

ภาคผนวก จ



เอกสารสอบเทียบเครื่องมือวิเคราะห์

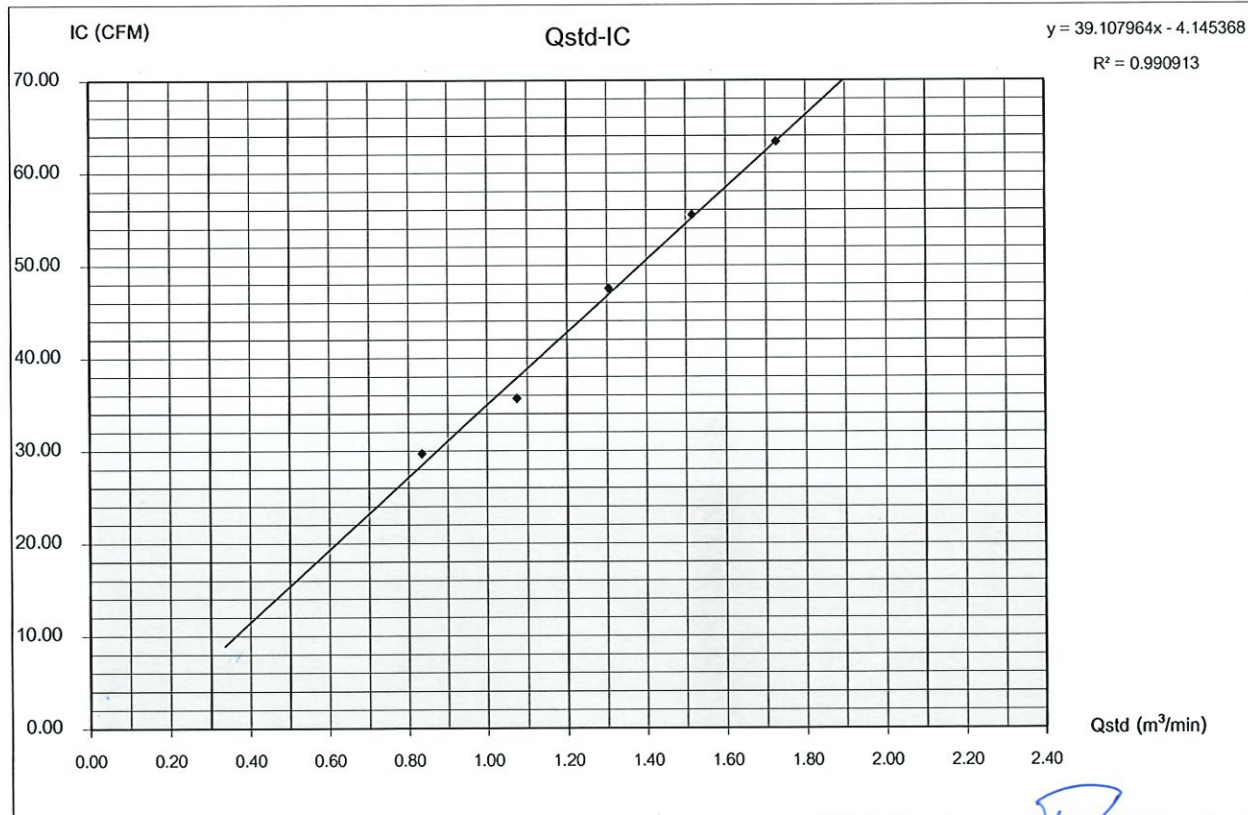
PM10 HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

Quotation	2023-00767			Date	November 14, 2023
Sampler Location	โรงเรียนบ้านหนองโสน			Start Time	11:53 AM
Sampler Number	PM-10 No.25	Transfer Standard Type	Orifice	Stop Time	12:03 PM
Instrument Model	HIVOL-BMBBE	Calibrator Model	TE-5025A	Calibrated By	Mr.Nuttapol Nanta
Motor Serial Number	2150	Calibrator Serial Number	2914		
Recorder Serial Number	2409				

Plate No.	(Delta H)			(A)	(X)	(I)	(Y)	Temperature	Barometric	Start	Stop	
	Pressure Drop Across Orifice (inH ₂ O)			$[\Delta H_2O(Pa/P_{std})(T_{std}/Ta)]^{1/2}$	$Q_{std} = (1/m)[(A-b)]$	Sample Flow Rate Indicator	$IC = I[(Pa/P_{std})(T_{std}/Ta)]^{1/2}$		Pressure	Meter	Meter	
	Positive	Negative	ΔH_2O		(m ³ /min)	(ft ³ /min)		(°K = °C+273)	(mmHg)			
5	1.5	1.5	3.0	1.71544	0.83419	30.0	29.71	303.0	758.0			
7	2.5	2.5	5.0	2.21462	1.07434	36.0	35.65	303.0	758.0			
10	3.7	3.7	7.4	2.69420	1.30505	48.0	47.54	303.0	758.0			
13	5.0	5.0	10.0	3.13195	1.51563	56.0	55.46	303.0	758.0			
18	6.5	6.5	13.0	3.57097	1.72683	64.0	63.39	303.0	758.0			
Linear Regression Y ON X : Y= mX + b							Average	303.0	758.0			
1	Slope (m)			2.07871	Linear Equation			r^2	0.990913	Pstd(mmHg)	760.0	
2	Intercept (b)			-0.01861	Set Point Flow Rate (X) (m ³ /min)		1.133	r	0.9954461	T _{NTP}	298.15	
3	Correlation Coefficient (r)			0.99984	Final Set Flow Rate = (I)		0	(Pa/Pstd)*(Tstd/Ta)		0.980910196		
Result									C=(Pa/Pstd)*(Tstd/Ta)^0.5		0.990409106	

COMMENT

Andersen Instruments, Inc.



Checked By

Nattaphon (nu)
(Mr. Prayun Detkla)
Technician



Approved By

(Mr. Panupon Podang)
Environmental Scientist

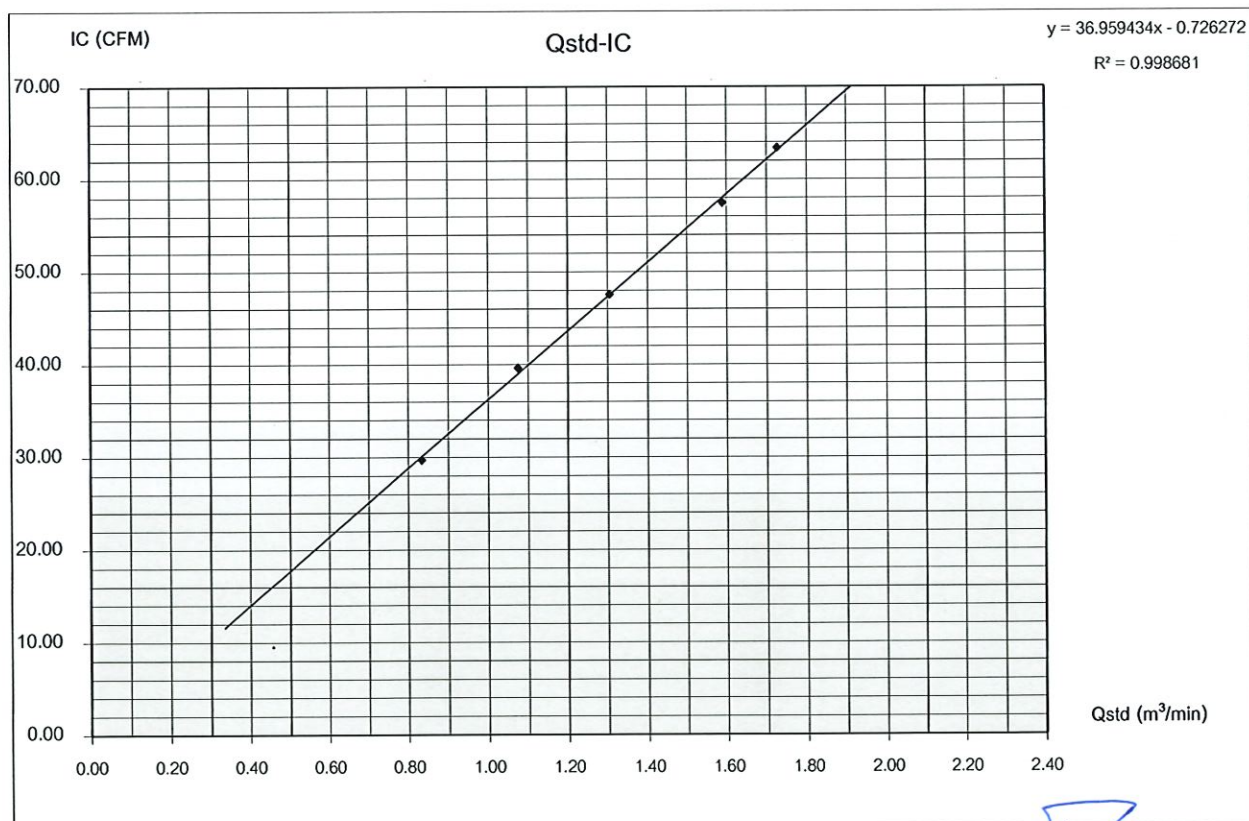
TSP HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

