

ภาคผนวก ช  
เอกสารสอบเทียบเครื่องมือ

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# Certificate of Calibration

Calibration Certification Information			
Cal. Date:	July 5, 2022	Rootsmeter S/N: 438320	Ta: 297 °K
Operator:	Jim Tisch		Pa: 750.1 mm Hg
Calibration Model #:	G25A	Calibrator S/N: 158M	

Run	Vol. Init (m3)	Vol. Final (m3)	ΔVol. (m3)	ΔTime (min)	ΔP (mm Hg)	ΔH (in H2O)
1	1	2	1	1.3240	3.2	2.00
2	3	4	1	0.9480	6.4	4.00
3	5	6	1	0.8480	7.9	5.00
4	7	8	1	0.8060	8.7	5.50
5	9	10	1	0.6670	12.7	8.00

Data Tabulation					
Vstd (m3)	Qstd (x-axis)	$\sqrt{\Delta H \left( \frac{Pa}{Pstd} \right) \left( \frac{Tstd}{Ta} \right)}$ (y-axis)	Va	Qa (x-axis)	$\sqrt{\Delta H \left( \frac{Ta}{Pa} \right)}$ (y-axis)
0.9860	0.7447	1.4073	0.9957	0.7521	0.8899
0.9818	1.0357	1.9902	0.9915	1.0459	1.2585
0.9798	1.1554	2.2251	0.9895	1.1668	1.4071
0.9788	1.2143	2.3337	0.9884	1.2263	1.4757
0.9735	1.4595	2.8146	0.9831	1.4739	1.7798
QSTD		m= 1.96745	QA		m= 1.23199
		b= -0.05315			b= -0.03361
		r= 0.99995			r= 0.99995

Calculations	
Vstd= ΔVol/((Pa-ΔP)/Pstd)(Tstd/Ta)	Va= ΔVol/((Pa-ΔP)/Pa)
Qstd= Vstd/ΔTime	Qa= Va/ΔTime
For subsequent flow rate calculations:	
Qstd= 1/m ( √ ( ΔH ( Pa Pstd ) ( Tstd Ta ) ) ) -b	Qa= 1/m ( √ ( ΔH Ta/Pa ) ) -b

Standard Conditions	
Tstd: 298.15 °K	
Pstd: 760 mm Hg	
Key	
ΔH: calibrator manometer reading (in H2O)	
ΔP: rootsmeter manometer reading (mm Hg)	
Ta: actual absolute temperature (°K)	
Pa: actual barometric pressure (mm Hg)	
b: intercept	
m: slope	

RECALIBRATION	
US EPA recommends annual recalibration per 1998	
40 Code of Federal Regulations Part 50 to 51,	
Appendix B to Part 50, Reference Method for the	
Determination of Suspended Particulate Matter in	
the Atmosphere, 9.2.17, page 30	

Tisch Environmental, Inc.  
145 South Miami Avenue  
Village of Cleves, OH 45002

www.tisch-env.com  
TOLL FREE: (877)263-7610  
7-9009

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TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)  
CORPORATE SERVICES 3: EQUIPMENT CALIBRATION AND TESTING SERVICES  
5344 PATTANAKARN ROAD SOI 18, SUANLIANG, SUANLIANG, BANGKOK 10250  
TEL: 0-2717-3000-24 FAX: 0-2719-9484

## Certificate of Calibration

Certificate No.: 22P914  
Page: 1 of 2

Equipment: U-Tube Manometer

Manufacturer: Dwyer

Model: 121-96-W/M

Serial No.:

ID No.: UAE.EFM.181/2561

Condition As-Received: Used Item

Received Date: 01 July 2022

Calibration Date: 11 July 2022

Reference: 2202-0083WSC

Submitted by: United Analyst and Engineering Consultant Co., Ltd.

Ambient Temperature: ( 23 ± 2 ) °C

Relative Humidity: ( 50 ± 15 ) %

Atmospheric Pressure: 1012 mbar

81 Soi Udomsuk 41, Sukhumvit Road, Bangchak,  
Phrakhanong, Bangkok 10260

Procedure used: The calibration was conducted by direct comparison method against Pressure Measuring Instruments Standard according to in-house calibration procedure CP-P04, using \* DKD-R 6-1 ; Calibration of Pressure Gauges, Edition 03/2014 \* as a guidelines.

### Condition of this result of calibration

1. Reference standards instruments:

Instrument	Model	Serial No.	Certificate No.	Due Date
1) Pressure Calibrator	PC100P	1189	MP-0113-22	14 Jul 2023
2. This result of calibration was made on requested at the point specified by customer.				
3. Scale and conversion factor is 1 kPa = 4.0146293 inH2O				
4. This instrument was used clean air as pressure media.				
5. This instrument was installed in vertical orientation and center of connector was used as the reference level.				
6. The certificate is valid only to the item calibrated on date and place of calibration.				
7. This Certification is traceable to the International System of Unit maintained at:-				
-National Institute of Metrology Thailand (NIMT)				

Calibrated by: Noppat Phangam  
Issue Date: 11 July 2022

Approved Signatory: [Signature]  
[ ] Phalinee Prabsapal  
[ ] Sura Suwannasri  
[x] Atapol Panurach

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Cert.No.: 22P914  
Page: 2 of 2

Result of calibration:- Without adjustment

Function:- Pressure Measurement  
Increasing Pressure

Range: 0 inH2O to 36 inH2O  
Scale Interval: 0.1 inH2O (The Fifth Estimate)

UUC Indication					
Applied Pressure (inH2O)	High-port side (inH2O)	Low-port side (inH2O)	ΔP (inH2O)	Error (inH2O)	
0.00	0.00	0.00	0.00	0.00	
2.00	1.00	-0.98	1.98	-0.02	
4.00	2.00	-1.98	3.98	-0.02	
6.00	3.00	-3.02	6.02	0.02	
8.00	4.00	-4.02	8.02	0.02	
10.00	5.00	-5.04	10.04	0.04	
12.00	6.00	-6.04	12.04	0.04	
14.00	7.00	-7.06	14.06	0.06	
16.00	8.00	-8.06	16.06	0.06	
18.00	9.00	-9.06	18.06	0.06	
20.00	10.00	-10.06	20.06	0.06	
22.00	11.00	-11.08	22.08	0.08	
24.00	12.00	-12.08	24.08	0.08	
26.00	13.02	-13.10	26.12	0.12	
28.00	14.02	-14.10	28.12	0.12	
30.00	15.02	-15.10	30.12	0.12	
32.00	16.02	-16.10	32.12	0.12	
34.00	17.02	-17.08	34.10	0.10	
35.50	17.86	-17.92	35.78	0.28	

The uncertainty of measurement was ± 0.11 inH2O  
\* UUC = Unit Under Calibration

\* ΔP = High-port side - Low-port side

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

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TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)  
CORPORATE SERVICES 3: EQUIPMENT CALIBRATION AND TESTING SERVICES  
5344 PATTANAKARN ROAD SOI 18, SUANLIANG, SUANLIANG, BANGKOK 10250  
TEL: 0-2717-3000-24 FAX: 0-2719-9484

## Certificate of Calibration

Certificate No.: 22P2722  
Page: 1 of 2

Equipment: Aneroid Barometer

Manufacturer: Barigo

Model: -

Serial No.: -

ID No.: UAE.ANV.013/2547

Condition As-Received: Used Item

Received Date: 20 July 2022

Calibration Date: 22 July 2022

Reference: 2207-0584WSC

Submitted by: United Analyst and Engineering Consultant Co., Ltd.

Ambient Temperature: ( 23 ± 2 ) °C

Relative Humidity: ( 50 ± 15 ) %

Atmospheric Pressure: 1010 mbar

81 Soi Udomsuk 41, Sukhumvit Road, Bangchak,  
Phrakhanong, Bangkok 10260

Procedure used: The calibration was conducted by direct comparison method against Pressure Measuring Instruments Standard according to in-house calibration procedure CP-P10, using \* DKD-R 5-1 ; Calibration of Pressure Gauges, Edition 03/2014 \* as a guidelines.

### Condition of this result of calibration

1. Reference standards instruments:

Instrument	Model	Serial No.	Certificate No.	Due Date
1) Standard Barometer	DP1142	1422505046	MP-0076-22	02 May 2023
2. This instrument was installed in vertical orientation and center of the dial was used as the reference level.				
3. This result of calibration was made on requested at the point specified by customer.				
4. Scale and conversion factor is 1 kPa = 7.50062 mmHg				
5. This result of calibration instrument was in absolute pressure.				
6. This instrument was used clean air as pressure media.				
7. The certificate is valid only to the item calibrated on date and place of calibration.				
8. This Certification is traceable to the International System of Unit maintained at:-				
-National Institute of Metrology Thailand (NIMT)				

Calibrated by: Suwit Aussarree  
Issue Date: 25 July 2022

Approved Signatory: [Signature]  
[ ] Phalinee Prabsapal  
[ ] Sura Suwannasri  
[x] Atapol Panurach

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Cert.No.: 22P2722  
Page: 2 of 2

Result of calibration:- Without adjustment  
Function:- Absolute Pressure Measurement

Range: 720 mmHg to 780 mmHg  
Scale Interval: 1 mmHg (The Fifth Estimate)

Increasing Pressure

Applied Pressure (mmHg)	718.46	729.33	739.85	750.22	760.90	772.01	785.89
UUC* Indication (mmHg)	720.0	730.0	740.0	750.0	760.0	770.0	780.0
Error (mmHg)	1.54	0.67	0.15	-0.22	-0.90	-2.01	-5.89

Decreasing Pressure

Applied Pressure (mmHg)	765.90	771.99	760.85	750.17	739.90	729.57	718.62
UUC* Indication (mmHg)	780.0	770.0	760.0	750.0	740.0	730.0	720.0
Error (mmHg)	-5.90	-1.99	-0.85	-0.17	0.10	0.43	1.38

The uncertainty of measurement was  $\pm 0.24$  mmHg

\* UUC = Unit Under Calibration

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

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TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)  
CORPORATE SERVICES 3: EQUIPMENT CALIBRATION AND TESTING SERVICES  
534/4 PATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG, BANGKOK 10250  
TEL. 0-2717-3000-34 FAX. 0-2719-9484



## Certificate of Calibration

Certificate No.: 22H1589  
Page: 1 of 2

Equipment: Dial Thermo-Hygrometer

Manufacturer: Barigo

Model: -

Serial No.: -

ID No.: UAE.ANV.132/2550

Condition As-Received: Used Item

Received Date: 20 July 2022

Calibration Date: 22 July 2022

Reference: 2207-0586WSC

Ambient Temperature:  $(25 \pm 3) ^\circ\text{C}$

Relative Humidity:  $(50 \pm 20) \%$

This certificate may not be reproduced other than in full, except with the prior written approval of the head of Corporate Services 3: Equipment Calibration and Testing Services.

Submitted by: United Analyst and Engineering Consultant Co., Ltd.

81 Soi Udomsuk 41, Sukhumvit Road, Bangchak, Phrakhanong, Bangkok 10260

Procedure used: Calibration were conducted using in-house calibration procedure CP-H02 according to comparison with standard chilled mirror sensor for humidity measurement function and comparison with standard temperature probe for temperature measurement function into humidity / temperature chamber.

### Condition of this result of calibration

1. Reference standards instruments:

Instrument	Model	Serial No.	Certificate No.	Due Date
1) Standard Chilled Mirror Hygrometer Sensor	Dew Prime II	31863	19714	17 Sep 2022
2) Standard Humidity/Temperature Meter	400	10240757	TH-0125-21	13 Dec 2022

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

3. This Certification is traceable to the International System of Unit maintained at:-

-National Institute of Standards and Technology (NIST), The United States of America

-National Institute of Metrology Thailand (NIMT)

Calibrated by: Somchai Dumvor  
Issue Date: 03 August 2022

Approved Signatory:

[✓] Chakrit Waewanjua  
[ ] Ponthippa Tameyakul  
[ ] Viporn Tantiyawutti

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Cert. No.: 22H1589  
Page: 2 of 2

Result of Calibration:-

Function: Humidity measurement.

Reference Temperature ( $^\circ\text{C}$ )	Standard Humidity (%R.H.)	UUC* Reading (%R.H.)	Error (%R.H.)	Uncertainty of Measurement ( $\pm$ %R.H.)
25.0	40.1	40	-0.1	1.6
25.0	60.0	57	-3.0	1.8
25.0	80.0	72	-8.0	2.0

Result of Calibration:-

Function: Humidity measurement.

