ภาคผนวก จ

ใบรับรองการสอบเทียบเครื่องมือ

บริษัท ยูไนเต็ด แอนนาลิสต์ แอนด์ เอ็นจิเนียริ่ง คอนซัลแตนท์ จำกัด

List of Instruments Certification for Air & Noise Quality Analysis

No.	Instrument/Equipment	Parameter	Manufacturer	Model/Serial No.	Calibrator	Certification No.	Date of Calibration	Due date of Calibration	Remark
Stack									
1	Pre-Test Console	Total Suspended Particulate Hydrogen Sulphide Methanethiol Dimethyl Sulfide Chloride	Apex Instruments, USA.	XC-572-V 1701018	Envi Equipment Service Co., Ltd.	E23-12095	12 Sep 23	11 Sep 24	-
2	Flue gas Analyzer	Sulphur Dioxide Oxide of Nitrogen as Nitrogen Dioxide	Testo	Testo 350 60899698	Entech Industrial Sulution Co., Ltd.	G 660095	17 Feb 23	16 Feb 24	-

List of Opacity Training Certification for Opacity Mesurement

No.	Name	Training Couse	Train	Date	Remark
1	Mr.Noppasin Thanuthammarat	Opacity	Pollution Control Department	30-31 March 2017	-
2	Mr.Theerawat Martphosri	Opacity	Pollution Control Department	30-31 March 2017	-

List of Instruments Certification for Air & Noise Quality Analysis

No.	Instrument/Equipment	Parameter	Manufacturer	Model/Serial No.	Calibrator	Certification No.	Date of Calibration	Due date of Calibration	Remark
Water									
1	pH Meter	pH	Horiba	LAQUA-PH210 HA0D0078	Technology Promotion Association (Thailand-Japan)	23CH281	1 Mar 23	28 Feb 24	-
2	DO Meter	DO	Horiba	LAQUA-DO210 HE0G0015	Technology Promotion Association (Thailand-Japan)	23TW2	5 Jan 23	4 Jan 24	-
3	Conductivity Meter	Conductivity	Horiba	LAQUA-EC210 HC9L0012	Technology Promotion Association (Thailand-Japan)	23CH428	29 Mar 23	28 Mar 24	-

Envi Equipment Service Co., Ltd.
110/254 Moo 3, Tumbon Bang Rak Phatthana, Amphur Bang Bua Thong, Nonthaburi 11110
Tel. 098 362 9152, 089 478 7885
E-mail: sales@envi-ees.com

CERTIFICATE OF CALIBRATION

Customer	:	United Analyst and Engineering Consultant Co., Ltd.
Address	:	81 Soi Udomsuk 41, Sukhumvit Road, Bangchak, Phrakhanong, Bangkok 10260
Description of Equipment	:	Console meter
Manufacturer	:	Apex Instrument
Model Number	:	XC-572-V
Serial Number	:	1701018
ID./Control No.	:	-
Environment Conditions	:	Temperature (25 ± 2) °C
	:	Humidity (50 ± 15) % RH
Cal. Date	:	09/12/2023
Issue Date	:	09/12/2023

Calibration Method or Calibration Procedure Used

US EPA Method (United State Environmental Protection Agency)

This certificate is traceable to national standard, which realize the units of measurement according to the International System of Units (IS).

Result of Calibration

This certificate may not be reproduced other than in full except with prior Written approval of the Technical Manager, Envi Equipment Service Company Limited.

These reported uncertainties of measurement are expanded by a coverage factor of k=2, providing a 95% confidence level

Calibrated by : Mr. Sanya Sangnil

Approved by : [redacted]
(Mr. Mana Fuekhud)
Technical Manger

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METHOD 5 CONSOLE CALIBRATION
USING REFERENCE WET GAS METER W-NK-2.5-B-Z No.547425
5-POINT METRIC UNIT

Meter Console Information	
Console Model Number	XC-572-V
Console Serial Number	1701018
DGM Model Number	SK25EX
DGM Serial Number	00002030

Calibration Conditions			
Date	Time	09/12/2023	11:40 AM
Calibration Reference No.		SER23-12095	
Barometric Pressure		759.66	mmHg
Calibration Meter Gamma		0.999	

Factors/Conversions		
Std Temp	293	K
Std Press	760	mm Hg
K_1	0.386	
Console Leak Check		PASS

Calibration Data

Run Time	Metering Console					Calibration Meter			
Elapsed	DGM Orifice DH	Volume Initial	Volume Final	Outlet Temp Initial	Outlet Temp Final	Volume Initial	Volume Final	Outlet Temp Initial	Outlet Temp Final
(Q)	(P_{ra})	(V_{mi})	(V_{mf})	(t_{mi})	(t_{mf})	(Vwi)	(Vwf)	(t_{wi})	(t_{wf})
min	mm H_2O	m^3	m^3	°C	°C	m^3	m^3	°C	°C
12.48	13.0	2395.552	2395.692	29	29	184.31872	184.46072	28	28
12.48	13.0	2395.692	2395.832	29	29	184.46072	184.60178	28	28
8.70	26.0	2395.839	2395.979	30	30	184.60924	184.75154	28	28
8.72	26.0	2395.979	2396.119	30	30	184.75154	184.89358	28	28
14.52	40.0	2396.133	2396.413	31	31	184.90784	185.19162	28	28
14.47	40.0	2396.413	2396.693	32	32	185.19162	185.47356	27	27
10.77	70.0	2396.701	2396.981	32	32	185.48168	185.76272	27	27
10.73	70.0	2396.981	2397.261	32	32	185.76272	186.04256	27	27
9.43	90.0	2397.272	2397.552	33	33	186.05334	186.33194	27	27
9.42	90.0	2397.552	2397.832	33	33	186.33194	186.60946	27	27

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METHOD 5 CONSOLE CALIBRATION
USING REFERENCE WET GAS METER W-NK-2.5-B-Z No.547425
5-POINT METRIC UNIT

Meter Console Information	
Console Model Number	XC-572-V
Console Serial Number	1701018
DGM Model Number	SK25EX
DGM Serial Number	00002030

Calibration Conditions			
Date	Time	09/12/2023	11:40 AM
Calibration Reference No.		SER23-12095	
Barometric Pressure		759.66	mmHg
Calibration Meter Gamma		0.999	

Factors/Conversions		
Std Temp	293	K
Std Press	760	mm Hg
K_1	0.386	
Console Leak Check		PASS

Calibration Data

Results								
Standardized Data				Dry Gas Meter				
				Calibration Factor		Flowrate		
Dry Gas Meter		Calibration Meter		Value	Variation	Std & Corr	.0212 m^3_{std}/min	Variation
($V_{m(std)}$)	($Q_{m(std)}$)	($Vw_{(std)}$)	($Qw_{(std)}$)	(Y)	(△Y)	($Q_{m(std)(corr)}$)	(△$H_@$)	(△$H_@$)
m^3	m^3/min	m^3	m^3/min			m^3/min	mm H_2O	
0.136	0.011	0.138	0.011	1.012	0.011	0.011	46.771	-0.951
0.136	0.011	0.137	0.011	1.005	0.005	0.011	47.396	-0.325
0.137	0.016	0.138	0.016	1.013	0.012	0.016	45.356	-2.365
0.137	0.016	0.138	0.016	1.011	0.010	0.016	45.697	-2.024
0.273	0.019	0.276	0.019	1.009	0.008	0.019	48.982	1.261
0.274	0.019	0.275	0.019	1.002	0.001	0.019	49.119	1.398
0.275	0.026	0.274	0.025	0.996	-0.005	0.025	48.195	0.473
0.275	0.026	0.273	0.025	0.992	-0.009	0.025	48.308	0.587
0.276	0.029	0.272	0.029	0.985	-0.015	0.029	48.591	0.869
0.276	0.029	0.271	0.029	0.982	-0.019	0.029	48.797	1.076
				1.001	Y Average		47.721	△H@ Average

Note: For Calibration Factor Y, the ratio of the reading of the calibration meter to the dry gas meter, acceptable tolerance of individual values from the average is ±0.02.
For △$H_@$, orifice pressure differential that equates to 0.75 cfm (0.0212 m^3/min) at standard temperature and pressure, acceptable tolerance of individual values from the average is ±0.2 inches (5.1mm).

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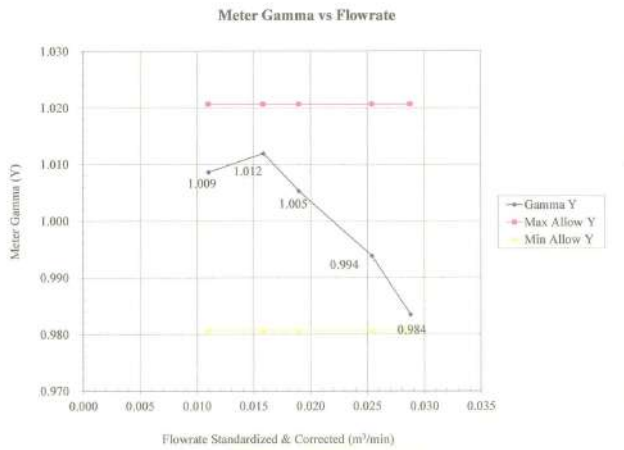
Meter Console Information	
Console Model Number	XC-572-V
Console Serial Number	1701018
DGM Model Number	SK25EX
DGM Serial Number	00002030

Calibration Conditions			
Date	Time	09/12/2023	11:40 AM
Calibration Reference No.		SER23-12095	
Barometric Pressure		759.66	mmHg
Calibration Meter Gamma		0.999	

Factors/Conversions		
Std Temp	293	K
Std Press	760	mm Hg
K_1	0.386	
Console Leak Check		PASS

Calibration Date: 9-12-2023 Calibration Reference No: SER23-12038



Console Serial: 1701018 Console Model: XC-572-V

เอกสารไม่ควบคุม

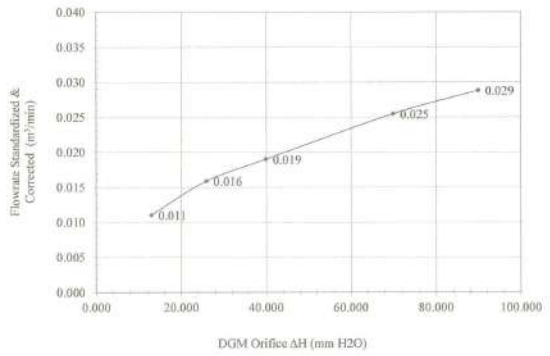
Meter Console Information	
Console Model Number	XC-572-V
Console Serial Number	1701018
DGM Model Number	SK25EX
DGM Serial Number	00002030

Calibration Conditions			
Date	Time	09/12/2023	11:40 AM
Calibration Reference No.		SER23-12095	
Barometric Pressure		759.66	mmHg
Calibration Meter Gamma		0.999	

Factors/Conversions		
Std Temp	293	K
Std Press	760	mm Hg
K_1	0.386	
Console Leak Check	PASS	

Calibration Date: 9-12-2023 Calibration Reference No: SER23-12038

Meter Pressure vs Flowrate



Console Serial: 1701018 Console Model: XC-572-V

Environ Equipment Service Co., Ltd. EES

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THERMOCOUPLES SYSTEM CALIBRATION

Sampling System Equipment Information	
Console Model Number	XC-572-V
Console Serial Number	1701018
DGM Model Number	SK25EX
DGM Serial Number	00002030
Meter Box Model Number	JENCO 765 KF
Meter Box Serial Number	JC 16103

Calibration Conditions			
Date	Time	09/12/2023	01:45 PM
Calibration Reference No.		SER23-12095	
Reference Thermometer		DIGICON	
Serial Number		183169105	

Results

Channel and test point	Console Thermocouple Simulator — Meter Box Channel Temperature Reading (°C)										
	-18.0	25.0	38.0	93.0	149.0	260.0	371.0	482.0	593.0	816.0	1038.0
Stack	-17.0	25.0	38.0	94.0	150.0	259.0	372.0	482.0	593.0	815.0	1037.0
Aux	-17.0	25.0	38.0	94.0	150.0						
Probe	-17.0	25.0	38.0	94.0	150.0						
Filter	-17.0	25.0	39.0	94.0	150.0						
Oven	-17.0	25.0	38.0	94.0	150.0						
Exit	-17.0	26.0	39.0								

Tolerance Range

Stack	± 1.50%	Absolute	Meter	± 3.0 °C
Probe	± 3.0 °C		Exit	± 2.0 °C
Filter	± 3.0 °C			

Environ Equipment Service Co., Ltd. EES

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Calibration Certificate

Certificate No: G 660095
Date of issue : 20-Feb-23

Instrument description	:	Flue gas Analyzer
Instrument model	:	Testo 350 New
Instrument serial no.	:	60899698
ID no. or control no.	:	UAE.EPM.008/2560
Manufacturer	:	Testo SE & Co. KGaA
Probe description	:	-
Probe model	:	-
Probe serial	:	-
Customer name	:	UNITED ANALYST CONSULTANT CO.,LTD.
Customer address	:	81 SOI UDOMSUK41,SUKHUMVIT ROAD,BANGCHAK PRAKANONG BANGKOK 10260
Total pages of certificate	:	3 Pages
Receiving no.	:	L-230327
Receiving date.	:	15-Feb-23
Parameter of calibration	:	Gas Calibration(Oxygen 2.498,10.04,21.02 %vol, Carbon Monoxide 80.14,309.9,1003 ppm, Nitrogen Dioxide 30.34,80.96,202.2 ppm, Nitric Oxide 30.08,150.9,320.6 ppm, Sulphur Dioxide 50.04,100.8,601.1 ppm)
Condition of UUC.	:	Used
Ambient condition	:	All of the Measurment ware caried out the stabilized labotary Temperature : 23 ±5 °C Humidity : 55 ± 15 %RH
Calibration place	:	17/121 Soi Ngamwongwan 47 Yaek 48, Toongsonghong, Laksi, Bangkok 10210
Calibration procedure no.	:	WI-CL-28-C

The calibration certificate expanded uncertainty of measurement is stated as the standard uncertainty of measurent Multiplied by coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

This certificate is applied only to item under test Environmental condition.

This Calibration Certificate may not be reproduced other than in full except with the permission of the issuing laboratory. Calibration certificates without signature and seal not valid.

This calibration certificate documents are traceblity to national standards, which realize measurement according to the International System of Units (SI).