Quotation	2023-00767			Date	November 14, 2023
Sampler Location	โรงเรียนหนองโดน			Start Time	11:43 AM
Sampler Number	TSP No.A26	Transfer Standard Type	Orifice	Stop Time	11:53 AM
Instrument Model	HIVOL-BBCBE	Calibrator Model	TE-5025A	Calibrated By	Mr.Nuttapol Nanta
Motor Serial Number	A26	Calibrator Serial Number	2914		
Recorder Serial Number	102950701				

Plate No.	(Delta H)			(A)	(X)	(I)	(Y)	Temperature	Barometric	Start	Stop
	Pressure Drop Across Orifice (inH ₂ O)			[ΔH ₂ O(Pa/P _{std})(T _{std} /Ta)] ^{1/2}	Qstd = (1/m)[(A-b)] (m ³ /min)	Sample Flow Rate Indication (ft ³ /min)	IC = I[(Pa/P _{std})(T _{std} /Ta)] ^{1/2}	(°K = °C+273)	Pressure (mmHg)	Meter	Meter
	Positive	Negative	ΔH ₂ O								
5	1.5	1.5	3.0	1.71544	0.83419	30.0	29.71	303.0	758.0		
7	2.5	2.5	5.0	2.21462	1.07434	40.0	39.62	303.0	758.0		
10	3.7	3.7	7.4	2.69420	1.30505	48.0	47.54	303.0	758.0		
13	5.5	5.5	11.0	3.28482	1.58917	58.0	57.44	303.0	758.0		
18	6.5	6.5	13.0	3.57097	1.72683	64.0	63.39	303.0	758.0		
Linear Regression Y ON X : Y= mX + b							Average	303.0	758.0		
1	Slope (m)			2.07871	Linear Equation			r ²	0.998681	Pstd(mmHg)	760.0
2	Intercept (b)			-0.01861	Set Point Flow Rate (X) (m ³ /min)		1.133	r	0.9993403	T _{NTP}	298.0
3	Correlation Coefficient (r)			0.99984	Final Set Flow Rate = (I)		0	(Pa/Pstd)*(Tstd/Ta)			0.980910196
Result								C=(Pa/Pstd)*(Tstd/Ta)^0.5			0.990409106

COMMENT

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Technician



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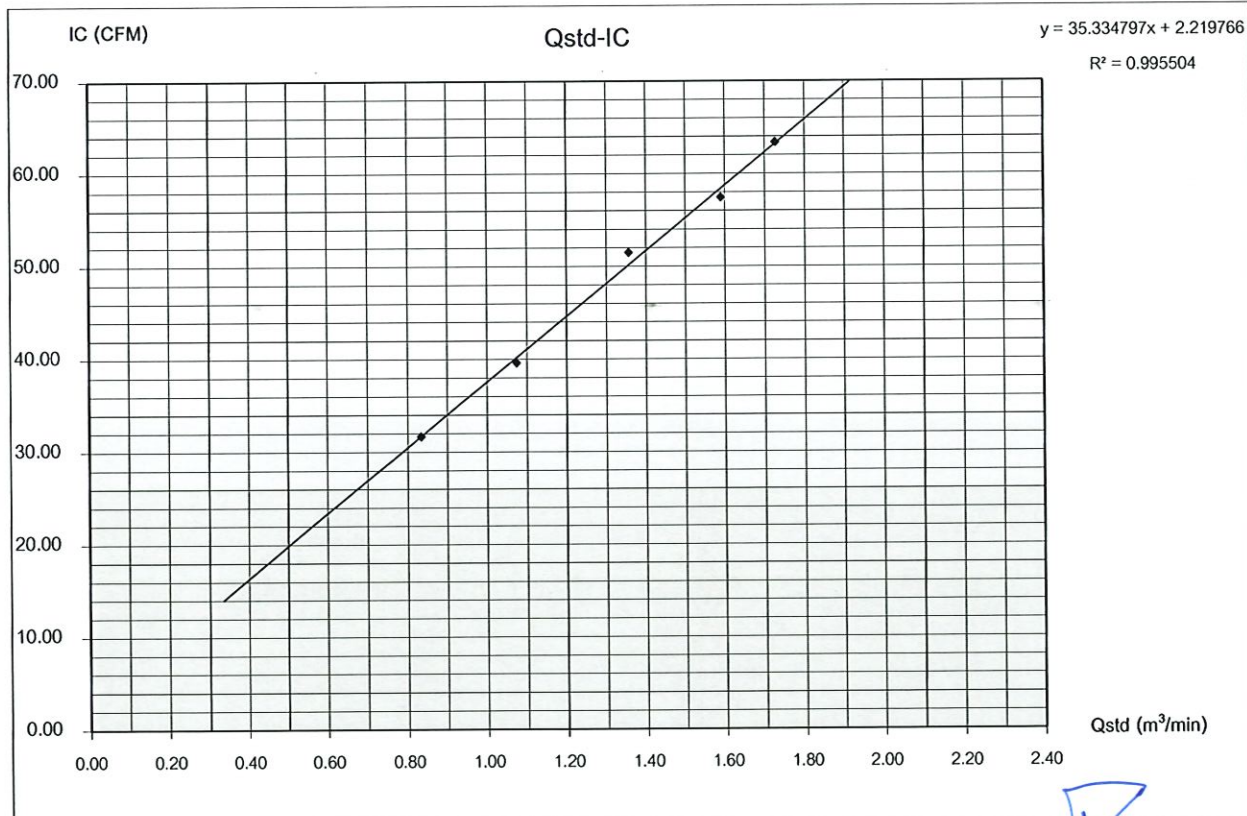
PM10 HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

Quotation	2023-00767	Date	November 14, 2023
Sampler Location	โรงเรียนบ้านบุเตียว	Start Time	10:59 AM
Sampler Number	PM-10 No.20	Transfer Standard Type	Onifice
Instrument Model	HIVOL-BMBBE	Calibrator Model	TE-5025A
Motor Serial Number	2140	Calibrator Serial Number	2914
Recorder Serial Number	2393	Calibrated By	Mr.Nuttapol Nanta

Plate No.	(Delta H)			(A)	(X)	(I)	(Y)	Temperature	Barometric Pressure	Start Meter	Stop Meter	
	Pressure Drop Across Orifice (inH ₂ O)			$[\Delta H_2O(Pa/P_{std})(T_{std}/Ta)]^{1/2}$	$Q_{std} = (1/m)[(A-b)]$ (m ³ /min)	ample Flow Rate Indicato (ft ³ /min)	$IC = I[(Pa/P_{std})(T_{std}/Ta)]^{1/2}$	(^°K = ^°C+273)	(mmHg)			
	Positive	Negative	ΔH ₂ O									
5	1.5	1.5	3.0	1.71544	0.83419	32.0	31.69	303.0	758.0			
7	2.5	2.5	5.0	2.21462	1.07434	40.0	39.62	303.0	758.0			
10	4.0	4.0	8.0	2.80130	1.35657	52.0	51.50	303.0	758.0			
13	5.5	5.5	11.0	3.28482	1.58917	58.0	57.44	303.0	758.0			
18	6.5	6.5	13.0	3.57097	1.72683	64.0	63.39	303.0	758.0			
Linear Regression Y ON X : Y= mX + b							Average	303.0	758.0			
1	Slope (m)			2.07871	Linear Equation			r ²	0.995504	Pstd(mmHg)	760.0	
2	Intercept (b)			-0.01861	Set Point Flow Rate (X) (m ³ /min)		1.133	r	0.9977495	T _{NTP}	298.0	
3	Correlation Coefficient (r)			0.99984	Final Set Flow Rate = (I)		0	(Pa/Pstd)*(Tstd/Ta)		0.980910196		
Result									C=(Pa/Pstd)*(Tstd/Ta)^0.5		0.990409106	