Reference Temperature ( $^\circ\text{C}$ )	Standard Humidity (%R.H.)	UUC* Reading (%R.H.)	Error (%R.H.)	Uncertainty of Measurement ( $\pm$ %R.H.)
25.0	40.1	41	0.9	1.6
25.0	60.0	60	0.0	1.8
25.0	80.0	72	-8.0	2.0

Result of Calibration:-

Function: Temperature measurement.

Standard Temperature ( $^\circ\text{C}$ )	UUC* Reading ( $^\circ\text{C}$ )	Error ( $^\circ\text{C}$ )	Uncertainty of Measurement ( $\pm$ $^\circ\text{C}$ )
20.00	20.0	0.00	0.72
25.04	25.0	-0.04	0.72
30.01	29.5	-0.51	0.72
35.04	34.0	-1.04	0.72
39.98	39.0	-0.98	0.72

UUC\* : Unit Under Calibration

The reported uncertainty of measurement was based on standard uncertainty multiplied by coverage factor  $k = 2.00$ , providing confidence level approximately 95%.

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Tel. 0 2763 2826 Fax 0 2763 2800 www.uaec consultant.com E-mail: uaec@uaec consultant.com

## MULTI-POINT GAS TEST REPORT

Test Date: Mar 18, 2023

Equipment: Gas Analyzer (NO<sub>2</sub>)  
Manufacturer: Thermo Electron Corporation  
Model: 42C  
Serial Number: 42C-0508011076

### Standard Gas Concentration

Sulphur Dioxide (SO <sub>2</sub> )	44.68	PPM
Nitric Oxide (NO)	45.94	PPM
Methane (CH <sub>4</sub> )	-	PPM
Carbon Monoxide (CO)	984.8	PPM
Cylinder No.:	EB0143262	
Expiration Date:	Jun 21, 2024	

### Dilutor Detail

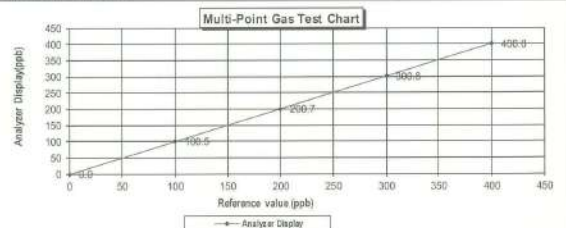
Manufacturer:	Thermo Scientific
Model:	1461
Serial Number:	1180540071

### Multi-point gas test data

Level	Reference Value (ppb)	Analyzer Display (ppb)	Difference Error	Percent Error	[% Error]
Level 1	Zero	0.0	0.00	0.00	0.00
Level 2	20.00%	100.0	0.50	0.50	0.50
Level 3	40.00%	200.0	0.70	0.35	0.35
Level 4	60.00%	300.0	0.80	0.27	0.27
Level 5	80.00%	400.0	0.00	0.00	0.00

Remark: Measuring Range 500.0 ppb  
Acceptable Limit  $\pm 5\%$

Average Difference (%) 0.22



Calculated by:

18/3/23

18/Mar/2023

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### MULTI-POINT GAS TEST REPORT

Test Date : Mar 16, 2023

Equipment : Gas Analyzer (NO<sub>2</sub>) Model : 42C  
Manufacturer : Thermo Electron Corporation Serial Number : 0517512000

#### Standard Gas Concentration

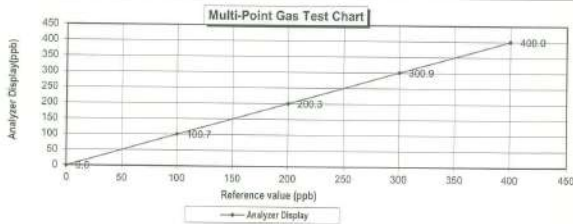
Sulphur Dioxide (SO<sub>2</sub>) 44.68 PPM  
Nitric Oxide (NO) 45.94 PPM  
Methane (CH<sub>4</sub>) - PPM  
Carbon Monoxide (CO) 984.8 PPM  
Cylinder No. : EB0143262  
Expiration Date : Jun 21, 2024

#### Dilutor Detail

Manufacturer : Thermo Scientific  
Model : 146i  
Serial Number : 1180540071

#### Multi-point gas test data

Reference Value (ppb)			Analyzer Display (ppb)	Difference Error	Percent Error	[% Error ]
Level 1	Zero	0.0	0.0			
Level 2	20.00%	100.0	100.7	0.70	0.70	0.70
Level 3	40.00%	200.0	200.3	0.30	0.15	0.15
Level 4	60.00%	300.0	300.9	0.90	0.30	0.30
Level 5	80.00%	400.0	400.0	0.00	0.00	0.00
Remark : Measuring Range			500.0 ppb	Average Difference (%)		0.23



Calculate by

16, 3, 66

16, Mar, 2023

### MULTI-POINT GAS TEST REPORT

Test Date : Apr 20, 2023

Equipment : Gas Analyzer (NO<sub>2</sub>) Model : 42C  
Manufacturer : Thermo Electron Corporation Serial Number : 0517512001

#### Standard Gas Concentration

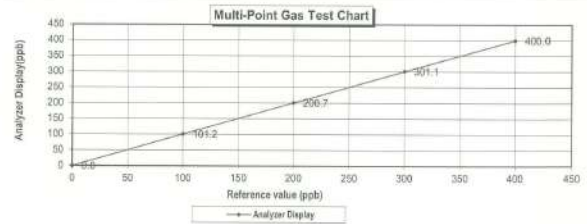
Sulphur Dioxide (SO<sub>2</sub>) 44.68 PPM  
Nitric Oxide (NO) 45.94 PPM  
Methane (CH<sub>4</sub>) - PPM  
Carbon Monoxide (CO) 984.8 PPM  
Cylinder No. : EB0143262  
Expiration Date : Jun 21, 2024

#### Dilutor Detail

Manufacturer : Thermo Scientific  
Model : 146i  
Serial Number : 1180540071

#### Multi-point gas test data

Reference Value (ppb)			Analyzer Display (ppb)	Difference Error	Percent Error	[ % Error ]
Level 1	Zero	0.0	0.0	0.00	0.00	0.00
Level 2	20.00%	100.0	101.2	1.20	1.19	1.19
Level 3	40.00%	200.0	200.7	0.70	0.35	0.35
Level 4	60.00%	300.0	301.1	1.10	0.37	0.37
Level 5	80.00%	400.0	400.0	0.00	0.00	0.00
Remark : Measuring Range			500.0 ppb	Average Difference (%)		0.38



Calculate by

20, 4, 66

20, Apr, 2023

### MULTI-POINT GAS TEST REPORT

Test Date : Jan 11, 2023

Equipment : Gas Analyzer (NO<sub>2</sub>) Model : 42i  
Manufacturer : Thermo Scientific Serial Number : CM08130002

#### Standard Gas Concentration

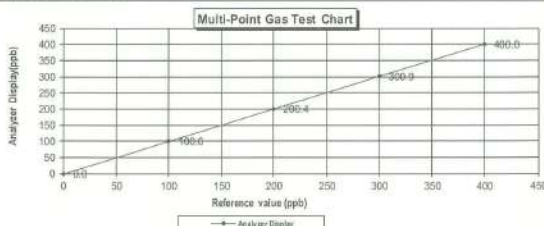
Sulphur Dioxide (SO<sub>2</sub>) 44.68 PPM  
Nitric Oxide (NO) 45.94 PPM  
Methane (CH<sub>4</sub>) - PPM  
Carbon Monoxide (CO) 984.8 PPM  
Cylinder No. : EB0143262  
Expiration Date : Jun 21, 2024

#### Dilutor Detail

Manufacturer : Thermo Scientific  
Model : 146i  
Serial Number : 1180540071

#### Multi-point gas test data

Reference Value (ppb)		Analyzer Display (ppb)	Difference Error	Percent Error	[% Error]
Level 1	Zero	0.0	0.00	0.00	0.00
Level 2	20.00%	100.6	0.60	0.60	0.60
Level 3	40.00%	200.0	200.4	0.40	0.20
Level 4	60.00%	300.0	300.9	0.90	0.30
Level 5	80.00%	400.0	400.0	0.00	0.00
Remark : Measuring Range			500.0 ppb	Average Difference (%)	0.22



Calculate by

11, 1, 66

11, Jan, 2023

### MULTI-POINT GAS TEST REPORT

Test Date : Feb 15, 2023

Equipment : Gas Analyzer (NO<sub>2</sub>) Model : 42i  
Manufacturer : Thermo Scientific Serial Number : CM19050148

#### Standard Gas Concentration

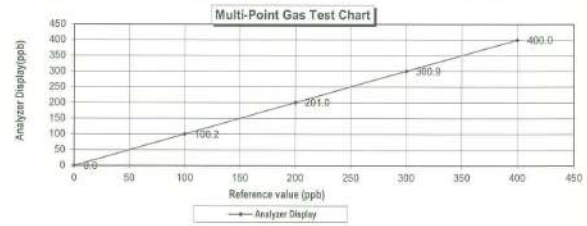
Sulphur Dioxide (SO<sub>2</sub>) 44.68 PPM  
Nitric Oxide (NO) 45.94 PPM  
Methane (CH<sub>4</sub>) - PPM  
Carbon Monoxide (CO) 984.8 PPM  
Cylinder No. : EB0143262  
Expiration Date : Jun 21, 2024

#### Dilutor Detail

Manufacturer : Thermo Scientific  
Model : 146i  
Serial Number : 1180540071

#### Multi-point gas test data

Reference Value (ppb)			Analyzer Display (ppb)	Difference Error	Percent Error	[% Error]
Level 1	Zero	0.0	0.0	0.00	0.00	0.00
Level 2	20.00%	100.0	100.2	0.20	0.20	0.20
Level 3	40.00%	200.0	201.0	1.00	0.50	0.50
Level 4	60.00%	300.0	300.9	0.90	0.30	0.30
Level 5	80.00%	400.0	400.0	0.00	0.00	0.00
Remark : Measuring Range			500.0 ppb	Average Difference (%)		0.20



15, 2, 66

15, Feb, 2023

**MULTI-POINT GAS TEST REPORT**

Test Date : Jan 9, 2023

Equipment : Gas Analyzer (NO<sub>2</sub>) Model : 42i  
 Manufacturer : Thermo Scientific Serial Number : CM19050149

**Standard Gas Concentration**  
 Sulphur Dioxide (SO<sub>2</sub>) 44.68 PPM  
 Nitric Oxide (NO) 45.94 PPM  
 Methane (CH<sub>4</sub>) - PPM  
 Carbon Monoxide (CO) 984.8 PPM  
 Cylinder No. : EB0143262  
 Expiration Date : Jun 21, 2024

**Dilutor Detail**  
 Manufacturer : Thermo Scientific  
 Model : 146i  
 Serial Number : 1180540071

**Multi-point gas test data**

Level	Reference Value (ppb)	Analyzer Display (ppb)	Difference Error	Percent Error	[% Error]
Level 1	Zero	0.0	0.00	0.00	0.00
Level 2	20.00%	100.0	0.80	0.79	0.79
Level 3	40.00%	201.2	1.20	0.60	0.60
Level 4	60.00%	300.7	0.70	0.23	0.23
Level 5	80.00%	400.0	0.00	0.00	0.00

Remark : Measuring Range 500.0 ppb  
 :Acceptable Limit  $\pm 5\%$   
 Average Difference (%) 0.32

**Multi-Point Gas Test Chart**

9 Jan 2023

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**MULTI-POINT GAS TEST REPORT**

Test Date : Jan 16, 2023

Equipment : Gas Analyzer (NO<sub>2</sub>) Model : 42i  
 Manufacturer : Thermo Scientific Serial Number : CM19050150

**Standard Gas Concentration**  
 Sulphur Dioxide (SO<sub>2</sub>) 44.68 PPM  
 Nitric Oxide (NO) 45.94 PPM  
 Methane (CH<sub>4</sub>) - PPM  
 Carbon Monoxide (CO) 984.8 PPM  
 Cylinder No. : EB0143262  
 Expiration Date : Jun 21, 2024

**Dilutor Detail**  
 Manufacturer : Thermo Scientific  
 Model : 146i  
 Serial Number : 1180540071

**Multi-point gas test data**

Level	Reference Value (ppb)	Analyzer Display (ppb)	Difference Error	Percent Error	[% Error]
Level 1	Zero	0.0	0.00	0.00	0.00
Level 2	20.00%	100.0	0.50	0.50	0.50
Level 3	40.00%	200.6	0.60	0.30	0.30
Level 4	60.00%	300.7	0.70	0.23	0.23
Level 5	80.00%	400.0	0.00	0.00	0.00

