)	Final Values System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.00	0.00	0.00	0.00	0.00	0.00
Up-scale Gas	16.96	16.00	0.80	16.10	1.20	0.40

NO _x ANALYZER Cylinder Conc. (ppm)	80.73	Span (ppm)	100
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	NO _x Analyzer Calibration Response	Initial Values System Calibration Response	System Cal Bias (% of Span)	Final Values System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.00	0.00	0.00	0.00	0.00	0.00
Up-scale Gas	80.70	80.00	0.20	79.40	0.80	0.80

CO ANALYZER Cylinder Conc. (ppm)	79.82	Span (ppm)	160
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	CO Analyzer Calibration Response	Initial Values System Calibration Response	System Cal Bias (% of Span)	Final Values System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.10	0.00	0.10	0.00	0.10	0.00
Up-scale Gas	80.20	79.40	0.80	79.10	1.10	0.30

Calibrated by

(Mr. Anuvat Moungpair)

Environmental Field Scientist (2)

FORM NO. F-06-03 REVISION NO. 3 ISSUE DATE 2011/03

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EMISSION TEST RESULT

Client	Map Ta Phut Olefins Co., Ltd.	Run #	1
Date	05 Apr 24	Location	OCU Feed Heater (H-780)
Start Time	12:30	Test Operator	Anuvat M.
SO ₂ Analyzer Model	-	Finish Time	12:50
NO _x /O ₂ Analyzer Model	TELEDYNE API T200H	Serial No.	-
CO/CO ₂ Analyzer Model	TELEDYNE API T300M	Serial No.	923
		Serial No.	845

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
12:30	8.88	0.03	23.16	-	21.06	
12:31	8.84	0.05	23.16	-	24.66	
12:32	8.89	0.05	23.53	-	25.90	
12:33	8.91	0.03	23.79	-	23.49	
12:34	8.90	0.02	24.06	-	27.26	
12:35	8.93	0.00	24.03	-	34.23	
12:36	8.91	0.00	24.06	-	29.11	
12:37	8.94	0.01	25.18	-	19.84	
12:38	8.93	0.00	25.08	-	21.68	
12:39	8.92	0.04	26.20	-	32.31	
12:40	8.91	0.00	26.25	-	20.42	
12:41	8.97	0.00	26.99	-	15.95	
12:42	9.01	0.07	25.67	-	18.38	
12:43	9.02	0.07	26.04	-	21.06	
12:44	8.94	0.00	25.35	-	23.84	
12:45	8.94	0.01	25.07	-	25.63	
12:46	8.94	0.02	25.04	-	23.46	
12:47	8.91	0.02	25.13	-	27.67	
12:48	8.94	0.00	24.79	-	26.33	
12:49	8.90	0.01	24.37	-	24.84	
12:50	8.92	0.01	24.54	-	22.51	
Average	8.92	0.01	24.92	-	24.29	

Anuvat M.

(Mr. Anuvat Moungepair)
Environmental Field Scientist (2)

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EMISSION TEST RESULT

Client	Map Ta Phut Olefins Co., Ltd.	Run #	2
Date	05 Apr 24	Location	OCU Feed Heater (H-780)
Start Time	12:51	Test Operator	Anuvat M.
SO ₂ Analyzer Model	-	Finish Time	13:11
NO _x /O ₂ Analyzer Model	TELEDYNE API T200H	Serial No.	-
CO/CO ₂ Analyzer Model	TELEDYNE API T300M	Serial No.	923
		Serial No.	845

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
12:51	8.94	0.01	24.85	-	25.15	
12:52	8.95	0.00	24.98	-	31.26	
12:53	8.97	0.00	25.80	-	25.15	
12:54	8.97	0.00	25.00	-	26.41	
12:55	9.00	0.07	25.68	-	29.04	
12:56	9.07	0.02	25.00	-	27.93	
12:57	9.05	0.02	24.48	-	24.63	
12:58	9.06	0.02	24.87	-	23.00	
12:59	9.01	0.02	24.97	-	20.77	
13:00	8.99	0.03	25.41	-	20.07	
13:01	8.95	0.08	25.69	-	19.29	
13:02	8.95	0.00	25.69	-	29.67	
13:03	8.97	0.08	24.95	-	32.40	
13:04	9.01	0.08	24.65	-	27.81	
13:05	9.03	0.05	25.23	-	25.11	
13:06	9.00	0.04	25.32	-	26.34	
13:07	8.95	0.07	25.65	-	24.94	
13:08	8.95	0.00	25.91	-	22.31	
13:09	8.95	0.00	26.30	-	25.16	
13:10	9.00	0.07	25.99	-	31.26	
13:11	8.99	0.05	25.58	-	25.15	
Average	8.99	0.07	25.38	-	25.94	

Anuvat M.

(Mr. Anuvat Moungepair)
Environmental Field Scientist (2)

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EMISSION TEST RESULT

Client	Map Ta Phut Olefins Co., Ltd.	Run #	3
Date	05 Apr 24	Location	OCU Feed Heater (H-780)
Start Time	13:12	Test Operator	Anuvat M.
SO ₂ Analyzer Model	-	Finish Time	13:32
NO _x /O ₂ Analyzer Model	TELEDYNE API T200H	Serial No.	-
CO/CO ₂ Analyzer Model	TELEDYNE API T300M	Serial No.	923
		Serial No.	845

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
13:12	8.97	0.05	25.57	-	20.41	
13:13	8.94	0.08	25.56	-	29.04	
13:14	8.95	0.00	25.21	-	27.91	
13:15	8.88	0.00	25.10	-	24.61	
13:16	8.85	0.03	25.54	-	23.03	
13:17	8.92	0.02	25.62	-	26.75	
13:18	8.98	0.07	25.60	-	27.20	
13:19	8.93	0.00	26.06	-	23.58	
13:20	8.98	0.01	25.06	-	24.84	
13:21	8.92	0.00	25.14	-	19.31	
13:22	8.94	0.02	24.57	-	20.76	
13:23	8.92	0.00	23.51	-	20.61	
13:24	8.93	0.01	23.59	-	26.76	
13:25	8.94	0.02	23.00	-	21.39	
13:26	9.01	0.08	24.03	-	17.90	
13:27	8.97	0.07	23.64	-	22.51	
13:28	8.97	0.07	21.36	-	22.41	
13:29	8.94	0.01	22.08	-	18.72	
13:30	8.94	0.02	23.45	-	17.63	
13:31	8.98	0.01	24.33	-	20.63	
13:32	8.91	0.02	23.97	-	30.73	
Average	8.94	0.00	24.45	-	24.20	

Anuvat M.

(Mr. Anuvat Moungepair)
Environmental Field Scientist (2)

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ANALYZER CALIBRATION DATA

Lot No. 2432722-1

Client	Map Ta Phut Olefins Co., Ltd.	Location	OCU Regeneration Heater (H-761)
Date	30 May 24	Test Operator	Ussarae N.
O ₂ ANALYZER Model	TELEDYNE API T200H	Serial No.	991
Span (%)	25		

	Cylinder Value (%)	Initial Analyzers Calibration Response (%)	Final Analyzers Calibration Response (%)	Difference (Percent of Span)
Zero Gas	0.00	0.02	0.02	0.00
Low-Level Gas	8.02	8.04	8.05	0.04
Span Gas	16.02	16.05	16.04	0.04

NO _x ANALYZER Model	TELEDYNE API T200H	Serial No.	991
Span (ppm)	100		

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.03	0.07	0.04
Low-Level Gas	56.16	56.50	56.57	0.03
Span Gas	79.77	80.04	79.86	0.18

SO ₂ ANALYZER Model	TELEDYNE API T100H	Serial No.	553
Span (ppm)	109		

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.03	0.00	0.03
Low-Level Gas	55.35	55.83	55.34	0.49
Span Gas	79.90	79.68	79.35	0.38

CO ANALYZER Model	TELEDYNE API T300M	Serial No.	924
Span (ppm)	109		

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.08	0.05	0.05	0.01
Low-Level Gas	54.22	54.46	54.50	0.10
Span Gas	79.90	80.03	80.10	0.07

Calibrated by

Ussarae N.

(Mr. Ussarae Namburae)
Environmental Field Scientist (4)

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Lot No. 2432722-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client Map Ta Phut Olefins Co., Ltd. Location OCU Regeneration Heater (H-761)
Date 30 May 24 Test Operator Ussaree N.O₂ ANALYZER
Cylinder Conc. (%) : 18.02 Span (%) : 25

	O ₂ Analyzer Calibration Response	Initial Values		Final Values		Drift (% of Span)
		System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	
Zero Gas	0.02	0.08	0.16	0.05	0.12	0.04
Upscale Gas	16.05	16.00	0.20	15.99	0.24	0.04

NO₂ ANALYZER
Cylinder Conc. (ppm) : 79.77 Span (ppm) : 100

	NO ₂ Analyzer Calibration Response	Initial Values		Final Values		Drift (% of Span)
		System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	
Zero Gas	0.03	0.11	0.08	0.15	0.12	0.04
Upscale Gas	80.04	80.15	0.11	80.39	0.32	0.21

SO₂ ANALYZER
Cylinder Conc. (ppm) : 78.89 Span (ppm) : 100

	SO ₂ Analyzer Calibration Response	Initial Values		Final Values		Drift (% of Span)
		System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	
Zero Gas	0.03	0.07	0.04	0.12	0.09	0.05
Upscale Gas	79.88	78.98	0.72	79.03	0.85	0.07

CO ANALYZER
Cylinder Conc. (ppm) : 79.90 Span (ppm) : 100

	CO Analyzer Calibration Response	Initial Values		Final Values		Drift (% of Span)
		System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	
Zero Gas	0.04	0.06	0.02	0.10	0.06	0.04
Upscale Gas	80.03	79.16	0.87	79.04	0.99	0.12

Calibrated by

(Mr. Ussaree Namburee)

Environmental Field Scientist (4)

FORM NO. F-05-03 REVISION NO. 4 ISSUE DATE 18/10/24

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EMISSION TEST RESULT

Client Map Ta Phut Olefins Co., Ltd.
Date 30 May 24

Start Time 11:50

SO₂ Analyzer Model TELEDYNE API T100HNO₂/O₂ Analyzer Model TELEDYNE API T200HCO/CO₂ Analyzer Model TELEDYNE API T300M

Run # 1

Location OCU Regeneration Heater (H-761)

Test Operator Ussaree N.

Finish Time 12:10

Serial No. 553

Serial No. 991

Serial No. 924

Time (min)	O ₂ (%)	CO ₂ (%)	NOx (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:50	8.44	0.21	22.55	0.48	28.99	
11:51	8.27	0.27	22.58	0.48	29.00	
11:52	8.24	0.33	22.71	0.45	21.12	
11:53	8.20	0.32	22.67	0.44	17.89	
11:54	8.20	0.34	22.65	0.42	14.37	
11:55	8.25	0.33	22.67	0.42	18.22	
11:56	8.21	0.32	22.72	0.41	23.40	
11:57	8.08	0.37	22.68	0.40	17.87	
11:58	7.98	0.45	22.89	0.41	14.17	
11:59	7.89	0.47	23.00	0.43	15.00	
12:00	7.84	0.52	22.68	0.38	10.87	
12:01	7.85	0.54	22.59	0.35	11.34	
12:02	7.72	0.57	23.00	0.38	10.10	
12:03	7.85	0.58	23.11	0.35	10.51	
12:04	7.81	0.52	23.16	0.35	8.77	
12:05	7.72	0.55	23.23	0.34	7.97	
12:06	7.67	0.60	23.42	0.33	8.44	
12:07	7.63	0.64	23.49	0.32	6.91	
12:08	7.59	0.65	23.48	0.32	7.19	
12:09	7.65	0.63	23.44	0.32	8.02	
12:10	7.64	0.61	23.33	0.47	6.93	
Average	7.94	0.47	22.98	0.41	14.00	

(Mr. Ussaree Namburee)

Environmental Field Scientist (4)

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EMISSION TEST RESULT

Client Map Ta Phut Olefins Co., Ltd.
Date 30 May 24
Start Time 12:11
SO₂ Analyzer Model TELEDYNE API T100H
NO₂/O₂ Analyzer Model TELEDYNE API T200H
CO/CO₂ Analyzer Model TELEDYNE API T300M
Run # 1
Location OCU Regeneration Heater (H-761)
Test Operator Ussaree N.
Finish Time 12:31
Serial No. 553
Serial No. 991
Serial No. 924

Time (min)	O ₂ (%)	CO ₂ (%)	NOx (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
12:11	7.63	0.64	23.31	0.48	6.46	
12:12	7.61	0.68	23.45	0.50	6.16	
12:13	7.64	0.64	23.49	0.48	6.01	
12:14	7.54	0.65	23.49	0.49	7.11	
12:15	7.47	0.72	23.60	0.45	4.76	
12:16	7.40	0.73	23.67	0.48	6.00	
12:17	7.52	0.73	23.69	0.47	5.51	
12:18	7.57	0.71	23.56	0.43	4.69	
12:19	7.47	0.68	23.43	0.43	4.00	
12:20	7.42	0.72	23.51	0.44	4.07	
12:21	7.38	0.75	23.71	0.44	3.79	
12:22	7.34	0.78	23.85	0.42	3.62	
12:23	7.33	0.80	23.85	0.43	3.77	
12:24	7.38	0.78	23.88	0.41	4.39	
12:25	7.47	0.74	23.90	0.39	4.21	
12:26	7.40	0.71	24.00	0.39	3.81	
12:27	7.38	0.71	23.98	0.39	4.15	
12:28	7.45	0.73	23.83	0.40	6.09	
12:29	7.35	0.77	23.74	0.38	3.41	
12:30	7.33	0.81	23.87	0.37	3.57	
12:31	7.16	0.87	24.16	0.37	2.91	
Average	7.44	0.73	23.71	0.43	4.62	

(Mr. Ussaree Namburee)

Environmental Field Scientist (4)

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EMISSION TEST RESULT

Client Map Ta Phut Olefins Co., Ltd.
Date 30 May 24

Start Time 12:32

SO₂ Analyzer Model TELEDYNE API T100HNO₂/O₂ Analyzer Model TELEDYNE API T200HCO/CO₂ Analyzer Model TELEDYNE API T300M

Run # 3

Location OCU Regeneration Heater (H-761)

Test Operator Ussaree N.

Finish Time 12:52

Serial No. 553

Serial No. 991

Serial No. 924

Time (min)	O ₂ (%)	CO ₂ (%)	NOx (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
12:32	7.17	0.90	24.15	0.39	3.83	
12:33	7.39	0.85	23.91	0.34	3.35	
12:34	7.28	0.75	20.79	0.37	3.20	
12:35	7.29	0.83	23.85	0.34	3.28	
12:36	7.16	0.87	23.92	0.33	3.33	
12:37	7.29	0.87	24.05	0.33	3.18	
12:38	7.41	0.78	23.99	0.45	3.59	
12:39	7.44	0.74	23.88	0.45	4.20	
12:40	7.50	0.72	23.74	0.44	4.22	
12:41	7.54	0.70	23.64	0.45	4.08	
12:42	7.48	0.70	23.53	0.44	3.59	
12:43	7.52	0.70	23.73	0.40	3.64	
12:44	7.33	0.73	23.78	0.44	4.19	
12:45	7.38	0.80	23.72	0.41	3.66	
12:46	7.45	0.78	23.77	0.41	3.64	
12:47	7.48	0.75	23.86	0.40	4.15	
12:48	7.50	0.72	23.57	0.39	3.97	
12:49	7.58	0.68	23.65	0.38	3.63	
12:50	7.49	0.70	23.56	0.37	3.37	
12:51	7.33	0.74	23.71	0.35	3.53	
12:52	7.33	0.82	23.87	0.39	3.65	
Average	7.39	0.77	23.77	0.39	3.71	

(Mr. Ussaree Namburee)

Environmental Field Scientist (4)

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Lot No. 2432723-1

ANALYZER CALIBRATION DATA

Client: Map Ta Phut Olefins Co., Ltd.
Date: 05 Apr 24
Location: Gas Cracking Furnace stack (H-S120A)
Test Operator: Worawich T.

O₂ ANALYZER
Model: TELEDYNE API T200H
Span (%): 25
Serial No.: 991

	Cylinder Value (%)	Initial Analyzers Calibration Response (%)	Final Analyzers Calibration Response (%)	Difference (Percent of Span)
Zero Gas	0.00	0.01	0.00	0.04
Low-Level Gas	8.02	7.98	8.01	0.12
Span Gas	16.92	16.91	16.93	0.06

NO_x ANALYZER
Model: TELEDYNE API T200H
Span (ppm): 100
Serial No.: 991

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.01	0.03	0.03
Low-Level Gas	55.15	55.54	55.50	0.14
Span Gas	79.77	79.76	79.47	0.29

SO₂ ANALYZER
Model: TELEDYNE API T100H
Span (ppm): 100
Serial No.: 553

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.00	0.00
Low-Level Gas	55.55	55.40	55.38	0.02
Span Gas	79.09	79.05	78.33	0.22

CO ANALYZER
Model: TELEDYNE API T300M
Span (ppm): 100
Serial No.: 924

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.00	0.00
Low-Level Gas	54.22	55.17	55.21	0.04
Span Gas	79.00	80.03	79.95	0.08

Calibrated by

Norawich T.

(Mr. Worawich Tongpoom)

Environmental Field Scientist (2)

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Lot No. 2432723-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client: Map Ta Phut Olefins Co., Ltd.
Date: 05 Apr 24
Location: Gas Cracking Furnace stack (H-S120A)
Test Operator: Worawich T.

O₂ ANALYZER
Cylinder Conc. (%): 16.92
Span (%): 25

	O ₂ Analyzer Calibration Response	Initial Values System Calibration Response	System Cal Bias (% of Span)	Final Values System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.01	0.01	0.00	0.01	0.00	0.00
Up-scale Gas	16.01	16.06	0.26	16.08	0.28	0.08

NO_x ANALYZER
Cylinder Conc. (ppm): 79.77
Span (ppm): 100

	NO _x Analyzer Calibration Response	Initial Values System Calibration Response	System Cal Bias (% of Span)	Final Values System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.01	0.02	0.01	0.04	0.03	0.02
Up-scale Gas	79.76	78.76	1.00	78.55	1.21	0.21

SO₂ ANALYZER
Cylinder Conc. (ppm): 79.09
Span (ppm): 100

	SO ₂ Analyzer Calibration Response	Initial Values System Calibration Response	System Cal Bias (% of Span)	Final Values System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.00	0.01	0.01	0.02	0.02	0.01
Up-scale Gas	79.05	78.58	0.56	78.49	0.59	0.13

CO ANALYZER
Cylinder Conc. (ppm): 79.00
Span (ppm): 100

	CO Analyzer Calibration Response	Initial Values System Calibration Response	System Cal Bias (% of Span)	Final Values System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.00	0.00	0.00	0.00	0.00	0.00
Up-scale Gas	80.03	79.81	0.22	79.70	0.33	0.11

Calibrated by

Norawich T.

(Mr. Worawich Tongpoom)

Environmental Field Scientist (2)

FORM NO. F-06-002 REVISION NO. 1 ISSUE DATE: 18/01/24

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EMISSION TEST RESULT

Client: Map Ta Phut Olefins Co., Ltd.
Date: 05 Apr 24
Start Time: 11:50
SO_x Analyzer Model: TELEDYNE API T100H
NO_x/O₂ Analyzer Model: TELEDYNE API T200H
CO/CO₂ Analyzer Model: TELEDYNE API T300M

Run # 1
Location: Gas Cracking Furnace stack (H-S120A)
Test Operator: Worawich T.
Finish Time: 12:10
Serial No.: 553
Serial No.: 991
Serial No.: 924

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:50	2.08	10.13	35.65	0.50	0.11	
11:51	2.09	10.16	35.63	0.48	0.14	
11:52	2.03	10.15	35.64	0.51	0.08	
11:53	2.03	10.18	35.66	0.48	0.09	
11:54	2.09	10.20	35.53	0.52	0.11	
11:55	2.09	10.15	35.34	0.50	0.07	
11:56	2.06	10.11	35.28	0.50	0.08	
11:57	2.10	10.13	35.41	0.48	0.10	
11:58	2.07	10.18	35.57	0.47	0.11	
11:59	2.01	10.20	35.72	0.48	0.07	
12:00	2.03	10.23	35.49	0.48	0.03	
12:01	2.05	10.19	35.16	0.40	0.05	
12:02	2.00	10.18	35.07	0.40	0.05	
12:03	2.03	10.17	35.17	0.46	0.03	
12:04	2.08	10.17	35.35	0.44	0.04	
12:05	2.01	10.18	35.42	0.48	0.02	
12:06	2.01	10.18	35.37	0.43	0.02	
12:07	2.01	10.20	35.41	0.44	0.06	
12:08	1.94	10.22	35.40	0.44	0.06	
12:09	2.01	10.25	35.28	0.48	0.04	
12:10	2.06	10.21	35.19	0.49	0.05	
Average	2.04	10.18	35.42	0.47	0.07	

Norawich T.

(Mr. Worawich Tongpoom)

Environmental Field Scientist (2)

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EMISSION TEST RESULT

Client: Map Ta Phut Olefins Co., Ltd.
Date: 05 Apr 24
Start Time: 12:11
SO_x Analyzer Model: TELEDYNE API T100H
NO_x/O₂ Analyzer Model: TELEDYNE API T200H
CO/CO₂ Analyzer Model: TELEDYNE API T300M

Run # 2
Location: Gas Cracking Furnace stack (H-S120A)
Test Operator: Worawich T.
Finish Time: 12:31
Serial No.: 553
Serial No.: 991
Serial No.: 924

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
12:11	2.07	10.18	35.06	0.51	0.00	
12:12	2.07	10.12	34.76	0.47	0.01	
12:13	2.07	10.19	34.95	0.48	0.02	
12:14	2.01	10.17	34.84	0.47	0.01	
12:15	2.04	10.18	34.72	0.47	0.02	
12:16	1.99	10.17	35.15	0.46	0.02	
12:17	2.06	10.20	35.69	0.48	0.02	
12:18	2.08	10.18	35.70	0.45	0.04	
12:19	2.07	10.15	35.88	0.43	0.02	
12:20	2.01	10.14	35.85	0.43	0.00	
12:21	1.99	10.19	35.73	0.45	0.04	
12:22	2.05	10.23	35.76	0.45	0.04	
12:23	2.05	10.22	35.81	0.44	0.04	
12:24	2.04	10.18	35.68	0.44	0.02	
12:25	2.01	10.17	35.72	0.44	0.06	
12:26	2.01	10.19	35.35	0.42	0.06	
12:27	2.04	10.20	35.27	0.42	0.05	
12:28	2.08	10.21	35.24	0.45	0.01	
12:29	2.05	10.22	35.17	0.43	0.03	
12:30	1.94	10.21	35.07	0.43	0.04	
12:31	2.03	10.21	35.08	0.43	0.04	
Average	2.03	10.19	35.34	0.45	0.03	

Norawich T.

(Mr. Worawich Tongpoom)

Environmental Field Scientist (2)

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CEMs Opacity Data

Client Name Map Ta Phut Olefins Co., Ltd.
Plant Name MOC

Date 21-Mar-24
Location Utility Boiler Stack 2 (Boiler B)

Run No.1		Run No.2		Run No.3	
Time	Opacity (%)	Time	Opacity (%)	Time	Opacity (%)
10:40	18.03	11:40	18.26	12:40	18.80
10:41	18.03	11:41	18.62	12:41	18.80
10:42	17.82	11:42	18.62	12:42	19.14
10:43	17.82	11:43	18.42	12:43	18.50
10:44	17.89	11:44	18.42	12:44	18.50
10:45	17.89	11:45	18.66	12:45	18.30
10:46	17.73	11:46	18.66	12:46	18.06
10:47	17.73	11:47	18.99	12:47	18.06
10:48	17.68	11:48	19.28	12:48	18.33
10:49	17.68	11:49	19.28	12:49	18.33
10:50	17.96	11:50	19.23	12:50	18.68
10:51	17.96	11:51	19.23	12:51	19.05
10:52	17.82	11:52	19.07	12:52	19.05
10:53	17.82	11:53	18.83	12:53	18.75
10:54	18.10	11:54	18.83	12:54	19.23
10:55	18.10	11:55	18.73	12:55	19.23
10:56	18.03	11:56	18.96	12:56	19.40
10:57	18.03	11:57	18.96	12:57	19.14
10:58	18.11	11:58	18.92	12:58	18.71
10:59	18.11	11:59	18.92	12:59	18.20
11:00	18.21	12:00	18.41	13:00	17.85
11:01	18.21	12:01	18.81	13:01	17.63
11:02	18.40	12:02	18.97	13:02	17.25
11:03	18.11	12:03	18.97	13:03	16.95
11:04	18.11	12:04	18.90	13:04	16.63
11:05	18.04	12:05	18.90	13:05	17.01
11:06	18.04	12:06	18.91	13:06	17.49
11:07	18.01	12:07	19.24	13:07	17.87
11:08	18.01	12:08	19.24	13:08	17.87
11:09	18.04	12:09	19.33	13:09	17.82
11:10	18.04	12:10	19.33	13:10	17.56
11:11	18.08	12:11	18.91	13:11	17.27
11:12	18.08	12:12	18.91	13:12	17.27
11:13	18.01	12:13	19.11	13:13	17.47
11:14	18.01	12:14	19.43	13:14	17.52
11:15	17.90	12:15	19.43	13:15	17.52
11:16	17.90	12:16	19.52	13:16	17.62
11:17	17.83	12:17	19.52	13:17	17.62
11:18	18.04	12:18	19.53	13:18	17.48
11:19	18.04	12:19	19.26	13:19	17.48
11:20	18.05	12:20	19.26	13:20	17.54
11:21	18.05	12:21	18.86	13:21	16.81
11:22	18.20	12:22	18.86	13:22	17.14
11:23	18.20	12:23	18.90	13:23	17.14
11:24	18.43	12:24	18.90	13:24	17.12
11:25	18.43	12:25	19.04	13:25	16.88
11:26	18.34	12:26	19.32	13:26	17.15
11:27	18.68	12:27	19.32	13:27	17.15
11:28	18.68	12:28	19.04	13:28	17.29
Avg.	18.05	Avg.	19.01	Avg.	17.91



CEMs Opacity Data

Client Name Map Ta Phut Olefins Co., Ltd.
Plant Name -

Date 2-Apr-24
Location Utility Boiler Stack 3 (Boiler C)

Run No.1		Run No.2		Run No.3	
Time	Opacity (%)	Time	Opacity (%)	Time	Opacity (%)
11:10	21.35	12:00	20.11	12:50	20.04
11:11	21.35	12:01	20.11	12:51	19.78
11:12	21.55	12:02	20.14	12:52	20.04
11:13	21.55	12:03	20.43	12:53	19.78
11:14	21.64	12:04	20.14	12:54	20.04
11:15	21.24	12:05	20.46	12:55	19.78
11:16	20.97	12:06	20.46	12:56	20.04
11:17	20.72	12:07	20.46	12:57	19.78
11:18	20.46	12:08	20.46	12:58	20.04
11:19	20.71	12:09	20.83	12:59	18.82
11:20	20.71	12:10	20.83	13:00	18.82
11:21	20.84	12:11	20.84	13:01	18.95
11:22	20.84	12:12	20.84	13:02	19.62
11:23	20.93	12:13	20.23	13:03	19.14
11:24	20.62	12:14	20.23	13:04	19.14
11:25	21.04	12:15	20.23	13:05	19.43
11:26	21.04	12:16	20.34	13:06	19.14
11:27	20.86	12:17	20.54	13:07	19.75
11:28	21.12	12:18	20.51	13:08	19.31
11:29	21.12	12:19	20.72	13:09	19.05
11:30	21.03	12:20	20.94	13:10	19.05
11:31	21.03	12:21	20.56	13:11	19.03
11:32	21.04	12:22	20.19	13:12	19.03
11:33	21.04	12:23	20.19	13:13	19.24
11:34	20.97	12:24	20.46	13:14	19.58
11:35	20.97	12:25	19.91	13:15	19.30
11:36	20.94	12:26	19.63	13:16	19.52
11:37	20.94	12:27	19.68	13:17	19.23
11:38	21.16	12:28	19.27	13:18	19.23
11:39	21.16	12:29	19.27	13:19	19.24
11:40	21.13	12:30	19.36	13:20	19.63
11:41	21.13	12:31	19.36	13:21	19.85
11:42	21.28	12:32	19.32	13:22	20.33
11:43	21.28	12:33	19.24	13:23	20.33
11:44	21.32	12:34	19.45	13:24	20.14
11:45	21.23	12:35	19.45	13:25	19.91
11:46	21.14	12:36	19.51	13:26	19.91
11:47	20.85	12:37	19.52	13:27	19.84
11:48	20.85	12:38	19.94	13:28	19.84
11:49	20.35	12:39	20.19	13:29	20.01
11:50	20.62	12:40	20.19	13:30	20.01
11:51	20.84	12:41	19.88	13:31	20.22
11:52	20.84	12:42	20.10	13:32	19.97
Avg.	21.02	Avg.	20.10	Avg.	19.60



Lab No. 2432728-1

ANALYZER CALIBRATION DATA

Client Map Ta Phut Olefins Co., Ltd. Location Naphtha Cracking Heater Stack 1 H-100A
Date 02 Apr 24 Test Operator Anuvat M.

O₂ ANALYZER
Model TELEDYNE API T200H Serial No. 922
Span (%) 25

	Cylinder Value (%)	Initial Analyzers Calibration Response (%)	Final Analyzers Calibration Response (%)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.00	0.00
Low-Level Gas	6.00	7.00	6.10	0.80
Span Gas	10.00	15.00	15.00	0.40

NO_x ANALYZER
Model TELEDYNE API T200H Serial No. 922
Span (ppm) 100

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.00	0.00
Low-Level Gas	54.00	55.00	55.30	0.30
Span Gas	80.75	80.20	80.00	0.20

Calibrated by

Anuvat M.

(Mr. Anuvat Meungpair)
Environmental Field Scientist (2)



Lab No. 2432728-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client Map Ta Phut Olefins Co., Ltd. Location Naphtha Cracking Heater Stack 1 H-100A
Date 02 Apr 24 Test Operator Anuvat M.

O₂ ANALYZER
Cylinder Conc. (%) 10.06 Span (%) 25

	O ₂ Analyzer Calibration Response	Initial Values System Calibration Response	System Cal Bias (% of Span)	Final Values System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.00	0.00	0.00	0.00	0.00	0.00
Upscale Gas	15.00	15.00	0.00	15.10	1.20	0.40

NO_x ANALYZER
Cylinder Conc. (ppm) 80.75 Span (ppm) 100

	NO _x Analyzer Calibration Response	Initial Values System Calibration Response	System Cal Bias (% of Span)	Final Values System Calibration Response	System Cal Bias (% of Span)	Drift (% of Span)
Zero Gas	0.00	0.00	0.00	0.00	0.00	0.00
Upscale Gas	80.20	79.80	0.40	80.00	0.20	0.20

Calibrated by

Anuvat M.

(Mr. Anuvat Meungpair)
Environmental Field Scientist (2)



CEMs Data

Date		27 Apr 24				
Location		Harpine Graveling Station, 8 mi S of Tule				
Run No.	2	Time Base: 27 Apr 24				
Date	Time	2002 ppm	2004 ppm	2005 ppm	2006 ppm	2007 ppm
27 Apr 24	10:21		36.68		3.78	
27 Apr 24	12:19		36.68		3.78	
27 Apr 24	12:23		36.67		3.78	
27 Apr 24	12:24		36.68		3.78	
27 Apr 24	12:28		36.68		3.78	
27 Apr 24	12:28		36.68		3.84	
27 Apr 24	12:27		36.68		3.84	
27 Apr 24	12:28		36.68		3.84	
27 Apr 24	12:28		36.64		3.87	
27 Apr 24	12:30		36.67		3.89	
27 Apr 24	12:31		36.67		3.93	
27 Apr 24	12:32		36.67		3.94	
27 Apr 24	12:33		36.68		3.95	
27 Apr 24	12:34		36.67		3.93	
27 Apr 24	12:38		36.68		3.99	
27 Apr 24	12:39		36.67		3.98	
27 Apr 24	12:39		36.70		3.98	
27 Apr 24	12:39		36.70		3.98	
27 Apr 24	12:39		36.70		3.98	
27 Apr 24	12:41		36.70		3.98	
Max			36.69		3.78	

Run No. 4		Time Base					
Date	Time	200 ft/min	1000 ft/min	500 ft/min	200 ft/min	100 ft/min	50 ft/min
27 Jan 24	13:03		20.71			9.61	
27 Jan 24	13:04		20.71			9.52	
27 Jan 24	13:05		20.67			9.50	
27 Jan 24	13:06		20.68			9.54	
27 Jan 24	13:07		20.67			9.54	
27 Jan 24	13:08		20.58			9.51	
27 Jan 24	13:09		20.20			9.38	
27 Jan 24	13:10		20.18			9.40	
27 Jan 24	13:11		20.18			9.25	
27 Jan 24	13:12		20.07			9.40	
27 Jan 24	13:13		20.07			9.51	
27 Jan 24	13:14		20.60			9.40	
27 Jan 24	13:15		20.45			9.45	
27 Jan 24	13:17		20.39			9.43	
27 Jan 24	13:18		20.34			9.43	
27 Jan 24	13:19		20.38			9.43	
27 Jan 24	13:20		20.18			9.43	
27 Jan 24	13:21		20.18			9.43	
27 Jan 24	13:22		20.19			9.43	
27 Jan 24	13:23		20.20			9.51	
Mon		20.84					
Tue		20.28					

Start Date		Time Base					
Date	Time	2002 gpm	2003 gpm	2004 gpm	2005 gpm	2006 gpm	2007 gpm
27 Jun '04	15:40		33.49				8.93
27 Jun '04	15:46		33.46				8.84
27 Jun '04	15:47		33.47				8.86
27 Jun '04	15:48		33.48				8.85
27 Jun '04	15:50		33.50				8.88
27 Jun '04	15:51		33.51				8.88
27 Jun '04	15:52		33.52				8.90
27 Jun '04	15:53		33.53				8.91
27 Jun '04	15:55		33.55				8.92
27 Jun '04	15:56		33.56				8.94
27 Jun '04	15:58		33.58				8.93
27 Jun '04	15:59		33.59				8.94
27 Jun '04	16:00		33.60				8.95
27 Jun '04	16:01		33.61				8.96
27 Jun '04	16:02		33.62				8.97
27 Jun '04	16:03		33.63				8.98
27 Jun '04	16:04		33.64				8.99
27 Jun '04	16:06		33.66				9.07
Mean			34.08				9.01
			33.63				8.96

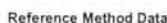


CEMs Data:

ALS											
Client Name		Map To Mail Climates Co. Ltd				Date		27 Jun 24			
Plant Name		100%				Location		Napping Cracking / 2000 / 3000 / 10000			
Run No 7		Time Base: 2015				Run No 8		Time Base: 2015			
Date	Time	300	500	1000	1000	Date	Time	300	500	1000	1000
		ppm	ppm	ppm	ppm			ppm	ppm	ppm	ppm
				100%	100%					100%	100%
27 Jun 24	14:06		10.90		1.40	27 Jun 24	14:27	10.20		9.40	
27 Jun 24	14:07		10.75		1.37	27 Jun 24	14:28	10.40		9.50	
27 Jun 24	14:08		10.50		1.42	27 Jun 24	14:29	10.20		9.50	
27 Jun 24	14:09		10.40		1.40	27 Jun 24	14:30	10.40		9.40	
27 Jun 24	14:10		10.30		1.40	27 Jun 24	14:31	10.20		9.50	
27 Jun 24	14:11		10.70		1.36	27 Jun 24	14:32	10.30		9.40	
27 Jun 24	14:12		10.70		1.42	27 Jun 24	14:33	10.40		9.40	
27 Jun 24	14:13		10.90		1.40	27 Jun 24	14:34	10.40		9.40	
27 Jun 24	14:14		10.70		1.40	27 Jun 24	14:35	10.20		9.40	
27 Jun 24	14:15		10.60		1.44	27 Jun 24	14:36	10.20		9.40	
27 Jun 24	14:16		10.50		1.44	27 Jun 24	14:37	10.20		9.40	
27 Jun 24	14:17		10.70		1.40	27 Jun 24	14:38	10.20		9.40	
27 Jun 24	14:18		10.60		1.40	27 Jun 24	14:39	10.20		9.40	
27 Jun 24	14:19		10.40		1.40	27 Jun 24	14:40	10.20		9.40	
27 Jun 24	14:20		10.40		1.40	27 Jun 24	14:41	10.20		9.40	
27 Jun 24	14:21		10.60		1.40	27 Jun 24	14:42	10.20		9.40	
27 Jun 24	14:22		10.40		1.40	27 Jun 24	14:43	10.20		9.40	
27 Jun 24	14:23		10.60		1.40	27 Jun 24	14:44	10.20		9.40	
27 Jun 24	14:24		10.40		1.40	27 Jun 24	14:45	10.20		9.40	
27 Jun 24	14:25		10.40		1.40	27 Jun 24	14:46	10.20		9.40	
27 Jun 24	14:26		10.40		1.40	27 Jun 24	14:47	10.20		9.40	
27 Jun 24	14:27		10.40		1.40	27 Jun 24	14:48	10.20		9.40	
27 Jun 24	14:28		10.40		1.40	27 Jun 24	14:49	10.20		9.40	
27 Jun 24	14:29		10.40		1.40	27 Jun 24	14:50	10.20		9.40	
27 Jun 24	14:30		10.40		1.40	27 Jun 24	14:51	10.20		9.40	
27 Jun 24	14:31		10.40		1.40	27 Jun 24	14:52	10.20		9.40	
27 Jun 24	14:32		10.40		1.40	27 Jun 24	14:53	10.20		9.40	
27 Jun 24	14:33		10.40		1.40	27 Jun 24	14:54	10.20		9.40	
27 Jun 24	14:34		10.40		1.40	27 Jun 24	14:55	10.20		9.40	
27 Jun 24	14:35		10.40		1.40	27 Jun 24	14:56	10.20		9.40	
27 Jun 24	14:36		10.40		1.40	27 Jun 24	14:57	10.20		9.40	
27 Jun 24											

[illegible]

Run No. 11										Run No. 12									
Time Base: 21 min										Time Base: 21 min									
Date	Time	NO2	NO	CO	CO2	CO2	CO2	CO2	CO2	Date	Time	NO2	NO	CO	CO2	CO2	CO2	CO2	CO2
		ppb	ppb	ppm	ppm	ppm	ppm	ppm	ppm			ppb	ppb	ppm	ppm	ppm	ppm	ppm	ppm
27 Jun 24	18:30	12.87	1.88	1.88						27 Jun 24	18:31	22.63	3.88						
27 Jun 24	18:31	22.44	3.88							27 Jun 24	18:32	22.80	3.87						
27 Jun 24	18:32	22.44	3.88							27 Jun 24	18:33	22.80	3.87						
27 Jun 24	18:33	20.83	3.88	1.88						27 Jun 24	18:34	22.80	3.88						
27 Jun 24	18:34	22.32	3.87							27 Jun 24	18:35	22.84	3.87						
27 Jun 24	18:35	22.32	3.88							27 Jun 24	18:36	22.84	3.87						
27 Jun 24	18:36	22.32	3.88	1.88						27 Jun 24	18:37	22.84	3.88						
27 Jun 24	18:37	22.32	3.88							27 Jun 24	18:38	22.84	3.87						
27 Jun 24	18:38	22.32	3.88							27 Jun 24	18:39	22.84	3.87						
27 Jun 24	18:39	22.32	3.88	1.88						27 Jun 24	18:40	22.84	3.87						
27 Jun 24	18:40	22.32	3.88							27 Jun 24	18:41	22.84	3.87						
27 Jun 24	18:41	22.32	3.88							27 Jun 24	18:42	22.84	3.87						
27 Jun 24	18:42	22.32	3.88							27 Jun 24	18:43	22.84	3.87						
27 Jun 24	18:43	22.32	3.88	1.88						27 Jun 24	18:44	22.84	3.87						
27 Jun 24	18:44	22.32	3.88							27 Jun 24	18:45	22.84	3.87						
27 Jun 24	18:45	22.32	3.88							27 Jun 24	18:46	22.84	3.87						
27 Jun 24	18:46	22.32	3.88	1.88						27 Jun 24	18:47	22.84	3.87						
27 Jun 24	18:47	22.32	3.88							27 Jun 24	18:48	22.84	3.87						
27 Jun 24	18:48	22.32	3.88							27 Jun 24	18:49	22.84	3.87						
27 Jun 24	18:49	22.32	3.88	1.88						27 Jun 24	18:50	22.84	3.87						
27 Jun 24	18:50	22.32	3.88							27 Jun 24	18:51	22.84	3.87						
27 Jun 24	18:51	22.32	3.88							27 Jun 24	18:52	22.84	3.87						
27 Jun 24	18:52	22.32	3.88	1.88						27 Jun 24	18:53	22.84	3.87						
27 Jun 24	18:53	22.32	3.88							27 Jun 24	18:54	22.84	3.87						
27 Jun 24	18:54	22.32	3.88							27 Jun 24	18:55	22.84	3.87						
27 Jun 24	18:55	22.32	3.88	1.88						27 Jun 24	18:56	22.84	3.87						
27 Jun 24	18:56	22.32	3.88							27 Jun 24	18:57	22.84	3.87						
27 Jun 24	18:57	22.32	3.88			</													



Reference Method Data

Date		27 Jun 24				
Location		Nephila Grackling Creek, Back 7, H-5500				
Run No	2	Time Base 22 min				
Date	Time	MO gpm	MO gpm	MO gpm	MO gpm	MO gpm
27 Jun 24	12:21		36.21		3.14	
27 Jun 24	12:22		36.21		3.17	
27 Jun 24	12:23		36.21		3.87	
27 Jun 24	12:24		36.21		3.40	
27 Jun 24	12:25		36.21		3.51	
27 Jun 24	12:26		36.21		3.40	
27 Jun 24	12:27		36.21		3.93	
27 Jun 24	12:28		36.21		3.96	
27 Jun 24	12:29		36.21		3.21	
27 Jun 24	12:30		36.21		3.26	
27 Jun 24	12:32		36.21		3.84	
27 Jun 24	12:33		36.21		3.24	
27 Jun 24	12:34		36.21		3.13	
27 Jun 24	12:36		36.21		3.08	
27 Jun 24	12:38		36.21		3.97	
27 Jun 24	12:39		36.21		3.13	
27 Jun 24	12:40		36.21		3.80	
27 Jun 24	12:41		36.21		3.84	
27 Jun 24	12:42		36.21		3.84	
27 Jun 24	12:43		36.21		3.89	
Mean			36.24		3.48	

Run No.		Time & State					
Date	Time	W2	W3	W4	W5	W6	W7
		gpm	gpm	gpm	gpm	gpm	gpm
27 Jan 24	13:02		67.47			7.74	
27 Jan 24	13:05		67.47			7.74	
27 Jan 24	13:08		67.47			7.74	
27 Jan 24	13:10		67.47			7.74	
27 Jan 24	13:12		67.47			7.74	
27 Jan 24	13:14		67.47			7.74	
27 Jan 24	13:16		67.47			7.74	
27 Jan 24	13:18		67.47			7.74	
27 Jan 24	13:20		67.47			7.74	
27 Jan 24	13:22		67.47			7.74	
27 Jan 24	13:24		67.47			7.74	
27 Jan 24	13:26		67.47			7.74	
27 Jan 24	13:28		67.47			7.74	
27 Jan 24	13:30		67.47			7.74	
27 Jan 24	13:32		67.47			7.74	
27 Jan 24	13:34		67.47			7.74	
27 Jan 24	13:36		67.47			7.74	
27 Jan 24	13:38		67.47			7.74	
27 Jan 24	13:40		67.47			7.74	
27 Jan 24	13:42		67.47			7.74	
27 Jan 24	13:44		67.47			7.74	
27 Jan 24	13:46		67.47			7.74	
27 Jan 24	13:48		67.47			7.74	
27 Jan 24	13:50		67.47			7.74	
27 Jan 24	13:52		67.47			7.74	
27 Jan 24	13:54		67.47			7.74	
27 Jan 24	13:56		67.47			7.74	
27 Jan 24	13:58		67.47			7.74	
27 Jan 24	14:00		67.47			7.74	
27 Jan 24	14:02		67.47			7.74	
27 Jan 24	14:04		67.47			7.74	
27 Jan 24	14:06		67.47			7.74	
27 Jan 24	14:08		67.47			7.74	
27 Jan 24	14:10		67.47			7.74	
27 Jan 24	14:12		67.47			7.74	
27 Jan 24	14:14		67.47			7.74	
27 Jan 24	14:16		67.47			7.74	
27 Jan 24	14:18		67.47			7.74	
27 Jan 24	14:20		67.47			7.74	
27 Jan 24	14:22		67.47			7.74	
27 Jan 24	14:24		67.47			7.74	
27 Jan 24	14:26		67.47			7.74	
27 Jan 24	14:28		67.47			7.74	
27 Jan 24	14:30		67.47			7.74	
27 Jan 24	14:32		67.47			7.74	
27 Jan 24	14:34		67.47			7.74	
27 Jan 24	14:36		67.47			7.74	
27 Jan 24	14:38		67.47			7.74	
27 Jan 24	14:40		67.47			7.74	
27 Jan 24	14:42		67.47			7.74	
27 Jan 24	14:44		67.47			7.74	
27 Jan 24	14:46		67.47			7.74	
27 Jan 24	14:48		67.47			7.74	
27 Jan 24	14:50		67.47			7.74	
27 Jan 24	14:52		67.47			7.74	
27 Jan 24	14:54		67.47			7.74	
27 Jan 24	14:56		67.47			7.74	
27 Jan 24	14:58		67.47			7.74	
27 Jan 24	15:00		67.47			7.74	
27 Jan 24	15:02		67.47			7.74	
27 Jan 24	15:04		67.47			7.74	
27 Jan 24	15:06		67.47			7.74	
27 Jan 24	15:08						