Date of calibration : 17-Feb-23

[redacted]

Mr. Sedtawut Nueathong — **Calibration Technician**
Mrs. Nongluck Wongsettee — **Technical Manager**

Entech Industrial Solution Co.,Ltd.
17/121 Soi Ngamwongwan 47 Yaek 48, Toongsonghong, Laksi Bangkok 10210 THAILAND Tel. 0-2779-8888 Calibration@entech.co.th
Tax ID : 0105536035591 www.entech.co.th

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Calibration Certificate

Certificate No.: G 660095

Standard References (Table 1)

Standard	Certificate No.	Vendor	Due date
Oxygen (O2) 2.498 % Vol	4219/21	Linde	30-Sep-25
Oxygen (O2) 10.04 % Vol	CG-0153-21	Nimt	18-Nov-26
Oxygen (O2) 21.02 % Vol	CG-0041-22	Nimt	10-Feb-27
Carbon monoxide (CO) 80.14 ppm	CG-0040-22	Nimt	14-Feb-27
Carbon monoxide (CO) 309.9 ppm	2803/21	Linde	22-Jun-23
Carbon monoxide (CO) 1003 ppm	2583/22	Linde	09-Aug-24
Nitrogen Dioxide (NO2) 30.34 ppm	2703/22	Linde	22-Aug-24
Nitrogen Dioxide (NO2) 80.96 ppm	2041/22	Linde	26-Jun-24
Nitrogen Dioxide (NO2) 202.2 ppm	3239/21	Linde	20-Jul-23
Nitric Oxide (NO) 30.08 ppm	CG-0089-22	Nimt	13-Jun-24
Nitric Oxide (NO) 150.9 ppm	2857/21	Linde	27-Jun-23
Nitric Oxide (NO) 320.6 ppm	2944/21	Linde	02-Jul-23
Sulphur Dioxide (SO2) 50.04 ppm	3205/21	Linde	25-Jul-23
Sulphur Dioxide (SO2) 100.8 ppm	3507/22	Linde	09-Nov-24
Sulphur Dioxide (SO2) 601.1 ppm	3204/21	Linde	20-Jul-23

Measured room conditions

Temperature : 22.3 °C Humidity : 58.5 %RH Pressure : 1012.4 mbar

Calibration conditions

Gas Temperature : 23 °C Flow rate : 1,200 ml/min Gas pressure : 1020.4 mbar

Calibration Results Before Adjustment (Table 2)

Parameter of Standard	Standard Values	Mean of UUC	Error	Uncertainty (±)
O2 (%Vol)	2.498	2.54	0.042	0.20
O2 (%Vol)	10.04	10.08	0.04	0.40
O2 (%Vol)	21.02	21.13	0.11	0.80
CO (ppm)	80.14	80	-0.14	3.0
CO (ppm)	309.9	309	-0.9	6.0
CO (ppm)	1003	1002	-1	12
NO2 (ppm)	30.34	29.2	-1.14	8.0
NO2 (ppm)	80.96	79.3	-1.66	8.0
NO2 (ppm)	202.2	198.5	-3.7	12
NO (ppm)	30.08	26	-4.08	8.0
NO (ppm)	150.9	145	-5.9	8.0
NO (ppm)	320.6	297	-23.6	12
SO2 (ppm)	50.04	49	-1.04	6.0
SO2 (ppm)	100.8	100	-0.8	6.0
SO2 (ppm)	601.1	598	-3.1	13

Entech Industrial Solution Co.,Ltd.
17/121 Soi Ngamwongwan 47 Yaek 48, Toongsonghong, Laksi Bangkok 10210 THAILAND Tel. 0-2779-8888 Calibration@entech.co.th
Tax ID : 0105536035591 www.entech.co.th

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Calibration Results After Adjustment (Table 3)

Parameter of Standard	Standard Values	Mean of UUC	Error	Uncertainty (±)
O2 (%Vol)	2.498	2.54	0.042	0.20
O2 (%Vol)	10.04	10.08	0.04	0.40
O2 (%Vol)	21.02	21.13	0.11	0.80
CO (ppm)	80.14	80	-0.14	3.0
CO (ppm)	309.9	309	-0.9	6.0
CO (ppm)	1003	1002	-1	12
NO2 (ppm)	30.34	29.2	-1.14	8.0
NO2 (ppm)	80.96	79.3	-1.66	8.0
NO2 (ppm)	202.2	198.5	-3.7	12
NO (ppm)	30.08	32	1.90	8.0
NO (ppm)	150.9	152	1.1	8.0
NO (ppm)	320.6	317	-3.6	12
SO2 (ppm)	50.04	49	-1.04	6.0
SO2 (ppm)	100.8	100	-0.8	6.0
SO2 (ppm)	601.1	598	-3.1	13

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

End of Report

Entech Industrial Solution Co.,Ltd.
17/121 Soi Nearmwongwan 47 Yaek 48, Toonsonshong, Lakai, Bangkok 10210 THAILAND Tel. 0-2779-8888 Calibration@entech.co.th
Tax ID : 0105536035591 www.entech.co.th

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Condition of this calibration result

1. Reference Standard Instrument : -

Instrument	Serial No.	ID No.	Cert. No.	Due Date
1) Document Process Calibrator	54030049	130RC116	22E2769	24 Aug 2023
2) Ref. Standard Thermometer	4982054	110RC044	22I1306	27 Oct 2023

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

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

Buffer Solution	Manufacturer	Lot No.	Exp. date
pH 4.008	CPA chem	826588	09 July 2024
pH 6.987	CPA chem	826589	09 July 2023
pH 10.010	CPA chem	863835	28 Dec 2023

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)(7,10)

Unit Under Calibration	Nominal Value	Standard Voltage Input	Actual Reading		Uncertainty of Measurement	Coverage factor
	pH	mV	mV	pH	(±mV)	k
pH Meter S/N.: HA0D0078	4.00	177.48	177.4	4.01	0.058	2.00
	7.00	0.00	0.0	7.00	0.058	2.00
	7.00	0.00	0.0	7.00	0.058	2.00
	10.00	-177.48	-177.5	10.01	0.058	2.00

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Calibration Results

Function : pH Measurement

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

Unit Under Calibration	Standard pH Buffer Solution	Actual pH Reading	Actual mV Reading (mV)	Uncertainty of pH measurement (±)	Coverage factor k
pH Electrode S/N.: 992H0385	4.008	4.01	166.8	0.0079	2.00
	6.987	6.99	-7.1	0.011	2.00
	6.987	6.99	-6.5	0.011	2.00
	10.010	10.02	-185.4	0.0096	2.00

Function : Temperature Measurement

(*) Without adjustment

This equipment was connected with Temperature Probe;
- Model : 9652
- Serial No. : 992H0385

Dimension of probe;
- Length : 110 mm.
- Diameter : 16 mm.
- Immersion Depth : 100 mm.

Calibration Point (°C)	Standard Temperature (°C)	UUC* Reading (°C)	Error (°C)	Uncertainty of measurement (± °C)	Coverage factor k
25.0	25.004	25.0	-0.004	0.13	2.00
30.0	30.001	30.0	-0.001	0.13	2.00
35.0	35.001	35.0	-0.001	0.13	2.00

Remark : - UUC* = Unit Under Calibration

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

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a 1150711

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

Certificate of Testing

Equipment :	DO Meter
Manufacturer :	Horiba
Model :	LAQUA-DO210
Serial No. :	HE0G0015
ID No. :	UAE.EFM.085/2564(EFM.DO.04/64)
Received Date :	04 January 2023
Test Date :	05 January 2023
Reference :	2301-0061WSC-3
Submitted by :	United Analyst and Engineering Consultant Co.,Ltd. 3 Soi Udomsuk 41, Sukhumvit Road, Bangchak, Phrakhanong, Bangkok 10260
Laboratory Condition :	Temperature (25 ± 5) °C Humidity (50 ± 20) %
Test Procedure :	In - house method : CP-CH9 by Comparison Technique with Azide Modification Method
Tested by :	Walalak Sirithean
Approved by :	[redacted] Approved Signatory

(/) Malee Butkruea
( ) Saithip Meangmai
( ) Warakorn Lerngagtrakul

Issue Date : 6 January 2023

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B 0303428

Condition of this result of calibration

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

Instruments	Serial No.	ID No.	Certificate No.	Due Date
1) Burette	-	130BU10	21CG1389	25 Mar 2023
2) Balance	1126143764	140RC004	22MM50	20 Sep 2023

2. Standard Material :-

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

Result : **Dissolved Oxygen Meter Adjustment With Air 100 %**

Dissolved Oxygen Probe No.: 9K0E0162

Titration Method (Azide Modification Method) (mg/L)	DO Meter Reading (mg/L)	Standard Deviation (mg/L)
8.14	8.14	0.012

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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[redacted]

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a 1142645

TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)
CORPORATE SERVICES 3: EQUIPMENT CALIBRATION AND TESTING SERVICES
534/4 PATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG BANGKOK 10250
TEL. 0-2717-3000-27 FAX. 0-2719-9484

ilac-MRA
NSC-TISI-TIS17025 CALIBRATION 0008

Cert. No.: 23LM2
Page.: 1 of 2

Certificate of Calibration

Equipment :	DO Meter With Sensor
Manufacturer :	Horiba
Model :	LAQUA-DO210
Serial No. :	HE0G0015
ID No. :	UAE.EFM.085/2564(EFM.DO.04/64)
Submitted by :	United Analyst and Engineering Consultant Co.,Ltd. 3 Soi Udomsuk 41, Sukhumvit Road, Bangchak, Phrakhanong, Bangkok 10260
Location :	TPA On Site Calibration Laboratory
Received Order :	4 January 2023
Calibrated Date :	6 January 2023
Ambient Temperature :	(26 ± 10) °C
Relative Humidity :	(50 ± 30) %
AC Line Voltage :	(220 ± 22) V
Calibrated by :	Malee Butkruea
Approved by :	[redacted] Approved Signatory

( ) Pornthippa Tameyakul
(✓) Suwit Imjai

Issue Date : 10 January 2023

The Uncertainties are for a confidence probability of approximately 95%

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เอกสารไม่ควบคุม

Equipment : DO Meter With Sensor
Condition As-Received : Used Item
Reference : 2301-0061WSC-4

Procedure Used :-

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

The temperature scale used was based on ITS-90.

Condition of this result of calibration

1. Reference standard instrument:-

Instrument	Model	Serial No.	Cert. No.	Due Date
1) Digital Thermometer	1523	2188080	22I1285	21 Oct 2023

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

Result of Calibration :- (*) Without Adjustment

Function : Temperature measurement.

This instrument was connected with temperature sensor, S/N.: 9K0E0162

Calibration Point (°C)	Immersion Depth (mm)	Standard Temperature (°C)	UUC* Reading (°C)	Error (°C)	Uncertainty (± °C)	Coverage Factor *k*
25.0	80	25.000	25.0	0.000	0.16	2.00
30.0	80	29.995	29.9	-0.095	0.16	2.00
35.0	80	34.999	34.9	-0.099	0.16	2.00

UUC* : Unit Under Calibration

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

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TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)
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ilac-MRA
NSC-TISI-TIS17025 CALIBRATION 0008

Cert.No.: 23CH428
Page.: 1 of 3

Certificate of Calibration

Equipment :	Conductivity Meter
Manufacturer :	Horiba
Model :	LAQUA-EC210
Serial No. :	HC9L0012
ID No. :	UAE.EFM.008/2563(EFM.SCT.02/63)
Condition As-Received:	Used Item
Received Date :	28 March 2023
Calibration Date :	29 March 2023
Reference :	2303-0999WSC-2
Submitted by :	United Analyst and Engineering Consultant Co.,Ltd. 3 Soi Udomsuk 41, Sukhumvit Road, Bangchak, Phrakhanong, Bangkok 10260
Ambient Temperature :	(25 ± 2.5) °C
Relative Humidity :	(50 ± 15) %
Calibration Procedure:	In -house method : - CP-CH6 by direct measurement with certified reference material (CRM) - CP-CH8 by comparison with standard thermometer
Calibrated by :	Walalak Sirithean
Approved by :	[redacted] Approved Signatory

(✓) Malee Butkruea
( ) Saithip Meangmai
( ) Warakorn Lerngagtrakul

Issue Date : 31 March 2023

The Uncertainties are for a confidence probability of approximately 95%

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Condition of this result of calibration

1. Reference Standard Instrument :-

Instrument	Serial No.	ID No.	Certificate No.	Due date
1) Thermometer	9549224	130RC003	22I484	17 Apr 2023
2) Ref. Std.Thermometer	4982054	110RC044	22I1306	27 Oct 2023

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

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

Conductivity Solution	Manufacturer	Lot No.	Exp. date
1413.0 µS/cm	CPA Chem	826595	09 July 2023
12.880 mS/cm	CPA Chem	823329	20 June 2023

- Control Conductivity calibration solution temperature by Water bath (25±0.1) °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 µS/cm
Conductivity Electrode Serial No.: 9B9F0278

Standard Conductivity Solution	Before Adjustment UUC* Reading	After Adjustment UUC* Reading	Uncertainty of Measurement (±)	Coverage factor k
1413.0 µS/cm	1377 µS/cm	1413 µS/cm	9.2 µS/cm	2.00
12.880 mS/cm	12.26 mS/cm	12.77 mS/cm	0.086 mS/cm	2.00

Remark - UUC* = Unit Under Calibration

[redacted]

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Calibration Results

Function : Temperature Measurement

(*) Without adjustment

This equipment was connected with Temperature Probe;

- Model : 9383
- Serial No. : 9B9F0278

Dimension of probe;

- Length : 110 mm
- Diameter : 16 mm
- Immersion Depth : 100 mm

Calibration Point (°C)	Standard Temperature (°C)	UUC* Reading (°C)	Error (°C)	Uncertainty of Measurement (± °C)	Coverage factor *k*
25.0	25.001	25.0	-0.001	0.13	2.00
30.0	29.999	30.0	0.001	0.13	2.00
35.0	34.999	35.0	0.001	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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[redacted]

เอกสารไม่ควบคุม

TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)
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TEL. 0-2717-3000-29 FAX. 0-2719-9484

NSC-TISI-TIS17025 CALIBRATION 0008

Certificate of Calibration

Equipment :	pH Meter
Manufacturer :	Horiba
Model :	LAQUA-PH210
Serial No. :	HA0D0078
ID No. :	UAE.EFM.073/2564(EFM.pH.06/64)
Condition As-Received:	Used Item
Received Date :	27 February 2023
Calibration Date :	01 March 2023
Reference :	2302-0942WSC-4
Submitted by :	United Analyst and Engineering Consultant Co.,Ltd. 3 Soi Udomsuk 41, Sukhumvit Road, Bangchak, Phrakhanong, Bangkok 10260
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 Lerngagtrakul
Approved by :	[redacted]