Remark : Measuring Range 500.0 ppb  
 :Acceptable Limit  $\pm 5\%$   
 Average Difference (%) 0.21

**Multi-Point Gas Test Chart**

16 Jan 2023

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Airgas Specialty Gases  
 Airgas USA, LLC  
 650 United Drive  
 Durham, NC 27713  
 Airgas.com

**CERTIFICATE OF ANALYSIS**  
 Grade of Product: EPA Protocol

Part Number: E04N199E15A01D3 Reference Number: 122-402135167-1  
 Cylinder Number: EB0143262 Cylinder Volume: 144.4 CF  
 Laboratory: 124 - Durham (SAP) - NC Cylinder Pressure: 2015 PSIG  
 PGVP Number: B22021 Valve Outlet: 650  
 Gas Code: CO,NO,NOX,SO<sub>2</sub>,BALN Certification Date: Jun 21, 2021  
 Expiration Date: Jun 21, 2024

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 800R-12/031, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.  
 Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
NOX	45.00 PPM	45.96 PPM	G1	+/- 1.4% NIST Traceable	08/14/2021, 09/21/2021
NITRIC OXIDE	45.00 PPM	45.94 PPM	G1	+/- 1.4% NIST Traceable	08/14/2021, 09/21/2021
SULFUR DIOXIDE	45.00 PPM	44.98 PPM	G1	+/- 1.0% NIST Traceable	08/14/2021, 09/21/2021
CARBON MONOXIDE	1000 PPM	984.8 PPM	G1	+/- 0.7% NIST Traceable	08/14/2021
NITROGEN	Balance				

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	20091120	CC708092	49.82 PPM NITRIC OXIDE/NITROGEN	+/- 1.2%	Feb 02, 2025
PRM	12388	D685025	9.91 PPM NITROGEN DIOXIDE/AIR	+/- 2.0%	Feb 26, 2020
GMS	401423838102	CC505881	4.348 PPM NITROGEN DIOXIDE/NITROGEN	+/- 2.1	Feb 18, 2023
NTRM	16011043	CC473277	46.02 PPM SULFUR DIOXIDE/NITROGEN	+/- 0.8%	Jun 17, 2022
NTRM	14050119	CC434277	980.9 PPM CARBON MONOXIDE/NITROGEN	+/- 0.6%	Nov 15, 2025

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nicolet 8700 AHR0601333 CO	FTIR	Jun 03, 2021
Nicolet 8700 AHR0601333 NO	FTIR	Jun 03, 2021
Nicolet 8700 AHR0601333 NO <sub>2</sub>	FTIR	Jun 03, 2021
Nicolet 8700 AHR0601333 SO <sub>2</sub>	FTIR	Jun 03, 2021

Triad Data Available Upon Request  
 NOTES: PO #5221002607  
 GROSS WT: 28.40kg  
 NET WT: 4.73kg



The analytical test results reported on this certificate relate only to the cylinder number specified above. This concludes the test report.

Approved for Release



CERT 3052.01  
 เอกสารไม่ควบคุม

**MULTI-POINT GAS TEST REPORT**

Test Date : May 3, 2023

Equipment : Gas Analyzer (SO<sub>2</sub>) Model : 43C  
 Manufacturer : Thermo Electron Corporation Serial Number : 43C-0607415779

**Standard Gas Concentration**  
 Sulphur Dioxide (SO<sub>2</sub>) 44.68 PPM  
 Nitric Oxide (NO) 45.94 PPM  
 Methane (CH<sub>4</sub>) - PPM  
 Carbon Monoxide (CO) 984.8 PPM  
 Cylinder No. : EB0143262  
 Expiration Date : Jun 24, 2024

**Dilutor Detail**  
 Manufacturer : Thermo SCIENTIFIC  
 Model : 146i  
 Serial Number : 1180540071

**Multi-point gas test data**

Level	Reference Value (ppb)	Analyzer Display (ppb)	Difference Error	Percent Error	[% Error]
Level 1	Zero	0.0	0.00	0.00	0.00
Level 2	20.00%	100.0	101.3	1.30	1.28
Level 3	40.00%	200.0	201.1	1.10	0.55
Level 4	60.00%	300.0	301.5	1.50	0.50
Level 5	80.00%	400.0	400.0	0.00	0.00

Remark : Measuring Range 500.0 ppb  
 :Acceptable Limit  $\pm 5\%$   
 Average Difference (%) 0.47

**Multi-Point Gas Test Chart**

3 May 2023

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เอกสารไม่ควบคุม

### MULTI-POINT GAS TEST REPORT

Test Date : Apr 7, 2023

Equipment : Gas Analyzer (SO<sub>2</sub>) Model : 43C  
Manufacturer : Thermo Electron Corporation Serial Number : 43C-0611116459

#### Standard Gas Concentration

Sulphur Dioxide (SO<sub>2</sub>) 44.68 PPM  
Nitric Oxide (NO) 45.94 PPM  
Methane (CH<sub>4</sub>) - PPM  
Carbon Monoxide (CO) 984.8 PPM  
Cylinder No. : EB0143262  
Expiration Date : Jun 24, 2024

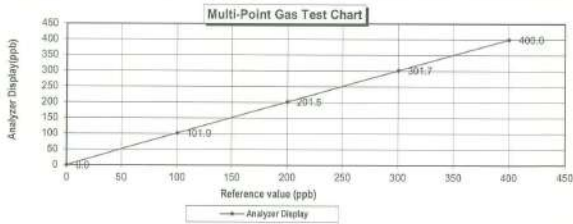
#### Dilutor Detail

Manufacturer : Thermo SCIENTIFIC  
Model : 146i  
Serial Number : 1180540071

#### Multi-point gas test data

Level	Reference Value (ppb)	Analyzer Display (ppb)	Difference Error	Percent Error	[% Error]
Level 1	Zero	0.0	0.00	0.00	0.00
Level 2	20.00%	100.0	101.9	1.90	1.86
Level 3	40.00%	200.0	201.5	1.50	0.74
Level 4	60.00%	300.0	301.7	1.70	0.56
Level 5	80.00%	400.0	400.0	0.00	0.00

Remark : Measuring Range 500.0 ppb  
Average Difference (%) 0.63  
Acceptable Limit  $\pm 5\%$



Calculate by

2, 4, 66

7 Apr 2023

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เอกสารไม่ควบคุม

### MULTI-POINT GAS TEST REPORT

Test Date : Apr 19, 2023

Equipment : Gas Analyzer (SO<sub>2</sub>) Model : 43C  
Manufacturer : Thermo Environmental Instruments Serial Number : 43CTL-78567-389

#### Standard Gas Concentration

Sulphur Dioxide (SO<sub>2</sub>) 44.68 PPM  
Nitric Oxide (NO) 45.94 PPM  
Methane (CH<sub>4</sub>) - PPM  
Carbon Monoxide (CO) 984.8 PPM  
Cylinder No. : EB0143262  
Expiration Date : Jun 24, 2024

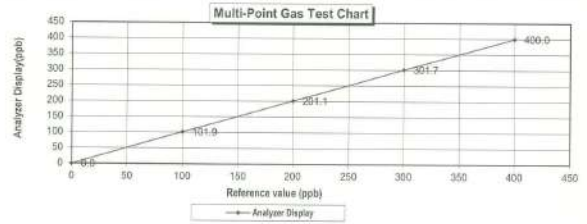
#### Dilutor Detail

Manufacturer : Thermo SCIENTIFIC  
Model : 146i  
Serial Number : 1180540071

#### Multi-point gas test data

Level	Reference Value (ppb)	Analyzer Display (ppb)	Difference Error	Percent Error	[% Error]
Level 1	Zero	0.0	0.00	0.00	0.00
Level 2	20.00%	100.0	101.9	1.90	1.86
Level 3	40.00%	200.0	201.1	1.10	0.55
Level 4	60.00%	300.0	301.7	1.70	0.56
Level 5	80.00%	400.0	400.0	0.00	0.00

Remark : Measuring Range 500.0 ppb  
Average Difference (%) 0.60  
Acceptable Limit  $\pm 5\%$



19, 4, 66

19 Apr 2023

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เอกสารไม่ควบคุม

### MULTI-POINT GAS TEST REPORT

Test Date : May 3, 2023

Equipment : Gas Analyzer (SO<sub>2</sub>) Model : 43C  
Manufacturer : Thermo Environmental Instruments Serial Number : 43C-62236-334

#### Standard Gas Concentration

Sulphur Dioxide (SO<sub>2</sub>) 44.68 PPM  
Nitric Oxide (NO) 45.94 PPM  
Methane (CH<sub>4</sub>) - PPM  
Carbon Monoxide (CO) 984.8 PPM  
Cylinder No. : EB0143262  
Expiration Date : Jun 24, 2024

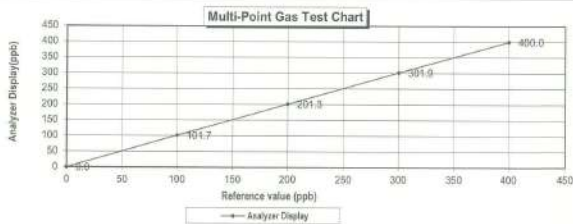
#### Dilutor Detail

Manufacturer : Thermo SCIENTIFIC  
Model : 146i  
Serial Number : 1180540071

#### Multi-point gas test data

Level	Reference Value (ppb)	Analyzer Display (ppb)	Difference Error	Percent Error	[% Error]
Level 1	Zero	0.0	0.00	0.00	0.00
Level 2	20.00%	100.0	101.7	1.70	1.67
Level 3	40.00%	200.0	201.3	1.30	0.65
Level 4	60.00%	300.0	301.9	1.90	0.63
Level 5	80.00%	400.0	400.0	0.00	0.00

Remark : Measuring Range 500.0 ppb  
Average Difference (%) 0.59  
Acceptable Limit  $\pm 5\%$



3, 5, 66

3 May 2023

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เอกสารไม่ควบคุม

### MULTI-POINT GAS TEST REPORT

Test Date : Apr 25, 2023

Equipment : Gas Analyzer (SO<sub>2</sub>) Model : 43C  
Manufacturer : Thermo Environmental Instruments Serial Number : 43C-76465-383

#### Standard Gas Concentration

Sulphur Dioxide (SO<sub>2</sub>) 44.68 PPM  
Nitric Oxide (NO) 45.94 PPM  
Methane (CH<sub>4</sub>) - PPM  
Carbon Monoxide (CO) 984.8 PPM  
Cylinder No. : EB0143262  
Expiration Date : Jun 24, 2024

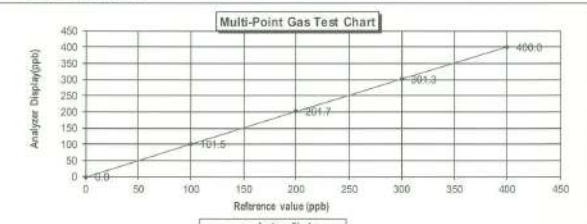
#### Dilutor Detail

Manufacturer : Thermo SCIENTIFIC  
Model : 146i  
Serial Number : 1180540071

#### Multi-point gas test data

Level	Reference Value (ppb)	Analyzer Display (ppb)	Difference Error	Percent Error	[% Error]
Level 1	Zero	0.0	0.00	0.00	0.00
Level 2	20.00%	100.0	101.5	1.50	1.48
Level 3	40.00%	200.0	201.7	1.70	0.84
Level 4	60.00%	300.0	301.3	1.30	0.43
Level 5	80.00%	400.0	400.0	0.00	0.00

Remark : Measuring Range 500.0 ppb  
Average Difference (%) 0.55  
Acceptable Limit  $\pm 5\%$



25, 4, 66

25 Apr 2023

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เอกสารไม่ควบคุม



### MULTI-POINT GAS TEST REPORT

Test Date : Apr 7, 2023

Equipment : Gas Analyzer (SO<sub>2</sub>) Model : 43C  
Manufacturer : Thermo Environmental Instruments Serial Number : 43C-65007-345

#### Standard Gas Concentration

Sulphur Dioxide (SO<sub>2</sub>) 44.68 PPM  
Nitric Oxide (NO) 45.94 PPM  
Methane (CH<sub>4</sub>) - PPM  
Carbon Monoxide (CO) 984.8 PPM  
Cylinder No. : EB0143262  
Expiration Date : Jun 24, 2024