[illegible]

Reference Method Data

[illegible]

Run No.		Time & Date						Temp		Wind		Wave State		Wave Dir	
Run No.	Date	MO	DO	CO	MO	DO	CO	MO	DO	CO	MO	DO	CO	MO	DO
Run No.	Date	MO	DO	CO	MO	DO	CO	MO	DO	CO	MO	DO	CO	MO	DO
27	27 Jan	1960	1	27	1960	1	27	27 Jan	1960	1	27	27 Jan	1960	1	27
28	28 Jan	1960	1	28	1960	1	28	28 Jan	1960	1	28	28 Jan	1960	1	28
29	29 Jan	1960	1	29	1960	1	29	29 Jan	1960	1	29	29 Jan	1960	1	29
30	30 Jan	1960	1	30	1960	1	30	30 Jan	1960	1	30	30 Jan	1960	1	30
31	31 Jan	1960	1	31	1960	1	31	31 Jan	1960	1	31	31 Jan	1960	1	31
32	1 Feb	1960	2	1	1960	2	1	1 Feb	1960	2	1	1 Feb	1960	2	1
33	2 Feb	1960	2	2	1960	2	2	2 Feb	1960	2	2	2 Feb	1960	2	2
34	3 Feb	1960	2	3	1960	2	3	3 Feb	1960	2	3	3 Feb	1960	2	3
35	4 Feb	1960	2	4	1960	2	4	4 Feb	1960	2	4	4 Feb	1960	2	4
36	5 Feb	1960	2	5	1960	2	5	5 Feb	1960	2	5	5 Feb	1960	2	5
37	6 Feb	1960	2	6	1960	2	6	6 Feb	1960	2	6	6 Feb	1960	2	6
38	7 Feb	1960	2	7	1960	2	7	7 Feb	1960	2	7	7 Feb	1960	2	7
39	8 Feb	1960	2	8	1960	2	8	8 Feb	1960	2	8	8 Feb	1960	2	8
40	9 Feb	1960	2	9	1960	2	9	9 Feb	1960	2	9	9 Feb	1960	2	9
41	10 Feb	1960	2	10	1960	2	10	10 Feb	1960	2	10	10 Feb	1960	2	10
42	11 Feb	1960	2	11	1960	2	11	11 Feb	1960	2	11	11 Feb	1960	2	11
43	12 Feb	1960	2	12	1960	2	12	12 Feb	1960	2	12	12 Feb	1960	2	12
44	13 Feb	1960	2	13	1960	2	13	13 Feb	1960	2	13	13 Feb	1960	2	13
45	14 Feb	1960	2	14	1960	2	14	14 Feb	1960	2	14	14 Feb	1960	2	14
46	15 Feb	1960	2	15	1960	2	15	15 Feb	1960	2	15	15 Feb	1960	2	15
47	16 Feb	1960	2	16	1960	2	16	16 Feb	1960	2	16	16 Feb	1960	2	16
48	17 Feb	1960	2	17	1960	2	17	17 Feb	1960	2	17	17 Feb	1960	2	17
49	18 Feb	1960	2	18	1960	2	18	18 Feb	1960	2	18	18 Feb	1960	2	18
50	19 Feb	1960	2	19	1960	2	19	19 Feb	1960	2	19	19 Feb	1960	2	19
51	20 Feb	1960	2	20	1960	2	20	20 Feb	1960	2	20	20 Feb	1960	2	20
52	21 Feb	1960	2	21	1960	2	21	21 Feb	1960	2	21	21 Feb	1960	2	21
53	22 Feb	1960	2	22	1960	2	22	22 Feb	1960	2	22	22 Feb	1960	2	22

Run No. 11							Time Based, 21 m/s							Run No. 12							Time Based, 21 m/s						
Date	Time	WCD	WCD	WCD	WCD	WCD	Date	Time	WCD	WCD	WCD	WCD	WCD	Date	Time	WCD	WCD	WCD	WCD	WCD	Date	Time	WCD	WCD	WCD	WCD	
		11.1	11.2	11.3	11.4	11.5			12.1	12.2	12.3	12.4	12.5			13.1	13.2	13.3	13.4	13.5			14.1	14.2	14.3	14.4	
27-Jun-24	18:26	12.81	12.81	12.81	12.81	12.81	27-Jun-24	18:31	12.81	12.81	12.81	12.81	12.81	27-Jun-24	18:31	12.81	12.81	12.81	12.81	12.81	27-Jun-24	18:31	12.81	12.81	12.81	12.81	
27-Jun-24	18:27	12.82	12.82	12.82	12.82	12.82	27-Jun-24	18:32	12.82	12.82	12.82	12.82	12.82	27-Jun-24	18:32	12.82	12.82	12.82	12.82	12.82	27-Jun-24	18:32	12.82	12.82	12.82	12.82	
27-Jun-24	18:28	12.83	12.83	12.83	12.83	12.83	27-Jun-24	18:33	12.83	12.83	12.83	12.83	12.83	27-Jun-24	18:33	12.83	12.83	12.83	12.83	12.83	27-Jun-24	18:33	12.83	12.83	12.83	12.83	
27-Jun-24	18:29	12.84	12.84	12.84	12.84	12.84	27-Jun-24	18:34	12.84	12.84	12.84	12.84	12.84	27-Jun-24	18:34	12.84	12.84	12.84	12.84	12.84	27-Jun-24	18:34	12.84	12.84	12.84	12.84	
27-Jun-24	18:30	12.85	12.85	12.85	12.85	12.85	27-Jun-24	18:35	12.85	12.85	12.85	12.85	12.85	27-Jun-24	18:35	12.85	12.85	12.85	12.85	12.85	27-Jun-24	18:35	12.85	12.85	12.85	12.85	
27-Jun-24	18:31	12.86	12.86	12.86	12.86	12.86	27-Jun-24	18:36	12.86	12.86	12.86	12.86	12.86	27-Jun-24	18:36	12.86	12.86	12.86	12.86	12.86	27-Jun-24	18:36	12.86	12.86	12.86	12.86	
27-Jun-24	18:32	12.87	12.87	12.87	12.87	12.87	27-Jun-24	18:37	12.87	12.87	12.87	12.87	12.87	27-Jun-24	18:37	12.87	12.87	12.87	12.87	12.87	27-Jun-24	18:37	12.87	12.87	12.87	12.87	
27-Jun-24	18:33	12.88	12.88	12.88	12.88	12.88	27-Jun-24	18:38	12.88	12.88	12.88	12.88	12.88	27-Jun-24	18:38	12.88	12.88	12.88	12.88	12.88	27-Jun-24	18:38	12.88	12.88	12.88	12.88	
27-Jun-24	18:34	12.89	12.89	12.89	12.89	12.89	27-Jun-24	18:39	12.89	12.89	12.89	12.89	12.89	27-Jun-24	18:39	12.89	12.89	12.89	12.89	12.89	27-Jun-24	18:39	12.89	12.89	12.89	12.89	
27-Jun-24	18:35	12.90	12.90	12.90	12.90	12.90	27-Jun-24	18:40	12.90	12.90	12.90	12.90	12.90	27-Jun-24	18:40	12.90	12.90	12.90	12.90	12.90	27-Jun-24	18:40	12.90	12.90	12.90	12.90	
27-Jun-24	18:36	12.91	12.91	12.91	12.91	12.91	27-Jun-24	18:41	12.91	12.91	12.91	12.91	12.91	27-Jun-24	18:41	12.91	12.91	12.91	12.91	12.91	27-Jun-24	18:41	12.91	12.91	12.91	12.91	
27-Jun-24	18:37	12.92	12.92	12.92	12.92	12.92	27-Jun-24	18:42	12.92	12.92	12.92	12.92	12.92	27-Jun-24													



Reference Method Data

Client Name		Map Ta Phut Olefins Co., Ltd.		Date		03 Apr 24		Location		Napthene Cracking Heater Stack 8 (H-120R)	
Plant Name		MOC		Time Base		21 min		Run No. 1		Time Base	
Date		SO ₂	NO _x	CO	CO ₂	CO ₂	CO ₂	Date		SO ₂	NO _x
ppm		ppm	ppm	ppm	ppm	ppm	ppm	ppm		ppm	ppm
%		%	%	%	%	%	%	%		%	%
Zero Gas		0.00	0.00	0.00	0.00	0.00	0.00	Zero Gas		0.00	0.00
Low-Level Gas		8.00	7.50	8.10	0.80	0.80	0.80	Low-Level Gas		8.00	7.50
Span Gas		16.00	15.00	15.90	0.40	0.40	0.40	Span Gas		16.00	15.00



Reference Method Data

Client Name		Map Ta Phut Olefins Co., Ltd.		Date		03 Apr 24		Location		Napthene Cracking Heater Stack 8 (H-120R)	
Plant Name		MOC		Time Base		21 min		Run No. 7		Time Base	
Date		SO ₂	NO _x	CO	CO ₂	CO ₂	CO ₂	Date		SO ₂	NO _x
ppm		ppm	ppm	ppm	ppm	ppm	ppm	ppm		ppm	ppm
%		%	%	%	%	%	%	%		%	%
Zero Gas		0.00	0.00	0.00	0.00	0.00	0.00	Zero Gas		0.00	0.00
Low-Level Gas		8.00	7.50	8.10	0.80	0.80	0.80	Low-Level Gas		8.00	7.50
Span Gas		16.00	15.00	15.90	0.40	0.40	0.40	Span Gas		16.00	15.00



Lot No. 2432742-1

ANALYZER CALIBRATION DATA

Client		Map Ta Phut Olefins Co., Ltd.		Date		03 Apr 24		Location		Recycle Cracking Heater (H-120R)	
Plant Name		MOC		Time Base		21 min		Run No. 1		Time Base	
Date		SO ₂	NO _x	CO	CO ₂	CO ₂	CO ₂	Date		SO ₂	NO _x
ppm		ppm	ppm	ppm	ppm	ppm	ppm	ppm		ppm	ppm
%		%	%	%	%	%	%	%		%	%
Zero Gas		0.00	0.00	0.00	0.00	0.00	0.00	Zero Gas		0.00	0.00
Low-Level Gas		8.00	7.50	8.10	0.80	0.80	0.80	Low-Level Gas		8.00	7.50
Span Gas		16.00	15.00	15.90	0.40	0.40	0.40	Span Gas		16.00	15.00



Lot No. 2432742-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client		Map Ta Phut Olefins Co., Ltd.		Date		03 Apr 24		Location		Recycle Cracking Heater (H-120R)	
Plant Name		MOC		Time Base		21 min		Run No. 1		Time Base	
Date		SO ₂	NO _x	CO	CO ₂	CO ₂	CO ₂	Date		SO ₂	NO _x
ppm		ppm	ppm	ppm	ppm	ppm	ppm	ppm		ppm	ppm
%		%	%	%	%	%	%	%		%	%
Zero Gas		0.00	0.00	0.00	0.00	0.00	0.00	Zero Gas		0.00	0.00
Low-Level Gas		8.00	7.50	8.10	0.80	0.80	0.80	Low-Level Gas		8.00	7.50
Span Gas		16.00	15.00	15.90	0.40	0.40	0.40	Span Gas		16.00	15.00

Calibrated by

Anuvut M.

(Mr. Anuvut Moungpair)

Environmental Field Scientist (2)

Calibrated by

Anuvut M.

(Mr. Anuvut Moungpair)

Environmental Field Scientist (2)



Date 05 Apr 24
Location Gas Cracking Furnace stack (H-8120A)

Run #1: 5						Time & Mass						Run #1: 6						Time & Mass					
Date	Time	MS	MS	MS	MS	Date	Time	MS	MS	MS	MS	Date	Time	MS	MS	MS	MS						
		g/g	g/g	g/g	g/g			g/g	g/g	g/g	g/g			g/g	g/g	g/g	g/g						
08 Apr 24	12:24		38.76		2.87	08 Apr 24	12:46		38.42		1.96	08 Apr 24	12:46		38.63		2.69						
08 Apr 24	12:25		38.99		2.91	08 Apr 24	12:47		38.63		2.69	08 Apr 24	12:47		38.79		2.61						
08 Apr 24	12:26		39.07		2.95	08 Apr 24	12:48		38.79		2.61	08 Apr 24	12:48		38.96		2.83						
08 Apr 24	12:27		38.76		3.08	08 Apr 24	12:49		38.96		2.83	08 Apr 24	12:49		39.22		2.84						
08 Apr 24	12:28		34.64		2.84	08 Apr 24	12:50		39.22		2.84	08 Apr 24	12:50		39.43		2.69						
08 Apr 24	12:29		34.64		2.84	08 Apr 24	12:51		39.43		2.69	08 Apr 24	12:51		39.62		2.84						
08 Apr 24	12:30		35.07		2.91	08 Apr 24	12:52		39.62		2.84	08 Apr 24	12:52		39.81		2.69						
08 Apr 24	12:31		35.07		2.91	08 Apr 24	12:53		39.81		2.69	08 Apr 24	12:53		39.98		2.84						
08 Apr 24	12:32		35.32		2.97	08 Apr 24	12:54		39.98		2.84	08 Apr 24	12:54		40.16		2.69						
08 Apr 24	12:33		35.07		2.78	08 Apr 24	12:55		40.16		2.69	08 Apr 24	12:55		40.34		2.68						
08 Apr 24	12:34		35.06		2.84	08 Apr 24	12:56		40.34		2.68	08 Apr 24	12:56		40.51		2.68						
08 Apr 24	12:35		35.06		2.68	08 Apr 24	12:57		40.51		2.68	08 Apr 24	12:57		40.68		2.68						
08 Apr 24	12:36		35.06		2.68	08 Apr 24	12:58		40.68		2.68	08 Apr 24	12:58		40.85		2.68						
08 Apr 24	12:37		35.06		2.68	08 Apr 24	12:59		40.85		2.68	08 Apr 24	12:59		41.02		2.68						
08 Apr 24	12:38		35.16		2.68	08 Apr 24	13:00		41.02		2.68	08 Apr 24	13:00		41.19		2.68						
08 Apr 24	12:39		35.16		2.68	08 Apr 24	13:01		41.19		2.68	08 Apr 24	13:01		41.36		2.68						
08 Apr 24	12:40		35.16		2.68	08 Apr 24	13:02		41.36		2.68	08 Apr 24	13:02		41.53		2.68						
08 Apr 24	12:41		35.09		2.68	08 Apr 24	13:03		41.53		2.68	08 Apr 24	13:03		41.70		2.68						
08 Apr 24	12:42		35.09		2.68	08 Apr 24	13:04		41.70		2.68	08 Apr 24	13:04		41.87		2.68						
08 Apr 24	12:43		35.21		2.68	08 Apr 24	13:05		41.87		2.68	08 Apr 24	13:05		42.04		2.68						
08 Apr 24	12:44		35.21		2.68	08 Apr 24	13:06		42.04		2.68	08 Apr 24	13:06		42.21		2.68						
Mass			58.86		2.75	Mass			58.78		2.67	Mass			58.78		2.67						



Date	05 Apr 24
Location	Gas Cracking Furnace stack (H-5120A)

Run No. 9							Run No. 10						
		Time Base 23 min							Time Base 23 min				
Run	Time	NO2	NOx	CO	CO2	CO2e	Run	Time	NO2	NOx	CO	CO2	CO2e
		ppm	ppm	ppm	ppm	ppm			ppm	ppm	ppm	ppm	ppm
9 Apr 24	13:46	-	38.93	-	2.03	-	9 Apr 24	14:06	36.76	-	2.04	-	-
9 Apr 24	13:49	-	38.94	-	2.07	-	9 Apr 24	14:11	36.77	-	2.04	-	-
9 Apr 24	13:50	-	38.84	-	2.04	-	9 Apr 24	14:11	36.77	-	2.04	-	-
9 Apr 24	13:51	-	38.81	-	2.01	-	9 Apr 24	14:12	36.75	-	2.04	-	-
9 Apr 24	13:52	-	38.82	-	2.00	-	9 Apr 24	14:13	36.74	-	2.04	-	-
9 Apr 24	13:53	-	38.76	-	2.01	-	9 Apr 24	14:14	36.75	-	2.05	-	-
9 Apr 24	13:54	38.77	-	2.05	-	-	9 Apr 24	14:15	36.82	-	2.07	-	-
9 Apr 24	13:54	38.74	12.04	2.04	-	-	9 Apr 24	14:16	36.78	-	2.06	-	-
9 Apr 24	13:59	38.16	-	2.11	-	-	9 Apr 24	14:17	36.78	-	2.06	-	-
9 Apr 24	13:57	-	38.19	-	2.08	-	9 Apr 24	14:18	36.79	-	2.07	-	-
9 Apr 24	13:58	-	38.19	-	2.11	-	9 Apr 24	14:18	36.78	-	2.06	-	-
9 Apr 24	14:01	-	38.15	-	2.11	-	9 Apr 24	14:20	36.78	-	2.07	-	-
9 Apr 24	14:03	-	38.13	-	2.11	-	9 Apr 24	14:21	36.79	-	2.07	-	-
9 Apr 24	14:04	-	38.13	-	2.11	-	9 Apr 24	14:22	36.79	-	2.07	-	-
9 Apr 24	14:05	-	38.87	-	2.08	-	9 Apr 24	14:23	36.20	-	2.07	-	-
9 Apr 24	14:07	-	38.72	-	2.08	-	9 Apr 24	14:24	36.21	-	2.07	-	-
9 Apr 24	14:08	-	38.16	-	2.05	-	9 Apr 24	14:25	36.37	-	2.02	-	-
9 Apr 24	14:09	-	38.19	-	2.06	-	9 Apr 24	14:26	36.36	-	2.03	-	-
9 Apr 24	14:10	-	38.19	-	2.06	-	9 Apr 24	14:27	36.24	-	2.14	-	-
9 Apr 24	14:11	-	38.12	-	2.02	-	9 Apr 24	14:28	36.30	-	2.06	-	-
9 Apr 24	14:12	-	38.12	-	2.02	-	9 Apr 24	14:29	36.30	-	2.06	-	-
9 Apr 24	14:13	38.11	-	2.02	-	-	9 Apr 24	14:30	36.30	-	2.04	-	-
9 Apr 24	14:14	38.13	-	2.04	-	-	9 Apr 24	14:31	36.38	-	2.01	-	-
9 Apr 24	14:15	38.13	-	2.04	-	-	9 Apr 24	14:32	36.38	-	2.01	-	-

Run: Apr 11						Time Base: 21 min						Run: No. 12						Time Base: 21 min					
Date	Time	Q02	Q04	Q05	Q02	Date	Time	Q02	Q04	Q05	Q02	Date	Time	Q02	Q04	Q05	Date	Time	Q02	Q04	Q05		
		ppm	ppm	ppm	%G			ppm	ppm	ppm	%G			ppm	ppm	ppm			ppm	ppm	%G		
08-Apr-24	14:30	38.94		2.01		08-Apr-24	14:31	38.94		2.01		08-Apr-24	14:32	38.94		2.01	08-Apr-24	14:33	38.94		2.01		
08-Apr-24	14:31	37.98		1.93		08-Apr-24	14:32	38.94		2.01		08-Apr-24	14:33	38.94		2.01	08-Apr-24	14:34	38.94		2.01		
08-Apr-24	14:32	38.71		2.04		08-Apr-24	14:33	38.94		2.01		08-Apr-24	14:34	38.94		2.01	08-Apr-24	14:35	38.94		2.01		
08-Apr-24	14:33	38.76		2.06		08-Apr-24	14:34	38.94		2.01		08-Apr-24	14:35	38.94		2.01	08-Apr-24	14:36	38.94		2.01		
08-Apr-24	14:34	38.74		2.11		08-Apr-24	14:35	38.94		2.01		08-Apr-24	14:36	38.94		2.01	08-Apr-24	14:37	38.94		2.01		
08-Apr-24	14:35	38.83		2.18		08-Apr-24	14:36	38.94		2.01		08-Apr-24	14:37	38.94		2.01	08-Apr-24	14:38	38.94		2.01		
08-Apr-24	14:36	38.83		2.18		08-Apr-24	14:37	38.94		2.01		08-Apr-24	14:38	38.94		2.01	08-Apr-24	14:39	38.94		2.01		
08-Apr-24	14:37	38.77		2.19		08-Apr-24	14:38	38.94		2.01		08-Apr-24	14:39	38.94		2.01	08-Apr-24	14:40	38.94		2.01		
08-Apr-24	14:38	38.63		2.11		08-Apr-24	14:39	38.94		2.01		08-Apr-24	14:40	38.94		2.01	08-Apr-24	14:41	38.94		2.01		
08-Apr-24	14:39	38.66		2.07		08-Apr-24	14:40	38.94		2.01		08-Apr-24	14:41	38.94		2.01	08-Apr-24	14:42	38.94		2.01		
08-Apr-24	14:40	38.66		2.07		08-Apr-24	14:41	38.94		2.01		08-Apr-24	14:42	38.94		2.01	08-Apr-24	14:43	38.94		2.01		
08-Apr-24	14:41	38.66		2.07		08-Apr-24	14:42	38.94		2.01		08-Apr-24	14:43	38.94		2.01	08-Apr-24	14:44	38.94		2.01		
08-Apr-24	14:42	38.68		2.08		08-Apr-24	14:43	38.94		2.01		08-Apr-24	14:44	38.94		2.01	08-Apr-24	14:45	38.94		2.01		
08-Apr-24	14:43	38.63		2.06		08-Apr-24	14:44	38.94		2.01		08-Apr-24	14:45	38.94		2.01	08-Apr-24	14:46	38.94		2.01		
08-Apr-24	14:44	38.64		2.06		08-Apr-24	14:45	38.94		2.01		08-Apr-24	14:46	38.94		2.01	08-Apr-24	14:47	38.94		2.01		
08-Apr-24	14:45	38.64		2.11		08-Apr-24	14:46	38.94		2.01		08-Apr-24	14:47	38.94		2.01	08-Apr-24	14:48	38.94		2.01		
08-Apr-24	14:46	38.66		2.10		08-Apr-24	14:47	38.94		2.01		08-Apr-24	14:48	38.94		2.01	08-Apr-24	14:49	38.94		2.01		
08-Apr-24	14:47	38.67		2.12		08-Apr-24	14:48	38.94		2.01		08-Apr-24	14:49	38.94		2.01	08-Apr-24	14:50	38.94		2.01		
08-Apr-24	14:48	38.69		2.13		08-Apr-24	14:49	38.94		2.01		08-Apr-24	14:50	38.94		2.01	08-Apr-24	14:51	38.94		2.01		
08-Apr-24	14:49	38.68		2.15		08-Apr-24	14:50	38.94		2.01		08-Apr-24	14:51	38.94		2.01	08-Apr-24	14:52	38.94		2.01		
08-Apr-24	14:50	38.75		2.17		08-Apr-24	14:51	38.94		2.01		08-Apr-24	14:52	38.94		2.01	08-Apr-24	14:53	38.94		2.01		
Max		38.94		2.18		Max		38.94		2.18		Max		38.94		2.18	Max		38.94		2.18		
Min		37.98		1.93		Min		37.98		1.93		Min		37.98		1.93	Min		37.98		1.93		

[illegible]

Date 05 Apr 24
Location Gas Cracking Furnace stack (H-8/20A)

[illegible]

Co., Ltd.

Date	05 Apr 24
Location	Gas Cracking Furnace stack (H-8120A)

Run Date: 11				Time & Date: 21:01				Run Date: 12				Time & Date: 21:01			
Date	Time	SSD	NOx	Date	Time	SSD	NOx	Date	Time	SSD	NOx	Date	Time	SSD	NOx
	ppm	%m	%m		ppm	%m	%m		ppm	%m	%m		ppm	%m	%m
05-Apr-24	14:50	36.28	2.03	05-Apr-24	14:51	36.43	2.19	05-Apr-24	14:51	36.43	2.19	05-Apr-24	14:51	36.43	2.19
05-Apr-24	14:51	36.43	2.19	05-Apr-24	14:52	36.58	2.14	05-Apr-24	14:52	36.58	2.14	05-Apr-24	14:52	36.58	2.14
05-Apr-24	14:52	36.58	2.14	05-Apr-24	14:53	36.73	2.03	05-Apr-24	14:53	36.73	2.03	05-Apr-24	14:53	36.73	2.03
05-Apr-24	14:53	36.73	2.03	05-Apr-24	14:54	36.88	2.08	05-Apr-24	14:54	36.88	2.08	05-Apr-24	14:54	36.88	2.08
05-Apr-24	14:54	36.88	2.08	05-Apr-24	14:55	37.03	2.04	05-Apr-24	14:55	37.03	2.04	05-Apr-24	14:55	37.03	2.04
05-Apr-24	14:55	37.03	2.04	05-Apr-24	14:56	37.18	2.09	05-Apr-24	14:56	37.18	2.09	05-Apr-24	14:56	37.18	2.09
05-Apr-24	14:56	37.18	2.09	05-Apr-24	14:57	37.33	2.14	05-Apr-24	14:57	37.33	2.14	05-Apr-24	14:57	37.33	2.14
05-Apr-24	14:57	37.33	2.14	05-Apr-24	14:58	37.48	2.11	05-Apr-24	14:58	37.48	2.11	05-Apr-24	14:58	37.48	2.11
05-Apr-24	14:58	37.48	2.11	05-Apr-24	14:59	37.63	2.06	05-Apr-24	14:59	37.63	2.06	05-Apr-24	14:59	37.63	2.06
05-Apr-24	14:59	37.63	2.06	05-Apr-24	15:00	37.78	2.01	05-Apr-24	15:00	37.78	2.01	05-Apr-24	15:00	37.78	2.01
05-Apr-24	15:00	37.78	2.01	05-Apr-24	15:01	37.93	1.96	05-Apr-24	15:01	37.93	1.96	05-Apr-24	15:01	37.93	1.96
05-Apr-24	15:01	37.93	1.96	05-Apr-24	15:02	38.08	1.91	05-Apr-24	15:02	38.08	1.91	05-Apr-24	15:02	38.08	1.91
05-Apr-24	15:02	38.08	1.91	05-Apr-24	15:03	38.23	1.86	05-Apr-24	15:03	38.23	1.86	05-Apr-24	15:03	38.23	1.86
05-Apr-24	15:03	38.23	1.86	05-Apr-24	15:04	38.38	1.81	05-Apr-24	15:04	38.38	1.81	05-Apr-24	15:04	38.38	1.81
05-Apr-24	15:04	38.38	1.81	05-Apr-24	15:05	38.53	1.76	05-Apr-24	15:05	38.53	1.76	05-Apr-24	15:05	38.53	1.76
05-Apr-24	15:05	38.53	1.76	05-Apr-24	15:06	38.68	1.71	05-Apr-24	15:06	38.68	1.71	05-Apr-24	15:06	38.68	1.71
05-Apr-24	15:06	38.68	1.71	05-Apr-24	15:07	38.83	1.66	05-Apr-24	15:07	38.83	1.66	05-Apr-24	15:07	38.83	1.66
05-Apr-24	15:07	38.83	1.66	05-Apr-24	15:08	38.98	1.61	05-Apr-24	15:08	38.98	1.61	05-Apr-24	15:08	38.98	1.61
05-Apr-24	15:08	38.98	1.61	05-Apr-24	15:09	39.13	1.56	05-Apr-24	15:09	39.13	1.56	05-Apr-24	15:09	39.13	1.56
05-Apr-24	15:09	39.13	1.56	05-Apr-24	15:10	39.28	1.51	05-Apr-24	15:10	39.28	1.51	05-Apr-24	15:10	39.28	1.51
05-Apr-24	15:10	39.28	1.51	05-Apr-24	15:11	39.43	1.46	05-Apr-24							

CERTIFICATE OF ANALYSIS

Grade of Product: EPA PROTOCOL STANDARD

Customer: AIR LIQUIDE
(THAILAND) LTD
Part Number: E04N199E3HA0066
Cylinder Number: GN0027222
Laboratory: 124 - Plumsteadville - PA
PGVP Number: A12022
Gas Code: CO,NO,NOX,SO2,BALN

Reference Number: 160-402340012-1
Cylinder Volume: 247.2 CF
Cylinder Pressure: 2215 PSIG
Valve Outlet: 660
Certification Date: Feb 09, 2022
Expiration Date: Feb 09, 2030

Certification performed in accordance with EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012) document EPA 600/R-12/51, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.
Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
NOX	55.00 PPM	55.88 PPM	G1	+/- 1.0% NIST Traceable	02/02/2022, 02/09/2022
CARBON MONOXIDE	55.00 PPM	55.22 PPM	G1	+/- 0.8% NIST Traceable	02/02/2022, 02/09/2022
NITRIC OXIDE	55.00 PPM	55.88 PPM	G1	+/- 1.0% NIST Traceable	02/02/2022, 02/09/2022
SULFUR DIOXIDE	55.00 PPM	55.30 PPM	G1	+/- 0.8% NIST Traceable	02/02/2022, 02/09/2022
NITROGEN	Balance				

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	09010212	KAL004777	98.46 PPM CARBON MONOXIDE/NITROGEN	+/- 0.5%	Oct 16, 2024
NTRM	200610-15	CC733106	98.61 PPM NITRIC OXIDE/NITROGEN	+/- 0.9%	Oct 06, 2026
GMIS	12420689139	CC323707	4.097 PPM NITROGEN DIOXIDE/NITROGEN	+/- 2.0%	Sep 03, 2024
NTRM	11010419	KAL004813	99.6 PPM SULFUR DIOXIDE/NITROGEN	+/- 0.8%	Jul 28, 2023

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nicel IS50 FTIR AUP2010245 CO	FTIR	Jan 06, 2022
Nicel IS50 FTIR AUP2010245 NO	FTIR	Jan 12, 2022
Nicel IS50 FTIR AUP2010245 NO2	FTIR	Jan 27, 2022
Nicel IS50 FTIR AUP2010245 SO2	FTIR	Jan 20, 2022

Triad Data Available Upon Request
NOTES: Gross Weight: 49.4 Kg
Net Weight: 8.4 Kg



Approved for Release

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CERTIFICATE OF ANALYSIS

Grade of Product: EPA PROTOCOL STANDARD

Customer: AIR LIQUIDE
(THAILAND) LTD
Part Number: E04N199E3HA0002
Cylinder Number: GN0027212
Laboratory: 124 - Plumsteadville - PA
PGVP Number: A12022
Gas Code: CO,NO,NOX,SO2,BALN

Reference Number: 160-402340013-1
Cylinder Volume: 247.2 CF
Cylinder Pressure: 2215 PSIG
Valve Outlet: 660
Certification Date: Feb 11, 2022
Expiration Date: Feb 11, 2030

Certification performed in accordance with EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012) document EPA 600/R-12/51, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.
Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
NOX	80.00 PPM	78.77 PPM	G1	+/- 1.0% NIST Traceable	02/04/2022, 02/11/2022
CARBON MONOXIDE	80.00 PPM	79.90 PPM	G1	+/- 0.8% NIST Traceable	02/04/2022, 02/11/2022
NITRIC OXIDE	80.00 PPM	79.77 PPM	G1	+/- 1.0% NIST Traceable	02/04/2022, 02/11/2022
SULFUR DIOXIDE	80.00 PPM	79.06 PPM	G1	+/- 0.9% NIST Traceable	02/04/2022, 02/11/2022
NITROGEN	Balance				

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	09010212	KAL004777	98.46 PPM CARBON MONOXIDE/NITROGEN	+/- 0.5%	Oct 16, 2024
NTRM	200610-15	CC733106	98.61 PPM NITRIC OXIDE/NITROGEN	+/- 0.9%	Oct 06, 2026
NTRM	200610-04	CC706044	98.61 PPM NITRIC OXIDE/NITROGEN	+/- 0.9%	Oct 06, 2026
GMIS	12420689139	CC323707	4.097 PPM NITROGEN DIOXIDE/NITROGEN	+/- 2.0%	Sep 03, 2024
NTRM	11010419	KAL004813	99.6 PPM SULFUR DIOXIDE/NITROGEN	+/- 0.8%	Jul 28, 2023

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nicel IS50 FTIR AUP2010245 CO	FTIR	Feb 03, 2022
Nicel IS50 FTIR AUP2010245 NO	FTIR	Feb 10, 2022
Nicel IS50 FTIR AUP2010245 NO2	FTIR	Jan 27, 2022
Nicel IS50 FTIR AUP2010245 SO2	FTIR	Jan 20, 2022

Triad Data Available Upon Request
NOTES: Gross Weight: 48.5 Kg
Net Weight: 8.1 Kg



CERTIFICATE OF ANALYSIS

Grade of Product: EPA PROTOCOL STANDARD

Customer: AIR LIQUIDE
(THAILAND) LTD
Part Number: E04N199E3HA0002
Cylinder Number: GN0027214
Laboratory: 124 - Plumsteadville - PA
PGVP Number: A12022
Gas Code: CO,NO,NOX,SO2,BALN

Reference Number: 160-402340013-1
Cylinder Volume: 247.2 CF
Cylinder Pressure: 2215 PSIG
Valve Outlet: 660
Certification Date: Feb 11, 2022
Expiration Date: Feb 11, 2030

Certification performed in accordance with EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012) document EPA 600/R-12/51, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.
Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
NOX	80.00 PPM	80.48 PPM	G1	+/- 1.0% NIST Traceable	12/14/2020, 12/22/2020
CARBON MONOXIDE	80.00 PPM	79.95 PPM	G1	+/- 0.8% NIST Traceable	12/14/2020, 12/22/2020
NITRIC OXIDE	80.00 PPM	80.47 PPM	G1	+/- 1.0% NIST Traceable	12/14/2020, 12/22/2020
SULFUR DIOXIDE	80.00 PPM	79.51 PPM	G1	+/- 0.8% NIST Traceable	12/14/2020, 12/22/2020
NITROGEN	Balance				

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	09010212	KAL004777	98.46 PPM CARBON MONOXIDE/NITROGEN	+/- 0.5%	Oct 16, 2024
NTRM	200610-15	CC733106	98.61 PPM NITRIC OXIDE/NITROGEN	+/- 0.9%	Oct 06, 2026
NTRM	200610-04	CC706044	98.61 PPM NITRIC OXIDE/NITROGEN	+/- 0.9%	Oct 06, 2026
GMIS	12420689139	CC323707	4.097 PPM NITROGEN DIOXIDE/NITROGEN	+/- 2.0%	Sep 03, 2024
NTRM	11010419	KAL004813	99.6 PPM SULFUR DIOXIDE/NITROGEN	+/- 0.8%	Jul 28, 2023

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nicel IS50 FTIR AUP2010245 CO	FTIR	Feb 03, 2022
Nicel IS50 FTIR AUP2010245 NO	FTIR	Feb 10, 2022
Nicel IS50 FTIR AUP2010245 NO2	FTIR	Jan 27, 2022
Nicel IS50 FTIR AUP2010245 SO2	FTIR	Jan 20, 2022

Triad Data Available Upon Request
NOTES: Gross Weight: 48.5 Kg
Net Weight: 8.1 Kg



Approved for Release

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CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Part Number: E04N199E15A0617
Cylinder Number: EB0140265
Laboratory: 124 - Plumsteadville - PA
PGVP Number: A12020
Gas Code: CO,NO,NOX,SO2,BALN

Reference Number: 160-401977168-1
Cylinder Volume: 144.4 CF
Cylinder Pressure: 2015 PSIG
Valve Outlet: 660
Certification Date: Dec 22, 2020
Expiration Date: Dec 22, 2028

Certification performed in accordance with EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012) document EPA 600/R-12/51, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.
Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
NOX	160.0 PPM	158.2 PPM	G1	+/- 0.7% NIST Traceable	12/14/2020, 12/22/2020
CARBON MONOXIDE	160.0 PPM	157.5 PPM	G1	+/- 0.5% NIST Traceable	12/14/2020, 12/22/2020
NITRIC OXIDE	160.0 PPM	156.1 PPM	G1	+/- 0.7% NIST Traceable	12/14/2020, 12/22/2020
SULFUR DIOXIDE	160.0 PPM	161.5 PPM	G1	+/- 1.0% NIST Traceable	12/14/2020, 12/22/2020
NITROGEN	Balance				

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	13010210	KAL003128	246.9 PPM CARBON MONOXIDE/NITROGEN	+/- 0.3%	Oct 16, 2024
PRM	12386	D6A0025	3.91 PPM AIR/NITROGEN DIOXIDE	2.0%	Feb 20, 2025
NTRM	13010302	KAL000522	240.4 PPM NITRIC OXIDE/NITROGEN	+/- 0.5%	May 04, 2026
GMIS	124206889	CC323707	4.028 PPM NITROGEN DIOXIDE/NITROGEN	± 1%	Aug 15, 2021
NTRM	10010212	AAL072873	255.3 PPM SULFUR DIOXIDE/NITROGEN	+/- 0.3%	Apr 28, 2022

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nicel 6700 APV1100391 CO	FTIR	Nov 30, 2020
Nicel 6700 APV1100391 NO	FTIR	Dec 02, 2020
Nicel 6700 APV1100391 NO2	FTIR	Dec 02, 2020
Nicel 6700 APV1100391 SO2	FTIR	Dec 10, 2020

Triad Data Available Upon Request
NOTES: Gross Weight: 21.7 Kg
Net Weight: 4.7 Kg



Approved for Release

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Airgas Specialty Gases
Airgas USA, LLC
6141 Easton Road
Bldg 2
Plumsteadville, PA 18949
airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Part Number: E04N189E15A0054
Cylinder Number: EB0136209
Laboratory: 124 - Plumsteadville - PA
PGVP Number: A12020
Gas Code: CO,NO,NOX,S02,BALN
Reference Number: 150-401907846-1
Cylinder Volume: 144.4 CF
Cylinder Pressure: 2015 PSIG
Valve Outlet: 550
Certification Date: Oct 06, 2020
Expiration Date: Oct 06, 2028

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 820R-12-021, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.

Do Not Use This Cylinder Below 100 psig, i.e. 6.7 megapascals

ANALYTICAL RESULTS				
Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty
NOX	55.00 PPM	54.84 PPM	G1	+/- 1.3% NIST Traceable
CARBON MONOXIDE	55.00 PPM	54.42 PPM	G1	+/- 0.8% NIST Traceable
NITRIC OXIDE	55.00 PPM	54.54 PPM	G1	+/- 1.3% NIST Traceable
SULFUR DIOXIDE	55.00 PPM	54.24 PPM	G1	+/- 1.0% NIST Traceable
NITROGEN	Balance			

CALIBRATION STANDARDS				
Type	Lot ID	Cylinder No	Concentration	Uncertainty
NTRM	11010130	KAL004536	97.31 PPM CARBON MONOXIDE/NITROGEN	+/- 0.4%
PRM	12365	D68525	9.91 PPM AIR/NITROGEN DIOXIDE	2.0%
NTRM	17050226	EB0079109	100.3 PPM NITRIC OXIDE/NITROGEN	+/- 1.0%
GMIS	124208889	CC323707	4.028 PPM NITROGEN DIOXIDE/NITROGEN	2.1%
NTRM	11010416	KAL004802	90.6 PPM SULFUR DIOXIDE/NITROGEN	+/- 0.8%
NTRM	15010203	KAL002087	97.69 PPM SULFUR DIOXIDE/NITROGEN	+/- 0.8%

ANALYTICAL EQUIPMENT		
Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nicolet iS50 FTIR AUP2010245 CO	FTIR	Sep 21, 2020
Nicolet iS50 FTIR AUP2010245 NO	FTIR	Sep 14, 2020
Nicolet iS50 FTIR AUP2010245 NO2	FTIR	Sep 22, 2020
Nicolet iS50 FTIR AUP2010245 SO2	FTIR	Sep 15, 2020

Triad Data Available Upon Request

NOTES: Gross Weight: 27.3 Kg. Net Weight: 4.6 Kg



Michael A. Huber
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Airgas Specialty Gases
Airgas USA, LLC
6141 Easton Road
Bldg 2
Plumsteadville, PA 18949
airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Part Number: E04N189E3HA0056
Cylinder Number: ND11215
Laboratory: 124 - Plumsteadville - PA
PGVP Number: A12021
Gas Code: CO,NO,NOX,S02,BALN
Reference Number: 150-402138464-1
Cylinder Volume: 247.2 CF
Cylinder Pressure: 2215 PSIG
Valve Outlet: 550
Certification Date: Jul 15, 2021
Expiration Date: Jul 15, 2029

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 820R-12-021, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.

Do Not Use This Cylinder Below 100 psig, i.e. 6.7 megapascals

ANALYTICAL RESULTS				
Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty
NOX	55.00 PPM	56.16 PPM	G1	+/- 1.4% NIST Traceable
CARBON MONOXIDE	55.00 PPM	54.32 PPM	G1	+/- 0.5% NIST Traceable
NITRIC OXIDE	55.00 PPM	55.16 PPM	G1	+/- 1.0% NIST Traceable
SULFUR DIOXIDE	55.00 PPM	55.56 PPM	G1	+/- 1.1% NIST Traceable
NITROGEN	Balance			

CALIBRATION STANDARDS				
Type	Lot ID	Cylinder No	Concentration	Uncertainty
NTRM	11010130	KAL004536	97.31 PPM CARBON MONOXIDE/NITROGEN	+/- 0.4%
PRM	12365	D68525	9.91 PPM AIR/NITROGEN DIOXIDE	2.0%
NTRM	200810-50	CC733426	56.81 PPM NITRIC OXIDE/NITROGEN	+/- 0.9%
GMIS	124208889	CC323707	4.028 PPM NITROGEN DIOXIDE/NITROGEN	2.1%
NTRM	18010224	KAL000838	97.68 PPM SULFUR DIOXIDE/NITROGEN	+/- 0.8%

The SRM, PRM or RQM noted above is only in reference to the GMS used in the assay and is not part of the analysis.

ANALYTICAL EQUIPMENT		
Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nicolet iS50 FTIR AUP2010245 CO	FTIR	Jun 24, 2021
Nicolet iS50 FTIR AUP2010245 NO	FTIR	Jul 01, 2021
Nicolet iS50 FTIR AUP2010245 NO2	FTIR	Jun 30, 2021
Nicolet iS50 FTIR AUP2010245 SO2	FTIR	Jul 09, 2021

Triad Data Available Upon Request

NOTES: Gross Weight: 47.9 Kg
Net Weight: 7.8 Kg



Michael A. Huber

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

CERTIFICATE OF ANALYSIS

Grade of Product: EPA PROTOCOL STANDARD

Customer: AIR LIQUIDE (THAILAND) LTD
Part Number: E02N182E3HA0000
Cylinder Number: GND027033
Laboratory: 124 - Plumsteadville - PA
PGVP Number: A12022
Gas Code: O2,BALN
Reference Number: 150-402340009-1
Cylinder Volume: 248.4 CF
Cylinder Pressure: 2214 PSIG
Valve Outlet: 590
Certification Date: Feb 10, 2022
Expiration Date: Feb 10, 2030

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 820R-12-021, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.

Do Not Use This Cylinder Below 100 psig, i.e. 6.7 megapascals

ANALYTICAL RESULTS				
Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty
OXYGEN	8.000 %	7.975 %	G1	+/- 0.4% NIST Traceable
NITROGEN	Balance			

CALIBRATION STANDARDS				
Type	Lot ID	Cylinder No	Concentration	Uncertainty
NTRM	10010535	K022176	5.967 % OXYGEN/NITROGEN	+/- 0.3%

ANALYTICAL EQUIPMENT		
Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
SIEMENS OXYMAT 6 - N1-W5-951 - O2	PARAMAGNETIC	Jan 27, 2022

Triad Data Available Upon Request

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



Michael A. Huber
Approved for Release

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

CERTIFICATE OF ANALYSIS

Grade of Product: EPA PROTOCOL STANDARD

Customer: AIR LIQUIDE (THAILAND) LTD
Part Number: E02N182E3HA0000
Cylinder Number: GND027004
Laboratory: 124 - Plumsteadville - PA
PGVP Number: A12022
Gas Code: O2,BALN
Reference Number: 150-402340009-1
Cylinder Volume: 248.4 CF
Cylinder Pressure: 2214 PSIG
Valve Outlet: 590
Certification Date: Feb 10, 2022
Expiration Date: Feb 10, 2030

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 820R-12-021, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.