COMMENT

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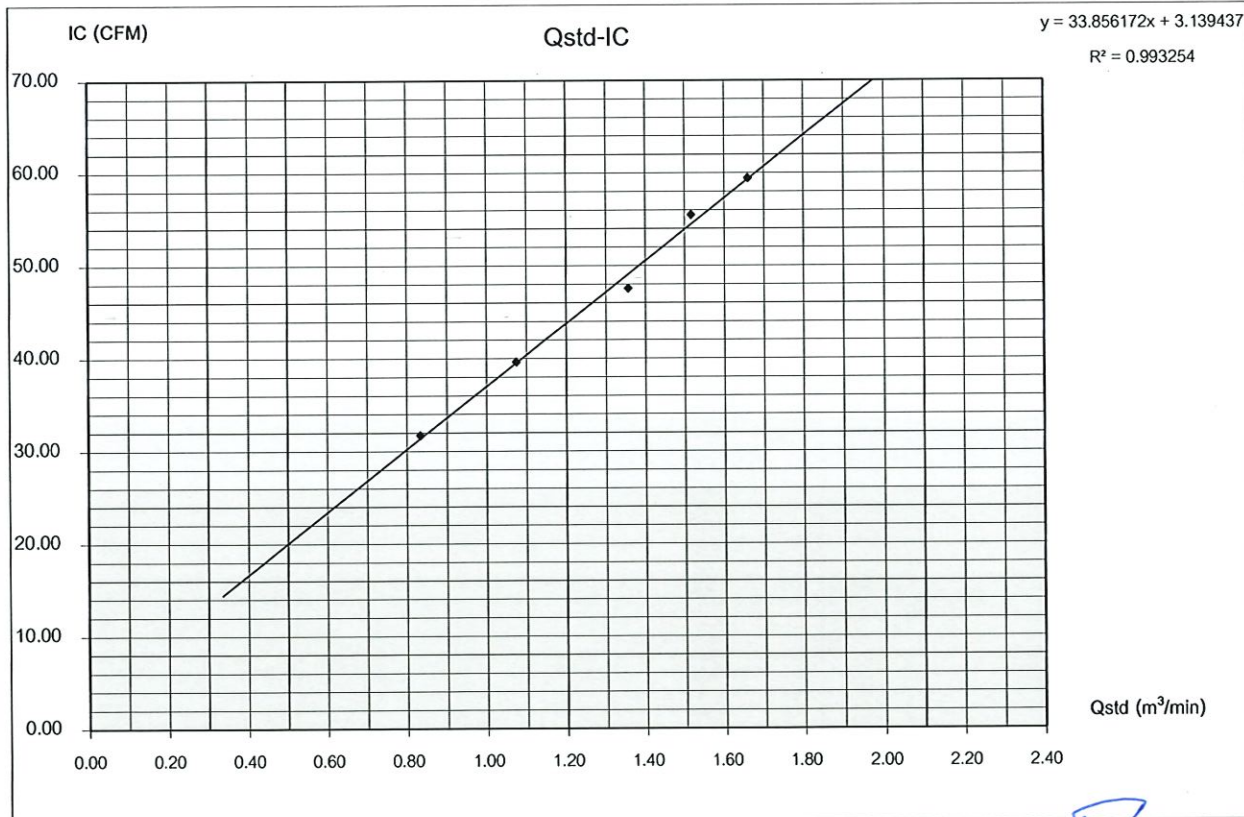
TSP HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

Quotation	2023-00767	Date	November 14, 2023
Sampler Location	โรงเรียนบ้านบุเตี๋ย	Start Time	10:49 AM
Sampler Number	TSP No.A10	Transfer Standard Type	Orifice
Instrument Model	HIVOL-BBCBE	Calibrator Model	TE-5025A
Motor Serial Number	2012-04	Calibrator Serial Number	2914
Recorder Serial Number	1504	Calibrated By	Mr.Nuttapol Nanta

Plate No.	(Delta H)			(A)	(X)	(I)	(Y)	Temperature	Barometric Pressure	Start Meter	Stop Meter
	Pressure Drop Across Orifice (inH ₂ O)			$[\Delta H_2O(Pa/P_{atm})(T_{atm}/Ta)]^{1/2}$	$Qstd = (1/m)[(A-b)]$ (m ³ /min)	sample Flow Rate Indication (ft ³ /min)	$IC = I[(Pa/P_{atm})(T_{atm}/Ta)]^{1/2}$	(°K = °C+273)	(mmHg)		
	Positive	Negative	ΔH ₂ O								
5	1.5	1.5	3.0	1.71544	0.83419	32.0	31.69	303.0	758.0		
7	2.5	2.5	5.0	2.21462	1.07434	40.0	39.62	303.0	758.0		
10	4.0	4.0	8.0	2.80130	1.35657	48.0	47.54	303.0	758.0		
13	5.0	5.0	10.0	3.13195	1.51563	56.0	55.46	303.0	758.0		
18	6.0	6.0	12.0	3.43088	1.65944	60.0	59.42	303.0	758.0		
Linear Regression Y ON X : Y= mX + b							Average	303.0	758.0		
1	Slope (m)			2.07871	Linear Equation			r ²	0.993254	Pstd(mmHg)	760.0
2	Intercept (b)			-0.01861	Set Point Flow Rate (X) (m ³ /min)		1.133	r	0.9966213	T _{NTP}	298.0
3	Correlation Coefficient (r)			0.99984	Final Set Flow Rate = (I)		0	(Pa/Pstd)*(Tstd/Ta)			0.980910196
Result								C=(Pa/Pstd)*(Tstd/Ta)^0.5			0.990409106

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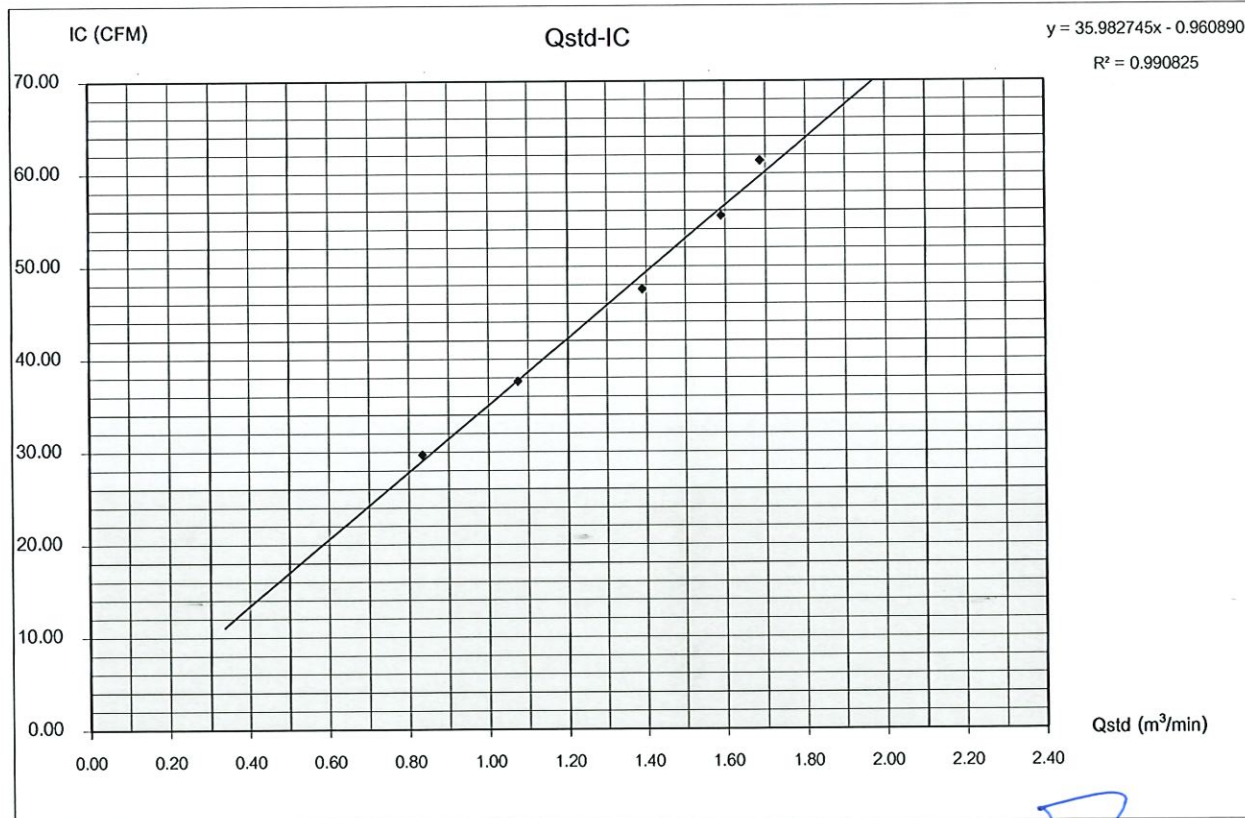
PM10 HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