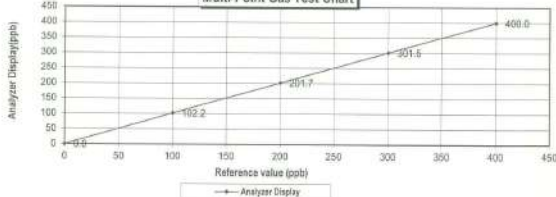
#### Dilutor Detail

Manufacturer : Thermo SCIENTIFIC  
Model : 146i  
Serial Number : 1180540071

#### Multi-point gas test data

Level	Reference Value (ppb)	Analyzer Display (ppb)	Difference Error	Percent Error	[% Error]
Level 1	Zero	0.0	0.00	0.00	0.00
Level 2	20.00%	100.0	102.2	2.20	2.15
Level 3	40.00%	200.0	201.7	1.70	0.84
Level 4	60.00%	300.0	301.5	1.50	0.50
Level 5	80.00%	400.0	400.0	0.00	0.00
Remark : Measuring Range			500.0 ppb	Average Difference (%)	
: Acceptable Limit $\pm 5\%$				0.70	

#### Multi-Point Gas Test Chart



Calculated by

3 4 6

7 Apr 2023

เอกสารไม่ควบคุม

### MULTI-POINT GAS TEST REPORT

Test Date : Apr 4, 2023

Equipment : Gas Analyzer (SO<sub>2</sub>) Model : 43C  
Manufacturer : Thermo Electron Corporation Serial Number : 0517512002

#### Standard Gas Concentration

Sulphur Dioxide (SO<sub>2</sub>) 44.68 PPM  
Nitric Oxide (NO) 45.94 PPM  
Methane (CH<sub>4</sub>) - PPM  
Carbon Monoxide (CO) 984.8 PPM  
Cylinder No. : EB0143262  
Expiration Date : Jun 24, 2024

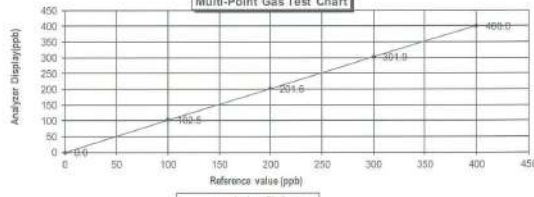
#### Dilutor Detail

Manufacturer : Thermo SCIENTIFIC  
Model : 146i  
Serial Number : 1180540071

#### Multi-point gas test data

Level	Reference Value (ppb)	Analyzer Display (ppb)	Difference Error	Percent Error	[% Error]
Level 1	Zero	0.0	0.00	0.00	0.00
Level 2	20.00%	100.0	102.5	2.50	2.44
Level 3	40.00%	200.0	201.6	1.60	0.79
Level 4	60.00%	300.0	301.9	1.90	0.63
Level 5	80.00%	400.0	400.0	0.00	0.00
Remark : Measuring Range			500.0 ppb	Average Difference (%)	
: Acceptable Limit $\pm 5\%$				0.77	

#### Multi-Point Gas Test Chart



Calculated by

4 4 6

4 Apr 2023

เอกสารไม่ควบคุม



### CERTIFICATE OF ANALYSIS

#### Grade of Product: EPA Protocol

Part Number: E04N09E15A01D3 Reference Number: 122-402135167-1  
Cylinder Number: EB0143262 Cylinder Volume: 144.4 CF  
Laboratory: 124 - Durham (SAP) - NC Cylinder Pressure: 2015 PSIG  
PGVP Number: B22021 Valve Outlet: 660  
Gas Code: CO,NO,NOX,SO<sub>2</sub>,BALN Certification Date: Jun 21, 2021  
Expiration Date: Jun 21, 2024

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 820R-12-031, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.  
Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
NOX	45.00 PPM	45.96 PPM	G1	$\pm 1.4\%$ NIST Traceable	08/14/2021, 09/21/2021
NITRIC OXIDE	45.00 PPM	45.94 PPM	G1	$\pm 1.4\%$ NIST Traceable	08/14/2021, 09/21/2021
SULFUR DIOXIDE	45.00 PPM	44.98 PPM	G1	$\pm 1.0\%$ NIST Traceable	08/14/2021, 09/21/2021
CARBON MONOXIDE	1000 PPM	984.8 PPM	G1	$\pm 0.7\%$ NIST Traceable	08/14/2021
NITROGEN	Balance				

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	20081120	CC708098	49.82 PPM NITRIC OXIDE/NITROGEN	$\pm 1.2\%$	Feb 02, 2025
PRM	12388	D685025	9.91 PPM NITROGEN DIOXIDE/AIR	$\pm 2.0\%$	Feb 20, 2020
GMS	401423838102	CC505881	4.348 PPM NITROGEN DIOXIDE/NITROGEN	$\pm 2.1\%$	Feb 18, 2023
NTRM	16011043	CC473277	46.02 PPM SULFUR DIOXIDE/NITROGEN	$\pm 0.8\%$	Jun 17, 2022
NTRM	14050119	CC434277	980.9 PPM CARBON MONOXIDE/NITROGEN	$\pm 0.6\%$	Nov 15, 2025

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nicolet 8700 AHR0601333 CO	FTIR	Jun 03, 2021
Nicolet 8700 AHR0601333 NO	FTIR	Jun 03, 2021
Nicolet 8700 AHR0601333 NO <sub>2</sub>	FTIR	Jun 03, 2021
Nicolet 8700 AHR0601333 SO <sub>2</sub>	FTIR	Jun 03, 2021

Triad Data Available Upon Request

NOTES: PO #5221002607  
GROSS WT: 28.40kg  
NET WT: 4.73kg



The analytical test results reported on this certificate relate only to the cylinder number specified above. This concludes the test report.

Approved for Release



CERT 3082.01  
เอกสารไม่ควบคุม



### MULTI-POINT GAS TEST REPORT

Test Date : Apr 3, 2023

Equipment : Gas Analyzer (CO) Model : 48i  
Manufacturer : Thermo Scientific Serial Number : 1182920019

#### Standard Gas Concentration

Sulphur Dioxide (SO<sub>2</sub>) 44.68 PPM  
Nitric Oxide (NO) 45.94 PPM  
Methane (CH<sub>4</sub>) - PPM  
Carbon Monoxide (CO) 984.8 PPM  
Cylinder No. : EB0143262  
Expiration Date : Jun 20, 2024

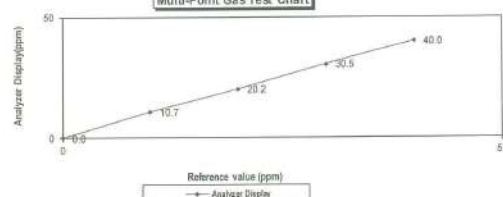
#### Dilutor Detail

Manufacturer : Thermo Scientific  
Model : 146i  
Serial Number : 1180540071

#### Multi-point gas test data

Level	Reference Value (ppm)	Analyzer Display (ppm)	Difference Error	Percent Error	[% Error]
Level 1	Zero	0.0	0.0	0.0	0.0
Level 2	20.00%	10.0	10.7	0.7	6.5
Level 3	40.00%	20.0	20.2	0.2	1.0
Level 4	60.00%	30.0	30.5	0.5	1.6
Level 5	80.00%	40.0	40.0	0.0	0.0
Remark : Measuring Range			50.0 ppm	Average Difference (%)	
: Acceptable Limit $\pm 5\%$				1.63	

#### Multi-Point Gas Test Chart



Calculated by

3 01 6

4 Apr 2023

เอกสารไม่ควบคุม

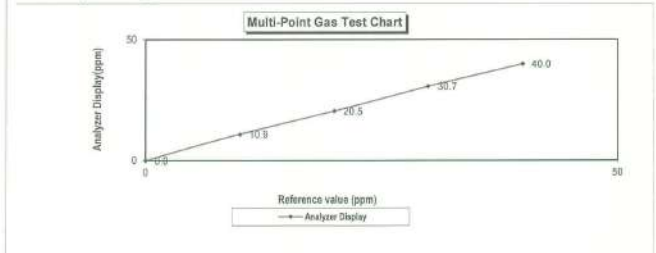
**MULTI-POINT GAS TEST REPORT**

Test Date : Feb 21, 2023

Equipment : Gas Analyzer (CO) Model : 48i  
 Manufacturer : Thermo Scientific Serial Number : 1182920020

Standard Gas Concentration			Dilutor Detail	
Sulphur Dioxide (SO <sub>2</sub> )	44.68	PPM	Manufacturer :	Thermo Scientific
Nitric Oxide (NO)	45.94	PPM	Model :	146i
Methane (CH <sub>4</sub> )	-	PPM	Serial Number :	1180540071
Carbon Monoxide (CO)	984.8	PPM		
Cylinder No. :	EB0143262			
Expiration Date :	Jun 20, 2024			

Multi-point gas test data						
Reference Value (ppm)			Analyzer Display (ppm)	Difference Error	Percent Error	[% Error ]
Level 1	Zero	0.0	0.0	0.0	0.0	0.0
Level 2	20.00%	10.0	10.9	0.9	8.3	8.3
Level 3	40.00%	20.0	20.5	0.5	2.4	2.4
Level 4	60.00%	30.0	30.7	0.7	2.3	2.3
Level 5	80.00%	40.0	40.0	0.0	0.0	0.0
Remark : Measuring Range		50.0 ppm	Average Difference (%)			2.60



Calculate by [Signature] 21, Feb, 2023

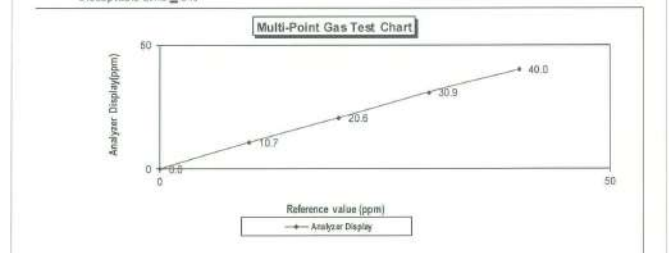
**MULTI-POINT GAS TEST REPORT**

Test Date : May 15, 2023

Equipment : Gas Analyzer (CO) Model : 48i  
 Manufacturer : Thermo Scientific Serial Number : 1182920021

Standard Gas Concentration			Dilutor Detail	
Sulphur Dioxide (SO <sub>2</sub> )	44.68	PPM	Manufacturer :	Thermo Scientific
Nitric Oxide (NO)	45.94	PPM	Model :	146i
Methane (CH <sub>4</sub> )	-	PPM	Serial Number :	1180540071
Carbon Monoxide (CO)	984.8	PPM		
Cylinder No. :	EB0143262			
Expiration Date :	Jun 20, 2024			

Multi-point gas test data						
Reference Value (ppm)			Analyzer Display (ppm)	Difference Error	Percent Error	[% Error ]
Level 1	Zero	0.0	0.0	0.0	0.0	0.0
Level 2	20.00%	10.0	10.7	0.7	6.5	6.5
Level 3	40.00%	20.0	20.6	0.6	2.9	2.9
Level 4	60.00%	30.0	30.9	0.9	2.9	2.9
Level 5	80.00%	40.0	40.0	0.0	0.0	0.0
Remark : Measuring Range			50.0 ppm	Average Difference (%)		2.47



Calculate by [Signature] 15, May, 2023

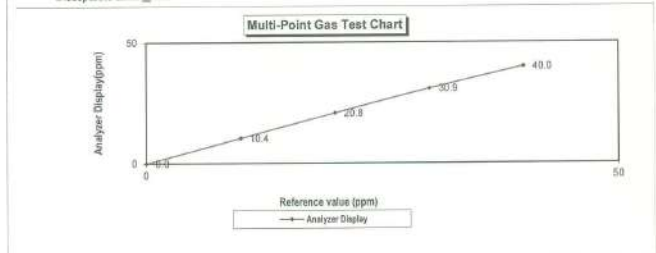
**MULTI-POINT GAS TEST REPORT**

Test Date : Feb 8, 2023

Equipment : Gas Analyzer (CO) Model : 48C  
 Manufacturer : Thermo Environmental Instruments Serial Number : 48C-62460-335/5

