

ภาคผนวก จ

เอกสารรับรองการสอบเทียบเครื่องมือ



รายการเครื่องมือที่ใช้ในการวิเคราะห์ / ทดสอบ

Sample Name	Parameter	Equipment Name	ID No.	Calibrated Date	Next Cal	Freq. Calibrate (Months)
Ambient	Total Suspended Particulate	High Volume	RYG_FS0177	-	-	On site Calibration
Ambient	Total Suspended Particulate	High Volume	RYG_FS0396	-	-	On site Calibration
Ambient	Total Suspended Particulate	High Volume	RYG_FS0182	-	-	On site Calibration
Ambient	Total Suspended Particulate	Digital Balance	RYG_EN0001	23-Mar-22	23-Mar-23	12
Ambient	Nitrogen Dioxide	NO ₂ Analyzer	BKK_FS1064	4-Jan-22	4-Jul-22	6
Ambient	Nitrogen Dioxide	NO ₂ Analyzer	RYG_FS0461	4-Jan-22	4-Jul-22	6
Ambient	Nitrogen Dioxide	NO ₂ Analyzer	RYG_FS0457	4-Jan-22	4-Jul-22	6
Ambient	Sulfur Dioxide	SO ₂ Analyzer	RYG_FS0263	4-Jan-22	4-Jul-22	6
Ambient	Sulfur Dioxide	SO ₂ Analyzer	RYG_FS0460	4-Jan-22	4-Jul-22	6
Ambient	Sulfur Dioxide	SO ₂ Analyzer	RYG_FS0456	4-Jan-22	4-Jul-22	6
Ambient	Total Hydrocarbon	Total Hydrocarbon Analyzer	RYG_EN0038	8-Jul-21	8-Jul-22	12
Ambient	Benzene	GC-MSD	RYG_EN0136	2-Feb-21	2-Aug-22	18
Ambient	1,3 Butadiene	GC-MSD	RYG_EN0136	2-Feb-21	2-Aug-22	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0413	29-Jul-21	27-Jan-23	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0414	29-Jul-21	27-Jan-23	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	BKK_FS0141	7-Jun-21	6-Dec-22	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0414	29-Jul-21	27-Jan-23	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0530	14-Jul-21	12-Jan-23	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0085	8-Oct-21	8-Apr-23	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0085	8-Oct-21	8-Apr-23	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0328	31-Jan-22	29-Jul-23	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0413	29-Jul-21	27-Jan-23	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0414	29-Jul-21	27-Jan-23	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0329	31-Jan-22	29-Jul-23	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0089	13-Jul-21	11-Jan-23	18
Ambient	Wind Speed / Wind Direction	Wind Speed / Wind Direction	RYG_FS0087	13-Jul-21	11-Jan-23	18
Stack (CEMs)	Oxides of Nitrogen	Analyzer , System calibration, Stand	-	-	-	-
Stack (CEMs)	Sulfur Dioxide	Analyzer , System calibration, Stand	-	-	-	-
Stack (CEMs)	Oxygen	Analyzer , System calibration, Stand	-	-	-	-
Stack (CEMs)	Flow Rate	Analyzer , System calibration, Stand	-	-	-	-
Stack	Total Suspended Particulate	Console Control Unit	BKK_FS0518	12-Jan-22	12-Jul-22	6
Stack	Total Suspended Particulate	Digital Balance	RYG_EN0003	23-Mar-22	23-Mar-23	12
Noise	Leq 12 hrs	Sound Calibrator	RYG_FS0215	9-Aug-21	9-Aug-22	12
Noise	Leq 12 hrs	Sound Level Meter	RYG_FS0301	13-Sep-21	13-Sep-22	12
Noise	Leq 12 hrs	Sound Level Meter	RYG_FS0302	2-Jun-21	2-Jun-22	12
Noise	Leq 12 hrs	Sound Level Meter	RYG_FS0303	2-Jun-21	2-Jun-22	12
Noise	Leq 24 hrs	Sound Calibrator	RYG_FS0215	9-Aug-21	9-Aug-22	12
Noise	Leq 24 hrs	Sound Level Meter	RYG_FS0020	10-Jan-22	10-Jan-23	12
Noise	Leq 24 hrs	Sound Level Meter	RYG_FS0022	21-Jan-22	21-Jan-23	12
Noise	Leq 24 hrs	Sound Level Meter	RYG_FS0023	10-Jan-22	10-Jan-23	12
Noise	Noise Dose, TWA	Dose Badge Reader	RYG_FS0211	7-Jul-21	7-Jul-22	12
Noise	Noise Dose, TWA	Dose Badge Reader	RYG_FS0212	1-Dec-21	1-Dec-22	12
Noise	Noise Dose, TWA	Dose Badge Reader	RYG_FS0212	1-Dec-21	1-Dec-22	12
Noise	Noise Dose, TWA	Dose Badge Reader	RYG_FS0440	7-Sep-21	7-Sep-22	12
Workplace	1,3-Butadiene	Field Rotameter	BKK_FS1006	4-Jan-22	4-Apr-22	3
Workplace	1,3-Butadiene	Field Rotameter	BKK_FS1044	1-Apr-22	1-Jul-22	3
Workplace	1,3-Butadiene	GC-MSD	BKK_EN0119	1-Oct-21	1-Apr-23	18
Workplace	Benzene	Field Rotameter	BKK_FS1006	4-Jan-22	4-Apr-22	3
Workplace	Benzene	Field Rotameter	BKK_FS1044	1-Apr-22	1-Jul-22	3
Workplace	Benzene	GC-MSD	BKK_EN0119	1-Oct-21	1-Apr-23	18
Workplace	Ethyl Benzene	Field Rotameter	BKK_FS1006	4-Jan-22	4-Apr-22	3
Workplace	Ethyl Benzene	Field Rotameter	BKK_FS1044	1-Apr-22	1-Jul-22	3
Workplace	Ethyl Benzene	GC-MSD	BKK_EN0119	1-Oct-21	1-Apr-23	18
Workplace	Dimethyl Disulfide	Field Rotameter	BKK_FS1006	4-Jan-22	4-Apr-22	3
Workplace	Dimethyl Disulfide	Field Rotameter	BKK_FS1044	1-Apr-22	1-Jul-22	3
Workplace	Hydrogen Sulfide	Field Rotameter	BKK_FS1040	4-Jan-22	4-Apr-22	3
Workplace	Hydrogen Sulfide	Field Rotameter	BKK_FS1044	1-Apr-22	1-Jul-22	3
Workplace	Hydrogen Sulfide	SPECTROPHOTOMETER	RYG_EN0037	1-Apr-21	1-Oct-22	18
Workplace	Toluene	Field Rotameter	BKK_FS1006	4-Jan-22	4-Apr-22	3
Workplace	Toluene	Field Rotameter	BKK_FS1044	1-Apr-22	1-Jul-22	3
Workplace	Toluene	GC-MSD	BKK_EN0119	1-Oct-21	1-Apr-23	18
Illuminance	Illuminance	Lux Meter	RYG_FS0200	22-Sep-21	22-Sep-22	12



รายการเครื่องมือที่ใช้ในการวิเคราะห์ / ทดสอบ

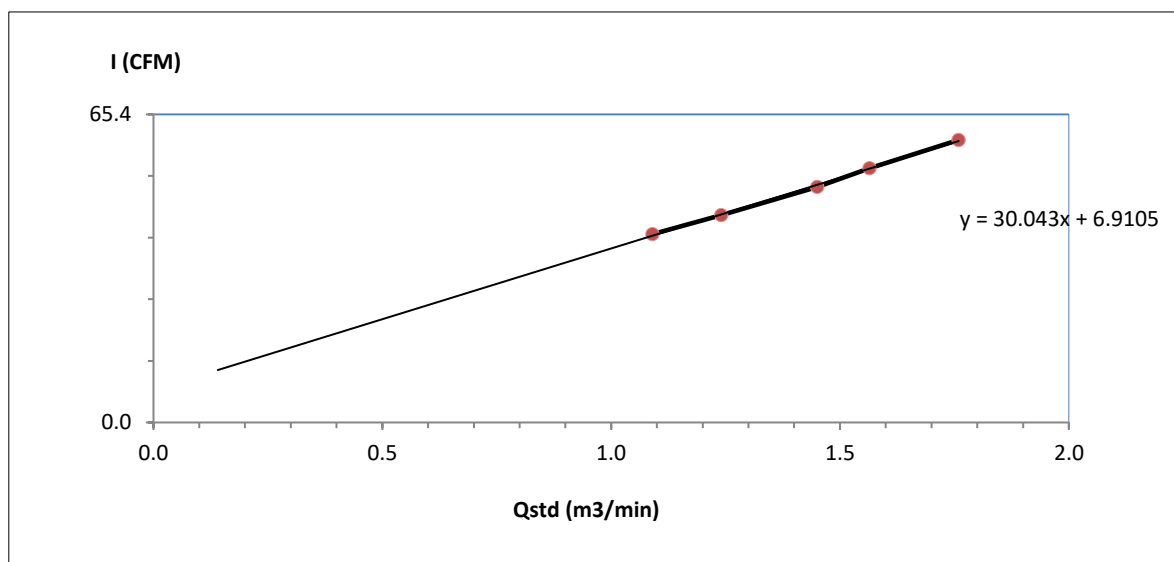
Sample Name	Parameter	Equipment Name	ID No.	Calibrated Date	Next Cal	Freq. Calibrate (Months)
Rayong Lab	pH at 25 °C	pH meter	RYG_EN0183	17-Mar-22	17-Mar-23	12
Rayong Lab	BOD (5 days at 20°C)	DO meter with Sensor	RYG_EN0140	2-Feb-21	3-Aug-22	18
Rayong Lab	BOD (5 days at 20°C)	Incubator	RYG_EN0154	22-Apr-22	21-Oct-23	18
Rayong Lab	COD	SPECTROPHOTOMETER	RYG_EN0037	1-Apr-21	1-Oct-22	18
Rayong Lab	Total Suspended Solids	Electronic Balance	RYG_EN0002	23-Mar-22	23-Mar-23	12
Rayong Lab	Total Suspended Solids	Chamber Oven	RYG_EN0010	5-May-21	3-Nov-22	18
Rayong Lab	Total Dissolved Solids 180°C	Electronic Balance	RYG_EN0002	23-Mar-22	23-Mar-23	12
Rayong Lab	Total Dissolved Solids 180°C	Chamber Oven	RYG_EN0010	5-May-21	3-Nov-22	18
Rayong Lab	Oil & Grease	Electronic Balance	RYG_EN0002	23-Mar-22	23-Mar-23	12
Rayong Lab	Oil & Grease	Chamber Oven	RYG_EN0006	5-May-21	3-Nov-22	18
Rayong Lab	Oil & Grease	Water Bath	RYG_EN0061	5-May-21	3-Nov-22	18
Rayong Lab	Temperature	Digital Thermometer	RYG_FS0467	7-Jul-21	7-Jul-22	18
Rayong Lab	Dissolved Oxygen	Chamber (Cold Room)	RYG_EN0184	22-Feb-22	22-Feb-23	12
Rayong Lab	Conductivity	Conductivity meter	RYG_EN0029	23-Feb-22	24-Aug-23	12
Rayong Lab	Sulfide	Chamber (Cold Room)	RYG_EN0184	22-Feb-22	22-Feb-23	12
Rayong Lab	Sulfate	SPECTROPHOTOMETER	RYG_EN0037	1-Apr-21	1-Oct-22	18
Rayong Lab	Turbidity	Chamber (Cold Room)	RYG_EN0184	22-Feb-22	22-Feb-23	12
Rayong Lab	Phenol	SPECTROPHOTOMETER	RYG_EN0037	1-Apr-21	1-Oct-22	18
Water Lab	Benzene	Gas Chromatography (MSD)	BKK_EN0059	24-Dec-20	24-Jun-22	18
Water Lab	Toluene	Gas Chromatography (MSD)	BKK_EN0059	24-Dec-20	24-Jun-22	18
Water Lab	Ethylbenzene	Gas Chromatography (MSD)	BKK_EN0059	24-Dec-20	24-Jun-22	18
Water Lab	Methanol	Gas Chromatography	BKK_EN0041	25-Nov-21	25-May-23	18
Water Lab	TPH C ₅ -C ₈	Gas Chromatography (MSD)	BKK_EN0059	24-Dec-20	24-Jun-22	18
Water Lab	TPH C ₉ -C ₁₆	Gas Chromatography (FID)	BKK_EN0103	20-Oct-21	20-Apr-23	18
Water Lab	TPH C ₁₇ -C ₃₅	Gas Chromatography (FID)	BKK_EN0103	20-Oct-21	20-Apr-23	18





High Volume Air Sampler Calibration Worksheet

Project Site :	Rayong Olefins Co.,Ltd.	Barometric Pressure (mm Hg) :	758
Calibrate Location :	บ้านพลอง	Temperature (°C) :	30
Calibrate Date :	3-May-22	High Volume ID :	RYG_FS0177
CalibrationSheet No.:	C-030522-RYG_FS0177	High Volume Model :	TE-5170D
Calibrator ID:	RYG_FS0205	High Volume S/N :	4803
Calibrator Model :	TE-5028A	Calibrator Slope :	1.53016
Calibrator S/N :	1166	Calibrator Intercept :	-0.0468

Test No.	Delta H ₂ O (inch)	Q _{std} (m ³ /min)	I : Chart (CFM)	Linear Regression
1	2.6	1.0905	40	Slope : 30.0428 Intercept : 6.9105 Correlation Coefficient : 0.9992
2	3.4	1.2403	44	
3	4.7	1.4500	50	
4	5.5	1.5647	54	
5	7.0	1.7593	60	



Calibrated by 
(Mr.Norranon Tathongkham)
Field Scientist(1)

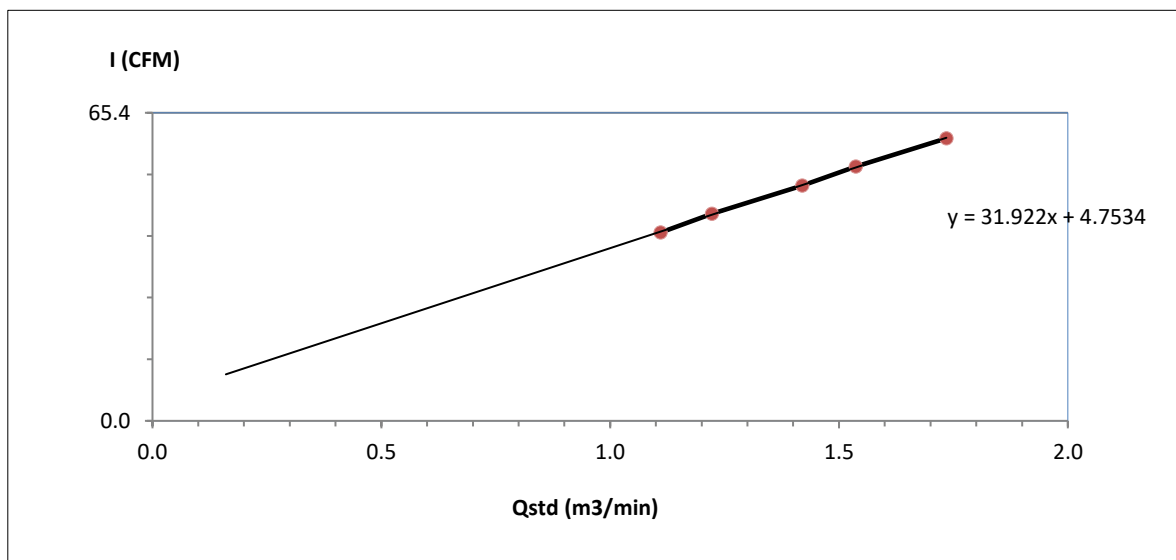
Approved by : 
(Mr. Noppong Juntarupan)
Enviro Field Coordinator Scientist (3)



High Volume Air Sampler Calibration Worksheet

Project Site :	Rayong Olefins Co.,Ltd. โรงเรียนบ้านมาบตาพุด(โสภณราษฎร์ บูรณะ)	Barometric Pressure (mm Hg) :	758
Calibrate Location :		Temperature (°C) :	30
Calibrate Date :	3-May-22	High Volume ID :	RYG_FS0396
CalibrationSheet No.:	C-030522-RYG_FS0396	High Volume Model :	TE-5170D
Calibrator ID:	RYG_FS0205	High Volume S/N :	5688
Calibrator Model :	TE-5028A	Calibrator Slope :	1.53016
Calibrator S/N :	1166	Calibrator Intercept :	-0.0468

Test No.	Delta H ₂ O (inch)	Q _{std} (m ³ /min)	I : Chart (CFM)	Linear Regression
1	2.7	1.1103	40	Slope : 31.9225 Intercept : 4.7534 Correlation Coefficient : 0.9997
2	3.3	1.2226	44	
3	4.5	1.4198	50	
4	5.3	1.5369	54	
5	6.8	1.7346	60	



Calibrated by

(Mr.Norranon Tathongkham)
Field Scientist(1)

Approved by :

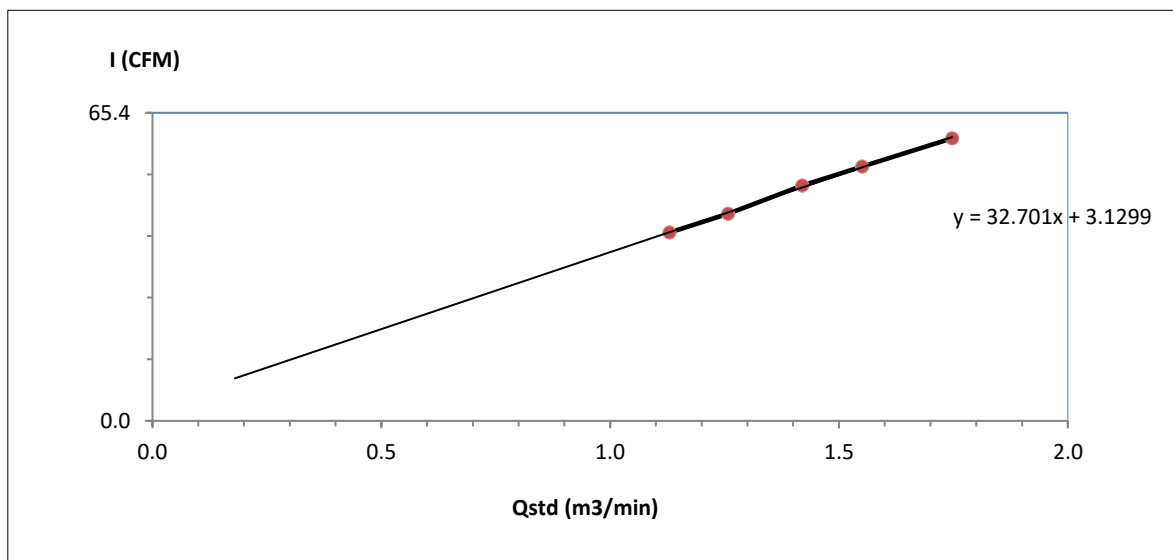
(Mr. Noppong Juntarupan)
Enviro Field Coordinator Scientist (3)



High Volume Air Sampler Calibration Worksheet

Project Site :	Rayong Olefins Co.,Ltd.	Barometric Pressure (mm Hg) :	758
Calibrate Location :	ศูนย์วิจัยและฝึกอบรมทรัพยากรมนุษย์ เพื่ออุตสาหกรรม มหาวิทยาลัย	Temperature (°C) :	30
Calibrate Date :	3-May-22	High Volume ID :	RYG_FS0182
CalibrationSheet No.:	C-030522-RYG_FS0182	High Volume Model :	TE-5170D
Calibrator ID:	RYG_FS0205	High Volume S/N :	5335
Calibrator Model :	TE-5028A	Calibrator Slope :	1.53016
Calibrator S/N :	1166	Calibrator Intercept :	-0.0468

Test No.	Delta H ₂ O (inch)	Q _{std} (m ³ /min)	I : Chart (CFM)	Linear Regression
1	2.8	1.1299	40	Slope : 32.7011 Intercept : 3.1299 Correlation Coefficient : 0.9993
2	3.5	1.2577	44	
3	4.5	1.4198	50	
4	5.4	1.5509	54	
5	6.9	1.7470	60	



Calibrated by

(Mr.Norranon Tathongkham)
Field Scientist(1)

Approved by :

(Mr. Noppong Juntarupan)
Enviro Field Coordinator Scientist (3)



PENTA
CALIBRATION

PENTA CALIBRATION CO., LTD.

66/124 The Connect 33 Village Kanchanaphisek Road
Dokmai Prawet Bangkok 10250
Tel: +66 (0) 2069-9773
www.pentacal.com

Certificate of Calibration

Represent to Certificate of Calibration ,PTC/07/22102

Certificate No.:	PTC/07/22102	Page:	1 of 2
Equipment:	Digital Balance	Condition:	Normal
Manufacturer:	Sartorius	Serial No:	25409664
Model:	LA130S-F	ID No:	RYG_EN0001
Type of Balance:	Single interval		



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



Environment Condition: Temperature 23.9 °C ± 0.3 °C
Humidity 58.1 %RH ± 4.4 %RH
Air density 1.17 kg/m³

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

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

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

Date Received: March 23, 2022

Calibration Date: March 23, 2022

Issued Date: March 25, 2022

Calibration By: Mr. Rungroje Metakul



PENTA CALIBRATION CO.,LTD

[Signature]

(Mr.Kriangsak Kalasri)

Reviewed by

Approved By :

[Signature]

(Mr. Keattisak Kerdto)

Laboratory Manager

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

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

This calibration certificate shall not be reproduced except in full only, without written approval from penta calibration co., ltd



Represent to Certificate of Calibration ,PTC/07/22102

Certificate No.: PTC/07/22102

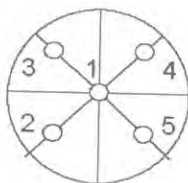
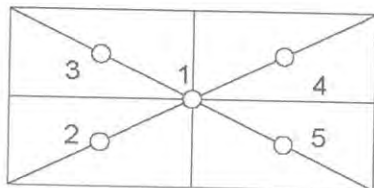
Page: 2 of 2

Measurement Results:

Without Adjustment :

Function Calibration: Non Adjustment

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



Eccentricity test 50 (g)

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

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

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

Nominal test value (g)	Standard Deviation
100	0.00009

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

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

Note: Weight of adjust - (g)

The End of Certificate

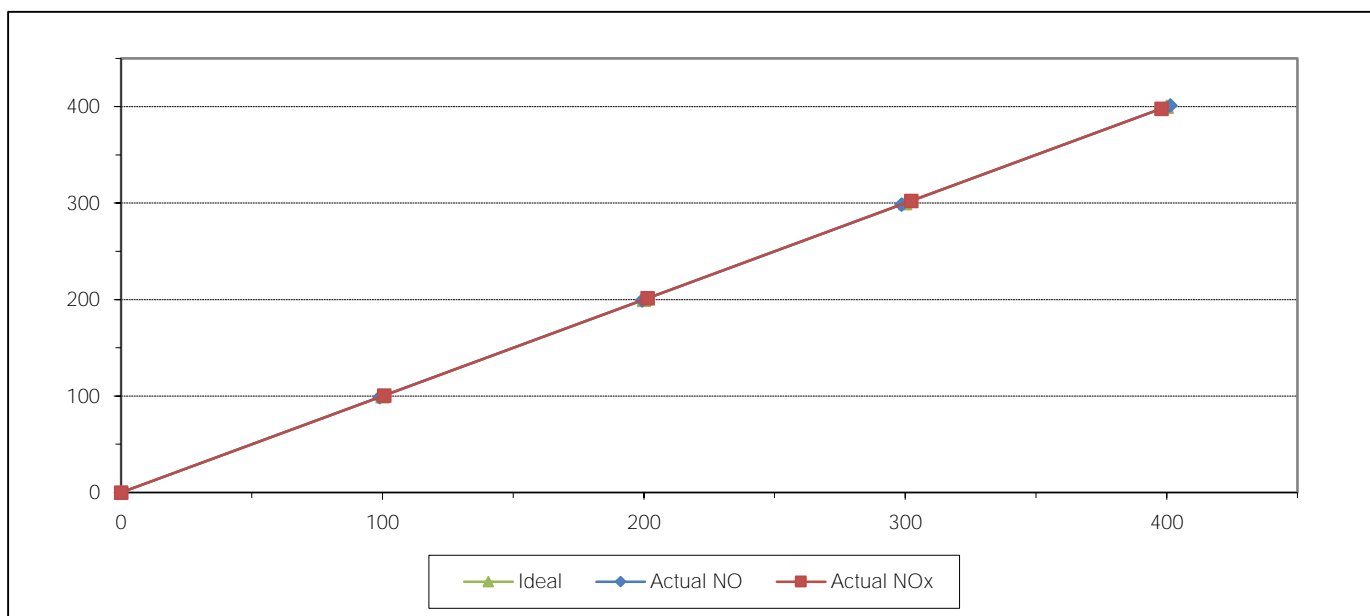


MULTIPOINT CALIBRATION REPORT

Calibration Date 4-Jan-22
Manufacturer HORIBA
Serial No. 148EH0E0
Calibrator Manufacturer Teledyne API
Serial No. 947
Std. Gas Concentration (PPM) 51.33
Cylinder Pressure (psi) 1200
Certified Date 18-Mar-14

Equipment Name NOx Analyzer
Model APNA-370
Equipment ID BKK_FS1064
Model 700
Cylinder No. LL36633
Certified By Airgas Inc.
Expired Date 18-Mar-22

Point	CALIBRATION RESULTS						
	Ideal	Actual NO	Error NO	%Error NO	Actual NOx	Error NOx	%Error NOx
ZERO	0.00	0.10	0.10	0.10	0.10	0.10	0.10
1	100.00	99.00	-1.00	-1.00	100.70	0.70	0.70
2	200.00	199.40	-0.60	-0.30	201.50	1.50	0.75
3	300.00	298.60	-1.40	-0.47	302.30	2.30	0.77
4	400.00	401.40	1.40	0.35	398.00	-2.00	-0.50
AVERAGE (%)				-0.26			0.36



Calibrated By

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

Approved By

(Mr.Sarayuth Jittranont)
Assistant General Manager

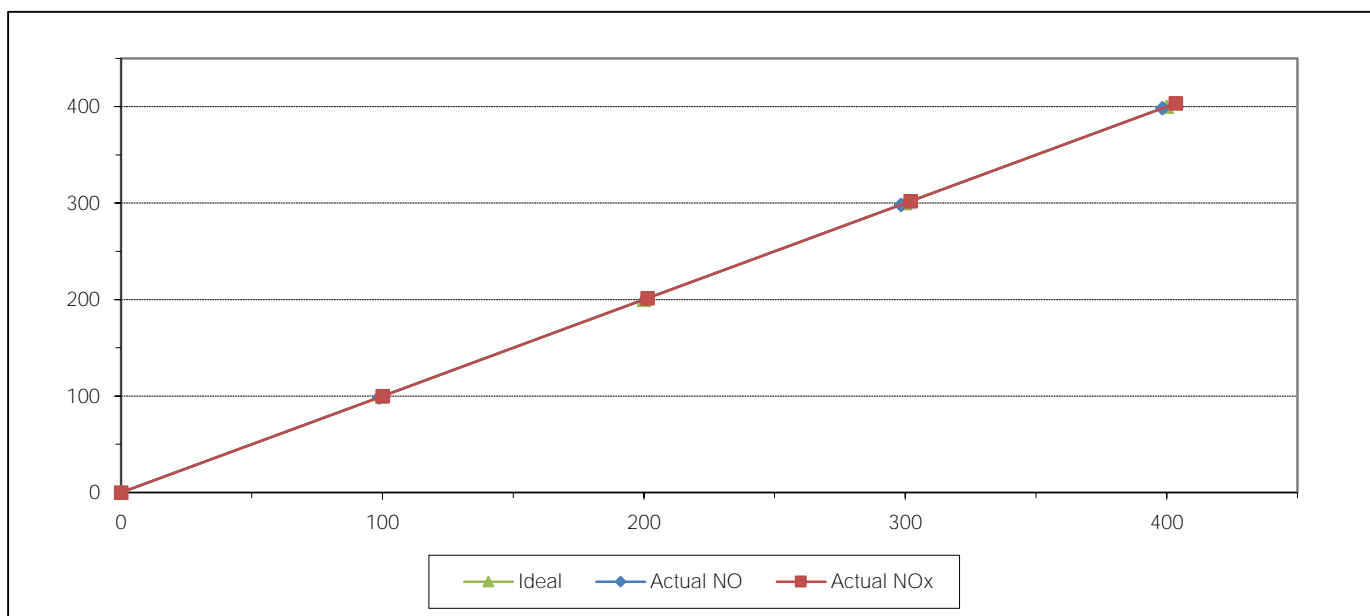


MULTIPOINT CALIBRATION REPORT

Calibration Date 4-Jan-22
Manufacturer HORIBA
Serial No. T95HWM41
Calibrator Manufacturer Teledyne API
Serial No. 947
Std. Gas Concentration (PPM) 51.33
Cylinder Pressure (psi) 1200
Certified Date 18-Mar-14

Equipment Name NOx Analyzer
Model APNA-370
Equipment ID RYG_FS0461
Model 700
Cylinder No. LL36633
Certified By Airgas Inc.
Expired Date 18-Mar-22

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



Calibrated By

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

Approved By

(Mr.Sarayuth Jittranont)
Assistant General Manager

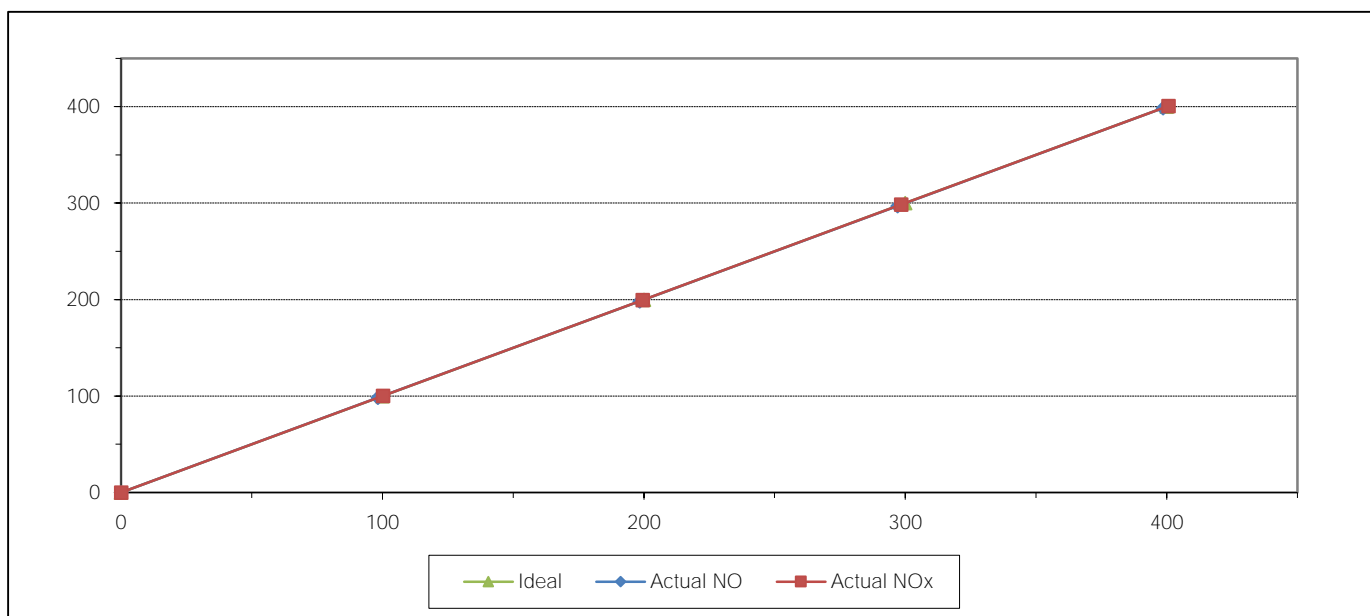


MULTIPOINT CALIBRATION REPORT

Calibration Date 4-Jan-22
Manufacturer HORIBA
Serial No. T2T8YRLL
Calibrator Manufacturer Teledyne API
Serial No. 947
Std. Gas Concentration (PPM) 51.33
Cylinder Pressure (psi) 1200
Certified Date 18-Mar-14

Equipment Name NOx Analyzer
Model APNA-370
Equipment ID RYG_FS0457
Model 700
Cylinder No. LL36633
Certified By Airgas Inc.
Expired Date 18-Mar-22

Point	CALIBRATION RESULTS						
	Ideal	Actual NO	Error NO	%Error NO	Actual NOx	Error NOx	%Error NOx
ZERO	0.00	0.10	0.10	0.10	0.10	0.10	0.10
1	100.00	98.30	-1.70	-1.70	100.20	0.20	0.20
2	200.00	198.40	-1.60	-0.80	199.60	-0.40	-0.20
3	300.00	297.10	-2.90	-0.97	298.50	-1.50	-0.50
4	400.00	398.60	-1.40	-0.35	400.70	0.70	0.17
AVERAGE (%)				-0.74			-0.05



Calibrated By

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

Approved By

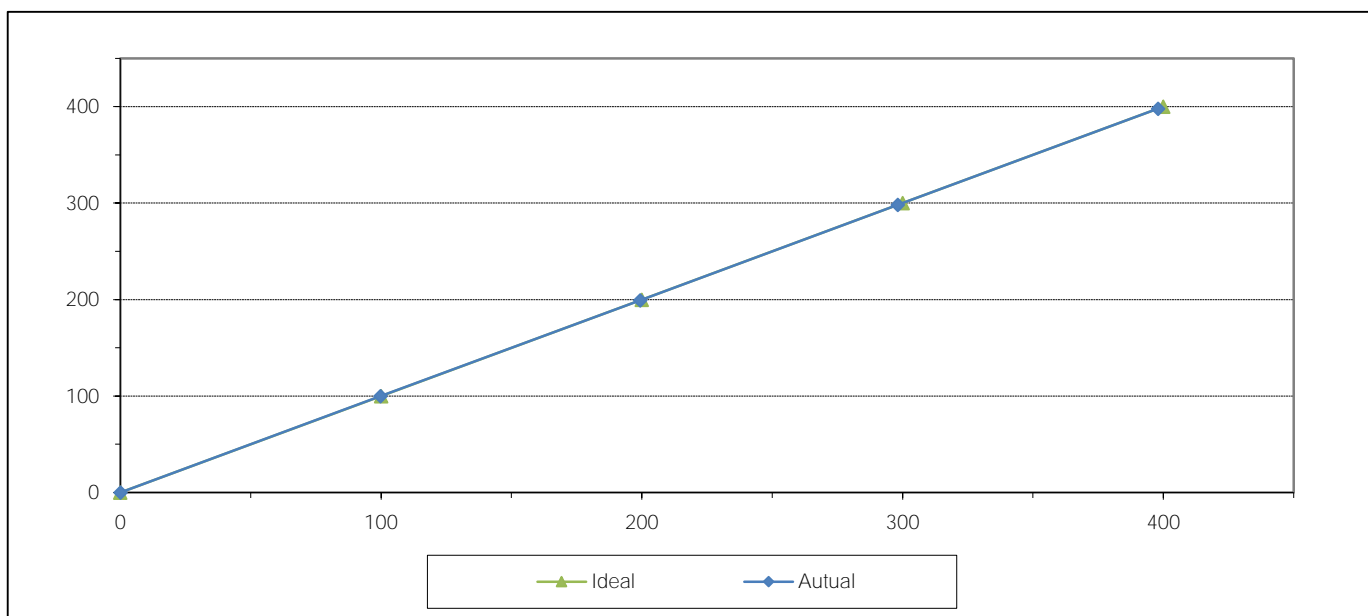
(Mr.Sarayuth Jittranont)
Assistant General Manager



MULTIPOINT CALIBRATION REPORT

Calibration Date	4-Jan-22	Equipment Name	SO2 Analyzer
Manufacturer	HORIBA	Model	APSA-370
Serial No.	YPRXJJ20	Equipment ID	RYG_FS0263
Calibrator Manufacturer	Teledyne API	Model	700
Serial No.	947		
Std. Gas Concentration (PPM)	50.87	Cylinder No.	LL36633
Cylinder Pressure (psi)	1200	Certified By	Airgas Inc.
Certified Date	18-Mar-14	Expired Date	18-Mar-22

Point	CALIBRATION RESULTS			
	Ideal	Autual	Error	%Error
ZERO	0.00	0.10	0.10	0.10
1	100.00	99.80	-0.20	-0.20
2	200.00	199.40	-0.60	-0.30
3	300.00	298.20	-1.80	-0.60
4	400.00	398.00	-2.00	-0.50
AVERAGE (%)				-0.30



Calibrated By

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

Approved By

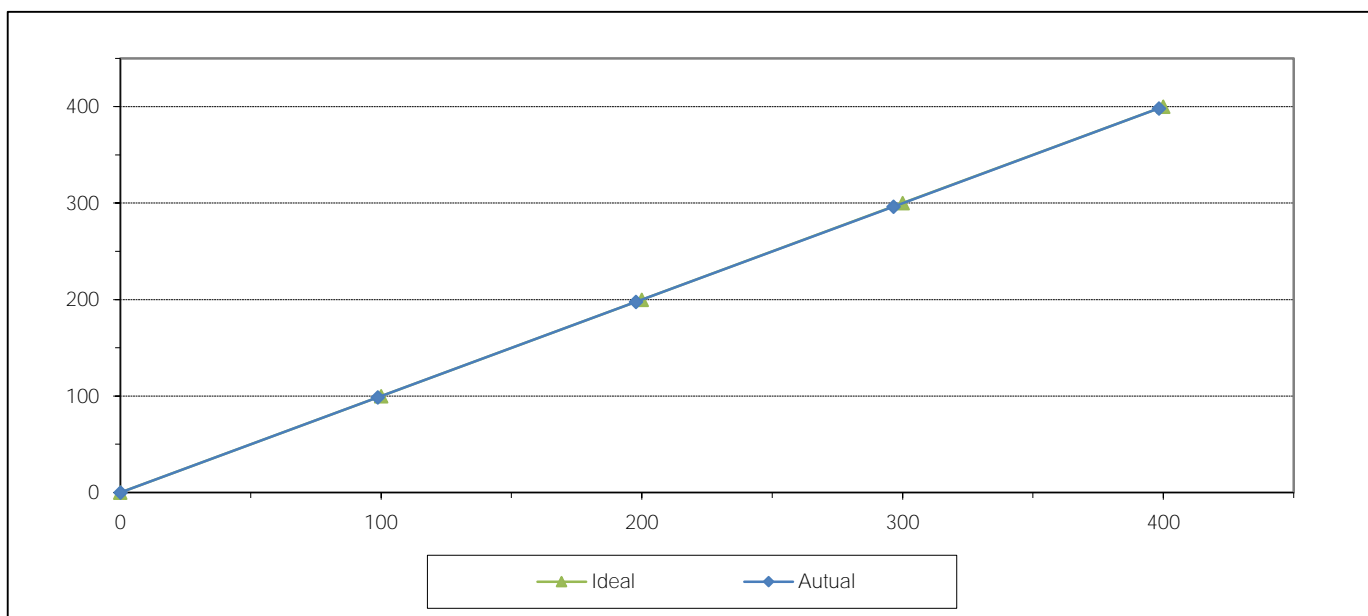
(Mr.Sarayuth Jittranont)
Assistant General Manager



MULTIPOINT CALIBRATION REPORT

Calibration Date	4-Jan-22	Equipment Name	SO2 Analyzer
Manufacturer	HORIBA	Model	APSA-370
Serial No.	VABF9LSH	Equipment ID	RYG_FS0460
Calibrator Manufacturer	Teledyne API	Model	700
Serial No.	947		
Std. Gas Concentration (PPM)	50.87	Cylinder No.	LL36633
Cylinder Pressure (psi)	1200	Certified By	Airgas Inc.
Certified Date	18-Mar-14	Expired Date	18-Mar-22

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



Calibrated By

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

Approved By

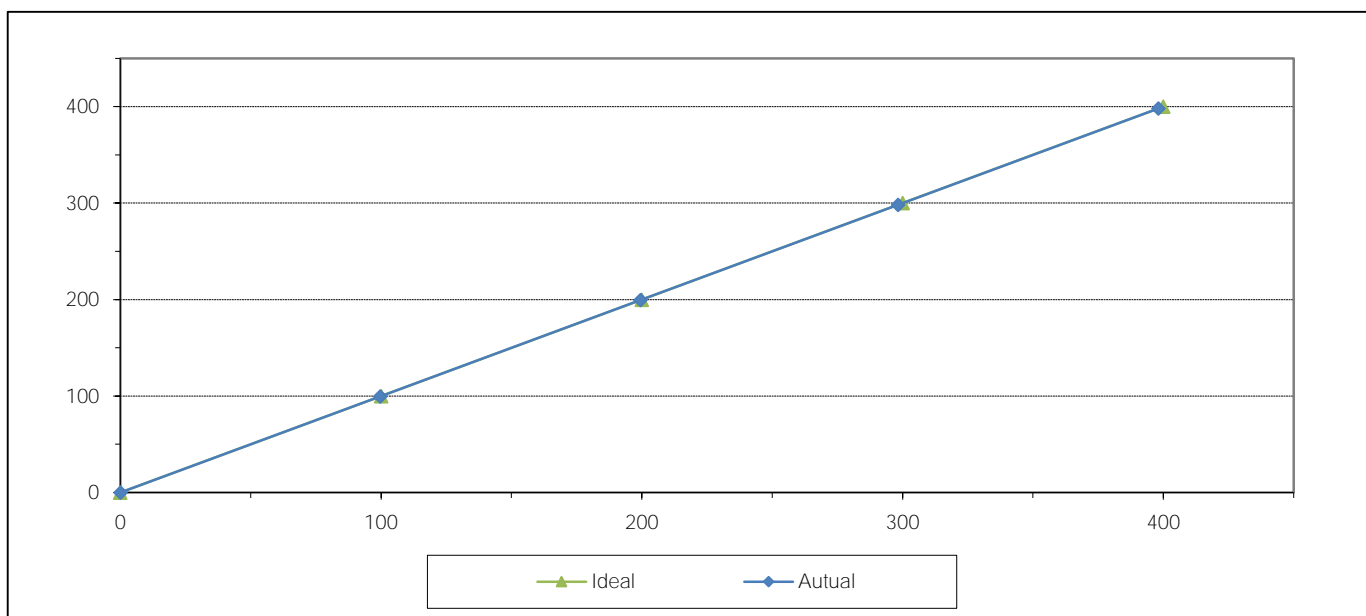
(Mr.Sarayuth Jittranont)
Assistant General Manager



MULTIPOINT CALIBRATION REPORT

Calibration Date	4-Jan-22	Equipment Name	SO2 Analyzer
Manufacturer	HORIBA	Model	APSA-370
Serial No.	R0HWYDVW	Equipment ID	RYG_FS0456
Calibrator Manufacturer	Teledyne API	Model	700
Serial No.	947		
Std. Gas Concentration (PPM)	50.87	Cylinder No.	LL36633
Cylinder Pressure (psi)	1200	Certified By	Airgas Inc.
Certified Date	18-Mar-14	Expired Date	18-Mar-22

Point	CALIBRATION RESULTS			
	Ideal	Autual	Error	%Error
ZERO	0.00	0.10	0.10	0.10
1	100.00	99.70	-0.30	-0.30
2	200.00	199.50	-0.50	-0.25
3	300.00	298.30	-1.70	-0.57
4	400.00	398.10	-1.90	-0.47
AVERAGE (%)				-0.30



Calibrated By

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

Approved By

(Mr.Sarayuth Jittranont)
Assistant General Manager



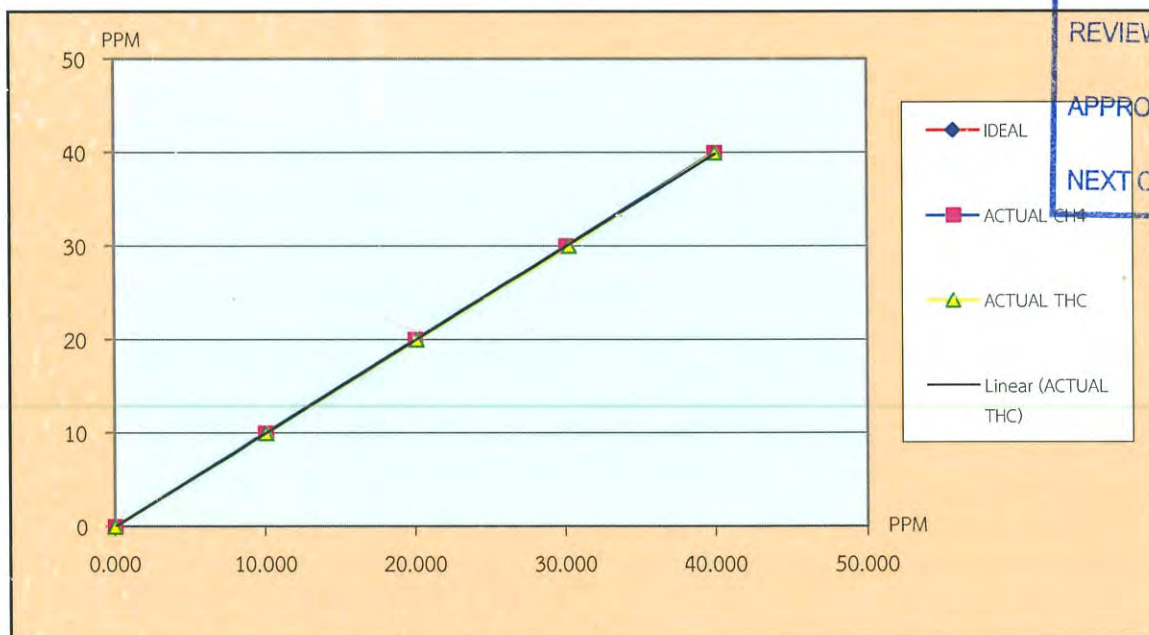
JIRANATEE ASSOCIATES CO.,LTD.

TEST REPORT

CUSTOMER NAME	: ALS Laboratory Group (Thailand) Co., Ltd. [บริษัท เอแอลเอส แลบบอราทอรี กรุ๊ป (ประเทศไทย) จำกัด]						
EQUIPMENT NAME	: THC Analyzer						
MANUFACTURER	: HORIBA	MODEL	: APHA-370	SERIAL NO	: U430GTHB		
STANDARD GAS CONCENTRATION (PPM)	: 506.1 PPM			CYLINDER NO	: CC734373		
CYLINDER PRESSURE (psig)	: 1,000 PSI			CERTIFIED DATE	: 12/05/2020		
CERTIFIED BY	: AIRGAS			EXPIRED DATE	: 12/05/2028		

TEST RESULTS

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

REVIEW BY Thamitall.APPROVED BY D. W.NEXT CAL. DATE 8/7/2022CALIBRATED BY : ชุตินันท์ ป้อมวิตรัตน์DATE : 8/7/64CHECKED BY : สโรจน์ นิลนาคDATE : 8/7/64

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

เลขที่ 63/14-15,67/35-36 ถนนเพชรเกษม 7,7/1 แขวงวัดท่าพระ เขตบางกอกใหญ่ กรุงเทพฯ 10600 โทร 02-8680812-13 โทรสาร 02-868-1889

CHECK LIST

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

TEST VALUES				
NO.	THC Analyzer (APHA-370)	UNIT	BEFORE	AFTER
1	Signal (THC)	mV	25.60	25.70
2	Signal (CH ₄)	mV	31.90	34.30
3	Detector	Temp °C , Standard Value : Ambient temp+(5°C to 15°C)	49.50	47.80
		Pressure kPa , Standard Value : (Ambient/1013x100-20)±4kPa	81.10	80.80
4	Ambient	kPa current atmospheric pressure	100.70	100.40
5	Purifire	°C , Standard Value : 390 °C to 430 °C	419.90	420.00
		kPa , Normal value : 8 kPa to 25 kPa	10.30	10.30
6	NMHC	°C , Standard Value : 230 °C to 260 °C	242.90	243.50
7	DC 24 V	V , Standard Value : 24 V ± 0.5 V	23.90	23.90
8	DC 5 V	V , Standard Value : 5 V ± 0.5 V	5.00	5.00
9	Bypass (Optional)	L/min, Normal value : 0.9 L/min ± 0.3 L/min	-	-
10	Over Flow (Optional)	L/min, Standard Value : 0.8 L/min or More	-	-
11	CH ₄ Sampling Reading	PPM	2.65	2.02
12	THC Sampling Reading	PPM	0.44	0.54
13	NMHC Sampling Reading	PPM	3.09	2.56
14	Zero Gas CH ₄ /THC	PPM	0.16/0.25	0.00/0.00
15	Sapn Gas	PPM	29.42/29.3	39.99/40.02
G	Gas H ₂ 20/1,300			

อาการที่ตรวจพบ

- เครื่องปกติ

รายละเอียดการดำเนินการ

- จัด Check list Analyzer , ทำการ calibrate Zero/Span และทำ Calibrat แบบ Multi Point

ผลการดำเนินการ

- เครื่องใช้งานได้ปกติ

CALIBRATED BY : ชฎารัตน์ ป่องจตุรัส

CHECKED BY : ศิริ มัทนา



DATE : 8/7/64

DATE : 8/7/64

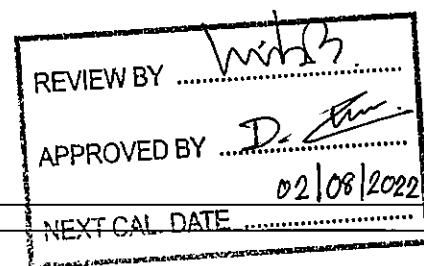
ต้องการข้อมูลทางด้านเทคนิคเพิ่มเติม : เจ้าหน้าที่ฝ่ายบริการหลังการขาย , โทร 02-868-0812 # 15-16 , E-Mail : Engineer@jiranatee.com

เลขที่ 63/14-15 ซอยเพชรเกษม 7 ถนนเพชรเกษม แขวงวัดท่าพระ เขตบางกอกใหญ่ กรุงเทพฯ 10600 โทร 02-868-0812-13 โทรสาร 02-868-1889

Certificate of System Qualification

GC-OQ + GCMS-OQ

System ID: RYG_EN0136
Organization Name: ALS Laboratory Group (Thailand) Co Ltd.
Organization Location: Tambol Pluak Daeng, Amphoe Pluak Daeng, Rayong, 21140, Thailand
Date: February 2, 2021 11:38:25 AM
EQP Name: AgilentRecommended , AgilentRecommended
EQP Revision: GC.02.50, GCMS.02.50
Overall Qualification Status: Pass



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	25.1	psi
Accuracy:			0.1	psi
Agilent Recommended:			<= 1.2	

Overall Inlet Pressure Accuracy Test Status

Pass

GC Oven Temperature Accuracy

Name: 7890

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

Setpoint Status:

Pass

Zone:

Oven

Setpoint/Actual

Temperature:

230.0

231.3

°C

Accuracy:

1.3

°C

Agilent Recommended:

>=

-1.0

% setpoint in K

(

-5.0

°C

)

<=

1.0

% setpoint in K

(

5.0

°C

)

Data for this setpoint was entered manually.