Quotation	2023-00767	Date	November 14, 2023
Sampler Location	โรงเรียนบ้านหนองไผ่ล้อม	Start Time	1:47 PM
Sampler Number	PM-10 No.30	Transfer Standard Type	Orifice
Instrument Model	HIVOL-BMBBE	Calibrator Model	TE-5025A
Motor Serial Number	2208	Calibrator Serial Number	2914
Recorder Serial Number	2616	Calibrated By	Mr.Nuttapol Nanta

Plate No.	(Delta H)			(A)	(X)	(I)	(Y)	Temperature	Barometric Pressure	Start Meter	Stop Meter	
	Pressure Drop Across Orifice (inH ₂ O)			$[\Delta H_2O(Pa/P_{std})(T_{std}/Ta)]^{1/2}$	$Q_{std} = (1/m)[(A-b)]$	sample Flow Rate Indicator	$IC = I[(Pa/P_{std})(T_{std}/Ta)]^{1/2}$	(^°K = °C+273)	(mmHg)			
	Positive	Negative	ΔH ₂ O	(m ³ /min)	(ft ³ /min)							
5	1.5	1.5	3.0	1.71544	0.83419	30.0	29.71	303.0	758.0			
7	2.5	2.5	5.0	2.21462	1.07434	38.0	37.64	303.0	758.0			
10	4.2	4.2	8.4	2.87048	1.38985	48.0	47.54	303.0	758.0			
13	5.5	5.5	11.0	3.28482	1.58917	56.0	55.46	303.0	758.0			
18	6.2	6.2	12.4	3.48759	1.68672	62.0	61.41	303.0	758.0			
Linear Regression Y ON X : Y= mX + b							Average	303.0	758.0			
1	Slope (m)			2.07871	Linear Equation			r ²	0.990825	Pstd(mmHg)	760.0	
2	Intercept (b)			-0.01861	Set Point Flow Rate (X) (m ³ /min)		1.133	r	0.9954019	T _{NTP}	298.15	
3	Correlation Coefficient (r)			0.99984	Final Set Flow Rate = (I)		0	(Pa/Pstd)*(Tstd/Ta)			0.980910196	
Result									C=(Pa/Pstd)*(Tstd/Ta)^0.5			0.990409106

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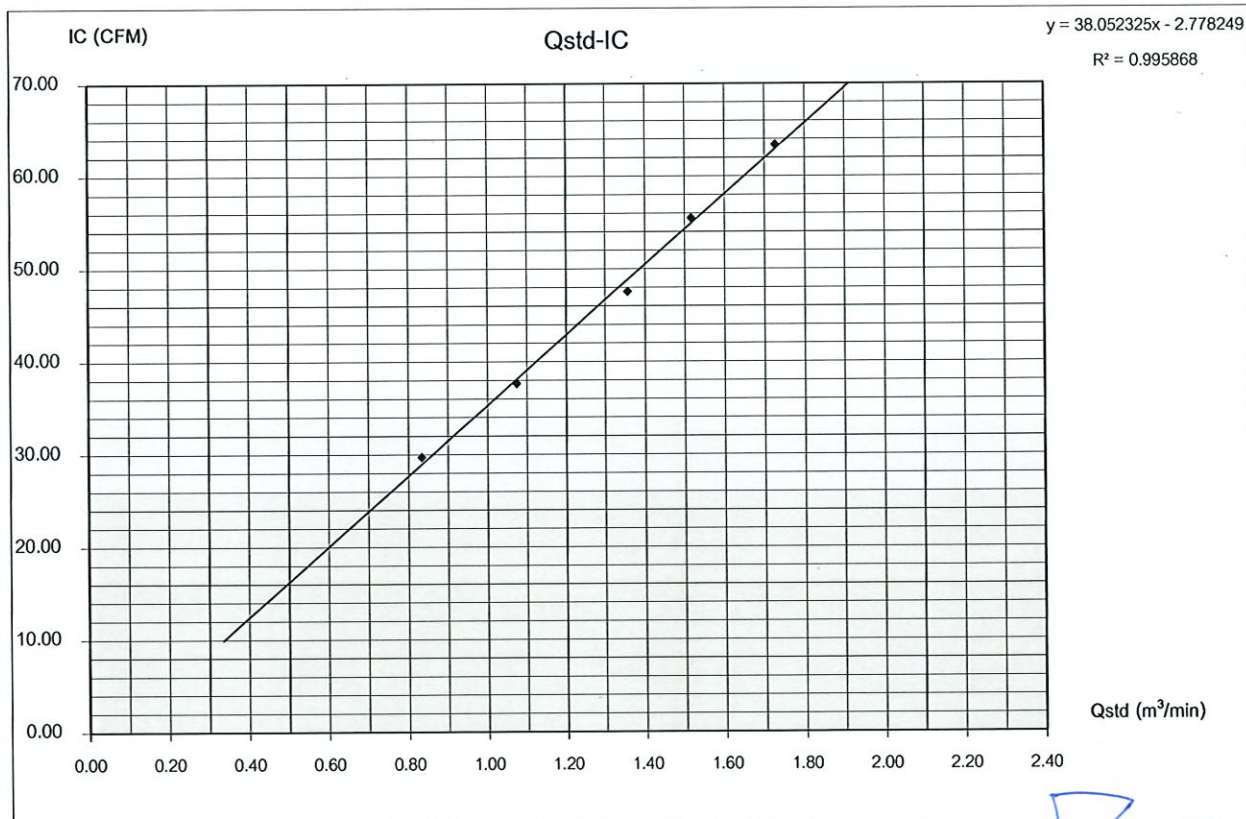
TSP HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

Quotation	2023-00767	Date	November 14, 2023
Sampler Location	โรงเรียนบ้านหนองไผ่ล้อม	Start Time	1:57 PM
Sampler Number	TSP No.A23	Transfer Standard Type	Orifice
Instrument Model	HIVOL-BBCBE	Calibrator Model	TE-5025A
Motor Serial Number	2055	Calibrator Serial Number	2914
Recorder Serial Number	2186	Calibrated By	Mr.Nuttapol Nanta

Plate No.	(Delta H)			(A)	(X)	(I)	(Y)	Temperature	Barometric Pressure	Start Meter	Stop Meter
	Pressure Drop Across Orifice (inH ₂ O)										
	Positive	Negative	ΔH ₂ O	(m ³ /min)	(ft ³ /min)	(°K = °C+273)	(mmHg)				
5	1.5	1.5	3.0	1.71544	0.83419	30.0	29.71	303.0	758.0		
7	2.5	2.5	5.0	2.21462	1.07434	38.0	37.64	303.0	758.0		
10	4.0	4.0	8.0	2.80130	1.35657	48.0	47.54	303.0	758.0		
13	5.0	5.0	10.0	3.13195	1.51563	56.0	55.46	303.0	758.0		
18	6.5	6.5	13.0	3.57097	1.72683	64.0	63.39	303.0	758.0		
Linear Regression Y ON X : Y= mX + b							Average	303.0	758.0		
1	Slope (m)			2.07871	Linear Equation			r ²	0.995868	Pstd(mmHg)	760.0
2	Intercept (b)			-0.01861	Set Point Flow Rate (X) (m ³ /min)			1.133	r	0.9979319	T _{NTP}
3	Correlation Coefficient (r)			0.99984	Final Set Flow Rate = (I)			0	(Pa/Pstd)*(Tstd/Ta)		
Result								C=(Pa/Pstd)*(Tstd/Ta)^0.5			0.990409106