Do Not Use This Cylinder Below 100 psig, i.e. 6.7 megapascals

ANALYTICAL RESULTS				
Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty
OXYGEN	8.000 %	8.000 %	G1	+/- 0.4% NIST Traceable
NITROGEN	Balance			

CALIBRATION STANDARDS				
Type	Lot ID	Cylinder No	Concentration	Uncertainty
NTRM	10010535	K022176	5.967 % OXYGEN/NITROGEN	+/- 0.3%

ANALYTICAL EQUIPMENT		
Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
SIEMENS OXYMAT 6 - N1-W5-951 - O2	PARAMAGNETIC	Jan 27, 2022

Triad Data Available Upon Request

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



Michael A. Huber
Approved for Release

Page 1 of 150-402340009-1

CERTIFICATE OF ANALYSIS

Grade of Product: EPA PROTOCOL STANDARD

Customer: AIR LIQUIDE (THAILAND) LTD
Part Number: E02N184E3HA0001
Cylinder Number: GN0027207
Laboratory: 124 - Plumsteadville - PA
PGVP Number: A12022
Gas Code: O2,BALN
Reference Number: 160-402340010-1
Cylinder Volume: 249.8 CF
Cylinder Pressure: 2214 PSIG
Valve Outlet: 590
Certification Date: Feb 02, 2022
Expiration Date: Feb 02, 2030

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 800/R-12/031, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.
Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS					
Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
OXYGEN	16.00 %	16.02 %	G1	+/- 0.4% NIST Traceable	02/02/2022
NITROGEN	Balance				
CALIBRATION STANDARDS					
Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	06010230	K005228	23.20 % OXYGEN/NITROGEN	+/- 0.4%	Jun 01, 2022
ANALYTICAL EQUIPMENT					
Instrument/Make/Model		Analytical Principle		Last Multipoint Calibration	
SIEMENS OXYMAT 6 - N1-W5-951 - O2		PARAMAGNETIC		Jan 27, 2022	

Triad Data Available Upon Request

NOTES: Gross Weight: 48.8 Kg
Net Weight: 5.2 Kg



Approved for Release

Page 1 of 160-402340010-1

CERTIFICATE OF ANALYSIS

Grade of Product: EPA PROTOCOL STANDARD

Customer: AIR LIQUIDE (THAILAND) LTD
Part Number: E02N184E3HA0001
Cylinder Number: GN0027201
Laboratory: 124 - Plumsteadville - PA
PGVP Number: A12022
Gas Code: O2,BALN
Reference Number: 160-402340010-1
Cylinder Volume: 249.8 CF
Cylinder Pressure: 2214 PSIG
Valve Outlet: 590
Certification Date: Feb 02, 2022
Expiration Date: Feb 02, 2030

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 800/R-12/031, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.
Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS					
Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
OXYGEN	16.00 %	16.04 %	G1	+/- 0.4% NIST Traceable	02/02/2022
NITROGEN	Balance				
CALIBRATION STANDARDS					
Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	06010230	K005228	23.20 % OXYGEN/NITROGEN	+/- 0.4%	Jun 01, 2022
ANALYTICAL EQUIPMENT					
Instrument/Make/Model		Analytical Principle		Last Multipoint Calibration	
SIEMENS OXYMAT 6 - N1-W5-951 - O2		PARAMAGNETIC		Jan 27, 2022	

Triad Data Available Upon Request

NOTES: Gross Weight: 48.8 Kg
Net Weight: 5.2 Kg



Approved for Release

Page 1 of 160-402340010-1

CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Part Number: E02N184E15A0787
Cylinder Number: CC740033
Laboratory: 124 - Plumsteadville - PA
PGVP Number: A12020
Gas Code: O2,BALN
Reference Number: 160-401946145-1
Cylinder Volume: 145.8 CF
Cylinder Pressure: 2015 PSIG
Valve Outlet: 590
Certification Date: Nov 11, 2020
Expiration Date: Nov 11, 2028

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 800/R-12/031, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.
Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS					
Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
OXYGEN	16.00 %	16.06 %	G1	+/- 0.2% NIST Traceable	11/11/2020
NITROGEN	Balance				
CALIBRATION STANDARDS					
Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	16060503	CC109542	23.204 % OXYGEN/NITROGEN	+/- 0.2%	Dec 24, 2021
ANALYTICAL EQUIPMENT					
Instrument/Make/Model		Analytical Principle		Last Multipoint Calibration	
SIEMENS OXYMAT 6 - N1-W5-951 - O2		PARAMAGNETIC		Oct 26, 2020	

Triad Data Available Upon Request

NOTES: Gross Weight: 27.6 Kg
Net Weight: 4.7 Kg



Approved for Release

Page 1 of 160-401946145-1

CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Part Number: E02N192E3HA0000
Cylinder Number: GN0025083
Laboratory: 124 - Plumsteadville - PA
PGVP Number: A12020
Gas Code: O2,BALN
Reference Number: 160-401948144-1
Cylinder Volume: 248.4 CF
Cylinder Pressure: 2214 PSIG
Valve Outlet: 590
Certification Date: Nov 11, 2020
Expiration Date: Nov 11, 2028

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 800/R-12/031, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.
Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS					
Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
OXYGEN	8.000 %	8.019 %	G1	+/- 0.3% NIST Traceable	11/11/2020
NITROGEN	Balance				
CALIBRATION STANDARDS					
Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	10010502	1D38055	9.967 % OXYGEN/NITROGEN	+/- 0.3%	Apr 18, 2022
ANALYTICAL EQUIPMENT					
Instrument/Make/Model		Analytical Principle		Last Multipoint Calibration	
SIEMENS OXYMAT 6 - N1-W5-951 - O2		PARAMAGNETIC		Oct 26, 2020	

Triad Data Available Upon Request

NOTES: Gross Weight: 48.1 Kg
Net Weight: 8.2 Kg



Approved for Release

Page 1 of 160-401948



CONSOLE CONTROL UNIT CALIBRATION TEST REPORT

Calibration of Data : 4 Jan 24
Next Cal. Date : 4 Jul 24

Barometric Pressure (mmHg) : 760
Relative Humidity (%) : 67.0
Temperature (°C) : 31.0

Reference Dry Gas Meter Data
Reference Dry Gas Meter ID : BKK_FS0629
Serial No. : 1807009
Correction Factor (%) : 1.0000
Next Calibration Date : 9 Jun 24

Console Control Meter Data
Calibration No. : C-040124-BKK_FS0396
Dry Gas Meter ID : BKK_FS0496
Serial No. : 1412087
Model No. : XC-572-V

Δt (mm-Hg)	Θ Minutes	Reference Dry Gas Meter Calibration						Console Control Dry Gas Meter						Dry Gas Meter Correction Factor (%)	Online Calibration Factor Δt Avg
		V ₁ (Liters)			T ₁ (°C)	V ₂ (Liters)			T ₂ (°C)	Avg T _m (°C)					
		Final	Initial	Total		Final	Initial	Total							
15	11.80	150.02	0.00	150.02	30.0	921286.4	921286.0	150.00	30.0	30.0	0.9969	42.5855			
25	9.13	150.06	0.00	150.06	31.0	921412.2	921292.0	150.00	31.0	31.0	0.9969	42.6644			
50	6.43	150.32	0.00	150.32	32.0	921385.0	921256.0	150.00	33.0	33.0	1.0005	42.1210			
80	5.11	150.33	0.00	150.33	33.0	921880.6	921830.0	150.00	34.0	34.0	0.9958	42.8973			
120	4.24	150.34	0.00	150.34	34.0	922238.2	922046.0	150.00	35.0	35.0	0.9927	44.2335			
											Avg	42.8602			

Y : Rate of reading of difference in dry gas meter. tolerance for individual values ± 0.02 from average.

X : Online calibration differential final results to 21.24 km of air @ 25°C and 760 mm of mercury. note: DO : tolerance for individual values ± 5 (km from average)

Provisional CFR (6 APP A.M.T.H.) SEC-5.3 & 7

Calibrated by

S Thongon

(Mr Suwicha Thong-On)

Field Scientist (2)

Approved by

S P

(Mr Samart Roongnan)

Field Specialist (1)

FORM NO. F 06-027 REVISION NO. 2 ISSUE DATE 30 Jun 23



Stopwatch Calibration Test Report

Calibration Date : 4 Jan 24
Barometric Pressure (mmHg) : 760
Relative Humidity (%) : 67.0

Next Cal. Date : 4 Jul 24
Temperature (°C) : 31.0

Reference Stopwatch Data
Stopwatch ID No. : E18061
Model : F808
Serial No. : -
Calibration Date : 8 Sep 20
Certificate No. : E-2009018

Console Control Meter Data
Dry Gas Meter No. : BKK_FS0498
Model : XC-572-V
Serial No. : 1452087

Run No.	Time Actual (m as ms)	Time Reading (m:ss)	Diff. (ms)	Diff. (min)
1	5:00:09	5:00	9	0.00015
2	5:00:10	5:00	10	0.00017
3	5:00:11	5:00	11	0.00018
4	5:00:10	5:00	10	0.00017
5	5:00:09	5:00	9	0.00015
6	5:00:09	5:00	9	0.00015
7	5:00:08	5:00	8	0.00013
8	5:00:10	5:00	10	0.00017
9	5:00:08	5:00	8	0.00015
10	5:00:10	5:00	10	0.00017
Average			0.00016	
SD			0.00001	

Calibrate by

S Thongon

Mr Suwicha Thong-On

Field Scientist (2)

Approved by

S P

Mr Samart Roongnan

Specialist (1)



DIGITAL TEMPERATURE CALIBRATION DATA SHEET

Calibration Date	4 Jan 24	Ambient Temperature (°C)	31
Calibration sheet No. :	C-040124-BKK_FS0497	Relative Humidity (%)	67
Digital Temperature ID :	BKK_FS0497	Reference Temperature ID	BKK_FS1144
Serial No.	1412087	Serial No.	20109006013
Model :	XC-572-V	Model	Digicon-CC-VT-MS
Next Calibrate		14 Aug 24	

Location	Reference Temperature °C	Digital Temperature °C	Error °C	MPE	Pass / Fail
Stack	0	1	1	±3	Pass
	25	25	0	±3	Pass
	50	50	0	±3	Pass
	100	101	1	±3	Pass
	150	151	1	±3	Pass
	200	199	-1	±3	Pass
	250	249	-1	±3	Pass
Probe	300	300	0	±3	Pass
	400	409	-1	±3	Pass
	500	501	1	±3	Pass
	120	120	0	±3	Pass
	140	140	0	±3	Pass
	160	161	1	±3	Pass
	180	181	1	±3	Pass
Oven	100	101	1	±3	Pass
	120	121	1	±3	Pass
	140	141	1	±3	Pass
	160	161	1	±3	Pass
	180	181	1	±3	Pass
	200	201	1	±3	Pass
	220	221	1	±3	Pass
Fillet	100	101	1	±3	Pass
	120	120	0	±3	Pass
	140	140	0	±3	Pass
	160	161	1	±3	Pass
	180	181	1	±3	Pass
	200	201	1	±3	Pass
	220	221	1	±3	Pass
Exit	0	0	0	±3	Pass
	10	10	0	±3	Pass
	20	20	0	±3	Pass
	30	30	0	±3	Pass
	40	40	0	±3	Pass
	50	50	0	±3	Pass
	60	60	0	±3	Pass
Meter	0	0	0	±3	Pass
	25	25	0	±3	Pass
	50	50	0	±3	Pass
	75	75	0	±3	Pass
	100	100	0	±3	Pass
	125	125	0	±3	Pass
	150	150	0	±3	Pass
AUX	0	1	1	±3	Pass
	25	26	1	±3	Pass
	50	51	1	±3	Pass
	75	76	1	±3	Pass
	100	101	1	±3	Pass
	125	126	1	±3	Pass
	150	151	1	±3	Pass

MPE : (Maximum permissible error of measurement) ค่าความผิดพลาดสูงสุดของการวัด

Calibrated by

S Thongon

(Mr Suwicha Thong-On)
Field Scientist (2)

Approved by

S P

(Mr Samart Roongnan)
Specialist (1)

FORM NO. F 06-027 REVISION NO. 2 ISSUE DATE 9 Feb 23

PROBE NOZZLE DIAMETER
CALIBRATION DATA SHEET

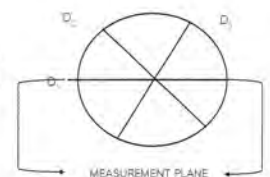
Calibration Date : 4 Jan 24	Nozzle Set ID : BKK_FS0502				
Calibration Sheet No. C-040124-BKK_FS0502	Vernier Caliper ID : RVG_FS0539				
Nozzle ID #	Nozzle Diameter (cm.)			Hi - Lo	(D ₁ + D ₂ + D ₃) / 3
	D ₁	D ₂	D ₃	ΔD	
1	0.315	0.315	0.315	0.000	0.315
2	0.475	0.475	0.475	0.000	0.475
3	0.530	0.530	0.530	0.000	0.530
4	0.635	0.635	0.635	0.000	0.635
5	0.790	0.790	0.790	0.000	0.790
6	0.950	0.950	0.950	0.000	0.950
7	1.110	1.110	1.110	0.000	1.110
8	1.270	1.270	1.270	0.000	1.270
9	1.600	1.600	1.600	0.000	1.600

Where:

D₁, D₂, D₃ : three different nozzle diameters at 60 degrees to each other, each measured to 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

S Thongon

Mr Suwicha Thong-On
Field Scientist (2)

Approved by

S P

(Mr Samart Roongnan)
Field Specialist (1)

FORM NO. F 06-027 REVISION NO. 2 ISSUE DATE 9 Feb 23



CONSOLE CONTROL UNIT CALIBRATION TEST REPORT

Calibration of Dato : 4 Jun 24
Next Cal. Date : 4 Jul 24

Barometric Pressure (mmHg) : 760
Relative Humidity (%) : 67.0
Temperature (C°) : 31.0

Reference Dry Gas Meter Data
Reference Dry Gas Meter ID : BKK_FS0629
Serial No. : 1807009
Correction Factor (Y) : 1.0000
Next Calibration Date : 9 Jun 24

Console Control Meter Data
Calibration No. : C-040124-BKK_FS0507
Dry Gas Meter ID : BKK_FS0507
Serial No. : 1503017
Model No. : XC-572-V

ΔH (mm H ₂ O)	Θ Minutes	Reference Dry Gas Meter Calibration					Console Control Dry Gas Meter					Dry Gas Meter Correction Factor (Y)	Office Calibration Facility ΔH ₀
		V ₁ (Liters)			T ₁ (°C)	V ₂ (Liters)			T ₂ (°C)	Avg T _m (°C)			
		Final	Initial	Total		Final	Initial	Total					
15	12.22	150.00	0.00	150.00	31.0	1248666.0	1248516.0	150.00	32.0	32.0	1.0018	49.820	
25	9.27	150.00	0.00	150.00	31.0	1248926.0	1248776.0	150.00	33.0	33.0	0.9975	43.671	
50	6.48	150.00	0.00	150.00	32.0	1248977.0	1248827.0	150.00	34.0	34.0	0.9980	42.821	
80	5.13	150.00	0.00	150.00	32.0	1249107.0	1248957.0	150.00	34.0	34.0	0.9957	42.803	
120	4.17	150.00	0.00	150.00	32.0	1249177.0	1249027.0	150.00	35.0	35.0	0.9851	42.821	
									Avg.		0.9917	43.5077	

Y : Rate of reading of substance to dry gas meter tolerance for individual values ± 0.07 from average.
ΔH₀ : Office pressure differential that results in 21.24 cm of air @ 25 °C and 760 mm of mercury, metered. Tolerance for individual values : 5.0% from average.
Procedure: 40 CFR 160 APP A MET11 SEC 5.3 & 7

Calibrated by : Navaphut S
(Mr. Navaphut Srivinya)
Field Scientist (2)

Approved by : S.P.
(Mr. Samart Roongnan)
Field Specialist (1)

FORM NO. F-04-027 REVISION NO. 2 (ISSUE DATE 9 Jan 22)



Stopwatch Calibration Test Report

Calibration Date : 4 Jan 24
Barometric Pressure (mmHg) : 760
Relative Humidity (%) : 67.0

Next Cal. Date : 4 Jul 24
Temperature (°C) : 31.0

Reference Stopwatch Data
Stopwatch ID No. : RYG_FS0540
Model : F808
Serial No. : E18061
Calibration Date : 9 Dec 22
Certificate No. : E-2009018

Console Control Meter Data
Dry Gas Meter No. : BKK_FS0507
Model : XC-572-V
Serial No. : 1503017

Run No.	Time Actual (m:ss.ms)	Time Reading (m:ss)	Diff. (ms)	Diff. (min)
1	5:00:10	5:00	10	0.00017
2	5:00:11	5:00	11	0.00018
3	5:00:11	5:00	11	0.00018
4	5:00:07	5:00	7	0.00012
5	5:00:07	5:00	7	0.00012
6	5:00:09	5:00	9	0.00015
7	5:00:11	5:00	11	0.00018
8	5:00:09	5:00	9	0.00015
9	5:00:10	5:00	10	0.00017
10	5:00:09	5:00	9	0.00015
Average				0.00016
SD				0.00003

Calibrate by : Navaphut S
Mr. Navaphut Srivinya
Field Scientist (2)

Approved by : S.P.
Mr. Samart Roongnan
Specialist (1)



DIGITAL TEMPERATURE CALIBRATION DATA SHEET

Calibration Date : 4 Jan 24		Ambient Temperature (°C) : 31			
Calibration sheet No. C-040124-BKK_FS0508		Relative Humidity (%) : 67			
Digital Temperature ID BKK_FS0508		Reference Temperature ID BKK_FS1144			
Serial No. 1503017		Serial No. 201000006013			
Model : XC-572-V		Model : Digicon-CC-VT-MS			
Next Calibrate :		14 Aug 24			
Location	Reference Temperature °C	Digital Temperature °C	Error °C	MPE	Pass / Fail
Stack	0	0	0	±3	Pass
	25	25	0	±3	Pass
	50	50	0	±3	Pass
	100	100	0	±3	Pass
	150	150	0	±3	Pass
	200	200	0	±3	Pass
Probe	250	249	-1	±3	Pass
	300	299	-1	±3	Pass
	500	498	-2	±3	Pass
	100	100	0	±3	Pass
	120	120	0	±3	Pass
	140	140	0	±3	Pass
Oven	100	100	0	±3	Pass
	120	120	0	±3	Pass
	140	140	0	±3	Pass
Filter	100	100	0	±3	Pass
	120	120	0	±3	Pass
	140	140	0	±3	Pass
Exit	0	0	0	±3	Pass
	10	10	0	±3	Pass
	20	20	0	±3	Pass
Meter	0	0	0	±3	Pass
	25	25	0	±3	Pass
	50	50	0	±3	Pass
AUX	0	0	0	±3	Pass
	25	25	0	±3	Pass
	50	50	0	±3	Pass

MPE : (Maximum permissible error of measurement) ค่าความผิดพลาดสูงสุดของเครื่องมือวัด

Calibrated by : Navaphut S
(Mr. Navaphut Srivinya)
Field Scientist (2)

Approved by : S.P.
(Mr. Samart Roongnan)
Specialist (1)

FORM NO. F-04-027 REVISION NO. 2 (ISSUE DATE 9 Feb 23)

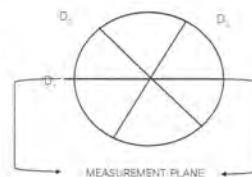


PROBE NOZZLE DIAMETER CALIBRATION DATA SHEET

Calibration Date : 4 Jan 24	Nozzle Set ID : BKK_FS0513
Calibration Sheet No. : C-040124-BKK_FS0513	Vernier Caliper ID : RYG_FS0539

Nozzle ID #	Nozzle Diameter (cm.)			Hi - Lo	(D ₁ + D ₂ + D ₃) / 3
	D ₁	D ₂	D ₃	ΔD	D _{avg}
1	0.315	0.315	0.315	0.000	0.315
2	0.475	0.475	0.475	0.000	0.475
3	0.530	0.530	0.530	0.000	0.530
4	0.635	0.635	0.635	0.000	0.635
5	0.790	0.790	0.790	0.000	0.790
6	0.950	0.950	0.950	0.000	0.950
7	1.110	1.110	1.110	0.000	1.110
8	1.270	1.270	1.270	0.000	1.270
9	1.600	1.600	1.600	0.000	1.600

Where:
D₁, D₂, D₃ : Three different nozzle diameters at 60 degrees to each other, each measured to 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 : Navaphut S
(Mr. Navaphut Srivinya)
Field Scientist (2)

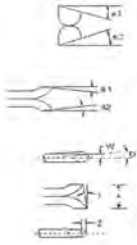
Approved by : S.P.
(Mr. Samart Roongnan)
Field Specialist (1)

FORM NO. F-04-027 REVISION NO. 2 (ISSUE DATE 9 Feb 23)



Type S Pitot Tube Calibration

Date Calibration 3-Jan-24 Due Date 3-Jul-24
 Pitot ID BKK_FS0453 Inclinator ID BKK_FS1131
 Pitot SN - Vernier ID SGK_FS0113



Parameter	Value	Allowable Range	Check
$\alpha 1$	-0.3	$-10^\circ < \alpha 1 < +10^\circ$	OK
$\alpha 2$	1.2	$-10^\circ < \alpha 2 < +10^\circ$	OK
$\beta 1$	-0.3	$-5^\circ < \beta 1 < +5^\circ$	OK
$\beta 2$	-1.5	$-5^\circ < \beta 2 < +5^\circ$	OK
γ	1.3	-	-
θ	0.2	-	-
$Z = A \tan \gamma$	0.021	$Z \leq 0.125"$	OK
$W = A \tan \theta$	0.003	$W \leq 0.031"$	OK
Dt	0.308	$0.188" \text{ to } 0.375"$	OK
A/2Dt	1.494	$1.05 \leq \text{PA/Dt} \leq 1.5$	OK
A	0.92	$2.1\text{Dt} \leq A \leq 3\text{Dt}$	OK

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

Calibrated by: Prasert S.
 (Mr. Prasert Surakhan)
 Enviro Field Services Scientist (3)

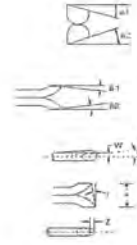
Approved By: S.P.
 (Mr. Samart Roo-ngan)
 Enviro Field Services Specialist (1)

FORM NO.: F-06-124 REVISION NO.: 0 ISSUE DATE: 25/12/23



Type S Pitot Tube Calibration

Date Calibration 16-Jan-24 Due Date 16-Jul-24
 Pitot ID BKK_FS0541 Inclinator ID BKK_FS1131
 Pitot SN - Vernier ID SGK_FS0113



Parameter	Value	Allowable Range	Check
$\alpha 1$	-2.3	$-10^\circ < \alpha 1 < +10^\circ$	OK
$\alpha 2$	6.8	$-10^\circ < \alpha 2 < +10^\circ$	OK
$\beta 1$	0.6	$-5^\circ < \beta 1 < +5^\circ$	OK
$\beta 2$	-1.6	$-5^\circ < \beta 2 < +5^\circ$	OK
γ	1	-	-
θ	-2.2	-	-
$Z = A \tan \gamma$	0.016	$Z \leq 0.125"$	OK
$W = A \tan \theta$	-0.035	$W \leq 0.031"$	OK
Dt	0.310	$0.188" \text{ to } 0.375"$	OK
A/2Dt	1.484	$1.05 \leq \text{PA/Dt} \leq 1.5$	OK
A	0.92	$2.1\text{Dt} \leq A \leq 3\text{Dt}$	OK

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

Calibrated by: Prasert S.
 (Mr. Prasert Surakhan)
 Enviro Field Services Scientist (3)

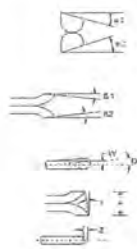
Approved By: S.P.
 (Mr. Samart Roo-ngan)
 Enviro Field Services Specialist (1)

FORM NO.: F-06-124 REVISION NO.: 0 ISSUE DATE: 25/12/23



Type S Pitot Tube Calibration

Date Calibration 4-Jan-24 Due Date 4-Jul-24
 Pitot ID BKK_FS0501 Inclinator ID BKK_FS1131
 Pitot SN - Vernier ID SGK_FS0113



Parameter	Value	Allowable Range	Check
$\alpha 1$	-1.4	$-10^\circ < \alpha 1 < +10^\circ$	OK
$\alpha 2$	1	$-10^\circ < \alpha 2 < +10^\circ$	OK
$\beta 1$	-0.2	$-5^\circ < \beta 1 < +5^\circ$	OK
$\beta 2$	-1.8	$-5^\circ < \beta 2 < +5^\circ$	OK
γ	-0.3	-	-
θ	-0.5	-	-
$Z = A \tan \gamma$	-0.005	$Z \leq 0.125"$	OK
$W = A \tan \theta$	-0.008	$W \leq 0.031"$	OK
Dt	0.375	$0.188" \text{ to } 0.375"$	OK
A/2Dt	1.227	$1.05 \leq \text{PA/Dt} \leq 1.5$	OK
A	0.92	$2.1\text{Dt} \leq A \leq 3\text{Dt}$	OK

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

Calibrated by: Prasert S.
 (Mr. Prasert Surakhan)
 Enviro Field Services Scientist (3)

Approved By: S.P.
 (Mr. Samart Roo-ngan)
 Enviro Field Services Specialist (1)

FORM NO.: F-06-124 REVISION NO.: 0 ISSUE DATE: 25/12/23



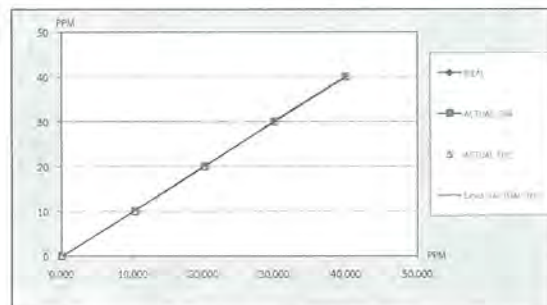
TEST REPORT

REVIEW BY: Vichai N.
 APPROVED BY: Jangjorn P.
 NEXT CAL DATE: 11/6/25

CUSTOMER NAME	ALS Laboratory Group (Thailand) Co., Ltd. (ผู้ให้บริการและเครื่องมือวัดคุณภาพอากาศ)		
EQUIPMENT NAME	THC Analyzer		
MANUFACTURER	HORIBA	MODEL	APHA-37D
SERIAL NO	WJ0059M		
STANDARD GAS CONCENTRATION (PPM)	506.1 PPM	CYLINDER NO	CC734375
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	MEASURED CH4	ACTUAL THC	ERROR THC	MEASURED THC
ZERO	0.000	0.00	0.000	-	0.00	0.000	-
1	10.000	10.30	0.300	3.00	10.29	0.290	2.90
2	20.000	20.20	0.200	1.00	20.09	0.090	0.45
3	30.000	30.01	0.010	0.03	30.10	0.100	0.33
4	40.000	39.90	-0.100	-0.25	39.89	-0.010	-0.02
AVERAGE (%)				0.95			0.91



CALIBRATED BY: Prasert S.
 CHECKED BY: Jangjorn P.
 DATE: 11/6/25

ผู้ให้บริการและเครื่องมือวัดคุณภาพอากาศ: ผู้ให้บริการและเครื่องมือวัดคุณภาพอากาศ โทร: 02-868-0812 # 15,16, E-MAIL: Engineer@pranatee.com
 ผู้ให้บริการและเครื่องมือวัดคุณภาพอากาศ: ผู้ให้บริการและเครื่องมือวัดคุณภาพอากาศ โทร: 02-868-0812 # 15,16, E-MAIL: Engineer@pranatee.com

NAC
NAC ASSOCIATES CO., LTD.

TEST REPORT

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
STANDARD GAS CONCENTRATION (PPM) (CH4) : 506.1 PPM CYLINDER NO : CC734373
CYLINDER PRESSURE (psig) : 1,600 PSI CERTIFIED DATE : 12/05/2020
CERTIFIED BY : AFGAS EXPIRED DATE : 12/05/2028

TEST RESULTS

POINT NO	IDEAL	ACTUAL CH4	ERROR CH4	ACTUAL THC	ERROR THC	MAJOR THC
ZERO	0.00	0.00	0.00	0.00	0.00	-
1	10.00	10.21	0.21	10.18	0.18	1.80
2	20.00	20.30	0.30	20.23	0.23	1.15
3	30.00	30.10	0.10	30.19	0.19	0.63
4	40.00	40.00	0.00	40.00	0.00	0.00
AVERAGE (%)			0.98		0.90	

REVIEW BY: Dr. J. J.
APPROVED BY: Dr. J. J.
NEXT CAL DATE: 10/05/28

CALIBRATED BY: Dr. J. J. DATE: 10/05/26
CHECKED BY: Dr. J. J. DATE: 10/05/26

ALSO ASSOCIATES CO., LTD.

10-EN-200 801/22-10-24

NAC
NAC ASSOCIATES CO., LTD.

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 (CH4)	mV	64.20	35.60
2	Signal (THC)	mV	68.10	64.70
3	Detector	Temp °C, Standard Value : Ambient temp±5°Cto±5°C	67.40	67.90
4	Amoient	Pressure kPa, Standard Value : (Ambient/1013x100-20) ±0.4°C	69.70	69.80
5	Purifire	kPa current atmospheric pressure	100.70	100.80
6	Purifire	°C, Standard Value : 390 °C to 430 °C	419.70	419.60
7	DC 24 V	kPa, Normal value : 6 kPa to 25 kPa	9.80	9.70
8	DC 5 V	°C, Standard Value : 230 °C to 260 °C	241.20	245.20
9	Bypass (Optional)	V, Standard Value : 24 V ± 0.5 V	23.90	23.90
10	Over Flow (Optional)	V, Standard Value : 5 V ± 0.5 V	5.00	5.00
11	CH4 Sampling Reading	L/min, Normal value : 0.9 L/min ± 0.3 L/min	-	-
12	FMHC Sampling Reading	L/min, Standard Value : 0.8 L/min or More	-	-
13	THC Sampling Reading	PPM	5.32	2.13
14	Zero Gas CH4/THC	PPM	0.11	0.45
15	Span Gas	PPM	5.43	2.60
16	Gas H2	PPM	0.17/0.17	0.00/0.00
17	Gas H2	20 PSI	54.63/55.20	40.00/40.00
18	Gas H2	20 PSI	20	20

Remark : Reference : EX-EN-017-56 , Ambient (HC Monitor APHA-370 Operation Manual Page #B1
Remark : (Ambient temperature = 3°C to 40°C)

การที่ตรวจพบ :
- Service Maintenance

รายละเอียดการดำเนินการ :
- เปลี่ยน Filter 52 mm , ทำ Calibration Zero/Span , Multipoint

ผลการดำเนินการ :
- ตรวจพบ เครื่องสามารถดำเนินการตรวจวัดได้ตามปกติ

CALIBRATED BY: Dr. J. J. DATE: 10/05/26
CHECKED BY: Dr. J. J. DATE: 10/05/26

ALSO ASSOCIATES CO., LTD.

10-EN-200 801/22-10-24

ALS

CALIBRATION REPORT

Calibration Date : 3-Jan-24 Equipment ID : BKK_FS0758
Equipment Name : FID Analyzer Manufacturer : Baseline Moon
Model : 9000H Serial No. : 0315EF0047
Std. Gas Conc. (ppm) : 152 Cylinder No. : D878173
Certified Date : 27-Jun-18 Expired Date : 27-Jun-28

CALIBRATION RESULTS

Point	Ideal	Actual	Error	%Error
ZERO	0.00	0.10	0.10	0.10
SPAN	152.00	151.20	-0.80	-0.53
AVERAGE (%)				-0.21

Calibrated By: Mr. Apieit Sing-ha
Approved By: Mr. Sarayuth Jitranont

(Mr. Apieit Sing-ha)
Field Environmental Scientist (4)

(Mr. Sarayuth Jitranont)
Assistant General Manager

Sartorius (Thailand) Co., Ltd.
129 Rama 9 Road, Huaykwang, Huaykwang, Bangkok 10310
Tel: +66 2543 8361-6, e-mail: service.thailand@sartorius.com

Certificate of Calibration

Model Number : SECURA224-1S Certificate No. : 238C10068
Description : Analytical Balance Issued Date : Friday, December 01, 2023
Serial Number : 0038304165 Reference No. : 223958
ID No. : BKK_EN0309 Page No. : 1 of 2
Manufacturer : Sartorius

Customer Name : ALS Laboratory Group (Thailand) Co., Ltd.
104 Phatthanakan 40, Phatthanakan Rd., Khwaeng Suan Luang, Khet Suan Luang, Bangkok 10250

Calibrated Place : Lab Room

Calibrated By : Mr. Chonchai Inthana
Calibration Date : Thursday, November 30, 2023

Calibration Procedure No. : This calibration was conducted by Using in-house calibration procedure number (WI-003)
Based on UKAS LAB 14 : 2019

Metrological data : Capacity : 220 g Readability : 0.0001 g
Reasons for calibration : ☐ New Installation ☐ Service / Repair ☒ Re-Calibration / Maintenance

Ambients Conditions : Temperature : 21.1 °C ± 5.0 °C
Humidity : 58.0 % RH ± 10.0 % RH
Pressure : ±

Equipment Condition : ☒ Good Operate ☐ Fair

Measurement Method UKAS Publication Ref : Lab 14
The measurement uncertainty stated is the expanded uncertainty which is obtained from the standard uncertainty multiplied by the coverage factor (k=2) to provide a level of confidence of approximately 95%. It is determined in accordance with the Guide to Expression of Uncertainty in Measurement (GUM). The calibration certificate documents the traceability to National Standards, which realise the unit of measurement according to the International Standard System of Units (SI). Report of Tolerance came from list of Sartorius Metrological Specifications.

Traceability:

Model Number	Description	Traceability	Certificate No.	Due Date
YCS011-522-00	Sartorius weight set 1mg - 5000g E2 YCS011-522-00	TCS	M2308197S	23-Aug-2025
MHB-382SD	Humidity/Barometer/Temp. Lutron MHB-382SD	DKSH	C19231845	23-Aug-2024

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

SOP FM 33 03 February 2022

Mr. Chonchai Inthana (Technical Manager)

STAMP

Certificate of Calibration

Model Number : SECURA224-1S Certificate No. : 23BCI0468
Description : Analytical Balance Issued Date : Friday, December 01, 2023
Serial Number : 0038304185 Reference No. : 223958
ID No. : BKK_EN0309
Manufacturer : Sartorius Page No. : 2 of 2

Calibration Results : Without Adjustment

Repeatability The reproducibility is the ability of a weighing instrument to display nearly identical readings under constant test conditions when the same load within a measurement series is placed repeatedly on the weighing pan in the same manner. The standard deviation is used to express reproducibility quantitatively.	Eccentricity (Off-center loading error) The off-center loading error is yielded by the difference between the readout of the load, i.e. 1/3 or 1/4 of maximum capacity, placed in the middle of the weighing pan and between each of four additional measurement points (positions defined according to OIML R110).																																																							
<table><tr><td>Nominal Value : (Low Load)</td><td>20.0000</td><td>199.9999</td></tr><tr><td>20 g</td><td>20.0000</td><td>200.0000</td></tr><tr><td>Tolerance</td><td>19.9999</td><td>200.0000</td></tr><tr><td>0.0001 g</td><td>19.9999</td><td>199.9999</td></tr><tr><td></td><td>20.0000</td><td>200.0000</td></tr><tr><td>Nominal Value : (High Load)</td><td>19.9999</td><td>200.0000</td></tr><tr><td>200 g</td><td>19.9999</td><td>199.9999</td></tr><tr><td>Tolerance</td><td>20.0000</td><td>199.9999</td></tr><tr><td>0.0001 g</td><td>20.0000</td><td>199.9999</td></tr><tr><td></td><td>20.0000</td><td>200.0000</td></tr><tr><td>Standard Deviation</td><td>0.00005</td><td>0.00005</td></tr></table>	Nominal Value : (Low Load)	20.0000	199.9999	20 g	20.0000	200.0000	Tolerance	19.9999	200.0000	0.0001 g	19.9999	199.9999		20.0000	200.0000	Nominal Value : (High Load)	19.9999	200.0000	200 g	19.9999	199.9999	Tolerance	20.0000	199.9999	0.0001 g	20.0000	199.9999		20.0000	200.0000	Standard Deviation	0.00005	0.00005	<table><tr><td>Nominal value :</td><td>100 g</td></tr><tr><td>Tolerance</td><td>0.0004 g</td></tr></table> <table><tr><td colspan="2">Difference</td></tr><tr><td>1</td><td>-</td></tr><tr><td>2</td><td>0.0000</td></tr><tr><td>3</td><td>0.0000</td></tr><tr><td>4</td><td>-0.0001</td></tr><tr><td>5</td><td>-0.0001</td></tr><tr><td>6</td><td>-</td></tr></table>	Nominal value :	100 g	Tolerance	0.0004 g	Difference		1	-	2	0.0000	3	0.0000	4	-0.0001	5	-0.0001	6	-				
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Linearity The linearity, also called linearity error, describes the deviation of the characteristic curve of a weighing instrument from the linear slope.																																																								
Tolerance 0.0002 g																																																								
<table><tr><th>Nominal Value (g)</th><th>Conventional Mass Value (g)</th><th>Displayed Value (g)</th><th>Deviation (g)</th><th>Uncertainty (g)</th></tr><tr><td>0.01</td><td>0.0100</td><td>0.0100</td><td>0.0000</td><td>0.00014</td></tr><tr><td>0.05</td><td>0.0500</td><td>0.0500</td><td>0.0000</td><td>0.00014</td></tr><tr><td>0.1</td><td>0.1000</td><td>0.1000</td><td>0.0000</td><td>0.00014</td></tr><tr><td>0.5</td><td>0.5000</td><td>0.5000</td><td>0.0000</td><td>0.00014</td></tr><tr><td>1</td><td>1.0000</td><td>1.0000</td><td>0.0000</td><td>0.00014</td></tr><tr><td>2</td><td>2.0000</td><td>2.0000</td><td>0.0000</td><td>0.00014</td></tr><tr><td>5</td><td>5.0000</td><td>5.0000</td><td>0.0000</td><td>0.00014</td></tr><tr><td>10</td><td>10.0000</td><td>10.0000</td><td>0.0000</td><td>0.00014</td></tr><tr><td>20</td><td>20.0000</td><td>20.0000</td><td>0.0000</td><td>0.00014</td></tr><tr><td>200</td><td>200.0000</td><td>200.0000</td><td>0.0000</td><td>0.00029</td></tr></table>	Nominal Value (g)	Conventional Mass Value (g)	Displayed Value (g)	Deviation (g)	Uncertainty (g)	0.01	0.0100	0.0100	0.0000	0.00014	0.05	0.0500	0.0500	0.0000	0.00014	0.1	0.1000	0.1000	0.0000	0.00014	0.5	0.5000	0.5000	0.0000	0.00014	1	1.0000	1.0000	0.0000	0.00014	2	2.0000	2.0000	0.0000	0.00014	5	5.0000	5.0000	0.0000	0.00014	10	10.0000	10.0000	0.0000	0.00014	20	20.0000	20.0000	0.0000	0.00014	200	200.0000	200.0000	0.0000	0.00029	
Nominal Value (g)	Conventional Mass Value (g)	Displayed Value (g)	Deviation (g)	Uncertainty (g)																																																				
0.01	0.0100	0.0100	0.0000	0.00014																																																				
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0.1	0.1000	0.1000	0.0000	0.00014																																																				
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SOP FM 33 03 February 2022



บริษัท เอกเสคคิวทิฟ เทรดดิ้ง จำกัด (สำนักงานใหญ่)
48/194-5 ซอยประดิษฐ์มนูธรรม 19 ถนนประดิษฐ์มนูธรรม แขวงลาดพร้าว เขตลาดพร้าว กรุงเทพฯ 10230
TEL (662) 515-0145-50 FAX (662) 515-0144 www.etthai.com E-mail: info@etthai.com

No. RA 015/24

Certificate of Calibration

Customer : A.I.S Laboratory Group (Thailand) Co., Ltd.
Address : 104 Phatthanakan 40, Phatthanakan Rd., Khwaeng Suan Luang, Khet Suan Luang Bangkok 10250 TH.
Calibration location : Executive Trading Limited.
Address : 48/194-5 Soi Praditmanutham 19, Pradit Manutham Road, Latphrao, Bangkok 10230
Tools :
Instrument : Gas Detector Temperature : (25 ± 3) °C
Product : RAE Systems Relative Humidity : (43 ± 15) %
Model Name : MiniRAE3000 Pressure : 760 mmHg
Serial Number : 592-906493
ID : BKK_FS0819
Date of Calibration : January 19, 2024
Calibration Method : This instrument has been calibrated using calibration gases. Test and calibration data is On file with Executive trading limited.
Reference Standard : Isobutylene Standard Gas 100 ppm; Lot number: 302-402431506

Test Result

Sensor Type	Reference Concentration	Before Cal.	After Cal.	Error Reading	Result
PID	0.0 ppm (Air Zero)	0.0 ppm	0.0 ppm	0.0 ppm	Pass
PID	100 ppm (Isobutylene)	93.2 ppm	100.0 ppm	0.0 ppm	Pass

Flow Rate of Pump : 480 cc/min.

Accuracy : ± 3 % at calibration point

Calibrated By : Approved By :
(Mr. Surinbun Saisaie) (Mr. Suttitong Konglonsaeng)
Service Engineer Service Engineer Manager

The results relate only to the items tested or calibrated.

Advertising the RAE/Certification and publicity of the results except as full are prohibited unless written permission is obtained from the company.

EXECUTIVE TRADING LIMITED 48/194-5 SOI PRADITMANUTHAM 19, PRADITMANUTHAM ROAD, LATPHRAO, BANGKOK 10230



บริษัท เอกเสคคิวทิฟ เทรดดิ้ง จำกัด (สำนักงานใหญ่)
48/194-5 ซอยประดิษฐ์มนูธรรม 19 ถนนประดิษฐ์มนูธรรม แขวงลาดพร้าว เขตลาดพร้าว กรุงเทพฯ 10230
TEL (662) 515-0145-50 FAX (662) 515-0144 www.etthai.com E-mail: info@etthai.com

ที่ RA 015/24

ใบรายงานผลการปรับเทียบ

ชื่อผู้ขอรับบริการ : บริษัท เอกเสคคิวทิฟ เทรดดิ้ง จำกัด (ประเทศไทย) จำกัด.
ที่อยู่ : 104 ซ.พัฒนาการ 40 อ.พัฒนาการ แขวงสวนหลวง เขตสวนหลวง กรุงเทพมหานคร 10250.
ปรับเทียบที่ : บริษัท เอกเสคคิวทิฟ เทรดดิ้ง จำกัด.
ที่อยู่ : 48/194-5 ซอย ประดิษฐ์มนูธรรม 19 ถนนประดิษฐ์มนูธรรม แขวงลาดพร้าว กรุงเทพฯ 10230

รายละเอียดเครื่องมือที่ทำการปรับเทียบ : สเกลน้ำหนัก : (25 ± 3) °C
เครื่องมือ : เครื่องชั่งน้ำหนักโอเวอร์เฮดจาก Starline
ผลิตภัณฑ์ : RAE Systems ความชื้นสัมพัทธ์ : (43 ± 15) %
รุ่น : MiniRAE3000 ความดันบรรยากาศ : 760 มิลลิเมตรปรอท
หมายเลขเครื่อง : 592-906493
ID : BKK_FS0819

วันที่ปรับเทียบมาตรฐาน : 19 มกราคม 2567
วิธีการปรับเทียบมาตรฐาน : ปรับเทียบโดยใช้ Standard Reference Gas
- Isobutylene Standard Gas 100 ppm; Lot number: 302-402431506.

ผลการปรับเทียบมาตรฐาน

Sensor Type	Reference Concentration	Before Cal.	After Cal.	Error Reading	Result
PID	0.0 ppm (Air Zero)	0.0 ppm	0.0 ppm	0.0 ppm	Pass
PID	100 ppm (Isobutylene)	93.2 ppm	100.0 ppm	0.0 ppm	Pass

Flow Rate of Pump : 480 cc/min.