Reason:

No Data Logging Software

Setpoint Status:

Pass

Zone:

Oven

Setpoint/Actual

Temperature:

100.0

99.8

°C

Accuracy:

-0.2

°C

Agilent Recommended:

>=

-1.0

% setpoint in K

(

-3.7

°C

)

<=

1.0

% setpoint in K

(

3.7

°C

)

Data for this setpoint was entered manually.

Reason:

No Data Logging Software

Overall GC Oven Temperature Accuracy Test Status

Pass

GC Oven Temperature Stability

Name:

7890

Setpoint Status:

Pass

Setpoint/Average

Temperature:

100.0

99.8

°C

Stability:

0.0

°C

Agilent Recommended:

<=

0.5

Data for this setpoint was entered manually.

Reason:

No Data Logging Software

Date:

February 2, 2021 11:38:25 AM

System ID:

RYG_EN0136

Overall GC Oven Temperature Stability Test Status

Pass

Log Amp

Tested Combination1

Front

SSL

/ External

SQ

Name:

5977B

Setpoint Status:

Pass

Overall Log Amp Test Status

Pass

RFPA

Tested Combination1

Front

SSL

/ External

SQ

Name:

5977B

Setpoint Status:

Pass

Amu:

1050

 m/z

Drift After Five Minutes:

RFPA Voltage:

1

 mV

475

 mV

Agilent Recommended:

>=

-100

 and

<=

100

<=

1100

Overall RFPA Test Status

Pass

Tune EI

Tested Combination1

Front

SSL

/ External

SQ

Name:

5977B

Setpoint Status:

Pass

Filament:

1

Setpoint Status:

Pass

Filament:

2

Overall Tune EI Test Status

Pass

Date:

February 2, 2021 11:38:25 AM

System ID:

RYG_EN0136

Signal to Noise EI

Tested Combination1	Front	SSL	/ External	SQ
---------------------	-------	-----	------------	----

Name:	5977B
-------	-------

Source:	EI - Extractor
---------	----------------

Filament:	1
-----------	---

Setpoint Status:	Pass
------------------	------

Signal to Noise:	7105
------------------	------

Agilent Recommended:	>= 1200
----------------------	---------

Source:	EI - Extractor
---------	----------------

Filament:	2
-----------	---

Setpoint Status:	Pass
------------------	------

Signal to Noise:	3440
------------------	------

Agilent Recommended:	>= 1200
----------------------	---------

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

Overall Signal to Noise EI Test Status

Pass

Instrument Details

Purpose

This section describes the as found system configuration.

Details

System

System ID	RYG_EN0136
Manufacturer	Agilent Technologies
Name	7890

Tested Combination1

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

Sampler 1

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

Mainframe 1

Manufacturer	Agilent Technologies
Name	7890
Model Number	G3442B
Serial Number	CN16463238
Firmware Revision	B.02.04.3
Component ID/Asset No.	081117000236
Oven Type	Standard

Inlet 1

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

Detector 1

Manufacturer	Agilent Technologies
Name	Mass Spectrometer
Type	Mass Spectrometer
Location	External

Mass Spectrometer 1

Manufacturer	Agilent Technologies
Type	SQ
Name	5977B
Serial Number	US1701M008
Firmware Revision	5977 6.00.34
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

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 logon 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_puangsopa@agilent.com
Signature Creation Date:	February 2, 2021
Reason for Signature:	Executed protocol and published this original version of document

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User Name: eaknarin_puangsoa
 Hostname: ASRYGW7002

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

ALS_US1701M008 Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
February 1, 2021 12:00:51 PM	Audit	SessionCreated	Session	None
February 1, 2021 12:00:51 PM	Start	Configuration	Session	None
February 1, 2021 12:00:51 PM	Audit	Entitlement	Licensing	User is FieldEngineer and does not require an unlock code
February 1, 2021 12:08:57 PM	Audit	EqpLoaded	Session	EQP details for primary technique [Gc] - File path: [ProtocolPacks/Gc/Configurations/02.50/Gc.02.50.eqp], EQP File Name: [Gc.02.50.eqp], EQP Name: [AgilentRecommended] EQP details for hyphenated technique [GcMs] - File path: [ProtocolPacks/GcMs/Configurations/02.50/GcMs.02.50.eqp], EQP File Name: [GcMs.02.50.eqp], EQP Name: [AgilentRecommended]
February 1, 2021 12:09:02 PM	End	Configuration	Session	None
February 1, 2021 12:09:06 PM	Start	Qualification	Session	OQ
February 1, 2021 12:09:07 PM	Start	Execution	System Inspection and Basic Safety and Operation - 7890: - Qualitative Test - No setpoints associated	None

Page 1 / 5

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

User Name: eaknarin_puangsoa
 Hostname: ASRYGW7002

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

ALS_US1701M008 Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
February 1, 2021 12:10:04 PM	End	Execution	System Inspection and Basic Safety and Operation - 7890: - Qualitative Test - No setpoints associated	Run Count : 1
February 1, 2021 12:10:07 PM	Start	Execution	Inlet Pressure Accuracy - Front SSL: - Pressure Controlled Inlet - S: 25.0 psi - L: <= 1.2 psi	None
February 1, 2021 12:19:39 PM	End	Execution	Inlet Pressure Accuracy - Front SSL: - Pressure Controlled Inlet - S: 25.0 psi - L: <= 1.2 psi	Run Count : 1
February 1, 2021 12:19:42 PM	Start	Execution	GC Oven Temperature Accuracy - 7890: - Temperature : Oven - S: 230.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	None
February 1, 2021 12:28:41 PM	Start	Execution	GC Oven Temperature Accuracy - 7890: - Temperature : Oven - S: 100.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	None
February 1, 2021 12:28:44 PM	Start	Execution	GC Oven Temperature Accuracy - 7890: - Temperature : Oven - S: 230.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	None
February 1, 2021 12:29:32 PM	Audit	Data	GC Oven Temperature Accuracy - 7890: - Temperature : Oven - S: 230.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	Manual Data Entry
February 1, 2021 12:29:36 PM	End	Execution	GC Oven Temperature Accuracy - 7890: - Temperature : Oven - S: 230.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	Run Count : 1
February 1, 2021 12:29:41 PM	Start	Execution	GC Oven Temperature Accuracy - 7890: - Temperature : Oven - S: 100.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	None

Page 2 / 5

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

User Name: eaknarin_puangsopa
 Hostname: ASRYGW7002

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

ALS_US1701M008 Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
February 1, 2021 12:37:42 PM	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
February 1, 2021 12:37:45 PM	End	Execution	GC Oven Temperature Accuracy - 7890: - Temperature : Oven - S: 100.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	Run Count : 1
February 1, 2021 12:37:51 PM	Start	Execution	GC Oven Temperature Stability - 7890: - Temperature : Oven - S: 100.0°C - L: <= 0.5°C	None
February 1, 2021 1:00:14 PM	Audit	Data	GC Oven Temperature Stability - 7890: - Temperature : Oven - S: 100.0°C - L: <= 0.5°C	Manual Data Entry
February 1, 2021 1:00:34 PM	End	Execution	GC Oven Temperature Stability - 7890: - Temperature : Oven - S: 100.0°C - L: <= 0.5°C	Run Count : 1
February 1, 2021 1:01:19 PM	Audit	AceClosed	Session	None
February 2, 2021 9:04:47 AM	Audit	AceRestarted	Session	None
February 2, 2021 9:04:48 AM	Audit	SessionReloaded	Session	None
February 2, 2021 9:04:51 AM	Start	Qualification	Session	OQ
February 2, 2021 9:05:09 AM	Start	Execution	Log Amp - 5977B SQ: - Source: EI - Extractor	None
February 2, 2021 9:15:18 AM	End	Execution	Log Amp - 5977B SQ: - Source: EI - Extractor	Run Count : 1
February 2, 2021 9:15:21 AM	Start	Execution	RFPA - 5977B SQ: - Source: EI - Extractor	None

Page 3 / 5

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

User Name: eaknarin_puangsopa
 Hostname: ASRYGW7002

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

ALS_US1701M008 Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
February 2, 2021 9:33:28 AM	End	Execution	RFPA - 5977B SQ: - Source: EI - Extractor	Run Count : 1
February 2, 2021 9:33:30 AM	Start	Execution	Tune EI - 5977B SQ: - Source: - None EI - Extractor Filament 1 (Qualitative - No setpoints associated)	
February 2, 2021 9:35:22 AM	End	Qualification	Session	OQ
February 2, 2021 9:35:22 AM	Start	Reporting	Session	None
February 2, 2021 9:53:31 AM	End	Reporting	Session	None
February 2, 2021 9:53:31 AM	Start	Qualification	Session	OQ
February 2, 2021 9:53:31 AM	Start	Execution	Tune EI - 5977B SQ: - Source: - None EI - Extractor Filament 1 (Qualitative - No setpoints associated)	
February 2, 2021 9:53:55 AM	End	Execution	Tune EI - 5977B SQ: - Source: - EI - Extractor Filament 1 (Qualitative - No setpoints associated)	Run Count : 1
February 2, 2021 9:53:57 AM	Start	Execution	Tune EI - 5977B SQ: - Source: - None EI - Extractor Filament 2 (Qualitative - No setpoints associated)	
February 2, 2021 9:54:15 AM	End	Qualification	Session	OQ
February 2, 2021 9:54:15 AM	Start	Reporting	Session	None
February 2, 2021 10:04:03 AM	End	Reporting	Session	None

Page 4 / 5

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

User Name: eaknarin_puangsopa
 Hostname: ASRYGW7002

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

ALS_US1701M008 Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
February 2, 2021 10:04:03 AM	Start	Qualification	Session	OQ
February 2, 2021 10:04:03 AM	Start	Execution	Tune EI - 5977B SQ: - Source: - None EI - Extractor Filament 2 (Qualitative - No setpoints associated)	
February 2, 2021 10:04:12 AM	End	Execution	Tune EI - 5977B SQ: - Source: - Run Count : 1 EI - Extractor Filament 2 (Qualitative - No setpoints associated)	
February 2, 2021 10:04:14 AM	Start	Execution	Signal to Noise EI - Liquid Injection, Front SSL, SQ: - Source: EI - Extractor using Filament 1 - L: >= 1200	None
February 2, 2021 10:10:00 AM	End	Qualification	Session	QQ
February 2, 2021 10:10:00 AM	Start	Reporting	Session	None
February 2, 2021 10:27:59 AM	End	Reporting	Session	None
February 2, 2021 10:27:59 AM	Start	Qualification	Session	OQ
February 2, 2021 10:27:59 AM	Start	Execution	Signal to Noise EI - Liquid Injection, Front SSL, SQ: - Source: EI - Extractor using Filament 1 - L: >= 1200	None
February 2, 2021 10:43:04 AM	End	Qualification	Session	OQ
February 2, 2021 10:43:04 AM	Start	Reporting	Session	None

CERTIFICATE OF CALIBRATION

Certificate No: WS-13072021

Page 1 of 2 pages

Measurement Item : Cup anemometer with data logger.

Manufacturer : Data logger: Novalynx.
: Cup anemometer: Novalynx.

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

Serial Number : Data logger: A5375.
: Cup anemometer: -.

ID No : Data logger: RYG_FS0413.
: Cup anemometer: -.

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

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

Test Conditions : Air temperature 24.8 ±0.8 °C
: Air pressure 1007.4 ±0.4 hPa
: Relative air humidity 52.4 ±3.5 %RH

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

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

Measurement Date : Jul 29, 2021.

Issued Date : Jul 29, 2021.



Calibrated by

- ☒ Mr. Sorawit Thachalad
☐ Miss Orathai Wiwatwittaya



Approved Signatory:

Mr. Parinya Booncharoen
Technical Support
and Calibration Manager

Continuation of Certificate of Calibration Number

Certificate No: WS-13072021

Page 2 of 2 Pages

Result of calibration: ☒ Without adjustment ☐ With adjustment

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

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

V _{STD} Reading m/s	V _{UUC} * Reading m/s	Error (m/s)	Uncertainty (%)
2.067	2.0	-0.1	2.4
4.138	4.1	0.0	1.2
6.03	6.1	0.1	0.97
7.99	8.0	0.0	0.84
10.00	10.1	0.1	0.59
12.03	12.2	0.2	0.72
13.99	14.3	0.3	0.47
15.98	16.4	0.4	0.35
15.03	15.3	0.3	0.38
12.99	13.1	0.1	0.69
11.01	11.1	0.1	0.57
9.01	9.0	0.0	0.87
6.99	7.1	0.1	0.81
5.177	5.1	-0.1	0.97
2.972	3.1	0.1	1.6
1.044	0.9	-0.1	5.3

UUC*: Unit Under Calibration

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

Appendix 1: Instrumentations

NO	Sensor	Manufacturer	Model/Type	Calibration Date	Certificate Report Number	Range
1	Pitot static	TESTO INC.	06352145	July 16, 2020	MW-0035-20	5 – 30 m/s
2	Precision Differential Pressure Meter	Zoglab	DPM2500	July 16, 2020	MW-0035-20	5 – 30 m/s
3	Air velocity transducer (hot wire)	TSI INC.	8455-12	July 20, 2020	MW-0036AA-20	0 – 5 m/s
4	Temperature	Zoglab	DSR-THP	March 30, 2021	CL-027-64	-30 – 70°C
5	Relative humidity	Zoglab	DSR-THP	March 30, 2021	RH-03032021	0 – 100 %RH
6	Atmospheric pressure	Zoglab	DSR-THP	March 30, 2021	BP-01032021	500 – 1100 hPa
7	Wind tunnel	ESSOM	MP330D	-	-	0 – 50 Hz

End of certificate of calibration



CERTIFICATE OF CALIBRATION

Certificate No.: WD-13072021

Page 1 of 2 pages

Measurement Item : Wind direction sensor with data logger.

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

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

Serial Number : Data logger: A5375.
: Wind direction sensor: -.

ID No : Data logger: RYG_FS0413.
: Wind direction sensor: -.

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

Environmental Condition:

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

Measurement Method:

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

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

Traceability:

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

Measurement Date : Jul 29, 2021.

Issued Date : Jul 29, 2021.

Performed by

- ☒ Mr. Sorawit Thachalad
☐ Miss Orathai Wiwatwittaya



Approved Signatory:

Mr. Parinya Booncharoen.
Technical Support
and Calibration Manager

Continuation of Certificate of Calibration Number

Certificate No: WD-13072021

Pages 2 of 2 pages

Result of calibration: ☐ Without adjustment ☒ With adjustment.

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

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

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

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

End of Certificate of Calibration



CERTIFICATE OF CALIBRATION

Certificate No: WS-14072021

Page 1 of 2 pages

Measurement Item : Cup anemometer with data logger.

Manufacturer : Data logger: Novalynx.
: Cup anemometer: Novalynx.

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

Serial Number : Data logger: A5376.
: Cup anemometer: -.

ID No : Data logger: RYG_FS0414.
: Cup anemometer: -.

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

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

Test Conditions : Air temperature 25.2 ±0.8 °C
: Air pressure 1006.6 ±0.4 hPa
: Relative air humidity 51.4 ±3.5 %RH

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

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

Measurement Date : Jul 29, 2021.

Issued Date : Jul 29, 2021.



Calibrated by

- ☒ Mr. Sorawit Thachalad
☐ Miss Orathai Wiwatwittaya



Approved Signatory: *[Signature]*

Mr. Parinya Booncharoen
Technical Support
and Calibration Manager

Continuation of Certificate of Calibration Number

Certificate No: WS-14072021

Page 2 of 2 Pages

Result of calibration: ☒ Without adjustment ☐ With adjustment

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

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

V _{STD} Reading m/s	V _{UUC} * Reading m/s	Error (m/s)	Uncertainty (%)
2.057	1.8	-0.3	3.1
4.135	4.0	-0.1	1.3
6.02	6.0	0.0	2.1
7.99	8.0	0.0	0.74
10.00	10.1	0.1	0.69
11.99	12.0	0.0	0.72
13.98	14.2	0.2	0.48
15.98	16.2	0.2	0.77
14.99	15.2	0.2	0.49
13.00	13.1	0.1	0.52
11.01	11.0	0.0	0.94
9.01	9.0	0.0	0.81
6.99	7.0	0.0	2.0
5.189	5.1	-0.1	0.96
2.987	3.0	0.0	2.0
1.034	0.8	-0.2	5.3

UUC*: Unit Under Calibration

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

Appendix 1: Instrumentations

NO	Sensor	Manufacturer	Model/Type	Calibration Date	Certificate Report Number	Range
1	Pitot static	TESTO INC.	06352145	July 16, 2020	MW-0035-20	5 – 30 m/s
2	Precision Differential Pressure Meter	Zoglab	DPM2500	July 16, 2020	MW-0035-20	5 – 30 m/s
3	Air velocity transducer (hot wire)	TSI INC.	8455-12	July 20, 2020	MW-0036AA-20	0 – 5 m/s
4	Temperature	Zoglab	DSR-THP	March 30, 2021	CL-027-64	-30 – 70°C
5	Relative humidity	Zoglab	DSR-THP	March 30, 2021	RH-03032021	0 – 100 %RH
6	Atmospheric pressure	Zoglab	DSR-THP	March 30, 2021	BP-01032021	500 – 1100 hPa
7	Wind tunnel	ESSOM	MP330D	-	-	0 – 50 Hz

End of certificate of calibration



CERTIFICATE OF CALIBRATION

Certificate No.: WD-14072021

Page 1 of 2 pages

Measurement Item : Wind direction sensor with data logger.

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

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

Serial Number : Data logger: A5376.
: Wind direction sensor: -.

ID No : Data logger: RYG_FSO414.
: Wind direction sensor: -.

Customer : ALS laboratory group (Thailand) Co.,Ltd.
104 Phatthanakan 40, Phatthanakan Rd.,Khwaeng Suan Luang, Khet Suan Luang, Bangkok 10260
Thailand.

Environmental Condition:

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

Measurement Method:

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

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

Traceability:

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

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

Performed by

- ☒ Mr. Sorawit Thachalad
☐ Miss Orathai Wiwatwittaya



Approved Signatory:.....



Mr. Parinya Booncharoen.
Technical Support
and Calibration Manager

Continuation of Certificate of Calibration Number

Certificate No: WD-14072021

Pages 2 of 2 pages

Result of calibration: ☐ Without adjustment ☒ With adjustment.

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

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

NO	Turning Direction	Nominal Angle (°)	Standard Reading (°)	UUC* Reading (°)	Error (°)	Uncertainty ±(°)
1	Clockwise	0/360	360	359	-1	3.0
2		45	45	43	-2	3.0
3		90	90	87	-3	3.0
4		135	135	132	-3	3.0
5		180	180	179	-1	3.0
6		225	225	228	3	3.0
7		270	270	273	3	3.0
8		315	315	318	3	3.0
9	Counter Clockwise	0/360	360	359	-1	3.0
10		45	45	43	-2	3.0
11		90	90	87	-3	3.0
12		135	135	132	-3	3.0
13		180	180	179	-1	3.0
14		225	225	228	3	3.0
15		270	270	273	3	3.0
16		315	315	318	3	3.0

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

End of Certificate of Calibration



CERTIFICATE OF CALIBRATION

Certificate No: WS-01062021

Page 1 of 2 pages

Measurement Item : Cup anemometer with data logger.

Manufacturer : Data logger: Novalynx.
: Cup anemometer: Novalynx.

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

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

ID No : Data logger: BKK_FSD141.
: Cup anemometer: -

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

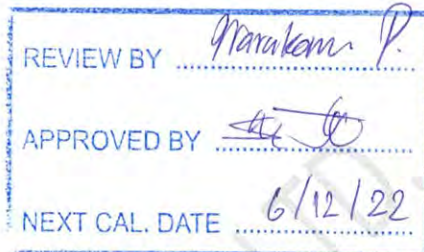
Test Conditions : Wind tunnel cross test section area 900 cm²
: Anemometer frontal area 100 cm²
: Diameter of mounting pipe - mm
: Blockage ratio of test object 0.111 [-]

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

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

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

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



Calibrated by

- ☒ Mr. Sorawit Thachalad
☐ Miss Orathai Wiwatwittaya



Approved Signatory:

[Signature]

Mr. Parinya Booncharoen
Technical Support
and Calibration Manager

Continuation of Certificate of Calibration Number

Certificate No: WS-01062021

Page 2 of 2 Pages

Result of calibration: ☒ Without adjustment ☐ With adjustment

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

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

V _{STD} Reading m/s	V _{UUC} Reading m/s	Error (m/s)	Uncertainty (%)
2.065	2.0	-0.1	2.6
4.124	4.0	-0.1	1.2
5.99	6.0	0.0	1.01
8.00	8.0	0.0	0.74
9.99	10.1	0.1	0.60
11.96	12.2	0.2	0.67
14.02	14.4	0.4	0.45
16.03	16.6	0.6	0.36
15.01	15.3	0.3	2.8
12.99	13.3	0.3	0.41
10.99	11.2	0.2	0.53
9.01	9.3	0.3	1.2
7.05	7.0	0.0	0.77
5.121	5.0	-0.1	0.88
3.048	3.0	0.0	1.8
1.088	1.0	-0.1	5.3

UUC*: Unit Under Calibration

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

Appendix 1: Instrumentations

NO	Sensor	Manufacturer	Model/Type	Calibration Date	Certificate Report Number	Range
1	Pitot static	TSTO INC.	06352145	July 16, 2020	MW-0035-20	5 – 30 m/s
2	Precision Differential Pressure Meter	Zoglab	DPM2500	July 16, 2020	MW-0035-20	5 – 30 m/s
3	Air velocity transducer (hot wire)	TSI INC.	8455-12	July 20, 2020	MW-0036AA-20	0 - 5 m/s
4	Temperature	Zoglab	DSR-THP	March 30, 2021	CL-027-64	-30 - 70°C
5	Relative humidity	Zoglab	DSR-THP	March 30, 2021	RH-03032021	0 – 100 %RH
6	Atmospheric pressure	Zoglab	DSR-THP	March 30, 2021	BP-01032021	500 – 1100 hPa
7	Wind tunnel	ESSOM	MP330D	-	-	0 – 50 Hz

End of certificate of calibration



CERTIFICATE OF CALIBRATION

Certificate No.: WD-01062021

Page 1 of 2 pages

Measurement Item : Wind direction sensor with data logger.

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

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

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

ID No : Data logger: BKK_FS0141.
: Cup anemometer: -

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

Environmental Condition:

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

Measurement Method:

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

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

Traceability:

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

Measurement Date : Jun 07, 2021.

Issued Date : Jun 07, 2021.

Performed by

- ☒ Mr. Sorawit Thachalad
☐ Miss Orathai Wiwatwittaya



Approved Signatory:

Mr. Parinya Booncharoen.
Technical Support
and Calibration Manager

Continuation of Certificate of Calibration Number

Certificate No: WD-01062021

Pages 2 of 2 pages

Result of calibration: ☐ Without adjustment ☒ With adjustment.

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

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

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

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

End of Certificate of Calibration



CERTIFICATE OF CALIBRATION

Certificate No: WS-14072021

Page 1 of 2 pages

Measurement Item : Cup anemometer with data logger.

Manufacturer : Data logger: Novalynx.
: Cup anemometer: Novalynx.

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

Serial Number : Data logger: A5376.
: Cup anemometer: -.

ID No : Data logger: RYG_FS0414.
: Cup anemometer: -.

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

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

Test Conditions : Air temperature 25.2 ±0.8 °C
: Air pressure 1006.6 ±0.4 hPa
: Relative air humidity 51.4 ±3.5 %RH

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

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

Measurement Date : Jul 29, 2021.

Issued Date : Jul 29, 2021.



Calibrated by

- ☒ Mr. Sorawit Thachalad
☐ Miss Orathai Wiwatwittaya



Approved Signatory: *[Signature]*

Mr. Parinya Booncharoen
Technical Support
and Calibration Manager

Continuation of Certificate of Calibration Number

Certificate No: WS-14072021

Page 2 of 2 Pages

Result of calibration: ☒ Without adjustment ☐ With adjustment

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

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

V _{STD} Reading m/s	V _{UUC} * Reading m/s	Error (m/s)	Uncertainty (%)
2.057	1.8	-0.3	3.1
4.135	4.0	-0.1	1.3
6.02	6.0	0.0	2.1
7.99	8.0	0.0	0.74
10.00	10.1	0.1	0.69
11.99	12.0	0.0	0.72
13.98	14.2	0.2	0.48
15.98	16.2	0.2	0.77
14.99	15.2	0.2	0.49
13.00	13.1	0.1	0.52
11.01	11.0	0.0	0.94
9.01	9.0	0.0	0.81
6.99	7.0	0.0	2.0
5.189	5.1	-0.1	0.96
2.987	3.0	0.0	2.0
1.034	0.8	-0.2	5.3

UUC*: Unit Under Calibration

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

Appendix 1: Instrumentations

NO	Sensor	Manufacturer	Model/Type	Calibration Date	Certificate Report Number	Range
1	Pitot static	TESTO INC.	06352145	July 16, 2020	MW-0035-20	5 – 30 m/s
2	Precision Differential Pressure Meter	Zoglab	DPM2500	July 16, 2020	MW-0035-20	5 – 30 m/s
3	Air velocity transducer (hot wire)	TSI INC.	8455-12	July 20, 2020	MW-0036AA-20	0 – 5 m/s
4	Temperature	Zoglab	DSR-THP	March 30, 2021	CL-027-64	-30 – 70°C
5	Relative humidity	Zoglab	DSR-THP	March 30, 2021	RH-03032021	0 – 100 %RH
6	Atmospheric pressure	Zoglab	DSR-THP	March 30, 2021	BP-01032021	500 – 1100 hPa
7	Wind tunnel	ESSOM	MP330D	-	-	0 – 50 Hz

End of certificate of calibration



CERTIFICATE OF CALIBRATION

Certificate No.: WD-14072021

Page 1 of 2 pages

Measurement Item : Wind direction sensor with data logger.

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

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

Serial Number : Data logger: A5376.
: Wind direction sensor: -.

ID No : Data logger: RYG_FSO414.
: Wind direction sensor: -.

Customer : ALS laboratory group (Thailand) Co.,Ltd.
104 Phatthanakan 40, Phatthanakan Rd., Khwaeng Suan Luang, Khet Suan Luang, Bangkok 10260
Thailand.

Environmental Condition:

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

Measurement Method:

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

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

Traceability:

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

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

Performed by

- ☒ Mr. Sorawit Thachalad
☐ Miss Orathai Wiwatwittaya



Approved Signatory:.....



Mr. Parinya Booncharoen.
Technical Support
and Calibration Manager

Continuation of Certificate of Calibration Number

Certificate No: WD-14072021

Pages 2 of 2 pages

Result of calibration: ☐ Without adjustment ☒ With adjustment.

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

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

NO	Turning Direction	Nominal Angle (°)	Standard Reading (°)	UUC* Reading (°)	Error (°)	Uncertainty ±(°)
1	Clockwise	0/360	360	359	-1	3.0
2		45	45	43	-2	3.0
3		90	90	87	-3	3.0
4		135	135	132	-3	3.0
5		180	180	179	-1	3.0
6		225	225	228	3	3.0
7		270	270	273	3	3.0
8		315	315	318	3	3.0
9	Counter Clockwise	0/360	360	359	-1	3.0
10		45	45	43	-2	3.0
11		90	90	87	-3	3.0
12		135	135	132	-3	3.0
13		180	180	179	-1	3.0
14		225	225	228	3	3.0
15		270	270	273	3	3.0
16		315	315	318	3	3.0

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

End of Certificate of Calibration



CERTIFICATE OF CALIBRATION

Certificate No: WS-08072021

Page 1 of 2 pages

Measurement Item : Cup anemometer with data logger.

Manufacturer : Data logger: Novalynx.
: Cup anemometer: Novalynx.

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

Serial Number : Data logger: A5660.
: Cup anemometer: WSD-014.

ID No : Data logger: -. 648-150930
: Cup anemometer: -.

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

Test Conditions	: Wind tunnel cross test section area	900	cm ²
	: Anemometer frontal area	100	cm ²
	: Diameter of mounting pipe	-	mm
	: Blockage ratio of test object	0.111	[-]

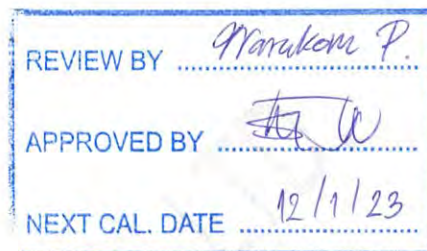
Test Conditions	: Air temperature	23.4	±0.8 °C
	: Air pressure	1006.2	±0.4 hPa
	: Relative air humidity	59.3	±3.5 %RH

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

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

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

Calibrated by
☒ Mr. Sorawit Thachalad
☐ Miss Orathai Wiwatwittaya



Approved Signatory: _____

Mr. Parinya Booncharoen
Technical Support
and Calibration Manager

Continuation of Certificate of Calibration Number

Certificate No: WS-08072021

Page 2 of 2 Pages

Result of calibration: ☒ Without adjustment ☐ With adjustment

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

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

V _{STD} Reading m/s	V _{UUC} * Reading m/s	Error (m/s)	Uncertainty (%)
2.069	1.9	-0.2	2.5
4.122	4.0	-0.1	1.2
6.02	6.0	0.0	0.95
7.97	8.0	0.0	0.84
9.98	10.0	0.0	0.59
12.02	12.1	0.1	0.47
13.99	14.2	0.2	0.45
15.98	16.2	0.2	0.55
14.99	15.2	0.2	0.39
13.00	13.1	0.1	0.45
11.02	11.1	0.1	0.53
8.99	9.0	0.0	0.70
6.98	7.0	0.0	0.96
5.112	5.0	-0.1	1.2
2.975	3.0	0.0	1.5
1.023	0.9	-0.1	5.3

UUC*: Unit Under Calibration

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

Appendix 1: Instrumentations

NO	Sensor	Manufacturer	Model/Type	Calibration Date	Certificate Report Number	Range
1	Pitot static	TESTO INC.	06352145	July 16, 2020	MW-0035-20	5 – 30 m/s
2	Precision Differential Pressure Meter	Zoglab	DPM2500	July 16, 2020	MW-0035-20	5 – 30 m/s
3	Air velocity transducer (hot wire)	TSI INC.	8455-12	July 20, 2020	MW-0036AA-20	0 – 5 m/s
4	Temperature	Zoglab	DSR-THP	March 30, 2021	CL-027-64	-30 – 70°C
5	Relative humidity	Zoglab	DSR-THP	March 30, 2021	RH-03032021	0 – 100 %RH
6	Atmospheric pressure	Zoglab	DSR-THP	March 30, 2021	BP-01032021	500 – 1100 hPa
7	Wind tunnel	ESSOM	MP330D	-	-	0 – 50 Hz

End of certificate of calibration



CERTIFICATE OF CALIBRATION

Certificate No.: WD-08072021

Page 1 of 2 pages

Measurement Item : Wind direction sensor with data logger.

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

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

Serial Number : Data logger: A5660.
: Wind direction sensor: WSD-014.

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

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

Environmental Condition:

The measurement was carried out in an ambient temperature of $(23\pm3)^{\circ}\text{C}$, and relative humidity of $(40\pm10)\%$.

Measurement Method:

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

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

Traceability:

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

Measurement Date : Jul 14, 2021.

Issued Date : Jul 15, 2021.



Performed by

- ☒ Mr. Sorawit Thachalad
☐ Miss Orathai Wiwatwittaya

Approved Signatory:.....

Mr. Parinya Booncharoen.
Technical Support
and Calibration Manager

Continuation of Certificate of Calibration Number

Certificate No: WD-08072021

Pages 2 of 2 pages

Result of calibration: ☐ Without adjustment ☒ With adjustment.

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

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

NO	Turning Direction	Nominal Angle (°)	Standard Reading (°)	UUC* Reading (°)	Error (°)	Uncertainty ±(°)
1	Clockwise	0/360	360	359	-1	3.0
2		45	45	42	-3	3.0
3		90	90	87	-3	3.0
4		135	135	134	-1	3.0
5		180	180	182	2	3.0
6		225	225	228	3	3.0
7		270	270	273	3	3.0
8		315	315	318	3	3.0
9	Counter Clockwise	0/360	360	359	-1	3.0
10		45	45	42	-3	3.0
11		90	90	87	-3	3.0
12		135	135	134	-1	3.0
13		180	180	182	2	3.0
14		225	225	228	3	3.0
15		270	270	273	3	3.0
16		315	315	318	3	3.0

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

End of Certificate of Calibration



CERTIFICATE OF CALIBRATION

Certificate No. : CL-050-64
Page 1 of 2

Equipment Name : Data Logger with Temperature
Sensor

Manufacturer : Novalynx

Model : 110-WS-25

Serial No. : A5660

ID No. : -

Customer

Name : ALS laboratory group (thailand) Co.,Ltd.

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

Received date : 12 JUL 2021

Calibration date : 13 JUL 2021

Issue date : 13 JUL 2021

Reference Used During Calibration

1.Standard Temperature Probe Model : STS-100 A500,
Serial No. : 667682-09, Due date : 25 Mar 2022

2.Digital Temperature Indicator Model : DTI-1000-A MK
II, Serial No.: 671407-00591 Due date : 04 June 2022

Calibration Condition

Temperature : $(23 \pm 3)^{\circ}\text{C}$

Relative Humidity : $(55 \pm 15)\%$

Calibration Procedure

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

Traceability


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

Calibrated by

- ☐ Mr. Sorawit Thachalad
☒ Miss Orathai Wiwatwittaya



Approved Signatory:


Mr. Parinya Booncharoen
Technical Support
And Calibration Manager

Certificate No. : CL-050-64
Page 2 of 2

Result of Calibration :- ☒ Without Adjustment ☐ With Adjustment

Calibration Range: 20 °C – 40 °C

Function:

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

Dimension : Diameter 12mm. Length 80 mm.

<u>Immersion Depth (mm)</u>	<u>Standard Reading (°C)</u>	<u>UUC Reading (°C)</u>	<u>Error (°C)</u>	<u>Uncertainty (°C)</u>
60	20.050	19.7	-0.3	0.080
60	24.875	24.5	-0.4	0.13
60	29.864	29.5	-0.4	0.080
60	34.829	34.3	-0.5	0.080
60	39.831	39.4	-0.5	0.95

UUC* : Unit Under Calibration

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

*** End of Certificate ***

CALIBRATION REPORT

Calibration No. : RH-02072021

Page 1 of 1 Pages

Measurement Item : Relative humidity with data logger.

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

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

Serial Number : Data logger: A5660.
: Relative humidity sensor: T0210901.

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

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

Environmental Condition:

The measurement was carried out in an ambient temperature of $(25 \pm 3)^{\circ}\text{C}$, and relative humidity of $(50 \pm 15)\%$.

Measurement Method:

The Relative humidity with data logger, Unit Under Calibration (UUC) was calibrated by comparison method with the equilibrium of standard salt solution CH_3COOK : Potassium Acetate, $\text{Mg}(\text{NO}_3)_2$: Magnesium Nitrate, KCl : Potassium Chloride to determine the errors.

Measurement Date : Jul 14, 2021
Issued Date : Jul 14, 2021

Measurement Results:

The results of calibration are reported in table below.

Standard salt solution.	Standard (%RH)	UUC(Reading)	Error
CH_3COOK : Potassium Acetate	22.51	22.2	-0.3
$\text{Mg}(\text{NO}_3)_2$: Magnesium Nitrate	52.89	52.3	-0.6
KCl : Potassium Chloride	84.34	83.8	-0.5

Performed by

- ☒ Mr. Sorawit Thachalad
☐ Miss Orathai Wiwatwittaya



Approved Signatory:.....

Mr. Parinya Booncharoen.
Technical Support
and Calibration Manager

CERTIFICATE OF CALIBRATION

Certificate No: WS-01102021

Page 1 of 2 pages

Measurement Item : Cup anemometer with data logger.

Manufacturer : Data logger: Novalynx.
: Cup anemometer: Novalynx.

Model/Type : Data logger: 200-WS-25DL
: Cup anemometer: WS-02F

Serial Number : Data logger: A4985
: Cup anemometer: -

ID No : Data logger: RYG_FS0085
: Cup anemometer: -

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

Test Conditions	: Wind tunnel cross test section area	900	cm ²
	: Anemometer frontal area	100	cm ²
	: Diameter of mounting pipe	-	mm
	: Blockage ratio of test object	0.111	[-]

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

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

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

Measurement Date : Oct 08, 2021.

Issued Date : Oct 11, 2021.

Calibrated by

- ☒ Mr. Sorawit Thachalad
☐ Miss Orathai Wiwatwittaya



Approved Signatory:

Mr. Parinya Booncharoen
Technical Support
and Calibration Manager

Continuation of Certificate of Calibration Number

Certificate No: WS-01102021

Page 2 of 2 Pages

Result of calibration: ☒ Without adjustment ☐ With adjustment

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

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

V _{STD} Reading m/s	V _{UUC} * Reading m/s	Error (m/s)	Uncertainty (%)
2.049	1.9	-0.1	2.7
4.103	4.0	-0.1	1.3
6.01	6.0	0.0	1.1
8.01	8.0	0.0	0.99
9.99	10.0	0.0	1.0
11.99	12.1	0.1	0.64
13.98	14.1	0.1	0.55
16.02	16.2	0.2	0.40
15.03	15.2	0.2	0.78
12.99	13.1	0.1	0.61
11.00	11.0	0.0	1.1
9.00	9.0	0.0	0.75
7.02	7.0	0.0	0.84
5.147	5.0	-0.1	0.98
2.974	2.9	-0.1	1.7
1.013	0.9	-0.1	4.5

UUC*: Unit Under Calibration

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

Appendix 1: Instrumentations

NO	Sensor	Manufacturer	Model/Type	Calibration Date	Certificate Report Number	Range
1	Pitot static	TGSTO INC.	06352145	Aug 07, 2021	MW-0034-21	5 – 30 m/s
2	Precision Differential Pressure Meter	Zoglab	DPM2500	Aug 07, 2021	MW-0034-21	5 – 30 m/s
3	Air velocity transducer (hot wire)	TSI INC.	8455-12	Aug 08, 2021	MW-0035-21	0 – 5 m/s
4	Temperature	Zoglab	DSR-THP	March 30, 2021	CL-027-64	-30 – 70°C
5	Relative humidity	Zoglab	DSR-THP	March 30, 2021	RH-03032021	0 – 100 %RH
6	Atmospheric pressure	Zoglab	DSR-THP	March 30, 2021	BP-01032021	500 – 1100 hPa
7	Wind tunnel	ESSOM	MP330D	-	-	0 – 50 Hz

End of certificate of calibration



CERTIFICATE OF CALIBRATION

Certificate No.: WD-01102021

Page 1 of 2 pages

Measurement Item : Wind direction sensor with data logger.

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

Model/Type : Data logger: 200-WS-25DL
: Wind direction sensor: WS-02F

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

ID No : Data logger: RYG_FS0085
: Wind direction sensor: -

Customer : ALS laboratory group (Thailand) Co.,Ltd.
104 Phatthanakan 40, Phatthanakan Rd.,Khwaeng Suan Luang, Khet Suan Luang, Bangkok 10260
Thailand.

Environmental Condition:

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

Measurement Method:

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

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

Traceability:

The measurement results are traceable to the international system of units (SI) through Certificate No.: CC563-07-0045, Certificate No.: KWS64/0025.

Measurement Date : Oct 08, 2021.

Issued Date : Oct 11, 2021.

Performed by

- ☒ Mr. Sorawit Thachalad
☐ Miss Orathai Wiwatwittaya



Approved Signatory:.....



Mr. Parinya Booncharoen.
Technical Support
and Calibration Manager

Continuation of Certificate of Calibration Number

Certificate No: WD-01102021

Pages 2 of 2 pages

Result of calibration: ☐ Without adjustment ☒ With adjustment.

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

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

NO	Turning Direction	Nominal Angle (°)	Standard Reading (°)	UUC* Reading (°)	Error (°)	Uncertainty ±(°)
1	Clockwise	0/360	360	359	-1	3.0
2		45	45	42	-3	3.0
3		90	90	88	-2	3.0
4		135	135	135	0	3.0
5		180	180	182	2	3.0
6		225	225	228	3	3.0
7		270	270	273	3	3.0
8		315	315	318	3	3.0
9	Counter Clockwise	0/360	360	359	-1	3.0
10		45	45	42	-3	3.0
11		90	90	88	-2	3.0
12		135	135	135	0	3.0
13		180	180	182	2	3.0
14		225	225	228	3	3.0
15		270	270	273	3	3.0
16		315	315	318	3	3.0

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

End of Certificate of Calibration

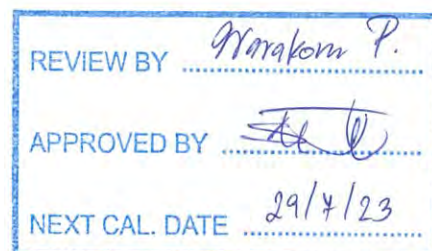


CERTIFICATE OF CALIBRATION

Certificate No: WS-06012022

Page 1 of 2 pages

Measurement Item	: Cup anemometer with data logger.		
Manufacturer	: Data logger: Novalynx : Cup anemometer: Novalynx		
Model/Type	: Data logger: 200-WS-25LB : Cup anemometer: WS-02F		
Serial Number	: Data logger: A5191 : Cup anemometer: -		
ID No	: Data logger: RYG_FS0328 : Cup anemometer: -		
Customer	: ALS laboratory group (Thailand) co., ltd. : 104 Phatthanakan 40, Phatthanakan Rd, Khwaeng Suan Luang, Khet Suan Luang, Bangkok 10250 Thailand.		
Test Conditions	: Wind tunnel cross test section area	900	cm ²
	: Anemometer frontal area	100	cm ²
	: Diameter of mounting pipe	-	mm
	: Blockage ratio of test object	0.111	[-]
Test Conditions	: Air temperature	23.9	±0.8 °C
	: Air pressure	1014.8	±0.4 hPa
	: Relative air humidity	58.9	±3.5 %RH
Calibration Procedure	Calibration was carried out base on; IEC 61400-12-1 ED.1: 2005-Power Performance Measurements of Electricity Producing Wind Turbines; M&SNET Anemometer Calibration Procedure – Version 2: 2009;		
Traceability	This calibration documents the traceable to national standard, Which realize the unit of measurements according to the international system of units (SI) through National Institute of Metrology Thailand (NIMT).		
Measurement Date	: JAN 28, 2022.		
Issued Date	: JAN 31, 2022.		



Calibrated by

- ☒ Mr. Sorawit Thachalad
☐ Miss Orathai Wiwatwittaya



Approved Signatory:


Mr. Parinya Booncharoen
Calibration Department Manager

Continuation of Certificate of Calibration Number

Certificate No: WS-06012022

Page 2 of 2 Pages

Result of calibration: ☒ Without adjustment ☐ With adjustment

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

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

V _{STD} Reading m/s	V _{UUC*} Reading m/s	Error (m/s)	Uncertainty (%)
2.078	2.0	-0.1	2.4
4.125	4.0	-0.1	1.5
6.00	5.8	-0.2	1.5
8.01	7.9	-0.1	1.0
10.00	9.8	-0.2	0.69
11.99	11.9	-0.1	0.67
14.00	13.6	-0.4	2.8
15.98	15.7	-0.3	1.2
14.99	14.8	-0.2	1.1
13.00	12.8	-0.2	1.5
11.01	10.8	-0.2	1.2
9.02	8.7	-0.3	0.90
7.02	6.7	-0.3	0.94
5.150	5.1	-0.1	1.1
2.976	3.0	0.0	2.0
1.024	0.8	-0.2	4.8

UUC*: Unit Under Calibration

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

Appendix 1: Instrumentations

NO	Sensor	Manufacturer	Model/Type	Calibration Date	Certificate Report Number	Range
1	Pitot static	TESTO INC.	06352145	Aug 07, 2021	MW-0034-21	5 – 30 m/s
2	Precision Differential Pressure Meter	Zoglab	DPM2500	Aug 07, 2021	MW-0034-21	5 – 30 m/s
3	Air velocity transducer (hot wire)	TSI INC.	8455-12	Aug 08, 2021	MW-0035-21	0 – 5 m/s
4	Temperature	Zoglab	DSR-THP	March 30, 2021	CL-027-64	-30 – 70°C
5	Relative humidity	Zoglab	DSR-THP	March 30, 2021	RH-03032021	0 – 100 %RH
6	Atmospheric pressure	Zoglab	DSR-THP	March 30, 2021	BP-01032021	500 – 1100 hPa
7	Wind tunnel	ESSOM	MP330D	-	-	0 – 50 Hz

End of certificate of calibration



CERTIFICATE OF CALIBRATION

Certificate No.: WD-06012022

Page 1 of 2 pages

Measurement Item : Wind direction sensor with data logger.

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

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

Serial Number : Data logger: A5191
: Wind direction sensor: -

ID No : Data logger: RYG_FS0328
: Wind direction sensor: -

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

Environmental Condition:

The measurement was carried out in an ambient temperature of $(23\pm3) ^\circ\text{C}$, and relative humidity of $(40\pm10) \%$.

Measurement Method:

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

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

Traceability:

The measurement results are traceable to the international system of units (SI) through Certificate No.: Q21086014, Certificate No.: KWS64/0025.

Measurement Date : JAN 26, 2022.

Issued Date : JAN 31, 2022.

Performed by

- ☒ Mr. Sorawit Thachalad
☐ Miss Orathai Wiwatwittaya



Approved Signatory:.....

Mr. Parinya Booncharoen.
Calibration Department Manager

Continuation of Certificate of Calibration Number

Certificate No: WD-06012022

Pages 2 of 2 pages

Result of calibration: ☐ Without adjustment ☒ With adjustment.

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

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

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

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

End of Certificate of Calibration



CERTIFICATE OF CALIBRATION

Certificate No: WS-05012022

Page 1 of 2 pages

Measurement Item : Cup anemometer with data logger.

Manufacturer : Data logger: Novalynx
: Cup anemometer: Novalynx

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

Serial Number : Data logger: A5190
: Cup anemometer: -

ID No : Data logger: RYG_FS0329
: Cup anemometer: -

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

Test Conditions	: Wind tunnel cross test section area	900	cm ²
	: Anemometer frontal area	100	cm ²
	: Diameter of mounting pipe	-	mm
	: Blockage ratio of test object	0.111	[-]

Test Conditions	: Air temperature	23.6	±0.8 °C
	: Air pressure	1014.5	±0.4 hPa
	: Relative air humidity	53.4	±3.5 %RH

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

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

Measurement Date : JAN 28, 2022.

Issued Date : JAN 31, 2022.