Standard Gas Concentration			Dilutor Detail	
Sulphur Dioxide (SO <sub>2</sub> )	44.68	PPM	Manufacturer :	Thermo Scientific
Nitric Oxide (NO)	45.94	PPM	Model :	146i
Methane (CH <sub>4</sub> )	-	PPM	Serial Number :	1180540071
Carbon Monoxide (CO)	984.8	PPM		
Cylinder No. :	EB0143262			
Expiration Date :	Jun 20, 2024			

Multi-point gas test data						
Reference Value (ppm)			Analyzer Display (ppm)	Difference Error	Percent Error	[% Error]
Level 1	Zero	0.0	0.0	0.0	0.0	0.0
Level 2	20.00%	10.0	10.4	0.4	3.8	3.8
Level 3	40.00%	20.0	20.8	0.8	3.8	3.8
Level 4	60.00%	30.0	30.9	0.9	2.9	2.9
Level 5	80.00%	40.0	40.0	0.0	0.0	0.0
Remark : Measuring Range			50.0 ppm	Average Difference (%)		2.12



Calculate by [Signature] 8, Feb, 2023

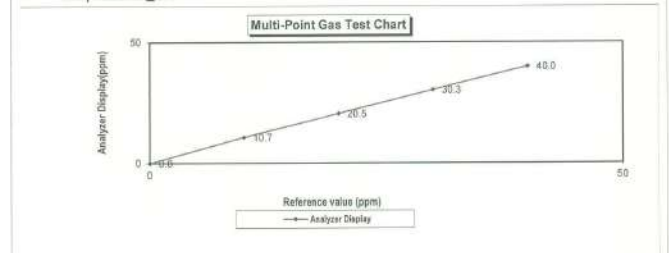
**MULTI-POINT GAS TEST REPORT**

Test Date : Jan 18, 2023

Equipment : Gas Analyzer (CO) Model : 48C  
 Manufacturer : Thermo Environmental Instruments Serial Number : 48C-62494-335/5

Standard Gas Concentration			Dilutor Detail	
Sulphur Dioxide (SO <sub>2</sub> )	44.68	PPM	Manufacturer :	Thermo Scientific
Nitric Oxide (NO)	45.94	PPM	Model :	146i
Methane (CH <sub>4</sub> )	-	PPM	Serial Number :	1180540071
Carbon Monoxide (CO)	984.8	PPM		
Cylinder No. :	EB0143262			
Expiration Date :	Jun 20, 2024			

Multi-point gas test data						
Reference Value (ppm)			Analyzer Display (ppm)	Difference Error	Percent Error	[% Error ]
Level 1	Zero	0.0	0.0	0.0	0.0	0.0
Level 2	20.00%	10.0	10.7	0.7	6.5	6.5
Level 3	40.00%	20.0	20.5	0.5	2.4	2.4
Level 4	60.00%	30.0	30.3	0.3	1.0	1.0
Level 5	80.00%	40.0	40.0	0.0	0.0	0.0
Remark : Measuring Range			50.0 ppm	Average Difference (%)		1.99



Calculate by [Signature] 18, Jan, 2023

**MULTI-POINT GAS TEST REPORT**

Test Date : Jan 18, 2023

Equipment : Gas Analyzer (CO) Model : 48C  
Manufacturer : Thermo Environmental Instruments Serial Number : 48C-69160-362

**Standard Gas Concentration**

Sulphur Dioxide (SO <sub>2</sub> )	44.68	PPM	Manufacturer :	Thermo Scientific
Nitric Oxide (NO)	45.94	PPM	Model :	146i
Methane (CH <sub>4</sub> )	-	PPM	Serial Number :	1180540071
Carbon Monoxide (CO)	984.8	PPM		
Cylinder No. :	EB0143262			
Expiration Date :	Jun 20, 2024			

**Dilutor Detail**

Multi-point gas test data

Level	Reference Value (ppm)	Analyzer Display (ppm)	Difference Error	Percent Error	[% Error]
Level 1	Zero	0.0	0.0	0.0	0.0
Level 2	20.00%	10.0	10.3	0.3	2.9
Level 3	40.00%	20.0	20.8	0.8	3.8
Level 4	60.00%	30.0	30.7	0.7	2.3
Level 5	80.00%	40.0	40.0	0.0	0.0

Remark : Measuring Range 50.0 ppm  
Average Difference (%) 1.81  
Acceptable Limit  $\pm 5\%$

**Multi-Point Gas Test Chart**

18 / 01 / 66  
19 Jan, 2023

Page 1 of 1

เอกสารไม่ควบคุม

**MULTI-POINT GAS TEST REPORT**

Test Date : Jan 18, 2023

Equipment : Gas Analyzer (CO) Model : 48C  
Manufacturer : Thermo Environmental Instruments Serial Number : 48C-73881-375

**Standard Gas Concentration**

Sulphur Dioxide (SO <sub>2</sub> )	44.68	PPM	Manufacturer :	Thermo Scientific
Nitric Oxide (NO)	45.94	PPM	Model :	146i
Methane (CH <sub>4</sub> )	-	PPM	Serial Number :	1180540071
Carbon Monoxide (CO)	984.8	PPM		
Cylinder No. :	EB0143262			
Expiration Date :	Jun 20, 2024			

**Dilutor Detail**

Multi-point gas test data

Level	Reference Value (ppm)	Analyzer Display (ppm)	Difference Error	Percent Error	[% Error]
Level 1	Zero	0.0	0.0	0.0	0.0
Level 2	20.00%	10.0	10.4	0.4	3.8
Level 3	40.00%	20.0	20.5	0.5	2.4
Level 4	60.00%	30.0	30.9	0.9	2.9
Level 5	80.00%	40.0	40.0	0.0	0.0

Remark : Measuring Range 50.0 ppm  
Average Difference (%) 1.84  
Acceptable Limit  $\pm 5\%$

**Multi-Point Gas Test Chart**

18 / 01 / 66  
19 Jan, 2023

Page 1 of 1

เอกสารไม่ควบคุม



Airgas Specialty Gases  
Airgas USA, LLC  
650 United Drive  
Durham, NC 27713  
Airgas.com

## CERTIFICATE OF ANALYSIS

### Grade of Product: EPA Protocol

Part Number: E04N199E15A01D3 Reference Number: 122-402135167-1  
Cylinder Number: EB0143262 Cylinder Volume: 144.4 CF  
Laboratory: 124 - Durham (SAP) - NC Cylinder Pressure: 2015 PSIG  
PGVP Number: B22021 Valve Outlet: 660  
Gas Code: CO,NO,NOX,SO<sub>2</sub>,BALN Certification Date: Jun 21, 2021

Expiration Date: Jun 21, 2024

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 820R-12-031, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.  
Do Not Use This Cylinder below 100 mg, i.e. 0.7 megapascals

ANALYTICAL RESULTS					
Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
NOX	45.00 PPM	45.96 PPM	G1	+/- 1.4% NIST Traceable	08/14/2021, 09/21/2021
NITRIC OXIDE	45.00 PPM	45.94 PPM	G1	+/- 1.4% NIST Traceable	08/14/2021, 09/21/2021
SULFUR DIOXIDE	45.00 PPM	44.98 PPM	G1	+/- 1.0% NIST Traceable	08/14/2021, 09/21/2021
CARBON MONOXIDE	1000 PPM	984.8 PPM	G1	+/- 0.7% NIST Traceable	08/14/2021
NITROGEN	Balance				

CALIBRATION STANDARDS			
Type	Lot ID	Cylinder No	Expiration Date
NTRM	20081120	CC708098	Feb 02, 2025
PRM	12388	D685025	Feb 02, 2020
GMS	401423838102	CC505881	Feb 18, 2023
NTRM	16011043	CC43277	Jun 17, 2022
NTRM	14050119	CC434277	Nov 15, 2025

ANALYTICAL EQUIPMENT		
Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nicolet 8700 AHR0801333 CO	FTIR	Jun 03, 2021
Nicolet 8700 AHR0801333 NO	FTIR	Jun 03, 2021
Nicolet 8700 AHR0801333 NO <sub>2</sub>	FTIR	Jun 03, 2021
Nicolet 8700 AHR0801333 SO <sub>2</sub>	FTIR	Jun 03, 2021

Triad Data Available Upon Request

NOTES: PO #5221002607  
GROSS WT: 28.40kg  
NET WT: 4.73kg



The analytical test results reported on this certificate relate only to the cylinder number specified above. This concludes the test report.

Approved for Release



CERT 3082.01

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United Analyst and Engineering Consultant Co., Ltd.  
3 Soi Udomsuk 41, Sukhumvit Road, Bangkok, Phrakhanong, Bangkok 10260  
Tel. 0 2763 2828 Fax 0 2763 2800 www.uaeconsultant.com E-mail: uae@uaeconsultant.com

**MULTI-POINT GAS TEST REPORT**

Test Date : Jan 25, 2023

Equipment : Hydrocarbon Analyzer Model : APHA-370  
Manufacturer : HORIBA Serial Number : VUPVTC21

**Standard Gas Concentration**

Sulphur Dioxide (SO <sub>2</sub> )	-	PPM	Manufacturer :	
Nitric Oxide (NO)	-	PPM	Model :	
Methane (CH <sub>4</sub> )	39.8	PPM	Serial Number :	
Carbon Monoxide (CO)	-	PPM		
Cylinder No. :	D824432			
Expiration Date :	Aug 4, 2028			

**Dilutor Detail**

Multi-point gas test data

Level	Reference Value (ppm)	Analyzer Display (ppm)	Difference Error	Percent Error	[% Error]
Level 1	Zero	0.00	0.32	0.32	0.32
Level 2	80.00%	40.00	39.71	-0.29	-0.73

Remark : Measuring Range 50.00 ppm  
Average Difference (%) 0.53  
Acceptable Limit  $\pm 5\%$

**Multi-Point Gas Test Chart**

25 / 1 / 66  
26 Jan, 2023

Page 1 of 1

เอกสารไม่ควบคุม



### MULTI-POINT GAS TEST REPORT

Test Date : Feb 8, 2023

Equipment : Hydrocarbon Analyzer Model : APHA-370  
Manufacturer : HORIBA Serial Number : PDXEGXF7

#### Standard Gas Concentration

Sulphur Dioxide (SO<sub>2</sub>) : PPM  
Nitric Oxide (NO) : PPM  
Methane (CH<sub>4</sub>) : 39.8 PPM  
Carbon Monoxide (CO) : PPM  
Cylinder No. : D824432  
Expiration Date : Aug 4, 2028

#### Dilutor Detail

Manufacturer :  
Model :  
Serial Number :

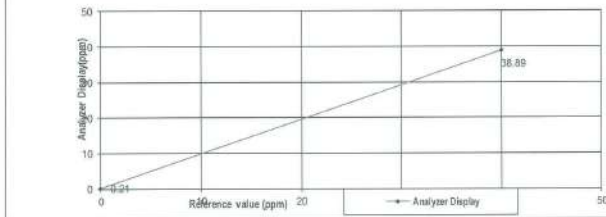
#### Multi-point gas test data

	Reference Value (ppm)	Analyzer Display (ppm)	Difference Error	Percent Error	[% Error]
Level 1	Zero	0.21	0.21	0.21	0.21
Level 2	80.00%	40.00	-1.11	-2.85	2.85

Remark : Measuring Range 50.00 ppm  
Acceptable Limit  $\pm 5\%$

Average Difference (%) 1.53

#### Multi-Point Gas Test Chart



81, 2, 66

8, Feb, 2023



### MULTI-POINT GAS TEST REPORT

Test Date : Jan 25, 2023

Equipment : Hydrocarbon Analyzer Model : APHA-370  
Manufacturer : HORIBA Serial Number : SSGEYBJ

#### Standard Gas Concentration

Sulphur Dioxide (SO<sub>2</sub>) : PPM  
Nitric Oxide (NO) : PPM  
Methane (CH<sub>4</sub>) : 39.8 PPM  
Carbon Monoxide (CO) : PPM  
Cylinder No. : D824432  
Expiration Date : Aug 4, 2028

#### Dilutor Detail

Manufacturer :  
Model :  
Serial Number :

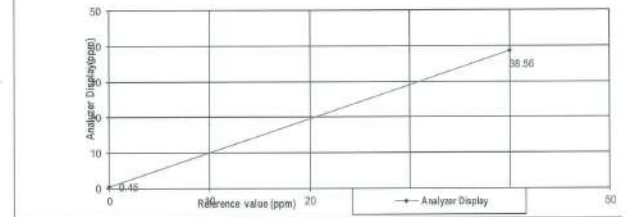
#### Multi-point gas test data

	Reference Value (ppm)	Analyzer Display (ppm)	Difference Error	Percent Error	[% Error]
Level 1	Zero	0.45	0.45	0.45	0.45
Level 2	80.00%	40.00	-1.44	-3.73	3.73