COMMENT

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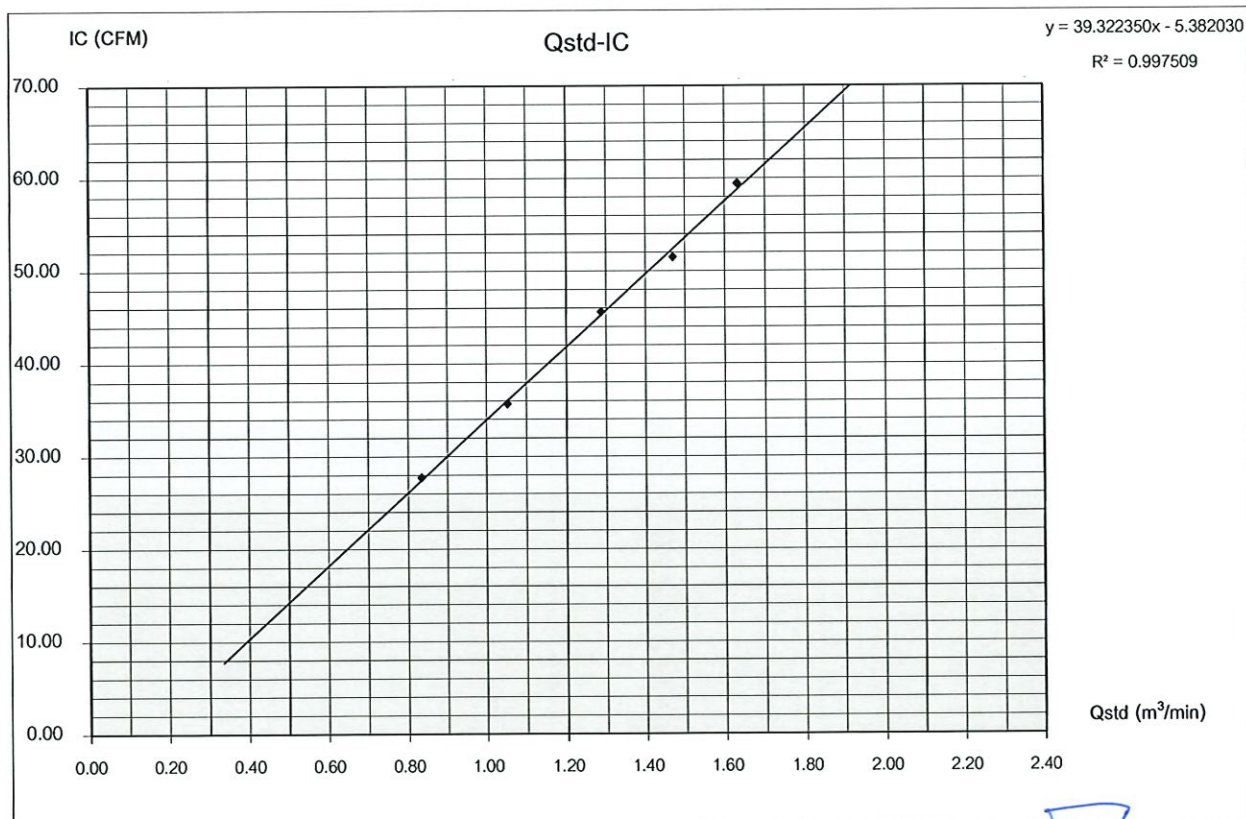
TSP HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

Quotation	2023-00767	Date	November 14, 2023
Sampler Location	วัดบ้านแพ้ว	Start Time	12:47 PM
Sampler Number	TSP No.A27	Transfer Standard Type	Orifice
Instrument Model	HIVOL-BBCBE	Calibrator Model	TE-5025A
Motor Serial Number	2215	Calibrator Serial Number	2914
Recorder Serial Number	2133	Calibrated By	Mr.Nuttapol Nanta

Plate No.	(Delta H)			(A)	(X)	(I)	(Y)	Temperature	Barometric Pressure	Start Meter	Stop Meter
	Pressure Drop Across Orifice (inH ₂ O)			$[\Delta H_2O(Pa/P_{std})(T_{std}/Ta)]^{1/2}$	Qstd = (1/m)[(A-b)]	Sample Flow Rate Indication	$IC = I[(Pa/P_{std})(T_{std}/Ta)]^{1/2}$	(^°K = ^°C+273)	(mmHg)		
	Positive	Negative	ΔH ₂ O								
5	1.5	1.5	3.0	1.71544	0.83419	28.0	27.73	303.0	758.0		
7	2.4	2.4	4.8	2.16988	1.05281	36.0	35.65	303.0	758.0		
10	3.6	3.6	7.2	2.65755	1.28741	46.0	45.56	303.0	758.0		
13	4.7	4.7	9.4	3.03654	1.46973	52.0	51.50	303.0	758.0		
18	5.8	5.8	11.6	3.37321	1.63170	60.0	59.42	303.0	758.0		
Linear Regression Y ON X : Y= mX + b							Average	303.0	758.0		
1	Slope (m)			2.07871	Linear Equation			r ²	0.997509	Pstd(mmHg)	760.0
2	Intercept (b)			-0.01861	Set Point Flow Rate (X) (m ³ /min)		1.133	r	0.9987537	T _{NTP}	298.0
3	Correlation Coefficient (r)			0.99984	Final Set Flow Rate = (I)		0	(Pa/Pstd)*(Tstd/Ta)		0.980910196	
Result								C=(Pa/Pstd)*(Tstd/Ta)^0.5		0.990409106	

COMMENT

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(Mr. Prayun Detkla)

Technician



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(Mr. Panupon Podang)

Environmental Scientist

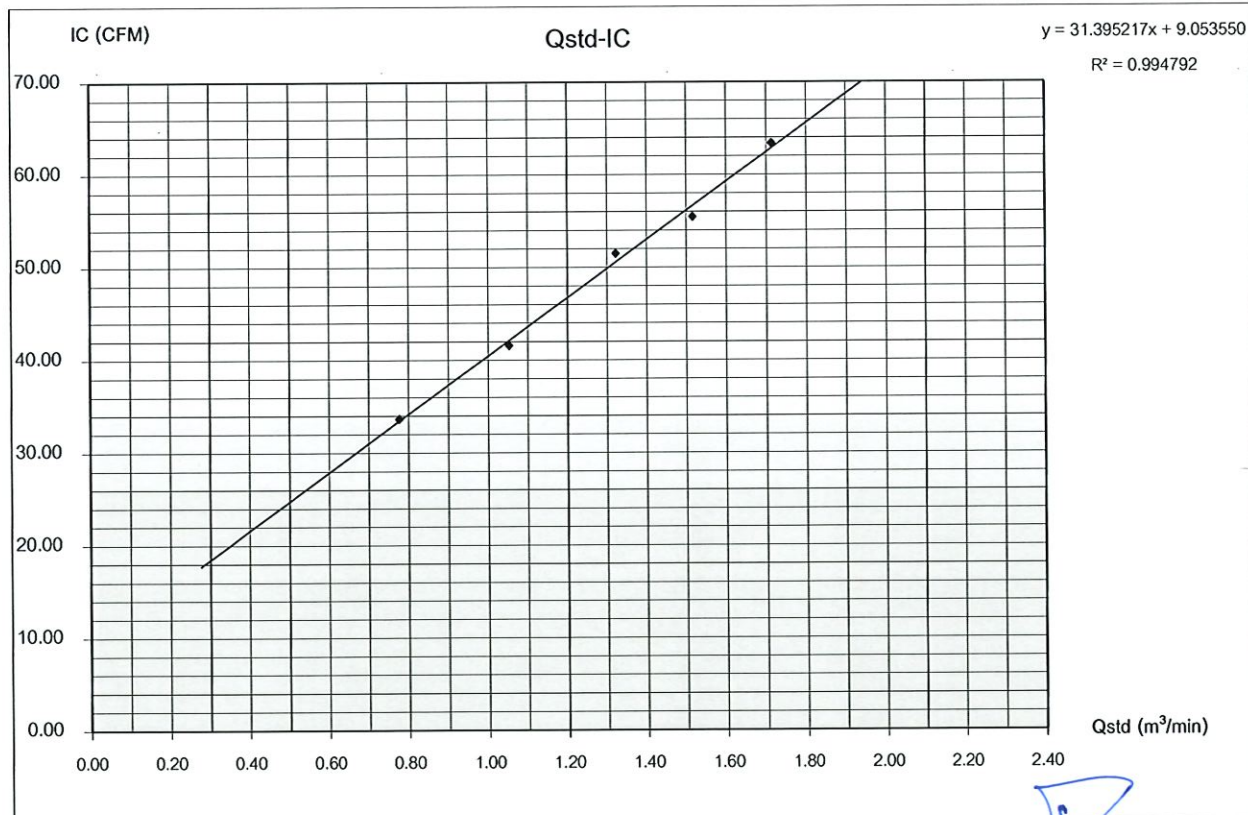
PM10 HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

Quotation	2023-00767			Date	November 14, 2023
Sampler Location	วัดบ้านแก่ง			Start Time	12:57 PM
Sampler Number	PM-10 No.23	Transfer Standard Type	Orifice	Stop Time	1:07 PM
Instrument Model	HIVOL-BMBBE	Calibrator Model	TE-5025A	Calibrated By	Mr.Nuttapol Nanta
Motor Serial Number	2135	Calibrator Serial Number	2914		
Recorder Serial Number	2391				