(✓) Malee Butkruea
( ) Saithip Meangmai
( ) Warakorn Lerngagtrakul

Issue Date : 7 March 2023

The Uncertainties are for a confidence probability of approximately 95%

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เอกสารไม่ควบคุม
A 0051728

รายการใบรับรองสอบเทียบ/ทวนสอบ เครื่องมือหลักประจำห้องปฏิบัติการวิเคราะห์ สำหรับวิเคราะห์คุณภาพสิ่งแวดล้อม

No.	Instrument/Equipment	Parameter	Manufacturer	Model/Serial No.	Calibrator	Certification No.	Date of Calibration	Due date of Calibration*	Remark
เครื่องมือหลักประจำห้องปฏิบัติการวิเคราะห์คุณภาพอากาศ									
1	Analytical Balance (Readability 0.1 mg)	TSP	Mettler-Toledo	AB204-S / 1128312528	Technology Promotion Association (Thailand-Japan)	23MM331	7 Apr 23	5 Apr 24	-
2	Analytical Balance (Readability 0.1 mg)		Mettler-Toledo	AB204-S/FACT / B108115858	Technology Promotion Association (Thailand-Japan)	23MM332	7 Apr 23	5 Apr 24	-
3	Analytical Balance (Readability 0.001 mg)		Mettler-Toledo	XP6 / B322373893	Technology Promotion Association (Thailand-Japan)	23MM333	7 Apr 23	5 Apr 24	-
4	UV-VIS Spectrophotometer	Nox	Agilent Technologies	Cary60 G6860A / MY15410009	DQE Services Co.,Ltd.	SP23-021	20 May 23	18 May 24	-
5	Gas Chromatography (GC)	CH_3SCH_3	Agilent Technologies	System ID:CN13113001 7890 / CN13113001	Agilent Technologies (Thailand) Co.,Ltd.	Certificate of System Qualification GC-OQ	19 Apr 23	17 Apr 24	-

TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)
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TEL. 0-2717-3000-29 FAX. 0-2719-9484

NSC-TISI-TIS17025 CALIBRATION 0008

Certificate of Calibration

Equipment : Electronic Balance

Manufacturer : Mettler Toledo

Model : AB204-S

Serial No. : 1128312528

ID No. : UAE.AIR.019/2550

Submitted by : United Analyst and Engineering Consultant Co.,Ltd.
3 Soi Udomsuk 41, Sukhumvit Road,
Bangchak, Phrakhanong,
Bangkok 10260

Location : Balance Room 2

Received order : 07 April 2023
Calibration Date : 07 April 2023
Ambient Temperature : 15 °C to 40 °C
Relative Humidity : 30 % to 90 %

Calibrated by : Suwit Imjai

Approved by : [redacted]ry

( ) Pornthippa Tameyakul
(✓) Malee Butkruea

Issue Date : 10 April 2023

The Uncertainties are for a confidence probability of approximately 95%

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Approval of the head of Corporate Services 3 : Equipment Calibration and Testing Services.

Uncontrolled Document

Equipment : Electronic Balance
Condition As-Received : Used Item
Reference : 2304-0015OC-1

Procedure used :-

Calibration were conducted using in-house calibration procedure CP-OB01 according to direct measurement method against standard weight.

Condition of this result of calibration

1. Reference standard instruments:-

Instruments	Model	Serial No.	ID No.	Test report No.	Due date
1) Standard Weight Set (E2)	15884	24053	70RC007	MM-0010-22	20 Jan 2024

2. This certificate is valid only to the item calibrated on date and place of calibration.
3. This result of calibration was made on requested at the point specified by customer.
4. This certificate is not certified for any commercial transaction.
5. This certification is traceable to the International System of Unit.

Result of calibration ( ) Without Adjustment (*) After Adjustment by Internal Calibration

Range capacity : 0 g to 220 g **Resolution** 0.0001 g

Before Adjustment :

Applied Weight (g)	Balance Reading (g)	Correction (g)	Measurement Uncertainty (± mg)	Coverage Factor (k)
100	99.9999	+0.0001	0.19	2.03
200	200.0001	-0.0001	0.29	2.00

After Adjustment :

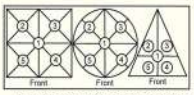
1. Determination of the standard deviation of weighing machine (n = 10)

Applied Weight (g)	Standard Deviation of Reading (g)
100	0.00007
200	0.00007

Uncontrolled [redacted]

Equipment : Electronic Balance
Condition As-Received : Used Item
Reference : 2304-0015OC-1

Result of calibration



2. Effect of off center loading

A mass of 100 g was placed to various position on the pan.
The weighing machine reading error obtained is given in the table

Position 1 (g)	Position 2 (g)	Position 3 (g)	Position 4 (g)	Position 5 (g)	Maximum difference between off-center and central loading (g)
-0.0001	-0.0002	+0.0004	-0.0001	-0.0006	0.0005

3. Departure from nominal value

Applied Weight (g)	Balance Reading (g)	Correction (g)	Measurement Uncertainty (± mg)	Coverage Factor (k)
Unload	0.0000	0.0000	0.15	2.13
0.1	0.0999	+0.0001	0.15	2.13
1	0.9999	+0.0001	0.15	2.13
5	4.9999	+0.0001	0.15	2.13
10	9.9999	+0.0001	0.15	2.11
20	20.0000	0.0000	0.15	2.11
50	50.0000	0.0000	0.16	2.06
70	69.9999	+0.0001	0.18	2.04
100	99.9999	+0.0001	0.19	2.03
150	150.0003	-0.0003	0.29	2.00
200	200.0005	-0.0005	0.29	2.00

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

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Uncontrolled [redacted]

TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)
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TEL. 0-2717-3000-29 FAX. 0-2719-9484

NSC-TISI-TIS17025 CALIBRATION 0009

Certificate of Calibration

Equipment : Electronic Balance

Manufacturer : Mettler Toledo

Model : AB204-S /FACT

Serial No. : B108115858

ID No. : UAE.AIR.016/2555

Submitted by : United Analyst and Engineering Consultant Co.,Ltd.
3 Soi Udomsuk 41, Sukhumvit Road,
Bangchak, Phrakhanong,
Bangkok 10260

Location : Balance Room 2

Received order : 07 April 2023
Calibration Date : 07 April 2023
Ambient Temperature : 15 °C to 40 °C
Relative Humidity : 30 % to 90 %

Calibrated by : Suwit Imjai

Approved by : [redacted]ry

( ) Pornthippa Tameyakul
(✓) Malee Butkruea

Issue Date : 10 April 2023

The Uncertainties are for a confidence probability of approximately 95%

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Equipment : Electronic Balance
Condition As-Received : Used Item
Reference : 2304-0015OC-2

Cert.No.: 23MM332
Page: 2 of 3

Procedure used :-

Calibration were conducted using in-house calibration procedure CP-OB01 according to direct measurement method against standard weight.

Condition of this result of calibration

1. Reference standard instruments:-

Instruments	Model	Serial No.	ID No.	Test report No.	Due date
1) Standard Weight Set (E2)	15884	24053	70RC007	MM-0010-22	20 Jan 2024

2. This certificate is valid only to the item calibrated on date and place of calibration.
3. This result of calibration was made on requested at the point specified by customer.
4. This certificate is not certified for any commercial transaction.
5. This certification is traceable to the International System of Unit.

Result of calibration ( ) Without Adjustment (*) After Adjustment by Internal Calibration

Range capacity : 0 g to 220 g **Resolution** 0.0001 g

Before Adjustment :

Applied Weight (g)	Balance Reading (g)	Correction (g)	Measurement Uncertainty (± mg)	Coverage Factor (k)
100	100.0002	-0.0002	0.21	2.06
200	200.0003	-0.0003	0.29	2.00

After Adjustment :

1. Determination of the standard deviation of weighing machine (n = 10)

Applied Weight (g)	Standard Deviation of Reading (g)
100	0.00009
200	0.00007

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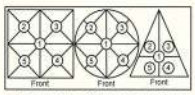
Uncontrolled Document

Equipment : Electronic Balance
Condition As-Received : Used Item
Reference : 2304-0015OC-2

Cert.No.: 23MM332
Page: 3 of 3

Result of calibration



2. Effect of off center loading

A mass of 100 g was placed to various position on the pan.
The weighing machine reading error obtained is given in the table

Position 1 (g)	Position 2 (g)	Position 3 (g)	Position 4 (g)	Position 5 (g)	Maximum difference between off-center and central loading (g)
+0.0001	-0.0003	+0.0003	+0.0006	+0.0002	0.0005

3. Departure from nominal value

Applied Weight (g)	Balance Reading (g)	Correction (g)	Measurement Uncertainty (± mg)	Coverage Factor (k)
Unload	0.0000	0.0000	0.18	2.17
0.1	0.0999	+0.0001	0.18	2.17
1	0.9998	+0.0002	0.18	2.17
5	5.0000	0.0000	0.18	2.17
10	10.0000	0.0000	0.18	2.17
20	20.0000	0.0000	0.18	2.15
50	50.0001	-0.0001	0.19	2.11
70	70.0001	-0.0001	0.20	2.07
100	100.0002	-0.0002	0.21	2.06
150	150.0004	-0.0004	0.29	2.00
200	200.0005	-0.0005	0.29	2.00

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

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NSC-TISI-TIS17025 CALIBRATION 0008

Cert.No.: 23MM333
Page.: 1 of 3

Certificate of Calibration

Equipment :	Electronic Balance
Manufacturer :	Mettler Toledo
Model :	XP6
Serial No. :	B322373893
ID No. :	UAE.AIR.019/2556
Submitted by :	United Analyst and Engineering Consultant Co.,Ltd. 3 Soi Udomsuk 41, Sukhumvit Road, Bangchak, Phrakhanong, Bangkok 10260
Location :	Balance Room 2
Received order :	07 April 2023
Calibration Date :	07 April 2023
Ambient Temperature :	15 °C to 40 °C
Relative Humidity :	30 % to 90 %
Calibrated by :	Suwit Imjai
Approved by :	[redacted] Approved Signatory

( ) Pornthippa Tameyakul
(✓) Malee Butkruea

Issue Date : 10 April 2023

The Uncertainties are for a confidence probability of approximately 95%

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Equipment : Electronic Balance
Condition As-Received : Used Item
Reference : 2304-0015OC-3

Cert.No.: 23MM333
Page: 2 of 3

Procedure used :-

Calibration were conducted using in-house calibration procedure CP-OB01 according to direct measurement method against standard weight.

Condition of this result of calibration

1. Reference standard instruments:-

Instruments	Model	Serial No.	ID No.	Test report No.	Due date
1) Standard Weight Set (E2)	15884	24053	70RC007	MM-0010-22	20 Jan 2024

2. This certificate is valid only to the item calibrated on date and place of calibration.
3. This result of calibration was made on requested at the point specified by customer.
4. This certificate is not certified for any commercial transaction.
5. This certification is traceable to the International System of Unit.

Result of calibration ( ) Without Adjustment (*) After Adjustment by Internal Calibration

Range capacity : 0 g to 6.1 g **Resolution** 0.000001 g

Before Adjustment :

Applied Weight (g)	Balance Reading (g)	Correction (g)	Measurement Uncertainty (± mg)	Coverage Factor (k)
3	2.999987	+0.000013	0.026	2.00
6	6.000003	-0.000003	0.036	2.00

After Adjustment :

1. Determination of the standard deviation of weighing machine (n = 10)

Applied Weight (g)	Standard Deviation of Reading (g)
3	0.0000027
6	0.0000030

[redacted]

Uncontrolled Document

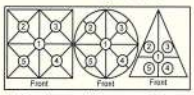
Equipment : Electronic Balance
Condition As-Received : Used Item
Reference : 2304-0015OC-3

Cert.No.: 23MM333
Page: 3 of 3

Result of calibration

2. Effect of off center loading

A mass of 2 g was placed to various position on the pan.
The weighing machine reading error obtained is given in the table



Position 1 (g)	Position 2 (g)	Position 3 (g)	Position 4 (g)	Position 5 (g)	Maximum difference between off-center and central loading (g)
-0.000006	-0.000007	-0.000007	-0.000010	-0.000002	0.000004

3. Departure from nominal value

Applied Weight (g)	Balance Reading (g)	Correction (g)	Measurement Uncertainty (± mg)	Coverage Factor (k)
Unload	0.000000	0.000000	0.0060	2.37
0.01	0.009998	+0.000002	0.0060	2.13
0.05	0.050003	-0.000003	0.0070	2.05
0.1	0.100007	-0.000007	0.0090	2.03
0.15	0.150000	0.000000	0.011	2.00
0.17	0.169998	+0.000002	0.014	2.00
0.2	0.200002	-0.000002	0.014	2.00
1.5	1.500001	-0.000001	0.020	2.00
3	2.999990	+0.000010	0.026	2.00
4.5	4.499994	+0.000006	0.036	2.00
6	5.999982	+0.000018	0.036	2.00

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

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DQE Services Co.,Ltd.
32 Soi Ladprao-Wanghin 55, Ladprao-Wanghin Rd., Ladprao, Ladprao, Bangkok 10230
Phone : +66 (0)2 538 2054, Email : dqeservicesinfo@gmail.com

CERTIFICATE OF CALIBRATION

Certificate No. : SP23-021 Page 1 of 5

Customer : United Analyst and Engineering Consultant Co.,Ltd. (Head Office)

Address : 3 Soi Udomsuk 41, Sukhumvit Road, Bangchak, Phrakhanong, Bangkok 10260

Location of calibration : Laboratory 315

Equipment : UV-Vis Spectrophotometer

Manufacturer : Agilent Technologies

Model : Cary 60

Serial No. : MY15410009

ID No. : N/A

Received Date : 20 May 2023

Calibration Date : 20 May 2023

Issue Date : 23 May 2023

Condition Instrument : Good

Calibrated by : [redacted]
Technical Manager

Approved by : [redacted]
Quality Manager

The calibration result is applied only to the above calibrated item and was found accurate as shown on date and place of calibration only.

The measurement capability of the laboratory and its traceability to recognized national standards and to the unit of measurement realized at the corresponding national standards laboratory. This certificate may not be reproduced other than in full except with the prior written approval of the DQE Services Co., Ltd.