Calibrated by

- ☒ Mr. Sorawit Thachalad
☐ Miss Orathai Wiwatwittaya



Approved Signatory:

25m
Mr. Parinya Booncharoen
Calibration Department Manager

Continuation of Certificate of Calibration Number

Certificate No: WS-05012022

Page 2 of 2 Pages

Result of calibration: ☒ Without adjustment ☐ With adjustment

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

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

V _{STD} Reading m/s	V _{UUC} * Reading m/s	Error (m/s)	Uncertainty (%)
2.076	2.0	-0.1	2.4
4.101	4.1	0.0	1.2
5.99	6.0	0.0	0.95
8.01	8.0	0.0	0.83
10.01	10.1	0.1	0.79
12.01	12.1	0.1	0.57
13.99	14.1	0.1	0.70
15.99	16.4	0.4	0.43
15.00	15.2	0.2	0.79
13.01	13.0	0.0	0.83
11.02	11.0	0.0	0.76
9.03	9.0	0.0	0.81
7.02	7.0	0.0	0.82
5.130	5.1	0.0	0.96
2.991	3.0	0.0	1.6
1.036	0.9	-0.1	4.5

UUC*: Unit Under Calibration

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

Appendix 1: Instrumentations

NO	Sensor	Manufacturer	Model/Type	Calibration Date	Certificate Report Number	Range
1	Pitot static	TESTO INC.	06352145	Aug 07, 2021	MW-0034-21	5 – 30 m/s
2	Precision Differential Pressure Meter	Zoglab	DPM2500	Aug 07, 2021	MW-0034-21	5 – 30 m/s
3	Air velocity transducer (hot wire)	TSI INC.	8455-12	Aug 08, 2021	MW-0035-21	0 – 5 m/s
4	Temperature	Zoglab	DSR-THP	March 30, 2021	CL-027-64	-30 – 70°C
5	Relative humidity	Zoglab	DSR-THP	March 30, 2021	RH-03032021	0 – 100 %RH
6	Atmospheric pressure	Zoglab	DSR-THP	March 30, 2021	BP-01032021	500 – 1100 hPa
7	Wind tunnel	ESSOM	MP330D	-	-	0 – 50 Hz

End of certificate of calibration



CERTIFICATE OF CALIBRATION

Certificate No.: WD-05012022

Page 1 of 2 pages

Measurement Item : Wind direction sensor with data logger.

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

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

Serial Number : Data logger: A5190
: Wind direction sensor: -

ID No : Data logger: RYG_FS0329
: Wind direction sensor: -

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

Environmental Condition:

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

Measurement Method:

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

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

Traceability:

The measurement results are traceable to the international system of units (SI) through Certificate No.: Q21086014, Certificate No.: KWS64/0025.

Measurement Date : JAN 26, 2022.

Issued Date : JAN 31, 2022.

Performed by

- ☒ Mr. Sorawit Thachalad
☐ Miss Orathai Wiwatwittaya



Approved Signatory:.....



Mr. Parinya Booncharoen.
Calibration Department Manager

Continuation of Certificate of Calibration Number

Certificate No: WD-05012022

Pages 2 of 2 pages

Result of calibration: ☐ Without adjustment ☒ With adjustment.

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

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

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

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

End of Certificate of Calibration



CERTIFICATE OF CALIBRATION

Certificate No: WS-04072021

Page 1 of 2 pages

Measurement Item : Cup anemometer with data logger.

Manufacturer : Data logger: Novalynx.
: Cup anemometer: Novalynx.

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

Serial Number : Data logger: A4987.
: Cup anemometer: -.

ID No : Data logger: RYG_FS0089.
: Cup anemometer: -.

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

Test Conditions	: Wind tunnel cross test section area	900	cm ²
	: Anemometer frontal area	100	cm ²
	: Diameter of mounting pipe	-	mm
	: Blockage ratio of test object	0.111	[-]

Test Conditions	: Air temperature	24.0	±0.8 °C
	: Air pressure	1005.9	±0.4 hPa
	: Relative air humidity	63.3	±3.5 %RH

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

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

Measurement Date : Jul 13, 2021.
Issued Date : Jul 14, 2021.

Calibrated by
☒ Mr. Sorawit Thachalad
☐ Miss Orathai Wiwatwittaya



Approved Signatory:

Don
Mr. Parinya Booncharoen
Technical Support
and Calibration Manager

Continuation of Certificate of Calibration Number

Certificate No: WS-04072021

Page 2 of 2 Pages

Result of calibration: ☒ Without adjustment ☐ With adjustment

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

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

V _{STD} Reading m/s	V _{UUC} Reading m/s	Error (m/s)	Uncertainty (%)
2.084	1.8	-0.3	2.7
4.112	4.0	-0.1	1.4
6.00	6.0	0.0	1.2
8.02	8.1	0.1	0.70
10.02	10.1	0.1	0.63
11.98	12.3	0.3	0.57
13.98	14.2	0.2	0.49
16.02	16.5	0.5	0.53
15.03	15.4	0.4	0.80
12.99	13.3	0.3	0.63
11.02	11.1	0.1	0.66
9.02	9.1	0.1	0.63
7.02	7.1	0.1	0.77
5.177	5.0	-0.2	0.97
3.007	3.0	0.0	1.7
1.053	0.6	-0.5	5.4

UUC*: Unit Under Calibration

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

Appendix 1: Instrumentations

NO	Sensor	Manufacturer	Model/Type	Calibration Date	Certificate Report Number	Range
1	Pitot static	T&STO INC.	06352145	July 16, 2020	MW-0035-20	5 – 30 m/s
2	Precision Differential Pressure Meter	Zoglab	DPM2500	July 16, 2020	MW-0035-20	5 – 30 m/s
3	Air velocity transducer (hot wire)	TSI INC.	8455-12	July 20, 2020	MW-0036AA-20	0 – 5 m/s
4	Temperature	Zoglab	DSR-THP	March 30, 2021	CL-027-64	-30 – 70°C
5	Relative humidity	Zoglab	DSR-THP	March 30, 2021	RH-03032021	0 – 100 %RH
6	Atmospheric pressure	Zoglab	DSR-THP	March 30, 2021	BP-01032021	500 – 1100 hPa
7	Wind tunnel	ESSOM	MP330D	-	-	0 – 50 Hz

End of certificate of calibration



CERTIFICATE OF CALIBRATION

Certificate No.: WD-04072021

Page 1 of 2 pages

Measurement Item : Wind direction sensor with data logger.

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

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

Serial Number : Data logger: A4987.
: Wind direction sensor: -.

ID No : Data logger: RYG_PS0089.
: Wind direction sensor: -.

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

Environmental Condition:

The measurement was carried out in an ambient temperature of $(23\pm3)^{\circ}\text{C}$, and relative humidity of $(40\pm10)\%$.

Measurement Method:

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

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

Traceability:

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

Measurement Date : Jul 14, 2021.

Issued Date : Jul 14, 2021.



Performed by

- ☒ Mr. Sorawit Thachalad
☐ Miss Orathai Wiwatwittaya

Approved Signatory:.....

Mr. Parinya Booncharoen.
Technical Support
and Calibration Manager

Continuation of Certificate of Calibration Number

Certificate No: WD-04072021

Pages 2 of 2 pages

Result of calibration: ☐ Without adjustment ☒ With adjustment.

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

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

NO	Turning Direction	Nominal Angle (°)	Standard Reading (°)	UUC* Reading (°)	Error (°)	Uncertainty ±(°)
1	Clockwise	0/360	0	0	0	3.0
2		45	45	42	-3	3.0
3		90	90	88	-2	3.0
4		135	135	133	-2	3.0
5		180	180	181	1	3.0
6		225	225	228	3	3.0
7		270	270	273	3	3.0
8		315	315	318	3	3.0
9	Counter Clockwise	0/360	0	0	0	3.0
10		45	45	42	-3	3.0
11		90	90	88	-2	3.0
12		135	135	133	-2	3.0
13		180	180	181	1	3.0
14		225	225	228	3	3.0
15		270	270	273	3	3.0
16		315	315	318	3	3.0

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

End of Certificate of Calibration



CERTIFICATE OF CALIBRATION

Certificate No: WS-03072021

Page 1 of 2 pages

Measurement Item : Cup anemometer with data logger.

Manufacturer : Data logger: Novalynx.
Cup anemometer: Novalynx.

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

Serial Number : Data logger: A4986.
Cup anemometer: -.

ID No : Data logger: RYG_FS0087.
Cup anemometer: -.

Customer : ALS laboratory group (Thailand) co., ltd.
104 Phatthanakan 40, Phatthanakan Rd, Khwaeng Suan Luang, Khet Suan Luang, Bangkok 10260 Thailand.

Test Conditions	: Wind tunnel cross test section area	900	cm ²
	: Anemometer frontal area	100	cm ²
	: Diameter of mounting pipe	-	mm
	: Blockage ratio of test object	0.111	[-]

Test Conditions	: Air temperature	24.1	±0.8 °C
	: Air pressure	1006.3	±0.4 hPa
	: Relative air humidity	60.2	±3.5 %RH

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

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

Measurement Date : Jul 13, 2021.

Issued Date : Jul 14, 2021.

Calibrated by

- ☒ Mr. Sorawit Thachalad
☐ Miss Orathai Wiwatwittaya



Approved Signatory:

Parinya Booncharoen

Mr. Parinya Booncharoen
Technical Support
and Calibration Manager

Continuation of Certificate of Calibration Number

Certificate No: WS-03072021

Page 2 of 2 Pages

Result of calibration: ☒ Without adjustment ☐ With adjustment

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

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

V _{STD} Reading m/s	V _{UUC*} Reading m/s	Error (m/s)	Uncertainty (%)
2.087	2.0	-0.1	2.4
4.150	4.1	-0.1	1.2
5.99	6.0	0.0	1.1
8.01	8.0	0.0	0.73
10.02	10.2	0.2	0.58
11.98	12.3	0.3	0.56
13.97	14.3	0.3	0.55
16.02	16.6	0.6	0.48
14.96	15.5	0.5	0.37
13.03	13.4	0.4	0.66
10.97	11.2	0.2	0.69
9.02	9.1	0.1	0.65
7.02	7.0	0.0	0.81
5.165	5.0	-0.2	0.88
3.018	3.0	0.0	1.5
1.037	0.9	-0.1	4.7

UUC*: Unit Under Calibration

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

Appendix 1: Instrumentations

NO	Sensor	Manufacturer	Model/Type	Calibration Date	Certificate Report Number	Range
1	Pitot static	TESTO INC.	06352145	July 16, 2020	MW-0035-20	5 – 30 m/s
2	Precision Differential Pressure Meter	Zoglab	DPM2500	July 16, 2020	MW-0035-20	5 – 30 m/s
3	Air velocity transducer (hot wire)	TSI INC.	8455-12	July 20, 2020	MW-0036AA-20	0 – 5 m/s
4	Temperature	Zoglab	DSR-THP	March 30, 2021	CL-027-64	-30 – 70°C
5	Relative humidity	Zoglab	DSR-THP	March 30, 2021	RH-03032021	0 – 100 %RH
6	Atmospheric pressure	Zoglab	DSR-THP	March 30, 2021	BP-01032021	500 – 1100 hPa
7	Wind tunnel	ESSOM	MP330D	-	-	0 – 50 Hz

End of certificate of calibration



CERTIFICATE OF CALIBRATION

Certificate No.: WD-03072021

Page 1 of 2 pages

Measurement Item : Wind direction sensor with data logger.

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

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

Serial Number : Data logger: A4986.
: Wind direction sensor: -.

ID No : Data logger: RYG_FS0087.
: Wind direction sensor: -.

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

Environmental Condition:

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

Measurement Method:

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

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

Traceability:

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

Measurement Date : Jul 14, 2021.

Issued Date : Jul 14, 2021.



Performed by

- ☒ Mr. Sorawit Thachalad
☐ Miss Orathai Wiwatwittaya

Approved Signatory:

Mr. Parinya Booncharoen.
Technical Support
and Calibration Manager

Continuation of Certificate of Calibration Number

Certificate No: WD-03072021

Pages 2 of 2 pages

Result of calibration: ☐ Without adjustment ☒ With adjustment.

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

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

NO	Turning Direction	Nominal Angle (°)	Standard Reading (°)	UUC* Reading (°)	Error (°)	Uncertainty ±(°)
1	Clockwise	0/360	360	359	-1	3.0
2		45	45	42	-3	3.0
3		90	90	87	-3	3.0
4		135	135	132	-3	3.0
5		180	180	178	-2	3.0
6		225	225	227	2	3.0
7		270	270	273	3	3.0
8		315	315	318	3	3.0
9	Counter Clockwise	0/360	360	359	-1	3.0
10		45	45	42	-3	3.0
11		90	90	87	-3	3.0
12		135	135	132	-3	3.0
13		180	180	178	-2	3.0
14		225	225	227	2	3.0
15		270	270	273	3	3.0
16		315	315	318	3	3.0

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

End of Certificate of Calibration





Lot No. 2249336-1

ANALYZER CALIBRATION DATA

Client : Rayong Olefins Co.,Ltd. Location : CH12 : Cracking Furnace (Heater) 12 (H-100K)
Date : 29 Jun 22 Test Operator : Saksit P.

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	0.03	0.01	0.08
Low-Level Gas	7.93	7.96	7.94	0.08
Span Gas	16.00	16.03	16.01	0.08

NO_x ANALYZER

Model : TELEDYNE API 200EH Serial No. : 549
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	0.01	0.02
Low-Level Gas	50.41	50.44	50.42	0.02
Span Gas	80.27	80.30	80.28	0.02

SO₂ ANALYZER

Model : TELEDYNE API 100EH Serial No. : 282
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	51.61	51.60	51.61	0.01
Span Gas	79.00	78.99	79.00	0.01

CO ANALYZER

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

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.02	0.00	0.02
Low-Level Gas	50.31	50.33	50.31	0.02
Span Gas	80.53	80.55	80.53	0.02

Calibrated by

(Mr.Saksit Phaisanphisut)

Environmental Field Scientist (4)



Lot No. 2249336-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client : Rayong Olefins Co.,Ltd. Location : CH12 : Cracking Furnace (Heater) 12 (H-100K)
Date : 29 Jun 22 Test Operator : Saksit P.

O₂ ANALYZER

Cylinder Conc. (%) : 16.00 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	0.03	0.03	0.00	0.01	0.08	0.08
Upscale Gas	16.03	16.03	0.00	16.01	0.08	0.08

NO_x ANALYZER

Cylinder Conc. (ppm) : 80.27 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	0.03	0.03	0.00	0.01	0.02	0.02
Upscale Gas	80.30	80.30	0.00	80.28	0.02	0.02

SO₂ ANALYZER

Cylinder Conc. (ppm) : 79.00 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	-0.01	-0.01	0.00	0.00	0.01	0.01
Upscale Gas	78.99	78.99	0.00	79.00	0.01	0.01

CO ANALYZER

Cylinder Conc. (ppm) : 80.53 Span (ppm) : 100

	CO Analyzer Calibration Response	Initial Values		Final Values		Drift (% of Span)
		System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	
Zero Gas	0.02	0.02	0.00	0.00	0.02	0.02
Upscale Gas	80.55	80.55	0.00	80.53	0.02	0.02

Calibrated by

(Mr.Saksit Phaisanphisut)

Environmental Field Scientist (4)

FORM NO.: F 06-062 REVISION NO.: 2 ISSUE DATE: 3/06/19

ALS Laboratory Group



EMISSION TEST RESULT

Client	Rayong Olefins Co.,Ltd.	Run #	1
Date	29 Jun 22	Location	CH12 : Cracking Furnace (Heater) 12 (H-100K)
Start Time	15:00	Test Operator	Saksit P.
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	15:20
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	282
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	549
		Serial No.	300

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
15:00	3.99	8.67	42.62	-	0.26	
15:01	4.19	8.56	43.49	-	0.19	
15:02	4.14	8.55	43.82	-	0.24	
15:03	3.93	8.83	43.69	-	0.17	
15:04	3.96	8.86	43.93	-	0.27	
15:05	3.90	8.89	44.37	-	0.27	
15:06	4.08	8.67	44.86	-	0.37	
15:07	4.09	8.61	45.52	-	0.25	
15:08	4.26	8.49	46.10	-	0.26	
15:09	4.35	8.47	46.56	-	0.18	
15:10	4.17	9.03	47.02	-	0.22	
15:11	4.10	8.75	46.45	-	0.17	
15:12	4.16	8.66	46.05	-	0.37	
15:13	4.27	8.60	46.42	-	0.23	
15:14	4.42	8.49	47.18	-	0.29	
15:15	4.42	8.43	47.81	-	0.14	
15:16	4.48	8.36	48.43	-	0.27	
15:17	4.31	8.56	48.46	-	0.24	
15:18	4.17	8.70	48.01	-	0.28	
15:19	4.14	8.73	46.94	-	0.18	
15:20	4.22	8.56	46.62	-	0.21	
Average	4.18	8.64	45.92	-	0.24	

(Mr.Saksit Phalsanphisut)

Environmental Field Scientist (4)



EMISSION TEST RESULT

Client	Rayong Olefins Co.,Ltd.	Run #	2
Date	29 Jun 22	Location	CH12 : Cracking Furnace (Heater) 12 (H-100K)
Start Time	15:21	Test Operator	Saksit P.
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	15:41
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	282
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	549
		Serial No.	300

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
15:21	4.28	8.61	46.73	-	0.41	
15:22	4.39	8.12	47.27	-	0.39	
15:23	4.36	8.50	47.54	-	0.33	
15:24	4.32	8.43	47.40	-	0.23	
15:25	4.22	8.28	46.98	-	0.27	
15:26	4.22	8.88	46.73	-	0.24	
15:27	4.15	8.74	46.08	-	0.30	
15:28	4.15	8.63	45.69	-	0.35	
15:29	4.15	8.70	45.47	-	0.28	
15:30	4.08	8.77	45.10	-	0.19	
15:31	4.16	8.64	45.43	-	0.17	
15:32	4.08	8.67	45.17	-	0.33	
15:33	4.22	8.64	45.09	-	0.20	
15:34	4.23	8.66	45.05	-	0.14	
15:35	4.37	8.57	45.56	-	0.32	
15:36	4.47	8.37	46.38	-	0.16	
15:37	4.37	8.45	46.20	-	0.24	
15:38	4.42	8.38	45.81	-	0.29	
15:39	4.43	8.32	45.89	-	0.21	
15:40	4.22	8.47	45.56	-	0.30	
15:41	4.03	8.68	44.79	-	0.18	
Average	4.25	8.54	46.00	-	0.26	

(Mr.Saksit Phalsanphisut)

Environmental Field Scientist (4)



EMISSION TEST RESULT

Client	Rayong Olefins Co.,Ltd.	Run #	3
Date	29 Jun 22	Location	CH12 : Cracking Furnace (Heater) 12 (H-100K)
Start Time	15:42	Test Operator	Saksit P.
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	16:02
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	282
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	549
		Serial No.	300

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
15:42	4.14	8.78	44.20	-	0.35	
15:43	4.16	8.72	44.47	-	0.27	
15:44	4.32	8.49	45.01	-	0.30	
15:45	4.38	8.42	45.66	-	0.31	
15:46	4.32	8.53	45.68	-	0.42	
15:47	4.12	8.74	44.76	-	0.33	
15:48	4.12	8.50	44.22	-	0.38	
15:49	4.07	8.84	43.85	-	0.37	
15:50	4.21	8.77	44.02	-	0.32	
15:51	4.37	11.23	44.76	-	0.32	
15:52	4.44	9.11	45.48	-	0.39	
15:53	4.38	8.53	45.78	-	0.31	
15:54	4.21	8.66	45.33	-	0.27	
15:55	4.27	8.72	45.07	-	0.27	
15:56	4.38	8.54	45.16	-	0.24	
15:57	4.39	8.50	45.46	-	0.31	
15:58	4.45	8.85	45.68	-	0.25	
15:59	4.36	8.46	45.79	-	0.27	
16:00	4.37	8.45	45.72	-	0.15	
16:01	4.19	8.63	45.11	-	0.21	
16:02	4.10	8.70	44.04	-	0.15	
Average	4.27	8.77	45.01	-	0.29	

Saksit P.

(Mr.Saksit Phalsanphisut)

Environmental Field Scientist (4)

Lot No. 2249328-1

ANALYZER CALIBRATION DATA

Client : Rayong Olefins Co.,Ltd. Location : CH4 : Cracking Furnace (Heater) 4 (H-100D)
Date : 27 Jun 22 Test Operator : Saksit P.

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	0.03	0.01	0.08
Low-Level Gas	7.93	7.96	7.94	0.08
Span Gas	16.00	16.03	16.01	0.08

NO_x ANALYZER
Model : TELEDYNE API 200EH Serial No. : 549
Span (ppm) : 100

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.04	0.01	0.03
Low-Level Gas	50.41	50.45	50.42	0.03
Span Gas	80.27	80.31	80.28	0.03

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

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.02	0.01	0.01
Low-Level Gas	50.31	50.33	50.32	0.01
Span Gas	80.53	80.55	80.54	0.01

Calibrated by

(Mr.Saksit Phaisanphisut)

Environmental Field Scientist (4)

FORM NO.: F 06-062 REVISION NO.: 2 ISSUE DATE: 3/06/19

ALS Laboratory Group



Lot No.

2249328-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client : Rayong Olefins Co.,Ltd.
Date : 27 Jun 22

Location : CH4 : Cracking Furnace (Heater) 4 (H-100D)
Test Operator : Saksit P.

O₂ ANALYZER

Cylinder Conc. (%) : 16.00

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	0.03	0.03	0.00	0.01	0.08	0.08
Upscale Gas	16.03	16.03	0.00	16.01	0.08	0.08

NO_x ANALYZER

Cylinder Conc. (ppm) : 80.27

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	0.04	0.04	0.00	0.01	0.03	0.03
Upscale Gas	80.31	80.31	0.00	80.28	0.03	0.03

CO ANALYZER

Cylinder Conc. (ppm) : 80.53

Span (ppm) : 100

	CO Analyzer Calibration Response	Initial Values		Final Values		Drift (% of Span)
		System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	
Zero Gas	0.02	0.02	0.00	0.01	0.01	0.01
Upscale Gas	80.55	80.55	0.00	80.54	0.01	0.01

Calibrated by

(Mr.Saksit Phaisanphitsut)

Environmental Field Scientist (4)

FORM NO.: F 06-062 REVISION NO.: 2 ISSUE DATE: 3/06/19

ALS Laboratory Group



EMISSION TEST RESULT

Client	Rayong Olefins Co.,Ltd.	Run #	1
Date	27 Jun 22	Location	CH4 : Cracking Furnace (Heater) 4 (H-100D)
Start Time	11:30	Test Operator	Saksit P.
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	11:50
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	282
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	549
		Serial No.	300

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:30	4.34	8.74	55.74	-	0.14	
11:31	4.20	8.78	56.04	-	0.15	
11:32	4.20	8.71	56.35	-	0.25	
11:33	4.35	8.62	56.63	-	0.25	
11:34	4.33	8.51	56.94	-	0.35	
11:35	4.46	8.48	57.39	-	0.24	
11:36	4.61	8.34	57.87	-	0.20	
11:37	4.47	8.56	57.72	-	0.27	
11:38	4.37	8.67	57.27	-	0.30	
11:39	4.31	8.63	57.03	-	0.36	
11:40	4.29	8.70	56.82	-	0.52	
11:41	4.24	8.77	56.57	-	0.51	
11:42	4.15	8.66	56.29	-	0.49	
11:43	4.18	8.72	56.58	-	0.42	
11:44	4.43	8.52	57.00	-	0.46	
11:45	4.43	8.48	57.61	-	0.53	
11:46	4.49	8.39	57.67	-	0.42	
11:47	4.65	8.42	57.57	-	0.54	
11:48	4.45	8.53	57.09	-	0.61	
11:49	4.35	8.73	56.64	-	0.24	
11:50	4.34	8.64	56.30	-	0.27	
Average	4.36	8.60	56.91	-	0.36	

(Mr.Saksit Phalsanphisut)

Environmental Field Scientist (4)



EMISSION TEST RESULT

Client	Rayong Olefins Co.,Ltd.	Run #	2
Date	27 Jun 22	Location	CH4 : Cracking Furnace (Heater) 4 (H-100D)
Start Time	11:51	Test Operator	Saksit P.
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	12:11
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	282
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	549
		Serial No.	300

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:51	4.29	8.59	56.34	-	0.30	
11:52	4.21	8.66	56.45	-	0.33	
11:53	4.25	8.62	56.19	-	0.41	
11:54	4.52	8.44	56.47	-	0.38	
11:55	4.59	8.36	56.74	-	0.40	
11:56	4.54	8.56	56.47	-	0.35	
11:57	4.30	8.69	56.05	-	0.47	
11:58	4.33	8.63	55.95	-	0.48	
11:59	4.47	8.73	55.85	-	0.48	
12:00	4.41	8.30	56.20	-	0.44	
12:01	4.47	8.30	56.54	-	0.59	
12:02	4.77	8.49	56.79	-	0.52	
12:03	4.74	8.31	56.77	-	0.61	
12:04	4.74	8.36	56.78	-	0.64	
12:05	4.84	7.78	56.75	-	0.38	
12:06	4.63	9.03	56.54	-	0.26	
12:07	4.58	8.43	56.17	-	0.33	
12:08	4.61	8.57	56.19	-	0.29	
12:09	4.44	8.58	56.43	-	0.33	
12:10	4.58	8.28	56.74	-	0.32	
12:11	4.74	8.34	57.23	-	0.29	
Average	4.53	8.47	56.46	-	0.41	

(Mr.Saksit Phalsanphisut)

Environmental Field Scientist (4)



EMISSION TEST RESULT

Client	Rayong Olefins Co.,Ltd.	Run #	3
Date	27 Jun 22	Location	CH4 : Cracking Furnace (Heater) 4 (H-100D)
Start Time	12:12	Test Operator	Saksit P.
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.	549
		Serial No.	300

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
12:12	4.80	8.25	57.36	-	0.30	
12:13	4.57	8.42	57.27	-	0.35	
12:14	4.63	9.30	56.89	-	0.37	
12:15	4.59	8.44	56.52	-	0.52	
12:16	4.33	8.72	56.07	-	0.45	
12:17	4.52	8.45	56.00	-	0.52	
12:18	4.48	8.46	56.34	-	0.36	
12:19	4.61	8.32	56.49	-	0.35	
12:20	4.70	8.51	56.28	-	0.36	
12:21	4.61	7.01	55.84	-	0.44	
12:22	4.61	8.45	55.56	-	0.44	
12:23	4.52	8.73	55.36	-	0.42	
12:24	4.47	8.51	55.22	-	0.53	
12:25	4.58	8.44	55.13	-	0.44	
12:26	4.67	8.39	55.42	-	0.42	
12:27	4.76	8.39	55.84	-	0.37	
12:28	4.70	8.49	55.89	-	0.35	
12:29	4.61	8.53	55.47	-	0.31	
12:30	4.47	9.03	54.86	-	0.36	
12:31	4.46	8.52	54.41	-	0.49	
12:32	4.52	8.54	54.45	-	0.56	
Average	4.58	8.47	55.84	-	0.41	

(Mr.Saksit Phalsanphisut)

Environmental Field Scientist (4)



Lot No. 2249334-1

ANALYZER CALIBRATION DATA

Client : Rayong Olefins Co.,Ltd. Location : CH10 : Cracking Furnace (Heater) 10 (H-120R)
Date : 27 Jun 22 Test Operator : Saksit P.

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	0.03	0.01	0.08
Low-Level Gas	7.93	7.96	7.94	0.08
Span Gas	16.00	16.03	16.01	0.08

NO_x ANALYZER

Model : TELEDYNE API 200EH Serial No. : 549
Span (ppm) : 100

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.04	0.01	0.03
Low-Level Gas	50.41	50.45	50.42	0.03
Span Gas	80.27	80.31	80.28	0.03

CO ANALYZER

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

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.02	0.01	0.01
Low-Level Gas	50.31	50.33	50.32	0.01
Span Gas	80.53	80.55	80.54	0.01

Calibrated by

(Mr.Saksit Phalsanphitsut)

Environmental Field Scientist (4)

FORM NO.: F 06-062 REVISION NO.: 2 ISSUE DATE: 3/06/19

ALS Laboratory Group



Lot No.

2249334-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client : Rayong Olefins Co.,Ltd.
Date : 27 Jun 22

Location : CH10 : Cracking Furnace (Heater) 10 (H-120R)
Test Operator : Saksit P.

O₂ ANALYZER

Cylinder Conc. (%) : 16.00

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	0.03	0.03	0.00	0.01	0.08	0.08
Upscale Gas	16.03	16.03	0.00	16.01	0.08	0.08

NO_x ANALYZER

Cylinder Conc. (ppm) : 80.27

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	0.04	0.04	0.00	0.01	0.03	0.03
Upscale Gas	80.31	80.31	0.00	80.28	0.03	0.03

CO ANALYZER

Cylinder Conc. (ppm) : 80.53

Span (ppm) : 100

	CO Analyzer Calibration Response	Initial Values		Final Values		Drift (% of Span)
		System Calibration Response	System Cal Bias (% of Span)	System Calibration Response	System Cal Bias (% of Span)	
Zero Gas	0.02	0.02	0.00	0.01	0.01	0.01
Upscale Gas	80.55	80.55	0.00	80.54	0.01	0.01

Calibrated by

(Mr.Saksit Phalsanphisut)

Environmental Field Scientist (4)

FORM NO.: F 06-062 REVISION NO.: 2 ISSUE DATE: 3/06/19

ALS Laboratory Group



EMISSION TEST RESULT

Client	Rayong Olefins Co.,Ltd.	Run #	1
Date	27 Jun 22	Location	CH10 : Cracking Furnace (Heater) 10 (H-120R)
Start Time	14:30	Test Operator	Saksit P.
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	14:50
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	282
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	549
		Serial No.	300

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
14:30	2.91	9.52	33.40	-	3.30	
14:31	3.63	8.96	32.98	-	0.25	
14:32	3.67	9.13	33.50	-	0.51	
14:33	3.13	9.20	33.70	-	0.38	
14:34	4.19	8.55	33.51	-	0.22	
14:35	3.89	9.12	34.12	-	0.47	
14:36	3.37	9.21	34.23	-	0.48	
14:37	4.21	8.66	33.96	-	0.40	
14:38	3.74	9.24	34.61	-	0.10	
14:39	3.40	9.01	34.36	-	0.13	
14:40	4.39	8.54	34.48	-	0.09	
14:41	3.76	8.90	35.01	-	0.41	
14:42	3.81	8.88	34.47	-	0.39	
14:43	4.43	8.59	33.62	-	0.31	
14:44	3.57	9.08	33.41	-	0.35	
14:45	3.94	8.81	33.15	-	0.43	
14:46	4.52	8.62	33.34	-	0.37	
14:47	3.71	8.95	33.76	-	0.22	
14:48	4.39	8.40	33.67	-	0.22	
14:49	4.75	8.47	33.77	-	0.30	
14:50	4.17	8.63	33.92	-	0.33	
Average	3.88	8.87	33.86	-	0.46	

(Mr.Saksit Phalsanphisut)

Environmental Field Scientist (4)



EMISSION TEST RESULT

Client	Rayong Olefins Co.,Ltd.	Run #	2
Date	27 Jun 22	Location	CH10 : Cracking Furnace (Heater) 10 (H-120R)
Start Time	14:51	Test Operator	Saksit P.
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	15:11
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	282
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	549
		Serial No.	300

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
14:51	4.87	8.20	34.05	-	0.43	
14:52	4.77	8.48	34.58	-	0.30	
14:53	4.12	10.56	34.53	-	0.40	
14:54	4.74	8.47	34.27	-	0.38	
14:55	4.25	8.83	34.12	-	0.39	
14:56	4.23	8.61	33.76	-	0.36	
14:57	4.82	8.41	33.93	-	0.47	
14:58	4.30	9.02	34.09	-	0.43	
14:59	5.15	8.09	34.34	-	0.29	
15:00	4.65	8.42	34.51	-	0.45	
15:01	5.07	8.13	34.63	-	0.13	
15:02	4.77	8.60	34.62	-	0.19	
15:03	4.31	8.71	34.23	-	0.16	
15:04	5.04	5.51	34.00	-	0.19	
15:05	4.65	8.58	34.32	-	0.24	
15:06	4.43	8.43	34.24	-	0.19	
15:07	5.23	8.09	34.17	-	0.15	
15:08	4.64	8.40	34.56	-	0.16	
15:09	4.70	8.30	34.82	-	0.30	
15:10	5.32	8.17	34.71	-	0.45	
15:11	4.53	8.59	34.43	-	0.34	
Average	4.70	8.40	34.33	-	0.30	

(Mr.Saksit Phalsanphisut)

Environmental Field Scientist (4)



EMISSION TEST RESULT

Client	Rayong Olefins Co.,Ltd.	Run #	3
Date	27 Jun 22	Location	CH10 : Cracking Furnace (Heater) 10 (H-120R)
Start Time	15:12	Test Operator	Saksit P.
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	15:32
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	282
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	549
		Serial No.	300

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
15:12	4.75	8.38	34.15	-	0.28	
15:13	5.03	8.43	34.18	-	0.25	
15:14	4.67	8.27	34.24	-	0.25	
15:15	5.24	8.13	34.45	-	0.32	
15:16	4.64	8.54	34.63	-	0.15	
15:17	4.96	8.06	34.46	-	0.34	
15:18	5.27	8.17	34.44	-	0.22	
15:19	4.70	8.39	34.43	-	0.24	
15:20	5.07	8.16	34.50	-	0.27	
15:21	4.98	8.43	34.70	-	0.35	
15:22	4.63	8.30	34.40	-	0.43	
15:23	5.09	8.20	33.95	-	0.31	
15:24	4.53	8.66	33.81	-	0.29	
15:25	4.88	8.14	33.89	-	0.27	
15:26	5.20	8.50	34.10	-	0.18	
15:27	4.71	8.27	34.42	-	0.16	
15:28	5.28	7.34	34.65	-	0.25	
15:29	4.62	8.35	34.76	-	0.31	
15:30	4.97	8.34	34.57	-	0.19	
15:31	4.36	8.64	34.25	-	0.28	
15:32	4.75	8.45	34.47	-	0.23	
Average	4.87	8.29	34.35	-	0.27	

Saksit P.

(Mr.Saksit Phaisanphisut)

Environmental Field Scientist (4)



Lot No. 2249715-1

ANALYZER CALIBRATION DATA

Client : Rayong Olefins Co.,Ltd. Location : GHU2 : GHU2 Feed Heater (H-840)
Date : 09 May 22 Test Operator : Sathapron.T

O₂ ANALYZER

Model : TELEDYNE API 200EH Serial No. : 725
Span (%) : 25

	Cylinder Value (%)	Initial Analyzers Calibration Response (%)	Final Analyzers Calibration Response (%)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.05	0.20
Low-Level Gas	8.04	8.06	8.08	0.08
Span Gas	16.00	16.00	16.04	0.16

NO_x ANALYZER

Model : TELEDYNE API 200EH Serial No. : 725
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	0.04	0.04
Low-Level Gas	54.96	54.93	54.90	0.03
Span Gas	79.42	79.42	79.38	0.04

CO ANALYZER

Model : TELEDYNE API 300EM Serial No. : 451
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	0.04	0.04
Low-Level Gas	54.84	54.82	54.80	0.02
Span Gas	80.16	80.16	80.10	0.06

Calibrated by

Sathapron Th.

(Mr. Sathapron Thakarw)

Environmental Field Scientist (3)

FORM NO.: F 06-062 REVISION NO.: 2 ISSUE DATE: 3/06/19

ALS Laboratory Group

Lot No. 2249715-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client : Rayong Olefins Co.,Ltd. Location : GHU2 : GHU2 Feed Heater (H-840)
Date : 09 May 22 Test Operator : Sathapron.T

O₂ ANALYZERCylinder Conc. (%) : 16.00 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	0.04	0.16	0.05	0.20	0.04
Upscale Gas	16.00	16.02	0.08	16.04	0.16	0.08

NO_x ANALYZERCylinder Conc. (ppm) : 79.42 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	0.02	0.02	0.04	0.04	0.02
Upscale Gas	79.42	79.40	0.02	79.38	0.04	0.02

CO ANALYZER

Cylinder Conc. (ppm) : 80.16 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	0.00	0.02	0.02	0.04	0.04	0.02
Upscale Gas	80.16	80.13	0.03	80.10	0.06	0.03

Calibrated by

Sathapron Th.

(Mr. Sathapron Thakarw)

Environmental Field Scientist (3)

FORM NO.: F 06-062 REVISION NO.: 2 ISSUE DATE: 3/06/19

ALS Laboratory Group



EMISSION TEST RESULT

Client	Rayong Olefins Co.,Ltd.	Run #	1
Date	09 May 22	Location	GHU2 : GHU2 Feed Heater (H-840)
Start Time	10:50	Test Operator	Sathapron.T
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	11:10
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	410
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	725
		Serial No.	451

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
10:50	13.35	3.91	27.71	-	9.70	
10:51	13.30	3.95	27.83	-	9.29	
10:52	13.30	3.94	27.98	-	9.17	
10:53	13.28	3.94	28.05	-	9.35	
10:54	13.23	4.01	27.88	-	10.13	
10:55	13.19	4.03	27.76	-	10.92	
10:56	13.13	4.09	27.75	-	10.45	
10:57	13.16	4.05	27.88	-	9.43	
10:58	13.19	4.00	28.15	-	8.70	
10:59	13.20	3.99	28.30	-	8.89	
11:00	13.16	4.00	28.47	-	8.40	
11:01	13.17	4.01	28.64	-	8.18	
11:02	13.18	4.01	28.76	-	8.75	
11:03	13.17	4.02	28.68	-	9.00	
11:04	13.14	4.03	28.51	-	8.69	
11:05	13.10	4.05	28.49	-	8.79	
11:06	13.11	4.06	28.48	-	8.74	
11:07	13.09	4.06	28.65	-	8.40	
11:08	13.07	4.07	28.76	-	8.45	
11:09	13.10	4.04	28.86	-	8.03	
11:10	13.14	3.98	29.13	-	7.21	
Average	13.18	4.01	28.32	-	8.98	

Sathapron Th.

(Mr. Sathapron Thakaw)

Environmental Field Scientist (3)



EMISSION TEST RESULT

Client	Rayong Olefins Co.,Ltd.	Run #	2
Date	09 May 22	Location	GHU2 : GHU2 Feed Heater (H-840)
Start Time	11:11	Test Operator	Sathapron.T
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	11:31
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	410
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	725
		Serial No.	451

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:11	13.17	3.97	29.24	-	7.58	
11:12	13.17	4.00	29.27	-	7.86	
11:13	13.10	4.07	29.21	-	8.36	
11:14	13.07	4.10	29.06	-	8.91	
11:15	13.08	4.07	29.03	-	8.02	
11:16	13.10	4.02	29.18	-	7.40	
11:17	13.11	4.02	29.33	-	7.16	
11:18	13.13	4.02	29.45	-	8.14	
11:19	13.08	4.06	29.32	-	8.35	
11:20	13.08	4.07	29.15	-	8.57	
11:21	13.10	4.06	29.19	-	8.36	
11:22	13.13	4.01	29.33	-	7.71	
11:23	13.15	4.00	29.62	-	7.98	
11:24	13.15	4.02	29.76	-	7.84	
11:25	13.13	4.04	29.63	-	8.14	
11:26	13.13	4.04	29.45	-	8.12	
11:27	13.12	4.03	29.49	-	7.71	
11:28	13.13	4.00	29.73	-	7.46	
11:29	13.21	3.96	29.82	-	7.15	
11:30	13.20	3.96	29.93	-	7.07	
11:31	13.15	4.01	29.97	-	7.73	
Average	13.13	4.03	29.44	-	7.89	

Sathapron Th.

(Mr. Sathapron Thakaw)

Environmental Field Scientist (3)



EMISSION TEST RESULT

Client	Rayong Olefins Co.,Ltd.	Run #	3
Date	09 May 22	Location	GHU2 : GHU2 Feed Heater (H-840)
Start Time	11:32	Test Operator	Sathapron.T
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	11:52
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	410
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	725
		Serial No.	451

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:32	13.12	4.05	29.86	-	8.07	
11:33	13.12	4.02	29.75	-	7.50	
11:34	13.17	4.00	29.71	-	7.00	
11:35	13.23	3.95	29.70	-	7.13	
11:36	13.21	3.97	29.56	-	7.45	
11:37	13.17	4.00	29.42	-	8.05	
11:38	13.16	4.02	29.28	-	8.53	
11:39	13.14	4.03	29.25	-	8.08	
11:40	13.17	4.02	29.31	-	7.39	
11:41	13.21	3.98	29.26	-	7.59	
11:42	13.16	3.99	29.25	-	7.87	
11:43	13.12	4.05	29.25	-	8.51	
11:44	13.11	4.05	29.30	-	7.73	
11:45	13.15	4.01	29.50	-	6.70	
11:46	13.18	3.98	29.55	-	6.51	
11:47	13.17	3.98	29.53	-	6.57	
11:48	13.16	3.98	29.46	-	7.25	
11:49	13.16	4.00	29.23	-	7.82	
11:50	13.14	4.04	29.13	-	7.96	
11:51	13.08	4.08	29.22	-	7.62	
11:52	13.10	4.07	29.39	-	7.21	
Average	13.15	4.01	29.42	-	7.55	

Sathapron Th.

(Mr. Sathapron Thakarw)

Environmental Field Scientist (3)



Lot No. 2249325-1

ANALYZER CALIBRATION DATA

Client : Rayong Olefins Co., Ltd. Location : CH1 : Cracking Furnace (Heater) 1(H-100A)
Date : 09 May 22 Test Operator : Saksit P.

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	0.00	0.04
Low-Level Gas	7.93	7.92	7.93	0.04
Span Gas	16.00	15.99	16.00	0.04

NO_x ANALYZER

Model : TELEDYNE API 200EH Serial No. : 549
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	-0.01	0.02
Low-Level Gas	50.41	50.38	50.40	0.02
Span Gas	80.27	80.24	80.26	0.02

SO₂ ANALYZER

Model : TELEDYNE API 100EH Serial No. : 282
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	51.61	51.60	51.61	0.01
Span Gas	79.00	78.99	79.00	0.01

CO ANALYZER

Model : TELEDYNE API 300EM Serial No. : 300
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	50.31	50.32	50.31	0.01
Span Gas	80.53	80.54	80.53	0.01

Calibrated by

(Mr. Saksit Phalsanphisut)

Environmental Field Scientist (4)



Lot No. 2249325-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client : Rayong Olefins Co., Ltd. Location : CH1 : Cracking Furnace (Heater) 1(H-100A)
Date : 09 May 22 Test Operator : Saksit P.

O₂ ANALYZER

Cylinder Conc. (%) : 16.00 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	-0.01	-0.01	0.00	0.00	0.04	0.04
Upscale Gas	15.99	15.99	0.00	16.00	0.04	0.04

NO_x ANALYZER

Cylinder Conc. (ppm) : 80.27 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	-0.03	-0.03	0.00	-0.01	0.02	0.02
Upscale Gas	80.24	80.24	0.00	80.26	0.02	0.02

SO₂ ANALYZER

Cylinder Conc. (ppm) : 79.00 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	-0.01	-0.01	0.00	0.00	0.01	0.01
Upscale Gas	78.99	78.99	0.00	79.00	0.01	0.01

CO ANALYZER

Cylinder Conc. (ppm) : 80.53 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	0.01	0.01	0.00	0.00	0.01	0.01
Upscale Gas	80.54	80.54	0.00	80.53	0.01	0.01

Calibrated by

(Mr. Saksit Phaisanphitsut)

Environmental Field Scientist (4)

FORM NO.: F 06-062 REVISION NO.: 2 ISSUE DATE: 3/06/19

ALS Laboratory Group



EMISSION TEST RESULT

Client	Rayong Olefins Co., Ltd.	Run #	1
Date	09 May 22	Location	CH1 : Cracking Furnace (Heater) 1(H-100A)
Start Time	11:10	Test Operator	Saksit P.
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	11:30
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	282
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	549
		Serial No.	300

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:10	5.05	7.67	53.89	-	0.32	
11:11	5.23	8.24	54.23	-	0.31	
11:12	5.17	7.93	54.28	-	0.30	
11:13	5.09	8.18	54.17	-	0.21	
11:14	5.03	8.24	53.76	-	0.23	
11:15	4.97	8.11	53.28	-	0.23	
11:16	5.03	8.14	53.85	-	0.15	
11:17	5.16	8.00	54.37	-	0.21	
11:18	5.10	8.02	54.37	-	0.21	
11:19	5.09	8.15	54.15	-	0.14	
11:20	5.04	8.18	53.79	-	0.15	
11:21	4.99	8.08	53.31	-	0.26	
11:22	5.08	8.05	53.62	-	0.24	
11:23	5.18	8.00	54.46	-	0.21	
11:24	5.09	7.96	55.12	-	0.16	
11:25	5.07	8.12	55.08	-	0.23	
11:26	5.05	8.14	54.62	-	0.17	
11:27	5.02	8.16	54.46	-	0.30	
11:28	5.07	8.03	54.47	-	0.35	
11:29	5.19	7.94	54.44	-	0.45	
11:30	5.18	8.01	54.64	-	0.37	
Average	5.09	8.06	54.21	-	0.25	

(Mr. Saksit Phaisanphisut)

Environmental Field Scientist (4)



EMISSION TEST RESULT

Client	Rayong Olefins Co., Ltd.	Run #	2
Date	09 May 22	Location	CH1 : Cracking Furnace (Heater) 1(H-100A)
Start Time	11:31	Test Operator	Saksit P.
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	11:51
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	282
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	549
		Serial No.	300

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:31	5.19	8.09	54.85	-	0.35	
11:32	5.06	8.13	54.69	-	0.35	
11:33	4.95	8.20	54.23	-	0.43	
11:34	5.09	9.22	54.31	-	0.34	
11:35	5.16	8.05	54.22	-	0.54	
11:36	5.17	8.12	54.18	-	0.47	
11:37	5.11	8.03	54.12	-	0.62	
11:38	5.02	8.15	53.96	-	0.16	
11:39	4.91	8.28	53.57	-	0.18	
11:40	4.99	8.10	53.06	-	0.25	
11:41	5.05	7.91	53.07	-	0.17	
11:42	5.05	8.08	53.82	-	0.17	
11:43	5.08	8.15	54.01	-	0.07	
11:44	5.00	8.63	53.80	-	0.17	
11:45	5.06	8.08	53.49	-	0.14	
11:46	5.18	7.97	53.74	-	0.18	
11:47	5.13	7.97	53.91	-	0.15	
11:48	5.17	8.07	54.12	-	0.16	
11:49	5.14	8.08	54.07	-	0.26	
11:50	5.05	8.11	53.50	-	0.22	
11:51	4.99	8.17	53.23	-	0.23	
Average	5.07	8.17	53.90	-	0.27	

(Mr. Saksit Phaisanphisut)

Environmental Field Scientist (4)



EMISSION TEST RESULT

Client	Rayong Olefins Co., Ltd.
Date	09 May 22
Start Time	11:52
SO ₂ Analyzer Model	TELEDYNE API 100EH
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM

Run #	3
Location	CH1 : Cracking Furnace (Heater) 1(H-100A)
Test Operator	Saksit P.
Finish Time	12:12
Serial No.	282
Serial No.	549
Serial No.	300

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:52	5.05	8.16	53.28	-	0.29	
11:53	5.06	8.03	53.23	-	0.24	
11:54	5.07	8.11	53.45	-	0.30	
11:55	5.19	7.96	53.87	-	0.28	
11:56	5.13	8.01	53.71	-	0.25	
11:57	5.16	8.10	53.61	-	0.28	
11:58	5.11	8.12	53.57	-	0.49	
11:59	4.99	8.15	53.30	-	0.34	
12:00	5.02	7.53	53.11	-	0.45	
12:01	5.00	8.22	52.93	-	0.30	
12:02	4.99	8.10	52.63	-	0.32	
12:03	5.05	8.14	52.63	-	0.43	
12:04	5.20	7.97	53.13	-	0.34	
12:05	5.17	8.05	53.68	-	0.19	
12:06	5.25	7.86	54.10	-	0.23	
12:07	5.21	7.99	53.72	-	0.18	
12:08	5.08	8.09	52.96	-	0.12	
12:09	5.03	8.15	52.44	-	0.24	
12:10	5.05	8.13	52.35	-	0.18	
12:11	5.01	8.10	52.66	-	0.22	
12:12	5.17	8.00	53.11	-	0.08	
Average	5.09	8.04	53.21	-	0.27	

Saksit P.

(Mr. Saksit Phalsanphisut)

Environmental Field Scientist (4)



Lot No. 2249327-1

ANALYZER CALIBRATION DATA

Client : Rayong Olefins Co., Ltd. Location : CH3 : Cracking Furnace (Heater) 3(H-100C)
Date : 09 May 22 Test Operator : Saksit P.

O₂ ANALYZER

Model : HORIBA PG-350 Serial No. : VKNVUGU9
Span (%) : 25

	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	7.93	7.92	7.93	0.04
Span Gas	16.00	15.99	16.00	0.04

NO_x ANALYZER

Model : HORIBA PG-350 Serial No. : VKNVUGU9
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	0.00	0.03
Low-Level Gas	50.41	50.44	50.41	0.03
Span Gas	80.27	80.30	80.27	0.03

SO₂ ANALYZER

Model : HORIBA PG-350 Serial No. : VKNVUGU9
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	51.61	51.60	51.61	0.01
Span Gas	79.00	78.99	79.00	0.01

CO ANALYZER

Model : HORIBA PG-350 Serial No. : VKNVUGU9
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	50.31	50.32	50.31	0.01
Span Gas	80.53	80.54	80.53	0.01

Calibrated by

(Mr. Saksit Phaisanphisut)

Environmental Field Scientist (4)

Lot No. 2249327-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client : Rayong Olefins Co., Ltd. Location : CH3 : Cracking Furnace (Heater) 3(H-100C)
Date : 09 May 22 Test Operator : Saksit P.