Remark : Measuring Range 50.00 ppm  
Acceptable Limit  $\pm 5\%$

Average Difference (%) 2.09

#### Multi-Point Gas Test Chart



25, 1, 66

25, Jan, 2023



### MULTI-POINT GAS TEST REPORT

Test Date : Feb 8, 2023

Equipment : Hydrocarbon Analyzer Model : APHA-370  
Manufacturer : HORIBA Serial Number : VV2FY3R3

#### Standard Gas Concentration

Sulphur Dioxide (SO<sub>2</sub>) : PPM  
Nitric Oxide (NO) : PPM  
Methane (CH<sub>4</sub>) : 39.8 PPM  
Carbon Monoxide (CO) : PPM  
Cylinder No. : D824432  
Expiration Date : Aug 4, 2028

#### Dilutor Detail

Manufacturer :  
Model :  
Serial Number :

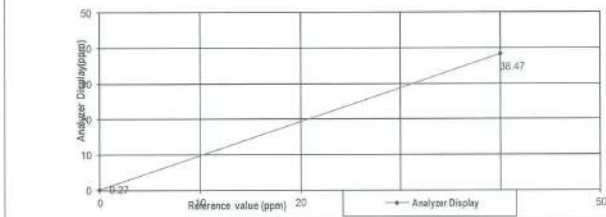
#### Multi-point gas test data

	Reference Value (ppm)	Analyzer Display (ppm)	Difference Error	Percent Error	[% Error]
Level 1	Zero	0.27	0.27	0.27	0.27
Level 2	80.00%	40.00	-1.53	-3.98	3.98

Remark : Measuring Range 50.00 ppm  
Acceptable Limit  $\pm 5\%$

Average Difference (%) 2.12

#### Multi-Point Gas Test Chart



81, 2, 66

8, Feb, 2023



### MULTI-POINT GAS TEST REPORT

Test Date : Feb 20, 2023

Equipment : Hydrocarbon Analyzer Model : APHA-370  
Manufacturer : HORIBA Serial Number : T4FG19AN

#### Standard Gas Concentration

Sulphur Dioxide (SO<sub>2</sub>) : PPM  
Nitric Oxide (NO) : PPM  
Methane (CH<sub>4</sub>) : 39.8 PPM  
Carbon Monoxide (CO) : PPM  
Cylinder No. : D824432  
Expiration Date : Aug 4, 2028

#### Dilutor Detail

Manufacturer :  
Model :  
Serial Number :

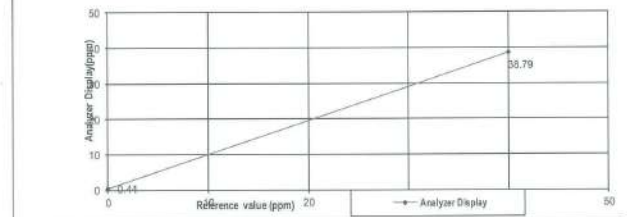
#### Multi-point gas test data

	Reference Value (ppm)	Analyzer Display (ppm)	Difference Error	Percent Error	[% Error]
Level 1	Zero	0.44	0.44	0.44	0.44
Level 2	80.00%	40.00	-1.21	-3.12	3.12

Remark : Measuring Range 50.00 ppm  
Acceptable Limit  $\pm 5\%$

Average Difference (%) 1.78

#### Multi-Point Gas Test Chart



20, 2, 66

20, Feb, 2023

### MULTI-POINT GAS TEST REPORT

Test Date : Jan 25, 2023

Equipment : Hydrocarbon Analyzer Model : APHA-370  
Manufacturer : HORIBA Serial Number : HAMEHUSM

#### Standard Gas Concentration

Sulphur Dioxide (SO<sub>2</sub>) : PPM  
Nitric Oxide (NO) : PPM  
Methane (CH<sub>4</sub>) : 39.8 PPM  
Carbon Monoxide (CO) : PPM  
Cylinder No. : D824432  
Expiration Date : Aug 4, 2028

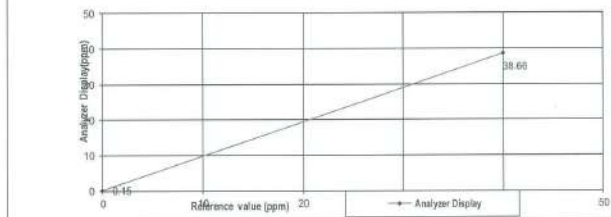
#### Dilutor Detail

Manufacturer :  
Model :  
Serial Number :

#### Multi-point gas test data

Reference Value (ppm)			Analyzer Display (ppm)	Difference Error	Percent Error	[% Error]
Level 1	Zero	0.00	0.15	0.15	0.15	0.15
Level 2	80.00%	40.00	38.66	-1.34	-3.47	3.47
Remark : Measuring Range			50.00 ppm	Average Difference (%)		1.81

#### Multi-Point Gas Test Chart



25, 1, 66

26, Jan, 2023

เอกสารไม่ควบคุม

### MULTI-POINT GAS TEST REPORT

Test Date : Feb 8, 2023

Equipment : Hydrocarbon Analyzer Model : APHA-370  
Manufacturer : HORIBA Serial Number : RTHK2PDH

#### Standard Gas Concentration

Sulphur Dioxide (SO<sub>2</sub>) : PPM  
Nitric Oxide (NO) : PPM  
Methane (CH<sub>4</sub>) : 39.8 PPM  
Carbon Monoxide (CO) : PPM  
Cylinder No. : D824432  
Expiration Date : Aug 4, 2028

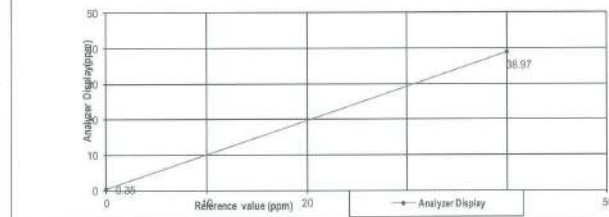
#### Dilutor Detail

Manufacturer :  
Model :  
Serial Number :

#### Multi-point gas test data

Reference Value (ppm)			Analyzer Display (ppm)	Difference Error	Percent Error	% Error ]
Level 1	Zero	0.00	0.35	0.35	0.35	0.35
Level 2	80.00%	40.00	38.97	-1.03	-2.64	2.64
Remark : Measuring Range			50.00 ppm	Average Difference (%)		1.50

#### Multi-Point Gas Test Chart



8, 2, 66

8, Feb, 2023

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### Certificate of Analysis

Customer Details  
Name: United Analyst & Engineering Co., Ltd.  
Address: 3 Soi Udomsuk 41, Sukhumvit Rd., Bang Chak, Khet Phra Khanong, Bangkok 10260  
Customer Tag No.:

Certificate Details  
Number: 3384/20  
Date of Issue: 4-Aug-2020  
Expiry date: 4-Aug-2028  
Material Details  
Production Order: 90161442  
Material Code: 400400-AL-34  
Cylinder No.: D824432  
Gas content: 6.60 M<sup>3</sup>  
Filling pressure: 137.0 bar  
Valve: CGA 590 BRASS  
Cylinder Owner: LINDE  
Cylinder Size: 50L

Laboratory Report  
Component: Methane  
Nominal Concentration: 40.0 ppm  
Analytical Result: 39.8 ppm  
Uncertainty:  $\pm 1\%$  relative  
Method of Analysis: (6) H-PB-152  
Assay Date: 4-Aug-2020

Reference Standard used in Assay  
Reference Standard: Methane in Nitrogen  
Cylinder number: 2559956  
Concentration: 39.29  $\pm$  0.39 ppm  
Expiry date: 3-Oct-2028

Analytical Instruments used in Assay  
Instrument/Make/Model: FTIR Spectrometers Nicolet 650  
Analytical Principle: FTIR-CH4  
Last Multipoint Calibration: 4-Aug-2020

Recommend usage condition  
Minimum utilization: 5% of actual content or before expiry date whichever comes first.  
Storage condition: Keep in well ventilation and secure area.

Comments  
When reordering, please quote the material number

Note:  
1. All results expressed in this report are on a dry basis, unless otherwise specified. The Assay of this Standard has been performed in accordance with the EPA Method 100/100 (EPA-800/10-12/2017) for the Assay and Certification of Gases Calibration Standards using gravimetric.  
2. The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a level of confidence of approximately 95%. The measurement of this material is traceable to the SI through the reference gas standard which is traceable to Swiss National Standard of Mass or other recognized national metrology institutions.  
3. (1) Gas Chromatography, (2) Paramagnetic Oxygen Analyzer, (3) Electrochemical Oxygen Analyzer, (4) Electrochemical Methane Analyzer, (5) Total Hydrocarbon Analyzer, (6) Other - Specified

Sukanya Paninyasontorn  
Signatory for and on behalf of Linde (Thailand) Co., Ltd.

Page 1 of 1  
This report shall not be reproduced except in full.  
Linde (Thailand) Public Company Limited  
17 Floor, Bangkok Tower A, 17/17 Moo 14, Bangkok Road, A.S. Road, Bangkok  
Bangkok, Thailand 10140 Tel: (66) 2306-6100 Fax: (66) 2306-6100  
Website: www.linde.co.th Email: info@linde.co.th  
Head Office: 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000

เอกสารไม่ควบคุม



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



Cert.No.: 23CH6  
Page: 1 of 3

### Certificate of Calibration

Equipment : pH Meter  
Manufacturer : Horiba  
Model : LAQUA-PH210  
Serial No. : HA0D0081  
ID No. : UAE.EFM.074/2564(EFM pH.07/64)  
Condition As-Received: Used Item  
Received Date : 04 January 2023  
Calibration Date : 05 January 2023  
Reference : 2301-0060WSC-2  
Submitted by : United Analyst and Engineering Consultant Co., Ltd.  
3 Soi Udomsuk 41, Sukhumvit Road, Bangkok, Phrakhanong, Bangkok 10260

Ambient Temperature : (25  $\pm$  2.5) °C  
Relative Humidity : (50  $\pm$  15) %  
Calibration Procedure :  
- CP-CH5 by direct measurement with standard voltage calibrator and direct measurement with certified reference material (CRM)  
- CP-CH6 by comparison with standard thermometer

Calibrated by : Sathip Meangmai

Approved by :  
Approved Signatory

( ) Malee Butkrusa  
( ) Sathip Meangmai  
( ) Warakorn Lemgatrakul  
Issue Date : 10 January 2023

The Uncertainties are for a confidence probability of approximately 95%

This certificate may not be reproduced other than in full, except with the prior written approval of the head of Corporate Services 3: Equipment Calibration and Testing Services

เอกสารไม่ควบคุม



เอกสารไม่ควบคุม

**Cert.No.:** 23CH6  
**Page:** 2 of 3

**Condition of this calibration result**

1. Reference Standard Instrument :-

Instrument	Serial No.	ID No.	Cert. No.	Due Date
1) Document Process Calibrator	54030049	130RC116	22E2769	24 Aug 2023
2) Ref. Standard Thermometer	4982054	110RC044	2211306	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	823322	20 June 2023
pH 10.008	CPA chem	826590	09 July 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 ( ±mV )	Coverage factor k
	pH	mV	mV	pH		
pH Meter S/N.: HA0D0081	4.00	177.48	177.4	4.01	0.058	2.00
	7.00	0.00	0.1	6.98	0.058	2.00
	7.00	0.00	0.1	6.98	0.058	2.00
	10.00	-177.48	-177.4	10.01	0.058	2.00

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**Cert.No.:** 23CH6  
**Page:** 3 of 3

**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.: 990C0039	4.008	4.01	138.5	0.0085	2.05
	6.987	6.98	-32.1	0.011	2.00
	6.987	7.00	-33.1	0.011	2.00
	10.008	10.03	-205.2	0.0096	2.00

**Function :** Temperature Measurement  
(\*) Without adjustment  
This equipment was connected with Temperature Probe;  
- Model : 9652  
- Serial No. : 990C0039  
Dimension of probe;  
- Length : 102 mm.  
- Diameter : 15.5 mm.  
- Immersion Depth : 85 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	35.003	35.0	-0.003	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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**TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)**  
CORPORATE SERVICES 3: EQUIPMENT CALIBRATION AND TESTING SERVICES  
534/4 PATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG BANGKOK 10250  
TEL. 0-2717-3000-29 FAX. 0-2719-9484