เอกสารไม่ควบคุม

DQE Services Co.,Ltd.
32 Soi Ladprao-Wanghin 55, Ladprao-Wanghin Rd., Ladprao, Ladprao, Bangkok 10230
Phone : +66 (0)2 538 2054, Email : dqeservicesinfo@gmail.com

REPORT OF CALIBRATION

Certificate No. : SP23-021 Page 2 of 5

Environment Condition : Ambient Temperature 25 ± 5 °C

Relative humidity 55 ± 20 %RH

Calibration method : In-house method CP-01 Based on ASTM E275-08

Certified Reference Materials :

Material	Serial No.	Certificate No.	Due date
Absobance Standard set	25760	95935	22 October 2023
Absobance Standard set	25757	95929	22 October 2023
Wavelength Standard set	25806	95916	22 October 2023
Wavelength Standard set	25758	95915	22 October 2023

Traceability This certification is traceable to the International System of Unit maintained at National - Institute of Standards and Technology (NIST) through Starna Scientific Limited

Spectral Band Width of UUC : 1.5 nm.

Scan Speed of UUC : 60 nm/min

Scan Interval of UUC : 0.15 nm.

Resolution of UUC : Photometric 0.0001 Abs.

Wavelength 0.1 nm.

เอกสารไม่ควบคุม

DQE Services Co.,Ltd.
32 Soi Ladprao-Wanghin 55, Ladprao-Wanghin Rd., Ladprao, Ladprao, Bangkok 10230
Phone : +66 (0)2 538 2054, Email : dqeservicesinfo@gmail.com

REPORT OF CALIBRATION

Certificate No. : SP23-021 Page 3 of 5

Calibration Results : Without adjustment

Photometric Accuracy :

Wavelength (nm.)	CRMs Values (Abs)	UUC Reading (Abs)	Correction (Abs)	Uncertainty (Abs)	Coverage factor k
420	0.0000	0.0000	0.0000	0.0028	2.00
	0.5787	0.5742	0.0045	0.0031	2.00
	1.0490	1.0423	0.0067	0.0029	2.00
	2.1900	2.1847	0.0053	0.0075	2.00
440	0.0000	0.0000	0.0000	0.0028	2.00
	0.5607	0.5577	0.0030	0.0034	2.00
	1.0247	1.0234	0.0013	0.0035	2.00
	2.1229	2.1171	0.0058	0.0088	2.00
465	0.0000	0.0000	0.0000	0.0028	2.00
	0.5236	0.5184	0.0052	0.0029	2.00
	0.9634	0.9607	0.0027	0.0029	2.00
	1.9763	1.9715	0.0048	0.0081	2.00
546.1	0.0000	-0.0001	0.0001	0.0028	2.00
	0.5191	0.5159	0.0032	0.0031	2.00
	1.0003	0.9980	0.0023	0.0033	2.00
	1.9987	1.9917	0.0070	0.0087	2.00
590	0.0000	0.0000	0.0000	0.0028	2.00
	0.5523	0.5501	0.0022	0.0030	2.00
	1.0809	1.0808	0.0001	0.0030	2.00
	2.0391	2.0336	0.0055	0.0081	2.00
635	0.0000	0.0000	0.0000	0.0028	2.00
	0.5601	0.5585	0.0016	0.0031	2.00
	1.0512	1.0485	0.0027	0.0030	2.00
	1.9294	1.9317	-0.0023	0.0083	2.00

เอกสารไม่ควบคุม

DQE Services Co.,Ltd.
32 Soi Ladprao-Wanghin 55, Ladprao-Wanghin Rd., Ladprao, Ladprao, Bangkok 10230
Phone : +66 (0)2 538 2054, Email : dqeservicesinfo@gmail.com

REPORT OF CALIBRATION

Certificate No. : SP23-021

Photometric Accuracy :

Wavelength (nm.)	CRMs Values (Abs)	UUC Reading (Abs)	Correction (Abs)	Uncertainty (Abs)	Coverage factor *k*
235	0.0000	0.0000	0.0000	0.0050	2.00
	0.7478	0.7436	0.0042	0.0058	2.00
257	0.0000	0.0000	0.0000	0.0050	2.00
	0.8686	0.8648	0.0038	0.0064	2.00
313	0.0000	0.0000	0.0000	0.0050	2.00
	0.2912	0.2908	0.0004	0.0052	2.00
350	0.0000	0.0000	0.0000	0.0050	2.00
	0.6448	0.6398	0.0050	0.0058	2.00

เอกสารไม่ควบคุม

DQE Services Co.,Ltd.
32 Soi Ladprao-Wanghin 55, Ladprao-Wanghin Rd., Ladprao, Ladprao, Bangkok 10230
Phone : +66 (0)2 538 2054, Email : dqeservicesinfo@gmail.com

REPORT OF CALIBRATION

Certificate No. : SP23-021

Wavelength Accuracy :

CRMs Values (nm.)	UUC Reading (nm.)	Correction (nm.)	Uncertainty (nm.)	Coverage factor *k*
241.72	242.0	-0.28	0.18	2.00
279.45	279.5	-0.05	0.18	2.00
287.81	287.5	0.31	0.18	2.00
334.06	333.5	0.56	0.18	2.00
360.93	360.3	0.63	0.18	2.00
418.59	418.0	0.59	0.18	2.00
445.94	445.3	0.64	0.18	2.00
453.66	453.0	0.66	0.18	2.00
460.02	459.6	0.42	0.18	2.00
536.59	536.4	0.19	0.18	2.00
637.98	638.3	-0.32	0.18	2.00
431.38	431.0	0.38	0.18	2.00
472.50	472.5	0.00	0.18	2.00
513.47	513.5	-0.03	0.18	2.00
528.88	529.0	-0.12	0.18	2.00
573.17	573.0	0.17	0.18	2.00
585.35	585.0	0.35	0.20	2.00
684.40	684.5	-0.10	0.18	2.00
740.72	741.0	-0.28	0.20	2.00
748.55	748.5	0.05	0.18	2.00
807.03	807.0	0.03	0.18	2.00
879.28	879.5	-0.22	0.18	2.00

Remark : - UUC = Unit Under Calibration

- N/A = Not Available
- The result expanded uncertainty of measurement U is stated as the standard uncertainty of measurement multiplied by the coverage factor *k*, which for a normal distribution corresponds to a coverage probability of approximately 95%
- * Indicates non TISI accredited

- End of Certificate -

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Certificate of System Qualification

GC-OQ

System ID:	CN13113001
Organization Name:	United Analyst and Engineering Consultant Co., Ltd.
Organization Location:	3 Soi Udomsuk 41, Sukhumvit Road, Bangchak, Phrakhanong, Bangkok 10260
Date:	April 19, 2023 10:36:30 AM
EQP Name:	AgilentRecommended
EQP Revision:	GC.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 Decay

Name: 7890
Front SSL

Setpoint Status: Pass

Pressure: 25.0 psi

Pressure Change: -0.1 psi /5 minutes

Agilent Recommended: >= -2.0 and <= 0.5

Overall Inlet Pressure Decay Test Status

Pass

Inlet Pressure Accuracy

Name: 7890
Front SSL

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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

Detector Flow Accuracy

Name: 7890
Front FID

Setpoint Status: Pass

Flow Type: Fuel

Setpoint: 30.0 mL/min Measured Flow: 30.2 mL/min

Accuracy: 0.2 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: 396.4 mL/min

Accuracy: 3.6 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: 24.9 mL/min

Accuracy: 0.1 mL/min

Agilent Recommended: <= 10.0 % setpoint (2.5 ml/min)

Limit is percentage of setpoint or 0.5 ml/minute, whichever is largest.

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Overall Detector Flow Accuracy Test Status

Pass

Detector Flow Accuracy

Name: 7890
Back FPD+

Setpoint Status: Pass
Flow Type: Fuel
Setpoint: 60.0 mL/min Measured Flow: 60.1 mL/min
Accuracy: 0.1 mL/min
Agilent Recommended: <= 10.0 % setpoint (6.0 ml/min)
Limit is percentage of setpoint or 0.5 ml/minute, whichever is largest.

Setpoint Status: Pass
Flow Type: Oxidizer
Setpoint: 60.0 mL/min Measured Flow: 60.2 mL/min
Accuracy: 0.2 mL/min
Agilent Recommended: <= 10.0 % setpoint (6.0 ml/min)
Limit is percentage of setpoint or 0.5 ml/minute, whichever is largest.

Setpoint Status: Pass
Flow Type: Makeup
Setpoint: 60.0 mL/min Measured Flow: 65.1 mL/min
Purge Offset: 20 % setpoint
Adjusted Setpoint: 72.00 mL/min
Accuracy: 6.9 mL/min
Agilent Recommended: <= 10.0 % setpoint (7.2 ml/min)
Limit is percentage of setpoint or 0.5 ml/minute, whichever is largest.

Overall Detector Flow Accuracy Test Status

Pass

GC Oven Temperature Accuracy

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Name: 7890

Setpoint Status: Pass
Zone: Oven
Setpoint/Actual
Temperature: 230.0 230.2 °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: 100.0 100.9 °C
Accuracy: 0.9 °C
Agilent Recommended: >= -1.0 % setpoint in K (-3.7 °C)
<= 1.0 % setpoint in K (3.7 °C)

Overall GC Oven Temperature Accuracy Test Status

Pass

GC Oven Temperature Stability

Name: 7890

Setpoint Status: Pass
Setpoint/Average
Temperature: 100.0 100.8833 °C
Stability: 0.1 °C
Agilent Recommended: <= 0.5

Overall GC Oven Temperature Stability Test Status

Pass

Scouting Run

Tested Combination1 Front SSL / Front FID
Injection Tower

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Name: 7693A

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: 14.2 pA

	ASTM Noise pA	Drift pA/Hr
	0.07	0.34
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: 7693A

Setpoint Status: Pass
Injection Volume on Column: 1.0 uL
Area RSD: 0.53 % Retention Time RSD: 0.61 %
Agilent Recommended: <= 3.00 <= 1.00

Overall Injection Precision Test Status

Pass

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Signal to Noise

Tested Combination1 Front SSL / Front FID
Injection Tower
Name: 7890

Setpoint Status: Pass
Signal to Noise: 2236578
Agilent Recommended: >= 300000

Overall Signal to Noise Test Status

Pass

Scouting Run

Tested Combination2 Front SSL / Back FPD+
Injection Tower
Name: 7693A

Setpoint Status: Completed
Injection Volume on Column: 1.0 uL
Mode: P-Mode

Overall Scouting Run Status

Completed

Noise and Drift

Tested Combination2 Front SSL / Back FPD+
Name: 7890

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Setpoint Status: Pass

Mode: P-Mode

Base Signal: 7.2 150 pA

	ASTM Noise DU	Drift DU/Hr
	1.38	0.18
Agilent Recommended:	<= 2.00	<= 1.50
Status:	Pass	Pass

Overall Noise and Drift Test Status

Pass

Injection Precision

Tested Combination2 Front SSL / Back FPD+

Name: 7693A

Setpoint Status: Pass

Injection Volume on Column: 1.0 uL

Mode: P-Mode

Area RSD: 0.77 % Retention Time RSD: 0.03 %

Agilent Recommended: <= 3.00 <= 1.00

Overall Injection Precision Test Status

Pass

Signal to Noise

Tested Combination2 Front SSL / Back FPD+

Injection Tower

Name: 7890

Mode: P-Mode

Setpoint Status: Pass

Signal to Noise: 4502

Agilent Recommended: >= 2400

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Overall Signal to Noise Test Status

Pass

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Instrument Details

Purpose

This section describes the as found system configuration.

Details

System	
System ID	CN13113001
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
Tested Combination2	
Injection Technique	Injection Tower
Inlet	Front
Detector	Back
LTM Included?	No
Sampler 1	
Manufacturer	Agilent Technologies
Type	Injection Tower
Name	7693A
Model Number	G4513A
Serial Number	CN13260018
Firmware Revision	A.10.08
Usage	Sample Injection
Location	Front
Syringe Volume (µL)	10

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Sampler 2	
Manufacturer	Agilent Technologies
Type	Tray
Name	7693A
Model Number	G4514A
Serial Number	CN13200169
Firmware Revision	A.10.16
Vial Heater	Not installed
Mainframe 1	
Manufacturer	Agilent Technologies
Name	7890
Model Number	G3440B
Serial Number	CN13113001
Firmware Revision	B.02.03.2
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

เอกสารไม่ควบคุม

Detector 2

Manufacturer	Agilent Technologies
Name	7890
Type	FPD+
Adapter	Capillary
Control Type	Electronic Pressure Control (EPC)
Location	Back
Makeup Gas	Nitrogen
First Filter Tested	P-Mode

เอกสารไม่ควบคุม

Electronic Signature

Purpose

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Details

Full Name of Signer:	Saenguthai Tarak
Logged On User Name:	saenguthai.tarak@non.agilent.com
Signature Creation Date:	April 19, 2023
Reason for Signature:	Executed protocol and published this original version of document

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เอกสารไม่ควบคุม

User Name: saenguthai.tarak
Hostname: LAPTOP-CQ3SKOMV

System Id: CN13113001
Print Date: April 19, 2023 10:36:32 AM

CN13113001_UAE Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
April 19, 2023 9:16:05 AM	Audit	SessionCreated	Session	None
April 19, 2023 9:16:05 AM	Start	Configuration	Session	None
April 19, 2023 9:16:05 AM	Audit	Entitlement	Licensing	User is Nonpaying and does not require an unlock code
April 19, 2023 9:16:23 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],Protocol Revision: [Gc.02.51]
April 19, 2023 9:16:25 AM	End	Configuration	Session	None
April 19, 2023 9:16:28 AM	Start	Qualification	Session	OQ
April 19, 2023 9:16:28 AM	Start	Execution	System Inspection and Basic Safety and Operation - 7890: - Qualitative Test - No setpoints associated	None
April 19, 2023 9:16:45 AM	End	Execution	System Inspection and Basic Safety and Operation - 7890: - Qualitative Test - No setpoints associated	Run Count : 1
April 19, 2023 9:16:47 AM	Start	Execution	Inlet Pressure Decay - Front SSL: - Pressure Controlled Inlet - S: 25.0 psi - L: >= -2.0 psi and <= 0.5 psi	None
April 19, 2023 9:16:55 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