O₂ ANALYZERCylinder Conc. (%) : 16.00 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	-0.01	-0.01	0.00	0.00	0.04	0.04
Upscale Gas	15.99	15.99	0.00	16.00	0.04	0.04

NO_x ANALYZERCylinder Conc. (ppm) : 80.27 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	0.03	0.03	0.00	0.00	0.03	0.03
Upscale Gas	80.30	80.30	0.00	80.27	0.03	0.03

SO₂ ANALYZERCylinder Conc. (ppm) : 79.00 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	-0.01	-0.01	0.00	0.00	0.01	0.01
Upscale Gas	78.99	78.99	0.00	79.00	0.01	0.01

CO ANALYZER

Cylinder Conc. (ppm) : 80.53 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	0.01	0.01	0.00	0.00	0.01	0.01
Upscale Gas	80.54	80.54	0.00	80.53	0.01	0.01

Calibrated by

(Mr. Saksit Phaisanphisut)

Environmental Field Scientist (4)

FORM NO.: F 06-062 REVISION NO.: 2 ISSUE DATE: 3/06/19

ALS Laboratory Group



EMISSION TEST RESULT

Client	Rayong Olefins Co., Ltd.	Run #	1
Date	09 May 22	Location	CH3 : Cracking Furnace (Heater) 3(H-100C)
Start Time	12:00	Test Operator	Saksit P.
SO ₂ Analyzer Model	HORIBA PG-350	Finish Time	12:20
NO _x /O ₂ Analyzer Model	HORIBA PG-350	Serial No.	VKNVUGU9
CO/CO ₂ Analyzer Model	HORIBA PG-350	Serial No.	VKNVUGU9
		Serial No.	VKNVUGU9

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
12:00	5.24	8.37	60.84	-	0.45	
12:01	5.26	8.38	60.74	-	0.45	
12:02	5.36	8.31	60.75	-	0.31	
12:03	5.23	8.29	60.55	-	0.31	
12:04	5.30	8.22	61.60	-	0.27	
12:05	5.38	8.16	61.33	-	0.37	
12:06	5.46	8.15	61.34	-	0.22	
12:07	5.46	8.17	60.97	-	0.46	
12:08	5.32	8.28	60.49	-	0.31	
12:09	5.25	8.37	60.38	-	0.21	
12:10	5.37	8.29	60.71	-	0.54	
12:11	5.41	8.26	61.07	-	0.31	
12:12	5.22	8.24	61.03	-	0.16	
12:13	5.37	8.18	61.05	-	0.27	
12:14	5.33	8.22	60.79	-	0.16	
12:15	5.26	8.33	60.77	-	0.21	
12:16	5.19	8.39	60.55	-	0.35	
12:17	5.23	8.39	60.46	-	0.25	
12:18	5.23	8.41	60.67	-	0.25	
12:19	5.29	8.37	60.68	-	0.11	
12:20	5.38	8.31	60.87	-	0.54	
Average	5.31	8.29	60.84	-	0.31	

(Mr. Saksit Phaisanphisut)

Environmental Field Scientist (4)



EMISSION TEST RESULT

Client	Rayong Olefins Co., Ltd.	Run #	2
Date	09 May 22	Location	CH3 : Cracking Furnace (Heater) 3(H-100C)
Start Time	12:21	Test Operator	Saksit P.
SO ₂ Analyzer Model	HORIBA PG-350	Finish Time	12:41
NO _x /O ₂ Analyzer Model	HORIBA PG-350	Serial No.	VKNVUGU9
CO/CO ₂ Analyzer Model	HORIBA PG-350	Serial No.	VKNVUGU9
		Serial No.	VKNVUGU9

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
12:21	5.36	8.32	60.84	-	0.21	
12:22	5.33	8.25	60.64	-	0.31	
12:23	5.40	8.17	60.57	-	0.40	
12:24	5.41	8.16	60.34	-	0.27	
12:25	5.47	8.17	60.41	-	0.70	
12:26	5.47	8.21	60.38	-	0.27	
12:27	5.28	8.36	60.69	-	0.21	
12:28	5.29	8.33	60.58	-	0.21	
12:29	5.42	8.23	60.46	-	0.16	
12:30	5.46	8.21	60.91	-	0.27	
12:31	5.00	8.23	60.79	-	0.16	
12:32	5.22	8.29	60.39	-	0.07	
12:33	5.17	8.38	60.31	-	0.01	
12:34	5.19	8.38	60.40	-	0.01	
12:35	5.18	8.41	60.62	-	0.01	
12:36	5.19	8.43	61.09	-	0.25	
12:37	5.35	8.32	61.23	-	0.21	
12:38	5.37	8.27	61.45	-	0.31	
12:39	5.38	8.26	61.13	-	0.16	
12:40	5.50	8.19	61.05	-	0.03	
12:41	5.38	8.19	60.73	-	0.27	
Average	5.32	8.27	60.71	-	0.21	

(Mr. Saksit Phaisanphisut)

Environmental Field Scientist (4)



EMISSION TEST RESULT

Client	Rayong Olefins Co., Ltd.
Date	09 May 22
Start Time	12:42
SO ₂ Analyzer Model	HORIBA PG-350
NO _x /O ₂ Analyzer Model	HORIBA PG-350
CO/CO ₂ Analyzer Model	HORIBA PG-350

Run #	3
Location	CH3 : Cracking Furnace (Heater) 3(H-100C)
Test Operator	Saksit P.
Finish Time	13:02
Serial No.	VKNVUGU9
Serial No.	VKNVUGU9
Serial No.	VKNVUGU9

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
12:42	5.40	8.19	60.76	-	0.27	
12:43	5.43	8.19	60.52	-	0.36	
12:44	5.32	8.26	60.38	-	0.07	
12:45	5.27	8.32	60.37	-	0.21	
12:46	5.30	8.30	60.40	-	0.07	
12:47	5.27	8.32	60.44	-	0.21	
12:48	5.31	8.33	60.48	-	0.45	
12:49	5.34	8.31	60.51	-	0.21	
12:50	5.33	8.32	60.59	-	0.03	
12:51	5.23	8.34	60.68	-	0.21	
12:52	5.30	8.30	60.55	-	0.11	
12:53	5.30	8.31	60.38	-	0.01	
12:54	5.26	8.37	60.60	-	0.16	
12:55	5.28	8.39	60.28	-	0.16	
12:56	5.26	8.40	60.19	-	0.29	
12:57	5.23	8.40	60.19	-	0.05	
12:58	5.41	8.28	60.17	-	0.21	
12:59	5.56	8.15	60.73	-	0.27	
13:00	5.59	8.13	60.86	-	0.16	
13:01	5.40	8.22	60.82	-	0.07	
13:02	5.31	8.30	60.18	-	0.11	
Average	5.34	8.29	60.48	-	0.17	

Saksit P.

(Mr. Saksit Phaisanphisut)

Environmental Field Scientist (4)



Lot No. 2249330-1

ANALYZER CALIBRATION DATA

Client : Rayong Olefins Co., Ltd. Location : CH6 : Cracking Furnace (Heater) 6(H-100F)
Date : 06 May 22 Test Operator : Saksit P.

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	0.00	0.04
Low-Level Gas	7.93	7.92	7.93	0.04
Span Gas	16.00	15.99	16.00	0.04

NO_x ANALYZER

Model : TELEDYNE API 200EH Serial No. : 549
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	-0.01	0.02
Low-Level Gas	50.41	50.38	50.40	0.02
Span Gas	80.27	80.24	80.26	0.02

SO₂ ANALYZER

Model : TELEDYNE API 100EH Serial No. : 282
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	51.61	51.60	51.61	0.01
Span Gas	79.00	78.99	79.00	0.01

CO ANALYZER

Model : TELEDYNE API 300EM Serial No. : 300
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	50.31	50.32	50.31	0.01
Span Gas	80.53	80.54	80.53	0.01

Calibrated by

(Mr. Saksit Phalsanphitsut)

Environmental Field Scientist (4)



Lot No. 2249330-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client : Rayong Olefins Co., Ltd. Location : CH6 : Cracking Furnace (Heater) 6(H-100F)
Date : 06 May 22 Test Operator : Saksit P.

O₂ ANALYZER

Cylinder Conc. (%) : 16.00 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	-0.01	-0.01	0.00	0.00	0.04	0.04
Upscale Gas	15.99	15.99	0.00	16.00	0.04	0.04

NO_x ANALYZER

Cylinder Conc. (ppm) : 80.27 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	-0.03	-0.03	0.00	-0.01	0.02	0.02
Upscale Gas	80.24	80.24	0.00	80.26	0.02	0.02

SO₂ ANALYZER

Cylinder Conc. (ppm) : 79.00 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	-0.01	-0.01	0.00	0.00	0.01	0.01
Upscale Gas	78.99	78.99	0.00	79.00	0.01	0.01

CO ANALYZER

Cylinder Conc. (ppm) : 80.53 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	0.01	0.01	0.00	0.00	0.01	0.01
Upscale Gas	80.54	80.54	0.00	80.53	0.01	0.01

Calibrated by

(Mr. Saksit Phaisanphitsut)

Environmental Field Scientist (4)

FORM NO.: F 06-062 REVISION NO.: 2 ISSUE DATE: 3/06/19

ALS Laboratory Group



EMISSION TEST RESULT

Client	Rayong Olefins Co., Ltd.	Run #	1
Date	06 May 22	Location	CH6 : Cracking Furnace (Heater) 6(H-100F)
Start Time	12:10	Test Operator	Saksit P.
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	12:30
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	282
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	549
		Serial No.	300

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
12:10	4.85	8.17	55.82	-	0.13	
12:11	4.97	8.12	55.88	-	0.24	
12:12	4.96	8.08	55.96	-	0.27	
12:13	4.82	8.23	55.89	-	0.10	
12:14	4.86	8.27	55.62	-	0.11	
12:15	4.88	8.11	55.63	-	0.19	
12:16	4.91	8.12	55.91	-	0.18	
12:17	4.90	8.04	56.13	-	0.16	
12:18	4.78	7.66	55.93	-	0.17	
12:19	4.68	8.32	55.50	-	0.40	
12:20	4.65	8.80	55.24	-	0.20	
12:21	4.65	8.24	55.10	-	0.14	
12:22	4.71	8.31	55.07	-	0.20	
12:23	4.57	8.31	54.73	-	0.34	
12:24	4.60	8.25	54.70	-	0.24	
12:25	4.70	8.22	54.86	-	0.19	
12:26	4.77	8.24	54.86	-	0.07	
12:27	4.83	8.25	54.96	-	0.32	
12:28	4.78	8.16	55.12	-	0.22	
12:29	4.71	8.24	55.05	-	0.21	
12:30	4.80	8.18	55.06	-	0.22	
Average	4.78	8.20	55.38	-	0.20	

(Mr. Saksit Phalsanphisut)

Environmental Field Scientist (4)



EMISSION TEST RESULT

Client	Rayong Olefins Co., Ltd.	Run #	2
Date	06 May 22	Location	CH6 : Cracking Furnace (Heater) 6(H-100F)
Start Time	12:31	Test Operator	Saksit P.
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	12:51
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	282
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	549
		Serial No.	300

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
12:31	4.87	8.14	55.06	-	0.32	
12:32	4.85	8.25	55.04	-	0.17	
12:33	4.81	8.18	55.03	-	0.17	
12:34	4.74	8.24	54.93	-	0.14	
12:35	4.83	8.12	55.01	-	0.31	
12:36	4.82	8.13	55.12	-	0.15	
12:37	4.82	8.22	55.18	-	0.22	
12:38	4.76	8.20	55.08	-	0.21	
12:39	4.70	8.29	54.90	-	0.29	
12:40	4.64	8.38	54.61	-	0.26	
12:41	4.65	8.25	54.36	-	0.20	
12:42	4.65	8.26	54.29	-	0.24	
12:43	4.75	8.25	54.54	-	0.16	
12:44	4.76	8.28	54.57	-	0.21	
12:45	4.63	8.45	54.43	-	0.18	
12:46	4.63	8.33	53.91	-	0.26	
12:47	4.63	8.33	53.86	-	0.26	
12:48	4.66	8.30	54.00	-	0.22	
12:49	4.75	8.10	54.13	-	0.23	
12:50	4.77	8.13	54.21	-	0.16	
12:51	4.78	8.25	54.25	-	0.17	
Average	4.74	8.24	54.60	-	0.22	

(Mr. Saksit Phalsanphisut)

Environmental Field Scientist (4)



EMISSION TEST RESULT

Client	Rayong Olefins Co., Ltd.	Run #	3
Date	06 May 22	Location	CH6 : Cracking Furnace (Heater) 6(H-100F)
Start Time	12:52	Test Operator	Saksit P.
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	13:12
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	282
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	549
		Serial No.	300

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
12:52	4.66	8.18	53.99	-	0.34	
12:53	4.58	8.34	53.77	-	0.25	
12:54	4.67	8.31	53.81	-	0.26	
12:55	4.69	8.15	54.10	-	0.38	
12:56	4.73	8.22	54.37	-	0.20	
12:57	4.73	8.22	54.48	-	0.27	
12:58	4.58	8.34	54.10	-	0.47	
12:59	4.56	8.52	53.95	-	0.26	
13:00	4.52	8.40	53.93	-	0.47	
13:01	4.46	8.53	53.93	-	0.39	
13:02	4.48	8.47	53.76	-	0.44	
13:03	4.52	8.41	53.89	-	0.56	
13:04	4.62	8.31	54.20	-	0.41	
13:05	4.66	8.31	54.54	-	0.48	
13:06	4.57	8.44	54.53	-	0.55	
13:07	4.57	8.42	54.43	-	0.45	
13:08	4.59	8.38	54.43	-	0.49	
13:09	4.59	8.32	54.49	-	0.50	
13:10	4.65	8.27	54.52	-	0.47	
13:11	4.66	8.28	54.42	-	0.49	
13:12	4.61	8.49	54.24	-	0.44	
Average	4.61	8.34	54.18	-	0.41	

(Mr. Saksit Phaisanphitsut)

Environmental Field Scientist (4)



Lot No. 2249335-1

ANALYZER CALIBRATION DATA

Client : Rayong Olefins Co.,Ltd. Location : CH11 : Cracking Furnace (Heater) 11 (H-100J)
Date : 09 May 22 Test Operator : Sathapron.T

O₂ ANALYZER

Model : TELEDYNE API 200EH Serial No. : 725
Span (%) : 25

	Cylinder Value (%)	Initial Analyzers Calibration Response (%)	Final Analyzers Calibration Response (%)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.02	0.08
Low-Level Gas	8.04	8.05	8.06	0.04
Span Gas	16.00	16.00	16.02	0.08

NO_x ANALYZER

Model : TELEDYNE API 200EH Serial No. : 725
Span (ppm) : 100

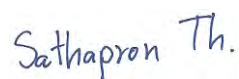
	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.03	0.03

CO ANALYZER

Model : TELEDYNE API 300EM Serial No. : 451
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	0.03	0.03
Low-Level Gas	54.84	54.82	54.80	0.02
Span Gas	80.16	80.16	80.10	0.06

Calibrated by



(Mr. Sathapron Thakarw)

Environmental Field Scientist (3)

FORM NO.: F 06-062 REVISION NO.: 2 ISSUE DATE: 3/06/19

ALS Laboratory Group

Lot No. 2249335-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client : Rayong Olefins Co.,Ltd. Location : CH11 : Cracking Furnace (Heater) 11 (H-100J)
Date : 09 May 22 Test Operator : Sathapron.T

O₂ ANALYZER
Cylinder Conc. (%) : 16.00 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	0.02	0.08	0.02	0.08	0.00
Upscale Gas	16.00	16.01	0.04	16.02	0.08	0.04

NO_x ANALYZER
Cylinder Conc. (ppm) : 79.42 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	0.02	0.02	0.03	0.03	0.01
Upscale Gas	79.42	79.41	0.01	79.40	0.02	0.01

CO ANALYZER
Cylinder Conc. (ppm) : 80.16 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	0.00	0.02	0.02	0.03	0.03	0.01
Upscale Gas	80.16	80.14	0.02	80.10	0.06	0.04

Calibrated by

Sathapron Th.

(Mr. Sathapron Thakaw)

Environmental Field Scientist (3)

FORM NO.: F 06-062 REVISION NO.: 2 ISSUE DATE: 3/06/19

ALS Laboratory Group



EMISSION TEST RESULT

Client	Rayong Olefins Co.,Ltd.	Run #	1
Date	09 May 22	Location	CH11 : Cracking Furnace (Heater) 11 (H-100J)
Start Time	14:40	Test Operator	Sathapron.T
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	15:00
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	410
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	725
		Serial No.	451

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
14:40	4.66	8.59	35.40	-	0.25	
14:41	4.47	8.74	35.47	-	0.26	
14:42	4.54	8.74	35.56	-	0.19	
14:43	4.50	8.77	35.48	-	0.20	
14:44	4.43	8.81	35.63	-	0.23	
14:45	4.26	8.93	35.68	-	0.25	
14:46	4.59	8.70	35.76	-	0.27	
14:47	4.41	8.81	35.85	-	0.25	
14:48	4.45	8.83	35.87	-	0.27	
14:49	4.44	8.83	35.71	-	0.25	
14:50	4.55	8.75	35.87	-	0.27	
14:51	4.17	8.95	36.14	-	0.22	
14:52	4.43	8.82	36.08	-	0.24	
14:53	4.39	8.80	35.72	-	0.26	
14:54	4.28	8.90	35.33	-	0.25	
14:55	4.43	8.82	35.06	-	0.22	
14:56	4.55	8.65	35.21	-	0.25	
14:57	4.48	8.68	36.00	-	0.23	
14:58	4.50	8.73	36.12	-	0.29	
14:59	4.35	8.83	36.17	-	0.27	
15:00	4.21	8.93	35.88	-	0.27	
Average	4.43	8.79	35.71	-	0.25	

Sathapron Th.

(Mr. Sathapron Thakarw)

Environmental Field Scientist (3)



EMISSION TEST RESULT

Client	Rayong Olefins Co.,Ltd.	Run #	2
Date	09 May 22	Location	CH11 : Cracking Furnace (Heater) 11 (H-100J)
Start Time	15:01	Test Operator	Sathapron.T
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	15:21
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	410
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	725
		Serial No.	451

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
15:01	4.32	8.85	35.55	-	0.28	
15:02	4.18	8.99	35.36	-	0.32	
15:03	4.08	8.93	35.16	-	0.30	
15:04	4.18	8.98	35.12	-	0.27	
15:05	4.26	8.91	35.24	-	0.32	
15:06	4.19	8.96	35.27	-	0.33	
15:07	4.07	9.03	35.43	-	0.32	
15:08	4.24	8.86	35.27	-	0.35	
15:09	4.25	8.77	34.73	-	0.38	
15:10	4.16	8.94	34.67	-	0.33	
15:11	4.22	8.95	34.75	-	0.37	
15:12	4.06	9.04	34.42	-	0.37	
15:13	3.90	9.16	34.24	-	0.37	
15:14	3.99	9.14	34.44	-	0.36	
15:15	4.09	9.02	34.60	-	0.35	
15:16	4.04	8.99	34.71	-	0.39	
15:17	4.11	9.02	34.88	-	0.38	
15:18	4.24	8.89	34.95	-	0.35	
15:19	4.17	8.91	34.96	-	0.37	
15:20	3.98	9.04	34.72	-	0.32	
15:21	4.18	8.91	34.54	-	0.37	
Average	4.14	8.96	34.90	-	0.34	

Sathapron Th.

(Mr. Sathapron Thakarw)

Environmental Field Scientist (3)



EMISSION TEST RESULT

Client	Rayong Olefins Co.,Ltd.	Run #	3
Date	09 May 22	Location	CH11 : Cracking Furnace (Heater) 11 (H-100J)
Start Time	15:22	Test Operator	Sathapron.T
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	15:42
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	410
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	725
		Serial No.	451

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
15:22	4.16	8.87	34.48	-	0.38	
15:23	3.98	8.98	34.58	-	0.37	
15:24	4.23	8.90	34.68	-	0.39	
15:25	4.17	8.84	34.66	-	0.37	
15:26	3.99	8.99	34.73	-	0.29	
15:27	4.10	9.02	34.76	-	0.38	
15:28	4.04	8.99	34.49	-	0.34	
15:29	3.70	9.28	34.19	-	0.32	
15:30	3.92	9.18	34.20	-	0.31	
15:31	3.90	9.06	34.13	-	0.32	
15:32	3.92	8.99	34.11	-	0.30	
15:33	4.04	9.04	34.47	-	0.33	
15:34	4.13	8.96	34.61	-	0.38	
15:35	4.01	8.99	34.22	-	0.33	
15:36	3.95	9.15	34.13	-	0.36	
15:37	4.10	9.07	34.08	-	0.41	
15:38	4.07	8.97	34.06	-	0.41	
15:39	3.99	9.00	34.28	-	0.39	
15:40	4.16	8.98	34.51	-	0.36	
15:41	4.18	8.90	34.58	-	0.38	
15:42	3.90	9.09	34.47	-	0.35	
Average	4.03	9.01	34.40	-	0.35	

Sathapron Th.

(Mr. Sathapron Thakarw)

Environmental Field Scientist (3)



Lot No. 2249307-1

ANALYZER CALIBRATION DATA

Client : Rayong Olefins Co.,Ltd. Location : UBS 1 : Utility Boiler Stack 1 (H-2050A)
Date : 05 May 22 Test Operator : Sathapron.T

O₂ ANALYZER

Model : TELEDYNE API 200EH Serial No. : 725
Span (%) : 25

	Cylinder Value (%)	Initial Analyzers Calibration Response (%)	Final Analyzers Calibration Response (%)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.04	0.16
Low-Level Gas	8.04	8.10	8.14	0.16
Span Gas	16.00	16.00	16.10	0.40

NO_x ANALYZER

Model : TELEDYNE API 200EH Serial No. : 725
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	54.96	54.90	54.88	0.02
Span Gas	79.42	79.42	79.36	0.06

CO ANALYZER

Model : TELEDYNE API 300EM Serial No. : 451
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	0.02	0.02
Low-Level Gas	54.84	54.80	54.77	0.03
Span Gas	80.16	80.16	80.10	0.06

Calibrated by

Sathapron Th.

(Mr. Sathapron Thakarw)

Environmental Field Scientist (3)

FORM NO.: F 06-062 REVISION NO.: 2 ISSUE DATE: 3/06/19

ALS Laboratory Group

Lot No. 2249307-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client : Rayong Olefins Co.,Ltd. Location : UBS 1 : Utility Boiler Stack 1 (H-2050A)
Date : 05 May 22 Test Operator : Sathapron.T

O₂ ANALYZER
Cylinder Conc. (%) : 16.00 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	0.02	0.08	0.04	0.16	0.08
Upscale Gas	16.00	16.06	0.24	16.10	0.40	0.16

NO_x ANALYZER
Cylinder Conc. (ppm) : 79.42 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	0.02	0.02	0.05	0.05	0.03
Upscale Gas	79.42	79.39	0.03	79.36	0.06	0.03

CO ANALYZER
Cylinder Conc. (ppm) : 80.16 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	0.00	0.02	0.02	0.02	0.02	0.00
Upscale Gas	80.16	80.12	0.04	80.10	0.06	0.02

Calibrated by

Sathapron Th.

(Mr. Sathapron Thakarw)

Environmental Field Scientist (3)

FORM NO.: F 06-062 REVISION NO.: 2 ISSUE DATE: 3/06/19

ALS Laboratory Group



EMISSION TEST RESULT

Client	Rayong Olefins Co.,Ltd.	Run #	1
Date	05 May 22	Location	UBS 1 : Utility Boiler Stack 1 (H-2050A)
Start Time	14:50	Test Operator	Sathapron.T
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	15:10
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	410
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	725
		Serial No.	451

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
14:50	5.58	8.14	69.94	-	1.50	
14:51	5.54	8.18	69.72	-	1.54	
14:52	5.59	8.22	69.45	-	1.50	
14:53	5.53	8.28	69.72	-	1.48	
14:54	5.48	8.33	69.30	-	1.51	
14:55	5.55	8.21	69.44	-	1.49	
14:56	5.57	8.18	71.87	-	1.49	
14:57	5.49	8.23	72.04	-	1.48	
14:58	5.47	8.28	70.45	-	1.48	
14:59	5.49	8.32	69.56	-	1.51	
15:00	5.44	8.34	69.83	-	1.51	
15:01	5.44	8.28	69.98	-	1.45	
15:02	5.50	8.18	70.38	-	1.48	
15:03	5.53	8.23	70.31	-	1.52	
15:04	5.58	8.25	70.44	-	1.47	
15:05	5.47	8.32	70.57	-	1.51	
15:06	5.30	8.37	70.95	-	1.45	
15:07	5.45	8.23	72.26	-	1.43	
15:08	5.47	8.21	73.17	-	1.53	
15:09	5.33	8.36	73.00	-	1.51	
15:10	5.38	8.35	73.35	-	1.49	
Average	5.48	8.26	70.75	-	1.49	

Sathapron Th.

(Mr. Sathapron Thakaw)

Environmental Field Scientist (3)



EMISSION TEST RESULT

Client	Rayong Olefins Co.,Ltd.	Run #	2
Date	05 May 22	Location	UBS 1 : Utility Boiler Stack 1 (H-2050A)
Start Time	15:11	Test Operator	Sathapron.T
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	15:31
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	410
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	725
		Serial No.	451

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
15:11	5.29	8.43	74.50	-	1.51	
15:12	5.24	8.45	75.46	-	1.47	
15:13	5.11	8.49	77.77	-	1.49	
15:14	4.94	8.58	77.22	-	1.45	
15:15	5.10	8.50	76.01	-	1.47	
15:16	5.24	8.43	75.42	-	1.52	
15:17	5.27	8.35	75.15	-	1.54	
15:18	5.35	8.34	74.07	-	1.49	
15:19	5.42	8.30	73.08	-	1.51	
15:20	5.35	8.32	72.86	-	1.54	
15:21	5.47	8.29	73.09	-	1.54	
15:22	5.55	8.23	74.06	-	1.53	
15:23	5.55	8.20	73.94	-	1.57	
15:24	5.71	8.14	72.13	-	1.51	
15:25	5.72	8.12	70.64	-	1.53	
15:26	5.73	8.14	70.65	-	1.51	
15:27	5.59	8.25	70.49	-	1.54	
15:28	5.51	8.27	70.37	-	1.52	
15:29	5.44	8.29	70.76	-	1.53	
15:30	5.44	8.30	70.89	-	1.57	
15:31	5.48	8.29	71.43	-	1.62	
Average	5.40	8.32	73.33	-	1.52	

Sathapron Th.

(Mr. Sathapron Thakaw)

Environmental Field Scientist (3)



EMISSION TEST RESULT

Client	Rayong Olefins Co.,Ltd.	Run #	3
Date	05 May 22	Location	UBS 1 : Utility Boiler Stack 1 (H-2050A)
Start Time	15:32	Test Operator	Sathapron.T
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	15:52
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	410
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	725
		Serial No.	451

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
15:32	5.45	8.29	71.98	-	1.58	
15:33	5.37	8.35	72.28	-	1.57	
15:34	5.27	8.38	73.30	-	1.54	
15:35	5.29	8.38	74.03	-	1.51	
15:36	5.17	8.45	74.56	-	1.56	
15:37	5.01	8.54	75.43	-	1.52	
15:38	4.90	8.61	76.06	-	1.55	
15:39	4.78	8.68	77.31	-	1.59	
15:40	4.59	8.78	78.96	-	1.58	
15:41	4.33	8.94	80.18	-	1.51	
15:42	5.35	8.96	74.07	-	1.51	
15:43	5.42	9.02	73.08	-	1.53	
15:44	5.35	9.00	72.86	-	1.53	
15:45	5.37	8.94	72.28	-	1.56	
15:46	5.27	8.99	73.30	-	1.56	
15:47	5.29	9.02	74.03	-	1.53	
15:48	5.59	8.98	69.45	-	1.54	
15:49	5.53	9.11	69.72	-	1.55	
15:50	5.48	8.99	69.30	-	1.54	
15:51	5.55	8.88	69.44	-	1.52	
15:52	5.57	8.91	71.87	-	1.58	
Average	5.23	8.77	73.50	-	1.55	

Sathapron Th.

(Mr. Sathapron Thakarw)

Environmental Field Scientist (3)



Lot No. 2249324-1

ANALYZER CALIBRATION DATA

Client : Rayong Olefins Co.,Ltd. Location : UBS 2 : Utility Boiler Stack 2 (H-2050B)
Date : 06 May 22 Test Operator : Sathapron.T

O₂ ANALYZER

Model : TELEDYNE API 200EH Serial No. : 725
Span (%) : 25

	Cylinder Value (%)	Initial Analyzers Calibration Response (%)	Final Analyzers Calibration Response (%)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.04	0.16
Low-Level Gas	8.04	8.03	8.06	0.12
Span Gas	16.00	16.00	16.02	0.08

NO_x ANALYZER

Model : TELEDYNE API 200EH Serial No. : 725
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	0.03	0.03
Low-Level Gas	54.96	54.93	54.92	0.01
Span Gas	79.42	79.42	79.40	0.02

CO ANALYZER

Model : TELEDYNE API 300EM Serial No. : 451
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	0.02	0.02
Low-Level Gas	54.84	54.83	54.81	0.02
Span Gas	80.16	80.16	80.14	0.02

Calibrated by

(Mr. Sathapron Thakarw)

Environmental Field Scientist (3)

FORM NO.: F 06-062 REVISION NO.: 2 ISSUE DATE: 3/06/19

ALS Laboratory Group

Lot No. 2249324-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client : Rayong Olefins Co.,Ltd. Location : UBS 2 : Utility Boiler Stack 2 (H-2050B)
Date : 06 May 22 Test Operator : Sathapron.T

O₂ ANALYZER
Cylinder Conc. (%) : 16.00 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	0.03	0.12	0.04	0.16	0.04
Upscale Gas	16.00	16.02	0.08	16.02	0.08	0.00

NO_x ANALYZER
Cylinder Conc. (ppm) : 79.42 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	0.02	0.02	0.03	0.03	0.01
Upscale Gas	79.42	79.40	0.02	79.40	0.02	0.00

CO ANALYZER
Cylinder Conc. (ppm) : 80.16 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	0.00	0.01	0.01	0.02	0.02	0.01
Upscale Gas	80.16	80.14	0.02	80.14	0.02	0.00

Calibrated by

Sathapron Th.

(Mr. Sathapron Thakarw)

Environmental Field Scientist (3)

FORM NO.: F 06-062 REVISION NO.: 2 ISSUE DATE: 3/06/19

ALS Laboratory Group



EMISSION TEST RESULT

Client	Rayong Olefins Co.,Ltd.	Run #	1
Date	06 May 22	Location	UBS 2 : Utility Boiler Stack 2 (H-2050B)
Start Time	13:50	Test Operator	Sathapron.T
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	14:10
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	410
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	725
		Serial No.	451

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
13:50	6.59	7.70	61.03	-	1.90	
13:51	6.47	7.76	62.02	-	1.89	
13:52	6.47	7.75	62.15	-	1.85	
13:53	6.43	7.74	62.47	-	1.84	
13:54	6.49	7.69	62.41	-	1.90	
13:55	6.61	7.61	62.18	-	1.88	
13:56	6.54	7.63	62.23	-	1.92	
13:57	6.45	7.81	61.82	-	1.88	
13:58	6.44	7.81	61.43	-	1.98	
13:59	6.38	7.84	60.97	-	1.93	
14:00	6.46	7.75	60.03	-	1.88	
14:01	6.45	7.75	59.80	-	1.89	
14:02	6.51	7.72	60.44	-	1.88	
14:03	6.52	7.69	60.91	-	1.85	
14:04	6.54	7.66	61.25	-	1.91	
14:05	6.63	7.65	60.54	-	1.92	
14:06	6.64	7.63	60.29	-	1.93	
14:07	6.54	7.68	60.59	-	1.87	
14:08	6.46	7.76	60.77	-	1.93	
14:09	6.16	7.86	62.19	-	1.85	
14:10	5.98	8.00	63.98	-	1.87	
Average	6.46	7.74	61.41	-	1.89	

Sathapron Th.

(Mr. Sathapron Thakaw)

Environmental Field Scientist (3)



EMISSION TEST RESULT

Client	Rayong Olefins Co.,Ltd.	Run #	2
Date	06 May 22	Location	UBS 2 : Utility Boiler Stack 2 (H-2050B)
Start Time	14:11	Test Operator	Sathapron.T
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	14:31
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	410
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	725
		Serial No.	451

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
14:11	5.85	8.04	65.37	-	1.87	
14:12	5.66	8.15	66.00	-	1.86	
14:13	5.59	8.25	65.68	-	1.83	
14:14	5.41	8.33	65.25	-	1.84	
14:15	5.38	8.34	65.30	-	1.85	
14:16	5.44	8.35	66.86	-	1.88	
14:17	5.22	8.42	69.56	-	1.86	
14:18	5.02	8.50	70.74	-	1.80	
14:19	4.90	8.56	71.08	-	1.86	
14:20	4.85	8.60	70.24	-	1.89	
14:21	4.68	8.74	69.76	-	1.85	
14:22	4.58	8.75	71.14	-	1.89	
14:23	4.58	8.67	73.38	-	1.85	
14:24	4.53	8.70	74.48	-	1.86	
14:25	4.44	8.77	75.88	-	1.84	
14:26	4.08	9.06	77.06	-	1.80	
14:27	4.06	9.05	77.46	-	1.88	
14:28	4.06	8.98	78.92	-	1.81	
14:29	3.99	9.04	79.74	-	1.81	
14:30	4.12	8.91	79.59	-	1.81	
14:31	4.06	8.93	81.23	-	1.85	
Average	4.79	8.63	72.13	-	1.85	

Sathapron Th.

(Mr. Sathapron Thakaw)

Environmental Field Scientist (3)



EMISSION TEST RESULT

Client	Rayong Olefins Co.,Ltd.	Run #	3
Date	06 May 22	Location	UBS 2 : Utility Boiler Stack 2 (H-2050B)
Start Time	14:32	Test Operator	Sathapron.T
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	14:52
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	410
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	725
		Serial No.	451

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
14:32	3.98	9.06	82.19	-	1.89	
14:33	4.02	9.04	82.51	-	1.81	
14:34	3.93	9.13	82.01	-	1.87	
14:35	3.86	9.14	81.48	-	1.89	
14:36	3.81	9.12	81.38	-	1.88	
14:37	3.75	9.13	79.94	-	1.87	
14:38	3.84	9.08	79.32	-	1.91	
14:39	3.80	9.17	79.41	-	1.89	
14:40	3.85	9.17	79.37	-	1.88	
14:41	3.90	9.11	80.23	-	1.85	
14:42	3.82	9.12	81.43	-	1.86	
14:43	3.97	9.03	82.52	-	1.85	
14:44	4.07	8.93	82.90	-	1.88	
14:45	4.01	9.03	82.18	-	1.82	
14:46	4.05	9.02	81.56	-	1.84	
14:47	3.85	9.12	82.42	-	1.86	
14:48	3.81	9.10	81.93	-	1.85	
14:49	3.89	9.00	81.05	-	1.83	
14:50	3.82	9.09	80.47	-	1.83	
14:51	3.99	9.02	79.94	-	1.83	
14:52	4.00	9.04	81.02	-	1.86	
Average	3.91	9.08	81.20	-	1.86	

Sathapron Th.

(Mr. Sathapron Thakarw)

Environmental Field Scientist (3)



Lot No. 2249326-1

ANALYZER CALIBRATION DATA

Client : Rayong Olefins Co., Ltd. Location : CH2 : Cracking Furnace (Heater) 2(H-100B)
Date : 05 May 22 Test Operator : Saksit P.

O₂ ANALYZER

Model : HORIBA PG-350 Serial No. : VKNVUGU9
Span (%) : 25

	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	7.93	7.92	7.93	0.04
Span Gas	16.00	15.99	16.00	0.04

NO_x ANALYZER

Model : HORIBA PG-350 Serial No. : VKNVUGU9
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	0.00	0.03
Low-Level Gas	50.41	50.44	50.41	0.03
Span Gas	80.27	80.30	80.27	0.03

SO₂ ANALYZER

Model : HORIBA PG-350 Serial No. : VKNVUGU9
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	51.61	51.60	51.61	0.01
Span Gas	79.00	78.99	79.00	0.01

CO ANALYZER

Model : HORIBA PG-350 Serial No. : VKNVUGU9
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	50.31	50.32	50.31	0.01
Span Gas	80.53	80.54	80.53	0.01

Calibrated by

(Mr. Saksit Phaisanphisut)

Environmental Field Scientist (4)



Lot No. 2249326-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client : Rayong Olefins Co., Ltd. Location : CH2 : Cracking Furnace (Heater) 2(H-100B)
Date : 05 May 22 Test Operator : Saksit P.

O₂ ANALYZER

Cylinder Conc. (%) : 16.00 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	-0.01	-0.01	0.00	0.00	0.04	0.04
Upscale Gas	15.99	15.99	0.00	16.00	0.04	0.04

NO_x ANALYZER

Cylinder Conc. (ppm) : 80.27 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	0.03	0.03	0.00	0.00	0.03	0.03
Upscale Gas	80.30	80.30	0.00	80.27	0.03	0.03

SO₂ ANALYZER

Cylinder Conc. (ppm) : 79.00 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	-0.01	-0.01	0.00	0.00	0.01	0.01
Upscale Gas	78.99	78.99	0.00	79.00	0.01	0.01

CO ANALYZER

Cylinder Conc. (ppm) : 80.53 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	0.01	0.01	0.00	0.00	0.01	0.01
Upscale Gas	80.54	80.54	0.00	80.53	0.01	0.01

Calibrated by

(Mr. Saksit Phalsanphisut)

Environmental Field Scientist (4)

FORM NO.: F 06-062 REVISION NO.: 2 ISSUE DATE: 3/06/19

ALS Laboratory Group



EMISSION TEST RESULT

Client	Rayong Olefins Co., Ltd.	Run #	1
Date	05 May 22	Location	CH2 : Cracking Furnace (Heater) 2(H-100B)
Start Time	11:10	Test Operator	Saksit P.
SO ₂ Analyzer Model	HORIBA PG-350	Finish Time	11:30
NO _x /O ₂ Analyzer Model	HORIBA PG-350	Serial No.	VKNVUGU9
CO/CO ₂ Analyzer Model	HORIBA PG-350	Serial No.	VKNVUGU9
		Serial No.	VKNVUGU9

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:10	5.15	8.27	56.71	-	0.74	
11:11	5.03	8.37	57.01	-	0.55	
11:12	4.99	8.44	57.76	-	0.59	
11:13	4.58	8.66	58.39	-	0.57	
11:14	4.52	8.75	58.49	-	0.61	
11:15	4.31	8.75	58.28	-	0.61	
11:16	4.60	8.57	59.45	-	0.53	
11:17	4.53	8.63	58.76	-	0.34	
11:18	4.66	8.62	58.51	-	0.44	
11:19	4.53	8.73	58.05	-	0.48	
11:20	4.64	8.68	58.46	-	0.34	
11:21	4.65	8.64	58.25	-	0.57	
11:22	4.12	8.81	57.82	-	0.42	
11:23	4.52	8.71	58.44	-	0.61	
11:24	4.57	8.62	58.25	-	0.58	
11:25	4.56	8.66	58.79	-	0.48	
11:26	4.62	8.68	58.18	-	0.48	
11:27	4.63	8.67	57.98	-	0.48	
11:28	4.56	8.68	58.46	-	0.38	
11:29	4.80	8.59	59.06	-	0.35	
11:30	4.59	8.70	58.09	-	0.29	
Average	4.63	8.63	58.25	-	0.50	

(Mr. Saksit Phaisanphisut)

Environmental Field Scientist (4)



EMISSION TEST RESULT

Client	Rayong Olefins Co., Ltd.	Run #	2
Date	05 May 22	Location	CH2 : Cracking Furnace (Heater) 2(H-100B)
Start Time	11:31	Test Operator	Saksit P.
SO ₂ Analyzer Model	HORIBA PG-350	Finish Time	11:51
NO _x /O ₂ Analyzer Model	HORIBA PG-350	Serial No.	VKNVUGU9
CO/CO ₂ Analyzer Model	HORIBA PG-350	Serial No.	VKNVUGU9
		Serial No.	VKNVUGU9

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:31	4.67	8.62	59.11	-	0.48	
11:32	4.81	8.53	59.15	-	0.44	
11:33	4.55	8.74	58.39	-	0.29	
11:34	4.69	8.68	58.94	-	0.39	
11:35	4.70	8.61	58.33	-	0.35	
11:36	4.48	8.64	58.66	-	0.39	
11:37	4.60	8.58	59.13	-	0.35	
11:38	4.61	8.63	58.44	-	0.39	
11:39	4.50	8.79	58.58	-	0.43	
11:40	4.61	8.71	58.32	-	0.29	
11:41	4.42	8.77	58.19	-	0.10	
11:42	4.66	8.65	59.12	-	0.39	
11:43	4.77	8.60	58.66	-	0.01	
11:44	4.42	8.77	57.68	-	0.43	
11:45	4.64	8.70	57.95	-	0.19	
11:46	4.42	8.81	57.34	-	0.23	
11:47	4.61	8.66	58.38	-	0.39	
11:48	4.69	8.57	58.94	-	0.35	
11:49	4.73	8.56	59.08	-	0.44	
11:50	4.79	8.61	59.22	-	0.48	
11:51	4.71	8.58	58.68	-	0.58	
Average	4.62	8.65	58.59	-	0.35	

(Mr. Saksit Phaisanphisut)

Environmental Field Scientist (4)



EMISSION TEST RESULT

Client	Rayong Olefins Co., Ltd.	Run #	3
Date	05 May 22	Location	CH2 : Cracking Furnace (Heater) 2(H-100B)
Start Time	11:52	Test Operator	Saksit P.
SO ₂ Analyzer Model	HORIBA PG-350	Finish Time	12:12
NO _x /O ₂ Analyzer Model	HORIBA PG-350	Serial No.	VKNVUGU9
CO/CO ₂ Analyzer Model	HORIBA PG-350	Serial No.	VKNVUGU9
		Serial No.	VKNVUGU9

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:52	4.39	8.77	57.82	-	0.33	
11:53	4.61	8.66	58.79	-	0.15	
11:54	4.78	8.50	58.95	-	0.31	
11:55	4.64	8.56	58.90	-	0.35	
11:56	4.85	8.48	59.61	-	0.39	
11:57	4.79	8.53	58.76	-	0.10	
11:58	4.60	8.72	58.38	-	0.20	
11:59	4.64	8.64	58.28	-	0.23	
12:00	4.33	8.84	57.37	-	0.14	
12:01	4.55	8.74	58.08	-	0.19	
12:02	4.56	8.68	58.38	-	0.29	
12:03	4.64	8.61	58.90	-	0.15	
12:04	4.80	8.54	58.76	-	0.35	
12:05	4.89	8.52	58.92	-	0.21	
12:06	4.49	8.79	57.71	-	0.23	
12:07	4.52	8.75	58.29	-	0.10	
12:08	4.51	8.70	57.79	-	0.10	
12:09	4.53	8.66	58.51	-	0.19	
12:10	4.91	8.44	59.32	-	0.44	
12:11	4.74	8.54	58.67	-	0.25	
12:12	4.63	8.66	58.61	-	0.33	
Average	4.64	8.63	58.51	-	0.24	

Saksit P.

(Mr. Saksit Phalsanphisut)

Environmental Field Scientist (4)



Lot No. 2249329-1

ANALYZER CALIBRATION DATA

Client : Rayong Olefins Co., Ltd. Location : CH5 : Cracking Furnace (Heater) 5(H-100E)
Date : 05 May 22 Test Operator : Saksit P.

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	-0.02	0.00	0.08
Low-Level Gas	7.93	7.91	7.93	0.08
Span Gas	16.00	15.98	16.00	0.08

NO_x ANALYZER

Model : TELEDYNE API 200EH Serial No. : 549
Span (ppm) : 100

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	-0.04	-0.01	0.03
Low-Level Gas	50.41	50.37	50.40	0.03
Span Gas	80.27	80.23	80.26	0.03

SO₂ ANALYZER

Model : TELEDYNE API 100EH Serial No. : 282
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	51.61	51.60	51.61	0.01
Span Gas	79.00	78.99	79.00	0.01

CO ANALYZER

Model : TELEDYNE API 300EM Serial No. : 300
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	50.31	50.32	50.31	0.01
Span Gas	80.53	80.54	80.53	0.01

Calibrated by

(Mr. Saksit Phalsanphitsut)

Environmental Field Scientist (4)



Lot No. 2249329-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client : Rayong Olefins Co., Ltd. Location : CH5 : Cracking Furnace (Heater) 5(H-100E)
Date : 05 May 22 Test Operator : Saksit P.

O₂ ANALYZER

Cylinder Conc. (%) : 16.00 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	-0.02	-0.02	0.00	0.00	0.08	0.08
Upscale Gas	15.98	15.98	0.00	16.00	0.08	0.08

NO_x ANALYZER

Cylinder Conc. (ppm) : 80.27 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	-0.04	-0.04	0.00	-0.01	0.03	0.03
Upscale Gas	80.23	80.23	0.00	80.26	0.03	0.03

SO₂ ANALYZER

Cylinder Conc. (ppm) : 79.00 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	-0.01	-0.01	0.00	0.00	0.01	0.01
Upscale Gas	78.99	78.99	0.00	79.00	0.01	0.01

CO ANALYZER

Cylinder Conc. (ppm) : 80.53 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	0.01	0.01	0.00	0.00	0.01	0.01
Upscale Gas	80.54	80.54	0.00	80.53	0.01	0.01

Calibrated by

(Mr. Saksit Phaisanphitsut)

Environmental Field Scientist (4)

FORM NO.: F 06-062 REVISION NO.: 2 ISSUE DATE: 3/06/19

ALS Laboratory Group



EMISSION TEST RESULT

Client	Rayong Olefins Co., Ltd.	Run #	1
Date	05 May 22	Location	CH5 : Cracking Furnace (Heater) 5(H-100E)
Start Time	14:30	Test Operator	Saksit P.
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	14:50
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	282
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	549
		Serial No.	300

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
14:30	4.54	8.38	57.48	-	0.12	
14:31	4.44	8.46	57.59	-	0.21	
14:32	4.28	8.79	57.33	-	0.34	
14:33	4.32	8.46	57.18	-	0.21	
14:34	4.36	8.33	57.44	-	0.23	
14:35	4.35	8.43	57.56	-	0.16	
14:36	4.24	8.61	57.37	-	0.20	
14:37	4.07	8.64	56.98	-	0.28	
14:38	4.06	8.70	56.78	-	0.24	
14:39	4.07	8.62	56.91	-	0.20	
14:40	4.10	8.43	57.14	-	0.27	
14:41	4.15	8.61	57.35	-	0.26	
14:42	4.20	8.68	57.47	-	0.22	
14:43	3.97	8.68	57.36	-	0.10	
14:44	3.86	8.88	57.29	-	0.18	
14:45	3.98	8.73	57.40	-	0.20	
14:46	3.99	8.61	57.70	-	0.20	
14:47	3.91	8.72	58.03	-	0.20	
14:48	3.97	8.69	57.66	-	0.23	
14:49	4.02	8.66	57.64	-	0.27	
14:50	4.40	8.45	57.92	-	0.26	
Average	4.16	8.59	57.41	-	0.22	

Saksit P.