Plate No.	(Delta H)			(A)	(X)	(I)	(Y)	Temperature	Barometric Pressure	Start Meter	Stop Meter	
	Pressure Drop Across Orifice (inH ₂ O)			$[\Delta H_2O(Pa/P_{std})(T_{std}/Ta)]^{1/2}$	$Q_{std} = (1/m)[(A-b)]$ (m ³ /min)	Sample Flow Rate Indication (ft ³ /min)	$IC = I[(Pa/P_{std})(T_{std}/Ta)]^{1/2}$	(°K = °C+273)	(mmHg)			
	Positive	Negative	ΔH ₂ O									
5	1.3	1.3	2.6	1.59699	0.77721	34.0	33.67	303.0	758.0			
7	2.4	2.4	4.8	2.16988	1.05281	42.0	41.60	303.0	758.0			
10	3.8	3.8	7.6	2.73037	1.32244	52.0	51.50	303.0	758.0			
13	5.0	5.0	10.0	3.13195	1.51563	56.0	55.46	303.0	758.0			
18	6.4	6.4	12.8	3.54340	1.71357	64.0	63.39	303.0	758.0			
Linear Regression Y ON X : Y= mX + b							Average	303.0	758.0			
1	Slope (m)			2.07871	Linear Equation			r ²	0.994792	Pstd(mmHg)	760.0	
2	Intercept (b)			-0.01861	Set Point Flow Rate (X) (m ³ /min)		1.133	r	0.9973926	T _{NTP}	298.0	
3	Correlation Coefficient (r)			0.99984	Final Set Flow Rate = (I)		0	(Pa/Pstd)*(Tstd/Ta)		0.980910196		
Result									C=(Pa/Pstd)*(Tstd/Ta)^0.5		0.990409106	

COMMENT

Andersen Instruments, Inc.



Checked By

Nattaphon (11/16/23)
(Mr. Prayun Detkla)
Technician

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ENVIRONMENT RESEARCH & TECHNOLOGY CO., LTD.

Approved By

(Mr. Panupon Podang)
Environmental Scientist

CERTIFICATE OF CALIBRATION

Certificate No. : COF-006-66

Page 1 of 2 Pages

MEASUREMENT ITEM : Top Load Orifice
MANUFACTURER : TISCH
MODEL/TYPE : TE-S025A
SERIAL NUMBER : 2914
ID NUMBER : -
CONDITION AS-RECEIVED : Used item
CUSTOMER : Environment Research & Technology Co., Ltd.
25/114 Moo 6 Soi Chinaket 1, Ngamwongwan Road,
Toongsonghong, Lakki, Bangkok 10210

RECEIVED DATE : 27 Jul 2023
MEASUREMENT DATE : 31 Jul 2023
ISSUE DATE : 31 Jul 2023

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

CALIBRATION CONDITION:
Preconditioning : 24 hours at ambient conditions.
Measurement Condition : The average values during measurement are 24.3 °C and 50.5 %RH.

Calibration procedure:
The Orifice gas flow device was calibrated against Standard Rotary Displacement Meter (Roots Meter) Model G65/IMC/W2-dp. The WI-CL-004 was used as a calibration guideline.

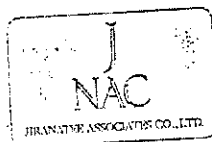
Traceability:
This certificate provides a traceability of The measurement to recognized the national standards, and to realization of the international system of units (SI) through the VSL (National Metrology Institute of Netherlands) via Certificate number: G2211901

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

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

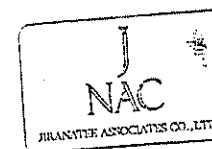
TABULATION OF RESULTS:
The table on next page give the measured values.

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



Approved signatory:
Mr. Parinya Booncharoen
Calibration Department Manager

End of Certificate of Calibration



MEASUREMENT RESULTS:

The Orifice gas flow device was calibrated by direct comparison method with the Standard Rotary Displacement Meter (Roots Meter). The Humid air was used as a medium in the system. The standard conditions are 25°C (298.15 K) and 760 mmHg for standard temperature and standard pressure respectively.

Table 1: The results of Q Standard calibration data

Plate	Flow rate m ³ /min	Pressure [Pa] mmHg	Temperature [Ta] °C	Temperature [Tm] °C	Δp_meter mmHg	Δp_Orifice inH ₂ O	γ	Standard Flow [Qs] m ³ /min
1	0.699	755.476	24.24	23.40	53.510	1.786	1.334	0.649
2	1.000	755.470	24.17	23.68	58.170	3.598	1.894	0.921
3	1.111	755.481	24.19	23.60	40.793	4.682	2.160	1.050
4	1.167	755.465	23.87	23.48	31.004	5.323	2.305	1.118
5	1.411	755.522	24.29	23.78	30.145	7.846	2.796	1.352

Slope (m): 2.07871
Intercept (b): -0.01861
Correlation coefficient (r): 0.99984
Uncertainty (k=2): 0.015 m³/min

Table 2: The results of Q actual calibration data

Plate	Flow rate m ³ /min	Pressure [Pa] mmHg	Temperature [Ta] °C	Temperature [Tm] °C	Δp_meter mmHg	Δp_Orifice inH ₂ O	γ	Standard Flow [Qs] m ³ /min
1	0.699	755.476	24.24	23.40	53.510	1.786	0.839	0.651
2	1.000	755.470	24.17	23.68	58.170	3.598	1.190	0.924
3	1.111	755.481	24.19	23.60	40.793	4.682	1.357	1.053
4	1.167	755.465	23.87	23.48	31.004	5.323	1.447	1.121
5	1.411	755.522	24.29	23.78	30.145	7.846	1.758	1.357

Slope (m): 1.30200
Intercept (b): -0.01171
Correlation coefficient (r): 0.99984
Uncertainty (k=2): 0.015 m³/min

Mettler-Toledo (Thailand) Ltd.
846/4 - 846/5 Lasalle Rd., Bangna Tai Sub-District
Bangna District, Bangkok 10260
+66 2723 0382
MT-TH.ServiceSupport@mtl.com



Accuracy Calibration Certificate

Customer

Company: Environment Research & Technology Co., Ltd.
Address: 25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Rd., Toongsongwan
City: Lakso Contact: Ramita Taengthai
Zip / Postalt: 10210
State / Province: Bangkok
Order Number:



Weighing Device

Manufacturer: Mettler Toledo Instrument Type: Weighing Instrument
Model: AB204-S Asset Number: ERTC-L-IN-0048
Serial No.: 1123103723 Terminal Model: N/A
Building: N/A Terminal Serial No.: N/A
Floor: 4 Terminal Asset No.: N/A
Room: 406

Range	Max. Capacity	Roadability (d)
1	220 g	0.0001 g

Procedure

Calibration Guideline: EURAMET cg-18 v. 4.0 (11/2015)
METTLER TOLEDO Work Instruction: CP/W002/20

This calibration certificate contains measurements for As Found and As Left calibrations.

The sensitivity/span of the weighing instrument was adjusted before As Found and As Left calibrations with a built-in weight.

In accordance with EURAMET cg-18 (11/2015), the test loads were selected to reflect the specific use of the weighing device or to accommodate specific calibration conditions.

	Temperature		Humidity	
As Found	Start: 23.6 °C	End: 23.5 °C	Start: 34.6 %	End: 35.1 %
As Left	Start: 23.6 °C	End: 23.5 °C	Start: 35.0 %	End: 35.7 %

As Found Calibration Date: 17-Jan-2023
As Left Calibration Date: 17-Jan-2023
Issue Date: 19-Jan-2023
Calibrator: Chawalit Matsuloke
Approved Signatory: [Signature]
Technical Manager / Head of Calibration Center

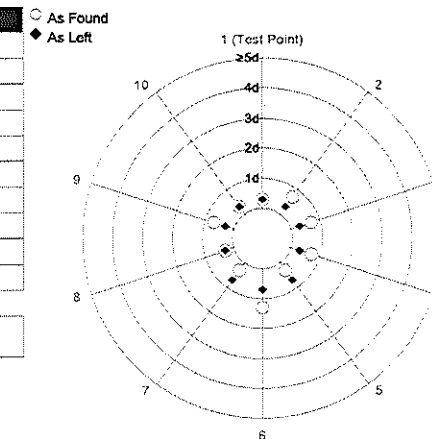
Measurement Results

Repeatability

Test Load: 100 g

	As Found	As Left
1	99.9992 g	100.0001 g
2	99.9991 g	100.0001 g
3	99.9991 g	100.0001 g
4	99.9991 g	100.0001 g
5	99.9992 g	100.0002 g
6	99.9993 g	100.0002 g
7	99.9992 g	100.0002 g
8	99.9992 g	100.0001 g
9	99.9991 g	100.0001 g
10	99.9992 g	100.0001 g

Standard Deviation	0.00007 g	0.00005 g
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The "d" in the graph represents the readability of the range/interval in which the test was performed.