เอกสารไม่ควบคุม

User Name: saenguthai.tarak
Hostname: LAPTOP-CQ3SKOMV

System id: CN13113001
Print Date: April 19, 2023 10:36:32 AM

CN13113001_UAE Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
April 19, 2023 9:16:57 AM	Start	Execution	Inlet Pressure Accuracy - Front SSL: - Pressure Controlled Inlet - S: 25.0 psi - L: <= 1.2 psi	None
April 19, 2023 9:17:02 AM	End	Execution	Inlet Pressure Accuracy - Front SSL: - Pressure Controlled Inlet - S: 25.0 psi - L: <= 1.2 psi	Run Count : 1
April 19, 2023 9:17:04 AM	Start	Execution	Detector Flow Accuracy - Front FID: - Type : Fuel - S: 30.0 mL/min - L: <= 10.0% setpoint	None
April 19, 2023 9:17:27 AM	Audit	Data	Detector Flow Accuracy - Front FID: - Type : Fuel - S: 30.0 mL/min - L: <= 10.0% setpoint	Manual Data Entry
April 19, 2023 9:17:29 AM	End	Execution	Detector Flow Accuracy - Front FID: - Type : Fuel - S: 30.0 mL/min - L: <= 10.0% setpoint	Run Count : 1
April 19, 2023 9:17:31 AM	Start	Execution	Detector Flow Accuracy - Front FID: - Type : Oxidizer - S: 400.0 mL/min - L: <= 10.0% setpoint	None
April 19, 2023 9:17:50 AM	Audit	Data	Detector Flow Accuracy - Front FID: - Type : Oxidizer - S: 400.0 mL/min - L: <= 10.0% setpoint	Manual Data Entry
April 19, 2023 9:17:52 AM	End	Execution	Detector Flow Accuracy - Front FID: - Type : Oxidizer - S: 400.0 mL/min - L: <= 10.0% setpoint	Run Count : 1
April 19, 2023 9:17:55 AM	Start	Execution	Detector Flow Accuracy - Front FID: - Type : Makeup - S: 25.0 mL/min - L: <= 10.0% setpoint	None
April 19, 2023 9:18:10 AM	Audit	Data	Detector Flow Accuracy - Front FID: - Type : Makeup - S: 25.0 mL/min - L: <= 10.0% setpoint	Manual Data Entry
April 19, 2023 9:18:12 AM	End	Execution	Detector Flow Accuracy - Front FID: - Type : Makeup - S: 25.0 mL/min - L: <= 10.0% setpoint	Run Count : 1

เอกสารไม่ควบคุม

User Name: saenguthai.tarak
Hostname: LAPTOP-CQ3SKOMV

System Id: CN13113001
Print Date: April 19, 2023 10:36:32 AM

CN13113001_UAE Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
April 19, 2023 9:18:14 AM	Start	Execution	Detector Flow Accuracy - Back FPD+: - Type : Fuel - S: 60.0 mL/min - L: <= 10.0% setpoint	None
April 19, 2023 9:18:48 AM	Audit	Data	Detector Flow Accuracy - Back FPD+: - Type : Fuel - S: 60.0 mL/min - L: <= 10.0% setpoint	Manual Data Entry
April 19, 2023 9:18:51 AM	End	Execution	Detector Flow Accuracy - Back FPD+: - Type : Fuel - S: 60.0 mL/min - L: <= 10.0% setpoint	Run Count : 1
April 19, 2023 9:18:53 AM	Start	Execution	Detector Flow Accuracy - Back FPD+: - Type : Oxidizer - S: 60.0 mL/min - L: <= 10.0% setpoint	None
April 19, 2023 9:19:05 AM	Audit	Data	Detector Flow Accuracy - Back FPD+: - Type : Oxidizer - S: 60.0 mL/min - L: <= 10.0% setpoint	Manual Data Entry
April 19, 2023 9:19:08 AM	End	Execution	Detector Flow Accuracy - Back FPD+: - Type : Oxidizer - S: 60.0 mL/min - L: <= 10.0% setpoint	Run Count : 1
April 19, 2023 9:19:10 AM	Start	Execution	Detector Flow Accuracy - Back FPD+: - Type : Makeup - S: 60.0 mL/min - L: <= 10.0% setpoint	None
April 19, 2023 9:20:45 AM	Start	Execution	Detector Flow Accuracy - Back FPD+: - Type : Makeup - S: 60.0 mL/min - L: <= 10.0% setpoint	None
April 19, 2023 9:20:58 AM	Audit	Data	Detector Flow Accuracy - Back FPD+: - Type : Makeup - S: 60.0 mL/min - L: <= 10.0% setpoint	Manual Data Entry

เอกสารไม่ควบคุม

User Name: saenguthai.tarak
Hostname: LAPTOP-CQ3SKOMV

System Id: CN13113001
Print Date: April 19, 2023 10:36:32 AM

CN13113001_UAE Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
April 19, 2023 9:21:03 AM	End	Execution	Detector Flow Accuracy - Back FPD+: - Type : Makeup - S: 60.0 mL/min - L: <= 10.0% setpoint	Run Count : 1
April 19, 2023 9:21:08 AM	Start	Execution	GC Oven Temperature Accuracy - 7890: - Temperature : Oven - S: 230.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	None
April 19, 2023 9:21:34 AM	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
April 19, 2023 9:21:35 AM	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
April 19, 2023 9:21:50 AM	Start	Execution	GC Oven Temperature Accuracy - 7890: - Temperature : Oven - S: 100.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	None
April 19, 2023 9:22:10 AM	Audit	Data	GC Oven Temperature Accuracy - 7890: - Temperature : Oven - S: 100.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	Manual Data Entry
April 19, 2023 9:22:12 AM	End	Execution	GC Oven Temperature Accuracy - 7890: - Temperature : Oven - S: 100.0°C - L: >= -1.0 AND <= 1.0 % setpoint in K	Run Count : 1
April 19, 2023 9:22:16 AM	Start	Execution	GC Oven Temperature Stability - 7890: - Temperature : Oven - S: 100.0°C - L: <= 0.5°C	None
April 19, 2023 9:23:09 AM	Audit	Data	GC Oven Temperature Stability - 7890: - Temperature : Oven - S: 100.0°C - L: <= 0.5°C	Manual Data Entry

เอกสารไม่ควบคุม

User Name: saenguthai.tarak
Hostname: LAPTOP-CQ3SKOMV

System Id: CN13113001
Print Date: April 19, 2023 10:36:32 AM

CN13113001_UAE Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
April 19, 2023 9:23:11 AM	End	Execution	GC Oven Temperature Stability - 7890: - Temperature : Oven - S: 100.0°C - L: <= 0.5°C	Run Count : 1
April 19, 2023 9:23:15 AM	Start	Execution	GC Scouting Run - Injection Tower, Front SSL, Front FID: - Part of System Preparation - No limits associated	None
April 19, 2023 9:24:10 AM	Audit	Data	GC Scouting Run - Injection Tower, Front SSL, Front FID: - Part of System Preparation - No limits associated	Data files Path : F:\Data OQ2023\OQ2023_FID 2023-04-18 10-48-18\FID_SC00112.D\FID1A.ch
April 19, 2023 9:24:42 AM	End	Execution	GC Scouting Run - Injection Tower, Front SSL, Front FID: - Part of System Preparation - No limits associated	Run Count : 1
April 19, 2023 9:24:45 AM	Start	Execution	Noise and Drift - Front FID: - Detector FID - L (Noise): <= 0.10 pA - L (Drift): <= 2.50 pA/hour	None
April 19, 2023 9:25:07 AM	Start	Execution	Noise and Drift - Front FID: - Detector FID - L (Noise): <= 0.10 pA - L (Drift): <= 2.50 pA/hour	None
April 19, 2023 9:25:28 AM	Audit	Data	Noise and Drift - Front FID: - Detector FID - L (Noise): <= 0.10 pA - L (Drift): <= 2.50 pA/hour	Data files Path : F:\Data OQ2023\OQ2023_FID 2023-04-18 10-48-18\FID_ND0012.D\FID1A.ch
April 19, 2023 9:25:39 AM	End	Execution	Noise and Drift - Front FID: - Detector FID - L (Noise): <= 0.10 pA - L (Drift): <= 2.50 pA/hour	Run Count : 1

เอกสารไม่ควบคุม

User Name: saenguthai.tarak
Hostname: LAPTOP-CQ3SKOMV

System Id: CN13113001
Print Date: April 19, 2023 10:36:32 AM

CN13113001_UAE Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
April 19, 2023 9:25:42 AM	Start	Execution	Injection Precision - Injection Tower, Front SSL, Front FID: - GC - L (Area): <= 3.00% - L (Ret. Time): <= 1.00%	None
April 19, 2023 9:26:06 AM	Start	Execution	Injection Precision - Injection Tower, Front SSL, Front FID: - GC - L (Area): <= 3.00% - L (Ret. Time): <= 1.00%	None
April 19, 2023 9:26:36 AM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Front FID: - GC - L (Area): <= 3.00% - L (Ret. Time): <= 1.00%	Data files Path : F:\Data OQ2023\OQ2023_FID 2023-04-18 10-48-18\FID_Pre01--005F.D\FID1A.ch
April 19, 2023 9:26:38 AM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Front FID: - GC - L (Area): <= 3.00% - L (Ret. Time): <= 1.00%	Data files Path : F:\Data OQ2023\OQ2023_FID 2023-04-18 10-48-18\FID_Pre01--006F.D\FID1A.ch
April 19, 2023 9:26:38 AM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Front FID: - GC - L (Area): <= 3.00% - L (Ret. Time): <= 1.00%	Data files Path : F:\Data OQ2023\OQ2023_FID 2023-04-18 10-48-18\FID_Pre01--007F.D\FID1A.ch
April 19, 2023 9:26:38 AM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Front FID: - GC - L (Area): <= 3.00% - L (Ret. Time): <= 1.00%	Data files Path : F:\Data OQ2023\OQ2023_FID 2023-04-18 10-48-18\FID_Pre01--008F.D\FID1A.ch
April 19, 2023 9:26:39 AM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Front FID: - GC - L (Area): <= 3.00% - L (Ret. Time): <= 1.00%	Data files Path : F:\Data OQ2023\OQ2023_FID 2023-04-18 10-48-18\FID_Pre01--009F.D\FID1A.ch

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User Name: saenguthai.tarak
Hostname: LAPTOP-CQ3SKOMV

System Id: CN13113001
Print Date: April 19, 2023 10:36:32 AM

CN13113001_UAE Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
April 19, 2023 9:26:39 AM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Front FID: - GC - L (Area): <= 3.00% - L (Ret. Time): <= 1.00%	Data files Path : F:\Data OQ2023\OQ2023_FID 2023-04-18 10-48-18\FID_Pre01--010F.D \FID1A.ch
April 19, 2023 9:27:20 AM	End	Execution	Injection Precision - Injection Tower, Front SSL, Front FID: - GC - L (Area): <= 3.00% - L (Ret. Time): <= 1.00%	Run Count : 1
April 19, 2023 9:27:27 AM	Start	Execution	Signal to Noise - Injection Tower, Front SSL, Front FID: - Detector FID - L: >= 300000	None
April 19, 2023 9:27:43 AM	Start	Execution	Signal to Noise - Injection Tower, Front SSL, Front FID: - Detector FID - L: >= 300000	None
April 19, 2023 9:29:10 AM	Start	Execution	Signal to Noise - Injection Tower, Front SSL, Front FID: - Detector FID - L: >= 300000	None
April 19, 2023 9:29:31 AM	Audit	Data	Signal to Noise - Injection Tower, Front SSL, Front FID: - Detector FID - L: >= 300000	Data files Path : F:\Data OQ2023\OQ2023_FID 2023-04-18 10-48-18\FID_SN--011F1.D\F ID1A.ch
April 19, 2023 9:29:55 AM	End	Execution	Signal to Noise - Injection Tower, Front SSL, Front FID: - Detector FID - L: >= 300000	Run Count : 1
April 19, 2023 10:20:54 AM	Start	Execution	GC Scouting Run - Injection Tower, Front SSL, Back FPD+: - Part of System Preparation - No limits associated	None
April 19, 2023 10:21:35 AM	Audit	Data	GC Scouting Run - Injection Tower, Front SSL, Back FPD+: - Part of System Preparation - No limits associated	Data files Path : F:\Data OQ2023\OQ2023 2023-04-18 13-35-09\FPD_SC001.D\FPD 1B.ch

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User Name: saenguthai.tarak
Hostname: LAPTOP-CQ3SKOMV

System Id: CN13113001
Print Date: April 19, 2023 10:36:32 AM

CN13113001_UAE Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
April 19, 2023 10:22:01 AM	End	Execution	GC Scouting Run - Injection Tower, Front SSL, Back FPD+: - Part of System Preparation - No limits associated	Run Count : 1
April 19, 2023 10:22:07 AM	Start	Execution	Noise and Drift - Back FPD+: - Detector FPD+ P-Mode - L (Noise): <= 2.00 150 pA - L (Drift): <= 1.50 150 pA/hour	None
April 19, 2023 10:22:26 AM	Start	Execution	Noise and Drift - Back FPD+: - Detector FPD+ P-Mode - L (Noise): <= 2.00 150 pA - L (Drift): <= 1.50 150 pA/hour	None
April 19, 2023 10:22:44 AM	Audit	Data	Noise and Drift - Back FPD+: - Detector FPD+ P-Mode - L (Noise): <= 2.00 150 pA - L (Drift): <= 1.50 150 pA/hour	Data files Path : F:\Data OQ2023\OQ2023 2023-04-18 13-35-09\FPD_ND001--006F. D\FPD1B.ch
April 19, 2023 10:22:56 AM	End	Execution	Noise and Drift - Back FPD+: - Detector FPD+ P-Mode - L (Noise): <= 2.00 150 pA - L (Drift): <= 1.50 150 pA/hour	Run Count : 1
April 19, 2023 10:22:58 AM	Start	Execution	Injection Precision - Injection Tower, Front SSL, Back FPD+: - GC - L (Area): <= 3.00% - L (Ret. Time): <= 1.00%	None
April 19, 2023 10:23:29 AM	Start	Execution	Injection Precision - Injection Tower, Front SSL, Back FPD+: - GC - L (Area): <= 3.00% - L (Ret. Time): <= 1.00%	None
April 19, 2023 10:24:08 AM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Back FPD+: - GC - L (Area): <= 3.00% - L (Ret. Time): <= 1.00%	Data files Path : F:\Data OQ2023\OQ2023 2023-04-18 13-35-09\FPD_Pre001--011F .D\FPD1B.ch

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User Name: saenguthai.tarak
Hostname: LAPTOP-CQ3SKOMV