(Mr. Saksit Phaisanphisut)

Environmental Field Scientist (4)



EMISSION TEST RESULT

Client	Rayong Olefins Co., Ltd.	Run #	2
Date	05 May 22	Location	CH5 : Cracking Furnace (Heater) 5(H-100E)
Start Time	14:51	Test Operator	Saksit P.
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	15:11
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	282
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	549
		Serial No.	300

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
14:51	4.50	8.40	58.13	-	0.05	
14:52	4.32	8.48	58.08	-	0.20	
14:53	4.31	8.62	57.75	-	0.25	
14:54	4.34	8.61	57.45	-	0.16	
14:55	4.22	8.57	57.39	-	0.24	
14:56	4.27	8.42	57.48	-	0.26	
14:57	4.43	8.36	58.00	-	0.18	
14:58	4.35	8.53	58.06	-	0.28	
14:59	4.28	8.58	57.94	-	0.13	
15:00	4.26	8.63	57.59	-	0.25	
15:01	4.23	8.52	57.57	-	0.35	
15:02	4.41	8.40	57.90	-	0.30	
15:03	4.50	8.37	58.17	-	0.23	
15:04	4.46	8.41	58.18	-	0.27	
15:05	4.50	8.51	57.95	-	0.19	
15:06	4.47	8.40	58.09	-	0.11	
15:07	4.54	8.39	58.33	-	0.15	
15:08	4.72	8.33	58.79	-	0.08	
15:09	4.68	8.35	58.96	-	0.03	
15:10	4.64	8.34	58.76	-	0.03	
15:11	4.65	8.39	58.26	-	0.10	
Average	4.43	8.45	58.04	-	0.18	

(Mr. Saksit Phaisanphisut)

Environmental Field Scientist (4)



EMISSION TEST RESULT

Client	Rayong Olefins Co., Ltd.	Run #	3
Date	05 May 22	Location	CH5 : Cracking Furnace (Heater) 5(H-100E)
Start Time	15:12	Test Operator	Saksit P.
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	15:32
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	282
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	549
		Serial No.	300

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
15:12	4.59	8.97	58.09	-	0.15	
15:13	4.54	9.91	57.86	-	0.26	
15:14	4.53	8.46	57.79	-	0.09	
15:15	4.53	8.35	57.95	-	0.15	
15:16	4.55	8.39	57.88	-	0.15	
15:17	4.58	8.57	58.08	-	0.22	
15:18	4.63	8.30	58.11	-	0.25	
15:19	4.66	8.32	58.16	-	0.05	
15:20	4.70	8.22	57.83	-	0.14	
15:21	4.71	8.20	57.54	-	0.16	
15:22	4.69	8.51	57.47	-	0.17	
15:23	4.70	7.87	57.52	-	0.14	
15:24	4.67	8.28	57.63	-	0.11	
15:25	4.68	8.26	57.80	-	0.15	
15:26	4.68	8.38	58.00	-	0.16	
15:27	4.70	8.28	58.22	-	0.20	
15:28	4.67	8.08	58.12	-	0.24	
15:29	4.65	8.33	57.82	-	0.12	
15:30	4.61	8.39	57.50	-	0.14	
15:31	4.65	8.38	57.22	-	0.07	
15:32	4.68	8.26	57.32	-	0.14	
Average	4.64	8.41	57.81	-	0.15	

Saksit P.

(Mr. Saksit Phaisanphisut)

Environmental Field Scientist (4)



Lot No. 2249331-1

ANALYZER CALIBRATION DATA

Client : Rayong Olefins Co., Ltd. Location : CH7 : Cracking Furnace (Heater) 7(H-100G)
Date : 05 May 22 Test Operator : Saksit P.

O₂ ANALYZER

Model : HORIBA PG-350 Serial No. : VKNVUGU9
Span (%) : 25

	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	7.93	7.92	7.93	0.04
Span Gas	16.00	15.99	16.00	0.04

NO_x ANALYZER

Model : HORIBA PG-350 Serial No. : VKNVUGU9
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	0.00	0.03
Low-Level Gas	50.41	50.44	50.41	0.03
Span Gas	80.27	80.30	80.27	0.03

SO₂ ANALYZER

Model : HORIBA PG-350 Serial No. : VKNVUGU9
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	51.61	51.60	51.61	0.01
Span Gas	79.00	78.99	79.00	0.01

CO ANALYZER

Model : HORIBA PG-350 Serial No. : VKNVUGU9
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	50.31	50.32	50.31	0.01
Span Gas	80.53	80.54	80.53	0.01

Calibrated by

(Mr. Saksit Phalsanphisut)

Environmental Field Scientist (4)



Lot No. 2249331-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client : Rayong Olefins Co., Ltd. Location : CH7 : Cracking Furnace (Heater) 7(H-100G)
Date : 05 May 22 Test Operator : Saksit P.

O₂ ANALYZER

Cylinder Conc. (%) : 16.00 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	-0.01	-0.01	0.00	0.00	0.04	0.04
Upscale Gas	15.99	15.99	0.00	16.00	0.04	0.04

NO_x ANALYZER

Cylinder Conc. (ppm) : 80.27 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	0.03	0.03	0.00	0.00	0.03	0.03
Upscale Gas	80.30	80.30	0.00	80.27	0.03	0.03

SO₂ ANALYZER

Cylinder Conc. (ppm) : 79.00 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	-0.01	-0.01	0.00	0.00	0.01	0.01
Upscale Gas	78.99	78.99	0.00	79.00	0.01	0.01

CO ANALYZER

Cylinder Conc. (ppm) : 80.53 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	0.01	0.01	0.00	0.00	0.01	0.01
Upscale Gas	80.54	80.54	0.00	80.53	0.01	0.01

Calibrated by

(Mr. Saksit Phalsanphisut)

Environmental Field Scientist (4)

FORM NO.: F 06-062 REVISION NO.: 2 ISSUE DATE: 3/06/19

ALS Laboratory Group



EMISSION TEST RESULT

Client	Rayong Olefins Co., Ltd.	Run #	1
Date	05 May 22	Location	CH7 : Cracking Furnace (Heater) 7(H-100G)
Start Time	14:30	Test Operator	Saksit P.
SO ₂ Analyzer Model	HORIBA PG-350	Finish Time	14:50
NO _x /O ₂ Analyzer Model	HORIBA PG-350	Serial No.	VKNVUGU9
CO/CO ₂ Analyzer Model	HORIBA PG-350	Serial No.	VKNVUGU9
		Serial No.	VKNVUGU9

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
14:30	4.99	8.48	46.76	-	0.39	
14:31	4.81	8.62	46.10	-	0.33	
14:32	4.63	8.73	46.55	-	0.04	
14:33	4.83	8.59	46.18	-	0.10	
14:34	5.00	8.46	46.98	-	0.15	
14:35	4.66	8.60	47.40	-	0.33	
14:36	4.68	8.68	46.57	-	0.12	
14:37	4.59	8.75	46.59	-	0.27	
14:38	4.50	8.81	46.58	-	0.41	
14:39	4.76	8.60	46.94	-	0.10	
14:40	4.91	8.48	47.22	-	0.19	
14:41	4.87	8.55	47.22	-	0.19	
14:42	4.85	8.62	46.74	-	0.10	
14:43	4.37	8.73	46.97	-	0.27	
14:44	4.40	8.84	47.31	-	0.01	
14:45	4.63	8.67	47.17	-	0.14	
14:46	4.67	8.61	47.11	-	0.00	
14:47	4.58	8.71	47.16	-	0.27	
14:48	4.55	8.77	46.43	-	0.18	
14:49	4.62	8.72	46.98	-	0.27	
14:50	4.71	8.64	46.84	-	0.14	
Average	4.70	8.65	46.85	-	0.19	

(Mr. Saksit Phalsanphisut)

Environmental Field Scientist (4)



EMISSION TEST RESULT

Client	Rayong Olefins Co., Ltd.	Run #	2
Date	05 May 22	Location	CH7 : Cracking Furnace (Heater) 7(H-100G)
Start Time	14:51	Test Operator	Saksit P.
SO ₂ Analyzer Model	HORIBA PG-350	Finish Time	15:11
NO _x /O ₂ Analyzer Model	HORIBA PG-350	Serial No.	VKNVUGU9
CO/CO ₂ Analyzer Model	HORIBA PG-350	Serial No.	VKNVUGU9
		Serial No.	VKNVUGU9

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
14:51	4.94	8.51	47.37	-	0.19	
14:52	4.65	8.58	47.32	-	0.10	
14:53	4.63	8.70	46.69	-	0.14	
14:54	4.68	8.70	47.01	-	0.14	
14:55	4.63	8.69	47.04	-	0.27	
14:56	4.83	8.55	47.39	-	0.33	
14:57	4.98	8.48	47.49	-	0.29	
14:58	4.84	8.57	47.58	-	0.23	
14:59	4.81	8.65	47.09	-	0.37	
15:00	4.86	8.63	46.19	-	0.23	
15:01	4.65	8.65	46.87	-	0.12	
15:02	4.75	8.57	47.21	-	0.10	
15:03	4.96	8.44	47.75	-	0.29	
15:04	4.93	8.51	47.61	-	0.19	
15:05	4.79	8.66	46.93	-	0.37	
15:06	4.74	8.64	46.34	-	0.14	
15:07	4.87	8.53	46.93	-	0.19	
15:08	4.95	8.49	46.78	-	0.19	
15:09	4.99	8.48	46.98	-	0.19	
15:10	4.65	8.63	46.64	-	0.46	
15:11	4.70	8.68	47.00	-	0.14	
Average	4.80	8.58	47.06	-	0.22	

(Mr. Saksit Phalsanphisut)

Environmental Field Scientist (4)



EMISSION TEST RESULT

Client	Rayong Olefins Co., Ltd.
Date	05 May 22
Start Time	15:12
SO ₂ Analyzer Model	HORIBA PG-350
NO _x /O ₂ Analyzer Model	HORIBA PG-350
CO/CO ₂ Analyzer Model	HORIBA PG-350

Run #	3
Location	CH7 : Cracking Furnace (Heater) 7(H-100G)
Test Operator	Saksit P.
Finish Time	15:32
Serial No.	VKNVUGU9
Serial No.	VKNVUGU9
Serial No.	VKNVUGU9

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
15:12	4.76	8.64	46.68	-	0.14	
15:13	4.77	8.64	46.46	-	0.14	
15:14	4.77	8.66	46.58	-	0.14	
15:15	4.84	8.61	46.93	-	0.23	
15:16	4.93	8.54	46.80	-	0.42	
15:17	4.88	8.59	46.77	-	0.23	
15:18	4.93	8.56	46.56	-	0.19	
15:19	4.93	8.55	46.61	-	0.10	
15:20	4.86	8.56	47.03	-	0.42	
15:21	4.84	8.56	47.56	-	0.19	
15:22	4.75	8.63	47.67	-	0.23	
15:23	4.87	8.57	47.66	-	0.19	
15:24	4.92	8.53	47.66	-	0.29	
15:25	4.84	8.60	47.45	-	0.10	
15:26	4.88	8.57	47.10	-	0.33	
15:27	4.98	8.53	47.26	-	0.29	
15:28	4.89	8.60	47.96	-	0.33	
15:29	4.83	8.57	47.74	-	0.19	
15:30	4.86	8.55	47.65	-	0.29	
15:31	4.81	8.60	47.63	-	0.10	
15:32	4.88	8.57	47.41	-	0.05	
Average	4.86	8.58	47.20	-	0.22	

(Mr. Saksit Phalsanphisut)

Environmental Field Scientist (4)

Lot No. 2249332-1

ANALYZER CALIBRATION DATA

Client : Rayong Olefins Co.,Ltd. Location : CH8 : Cracking Furnace (Heater) 8 (H100H)
Date : 05 May 22 Test Operator : Sathapron.T

O₂ ANALYZER

Model : TELEDYNE API 200EH Serial No. : 725
Span (%) : 25

	Cylinder Value (%)	Initial Analyzers Calibration Response (%)	Final Analyzers Calibration Response (%)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.02	0.08
Low-Level Gas	8.04	8.05	8.08	0.12
Span Gas	16.00	16.00	16.03	0.12

NO_x ANALYZER

Model : TELEDYNE API 200EH Serial No. : 725
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	0.02	0.02
Low-Level Gas	54.96	54.95	54.90	0.05
Span Gas	79.42	79.42	79.40	0.02

CO ANALYZER

Model : TELEDYNE API 300EM Serial No. : 451
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	54.84	54.82	54.80	0.02
Span Gas	80.16	80.16	80.10	0.06

Calibrated by

Sathapron Th.

(Mr. Sathapron Thakarw)

Environmental Field Scientist (3)

FORM NO.: F 06-062 REVISION NO.: 2 ISSUE DATE: 3/06/19

ALS Laboratory Group

Lot No. 2249332-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client : Rayong Olefins Co.,Ltd. Location : CH8 : Cracking Furnace (Heater) 8 (H100H)
Date : 05 May 22 Test Operator : Sathapron.T

O₂ ANALYZERCylinder Conc. (%) : 16.00 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	0.02	0.08	0.02	0.08	0.00
Upscale Gas	16.00	16.02	0.08	16.03	0.12	0.04

NO_x ANALYZERCylinder Conc. (ppm) : 79.42 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	0.01	0.01	0.02	0.02	0.01
Upscale Gas	79.42	79.41	0.01	79.40	0.02	0.01

CO ANALYZER

Cylinder Conc. (ppm) : 80.16 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	0.00	0.01	0.01	0.01	0.01	0.00
Upscale Gas	80.16	80.14	0.02	80.10	0.06	0.04

Calibrated by

Sathapron Th.

(Mr. Sathapron Thakarw)

Environmental Field Scientist (3)

FORM NO.: F 06-062 REVISION NO.: 2 ISSUE DATE: 3/06/19

ALS Laboratory Group



EMISSION TEST RESULT

Client	Rayong Olefins Co.,Ltd.
Date	05 May 22
Start Time	11:05
SO ₂ Analyzer Model	TELEDYNE API 100EH
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM

Run #	1
Location	CH8 : Cracking Furnace (Heater) 8 (H100H)
Test Operator	Sathapron.T
Finish Time	11:25
Serial No.	410
Serial No.	725
Serial No.	451

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:05	4.24	8.86	56.91	-	1.67	
11:06	4.57	8.74	56.61	-	1.59	
11:07	4.52	8.77	56.61	-	1.60	
11:08	4.13	8.94	56.36	-	1.50	
11:09	4.27	8.88	56.38	-	1.56	
11:10	4.39	8.74	56.69	-	1.51	
11:11	4.26	8.80	56.95	-	1.46	
11:12	4.49	8.73	57.15	-	1.43	
11:13	4.34	8.89	57.05	-	1.44	
11:14	4.22	8.93	56.82	-	1.39	
11:15	4.58	8.68	56.45	-	1.32	
11:16	4.40	8.78	56.66	-	1.37	
11:17	4.29	8.81	56.94	-	1.30	
11:18	4.10	8.95	56.83	-	1.29	
11:19	4.28	8.92	56.72	-	1.23	
11:20	4.12	8.94	56.52	-	1.29	
11:21	4.61	8.64	56.58	-	1.24	
11:22	4.26	9.00	56.65	-	1.18	
11:23	4.37	8.84	56.60	-	1.16	
11:24	4.25	8.83	56.31	-	1.18	
11:25	4.44	8.76	56.57	-	1.14	
Average	4.34	8.83	56.68	-	1.37	

Sathapron Th.

(Mr. Sathapron Thakarw)

Environmental Field Scientist (3)



EMISSION TEST RESULT

Client	Rayong Olefins Co.,Ltd.
Date	05 May 22
Start Time	11:26
SO ₂ Analyzer Model	TELEDYNE API 100EH
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM

Run #	2
Location	CH8 : Cracking Furnace (Heater) 8 (H100H)
Test Operator	Sathapron.T
Finish Time	11:46
Serial No.	410
Serial No.	725
Serial No.	451

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:26	4.22	8.88	56.63	-	1.14	
11:27	4.10	9.05	56.49	-	1.08	
11:28	4.33	8.82	56.45	-	1.08	
11:29	4.37	8.73	56.55	-	1.04	
11:30	4.25	8.96	56.85	-	1.00	
11:31	4.41	8.73	56.70	-	0.96	
11:32	4.31	8.80	56.91	-	0.97	
11:33	4.50	8.77	57.15	-	0.88	
11:34	4.28	8.89	57.23	-	0.91	
11:35	4.48	8.75	57.24	-	0.87	
11:36	4.52	8.66	57.24	-	0.83	
11:37	4.45	8.70	57.52	-	1.64	
11:38	4.43	8.84	57.41	-	1.64	
11:39	4.11	8.99	56.87	-	1.63	
11:40	4.17	8.99	56.63	-	1.59	
11:41	4.32	8.88	56.63	-	1.59	
11:42	4.50	8.69	56.93	-	1.57	
11:43	4.57	8.69	57.02	-	1.49	
11:44	4.53	8.84	56.84	-	1.50	
11:45	3.97	9.08	56.29	-	1.52	
11:46	4.23	8.90	55.88	-	1.49	
Average	4.34	8.84	56.83	-	1.26	

Sathapron Th.

(Mr. Sathapron Thakarw)

Environmental Field Scientist (3)



EMISSION TEST RESULT

Client	Rayong Olefins Co.,Ltd.	Run #	3
Date	05 May 22	Location	CH8 : Cracking Furnace (Heater) 8 (H100H)
Start Time	11:47	Test Operator	Sathapron.T
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	12:07
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	410
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	725
		Serial No.	451

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:47	4.41	8.82	56.12	-	1.45	
11:48	4.40	8.71	56.71	-	1.51	
11:49	4.36	8.84	57.04	-	1.46	
11:50	4.60	8.68	57.10	-	1.49	
11:51	4.24	8.89	57.07	-	1.43	
11:52	4.39	8.84	56.95	-	1.40	
11:53	4.41	8.76	56.82	-	1.42	
11:54	4.35	8.83	56.96	-	1.41	
11:55	4.55	8.67	57.29	-	1.38	
11:56	4.46	8.66	57.41	-	1.39	
11:57	4.52	8.76	57.38	-	1.32	
11:58	4.49	8.76	57.14	-	1.33	
11:59	4.23	8.98	57.02	-	1.33	
12:00	4.10	9.06	56.52	-	1.33	
12:01	4.49	8.82	56.40	-	1.27	
12:02	4.35	8.81	56.73	-	1.27	
12:03	4.48	8.71	57.19	-	1.18	
12:04	4.61	8.62	57.15	-	1.23	
12:05	4.45	8.76	57.06	-	1.19	
12:06	4.38	8.89	57.13	-	1.20	
12:07	4.49	8.79	56.72	-	1.17	
Average	4.42	8.79	56.95	-	1.34	

Sathapron Th.

(Mr. Sathapron Thakarw)

Environmental Field Scientist (3)



Lot No. 2249333-1

ANALYZER CALIBRATION DATA

Client : Rayong Olefins Co., Ltd. Location : CH9 : Cracking Furnace (Heater) 9(H-100I)
Date : 06 May 22 Test Operator : Saksit P.

O₂ ANALYZER

Model : HORIBA PG-350 Serial No. : VKNVUGU9
Span (%) : 25

	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	7.93	7.92	7.93	0.04
Span Gas	16.00	15.99	16.00	0.04

NO_x ANALYZER

Model : HORIBA PG-350 Serial No. : VKNVUGU9
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	0.00	0.03
Low-Level Gas	50.41	50.44	50.41	0.03
Span Gas	80.27	80.30	80.27	0.03

SO₂ ANALYZER

Model : HORIBA PG-350 Serial No. : VKNVUGU9
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	51.61	51.60	51.61	0.01
Span Gas	79.00	78.99	79.00	0.01

CO ANALYZER

Model : HORIBA PG-350 Serial No. : VKNVUGU9
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	50.31	50.32	50.31	0.01
Span Gas	80.53	80.54	80.53	0.01

Calibrated by

(Mr. Saksit Phalsanphisut)

Environmental Field Scientist (4)

Lot No. 2249333-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client : Rayong Olefins Co., Ltd. Location : CH9 : Cracking Furnace (Heater) 9(H-100I)
Date : 06 May 22 Test Operator : Saksit P.

O₂ ANALYZERCylinder Conc. (%) : 16.00 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	-0.01	-0.01	0.00	0.00	0.04	0.04
Upscale Gas	15.99	15.99	0.00	16.00	0.04	0.04

NO_x ANALYZERCylinder Conc. (ppm) : 80.27 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	0.03	0.03	0.00	0.00	0.03	0.03
Upscale Gas	80.30	80.30	0.00	80.27	0.03	0.03

SO₂ ANALYZERCylinder Conc. (ppm) : 79.00 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	-0.01	-0.01	0.00	0.00	0.01	0.01
Upscale Gas	78.99	78.99	0.00	79.00	0.01	0.01

CO ANALYZER

Cylinder Conc. (ppm) : 80.53 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	0.01	0.01	0.00	0.00	0.01	0.01
Upscale Gas	80.54	80.54	0.00	80.53	0.01	0.01

Calibrated by

(Mr. Saksit Phaisanphisut)

Environmental Field Scientist (4)

FORM NO.: F 06-062 REVISION NO.: 2 ISSUE DATE: 3/06/19

ALS Laboratory Group



EMISSION TEST RESULT

Client	Rayong Olefins Co., Ltd.	Run #	1
Date	06 May 22	Location	CH9 : Cracking Furnace (Heater) 9(H-100I)
Start Time	12:10	Test Operator	Saksit P.
SO ₂ Analyzer Model	HORIBA PG-350	Finish Time	12:30
NO _x /O ₂ Analyzer Model	HORIBA PG-350	Serial No.	VKNVUGU9
CO/CO ₂ Analyzer Model	HORIBA PG-350	Serial No.	VKNVUGU9
		Serial No.	VKNVUGU9

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
12:10	4.09	8.84	51.01	-	0.32	
12:11	4.10	8.88	51.02	-	0.22	
12:12	3.95	9.03	50.09	-	0.17	
12:13	4.08	8.94	50.51	-	0.26	
12:14	4.22	8.80	51.47	-	0.32	
12:15	4.27	8.78	51.88	-	0.18	
12:16	4.24	8.82	51.66	-	0.41	
12:17	4.09	8.97	50.49	-	0.17	
12:18	4.07	9.04	50.30	-	0.30	
12:19	4.08	8.94	50.24	-	0.26	
12:20	4.12	8.89	50.72	-	0.12	
12:21	4.20	8.89	50.54	-	0.12	
12:22	4.06	9.00	49.77	-	0.17	
12:23	4.12	8.95	50.10	-	0.26	
12:24	4.24	8.82	50.51	-	0.22	
12:25	4.26	8.83	51.12	-	0.22	
12:26	4.21	8.92	50.27	-	0.26	
12:27	4.15	8.94	50.62	-	0.26	
12:28	4.10	9.00	50.04	-	0.07	
12:29	4.31	8.80	50.95	-	0.32	
12:30	4.31	8.78	51.22	-	0.08	
Average	4.16	8.89	50.69	-	0.22	

(Mr. Saksit Phalsanphisut)

Environmental Field Scientist (4)



EMISSION TEST RESULT

Client	Rayong Olefins Co., Ltd.	Run #	2
Date	06 May 22	Location	CH9 : Cracking Furnace (Heater) 9(H-100I)
Start Time	12:31	Test Operator	Saksit P.
SO ₂ Analyzer Model	HORIBA PG-350	Finish Time	12:51
NO _x /O ₂ Analyzer Model	HORIBA PG-350	Serial No.	VKNVUGU9
CO/CO ₂ Analyzer Model	HORIBA PG-350	Serial No.	VKNVUGU9
		Serial No.	VKNVUGU9

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
12:31	4.24	8.89	50.47	-	0.03	
12:32	4.17	8.93	50.14	-	0.26	
12:33	4.14	8.92	50.57	-	0.03	
12:34	4.32	8.79	51.15	-	0.22	
12:35	4.30	8.76	51.63	-	0.32	
12:36	4.27	8.83	51.25	-	0.13	
12:37	4.20	8.89	51.05	-	0.26	
12:38	4.12	8.96	50.55	-	0.30	
12:39	4.18	8.98	50.56	-	0.21	
12:40	4.30	8.86	51.05	-	0.26	
12:41	4.35	8.82	50.83	-	0.13	
12:42	4.55	8.71	51.12	-	0.08	
12:43	4.52	8.69	51.11	-	0.32	
12:44	4.32	8.90	50.51	-	0.17	
12:45	4.35	8.86	49.90	-	0.17	
12:46	4.40	8.79	50.34	-	0.46	
12:47	4.46	8.75	50.30	-	0.32	
12:48	4.60	8.62	51.00	-	0.28	
12:49	4.57	8.64	50.89	-	0.28	
12:50	4.54	8.71	50.37	-	0.32	
12:51	4.39	8.80	49.91	-	0.46	
Average	4.35	8.81	50.70	-	0.24	

(Mr. Saksit Phalsanphisut)

Environmental Field Scientist (4)



EMISSION TEST RESULT

Client	Rayong Olefins Co., Ltd.
Date	06 May 22
Start Time	12:52
SO ₂ Analyzer Model	HORIBA PG-350
NO _x /O ₂ Analyzer Model	HORIBA PG-350
CO/CO ₂ Analyzer Model	HORIBA PG-350

Run #	3
Location	CH9 : Cracking Furnace (Heater) 9(H-100I)
Test Operator	Saksit P.
Finish Time	13:12
Serial No.	VKNVUGU9
Serial No.	VKNVUGU9
Serial No.	VKNVUGU9

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
12:52	4.33	8.87	49.87	-	0.50	
12:53	4.31	8.70	50.42	-	0.08	
12:54	4.51	8.60	50.97	-	0.04	
12:55	4.55	8.60	51.20	-	0.37	
12:56	4.49	8.66	51.15	-	0.28	
12:57	4.35	8.80	50.31	-	0.22	
12:58	4.41	8.81	50.30	-	0.22	
12:59	4.41	8.79	50.40	-	0.55	
13:00	4.42	8.82	50.43	-	0.12	
13:01	4.50	8.75	50.43	-	0.22	
13:02	4.59	8.65	50.82	-	0.41	
13:03	4.70	8.61	51.13	-	0.37	
13:04	4.60	8.62	51.26	-	0.28	
13:05	4.43	8.77	50.29	-	0.12	
13:06	4.46	8.78	50.22	-	0.12	
13:07	4.52	8.69	50.37	-	0.08	
13:08	4.57	8.64	50.48	-	0.08	
13:09	4.64	8.59	50.79	-	0.41	
13:10	4.64	8.62	50.77	-	0.41	
13:11	4.54	8.77	50.30	-	0.22	
13:12	4.55	8.74	50.24	-	0.22	
Average	4.50	8.70	50.58	-	0.25	

Saksit P.

(Mr. Saksit Phaisanphisut)

Environmental Field Scientist (4)



Lot No. 2249337-1

ANALYZER CALIBRATION DATA

Client : Rayong Olefins Co., Ltd. Location : CH13 : Cracking Furnace (Heater) 13(H-100Q)
Date : 05 May 22 Test Operator : Saksit P.

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	-0.02	0.00	0.08
Low-Level Gas	7.93	7.91	7.93	0.08
Span Gas	16.00	15.98	16.00	0.08

NO_x ANALYZER

Model : TELEDYNE API 200EH Serial No. : 549
Span (ppm) : 100

	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	-0.04	-0.01	0.03
Low-Level Gas	50.41	50.37	50.40	0.03
Span Gas	80.27	80.23	80.26	0.03

SO₂ ANALYZER

Model : TELEDYNE API 100EH Serial No. : 282
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	51.61	51.60	51.61	0.01
Span Gas	79.00	78.99	79.00	0.01

CO ANALYZER

Model : TELEDYNE API 300EM Serial No. : 300
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	50.31	50.32	50.31	0.01
Span Gas	80.53	80.54	80.53	0.01

Calibrated by

(Mr. Saksit Phalsanphisut)

Environmental Field Scientist (4)



Lot No.

2249337-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client : Rayong Olefins Co., Ltd. Location : CH13 : Cracking Furnace (Heater) 13(H-100Q)
Date : 05 May 22 Test Operator : Saksit P.

O₂ ANALYZER

Cylinder Conc. (%) : 16.00 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	-0.02	-0.02	0.00	0.00	0.08	0.08
Upscale Gas	15.98	15.98	0.00	16.00	0.08	0.08

NO_x ANALYZER

Cylinder Conc. (ppm) : 80.27 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	-0.04	-0.04	0.00	-0.01	0.03	0.03
Upscale Gas	80.23	80.23	0.00	80.26	0.03	0.03

SO₂ ANALYZER

Cylinder Conc. (ppm) : 79.00 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	-0.01	-0.01	0.00	0.00	0.01	0.01
Upscale Gas	78.99	78.99	0.00	79.00	0.01	0.01

CO ANALYZER

Cylinder Conc. (ppm) : 80.53 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	0.01	0.01	0.00	0.00	0.01	0.01
Upscale Gas	80.54	80.54	0.00	80.53	0.01	0.01

Calibrated by

(Mr. Saksit Phalsanphisut)

Environmental Field Scientist (4)

FORM NO.: F 06-062 REVISION NO.: 2 ISSUE DATE: 3/06/19

ALS Laboratory Group



EMISSION TEST RESULT

Client	Rayong Olefins Co., Ltd.	Run #	1
Date	05 May 22	Location	CH13 : Cracking Furnace (Heater) 13(H-100Q)
Start Time	10:40	Test Operator	Saksit P.
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	11:00
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	282
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	549
		Serial No.	300

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
10:40	4.00	8.24	56.43	-	0.11	
10:41	4.19	8.47	56.94	-	0.09	
10:42	4.24	8.52	57.18	-	0.11	
10:43	4.14	8.71	57.09	-	0.15	
10:44	4.16	8.61	56.88	-	0.11	
10:45	4.15	8.56	57.01	-	0.26	
10:46	4.21	8.25	57.56	-	0.21	
10:47	4.11	8.65	57.29	-	0.25	
10:48	4.01	8.78	57.00	-	0.18	
10:49	4.08	8.56	56.90	-	0.24	
10:50	4.00	8.63	56.97	-	0.15	
10:51	4.13	8.56	57.07	-	0.27	
10:52	4.31	8.44	57.44	-	0.25	
10:53	4.21	8.53	57.71	-	0.33	
10:54	4.21	8.52	57.84	-	0.15	
10:55	4.04	8.62	57.74	-	0.19	
10:56	4.07	8.67	57.31	-	0.50	
10:57	4.03	8.74	56.99	-	0.24	
10:58	4.02	7.79	56.90	-	0.23	
10:59	4.07	8.64	57.04	-	0.20	
11:00	4.02	8.63	57.04	-	0.24	
Average	4.11	8.52	57.16	-	0.21	

(Mr. Saksit Phaisanphisut)

Environmental Field Scientist (4)



EMISSION TEST RESULT

Client	Rayong Olefins Co., Ltd.	Run #	2
Date	05 May 22	Location	CH13 : Cracking Furnace (Heater) 13(H-100Q)
Start Time	11:01	Test Operator	Saksit P.
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	11:21
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	282
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	549
		Serial No.	300

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:01	4.05	8.70	56.95	-	0.30	
11:02	3.87	8.93	56.19	-	0.29	
11:03	3.79	8.71	55.81	-	0.28	
11:04	3.78	8.77	55.76	-	0.35	
11:05	3.93	8.76	56.06	-	0.31	
11:06	4.01	8.67	56.18	-	0.39	
11:07	4.00	8.81	56.24	-	0.36	
11:08	4.01	8.70	55.96	-	0.28	
11:09	3.95	8.82	55.70	-	0.45	
11:10	4.11	8.55	55.95	-	0.38	
11:11	4.11	8.59	56.22	-	0.31	
11:12	4.21	8.56	56.55	-	0.41	
11:13	4.31	8.47	56.81	-	0.36	
11:14	4.29	8.55	56.69	-	0.44	
11:15	4.08	8.71	56.28	-	0.45	
11:16	4.01	8.71	55.85	-	0.55	
11:17	3.97	8.07	55.74	-	0.44	
11:18	4.10	8.57	55.76	-	0.46	
11:19	4.07	9.24	55.61	-	0.43	
11:20	3.83	8.81	55.13	-	0.46	
11:21	3.82	8.75	54.68	-	0.65	
Average	4.02	8.68	56.01	-	0.40	

(Mr. Saksit Phaisanphisut)

Environmental Field Scientist (4)



EMISSION TEST RESULT

Client	Rayong Olefins Co., Ltd.	Run #	3
Date	05 May 22	Location	CH13 : Cracking Furnace (Heater) 13(H-100Q)
Start Time	11:22	Test Operator	Saksit P.
SO ₂ Analyzer Model	TELEDYNE API 100EH	Finish Time	11:42
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH	Serial No.	282
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM	Serial No.	549
		Serial No.	300

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
11:22	3.83	8.73	54.67	-	0.43	
11:23	3.76	9.09	54.56	-	0.54	
11:24	3.72	8.88	54.34	-	0.58	
11:25	3.79	8.50	54.26	-	0.49	
11:26	4.05	8.62	54.73	-	0.54	
11:27	4.05	8.76	55.08	-	0.46	
11:28	3.91	8.76	54.83	-	0.46	
11:29	4.00	9.80	54.88	-	0.32	
11:30	4.00	8.58	55.54	-	0.51	
11:31	3.94	8.75	55.51	-	0.60	
11:32	4.01	8.54	55.46	-	0.56	
11:33	4.02	8.59	55.83	-	0.66	
11:34	4.04	8.62	55.73	-	0.56	
11:35	4.00	8.76	55.06	-	0.64	
11:36	3.88	8.73	55.00	-	0.62	
11:37	4.00	8.77	55.28	-	0.65	
11:38	4.04	8.61	55.56	-	0.67	
11:39	3.98	8.71	55.49	-	0.80	
11:40	4.00	8.76	55.29	-	0.72	
11:41	3.91	8.83	55.01	-	0.54	
11:42	3.90	8.70	54.88	-	0.44	
Average	3.94	8.76	55.10	-	0.56	

Saksit P.

(Mr. Saksit Phalsanphisut)

Environmental Field Scientist (4)



Lot No. 2249426-1

ANALYZER CALIBRATION DATA

Client : Rayong Olefins Co.,Ltd. Location : UBS3 : Utility Boiler Stack 3 (H-2050C)
Date : 06 May 22 Test Operator : Sathapron.T

O₂ ANALYZER

Model : TELEDYNE API 200EH Serial No. : 725
Span (%) : 25

	Cylinder Value (%)	Initial Analyzers Calibration Response (%)	Final Analyzers Calibration Response (%)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.04	0.16
Low-Level Gas	8.04	8.05	8.08	0.12
Span Gas	16.00	16.00	16.04	0.16

NO_x ANALYZER

Model : TELEDYNE API 200EH Serial No. : 725
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	54.96	54.93	54.90	0.03
Span Gas	79.42	79.42	79.38	0.04

SO₂ ANALYZER

Model : TELEDYNE API 100EH Serial No. : 437
Span (ppm) : 100

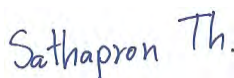
	Cylinder Value (ppm)	Initial Analyzers Calibration Response (ppm)	Final Analyzers Calibration Response (ppm)	Difference (Percent of Span)
Zero Gas	0.00	0.00	0.02	0.02
Low-Level Gas	55.55	55.54	55.53	0.01
Span Gas	80.22	80.22	80.20	0.02

CO ANALYZER

Model : TELEDYNE API 300EM Serial No. : 451
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	54.84	54.83	54.80	0.03
Span Gas	80.16	80.16	80.14	0.02

Calibrated by



(Mr. Sathapron Thakarw)

Environmental Field Scientist (3)

Lot No. 2249426-1

SYSTEM CALIBRATION BIAS AND DRIFT DATA

Client : Rayong Olefins Co.,Ltd. Location : UBS3 : Utility Boiler Stack 3 (H-2050C)
Date : 06 May 22 Test Operator : Sathapron.T

O₂ ANALYZERCylinder Conc. (%) : 16.00 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	0.03	0.12	0.04	0.16	0.04
Upscale Gas	16.00	16.03	0.12	16.04	0.16	0.04

NO_x ANALYZERCylinder Conc. (ppm) : 79.42 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	0.02	0.02	0.05	0.05	0.03
Upscale Gas	79.42	79.40	0.02	79.38	0.04	0.02

SO₂ ANALYZERCylinder Conc. (ppm) : 80.22 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	0.02	0.02	0.01
Upscale Gas	80.22	80.21	0.01	80.20	0.02	0.01

CO ANALYZER

Cylinder Conc. (ppm) : 80.16 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	0.00	0.01	0.01	0.01	0.01	0.00
Upscale Gas	80.16	80.14	0.02	80.14	0.02	0.00

Calibrated by

Sathapron Th.

(Mr. Sathapron Thakarw)

Environmental Field Scientist (3)

FORM NO.: F 06-062 REVISION NO.: 2 ISSUE DATE: 3/06/19

ALS Laboratory Group



EMISSION TEST RESULT

Client	Rayong Olefins Co.,Ltd.
Date	06 May 22
Start Time	10:15
SO ₂ Analyzer Model	TELEDYNE API 100EH
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM

Run #	1
Location	UBS3 : Utility Boiler Stack 3 (H-2050C)
Test Operator	Sathapron.T
Finish Time	10:35
Serial No.	437
Serial No.	725
Serial No.	451

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
10:15	6.62	9.16	61.96	10.48	2.78	
10:16	6.59	9.19	61.81	11.22	2.75	
10:17	6.64	9.14	61.33	12.24	2.75	
10:18	6.57	9.16	61.63	12.75	2.62	
10:19	6.51	9.19	62.20	13.07	2.63	
10:20	6.58	9.19	62.44	13.08	2.56	
10:21	6.51	9.20	62.69	12.72	2.56	
10:22	6.45	9.24	63.06	12.36	2.51	
10:23	6.42	9.24	63.32	12.30	2.51	
10:24	6.54	9.14	63.09	12.21	2.44	
10:25	6.56	9.15	62.09	12.20	2.41	
10:26	6.55	9.17	61.69	12.10	2.34	
10:27	6.57	9.13	61.79	11.98	2.30	
10:28	6.65	9.07	61.56	11.86	2.31	
10:29	6.61	9.07	61.37	12.12	2.28	
10:30	6.62	9.07	60.87	12.19	2.23	
10:31	6.66	9.07	60.46	11.81	2.20	
10:32	6.62	9.11	60.32	11.69	2.19	
10:33	6.61	9.11	60.21	11.69	2.14	
10:34	6.64	9.10	60.64	11.63	2.12	
10:35	6.58	9.16	61.12	11.76	2.05	
Average	6.58	9.15	61.70	12.07	2.41	

Sathapron Th.

(Mr. Sathapron Thakarw)

Environmental Field Scientist (3)



EMISSION TEST RESULT

Client	Rayong Olefins Co.,Ltd.
Date	06 May 22
Start Time	10:36
SO ₂ Analyzer Model	TELEDYNE API 100EH
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM

Run #	2
Location	UBS3 : Utility Boiler Stack 3 (H-2050C)
Test Operator	Sathapron.T
Finish Time	10:56
Serial No.	437
Serial No.	725
Serial No.	451

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
10:36	6.60	9.17	61.11	11.89	2.01	
10:37	6.55	9.20	61.21	11.87	2.00	
10:38	6.55	9.21	61.17	11.93	2.03	
10:39	6.50	9.24	61.49	12.12	2.00	
10:40	6.56	9.16	61.43	12.28	1.93	
10:41	6.56	9.13	60.87	12.43	1.92	
10:42	6.58	9.14	60.60	12.39	1.85	
10:43	6.60	9.16	60.36	12.28	1.87	
10:44	6.55	9.21	60.28	12.10	1.80	
10:45	6.53	9.18	60.37	11.94	1.74	
10:46	6.60	9.14	59.46	11.93	1.73	
10:47	6.57	9.13	58.99	12.08	1.69	
10:48	6.56	9.15	59.47	12.35	1.67	
10:49	6.65	9.11	60.32	12.20	1.68	
10:50	6.65	9.10	61.05	12.26	1.64	
10:51	6.57	9.16	61.46	12.55	1.64	
10:52	6.59	9.15	61.69	12.72	1.54	
10:53	6.55	9.16	61.49	12.77	1.63	
10:54	6.41	9.24	61.18	12.95	1.52	
10:55	6.27	9.34	62.14	13.00	1.55	
10:56	6.24	9.37	62.90	13.27	1.50	
Average	6.54	9.19	60.91	12.35	1.76	

Sathapron Th.

(Mr. Sathapron Thakarw)

Environmental Field Scientist (3)



EMISSION TEST RESULT

Client	Rayong Olefins Co.,Ltd.
Date	06 May 22
Start Time	10:57
SO ₂ Analyzer Model	TELEDYNE API 100EH
NO _x /O ₂ Analyzer Model	TELEDYNE API 200EH
CO/CO ₂ Analyzer Model	TELEDYNE API 300EM

Run #	3
Location	UBS3 : Utility Boiler Stack 3 (H-2050C)
Test Operator	Sathapron.T
Finish Time	11:17
Serial No.	437
Serial No.	725
Serial No.	451

Time (min)	O ₂ (%)	CO ₂ (%)	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	Remark
10:57	5.96	9.59	63.70	13.74	1.53	
10:58	5.52	9.82	65.67	13.86	1.40	
10:59	5.12	10.06	68.40	14.13	1.41	
11:00	4.97	10.14	71.37	14.34	1.40	
11:01	4.54	10.44	73.26	14.88	1.42	
11:02	4.27	10.63	74.64	15.68	1.47	
11:03	3.88	10.87	77.04	16.50	1.61	
11:04	3.70	11.03	78.10	16.53	1.54	
11:05	3.69	11.01	79.52	16.49	1.49	
11:06	3.73	10.94	80.08	16.29	1.50	
11:07	3.80	10.88	79.63	16.16	1.58	
11:08	3.75	10.88	79.57	16.64	2.28	
11:09	3.69	10.94	80.19	16.88	2.19	
11:10	3.69	11.00	80.30	16.78	2.14	
11:11	3.70	10.97	80.34	16.44	2.18	
11:12	3.67	10.98	80.40	16.47	2.18	
11:13	3.71	10.95	80.34	16.48	2.14	
11:14	3.74	10.88	80.17	16.40	2.11	
11:15	3.80	10.92	79.92	16.53	2.07	
11:16	3.76	10.97	80.28	16.41	2.07	
11:17	3.74	10.98	81.32	16.18	2.10	
Average	4.12	10.71	76.87	15.90	1.80	

Sathapron Th.

(Mr. Sathapron Thakarw)

Environmental Field Scientist (3)

CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Part Number:	E04NI99E15A0440	Reference Number:	160-401977167-1
Cylinder Number:	EB0140237	Cylinder Volume:	144.4 CF
Laboratory:	124 - Plumsteadville - PA	Cylinder Pressure:	2015 PSIG
PGVP Number:	A12020	Valve Outlet:	660
Gas Code:	CO,NO,NOX,SO2,BALN	Certification Date:	Dec 23, 2020

Expiration Date: Dec 23, 2028

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.

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

ANALYTICAL RESULTS					
Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
NOX	80.00 PPM	79.42 PPM	G1	+/- 1.1% NIST Traceable	12/14/2020, 12/23/2020
CARBON MONOXIDE	80.00 PPM	80.16 PPM	G1	+/- 0.5% NIST Traceable	12/14/2020
NITRIC OXIDE	80.00 PPM	79.41 PPM	G1	+/- 1.1% NIST Traceable	12/14/2020, 12/23/2020
SULFUR DIOXIDE	80.00 PPM	80.22 PPM	G1	+/- 1.1% NIST Traceable	12/14/2020, 12/23/2020
NITROGEN	Balance				

CALIBRATION STANDARDS					
Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	11010130	KAL004536	97.31 PPM CARBON MONOXIDE/NITROGEN	+/- 0.4%	Oct 04, 2022
PRM	12386	D685025	9.91 PPM AIR/NITROGEN DIOXIDE	2.0%	Feb 20, 2020
NTRM	17060226	EB0079109	100.3 PPM NITRIC OXIDE/NITROGEN	+/- 1.0%	Jul 23, 2023
GMIS	124206889	CC323707	4.028 PPM NITROGEN DIOXIDE/NITROGEN	2.1%	Aug 15, 2021
NTRM	16010203	KAL003087	97.69 PPM SULFUR DIOXIDE/NITROGEN	+/-0.8%	Dec 23, 2021

The SRM, PRM or RGM noted above is only in reference to the GMIS used in the assay and not part of the analysis.

ANALYTICAL EQUIPMENT		
Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nicolet iS50 FTIR AUP2010245 CO	FTIR	Dec 10, 2020
Nicolet iS50 FTIR AUP2010245 NO	FTIR	Dec 16, 2020
Nicolet iS50 FTIR AUP2010245 NO2	FTIR	Dec 02, 2020
Nicolet iS50 FTIR AUP2010245 SO2	FTIR	Dec 02, 2020

Triad Data Available Upon Request

NOTES:

Gross Weight: 27.8 Kg

Net Weight: 4.7 Kg



Michael A. Miller
Approved for Release

CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Part Number:	E04NI99E15A021C	Reference Number:	160-402020199-1
Cylinder Number:	CC709609	Cylinder Volume:	144.4 CF
Laboratory:	124 - Plumsteadville - PA	Cylinder Pressure:	2015 PSIG
PGVP Number:	A12021	Valve Outlet:	660
Gas Code:	CO,NO,NOX,SO2,BALN	Certification Date:	Feb 22, 2021

Expiration Date: Feb 22, 2029

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.

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

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
NOX	55.00 PPM	54.96 PPM	G1	+/- 1.4% NIST Traceable	02/15/2021, 02/22/2021
CARBON MONOXIDE	55.00 PPM	54.84 PPM	G1	+/- 0.7% NIST Traceable	02/15/2021
NITRIC OXIDE	55.00 PPM	54.69 PPM	G1	+/- 1.1% NIST Traceable	02/15/2021, 02/22/2021
SULFUR DIOXIDE	55.00 PPM	55.55 PPM	G1	+/- 1.0% NIST Traceable	02/15/2021, 02/22/2021
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	14060753	CC434455	49.88 PPM CARBON MONOXIDE/NITROGEN	+/- 0.6%	Feb 13, 2026
PRM	12386	D685025	9.91 PPM AIR/NITROGEN DIOXIDE	2.0%	Feb 20, 2020
NTRM	200611-04	CC707968	49.82 PPM NITRIC OXIDE/NITROGEN	+/- 1.0%	Feb 02, 2025
GMIS	124206889	CC323707	4.028 PPM NITROGEN DIOXIDE/NITROGEN	2.1%	Aug 15, 2021
NTRM	0141709	KAL003190	49.67 PPM SULFUR DIOXIDE/NITROGEN	+/- 1.0%	Jun 20, 2022

The SRM, PRM or RGM noted above is only in reference to the GMIS used in the assay and not part of the analysis.

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nicolet iS50 FTIR AUP2010245 CO	FTIR	Feb 04, 2021
Nicolet iS50 FTIR AUP2010245 NO	FTIR	Feb 11, 2021
Nicolet iS50 FTIR AUP2010245 NO2	FTIR	Feb 22, 2021
Nicolet iS50 FTIR AUP2010245 SO2	FTIR	Feb 18, 2021

Triad Data Available Upon Request

NOTES:

Gross Weight: 28.8 Kg

Net Weight: 4.8 Kg



[Signature]

Approved for Release

CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Part Number:	E04NI99E3HA0023	Reference Number:	82-401123195-1
Cylinder Number:	ND33083	Cylinder Volume:	247.2 CF
Laboratory:	124 - Riverton (SAP) - NJ	Cylinder Pressure:	2215 PSIG
PGVP Number:	B52018	Valve Outlet:	660
Gas Code:	CO,NO,NOX,SO2,BALN	Certification Date:	Feb 26, 2018

Expiration Date: Feb 26, 2026

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, 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 volume/volume basis unless otherwise noted.

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

ANALYTICAL RESULTS					
Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
NOX	50.00 PPM	50.41 PPM	G1	+/- 1.0% NIST Traceable	02/19/2018, 02/26/2018
CARBON MONOXIDE	50.00 PPM	50.31 PPM	G1	+/- 0.7% NIST Traceable	02/19/2018
NITRIC OXIDE	50.00 PPM	50.39 PPM	G1	+/- 1.0% NIST Traceable	02/19/2018, 02/26/2018
SULFUR DIOXIDE	50.00 PPM	51.81 PPM	G1	+/- 1.2% NIST Traceable	02/19/2018, 02/26/2018
NITROGEN	Balance				

CALIBRATION STANDARDS					
Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	14060735	CC434383	49.88 PPM CARBON MONOXIDE/NITROGEN	+/- 0.8%	Feb 22, 2020
PRM	12367	APEX1099237	9.82 PPM NITROGEN DIOXIDE/AIR	+/- 2.0%	Jun 02, 2017
NTRM	16060807	CC442584	50.42 PPM NITRIC OXIDE/NITROGEN	+/- 0.8%	Jun 27, 2020
GMIS	0315201604	CC503358	4.975 PPM NITROGEN DIOXIDE/NITROGEN	+/- 1.6%	Mar 15, 2019
NTRM	16011025	CC473218	49.02 PPM SULFUR DIOXIDE/NITROGEN	+/- 0.8%	Jun 07, 2022

The SRM, PRM or RGM noted above is only in reference to the GMIS used in the assay and not part of the analysis.

ANALYTICAL EQUIPMENT		
Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nicolet 6700 APW1100391 CO	FTIR	Feb 08, 2018
Nicolet 6700 APW1100391 NO	FTIR	Feb 15, 2018
Nicolet 6700 APW1100391 NO2	FTIR	Feb 16, 2018
Nicolet 6700 APW1100391 SO2	FTIR	Feb 05, 2018

Triad Data Available Upon Request

NOTES:

This calibration std. has been certified in accordance with the May 2012 EPA Traceability Protocol, Document EPA-600/R-12/531. All testing processes and measurements conform to the requirements of ISO/IEC 17025 and to Airgas ISO 9001:2000 and relate only to items identified on this certificate. All values are certified to be NIST Traceable with total uncertainty as detailed under Analytical Uncertainty. This document shall not be reproduced in full without written approval of the issuer.