Accuracy : ± 3 % at calibration point

ผู้ปรับเทียบ : ผู้ตรวจสอบ :
(นายสุรินทร์ สายนคร) (นายสุทิวรพงศ์ คงทองสิงห์)
Service Engineer Service Engineer Manager

ผลการสอบเทียบใบปรับเทียบนี้ มีผลเฉพาะเครื่องมือและรายการที่ระบุไว้เท่านั้น
การนำรายงานผลใบปรับเทียบไปโฆษณาและการค้าหรือการนำเผยแพร่โดยไม่ได้รับอนุญาตเป็นอาชญากรรมตามกฎหมายไทย

EXECUTIVE TRADING LIMITED 48/194-5 SOI PRADITMANUTHAM 19, PRADITMANUTHAM ROAD, LATPHRAO, BANGKOK 10230



บริษัท เอกเสคคิวทิฟ เทรดดิ้ง จำกัด (สำนักงานใหญ่)
48/194-5 ซอยประดิษฐ์มนูธรรม 19 ถนนประดิษฐ์มนูธรรม แขวงลาดพร้าว เขตลาดพร้าว กรุงเทพฯ 10230
TEL (662) 515-0145-50 FAX (662) 515-0144 www.etthai.com E-mail: info@etthai.com

ที่ RA 015/24

ใบรายงานการตรวจเช็คเครื่องตรวจวัดก๊าซ รุ่น MiniRAE3000

หมายเลขเครื่อง : 592-906493

วันที่ตรวจเช็ค : 19 มกราคม 2567

ลำดับที่	รายละเอียดการตรวจสอบ	RAW COUNT		สรุป	หมายเหตุ
		REF.	REAL		
1.	PID RAW COUNT				เปลี่ยนใหม่
	Ch.H	10000-62500	47933	■ YES □ NO	
	Ch.L	<62500	52971	■ YES □ NO	
2.	Lamp	>40	45	■ YES □ NO	

ลำดับที่	รายละเอียดการตรวจสอบ	การแก้ไข	สรุป	หมายเหตุ
1.	Motor Pump	Check flow rate	■ YES □ NO	480 cc/min.
2.	Buzzer	-	■ YES □ NO	-
3.	Li-ion Battery	-	■ YES □ NO	-
4.	Key Pad			
	Y/+	-	■ YES □ NO	-
	N/-	-	■ YES □ NO	-
	MODE	-	■ YES □ NO	-
5.	LCD Display	-	■ YES □ NO	-
6.	THP sensor	-	■ YES □ NO	-
7.	Light Sensor	-	■ YES □ NO	-
8.	Pocket Clip	-	□ YES □ NO	-
9.	PC Port	-	■ YES □ NO	-
10.	Slim Rubber Boot	-	■ YES □ NO	-

ผู้ตรวจเช็ค : (นายสุรินทร์ สายนคร)
Service Engineer

ผลการสอบเทียบใบปรับเทียบนี้ มีผลเฉพาะเครื่องมือและรายการที่ระบุไว้เท่านั้น
การนำรายงานผลใบปรับเทียบไปโฆษณาและการค้าหรือการนำเผยแพร่โดยไม่ได้รับอนุญาตเป็นอาชญากรรมตามกฎหมายไทย

EXECUTIVE TRADING LIMITED 48/194-5 SOI PRADITMANUTHAM 19, PRADITMANUTHAM ROAD, LATPHRAO, BANGKOK 10230

CERTIFICATE OF ANALYSIS

Date: 06/06/2022
Order Number: 1110821892
Lot Number: 302-402431506

Customer: EXECUTIVE TRADING LIMITED
Part Number: 600-0002-000
Use Before: JUN 6, 2027

Component	Concentration (± 2%)
ISOBUTYLENE	100PPM
AIR	Balance

Cylinder Size: 1.2 Cu. Ft.
Contents: 34 Liter

Valve: CGA600
Pressure: 494 PSIG

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

Analyst:

Chris Donnelly
Chris Donnelly

Honeywell

Honeywell Analytical Services
17 Shady Grove Park Circle
Baltimore, MD 21201
Call Toll Free 1-800-441-4444

CERTIFICATE of Attendance

It is hereby certified that

Mr Surinthorn Sainate
(Executive Trading Limited)

has successfully completed the

RAE Service Training Course

Conducted by

HONEYWELL

on **2nd August 2022**

Conducted by: Desmond Tan
Service Engineer / Technical Trainer
Date of Issue: 2nd August 2022
Certificate valid for 2 years from date of issue



DRY GAS METER CALIBRATION TEST REPORT

Calibration of Date: 3 Jan 24
Next Calibration Date: 3 Jul 24
Barometric Pressure (mm.Hg): 760
Relative Humidity (%): 57.0
Temperature (°C): 30.0
Dry Gas Meter Data
Calibration sheet No.: C-030124-BKK_FS0505
Reference Dry Gas Meter ID: BKK_FS0629
Dry Gas Meter No.: BKK_FS0505
Serial No.: 1607009
Console Serial No.: 1503004
Correction Factor (Yr): 1.0000
Model No.: XC-60-CV
Next Calibration Date: 9 Jun 24

Reference Dry Gas Meter Calibration			Dry Gas Meter							Dry Gas Meter Correction Factor (Yr)
Vr (Liters)			Tr (°C)	Vm (Liters)			Ti (°C)	To (°C)	Avg. Tm (°C)	
Final	Initial	Total		Final	Initial	Total				
30.01	0.00	30.01	30.0	30.13	0.00	30.13	32.0	32.0	32.0	1.0026
30.00	0.00	30.00	30.0	30.20	0.00	30.20	34.0	34.0	34.0	1.0065
60.00	0.00	60.00	30.0	60.43	0.00	60.43	36.0	36.0	36.0	1.0092
60.00	0.00	60.00	31.0	60.34	0.00	60.34	36.0	36.0	36.0	1.0107
90.02	0.00	90.02	31.0	90.76	0.00	90.76	36.0	36.0	36.0	1.0081
90.03	0.00	90.03	31.0	90.66	0.00	90.66	36.0	36.0	36.0	1.0094
									Avg.	1.0078

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

DIGITAL TEMPERATURE CALIBRATION DATA SHEET

Calibration Date	3 Jan 24	Ambient Temperature (°C)	30		
Calibration sheet No	C-030124-BKK_FS0505	Relative Humidity (%)	58		
Digital Temperature ID	BKK_FS0505	Reference Temperature ID	BKK_FS1144		
Serial No	1583004	Serial No	201090000013		
Model	XC-62-CV	Model	Digicon-CC-VT-MS		
		Next Calibrate	14 Aug 24		
Location	Reference Temperature °C	Digital Temperature °C	Error °C	MPE	Pass / Fail
Stick	0	-1	-1	±3	Pass
	25	23	-2	±3	Pass
	50	48	-2	±3	Pass
	100	90	-10	±3	Pass
	150	149	-1	±3	Pass
	200	198	-2	±3	Pass
Probe	250	247	-3	±3	Pass
	300	297	-3	±3	Pass
	500	498	-2	±3	Pass
	100	100	0	±3	Pass
	120	120	0	±3	Pass
	140	140	0	±3	Pass
Oven	100	-	-	±3	-
	120	-	-	±3	-
	140	-	-	±3	-
Fiber	100	98	-2	±3	Pass
	120	119	-1	±3	Pass
	140	138	-2	±3	Pass
Exit	0	0	0	±3	Pass
	10	8	-2	±3	Pass
	20	18	-2	±3	Pass
Meter	0	0	0	±3	Pass
	25	24	-1	±3	Pass
	50	48	-2	±3	Pass
AUX	0	-1	-1	±3	Pass
	25	23	-2	±3	Pass
	50	48	-2	±3	Pass

MPE: (Maximum permissible error of measurement) 4.0°C for temperatures below 100°C

Calibrated by:

Mr Prasert Surathan
Field Scientist (3)

Approved by:

Mr Samart Roo-ngan
Specialist (1)

Certificate of System Qualification
GC-OQ • GCMS-OQ

System ID: GM-2
Organization Name: ALS Laboratory Group (Thailand) Co., Ltd.
Organization Location: 104 Phatthanakan 40, Phattanakon Rd., Kheirang Suan Luang, Khet Suan Luang, Bangkok 10250
Date: April 18, 2023 3:15:25 PM
EQP Name: Agilent/Recommended - Agilent/Recommended
EQP Revision: GC.02.51, GCMS.02.51
Overall Qualification Status: Pass

REVIEW BY: Suchada T.
APPROVED BY: Thanyarat V.
NEXT CAL. DATE: 18 Oct 24

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 Accuracy

Name: 7890
Front MMI
Setpoint Status: Pass
Setpoint: 25.0 psi
Actual: 25.0 psi
Accuracy: 0.0 psi
Agilent Recommended: <= 1.2

Overall Inlet Pressure Accuracy Test Status
Pass

GC Oven Temperature Accuracy

Name: 7890

Date: April 18, 2023 3:15:25 PM
System ID: GM-2

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Setpoint Status: Pass
Zone: Oven
Setpoint/Actual
Temperature: 230.0 230.1 °C
Accuracy: 0.1 °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: 100.0 100.4 °C
Accuracy: 0.4 °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: 100.0 100.4 °C
Stability: 0.0 °C
Agilent Recommended: <= 0.5

Overall GC Oven Temperature Stability Test Status
Pass

Log Amp

Tested Combination1 Front MMI / External SQ
Name: 5875C Inert XL with TAD
Setpoint Status: Pass

Date: April 18, 2023 3:15:25 PM
System ID: GM-2

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Overall Log Amp Test Status
Pass

RFFA

Tested Combination1 Front MMI / External SQ
Name: 5875C Inert XL with TAD
Setpoint Status: Pass
Amu: 1050 m/z
Drift After Five Minutes: 4 mV
RFFA Voltage: 441 mV
Agilent Recommended: >= -100 and <= 100 <= 1100

Overall RFFA Test Status
Pass

Tune EI

Tested Combination1 Front MMI / External SQ
Name: 5875C Inert XL with TAD
Setpoint Status: Pass
Filament: 1
Setpoint Status: Pass
Filament: 2

Overall Tune EI Test Status
Pass

Scouting Run

Tested Combination1 Front MMI / External SQ
Injection Tower
Name: 7693A
Source: EI - Inert

Date: April 18, 2023 3:15:25 PM
System ID: GM-2

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Setpoint Status: Completed
Injection Volume on Column: 1.0 µL
Overall Scouting Run Status: Completed
Signal to Noise EI
Tested Combination1 Front MMI / External SQ
Name: 5875C Inert XL with TAD
Source: EI - Inert Filament: 1
Setpoint Status: Pass
Signal to Noise: 455
Agilent Recommended: >= 320
Source: EI - Inert Filament: 2
Setpoint Status: Pass
Signal to Noise: 2034
Agilent Recommended: >= 320
Overall Signal to Noise EI Test Status: Pass

Injection Precision

Tested Combination1 Front MMI / External SQ
Name: 7693A
Source: EI - Inert
Setpoint Status: Pass
Injection Volume on Column: 1.0 µL
Area RSD: 1.86 %
Agilent Recommended: <= 5.00
Retention Time RSD: 0.04 %
Agilent Recommended: <= 1.00

Overall Injection Precision Test Status
Pass

Date: April 18, 2023 3:15:25 PM
System ID: GM-2

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Instrument Details

Purpose

This section describes the as found system configuration.

Details

System

System ID	GM-2
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
Inlet	Front
Detector	External
LTM Included?	No

Sampler 1

Manufacturer	Agilent Technologies
Type	Injection Tower
Name	7693A
Model Number	G4513A
Serial Number	CN10120123
Firmware Revision	A.10.08
Usage	Sample Injection
Location	Front
Syringe Volume (µL)	10

Mass Ratio Precision

Tested Combination1	Front	MMI	/	External	SQ
Name:	Injection Tower				
Source:	7693A				
Setpoint Status:	EI - Inert				
Injection Volume on Column:	1.0 µL				
RSD:	Area Mass 1		Mass Ratio		
Agilent Recommended:	Abundance's		Abundance's		
	1.66 %		0.39 %		
	<= 5.00		<= 5.00		
	Pass		Pass		
Overall Mass Ratio Precision Test Status	Pass				

Date: April 18, 2023 3:15:25 PM
System ID: GM-2

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Date: April 18, 2023 3:15:25 PM
System ID: GM-2

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Sampler 2

Manufacturer	Agilent Technologies
Type	Tray
Name	7693A
Model Number	G4514A
Serial Number	CN10050099
Firmware Revision	A.10.16
Vial Heater	Not Installed

Mainframe 1

Manufacturer	Agilent Technologies
Name	7890
Model Number	G3440A
Serial Number	CN10141049
Firmware Revision	A.D1.16
Oven Type	Standard

Inlet 1

Manufacturer	Agilent Technologies
Name	7890
Type	MMI
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	5975C Inert XL with TAD
Serial Number	US10153217
Firmware Revision	5.02.12
High Vacuum System	Turbo Pump
Scouting Run Standard	OPN Std
MS EI Source 1	
Manufacturer	Agilent Technologies
Source Type	EI - Inert
Number of Elements	2

Date: April 18, 2023 3:15:25 PM
System ID: GM-2

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Date: April 18, 2023 3:15:25 PM
System ID: GM-2

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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: Supasak Nimsongtham
Logged On User Name: supasak.nimsongtham@agilent.com
Signature Creation Date: April 18, 2023
Reason for Signature: Executed protocol and published this original version of document

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Date: April 18, 2023 3:15:25 PM
System ID: GM-2

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User Name: supasak.nimsongtham
Username: SCG115461C
System ID: GM-2
Print Date: April 18, 2023 3:15:26 PM

ALS GM2 Transaction Log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
April 18, 2023 2:14:23 PM	Audit	SessionCreated	Session	None
April 18, 2023 2:14:23 PM	Start	Configuration	Session	None
April 18, 2023 2:14:23 PM	Audit	Enrollment	Licensing	User is Field Engineer and does not require an unlock code
April 18, 2023 2:19:04 PM	Audit	Enrollment	Session	EOP details for primary technique (SC) - File path: (ProtocolPacks/G2/Configuration/02.51/G2.51.aeq), EOP File Name: (G2.51.aeq), EOP Name: (AgilentRecommended) (Print out Review: (G2.51.aeq)) EOP details for hybridated technique (GGM) - File path: (ProtocolPacks/G2/Configuration/02.51/G2.51.aeq), EOP File Name: (GGM.02.51.aeq), EOP Name: (AgilentRecommended)
April 18, 2023 2:19:07 PM	End	Configuration	Session	None
April 18, 2023 2:19:11 PM	Start	Qualification	Session	QC
April 18, 2023 2:19:11 PM	Start	Execution	System Inspection and Basic Safety and Operation - 7850 - Qualitative Test - No repairs associated	None
April 18, 2023 2:17:27 PM	End	Execution	System Inspection and Basic Safety and Operation - 7850 - Qualitative Test - No repairs associated	Run Count: 1

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Date: April 18, 2023 3:15:26 PM
System ID: GM-2

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User Name: supasak.nimsongtham
Username: SCG115461C
System ID: GM-2
Print Date: April 18, 2023 3:15:30 PM

ALS GM2 Transaction Log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
April 18, 2023 2:17:28 PM	Start	Execution	HM Pressure Accuracy - Front - HAM - Pressure Controlled Inlet - S: 25.0 psi - L: +/- 1.2 psi	None
April 18, 2023 2:17:28 PM	End	Execution	HM Pressure Accuracy - Front - HAM - Pressure Controlled Inlet - S: 25.0 psi - L: +/- 1.2 psi	Run Count: 1
April 18, 2023 2:17:35 PM	Start	Execution	GC Oven Temperature Accuracy - 7850 - Temperature - Oven - S: 220.0°C - L: +/- 1.0 AND +/- 1.0 % dependent on K	None
April 18, 2023 2:18:00 PM	Audit	Data	GC Oven Temperature Accuracy - 7850 - Temperature - Oven - S: 220.0°C - L: +/- 1.0 AND +/- 1.0 % dependent on K	Manual Data Entry
April 18, 2023 2:18:01 PM	End	Execution	GC Oven Temperature Accuracy - 7850 - Temperature - Oven - S: 220.0°C - L: +/- 1.0 AND +/- 1.0 % dependent on K	Run Count: 1
April 18, 2023 2:18:03 PM	Start	Execution	GC Oven Temperature Accuracy - 7850 - Temperature - Oven - S: 100.0°C - L: +/- 1.0 AND +/- 1.0 % dependent on K	None
April 18, 2023 2:18:00 PM	Audit	Data	GC Oven Temperature Accuracy - 7850 - Temperature - Oven - S: 100.0°C - L: +/- 1.0 AND +/- 1.0 % dependent on K	Manual Data Entry
April 18, 2023 2:18:02 PM	End	Execution	GC Oven Temperature Accuracy - 7850 - Temperature - Oven - S: 100.0°C - L: +/- 1.0 AND +/- 1.0 % dependent on K	Run Count: 1
April 18, 2023 2:18:04 PM	Start	Execution	GC Oven Temperature Stability - 7850 - Temperature - Oven - S: 100.0°C - L: +/- 0.5°C	None

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Date: April 18, 2023 3:15:25 PM
System ID: GM-2

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User Name: supasak.nimsongtham
Username: SCG115461C
System ID: GM-2
Print Date: April 18, 2023 3:15:30 PM

ALS GM2 Transaction Log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
April 18, 2023 2:18:31 PM	Audit	Data	GC Oven Temperature Stability - 7850 - Temperature - Oven - S: 100.0°C - L: +/- 0.5°C	Manual Data Entry
April 18, 2023 2:19:30 PM	End	Execution	GC Oven Temperature Stability - 7850 - Temperature - Oven - S: 100.0°C - L: +/- 0.5°C	Run Count: 1
April 18, 2023 2:19:36 PM	Start	Execution	Log Amp - 5975C Inlet XL with TAD SC - Source: EI - Inlet	None
April 18, 2023 2:19:46 PM	End	Execution	Log Amp - 5975C Inlet XL with TAD SC - Source: EI - Inlet	Run Count: 1
April 18, 2023 2:19:49 PM	Start	Execution	RPPA - 5975C Inlet XL with TAD SC - Source: EI - Inlet	None
April 18, 2023 2:12:54 PM	End	Execution	RPPA - 5975C Inlet XL with TAD SC - Source: EI - Inlet	Run Count: 1
April 18, 2023 2:32:57 PM	Start	Execution	Tune EI - 5975C Inlet XL with TAD SC - Source: EI - Inlet	None
April 18, 2023 2:34:05 PM	End	Execution	Tune EI - 5975C Inlet XL with TAD SC - Source: EI - Inlet	Run Count: 1
April 18, 2023 2:34:07 PM	Start	Execution	Tune EI - 5975C Inlet XL with TAD SC - Source: EI - Inlet	None
April 18, 2023 2:34:25 PM	End	Execution	Tune EI - 5975C Inlet XL with TAD SC - Source: EI - Inlet	Run Count: 1

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Date: April 18, 2023 3:15:25 PM
System ID: GM-2

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User Name: supasak.kimsongtham
Hostname: SCG1110KIC

System ID: GM-2
Print Date: April 18, 2023 3:15:36 PM

ALS GM2 Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
April 18, 2023 2:34:23 PM	Start	Execution	Souling Run - Injection Tower, Front MM, SQ - Source: EI - Inert Part of GCMS System Preparation	None
April 18, 2023 2:34:56 PM	Audio	Data	Souling Run - Injection Tower, Front MM, SQ - Source: EI - Inert Part of GCMS System Preparation	Data file Path: E:\GM-2\GC2023\PMRPP\1_001.D\DATA.MS
April 18, 2023 2:35:12 PM	End	Execution	Souling Run - Injection Tower, Front MM, SQ - Source: EI - Inert Part of GCMS System Preparation	Run Count: 1
April 18, 2023 2:35:13 PM	Start	Execution	Signal to Noise EI - Injection Tower, Front MM, SQ - Source: EI - Inert using Filament 1 - L: >= 320	None
April 18, 2023 2:35:24 PM	Audio	Data	Signal to Noise EI - Injection Tower, Front MM, SQ - Source: EI - Inert using Filament 1 - L: >= 320	Data file Path: E:\GM-2\GC2023\PMRPP\1_001.D\DATA.MS
April 18, 2023 2:35:45 PM	End	Execution	Signal to Noise EI - Injection Tower, Front MM, SQ - Source: EI - Inert using Filament 1 - L: >= 320	Run Count: 1
April 18, 2023 2:35:47 PM	Start	Execution	Signal to Noise EI - Injection Tower, Front MM, SQ - Source: EI - Inert using Filament 2 - L: >= 320	None
April 18, 2023 2:35:52 PM	Start	Execution	Injection Precision - Injection Tower, Front MM, SQ - Source: EI - Inert L (Area) <= 5.00% - L (Ret. Time) <= 1.00%	None

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Date: April 18, 2023 3:15:25 PM
System ID: GM-2

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User Name: supasak.kimsongtham
Hostname: SCG1110KIC

System ID: GM-2
Print Date: April 18, 2023 3:15:36 PM

ALS GM2 Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
April 18, 2023 2:35:33 PM	Audio	Data	Injection Precision - Injection Tower, Front MM, SQ - Source: EI - Inert L (Area) <= 5.00% - L (Ret. Time) <= 1.00%	Data file Path: E:\GM-2\GC2023\PMRPP\1_MRP002.D\DATA.MS
April 18, 2023 2:35:25 PM	Audio	Data	Injection Precision - Injection Tower, Front MM, SQ - Source: EI - Inert L (Area) <= 5.00% - L (Ret. Time) <= 1.00%	Data file Path: E:\GM-2\GC2023\PMRPP\1_MRP003.D\DATA.MS
April 18, 2023 2:35:26 PM	Audio	Data	Injection Precision - Injection Tower, Front MM, SQ - Source: EI - Inert L (Area) <= 5.00% - L (Ret. Time) <= 1.00%	Data file Path: E:\GM-2\GC2023\PMRPP\1_MRP004.D\DATA.MS
April 18, 2023 2:35:25 PM	Audio	Data	Injection Precision - Injection Tower, Front MM, SQ - Source: EI - Inert L (Area) <= 5.00% - L (Ret. Time) <= 1.00%	Data file Path: E:\GM-2\GC2023\PMRPP\1_MRP005.D\DATA.MS
April 18, 2023 2:35:24 PM	Audio	Data	Injection Precision - Injection Tower, Front MM, SQ - Source: EI - Inert L (Area) <= 5.00% - L (Ret. Time) <= 1.00%	Data file Path: E:\GM-2\GC2023\PMRPP\1_MRP006.D\DATA.MS
April 18, 2023 2:35:23 PM	Audio	Data	Injection Precision - Injection Tower, Front MM, SQ - Source: EI - Inert L (Area) <= 5.00% - L (Ret. Time) <= 1.00%	Data file Path: E:\GM-2\GC2023\PMRPP\1_MRP007.D\DATA.MS
April 18, 2023 2:35:43 PM	End	Execution	Injection Precision - Injection Tower, Front MM, SQ - Source: EI - Inert L (Area) <= 5.00% - L (Ret. Time) <= 1.00%	Run Count: 1
April 18, 2023 2:35:45 PM	Start	Execution	Mass Ratio Precision - Injection Tower, Front MM, SQ - Source: EI - Inert - L (RSD) <= 5.00%	None

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Date: April 18, 2023 3:15:25 PM
System ID: GM-2

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User Name: supasak.kimsongtham
Hostname: SCG1110KIC

System ID: GM-2
Print Date: April 18, 2023 3:15:36 PM

ALS GM2 Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
April 18, 2023 2:37:04 PM	Audio	Data	Mass Ratio Precision - Injection Tower, Front MM, SQ - Source: EI - Inert - L (RSD) <= 5.00%	Data file Path: E:\GM-2\GC2023\PMRPP\1_MRP002.D\DATA.MS
April 18, 2023 2:37:04 PM	Audio	Data	Mass Ratio Precision - Injection Tower, Front MM, SQ - Source: EI - Inert - L (RSD) <= 5.00%	Data file Path: E:\GM-2\GC2023\PMRPP\1_MRP003.D\DATA.MS
April 18, 2023 2:37:04 PM	Audio	Data	Mass Ratio Precision - Injection Tower, Front MM, SQ - Source: EI - Inert - L (RSD) <= 5.00%	Data file Path: E:\GM-2\GC2023\PMRPP\1_MRP004.D\DATA.MS
April 18, 2023 2:37:04 PM	Audio	Data	Mass Ratio Precision - Injection Tower, Front MM, SQ - Source: EI - Inert - L (RSD) <= 5.00%	Data file Path: E:\GM-2\GC2023\PMRPP\1_MRP005.D\DATA.MS
April 18, 2023 2:37:06 PM	Audio	Data	Mass Ratio Precision - Injection Tower, Front MM, SQ - Source: EI - Inert - L (RSD) <= 5.00%	Data file Path: E:\GM-2\GC2023\PMRPP\1_MRP006.D\DATA.MS
April 18, 2023 2:37:06 PM	Audio	Data	Mass Ratio Precision - Injection Tower, Front MM, SQ - Source: EI - Inert - L (RSD) <= 5.00%	Data file Path: E:\GM-2\GC2023\PMRPP\1_MRP007.D\DATA.MS
April 18, 2023 2:37:17 PM	End	Execution	Mass Ratio Precision - Injection Tower, Front MM, SQ - Source: EI - Inert - L (RSD) <= 5.00%	Run Count: 1
April 18, 2023 2:37:33 PM	Start	Execution	Signal to Noise EI - Injection Tower, Front MM, SQ - Source: EI - Inert using Filament 2 - L: >= 320	None

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Date: April 18, 2023 3:15:25 PM
System ID: GM-2

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User Name: supasak.kimsongtham
Hostname: SCG1110KIC

System ID: GM-2
Print Date: April 18, 2023 3:15:36 PM

ALS GM2 Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
April 18, 2023 2:36:56 PM	Start	Execution	Signal to Noise EI - Injection Tower, Front MM, SQ - Source: EI - Inert using Filament 2 - L: >= 320	None
April 18, 2023 2:37:00 PM	Audio	Data	Signal to Noise EI - Injection Tower, Front MM, SQ - Source: EI - Inert using Filament 2 - L: >= 320	DiscManager was in a dead verification state but the user chose to start over
April 18, 2023 2:37:18 PM	Audio	Data	Signal to Noise EI - Injection Tower, Front MM, SQ - Source: EI - Inert using Filament 2 - L: >= 320	Data file Path: E:\GM-2\GC2023\PMRPP\2_003.D\DATA.MS
April 18, 2023 2:37:56 PM	Start	Execution	Signal to Noise EI - Injection Tower, Front MM, SQ - Source: EI - Inert using Filament 2 - L: >= 320	None
April 18, 2023 2:38:05 PM	End	Execution	Signal to Noise EI - Injection Tower, Front MM, SQ - Source: EI - Inert using Filament 2 - L: >= 320	Run Count: 1
April 18, 2023 3:01:14 PM	End	Quiescence	Session	QQ
April 18, 2023 3:01:14 PM	Start	Reporting	Session	None
April 18, 2023 3:14:47 PM	Audio	Reporting	Execution	Report Generated: Certificate

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Date: April 18, 2023 3:15:25 PM
System ID: GM-2

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SITHIPORN ASSOCIATES CO.,LTD. CALIBRATION LABORATORY

451-451/1 Sirinthon Rd, Bangbunru, Bangplud Bangkok 10700 THAILAND
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Cert. No. : ACC23029
Pages : 1 of 3

Calibration Certificate

Equipment : SOUND CALIBRATOR
Manufacturer : RION
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 : 07 SEPTEMBER 2023
Calibration Date : 20 SEPTEMBER 2023
Date of Issue : 20 SEPTEMBER 2023

Calibrated by : Nathakorn Pisutpaisan

Approved by :

T. Petchurai
(Thanakul Petchurai)

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QF-TS12-04-04-020664

SITHIPORN ASSOCIATES CO.,LTD. CALIBRATION LABORATORY

Continuation of Calibration Certificate

Cert. No. : ACC23029
Job No. : VC66AC0100
Pages : 3 of 3

Result of calibration :

1. Sound pressure level

Specified sound pressure level (dB)	Measured value (dB)	Deviated value (dB)	Uncertainty (dB)	Acceptance limit (dB)
94	94.1	0.10	0.14	0.40

2. Frequency

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

3. Total distortion

Measured value (%)	Uncertainty (%)	Acceptance limit (%)
1.70	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

SITHIPORN ASSOCIATES CO.,LTD. CALIBRATION LABORATORY

Continuation of Calibration Certificate

Cert. No. : ACC23029
Job No. : VC66AC0100
Pages : 2 of 3

Calibration Procedure : CP-AC-03

Calibration Method :

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

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

Condition of this result of calibration :

1. Reference Standard Instruments :

Instrument	Model	Serial No.	Cert. No.	Due Date
Waveform Generator	33511B	MY52302742	EF-0010-23	07-FEB-24
Digital Multimeter	33461A	MY53220104	EEL_BP 30/0266	13-FEB-24
Digital Multimeter	33461A	MY53220076	EEL_BP 30/0267	13-FEB-24
Digital Multimeter	33461A	MY60024273	EEL_BP 31/0266	14-FEB-24
Programmable Attenuator	MAT-1070	62100114	EF-0011-23	08-FEB-24
Condenser Microphone	4180	2977900	AA-1001-23	14-FEB-24
Measuring Amplifier	NA-42KAI	34560495	AA-3002-23	14-FEB-24
Audio Analyzer	AVR-3360A	V744B6069	EF-0012-23	10-FEB-24

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

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

3.1 National Institute of Metrology (Thailand).

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

SITHIPORN ASSOCIATES CO., LTD. CALIBRATION LABORATORY

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Tel. +66 2433 8391 Email : calibration@sithiporn.com

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Cert. No. : ACL24081
Pages : 1 of 8

Calibration Certificate

Equipment : SOUND LEVEL METER
Manufacturer : RION
Model : NL-52A / Microphone UC-59 / Pre-amplifier NH-25
Serial No. : 01120936 / 21737 / 22325
ID No. : RYG_FS0627

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



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

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Cert. No. : ACL24081
Job No. : VC67AC0054
Pages : 2 of 8

Calibration Procedure : CP-AC-01

Calibration Method :

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

Condition of this result of calibration :

1. Reference Standard Instruments :

Instrument	Model	Serial No.	Cert. No.	Due Date
Waveform Generator	33210A	MY48017076	EF-0009-23	07-FEB-24
Waveform Generator	33511B	MY52302742	EF-0010-23	07-FEB-24
Digital Multimeter	33461A	MY53220104	EEL-BP 30/0266	13-FEB-24
Digital Multimeter	33461A	MY53220076	EEL-BP 29/0266	13-FEB-24
Digital Multimeter	34461A	MY60024273	EEL-BP 31/0266	14-FEB-24
Programmable Attenuator	MAT-1070	62100114	EF-0011-23	08-FEB-24
Condenser Microphone	4180	2977900	AA-1001-23	14-FEB-24
Measuring Amplifier	NA-42KAI	34560495	AA-3002-23	14-FEB-24

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

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

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

g. Piter

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Job No. : VC67AC0054
Pages : 4 of 8

Result of calibration :

1. Absolute sensitivity

Reference Acoustic Signal (dB)	Measured Value (dB)	Deviation (dB)	Acceptance Limit (dB)
93.9 (93.98)	94.0	0.0	±0.3

2. Self-generated noise

2.1 Normal test

Measured Value (dB)
13.4

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

Frequency Weighting	Measured value (dB)
A - weight	8.7
C - weight	13.7
Flat	19.3

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	0.3	0.3	± 1.0
1000	0.2	0.2	0.2	± 0.7
8000	0.4	0.5	0.5	+ 1.5, - 2.5

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Job No. : VC67AC0054
Pages : 3 of 8

Summary of Measurement Result :

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

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Job No. : VC67AC0054
Pages : 5 of 8

4. Electrical signal tests of frequency weightings

Weighting network response with relative to 1 kHz.

Frequency (Hz)	Deviation from various frequency weighting response curve (dB)			
	Flat	C-weight	A-weight	Acceptance Limits
63	0.0	0.0	0.1	±1.0
125	0.1	0.1	0.0	±1.0
250	0.1	0.0	0.0	±1.0
500	0.1	0.1	0.0	±1.0
1000	0.0	0.0	0.0	±1.0
2000	0.0	0.1	0.0	±1.0
4000	0.0	0.0	0.0	±1.0
8000	0.0	0.1	0.1	+ 1.5, - 2.5
16000	0.0	-1.2	-1.1	+ 2.5, -16.0

5. Frequency and time weightings at 1 kHz

5.1 Frequency weightings at 1 kHz

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

5.2 Time weighting at 1 kHz

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

6. Long - term stability

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

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Job No. : VC67AC0054
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	±0.8
136.0	136.0	0.0	±0.8
135.0	135.1	0.1	±0.8
134.0	134.0	0.0	±0.8
133.0	133.0	0.0	±0.8
132.0	132.0	0.0	±0.8
131.0	131.0	0.0	±0.8
129.0	129.0	0.0	±0.8
124.0	124.0	0.0	±0.8
119.0	119.0	0.0	±0.8
114.0	114.0	0.0	±0.8
109.0	109.0	0.0	±0.8
104.0	104.0	0.0	±0.8
99.0	99.0	0.0	±0.8
94.0	94.0	0.0	±0.8
89.0	89.0	0.0	±0.8
84.0	84.0	0.0	±0.8
79.0	79.0	0.0	±0.8
74.0	74.0	0.0	±0.8
69.0	69.0	0.0	±0.8
64.0	64.0	0.0	±0.8
59.0	59.0	0.0	±0.8
54.0	54.0	0.0	±0.8
49.0	49.0	0.0	±0.8
44.0	44.0	0.0	±0.8
39.0	39.0	0.0	±0.8
34.0	34.0	0.0	±0.8
30.0	29.9	-0.1	±0.8
29.0	28.9	-0.1	±0.8
28.0	27.9	-0.1	±0.8
27.0	26.9	-0.1	±0.8
26.0	26.0	0.0	±0.8
25.0	24.9	-0.1	±0.8

T. Petchur

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Job No. : VC67AC0054
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	±0.8

9. Tone burst response

Time Weighting	Tone burst duration, T _b (ms)	Cycle	Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Fast	0.25	1	108.0	107.9	-0.1	1.0 ; -3.0
	2	8	117.0	116.9	-0.1	1.0 ; -1.5
	200	800	134.0	134.0	0.0	±0.5
Slow	2	8	108.0	107.9	-0.1	1.0 ; -3.0
	200	800	127.6	127.5	-0.1	±0.5
	0.25	1	99.0	98.8	-0.2	1.0 ; -3.0
SEL	2	8	108.0	107.9	-0.1	1.0 ; -1.5
	200	800	128.0	128.0	0.0	±0.5

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	±2.0
One	136.4	136.1	-0.3	±2.0

Number of cycle in test signal	Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Continuous	135.0	135.0	0.0	±1.0
Positive half cycle	135.4	135.1	-0.3	±1.0
Negative half cycle	135.4	135.1	-0.3	±1.0

T. Petchur

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Cert. No. : ACL24081
Job No. : VC67AC0054
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	89.5	0.0	±1.5

12. High level stability

Frequency Weighting	SLM Display at initial (dB)	SLM Display at final (dB)	Deviated Value (dB)	Acceptance Limits (dB)
A-weight	137.0	137.0	0.0	±0.1

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

End of Calibration Certificate

T. Petchur

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Cert. No. : ACL24083
Pages : 1 of 8

Calibration Certificate

Equipment : SOUND LEVEL METER
Manufacturer : RION
Model : NL-52A / Microphone UC-59 / Preamplifier NH-25
Serial No.: 01120938 / 21888 / 22327
ID No.: RYG_FS0629

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

Calibrated by : Nithakorn Pisutpaissan

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

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CALIBRATION LABORATORY

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Cert. No. : ACL24083
Job No. : VC67AC0054
Pages : 2 of 8

Calibration Procedure : CP-AC-01

Calibration Method :

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

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

Condition of this result of calibration :

1. Reference Standard Instruments :

Instrument	Model	Serial No.	Cert. No.	Due Date
Waveform Generator	33210A	MY48017076	EF-0009-23	07-FEB-24
Waveform Generator	33511B	MY52302742	EF-0010-23	07-FEB-24
Digital Multimeter	33461A	MY53220104	EEL_BP 30/0266	13-FEB-24
Digital Multimeter	33461A	MY53220076	EEL_BP 29/0266	13-FEB-24
Digital Multimeter	34461A	MY60024273	EEL_BP 31/0266	14-FEB-24
Programmable Attenuator	MAT-1070	62100114	EF-0011-23	08-FEB-24
Condenser Microphone	4180	2977900	AA-1001-23	14-FEB-24
Measuring Amplifier	NA-42KA1	34560495	AA-3002-23	14-FEB-24

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

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

3.1 National Institute of Metrology (Thailand).

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

SITHIPORN ASSOCIATES CO., LTD.
CALIBRATION LABORATORY

45/45/1 Sirinthorn Road, Bangbunmu, Bangkok, Bangkok 10700 Thailand
Tel: +66 2433 8331 Email: calibration@sithiporn.com

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Cert. No. : ACL24083
Job No. : VC67AC0054
Pages : 3 of 8

Summary of Measurement Result :

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

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Cert. No. : ACL24083
Job No. : VC67AC0054
Pages : 4 of 8

Result of calibration :

1. Absolute sensitivity

Reference Acoustic Signal (dB)	Measured Value (dB)	Deviation (dB)	Acceptance Limit (dB)
93.9 (93.98)	94.0	0.0	±0.3

2. Self-generated noise

2.1 Normal test

Measured Value (dB)
14.4

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

Frequency Weighting	Measured value (dB)
A - weight	9.9
C - weight	14.5
Flat	20.2

3. Acoustical signal tests of frequency weightings

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

Frequency (Hz)	Flat	C-weight	A-weight	Acceptance Limits
125	0.1	0.1	0.1	± 1.0
1000	0.2	0.2	0.2	± 0.7
8000	0.7	0.8	0.8	+ 1.5, - 2.5

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Cert. No. : ACL24083
Job No. : VC67AC0054
Pages : 5 of 8

4. Electrical signal tests of frequency weightings

Weighting network response with relative to 1 kHz.

Frequency (Hz)	Flat	C-weight	A-weight	Acceptance Limits
63	0.0	0.0	0.0	±1.0
125	0.0	0.0	0.0	±1.0
250	0.0	0.0	-0.1	±1.0
500	0.0	0.0	-0.1	±1.0
1000	0.0	0.0	0.0	±1.0
2000	0.0	0.0	0.0	±1.0
4000	0.0	0.0	0.0	±1.0
8000	0.0	0.1	0.1	- 1.5, + 2.5
16000	0.0	-1.2	-1.2	+ 2.5, -16.0

5. Frequency and time weightings at 1 kHz

5.1 Frequency weightings at 1 kHz

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

5.2 Time weighting at 1 kHz

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

6. Long - term stability

Frequency Weighting	SLM Display at initial (dB)	SLM Display at final (dB)	Deviated Value (dB)	Acceptance Limits (dB)
A - weight	94.0	94.0	0.0	± 0.1

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Cert. No. : ACL24083
Job No. : VC67AC0054
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	±0.8
136.0	136.0	0.0	±0.8
135.0	135.0	0.0	±0.8
134.0	134.0	0.0	±0.8
133.0	133.0	0.0	±0.8
132.0	132.0	0.0	±0.8
131.0	131.0	0.0	±0.8
129.0	129.0	0.0	±0.8
124.0	124.0	0.0	±0.8
119.0	119.0	0.0	±0.8
114.0	114.0	0.0	±0.8
109.0	109.0	0.0	±0.8
104.0	104.0	0.0	±0.8
99.0	99.0	0.0	±0.8
94.0	94.0	0.0	±0.8
89.0	89.0	0.0	±0.8
84.0	84.0	0.0	±0.8
79.0	79.0	0.0	±0.8
74.0	74.0	0.0	±0.8
69.0	69.0	0.0	±0.8
64.0	64.0	0.0	±0.8
59.0	59.0	0.0	±0.8
54.0	54.0	0.0	±0.8
49.0	49.0	0.0	±0.8
44.0	44.0	0.0	±0.8
39.0	39.0	0.0	±0.8
34.0	34.0	0.0	±0.8
30.0	30.0	0.0	±0.8
29.0	29.0	0.0	±0.8
28.0	28.0	0.0	±0.8
27.0	27.0	0.0	±0.8
26.0	26.0	0.0	±0.8
25.0	25.0	0.0	±0.8

T. Petchur

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Cert. No. : ACL24083
Job No. : VC67AC0054
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	±0.8

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	1.0 ; -3.0
	2	8	117.0	117.0	0.0	1.0 ; -1.5
	200	800	134.0	134.0	0.0	±0.5
Slow	2	8	108.0	108.0	0.0	1.0 ; -3.0
	200	800	127.6	127.6	0.0	±0.5
SEL	0.25	1	99.0	98.9	-0.1	1.0 ; -3.0
	2	8	108.0	108.0	0.0	1.0 ; -1.5
	200	800	128.0	128.0	0.0	±0.5

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	±2.0
One	136.4	136.3	-0.1	±2.0

Number of cycle in test signal	Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Continuous	133.0	132.9	-0.1	±1.0
Positive half cycle	135.4	135.1	-0.3	±1.0
Negative half cycle	135.4	135.1	-0.3	±1.0

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Cert. No. : ACL24083
Job No. : VC67AC0054
Pages : 8 of 8

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Cert. No. : ACL23162
Pages : 1 of 8

11. Overload indication

Measured value (dB)		Deviated Value (dB)	Acceptance Limits (dB)
Positive one-half cycle	Negative one-half cycle		
89.6	89.7	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	±0.1

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

Calibration Certificate

Equipment : SOUND LEVEL METER
Manufacturer : RION
Model : NL-52 / Microphone UC-59 / Preamplifier NH-25
Serial No.: 00764923 / 09851 / 65049
ID No.: BKK_FS0135

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 MAY 2023
Calibration Date : 10-16 MAY 2023
Date of Issue : 17 MAY 2023

Calibrated by : Nathakorn Pisutpaisan

Approved by : *T. Petchur*
(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.

T. Petchur

Continuation of Calibration Certificate

Cert. No. : ACL23162
Job No. : VC66AC0052
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-0009-23	07-FEB-24
Waveform Generator	33511B	MY52302742	EF-0010-23	07-FEB-24
Digital Multimeter	33461A	MY53220104	EEL-BP 30/0266	13-FEB-24
Digital Multimeter	33461A	MY53220076	EEL-BP 29/0266	13-FEB-24
Digital Multimeter	34461A	MY60024273	EEL-BP 31/0266	14-FEB-24
Programmable Attenuator	MAT-1070	62100114	EF-0011-23	08-FEB-24
Condenser Microphone	4180	2977900	AA-1001-23	14-FEB-24
Measuring Amplifier	NA-42KA1	34560495	AA-3002-23	14-FEB-24

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

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

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

QF-TS12-04-04-020664

T. Petch

Continuation of Calibration Certificate

Cert. No. : ACL23162
Job No. : VC66AC0052
Pages : 4 of 8

Result of calibration :

1. Absolute sensitivity

Reference Acoustic Signal (dB)	Measured Value (dB)	Deviation (dB)	Acceptance Limit (dB)
93.9 (93.98)	94.0	0.0	±0.3

2. Self-generated noise

2.1 Normal test

Measured Value (dB)
14.6

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	15.4
Flat	21.3

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	0.3	0.3	0.3	±1.0
1000	0.2	0.2	0.2	±0.7
8000	0.8	0.9	0.8	+1.5, -2.5

Continuation of Calibration Certificate

Cert. No. : ACL23162
Job No. : VC66AC0052
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	✓	-	0.3	N/A
3. Acoustical signal tests of frequency weightings				
125 Hz	✓	-	0.3	0.6
1000 Hz	✓	-	0.3	0.6
8000 Hz	✓	-	0.3	0.7
4. Electrical signal tests of frequency weightings				
For 10 Hz to 4 kHz	✓	-	0.3	0.6
For > 4 kHz to 10 kHz	✓	-	0.3	0.7
For > 10 kHz to 20 kHz	✓	-	0.3	1.0
5. Frequency and time weightings at 1 kHz	✓	-	0.2	0.2
6. Long-term stability	✓	-	0.1	0.1
7. Level linearity on the reference level range	✓	-	0.2	0.3
8. Level linearity including the level range control	✓	-	0.2	0.3
9. Tone burst response	✓	-	0.2	0.3
10. Peak C sound level	✓	-	0.2	0.35
11. Overload indication	✓	-	0.2	0.25
12. High level stability	✓	-	0.1	0.1

Note : Pass/Fail evaluation for each parameter, will be considered together from the acceptance limit and the Maximum-permitted uncertainty of measurement.

QF-TS12-04-04-020664

T. Petch

Continuation of Calibration Certificate

Cert. No. : ACL23162
Job No. : VC66AC0052
Pages : 5 of 8

4. Electrical signal tests of frequency weightings

Weighting network response with relative to 1 kHz.