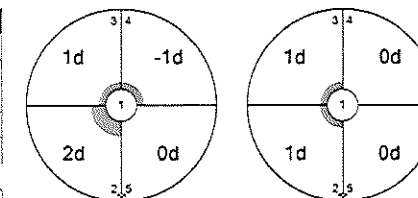
The results of this graph are based upon the absolute values of the differences from the mean value.

Eccentricity

Test Load: 100 g

Position	As Found	As Left
1	99.9991 g	100.0001 g
2	99.9993 g	100.0002 g
3	99.9992 g	100.0002 g
4	99.9990 g	100.0001 g
5	99.9991 g	100.0001 g

Maximum Deviation	0.0002 g	0.0001 g
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As Found

As Left

The "d" in the graph represents the readability of the range/interval in which the test was performed.

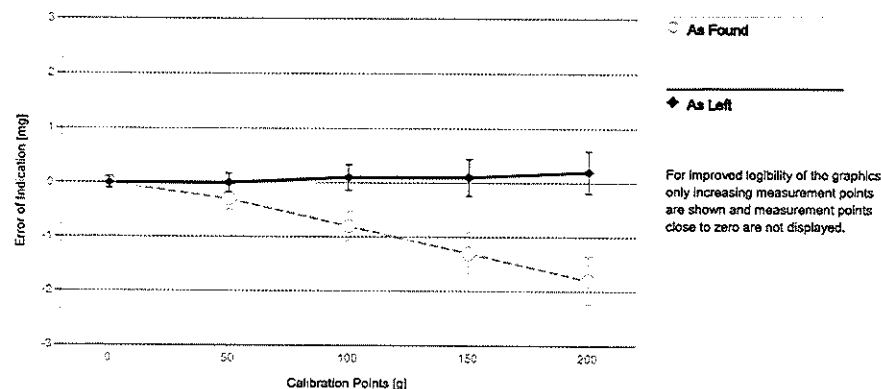
Error of Indication

As Found

	Reference Value	Indication	Error of Indication	Expanded Uncertainty	k
1	0.0000 g	0.0000 g	0.0000 g	0.15 mg	2
2	0.0500 g	0.0500 g	0.0000 g	0.16 mg	2
3	0.1000 g	0.0999 g	-0.0001 g	0.16 mg	2
4	0.5000 g	0.4999 g	-0.0001 g	0.16 mg	2
5	1.0000 g	1.0000 g	0.0000 g	0.16 mg	2
6	5.0000 g	5.0001 g	0.0001 g	0.16 mg	2
7	10.0000 g	10.0001 g	0.0001 g	0.17 mg	2
8	50.0000 g	49.9997 g	-0.0003 g	0.20 mg	2
9	100.0000 g	99.9992 g	-0.0008 g	0.27 mg	2
10	150.0000 g	149.9987 g	-0.0013 g	0.38 mg	2
11	200.0000 g	199.9982 g	-0.0018 g	0.44 mg	2

As Left

	Reference Value	Indication	Error of Indication	Expanded Uncertainty	k
1	0.0000 g	0.0000 g	0.0000 g	0.11 mg	2
2	0.0500 g	0.0500 g	0.0000 g	0.13 mg	2
3	0.1000 g	0.1000 g	0.0000 g	0.13 mg	2
4	0.5000 g	0.5000 g	0.0000 g	0.13 mg	2
5	1.0000 g	1.0000 g	0.0000 g	0.13 mg	2
6	5.0000 g	5.0001 g	0.0001 g	0.13 mg	2
7	10.0000 g	10.0000 g	0.0000 g	0.14 mg	2
8	50.0000 g	50.0000 g	0.0000 g	0.17 mg	2
9	100.0000 g	100.0001 g	0.0001 g	0.24 mg	2
10	150.0000 g	150.0001 g	0.0001 g	0.34 mg	2
11	200.0000 g	200.0002 g	0.0002 g	0.39 mg	2



The uncertainty stated is the expanded uncertainty at calibration obtained by multiplying the standard combined uncertainty by the coverage factor k – which can be larger than 2 according to EURAMET cg-18. The value of the measurand lies within the assigned range of values with a probability of approximately 95%.

The user is responsible for maintaining environmental conditions and the settings of the weighing instrument when it was calibrated.

Test Equipment

All weights used for metrological testing are traceable to national or international standards. The weights were calibrated and certified by an accredited calibration laboratory.

Weight Set 1: OIML E2

Weight Set No.:	WSS7	Date of Issue:	06-Jan-2022
Certificate Number:	177037	Calibration Due Date:	03-Jul-2023

Thermo Hygrometer

Equipment No.:	IN255	Date of Issue:	20-Jul-2022
Certificate Number:	22H1503	Calibration Due Date:	04-Jul-2023

Remarks

Equipment condition: Good
Next calibration according to customer's procedure
Calibration data not decide by calibration laboratory

End of Accredited Section

The information below and any attachments to this calibration certificate are not part of the accredited calibration.

Measurement Uncertainty of the Weighing Instrument in Use

Stated is the expanded uncertainty with $k=2$ in use. The formula shall be used for the estimation of the uncertainty under consideration of the errors of indication. The value R represents the net load indication in the unit of measure of the device.

Temperature coefficient for the evaluation of the measurement uncertainty in use: $3.0 \cdot 10^{-4} / K$

Temperature range on site for the evaluation of the measurement uncertainty in use: $3 K$

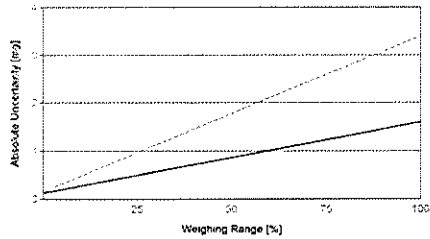
Linearization of Uncertainty Equation

Range			As Found	As Left
	d	Max		
1	0.0001 g	220 g	$U_1 = 0.16 \text{ mg} + 0.0147 \text{ mg/g} \cdot R$	$U_1 = 0.13 \text{ mg} + 0.00671 \text{ mg/g} \cdot R$

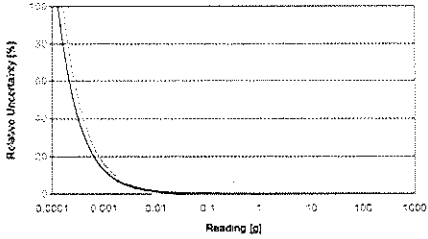
To optimize the stability of the linearization, besides of the zero load only increasing measurement points with a test load of 5% of the measurement range or larger are taken for the calculation of the linear equation.

Absolute and Relative Measurement Uncertainty in Use for Various Net Indications (Examples)

Net Indication	As Found		As Left	
0.0220 g	0.16 mg	0.73%	0.13 mg	0.59%
0.2200 g	0.16 mg	0.074%	0.13 mg	0.060%
2.2000 g	0.19 mg	0.0087%	0.14 mg	0.0066%
22.0000 g	0.48 mg	0.0022%	0.28 mg	0.0013%
220.0000 g	3.4 mg	0.0015%	1.6 mg	0.00073%



As Found



As Left

GWP®
Certificate



As
Found



As
Left



The weighing device meets the given
process requirements.

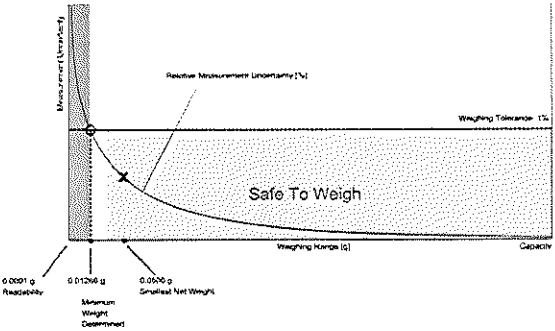
The weighing device meets the given
process requirements.

Tests Performed: ☒ As Found ☒ As Left

Process Requirements

Weighing Tolerance: 1% | Smallest Net Weight: 0.0500 g | Safety Factor: 2

Safe Weighing Range



While the values in this graph reflect the actual calibration results, the measurement uncertainty curves are simply a visual representation. This graph reflects As Left testing, unless only As Found was performed.