TESTING CERT No. 3082.05

Approved for Release

CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Part Number:	E04NI99E15A0440	Reference Number:	160-401907847-1
Cylinder Number:	EB0137377	Cylinder Volume:	144.4 Cubic Feet
Laboratory:	124 - Plumsteadville - PA	Cylinder Pressure:	2015 PSIG
PGVP Number:	A12020	Valve Outlet:	660
Gas Code:	CO,NO,NOX,SO2,BALN	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 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.

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

ANALYTICAL RESULTS					
Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
NOX	80.00 PPM	80.27 PPM	G1	+/- 1.4% NIST Traceable	09/29/2020, 10/06/2020
CARBON MONOXIDE	80.00 PPM	80.53 PPM	G1	+/- 1.0% NIST Traceable	09/29/2020
NITRIC OXIDE	80.00 PPM	80.27 PPM	G1	+/- 1.4% NIST Traceable	09/29/2020, 10/06/2020
SULFUR DIOXIDE	80.00 PPM	79.00 PPM	G1	+/- 1.0% NIST Traceable	09/29/2020, 10/06/2020
NITROGEN	Balance				

CALIBRATION STANDARDS					
Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	11010130	KAL004536	97.31 PPM CARBON MONOXIDE/NITROGEN	+/- 0.4%	Oct 04, 2022
PRM	12386	D685025	9.91 PPM AIR/NITROGEN DIOXIDE	2.0%	Feb 20, 2020
NTRM	17060226	EB0079109	100.3 PPM NITRIC OXIDE/NITROGEN	+/- 1.0%	Jul 23, 2023
GMIS	124206889	CC323707	4.028 PPM NITROGEN DIOXIDE/NITROGEN	2.1%	Aug 15, 2021
NTRM	07060227	EB0079116	100.6 PPM NOx/NITROGEN	+/- 1.0%	Jul 23, 2023
NTRM	16010235	KAL004419	97.69 PPM SULFUR DIOXIDE/NITROGEN	+/- 0.8%	Dec 23, 2021
NTRM	11010416	KAL004802	99.6 PPM SULFUR DIOXIDE/NITROGEN	+/- 0.8%	Jul 28, 2023

The SRM, PRM or RGM noted above is only in reference to the GMIS used in the assay and not part of the analysis.

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 16, 2020

Triad Data Available Upon Request

NOTES: Gross Weight: 27.8 Kg, Net Weight: 4.6 Kg.



[Signature]
Approved for Release

CERTIFICATE OF ANALYSIS

Customer Detail:

ALS Laboratory Group (Thailand)

Production Order Number: 90145553

Material Number: 478100-J-44

Certification Date: 07-Dec-2017

Expiry Date: 07-Dec-2025

Cylinder Description:

STEEL 47 L

The measurement of this reference material is traceable to SI through the reference standard which is traceable to Swiss National Standard of Mass. The Assay of this Standard has been performed in accordance with the EPA Traceability Protocol EPA-600/R-12/S31 for the Assay and Certification of Gaseous Calibration Standards using procedure G1. The results are expressed on a mole/mole basis, unless otherwise specified. The reported uncertainty is based on a standard uncertainty multiplied by coverage factor $k=2$, providing a level of confidence of approximately 95%.

Certificate Number:

3982/17

Analyst:

Arissara T.

ARISSARA THONGNURL

Cylinder Number:

14465

Nominal Cylinder Content:

6.520 M³

Approve:



SUKANYA KAMUTHARAT

Nominal Pressure:

145.0 Bar

Valve Outlet:

CGA 590 BRASS

To Re-Order Please Quote:

478100-J-44

Comment:

- It is recommended that this product be not used below 5% of actual contents or should not be used when its gas pressure is below 150psig.
- Other impurities that detect by analytical condition of this mixture shall be report if it is more than 10% of minimum minor component.
- Keep and use in well-ventilated and secure area.

CERTIFICATE OF ANALYSIS

Analytical Result

<u>Component</u>	<u>Request Concentration</u>	<u>Certified Concentration</u>	<u>Certified Uncertainty</u>	<u>Method</u>	<u>Assay Date</u>
Oxygen In Nitrogen	8.00 %	8.04 %	± 1% relative	(2) I-PB-354	04-Dec-2017

Reference Standard used in Assay

<u>Reference Standard</u>	<u>Cylinder No.</u>	<u>Concentration</u>	<u>Expired Date</u>
Oxygen In Nitrogen	113553SG	9.976± 0.02 %	26-Mar-2018

Analytical Instruments used in Assay

<u>Instrument/Make/Model</u>	<u>Analytical Principle</u>	<u>Last Multipoint Calibration</u>
Servomex 4100 O2 Analyzer	Paramagnetic	04-Dec-2017



Method of Analysis

1. Gas Chromatograph
2. Paramagnetic Oxygen Analyser
3. Electrochemical Oxygen Analyser
4. Electrochemical Moisture Analyser
5. Total Hydrocarbon Analyser
6. Other specified

Cylinder Number **14465**
Production Order Number **90145553**

Certification Date: **07-Dec-2017**
Expiration Date: **07-Dec-2025**

CERTIFICATE OF ANALYSIS

Customer Detail: ALS Laboratory Group (Thailand)		Production Order Number: 90145554 Material Number: 557200-J-44 Certification Date: 07-Dec-2017 Expiry Date: 07-Dec-2025	
Cylinder Description: STEEL 47 L		The measurement of this reference material is traceable to SI through the reference standard which is traceable to Swiss National Standard of Mass. The Assay of this Standard has been performed in accordance with the EPA Traceability Protocol EPA-600/R-12/531 for the Assay and Certification of Gaseous Calibration Standards using procedure G1. The results are expressed on a mole/mole basis, unless otherwise specified. The reported uncertainty is based on a standard uncertainty multiplied by coverage factor k=2, providing a level of confidence of approximately 95%.	
Certificate Number: 3977/17		Analyst:  ARISSARA THONGNURL	
Cylinder Number: 94892			
Nominal Cylinder Content: 6.560 M³		Approve:  SUKANYA KAMUTHARAT	
Nominal Pressure: 145.0 Bar			
Valve Outlet: CGA 590 BRASS		To Re-Order Please Quote: 557200-J-44	
Comment:		<ul style="list-style-type: none"> ● It is recommended that this product be not used below 5% of actual contents or should not be used when its gas pressure is below 150psig. ● Other impurities that detect by analytical condition of this mixture shall be report if it is more than 10% of minimum minor component. ● Keep and use in well-ventilated and secure area. 	

CERTIFICATE OF ANALYSIS

Analytical Result

<u>Component</u>	<u>Request Concentration</u>	<u>Certified Concentration</u>	<u>Certified Uncertainty</u>	<u>Method</u>	<u>Assay Date</u>
Oxygen In Nitrogen	16.0 %	16.0 %	± 1% relative	(2) I-PB-354	04-Dec-2017

Reference Standard used in Assay

<u>Reference Standard</u>	<u>Cylinder No.</u>	<u>Concentration</u>	<u>Expired Date</u>
Oxygen In Nitrogen	113553SG	9.976± 0.02 %	26-Mar-2018

Analytical Instruments used in Assay

<u>Instrument/Make/Model</u>	<u>Analytical Principle</u>	<u>Last Multipoint Calibration</u>
Servomex 4100 O2 Analyser	Paramagnetic	04-Dec-2017



Method of Analysis

1. Gas Chromatograph
2. Paramagnetic Oxygen Analyser
3. Electrochemical Oxygen Analyser
4. Electrochemical Moisture Analyser
5. Total Hydrocarbon Analyser
6. Other specified

Cylinder Number 94892
Production Order Number 90145554

Certification Date: 07-Dec-2017
Expiration Date: 07-Dec-2025

CERTIFICATE OF ANALYSIS

Customer Detail: ALS Laboratory Group (Thailand)		Production Order Number: 90132928 Material Number: 478100-J-44 Certification Date: 20-Jan-2016 Expiry Date: 20-Jan-2024	
Cylinder Description: Steel 47 L			
<p>The measurement of this reference material is traceable to SI through the reference standard which is traceable to Swiss National Standard of Mass. The Assay of this Standard has been performed in accordance with the EPA Traceability Protocol EPA-600/R-12/531 for the Assay and Certification of Gaseous Calibration Standards using procedure G1. The results are expressed on a mole/mole basis, unless otherwise specified. The reported uncertainty is based on a standard uncertainty multiplied by coverage factor k=2, providing a level of confidence of approximately 95%.</p>			
Certificate Number: 4676/15		Analyst:  THITIRAT LOYRAT	
Cylinder Number: S50730			
Nominal Cylinder Content: 6.520 M³		Approve:  SUKANYA KAMUTHARAT	
Nominal Pressure: 145.0 Bar			
Valve Outlet: CGA 590 BRASS		To Re-Order Please Quote: 478100-J-44	
Comment:	<ul style="list-style-type: none"> ● It is recommended that this product be not used below 5% of actual contents or should not be used when its gas pressure is below 150psig. ● Other impurities that detect by analytical condition of this mixture shall be report if it is more than 10% of minimum minor component. ● Keep and use in well-ventilated and secure area. 		

CERTIFICATE OF ANALYSIS

Analytical Result

<u>Component</u>	<u>Request Concentration</u>	<u>Certified Concentration</u>	<u>Certified Uncertainty</u>	<u>Method</u>	<u>Assay Date</u>
Oxygen in Nitrogen	8.00 %	7.93 %	+/- 1% relative	(2) I-PB-354	20-Jan-2015

Reference Standard used in Assay

<u>Reference Standard</u>	<u>Cylinder No.</u>	<u>Concentration</u>	<u>Expired Date</u>
Oxygen in Nitrogen	243625SG	25.08 ± 0.13 %	19-Aug-2017

Analytical Instruments used in Assay

<u>Instrument/Make/Model</u>	<u>Analytical Principle</u>	<u>Last Multipoint Calibration</u>
Servomex 4100 O2 Analyzer	Paramagnetic	23-Dec-2015



Method of Analysis

1. Gas Chromatograph
2. Paramagnetic Oxygen Analyser
3. Electrochemical Oxygen Analyser
4. Electrochemical Moisture Analyser
5. Total Hydrocarbon Analyser
6. Other specified

Cylinder Number **S50730**
Production Order Number **90132928**

Certification Date: **20-Jan-2016**
Expiration Date: **20-Jan-2024**

CERTIFICATE OF ANALYSIS

Customer Detail: ALS Laboratory Group (Thailand)		Production Order Number: 90137389 Material Number: 557200-J-44 Certification Date: 24-Sep-2016 Expiry Date: 24-Sep-2024	
Cylinder Description: STEEL 47 L			
The measurement of this reference material is traceable to SI through the reference standard which is traceable to Swiss National Standard of Mass. The Assay of this Standard has been performed in accordance with the EPA Traceability Protocol EPA-600/R-12/531 for the Assay and Certification of Gaseous Calibration Standards using procedure G1. The results are expressed on a mole/mole basis, unless otherwise specified. The reported uncertainty is based on a standard uncertainty multiplied by coverage factor $k=2$, providing a level of confidence of approximately 95%.			
Certificate Number: 2857/16		Analyst:  THITIRAT LOYRAT	
Cylinder Number: 363075			
Nominal Cylinder Content: 6.560 M³		Approve:  SUKANYA KAMUTHARAT	
Nominal Pressure: 145.0 Bar			
Valve Outlet: CGA 590 BRASS			
		To Re-Order Please Quote: 557200-J-44	
Comment:		<ul style="list-style-type: none"> ● It is recommended that this product be not used below 5% of actual contents or should not be used when its gas pressure is below 150psig. ● Other impurities that detect by analytical condition of this mixture shall be report if it is more than 10% of minimum minor component. ● Keep and use in well-ventilated and secure area. 	

CERTIFICATE OF ANALYSIS

Analytical Result

<u>Component</u>	<u>Request Concentration</u>	<u>Certified Concentration</u>	<u>Certified Uncertainty</u>	<u>Method</u>	<u>Assay Date</u>
Oxygen in Nitrogen	16.0 %	16.0 %	+/- 1% relative	(2) I-PB-354	24-Sep-2016

Reference Standard used in Assay

<u>Reference Standard</u>	<u>Cylinder No.</u>	<u>Concentration</u>	<u>Expired Date</u>
Oxygen in Nitrogen	243625SG	25.08 ± 0.13 %	19-Aug-2017

Analytical Instruments used in Assay

<u>Instrument/Make/Model</u>	<u>Analytical Principle</u>	<u>Last Multipoint Calibration</u>
Servomex 4100 O2 Analyzer	Paramagnetic	24-Sep-2016

Method of Analysis

1. Gas Chromatograph
2. Paramagnetic Oxygen Analyser
3. Electrochemical Oxygen Analyser
4. Electrochemical Moisture Analyser
5. Total Hydrocarbon Analyser
6. Other specified

Cylinder Number 363075
Production Order Number 90137389

Certification Date: 24-Sep-2016
Expiration Date: 24-Sep-2024



CONSOLE CONTROL UNIT CALIBRATION TEST REPORT

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

Barometric Pressure (mm.Hg) : 760
Relative Humidity (%) : 58.0
Temperature (°C) : 25.0

Console Control Meter Data

Calibration No. : C-120122-BKK_FS0518
Dry Gas Meter No. : BKK_FS0518
Console Serial No. : 1504025
Console Model No. : XC-572-V

Reference Dry Gas Meter Data

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

ΔH (mm.H ₂ O)	Θ Minutes	Reference Dry Gas Meter Calibration				Console Control ; Drygas Meter						Dry Gas Meter Correction	Orifice Calibration
		Vr (Liters)			Tr (°C)	Vm (Liters)			Ti (°C)	To (°C)	Avg.Tm (°C)	Factor (Y)	Factor $\Delta H@$
		Final	Initial	Total		Final	Initial	Total					
15	12.75	150.00	0.00	150.00	31.0	49103.0	48950.0	153.00	29.0	29.0	29.0	0.9784	50.2263
25	9.55	150.00	0.00	150.00	30.0	49263.0	49110.0	153.00	29.0	29.0	29.0	0.9806	46.6557
50	6.75	150.00	0.00	150.00	30.0	49603.0	49450.0	153.00	29.0	29.0	29.0	0.9783	46.6160
80	5.22	150.00	0.00	150.00	30.0	49773.0	49620.0	153.00	30.0	30.0	30.0	0.9787	44.4583
120	4.25	150.00	0.00	150.00	30.0	49933.0	49780.0	153.00	30.0	30.0	30.0	0.9750	44.2060
											Avg.	0.9782	46.4324

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

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

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

Calibrated by:

Saksit Phaisanphisut

(Mr.Saksit Phaisanphisut)

Field Scientist (4)

Approved by:

Wichan Choonharat

(Mr.Wichan Choonharat)

Manager



DIGITAL TEMPERATURE CALIBRATION DATA SHEET

Calibration Date :	12 Jan 22	Ambient Temperature (°C) :	25
Calibration sheet No. : C-120122-BKK_FS0519		Relative Humidity (%) :	58

Digital Temperature ID	BKK_FS0519	Reference Temperature ID. : BKK_FS0609	
Console Serial No. :	1504025	Serial No. :	7688004
Console Model :	XC-572-V	Model :	FLUKE 714
		Next Calibrate :	13 Jan 22

Location	Reference Temperature °C	Digital Temperature °C	Error °C	Remark
Stack	0	0	0	
	25	25	0	
	50	50	0	
	100	101	1	
	150	153	3	
	200	202	2	
	250	252	2	
	300	302	2	
	500	503	3	
	1000	1004	4	
	1200	1205	5	
Probe	100	101	1	
	125	127	2	
	150	153	3	
Oven	100	101	1	
	125	127	2	
	150	153	3	
Filter	100	101	1	
	125	127	2	
	150	153	3	
Exit	0	0	0	
	10	9	-1	
	20	19	-1	
Meter	0	0	0	
	25	24	-1	
	50	50	0	
AUX	0	0	0	
	25	25	0	
	50	50	0	

Calibrated by

Saksit Phaisanphisut

(Mr.Saksit Phaisanphisut)

Field Scientist (4)

Approved by :

Wichan Chonharat

Mr.Wichan Choonharat

Manager



Pitot Tube Calibration Data

Pitot Tube Identification Number : BKK_FS0522 Calibration Date : 12 Jan 22
 Lab test duct Number : 258-1-13-01 Standard Pitot ID : BKK_FS0441
 Calibration Sheet No. : C-120122-BKK_FS0522 Cp Standard : 0.99

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

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

$$\bar{C}_{p(A)} - \bar{C}_{p(B)} \Big] must BE \leq 0.01$$

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

Calibrated by : Saksit Phaisanphisut

(Mr.Saksit Phaisanphisut)

Field Scientist (4)

Approved by : Wichan Choonharat

(Mr.Wichan Choonharat)

Manager



Pitot Tube Calibration Data

Pitot Tube Identification Number : BKK_FS0523 Calibration Date : 12 Jan 22
 Lab test duct Number : 258-1-13-01 Standard Pitot ID : BKK_FS0441
 Calibration Sheet No. : C-120122-BKK_FS0523 Cp Standard : 0.99

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

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

$$\bar{C}_{p(A)} - \bar{C}_{p(B)} \Big] must BE \leq 0.01$$

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

Calibrated by : Saksit Phaisanphisut

(Mr.Saksit Phaisanphisut)

Field Scientist (4)

Approved by : Wichan Choonharat

(Mr.Wichan Choonharat)

Manager



PROBE NOZZLE DIAMETER CALIBRATION DATA SHEET

Calibration Date	12 Jan 22	Nozzle Set ID. :	BKK_FS0524
Calibration Sheet No. :	C-120122-BKK_FS0524	Vernier Caliper ID. :	BKK_FS0626

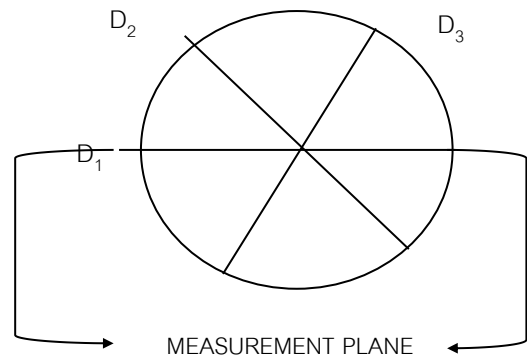
Nozzle ID #	Nozzle Diameter (cm.)			Hi - Lo	$(D_1 + D_2 + D_3) / 3$
	D_1	D_2	D_3	ΔD	D_{avg}
1	0.318	0.318	0.318	0.000	0.318
2	0.475	0.475	0.475	0.000	0.475
3	0.635	0.635	0.635	0.000	0.635
4	0.792	0.792	0.792	0.000	0.792
5	0.952	0.952	0.952	0.000	0.952
6	1.110	1.110	1.110	0.000	1.110
7	1.270	1.270	1.270	0.000	1.270

Where :

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

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

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



Calibrated by : Saksit Phaisanphisut Approved by : Wichan Choonharat

(Mr.Saksit Phaisanphisut)

(Mr.Wichan Choonharat)

Field Scientist (4)

Manager



PENTA
CALIBRATION

PENTA CALIBRATION CO., LTD.

66/124 The Connect 33 Village Kanchanaphisek Road
Dokmai Prawet Bangkok 10250
Tel: +66 (0) 2069-9773
www.pentacal.com

Certificate of Calibration

Represent to Certificate of Calibration ,PTC/07/22099

Certificate No.:	PTC/07/22099	Page:	1 of 2
Equipment:	Digital Balance	Condition:	Normal
Manufacturer:	Sartorius	Serial No:	31709552
Model:	MSU224S-100-DU	ID No:	RYG_EN0003
Type of Balance:	Single interval		



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

REVIEW BY Thanitall.
APPROVED BY D. [Signature]
NEXT CAL. DATE 23/03/23

Environment Condition: Temperature 23.9 °C ± 0.3 °C
Humidity 58.1 %RH ± 4.4 %RH
Air density 1.17 kg/m³

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

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

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

Date Received: March 23, 2022

Calibration Date: March 23, 2022

Issued Date: March 25, 2022

Calibration By: Mr. Rungroje Metakul



PENTA CALIBRATION CO.,LTD

[Signature]

(Mr.Kriangsak Kalasri)

Reviewed by

Approved By :

[Signature]

(Mr. Keattisak Kerdto)

Laboratory Manager

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

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

This calibration certificate shall not be reproduced except in full only, without written approval from penta calibration co., ltd



Represent to Certificate of Calibration ,PTC/07/22099

Certificate No.: PTC/07/22099

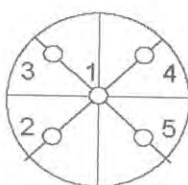
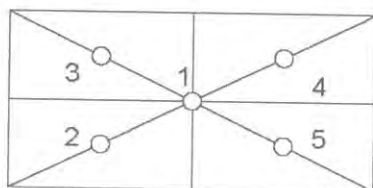
Page: 2 of 2

Measurement Results:

Without Adjustment :

Function Calibration: Non Adjustment

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



Eccentricity test 100 (g)

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

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

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

Nominal test value (g)	Standard Deviation
200	0.00007

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

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

Note: Weight of adjust - (g)

The End of Certificate

SITHIPORN ASSOCIATES CO.,LTD.

CALIBRATION LABORATORY

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



NSC-TISI-TIS 17025
CALIBRATION 0394

Cert. No. : ACC21009

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,
KHWANG PHATTHANAKAN, KHET SUAN LUANG,
BANGKOK, 10250 THAILAND.

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

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

REVIEW BY	<i>Nathakorn</i>
APPROVED BY	<i>T. Petchurai</i>
NEXT CAL. DATE	9/8/22

Calibrated by : Nathakorn Pisutpaisan

Approved by :

T. Petchurai
(Thanakul Petchurai)

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

Continuation of Calibration Certificate

Cert. No. : ACC21009

Job No. : VC64AC0058

Pages : 2 of 3

Calibration Procedure : CP-AC-03

Calibration Method :

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

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

Condition of this result of calibration :

1. Reference Standard Instruments :

<u>Instrument</u>	<u>Model</u>	<u>Serial No.</u>	<u>Cert. No.</u>	<u>Due Date</u>
Waveform Generator	33511B	MY52302742	EF-0011-21	10-Feb-22
Digital Multimeter	33461A	MY53220104	EEL.BP. 05/0264	10-Feb-22
Digital Multimeter	8846A	1997025	EEL.BP. 06/0264	05-Feb-22
Digital Multimeter	33461A	MY53220116	EEL.BP. 04/0264	10-Feb-22
Programmable Attenuator	MAT-1070	62100114	1500-07774E	08-Mar-22
Condenser Microphone	4180	2977900	AA-1008-21	05-Feb-22
Measuring Amplifier	NA-42KAI	34560495	AA-3003-21	16-Feb-22
Audio Analyzer	AVR-3360A	V744B6069	EF-0010-21	10-Feb-22

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

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

3.1 National Institute of Metrology (Thailand).

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

Continuation of Calibration Certificate

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

Result of calibration :**1. Sound pressure level**

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

2. Frequency

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

3. Total distortion

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

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

————— End of Calibration Certificate —————

SITHIPHORN ASSOCIATES CO.,LTD. CALIBRATION LABORATORY

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



Cert. No. : ACL21098

Pages : 1 of 8

Calibration Certificate

Equipment : SOUND LEVEL METER
Manufacturer : RION
Model : NL-42/ Microphone UC-52 / Preamplifier NH-24
Serial No.: 00472126 / 180410 / 88180
ID No.: RYG_FS0301

Condition As Found : GOOD

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

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

Received Date : 01 SEPTEMBER 2021
Calibration Date : 13-15 SEPTEMBER 2021
Date of Issue : 16 SEPTEMBER 2021

REVIEW BY	<i>Nathakorn P.</i>
APPROVED BY	<i>[Signature]</i>
NEXT CAL. DATE	13/9/22

Calibrated by :

Nathakorn Pisutpaisan

Approved by :

[Signature]
(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. : ACL21098
Job No. : VC64AC0066
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 :

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

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

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

3.1 National Institute of Metrology (Thailand).

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

Continuation of Calibration Certificate

Cert. No. : ACL21098
Job No. : VC64AC0066
Pages : 3 of 8

Summary of Measurement Result :

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

Continuation of Calibration Certificate

Cert. No. : ACL21098
Job No. : VC64AC0066
Pages : 4 of 8

Result of calibration :

1. Absolute sensitivity

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

2. Self-generated noise

2.1 Normal test

Measured Value (dB)
26.1

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

Frequency Weighting	Measured value (dB)
A - weight	12.0
C - weight	18.4
Flat	23.9

3. Acoustical signal tests of frequency weightings

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

Frequency (Hz)	Deviation from various frequency weighting response curve (dB)			Acceptance Limits
	Flat	C-weight	A-weight	
125	-1.6	-1.6	-1.6	± 1.5
1000	0.0	0.0	0.0	± 1.0
8000	0.4	0.5	0.5	±5.0

Continuation of Calibration Certificate

Cert. No. : ACL21098
Job No. : VC64AC0066
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	-0.2	-0.1	±2.0
125	0.0	0.0	0.0	±1.5
250	0.0	0.0	-0.1	±1.5
500	0.0	0.0	-0.1	±1.5
1000	0.0	0.0	0.0	±1.0
2000	0.0	0.0	0.0	±2.0
4000	0.0	0.0	0.0	±3.0
8000	0.0	0.1	0.1	±5.0

5. Frequency and time weightings at 1 kHz

5.1 Frequency weightings at 1 kHz

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

5.2 Time weighting at 1 kHz

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

6. Long - term stability

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

Continuation of Calibration Certificate

Cert. No. : ACL21098

Job No. : VC64AC0066

Pages : 6 of 8

7. Level linearity on the reference level range

Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
137.0	137.0	0.0	± 1.1
136.0	136.0	0.0	± 1.1
135.0	135.0	0.0	± 1.1
134.0	134.0	0.0	± 1.1
133.0	133.0	0.0	± 1.1
132.0	132.0	0.0	± 1.1
131.0	131.0	0.0	± 1.1
129.0	129.0	0.0	± 1.1
124.0	124.0	0.0	± 1.1
119.0	119.0	0.0	± 1.1
114.0	114.0	0.0	± 1.1
109.0	109.0	0.0	± 1.1
104.0	104.0	0.0	± 1.1
99.0	99.0	0.0	± 1.1
94.0	94.0	0.0	± 1.1
89.0	89.1	0.1	± 1.1
84.0	84.1	0.1	± 1.1
79.0	79.1	0.1	± 1.1
74.0	74.1	0.1	± 1.1
69.0	69.1	0.1	± 1.1
64.0	64.1	0.1	± 1.1
59.0	59.1	0.1	± 1.1
54.0	54.0	0.0	± 1.1
49.0	49.1	0.1	± 1.1
44.0	44.0	0.0	± 1.1
39.0	39.1	0.1	± 1.1
34.0	34.0	0.0	± 1.1
30.0	30.1	0.1	± 1.1
29.0	29.1	0.1	± 1.1
28.0	28.1	0.1	± 1.1
27.0	27.2	0.2	± 1.1
26.0	26.2	0.2	± 1.1
25.0	25.2	0.2	± 1.1

Continuation of Calibration Certificate

Cert. No. : ACL21098

Job No. : VC64AC0066

Pages : 7 of 8

8. Level linearity including the level range control

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

9. Tone burst response

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

10. Peak C sound level

Number of cycle in test signal	Anticipated Value (dB)	Measured Value, L _{peak} (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Continuous	133.0	133.0	0.0	-
One	136.4	135.8	-0.6	±3.0

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

Continuation of Calibration Certificate

Cert. No. : ACL21098

Job No. : VC64AC0066

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	±0.3

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

End of Calibration Certificate

Certificate No.: 0223SV21
Operation No.: CP2021050033

Certificate of Calibration

Equipment: Sound Level Meter

Manufacturer: RION

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

Serial No.: 00472127 (Meter), 169440 (Microphone), 72461 (Preamplifier)

ID No.: RYG_FS0302

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

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

Received Date: 28 May 2021

Calibrated Date: 2 - 9 June 2021

Issued Date: 11 June 2021

Calibrated by: Ms. Juntaporn Kunhakom

REVIEW BY	<i>Marakorn P.</i>
APPROVED BY	<i>[Signature]</i>
NEXT CAL. DATE	2/6/22

Approved by: _____

(Mr. Sittichai Swaksurijayvong)

Group Manager

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

Certificate No.: 0223SV21

Calibration Report

Equipment: Sound Level Meter
Manufacturer: RION
Model/Type: NL-42 (Meter), UC-52 (Microphone), NH-24 (Preamplifier)
Serial No.: 00472127 (Meter), 169440 (Microphone), 72461 (Preamplifier)
ID No.: RYG_FS0302
Ambient Temperature: (23 ± 2) °C
Relative Humidity: (50 ± 15) %
Pressure: (101.3 ± 1.5) kPa

Method of Calibration :-

IEC 61672-3:2013.

Condition of this result of calibration

1. Reference standards instrument :-

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

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

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

Reference standards instrument for Acoustic function

- National Institute of Metrology (Thailand)

Reference standards instrument for Electrical function

- National Institute of Metrology (Thailand)

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

Result of Calibration:-

Function : 1. Indication at the calibration check frequency

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

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

Certificate No.: 0223SV21

Calibration Report

Function : 2. Self-generated Noise

2.1 Microphone Installed

Measured value (dB)
15.4

2.2 Microphone replaced by the electrical input signal device

Frequency Weighting	Measured value (dB)
A-weighting	11.3
C-weighting	18.1
Z-weighting	23.4

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

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

Frequency (Hz)	Deviation from various Frequency Weighting Response Curve			
	C-Weighting (dB)	A-Weighting (dB)	Z-Weighting (dB)	Acceptance limits (dB)
125	0.2	0.6	0.1	±1.5
1000	0.0	0.0	0.0	±1.0
8000	-0.3	-0.3	-0.4	±5.0

Function : 4. Electrical signal tests of frequency weightings

Weighting network response with relative to 1 kHz.

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

Function : 5. Frequency and time weighting at 1 kHz

5.1 Frequency weighting at 1 kHz

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

Certificate No.: 0223SV21

Calibration Report

5.2 Time weighting at 1 kHz

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

Function : 6. Long-Term Stability

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

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

Function : 7. Level Linearity on the reference level range

7.1 Level Linearity on the reference level range, Upper

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

7.2 Level Linearity on the reference level range, Lower

Anticipated Value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
94.0	94.0	0.0	±1.1
89.0	89.0	0.0	±1.1
84.0	84.0	0.0	±1.1
79.0	79.0	0.0	±1.1
74.0	74.0	0.0	±1.1
69.0	69.0	0.0	±1.1
64.0	64.0	0.0	±1.1
59.0	59.0	0.0	±1.1

Certificate No.: 0223SV21

Calibration Report

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

Anticipated Value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
54.0	54.0	0.0	±1.1
49.0	49.0	0.0	±1.1
44.0	44.0	0.0	±1.1
39.0	39.0	0.0	±1.1
34.0	33.9	-0.1	±1.1
29.0	28.9	-0.1	±1.1
24.0	23.9	-0.1	±1.1

Function : 8. Tone burst response

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

Function : 9. Peak C sound level

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

Function : 10. Overload indication

Measured value (dB)		Deviated value (dB)	Acceptance limits (dB)
Positive one-half cycle	Negative one-half cycle		
139.4	139.4	0.0	±1.5

Certificate No.: 0223SV21

Calibration Report

Function : 11. High-Level Stability

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

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

Uncertainty of measurement

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

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

-- End of Report --

Certificate No.: 0224SV21
Operation No.: CP2021050034

Certificate of Calibration

Equipment: Sound Level Meter
Manufacturer: RION
Model/Type: NL-42 (Meter), UC-52 (Microphone), NH-24 (Preamplifier)
Serial No.: 00472130 (Meter), 157774 (Microphone), 72464 (Preamplifier)
ID No.: RYG_FS0303
Customer: ALS Laboratory Group (Thailand) Co.,Ltd.
Address: 104 Phatthanakan 40, Phatthanakan Rd., Khwaeng Phatthanakan
Khet Suan Luang, Bangkok 10250 Thailand
Received Date: 28 May 2021
Calibrated Date: 2 - 9 June 2021
Issued Date: 11 June 2021
Calibrated by: Ms. Juntaporn Kunhakom

REVIEW BY	<i>Narakorn P.</i>
APPROVED BY	<i>[Signature]</i>
NEXT CAL. DATE	<i>2/6/22</i>

Approved by: _____

(Mr. Sittichai Swaksriwong)
Group Manager
ELECTRICAL AND ELECTRONICS INSTITUTE

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

Certificate No.: 0224SV21

Calibration Report

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

Method of Calibration :-

IEC 61672-3:2013.

Condition of this result of calibration

1. Reference standards instrument :-

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

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

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

Reference standards instrument for Acoustic function

- National Institute of Metrology (Thailand)

Reference standards instrument for Electrical function

- National Institute of Metrology (Thailand)

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

Result of Calibration:-

Function : 1. Indication at the calibration check frequency

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

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

Certificate No.: 0224SV21

Calibration Report

Function : 2. Self-generated Noise

2.1 Microphone Installed

Measured value (dB)
19.6

2.2 Microphone replaced by the electrical input signal device

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

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

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

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

Function : 4. Electrical signal tests of frequency weightings

Weighting network response with relative to 1 kHz.

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

Function : 5. Frequency and time weighting at 1 kHz

5.1 Frequency weighting at 1 kHz

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

Certificate No.: 0224SV21

Calibration Report

5.2 Time weighting at 1 kHz

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

Function : 6. Long-Term Stability

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

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

Function : 7. Level Linearity on the reference level range

7.1 Level Linearity on the reference level range, Upper

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

7.2 Level Linearity on the reference level range, Lower

Anticipated Value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
94.0	94.0	0.0	±1.1
89.0	89.0	0.0	±1.1
84.0	84.0	0.0	±1.1
79.0	79.0	0.0	±1.1
74.0	74.0	0.0	±1.1
69.0	69.0	0.0	±1.1
64.0	64.0	0.0	±1.1
59.0	59.0	0.0	±1.1

Certificate No.: 0224SV21

Calibration Report

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

Anticipated Value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
54.0	54.0	0.0	±1.1
49.0	49.0	0.0	±1.1
44.0	44.0	0.0	±1.1
39.0	39.0	0.0	±1.1
34.0	33.9	-0.1	±1.1
29.0	29.0	0.0	±1.1
24.0	24.1	0.1	±1.1

Function : 8. Tone burst response

Time Weighting	Tone burst duration, Tb (ms)	Measured value (dB)	Deviated value (dB)	Acceptance limits (dB)
Fast	200	126.0	0.0	±1.0
	2	108.9	-0.1	+1.0 ; -2.5
	0.25	99.9	-0.1	+1.5 ; -5.0
Slow	200	119.6	0.0	±1.0
	2	100.0	0.0	+1.0 ; -5.0
LAE	200	120.0	0.0	±1.0
	2	100.0	0.0	+1.0 ; -2.5
	0.25	90.8	-0.2	+1.5 ; -5.0

Function : 9. Peak C sound level

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

Function : 10. Overload indication

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

Certificate No.: 0224SV21

Calibration Report

Function : 11. High-Level Stability

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

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

Uncertainty of measurement

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

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

-- End of Report --

SITHIPHORN ASSOCIATES CO.,LTD. CALIBRATION LABORATORY

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



Cert. No. : ACL22031

Pages : 1 of 8

Calibration Certificate

Equipment : SOUND LEVEL METER
Manufacturer : RION
Model : NL-42/ Microphone UC-52 / Preamplifier NH-24
Serial No.: 01222716 / 143832 / 22763
ID No.: RYG_FS0020

Condition As Found : GOOD

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

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

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

REVIEW BY	Narakorn P.
APPROVED BY	[Signature]
NEXT CAL. DATE	10/1/23

Calibrated by : Nathakorn Pisutpaisan

Approved by :

[Signature]
(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. : ACL22031
Job No. : VC65AC0040
Pages : 2 of 8

Calibration Procedure : CP-AC-01

Calibration Method :

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

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

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

Condition of this result of calibration :

1. Reference Standard Instruments :

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

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

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

3.1 National Institute of Metrology (Thailand).

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

Continuation of Calibration Certificate

Cert. No. : ACL22031
Job No. : VC65AC0040
Pages : 3 of 8

Summary of Measurement Result :

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

Continuation of Calibration Certificate

Cert. No. : ACL22031

Job No. : VC65AC0040

Pages : 4 of 8

Result of calibration :**1. Absolute sensitivity**

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

2. Self-generated noise

2.1 Normal test

Measured Value (dB)
14.6

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	19.2
Flat	24.6

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)			Acceptance Limits
	Flat	C-weight	A-weight	
125	0.7	0.7	0.7	± 1.5
1000	0.0	0.0	0.0	± 1.0
8000	-2.1	-2.0	-2.0	±5.0

Continuation of Calibration Certificate

Cert. No. : ACL22031

Job No. : VC65AC0040

Pages : 5 of 8

4. Electrical signal tests of frequency weightings

Weighting network response with relative to 1 kHz.

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

5. Frequency and time weightings at 1 kHz

5.1 Frequency weightings at 1 kHz

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

5.2 Time weighting at 1 kHz

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

6. Long - term stability

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

Continuation of Calibration Certificate

Cert. No. : ACL22031

Job No. : VC65AC0040

Pages : 6 of 8

7. Level linearity on the reference level range

Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
137.0	137.0	0.0	± 1.1
136.0	136.0	0.0	± 1.1
135.0	135.0	0.0	± 1.1
134.0	134.0	0.0	± 1.1
133.0	133.0	0.0	± 1.1
132.0	132.0	0.0	± 1.1
131.0	131.0	0.0	± 1.1
129.0	129.0	0.0	± 1.1
124.0	124.0	0.0	± 1.1
119.0	119.0	0.0	± 1.1
114.0	114.0	0.0	± 1.1
109.0	109.0	0.0	± 1.1
104.0	104.0	0.0	± 1.1
99.0	99.0	0.0	± 1.1
94.0	94.0	0.0	± 1.1
89.0	89.0	0.0	± 1.1
84.0	84.0	0.0	± 1.1
79.0	79.0	0.0	± 1.1
74.0	74.0	0.0	± 1.1
69.0	69.0	0.0	± 1.1
64.0	64.0	0.0	± 1.1
59.0	59.0	0.0	± 1.1
54.0	54.0	0.0	± 1.1
49.0	49.0	0.0	± 1.1
44.0	44.0	0.0	± 1.1
39.0	38.9	-0.1	± 1.1
34.0	34.0	0.0	± 1.1
30.0	29.9	-0.1	± 1.1
29.0	28.9	-0.1	± 1.1
28.0	27.9	-0.1	± 1.1
27.0	26.9	-0.1	± 1.1
26.0	25.9	-0.1	± 1.1
25.0	24.8	-0.2	± 1.1

Continuation of Calibration Certificate

Cert. No. : ACL22031
Job No. : VC65AC0040
Pages : 7 of 8

8. Level linearity including the level range control

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

9. Tone burst response

Time Weighting	Tone burst duration, Tb (ms)	Cycle	Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Fast	0.25	1	108.0	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	-
One	136.4	136.3	-0.1	±3.0

Number of cycle in test signal	Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Continuous	133.0	133.1	0.1	-
Positive half cycle	135.4	135.2	-0.2	±2.0
Negative half cycle	135.4	135.2	-0.2	±2.0

Continuation of Calibration Certificate

Cert. No. : ACL22031

Job No. : VC65AC0040

Pages : 8 of 8

11. Overload indication

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

12. High level stability

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

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

_____ **End of Calibration Certificate** _____

SITHIPHORN ASSOCIATES CO.,LTD. CALIBRATION LABORATORY

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



Cert. No. : ACL22062

Pages : 1 of 8

Calibration Certificate

Equipment : SOUND LEVEL METER
Manufacturer : RION
Model : NL-42/ Microphone UC-52 / Preamplifier NH-24
Serial No.: 01222723 / 143841 / 22770
ID No.: RYG_FS0022

Condition As Found : GOOD

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

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

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



Calibrated by : Nathakorn Pisutpaisan

Approved by :

()
(Thanakul Petchurai)

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

Continuation of Calibration Certificate

Cert. No. : ACL22062
Job No. : VC65AC0043
Pages : 2 of 8

Calibration Procedure : CP-AC-01

Calibration Method :

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

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

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

Condition of this result of calibration :

1. Reference Standard Instruments :

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

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

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

3.1 National Institute of Metrology (Thailand).

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

Continuation of Calibration Certificate

Cert. No. : ACL22062
Job No. : VC65AC0043
Pages : 3 of 8

Summary of Measurement Result :

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

Continuation of Calibration Certificate

Cert. No. : ACL22062

Job No. : VC65AC0043

Pages : 4 of 8

Result of calibration :**1. Absolute sensitivity**

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

2. Self-generated noise

2.1 Normal test

Measured Value (dB)
14.8

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

Frequency Weighting	Measured value (dB)
A - weight	12.0
C - weight	18.0
Flat	24.1

3. Acoustical signal tests of frequency weightings

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

Frequency (Hz)	Deviation from various frequency weighting response curve (dB)			
	Flat	C-weight	A-weight	Acceptance Limits
125	0.4	0.4	0.4	± 1.5
1000	-0.1	-0.1	-0.1	± 1.0
8000	-0.4	-0.3	-0.3	±5.0

Continuation of Calibration Certificate

Cert. No. : ACL22062

Job No. : VC65AC0043

Pages : 5 of 8

4. Electrical signal tests of frequency weightings

Weighting network response with relative to 1 kHz.

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

5. Frequency and time weightings at 1 kHz
5.1 Frequency weightings at 1 kHz

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

5.2 Time weighting at 1 kHz

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

6. Long - term stability

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

Continuation of Calibration Certificate

Cert. No. : ACL22062
Job No. : VC65AC0043
Pages : 6 of 8

7. Level linearity on the reference level range

Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
137.0	137.0	0.0	± 1.1
136.0	136.0	0.0	± 1.1
135.0	135.0	0.0	± 1.1
134.0	134.0	0.0	± 1.1
133.0	133.0	0.0	± 1.1
132.0	132.0	0.0	± 1.1
131.0	131.0	0.0	± 1.1
129.0	129.0	0.0	± 1.1
124.0	124.0	0.0	± 1.1
119.0	119.0	0.0	± 1.1
114.0	114.0	0.0	± 1.1
109.0	109.0	0.0	± 1.1
104.0	104.0	0.0	± 1.1
99.0	99.0	0.0	± 1.1
94.0	94.0	0.0	± 1.1
89.0	89.0	0.0	± 1.1
84.0	84.0	0.0	± 1.1
79.0	79.0	0.0	± 1.1
74.0	74.0	0.0	± 1.1
69.0	69.0	0.0	± 1.1
64.0	64.0	0.0	± 1.1
59.0	59.0	0.0	± 1.1
54.0	54.0	0.0	± 1.1
49.0	49.0	0.0	± 1.1
44.0	44.0	0.0	± 1.1
39.0	39.0	0.0	± 1.1
34.0	34.0	0.0	± 1.1
30.0	30.0	0.0	± 1.1
29.0	29.0	0.0	± 1.1
28.0	28.0	0.0	± 1.1
27.0	27.1	0.1	± 1.1
26.0	26.1	0.1	± 1.1
25.0	25.1	0.1	± 1.1

Continuation of Calibration Certificate

 Cert. No. : ACL22062
 Job No. : VC65AC0043
 Pages : 7 of 8

8. Level linearity including the level range control

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

9. Tone burst response

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

10. Peak C sound level

Number of cycle in test signal	Anticipated Value (dB)	Measured Value, Lcpeak (dB)	Deviated Value (dB)	Acceptance Limits (dB)
Continuous	133.0	133.0	0.0	-
One	136.4	135.8	-0.6	±3.0

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

Continuation of Calibration Certificate

Cert. No. : ACL22062

Job No. : VC65AC0043

Pages : 8 of 8

11. Overload indication

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

12. High level stability

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

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

————— **End of Calibration Certificate** —————

SITHIPHORN ASSOCIATES CO.,LTD. CALIBRATION LABORATORY

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



Cert. No. : ACL22032

Pages : 1 of 8

Calibration Certificate

Equipment : SOUND LEVEL METER
Manufacturer : RION
Model : NL-42/ Microphone UC-52 / Preamplifier NH-24
Serial No.: 01222724 / 143842 / 22771
ID No.: RYG_FS0023

Condition As Found : GOOD

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

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

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

REVIEW BY	<i>Nathakorn P.</i>
APPROVED BY	<i>[Signature]</i>
NEXT CAL. DATE	10/1/23

Calibrated by : Nathakorn Pisutpaisan

Approved by :

[Signature]
(Thanakul Petchurai)

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Continuation of Calibration Certificate

Cert. No. : ACL22032

Job No. : VC65AC0040

Pages : 2 of 8

Calibration Procedure : CP-AC-01

Calibration Method :

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

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

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

Condition of this result of calibration :

1. Reference Standard Instruments :

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

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

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

3.1 National Institute of Metrology (Thailand).

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

Continuation of Calibration Certificate

Cert. No. : ACL22032

Job No. : VC65AC0040

Pages : 3 of 8

Summary of Measurement Result :

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

Continuation of Calibration Certificate

Cert. No. : ACL22032

Job No. : VC65AC0040

Pages : 4 of 8

Result of calibration :**1. Absolute sensitivity**

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

2. Self-generated noise

2.1 Normal test

Measured Value (dB)
14.6

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

Frequency Weighting	Measured value (dB)
A - weight	12.8
C - weight	19.5
Flat	25.0

3. Acoustical signal tests of frequency weightings

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

Frequency (Hz)	Deviation from various frequency weighting response curve (dB)			
	Flat	C-weight	A-weight	Acceptance Limits
125	0.4	0.4	0.4	± 1.5
1000	0.0	0.0	0.0	± 1.0
8000	-1.0	-0.9	-0.9	±5.0

Continuation of Calibration Certificate

Cert. No. : ACL22032

Job No. : VC65AC0040

Pages : 5 of 8

4. Electrical signal tests of frequency weightings

Weighting network response with relative to 1 kHz.

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

5. Frequency and time weightings at 1 kHz

5.1 Frequency weightings at 1 kHz

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

5.2 Time weighting at 1 kHz

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

6. Long - term stability

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

Continuation of Calibration Certificate

Cert. No. : ACL22032
Job No. : VC65AC0040
Pages : 6 of 8

7. Level linearity on the reference level range

Anticipated Value (dB)	Measured Value (dB)	Deviated Value (dB)	Acceptance Limits (dB)
137.0	137.0	0.0	± 1.1
136.0	136.0	0.0	± 1.1
135.0	135.0	0.0	± 1.1
134.0	134.0	0.0	± 1.1
133.0	133.0	0.0	± 1.1
132.0	132.0	0.0	± 1.1
131.0	131.0	0.0	± 1.1
129.0	129.0	0.0	± 1.1
124.0	124.0	0.0	± 1.1
119.0	119.0	0.0	± 1.1
114.0	114.0	0.0	± 1.1
109.0	109.0	0.0	± 1.1
104.0	104.0	0.0	± 1.1
99.0	99.0	0.0	± 1.1
94.0	94.0	0.0	± 1.1
89.0	89.0	0.0	± 1.1
84.0	84.0	0.0	± 1.1
79.0	79.0	0.0	± 1.1
74.0	74.0	0.0	± 1.1
69.0	69.0	0.0	± 1.1
64.0	64.0	0.0	± 1.1
59.0	59.0	0.0	± 1.1
54.0	54.0	0.0	± 1.1
49.0	49.0	0.0	± 1.1
44.0	44.0	0.0	± 1.1
39.0	39.0	0.0	± 1.1
34.0	34.0	0.0	± 1.1
30.0	30.0	0.0	± 1.1
29.0	28.9	-0.1	± 1.1
28.0	27.9	-0.1	± 1.1
27.0	26.9	-0.1	± 1.1
26.0	25.9	-0.1	± 1.1
25.0	24.9	-0.1	± 1.1

Continuation of Calibration Certificate

Cert. No. : ACL22032
Job No. : VC65AC0040
Pages : 7 of 8

8. Level linearity including the level range control

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

9. Tone burst response

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

10. Peak C sound level

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

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

Continuation of Calibration Certificate

Cert. No. : ACL22032

Job No. : VC65AC0040

Pages : 8 of 8

11. Overload indication

Measured value (dB)		Deviated Value (dB)	Acceptance Limits (dB)
Positive one-half cycle	Negative one-half cycle		
89.5	89.4	-0.1	±1.5

12. High level stability

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

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

————— **End of Calibration Certificate** —————

CERTIFICATE OF CALIBRATION

ISSUED BY Cirrus Research plc

DATE OF ISSUE 07/07/21

CERTIFICATE NUMBER 159632



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

Page 1 of 1

Test engineer:

Nigel Smith

Electronically signed:

doseBadge Reader

Instrument

Manufacturer: Cirrus Research plc
Model Number: RC:110A

Serial Number: 75996
Notes:

Calibration Procedure

The tests were carried out in accordance with the requirements of IEC 60942:2003 where applicable.