Frequency (Hz)	Deviation from various frequency weighting response curve (dB)			
	Flat	C-weight	A-weight	Acceptance Limits
63	-0.1	-0.1	-0.1	±1.0
125	0.0	0.0	0.0	±1.0
250	0.0	0.0	-0.1	±1.0
500	0.0	0.0	0.0	±1.0
1000	0.0	0.0	0.0	±1.0
2000	0.0	0.0	0.0	±1.0
4000	0.0	0.0	0.0	±1.0
8000	0.0	0.1	0.1	+1.5, -2.5
16000	0.0	-1.2	-1.2	+2.5, -16.0

5. Frequency and time weightings at 1 kHz

5.1 Frequency weightings at 1 kHz

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

5.2 Time weighting at 1 kHz

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

6. Long-term stability

Frequency Weighting	SLM Display at initial (dB)	SLM Display at final (dB)	Deviated Value (dB)	Acceptance Limits (dB)
A-weight	94.0	94.0	0.0	±0.1

QF-TS12-04-04-020664

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Continuation of Calibration Certificate

Cert. No. : ACL23162
Job No. : VC66AC0052
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	±0.8
136.0	136.0	0.0	±0.8
135.0	135.0	0.0	±0.8
134.0	134.0	0.0	±0.8
133.0	133.0	0.0	±0.8
132.0	132.0	0.0	±0.8
131.0	131.0	0.0	±0.8
129.0	129.0	0.0	±0.8
124.0	124.0	0.0	±0.8
119.0	119.0	0.0	±0.8
114.0	114.0	0.0	±0.8
109.0	109.0	0.0	±0.8
104.0	104.0	0.0	±0.8
99.0	99.0	0.0	±0.8
94.0	94.0	0.0	±0.8
89.0	89.1	0.1	±0.8
84.0	84.1	0.1	±0.8
79.0	79.0	0.0	±0.8
74.0	74.1	0.1	±0.8
69.0	69.1	0.1	±0.8
64.0	64.0	0.0	±0.8
59.0	59.1	0.1	±0.8
54.0	54.0	0.0	±0.8
49.0	49.0	0.0	±0.8
44.0	44.0	0.0	±0.8
39.0	39.0	0.0	±0.8
34.0	34.0	0.0	±0.8
30.0	30.0	0.0	±0.8
29.0	28.9	-0.1	±0.8
28.0	28.0	0.0	±0.8
27.0	26.9	-0.1	±0.8
26.0	25.9	-0.1	±0.8
25.0	24.8	-0.2	±0.8

QF-TS12-04-04-020664

T. Petchuraj

Continuation of Calibration Certificate

Cert. No. : ACL23162
Job No. : VC66AC0052
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	±0.8

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	±2.0
One	136.4	135.8	-0.6	±2.0

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	±1.0
Positive half cycle	135.4	135.2	-0.2	±1.0
Negative half cycle	135.4	135.2	-0.2	±1.0

QF-TS12-04-04-020664

T. Petchuraj

Continuation of Calibration Certificate

Cert. No. : ACL23162
Job No. : VC66AC0052
Pages : 8 of 8

11. Overload indication

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

12. High level stability

Frequency Weighting	SLM Display at initial (dB)	SLM Display at final (dB)	Deviated Value (dB)	Acceptance Limits (dB)
A-weight	137.0	137.0	0.0	±0.1

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 Sirinthon Road, Bangtumru, Bangplut, Bangkok, 10700 Thailand
Tel. +66 2433 8231 Email: calibration@sithiporn.comCert. No. : ACL24077
Pages : 1 of 8

Calibration Certificate

Equipment : SOUND LEVEL METER
Manufacturer : RION
Model : NL-52A / Microphone UC-59 / Preamplifier NH-25
Serial No. : 00920831 / 22191 / 22220
ID No. : RYG_FS0622

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

Calibrated by : Nathakorn Pisutpaisan

Approved by :

T. Petchuraj
(Thanakul Petchuraj)

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QF-TS12-04-04-020664

T. Petchuraj

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CALIBRATION LABORATORY

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Tel: +66 2432 8331 Email: calibration@sithiporn.com

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Cert. No. : ACL24077
Job No. : VC67AC0054
Pages : 2 of 8

Calibration Procedure : CP-AC-01

Calibration Method :

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

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

Condition of this result of calibration :

1. Reference Standard Instruments :

Instrument	Model	Serial No.	Cert. No.	Due Date
Waveform Generator	33210A	MY48017076	EF-0009-23	07-FEB-24
Waveform Generator	33511B	MY52302742	EF-0010-23	07-FEB-24
Digital Multimeter	33461A	MY53220104	EEL-BP 30/0266	13-FEB-24
Digital Multimeter	33461A	MY53220076	EEL-BP 29/0266	13-FEB-24
Digital Multimeter	34461A	MY60024273	EEL-BP 31/0266	14-FEB-24
Programmable Attenuator	MAT-1070	62100114	EF-0011-23	08-FEB-24
Condenser Microphone	4180	2977900	AA-1001-23	14-FEB-24
Measuring Amplifier	NA-42KAI	34560495	AA-3002-23	14-FEB-24

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

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

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

T. Petch

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Cert. No. : ACL24077
Job No. : VC67AC0054
Pages : 4 of 8

Result of calibration :

1. Absolute sensitivity

Reference Acoustic Signal (dB)	Measured Value (dB)	Deviation (dB)	Acceptance Limit (dB)
93.9 (93.98)	94.0	0.0	±0.3

2. Self-generated noise

2.1 Normal test

Measured Value (dB)
13.8

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

Frequency Weighting	Measured value (dB)
A-weight	8.7
C-weight	13.7
Flat	19.6

3. Acoustical signal tests of frequency weightings

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

Frequency (Hz)	Deviation from various frequency weighting response curve (dB)			
	Flat	C-weight	A-weight	Acceptance Limits
125	0.1	0.2	0.2	± 1.0
1000	0.2	0.2	0.2	± 0.7
8000	0.4	0.5	0.5	+ 1.5, - 2.5

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Cert. No. : ACL24077
Job No. : VC67AC0054
Pages : 3 of 8

Summary of Measurement Result :

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

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Cert. No. : ACL24077
Job No. : VC67AC0054
Pages : 5 of 8

4. Electrical signal tests of frequency weightings

Weighting network response with relative to 1 kHz.

Frequency (Hz)	Deviation from various frequency weighting response curve (dB)			
	Flat	C-weight	A-weight	Acceptance Limits
63	0.0	0.0	0.0	±1.0
125	0.1	0.1	0.0	±1.0
250	0.0	0.0	0.0	±1.0
500	0.0	0.0	0.0	±1.0
1000	0.0	0.0	0.0	±1.0
2000	0.0	0.0	0.0	±1.0
4000	0.0	0.0	0.0	±1.0
8000	0.0	0.1	0.1	+ 1.5, - 2.5
16000	0.0	-1.2	-1.2	+ 2.5, -16.0

5. Frequency and time weightings at 1 kHz

5.1 Frequency weightings at 1 kHz

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

5.2 Time weighting at 1 kHz

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

6. Long-term stability

Frequency Weighting	SLM Display at initial (dB)	SLM Display at final (dB)	Deviated Value (dB)	Acceptance Limits (dB)
A-weight	94.0	94.0	0.0	± 0.1

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Cert. No. : ACL24077
Job No. : VC67AC0054
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	±0.8
136.0	136.0	0.0	±0.8
135.0	135.0	0.0	±0.8
134.0	134.0	0.0	±0.8
133.0	133.0	0.0	±0.8
132.0	132.0	0.0	±0.8
131.0	131.0	0.0	±0.8
129.0	129.0	0.0	±0.8
124.0	124.0	0.0	±0.8
119.0	119.0	0.0	±0.8
114.0	114.0	0.0	±0.8
109.0	109.0	0.0	±0.8
104.0	104.0	0.0	±0.8
99.0	99.0	0.0	±0.8
94.0	94.0	0.0	±0.8
89.0	89.0	0.0	±0.8
84.0	84.0	0.0	±0.8
79.0	79.0	0.0	±0.8
74.0	74.0	0.0	±0.8
69.0	69.0	0.0	±0.8
64.0	64.0	0.0	±0.8
59.0	59.0	0.0	±0.8
54.0	53.9	-0.1	±0.8
49.0	49.0	0.0	±0.8
44.0	44.0	0.0	±0.8
39.0	38.9	-0.1	±0.8
34.0	33.9	-0.1	±0.8
30.0	29.9	-0.1	±0.8
29.0	28.9	-0.1	±0.8
28.0	27.9	-0.1	±0.8
27.0	26.9	-0.1	±0.8
26.0	25.9	-0.1	±0.8
25.0	24.9	-0.1	±0.8

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Cert. No. : ACL24077
Job No. : VC67AC0054
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	±0.8

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	1.0 ; -3.0
	2	8	117.0	117.0	0.0	1.0 ; -1.5
	200	800	134.0	134.1	0.1	±0.5
Slow	2	8	108.0	108.0	0.0	1.0 ; -3.0
	200	800	127.6	127.6	0.0	±0.5
SEL	0.25	1	99.0	98.9	-0.1	1.0 ; -3.0
	2	8	108.0	108.0	0.0	1.0 ; -1.5
	200	800	128.0	128.0	0.0	±0.5

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	±2.0
One	136.4	135.4	-1.0	±2.0

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	±1.0
Positive half cycle	135.4	135.2	-0.2	±1.0
Negative half cycle	135.4	135.2	-0.2	±1.0

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Cert. No. : ACL24077
Job No. : VC67AC0054
Pages : 8 of 8

11. Overload indication

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

12. High level stability

Frequency Weighting	SLM Display at initial (dB)	SLM Display at final (dB)	Deviated Value (dB)	Acceptance Limits (dB)
A-weight	137.0	137.0	0.0	±0.1

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

End of Calibration Certificate

T. Petchur

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Cert. No. : ACL24079
Pages : 1 of 8

Calibration Certificate

Equipment : SOUND LEVEL METER
Manufacturer : RION
Model : NL-52A / Microphone UC-59 / Preamplifier NH-25
Serial No.: 00920833 / 22193 / 22222
ID No.: RYG_FS0624

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

Calibrated by : Nathakorn Pisutpaisan

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

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

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Cert. No. : ACL24079
Job No. : VC67AC0054
Pages : 2 of 8

Calibration Procedure : CP-AC-01

Calibration Method :

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

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

Condition of this result of calibration :

1. Reference Standard Instruments :

Instrument	Model	Serial No.	Cert. No.	Due Date
Waveform Generator	33210A	MY48017076	EF-0009-23	07-FEB-24
Waveform Generator	33511B	MY52302742	EF-0010-23	07-FEB-24
Digital Multimeter	33461A	MY53220104	EEL_BP 30/0266	13-FEB-24
Digital Multimeter	33461A	MY53220076	EEL_BP 29/0266	13-FEB-24
Digital Multimeter	34461A	MY60024273	EEL_BP 31/0266	14-FEB-24
Programmable Attenuator	MAT-1070	62100114	EF-0011-23	08-FEB-24
Condenser Microphone	4180	2977900	AA-1001-23	14-FEB-24
Measuring Amplifier	NA-42KAI	34560495	AA-3002-23	14-FEB-24

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

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

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

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Cert. No. : ACL24079
Job No. : VC67AC0054
Pages : 3 of 8

Summary of Measurement Result :

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

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Cert. No. : ACL24079
Job No. : VC67AC0054
Pages : 4 of 8

Result of calibration :

1. Absolute sensitivity

Reference Acoustic Signal (dB)	Measured Value (dB)	Deviation (dB)	Acceptance Limit (dB)
93.9 (93.98)	94.0	0.0	±0.3

2. Self-generated noise

2.1 Normal test

Measured Value (dB)
14.1

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

Frequency Weighting	Measured value (dB)
A-weight	8.7
C-weight	13.4
Flat	19.0

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	0.2	0.2	0.2	± 1.0
1000	0.2	0.2	0.2	± 0.7
8000	0.3	0.5	0.4	+ 1.5, - 2.5

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Cert. No. : ACL24079
Job No. : VC67AC0054
Pages : 5 of 8

4. Electrical signal tests of frequency weightings

Weighing network response with relative to 1 kHz

Frequency (Hz)	Deviation from various frequency weighting response curve (dB)			
	Flat	C-weight	A-weight	Acceptance Limits
63	-0.1	-0.1	0.0	±1.0
125	0.0	0.0	0.0	±1.0
250	0.0	0.0	0.0	±1.0
500	0.0	0.0	0.0	±1.0
1000	0.0	0.0	0.0	±1.0
2000	0.0	0.0	0.0	±1.0
4000	0.0	0.0	0.0	±1.0
8000	0.0	0.1	0.1	- 1.5, - 2.5
16000	0.0	-1.2	-1.2	+ 2.5, -16.0

5. Frequency and time weightings at 1 kHz

5.1 Frequency weightings at 1 kHz

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

5.2 Time weighting at 1 kHz

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

6. Long-term stability

Frequency Weighting	SLM Display at initial (dB)	SLM Display at final (dB)	Deviated Value (dB)	Acceptance Limits (dB)
A-weight	94.0	94.0	0.0	± 0.1

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Cert. No. : ACL24079
Job No. : VC67AC0054
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	±0.8
136.0	136.0	0.0	±0.8
135.0	135.0	0.0	±0.8
134.0	134.0	0.0	±0.8
133.0	133.0	0.0	±0.8
132.0	132.0	0.0	±0.8
131.0	131.0	0.0	±0.8
129.0	129.0	0.0	±0.8
124.0	124.0	0.0	±0.8
119.0	119.0	0.0	±0.8
114.0	114.0	0.0	±0.8
109.0	109.0	0.0	±0.8
104.0	104.0	0.0	±0.8
99.0	99.0	0.0	±0.8
94.0	94.0	0.0	±0.8
89.0	89.0	0.0	±0.8
84.0	84.0	0.0	±0.8
79.0	79.0	0.0	±0.8
74.0	74.0	0.0	±0.8
69.0	69.0	0.0	±0.8
64.0	64.0	0.0	±0.8
59.0	59.0	0.0	±0.8
54.0	54.0	0.0	±0.8
49.0	49.0	0.0	±0.8
44.0	44.0	0.0	±0.8
39.0	39.0	0.0	±0.8
34.0	34.0	0.0	±0.8
30.0	30.0	0.0	±0.8
29.0	29.0	0.0	±0.8
28.0	28.0	0.0	±0.8
27.0	27.0	0.0	±0.8
26.0	26.1	0.1	±0.8
25.0	25.0	0.0	±0.8

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Cert. No. : ACL24079
Job No. : VC67AC0054
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	±0.8

9. Tone burst response

Time Weighting	Tone burst duration, T _b (ms)	Cycle	Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Fast	0.25	1	108.0	107.9	-0.1	1.0; -3.0
	2	8	117.0	117.0	0.0	1.0; -1.5
	200	800	134.0	134.0	0.0	±0.5
Slow	2	8	108.0	108.0	0.0	1.0; -3.0
	200	800	127.6	127.6	0.0	±0.5
SEL	0.25	1	99.0	98.9	-0.1	1.0; -3.0
	2	8	108.0	108.0	0.0	1.0; -1.5
	200	800	128.0	128.0	0.0	±0.5

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	±2.0
One	136.4	135.7	-0.7	±2.0

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	±1.0
Positive half cycle	135.4	135.2	-0.2	±1.0
Negative half cycle	135.4	135.2	-0.2	±1.0

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Cert. No. : ACL24079
Job No. : VC67AC0054
Pages : 8 of 8

11. Overload indication

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

12. High level stability

Frequency Weighting	SLM Display at initial (dB)	SLM Display at final (dB)	Deviated Value (dB)	Acceptance Limits (dB)
A-weight	137.0	137.0	0.0	±0.1

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

End of Calibration Certificate

T. Petchur

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Cert. No. : ACL23160
Pages : 1 of 8

Calibration Certificate

Equipment : SOUND LEVEL METER
Manufacturer : RION
Model : NL-S2 / Microphone UC-59 / Preamplifier NH-25
Serial No.: 00764920 / 09848 / 65046
ID No.: BKK_FS0133

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 MAY 2023
Calibration Date : 10-16 MAY 2023
Date of Issue : 17 MAY 2023

Calibrated by : Nathakorn Pisutpaisan

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

REVIEW BY	<i>Nathakorn P</i>
APPROVED BY	<i>T. Petchur</i>
NEXT CAL DATE	10/15/24

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Continuation of Calibration Certificate

Cert. No. : ACL23160
Job No. : VC66AC0052
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-0009-23	07-FEB-24
Waveform Generator	33511B	MY52302742	EF-0010-23	07-FEB-24
Digital Multimeter	33461A	MY53220104	EEL_BP 30/0266	13-FEB-24
Digital Multimeter	33461A	MY53220076	EEL_BP 29/0266	13-FEB-24
Digital Multimeter	33461A	MY60024273	EEL_BP 31/0266	14-FEB-24
Programmable Attenuator	MAT-1070	62100114	EF-0011-23	08-FEB-24
Condenser Microphone	4180	2977900	AA-1001-23	14-FEB-24
Measuring Amplifier	NA-42KAI	34560495	AA-3002-23	14-FEB-24

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

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

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

QF-TS12-04-04-020664

Continuation of Calibration Certificate

Cert. No. : ACL23160
Job No. : VC66AC0052
Pages : 4 of 8

Result of calibration :

1. Absolute sensitivity

Reference Acoustic Signal (dB)	Measured Value (dB)	Deviation (dB)	Acceptance Limit (dB)
93.9 (93.98)	94.0	0.0	±0.3

2. Self-generated noise

2.1 Normal test

Measured Value (dB)
15.4

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

Frequency Weighting	Measured value (dB)
A - weight	12.1
C - weight	16.6
Flat	22.3

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	0.3	0.4	0.4	± 1.0
1000	0.2	0.2	0.2	± 0.7
8000	1.4	1.5	1.5	+ 1.5, - 2.5

QF-TS12-04-04-020664

Continuation of Calibration Certificate

Cert. No. : ACL23160
Job No. : VC66AC0052
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	✓	-	0.3	N/A
3. Acoustical signal tests of frequency weightings				
125 Hz	✓	-	0.3	0.6
1000 Hz	✓	-	0.3	0.6
8000 Hz	✓	-	0.3	0.7
4. Electrical signal tests of frequency weightings				
For 10 Hz to 4 kHz	✓	-	0.3	0.6
For > 4 kHz to 10 kHz	✓	-	0.3	0.7
For > 10 kHz to 20 kHz	✓	-	0.3	1.0
5. Frequency and time weightings at 1 kHz	✓	-	0.2	0.2
6. Long - term stability	✓	-	0.1	0.1
7. Level linearity on the reference level range	✓	-	0.2	0.3
8. Level linearity including the level range control	✓	-	0.2	0.3
9. Tone burst response	✓	-	0.2	0.3
10. Peak C sound level	✓	-	0.2	0.35
11. Overload indication	✓	-	0.2	0.25
12. High level stability	✓	-	0.1	0.1

Note : Pass/Fail evaluation for each parameter,
will be considered together from the acceptance limit and the Maximum-permitted uncertainty of measurement.

QF-TS12-04-04-020664

Continuation of Calibration Certificate

Cert. No. : ACL23160
Job No. : VC66AC0052
Pages : 5 of 8

4. Electrical signal tests of frequency weightings

Weighting network response with relative to 1 kHz.

Frequency (Hz)	Deviation from various frequency weighting response curve (dB)			
	Flat	C-weight	A-weight	Acceptance Limits
63	-0.1	-0.1	0.0	±1.0
125	0.0	0.0	0.0	±1.0
250	0.0	0.0	0.0	±1.0
500	0.0	0.0	0.0	±1.0
1000	0.0	0.0	0.0	±1.0
2000	0.0	0.0	0.0	±1.0
4000	0.0	0.0	0.0	±1.0
8000	0.0	0.1	0.1	+ 1.5, - 2.5
16000	0.0	-1.2	-1.2	+ 2.5, -16.0

5. Frequency and time weightings at 1 kHz

5.1 Frequency weightings at 1 kHz

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

5.2 Time weighting at 1 kHz

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

6. Long - term stability

Frequency Weighting	SLM Display at initial (dB)	SLM Display at final (dB)	Deviated Value (dB)	Acceptance Limits (dB)
A - weight	94.0	94.0	0.0	± 0.1

QF-TS12-04-04-020664

Continuation of Calibration Certificate

Cert. No. : ACL23160
Job No. : VC66AC0052
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	±0.8
136.0	136.0	0.0	±0.8
135.0	135.0	0.0	±0.8
134.0	134.0	0.0	±0.8
133.0	133.0	0.0	±0.8
132.0	132.0	0.0	±0.8
131.0	131.0	0.0	±0.8
129.0	129.0	0.0	±0.8
124.0	124.0	0.0	±0.8
119.0	119.0	0.0	±0.8
114.0	114.0	0.0	±0.8
109.0	109.0	0.0	±0.8
104.0	104.0	0.0	±0.8
99.0	99.0	0.0	±0.8
94.0	94.0	0.0	±0.8
89.0	89.0	0.0	±0.8
84.0	84.0	0.0	±0.8
79.0	79.0	0.0	±0.8
74.0	74.0	0.0	±0.8
69.0	69.0	0.0	±0.8
64.0	64.0	0.0	±0.8
59.0	59.0	0.0	±0.8
54.0	54.0	0.0	±0.8
49.0	49.0	0.0	±0.8
44.0	44.0	0.0	±0.8
39.0	39.0	0.0	±0.8
34.0	33.9	-0.1	±0.8
30.0	29.9	-0.1	±0.8
29.0	28.9	-0.1	±0.8
28.0	27.9	-0.1	±0.8
27.0	26.9	-0.1	±0.8
26.0	25.9	-0.1	±0.8
25.0	24.8	-0.2	±0.8

QF-TS12-04-04-020664

T. Petchurai

Continuation of Calibration Certificate

Cert. No. : ACL23160
Job No. : VC66AC0052
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	±0.8

9. Tone burst response

Time Weighting	Tone burst duration, Tb (ms)	Cycle	Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Fast	0.25	1	108.0	107.9	-0.1	1.5; -5.0
	2	8	117.0	117.0	0.0	1.0; -2.5
	200	800	134.0	134.1	0.1	±1.0
Slow	2	8	108.0	108.0	0.0	1.5; -5.0
	200	800	127.6	127.6	0.0	±1.0
SEL	0.25	1	99.0	98.9	-0.1	1.5; -5.0
	2	8	108.0	108.0	0.0	1.0; -2.5
	200	800	128.0	128.1	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	±2.0
One	136.4	135.7	-0.7	±2.0

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	±1.0
Positive half cycle	135.4	135.2	-0.2	±1.0
Negative half cycle	135.4	135.2	-0.2	±1.0

QF-TS12-04-04-020664

T. Petchurai

Continuation of Calibration Certificate

Cert. No. : ACL23160
Job No. : VC66AC0052
Pages : 8 of 8

11. Overload indication

Measured value (dB)		Deviated Value (dB)	Acceptance Limits (dB)
Positive one-half cycle	Negative one-half cycle		
89.7	89.5	-0.2	±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	±0.1

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/ Sirinphorn Road, Bangbuem, Bangpuat, Bangkok, 10700 Thailand
Tel : +66 2433 9331 Email : calibration@sithiporn.comCert. No. : ACL24082
Pages : 1 of 8

Calibration Certificate

Equipment : SOUND LEVEL METER
Manufacturer : RION
Model : NL-52A / Microphone UC-59 / Preamplifier NH-25
Serial No. : 01120937 / 21845 / 22326
ID No. : RYG_FS0628

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

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.

T. Petchurai

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CALIBRATION LABORATORY

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MSC-TS-17023
CALIBRATION 0394

Cert. No. : ACL24082
Job No. : VC67AC0054
Pages : 2 of 8

Calibration Procedure : CP-AC-01

Calibration Method :

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

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

Condition of this result of calibration :

1. Reference Standard Instruments :

Instrument	Model	Serial No.	Cert. No.	Due Date
Waveform Generator	33210A	MY48017076	EF-0009-23	07-FEB-24
Waveform Generator	33511B	MY52302742	EF-0010-23	07-FEB-24
Digital Multimeter	33461A	MY53220104	EEL_BP 30/0266	13-FEB-24
Digital Multimeter	33461A	MY53220076	EEL_BP 29/0266	13-FEB-24
Digital Multimeter	34461A	MY60024273	EEL_BP 31/0266	14-FEB-24
Programmable Attenuator	MAT-1070	62100114	EF-0011-23	08-FEB-24
Condenser Microphone	4180	2977900	AA-1001-23	14-FEB-24
Measuring Amplifier	NA-42KA1	34560495	AA-3002-23	14-FEB-24

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

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

3.1 National Institute of Metrology (Thailand).

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

T. Petch

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MSC-TS-17023
CALIBRATION 0394

Cert. No. : ACL24082
Job No. : VC67AC0054
Pages : 4 of 8

Result of calibration :

1. Absolute sensitivity

Reference Acoustic Signal (dB)	Measured Value (dB)	Deviation (dB)	Acceptance Limit (dB)
93.9 (93.98)	94.0	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	9.9
C-weight	14.3
Flat	19.9

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	0.2	0.2	0.2	± 1.0
1000	0.2	0.2	0.2	± 0.7
8000	0.4	0.5	0.5	+ 1.5, - 2.5

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Cert. No. : ACL24082
Job No. : VC67AC0054
Pages : 3 of 8

Summary of Measurement Result :

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

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CALIBRATION 0394

Cert. No. : ACL24082
Job No. : VC67AC0054
Pages : 5 of 8

4. Electrical signal tests of frequency weightings

Weighting network response with relative to 1 kHz

Frequency (Hz)	Deviation from various frequency weighting response curve (dB)			
	Flat	C-weight	A-weight	Acceptance Limits
63	0.0	0.0	0.0	±1.0
125	0.0	0.1	0.1	±1.0
250	0.0	0.0	0.0	±1.0
500	0.0	0.1	0.0	±1.0
1000	0.0	0.0	0.0	±1.0
2000	0.0	0.1	0.0	±1.0
4000	0.0	0.0	0.0	±1.0
8000	0.0	0.1	0.1	+ 1.5, - 2.5
16000	0.0	-1.2	-1.1	+ 2.5, -16.0

5. Frequency and time weightings at 1 kHz

5.1 Frequency weightings at 1 kHz

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

5.2 Time weighting at 1 kHz

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

6. Long-term stability

Frequency Weighting	SLM Display at initial (dB)	SLM Display at final (dB)	Deviated Value (dB)	Acceptance Limits (dB)
A-weight	94.0	94.0	0.0	± 0.1

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Cert. No. : ACL24082
Job No. : VC67AC0054
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	137.1	0.1	±0.8
136.0	136.0	0.0	±0.8
135.0	135.1	0.1	±0.8
134.0	134.0	0.0	±0.8
133.0	133.0	0.0	±0.8
132.0	132.0	0.0	±0.8
131.0	131.0	0.0	±0.8
129.0	129.0	0.0	±0.8
124.0	124.0	0.0	±0.8
119.0	119.0	0.0	±0.8
114.0	114.0	0.0	±0.8
109.0	109.0	0.0	±0.8
104.0	104.0	0.0	±0.8
99.0	99.0	0.0	±0.8
94.0	94.0	0.0	±0.8
89.0	89.0	0.0	±0.8
84.0	84.0	0.0	±0.8
79.0	79.0	0.0	±0.8
74.0	74.0	0.0	±0.8
69.0	69.0	0.0	±0.8
64.0	64.0	0.0	±0.8
59.0	59.0	0.0	±0.8
54.0	54.0	0.0	±0.8
49.0	49.0	0.0	±0.8
44.0	44.0	0.0	±0.8
39.0	39.0	0.0	±0.8
34.0	34.0	0.0	±0.8
30.0	30.0	0.0	±0.8
29.0	28.9	-0.1	±0.8
28.0	28.0	0.0	±0.8
27.0	26.9	-0.1	±0.8
26.0	25.9	-0.1	±0.8
25.0	24.9	-0.1	±0.8

T. Petchur

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Cert. No. : ACL24082
Job No. : VC67AC0054
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8. Level linearity including the level range control

Range	Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Auto	94.0	94.0	0.0	±0.8

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	1.0 ; -3.0
	2	8	117.0	117.0	0.0	1.0 ; -1.5
	200	800	134.0	134.1	0.1	±0.5
Slow	2	8	108.0	108.0	0.0	1.0 ; -3.0
	200	800	127.6	127.6	0.0	±0.5
SEL	0.25	1	99.0	98.9	-0.1	1.0 ; -3.0
	2	8	108.0	108.0	0.0	1.0 ; -1.5
	200	800	128.0	128.1	0.1	±0.5

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	±2.0
One	136.4	136.4	0.0	±2.0

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	±1.0
Positive half cycle	135.4	135.1	-0.3	±1.0
Negative half cycle	135.4	135.1	-0.3	±1.0

T. Petchur

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Cert. No. : ACL24082
Job No. : VC67AC0054
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	±0.1

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

End of Calibration Certificate

T. Petchur

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



Cert. No. : ACL24084
Pages : 1 of 8

Calibration Certificate

Equipment : SOUND LEVEL METER
Manufacturer : RION
Model : NL-52A / Microphone UC-59 / Preamplifier NH-25
Serial No.: 01120939 / 21940 / 22328
ID No.: RYG_FS0630

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

Calibrated by : Nathakorn Pisutpaisan

Approved by : T. Petchur
(Thanakul Petchurai)

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SITHIPORN ASSOCIATES CO., LTD.
CALIBRATION LABORATORY

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Cert. No. : ACL24084
Job No. : VC67AC0054
Pages : 2 of 8

Calibration Procedure : CP-AC-01

Calibration Method :

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

Condition of this result of calibration :

1. Reference Standard Instruments :

Instrument	Model	Serial No.	Cert. No.	Due Date
Waveform Generator	33210A	MY48017076	EF-0009-23	07-FEB-24
Waveform Generator	33511B	MY52302742	EF-0010-23	07-FEB-24
Digital Multimeter	33461A	MY53220104	EEL-BP 30/0266	13-FEB-24
Digital Multimeter	33461A	MY53220076	EEL-BP 29/0266	13-FEB-24
Digital Multimeter	34461A	MY60024273	EEL-BP 31/0266	14-FEB-24
Programmable Attenuator	MAT-1070	62100114	EF-0011-23	08-FEB-24
Condenser Microphone	4180	2977900	AA-1001-23	14-FEB-24
Measuring Amplifier	NA-42KAI	34560495	AA-3002-23	14-FEB-24

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

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

3.1 National Institute of Metrology (Thailand).

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

Signature

SITHIPORN ASSOCIATES CO., LTD.
CALIBRATION LABORATORY

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

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Cert. No. : ACL24084
Job No. : VC67AC0054
Pages : 4 of 8

Result of calibration :

1. Absolute sensitivity

Reference Acoustic Signal (dB)	Measured Value (dB)	Deviation (dB)	Acceptance Limit (dB)
93.9 (93.98)	94.0	0.0	±0.3

2. Self-generated noise

2.1 Normal test

Measured Value (dB)
13.8

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

Frequency Weighting	Measured value (dB)
A - weight	8.7
C - weight	14.0
Flat	19.8

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	± 1.0
1000	0.2	0.2	0.2	± 0.7
8000	0.6	0.6	0.6	± 1.5, -2.5

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451-451/1 Sirinthorn Road, Bangbunmu, Bangkok, Bangkok, 10700 Thailand
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Cert. No. : ACL24084
Job No. : VC67AC0054
Pages : 3 of 8

Summary of Measurement Result :

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

Signature

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Cert. No. : ACL24084
Job No. : VC67AC0054
Pages : 5 of 8

4. Electrical signal tests of frequency weightings

Weighting network response with relative to 1 kHz.

Frequency (Hz)	Deviation from various frequency weighting response curve (dB)			
	Flat	C-weight	A-weight	Acceptance Limits
63	-0.1	0.0	0.0	±1.0
125	0.0	0.0	0.0	±1.0
250	0.0	0.0	0.0	±1.0
500	0.0	0.0	0.0	±1.0
1000	0.0	0.0	0.0	±1.0
2000	0.0	0.0	0.0	±1.0
4000	0.0	0.0	0.0	±1.0
8000	0.0	0.1	0.1	± 1.5, -2.5
16000	0.0	-1.2	-1.2	± 2.5, -16.0

5. Frequency and time weightings at 1 kHz

5.1 Frequency weightings at 1 kHz

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

5.2 Time weighting at 1 kHz

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

6. Long - term stability

Frequency Weighting	SLM Display at initial (dB)	SLM Display at final (dB)	Deviated Value (dB)	Acceptance Limits (dB)
A - weight	94.0	94.0	0.0	± 0.1

Signature

SITHIPORN ASSOCIATES CO., LTD.
CALIBRATION LABORATORY

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



Cert. No. : ACL24084
Job No. : VC67AC0054
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	±0.8
136.0	136.0	0.0	±0.8
135.0	135.0	0.0	±0.8
134.0	134.0	0.0	±0.8
133.0	133.0	0.0	±0.8
132.0	132.0	0.0	±0.8
131.0	131.0	0.0	±0.8
129.0	129.0	0.0	±0.8
124.0	124.0	0.0	±0.8
119.0	119.0	0.0	±0.8
114.0	114.0	0.0	±0.8
109.0	109.0	0.0	±0.8
104.0	104.0	0.0	±0.8
99.0	99.0	0.0	±0.8
94.0	94.0	0.0	±0.8
89.0	89.0	0.0	±0.8
84.0	84.0	0.0	±0.8
79.0	79.0	0.0	±0.8
74.0	74.0	0.0	±0.8
69.0	69.0	0.0	±0.8
64.0	63.9	-0.1	±0.8
59.0	59.0	0.0	±0.8
54.0	53.9	-0.1	±0.8
49.0	48.9	-0.1	±0.8
44.0	43.9	-0.1	±0.8
39.0	38.9	-0.1	±0.8
34.0	33.9	-0.1	±0.8
30.0	29.9	-0.1	±0.8
29.0	28.9	-0.1	±0.8
28.0	27.9	-0.1	±0.8
27.0	26.9	-0.1	±0.8
26.0	25.9	-0.1	±0.8
25.0	24.8	-0.2	±0.8

T. Petchur

SITHIPORN ASSOCIATES CO., LTD.
CALIBRATION LABORATORY

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



Cert. No. : ACL24084
Job No. : VC67AC0054
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	±0.8

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	1.0 ; -3.0
	2	8	117.0	117.0	0.0	1.0 ; -1.5
	200	800	134.0	134.0	0.0	±0.5
Slow	2	8	108.0	108.0	0.0	1.0 ; -3.0
	200	800	127.6	127.6	0.0	±0.5
SEL	0.25	1	99.0	98.9	-0.1	1.0 ; -3.0
	2	8	108.0	108.0	0.0	1.0 ; -1.5
	200	800	128.0	128.1	0.1	±0.5

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	±2.0
One	136.4	136.3	-0.1	±2.0

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	±1.0
Positive half cycle	135.4	135.2	-0.2	±1.0
Negative half cycle	135.4	135.2	-0.2	±1.0

T. Petchur

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CALIBRATION LABORATORY

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Cert. No. : ACL24084
Job No. : VC67AC0054
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	89.5	0.0	±1.5

12. High level stability

Frequency Weighting	SLM Display at initial (dB)	SLM Display at final (dB)	Deviated Value (dB)	Acceptance Limits (dB)
A-weight	137.0	137.0	0.0	±0.1

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

End of Calibration Certificate

T. Petchur

SITHIPORN ASSOCIATES CO., LTD.
CALIBRATION LABORATORY

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Cert. No. : ACL23161
Pages : 1 of 8

Calibration Certificate

Equipment : SOUND LEVEL METER
Manufacturer : RION
Model : NL-52 / Microphone UC-59 / Preamplifier NH-25
Serial No.: 00764922 / 09850 / 65048
ID No.: BKK_FS0134

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 MAY 2023
Calibration Date : 10-16 MAY 2023
Date of Issue : 17 MAY 2023

REVIEW BY	<i>Nathakorn P.</i>
APPROVED BY	<i>[Signature]</i>
NEXT CAL DATE	10/5/24

Calibrated by : Nathakorn Pisutpaisan

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

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

Continuation of Calibration Certificate

Cert. No. : ACL23161
Job No. : VC66AC0052
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-0009-23	07-FEB-24
Waveform Generator	33511B	MY52302742	EF-0010-23	07-FEB-24
Digital Multimeter	33461A	MY53220104	EEL-BP 30.0266	13-FEB-24
Digital Multimeter	33461A	MY53220076	EEL-BP 29.0266	13-FEB-24
Digital Multimeter	34461A	MY60024273	EEL-BP 31.0266	14-FEB-24
Programmable Attenuator	MAT-1070	62100114	EF-0011-23	08-FEB-24
Condenser Microphone	4180	2977900	AA-1001-23	14-FEB-24
Measuring Amplifier	NA-42KAI	34560495	AA-3002-23	14-FEB-24

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

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

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

Continuation of Calibration Certificate

Cert. No. : ACL23161
Job No. : VC66AC0052
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	✓	-	0.3	N/A
3. Acoustical signal tests of frequency weightings				
125 Hz	✓	-	0.3	0.6
1000 Hz	✓	-	0.3	0.6
8000 Hz	✓	-	0.3	0.7
4. Electrical signal tests of frequency weightings				
For 10 Hz to 4 kHz	✓	-	0.3	0.6
For > 4 kHz to 10 kHz	✓	-	0.3	0.7
For > 10 kHz to 20 kHz	✓	-	0.3	1.0
5. Frequency and time weightings at 1 kHz	✓	-	0.2	0.2
6. Long - term stability	✓	-	0.1	0.1
7. Level linearity on the reference level range	✓	-	0.2	0.3
8. Level linearity including the level range control	✓	-	0.2	0.3
9. Tone burst response	✓	-	0.2	0.3
10. Peak C sound level	✓	-	0.2	0.35
11. Overload indication	✓	-	0.2	0.25
12. High level stability	✓	-	0.1	0.1

Note : Pass/Fail evaluation for each parameter, will be considered together from the acceptance limit and the Maximum-permitted uncertainty of measurement.

QF-TS12-04-04-020664

T. Petch

Continuation of Calibration Certificate

Cert. No. : ACL23161
Job No. : VC66AC0052
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%)	94.0	0.0	±0.3

2. Self-generated noise

2.1 Normal test

Measured Value (dB)
14.8

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

Frequency Weighting	Measured value (dB)
A - weight	10.8
C - weight	15.4
Flat	21.2

3. Acoustical signal tests of frequency weightings

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

Frequency (Hz)	Flat	C-weight	A-weight	Acceptance Limits
125	0.4	0.4	0.4	± 1.0
1000	0.3	0.3	0.3	± 0.7
8000	1.0	1.1	1.1	+ 1.5, - 2.5

Continuation of Calibration Certificate

Cert. No. : ACL23161
Job No. : VC66AC0052
Pages : 5 of 8

4. Electrical signal tests of frequency weightings

Weighting network response with relative to 1 kHz.

Frequency (Hz)	Flat	C-weight	A-weight	Acceptance Limits
63	-0.1	-0.1	-0.1	±1.0
125	-0.1	0.0	0.0	±1.0
250	0.0	0.0	-0.1	±1.0
500	0.0	0.0	-0.1	±1.0
1000	0.0	0.0	0.0	±1.0
2000	0.0	0.0	0.0	±1.0
4000	0.0	0.0	0.0	±1.0
8000	0.0	0.0	0.0	+ 1.5, - 2.5
16000	0.0	-1.2	-1.2	+ 2.5, -16.0

5. Frequency and time weightings at 1 kHz

5.1 Frequency weightings at 1 kHz

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

5.2 Time weighting at 1 kHz

Frequency Weighting	Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Fast	94.0	94.0	0.0	± 0.1
Slow	94.0	93.9	-0.1	± 0.1
Leq	94.0	93.9	-0.1	± 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	± 0.1

QF-TS12-04-04-020664

T. Petch

QF-TS12-04-04-020664

T. Petch

Cert. No. : ACL23161
Job No. : VC66AC0052
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	137.1	0.1	±0.8
136.0	136.1	0.1	±0.8
135.0	135.1	0.1	±0.8
134.0	134.1	0.1	±0.8
133.0	133.0	0.0	±0.8
132.0	132.0	0.0	±0.8
131.0	131.0	0.0	±0.8
129.0	129.0	0.0	±0.8
124.0	124.0	0.0	±0.8
119.0	119.1	0.1	±0.8
114.0	114.1	0.1	±0.8
109.0	109.0	0.0	±0.8
104.0	104.1	0.1	±0.8
99.0	99.1	0.1	±0.8
94.0	94.0	0.0	±0.8
89.0	89.0	0.0	±0.8
84.0	84.0	0.0	±0.8
79.0	79.0	0.0	±0.8
74.0	74.0	0.0	±0.8
69.0	69.0	0.0	±0.8
64.0	64.0	0.0	±0.8
59.0	59.0	0.0	±0.8
54.0	54.0	0.0	±0.8
49.0	49.0	0.0	±0.8
44.0	44.0	0.0	±0.8
39.0	39.0	0.0	±0.8
34.0	34.0	0.0	±0.8
30.0	29.9	-0.1	±0.8
29.0	29.0	0.0	±0.8
28.0	28.0	0.0	±0.8
27.0	27.0	0.0	±0.8
26.0	26.0	0.0	±0.8
25.0	24.9	-0.1	±0.8

QF-TS12-04-04-020664

T. Petchur

Cert. No. : ACL23161
Job No. : VC66AC0052
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	±0.8

9. Tone burst response

Time Weighting	Tone burst duration, T _b (ms)	Cycle	Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Fast	0.25	1	108.0	107.9	-0.1	1.5 ; -5.0
	2	8	117.0	116.9	-0.1	1.0 ; -2.5
	200	800	134.0	134.0	0.0	±1.0
Slow	2	8	108.0	108.0	0.0	1.5 ; -5.0
	200	800	127.6	127.6	0.0	±1.0
SEL	0.25	1	99.0	98.9	-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 _{Cpeak} (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Continuous	133.0	133.0	0.0	±2.0
One	136.4	136.3	-0.1	±2.0

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	±1.0
Positive half cycle	135.4	135.1	-0.3	±1.0
Negative half cycle	135.4	135.1	-0.3	±1.0

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T. Petchur

Cert. No. : ACL23161
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11. Overload indication

Measured value (dB)		Deviated Value (dB)	Acceptance Limits (dB)
Positive one-half cycle	Negative one-half cycle		
89.5	89.5	0.0	±1.5

12. High level stability

Frequency Weighting	SLM Display at initial (dB)	SLM Display at final (dB)	Deviated Value (dB)	Acceptance Limits (dB)
A - weight	137.0	137.0	0.0	±0.1

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 Sirthiporn Road, Bangbunmei, Bangplud, Bangkok, 10700 Thailand
Tel : +66 3433 8831 Email : calibration@sithiporn.comCert. No. : ACL24078
Pages : 1 of 8

Calibration Certificate

Equipment : SOUND LEVEL METER
Manufacturer : RION
Model : NL-52A / Microphone UC-59 / Preamplifier NH-25
Serial No. : 00920832 / 22192 / 22221
ID No. : RYG_FS0623

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

Calibrated by : Nathakorn Pisutpaisan

Approved by :

T. Petchur
(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

T. Petchur

SITHIPORN ASSOCIATES CO., LTD.
CALIBRATION LABORATORY

459-45/1 Srinthorn Road, Bangnaerue, Bangkok, 10700 Thailand
Tel: +66 2433 8331 Email: calibration@sithiporn.com

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Cert. No. : ACL24078
Job No. : VC67AC0054
Pages : 2 of 8

Calibration Procedure : CP-AC-01

Calibration Method :

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

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

Condition of this result of calibration :

1. Reference Standard Instruments :

Instrument	Model	Serial No.	Cert. No.	Due Date
Waveform Generator	33210A	MY48017076	EF-0009-23	07-FEB-24
Waveform Generator	33511B	MY52302742	EF-0010-23	07-FEB-24
Digital Multimeter	33461A	MY53220104	EEL_BP 30/0266	13-FEB-24
Digital Multimeter	33461A	MY53220076	EEL_BP 29/0266	13-FEB-24
Digital Multimeter	34461A	MY60024273	EEL_BP 31/0266	14-FEB-24
Programmable Attenuator	MAT-1070	62100114	EF-0011-23	08-FEB-24
Condenser Microphone	4180	2977900	AA-1001-23	14-FEB-24
Measuring Amplifier	NA-42KA1	34560495	AA-3002-23	14-FEB-24

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

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

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

T. Retan

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CALIBRATION LABORATORY

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Cert. No. : ACL24078
Job No. : VC67AC0054
Pages : 4 of 8

Result of calibration :

1. Absolute sensitivity

Reference Acoustic Signal (dB)	Measured Value (dB)	Deviation (dB)	Acceptance Limit (dB)
93.9 (93.98)	94.0	0.0	±0.3

2. Self-generated noise

2.1 Normal test

Measured Value (dB)
14.1

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

Frequency Weighting	Measured value (dB)
A - weight	8.7
C - weight	13.4
Flat	19.1

3. Acoustical signal tests of frequency weightings

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

Frequency (Hz)	Deviation from various frequency weighting response curve (dB)			
	Flat	C-weight	A-weight	Acceptance Limits
125	0.2	0.2	0.2	± 1.0
1000	0.2	0.2	0.2	± 0.7
8000	0.2	0.3	0.3	+ 1.5, - 2.5

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Cert. No. : ACL24078
Job No. : VC67AC0054
Pages : 3 of 8

Summary of Measurement Result :

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

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Cert. No. : ACL24078
Job No. : VC67AC0054
Pages : 5 of 8

4. Electrical signal tests of frequency weightings

Weighting network response with relative to 1 kHz.