System Id: CN13113001
Print Date: April 19, 2023 10:36:32 AM

CN13113001_UAE Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
April 19, 2023 10:24:08 AM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Back FPD+: - GC - L (Area): <= 3.00% - L (Ret. Time): <= 1.00%	Data files Path : F:\Data OQ2023\OQ2023 2023-04-18 13-35-09\FPD_Pre001--012F .D\FPD1B.ch
April 19, 2023 10:24:08 AM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Back FPD+: - GC - L (Area): <= 3.00% - L (Ret. Time): <= 1.00%	Data files Path : F:\Data OQ2023\OQ2023 2023-04-18 13-35-09\FPD_Pre001--013F .D\FPD1B.ch
April 19, 2023 10:24:08 AM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Back FPD+: - GC - L (Area): <= 3.00% - L (Ret. Time): <= 1.00%	Data files Path : F:\Data OQ2023\OQ2023 2023-04-18 13-35-09\FPD_Pre001--014F .D\FPD1B.ch
April 19, 2023 10:24:10 AM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Back FPD+: - GC - L (Area): <= 3.00% - L (Ret. Time): <= 1.00%	Data files Path : F:\Data OQ2023\OQ2023 2023-04-18 13-35-09\FPD_Pre001--015F .D\FPD1B.ch
April 19, 2023 10:24:10 AM	Audit	Data	Injection Precision - Injection Tower, Front SSL, Back FPD+: - GC - L (Area): <= 3.00% - L (Ret. Time): <= 1.00%	Data files Path : F:\Data OQ2023\OQ2023 2023-04-18 13-35-09\FPD_Pre001--016F .D\FPD1B.ch
April 19, 2023 10:24:31 AM	End	Execution	Injection Precision - Injection Tower, Front SSL, Back FPD+: - GC - L (Area): <= 3.00% - L (Ret. Time): <= 1.00%	Run Count : 1
April 19, 2023 10:24:34 AM	Start	Execution	Signal to Noise - Injection Tower, Front SSL, Back FPD+: - Detector FPD+ - L: >= 2400	None
April 19, 2023 10:25:08 AM	Audit	Data	Signal to Noise - Injection Tower, Front SSL, Back FPD+: - Detector FPD+ - L: >= 2400	Data files Path : F:\Data OQ2023\SN_FPD2.D\FPD1B .ch
April 19, 2023 10:25:15 AM	End	Execution	Signal to Noise - Injection Tower, Front SSL, Back FPD+: - Detector FPD+ - L: >= 2400	Run Count : 1

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User Name: saenguthai.tarak
Hostname: LAPTOP-CQ3SKOMV

System Id: CN13113001
Print Date: April 19, 2023 10:36:32 AM

CN13113001_UAE Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
April 19, 2023 10:25:19 AM	End	Qualification	Session	OQ
April 19, 2023 10:25:19 AM	Start	Reporting	Session	None
April 19, 2023 10:35:32 AM	Audit	Reporting	Session	Report Generated : Certificate

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บริษัท อินทิเกรทเต็ด รีเสิร์ช เซ็นเตอร์ จำกัด

CALIBRATION CERTIFICATE

Submitted by : Integrated Research Center Company Limited.

Address : 122 Moo 2 T.Thatoom A.Srimahaphote Prachinburi 25140.

Calibrated at : Electrical and Electronic Standards Laboratory, Industrial Metrology and Testing Service Centre.

Soi 1C, Bangpoo Industrial Estate, Sukhumvit Rd., A.Muang, Samutprakan 10280.

Instrument Calibrated :

Description : Integrating Sound Level Meter

Manufacturer : ACO

Model : 6236

Serial No. : 192016

Microphone : Type 7052NR No.73305

Preamplifier : -

Ambient Environment

Temperature : (23 ± 3) °C

Relative Humidity : (50 ± 15) %

Ambient Pressure : (101.325±1.5) kPa

Standards used :

1. Band Pass Filter Stanford Research Systems SR 650 S/N 28712.
2. Condenser Microphone Brüel&Kjær 4180 S/N 2889871.
3. Decade Attenuator Ando AL-205 S/N 00464602.
4. Function/Arbitrary Waveform Generator Agilent 33220A S/N MY44042668.
5. Digital Function Synthesizer NF Electronic Instruments DF-193A S/N 122037.
6. Digital Multimeter Fluke 8520A S/N 4985007.
7. Pistonphone Rion NC-72 S/N 00402446.
8. Measuring Amplifier Brüel&Kjær 2636 S/N 1537484.

Date of Receipt : 13 Jan. 2023

Date of Calibration : 7-8 Feb. 2023

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E-mail : sumalee@tistr.or.th

9. Power Amplifier Brüel&Kjær 2706 S/N 1517650.
10. Speaker Tannoy Limited, Great Britain British Patent No. 215300.
11. Digital Multimeter Agilent 34401A S/N MY44005560.
12. Programmable Attenuator Tamagawa TPA-303A S/N 2212.

Calibration Procedure :

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

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

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

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

Date of Calibration : 7-8 Feb. 2023

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1. Absolute Sensitivity

Reference Acoustic Signal (dB)	Measured value (dB)		Deviation value (dB)	Acceptance limit Class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	Before adjust	After adjust				
113.96	109.6	113.9	-0.1	1.0	0.30	N/A

Note: The external calibration adjustment was firstly performed. The internal calibration adjustment was then completed at the display of 115.7 dB.

2. Self-generated noise

2.1 Normal test

Measured value (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
19.8	0.10	N/A

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

Frequency Weighting	Measured value (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
A-Weight	14.7	0.10	N/A
C-Weight	20.6	0.10	N/A
Flat	24.6	0.10	N/A

Date of Calibration : 7-8 Feb. 2023

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3. Acoustical signal test of frequency weightings

Frequency (Hz)	Deviation from frequency response			Acceptance limit class 2 (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	A-weight	C-weight	Flat			
125	0.3	0.2	0.0	±1.5	0.45	0.6
1 000	-0.5	-0.5	-0.3	±1.0	0.45	0.6
8 000	-1.7	-1.7	-2.0	±5.0	0.45	0.7

4. Electrical signal test of frequency weightings

Frequency (Hz)	Deviation from frequency response			Acceptance limit class 2 (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	A-weight	C-weight	Flat			
63	0.1	0.0	0.0	±2.0	0.20	0.6
125	0.0	0.0	0.0	±1.5	0.20	0.6
250	0.0	0.0	0.0	±1.5	0.20	0.6
500	0.0	0.0	0.0	±1.5	0.20	0.6
1 000	0.0	0.0	0.0	±1.0	0.20	0.6
2 000	-0.1	-0.1	0.0	±2.0	0.20	0.6
4 000	-0.4	-0.4	-0.1	±3.0	0.20	0.6
8 000	-0.7	-0.7	-0.2	±5.0	0.20	0.7

Date of Calibration : 7-8 Feb. 2023

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5. Long-term stability

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

6. Frequency and time weightings at 1 kHz

6.1 Frequency weightings at 1 kHz

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

6.2 Time weightings at 1 kHz

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

Date of Calibration : 7-8 Feb. 2023

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7. Level linearity on the reference level range

Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
122	122.2	0.2	1.1	0.30	0.3
121	121.2	0.2	1.1	0.30	0.3
120	120.1	0.1	1.1	0.30	0.3
119	119.1	0.1	1.1	0.30	0.3
114	114.1	0.1	1.1	0.30	0.3
109	109.1	0.1	1.1	0.30	0.3
104	103.9	-0.1	1.1	0.30	0.3
99	99.1	0.1	1.1	0.30	0.3
94	94.0	0.0	1.1	0.30	0.3
89	89.0	0.0	1.1	0.30	0.3
84	83.9	-0.1	1.1	0.30	0.3
79	79.2	0.2	1.1	0.30	0.3
74	74.2	0.2	1.1	0.30	0.3
69	69.2	0.2	1.1	0.30	0.3
64	64.1	0.1	1.1	0.30	0.3
59	59.1	0.1	1.1	0.30	0.3
54	54.1	0.1	1.1	0.30	0.3
49	49.1	0.1	1.1	0.30	0.3
44	44.2	0.2	1.1	0.30	0.3
39	39.1	0.1	1.1	0.30	0.3
34	34.3	0.3	1.1	0.30	0.3

Date of Calibration : 7-8 Feb. 2023

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

Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
33	33.3	0.3	1.1	0.30	0.3
32	32.3	0.3	1.1	0.30	0.3
31	31.4	0.4	1.1	0.30	0.3
30	30.5	0.5	1.1	0.30	0.3

8. Level linearlity including the level range control

At reference sound level on the reference level range

Range	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
40-130	94.0	94.0	0.0	1.1	0.30	0.3
30-120	94.0	94.0	0.0	1.1	0.30	0.3
20-110	94.0	94.0	0.0	1.1	0.30	0.3
20-100	94.0	94.0	0.0	1.1	0.30	0.3

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8. Level linearlity including the level range control

At reference level at 5 dB greater than the signal level that first clause an indication of under-range on a level range

Range	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
40-130	45	45.1	0.1	1.1	0.30	0.3
30-120	35	35.0	0.0	1.1	0.30	0.3
20-110	25	25.5	0.5	1.1	0.30	0.3
20-100	25	25.6	0.6	1.1	0.30	0.3
20-90	25	25.4	0.4	1.1	0.30	0.3
20-80	25	25.2	0.2	1.1	0.30	0.3

9. Tone burst response

Time Weighting	Toneburst Duration, Tb (ms)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Fast	200	116.0	0.0	±1.0	0.20	0.3
	2	98.8	-0.2	+1.0; -2.5	0.20	0.3
	0.25	89.6	-0.4	+1.5; -5.0	0.20	0.3
Slow	200	109.4	-0.2	±1.0	0.20	0.3
	2	89.7	-0.3	+1.0; -5.0	0.20	0.3
SEL	200	109.9	-0.1	±1.0	0.20	0.3
	2	90.0	0.0	+1.0; -2.5	0.20	0.3
	0.25	80.9	-0.1	+1.5; -5.0	0.20	0.3

Date of Calibration : 7-8 Feb. 2023

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10. Peak C sound level

Number of cycles in test signal	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Complete cycle	125.4	125.8	0.4	3.0	0.20	0.35
Positive half cycle	124.4	124.2	-0.2	2.0	0.20	0.35
Negative half cycle	124.4	124.2	-0.2	2.0	0.20	0.35

11. Overload indication

Measured value (dB)		Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Positive one-half cycle	Negative one-half cycle				
131.1	131.1	0.0	2.0	0.20	0.25

12. High-level stability

Time	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Begin	119.0	0.0	0.3	0.10	0.1
End	119.0				

Calibrated by [redacted]

(Mr. Pannasit Phasingsri)

Approved by : [redacted]

(Mr. Prawate Klinaypa)
Director
Electrical and Electronic Standards Laboratory
Industrial Metrology and Testing Service Centre

Date of Calibration : 7-8 Feb. 2023

Date of Issue : 13 Feb. 2023

Ref : 2011266011300149018

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Request No. 21-66/0219 **MTC No.** EEL. BP. 144/0166

CALIBRATION CERTIFICATE

Submitted by : Integrated Research Center Company Limited.

Address : 122 Moo 2 T.Thatoom, A.Srimahaphote, Prachinburi 25140

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

Instrument Calibrated :

Description : Sound Level Meter
Manufacturer : ACO
Model : 6236
Serial No. : 192014
Microphone : 7052NR No.73303
Preamplifier : -

Ambient Environment

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

Standards used :

1. Band Pass Filter Stanford Research Systems SR 650 S/N 28712.
2. Condenser Microphone Brüel&Kjær 4180 S/N 2889871.
3. Decade Attenuator Ando AL-205 S/N 00464602.
4. Function/Arbitrary Waveform Generator Agilent 33220A S/N MY44042668.
5. Digital Function Synthesizer NF Electronic Instruments DF-193A S/N 122037.
6. Digital Multimeter Fluke 8520A S/N 4985007.
7. Pistonphone Rion NC-72 S/N 00402446.
8. Measuring Amplifier Brüel&Kjær 2636 S/N 1537484.

Date of Receipt : 13 Jan. 2023

Date of Calibration : 13 Feb. 2023

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Request No. 21-66/0219 **MTC No.** EEL. BP. 144/0166

9. Power Amplifier Brüel&Kjær 2706 S/N 1517650.
10. Speaker Tannoy Limited, Great Britain British Patent No. 215300.
11. Digital Multimeter Agilent 34401A S/N MY44005560.
12. Programmable Attenuator Tamagawa TPA-303A S/N 2212.

Calibration Procedure :

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

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

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

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

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Request No. 21-66/0219 **MTC No.** EEL. BP. 144/0166

1. Absolute Sensitivity

Reference Acoustic Signal (dB)	Measured value (dB)		Deviation value(dB)	Acceptance limit class 2(±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	Before adjust	After adjust				
114.00	113.9	114.0	0.0	1.0	0.30	N/A

Note: The external calibration adjustment was firstly performed. The internal calibration adjustment was then completed at the display of 114.1 dB.