**Cert.No.:** 23MM331  
**Page:** 1 of 3

**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 :** [Signature]  
[Signature] Pornthippa Tameyakul  
[Signature] 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-1

Cert.No.: 23MM331  
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

- This certificate is valid only to the item calibrated on date and place of calibration.
- This result of calibration was made on requested at the point specified by customer.
- This certificate is not certified for any commercial transaction.
- 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	Balance Reading	Correction	Measurement Uncertainty	Coverage Factor
( g )	( g )	( g )	( $\pm$ mg )	( 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 )

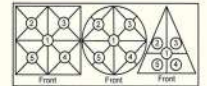
Applied Weight	Standard Deviation of Reading ( g )
( g )	
100	0.00007
200	0.00007

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

Cert.No.: 23MM331  
Page: 3 of 3



**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	Position 2	Position 3	Position 4	Position 5
( g )	( g )	( g )	( g )	( g )
-0.0001	-0.0002	+0.0004	-0.0001	-0.0006

Maximum difference between off-center and central loading ( g )  
0.0005

**3. Departure from nominal value**

Applied Weight	Balance Reading	Correction	Measurement Uncertainty	Coverage Factor
( g )	( g )	( g )	( $\pm$ mg )	( 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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TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)  
CORPORATE SERVICES 3: EQUIPMENT CALIBRATION AND TESTING SERVICES  
534/4 PATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG BANGKOK 10250  
TEL. 0-2717-3000-29 FAX. 0-2719-9484



Cert.No.: 23MM332  
Page.: 1 of 3

**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 :**   
( ) Porphippa 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

- This certificate is valid only to the item calibrated on date and place of calibration.
- This result of calibration was made on requested at the point specified by customer.
- This certificate is not certified for any commercial transaction.
- 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	Balance Reading	Correction	Measurement Uncertainty	Coverage Factor
( g )	( g )	( g )	( $\pm$ mg )	( 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	Standard Deviation of Reading ( g )
( g )	
100	0.00009
200	0.00007

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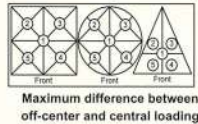
Equipment : Electronic Balance  
Condition As-Received : Used Item  
Reference : 2304-00150C-2

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 ( $\pm$ 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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## PinAAcle 900F Preventive Maintenance Report

Company Name: UNITED ANALYST AND ENGINEERING

Instrument Location: BANGCHAK, PRAKHANONG  
BANGKOK, 10260

Instrument Serial No.: PFBS20031902

Date: 20-Jul-2022

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### PinAAcle 900F Preventive Maintenance (PM)

Company Name:	UNITED ANALYST AND ENGINEERING		
Address (Instrument Location):	BANGCHAK, PRAKHANONG, BANGKOK, 10260		
Serial Number:	PFBS20031902	PM Number:	2/2
Customer Name (if applicable):	K. SATHIDA	Telephone Number:	095-5580-049
Customer Support Engineer Name:	K. DUANG	Service Order Number:	WO-01710010
Date PM Performed: (DD-MMM-YYYY)	Jul 20, 2022	Next PM Due Date: (DD-MMM-YYYY)	Jan 20, 2023
Standard Labor Hours to Complete PM :		5 hours	

Part Number	Release	Publication Date	
09370145 Rev.9	A	January 2018	

#### Scope

The purpose of this PM is to ensure the continued functionality of the PinAAcle 900F by inspecting and replacing any worn or damaged parts. This service should only be performed by a trained representative of PerkinElmer.

The customer should save their method before the PM begins.

#### General Instructions:

The customer must provide the engineer operational data to demonstrate recent instrument performance prior to starting the PM. Always check with the customer before making any changes that may affect the customer's analysis or calibration, including a current back-up of system software and/or data files.

The completed document should be signed by an authorized PerkinElmer and customer representative and left with the customer.

Update the PM sticker and instrument logbook as required.

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### Component List

Component / Specific Model	Serial #	Configuration Notes

### Parts Lists

Parts included with the PM		
Part Number (if applicable)	Description	Quantity
80501696	Fan Filters	N/A
N3160156	O-Ring Kits for Sampling Introduction (Stainless Steels Nebulizer)	N/A
N3160157	O-Ring Kits for Sampling Introduction (Plastic Nebulizer)	N/A
N9301714	Replacement Acetylene Filter Cartridge	N/A
TH001022	Replacement Air Filter Cartridge	N/A

### Additional Reagents and Standards Required for PM

Part Number (if applicable)	Description	Quality	Batch/Lot #	Expired Date (MM/YY)
N9300183	1000 mg/L Copper Standard	AR	25-76CUY1	30-Oct-2022

### Additional Reagents and Standards Required for PM (Customer Support Solution)

Part Number (if applicable)	Description	Quantity	Batch/Lot #	Expiration Date (MM/YY)
N/A	DI Water	250 mL	AR	AR
N/A	0.5% HNO <sub>3</sub>	250 mL	AR	AR

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Additional Tools Required for PM			
Part Number (if applicable)	Description	Quantity	Serial #
N1013000	0.2A Neutral density filter	1	MG0-252
N1013002	1.0A Neutral density filter	1	MG0-358
03030997	System 2 EDL Driver	1	03030997
N3050605	As System 2 EDL	1	16148
N3050121	Cu Lumina HCL	1	092216-010130
N3050109	Ba Lumina HCL	1	102416-040160
N3050139	K Lumina HCL	1	110716-010060
N3050152	Ni Lumina HCL	1	100516-030190

## Procedure Checklist

Use (✓) to check off those steps in the checklist that have been completed.

### 1. General:

- ☒ Review the instrument performance with the customer and document any recent problems.
- ☒ Inspect the customer log book and make any appropriate PM entries.
- ☒ Perform general inspection of system for cleanliness.

### 2. PC Instrument Software:

- ☒ Instrument Software user files/databases archived, packed, and/or deleted as needed.

### 3. Mechanical:

- ☒ Inspect and clean all fans and filters. Replace filters if necessary
- ☒ Inspect all gas lines for leaks and/or wear. Replace if needed.
- ☒ Clean exterior of the instrument.
- ☒ Inspect the burner head, burner chamber, and nebulizer. Clean if needed as stated in the Hardware Guide.
- ☒ Check burner head dimensions with the feeler gauge as stated in the Hardware Guide in the Maintenance chapter section on cleaning the burner head and checking sloth width. Replace if out of specification
- ☒ Check the condition of the end cap, burner head, and nebulizer O-rings. Replace if necessary.
- ☒ Check the drain system for signs of wear. Replace worn or damaged parts.
- ☒ Visually check for proper flame conditions when igniting the Air-C2H2 and N2O-C2H2 flames (if applicable).

### 4. Electrical:

- ☒ Inspect PC boards. Clean if necessary.
- ☒ Carefully check all internal and external cable connections.
- ☒ Check instrument firmware revisions upgrade to current levels (if necessary)
- ☒ Run Diagnostics Test within the Advanced function of the Spectrometer page. Check the results in the service log folder in the Spectrometer BM Log Viewer.

### 5. Optics:

- ☒ Inspect and clean the sample compartment windows, if needed.
- ☒ Inspect optics. Clean or replace if necessary,

### 6. Gasses:

- ☒ Verify that the Gasses supplied to the instrument are within the pressure and purity specifications found in the PinAAcle 900F Series Pre-installation Checklist SDB.
- ☒ Verify that the acetylene filter and air filter element is dry. Replace if necessary.

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### 7. Flame Interlock Check:

Description: Check to ensure that all safety interlocks are closed.

Parameter	Specification	Test Results	Pass/Fail
Flame Sensor	Air/C <sub>2</sub> H <sub>2</sub> Flame correctly shuts down	Active	Passed
Drain Sensor	Air/C <sub>2</sub> H <sub>2</sub> Flame correctly shuts down	Active	Passed
Nebulizer Sensor	Air/C <sub>2</sub> H <sub>2</sub> Flame correctly shuts down	Active	Passed
C <sub>2</sub> H <sub>2</sub> Pressure Sensor	Air/C <sub>2</sub> H <sub>2</sub> Flame correctly shuts down	Active	Passed
Air Pressure Sensor	Air/C <sub>2</sub> H <sub>2</sub> Flame correctly shuts down	Active	Passed
Burner Head Sensor	Choosing Nitrous Oxide as the oxidant should trigger an interlock shuts down	Active	Passed

### 8. After PM Performance tests:

#### 8.1 Detector Linearity with Barium

Description: Ensures that the detector is linear in the Visible Range.

Parameter	Specification	Certificate Value at 553.6 nm (Abs.)	Test Results	Pass/Fail
1.0 A ND Filter	± 5% from Cert.	0.9798	0.9848	Passed
0.2 A ND Filter	± 5% from Cert.	0.2042	0.1963	Passed

#### 8.2 Baseline Noise at 1.0 Absorbance with Barium

Description: Ensures that a high absorbance will not produce excessive noise.

Parameter	Specification	Results	Pass/Fail
Standard Deviation	≤ 0.010	0.0008	Passed

#### 8.3 AA Baseline Noise with Copper

Description: Check baseline noise.

Parameter	Specification	Results	Pass/Fail
Standard Deviation	≤ 0.001	0.0001	Passed

#### 8.4 D<sub>2</sub> Background Compensation with Copper

Description: Verifies the instruments ability to compensate for Background absorption.

Parameter	Specification	Results	Pass/Fail
Standard Deviation	≤ 0.010	0.0049	Passed

#### 8.5 AA-BG Baseline Noise with Copper

Description: Ensures that background correction does not produce excessive noise.

Parameter	Specification	Results	Pass/Fail
Standard Deviation	≤ 0.005	0.0003	Passed

#### 8.6 AA-BG Baseline Noise with Arsenic

Description: Ensures that background correction does not produce excessive noise at a low wavelength.

Parameter	Specification	Results	Pass/Fail
Standard Deviation	≤ 0.005	0.0005	Passed

#### 8.7 Flame Sensitivity

Description: Instrument Sensitivity checked against Copper standard.

Standard Copper Sensitivity	Specification	Results (Abs.)	Pass/Fail
5 mg/L Sensitivity SS Neb (if applicable)	> 0.250 Abs.	NA	Not Applicable
2 mg/L Sensitivity HS Neb (if applicable)	> 0.250 Abs.	0.3353	Passed

### 10. Review:

- ☒ Review with the customer PM work performed.
- ☒ Review with the customer routine maintenance procedures.
- ☒ Discuss recommended customer supplied materials to have on hand.
- ☒ Attach PM sticker.

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## Additional Comments

### Additional Comments Regarding the PM

## Review

The preventive maintenance checks and if applicable performance tests for PinAAcle 900F have been completed.

This PinAAcle 900F ☒ Passes ☐ Fails ☐ the preventive maintenance.

### Review of Preventive Maintenance:

Authorized PerkinElmer Representative:

Date:

20-Jul-2022  
(DD-MMM-YYYY)

Authorized Customer Representative:

Date:

20-Jul-2022  
(DD-MMM-YYYY)

PinAAcle 900F Preventive Maintenance Report (PM)

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Request No. 25-66 / 0323

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MTC. ACL. No. 387 / 66

## CALIBRATION DATA

### 1. Noise Level

Element	Cd	Cr	Cu	Fe	Pb	Mn	Ni	Zn
Absorbance	0.0020	0.0000	0.0008	0.0000	-0.0009	0.0021	-0.0016	-0.0022
	0.0015	0.0006	0.0005	-0.0009	-0.0014	0.0018	0.0002	-0.0023
	0.0014	0.0006	0.0010	-0.0009	0.0015	0.0008	-0.0004	-0.0015
	0.0021	-0.0008	0.0013	-0.0010	0.0005	0.0005	-0.0008	-0.0004
	0.0020	-0.0012	0.0004	0.0003	-0.0004	0.0001	-0.0024	-0.001
	0.0021	-0.0011	0.0011	0.0003	0.0006	0.0009	-0.0002	-0.0013
	0.0017	-0.0009	0.0001	-0.0015	0.0010	0.0007	0.0001	-0.0016
	0.0024	-0.0012	0.0004	-0.0002	0.0008	-0.0005	-0.0012	-0.0019
	0.0011	-0.0002	0.0015	-0.0004	0.0004	0.0008	-0.0003	-0.0017
	0.0017	0.0000	0.0009	0.0004	0.0001	0.0015	-0.0009	-0.0024
	0.0019	-0.0004	0.0004	0.0000	0.0006	0.0010	-0.0005	-0.0016
	0.0016	-0.0025	0.0003	0.0005	0.0009	-0.0004	-0.0013	-0.0016
	0.0018	-0.0014	0.0001	-0.0009	-0.0006	0.0010	-0.0004	-0.0017
	0.0019	-0.0006	0.0011	-0.0008	0.0011	0.0004	-0.0003	-0.0005
	0.0024	0.0003	0.0005	-0.0012	-0.0002	0.0012	-0.0006	-0.0011
	0.0023	-0.0012	0.0006	-0.0007	0.0002	0.0014	-0.0012	-0.0013
	0.0020	-0.0014	0.0009	-0.0018	0.0003	0.0012	-0.0012	-0.0013
	0.0010	-0.0015	0.0002	0.0004	0.0017	0.0011	-0.0018	-0.0013
	0.0016	-0.0011	0.0013	0.0003	0.0007	0.0026	-0.0006	-0.0006
	0.0001	-0.0007	0.0009	-0.0003	0.0008	0.0008	0.0000	-0.0001
Average Absorbance	0.002	-0.001	0.001	0.000	0.000	0.001	-0.001	-0.001

Continue 2 / 5

INDUSTRIAL METROLOGY AND TESTING SERVICE CENTRE

The results relate only to the items tested/calibrated or value assigned.