Frequency (Hz)	Deviation from various frequency weighting response curve (dB)			
	Flat	C-weight	A-weight	Acceptance Limits
63	0.1	0.0	0.0	±1.0
125	0.0	0.1	0.0	±1.0
250	0.1	0.1	0.0	±1.0
500	0.0	0.1	0.0	±1.0
1000	0.0	0.0	0.0	±1.0
2000	0.0	0.1	0.0	±1.0
4000	0.0	0.0	-0.0	±1.0
8000	0.0	0.1	0.1	+ 1.5, - 2.5
16000	0.0	-1.2	-1.1	+ 2.5, -16.0

5. Frequency and time weightings at 1 kHz

5.1 Frequency weightings at 1 kHz

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

5.2 Time weighting at 1 kHz

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

6. Long - term stability

Frequency Weighting	SLM Display at initial (dB)	SLM Display at final (dB)	Deviated Value (dB)	Acceptance Limits (dB)
A - weight	94.0	94.0	0.0	± 0.1

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Cert. No. : ACL24078
Job No. : VC67AC0054
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	137.1	0.1	±0.8
136.0	136.1	0.1	±0.8
135.0	135.1	0.1	±0.8
134.0	134.1	0.1	±0.8
133.0	133.0	0.0	±0.8
132.0	132.0	0.0	±0.8
131.0	131.0	0.0	±0.8
129.0	129.0	0.0	±0.8
124.0	124.0	0.0	±0.8
119.0	119.0	0.0	±0.8
114.0	114.0	0.0	±0.8
109.0	109.0	0.0	±0.8
104.0	104.0	0.0	±0.8
99.0	99.0	0.0	±0.8
94.0	94.0	0.0	±0.8
89.0	89.0	0.0	±0.8
84.0	84.0	0.0	±0.8
79.0	79.0	0.0	±0.8
74.0	74.0	0.0	±0.8
69.0	69.0	0.0	±0.8
64.0	64.0	0.0	±0.8
59.0	59.0	0.0	±0.8
54.0	54.0	0.0	±0.8
49.0	49.0	0.0	±0.8
44.0	44.0	0.0	±0.8
39.0	39.0	0.0	±0.8
34.0	34.0	0.0	±0.8
30.0	30.0	0.0	±0.8
29.0	29.0	0.0	±0.8
28.0	28.0	0.0	±0.8
27.0	27.0	0.0	±0.8
26.0	26.0	0.0	±0.8
25.0	25.0	0.0	±0.8

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Cert. No. : ACL24078
Job No. : VC67AC0054
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	±0.8

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	1.0 ; -3.0
	2	8	117.0	116.9	-0.1	1.0 ; -1.5
	200	800	134.0	134.0	0.0	±0.5
Slow	2	8	108.0	107.9	-0.1	1.0 ; -3.0
	200	800	127.6	127.5	-0.1	±0.5
	0.25	1	99.0	98.8	-0.2	1.0 ; -3.0
SEL	2	8	108.0	107.9	-0.1	1.0 ; -1.5
	200	800	128.0	128.0	0.0	±0.5

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	±2.0
One	136.4	135.4	-1.0	±2.0

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	±1.0
Positive half cycle	135.4	135.1	-0.3	±1.0
Negative half cycle	135.4	135.1	-0.3	±1.0

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Cert. No. : ACL24078
Job No. : VC67AC0054
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11. Overload indication

Measured value (dB)		Deviated Value (dB)	Acceptance Limits (dB)
Positive one-half cycle	Negative one-half cycle		
89.5	89.7	0.2	±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	±0.1

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

End of Calibration Certificate

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Cert. No. : ACL24080
Pages : 1 of 8

Calibration Certificate

Equipment : SOUND LEVEL METER
Manufacturer : RION
Model : NL-S2A / Microphone UC-59 / Preamplifier NH-25
Serial No. : 00920834 / 22194 / 22223
ID No. : RYG_FS0625

Condition As Found : GOOD

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

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

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

Calibrated by : Nadinorn Pisutpaisan

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

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Cert. No. : ACL24080
Job No. : VC67AC0054
Pages : 2 of 8

Calibration Procedure : CP-AC-01

Calibration Method :

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

Condition of this result of calibration :

1. Reference Standard Instruments :

Instrument	Model	Serial No.	Cert. No.	Due Date
Waveform Generator	33210A	MY48017076	EF-0009-23	07-FEB-24
Waveform Generator	33511B	MY52302742	EF-0010-23	07-FEB-24
Digital Multimeter	33461A	MY53220104	EEL-BP 30/0266	13-FEB-24
Digital Multimeter	33461A	MY53220076	EEL-BP 29/0266	13-FEB-24
Digital Multimeter	34461A	MY60024273	EEL-BP 31/0266	14-FEB-24
Programmable Attenuator	MAT-1070	62100114	EF-0011-23	08-FEB-24
Condenser Microphone	4180	2977900	AA-1001-23	14-FEB-24
Measuring Amplifier	NA-42KA1	34560495	AA-3002-23	14-FEB-24

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

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

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

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Cert. No. : ACL24080
Job No. : VC67AC0054
Pages : 4 of 8

Result of calibration :

1. Absolute sensitivity

Reference Acoustic Signal (dB)	Measured Value (dB)	Deviation (dB)	Acceptance Limit (dB)
93.9 (93.98)	94.0	0.0	±0.3

2. Self-generated noise

2.1 Normal test

Measured Value (dB)
13.4

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

Frequency Weighting	Measured value (dB)
A - weight	8.7
C - weight	13.6
Flat	19.3

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	± 1.0
1000	0.2	0.2	0.2	± 0.7
8000	0.7	0.8	0.8	+ 1.5, - 2.5

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Cert. No. : ACL24080
Job No. : VC67AC0054
Pages : 3 of 8

Summary of Measurement Result :

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

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Cert. No. : ACL24080
Job No. : VC67AC0054
Pages : 5 of 8

4. Electrical signal tests of frequency weightings

Weighting network response with relative to 1 kHz.

Frequency (Hz)	Deviation from various frequency weighting response curve (dB)			
	Flat	C-weight	A-weight	Acceptance Limits
63	0.0	0.0	0.0	±1.0
125	0.0	0.1	0.0	±1.0
250	0.0	0.0	0.0	±1.0
500	0.0	0.0	0.0	±1.0
1000	0.0	0.0	0.0	±1.0
2000	0.0	0.0	0.0	±1.0
4000	0.0	0.0	0.0	±1.0
8000	0.0	0.1	0.1	+ 1.5, - 2.5
16000	0.0	-1.2	-1.2	+ 2.5, -16.0

5. Frequency and time weightings at 1 kHz

5.1 Frequency weightings at 1 kHz

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

5.2 Time weighting at 1 kHz

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

6. Long - term stability

Frequency Weighting	SLM Display at initial (dB)	SLM Display at final (dB)	Deviated Value (dB)	Acceptance Limits (dB)
A - weight	94.0	94.0	0.0	± 0.1

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Cert. No. : ACL24080
Job No. : VC67AC0054
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	±0.8
136.0	136.0	0.0	±0.8
135.0	135.0	0.0	±0.8
134.0	134.0	0.0	±0.8
133.0	133.0	0.0	±0.8
132.0	132.0	0.0	±0.8
131.0	131.0	0.0	±0.8
129.0	129.0	0.0	±0.8
124.0	124.0	0.0	±0.8
119.0	119.0	0.0	±0.8
114.0	114.0	0.0	±0.8
109.0	109.0	0.0	±0.8
104.0	104.0	0.0	±0.8
99.0	99.0	0.0	±0.8
94.0	94.0	0.0	±0.8
89.0	89.1	0.1	±0.8
84.0	84.1	0.1	±0.8
79.0	79.0	0.0	±0.8
74.0	74.1	0.1	±0.8
69.0	69.1	0.1	±0.8
64.0	64.0	0.0	±0.8
59.0	59.1	0.1	±0.8
54.0	54.0	0.0	±0.8
49.0	49.0	0.0	±0.8
44.0	44.0	0.0	±0.8
39.0	39.0	0.0	±0.8
34.0	34.1	0.1	±0.8
30.0	30.0	0.0	±0.8
29.0	29.0	0.0	±0.8
28.0	28.0	0.0	±0.8
27.0	27.0	0.0	±0.8
26.0	26.0	0.0	±0.8
25.0	25.0	0.0	±0.8

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Cert. No. : ACL24080
Job No. : VC67AC0054
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	±0.8

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	1.0 ; -3.0
	2	8	117.0	117.0	0.0	1.0 ; -1.5
	200	800	134.0	134.0	0.0	±0.5
Slow	2	8	108.0	108.0	0.0	1.0 ; -3.0
	200	800	127.6	127.6	0.0	±0.5
	0.25	1	99.0	98.9	-0.1	1.0 ; -3.0
SEL	2	8	108.0	108.0	0.0	1.0 ; -1.5
	200	800	128.0	128.0	0.0	±0.5

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	±2.0
One	136.4	136.3	-0.1	±2.0

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	±1.0
Positive half cycle	135.4	135.2	-0.2	±1.0
Negative half cycle	135.4	135.2	-0.2	±1.0

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Cert. No. : ACL24080
Job No. : VC67AC0054
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	89.7	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	±0.1

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

End of Calibration Certificate

T. Petchur

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Cert. No. : ACL23159
Pages : 1 of 8

Calibration Certificate

Equipment : SOUND LEVEL METER
Manufacturer : RION
Model : NL-52 / Microphone UC-59 / Preamplifier NH-25
Serial No.: 00764919 / 09846 / 65045
ID No.: BKK_FS0132

Condition As Found : GOOD

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

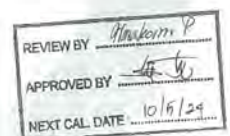
Location : -
Ambient Temperature : (23.0 ± 3) °C
Pressure : (101.3 ± 3) kPa
Relative Humidity : (50.0 ± 20) %

Received Date : 05 MAY 2023
Calibration Date : 10-16 MAY 2023
Date of Issue : 17 MAY 2023

Calibrated by : Nathakorn Pisutpassan

Approved by :

T. Petchur
(Thanakul Petchurai)



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Continuation of Calibration Certificate

Cert. No. : ACL23159
Job No. : VC66AC0052
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-0009-23	07-FEB-24
Waveform Generator	33511B	MY52302742	EF-0010-23	07-FEB-24
Digital Multimeter	33461A	MY53220104	EEL_BP 30/0266	13-FEB-24
Digital Multimeter	33461A	MY53220076	EEL_BP 29/0266	13-FEB-24
Digital Multimeter	34461A	MY60024273	EEL_BP 31/0266	14-FEB-24
Programmable Attenuator	MAT-1070	62100114	EF-0011-23	08-FEB-24
Condenser Microphone	4180	2977900	AA-1001-23	14-FEB-24
Measuring Amplifier	NA-42KA1	34560495	AA-3002-23	14-FEB-24

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

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

3.1 National Institute of Metrology (Thailand).

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

Continuation of Calibration Certificate

Cert. No. : ACL23159
Job No. : VC66AC0052
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Summary of Measurement Result :

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

Note : Pass/Fail evaluation for each parameter,

will be considered together from the acceptance limit and the Maximum-permitted uncertainty of measurement.

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S. B. A. H.

Continuation of Calibration Certificate

Cert. No. : ACL23159
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Result of calibration :

1. Absolute sensitivity

Reference Acoustic Signal (dB)	Measured Value (dB)	Deviation (dB)	Acceptance Limit (dB)
93.9 (93.98)	94.0	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	12.6
C - weight	18.4
Flat	23.8

3. Acoustical signal tests of frequency weightings

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

Frequency (Hz)	Flat	C-weight	A-weight	Acceptance Limits
125	0.2	0.2	0.2	± 1.0
1000	0.1	0.1	0.1	± 0.7
8000	0.5	0.6	0.6	+ 1.5, - 2.5

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4. Electrical signal tests of frequency weightings

Weighting network response with relative to 1 kHz.

Frequency (Hz)	Flat	C-weight	A-weight	Acceptance Limits
63	0.0	0.0	0.0	±1.0
125	0.0	0.1	0.0	±1.0
250	0.0	0.0	0.0	±1.0
500	0.0	0.1	0.0	±1.0
1000	0.0	0.0	0.0	±1.0
2000	0.0	0.1	0.0	±1.0
4000	0.0	0.1	0.0	±1.0
8000	0.0	0.1	0.1	+ 1.5, - 2.5
16000	0.0	-1.2	-1.1	+ 2.5, -16.0

5. Frequency and time weightings at 1 kHz

5.1 Frequency weightings at 1 kHz

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

5.2 Time weighting at 1 kHz

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

6. Long - term stability

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

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Continuation of Calibration Certificate

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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	±0.8
136.0	136.0	0.0	±0.8
135.0	135.0	0.0	±0.8
134.0	134.0	0.0	±0.8
133.0	133.0	0.0	±0.8
132.0	132.0	0.0	±0.8
131.0	131.0	0.0	±0.8
129.0	129.0	0.0	±0.8
124.0	124.0	0.0	±0.8
119.0	119.0	0.0	±0.8
114.0	114.0	0.0	±0.8
109.0	109.0	0.0	±0.8
104.0	104.1	0.1	±0.8
99.0	99.0	0.0	±0.8
94.0	94.0	0.0	±0.8
89.0	89.0	0.0	±0.8
84.0	84.0	0.0	±0.8
79.0	79.0	0.0	±0.8
74.0	74.0	0.0	±0.8
69.0	69.0	0.0	±0.8
64.0	64.0	0.0	±0.8
59.0	59.0	0.0	±0.8
54.0	54.0	0.0	±0.8
49.0	49.0	0.0	±0.8
44.0	44.0	0.0	±0.8
39.0	39.0	0.0	±0.8
34.0	34.0	0.0	±0.8
30.0	30.0	0.0	±0.8
29.0	28.9	-0.1	±0.8
28.0	27.9	-0.1	±0.8
27.0	26.9	-0.1	±0.8
26.0	26.0	0.0	±0.8
25.0	24.8	-0.2	±0.8

Continuation of Calibration Certificate

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8. Level linearity including the level range control

Range	Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Auto	94.0	94.0	0.0	±0.8

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	108.1	0.1	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	±2.0
One	136.4	135.6	-0.8	±2.0

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	±1.0
Positive half cycle	135.4	135.1	-0.3	±1.0
Negative half cycle	135.4	135.1	-0.3	±1.0

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S. B. L. M.

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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	±0.1

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



THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-67/0232

MTC No. EEL-BP. 176/0167

CALIBRATION CERTIFICATE

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

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

Calibrated at : Electrical and Electronic Standards Laboratory, Industrial Metrology and Testing Service Centre.

Sri 1C, Bangpoo Industrial Estate, Sukhumvit Rd., A-Muang, Samutprakan 10280.

Instrument Calibrated :

Description : Sound Level Meter

Manufacturer : Rion

Model : NL-42

Serial No. : 00900071 (ID: RYG_FS0492)

Microphone : UC-52 No. 188464

Preamplifier : NH-24 No. 01733

Standards used :

- Band Pass Filter Wavetek 752A S/N 90010494.
- Condenser Microphone Brüel&Kjær 4180 S/N 2889871.
- Decade Attenuator Ando AL-205 S/N 00464602.
- Function/Arbitrary Waveform Generator Agilent 33220A S/N MY44042668.
- Digital Function Synthesizer NF Electronic Instruments DF-193A S/N 122037.
- Digital Multimeter Fluke 8520A S/N 4985007.
- Pistonphone Rion NC-72 S/N 00402446.
- Measuring Amplifier Brüel&Kjær 2636 S/N 1537484.

Date of Receipt : 24 Jan. 2024

Date of Calibration : 23 Feb. 2024 - 1 Mar. 2024

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This is valid only if the permit is used in accordance with the terms and conditions of the permit. The results of the measurements are not valid if the permit is not used in accordance with the terms and conditions of the permit.

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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

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

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

11. Digital Multimeter Agilent 34401A S/N MY44005660.

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

Calibration Procedure :

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

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

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

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

Date of Calibration : 23 Feb.2024-1 Mar.2024

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MTC No. EEL. BP. 176/0167

3. Acoustical signal test of frequency weightings

Frequency (Hz)	Deviation from frequency response (dB)			Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	A-weight	C-weight	Flat			
125	0.1	0.2	0.2	1.5	0.45	0.6
1 000	-0.1	-0.1	-0.1	1.0	0.45	0.6
8 000	0.3	0.3	0.2	5.0	0.45	0.7

4. Electrical signal test of frequency weightings

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

Date of Calibration : 23 Feb.2024-1 Mar.2024

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Request No. 21-67/0232

MTC No. EEL. BP. 176/0167

1. Absolute Sensitivity

Reference Acoustic Signal (dB)	Measured value (dB)		Deviation value (dB)	Acceptance limit Class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	Before adjust	After adjust				
113.94	113.7	113.9	0.0	1.0	0.30	N/A

Note: The external calibration adjustment was firstly performed. The internal calibration adjustment was then completed at the display of 124.2 dB.

2. Self-generated noise

2.1 Normal test

Measured value (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
17.3	0.10	N/A

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

Frequency Weighting	Measured value (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
A-Weight	12.4	0.10	N/A
C-Weight	18.1	0.10	N/A
Flat	23.9	0.10	N/A

Date of Calibration : 23 Feb.2024-1 Mar.2024

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5. Long-term stability

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

6. Frequency and time weightings at 1 kHz

6.1 Frequency weightings at 1 kHz

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

6.2 Time weightings at 1 kHz

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

Date of Calibration : 23 Feb.2024-1 Mar.2024

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7. Level linearity on the reference level range

Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
136	136.0	0.0	1.1	0.30	0.3
135	135.0	0.0	1.1	0.30	0.3
134	134.0	0.0	1.1	0.30	0.3
133	133.0	0.0	1.1	0.30	0.3
132	132.0	0.0	1.1	0.30	0.3
131	131.0	0.0	1.1	0.30	0.3
130	130.0	0.0	1.1	0.30	0.3
129	129.0	0.0	1.1	0.30	0.3
124	124.0	0.0	1.1	0.30	0.3
119	119.0	0.0	1.1	0.30	0.3
114	114.0	0.0	1.1	0.30	0.3
109	109.0	0.0	1.1	0.30	0.3
104	104.0	0.0	1.1	0.30	0.3
99	99.0	0.0	1.1	0.30	0.3
94	94.0	0.0	1.1	0.30	0.3
89	89.0	0.0	1.1	0.30	0.3
84	84.1	0.1	1.1	0.30	0.3
79	79.0	0.0	1.1	0.30	0.3
74	74.0	0.0	1.1	0.30	0.3
69	69.0	0.0	1.1	0.30	0.3

Date of Calibration : 23 Feb 2024-1 Mar 2024

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

Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
64	64.0	0.0	1.1	0.30	0.3
59	59.0	0.0	1.1	0.30	0.3
54	53.9	-0.1	1.1	0.30	0.3
49	49.0	0.0	1.1	0.30	0.3
44	44.0	0.0	1.1	0.30	0.3
39	38.9	-0.1	1.1	0.30	0.3
34	33.9	-0.1	1.1	0.30	0.3
29	28.9	-0.1	1.1	0.30	0.3
28	27.9	-0.1	1.1	0.30	0.3
27	26.9	-0.1	1.1	0.30	0.3
26	25.9	-0.1	1.1	0.30	0.3
25	24.8	-0.2	1.1	0.30	0.3

8. Level linearity including the level range control

At reference sound level on the reference level range

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

Date of Calibration : 23 Feb 2024-1 Mar 2024

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Request No. 21-67/0232

MTC No. EEL. BP. 176/0167

8. Level linearity including the level range control

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

Range	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
30-130	35.0	35.0	0.0	1.1	0.30	0.3

9. Tone burst response

Time Weighing	Toneburst Duration, Tb (ms)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Fast	200	126.0	0.0	±1.0	0.20	0.3
	2	108.9	-0.1	+1.0; -2.5	0.20	0.3
	0.25	99.9	-0.1	+1.5; -5.0	0.20	0.3
Slow	200	119.6	0.0	±1.0	0.20	0.3
	2	100.0	0.0	+1.0; -5.0	0.20	0.3
	200	120.0	0.0	±1.0	0.20	0.3
SEL	2	100.0	0.0	+1.0; -2.5	0.20	0.3
	0.25	90.8	-0.2	+1.5; -5.0	0.20	0.3

Date of Calibration : 23 Feb 2024-1 Mar 2024

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Request No. 21-67/0232

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10. Peak C sound level

Number of cycles in test signal	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Complete cycle	125.4	125.2	-0.2	3.0	0.20	0.35
Positive half cycle	124.4	124.2	-0.2	2.0	0.20	0.35
Negative half cycle	124.4	124.2	-0.2	2.0	0.20	0.35

11. Overload indication

Measured value (dB)		Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Positive one-half cycle	Negative one-half cycle				
135.0	135.0				

12. High-level stability

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

Calibrated by :

Approved by :

(Mr. Tawikiat Jamsamran)

(Mr. Piyawit Klumrue)

Electrical and Electronic Standards Laboratory

Date of Calibration : 23 Feb 2024-1 Mar 2024

Industrial Metrology and Testing Service Centre

Date of Issue : 1 Mar 2024

Ref : 2011267012400347006

End of Certificate

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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-67/0232

MTC No. EEL. BP. 178/0167

CALIBRATION CERTIFICATE

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

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

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

Instrument Calibrated :

Description : Sound Level Meter

Manufacturer : Rion

Model : NL-42

Serial No. : 00900073 (ID-RYG_FS0494)

Microphone : UC-52 No.188466

Preamplifier : NH-24 No.01735

Standards used :

1. Band Pass Filter Wavetek 752A S/N 90010494.
2. Condenser Microphone Brüel&Kjær 4180 S/N 2889871.
3. Decade Attenuator Ando AL-205 S/N 00464602.
4. Function/Arbitrary Waveform Generator Agilent 33220A S/N MY44042668.
5. Digital Function Synthesizer NF Electronic Instruments DF-193A S/N 122037.
6. Digital Multimeter Fluke 8520A S/N 4985007.
7. Pistophone Rion NC-72 S/N 00402446.
8. Measuring Amplifier Brüel&Kjær 2636 S/N 1537484.

Date of Receipt : 24 Jan. 2024

Date of Calibration : 23 Feb.2024-1 Mar.2024



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Request No. 21-67/0232

MTC No. EEL. BP. 178/0167

1. Absolute Sensitivity

Reference Acoustic Signal (dB)	Measured value (dB)		Deviation value (dB)	Acceptance limit Class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	Before adjust	After adjust				
113.91	114.1	113.9	0.0	1.0	0.30	N/A

Note: The external calibration adjustment was firstly performed. The internal calibration adjustment was then completed at the display of 124.6 dB.

2. Self-generated noise

2.1 Normal test

Measured value (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
17.8	0.10	N/A

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

Frequency Weighting	Measured value (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
A-Weight	12.9	0.10	N/A
C-Weight	18.5	0.10	N/A
Flat	24.2	0.10	N/A

Date of Calibration : 23 Feb.2024-1 Mar.2024

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

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

11. Digital Multimeter Agilent 34401A S/N MY44005560.

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

Calibration Procedure :

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

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

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

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

Date of Calibration : 23 Feb.2024-1 Mar.2024

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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-67/0232

MTC No. EEL. BP. 178/0167

3. Acoustical signal test of frequency weightings

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

4. Electrical signal test of frequency weightings

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

Date of Calibration : 23 Feb.2024-1 Mar.2024

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Request No. 21-67/0232

MTC No. EEL BP. 178/0167

5. Long-term stability

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

6. Frequency and time weightings at 1 kHz

6.1 Frequency weightings at 1 kHz

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

6.2 Time weightings at 1 kHz

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

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7. Level linearity on the reference level range

Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
136	136.0	0.0	1.1	0.30	0.3
135	135.0	0.0	1.1	0.30	0.3
134	134.0	0.0	1.1	0.30	0.3
133	133.0	0.0	1.1	0.30	0.3
132	132.0	0.0	1.1	0.30	0.3
131	131.0	0.0	1.1	0.30	0.3
130	130.0	0.0	1.1	0.30	0.3
129	129.0	0.0	1.1	0.30	0.3
124	124.0	0.0	1.1	0.30	0.3
119	119.0	0.0	1.1	0.30	0.3
114	114.0	0.0	1.1	0.30	0.3
109	109.0	0.0	1.1	0.30	0.3
104	104.0	0.0	1.1	0.30	0.3
99	99.0	0.0	1.1	0.30	0.3
94	94.0	0.0	1.1	0.30	0.3
89	89.0	0.0	1.1	0.30	0.3
84	84.0	0.0	1.1	0.30	0.3
79	79.0	0.0	1.1	0.30	0.3
74	74.0	0.0	1.1	0.30	0.3
69	68.9	-0.1	1.1	0.30	0.3

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

Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
64	63.9	-0.1	1.1	0.30	0.3
59	58.9	-0.1	1.1	0.30	0.3
54	53.9	-0.1	1.1	0.30	0.3
49	49.0	0.0	1.1	0.30	0.3
44	44.0	0.0	1.1	0.30	0.3
39	38.9	-0.1	1.1	0.30	0.3
34	33.9	-0.1	1.1	0.30	0.3
29	28.9	-0.1	1.1	0.30	0.3
28	27.9	-0.1	1.1	0.30	0.3
27	26.9	-0.1	1.1	0.30	0.3
26	25.9	-0.1	1.1	0.30	0.3
25	24.9	-0.1	1.1	0.30	0.3

8. Level linearity including the level range control

At reference sound level on the reference level range

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

Date of Calibration : 23 Feb.2024-1 Mar.2024

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8. Level linearity including the level range control

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

Range	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
30-130	35.0	35.0	0.0	1.1	0.30	0.3

9. Tone burst response

Time Weighting	Toneburst Duration, Tb (ms)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Fast	200	126.0	0.0	±1.0	0.20	0.3
	2	109.0	0.0	+1.0, -2.5	0.20	0.3
	0.25	99.9	-0.1	+1.5, -5.0	0.20	0.3
Slow	200	119.6	0.0	±1.0	0.20	0.3
	2	100.0	0.0	+1.0, -5.0	0.20	0.3
	200	120.0	0.0	±1.0	0.20	0.3
SEL	2	100.0	0.0	+1.0, -2.5	0.20	0.3
	0.25	90.9	-0.1	+1.5, -5.0	0.20	0.3

Date of Calibration : 23 Feb.2024-1 Mar.2024

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10. Peak C sound level

Number of cycles in test signal	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Complete cycle	125.4	125.3	-0.1	3.0	0.20	0.35
Positive half cycle	124.4	124.1	-0.3	2.0	0.20	0.35
Negative half cycle	124.4	124.1	-0.3	2.0	0.20	0.35

11. Overload indication

Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Positive one-half cycle	Negative one-half cycle			
135.5	135.5	0.0	1.5	0.20

12. High-level stability

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

Calibrated by:

Approved by:

(Mr. Tawikij Iamsamran)

(Mr. Prawit Klueypa)

Electrical and Electronic Standards Laboratory
Industrial Metrology and Testing Service Centre

Date of Calibration : 23 Feb.2024-1 Mar.2024

Industrial Metrology and Testing Service Centre

Date of Issue : 1 Mar. 2024

Ref: 2011267012400347008

End of Certificate

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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-67/0232

MTC No. EEL. BP. 177/0167

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

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

11. Digital Multimeter Agilent 34401A S/N MY44005560.

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

Calibration Procedure:

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

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

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

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

Date of Calibration : 23 Feb.2024-1 Mar.2024

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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-67/0232

MTC No. EEL. BP. 177/0167

CALIBRATION CERTIFICATE

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

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

Calibrated at : Electrical and Electronic Standards Laboratory, Industrial Metrology and Testing Service Centre.

Soi 1C, Bangpoo Industrial Estate, Sukhumvit Rd., A.Muang, Samutprakan 10280.

Instrument Calibrated:

Description : Sound Level Meter

Manufacturer : Rion

Model : NL-42

Serial No. : 00900072 (ID:RYG_FS0493)

Microphone : UC-52 No.188465

Preamplifier : NH-24 No.01734

Ambient Environment

Temperature : (23 ± 3) °C

Relative Humidity : (50 ± 15) %

Ambient Pressure : (101.325 ± 1.5) kPa

Standards used:

1. Band Pass Filter Wavetek 752A S/N 90010494.
2. Condenser Microphone Brüel&Kjær 4180 S/N 2889871.
3. Decade Attenuator Ando AL-205 S/N 00464602.
4. Function/Arbitrary Waveform Generator Agilent 33220A S/N MY44042668.
5. Digital Function Synthesizer NF Electronic Instruments DF-193A S/N 122037.
6. Digital Multimeter Fluke 8520A S/N 4985007.
7. Pistonphone Rion NC-72 S/N 00402446.
8. Measuring Amplifier Brüel&Kjær 2636 S/N 1537484.

Date of Receipt : 24 Jan. 2024

Date of Calibration : 23 Feb.2024-1 Mar.2024

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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-67/0232

MTC No. EEL. BP. 177/0167

1. Absolute Sensitivity

Reference Acoustic Signal (dB)	Measured value (dB)	Deviation value (dB)	Acceptance limit Class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
113.91	114.0	113.9	0.0	1.0	0.30

Note: The external calibration adjustment was firstly performed. The internal calibration adjustment was then completed at the display of 123.8 dB.

2. Self-generated noise

2.1 Normal test

Measured value (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
17.8	0.10	N/A

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

Frequency	Measured value (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Weighting			
A-Weight	11.3	0.10	N/A
C-Weight	17.0	0.10	N/A
Flat	23.4	0.10	N/A

Date of Calibration : 23 Feb.2024-1 Mar.2024

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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-67/0232

MTC No. EEL- BP. 177/0167

3. Acoustical signal test of frequency weightings

Frequency (Hz)	Deviation from frequency response (dB)			Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	A-weight	C-weight	Flat			
125	0.3	0.4	0.4	1.5	0.45	0.6
1 000	-0.2	-0.2	-0.2	1.0	0.45	0.6
8 000	-0.4	-0.5	-0.5	5.0	0.45	0.7

4. Electrical signal test of frequency weightings

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

Date of Calibration : 23 Feb.2024-1 Mar.2024

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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-67/0232

MTC No. EEL- BP. 177/0167

5. Long-term stability

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

6. Frequency and time weightings at 1 kHz

6.1 Frequency weightings at 1 kHz

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

6.2 Time weightings at 1 kHz

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

Date of Calibration : 23 Feb.2024-1 Mar.2024

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Request No. 21-67/0232

MTC No. EEL- BP. 177/0167

7. Level linearity on the reference level range

Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
136	136.0	0.0	1.1	0.30	0.3
135	135.0	0.0	1.1	0.30	0.3
134	134.1	0.1	1.1	0.30	0.3
133	133.0	0.0	1.1	0.30	0.3
132	132.0	0.0	1.1	0.30	0.3
131	131.0	0.0	1.1	0.30	0.3
130	130.0	0.0	1.1	0.30	0.3
129	129.0	0.0	1.1	0.30	0.3
124	124.0	0.0	1.1	0.30	0.3
119	119.0	0.0	1.1	0.30	0.3
114	114.0	0.0	1.1	0.30	0.3
109	109.0	0.0	1.1	0.30	0.3
104	104.0	0.0	1.1	0.30	0.3
99	99.0	0.0	1.1	0.30	0.3
94	94.0	0.0	1.1	0.30	0.3
89	89.0	0.0	1.1	0.30	0.3
84	84.1	0.1	1.1	0.30	0.3
79	79.0	0.0	1.1	0.30	0.3
74	74.0	0.0	1.1	0.30	0.3
69	69.0	0.0	1.1	0.30	0.3

Date of Calibration : 23 Feb.2024-1 Mar.2024

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

Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
64	64.0	0.0	1.1	0.30	0.3
59	59.0	0.0	1.1	0.30	0.3
54	53.9	-0.1	1.1	0.30	0.3
49	49.0	0.0	1.1	0.30	0.3
44	44.0	0.0	1.1	0.30	0.3
39	38.9	-0.1	1.1	0.30	0.3
34	33.9	-0.1	1.1	0.30	0.3
29	28.9	-0.1	1.1	0.30	0.3
28	27.9	-0.1	1.1	0.30	0.3
27	26.9	-0.1	1.1	0.30	0.3
26	25.9	-0.1	1.1	0.30	0.3
25	24.9	-0.1	1.1	0.30	0.3

8. Level linearity including the level range control

At reference sound level on the reference level range

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

Date of Calibration : 23 Feb.2024-1 Mar.2024

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Request No. 21-67/0232

MTC No. EEL. BP. 177/0167

8. Level linearity including the level range control

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

Range	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
30-130	35.0	35.0	0.0	±1.1	0.30	0.3

9. Tone burst response

Time Weighing	Toneburst Duration, T _b (ms)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Fast	200	126.0	0.0	±1.0	0.20	0.3
	2	109.0	0.0	+1.0; -2.5	0.20	0.3
	0.25	99.9	-0.1	+1.5; -5.0	0.20	0.3
Slow	200	119.6	0.0	±1.0	0.20	0.3
	2	100.0	0.0	+1.0; -5.0	0.20	0.3
	200	120.0	0.0	±1.0	0.20	0.3
SEL	2	100.0	0.0	+1.0; -2.5	0.20	0.3
	0.25	90.9	-0.1	+1.5; -5.0	0.20	0.3

Date of Calibration : 23 Feb.2024-1 Mar.2024

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Request No. 21-67/0232

MTC No. EEL. BP. 177/0167

10. Peak C sound level

Number of cycles in test signal	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Complete cycle	125.4	125.2	-0.2	3.0	0.20	0.35
Positive half cycle	124.4	124.1	-0.3	2.0	0.20	0.35
Negative half cycle	124.4	124.1	-0.3	2.0	0.20	0.35

11. Overload indication

Measured value (dB)		Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Positive one-half cycle	Negative one-half cycle				
135.5	135.5	0.0	1.5	0.20	0.25

12. High-level stability

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

Calibrated by :

(Mr. Tawakiat Jamsanran)

Approved by :

(Mr. Prawee Kijyapa)
Director

Electrical and Electronic Standards Laboratory

Industrial Metrology and Testing Service Centre

Date of Calibration : 23 Feb.2024-1 Mar.2024

Date of Issue : 1 Mar. 2024

Ref: 2011267012400347007

End of Certificate

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CERTIFICATE OF CALIBRATION

ISSUED BY Cirrus Research plc

DATE OF ISSUE 29 January 2024

CERTIFICATE NUMBER 207459

REVIEW BY *Monika P.*
APPROVED BY *[Signature]*
NEXT CAL. DATE 25/1/26

Page 1 of 2

Approved signatory
N Smith
Electronically signed:

[Signature]

doseBadge Reader : IEC 60942:2003

Instrument Information

Manufacturer: Cirrus Research plc

Notes:

Model: RC-110A

Serial number: 92612

Class: 2

Test summary

Date of calibration: 29 January 2024

The doseBadge reader detailed above has been calibrated to the published data as described in the operating manual and in the half-inch configuration. The procedures and techniques used are as described in IEC60942_2003 Annex B - Periodic Tests and three determinations of the sound pressure level, frequency and total distortion were made.

The sound pressure level was measured using a WS2F condenser microphone type MK-224 manufactured by Cirrus Research plc.

The results have been corrected to the reference pressure of 101.33 kPa using the manufacturer's data.

The doseBadge Reader has been shown to conform to the Class 2 requirements for periodic testing, described in Annex B of IEC 60942:2003 for the sound pressure level(s) and frequency(ies) stated, for the environmental conditions under which the tests were performed.

However, as public evidence was not available, from a testing organisation responsible for pattern approval, to demonstrate that the model of doseBadge Reader conformed to the requirements for pattern evaluation described in Annex A of IEC 60942:2003, no general statement or conclusion can be made about conformance of the doseBadge Reader to the requirements of IEC 60942:2003.

Notes:

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

CERTIFICATE OF CALIBRATION

Certificate Number: 207459

Page 2 of 2

Environmental conditions

The following conditions were recorded at the time of the test:

Before Pressure: 101.35 kPa Temperature: 21.9 °C Humidity: 38.3 %
After Pressure: 101.35 kPa Temperature: 21.9 °C Humidity: 40.5 %

Test equipment

Equipment	Manufacturer	Model	Serial number
Distortion Meter	Keithley	2015	0994818
Acoustic Calibrator	Brüel and Kjær	4231	2610257
Environmental Monitor	Comet	T7510	21962628

Acoustic Results

	Expected	Sample 1	Sample 2	Sample 3	Average	Deviation	Tolerance	Uncertainty
Level (dB)	114.00	114.01	113.98	113.97	113.99	-0.01	±0.75	0.11 dB
Distortion (%)	< 4.00	0.37	0.38	0.38	0.38	0.38	+4.00	0.13 %
Frequency (Hz)	1000.0	1004.6	1004.6	1004.6	1004.6	4.6	±20.0	0.1 Hz

The measured quantities or deviations (as applicable), extended by the expanded combined uncertainty of measurement, must not exceed the corresponding tolerance.

Functionality Results

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

End of results

CERTIFICATE OF CALIBRATION

ISSUED BY
Cirrus Research plc

DATE OF ISSUE
29 January 2024

CERTIFICATE NUMBER
207437

REVIEW BY
Harsham P

APPROVED BY
h

EXPIRATION DATE
26/1/26

Page 1 of 2

Approved signatory
N.Smith
Electronically signed:
h

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

doseBadge Reader : IEC 60942:2003

Instrument Information

Manufacturer: Cirrus Research plc

Model: RC-110A

Serial number: 73729

Class: 2

Notes:

Test summary

Date of calibration: 29 January 2024

The doseBadge reader detailed above has been calibrated to the published data as described in the operating manual and in the half-inch configuration. The procedures and techniques used are as described in IEC60942_2003 Annex B – Periodic Tests and three determinations of the sound pressure level, frequency and total distortion were made.

The sound pressure level was measured using a WS2F condenser microphone type MK 224 manufactured by Cirrus Research plc.

The results have been corrected to the reference pressure of 101.33 kPa using the manufacturer's data.

The doseBadge Reader has been shown to conform to the Class 2 requirements for periodic testing, described in Annex B of IEC 60942:2003 for the sound pressure level(s) and frequency(ies) stated, for the environmental conditions under which the tests were performed.

However, as public evidence was not available, from a testing organisation responsible for pattern approval, to demonstrate that the model of doseBadge Reader conformed to the requirements for pattern evaluation described in Annex A of IEC 60942:2003, no general statement or conclusion can be made about conformance of the doseBadge Reader to the requirements of IEC 60942:2003.

Notes:

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

CERTIFICATE OF CALIBRATION

ISSUED BY
Cirrus Research

DATE OF ISSUE
18 August 2023

CERTIFICATE NUMBER
197597

REVIEW BY
Harsham P

APPROVED BY
h

EXPIRATION DATE
18/8/24

Page 1 of 2

Approved signatory
R.Thomas
Electronically signed:
R.Thomas

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

doseBadge Reader : IEC 60942:2003

Instrument Information

Manufacturer: Cirrus Research plc

Model: RC-110A

Serial number: 76062

Class: 2

Notes:

Test summary

Date of calibration: 18 August 2023

The doseBadge reader detailed above has been calibrated to the published data as described in the operating manual and in the half-inch configuration. The procedures and techniques used are as described in IEC60942_2003 Annex B – Periodic Tests and three determinations of the sound pressure level, frequency and total distortion were made.

The sound pressure level was measured using a WS2F condenser microphone type MK 224 manufactured by Cirrus Research plc.

The results have been corrected to the reference pressure of 101.33 kPa using the manufacturer's data.

The doseBadge Reader has been shown to conform to the Class 2 requirements for periodic testing, described in Annex B of IEC 60942:2003 for the sound pressure level(s) and frequency(ies) stated, for the environmental conditions under which the tests were performed.

However, as public evidence was not available, from a testing organisation responsible for pattern approval, to demonstrate that the model of doseBadge Reader conformed to the requirements for pattern evaluation described in Annex A of IEC 60942:2003, no general statement or conclusion can be made about conformance of the doseBadge Reader to the requirements of IEC 60942:2003.

Notes:

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

CERTIFICATE OF CALIBRATION

Certificate Number
207437

Page 2 of 2

Environmental conditions

The following conditions were recorded at the time of the test.

Before Pressure: 101.44 kPa Temperature: 21.3 °C Humidity: 35.8 %

After Pressure: 101.44 kPa Temperature: 21.3 °C Humidity: 35.9 %

Test equipment

Equipment	Manufacturer	Model	Serial number
Distortion Meter	Keithley	2015	0994818
Acoustic Calibrator	Briel and Kjaer	4231	2610257
Environmental Monitor	Comet	T7510	21962628

Initial Acoustic Results

	Expected	Sample 1	Sample 2	Sample 3	Average	Deviation	Tolerance	Uncertainty
Level (dB)	114.00	114.31	114.31	114.29	114.30	0.30	±0.75	0.11 dB
Distortion (%)	< 4.00	0.32	0.26	0.40	0.33	0.33	+4.00	0.13 %
Frequency (Hz)	1000.0	998.2	998.3	998.3	998.3	-1.7	±20.0	0.1 Hz

The measured quantities or deviations (as applicable), extended by the expanded combined uncertainty of measurement, must not exceed the corresponding tolerance.

Adjusted Acoustic Results

	Expected	Sample 1	Sample 2	Sample 3	Average	Deviation	Tolerance	Uncertainty
Level (dB)	114.00	114.01	114.01	114.02	114.01	0.01	±0.75	0.11 dB
Distortion (%)	< 4.00	0.30	0.34	0.34	0.33	0.33	+4.00	0.13 %
Frequency (Hz)	1000.0	998.1	998.3	998.3	998.2	-1.6	±20.0	0.1 Hz

Functionality Results

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

End of results

CERTIFICATE OF CALIBRATION

ISSUED BY
Cirrus Research plc

DATE OF ISSUE
15 December 2023

CERTIFICATE NUMBER
205046

REVIEW BY
Harsham P

APPROVED BY
h

EXPIRATION DATE
15/12/24

Page 1 of 2

Approved signatory
N.Smith
Electronically signed:
h

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

doseBadge Reader : IEC 60942:2003

Instrument Information

Manufacturer: Cirrus Research plc

Model: RC-110A

Serial number: 75996

Class: 2

Notes:

Test summary

Date of calibration: 15 December 2023

The doseBadge reader detailed above has been calibrated to the published data as described in the operating manual and in the half-inch configuration. The procedures and techniques used are as described in IEC60942_2003 Annex B – Periodic Tests and three determinations of the sound pressure level, frequency and total distortion were made.

The sound pressure level was measured using a WS2F condenser microphone type MK 224 manufactured by Cirrus Research plc.

The results have been corrected to the reference pressure of 101.33 kPa using the manufacturer's data.

The doseBadge Reader has been shown to conform to the Class 2 requirements for periodic testing, described in Annex B of IEC 60942:2003 for the sound pressure level(s) and frequency(ies) stated, for the environmental conditions under which the tests were performed.

However, as public evidence was not available, from a testing organisation responsible for pattern approval, to demonstrate that the model of doseBadge Reader conformed to the requirements for pattern evaluation described in Annex A of IEC 60942:2003, no general statement or conclusion can be made about conformance of the doseBadge Reader to the requirements of IEC 60942:2003.

Notes:

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

CERTIFICATE OF CALIBRATION

Certificate Number:
205046

Page 2 of 2

Environmental conditions

The following conditions were recorded at the time of the test:

Before Pressure: 102.46 kPa Temperature: 23.4 °C Humidity: 34 %
After Pressure: 102.46 kPa Temperature: 23.4 °C Humidity: 35 %

Test equipment

Equipment	Manufacturer	Model	Serial number
Distortion Meter	Keithley	2015	0994818
Acoustic Calibrator	Brüel and Kjær	4231	2610257
Environmental Monitor	Cornel	T7510	21962628

Initial Acoustic Results

	Expected	Sample 1	Sample 2	Sample 3	Average	Deviation	Tolerance	Uncertainty
Level (dB)	114.00	114.17	114.16	114.17	114.17	0.17	±0.75	0.11 dB
Distortion (%)	< 4.00	0.28	0.25	0.23	0.25	0.25	+4.00	0.13 %
Frequency (Hz)	1000.0	1004.0	1004.0	1004.0	1004.0	4.0	±20.0	0.1 Hz

The measured quantities or deviations (as applicable), extended by the expanded combined uncertainty of measurement, must not exceed the corresponding tolerance.