Date of Calibration: 07 July 2021

Functionality Results

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

REVIEW BY	<i>Narakan F.</i>
APPROVED BY	<i>[Signature]</i>
NEXT CAL. DATE	7/7/22

Calibration Results

	Level (dB)	Frequency (Hz)	Distortion (% THD + Noise)
Initial	113.80	1000.0	0.28
Adjusted	114.00	1000.0	0.28
Uncertainty	± 0.11	± 0.14	± 0.10
Tolerances	± 0.60	± 2.00	± 4.00

Environmental Conditions

Pressure: 100.00 kPa
Temperature: 21.6 °C
Humidity: 60.1 %

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 plc

DATE OF ISSUE 02/12/21 CERTIFICATE NUMBER 166913



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

Page 1 of 1

Test engineer:
Rebecca Thomas
Electronically signed:

doseBadge Reader

Instrument

Manufacturer: Cirrus Research plc
Model Number: RC:110A

Serial Number: 76062
Notes:

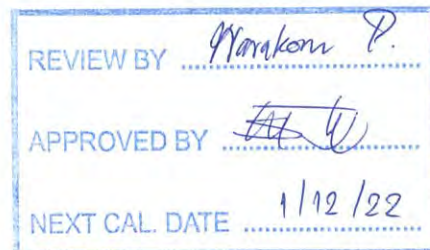
Calibration Procedure

The tests were carried out in accordance with the requirements of IEC 60942:2003 where applicable.

Date of Calibration: 01 December 2021

Functionality Results

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



Calibration Results

	Level (dB)	Frequency (Hz)	Distortion (% THD + Noise)
Initial	114.20	1000.9	0.35
Adjusted	113.99	1000.9	0.34
Uncertainty	± 0.11	± 0.14	± 0.10
Tolerances	± 0.60	± 2.00	± 4.00

Environmental Conditions

Pressure: 98.75 kPa
Temperature: 22.4 °C
Humidity: 43.9 %

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 plc

DATE OF ISSUE 07/09/21 CERTIFICATE NUMBER 162335

REVIEW BY *Narakorn P.*
APPROVED BY *Nigel Smith*
NEXT CAL. DATE 7/9/22



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

Page 1 of 1

Test engineer:

Nigel Smith

Electronically signed:

doseBadge Reader

Instrument

Manufacturer: Cirrus Research plc

Serial Number: 89107

Model Number: RC:110A

Notes:

Calibration Procedure

The tests were carried out in accordance with the requirements of IEC 60942:2003 where applicable.

Date of Calibration: 07 September 2021

Functionality Results

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

Calibration Results

	Level (dB)	Frequency (Hz)	Distortion (% THD + Noise)
Initial	113.90	1000.2	0.20
Adjusted	114.00	1000.2	0.20
Uncertainty	± 0.11	± 0.14	± 0.10
Tolerances	± 0.60	± 2.00	± 4.00

Environmental Conditions

Pressure: 101.40 kPa

Temperature: 22.4 °C

Humidity: 60.2 %

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%.



ROTA METER CALIBRATION RESULT JANUARY 2022

Rotameter ID.	Calibration Date	Regression Result	Coefficient (R ²)
BKK_FS0577	05 Jan 22	$Y = 0.9899x + 0.9112$	0.9999
BKK_FS0579	05 Jan 22	$Y = 1.007x - 0.0299$	1.0000
BKK_FS0583	05 Jan 22	$Y = 1.0513x + 1.869$	0.9967
BKK_FS0584	05 Jan 22	$Y = 1.0048x - 1.069$	1.0000
BKK_FS0585	05 Jan 22	$Y = 1.0076x - 1.1036$	0.9999
BKK_FS0586	05 Jan 22	$Y = 0.9933x + 3.2655$	1.0000
BKK_FS0587	05 Jan 22	$Y = 1.0401x - 17.457$	0.9996
BKK_FS0588	05 Jan 22	$Y = 1.0154x + 4.8357$	0.9999
BKK_FS0589	05 Jan 22	$Y = 0.9918x + 4.8069$	0.9999
BKK_FS0590	05 Jan 22	$Y = 0.9861x + 10.07$	0.9995
BKK_FS0591	05 Jan 22	$Y = 1.0117x - 92.415$	0.9995
BKK_FS0592	05 Jan 22	$Y = 1.0031x - 69.305$	0.9996
BKK_FS0593	05 Jan 22	$Y = 1.0131x - 98.198$	0.9996
BKK_FS0594	05 Jan 22	$Y = 1.0075x - 7.0829$	0.9999
BKK_FS0595	05 Jan 22	$Y = 1.0249x - 98.162$	0.9999
BKK_FS0596	05 Jan 22	$Y = 0.9843x - 26.806$	0.9991
BKK_FS0597	05 Jan 22	$Y = 1.0203x - 122.14$	0.9999
BKK_FS1004	04 Jan 22	$Y = 0.9651x + 19.648$	0.9989
BKK_FS1005	04 Jan 22	$Y = 1.0096x + 4.6643$	0.9997
BKK_FS1006	04 Jan 22	$Y = 1.2188x - 7.1214$	0.9994
BKK_FS1007	05 Jan 22	$Y = 1.0563x - 1.0912$	1.0000
BKK_FS1008	05 Jan 22	$Y = 0.9689x + 1.9061$	1.0000
BKK_FS1009	05 Jan 22	$Y = 1.0132x + 1.1633$	0.9960
BKK_FS1010	05 Jan 22	$Y = 1.0033x + 0.5758$	0.9999
BKK_FS1014	05 Jan 22	$Y = 1.0021x + 0.3148$	0.9998
BKK_FS1015	05 Jan 22	$Y = 0.9994x + 1.786$	1.0000
BKK_FS1016	05 Jan 22	$Y = 1.0105x - 80.256$	0.9998
BKK_FS1017	05 Jan 22	$Y = 0.9995x + 0.649$	1.0000
BKK_FS1018	05 Jan 22	$Y = 1.0011x + 1.1786$	1.0000
BKK_FS1019	05 Jan 22	$Y = 1.0023x - 68.424$	0.9996
BKK_FS1020	05 Jan 22	$Y = 0.9887x + 2.8844$	0.9999
BKK_FS1021	05 Jan 22	$Y = 0.9659x + 1.4905$	0.9978
BKK_FS1022	05 Jan 22	$Y = 1.022x - 17.957$	0.9997
BKK_FS1023	05 Jan 22	$Y = 1.0094x + 0.0717$	0.9999
BKK_FS1024	05 Jan 22	$Y = 1.0042x + 0.4086$	0.9997
BKK_FS1025	05 Jan 22	$Y = 1.0132x - 88.507$	0.9996
BKK_FS1026	05 Jan 22	$Y = 0.9902x + 0.9554$	1.0000
BKK_FS1027	05 Jan 22	$Y = 1.0086x - 2.279$	1.0000
BKK_FS1028	05 Jan 22	$Y = 1.0105x - 81.055$	0.9997



ROTA METER CALIBRATION RESULT JANUARY 2022

Rotameter ID.	Calibration Date	Regression Result	Coefficient (R ²)
BKK_FS1029	05 Jan 22	$Y = 0.9935x + 0.8234$	1.0000
BKK_FS1030	05 Jan 22	$Y = 1.0039x + 0.515$	0.9999
BKK_FS1031	05 Jan 22	$Y = 1.009x - 79.295$	0.9998
BKK_FS1039	04 Jan 22	$Y = 0.9916x + 6.1524$	0.9988
BKK_FS1040	04 Jan 22	$Y = 1.0133x - 10.177$	0.9985
BKK_FS1041	04 Jan 22	$Y = 1.0805x - 1.7381$	0.9998
BKK_FS1042	04 Jan 22	$Y = 1.0061x + 1.3405$	0.9994
BKK_FS1043	04 Jan 22	$Y = 1.0112x - 10.393$	0.9999
BKK_FS1044	04 Jan 22	$Y = 1.0495x - 1.0136$	0.9996
BKK_FS1161	05 Jan 22	$Y = 0.9812x + 15571$	1.0000
BKK_FS1162	05 Jan 22	$Y = 0.9932x + 5.0014$	0.9997
BKK_FS1163	05 Jan 22	$Y = 1.0082x - 82.062$	0.9998
BKK_FS1164	05 Jan 22	$Y = 0.9914x + 0.8427$	0.9997
BKK_FS1165	05 Jan 22	$Y = 0.9893x + 6.5919$	0.9998
BKK_FS1166	05 Jan 22	$Y = 1.0031x - 77.881$	0.9996
RYG_FS0197	04 Jan 22	$Y = 1.0068x + 1.7152$	0.9998
RYG_FS0198	04 Jan 22	$Y = 0.9986x + 18.196$	0.9995
RYG_FS0199	04 Jan 22	$Y = 1.1202x - 3.5782$	0.9999

Review By :

(Mr. Wichan Choonharat)

Enviro Field Services Manager

Approved By :

(Mr. Sarayuth Jittrantont)

Assistant General Manager



ROTA METER CALIBRATION RESULT APRIL 2022

Rotameter ID.	Calibration Date	Regression Result	Coefficient (R ²)
BKK_FS0577	01 Apr 22	$Y = 1.0202x + 0.1976$	1.0000
BKK_FS0579	01 Apr 22	$Y = 1.0078x + 0.4789$	0.9998
BKK_FS0583	01 Apr 22	$Y = 1.016x + 0.3922$	1.0000
BKK_FS0584	01 Apr 22	$Y = 1.0036x + 2.2262$	0.9997
BKK_FS0585	01 Apr 22	$Y = 1.0189x - 5.6476$	0.9997
BKK_FS0586	01 Apr 22	$Y = 1.0095x - 1.1524$	0.9995
BKK_FS0587	01 Apr 22	$Y = 1.013x - 3.6619$	0.9996
BKK_FS0588	01 Apr 22	$Y = 1.0154x + 4.8357$	0.9999
BKK_FS0589	01 Apr 22	$Y = 0.9918x + 4.8069$	0.9999
BKK_FS0590	01 Apr 22	$Y = 1.0038x - 0.4857$	0.9996
BKK_FS0591	01 Apr 22	$Y = 0.9705x - 52.174$	0.9986
BKK_FS0592	01 Apr 22	$Y = 0.9646x - 37.642$	0.9985
BKK_FS0593	01 Apr 22	$Y = 0.9767x - 58.445$	0.9988
BKK_FS0594	01 Apr 22	$Y = 0.9902x - 62.87$	0.9999
BKK_FS0595	01 Apr 22	$Y = 1.0249x - 98.162$	0.9999
BKK_FS0596	01 Apr 22	$Y = 0.9843x - 26.806$	0.9991
BKK_FS0597	01 Apr 22	$Y = 0.9802x - 61.653$	0.9978
BKK_FS1004	01 Apr 22	$Y = 0.9696x + 17.69$	0.9990
BKK_FS1005	01 Apr 22	$Y = 1.0065x + 5.6786$	0.9997
BKK_FS1006	01 Apr 22	$Y = 1.2142x - 7.1037$	0.9993
BKK_FS1007	01 Apr 22	$Y = 0.9917x + 1.6592$	1.0000
BKK_FS1008	01 Apr 22	$Y = 1.0132x + 0.7207$	1.0000
BKK_FS1009	01 Apr 22	$Y = 1.0132x + 1.1633$	0.9960
BKK_FS1010	01 Apr 22	$Y = 1.0033x + 0.5758$	0.9999
BKK_FS1011	01 Apr 22	$Y = 1.0234x + 0.1759$	0.9996
BKK_FS1012	01 Apr 22	$Y = 1.0106x - 2.0048$	0.9997
BKK_FS1013	01 Apr 22	$Y = 0.9677x - 35.851$	0.9997
BKK_FS1014	01 Apr 22	$Y = 1.0021x + 0.3148$	0.9998
BKK_FS1015	01 Apr 22	$Y = 0.9994x + 1.786$	1.0000
BKK_FS1016	01 Apr 22	$Y = 1.0105x - 80.256$	0.9998
BKK_FS1017	01 Apr 22	$Y = 0.9995x + 0.649$	1.0000
BKK_FS1018	01 Apr 22	$Y = 1.0011x + 1.1786$	1.0000
BKK_FS1019	01 Apr 22	$Y = 1.0023x - 68.424$	0.9996
BKK_FS1020	01 Apr 22	$Y = 1.0547x - 0.666$	0.9998
BKK_FS1021	01 Apr 22	$Y = 1.018x - 3.3286$	0.9998
BKK_FS1022	01 Apr 22	$Y = 0.9932x - 57.035$	0.9986
BKK_FS1023	01 Apr 22	$Y = 1.0094x + 0.0717$	0.9999
BKK_FS1024	01 Apr 22	$Y = 1.0042x + 0.4086$	0.9997



ROTA METER CALIBRATION RESULT APRIL 2022

Rotameter ID.	Calibration Date	Regression Result	Coefficient (R ²)
BKK_FS1025	01 Apr 22	$Y = 1.0132x - 88.507$	0.9996
BKK_FS1026	01 Apr 22	$Y = 1.0018x + 1.0776$	0.9997
BKK_FS1027	01 Apr 22	$Y = 1.0053x + 0.231$	0.9995
BKK_FS1028	01 Apr 22	$Y = 0.9792x - 60.312$	0.9982
BKK_FS1029	01 Apr 22	$Y = 0.9935x + 0.8234$	1.0000
BKK_FS1030	01 Apr 22	$Y = 1.0039x + 0.515$	0.9999
BKK_FS1031	01 Apr 22	$Y = 1.009x - 79.295$	0.9998
BKK_FS1039	01 Apr 22	$Y = 0.9868x + 7.8119$	0.9993
BKK_FS1040	01 Apr 22	$Y = 1.0096x - 7.2905$	0.9990
BKK_FS1041	01 Apr 22	$Y = 1.076x - 2.0503$	0.9999
BKK_FS1042	01 Apr 22	$Y = 1.0054x + 1.6095$	0.9995
BKK_FS1043	01 Apr 22	$Y = 1.0108x - 11.048$	0.9999
BKK_FS1044	01 Apr 22	$Y = 1.0468x - 0.9391$	0.9997
BKK_FS1161	01 Apr 22	$Y = 1.0126x + 0.7738$	0.9999
BKK_FS1162	01 Apr 22	$Y = 0.9994x + 2.6357$	0.9995
BKK_FS1163	01 Apr 22	$Y = 0.977x - 55.03$	0.9987
BKK_FS1164	01 Apr 22	$Y = 0.9914x + 0.8427$	0.9997
BKK_FS1165	01 Apr 22	$Y = 0.9893x + 6.5919$	0.9998
BKK_FS1166	01 Apr 22	$Y = 1.0031x - 77.881$	0.9996
RYG_FS0197	01 Apr 22	$Y = 1.0055x + 1.1914$	0.9998
RYG_FS0198	01 Apr 22	$Y = 0.996x + 23.788$	0.9996
RYG_FS0199	01 Apr 22	$Y = 1.1166x - 3.3942$	0.9998

Review By :

(Mr. Wichan Choonharat)

Enviro Field Services Manager

Approved By :

(Mr. Sarayuth Jittrantont)

Assistant General Manager

Certificate of System Qualification

GC-OQ + GCMS-OQ

REVIEW BY	Sarat M.
APPROVED BY	Ch
NEXT CAL. DATE	1 April 23

System ID: GM-2
Organization Name: ALS Laboratory Group (Thailand) Co., Ltd.
Organization Location: 104 Phatthanakan 40, Phattanakan Rd., Kheiwang Suan Luang, Khet Suan Luang, Bangkok 10250
Date: October 1, 2021 1:10:17 PM
EQP Name: AgilentRecommended , AgilentRecommended
EQP Revision: GC.02.51, GCMS.02.51
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 MMI
Setpoint Status: Pass

	Setpoint		Actual	
Inlet Pressure:	25.0	psi	24.9	psi
Accuracy:			0.1	psi
Agilent Recommended:			<= 1.2	

Overall Inlet Pressure Accuracy Test Status

Pass

GC Oven Temperature Accuracy

Name: 7890

Date: October 1, 2021 1:10:17 PM
System ID: GM-2

Setpoint Status:	Pass			
Zone:	Oven			
	Setpoint/Actual			
Temperature:	230.0	230.5	°C	
Accuracy:		0.5	°C	
Agilent Recommended:	>=	-1.0	% setpoint in K	(-5.0 °C)
	<=	1.0	% setpoint in K	(5.0 °C)

Setpoint Status:	Pass			
Zone:	Oven			
	Setpoint/Actual			
Temperature:	100.0	101.5	°C	
Accuracy:		1.5	°C	
Agilent Recommended:	>=	-1.0	% setpoint in K	(-3.7 °C)
	<=	1.0	% setpoint in K	(3.7 °C)

Overall GC Oven Temperature Accuracy Test Status**Pass****GC Oven Temperature Stability**

Name:	7890			
Setpoint Status:	Pass			
	Setpoint/Average			
Temperature:	100.0	101.5	°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:	5975C inert XL with TAD			
Setpoint Status:	Pass			

Overall Log Amp Test Status

Pass

RFPA

Tested Combination1

Front

MMI

/ External

SQ

Name:

5975C inert XL with TAD

Setpoint Status:

Pass

Amu:

1050

m/z

Drift After Five Minutes:

6

mV

RFPA Voltage:

461

mV

Agilent Recommended:

>=

-100

and

<=

100

<=

1100

Overall RFPA Test Status

Pass

Tune EI

Tested Combination1

Front

MMI

/ External

SQ

Name:

5975C 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:

October 1, 2021 1:10:17 PM

System ID:

GM-2

Setpoint Status:

Completed

Injection Volume on Column:

1.0 uL

Overall Scouting Run Status

Completed

Signal to Noise EI

Tested Combination1

Front

MMI

/ External

SQ

Name:

5975C Inert XL with TAD

Source:

EI - Inert

Filament:

1

Setpoint Status:

Pass

Signal to Noise:

619

Agilent Recommended:

>=

320

Source:

EI - Inert

Filament:

2

Setpoint Status:

Pass

Signal to Noise:

647

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 uL

Area RSD:

4.75

%

Retention Time RSD:

0.02

%

Agilent Recommended:

<=

5.00

<=

1.00

Overall Injection Precision Test Status

Pass

Date:

October 1, 2021 1:10:17 PM

System ID:

GM-2

Mass Ratio Precision

Tested Combination1

Front

MMI

/ External

SQ

Injection Tower

Name:

7693A

Source:

EI - Inert

Setpoint Status:**Pass**

Injection Volume on Column:

1.0

uL

Area Mass 1

Mass Ratio

Abundance*s

RSD:

4.75

%

0.81

%

Agilent Recommended:

<=

5.00

<=

5.00

Pass

Pass

Overall Mass Ratio Precision Test Status

Pass

Date:

October 1, 2021 1:10:17 PM

System ID:

GM-2

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

Sampler 2

Manufacturer	Agilent Technologies
Type	Tray
Name	7693A
Model Number	G4514A
Serial Number	CN10060099
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.01.16
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	OFN Std

MS EI Source 1

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

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 logon 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:	October 1, 2021
Reason for Signature:	Executed protocol and published this original version of document

Regulatory Disclaimer

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
 Hostname: 5CG1115HKC

System id: GM-2
 Print Date: October 1, 2021 1:10:19 PM

ALS_GM2 Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
October 1, 2021 12:42:37 PM	Audit	SessionCreated	Session	None
October 1, 2021 12:42:37 PM	Start	Configuration	Session	None
October 1, 2021 12:42:37 PM	Audit	Entitlement	Licensing	User is FieldEngineer and does not require an unlock code
October 1, 2021 12:44:21 PM	Audit	EqpLoaded	Session	EQP details for primary technique [Gc] - File path: [ProtocolPacks/Gc/Configurations/02.51/Gc.02.51.eqp], EQP File Name: [Gc.02.51.eqp], EQP Name: [AgilentRecommended] EQP details for hyphenated technique [GcMs] - File path: [ProtocolPacks/GcMs/Configurations/02.51/GcMs.02.51.eqp], EQP File Name: [GcMs.02.51.eqp], EOP Name: [AgilentRecommended]
October 1, 2021 12:44:24 PM	End	Configuration	Session	None
October 1, 2021 12:44:28 PM	Start	Qualification	Session	OQ
October 1, 2021 12:44:28 PM	Start	Execution	System Inspection and Basic Safety and Operation - 7890: - Qualitative Test - No setpoints associated	None

User Name: supasak.nimsongtham
 Hostname: 5CG1115HKC

System Id: GM-2
 Print Date: October 1, 2021 1:10:19 PM

ALS_GM2 Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
October 1, 2021 12:47:35 PM	End	Execution	System Inspection and Basic Safety and Operation - 7890: - Qualitative Test - No setpoints associated	Run Count : 1
October 1, 2021 12:47:37 PM	Start	Execution	Inlet Pressure Accuracy - Front MMf: - Pressure Controlled Inlet - S: 25.0 psi - L: <= 1.2 psi	None
October 1, 2021 12:47:42 PM	End	Execution	Inlet Pressure Accuracy - Front MMf: - Pressure Controlled Inlet - S: 25.0 psi - L: <= 1.2 psi	Run Count : 1
October 1, 2021 12:47:44 PM	Start	Execution	GC Oven Temperature Accuracy - 7890: - Temperature : Oven - S: 230.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	None
October 1, 2021 12:48:04 PM	Audit	Data	GC Oven Temperature Accuracy - 7890: - Temperature : Oven - S: 230.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	Manual Data Entry
October 1, 2021 12:48:05 PM	End	Execution	GC Oven Temperature Accuracy - 7890: - Temperature : Oven - S: 230.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	Run Count : 1
October 1, 2021 12:48:07 PM	Start	Execution	GC Oven Temperature Accuracy - 7890: - Temperature : Oven - S: 100.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	None
October 1, 2021 12:48:34 PM	Audit	Data	GC Oven Temperature Accuracy - 7890: - Temperature : Oven - S: 100.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	Manual Data Entry
October 1, 2021 12:48:36 PM	End	Execution	GC Oven Temperature Accuracy - 7890: - Temperature : Oven - S: 100.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	Run Count : 1

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User Name: supasak.nimsongtham
 Hostname: 5CG1115HKC

System id: GM-2
 Print Date: October 1, 2021 1:10:19 PM

ALS_GM2 Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
October 1, 2021 12:48:38 PM	Start	Execution	GC Oven Temperature Stability - 7890: - Temperature : Oven - S: 100.0°C - L: <= 0.5°C	None
October 1, 2021 12:49:34 PM	Audit	Data	GC Oven Temperature Stability - 7890: - Temperature : Oven - S: 100.0°C - L: <= 0.5°C	Manual Data Entry
October 1, 2021 12:49:36 PM	End	Execution	GC Oven Temperature Stability - 7890: - Temperature : Oven - S: 100.0°C - L: <= 0.5°C	Run Count : 1
October 1, 2021 12:49:37 PM	Start	Execution	Log Amp - 5975C inert XL with TAD SQ: - Source: EI - Inert	None
October 1, 2021 12:49:47 PM	End	Execution	Log Amp - 5975C inert XL with TAD SQ: - Source: EI - Inert	Run Count : 1
October 1, 2021 12:49:48 PM	Start	Execution	RFPA - 5975C inert XL with TAD SQ: - Source: EI - Inert	None
October 1, 2021 12:50:23 PM	End	Execution	RFPA - 5975C inert XL with TAD SQ: - Source: EI - Inert	Run Count : 1
October 1, 2021 12:50:25 PM	Start	Execution	Tune EI - 5975C inert XL with TAD SQ: - Source: - EI - Inert Filament 1 (Qualitative - No setpoints associated)	None
October 1, 2021 12:50:49 PM	End	Execution	Tune EI - 5975C inert XL with TAD SQ: - Source: - EI - Inert Filament 1 (Qualitative - No setpoints associated)	Run Count : 1
October 1, 2021 12:50:50 PM	Start	Execution	Tune EI - 5975C inert XL with TAD SQ: - Source: - EI - Inert Filament 2 (Qualitative - No setpoints associated)	None
October 1, 2021 12:50:59 PM	End	Execution	Tune EI - 5975C inert XL with TAD SQ: - Source: - EI - Inert Filament 2 (Qualitative - No setpoints associated)	Run Count : 1

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User Name: supasak.nimsongtham
 Hostname: 5CG1115HKC

System Id: GM-2
 Print Date: October 1, 2021 1:10:19 PM

ALS_GM2 Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
October 1, 2021 12:51:01 PM	Start	Execution	Scouting Run - Injection Tower, Front MMI, SQ: - Source: - EI - Inert- Part of GCMS System Preparation	None
October 1, 2021 12:51:18 PM	Audit	Data	Scouting Run - Injection Tower, Front MMI, SQ: - Source: - EI - Inert- Part of GCMS System Preparation	Data files Path : E:\GM2OQ2021\SCOUTING RUN001.D\DATA.MS
October 1, 2021 12:51:42 PM	Audit	Data	Scouting Run - Injection Tower, Front MMI, SQ: - Source: - EI - Inert- Part of GCMS System Preparation	Data files Path : E:\GM2OQ2021\SCOUTING RUN001.D\DATA.MS
October 1, 2021 12:52:42 PM	Audit	Data	Scouting Run - Injection Tower, Front MMI, SQ: - Source: - EI - Inert- Part of GCMS System Preparation	Data files Path : E:\GM2OQ2021\SCOUTING RUN001.D\DATA.MS
October 1, 2021 12:53:25 PM	End	Execution	Scouting Run - Injection Tower, Front MMI, SQ: - Source: - EI - Inert- Part of GCMS System Preparation	Run Count : 1
October 1, 2021 12:53:27 PM	Start	Execution	Signal to Noise EI - Injection Tower, Front MMI, SQ: - Source: EI - Inert using Filament 1 - L: >= 320	None
October 1, 2021 12:53:40 PM	Audit	Data	Signal to Noise EI - Injection Tower, Front MMI, SQ: - Source: EI - Inert using Filament 1 - L: >= 320	Data files Path : E:\GM2OQ2021\SNF1_001.D\DATA.MS
October 1, 2021 12:53:56 PM	End	Execution	Signal to Noise EI - Injection Tower, Front MMI, SQ: - Source: EI - Inert using Filament 1 - L: >= 320	Run Count : 1

User Name: supasak.nimsongtham
 Hostname: 5CG1115HKC

System Id: GM-2
 Print Date: October 1, 2021 1:10:19 PM

ALS_GM2 Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
October 1, 2021 12:53:59 PM	Start	Execution	Signal to Noise EI - Injection Tower, Front MMI, SQ: - Source: EI - Inert using Filament 2 - L: >= 320	None
October 1, 2021 12:54:04 PM	Audit	Data	Signal to Noise EI - Injection Tower, Front MMI, SQ: - Source: EI - Inert using Filament 2 - L: >= 320	Data files Path : E:\GM2OQ2021\SNF2_001.D D\DATA.MS
October 1, 2021 12:54:22 PM	End	Execution	Signal to Noise EI - Injection Tower, Front MMI, SQ: - Source: EI - Inert using Filament 2 - L: >= 320	Run Count : 1
October 1, 2021 12:54:26 PM	Start	Execution	Injection Precision - Injection Tower, Front MMI, SQ: - Source: - EI - Inert L (Area): <= 5.00% - L (Ret. Time): <= 1.00%	None
October 1, 2021 12:54:37 PM	Audit	Data	Injection Precision - Injection Tower, Front MMI, SQ: - Source: - EI - Inert L (Area): <= 5.00% - L (Ret. Time): <= 1.00%	Data files Path : E:\GM2OQ2021\IP_MRP003. D\DATA.MS
October 1, 2021 12:54:37 PM	Audit	Data	Injection Precision - Injection Tower, Front MMI, SQ: - Source: - EI - Inert L (Area): <= 5.00% - L (Ret. Time): <= 1.00%	Data files Path : E:\GM2OQ2021\IP_MRP004. D\DATA.MS
October 1, 2021 12:54:37 PM	Audit	Data	Injection Precision - Injection Tower, Front MMI, SQ: - Source: - EI - Inert L (Area): <= 5.00% - L (Ret. Time): <= 1.00%	Data files Path : E:\GM2OQ2021\IP_MRP005. D\DATA.MS
October 1, 2021 12:54:37 PM	Audit	Data	Injection Precision - Injection Tower, Front MMI, SQ: - Source: - EI - Inert L (Area): <= 5.00% - L (Ret. Time): <= 1.00%	Data files Path : E:\GM2OQ2021\IP_MRP006. D\DATA.MS

User Name: supasak.nimsongtham

System Id: GM-2

Hostname: 5CG1115HKC

Print Date: October 1, 2021 1:10:19 PM

ALS_GM2 Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
October 1, 2021 12:54:37 PM	Audit	Data	Injection Precision - Injection Tower, Front MMI, SQ: - Source: - EI - Inert L (Area): <= 5.00% - L (Ret. Time): <= 1.00%	Data files Path : E:\GM2OQ2021\IP_MRP007.D\DATA.MS
October 1, 2021 12:54:37 PM	Audit	Data	Injection Precision - Injection Tower, Front MMI, SQ: - Source: - EI - Inert L (Area): <= 5.00% - L (Ret. Time): <= 1.00%	Data files Path : E:\GM2OQ2021\IP_MRP008.D\DATA.MS
October 1, 2021 12:54:52 PM	End	Execution	Injection Precision - Injection Tower, Front MMI, SQ: - Source: - EI - Inert L (Area): <= 5.00% - L (Ret. Time): <= 1.00%	Run Count : 1
October 1, 2021 12:54:55 PM	Start	Execution	Mass Ratio Precision - Injection Tower, Front MMI, SQ: - Source: EI - Inert - L (RSD): <= 5.00%	None
October 1, 2021 12:55:06 PM	Audit	Data	Mass Ratio Precision - Injection Tower, Front MMI, SQ: - Source: EI - Inert - L (RSD): <= 5.00%	Data files Path : E:\GM2OQ2021\IP_MRP003.D\DATA.MS
October 1, 2021 12:55:06 PM	Audit	Data	Mass Ratio Precision - Injection Tower, Front MMI, SQ: - Source: EI - Inert - L (RSD): <= 5.00%	Data files Path : E:\GM2OQ2021\IP_MRP004.D\DATA.MS
October 1, 2021 12:55:06 PM	Audit	Data	Mass Ratio Precision - Injection Tower, Front MMI, SQ: - Source: EI - Inert - L (RSD): <= 5.00%	Data files Path : E:\GM2OQ2021\IP_MRP005.D\DATA.MS
October 1, 2021 12:55:06 PM	Audit	Data	Mass Ratio Precision - Injection Tower, Front MMI, SQ: - Source: EI - Inert - L (RSD): <= 5.00%	Data files Path : E:\GM2OQ2021\IP_MRP006.D\DATA.MS

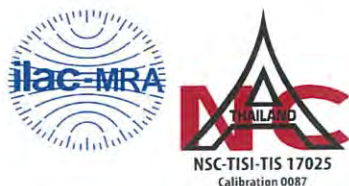
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User Name: supasak.nimsongtham
 Hostname: 5CG1115HKC

System Id: GM-2
 Print Date: October 1, 2021 1:10:19 PM

ALS_GM2 Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
October 1, 2021 12:55:06 PM	Audit	Data	Mass Ratio Precision - Injection Tower, Front MMI, SQ: - Source: EI - Inert - L (RSD): <= 5.00%	Data files Path : E:\GM2OQ2021\IP_MRP007. D:\DATA.MS
October 1, 2021 12:55:06 PM	Audit	Data	Mass Ratio Precision - Injection Tower, Front MMI, SQ: - Source: EI - Inert - L (RSD): <= 5.00%	Data files Path : E:\GM2OQ2021\IP_MRP008. D:\DATA.MS
October 1, 2021 12:55:10 PM	End	Execution	Mass Ratio Precision - Injection Tower, Front MMI, SQ: - Source: EI - Inert - L (RSD): <= 5.00%	Run Count : 1
October 1, 2021 12:55:13 PM	End	Qualification	Session	OQ
October 1, 2021 12:55:13 PM	Start	Reporting	Session	None
October 1, 2021 1:09:11 PM	Audit	Reporting	Session	Report Generated : Certificate

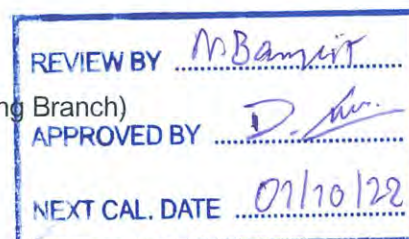


Certificate of Calibration

Equipment: SPECTROPHOTOMETER
Model: DR6000
Serial No. (or ID.): 1627845 (RYG_EN0037)
Manufacturer: HACH
Condition: In Condition

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

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



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

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

Calibration By: Mr. Chattuphon Foithong

Calibration Date: 01 April 2021

The Method used: In house method, SPCC-WI-24, base on ASTM E 275-08 and ASTM E 387-04

Traceability: This certificate is traceable to the CRM maintained by National Institute of Standards and Technology (NIST) through Starna Scientific Limited.

The standard for Wavelength Certificate No. 87146 and 87152

The standard for Photometric Certificate No. 87220 and 87139

The standard for Stray light Certificate No. 87163 and 87161

The standard for Spectral resolution Certificate No. 87173

(Mr. Chattuphon Foithong)

Person in charge

บริษัท เอสพีซี อาร์ที จำกัด
SPC RT Co., Ltd.

(Mr. Dumrong Boonsopon)
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 SPC RT Co., Ltd.

Calibration Results:**Without Adjustment****Wavelength Accuracy (nm), The spectral bandwidth of Std at 2 nm and UUC at 2 nm**

Standard Wavelength	Unit Under Calibration	Correction	Uncertainty
418.61	418.4	0.21	0.13
536.66	536.7	-0.04	0.13
637.98	638.3	-0.32	0.14
748.48	748.7	-0.22	0.14
807.03	807.4	-0.37	0.14

Photometric Accuracy (Absorbance)

Wavelength	Standard absorbance	Unit Under Calibration	Correction	Uncertainty
420 nm	0.0000	0.000	0.0000	0.0045
	0.5890	0.590	-0.0010	0.0045
	0.7616	0.762	-0.0004	0.0045
	1.0263	1.027	-0.0007	0.0045
440 nm	0.0000	0.000	0.0000	0.0045
	0.5787	0.579	-0.0003	0.0045
	0.7442	0.744	0.0002	0.0045
	1.0039	1.004	-0.0001	0.0045
465 nm	0.0000	0.000	0.0000	0.0045
	0.5292	0.530	-0.0008	0.0045
	0.6865	0.687	-0.0005	0.0045
	0.9534	0.954	-0.0006	0.0045
546.1 nm	0.0000	0.000	0.0000	0.0045
	0.5468	0.546	0.0008	0.0045
	0.6957	0.695	0.0007	0.0045
	0.9991	0.998	0.0011	0.0045
590 nm	0.0000	0.000	0.0000	0.0045
	0.5851	0.584	0.0011	0.0045
	0.7238	0.723	0.0008	0.0045
	1.0957	1.094	0.0017	0.0045
635 nm	0.0000	0.000	0.0000	0.0045
	0.5692	0.568	0.0012	0.0045
	0.6914	0.691	0.0004	0.0045
	1.0881	1.087	0.0011	0.0045

Calibration Results:
Without Adjustment

Photometric Accuracy (Absorbance)				
Wavelength	Standard absorbance	Unit Under Calibration	Correction	Uncertainty
235 nm	0.0000	0.000	0.0000	0.0080
	0.7307	0.730	0.0007	0.0080
257 nm	0.0000	0.000	0.0000	0.0080
	0.8516	0.850	0.0016	0.0080
313 nm	0.0000	0.000	0.0000	0.0080
	0.2836	0.285	-0.0014	0.0080
350 nm	0.0000	0.000	0.0000	0.0080
	0.6319	0.629	0.0029	0.0080

Stray light *			
Standard: cut-off	UUC: Wavelength (nm)	UUC: Transmission (%T)	Absorbance (A)
260.57 +/- 0.11 nm	260.6	1.5	1.824
392.03 +/- 0.11 nm	392.0	1.5	1.824

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

Spectral Resolution *				
Nominal Concentration 0.02 % v/v	Peak	Trough	Ratio	SBW
Standard Wavelength (nm)	268.72	266.76	1.39	2.00
UUC: Wavelength (nm)	268.2	266.1		
Std Absorbance (A)	0.4616	0.2797		
Absorbance (A)	0.416	0.300		

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

The End of Certificate

ใบตรวจสอบสภาพเครื่องวัดสิ่งแวดล้อม

เลขที่ใบงาน: KSPR2104738

ชนิดเครื่องมือ: SPECTROPHOTOMETER

รุ่น: DR6000

หมายเลขเครื่อง: 1627845

ตรวจสอบ (รับ)		รายการตรวจเช็ค	ตรวจสอบ (ส่ง)		หมายเหตุ
01 Apr 2021			01 Apr 2021		
ปกติ	ไม่ปกติ		ปกติ	ไม่ปกติ	
		General			
<input checked="" type="checkbox"/>	<input type="checkbox"/>	1. ความสมบูรณ์เครื่อง	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	2. ความสะอาด (ช่องใส่ตัวอย่าง, ภายใน-นอกเครื่อง)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	3. สวิทช์ ปิด – เปิด เครื่อง (On-Off Swicth)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	4. ปุ่มกด (Keypad)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	5. หน้าจอ (Display, Screen Contrast)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
		Spectrophotometer			
<input type="checkbox"/>	<input type="checkbox"/>	6. แรงดันไฟฟ้า (Battery Backup) >= 2.5 VDC	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	<input type="checkbox"/>	7. ตัวหมุนเลือกความยาวคลื่น (Wavelength Control)	<input type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	8. ความยาวคลื่น (Wavelength Check)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	656.1=656.1 nm
<input checked="" type="checkbox"/>	<input type="checkbox"/>	9. แหล่งกำเนิดแสง (UV < 3,000 hour)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	10. แหล่งกำเนิดแสง (Visible < 5,000 hour)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	11. ช่องวัดหลายตัวอย่าง (Carousel Module)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
		pH Meter and Conductivity Meter			
<input type="checkbox"/>	<input type="checkbox"/>	12. อิเล็กโทรด (Electrode and Connection Cable)	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	<input type="checkbox"/>	13. ระดับสารละลายใน Electrode (Level KCl)	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	<input type="checkbox"/>	14. ฝาปิดกันปลาย Electrode (Dust Protection Hood)	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	<input type="checkbox"/>	15. ขาจับอิเล็กโทรด (Stand)	<input type="checkbox"/>	<input type="checkbox"/>	
		Turbidimeter			
<input type="checkbox"/>	<input type="checkbox"/>	16. ค่าความขุ่นที่ต่ำสุด (No Sample)	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	<input type="checkbox"/>	17. ระดับการส่องสว่างของแสง (>= 2.5 ไม่เกิน 3.0)	<input type="checkbox"/>	<input type="checkbox"/>	
		Automatic titrator			
<input type="checkbox"/>	<input type="checkbox"/>	18. สภาพ Piston Burettes	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	<input type="checkbox"/>	19. Function Rinsing and Dosing	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	<input type="checkbox"/>	20. ระบบท่อสายยางและอุปกรณ์ประกอบ	<input type="checkbox"/>	<input type="checkbox"/>	

เพิ่มเติม/ข้อแนะนำ :

Mr. Chattuphon Foithong

Service Engineer



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Certificate of Calibration

Certificate No. : 21PH487

Page : 1 of 2

Equipment : Lux Meter
Manufacturer: Delta OHM
Model : HD2102.21
Serial No.: 16002032
ID No.: RYG_FS0200
Condition As-Received: Used Item
Received Date: 15 September 2021
Calibration Date: 22 September 2021

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

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

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

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

Condition of this result of calibration

1. Reference standards instruments :

<u>Instrument</u>	<u>Model</u>	<u>Serial No.</u>	<u>Certificate No.</u>	<u>Due Date</u>
1) Photometry & Encorder	LMguide 9,6 m	120RC003	61-140006-1	30 Apr 2022
2) High-accuracy Irradiance Standard	OL-FEL-U	F-1472	TP-1045-20	20 Oct 2021

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

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

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

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

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

-National Institute of Metrology Thailand (NIMT)

REVIEW BY	<i>Nongkorn P.</i>
APPROVED BY	<i>[Signature]</i>
NEXT CAL. DATE	<i>22/9/22</i>

Calibrated by : Nuntawat Khamchai
Issue Date : 24 September 2021

Approved Signatory :

[*✓*] Phalinee Prabpaipal

[] Chatchawan Khunpiluek



Cert. No.: 21PH487

Page.: 2 of 2

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

Function : Illuminance Measurement

Range : Autorange

<u>Standard Value</u>	<u>UUC* Reading</u>	<u>Error</u>	<u>Uncertainty</u>
(lx)	(lx)	(lx)	(± lx)
0	0.00	0.00	0.060
15	14.44	-0.56	0.20
100	96.83	-3.17	1.3
500	480.8	-19.2	6.5
1000	973.0	-27.0	13
2000	1976.2	-23.8	26
3000	2976	-24	39
4000	3975	-25	52
5000	4986	-14	65

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

Calibration with probe sensor s/n. 20011666

UUC* = Unit Under Calibration.

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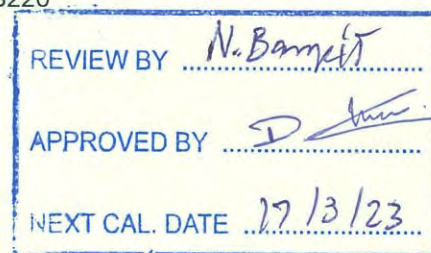
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Cert.No.: 22CH405
Page.: 1 of 3

Certificate of Calibration

Equipment :	pH Meter
Manufacturer :	Mettler Toledo
Model :	Seven Compact S220
Serial No. :	C104059460
ID No. :	RYG_EN0183
Condition As-Received:	Used Item
Received Date :	16 March 2022
Calibration Date :	17 March 2022
Reference :	2203-0611DSC-4
Submitted by :	ALS Laboratory Group (Thailand) Co.,Ltd. Rayong Branch 616/10 Moo 5 T.Maenam Khu, A.Pluakdaeng, Rayong 21140, Thailand
Ambient Temperature :	(25 ± 2.5) °C
Relative Humidity :	(50 ± 15) %
Calibration Procedure :	In - house method : - CP-CH5 by direct measurement with standard voltage calibrator and direct measurement with certified reference material (CRM) - CP-CH8 by comparison with standard thermometer



Calibrated by : Warakorn Lernagtrakul

Approved by :

Malee

Approved Signatory

- (☒) Malee Butkruea
() Saithip Meangmai
() Warakorn Lernagtrakul

Issue Date : 22 March 2022

The Uncertainties are for a confidence probability of approximately 95%

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Approval of the head of Corporate Services 3 : Equipment Calibration and Testing Services.

A 0037307



Cert.No.: 22CH405

Page.: 2 of 3

Condition of this calibration result

1. Reference Standard Instrument : -

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

This certification is traceable to the International System of Unit maintained at:-

- Traceable to National Institute of Metrology (Thailand), NIMT

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

<u>Buffer Solution</u>	<u>Manufacturer</u>	<u>Lot No.</u>	<u>Exp. date</u>
pH 4.008	CPA chem	788995	01 Jan 2024
pH 6.982	CPA chem	761017	02 Aug 2022
pH 10.015	CPA chem	766824	04 Sep 2022

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

Calibration Results

Function : mV Measurement

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

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

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Cert.No.: 22CH405

Page.: 3 of 3

Calibration Results**Function : pH Measurement**

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

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

Function : Temperature Measurement**(*) Without adjustment**

This equipment was connected with Temperature Probe;

- Model : InLab Expert Pro-ISM

- Serial No. : 1453404

Dimension of probe;

- Length : 120 mm.

- Diameter : 12 mm.

- Immersion Depth : 100 mm.

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

Remark : - UUC* = Unit Under Calibration

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

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Maku.



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Certificate of Calibration

Certificate No. : 22E986

Page : 1 of 2

Equipment : pH Meter
Manufacturer: Mettler Toledo
Model : SevenCompact S220
Serial No.: C104059460
ID No.: RYG_EN0183

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except with the prior written approval of the head of
Corporate Services 3: Equipment Calibration and Testing Services.

Condition As-Received: Used Item

Received Date: 16 March 2022

Calibration Date: 21 March 2022

Reference: 2203-0611DSC

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

Ambient Temperature: (23 ± 2) °C

Relative Humidity: (50 ± 10) %

616/10 Moo 5 T.Maenam Khu, A.Pluakdaeng, Rayong
21140, Thailand

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

Condition of this result of calibration

1.Reference standards instruments :

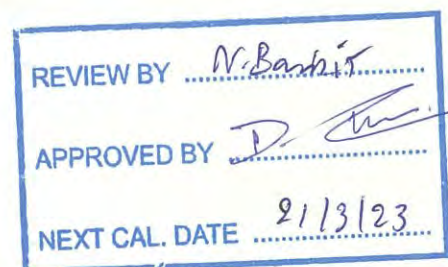
<u>Instrument</u>	<u>Model</u>	<u>Serial No.</u>	<u>Certificate No.</u>	<u>Due Date</u>
1) Multi-Product Calibrator	5500A	6440007	21E1444	07 May 2022

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

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

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

-National Institute of Metrology Thailand (NIMT)



Calibrated by : Pongsagorn Boonyaporn
Issue Date : 22 March 2022

Approved Signatory :

☒ Phalinee Prabpaipal

☐ Nuntawat Khamchai

☐ Pornthippa Tameyakul

B 0284414



Cert. No.: 22E986

Page.: 2 of 2

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

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

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

*UUC= Unit Under Calibration.

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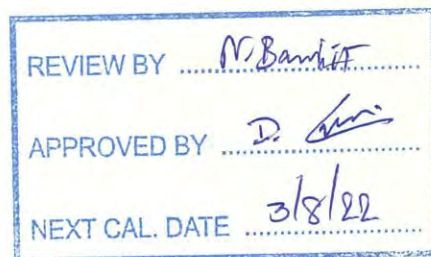
TEL. 0-2717-3000 FAX. 0-2719-9484

Cert.No.: 21TW20

Page.: 1 of 2

Certificate of Testing

Equipment :	DO Meter
Manufacturer :	YSI
Model :	5100
Serial No. :	15L102139
ID No. :	RYG_EN0140
Received Date :	29 January 2021
Test Date :	02 February 2021
Reference :	2101-0817DSC-1
Submitted by :	ALS Laboratory Group (Thailand) Co.,Ltd. Rayong Branch Eastern Seaboard Industrial Estate (Rayong) 64/77 Moo 4,Building No.B1, Highway 331, Km91.5, T.Pluakdaeng, A.Pluakdaeng, Rayong 21140 Thailand
Laboratory Condition :	Temperature (25 ± 5) °C Humidity (50 ± 20) %
Test Procedure :	In - house method : CP-CH9 by Comparison Technique with Azide Modification Method
Calibrated by :	Walalak Sirithean
Approved by :	<u>Malee Butkruea</u> Approved Signatory
<input checked="" type="checkbox"/> Malee Butkruea <input type="checkbox"/> Saithip Meangmai <input type="checkbox"/> Warakorn Lerngagtrakul	
Issue Date :	3 February 2021





Cert.No.: 21TW20

Page.: 2 of 2

Result : Dissolved Oxygen Meter Adjustment With Air 100 %

Dissolved Oxygen Probe No.: 16C100647

Titration Method (Azide Modification Method) (mg/L)	DO Meter Reading (mg/L)	Standard Deviation (mg/L)
8.02	8.02	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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a 1038971



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Cert. No.: 21TM271

Page.: 1 of 2

Certificate of Calibration

Equipment : DO Meter with Sensor

Manufacturer : YSI

Model : 5100

Serial No. : 15L102139

ID No. : RYG_EN0140

Submitted by : ALS Laboratory Group (Thailand) Co.,Ltd. Rayong Branch
Eastern Seaboard Industrial Estate (Rayong)
64/77 Moo 4 Building No.B1, Highway 331 km. 91.5,
T. Pluakdaeng, A. Pluakdaeng, Rayong 21140 Thailand

Location : TPA On Site Calibration Laboratory

Received Order : 29 January 2021

Calibrated Date : 3 February 2021

Ambient Temperature : (26 \pm 10) °C

Relative Humidity : (50 \pm 30) %

AC Line Voltage : (220 \pm 22) V

Calibrated by : Malee Butkruea

Approved by :

Approved Signatory

() Pornthippa Tameyakul

(✓) Suwit Imjai

Issue Date : 4 February 2021

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 0024028



Equipment : DO Meter with Sensor
Condition As-Received : Used Item
Reference : 2101-0817DSC-2

Cert. No.: 21TM271

Page.: 2 of 2

Procedure Used :-

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

The temperature scale used was based on ITS-90.

Condition of this result of calibration

1. Reference standard instrument:-

<u>Instrument</u>	<u>Model</u>	<u>Serial No.</u>	<u>Cert. No.</u>	<u>Due Date</u>
1) Digital Thermometer	1523	2188080	2011389	20 Nov 2021

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

3. This certification is traceable to the International System of Unit maintained at:-

- National Institute of Metrology Thailand (NIMT)

Result of Calibration :- (*) Without Adjustment

Function : Temperature measurement.