2. Self-generated noise

2.1 Normal test

Measured value (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
19.7	0.10	N/A

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

Frequency Weighting	Measured value (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
A-Weight	13.1	0.10	N/A
C-Weight	18.0	0.10	N/A
Flat	21.9	0.10	N/A

Date of Calibration : 13 Feb. 2023

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Request No. 21-66/0219 **MTC No.** EEL. BP. 144/0166

3. Acoustical signal test of frequency weightings

Frequency (Hz)	Deviation from frequency response curve(dB) A-weight	C-weight	Flat	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
125	0.1	0.1	0.0	1.5	0.45	0.6
1 000	-0.6	-0.6	-0.5	1.0	0.45	0.6
8 000	-2.3	-2.5	-2.1	5.0	0.45	0.7

4. Electrical signal test of frequency weightings

Frequency (Hz)	Deviation from frequency response curve(dB) A-weight	C-weight	Flat	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
63	0.1	0.0	-0.1	2.0	0.20	0.6
125	0.0	0.0	-0.1	1.5	0.20	0.6
250	0.0	0.0	0.0	1.5	0.20	0.6
500	0.0	0.0	0.0	1.5	0.20	0.6
1 000	0.0	0.0	0.0	1.0	0.20	0.6
2 000	-0.1	0.0	-0.1	2.0	0.20	0.6
4 000	-0.4	-0.4	-0.1	3.0	0.20	0.6
8 000	-0.6	-0.6	-0.2	5.0	0.20	0.7

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Request No. 21-66/0219 **MTC No.** EEL. BP. 144/0166

5. Long-term stability

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

6. Frequency and time weightings at 1 kHz

6.1 Frequency weightings at 1 kHz

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

6.2 Time weightings at 1 kHz

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

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Request No. 21-66/0219 **MTC No.** EEL. BP. 144/0166

7. Level linearity on the reference level range

Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
120	120.0	0.0	1.1	0.30	0.3
119	119.0	0.0	1.1	0.30	0.3
114	113.9	-0.1	1.1	0.30	0.3
109	109.0	0.0	1.1	0.30	0.3
104	104.0	0.0	1.1	0.30	0.3
99	99.0	0.0	1.1	0.30	0.3
94	94.0	0.0	1.1	0.30	0.3
89	88.9	-0.1	1.1	0.30	0.3
84	84.0	0.0	1.1	0.30	0.3
79	79.0	0.0	1.1	0.30	0.3
74	74.0	0.0	1.1	0.30	0.3
69	69.0	0.0	1.1	0.30	0.3
64	63.9	-0.1	1.1	0.30	0.3
59	58.9	-0.1	1.1	0.30	0.3
54	53.9	-0.1	1.1	0.30	0.3
49	49.0	0.0	1.1	0.30	0.3
44	44.0	0.0	1.1	0.30	0.3
39	38.9	-0.1	1.1	0.30	0.3

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Request No. 21-66/0219 **MTC No.** EEL. BP. 144/0166

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

Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
34	34.0	0.0	1.1	0.30	0.3
33	33.0	0.0	1.1	0.30	0.3
32	32.1	0.1	1.1	0.30	0.3
31	31.1	0.1	1.1	0.30	0.3
30	30.2	0.2	1.1	0.30	0.3

8. Level linearlity including the level range control

At reference sound level on the reference level range

Range	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2(±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
40-130	94.0	94.0	0.0	1.1	0.30	0.3
30-120	94.0	94.0	0.0	1.1	0.30	0.3
20-110	94.0	94.0	0.0	1.1	0.30	0.3
20-100	94.0	94.0	0.0	1.1	0.30	0.3

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8. Level linearlity including the level range control

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

Range	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2(±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
40-130	45	45.0	0.0	1.1	0.30	0.3
30-120	35	35.0	0.0	1.1	0.30	0.3
20-110	25	25.3	0.3	1.1	0.30	0.3
20-100	25	25.3	0.3	1.1	0.30	0.3
20-90	25	25.2	0.2	1.1	0.30	0.3
20-80	25	25.0	0.0	1.1	0.30	0.3

9. Tone burst response

Time Weighting	Toneburst Duration, Tb(ms)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2(dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Fast	200	116.0	0.0	±1.0	0.20	0.3
	2	98.9	-0.1	+1.0; -2.5	0.20	0.3
	0.25	89.2	-0.8	+1.5; -5.0	0.20	0.3
Slow	200	109.5	-0.1	±1.0	0.20	0.3
	2	89.8	-0.2	+1.0; -5.0	0.20	0.3
SEL	200	109.9	-0.1	±1.0	0.20	0.3
	2	90.0	0.0	+1.0; -2.5	0.20	0.3
	0.25	80.9	-0.1	+1.5; -5.0	0.20	0.3

Date of Calibration : 13 Feb. 2023

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10. Peak C sound level

Number of cycles in test signal	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2(±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Complete cycle	125.4	125.8	0.4	3.0	0.20	0.35
Positive half cycle	124.4	124.2	-0.2	2.0	0.20	0.35
Negative half cycle	124.4	124.2	-0.2	2.0	0.20	0.35

11. Overload indication

Measured value (dB)		Deviated value (dB)	Acceptance limit class 2(±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Positive one-half cycle	Negative one-half cycle				
133.0	133.0	0.0	1.5	0.20	0.25

12. High-level stability

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

Calibrated by [redacted]
(Mr. Wittawat Supanich)

Approved by : [redacted]
(Mr. Prawate Khuypa)
Director
Electrical and Electronic Standards Laboratory
Industrial Metrology and Testing Service Centre

Date of Calibration : 13 Feb. 2023
Date of Issue : 13 Feb. 2023
Ref : 2011266011300149010

End of Certificate

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E-mail : sumalee@tistr.or.th

CALIBRATION CERTIFICATE

Submitted by : Integrated Research Center Company Limited.
Address : 122 Moo 2 T.Thatoom A.Srimahaphote, Prachinburi 25140.
Calibrated at : Electrical and Electronic Standards Laboratory, Industrial Metrology and Testing Service Centre.
Soi 1C, Bangpoo Industrial Estate, Sukhumvit Rd., A.Muang, Samutprakan 10280.

Instrument Calibrated :

Description : Sound Level Meter
Manufacturer : Delta OHM
Model : HD 2010UC
Serial No. : 11040842479
Microphone : Type UC-52 No.114674
Preamplifier : Delta Type HD2010PNE2 No.11001018

Ambient Environment

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

Standards used :

1. Band Pass Filter Stanford Research Systems SR 650 S/N 28712.
2. Condenser Microphone Brüel&Kjær 4180 S/N 2889871.
3. Decade Attenuator Ando AL-205 S/N 00464602.
4. Function/Arbitrary Waveform Generator Agilent 33220A S/N MY44042668.
5. Digital Function Synthesizer NF Electronic Instruments DF-193A S/N 122037.
6. Digital Multimeter Fluke 8520A S/N 4985007.
7. Pistonphone Rion NC-72 S/N 00402446.
8. Measuring Amplifier Brüel&Kjær 2636 S/N 1537484.

Date of Receipt : 1 Feb. 2023
Date of Calibration : 20-21 Feb. 2023

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9. Power Amplifier Brüel&Kjær 2706 S/N 1517650.
10. Speaker Tannoy Limited, Great Britain British Patent No. 215300.
11. Digital Multimeter Agilent 34401A S/N MY44005560.
12. Programmable Attenuator Tamagawa TPA-303A S/N 2212.

Calibration Procedure :

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

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

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

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

Date of Calibration : 20-21 Feb. 2023

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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-66/0268 **MTC No.** EEL. BP. 15/0266

1. Absolute Sensitivity

Reference Acoustic Signal (dB)	Measured value (dB)		Deviation value (dB)	Acceptance limit Class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	Before adjust	After adjust				
113.96	114.2	114.0	0.0	1.0	0.30	N/A

Note: The external calibration adjustment was firstly performed. The internal calibration adjustment was then completed at the display of 114.2 dB.

2. Self-generated noise

2.1 Normal test

Measured value (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
23.1	0.10	N/A

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

Frequency Weighting	Measured value (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
A-Weight	19.1	0.10	N/A
C-Weight	27.3	0.10	N/A
Flat	31.1	0.10	N/A

Date of Calibration : 20-21 Feb. 2023

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NSC-TISI-TIS 17025
CALIBRATION 0037

THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-66/0268 **MTC No.** EEL. BP. 15/0266

3. Acoustical signal test of frequency weightings

Frequency (Hz)	Deviation from frequency response (dB)			Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	A-weight	C-weight	Flat			
125	0.3	0.2	0.2	1.5	0.45	0.6
1 000	-0.4	-0.4	-0.4	1.0	0.45	0.6
8 000	-4.5	-3.9	-4.5	5.0	0.45	0.7

4. Electrical signal test of frequency weightings

Frequency (Hz)	Deviation from frequency response (dB)			Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	A-weight	C-weight	Flat			
63	-0.1	-0.2	-0.4	2.0	0.20	0.6
125	0.0	-0.1	-0.1	1.5	0.20	0.6
250	0.0	-0.1	-0.1	1.5	0.20	0.6
500	0.0	0.0	0.0	1.5	0.20	0.6
1 000	0.0	0.0	0.0	1.0	0.20	0.6
2 000	0.0	0.0	0.1	2.0	0.20	0.6
4 000	0.0	0.1	0.1	3.0	0.20	0.6
8 000	0.0	0.1	0.1	5.0	0.20	0.7

Date of Calibration : 20-21 Feb. 2023

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FM.BL.MTC.002 Rev.4

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NSC-TISI-TIS 17025
CALIBRATION 0037

THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-66/0268 **MTC No.** EEL. BP. 15/0266

5. Long-term stability

Time	Measured Value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Begin	114.0	0.0	0.3	0.10	0.1
End	114.0				

6. Frequency and time weightings at 1 kHz

6.1 Frequency weightings at 1 kHz

Frequency Weighting	Measured Value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
A-weight	114.0	0.0	0.2	0.20	0.2
C-weight	114.0	0.0	0.2	0.20	0.2
Flat	114.0	0.0	0.2	0.20	0.2

6.2 Time weightings at 1 kHz

Frequency Weighting	Measured Value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Fast	114.0	0.0	0.1	0.20	0.2
Slow	114.0	0.0	0.1	0.20	0.2
Leq	114.0	0.0	0.1	0.20	0.2

Date of Calibration : 20-21 Feb. 2023

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NSC-TISI-TIS 17025
CALIBRATION 0037

THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-66/0268 **MTC No.** EEL. BP. 15/0266

7. Level linearity on the reference level range

Anticipated value (dB)	Measured Value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
120	120.0	0.0	1.1	0.30	0.3
119	119.0	0.0	1.1	0.30	0.3
114	114.0	0.0	1.1	0.30	0.3
109	109.0	0.0	1.1	0.30	0.3
104	104.0	0.0	1.1	0.30	0.3
99	99.0	0.0	1.1	0.30	0.3
94	94.0	0.0	1.1	0.30	0.3
89	89.0	0.0	1.1	0.30	0.3
84	84.0	0.0	1.1	0.30	0.3
79	79.0	0.0	1.1	0.30	0.3
74	74.0	0.0	1.1	0.30	0.3
69	69.0	0.0	1.1	0.30	0.3
64	64.0	0.0	1.1	0.30	0.3
59	59.0	0.0	1.1	0.30	0.3
54	54.0	0.0	1.1	0.30	0.3
49	49.0	0.0	1.1	0.30	0.3
44	44.0	0.0	1.1	0.30	0.3
39	39.1	0.1	1.1	0.30	0.3

Date of Calibration : 20-21 Feb. 2023

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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-66/0268 **MTC No.** EEL. BP. 15/0266

8. Level linearlity including the level range control

At reference sound level on the reference level range

Range	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
60-140	114.0	114.0	0.0	1.1	0.30	0.3
50-130	114.0	114.0	0.0	1.1	0.30	0.3
40-120	114.0	114.0	0.0	1.1	0.30	0.3

Date of Calibration : 20-21 Feb. 2023 [redacted]

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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-66/0268 **MTC No.** EEL. BP. 15/0266

8. Level linearlity including the level range control

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

Range	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
60-140	65	65.2	0.2	1.1	0.30	0.3
50-130	55	55.0	0.0	1.1	0.30	0.3
40-120	45	45.0	0.0	1.1	0.30	0.3
30-110	35	35.1	0.1	1.1	0.30	0.3
20-100	25	25.9	0.9	1.1	0.30	0.3

9. Tone burst response

Time Weighting	Toneburst Duration, Tb (ms)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Fast	200	115.9	-0.1	±1.0	0.20	0.3
	2	98.8	-0.2	+1.0; -2.5	0.20	0.3
	0.25	89.6	-0.4	+1.5; -5.0	0.20	0.3
Slow	200	109.4	-0.2	±1.0	0.20	0.3
	2	89.8	-0.2	+1.0; -5.0	0.20	0.3
SEL	200	109.9	-0.1	±1.0	0.20	0.3
	2	90.0	0.0	+1.0; -2.5	0.20	0.3
	0.25	80.9	-0.1	+1.5; -5.0	0.20	0.3

Date of Calibration ; 20-21 Feb. 2023 [redacted]

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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-66/0268 **MTC No.** EEL. BP. 15/0266

10. Peak C sound level

Number of cycles in test signal	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Complete cycle	135.4	135.3	-0.1	3.0	0.20	0.35
Positive half cycle	134.4	134.0	-0.4	2.0	0.20	0.35
Negative half cycle	134.4	134.0	-0.4	2.0	0.20	0.35

11. Overload indication

Measured value (dB)		Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Positive one-half cycle	Negative one-half cycle				
141.0	141.0	0.0	1.5	0.20	0.25

12. High-level stability

Time	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Begin	139.0	0.0	0.3	0.10	0.1
End	139.0				

Calibrated b [redacted]

(Mr. Pannasit Phasingsri)

Approved by : [redacted]

(Mr. Prawate Kluaypa)
Director
Electrical and Electronic Standards Laboratory
Industrial Metrology and Testing Service Centre
Ref : 20112660201004530 01

Date of Calibration : 20-21 Feb. 2023

Date of Issue : 28 Feb. 2023

End of Certificate

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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-66/0219 **MTC No.** EEL. BP. 139/0166

CALIBRATION CERTIFICATE

Submitted by : Integrated Research Center Company Limited.

Address : 122 Moo 2 T.Thatoom, A.Srimahaphote, Prachinburi 25140

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

Instrument Calibrated :

Description : Sound Level Meter
Manufacturer : ACO
Model : 6236
Serial No. : 212016
Microphone : 7052NR No.76237
Preamplifier : -

Ambient Environment

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

Standards used :

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2. Condenser Microphone Brüel&Kjær 4180 S/N 2889871.
3. Decade Attenuator Ando AL-205 S/N 00464602.
4. Function/Arbitrary Waveform Generator Agilent 33220A S/N MY44042668.
5. Digital Function Synthesizer NF Electronic Instruments DF-193A S/N 122037.
6. Digital Multimeter Fluke 8520A S/N 4985007.
7. Pistonphone Rion NC-72 S/N 00402446.
8. Measuring Amplifier Brüel&Kjær 2636 S/N 1537484.

Date of Receipt : 13 Jan. 2023

Date of Calibration : 10 Feb. 2023

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10. Speaker Tannoy Limited, Great Britain British Patent No. 215300.
11. Digital Multimeter Agilent 34401A S/N MY44005560.
12. Programmable Attenuator Tamagawa TPA-303A S/N 2212.

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

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

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

Date of Calibration : 10 Feb. 2023

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NSC-TISI-TIS 17025
CALIBRATION 0037

THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-66/0219 **MTC No.** EEL. BP. 139/0166

1. Absolute Sensitivity

Reference Acoustic Signal (dB)	Measured value (dB)		Deviation value(dB)	Acceptance limit class 2(±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	Before adjust	After adjust				
114.00	114.5	114.0	0.0	1.0	0.30	N/A

Note: The external calibration adjustment was firstly performed. The internal calibration adjustment was then completed at the display of 113.6 dB.