Adjusted Acoustic Results

	Expected	Sample 1	Sample 2	Sample 3	Average	Deviation	Tolerance	Uncertainty
Level (dB)	114.00	114.02	114.01	114.01	114.01	0.01	±0.75	0.11 dB
Distortion (%)	< 4.00	0.23	0.26	0.25	0.25	0.25	+4.00	0.13 %
Frequency (Hz)	1000.0	1004.1	1004.0	1004.0	1004.0	4.0	±20.0	0.1 Hz

Functionality Results

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

End of results



ROTA METER CALIBRATION RESULT JANUARY 2024

Rotameter ID.	Calibration Date	Regression Result	Coefficient (R ²)
BKK_FS0585	10 Jan 24	Y = 1.0351x + 2.3733	0.9998
BKK_FS0587	10 Jan 24	Y = 1.0168x + 15.05	0.9997
BKK_FS0592	10 Jan 24	Y = 1.0013x + 12.556	1.0000
BKK_FS0594	10 Jan 24	Y = 1.0048x + 4.9762	1.0000
BKK_FS1004	04 Jan 24	Y = 0.9873x + 13.47	0.9993
BKK_FS1005	04 Jan 24	Y = 1.0187x + 1.25	0.9998
BKK_FS1006	04 Jan 24	Y = 1.1589x - 3.6605	0.9981
BKK_FS1007	10 Jan 24	Y = 1.1347x + 1.6007	0.9989
BKK_FS1008	10 Jan 24	Y = 1.127x + 4.3827	0.9996
BKK_FS1017	04 Jan 24	Y = 1.0632x - 0.0701	0.9998
BKK_FS1018	04 Jan 24	Y = 1.0115x + 1.2867	0.9996
BKK_FS1019	04 Jan 24	Y = 1.0019x + 8.4867	1.0000
BKK_FS1026	19 Jan 24	Y = 0.9618x + 1.9626	0.9999
BKK_FS1027	19 Jan 24	Y = 1.0065x - 4.3786	1.0000
BKK_FS1028	19 Jan 24	Y = 1.0184x - 37.308	0.9997
BKK_FS1029	19 Jan 24	Y = 0.9809x + 2.7925	0.9977
BKK_FS1030	19 Jan 24	Y = 0.996x - 1.2366	1.0000
BKK_FS1031	19 Jan 24	Y = 1.015x - 27.236	0.9997
BKK_FS1039	04 Jan 24	Y = 1.0047x + 8.0267	0.9997
BKK_FS1040	04 Jan 24	Y = 1.0059x + 3.6952	1.0000
BKK_FS1041	04 Jan 24	Y = 1.0677x - 0.0486	0.9995
BKK_FS1042	04 Jan 24	Y = 1.0021x + 11.273	0.9995
BKK_FS1043	04 Jan 24	Y = 1.0023x + 8.3905	1.0000
BKK_FS1044	04 Jan 24	Y = 1.0738x + 1.2527	0.9997
PHK_FS0027	10 Jan 24	Y = 1.1096x + 0.3565	1.0000
PHK_FS0028	10 Jan 24	Y = 1.034x - 2.52	1.0000
PHK_FS0029	10 Jan 24	Y = 1.0017x + 8.0124	1.0000
RYG_FS0197	04 Jan 24	Y = 1.0045x + 10.275	1.0000
RYG_FS0198	04 Jan 24	Y = 1.0024x + 10.1	1.0000
RYG_FS0199	04 Jan 24	Y = 1.0343x - 0.3854	0.9999
RYG_FS0654	04 Jan 24	Y = 1.0529x + 0.1565	0.9996
RYG_FS0655	04 Jan 24	Y = 0.992x + 8.9667	0.9992
RYG_FS0656	04 Jan 24	Y = 1.0068x - 2.8429	1.0000
RYG_FS0657	04 Jan 24	Y = 1.0472x + 1.9228	0.9999
RYG_FS0658	04 Jan 24	Y = 0.9675x + 20.263	0.9996
RYG_FS0659	04 Jan 24	Y = 1.0028x + 10.275	1.0000
SGK_FS0135	17 Jan 24	Y = 1.0145x + 2.8273	1.0000
SGK_FS0136	17 Jan 24	Y = 1.0113x + 1.75	0.9999
SGK_FS0138	04 Jan 24	Y = 1.0632x - 1.0034	0.9999

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ALS Laboratory Group



ROTA METER CALIBRATION RESULT JANUARY 2024

Rotameter ID.	Calibration Date	Regression Result	Coefficient (R ²)
SGK_FS0139	04 Jan 24	Y = 1.0047x + 1.8667	0.9999
SGK_FS0140	04 Jan 24	Y = 1.0001x + 14.149	1.0000
SGK_FS0141	04 Jan 24	Y = 1.111x - 1.1337	0.9994
SGK_FS0142	04 Jan 24	Y = 1.0179x + 0.3633	0.9999
SGK_FS0143	04 Jan 24	Y = 1.054x + 2.2352	1.0000

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

Approved By: (Mr. Sarayuth Jittrantoni)
(Mr. Sarayuth Jittrantoni)
Assistant General Manager



MesaLabs



NVLAP Lab Code 200661-0
Calibration

Calibration Certificate

Certificate No. 551422
Product 200-510M Defender 510 Medium Flow
Serial No. 208345
Cal. Date 16-Aug-2023

Sold To:

All calibrations are performed in accordance with ISO 17025 at Mesa Laboratories, Inc., 12100 W. 6th Ave, Lakewood, CO 80228, an ISO 17025:2017 accredited laboratory through NVLAP. This report shall not be reproduced except in full without the written approval of the laboratory. Results only relate to the items calibrated. This report must not be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the U.S. Government.

As Received Calibration Data

Technician	Aaron Schwartz		Lab. Pressure	620.1 mmHg
			Lab. Temperature	23.5 °C
Instrument Reading	Lab Standard Reading	Deviation	Allowable Deviation	As Received
4523.09 ccm	4519.02 ccm	0.09%	1.00%	In Tolerance
999.43 ccm	999.31 ccm	0.01%	1.00%	In Tolerance
245.22 ccm	245.88 ccm	-0.27%	1.00%	In Tolerance

Mesa Laboratories Standards Used

Description	Standard Serial Number	Calibration Date	Calibration Due Date
ML_800_24	205307	25-May-2023	25-May-2024





As Shipped Calibration Data

Certificate No	561422	Lab. Pressure	616.6 mmHg
Technician	Xiem Ly	Lab. Temperature	24.2 °C
Instrument Reading	Lab Standard Reading	Deviation	Allowable Deviation
4516.61 ccm	4515.56 ccm	0.02%	1.00%
1000.87 ccm	1000.67 ccm	0.02%	1.00%
246.84 ccm	249.93 ccm	-0.04%	1.00%
			As Shipped
			In Tolerance
			In Tolerance

Mesa Laboratories Standards Used

Description	Standard Serial Number	Calibration Date	Calibration Due Date
ML_800_24	100439	14-Sep-2022	14-Sep-2023

Calibration Notes

The expanded uncertainty of flow has a coverage factor of $k = 2$ for a confidence interval of approximately 95%.
Flow testing is in accordance with our test number MP-00672 with an expanded uncertainty of 0.27% using high-purity nitrogen or filtered laboratory air.
Traceability to the International System of Units (SI) is verified by accreditation to ISO/IEC 17025 by NVLAP under NVLAP Code 200661-0.

Technician Notes

By: *Xiem Ly* Approved By: *Norma Aragon*

Xiem Ly
Production Technician II
Norma Aragon
QC Inspector

Mesa Laboratories, Inc. certifies that the above instrument meets or exceeds published specifications, and that the calibration results in this certificate were obtained using equipment capable of producing results that are traceable through NIST to the International System of Units (SI). Calibration results are in compliance with ISO/IEC 17025:2017. Calibration process has a Test Uncertainty Ratio (TUR) of 4:1 or greater. Any Pass/Fail determination is made without taking measurement uncertainty into account and is based on UUT performance against required tolerance only.

Mesa Laboratories Inc. 12100 W. 6th Ave, Lakewood, CO 80228 USA
(303) 987-8000 www.mesalabs.com Symbol "MLAB" on the NASDAQ

FM-00228 Rev. B

2 of 2



Calibration Certificate

Certificate No. 561597
Product 200-510L Defender 510 Low Flow
Serial No. 130028
Cal. Date 25-Sep-2023

Sold To:

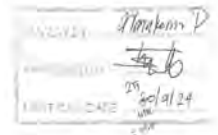
All calibrations are performed in accordance with ISO 17025 at Mesa Laboratories, Inc., 12100 W. 6th Ave, Lakewood, CO 80228, an ISO 17025:2017 accredited laboratory through NVLAP. This report shall not be reproduced except in full without the written approval of the laboratory. Results only relate to the items calibrated. This report must not be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the U.S. Government.

As Received Calibration Data

Technician	Aaron Schwartz		Lab. Pressure	616.1 mmHg
			Lab. Temperature	24 °C
Instrument Reading	Lab Standard Reading	Deviation	Allowable Deviation	As Received
0 ccm	456.41 ccm	100.0%	1.00%	Out of Tolerance
0 ccm	101.19 ccm	-100.0%	1.00%	Out of Tolerance
0 ccm	30.36 ccm	-100.0%	1.00%	Out of Tolerance

Mesa Laboratories Standards Used

Description	Standard Serial Number	Calibration Date	Calibration Due Date
ML_800_10	103743	25-Jan-2023	25-Jan-2024



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(303) 987-8000 www.mesalabs.com Symbol "MLAB" on the NASDAQ

FM-00228 Rev. B

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As Shipped Calibration Data

Certificate No	561587	Lab. Pressure	622.2 mmHg
Technician	Aaron Schwartz	Lab. Temperature	23.6 °C
Instrument Reading	Lab Standard Reading	Deviation	Allowable Deviation
449.75 ccm	450.46 ccm	-0.16%	1.00%
100.96 ccm	100.82 ccm	0.14%	1.00%
30.63 ccm	30.38 ccm	0.82%	1.00%
			As Shipped
			In Tolerance
			In Tolerance

Mesa Laboratories Standards Used

Description	Standard Serial Number	Calibration Date	Calibration Due Date
ML_800_10	103743	25-Jan-2023	25-Jan-2024

Calibration Notes

The expanded uncertainty of flow has a coverage factor of $k = 2$ for a confidence interval of approximately 95%.
Flow testing is in accordance with our test number MP-00672 with an expanded uncertainty of 0.27% using high-purity nitrogen or filtered laboratory air.
Traceability to the International System of Units (SI) is verified by accreditation to ISO/IEC 17025 by NVLAP under NVLAP Code 200661-0.

Technician Notes

By: *Aaron Schwartz* Approved By: *David Thomas*

Aaron Schwartz
Assembler I
David Thomas
Quality Engineer

Mesa Laboratories, Inc. certifies that the above instrument meets or exceeds published specifications, and that the calibration results in this certificate were obtained using equipment capable of producing results that are traceable through NIST to the International System of Units (SI). Calibration results are in compliance with ISO/IEC 17025:2017. Calibration process has a Test Uncertainty Ratio (TUR) of 4:1 or greater. Any Pass/Fail determination is made without taking measurement uncertainty into account and is based on UUT performance against required tolerance only.

Mesa Laboratories Inc. 12100 W. 6th Ave, Lakewood, CO 80228 USA
(303) 987-8000 www.mesalabs.com Symbol "MLAB" on the NASDAQ

FM-00228 Rev. B

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Calibration Certificate

Certificate No. 561588
Product 200-510M Defender 510 Medium Flow
Serial No. 151114
Cal. Date 30-Sep-2023

Sold To:

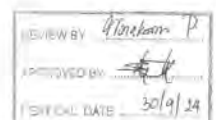
All calibrations are performed in accordance with ISO 17025 at Mesa Laboratories, Inc., 12100 W. 6th Ave, Lakewood, CO 80228, an ISO 17025:2017 accredited laboratory through NVLAP. This report shall not be reproduced except in full without the written approval of the laboratory. Results only relate to the items calibrated. This report must not be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the U.S. Government.

As Received Calibration Data

Technician	Xiem Ly		Lab. Pressure	616.8 mmHg
			Lab. Temperature	25.8 °C
Instrument Reading	Lab Standard Reading	Deviation	Allowable Deviation	As Received
0 ccm	4499.86 ccm	-100.0%	1.00%	Out of Tolerance
0 ccm	997.35 ccm	-100.0%	1.00%	Out of Tolerance
0 ccm	250.32 ccm	-100.0%	1.00%	Out of Tolerance

Mesa Laboratories Standards Used

Description	Standard Serial Number	Calibration Date	Calibration Due Date
ML_800_24	117691	16-Aug-2023	16-Aug-2024



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(303) 987-8000 www.mesalabs.com Symbol "MLAB" on the NASDAQ

FM-00228 Rev. B

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As Shipped Calibration Data

Certificate No	561588	Lab. Pressure	816.2 mmHg
Technician	Xiem Ly	Lab. Temperature	26.1 °C
Instrument Reading	4496.74 ccm	Deviation	0.05%
Lab Standard Reading	4494.43 ccm	Allowable Deviation	1.00%
997.03 ccm	997.18 ccm	As Shipped	In Tolerance
249.84 ccm	250.5 ccm	In Tolerance	In Tolerance
			In Tolerance

Mesa Laboratories Standards Used

Description	Standard Serial Number	Calibration Date	Calibration Due Date
ML_800_24	117991	05-Dec-2022	05-Dec-2023

Calibration Notes

The expanded uncertainty of flow has a coverage factor of $k = 2$ for a confidence interval of approximately 95%. Flow testing is in accordance with our test number MP-00672 with an expanded uncertainty of 0.27% using high-purity nitrogen or filtered laboratory air. Traceability to the International System of Units (SI) is verified by accreditation to ISO/IEC 17025 by NVLAP under NVLAP Code 200661-0.

Technician Notes:

By: *Xiem Ly*
Xiem Ly
Production Technician II

Approved By: *Norma Aragon*
Norma Aragon
QC Inspector

Mesa Laboratories, Inc. certifies that the above instrument meets or exceeds published specifications, and that the calibration results in this certificate were obtained using equipment capable of producing results that are traceable through NIST to the International System of Units (SI). Calibration results are in compliance with ISO/IEC 17025:2017. Calibrations process has a Test Uncertainty Ratio (TUR) of 4:1 or greater. Any Pass/Fail determination is made without taking measurement uncertainty into account and is based on UUT performance against required tolerance only.

Certificate No : 24-AFM-018 Rev.1

Request No : Req-2024-0043

Result of Calibration : Without Adjustment

Temperature	Pressure	STD	LUC	Error	Uncertainty
(°C)	(kPa)	(ml/min)	(ml/min)	(ml/min)	(ml/min)
25.00	101.66	20	20.148	0.1	1.3
25.00	101.67	100	99.499	-0.6	2.8
24.90	101.63	199	197.46	-1.5	5.6
25.00	101.61	300	298.15	-1.8	8.4
24.90	101.60	399	400.13	1	11
24.90	101.59	490	478.02	-2.0	6.8

Note: STD - Standard LUC - Unit Under Calibration
- LUC Reference Condition / At atmospheric pressure and room temperature condition
- Flow Rate was corrected for non-standard operating condition by using equation :

$$Q_{meas} = Q_{ref} \times \frac{P_{ref}}{P_{meas}} \times \frac{T_{meas}}{T_{ref}}$$

where: Q = Flow Rate P = Absolute Pressure T = Absolute Temperature
Meas = Measurement Condition ref = Standard Condition

* Indicates non Accredited

End of Certificate

Certificate of Calibration

Customer: ALS Laboratory Group Thailand Co., Ltd.
Name: 104 Soi Phatthanakan 40, Phatthanakan Road, Suan Luang, Bangkok
Address: 10250

Certificate No : 24-AFM-018 Rev.1
Request No : Req-2024-0043

Unit Under Calibration Details

Measurement Item: Air Flow Meter
Manufacturer: Biot
Model: Defender 510-L
Serial Number: 206895
ID: BKK_FS1346

Sensor Model :
Sensor Serial Number :

Location of Calibration : LAB 4 AIR VELOCITY METER

Calibration Environment and Details

Temperature: 23 °C ± 2 °C
Humidity: 55 %RH ± 20 %RH
Barometric Pressure: 1013 hPa ± 10 hPa
Received Date: 3 January 2024
Calibration Date: 29 January 2024

Calibration Procedure: In-house method CP-AFM-01 by Comparison technique with Standard Primary Flow Calibrator

Reference Standard	Model	Serial Number	Traceable	Due Calibration
Air Flow Meter	Gilibrator 3 Low flow	18501010006	Sensidyne	12 July 2024
Air Flow Meter	Gilibrator 3 Standard flow	19031011003	Sensidyne	12 July 2024
Temperature meter	GT 11	08000057	Qreborn	27 February 2024
Pressure meter	CPG2400	41000KDU/651852	TPA	9 November 2024

Traceability :

This Certificate is traceable to SI Unit through Sensidyne A2LA Accreditation No. 3943.01

Note :

The reported uncertainty is based on standard uncertainty multiplied by the Coverage Factor $k = 2$, providing a level of confidence approximately 95 %.

This Certificate was issued to replace to Calibration Certificate No. 24-AFM-018

Calibration By: *Mr. Noppadol Luangrat*
Mr. Noppadol Luangrat
Service Calibration Engineer

Approved By: *Mr. Pachi Mathavorn*
Mr. Pachi Mathavorn
Calibration Engineer Supervisor

Issue Date : 1 February 2024

The results related only to the item calibrated. The certificate shall not be reproduced except in full, without written approval of the Innovative Instrument Co., Ltd.
FM-708-AFM-01 Rev 01 Issue date 25/01/24

Certificate of Calibration

Customer: ALS Laboratory Group Thailand Co., Ltd.
Name: 104 Soi Phatthanakan 40, Phatthanakan Road, Suan Luang, Bangkok
Address: 10250

Certificate No : 24-AFM-033
Request No : Req-2024-0041

Unit Under Calibration Details

Measurement Item: Primary Flow Calibrator
Manufacturer: Biot
Model: Defender 510-L
Serial Number: 130027
ID: RYG_FS0208

Sensor Model :
Sensor Serial Number :

Location of Calibration : LAB 4 AIR VELOCITY METER

Calibration Environment and Details

Temperature: 23 °C ± 3 °C
Humidity: 55 %RH ± 20 %RH
Barometric Pressure: 1013 hPa ± 10 hPa
Received Date: 31 January 2024
Calibration Date: 13 February 2024

Calibration Procedure: In-house method CP-AFM-01 by Comparison technique with Standard Primary Flow Calibrator

Reference Standard	Model	Serial Number	Traceable	Due Calibration
Air Flow Meter	Gilibrator 3 Low flow	18501010006	Sensidyne	12 July 2024
Air Flow Meter	Gilibrator 3 Standard flow	19031011003	Sensidyne	12 July 2024
Temperature meter	GT 11	08000057	Qreborn	27 February 2024
Pressure meter	CPG2400	41000KDU/651852	TPA	9 November 2024

Traceability :

This Certificate is traceable to SI Unit through Sensidyne A2LA Accreditation No. 3943.01

Note :

The reported uncertainty is based on standard uncertainty multiplied by the Coverage Factor $k = 2$, providing a level of confidence approximately 95 %.

Calibration By: *Mr. Noppadol Luangrat*
Mr. Noppadol Luangrat
Service Calibration Engineer

Approved By: *Mr. Pachi Mathavorn*
Mr. Pachi Mathavorn
Calibration Engineer Supervisor

Issue Date : 13 February 2024

Certificate No : 24-AFM-033
Request No : Req-2024-0241

Result of Calibration : Without Adjustment

Temperature (°C)	Pressure (kPa)	STD (cc/min)	UUC (cc/min)	Error (cc/min)	Uncertainty (cc/min)
24.59	101.26	20	19.965	0.0	1.3
24.29	101.25	101	100.50	-0.5	2.8
24.09	101.31	200	199.12	-0.9	5.6
23.89	101.42	301	303.56	2.6	8.4
24.10	101.41	401	404.57	4	11
24.10	101.49	489	483.81	-3.8	7.0

Note : STD : Standard UUC : Unit Under Calibration
- UUC Reference Condition : At atmospheric pressure and room temperature condition
- Flow Rate was corrected for non-standard operating condition by using equation :

$$Q_{meas} = Q_{ref} \times \frac{P_{ref}}{P_{meas}} \times \frac{T_{meas}}{T_{ref}}$$

where : Q = Flow Rate P = Absolute Pressure T = Absolute Temperature
Meas = Measurement Condition ref = Standard Condition

* Indicates non accredited

End of Certificate

This report issued only to the unit calibrated. The certificate shall not be reproduced except in full, without written approval of the Innovate Instrument Co., Ltd.

FM-708-AFM-01 Rev 01 Issue date 25/01/24

Certificate No : 24-AFM-032
Request No : Req-2024-0240

Result of Calibration : Without Adjustment

Temperature (°C)	Pressure (kPa)	STD (cc/min)	UUC (cc/min)	Error (cc/min)	Uncertainty (cc/min)
23.89	101.39	95	100.13	5.1	2.8
23.90	101.71	501	513.97	12.9	2.5
24.19	101.62	1006	1019.3	13	14
24.09	101.81	1997	2023.0	26	29
24.10	101.87	2999	3035.5	37	45
24.60	102.00	5944	5991.8	48	59
24.60	102.08	4739	4790.5	52	72

Note : STD : Standard UUC : Unit Under Calibration
- UUC Reference Condition : At atmospheric pressure and room temperature condition
- Flow Rate was corrected for nonstandard operating condition by using equation :

$$Q_{meas} = Q_{ref} \times \frac{P_{ref}}{P_{meas}} \times \frac{T_{meas}}{T_{ref}}$$

where : Q = Flow Rate P = Absolute Pressure T = Absolute Temperature
Meas = Measurement Condition ref = Standard Condition

* Indicates non accredited

End of Certificate

This report issued only to the unit calibrated. The certificate shall not be reproduced except in full, without written approval of the Innovate Instrument Co., Ltd.

FM-708-AFM-01 Rev 01 Issue date 25/01/24

Certificate of Calibration

Certificate No : 24-AFM-032
Request No : Req-2024-0240

Customer : ALS Laboratory Group Thailand Co., Ltd.
Name : 104 Soi Phattharakarn 40, Phattharakarn Road, Suan Luang, Bangkok
Address : 10250

Unit Under Calibration Details
Measurement Item : Primary Flow Calibrator
Manufacturer : Binn
Model : Defender 510-M
Serial Number : 129958
ID : RYG_FS0209
Sensor Model :
Sensor Serial Number :
Location of Calibration : LAB 4 AIR VELOCITY METER

Calibration Environment and Details

Temperature : 23 °C ± 3 °C
Humidity : 55 %RH ± 20 %RH
Barometric Pressure : 1013.6 Pa ± 10 hPa
Received Date : 31 January 2024
Calibration Date : 13 February 2024

Calibration Procedure : In-house method CP-AFM-01 by Compression technique with Standard Primary Flow Calibrator

Reference Standard	Model	Serial Number	Traceable	Due Calibration
Air Flow Meter	Gilibrator 3 Low flow	18501010006	Sensidyne	12 July 2024
Air Flow Meter	Gilibrator 3 Standard flow	1901011003	Sensidyne	12 July 2024
Temperature meter	GT 11	09000057	Qreborn	27 February 2024
Pressure meter	CPG2400	41000KDU/651862	TPA	9 November 2024

Traceability :

This Certificate is traceable in SI Unit through Sensidyne A2LA Accreditation No. 1943.01

Note :

The reported uncertainty is based on standard uncertainty multiplied by the Coverage Factor k = 2, providing a level of confidence approximately 95 %

Calibration By :
Mr. Noppadol Luangtan
Service Calibration Engineer

Approved By :
Mr. Patchai Muthayom
Calibration Engineer Supervisor
Issue Date : 13 February 2024

This report issued only to the unit calibrated. The certificate shall not be reproduced except in full, without written approval of the Innovate Instrument Co., Ltd.

FM-708-AFM-01 Rev 01 Issue date 25/01/24



Certificate of Calibration

Equipment : SPECTROPHOTOMETER
Model : DR3900
Serial No. (or ID.): 2021761 (RYG_EN0179)
Manufacturer : HACH
Condition : In Condition

Certificate No.: C06230442
Issued Date: 22 September 2023
Job No.: WO-00005382
Page: 1 of 3

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

Environment Condition: Temperature 24.1 °C ± 0.1 °C
Humidity 61.6 %RH ± 1.6 %RH

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

Calibration By: Mr. Nattapat Rungueang
Calibration Date: 18 September 2023
The Method used: In house method, CAL-WI-24, base on ASTM E 275-08 and ASTM E 387-04
Traceability: This certificate is traceable to the CRM maintained by National Institute of Standards and Technology (NIST) through Star Scientific Limited.
The standard for Wavelength Certificate No. 111583 and 111584
The standard for Photometric Certificate No. 9114984
The standard for Stray light Certificate No. 111585

(Mr. Nattapat Rungueang)
Person in charge

(Mr. Nithun Srihawan)
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 which is obtained from the standard uncertainty multiplied by the coverage factor (k=2) to provide a level of confidence of approximately 95%. It is determined in accordance with the Guide to Expression of Uncertainty in Measurement (GUM).
These results may be affected by deviations from specified conditions. The results relate only to the items tested, calibrated or sampled. The report shall not be reproduced except in full without approval of DKSH Technology Limited.

DKSH Technology Limited
2523 Sukhumvit Road, Bangkok, Phraethong, Bangkok 10260
Phone : +66 2039 7000 Email : info.calibration@dksh.com Website : www.dksh.com/en/india-thailand

Delivering Growth - In Asia and Beyond.

CAL-FM-C05-15: 12 Sep 2022

Calibration Results:
Without Adjustment

Wavelength Accuracy (nm), The spectral bandwidth of Std at 5 nm and UUC at 5 nm			
Standard Wavelength	Unit Under Calibration	Correction	Uncertainty
418.40	418	0.40	0.59
537.00	536	1.00	0.59
638.00	638	0.00	0.59
747.81	748	-0.39	0.59
807.04	807	0.04	0.59

Photometric Accuracy (Absorbance)				
Wavelength	Standard absorbance	Unit Under Calibration	Correction	Uncertainty
420 nm	0.0000	0.000	0.0000	0.0045
	0.2930	0.289	0.0040	0.0045
	0.5168	0.517	-0.0002	0.0045
	1.0298	1.026	0.0038	0.0045
440 nm	0.0000	0.000	0.0000	0.0045
	0.2867	0.281	0.0057	0.0045
	0.5073	0.506	0.0013	0.0045
	1.0083	1.003	0.0053	0.0045
465 nm	0.0000	0.000	0.0000	0.0045
	0.2516	0.249	0.0026	0.0045
	0.4595	0.461	-0.0015	0.0045
	0.9334	0.933	0.0004	0.0045
546.1 nm	0.0000	0.000	0.0000	0.0045
	0.2461	0.244	0.0021	0.0045
	0.4662	0.466	-0.0008	0.0045
	0.9468	0.945	0.0018	0.0045
590 nm	0.0000	0.000	0.0000	0.0045
	0.2584	0.257	0.0014	0.0045
	0.5040	0.504	0.0000	0.0045
	1.0032	1.000	0.0032	0.0045
635 nm	0.0000	0.000	0.0000	0.0045
	0.2579	0.256	0.0019	0.0045
	0.4971	0.497	0.0001	0.0045
	0.9720	0.970	0.0020	0.0045

DKSH Technology Limited
2533 Sukhumvit Road, Bangkok, Thailand 10260
Phone: +66 2639 7000 Email: info@calibration@dksh.com Website: www.dksh.com/calibration-thailand
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CAL-FM-C06-15: 12 Sep 2022

Calibration Results:
Without Adjustment

Standard: cut-off	UUC: Wavelength (nm)	UUC: Transmission (%)	Absorbance (A)
391.44 +/- 0.11 nm	391	3.6	1.444

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

The End of Certificate

DKSH Technology Limited
2533 Sukhumvit Road, Bangkok, Thailand 10260
Phone: +66 2639 7000 Email: info@calibration@dksh.com Website: www.dksh.com/calibration-thailand
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CAL-FM-C06-15: 12 Sep 2022

ใบตรวจสอบสภาพเครื่องวัดสิ่งแวดล้อม

เลขที่ใบงาน: WO-00005382

ชนิดเครื่องมือ: SPECTROPHOTOMETER รุ่น: DR3900

หมายเลขเครื่อง: 2021761

ตรวจสอบ (วัน)		รายการตรวจเช็ค	ตรวจสอบ (ส่ง)		หมายเหตุ
18 Sep 2023			18 Sep 2023		
ปกติ	ไม่ปกติ		ปกติ	ไม่ปกติ	
		General			
☒	☐	1. ความสมบูรณ์เครื่อง	☒	☐	
☒	☐	2. ความสะอาด (ช่องใส่ตัวอย่าง, ภายใน-นอกเครื่อง)	☒	☐	
☒	☐	3. สวิทช์ เปิด - ปิด เครื่อง (On-Off Switch)	☒	☐	
☒	☐	4. ปุ่มกด (Keypad)	☒	☐	
☒	☐	5. หน้าจอ (Display, Screen Contrast)	☒	☐	
		Spectrophotometer			
☐	☐	6. แรงดันไฟฟ้า (Battery Backup) >= 2.5 VDC	☐	☐	
☐	☐	7. ตัวควบคุมความยาวคลื่น (Wavelength Control)	☐	☐	
☒	☐	8. ความยาวคลื่น (Wavelength Check)	☒	☐	B07nm=807.3nm
☐	☐	9. แสงยูวี (UV < 3,000 hour)	☐	☐	
☒	☐	10. แสงที่มองเห็น (Visible < 5,000 hour)	☒	☐	
☐	☐	11. ช่องใส่ภาชนะตัวอย่าง (Carousel Module)	☐	☐	
		pH Meter and Conductivity Meter			
☐	☐	12. อิเล็กโทรด (Electrode and Connection Cable)	☐	☐	
☐	☐	13. ระดับสารละลายใน Electrode (Level KCl)	☐	☐	
☐	☐	14. ฝาปิดกันปลาย Electrode (Dust Protection Hood)	☐	☐	
☐	☐	15. ขาตั้งอิเล็กโทรด (Stand)	☐	☐	
		Turbidimeter			
☐	☐	16. ค่าความขุ่นที่ต่ำสุด (No Sample)	☐	☐	
☐	☐	17. ระดับการส่องสว่างของแสง (>= 2.5 ไม่น้อย 3.0)	☐	☐	
		Automatic titrator			
☐	☐	18. ลิ้นชัก Piston Burettes	☐	☐	
☐	☐	19. Function Rinsing and Dosing	☐	☐	
☐	☐	20. ระบบท่อสายยางและอุปกรณ์ประกอบ	☐	☐	

เห็นด้วยข้อแนะนำ:

Mr.Nattapat Rungreung
Service Engineer



TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)
CORPORATE SERVICES 3 : EQUIPMENT CALIBRATION AND TESTING SERVICES

554/4 PATTANAKARN ROAD SOI 18, SUANLIANG, SUANLIANG BANGKOK 10250

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

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

Certificate of Testing

Equipment :	DO Meter
Manufacturer :	YSI
Model :	5000-115V
Serial No. :	15E102796
ID No. :	RYG_EN0032
Received Date :	21 July 2023
Test Date :	24 July 2023
Reference :	2307-0713DSC-1
Submitted by :	ALS Laboratory Group (Thailand) Co.,Ltd. Rayong Branch 618/10 Moo 5, T.Maenam Khu, A.Pluakdaeng, Rayong 21140, Thailand
Laboratory Condition :	Temperature (25 ± 5) °C Humidity (50 ± 20) % In - house method : CP-CH9 by Comparison Technique with Azide Modification Method
Test Procedure :	
Tested by :	Walailak Sirthean
Approved by :	 Approved Signatory
	() Maiee Butkrua (✓) Sathip Meangmai () Warakorn Lemgagrakul

Issue Date : 26 July 2023

DKSH Technology Limited
2533 Sukhumvit Road, Bangkok, Thailand 10260
Phone: +66 2639 7000 Email: info@calibration@dksh.com Website: www.dksh.com/calibration-thailand
Delivering Growth - In Asia and Beyond.

CAL-FM-R31-03: 20 Jul 2022

B 0320211



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

Condition of this result of calibration

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

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

2. Standard Material :-

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

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

Titration Method (Azide Modification Method) (mg/L)	DO Meter Reading (mg/L)	Standard Deviation (mg/L)
B.1B	B.17	0.0055

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

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Signature

a 1172155



TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)
CORPORATE SERVICES & EQUIPMENT CALIBRATION AND TESTING SERVICES
344 PATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG BANGKOK 10250
TEL: 0-2717-3000-29 FAX: 0-2719-4464



Cert. No.: 23LM125
Page.: 1 of 2

Certificate of Calibration

Equipment : DO Meter with Sensor
Manufacturer : YSI
Model : 5000-115V
Serial No. : 15E102796
ID No. : RYG_EN0032
Submitted by : ALS Laboratory Group (Thailand) Co., Ltd.
Rayong Branch
616/10 Moo 5 T. Maenam Khu, A. Phuakdaeng,
Rayong 21140 Thailand
Location : TPA On Site Calibration Laboratory
Received Order : 25 July 2023
Calibrated Date : 27 July 2023
Ambient Temperature : (26 ± 10) °C
Relative Humidity : (50 ± 30) %
AC Line Voltage : (220 ± 22) V
Calibrated by : Preecha Hahib
Approved by : *Signature*
Approved Signatory
() Pornthippa Tameyakul
() Malee Butkruea
(x) Suwit Imjai
Issue Date : 31 July 2023

The Uncertainties are for a confidence probability of approximately 95%

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Approved of the Head of Corporate Services & Equipment Calibration and Testing Services

A 0053615



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

Calibration were conducted using in-house calibration procedure CP-QT01 according to comparison with Industrial Platinum Resistance Thermometer (IPRT) into Temperature Bath.
The temperature scale used was based on ITS-90.

Condition of this result of calibration

- Reference standard instrument:-

Instrument	Serial No.	Cert. No.	Traceable	Due Date
1) Digital Thermometer	2188080	221285	TPA	21 Oct 2023
- This certificate is valid only to the item calibrated on date and place of calibration.
- This certification is traceable to the International System of Unit.

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

Result of Calibration :- (*) Without Adjustment

Function : Temperature measurement

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

Calibration Point (°C)	Immersion Depth (mm)	Standard Temperature (°C)	UUC* Reading (°C)	Error (°C)	Uncertainty (± °C)	Coverage Factor k
20.00	100	20.011	19.91	-0.101	0.15	2.00

UUC* : Unit Under Calibration

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

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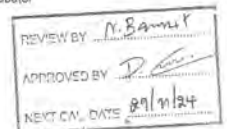
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TEL: 0-2717-3000-29 FAX: 0-2719-4464



Cert. No.: 23TM662
Page.: 1 of 3

Certificate of Calibration

Equipment : Low Temp. Incubator
Manufacturer : Memmert
Model : IPF750
Serial No. : V816.0064
ID No. : RYG_EN0154
Submitted by : ALS Laboratory Group (Thailand) Co., Ltd.
(Rayong Branch)
616/10 Moo 5 T. Maenam Khu, A. Phuakdaeng, Rayong 21140 Thailand
Location : BOD Room
Received Order : 29 May 2023
Calibration Date : 29 May 2023
Ambient Temperature : (26 ± 10) °C
Relative Humidity : (50 ± 30) %
Calibrated by : Mani Patanapongpaiboon
Approved by : *Signature*
Approved Signatory
() Pornthippa Tameyakul
() Malee Butkruea
(x) Suwit Imjai
Issue Date : 7 June 2023



The Uncertainties are for a confidence probability of approximately 95%

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Approved of the Head of Corporate Services & Equipment Calibration and Testing Services

a 1159515

A 0054967



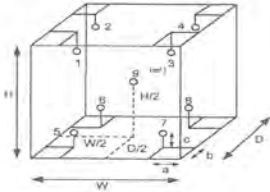
Equipment : Low Temp. Incubator
Condition As-Received : Used Item
Reference : 2305-0898OC-2
Procedure Used :-

Cert. No.: 23TM962
Page : 2 of 3

Calibration were conducted using calibration procedure CP-OT02 according to direct measurement method with Data Acquisition which connected with Resistance Temperature Detector (RTD).
The temperature scale used was based on ITS-90.

Condition of this result of calibration

1. Reference standard instrument:-
Instrument Model Serial No. Cert. No. Due Date
1) Data Acquisition 34872A MY57013711 22LM93 02 Jul 2023
 2. This certificate is valid only to the item calibrated on date and place of calibration.
 3. This certification is traceable to the International System of Unit.
- Result of Calibration :- (*) Without Adjustment
Function of UUC* : Temperature Source
Fresh air setting : Close



Probe Installation Details : Dimension of Chamber :
a = 10 cm D = 0.80 m
b = 10 cm W = 1.0 m
c = 10 cm H = 1.2 m
Capacity = 0.75 m³

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

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



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

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

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

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

Average* : The average of 30 values in each position.
Temperature stability : One-half of the greatest maximum difference of measured temperature at any one sensor.
Temperature uniformity : The maximum difference of measured temperatures at any sensors and the measured temperature at the reference location which are observed at the same time or at as close an observation time as possible to determine the temperature pattern or homogeneity within the chamber under steady-state conditions.
Overall Variation : The Difference of the maximum and minimum measured temperatures throughout observation.
UUC* : Unit Under Calibration
Note : The reported uncertainty of measurement was included stability and excluded uniformity.

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

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a 1165130

a 1165129



Certificate of Calibration

Certificate No.: C06250441 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
415.51	418.3	0.31	0.13
536.66	536.6	0.06	0.13
537.96	638.3	-0.32	0.13
748.48	748.7	-0.22	0.13
807.03	807.4	-0.37	0.13

Photometric Accuracy (Absorbance)

Wavelength	Standard absorbance	Unit Under Calibration	Correction	Uncertainty
420 nm	0.0000	0.000	0.0000	0.0045
	0.2930	0.286	0.0040	0.0045
	0.5168	0.519	-0.0022	0.0045
	1.0298	1.029	0.0008	0.0045
440 nm	0.0000	0.000	0.0000	0.0045
	0.2867	0.283	0.0037	0.0045
	0.5073	0.509	-0.0017	0.0045
	1.0083	1.007	0.0013	0.0045
485 nm	0.0000	0.000	0.0000	0.0045
	0.2516	0.250	0.0016	0.0045
	0.4595	0.462	-0.0025	0.0045
	0.9334	0.933	0.0004	0.0045
546.1 nm	0.0000	0.000	0.0000	0.0045
	0.2461	0.245	0.0011	0.0045
	0.4852	0.486	-0.0008	0.0045
	0.9468	0.946	0.0008	0.0045
590 nm	0.0000	0.000	0.0000	0.0045
	0.2594	0.259	0.0004	0.0045
	0.5040	0.505	-0.0010	0.0045
	1.0032	1.002	0.0012	0.0045
635 nm	0.0000	0.000	0.0000	0.0045
	0.2579	0.257	0.0009	0.0045
	0.4971	0.497	0.0001	0.0045
	0.9720	0.971	0.0010	0.0045

Unit Under Calibration
DKSH Technology Limited
2533 Sukhumvit Road, Bangkok, Thailand 10260
Phone: +66 2638 7000 Email: info@dksh.com Website: www.dksh.com

Delivering Growth - in Asia and Beyond.

CAL-FM-C06-16 12 Sep 2022

Equipment: SPECTROPHOTOMETER
Model: DR6000
Serial No. (or ID.): 1627845 (RYG_EN0037)
Manufacturer: HACH
Condition: In Condition

Certificate No.: C06250441
Issued Date: 19 September 2023
Job No.: WO-00005382
Page: 1 of 3

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

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

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

Calibration By: Mr. Nattapat Rungrueng
Calibration Date: 18 September 2023
The Method used: In house method, CAL-WI-24, base on ASTM E 275-08 and ASTM E 367-04
Traceability: This certificate is traceable to the CRM maintained by National Institute of Standards and Technology (NIST) through Starna Scientific Limited.

The standard for Wavelength Certificate No. 111583 and 111584
The standard for Photometric Certificate No. 9114864 and 111588
The standard for Stray light Certificate No. 111586 and 111585
The standard for Spectral resolution Certificate No. 111587

(Mr. Nattapat Rungrueng)
Person in charge

(Mr. Nitinun Sthawan)
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 in the expanded uncertainty which is obtained from the standard uncertainty multiplied by the coverage factor (k=2) to provide a level of confidence of approximately 95%. It is determined in accordance with the Guide to Expression of Uncertainty in Measurement (GUM).
These results may be affected by deviations from specified conditions. The results relate only to the items tested, calibrated or sampled. The report shall not be reproduced except in full without approval of DKSH Technology Limited.

Unit Under Calibration
DKSH Technology Limited
2533 Sukhumvit Road, Bangkok, Thailand 10260
Phone: +66 2638 7000 Email: info@dksh.com Website: www.dksh.com

Delivering Growth - in Asia and Beyond.

CAL-FM-C06-16 12 Sep 2022

Calibration Results:
Without Adjustment

Photometric Accuracy (Absorbance)				
Wavelength	Standard absorbance	Unit Under Calibration	Correction	Uncertainty
235 nm	0.0000	0.000	0.0000	0.0080
	0.7355	0.737	-0.0015	0.0080
257 nm	0.0000	0.000	0.0000	0.0080
	0.8574	0.857	0.0004	0.0080
313 nm	0.0000	0.000	0.0000	0.0080
	0.2864	0.290	-0.0036	0.0080
350 nm	0.0000	0.000	0.0000	0.0080
	0.6374	0.637	0.0004	0.0080
Stray light *				
Standard: cut-off		UUC: Wavelength (nm)	UUC: Transmission (%T)	Absorbance (A)
250.62 ± 0.11 nm		250.6	1.3	1.886
381.44 ± 0.11 nm		391.4	1.3	1.886
Spectral Resolution *				
Nominal Concentration 0.02 % v/v	Peak	Trough	Ratio	SBW
Standard Wavelength (nm)	268.66	268.69	1.38	2.00
UUC: Wavelength (nm)	268.2	266.1		
Std Absorbance (A)	0.4566	0.2780		
Absorbance (A)	0.413	0.300		

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

The End of Certificate

Valid Signature (ภาษาไทย) only
DKSH Technology Limited
2533 Sukhumvit Road, Bangkok, Prachinwong, Bangkok 10250
Phone +66 2634 7000 Email info@dksh.com Website www.dksh.com

Delivering Growth - In Asia and Beyond.

CAL-FM-C06-16: 12 Sep 2022

ใบตรวจสอบสภาพเครื่องวัดสิ่งแวดล้อม

เลขที่ใบงาน: WO-00005382

ชนิดเครื่องมือ: SPECTROPHOTOMETER รุ่น: DR8000

หมายเลขเครื่อง: 1627845

ตรวจสอบ (รับ)		ตรวจสอบ (ส่ง)		หมายเหตุ
18 Sep 2023	รายการตรวจเช็ค	18 Sep 2023		
ปกติ	ไม่ปกติ	ปกติ	ไม่ปกติ	
General				
☒	☒	☒	☒	1. ความแม่นยำเครื่อง
☒	☒	☒	☒	2. ความสะอาด (ช่องใส่ตัวอย่าง, ภายในหน้าจอเครื่อง)
☒	☒	☒	☒	3. สวิตช์ ปิด - เปิด เครื่อง (On-Off Switch)
☒	☒	☒	☒	4. ปุ่มกด (Keypad)
☒	☒	☒	☒	5. หน้าจอ (Display, Screen Contrast)
Spectrophotometer				
☒	☒	☒	☒	6. แบตเตอรี่สำรอง (Battery Backup) >= 2.5 VDC
☒	☒	☒	☒	7. ควบคุมแสงความยาวคลื่น (Wavelength Control)
☒	☒	☒	☒	8. ความยาวคลื่น (Wavelength Check)
☒	☒	☒	☒	9. แหล่งกำเนิดแสง (UV < 3,000 hour)
☒	☒	☒	☒	10. แหล่งกำเนิดแสง (Visible < 5,000 hour)
☒	☒	☒	☒	11. ช่องวัดค่าความยาวคลื่น (Carousel Module)
pH Meter and Conductivity Meter				
☒	☒	☒	☒	12. อิเล็กโทรด (Electrode and Connection Cable)
☒	☒	☒	☒	13. ระดับสารละลายใน Electrode (Level KCl)
☒	☒	☒	☒	14. ฝาปิดกันปลาย Electrode (Dust Protection Hood)
☒	☒	☒	☒	15. ขาตั้งอิเล็กโทรด (Stand)
Turbidimeter				
☒	☒	☒	☒	16. ค่าความขุ่นที่ต่ำสุด (No Sample)
☒	☒	☒	☒	17. ระดับการส่องสว่างของแสง (>= 2.5 ไมล์ 3.0)
Automatic titrator				
☒	☒	☒	☒	18. สภาพ Piston Burettes
☒	☒	☒	☒	19. Function Rinsing and Dosing
☒	☒	☒	☒	20. ระบบจ่ายยาและอุปกรณ์ประกอบ

เพิ่มเติมข้อมูล: *656.1nm=656.1nm

*485.0nm=485.5nm

Mr. Natapat Rungreang
Service EngineerValid Signature (ภาษาไทย) only
DKSH Technology Limited
2533 Sukhumvit Road, Bangkok, Prachinwong, Bangkok 10250
Phone +66 2634 7000 Email info@dksh.com Website www.dksh.com

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CAL-FM-R51-03: 20 Jul 2022

Sartorius (Thailand) Co., Ltd.
129 Rama 9 Road, Huaykwang, Huaykwang, Bangkok 10310
Tel: +66 2643 8361-6 e-mail: service.thailand@sartorius.com

SARTORIUS

Certificate of Calibration

REVIEW BY: Thirathol
APPROVED BY: D
NEXT CAL DATE: 21/02/2025

Model Number: MSE224S-100-DU Certificate No.: 24BCI0069
Description: Analytical Balance Issued Date: Friday, February 23, 2024
Serial Number: 0026207038 Reference No.: 229195
ID No.: RYG_EN0002
Manufacturer: Sartorius Page No.: 1 of 2

Customer Name: ALS Laboratory Group (Thailand) Co., Ltd. (Rayong Branch)
618/10 Moo 5 T.Maenam Khu, A.Pluek Daeng, Rayong 21140, Thailand.Calibrated Place: ALS Laboratory Group (Thailand) Co., Ltd. (Balance Room)
618/10 Moo 5 T.Maenam Khu, A.Pluek Daeng, Rayong 21140, Thailand.Calibrated By: Mr.Chonchai Inthana
Calibration Date: Thursday, February 22, 2024
Calibration Procedure No.: This calibration was conducted by
Using in-house calibration procedure number (WI-003)
Based on UKAS LAB 14: 2019

Metrological data:
Capacity: 220 g Readability: 0.0001 g
Reasons for calibration:
☐ New Installation ☐ Service / Repair ☒ Re-calibration / Maintenance
Ambients Conditions:
Temperature: 24.2 °C ± 5.0 °C
Humidity: 57.0 % RH ± 10.0 % RH
Pressure: ±
Equipment Condition: ☒ Good Operate ☐ Fail

Measurement Method UKAS Publication Ref: Lab 14
The measurement uncertainty stated is the expanded uncertainty which is obtained from the standard uncertainty multiplied by the coverage factor (k=2) to provide a level of confidence of approximately 95%. It is determined in accordance with the Guide to Expression of Uncertainty in Measurement (GUM). The calibration certificate documents the traceability to National Standards, which realise the unit of measurement according to the International Standard System of Units (SI). Report of Tolerance came from list of Sartorius Metrological Specifications.