This instrument was connected with temperature sensor, S/N.: 16C100647

<u>Calibration Point</u> (°C)	<u>Immersion Depth</u> (mm)	<u>Standard Temperature</u> (°C)	<u>UUC* Reading</u> (°C)	<u>Error</u> (°C)	<u>Uncertainty</u> (±°C)	<u>Coverage Factor</u> <i>k</i>
20.00	60	20.008	19.96	-0.048	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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Cert. No.: 22TM317

Page.: 1 of 3

Certificate of Calibration

Equipment : Low Temp. Incubator

Manufacturer : Memmert

Model : IPP750

Serial No. : V818.0084

ID No. : RYG_EN0154

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

Location : BOD Room

Received Order : 22 April 2022

Calibration Date : 22 April 2022

Ambient Temperature : (26 ± 10) °C

Relative Humidity : (50 ± 30) %

Calibrated by : Man Pattanapongpaiboon

REVIEW BY	<i>N. Banvit</i>
APPROVED BY	<i>D. [Signature]</i>
NEXT CAL. DATE	21/10/23

Approved by :

Manu
Approved Signatory

- () Pornthippa Tameyakul
(/) Malee Butkruea
() Suwit Imjai

Issue Date :

3 May 2022

The Uncertainties are for a confidence probability of approximately 95%

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Approval of the head of Corporate Services 3 : Equipment Calibration and Testing Services.

A 0040735



Equipment : Low Temp. Incubator

Condition As-Received : Used Item

Reference : 2204-0146OC-1

Cert. No.: 22TM317

Page.: 2 of 3

Procedure Used :-

Calibration were conducted using calibration procedure CP-OT02 according to direct measurement

The temperature scale used was based on ITS-90.

Condition of this result of calibration

1. Reference standard instrument:-

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

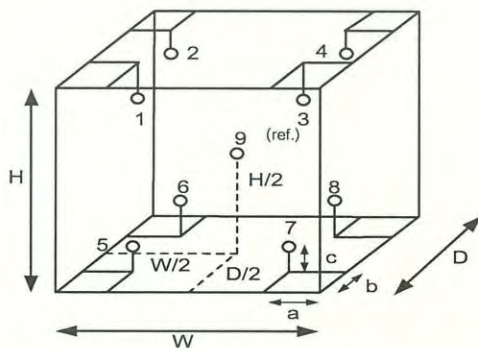
2. This certificate is valid only to the item calibrated on date and place of calibration.

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

Result of Calibration :- (*) Without Adjustment

Function of UUC* : Temperature Source

Fresh air setting : Close



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

Probe Installation Details :

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

Dimension of Chamber :

D = 0.60 m
W = 1.0 m
H = 1.2 m
Capacity = 0.75 m³

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

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Equipment : Low Temp. Incubator
Condition As-Received : Used Item
Reference : 2204-0146OC-1
Result of Calibration :- (*) Without Adjustment

Cert. No.: 22TM317

Page.: 3 of 3

Function of UUC* : Temperature Source

Fresh air setting : Close

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

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

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

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

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

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

UUC* : Unit Under Calibration

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

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

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PENTA CALIBRATION CO., LTD.

66/124 The Connect 33 Village Kanchanaphisek Road
Dokmai Prawet Bangkok 10250
Tel: +66 (0) 2069-9773
www.pentacal.com

Certificate of Calibration

Represent to Certificate of Calibration ,PTC/07/22103

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



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



Environment Condition: Temperature 23.9 °C ± 0.3 °C
Humidity 58.1 %RH ± 4.4 %RH
Air density 1.17 kg/m³

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

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

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

Date Received: March 23, 2022

Calibration Date: March 23, 2022

Issued Date: March 25, 2022

Calibration By: Mr. Rungroje Metakul



PENTA CALIBRATION CO.,LTD.

(Mr.Kriangsak Kalasri)

Reviewed by

Approved By :

(Mr. Keattisak Kerdto)

Laboratory Manager

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

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

This calibration certificate shall not be reproduced except in full only, without written approval from penta calibration co., ltd



Represent to Certificate of Calibration ,PTC/07/22103

Certificate No.: PTC/07/22103

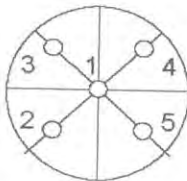
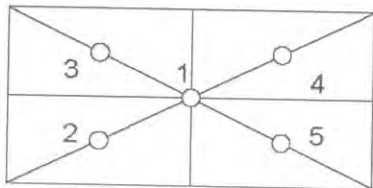
Page: 2 of 2

Measurement Results:

Without Adjustment :

Function Calibration: Non Adjustment

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



Eccentricity test 100 (g)

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

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

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

Nominal test value (g)	Standard Deviation
200	0.00003

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

Nominal Value (g)	Conventional Mass (g)	Indication (g)	Correction of Balance (g)	Uncertainty (g)	k
0	0.00000	0.0000	0.0000	0.000086	2.16
0.01	0.01000	0.0100	0.0000	0.00010	2.06
0.1	0.10000	0.1000	0.0000	0.00010	2.06
1	1.00000	1.0000	0.0000	0.00010	2.06
2	2.00000	1.9999	0.0001	0.00010	2.06
5	5.00001	5.0000	0.0000	0.00010	2.06
10	10.00000	10.0000	0.0000	0.00010	2.06
20	20.00003	19.9999	0.0001	0.00011	2.05
50	50.00004	49.9999	0.0001	0.00012	2.00
100	100.00004	100.0001	-0.0001	0.00017	2.00
200	200.00011	200.0000	0.0001	0.00027	2.00

Note: Weight of adjust - (g)

The End of Certificate



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Cert. No.: 21TM827

Page.: 1 of 3

Certificate of Calibration

Equipment : Hot Air Oven

Manufacturer : Memmert

Model : UFE 500

Serial No. : G511.1572

ID No. : RYG_EN0010

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

Location : Oven Room

Received Order : 5 May 2021

Calibration Date : 5 May 2021

Ambient Temperature : (26 ± 10) °C

Relative Humidity : (50 ± 30) %

Calibrated by : Khit Ruttanaprapachai

Approved by :

Malee

Approved Signatory

() Pornthippa Tameyakul

(✓) Malee Butkruea

() Suwit Imjai

Issue Date : 14 May 2021

The Uncertainties are for a confidence probability of approximately 95%

This certificate may not be reproduced other than in full, except with the prior written

Approval of the head of Corporate Services 3 : Equipment Calibration and Testing Services.



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

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

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

The temperature scale used was based on ITS-90.

Condition of this result of calibration

1. Reference standard instrument:-

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

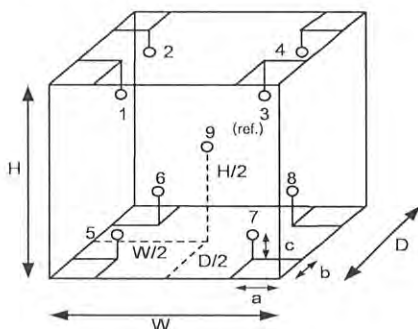
2. This certificate is valid only to the item calibrated on date and place of calibration.

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

Result of Calibration :- (*) Without Adjustment

Function of UUC* : Temperature Source

Fresh air setting : Close



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

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

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

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

Cert. No.: 21TM827

Page.: 3 of 3

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

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

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

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

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

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

UUC* : Unit Under Calibration

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

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

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Cert. No.: 21TM829

Page.: 1 of 3

Certificate of Calibration

Equipment :	Hot Air Oven	 REVIEW BY <u>Thamta.</u> APPROVED BY <u>D. [Signature]</u> NEXT CAL. DATE <u>3/11/22</u>
Manufacturer :	Memmert	
Model :	UM 400	
Serial No. :	b495.0899	
ID No. :	RYG_EN0006	
Submitted by :	ALS Laboratory Group (Thailand) Co.,Ltd. (Rayong Branch) 616/10 Moo 5 T. Maenam Khu, A. Pluakdaeng, Rayong 21140 Thailand	
Location :	Oven Room	
Received Order :	5 May 2021	
Calibration Date :	5 - 6 May 2021	
Ambient Temperature :	(26 ± 10) °C	
Relative Humidity :	(50 ± 30) %	
Calibrated by :	Khit Ruttanaprapachai	

Approved by :

Approved Signatory

- () Pornthippa Tameyakul
 (✓) Malee Butkruea
 () Suwit Imjai

Issue Date :

14 May 2021

The Uncertainties are for a confidence probability of approximately 95%

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 Approval of the head of Corporate Services 3 : Equipment Calibration and Testing Services.



Equipment : Hot Air Oven
 Condition As-Received : Used Item
 Reference : 2105-0005OC-1
 Procedure Used :-

Cert. No.: 21TM829
 Page.: 2 of 3

Calibration were conducted using calibration procedure CP-OT02 according to direct measurement method with Data Acquisition which connected with Resistance Temperature Detector (RTD).
 The temperature scale used was based on ITS-90.

Condition of this result of calibration

1. Reference standard instrument:-

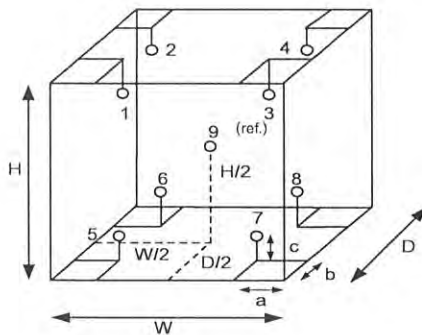
Instrument	Model	Serial No.	Cert. No.	Due Date
1) Data Acquisition	34972A	MY57013823	21LM3	26 Feb 2022

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

Result of Calibration :- (*) Without Adjustment

Function of UUC* : Temperature Source

Fresh air setting : Close



Environment during calibration		
	Beginning	Finished
Temp. (°C)	29	30
REL.Humid. (%)	56	58
AC Supply (Volt)	221	222

Position :	Ref. Std. ID No.:
1	21-17RTD-01
2	21-17RTD-02
3	17RTD-03
4	17RTD-04
5	17RTD-05
6	17RTD-06
7	17RTD-07
8	17RTD-08
9 (ref.)	17RTD-09

Probe Installation Details :

a = 5.0 cm
 b = 5.0 cm
 c = 5.0 cm

Dimension of Chamber :

D = 0.33 m
 W = 0.40 m
 H = 0.40 m
 Capacity = 0.053 m³

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Equipment : Hot Air Oven
Condition As-Received : Used Item
Reference : 2105-0005OC-1
Result of Calibration :- (*) Without Adjustment
Function of UUC* : Temperature Source

Cert. No.: 21TM829

Page.: 3 of 3

Calibration Point (°C)	UUC* Setting (°C)	UUC* Reading (°C)	Temperature stability (± °C)	Temperature uniformity (°C)	Overall Variation (°C)	Uncertainty (± °C)	Coverage Factor <i>k</i>
70.0	70.0	70.0	0.21	1.8	2.0	0.55	2

Calibration Point (°C)	Measured Temperature (°C)								
	Position								
	1	2	3	4	5	6	7	8	9 (ref.)
70.0	70.404	70.277	70.607	70.307	68.789	69.257	68.846	69.331	70.495

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

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

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

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

UUC* : Unit Under Calibration

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

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

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Cert. No.: 21TM673

Page.: 1 of 3

Certificate of Calibration

Equipment : Water Bath

Manufacturer : Memmert

Model : WNB22

Serial No. : L513.0648

ID No. : RYG_EN0061

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

Location : Wet Chemistry Lab

Received Order : 5 May 2021

Calibration Date : 5 May 2021

Ambient Temperature : (26 ± 10) °C

Relative Humidity : (50 ± 30) %

Calibrated by : Tawatchai Pama

Approved by :

Malee

Approved Signatory

() Pornthippa Tameyakul

(☒) Malee Butkruea

() Suwit Imjai

Issue Date : 14 May 2021

The Uncertainties are for a confidence probability of approximately 95%

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Approval of the head of Corporate Services 3 : Equipment Calibration and Testing Services.



Equipment : Water Bath
Condition As-Received : Used Item
Reference : 2105-0005OC-3
Procedure Used :-

Cert. No.: 21TM673
Page.: 2 of 3

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

The temperature scale used was based on ITS-90.

Condition of this result of calibration

1. Reference standard instrument:-

<u>Instrument</u>	<u>Model</u>	<u>Serial No.</u>	<u>Cert. No.</u>	<u>Due Date</u>
1) Data Acquisition	34970A	MY44060450	21LM4	06 Mar 2022

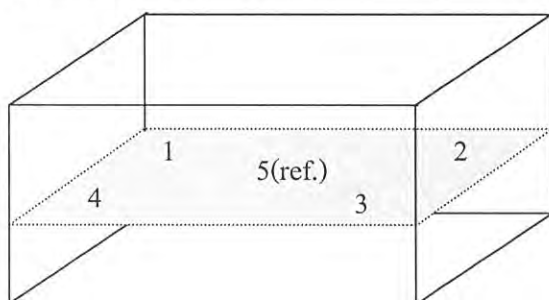
2. This certificate is valid only to the item calibrated on date and place of calibration.

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

Result of Calibration :- (*) Without Adjustment

Function of UUC* : Temperature Source

	Environmental		AC Voltage Supply
	(°C)	(%R.H.)	(Volt)
Beginning of Calibration	22	68	230
Finished of Calibration	20	64	231



Front

Position :	Ref. Std. S/N.:
1	4803988-001
2	4803988-002
3	4803988-003
4	4803988-004
5(ref.)	4803988-005

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Equipment : Water Bath
Condition As-Received : Used Item
Reference : 2105-0005OC-3
Result of Calibration :- (*) Without Adjustment
Function of UUC* : Temperature Source

Cert. No.: 21TM673
Page.: 3 of 3

Calibration point (°C)	UUC* Setting (°C)	UUC* Reading (°C)	Average* Standard Reading (°C)				
			Position				
			1	2	3	4	5 (ref.)
85.0	85.0	85.0	84.891	84.893	84.880	84.892	84.917

Calibration point (°C)	Uniformity (°C)	Stability (± °C)	Uncertainty (± °C)	Coverage Factor <i>k</i>
85.0	0.089	0.052	0.22	2

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

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

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

UUC* : Unit Under Calibration

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

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

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Certificate of Calibration

Certificate No. : 21T1200

Page : 1 of 2

Equipment : Digital Thermometer With Sensor

Manufacturer: Testo

Model : 106

Serial No.: 31281494/504

ID No.: RYG_FS0467

Condition As-Received: Used Item

Received Date: 02 July 2021

Calibration Date: 07 July 2021
to 08 July 2021

Reference: 2107-0069DSC

Ambient Temperature: (25 ± 3) °C

Relative Humidity: (50 ± 20) %

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Corporate Services 3: Equipment Calibration and Testing Services.

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

616/10 Moo 5 T.Maenam Khu, A.Pluakdaeng, Rayong
21140, Thailand

Procedure used: Calibration were conducted using in-house calibration procedure CP-T01 according to comparison with
Platinum Resistance Thermometer (PRT) into liquid bath temperature controller.
The temperature scale used was based on ITS-90.

Condition of this result of calibration

1.Reference standards instruments :

<u>Instrument</u>	<u>Model</u>	<u>Serial No.</u>	<u>Certificate No.</u>	<u>Due Date</u>
1) Digital Thermometer	1529-R	B19520	211680	26 Jun 2022
2) Platinum Resistance Thermometer	935-14-95	261589/1	211680	26 Jun 2022

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

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

-National Institute of Metrology Thailand (NIMT)

REVIEW BY	Tanasit.
APPROVED BY	Supt S
NEXT CAL. DATE	7/7/22

Calibrated by : Yossapon Poljorn

Issue Date : 09 July 2021

Approved Signatory : _____

☐ Phalinee Prabpaipal

☐ Chatchawan Khunpiluek

☒ Wanlop Larpkurn

B 0265214



Cert. No.: 21T1200

Page.: 2 of 2

Result of Calibration:-

Without Adjustment

Function:

Temperature measurement

Dimension of probe : Diameter 3 mm., Length 55 mm. Sheath material : Stainless Steel

Immersion Depth (mm.)	Standard Temperature (°C)	UUC* Reading (°C)	Error (°C)	Uncertainty of Measurement (±°C)
50	25.0029	24.9	-0.1029	0.12
50	30.0018	29.9	-0.1018	0.12
50	40.0035	40.0	-0.0035	0.12

UUC* : Unit Under Calibration

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

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Metrological Center

SCI ECO Services Company Limited

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

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

Bangkok Tel : +668 9205 6851 , +669 8247 2360

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



Certificate No. T220384I01 "Substitute for Calibration Certificate Number T220384" Page 1 of 4

Certificate of Calibration

Equipment : Chamber (Cold Room)

Manufacturer : MODULAR

Model : IREVCOHCOO

Serial No. : C00351459

Customer Code : RYG_EN0184


ID No. : T1939A5

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

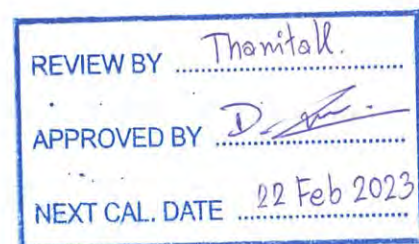
Customer Location : Laboratory

Date of Receipt : 18 February 2022

Calibrated By : Boonchai Suriyawong (Site Calibration Manager)

Approved By :  / Sujjar Naknakred (Site Calibration Manager)

Date of Issue : 18 MAR 2022



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

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

Certificate No. T220384I01

Page 2 of 4

Calibration Report

Equipment : Chamber (Cold Room)
Date of Calibration : 22 February 2022
Environment : Temperature : 23.2-24.3 °C
Line Voltage : 221.8-227.2 V
Relative Humidity : 55 - 65 %RH

Condition of this results of calibration :

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

2. Reference Standard Instrument :

Instrument	Model	Instrument No.	Certificate No.	Due Date
TC	TYPE T	TN141-TN150	T210743	21 April 2022
TC	TYPE T	TN151-TN160	T210743	21 April 2022
DATA LOGGER	34970A	T150	T210743	21 April 2022

3. This certificate is traceable to :

National Institute of Metrology (Thailand) through Metrological Center (NSC-TISI-TIS 17025 CALIBRATION 0244.)

4. Condition of calibrated item : good

Equipment Description :

Time Constant - Hour 40 Minute At 3 °C
Fresh Air Damper ☐ Open ☐ Min ☐ Medium ☐ Max
☐ Close
☒ Not Available

5. Adjustment :

(X) without adjustment

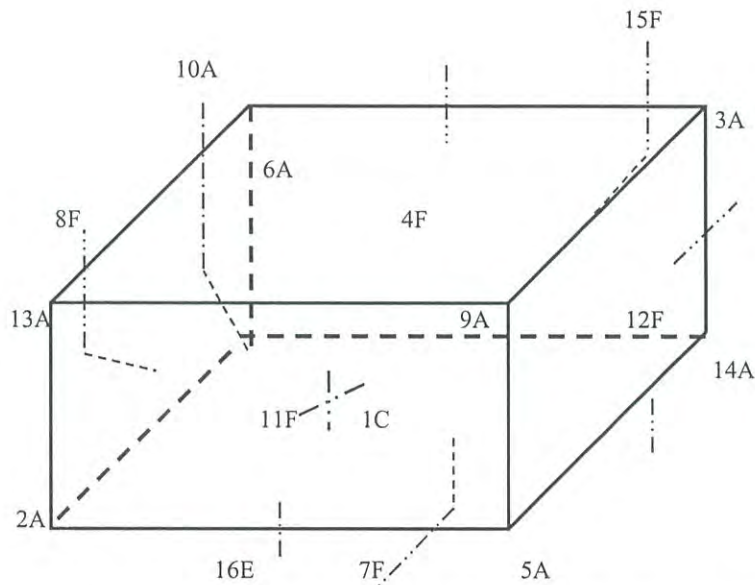
() after adjustment

Approved By. 

Certificate No. T220384I01

Page 3 of 4

Calibration Report



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

1C	=	TN141
2A	=	TN142
3A	=	TN143
4F	=	TN144
5A	=	TN145
6A	=	TN146
7F	=	TN147
8F	=	TN148
9A	=	TN149
10A	=	TN150
11F	=	TN151

12F	=	TN152
13A	=	TN153
14A	=	TN154
15F	=	TN155
16E	=	TN156

Approved By. 

Certificate No. T220384I01

Page 4 of 4

Calibration Report

Measurement Results

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

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

* The Acuoted uncertainty exclude "uniformity"

The calibration result apply only the above calibrated item.

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

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

Approved By. _____





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Cert.No.: 22CH283

Page.: 1 of 2

Certificate of Calibration

Equipment :	Conductivity Meter
Manufacturer :	Mettler Toledo
Model :	S230
Serial No. :	B241407147
ID No. :	RYG_EN0029
Condition As-Received:	Used Item
Received Date :	22 February 2022
Calibration Date :	23 February 2022
Reference :	2202-0732DSC-1
Submitted by :	ALS Laboratory Group (Thailand) Co.,Ltd. (Rayong Branch) 616/10 Moo 5 T.Maenam Khu, A.Pluakdaeng, Rayong 21140, Thailand
Ambient Temperature :	(25 \pm 2.5) °C
Relative Humidity :	(50 \pm 15) %
Calibration Procedure:	In -house method : - CP-CH6 : based on direct measurement by using certified reference material (CRM)
Calibrated by :	Walalak Sirithean
Approved by :	<u>Malee Butkruea</u> Approved Signatory
	(<input checked="" type="checkbox"/>) Malee Butkruea (<input type="checkbox"/>) Saithip Meangmai (<input type="checkbox"/>) Warakorn Lernagtrakul
Issue Date :	25 February 2022



The Uncertainties are for a confidence probability of approximately 95%

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Approval of the head of Corporate Services 3 : Equipment Calibration and Testing Services.



Cert.No.: 22CH283

Page.: 2 of 2

Condition of this result of calibration

1. Reference Standard Instrument :-

<u>Instrument</u>	<u>Serial No.</u>	<u>ID No.</u>	<u>Certificate No.</u>	<u>Due date</u>
1) Thermometer	9549224	130RC003	211451	15 Apr 2022

This certification is traceable to the International System of Unit maintained at:-

- Traceable to National Institute of Metrology (Thailand), NIMT

2. Certified Reference Materials :-

- Conductivity calibration solution, CPA chem Ltd., The measurement results are traceable to SI through CPA chem Ltd., ANSI-ASQ National Accreditation Board, Accredited No. AR-1835

<u>Conductivity Solution</u>	<u>Manufacturer</u>	<u>Lot No.</u>	<u>Exp. date</u>
84.000 $\mu\text{S/cm}$	CPA Chem	754034	28 June 2022
1413.0 $\mu\text{S/cm}$	CPA Chem	766815	04 Sep 2022
12.880 mS/cm	CPA Chem	761022	02 Aug 2022

- Control Conductivity calibration solution temperature by Water bath (25 ± 0.1) $^{\circ}\text{C}$

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

Calibration results**Function : Conductivity Measurement**(*) After Adjustment at 1413.0 $\mu\text{S/cm}$

Conductivity Electrode Serial No.: 5821441030

Standard Conductivity Solution	Before Adjustment UUC* Reading	After Adjustment UUC* Reading	Uncertainty of Measurement (\pm)	Coverage factor k
84.000 $\mu\text{S/cm}$	82.4 $\mu\text{S/cm}$	84.4 $\mu\text{S/cm}$	0.62 $\mu\text{S/cm}$	2.00
1413.0 $\mu\text{S/cm}$	1375 $\mu\text{S/cm}$	1413 $\mu\text{S/cm}$	9.2 $\mu\text{S/cm}$	2.00
12.880 mS/cm	12.54 mS/cm	12.81 mS/cm	0.086 mS/cm	2.00

Remark

- UUC* = Unit Under Calibration

- Cell constant = 0.555236 cm^{-1}

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

-o0o-

Malu

a 1090534



แบบฟอร์มการประเมินเครื่องมือภายหลังทำการสอบเทียบเครื่องมือเทคโนโลยีระดับสูง

ชื่อเครื่องมือ : GC-MSD

ID No. : BKK_EN0059(GM7)

S/N : CN14133181/US1415M029

Parameter	Set point	Acceptable	Test Results	Pass	Fail	Remark
Inlet Pressure Accuracy	25 psi	23.8 -26.2	25.3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Oven Temp. Accuracy	230°C	225 -235	230.6	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Oven Temp. Accuracy	100°C	96.3 -103.7	100.9	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Oven Temp. Stability	100°C	99.5 -100.5	100.9	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
RFPA Voltage	1050 m/z	≤ 1100 mV	518	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Signal to Noise Filament 1	-	≥ 1200	1472	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Signal to Noise Filament 2	-	≥ 1200	3400	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
				<input type="checkbox"/>	<input type="checkbox"/>	
				<input type="checkbox"/>	<input type="checkbox"/>	
				<input type="checkbox"/>	<input type="checkbox"/>	
				<input type="checkbox"/>	<input type="checkbox"/>	
				<input type="checkbox"/>	<input type="checkbox"/>	

ผู้ตรวจสอบ: *Nant Somb*
28/12/20
ว/ด/ป:

ผู้อนุมัติ: *Kant Anuk*
28/12/20
ว/ด/ป:

Certificate of System Qualification

GC-OQ + GCMS-OQ

System ID: GM-7
Organization Name: ALS Laboratory Group (Thailand) Co., Ltd.
Organization Location: 104 Patthanakarn 40, Patthanakarn rd., Khwang Suan Luang, Khet Suan Luang, Bangkok 10250

Date: December 24, 2020 2:51:10 PM
EQP Name: AgilentRecommended , AgilentRecommended
EQP Revision: GC.02.50, GCMS.02.50
Overall Qualification Status: Pass

REVIEW BY	<i>Nant Somb</i>
APPROVED BY	<i>KL AL</i>
NEXT CAL DATE	20/06/22

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	25.3	psi
Accuracy:			0.3	psi
Agilent Recommended:			<= 1.2	

Overall Inlet Pressure Accuracy Test Status

Pass

GC Oven Temperature Accuracy

Name: 7890

Date: December 24, 2020 2:51:10 PM
System ID: GM-7

Setpoint Status:	Pass			
Zone:	Oven			
	Setpoint/Actual			
Temperature:	230.0	230.6	°C	
Accuracy:		0.6	°C	
Agilent Recommended:	>=	-1.0	% setpoint in K	(-5.0 °C)
	<=	1.0	% setpoint in K	(5.0 °C)

Data for this setpoint was entered manually.

Reason: Data logging currently not available.

Setpoint Status:	Pass			
Zone:	Oven			
	Setpoint/Actual			
Temperature:	100.0	100.9	°C	
Accuracy:		0.9	°C	
Agilent Recommended:	>=	-1.0	% setpoint in K	(-3.7 °C)
	<=	1.0	% setpoint in K	(3.7 °C)

Data for this setpoint was entered manually.

Reason: Data logging solution currently not available.

Overall GC Oven Temperature Accuracy Test Status

Pass

GC Oven Temperature Stability

Name:	7890			
Setpoint Status:	Pass			
	Setpoint/Average			
Temperature:	100.0	100.9	°C	
Stability:		0.0	°C	
Agilent Recommended:	<=	0.5		

Data for this setpoint was entered manually.

Reason: Data logging solution currently not available.

Overall GC Oven Temperature Stability Test Status

Pass

Log Amp

Tested Combination1 Front SSL / External SQ

Name: 5977A

Setpoint Status: Pass

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:

15 mV

518 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

Date: December 24, 2020 2:51:10 PM

System ID: GM-7

Signal to Noise EI

Tested Combination1	Front	SSL	/ External	SQ
Name:	5977A			

Source:	EI - Extractor	Filament:	1
---------	----------------	-----------	---

Setpoint Status:	Pass
------------------	------

Signal to Noise:	1472
------------------	------

Agilent Recommended:	>= 1200
----------------------	---------

Source:	EI - Extractor	Filament:	2
---------	----------------	-----------	---

Setpoint Status:	Pass
------------------	------

Signal to Noise:	3400
------------------	------

Agilent Recommended:	>= 1200
----------------------	---------

Overall Signal to Noise EI Test Status

Pass

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 (µL)	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	US1415M209
Firmware Revision	5977 6.00.21
High Vacuum System	Turbo Pump
Scouting Run Standard	OFN Std

MS EI Source 1

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

Electronic Signature

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Details

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Logged On User Name:	supasak.nimsongtham@agilent.com
Signature Creation Date:	December 24, 2020
Reason for Signature:	Executed protocol and published this original version of document

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REVIEW BY	Nant Sot
APPROVED BY	LL AL
NEXT CAL. DATE	25/05/23

Certificate of System Qualification

GC-OQ + GCMS-OQ

System ID: GM-6
Organization Name: ALS Laboratory Group(Thailand) Co., Ltd.
Organization Location: 104 Patthanakarn 40, Patthanakarn Rd., Kwang Suan Luang< Khet Suan Luang, Bangkok 10250
Date: November 25, 2021 5:20:10 PM
EQP Name: AgilentRecommended , AgilentRecommended
EQP Revision: GC.02.52, GCMS.02.51
Overall Qualification Status: Pass

CDS Logon Verification - GC

Logon: Nanthawadee.Somboon

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	Actual
Inlet Pressure:	25.0 psi	25.1 psi
Accuracy:		0.1 psi
Agilent Recommended:	<=	1.2

Date: November 25, 2021 5:20:10 PM
System ID: GM-6

Overall Inlet Pressure Accuracy Test Status

Pass

Headspace Leak

Name:

7697A with Tray

Sampler 1

Setpoint Status:

Pass

Overall Headspace Leak Test Status

Pass

Headspace Heated Zones Temperature Accuracy

Name:

7697A with Tray

Sampler 1

Setpoint Status:

Pass

Zone:

Transferline

Temperature:

Setpoint

115.0

°C

Actual

114.9

Accuracy:

-0.1

°C

Agilent Recommended:

>=

-1.8

% setpoint

(

-2.1

°C

)

<=

5.2

% setpoint

(

6.0

°C

)

Setpoint Status:

Pass

Zone:

Sample Loop

Temperature:

Setpoint

110.0

°C

Actual

109.8

Accuracy:

-0.2

°C

Agilent Recommended:

>=

-4.0

<=

4.0

Date: November 25, 2021 5:20:10 PM

System ID: GM-6

Setpoint Status:

Pass

Zone:

Oven

Temperature:

Setpoint	100.0	°C
Actual	99.9	

Accuracy:

-0.1 °C

Agilent Recommended:

>=	-4.0
<=	4.0

Overall Headspace Heated Zones Temperature Accuracy Test

Pass

GC Oven Temperature Accuracy

Name:

7890

Setpoint Status:

Pass

Zone:

Oven

Setpoint/Actual

Temperature:	230.0	229.8	°C
--------------	-------	-------	----

Accuracy:

-0.2 °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	99.8	°C
--------------	-------	------	----

Accuracy:

-0.2 °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

Date:

November 25, 2021 5:20:10 PM

System ID:

GM-6

Setpoint Status:

Pass

Setpoint/Average

Temperature:

100.0 99.8 °C

Stability:

0.2 °C

Agilent Recommended:

<= 0.5

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

RFPA

Tested Combination1

Front

SSL

/ External

SQ

Name:

5975C inert XL with TAD

Setpoint Status:

Pass

Amu: 1050 m/z

Drift After Five Minutes:

RFPA Voltage:

18 mV

519 mV

Agilent Recommended:

>= -100 and <= 100

<= 1100

Overall RFPA Test Status

Pass

Tune EI

Tested Combination1

Front

SSL

/ External

SQ

Name:

5975C inert XL with TAD

Setpoint Status:

Pass

Filament:

1

Date: November 25, 2021 5:20:10 PM

System ID: GM-6

Setpoint Status:

Pass

Filament:

2

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

Overall Tune EI Test Status

Pass

Scouting Run

Tested Combination1

Front

SSL

/ External

SQ

Headspace

Name:

7697A with Tray

Source:

EI - Inert

Setpoint Status:

Completed

Injection Volume on Column:

1000

uL

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

uL

Area RSD:

1.61

%

Retention Time RSD:

0.01

%

Agilent Recommended:

<=

5.00

<=

1.00

Overall Injection Precision Test Status

Pass

Mass Ratio Precision

Date:

November 25, 2021 5:20:10 PM

System ID:

GM-6

Tested Combination1	Front	SSL	/ External	SQ
Headspace				
Name:	7697A with Tray			
Source:	EI - Inert			
Setpoint Status:	Pass			
Injection Volume on Column:	1000	uL		
	Area Mass 1		Mass Ratio	
	Abundance*s			
RSD:	1.61	%	0.25	%
Agilent Recommended:	<= 5.00		<= 5.00	
	Pass		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	uL		
Area Carry Over:	0.00	%		
Agilent Recommended:	<= 1.00			

This test's 0 comment(s) and 2 deviation(s) are available in the Attachments section.

Overall Injection Carry Over Test Status

Pass

Certificate of System Qualification

GC-OQ

REVIEW BY	Sarasat M.
APPROVED BY	KL AL
NEXT CAL. DATE	20 Apr 23

System ID: GC-5
Organization Name: ALS Laboratory Group (Thailand) Co., Ltd.
Organization Location: 104 Phattanakan 40, Phattanakan Rd., Suan Luang, Bangkok 10250

Date: October 20, 2021 10:15:57 AM
EQP Name: AgilentRecommended
EQP Revision: GC.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 Decay

Name: 7890

Front SSL

Setpoint Status: Pass

Pressure: 25.0 psi

Pressure Change: 0.3 psi /5 minutes

Agilent Recommended: ≥ -2.0 and ≤ 0.5

Overall Inlet Pressure Decay Test Status

Pass

Inlet Pressure Accuracy

Name: 7890

Front SSL

Date: October 20, 2021 10:15:57 AM

System ID: GC-5

Setpoint Status:

Pass

Setpoint Actual

Inlet Pressure: 25.0 psi 24.9 psi

Accuracy: 0.1 psi

Agilent Recommended: ≤ 1.2

Overall Inlet Pressure Accuracy Test Status

Pass

Detector Flow Accuracy

Name:

7890

Front

FID

Setpoint Status:

Pass

Flow Type:

Fuel

Setpoint:

30.0

mL/min

Measured Flow:

30.0

mL/min

Accuracy:

0.0

mL/min

Agilent Recommended:

≤

10.0

% setpoint

(

3.0

mL/min

)

Limit is percentage of setpoint or 0.5 mL/minute, whichever is largest.

Setpoint Status:

Pass

Flow Type:

Oxidizer

Setpoint:

400.0

mL/min

Measured Flow:

390.3

mL/min

Accuracy:

9.7

mL/min

Agilent Recommended:

≤

10.0

% setpoint

(

40.0

mL/min

)

Limit is percentage of setpoint or 0.5 mL/minute, whichever is largest.

Setpoint Status:

Pass

Flow Type:

Makeup

Setpoint:

25.0

mL/min

Measured Flow:

24.5

mL/min

Accuracy:

0.5

mL/min

Agilent Recommended:

≤

10.0

% setpoint

(

2.5

mL/min

)

Limit is percentage of setpoint or 0.5 mL/minute, whichever is largest.

Date:

October 20, 2021 10:15:57 AM

System ID:

GC-5

Overall Detector Flow Accuracy Test Status

Pass

GC Oven Temperature Accuracy

Name: 7890

Setpoint Status: Pass

Zone: Oven

Setpoint/Actual

Temperature: 230.0 231.2 °C

Accuracy: 1.2 °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

Scouting Run

Tested Combination1	Front	SSL	/ Front	FID
	Injection Tower			
Name:	7683B			
Setpoint Status:	Completed			
Injection Volume on Column:	1.0	uL		
Overall Scouting Run Status	Completed			

Noise and Drift

Tested Combination1	Front	SSL	/ Front	FID
Name:	7890			
Setpoint Status:	Pass			
Base Signal:	20.2	pA		
	ASTM Noise		Drift	
	pA		pA/Hr	
	0.05		0.50	
Agilent Recommended:	<=	0.10	<=	2.50
Status:	Pass		Pass	
Overall Noise and Drift Test Status	Pass			

Injection Precision

Tested Combination1	Front	SSL	/ Front	FID
Name:	7683B			

Setpoint Status:

Pass

Injection Volume on Column:

1.0 uL

Area RSD:

0.52 %

Retention Time RSD:

0.22 %

Agilent Recommended:

<= 3.00

<= 1.00

Overall Injection Precision Test Status

Pass

Signal to Noise

Tested Combination1

Front

SSL

/ Front

FID

Injection Tower

Name:

7890

Setpoint Status:

Pass

Signal to Noise:

1258310

Agilent Recommended:

>= 300000

Overall Signal to Noise Test Status

Pass

Date:

October 20, 2021 10:15:57 AM

System ID:

GC-5

Instrument Details

Purpose

This section describes the as found system configuration.

Details

System

System ID	GC-5
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	Front
LTM Included?	No

Sampler 1

Manufacturer	Agilent Technologies
Type	Injection Tower
Name	7683B
Model Number	G2913A
Serial Number	CN00259643
Firmware Revision	A.11.03
Usage	Sample Injection
Location	Front
Syringe Volume (µL)	10

Sampler 2

Manufacturer	Agilent Technologies
Type	Tray
Name	7683A
Model Number	G2614A
Serial Number	CN81347892
Firmware Revision	A.02.01

Mainframe 1

Manufacturer	Agilent Technologies
Name	7890
Model Number	G3440A
Serial Number	US10813027
Firmware Revision	A.01.12.1
Component ID/Asset No.	GC-5
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	7890
Type	FID
Adapter	Capillary
Control Type	Electronic Pressure Control (EPC)
Location	Front
Makeup Gas	Nitrogen

Electronic Signature

Purpose

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Logged On User Name:	suriya.thongkaew@non.agilent.com
Signature Creation Date:	October 20, 2021
Reason for Signature:	Executed protocol and published this original version of document

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User Name: suriya.thongkaew
 Hostname: ASBKW7029

System Id: GC-5
 Print Date: October 20, 2021 10:16:00 AM

OQ GC ALS US10813027 Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
October 19, 2021 10:37:29 AM	Audit	SessionCreated	Session	None
October 19, 2021 10:37:29 AM	Start	Configuration	Session	None
October 19, 2021 10:37:30 AM	Audit	Entitlement	Licensing	Session identifier generated: 0800-0002-0000-1YQP-0M4 G
October 19, 2021 10:45:44 AM	Audit	Entitlement	Licensing	Successfully unlocked session identified by 0800-0002-0000-1YQP-0M4 G with unlock code CZR6-QXE5-0GQD-6681-68 3G
October 19, 2021 10:57:00 AM	Audit	EqpLoaded	Session	EQP details for primary technique [Gc] - File path: [ProtocolPacks/Gc/Configurations/02.51/Gc.02.51.eqp], EQP File Name: [Gc.02.51.eqp], EQP Name: [AgilentRecommended]
October 19, 2021 10:58:11 AM	End	Configuration	Session	None
October 19, 2021 10:58:14 AM	Start	Qualification	Session	OQ
October 19, 2021 10:58:14 AM	Start	Execution	System Inspection and Basic Safety and Operation - 7890: - Qualitative Test - No setpoints associated	None
October 19, 2021 10:59:07 AM	End	Execution	System Inspection and Basic Safety and Operation - 7890: - Qualitative Test - No setpoints associated	Run Count : 1

Page 1 / 7

User Name: suriya.thongkaew
 Hostname: ASBKKW7029

System Id: GC-5
 Print Date: October 20, 2021 10:16:00 AM

OQ GC ALS US10813027 Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
October 19, 2021 11:11:55 AM	Start	Execution	Inlet Pressure Decay - Front SSL: - Pressure Controlled Inlet - S: 25.0 psi - L: >= -2.0 psi and <= 0.5 psi	None
October 19, 2021 11:28:02 AM	End	Execution	Inlet Pressure Decay - Front SSL: - Pressure Controlled Inlet - S: 25.0 psi - L: >= -2.0 psi and <= 0.5 psi	Run Count : 1
October 19, 2021 11:28:08 AM	Start	Execution	Inlet Pressure Accuracy - Front SSL: - Pressure Controlled Inlet - S: 25.0 psi - L: <= 1.2 psi	None
October 19, 2021 11:28:15 AM	End	Execution	Inlet Pressure Accuracy - Front SSL: - Pressure Controlled Inlet - S: 25.0 psi - L: <= 1.2 psi	Run Count : 1
October 19, 2021 11:28:17 AM	Start	Execution	Detector Flow Accuracy - Front FID: - Type : Fuel - S: 30.0 mL/min - L: <= 10.0% setpoint	None
October 19, 2021 11:45:30 AM	Audit	Data	Detector Flow Accuracy - Front FID: - Type : Fuel - S: 30.0 mL/min - L: <= 10.0% setpoint	Manual Data Entry
October 19, 2021 11:45:36 AM	End	Execution	Detector Flow Accuracy - Front FID: - Type : Fuel - S: 30.0 mL/min - L: <= 10.0% setpoint	Run Count : 1
October 19, 2021 11:45:38 AM	Start	Execution	Detector Flow Accuracy - Front FID: - Type : Oxidizer - S: 400.0 mL/min - L: <= 10.0% setpoint	None
October 19, 2021 11:52:52 AM	Audit	Data	Detector Flow Accuracy - Front FID: - Type : Oxidizer - S: 400.0 mL/min - L: <= 10.0% setpoint	Manual Data Entry
October 19, 2021 11:52:54 AM	End	Execution	Detector Flow Accuracy - Front FID: - Type : Oxidizer - S: 400.0 mL/min - L: <= 10.0% setpoint	Run Count : 1

User Name: suriya.thongkaew

System Id: GC-5

Hostname: ASBKKW7029

Print Date: October 20, 2021 10:16:00 AM

OQ GC ALS US10813027 Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
October 19, 2021 11:52:55 AM	Start	Execution	Detector Flow Accuracy - Front FID: - Type : Makeup - S: 25.0 mL/min - L: <= 10.0% setpoint	None
October 19, 2021 12:03:38 PM	Audit	Data	Detector Flow Accuracy - Front FID: - Type : Makeup - S: 25.0 mL/min - L: <= 10.0% setpoint	Manual Data Entry
October 19, 2021 12:03:39 PM	End	Execution	Detector Flow Accuracy - Front FID: - Type : Makeup - S: 25.0 mL/min - L: <= 10.0% setpoint	Run Count : 1
October 19, 2021 12:03:42 PM	Start	Execution	GC Oven Temperature Accuracy - 7890: - Temperature : Oven - S: 230.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	None
October 19, 2021 12:23:23 PM	Audit	Data	GC Oven Temperature Accuracy - 7890: - Temperature : Oven - S: 230.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	Manual Data Entry
October 19, 2021 12:23:24 PM	End	Execution	GC Oven Temperature Accuracy - 7890: - Temperature : Oven - S: 230.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	Run Count : 1
October 19, 2021 12:23:28 PM	Start	Execution	GC Oven Temperature Accuracy - 7890: - Temperature : Oven - S: 100.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	None
October 19, 2021 12:33:48 PM	Audit	Data	GC Oven Temperature Accuracy - 7890: - Temperature : Oven - S: 100.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	Manual Data Entry
October 19, 2021 12:33:50 PM	End	Execution	GC Oven Temperature Accuracy - 7890: - Temperature : Oven - S: 100.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	Run Count : 1

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User Name: suriya.thongkaew

System Id: GC-5

Hostname: ASBKKW7029

Print Date: October 20, 2021 10:16:00 AM

OQ GC ALS US10813027 Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
October 19, 2021 12:33:53 PM	Start	Execution	GC Oven Temperature Stability - 7890: - Temperature : Oven - S: 100.0°C - L: <= 0.5°C	None
October 19, 2021 12:54:48 PM	Audit	Data	GC Oven Temperature Stability - 7890: - Temperature : Oven - S: 100.0°C - L: <= 0.5°C	Manual Data Entry
October 19, 2021 12:54:49 PM	End	Execution	GC Oven Temperature Stability - 7890: - Temperature : Oven - S: 100.0°C - L: <= 0.5°C	Run Count : 1
October 19, 2021 12:54:52 PM	Start	Execution	GC Scouting Run - Injection Tower, Front SSL, Front FID: - Part of System Preparation - No limits associated	None
October 19, 2021 4:48:40 PM	Audit	AceClosed	Session	None
October 20, 2021 9:34:06 AM	Audit	AceRestarted	Session	None
October 20, 2021 9:34:08 AM	Audit	SessionReloaded	Session	None
October 20, 2021 9:34:12 AM	Start	Qualification	Session	OQ
October 20, 2021 9:34:12 AM	Start	Execution	GC Scouting Run - Injection Tower, Front SSL, Front FID: - Part of System Preparation - No limits associated	None
October 20, 2021 9:35:51 AM	Audit	Data	GC Scouting Run - Injection Tower, Front SSL, Front FID: - Part of System Preparation - No limits associated	Data files Path : C:\Chem32\1\DATA\OQPV20 21\OQPV2021 2021-10-19 17-23-14\SCOUTING001.D\F ID1A.ch

User Name: suriya.thongkaew

System Id: GC-5

Hostname: ASBKW7029

Print Date: October 20, 2021 10:16:00 AM

OQ GC ALS US10813027 Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
October 20, 2021 9:36:24 AM	End	Execution	GC Scouting Run - Injection Tower, Front SSL, Front FID: - Part of System Preparation - No limits associated	Run Count : 1
October 20, 2021 9:36:27 AM	Start	Execution	Noise and Drift - Front FID: - Detector FID - L (Noise): <= 0.10 pA - L (Drift): <= 2.50 pA/hour	None
October 20, 2021 9:37:19 AM	Audit	Data	Noise and Drift - Front FID: - Detector FID - L (Noise): <= 0.10 pA - L (Drift): <= 2.50 pA/hour	Data files Path : C:\Chem32\1\DATA\OQPV2021\OQPV2021-10-19-17-23-14\NSDRF001.D\FID1A.ch
October 20, 2021 9:37:30 AM	End	Execution	Noise and Drift - Front FID: - Detector FID - L (Noise): <= 0.10 pA - L (Drift): <= 2.50 pA/hour	Run Count : 1
October 20, 2021 9:37:32 AM	Start	Execution	Injection Precision - Injection Tower, Front SSL, Front FID: - GC - L (Area): <= 3.00% - L (Ret. Time): <= 1.00%	None
October 20, 2021 9:37:53 AM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Front FID: - GC - L (Area): <= 3.00% - L (Ret. Time): <= 1.00%	Data files Path : C:\Chem32\1\DATA\OQPV2021\OQPV2021-10-19-17-23-14\INJPREC002.D\FID1A.ch
October 20, 2021 9:37:53 AM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Front FID: - GC - L (Area): <= 3.00% - L (Ret. Time): <= 1.00%	Data files Path : C:\Chem32\1\DATA\OQPV2021\OQPV2021-10-19-17-23-14\INJPREC003.D\FID1A.ch

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User Name: suriya.thongkaew

System Id: GC-5

Hostname: ASBKKW7029

Print Date: October 20, 2021 10:16:00 AM

OQ GC ALS US10813027 Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
October 20, 2021 9:37:53 AM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Front FID: - GC - L (Area): <= 3.00% - L (Ret. Time): <= 1.00%	Data files Path : C:\Chem32\1\DATA\OQPV2021\OQPV2021 2021-10-19 17-23-14\INJPREC004.D\FID 1A.ch
October 20, 2021 9:37:53 AM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Front FID: - GC - L (Area): <= 3.00% - L (Ret. Time): <= 1.00%	Data files Path : C:\Chem32\1\DATA\OQPV2021\OQPV2021 2021-10-19 17-23-14\INJPREC005.D\FID 1A.ch
October 20, 2021 9:37:53 AM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Front FID: - GC - L (Area): <= 3.00% - L (Ret. Time): <= 1.00%	Data files Path : C:\Chem32\1\DATA\OQPV2021\OQPV2021 2021-10-19 17-23-14\INJPREC006.D\FID 1A.ch
October 20, 2021 9:37:53 AM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Front FID: - GC - L (Area): <= 3.00% - L (Ret. Time): <= 1.00%	Data files Path : C:\Chem32\1\DATA\OQPV2021\OQPV2021 2021-10-19 17-23-14\INJPREC007.D\FID 1A.ch
October 20, 2021 9:38:21 AM	End	Execution	Injection Precision - Injection Tower, Front SSL, Front FID: - GC - L (Area): <= 3.00% - L (Ret. Time): <= 1.00%	Run Count : 1
October 20, 2021 9:38:28 AM	Start	Execution	Signal to Noise - Injection Tower, Front SSL, Front FID: - Detector FID - L: >= 300000	None
October 20, 2021 9:38:42 AM	Audit	Data	Signal to Noise - Injection Tower, Front SSL, Front FID: - Detector FID - L: >= 300000	Data files Path : C:\Chem32\1\DATA\OQPV2021\OQPV2021 2021-10-19 17-23-14\SIGTONS001.D\FID 1A.ch
October 20, 2021 9:38:50 AM	End	Execution	Signal to Noise - Injection Tower, Front SSL, Front FID: - Detector FID - L: >= 300000	Run Count : 1

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User Name: suriya.thongkaew

System Id: GC-5

Hostname: ASBKkW7029

Print Date: October 20, 2021 10:16:00 AM

OQ GC ALS US10813027 Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
October 20, 2021 9:38:54 AM	End	Qualification	Session	OQ
October 20, 2021 9:38:54 AM	Start	Reporting	Session	None
October 20, 2021 10:15:14 AM	Audit	Reporting	Session	Report Generated : Certificate