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FMBL.MTC.002 Rev.4

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E-mail : rumpai@tistr.or.th Website:www.tistr.or.th

Office/Laboratory  
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Amphoe Muang, Changwat Samutprakan 10280, Thailand  
Tel. (66) 0 2323 1672-80 ext. 115, 116  
Fax. (66) 0 2323 9165  
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Fax. (66) 0 2577 9009  
E-mail : mtg@tistr.or.th

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Request No. 25-66 / 0323

MTC. ACL.No. 387 / 66

## CALIBRATION CERTIFICATE

NOMENCLATURE : 1. Atomic Absorption Spectrophotometer "Agilent Technologies"

Model AA240FS, Serial No. MY13160001

2. Working standard solution "Inorganic Ventures"

Multi Analyte Custom Grade Solution, Lot No. S2-MEB708640

SUBMITTED BY : United Analyst and Engineering Consultant Co., Ltd.

3. Soi Udomsuk41, Sukhumvit Road, Bangkok, Prakanong, Bangkok 10260

CALIBRATION PROCEDURE : 1. Performance Verification of Atomic Absorption Spectrophotometer  
(WI-500-02-30)

2. Estimation Uncertainty of Measurement in Analytical Chemistry (QP-513)

CALIBRATION RANGE: 0.02,0.10,0.30,0.50,0.70 mg/l at 228.8 nm.Cd, 0.10,0.20,0.30,0.50,0.70 mg/l at 357.9 nm.Cr,  
0.05,0.10,0.30,0.50,0.70 mg/l at 324.7 nm.Cu, 0.10,0.30,0.50,0.70,1.00 mg/l at 248.3 nm.Fe, 0.20,0.50,0.70,1.00,1.50 mg/l  
at 217.0 nm.Pb, 0.05,0.10,0.30,0.50,0.70 mg/l at 279.5 nm.Mn, 0.10,0.30,0.50,0.70,1.00 mg/l at 232.0 nm.Ni,  
0.05,0.10,0.30,0.50,0.70 mg/l at 213.9 nm.Zn

CALIBRATION DATE : 2 February 2023

REFERENCE MATERIAL : Traceable to NIST "Carlo Erba", "PanReac AppliChem"

Cadmium Lot No. 1152457, Chromium Lot No. 1793249, Copper Batch No. T117098A, Iron Batch No. T126087A,  
Lead Lot No. 1227873, Manganese Batch No. T109228A, Nickel Batch No. T270178A, Zinc Batch No. T820140A

AMBIENT CONDITIONS : Temperature 22 °C Relative humidity 58 %

The Atomic Absorption Spectrophotometer has been calibrated against Reference  
Material traceable to National Institute of Standards and Technology ( NIST ) by The Analytical Chemistry  
Laboratory. The results are attached herewith.

Calibrated by 1. [Redacted]

( Mr. Danal Srithongkum )

Approved by [Redacted]

( Miss Sutadida Deawong )

Senior Technical Officer

Acting Director of Analytical Chemistry Laboratory

Ref. 2015266012600366001

Issued Date : 15 February 2023

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Request No. 25-66 / 0323

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MTC. ACL. No. 387 / 66

### 2. Precision

Element	Conc. (mg/l)	Absorbance										Ave. Abs.	SD	%RSD
Cd	0.02	0.0085	0.0084	0.0090	0.0089	0.0089	0.0090	0.0086	0.0092	0.0090	0.0089	0.009	0.0003	2.88
	0.30	0.0993	0.1001	0.1007	0.1004	0.1004	0.0995	0.0997	0.0998	0.0999	0.0996	0.100	0.0005	0.45
	0.70	0.2238	0.2229	0.2244	0.2249	0.2243	0.2233	0.2235	0.2231	0.2251	0.2240	0.224	0.0007	0.33
Cr	0.10	0.0088	0.0087	0.0094	0.0086	0.0086	0.0091	0.0099	0.0095	0.0076	0.0085	0.009	0.0006	7.25
	0.30	0.0257	0.0265	0.0255	0.0270	0.0266	0.0258	0.0261	0.0262	0.0274	0.0262	0.026	0.0006	2.25
	0.70	0.0573	0.0590	0.0580	0.0576	0.0578	0.0579	0.0593	0.0599	0.0586	0.0594	0.058	0.0009	1.51
Cu	0.05	0.0083	0.0084	0.0084	0.0075	0.0086	0.0086	0.0081	0.0080	0.0087	0.0092	0.008	0.0005	5.45
	0.30	0.0430	0.0444	0.0426	0.0429	0.0435	0.0432	0.0428	0.0441	0.0427	0.0436	0.043	0.0006	1.41
	0.70	0.0981	0.0992	0.0990	0.0997	0.0977	0.0986	0.0990	0.0982	0.0988	0.0980	0.099	0.0006	0.63
Fe	0.10	0.0109	0.0104	0.0087	0.0100	0.0087	0.0094	0.0102	0.0092	0.0094	0.0100	0.010	0.0007	7.53
	0.50	0.0456	0.0442	0.0450	0.0444	0.0450	0.0455	0.0455	0.0441	0.0446	0.0444	0.045	0.0006	1.27
	1.00	0.0904	0.0901	0.0891	0.0896	0.0876	0.0903	0.0901	0.0876	0.0886	0.0879	0.090	0.0012	1.38
Pb	0.20	0.0093	0.0099	0.0104	0.0102	0.0104	0.0109	0.0102	0.0103	0.0115	0.0117	0.010	0.0007	6.85
	0.70	0.0344	0.0336	0.0336	0.0328	0.0338	0.0346	0.0336	0.0331	0.0343	0.0350	0.034	0.0007	2.02
	1.50	0.0709	0.0718	0.0706	0.0713	0.0698	0.0718	0.0712	0.0713	0.0715	0.0719	0.071	0.0006	0.90
Mn	0.05	0.0115	0.0130	0.0131	0.0127	0.0135	0.0136	0.0124	0.0133	0.0124	0.0130	0.013	0.0006	4.88
	0.30	0.0709	0.0700	0.0714	0.0704	0.0700	0.0705	0.0714	0.0698	0.0694	0.0700	0.070	0.0007	0.96
	0.70	0.1619	0.1633	0.1646	0.1638	0.1646	0.1614	0.1632	0.1614	0.1636	0.1652	0.163	0.0014	0.83
Ni	0.10	0.0113	0.0105	0.0113	0.0114	0.0110	0.0113	0.0117	0.0112	0.0107	0.0117	0.011	0.0004	3.45
	0.50	0.0509	0.0517	0.0508	0.0502	0.0517	0.0516	0.0516	0.0523	0.0518	0.0503	0.051	0.0007	1.36
	1.00	0.0997	0.1006	0.1006	0.1006	0.0996	0.0998	0.1007	0.1000	0.1013	0.0999	0.100	0.0006	0.55
Zn	0.05	0.0315	0.0309	0.0322	0.0304	0.0329	0.0312	0.0313	0.0319	0.0308	0.0311	0.031	0.0007	2.35
	0.30	0.1705	0.1728	0.1688	0.1693	0.1711	0.1704	0.1704	0.1707	0.1708	0.1688	0.170	0.0012	0.70
	0.70	0.3559	0.3572	0.3548	0.3560	0.3559	0.3550	0.3579	0.3552	0.3574	0.3573	0.356	0.0011	0.31

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## 3. Trueness

## 3.1 Reading on wavelength- Cadmium(Cd) at 228.8 nm.

Element	Standard Value of RM (mg/l)	Reading (mg/l)	Error of Measurement (mg/l)	Error of Measurement (%)	Uncertainty (mg/l)
Cd	0.02002	0.021	0.001	4.90	± 0.005
	0.30030	0.298	-0.002	0.77	± 0.005
	0.70070	0.675	-0.026	3.67	± 0.008

## 3.2 Reading on wavelength- Chromium (Cr) at 357.9 nm.

Element	Standard Value of RM (mg/l)	Reading (mg/l)	Error of Measurement (mg/l)	Error of Measurement (%)	Uncertainty (mg/l)
Cr	0.1001	0.101	0.001	0.90	± 0.009
	0.3003	0.293	-0.007	2.43	± 0.012
	0.7007	0.648	-0.053	7.52	± 0.023

## 3.3 Reading on wavelength- Copper (Cu) at 324.7 nm.

Element	Standard Value of RM (mg/l)	Reading (mg/l)	Error of Measurement (mg/l)	Error of Measurement (%)	Uncertainty (mg/l)
Cu	0.050	0.046	-0.004	8.00	± 0.003
	0.300	0.289	-0.011	3.67	± 0.009
	0.700	0.674	-0.026	3.71	± 0.020

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## 3.4 Reading on wavelength- Iron (Fe) at 248.3 nm.

Element	Standard Value of RM (mg/l)	Reading (mg/l)	Error of Measurement (mg/l)	Error of Measurement (%)	Uncertainty (mg/l)
Fe	0.100	0.095	-0.005	5.00	± 0.014
	0.500	0.474	-0.026	5.20	± 0.016
	1.000	0.950	-0.050	5.00	± 0.029

## 3.5 Reading on wavelength- Lead (Pb) at 217.0 nm.

Element	Standard Value of RM (mg/l)	Reading (mg/l)	Error of Measurement (mg/l)	Error of Measurement (%)	Uncertainty (mg/l)
Pb	0.200	0.207	0.007	3.50	± 0.014
	0.700	0.673	-0.027	3.86	± 0.030
	1.500	1.417	-0.083	5.53	± 0.061

## 3.6 Reading on wavelength- Manganese (Mn) at 279.5 nm.

Element	Standard Value of RM (mg/l)	Reading (mg/l)	Error of Measurement (mg/l)	Error of Measurement (%)	Uncertainty (mg/l)
Mn	0.04995	0.046	-0.004	7.91	± 0.005
	0.29970	0.294	-0.0057	1.90	± 0.007
	0.69930	0.694	-0.0053	0.76	± 0.014

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## 3.7 Reading on wavelength- Nickel (Ni) at 232.0 nm.

Element	Standard Value of RM (mg/l)	Reading (mg/l)	Error of Measurement (mg/l)	Error of Measurement (%)	Uncertainty (mg/l)
Ni	0.1001	0.103	0.003	2.90	± 0.013
	0.5005	0.501	0.001	0.10	± 0.018
	1.0010	0.987	-0.014	1.40	± 0.032

## 3.8 Reading on wavelength- Zinc (Zn) at 213.9 nm.

Element	Standard Value of RM (mg/l)	Reading (mg/l)	Error of Measurement (mg/l)	Error of Measurement (%)	Uncertainty (mg/l)
Zn	0.050	0.046	-0.004	8.00	± 0.013
	0.300	0.311	0.011	3.67	± 0.013
	0.700	0.665	-0.035	5.00	± 0.019

Remark : The reported uncertainty is an expanded uncertainty calculated using a coverage factor of 2 (k = 2)  
which gives a level of confidence of approximately 95%

Calibrated by 1. [Redacted]  
(Mr. Danai Srithongkum)  
2. [Redacted]  
(Mr. Atipat Ratana)

Approved by [Redacted]  
(Miss Sutadee Deawong)  
Senior Technical Officer  
Acting Director of  
Analytical Chemistry Laboratory  
Issued Date : 15 February 2023

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End of Certificate

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