2. Self-generated noise

2.1 Normal test

Measured value (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
20.1	0.10	N/A

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

Frequency Weighting	Measured value (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
A-Weight	13.9	0.10	N/A
C-Weight	18.7	0.10	N/A
Flat	23.6	0.10	N/A

Date of Calibration : 10 Feb. 2023

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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-66/0219 **MTC No.** EEL. BP. 139/0166

3. Acoustical signal test of frequency weightings

Frequency (Hz)	Deviation from frequency response curve(dB)			Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	A-weight	C-weight	Flat			
125	0.1	0.0	-0.1	1.5	0.45	0.6
1 000	-0.9	-0.9	-0.7	1.0	0.45	0.6
8 000	0.4	0.4	0.7	5.0	0.45	0.7

4. Electrical signal test of frequency weightings

Frequency (Hz)	Deviation from frequency response curve(dB)			Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	A-weight	C-weight	Flat			
63	0.1	0.0	0.0	2.0	0.20	0.6
125	0.1	0.0	0.0	1.5	0.20	0.6
250	0.0	0.0	0.0	1.5	0.20	0.6
500	0.0	0.0	0.0	1.5	0.20	0.6
1 000	0.0	0.0	0.0	1.0	0.20	0.6
2 000	-0.1	-0.1	0.0	2.0	0.20	0.6
4 000	-0.4	-0.4	-0.1	3.0	0.20	0.6
8 000	-0.6	-0.6	-0.2	5.0	0.20	0.7

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5. Long-term stability

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

6. Frequency and time weightings at 1 kHz

6.1 Frequency weightings at 1 kHz

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

6.2 Time weightings at 1 kHz

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

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7. Level linearity on the reference level range

Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
120	120.0	0.0	1.1	0.30	0.3
119	119.0	0.0	1.1	0.30	0.3
114	113.9	-0.1	1.1	0.30	0.3
109	109.0	0.0	1.1	0.30	0.3
104	103.9	-0.1	1.1	0.30	0.3
99	99.0	0.0	1.1	0.30	0.3
94	94.0	0.0	1.1	0.30	0.3
89	88.9	-0.1	1.1	0.30	0.3
84	83.9	-0.1	1.1	0.30	0.3
79	79.1	0.1	1.1	0.30	0.3
74	74.1	0.1	1.1	0.30	0.3
69	69.0	0.0	1.1	0.30	0.3
64	63.9	-0.1	1.1	0.30	0.3
59	59.0	0.0	1.1	0.30	0.3
54	53.9	-0.1	1.1	0.30	0.3
49	49.0	0.0	1.1	0.30	0.3
44	44.0	0.0	1.1	0.30	0.3
39	39.0	0.0	1.1	0.30	0.3

Date of Calibration : 10 Feb. 2023

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

Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
34	34.0	0.0	1.1	0.30	0.3
33	33.0	0.0	1.1	0.30	0.3
32	32.1	0.1	1.1	0.30	0.3
31	31.1	0.1	1.1	0.30	0.3
30	30.2	0.2	1.1	0.30	0.3

8. Level linearlity including the level range control

At reference sound level on the reference level range

Range	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2(±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
40-130	94.0	93.9	-0.1	1.1	0.30	0.3
30-120	94.0	94.0	0.0	1.1	0.30	0.3
20-110	94.0	93.9	-0.1	1.1	0.30	0.3
20-100	94.0	93.9	-0.1	1.1	0.30	0.3

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8. Level linearlity including the level range control

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

Range	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2(±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
40-130	45	45.0	0.0	1.1	0.30	0.3
30-120	35	35.0	0.0	1.1	0.30	0.3
20-110	25	25.1	0.1	1.1	0.30	0.3
20-100	25	25.2	0.2	1.1	0.30	0.3
20-90	25	25.2	0.2	1.1	0.30	0.3
20-80	25	25.1	0.1	1.1	0.30	0.3

9. Tone burst response

Time Weighting	Toneburst Duration, Tb(ms)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2(dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Fast	200	115.8	-0.2	±1.0	0.20	0.3
	2	98.9	-0.1	+1.0; -2.5	0.20	0.3
	0.25	89.8	-0.2	+1.5; -5.0	0.20	0.3
Slow	200	109.5	-0.1	±1.0	0.20	0.3
	2	89.8	-0.2	+1.0; -5.0	0.20	0.3
SEL	200	110.0	0.0	±1.0	0.20	0.3
	2	90.0	0.0	+1.0; -2.5	0.20	0.3
	0.25	80.9	-0.1	+1.5; -5.0	0.20	0.3

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10. Peak C sound level

Number of cycles in test signal	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2(±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Complete cycle	125.4	125.8	0.4	3.0	0.20	0.35
Positive half cycle	124.4	124.2	-0.2	2.0	0.20	0.35
Negative half cycle	124.4	124.2	-0.2	2.0	0.20	0.35

11. Overload indication

Measured value (dB)		Deviated value (dB)	Acceptance limit class 2(±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Positive one-half cycle	Negative one-half cycle				
133.0	133.0	0.0	1.5	0.20	0.25

12. High-level stability

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

Calibrated by : [redacted]
(Mr. Wittawat Supanich)

Approved by : [redacted]
(Mr. Pruwate Khuaypa)
Director
Electrical and Electronic Standards Laboratory
Industrial Metrology and Testing Service Centre

Date of Calibration : 10 Feb. 2023
Date of Issue : 10 Feb. 2023

Ref : 2011266011300149005

End of Certificate

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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-66/0219 **MTC No.** EEL. BP. 135/0166

CALIBRATION CERTIFICATE

Submitted by : Integrated Research Center Company Limited.

Address : 122 Moo 2 T.Thatoom A.Srimahaphote Prachinburi 25140.

Calibrated at : Electrical and Electronic Standards Laboratory, Industrial Metrology and Testing Service Centre.

: Soi 1C, Bangpoo Industrial Estate, Sukhumvit Rd., Muang, Samutprakan 10280.

Instrument Calibrated :

Description : Sound Calibrator

Manufacturer : ACO

Model : 2127

Serial No. : 100012

Ambient Environment

Temperature : (23 ± 3) °C

Relative Humidity : (50 ± 15) %

Ambient Pressure : (101.325 ± 1.500) kPa

Standards used :
1. Digital Function Synthesizer NF Electronic DF-193A S/N 122037.
2. Measuring Amplifier Bruel&Kjaer 2636 S/N 1537484.
3. Programmable Attenuator Tamagawa TPA-303A S/N OF 2214.
4. Digital Multimeter Agilent 34401A S/N MY44005560.
5. Pressure Transmitter Vaisala PTB202AD S/N T0650001.
6. Audio Analyzer Keithley 2015-P S/N 4106495.
7. Condenser Microphone Bruel&Kjaer 4180 S/N 2889871.

Calibration Procedure: CP-102-04 based on IEC 60942-2003. The sound pressure level of instrument was measured by standard microphone using an insert voltage technique.

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

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

Date of Receipt : 13 Jan. 2023

Date of Calibration : 18 Jan. 2023

[redacted]

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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-66/0219 **MTC No.** EEL. BP. 135/0166

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

Nominal Output of Unit Under Test = 94 dB re 20μPa at 1000 Hz

Acoustic Output in dB re 20μPa , Corrected to Reference Conditions : 101.325 kPa , 23.0°C and 50 %RH

1. Sound Pressure Level

Standard Microphone Type	Measured Sound Pressure Level (dB)	Deviated value (dB)	Uncertainty (dB)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer 4180	93.92	-0.08	± 0.10	±0.40 dB

2. Frequency

Standard Microphone Type	Measured Frequency (Hz)	Deviated value (Hz)	Uncertainty (Hz)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer 4180	999.9	-0.1	± 1.5	±1.0%

3. Total distortion

Standard Microphone Type	Measured Total distortion (%)	Uncertainty (%)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer 4180	2.15	± 0.50	±3.0%

Note : 1. No adjustment.
2. The calibrator pressure correction was not included.
3. The microphone volume correction was not included.

Calibrated by : [redacted]

(Mr.Weerachai Deechaiyae)

Approved by : [redacted]

(Mr.Prawate Kluaypa)

Director

Electrical and Electronic Standards Laboratory

Industrial Metrology and Testing Service Centre

Date of Calibration : 18 Jan. 2023

Date of Issue : 19 Jan. 2023

Ref : 2011266011300149001

End of Certificate

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Request No. 21-66/0219 **MTC No.** EEL. BP. 137/0166

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Submitted by : Integrated Research Center Company Limited

Address : 122 Moo 2 T.Thatoom A.Srimahaphote Prachinburi 25140.

Calibrated at : Electrical and Electronic Standards Laboratory, Industrial Metrology and Testing Service Centre.

: Soi 1C, Bangpoo Industrial Estate, Sukhumvit Rd., Muang, Samutprakan 10280.

Instrument Calibrated :

Description : Sound Calibrator

Manufacturer : Delta Ohm

Model : HD9102

Serial No. : 10038483

Ambient Environment

Temperature : (23 ± 3) °C

Relative Humidity : (50 ± 15) %

Ambient Pressure : (101.325 ± 1.500) kPa

Standards used :
1. Digital Function Synthesizer NF Electronic DF-193A S/N 122037.
2. Measuring Amplifier Bruel&Kjaer 2636 S/N 1537484.
3. Programmable Attenuator Tamagawa TPA-303A S/N OF 2214.
4. Digital Multimeter Agilent 34401A S/N MY44005560.
5. Pressure Transmitter Vaisala PTB202AD S/N T0650001.
6. Audio Analyzer Keithley 2015-P S/N 4106495.
7. Condenser Microphone Bruel&Kjaer 4180 S/N 2889871.

Calibration Procedure: CP-102-04 based on IEC 60942-2003. The sound pressure level of instrument was measured by standard microphone using an insert voltage technique.

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Nominal Output of Unit Under Test = 94 dB re 20μPa at 1000 Hz

Acoustic Output in dB re 20μPa , Corrected to Reference Conditions : 101.325 kPa , 23.0°C and 50 %RH

1. Sound Pressure Level

Standard Microphone Type	Measured Sound Pressure Level (dB)	Deviated value (dB)	Uncertainty (dB)	Tolerance limit IEC60942:2003 Class 2
1/2 inch Bruel&Kjaer 4180	93.99	-0.01	± 0.10	±0.75 dB

2. Frequency

Standard Microphone Type	Measured Frequency (Hz)	Deviated value (Hz)	Uncertainty (Hz)	Tolerance limit IEC60942:2003 Class 2
1/2 inch Bruel&Kjaer 4180	988.7	-11.3	± 1.5	±2.0%

3. Total distortion

Standard Microphone Type	Measured Total distortion (%)	Uncertainty (%)	Tolerance limit IEC60942:2003 Class 2
1/2 inch Bruel&Kjaer 4180	1.02	± 0.60	±4.0%

Note : 1. No adjustment.
2. The calibrator pressure correction was not included.
3. The microphone volume correction was not included.

Date of Calibration : 18 Jan. 2023

The results relate only to the items tested/calibrated or value assigned.
Advertising the Report/Certificate and publicity of the results except in full are prohibited unless written permission is obtained from the governor of TISTR.

FM.BL.MTC.002 Rev.4

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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-66/0219 **MTC No.** EEL. BP. 137/0166

Nominal Output of Unit Under Test = 114 dB re 20µPa at 1000 Hz

Acoustic Output in dB re 20µPa , Corrected to Reference Conditions : 101.325 kPa , 23.0 °C and 50 %RH

1. Sound Pressure Level

Standard Microphone Type	Measured Sound Pressure Level (dB)	Deviated value (dB)	Uncertainty (dB)	Tolerance limit IEC60942:2003 Class 2
1/2 inch Bruel&Kjaer 4180	113.96	-0.04	± 0.10	±0.75 dB

2. Frequency

Standard Microphone Type	Measured Frequency (Hz)	Deviated value (Hz)	Uncertainty (Hz)	Tolerance limit IEC60942:2003 Class 2
1/2 inch Bruel&Kjaer 4180	988.7	-11.3	± 1.5	±2.0%

3. Total Distortion

Standard Microphone Type	Measured Total Distortion (%)	Uncertainty (%)	Tolerance limit IEC60942:2003 Class 2
1/2 inch Bruel&Kjaer 4180	0.32	± 0.60	±4.0%

Note : 1. No adjustment.

2. The calibrator pressure correction was not included.

3. The microphone volume correction was not included.

Calibrated by : [redacted]

(Mr.Weerachai Deechaiyae)

Approved by : [redacted]

(Mr.Prawate Kluaypa)

Director

Electrical and Electronic Standards Laboratory

Industrial Metrology and Testing Service Centre

Ref : 2011266011300149003

Date of Calibration : 18 Jan. 2023

Date of Issue : 19 Jan. 2023

End of Certificate

3 / 3

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Airgas
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Airgas Specialty Gases
Airgas USA, LLC
600 Union Landing Road
Cinnaminson, NJ 08077-0000
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Part Number:	E03NI99E80A0020	Reference Number:	82-401285019-1
Cylinder Number:	LL193324	Cylinder Volume:	83.4 CF
Laboratory:	124 - Riverton (SAP) - NJ	Cylinder Pressure:	2215 PSIG
PGVP Number:	B52018	Valve Outlet:	660
Gas Code:	NO,NOX,SO2,BALN	Certification Date:	Sep 05, 2018

Expiration Date: Sep 05, 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	50.71 PPM	G1	+/- 1.4% NIST Traceable	08/27/2018, 09/05/2018
NITRIC OXIDE	50.00 PPM	50.67 PPM	G1	+/- 1.4% NIST Traceable	08/27/2018, 09/05/2018
SULFUR DIOXIDE	50.00 PPM	50.54 PPM	G1	+/- 1.0% NIST Traceable	08/27/2018, 09/05/2018
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	16060625	CC442585	50.42 PPM NITRIC OXIDE/NITROGEN	+/- 0.8%	Jun 27, 2020
PRM	12368	5604119	29.86 PPM NITROGEN DIOXIDE/AIR	+/- 1.5%	Jun 02, 2017
GMIS	7042010104	CC503941	5.101 PPM NITROGEN DIOXIDE/NITROGEN	+/- 2.0%	Jun 01, 2020
NTRM	14010327	KAL004376	49.08 PPM SULFUR DIOXIDE/NITROGEN	+/- 1.0%	Apr 17, 2024

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 NO	FTIR	Aug 09, 2018
Nicolet 6700 APW1100391 NO2	FTIR	Aug 31, 2018
Nicolet 6700 APW1100391 SO2	FTIR	Aug 30, 2018

Triad Data Available Upon Request

NOTES:PO# 5218003935

Net weight: 2736 grams
Gross weight: 17393 grams

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 9001:2008 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.

ACCREDITED

TESTING CERT No. 3082.05

[redacted]