Traceability:

Model Number	Description	Traceability	Certificate No.	Due Date
YCS011-522-00	Sartorius weight set 1mg - 5000g E2.YCS011-522-00	TCS	M2308197S	23-Aug-2025
MHB-382SD	Humidity/Barometer/Temp. Luftron MHB-382SD	DKSH	C19231845	23-Aug-2024

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

Mr.Chonchai Inthana(Technical Manager)



SOP FM 33 03 February 2022

Sartorius (Thailand) Co., Ltd.
129 Rama 9 Road, Huaykwang, Huaykwang, Bangkok 10310
Tel: +66 2643 8361-6 Fax: +66 2643-8207, e-mail: service.thailand@sartorius.com

SARTORIUS

Certificate of Calibration

Model Number: MSE224S-100-DU Certificate No.: 24BCI0069
Description: Analytical Balance Issued Date: Friday, February 23, 2024
Serial Number: 0026207038 Reference No.: 229195
ID No.: RYG_EN0002
Manufacturer: Sartorius Page No.: 2 of 2

Calibration Results : Without Adjustment

Repeatability		Eccentricity (Off-center loading error)	
The repeatability is the ability of a weighing instrument to display nearly identical readouts under constant load conditions when the same load within a measurement series is placed repeatedly on the weighing pan in the same manner. The standard deviation is used to express reproducibility quantitatively.		The off-center loading error is yielded by the difference between the readout of the load, i.e. 10 or 5% of maximum capacity, placed in the middle of the weighing pan and between each of four additional measurement points (positions defined according to OIML R110).	
Nominal Value : (Low Load)	20.0000	199.9999	
20 g	20.0000	200.0000	
Tolerance	20.0001	200.0000	
0.0001 g	20.0000	199.9999	
	20.0001	200.0000	
Nominal Value : (High Load)	19.9999	200.0000	
200 g	20.0000	200.0000	
Tolerance	20.0000	199.9999	
0.0001 g	19.9999	200.0001	
	19.9999	200.0000	
Standard Deviation	0.00007	0.00006	

Linearity

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

Tolerance 0.0002 g				
Nominal Value	Conventional Mass Value	Displayed Value	Deviation	Uncertainty
(g)	(g)	(g)	(g)	(g)
0.01	0.0100	0.0100	0.0000	0.00018
0.05	0.0500	0.0500	0.0000	0.00018
0.1	0.1000	0.1000	0.0000	0.00018
0.5	0.5000	0.5000	0.0000	0.00018
1	1.0000	1.0000	0.0000	0.00018
5	5.0000	5.0000	0.0000	0.00018
10	10.0000	10.0000	0.0000	0.00018
20	20.0000	20.0000	0.0000	0.00024
50	50.0000	49.9999	-0.0001	0.00019
100	100.0000	100.0000	0.0000	0.00023
200	200.0000	199.9999	-0.0001	0.00032

End of Report

SOP FM 33 03 February 2022



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

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

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

The temperature scale used was based on ITS-90.

Condition of this result of calibration

1. Reference standard instrument:-

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

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

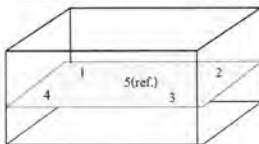
Remark : TPA : Technology Promotion Association (Thailand - Japan)

Result of Calibration :- (*) Without Adjustment

Function of UUC* : Temperature Source

Heat transfer medium used : Water

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



Front

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



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

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

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

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

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

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

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

UUC* : Unit Under Calibration

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

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

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TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)
CORPORATE SERVICES 3: EQUIPMENT CALIBRATION AND TESTING SERVICES
5344 PATTANAKARN ROAD SOI 18, SUKHLIANG, SUKHLIANG, BANGKOK 10250
TEL: 0-2717-3000-24 FAX: 0-2719-9484



Certificate of Calibration

Certificate No.: 23E3924
Page : 1 of 2

Equipment : pH Meter
Manufacturer : Mettler Toledo
Model : SevenExcellence
Serial No.: 8834291445
ID No.: RYG_EN0152
Condition As-Received: Used Item
Received Date: 08 December 2023
Calibration Date: 14 December 2023

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

Reference: 2312-0151DSC
Ambient Temperature: (23 ± 2) °C
Relative Humidity: (50 ± 10) %

Submitted by: ALS Laboratory Group (Thailand) Co., Ltd. Rayong Branch
615/10 Moo 5, T.Malanam Khu, A Phrakdeang,
Rayong 21140, Thailand.

Procedure used: Calibration were conducted using calibration procedure No. CP-E17 according to EURAMET cp-15.

Condition of this result of calibration

1. Reference standards instruments

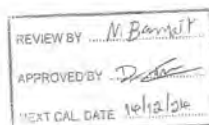
Instrument	Model	Serial No.	Certificate No.	Due Date
1) Multi-Product Calibrator	5502A	2435802	EE-0041-23	26 Apr 2024

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 through:-

-National Institute of Metrology Thailand (NIMT)



Calibrated by : Napachonk Prasomsosoli
Issue Date : 15 December 2023

Approved Signatory :
[] Phalinee Pratsapal
[x] Nuntawal Khamchai
[] Pongsagorn Boonsaporn

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

Function: DC voltage measurement	Standard Value (mV)	UUC* Reading (mV)	Error (mV)	Uncertainty (± μV)
	-200.0000	-199.9	0.1	68
	-150.0000	-150.0	0.0	65
	-100.0000	-100.0	0.0	63
	-50.0000	-50.0	0.0	61
	0.0000	0.0	0.0	58
	50.0000	50.0	0.0	61
	100.0000	100.0	0.0	63
	150.0000	150.0	0.0	65
	200.0000	199.9	-0.1	66

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.

-o0o-



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

Certificate of Calibration

Equipment : pH Meter
Manufacturer : Mettler Toledo
Model : SevenExcellence
Serial No. : B834291445
ID No. : RYG_EN0152
Condition As-Received: Used Item
Received Date : 08 December 2023
Calibration Date : 15 December 2023
Reference : 2312-0151DSC-3
Submitted by : ALS Laboratory Group (Thailand) Co.,Ltd. Rayong Branch
616/10 Moo 5, T.Maenam Khu, A.Pluakdaeng,
Rayong 21140, Thailand

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

Calibrated by : Warakorn Lemgagrakul

Approved by :
Approved Signatory

() Sathip Meangmai
() Warakorn Lemgagrakul
(x) Ponpan Palpim

Issue Date : 19 December 2023

The Uncertainties are for a confidence probability of approximately 95%

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

A 0061696



Cert.No.: 23CH1574
Page.: 2 of 3

Condition of this calibration result

1. Reference Standard Instrument :-

Instrument	Serial No.	ID No.	Cert. No.	Due Date
1) Document Process Calibrator	54030049	130RC116	23E2802	27 Aug 2024
2) Ref. Standard Thermometer	4982054	110RC044	23I908	26 July 2024

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

2. Certified Reference Materials : The measurement results are traceable to SI through CPA chem Ltd.,
ANSI-ASQ National Accreditation Board, Accredited No. AR-1635

Buffer Solution	Manufacturer	Lot No.	Exp. date
pH 4.008	CPA chem	913598	14 July 2025
pH 6.986	CPA chem	931959	01 Oct 2024
pH 9.997	CPA chem	940106	02 Nov 2024

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

Calibration Results

Function : mV Measurement

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

Unit Under Calibration	Nominal Value	Standard Voltage Input	Actual Reading		Uncertainty of Measurement (±mV)	Coverage factor k
			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 1193852



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

Calibration Results

Function : pH Measurement

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

Unit Under Calibration	Standard pH Buffer Solution	Actual pH Reading	Actual mV Reading (mV)	Uncertainty of pH measurement (±)	Coverage factor k
pH Electrode S/N.: 3225368	4.008	4.013	184.1	0.0045	2.00
	6.986	6.998	8.7	0.0084	2.00
	9.997	10.002	-164.7	0.0088	2.11

Function : Temperature Measurement

(*) Without adjustment

This equipment was connected with Temperature Probe;

- Model : InLab®Expert Pro-ISM
- Serial No. : 3225368

Dimension of probe:

- Length : 120 mm
- Diameter : 12 mm
- Immersion Depth : 100 mm

Calibration Point (°C)	Standard Temperature (°C)	UUC* Reading (°C)	Error (°C)	Uncertainty of measurement (± °C)	Coverage factor k
25.0	25.003	24.3	-0.703	0.13	2.00

Remark : - UUC* = Unit Under Calibration

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

-000-

a 1193851



Certificate of Calibration

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

Equipment : Hot Air Oven
Manufacturer : Mammert
Model : UFE 500
Serial No. : G511.1572
ID No. : RYG_EN0010

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

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

Calibrated by : Man Pattanapongpalboon

Approved by :
Approved Signatory

() Pomthippa Tameyakul
() Unnoppol Harachai
(x) Suwit Imjai

Issue Date : 22 March 2024

The Uncertainties are for a confidence probability of approximately 95%

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Approval of the head of Corporate Services 3 : Equipment Calibration and Testing Services.



TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)
CORPORATE SERVICES & EQUIPMENT CALIBRATION AND TESTING SERVICES
53/14 PATTANAKARN ROAD SOI 14, SUANLUANG, SUANLUANG BANGKOK 10250
TEL: 02-717-9000-28 FAX: 02-719-9459



Cert. No.: 23LM131
Page.: 1 of 2

Certificate of Calibration

Equipment : pH Meter with Sensor
Manufacturer : Mettler Toledo
Model : SevenGo S2
Serial No. : C222171779
ID No. : RYG_FS0594
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 : 02 August 2023
Calibrated Date : 04 August 2023
Ambient Temperature : (26 ± 10) °C
Relative Humidity : (50 ± 30) %
AC Line Voltage : (220 ± 22) V

Calibrated by : Uthen Kankawi

Approved by :
() Ponthippa Tameyskul
() Mailee Butkruea
(✓) Suwit Imjai

Issue Date : 8 August 2023

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.



Equipment : pH Meter with Sensor
Condition As-Received : Used Item
Reference : 2306-0023DSC-4
Procedure Used :-

Cert. No.: 23LM131
Page.: 2 of 2

Calibration were conducted using in-house calibration procedure CP-OT01 according to comparison with Industrial Platinum Resistance Thermometer (IPRT) into Temperature Bath.
The temperature scale used was based on ITS-90.

Condition of this result of calibration

1. Reference standard instrument:-

Instrument	Serial No.	Cert. No.	Traceable	Due Date
1) Digital Thermometer	A7B843	23124	TPA	04 Jan 2024

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

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

Result of Calibration :- (*) Without Adjustment

Function : Temperature measurement.

This instrument was connected with temperature sensor, S/N : 3272074

Calibration Point (°C)	Immersion Depth (mm)	Standard Temperature (°C)	UUC* Reading (°C)	Error (°C)	Uncertainty (± °C)	Coverage Factor k
25.0	100	25.004	25.1	0.096	0.16	2.00
30.0	100	30.008	30.2	0.192	0.16	2.00
40.0	100	40.001	40.2	0.199	0.16	2.00
50.0	100	50.012	50.2	0.188	0.16	2.00

UUC* : Unit Under Calibration

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

-000-

A 0056946

a 1174196

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Certificate of System Qualification

GC-00 + GCMS-00

System ID : GM-7
Organization Name : ALS Laboratory Group (Thailand) Co., Ltd.
Organization Location : 104 Pathanakarn Rd., Khwang Suan Luang, Khwa Suan Luang, Bangkok.

Date : December 13, 2023 3:32:46 PM
EQP Name : Agilent/Recommended, Agilent/Recommended
EQP Revision : GC.02.50, GCMS.02.50
Overall Qualification 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 Accuracy

Name : 7890
Front : SSL

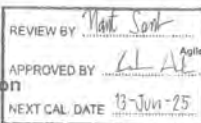
Setpoint Status : Pass
Setpoint : Actual
Inlet Pressure : 25.0 psi 25.0 psi
Accuracy : 0.0 psi
Agilent Recommended : ± 1.2

Overall Inlet Pressure Accuracy Test Status
Pass

GC Oven Temperature Accuracy

Name : 7890

Date : December 13, 2023 3:32:46 PM
System ID : GM-7



REVIEW BY : Nait Sank
APPROVED BY : [Signature]
NEXT CAL DATE : 13-JUN-25

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Setpoint Status :

Pass

Zone :

Oven

Setpoint/Actual

Temperature : 230.0 232.3 °C

Accuracy : 2.3 °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 : 100.0 100.7 °C

Accuracy : 0.7 °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 : 100.0 100.4 °C

Stability : 0.0 °C

Agilent Recommended : <= 0.5

Overall GC Oven Temperature Stability Test Status

Pass

Log Amp

Tested Combination : Front SSL / External SD

Name : 5977A

Setpoint Status : Pass

Date : December 13, 2023 3:32:46 PM
System ID : GM-7

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Overall Log Amp Test Status
Pass

RFPA

Tested Combination1	Front	SSL	/ External	SQ
Name:	5977A			
Setpoint Status:	Pass			
Amu:	1050	m/z	Drift After Five Minutes:	RFPA Voltage:
			2	504
			mV	mV
Agilent Recommended:	>= -100	and	<= 100	<= 1100

Overall RFPA Test Status
Pass

Tune EI

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

Overall Tune EI Test Status
Pass

Signal to Noise EI

Tested Combination1	Front	SSL	/ External	SQ
Name:	5977A			

Date: December 13, 2023 3:32:46 PM
System ID: GM-7

Source:	EI - Extractor	Filament:	1
Setpoint Status:	Pass		
Signal to Noise:	11319		
Agilent Recommended:	>= 1200		
Source:	EI - Extractor	Filament:	2
Setpoint Status:	Pass		
Signal to Noise:	16568		
Agilent Recommended:	>= 1200		

Overall Signal to Noise EI Test Status
Pass

NOTE: This test's 0 comment(s) and 6 deviation(s) are available in the Attachments section.

Date: December 13, 2023 3:32:46 PM
System ID: GM-7

Instrument Details

Purpose

This section describes the as found system configuration.

Details

System	
System ID	GM-7
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 (uL)	10
Mainframe 1	
Manufacturer	Agilent Technologies
Name	7890
Model Number	G3442B
Serial Number	CN14133181
Firmware Revision	B.02.03
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	5977A
Serial Number	US1415M200
Firmware Revision	5977 6.00.2.1
High Vacuum System	Turbo Pump
Scouting Run Standard	OPN Std
MS EI Source 1	
Manufacturer	Agilent Technologies
Source Type	EI - Extractor
Number of filaments	2

Date: December 13, 2023 3:32:46 PM
System ID: GM-7

Date: December 13, 2023 3:32:46 PM
System ID: GM-7

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: Supasak Nimsongtham
Logged On User Name: supasak.nimsongtham@agilent.com
Signature Creation Date: December 13, 2023
Reason for Signature: Executed protocol and published this original version of document

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This document provides a protocol to verify and record instrument configuration and evidence of proper operation. It has been prepared from our interpretation of applicable regulations as well as industry best practices. The document is designed to provide an important component of a complete compliance package. Validation depends upon many factors and use of this protocol alone does not assure compliance. Agilent Technologies makes no promises or representations as to its sufficiency for any specific regulatory program.

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User Name: supasak.nimsongtham Report Generated by Hostname: ASB/KW3492				System ID: GM-7 Print Date: December 13, 2023 3:32:47 PM
GM-7-2023 Transaction log				
Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
December 13, 2023 10:22:24 AM	Auth	SessionCreated	Session	None
December 13, 2023 10:22:24 AM	Start	Configuration	Session	None
December 13, 2023 10:22:24 AM	Auth	Enrollment	Licensing	User is FieldEngineer and does not require an unlock code
December 13, 2023 10:33:53 AM	Auth	Explored	Session	EQP details for memory technique (Gr): File path: [ProtocolPacks/GoConfig/usa102_50Gr_02_50_eqp] EQP File Name: [Gr_02_50_eqp].EQP File Name: [AgilentRecommended/Protosid Revision] (Gr_02_50) EQP details for hypersensitized technique (GrMa): File path: [ProtocolPacks/GrMa/Config/usame102_50GrMa_02_50_eqp] EQP File Name: [GrMa_02_50_eqp].EQP File Name: [AgilentRecommended]
December 13, 2023 10:33:55 AM	End	Configuration	Session	None
December 13, 2023 10:23:58 AM	Start	Qualification	Session	QG
December 13, 2023 10:23:58 AM	Start	Execution	System Inspection and Basic Safety and Operation - F890 - Qualitative Test - No stoppoints associated	None

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Date: December 13, 2023 3:32:46 PM
System ID: GM-7

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Date: December 13, 2023 3:32:46 PM
System ID: GM-7

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User Name: supasak.nimsongtham Report Generated by Hostname: ASB/KW3492				System ID: GM-7 Print Date: December 13, 2023 3:32:47 PM
GM-7-2023 Transaction log				
Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
December 13, 2023 10:24:10 AM	End	Execution	System Inspection and Basic Safety and Operation - F890 - Qualitative Test - No stoppoints associated	Run Count: 1
December 13, 2023 10:24:11 AM	Start	Execution	Init Pressure Accuracy - F490 - SSL - Pressure Controlled Inlet - S: 25.0 psi - L: +/- 0.2 psi	None
December 13, 2023 10:24:15 AM	End	Execution	Init Pressure Accuracy - F490 - SSL - Pressure Controlled Inlet - S: 25.0 psi - L: +/- 0.2 psi	Run Count: 1
December 13, 2023 10:24:17 AM	Start	Execution	GC Oven Temperature Accuracy - F890 - Temperature Over - S: 200.0°C - L: +/- 1.0 AND +/- 1.0 % setpoint in K	None
December 13, 2023 10:32:09 AM	Auth	Data	GC Oven Temperature Accuracy - F890 - Temperature Over - S: 200.0°C - L: +/- 1.0 AND +/- 1.0 % setpoint in K	Manual Data Entry
December 13, 2023 10:32:11 AM	End	Execution	GC Oven Temperature Accuracy - F890 - Temperature Over - S: 200.0°C - L: +/- 1.0 AND +/- 1.0 % setpoint in K	Run Count: 1
December 13, 2023 10:32:12 AM	Start	Execution	GC Oven Temperature Accuracy - F890 - Temperature Over - S: 200.0°C - L: +/- 1.0 AND +/- 1.0 % setpoint in K	None
December 13, 2023 10:34:58 AM	Auth	Data	GC Oven Temperature Accuracy - F890 - Temperature Over - S: 200.0°C - L: +/- 1.0 AND +/- 1.0 % setpoint in K	Manual Data Entry
December 13, 2023 10:34:59 AM	End	Execution	GC Oven Temperature Accuracy - F890 - Temperature Over - S: 200.0°C - L: +/- 1.0 AND +/- 1.0 % setpoint in K	Run Count: 1

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User Name: supasak.nimsongtham Report Generated by Hostname: ASB/KW3492				System ID: GM-7 Print Date: December 13, 2023 3:32:47 PM
GM-7-2023 Transaction log				
Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
December 13, 2023 10:35:20 AM	Start	Execution	GC Oven Temperature Stability - F890 - Temperature Over - S: 200.0°C - L: +/- 0.5°C	None
December 13, 2023 10:35:27 AM	Start	Execution	Signal to Noise (E) - Liquid Injection - From 6.50 - 9.0 - Source: (E) - Extractor using Filament 1 - L: +/- 1200	None
December 13, 2023 10:35:39 AM	Start	Execution	GC Oven Temperature Stability - F890 - Temperature Over - S: 200.0°C - L: +/- 0.5°C	None
December 13, 2023 10:35:12 AM	Auth	Data	GC Oven Temperature Stability - F890 - Temperature Over - S: 200.0°C - L: +/- 0.5°C	Manual Data Entry
December 13, 2023 10:35:12 AM	End	Execution	GC Oven Temperature Stability - F890 - Temperature Over - S: 200.0°C - L: +/- 0.5°C	Run Count: 1
December 13, 2023 10:35:13 AM	Start	Execution	Log Arri - 5877A SQ - Source: None (E) - Extractor	None
December 13, 2023 10:36:47 AM	End	Execution	Log Arri - 5877A SQ - Source: None (E) - Extractor	Run Count: 1
December 13, 2023 10:36:47 AM	Start	Execution	RPTA - 5877A SQ - Source: (E) None - Extractor	None
December 13, 2023 11:04:44 AM	End	Execution	RPTA - 5877A SQ - Source: (E) Run Count: 1 - Extractor	None
December 13, 2023 11:04:45 AM	Start	Execution	Turn (E) - 5877A SQ - Source: None (E) - Extractor Filament 1 (Qualitative - No stoppoints associated)	None
December 13, 2023 11:30:36 AM	End	Execution	Turn (E) - 5877A SQ - Source: None (E) - Extractor Filament 1 (Qualitative - No stoppoints associated)	Run Count: 1

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System ID: GM-7

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Date: December 13, 2023 3:32:46 PM
System ID: GM-7

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User Name: supasak.kimsongtham
Report Generated by Hostname: ASDK09X452
System ID: GM-7
Print Date: December 13, 2023 3:32:47 PM

GM-7-2023 Transaction log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
December 13, 2023 11:30:28 AM	Start	Extension	Tune EI - 5977A SQ - Source - None EI - Extractor Filament 2 (Qualitative - No reports associated)	
December 13, 2023 11:33:06 AM	Start	Execution	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 1 - L, >= 1200	None
December 13, 2023 11:49:38 AM	Start	Execution	Tune EI - 5977A SQ - Source - None EI - Extractor Filament 2 (Qualitative - No reports associated)	
December 13, 2023 11:49:42 AM	End	Execution	Tune EI - 5977A SQ - Source - None EI - Extractor Filament 2 (Qualitative - No reports associated)	Run Count: 1
December 13, 2023 11:43:43 AM	Start	Execution	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 1 - L, >= 1200	None
December 13, 2023 11:49:48 AM	Auto	AcqClosed	Session	None
December 13, 2023 12:38:39 PM	Auto	AcqPlotted	Session	None
December 13, 2023 12:38:40 PM	Auto	SessionRetarded	Session	None
December 13, 2023 12:38:42 PM	Start	Qualification	Session	IQ
December 13, 2023 12:38:42 PM	Start	Execution	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 1 - L, >= 1200	None

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Date: December 13, 2023 3:32:46 PM
System ID: GM-7

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User Name: supasak.kimsongtham
Report Generated by Hostname: ASDK09X452
System ID: GM-7
Print Date: December 13, 2023 3:32:47 PM

GM-7-2023 Transaction log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
December 13, 2023 12:37:33 PM	Auto	Data	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 1 - L, >= 1200	Data File Path: D:\MassHunter\GCMS\data\IQ0202302N_F1.D
December 13, 2023 12:58:18 PM	End	Execution	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 1 - L, >= 1200	Run Count: 1
December 13, 2023 12:33:51 PM	Auto	TestUnlocked	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 1 - L, >= 1200	Deviation fixed for Run Count: 1
December 13, 2023 12:38:51 PM	Start	Execution	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 1 - L, >= 1200	None
December 13, 2023 12:45:15 PM	Auto	Data	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 1 - L, >= 1200	Data File Path: D:\MassHunter\GCMS\data\IQ0202302N_F1.D
December 13, 2023 12:47:00 PM	End	Execution	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 1 - L, >= 1200	Run Count: 2
December 13, 2023 12:42:05 PM	Start	Execution	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 2 - L, >= 1200	None
December 13, 2023 12:42:47 PM	Auto	Data	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 2 - L, >= 1200	Data File Path: D:\MassHunter\GCMS\data\IQ0202302N_F2.D

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Date: December 13, 2023 3:32:46 PM
System ID: GM-7

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User Name: supasak.kimsongtham
Report Generated by Hostname: ASDK09X452
System ID: GM-7
Print Date: December 13, 2023 3:32:47 PM

GM-7-2023 Transaction log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
December 13, 2023 12:43:54 PM	End	Execution	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 2 - L, >= 1200	Run Count: 1
December 13, 2023 1:54:41 PM	Auto	TestUnlocked	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 1 - L, >= 1200	Deviation fixed for Run Count: 2
December 13, 2023 1:54:41 PM	Start	Execution	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 1 - L, >= 1200	None
December 13, 2023 1:54:50 PM	Auto	Data	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 1 - L, >= 1200	Data File Path: D:\MassHunter\GCMS\data\IQ0202302N_F1.D
December 13, 2023 1:55:22 PM	End	Execution	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 1 - L, >= 1200	Run Count: 3
December 13, 2023 1:56:00 PM	Auto	TestUnlocked	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 1 - L, >= 1200	Deviation fixed for Run Count: 3
December 13, 2023 1:58:50 PM	Start	Execution	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 1 - L, >= 1200	None
December 13, 2023 2:14:32 PM	Auto	Data	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 1 - L, >= 1200	Data File Path: D:\MassHunter\GCMS\data\IQ0202302N_F1.D

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Date: December 13, 2023 3:32:46 PM
System ID: GM-7

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User Name: supasak.kimsongtham
Report Generated by Hostname: ASDK09X452
System ID: GM-7
Print Date: December 13, 2023 3:32:47 PM

GM-7-2023 Transaction log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
December 13, 2023 2:15:03 PM	End	Execution	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 1 - L, >= 1200	Run Count: 4
December 13, 2023 2:26:07 PM	Auto	TestUnlocked	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 2 - L, >= 1200	Deviation fixed for Run Count: 1
December 13, 2023 2:26:07 PM	Start	Execution	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 2 - L, >= 1200	None
December 13, 2023 2:25:30 PM	Auto	Data	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 2 - L, >= 1200	Data File Path: D:\MassHunter\GCMS\data\IQ0202302N_F2.D
December 13, 2023 2:25:41 PM	End	Execution	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 2 - L, >= 1200	Run Count: 2
December 13, 2023 2:26:51 PM	Auto	TestUnlocked	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 2 - L, >= 1200	Deviation fixed for Run Count: 2
December 13, 2023 2:28:01 PM	Start	Execution	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 2 - L, >= 1200	None
December 13, 2023 2:27:01 PM	Auto	Data	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 2 - L, >= 1200	Data File Path: D:\MassHunter\GCMS\data\IQ0202302N_F2.D

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Date: December 13, 2023 3:32:46 PM
System ID: GM-7

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User Name: akusarak.nimsongtham

Report Generated by Hostname: ASB/KW0492

System ID: GM-7

Print Date: December 13, 2023 3:32:47 PM

GM-7-2023 Transaction log

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
December 13, 2023 2:27:42 PM	End	Execution	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 2 - L, <= 1200	Run Count: 3
December 13, 2023 2:29:14 PM	Abort	Test/Checked	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 2 - L, <= 1200	Deviation Alert for Run Count: 3
December 13, 2023 2:29:14 PM	Start	Execution	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 2 - L, <= 1200	None
December 13, 2023 2:34:00 PM	Start	Execution	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 2 - L, <= 1200	None
December 13, 2023 2:41:26 PM	Start	Execution	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 2 - L, <= 1200	None
December 13, 2023 2:42:42 PM	Abort	Data	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 2 - L, <= 1200	Data File Path: D:\MassHunter\GCMS1\data\0002034024\F1_001.D
December 13, 2023 2:44:32 PM	End	Execution	Signal to Noise EI - Liquid Injection, Front SSL, SQ - Source: EI - Extractor using Filament 2 - L, <= 1200	Run Count: 4
December 13, 2023 2:44:56 PM	End	Qualification	Session	OQ
December 13, 2023 2:48:56 PM	Start	Reporting	Session	None

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Date: December 13, 2023 3:32:46 PM
System ID: GM-7

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BKK_EN0041

User Name: akusarak.nimsongtham

Report Generated by Hostname: ASB/KW0492

System ID: GM-7

Print Date: December 13, 2023 3:32:47 PM

GM-7-2023 Transaction log

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
December 13, 2023 3:01:22 PM	Abort	Acq/Check	Session	None
December 13, 2023 3:29:10 PM	Abort	Acq/Restarted	Session	None
December 13, 2023 3:29:10 PM	Abort	Session/Offloaded	Session	None
December 13, 2023 3:29:13 PM	Start	Qualification	Session	OQ
December 13, 2023 3:31:03 PM	Abort	Recording	Session	Report Generated: Certificate
December 13, 2023 3:32:15 PM	Abort	Recording	Session	Report Generated: Report

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Date: December 13, 2023 3:32:46 PM
System ID: GM-7

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Certificate of System Qualification

GC-00 + GCMS-OQ

System ID: GM-6
Organization Name: ALS Laboratory Group (Thailand) Co., Ltd.
Organization Location: 104 Phatthanakan Rd., Phatthanakan Rd., Suan Luang, Bangkok 10250Date: June 26, 2023 5:00:36 PM
EQP Name: AgilentRecommended, AgilentRecommended
EQP Revision: GC 02.53, GCMS 02.54
Overall Qualification Status: PassCDS Logon Verification - GC:
Logon: Nanhawadee.SombornOverall CDS Logon Verification - GC Test Status
Pass

System Inspection and Basic Safety and Operation

Name: 7890
Setpoint Status: PassOverall System Inspection and Basic Safety and Operation Test Status
Pass

Inlet Pressure Accuracy

Name: 7890
Front SSL
Setpoint Status: Pass
Setpoint: 25.0 psi
Actual: 25.1 psi
Inlet Pressure: 25.0 psi
Accuracy: 0.1 psi
Agilent Recommended: <= 1.2

REVIEW BY	Nant Somborn
APPROVED BY	AL
NEXT CAL DATE	06/19/24

Date: June 26, 2023 5:00:36 PM
System ID: GM-6

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Overall Inlet Pressure Accuracy Test Status
Pass

Headspace Leak

Name: 7897A with Tray
Sampler 1

Setpoint Status: Pass

Overall Headspace Leak Test Status
Pass

Headspace Heated Zones Temperature Accuracy

Name: 7897A with Tray
Sampler 1Setpoint Status: Pass
Zone: TransferlineTemperature:
Setpoint: 115.0 °C
Actual: 115.6Accuracy:
Agilent Recommended: >= -1.8 % setpoint, <= 5.2 % setpoint
(-2.1 °C, 6.0 °C)Setpoint Status: Pass
Zone: Sample LoopTemperature:
Setpoint: 110.0 °C
Actual: 110.4Accuracy:
Agilent Recommended: >= -0.4 % setpoint, <= 4.0 % setpointDate: June 26, 2023 5:00:36 PM
System ID: GM-6

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Setpoint Status: **Pass**
Zone: **Oven**
Temperature:
Setpoint 100.0 °C
Actual 100.6 °C
Accuracy: 0.6 °C
Agilent Recommended: >= -4.0 °C
<= 4.0 °C

Overall Headspace Heated Zones Temperature Accuracy Test

Pass

GC Oven Temperature Accuracy

Name: 7890
Setpoint Status: **Pass**
Zone: **Oven**
Setpoint/Actual
Temperature: 230.0 231.1 °C
Accuracy: 1.1 °C
Agilent Recommended: >= -1.0 °C % setpoint in K (-5.0 °C)
<= 1.0 °C % setpoint in K (5.0 °C)
Setpoint Status: **Pass**
Zone: **Oven**
Setpoint/Actual
Temperature: 100.0 100.2 °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)

Overall GC Oven Temperature Accuracy Test Status

Pass

GC Oven Temperature Stability

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Setpoint Status: **Pass**
Setpoint/Average
Temperature: 100.0 100.1667 °C
Stability: 0.1 °C
Agilent Recommended: <= 0.5 °C

Overall GC Oven Temperature Stability Test Status

Pass

Log Amp

Tested Combination1 Front SSL / External SQ
Name: 5975C Inert XL with TAD
Setpoint Status: **Pass**

Overall Log Amp Test Status

Pass

RPPA

Tested Combination1 Front SSL / External SQ
Name: 5975C Inert XL with TAD
Setpoint Status: **Pass**
Amu: 1050 m/z Drift After Five Minutes: RPPA Voltage: 542 mV
Agilent Recommended: >= -100 mV and <= 100 mV <= 1100 mV

Overall RPPA Test Status

Pass

Tune EI

Tested Combination1 Front SSL / External SQ
Name: 5975C Inert XL with TAD
Setpoint Status: **Pass**
Filament: 1

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Setpoint Status: **Pass**
Filament: 2
Overall Tune EI Test Status
Pass

Scouting Run

Tested Combination1 Front SSL / External SQ
Name: 7697A with Tray
Source: EI - Inert
Setpoint Status: **Completed**
Injection Volume on Column: 1000 µL
Overall Scouting Run Status
Completed

Injection Precision

Tested Combination1 Front SSL / External SQ
Name: 7697A with Tray
Source: EI - Inert
Setpoint Status: **Pass**
Injection Volume on Column: 1000 µL
Area RSD: 1.27 % Retention Time RSD: 0.00 %
Agilent Recommended: <= 5.00 % <= 1.00 %

Overall Injection Precision Test Status

Pass

Mass Ratio Precision

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Tested Combination1 Front SSL / External SQ
Name: 7697A with Tray
Source: EI - Inert
Setpoint Status: **Pass**
Injection Volume on Column: 1000 µL
Area Mass 1
Abundance's
RSD: 1.27 %
Agilent Recommended: <= 5.00 %
Mass Ratio
0.28 %
Agilent Recommended: <= 5.00 %
Pass

Overall Mass Ratio Precision Test Status

Pass

Injection Carry Over

Tested Combination1 Front SSL / External SQ
Name: 7697A with Tray
Source: EI - Inert
Setpoint Status: **Pass**
Injection Volume on Column: 1000 µL
Area Carry Over: 0.00 %
Agilent Recommended: <= 1.00 %

Overall Injection Carry Over Test Status

Pass

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Instrument Details

Purpose

This section describes the as found system configuration.

Details

System

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

Tested Combination1

Injection Technique	Headspace
Inlet	Front
Detector	External
LTM Included?	No

Sampler 1

Manufacturer	Agilent Technologies
Type	Headspace
Name	7597A with Tray
Model Number	G4567A
Serial Number	CN13020009
Firmware Revision	A.01.05.1
Sampling System	Loop fill
Location	Front
Injection Volume (µL)	1000
Headspace to GC Connection	EPC Headspace

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Mainframe 1

Manufacturer	Agilent Technologies
Name	7890
Model Number	G3440A
Serial Number	CN12511156
Firmware Revision	A.01.14
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	5975C Inert XL with TAD
Model Number	G3172A
Serial Number	U513023A30
Firmware Revision	5.02.09
High Vacuum System	Turbo Pump
Scouting Run Standard	MRP Std

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MS EI Source 1

Manufacturer	Agilent Technologies
Source Type	EI - Inert
Number of Elements	2

Electronic Signature

Purpose

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Details

Full Name of Signer	Sulphi Mama
Logged On User Name:	sulphi.mama@agilent.com
Signature Creation Date:	June 26, 2023
Reason for Signature:	Executed protocol and published this original version of document

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Date: June 26, 2023 5:00:36 PM
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User Name: sukhil.manna
Hostname: ASBKKW7004

System ID: GM-6
Print Date: June 26, 2023 5:00:37 PM

606258789_ALS_OG_GMS Transaction Log

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
June 26, 2023 9:12:05 AM	Audit	Session Created	Session	None
June 26, 2023 9:12:05 AM	Start	Configuration	Session	None
June 26, 2023 9:12:05 AM	Audit	End (Session)	Licensing	User is Field Engineer and does not require an unlock code
June 26, 2023 9:16:38 AM	Audit	End (Session)	Session	EOP details for primary technique (GC) - File path: (Process\FactorGC\Config\unit02.55(GC.02.53).exp), EOP File Name: (GC.02.53.exp), EOP Name: (AgilentRecommended), Protocol Revision: (GC.02.53) EOP details for hyphenated technique (GCMS) - File path: (Process\FactorGCMS\Config\unit02.54(GCMS.02.54).exp), EOP File Name: (GCMS.02.54.exp), EOP Name: (AgilentRecommended)
June 26, 2023 9:39:19 AM	End	Configuration	Session	None
June 26, 2023 9:39:21 AM	Start	Qualification	Session	OG
June 26, 2023 9:39:21 AM	Start	Execution	CDG Logon Verification - GC - 7890 - Qualitative test	None
June 26, 2023 9:41:50 AM	End	Execution	CDG Logon Verification - GC - 7890 - Qualitative test	Run Count: 1
June 26, 2023 9:41:57 AM	Start	Execution	System Inspection and Basic Safety and Operation - 7890 - Qualitative Test - No setpoints associated	None

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User Name: sukhil.manna
Hostname: ASBKKW7004

System ID: GM-6
Print Date: June 26, 2023 5:00:37 PM

606258789_ALS_OG_GMS Transaction Log

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
June 26, 2023 9:42:21 AM	End	Execution	System Inspection and Basic Safety and Operation - 7890 - Qualitative Test - No setpoints associated	Run Count: 1
June 26, 2023 9:43:34 AM	Start	Execution	Initial Pressure Accuracy - Front SSL - Pressure Controlled Inlet - S: 25.0 psi - L: <= 1.2 psi	None
June 26, 2023 9:43:27 AM	End	Execution	Initial Pressure Accuracy - Front SSL - Pressure Controlled Inlet - S: 25.0 psi - L: <= 1.2 psi	Run Count: 1
June 26, 2023 9:43:37 AM	Start	Execution	Headspace Load - 7897A with Tray (Sample 1) - Qualitative Test - No setpoints associated	None
June 26, 2023 10:18:49 AM	End	Execution	Headspace Load - 7897A with Tray (Sample 1) - Qualitative Test - No setpoints associated	Run Count: 1
June 26, 2023 10:19:02 AM	Start	Execution	Headspace Heated Zones - Temperature Accuracy - 7897A with Tray (Sample 1) - Zone - Transference - S: 115.0°C - L: >= -1.8% setpoint and <= 5.2% setpoint	None
June 26, 2023 10:20:42 AM	Audit	Data	Headspace Heated Zones - Temperature Accuracy - 7897A with Tray (Sample 1) - Zone - Transference - S: 115.0°C - L: >= -1.8% setpoint and <= 5.2% setpoint	Manual Data Entry
June 26, 2023 10:25:48 AM	End	Execution	Headspace Heated Zones - Temperature Accuracy - 7897A with Tray (Sample 1) - Zone - Transference - S: 115.0°C - L: >= -1.8% setpoint and <= 5.2% setpoint	Run Count: 1

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Date: June 26, 2023 5:00:36 PM
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User Name: sukhil.manna
Hostname: ASBKKW7004

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606258789_ALS_OG_GMS Transaction Log

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
June 26, 2023 10:20:48 AM	Start	Execution	Headspace Heated Zones - Temperature Accuracy - 7897A with Tray (Sample 1) - Zone - Sample Loop - S: 110.0°C - L: >= -4.0°C and <= 4.0°C	None
June 26, 2023 10:25:37 AM	Audit	Data	Headspace Heated Zones - Temperature Accuracy - 7897A with Tray (Sample 1) - Zone - Sample Loop - S: 110.0°C - L: >= -4.0°C and <= 4.0°C	Manual Data Entry
June 26, 2023 10:25:59 AM	End	Execution	Headspace Heated Zones - Temperature Accuracy - 7897A with Tray (Sample 1) - Zone - Sample Loop - S: 110.0°C - L: >= -4.0°C and <= 4.0°C	Run Count: 1
June 26, 2023 10:25:41 AM	Start	Execution	Headspace Heated Zones - Temperature Accuracy - 7897A with Tray (Sample 1) - Zone - Oven - S: 100.0°C - L: >= -4.0°C and <= 4.0°C	None
June 26, 2023 10:32:03 AM	Audit	Data	Headspace Heated Zones - Temperature Accuracy - 7897A with Tray (Sample 1) - Zone - Oven - S: 100.0°C - L: >= -4.0°C and <= 4.0°C	Manual Data Entry
June 26, 2023 10:32:25 AM	End	Execution	Headspace Heated Zones - Temperature Accuracy - 7897A with Tray (Sample 1) - Zone - Oven - S: 100.0°C - L: >= -4.0°C and <= 4.0°C	Run Count: 1
June 26, 2023 10:33:08 AM	Start	Execution	GC Oven Temperature Accuracy - 7890 - Temperature - Oven - S: 220.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	None

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User Name: sukhil.manna
Hostname: ASBKKW7004

System ID: GM-6
Print Date: June 26, 2023 5:00:37 PM

606258789_ALS_OG_GMS Transaction Log

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
June 26, 2023 10:37:21 AM	Audit	Data	GC Oven Temperature Accuracy - 7890 - Temperature - Oven - S: 220.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	Manual Data Entry
June 26, 2023 10:37:27 AM	End	Execution	GC Oven Temperature Accuracy - 7890 - Temperature - Oven - S: 220.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	Run Count: 1
June 26, 2023 10:37:29 AM	Start	Execution	GC Oven Temperature Accuracy - 7890 - Temperature - Oven - S: 100.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	None
June 26, 2023 10:42:29 AM	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
June 26, 2023 10:42:31 AM	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
June 26, 2023 10:42:37 AM	Start	Execution	GC Oven Temperature Stability - 7890 - Temperature - Oven - S: 100.0°C - L: >= -0.0°C	None
June 26, 2023 10:44:30 AM	Start	Execution	Seeding Run - 7897A with Tray - Headspace, Front SSL, PG - Source - All - Inlet - Part of GCMS System Regulation	None
June 26, 2023 10:55:53 AM	Start	Execution	GC Oven Temperature Stability - 7890 - Temperature - Oven - S: 100.0°C - L: <= 0.0°C	None
June 26, 2023 11:18:30 AM	Audit	Data	GC Oven Temperature Stability - 7890 - Temperature - Oven - S: 100.0°C - L: <= 0.0°C	Manual Data Entry

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Date: June 26, 2023 5:00:36 PM
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User Name: autk@luma
Hostname: ASBKKW7024
System ID: GM-6
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604254795_AIS_OQ_006 Transaction log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
June 26, 2023 4:36:30 PM	Auto	Data	Mass Ratio Precision - 7897A with Tray Headspace, Front SSL, SQ - Source: EI - Inlet - L MS (RSD) <= 5.00%	Data File Path: D:\OQ\2023\HSIP03.D\DATA
June 26, 2023 4:36:31 PM	Auto	Data	Mass Ratio Precision - 7897A with Tray Headspace, Front SSL, SQ - Source: EI - Inlet - L MS (RSD) <= 5.00%	Data File Path: D:\OQ\2023\HSIP03.D\DATA
June 26, 2023 4:36:31 PM	Auto	Data	Mass Ratio Precision - 7897A with Tray Headspace, Front SSL, SQ - Source: EI - Inlet - L MS (RSD) <= 5.00%	Data File Path: D:\OQ\2023\HSIP04.D\DATA
June 26, 2023 4:36:31 PM	Auto	Data	Mass Ratio Precision - 7897A with Tray Headspace, Front SSL, SQ - Source: EI - Inlet - L MS (RSD) <= 5.00%	Data File Path: D:\OQ\2023\HSIP05.D\DATA
June 26, 2023 4:36:33 PM	Auto	Data	Mass Ratio Precision - 7897A with Tray Headspace, Front SSL, SQ - Source: EI - Inlet - L MS (RSD) <= 5.00%	Data File Path: D:\OQ\2023\HSIP06.D\DATA
June 26, 2023 4:36:33 PM	Auto	Data	Mass Ratio Precision - 7897A with Tray Headspace, Front SSL, SQ - Source: EI - Inlet - L MS (RSD) <= 5.00%	Data File Path: D:\OQ\2023\HSIP07.D\DATA
June 26, 2023 4:37:26 PM	End	Execution	Mass Ratio Precision - 7897A with Tray Headspace, Front SSL, SQ - Source: EI - Inlet - L MS (RSD) <= 5.00%	Run Count: 1
June 26, 2023 4:57:52 PM	Start	Execution	Injection Carry Over - 7897A with Tray Headspace, Front SSL, SQ - Headspace Sampler - EI - Inlet - L <= 1.00%	None

User Name: autk@luma
Hostname: ASBKKW7024
System ID: GM-6
Print Date: June 26, 2023 5:00:37 PM

604254795_AIS_OQ_006 Transaction log:

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
June 26, 2023 4:57:53 PM	Auto	Data	Injection Carry Over - 7897A with Tray Headspace, Front SSL, SQ - Headspace Sampler - EI - Inlet - L <= 1.00%	Data File Path: D:\OQ\2023\HSIP07.D\DATA
June 26, 2023 4:57:53 PM	Auto	Data	Injection Carry Over - 7897A with Tray Headspace, Front SSL, SQ - Headspace Sampler - EI - Inlet - L <= 1.00%	Data File Path: D:\OQ\2023\HSIP08.D\DATA
June 26, 2023 4:58:51 PM	End	Execution	Injection Carry Over - 7897A with Tray Headspace, Front SSL, SQ - Headspace Sampler - EI - Inlet - L <= 1.00%	Run Count: 1
June 26, 2023 4:58:58 PM	End	Qualification	Session	OQ
June 26, 2023 4:58:58 PM	Start	Reporting	Session	None
June 26, 2023 4:59:50 PM	Auto	Reporting	Session	Report Generated / Certificate