Minimum Weight

As Found Minimum Weight Table

Minimum weights for different weighing tolerances and safety factors					
Tolerance	Safety Factor				
	1	2	3	5	10
0.1%	0.16012 g	0.32511 g	0.49518 g	0.85155 g	1.85026 g
0.2%	0.07947 g	0.16012 g	0.24199 g	0.40949 g	0.85155 g
0.5%	0.03165 g	0.06348 g	0.09550 g	0.16012 g	0.32511 g
1%	0.01580 g	0.03165 g	0.04754 g	0.07947 g	0.16012 g
2%	0.00789 g	0.01580 g	0.02372 g	0.03959 g	0.07947 g
5%	0.00316 g	0.00631 g	0.00947 g	0.01580 g	0.03165 g

✓ Pass: The determined minimum weight meets the requirement for the smallest net weight.

As Left Minimum Weight Table

Minimum weights for different weighing tolerances and safety factors					
Tolerance	Safety Factor				
	1	2	3	5	10
0.1%	0.12735 g	0.25642 g	0.38726 g	0.65440 g	1.35584 g
0.2%	0.06346 g	0.12735 g	0.19166 g	0.32162 g	0.65440 g
0.5%	0.02533 g	0.05073 g	0.07620 g	0.12735 g	0.25642 g
1%	0.01266 g	0.02533 g	0.03802 g	0.06346 g	0.12735 g
2%	0.00633 g	0.01266 g	0.01899 g	0.03168 g	0.06346 g
5%	0.00253 g	0.00506 g	0.00759 g	0.01266 g	0.02533 g

✓ Pass: The determined minimum weight meets the requirement for the smallest net weight.

At these net minimum weight values, the measurement uncertainty of the weighing device is equal to or less than 1/1 (no safety factor), 1/2, 1/3, 1/5, or 1/10 of the required tolerance. The values are calculated with $k = 2$ and based on the linear formula of the measurement uncertainty of the weighing device in use.

The safety factor for As Found is always 1. This implies no safety factor. As Found testing looks at the behavior of the instrument from the past until test occurred. For the past, it is necessary to know that the tolerance was met, but not the safety factor. The safety factor is a proactive measure to apply for future measurements.

Notes on minimum weight values in above table:

1. If "N/A" is shown above, no appropriate value could be calculated.
2. METTLER TOLEDO is not responsible for the definition of the process requirements.

Measurement Results

Results Summary

	Repeatability	Eccentricity	Error of Indication
As Found	✓	✓	✓
As Left	✓	✓	✓

✓ = Passed

✗ = Failed

! = Safety Factor not met

Repeatability

Test Load: 100 g

Tolerance	Control Limit	As Found		As Left	
		Std. Deviation	Result	Std. Deviation	Result
0.1%	N/A	0.00007 g*	N/A	0.00005 g*	N/A
0.2%	0.00005 g		✗		!
0.5%	0.00013 g		✓		✓
1%	0.00025 g		✓		✓
2%	0.00050 g		✓		✓
5%	0.00125 g		✓		✓

*The calculated standard deviation value is below the rounding error of the balance. The $0.41 \cdot d$ rule is used for the assessment of this repeatability test and the calculation of the minimum weight.

The weighing tolerance is met if the standard deviation is less than or equal to the corresponding control limit.

Eccentricity

Test Load: 100 g

Tolerance	Control Limit	As Found		As Left	
		Deviation	Result	Deviation	Result
0.1%	0.0500 g	0.0002 g	✓	0.0001 g	✓
0.2%	0.1000 g		✓		✓
0.5%	0.2500 g		✓		✓
1%	0.5000 g		✓		✓
2%	1.0000 g		✓		✓
5%	2.5000 g		✓		✓

The weighing tolerance is met if the deviation is less than or equal to the corresponding control limit.

Error of Indication

As Found

		Control limits for various weighing tolerances					
Reference Value	Error	0.1%	0.2%	0.5%	1%	2%	5%
0.0000 g	0.0000 g	N/A	N/A	N/A	N/A	N/A	N/A
50.0000 g	-0.0003 g	0.0250 g	0.0500 g	0.1250 g	0.2500 g	0.5000 g	1.2500 g
100.0000 g	-0.0008 g	0.0500 g	0.1000 g	0.2500 g	0.5000 g	1.0000 g	2.5000 g
150.0000 g	-0.0013 g	0.0750 g	0.1500 g	0.3750 g	0.7500 g	1.5000 g	3.7500 g
200.0000 g	-0.0018 g	0.1000 g	0.2000 g	0.5000 g	1.0000 g	2.0000 g	5.0000 g
Result		✓	✓	✓	✓	✓	✓

As Left

		Control limits for various weighing tolerances					
Reference Value	Error	0.1%	0.2%	0.5%	1%	2%	5%
0.0000 g	0.0000 g	N/A	N/A	N/A	N/A	N/A	N/A
50.0000 g	0.0000 g	0.0250 g	0.0500 g	0.1250 g	0.2500 g	0.5000 g	1.2500 g
100.0000 g	0.0001 g	0.0500 g	0.1000 g	0.2500 g	0.5000 g	1.0000 g	2.5000 g
150.0000 g	0.0001 g	0.0750 g	0.1500 g	0.3750 g	0.7500 g	1.5000 g	3.7500 g
200.0000 g	0.0002 g	0.1000 g	0.2000 g	0.5000 g	1.0000 g	2.0000 g	5.0000 g
Result		✓	✓	✓	✓	✓	✓

The weighing tolerance is met if the error (of indication) for each test point is less than or equal to the corresponding control limit for that particular weighing tolerance. Results at or close to the zero point cannot be assessed.

Calibration Data of SO₂ Analyzer

Analyzer Performance Test

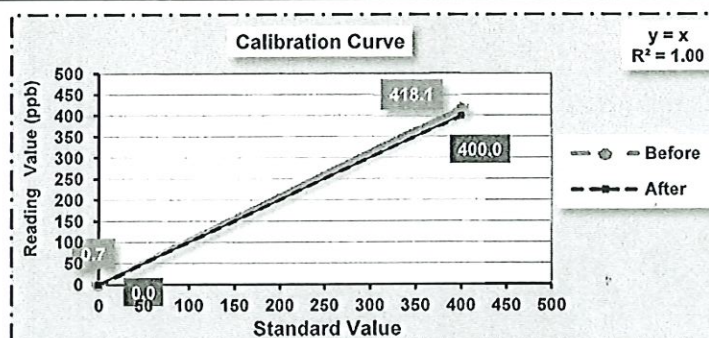
Equipment	Gas Analyzer (SO ₂)	Customer Name	โพธิ์เกียรติ์ คอนซัลแตนต์
Manufacture	Horiba	Location	Envi Research
Model	APSA-370	Quotation	2023-00467
Serial No.	4X01KWWU	Calibration Date	September 17, 2023
Analyzer Unit	ppb	Time	11:15 AM

Instruments for Calibration

Instruments	Manufacture	Model	Serial Number
Zero Air Supply	Thermo Env.	111	0700419829
Dynamic Dilution Calibrator	Tanabyte	300	0165
Standard Gas Components	CO = 4,516 ppm		
Cylinder No : EB0123013	NO = 55.3 ppm		
Expire Date : Oct 22, 2027	SO ₂ = 54.9 ppm		

Single Point Calibration

Standard Gas	Standard Gas Value	Analyzer Value (ppb)		Stability		% Abs Error
		Before	After	Before	After	
Zero	0	0.7	0.0	-	-	-
Span	400	418.1	400.0	-	-	4.5



STATUS TEST AND VALIDATION OF SO₂ ANALYZER MODEL APSA-370

Parameter	Unit	Observed Value		Nominal Range
		Before Adjust	After Adjust	
Range	ppb	500	500	0 - 500 Standard
Signal (SO ₂)	mV	13	13.4	Voltage of the measured SO ₂ value
LAMP	mV	326.7	325.3	200 mV - 1200 mV
CELL	°C	34.6	35.5	Ambient temperature + 5 °C - 15 °C
PUMP	Kpa	45.1	45.1	65 kPa or less
AMBIENT	kPa	101.2	101.1	Current atmospheric pressure
DC 24V	V	23.9	23.9	24 V ±0.5 V
DC 5V	V	5.0	5.0	5 V ±0.5 V

Calibrate By :

(MR.PANUPON PODANG)
September 17, 2023

Checked By :

(MS.SUTATIP IM-NOI)
September 17, 2023

Calibration Data of SO₂ Analyzer

Analyzer Performance Test

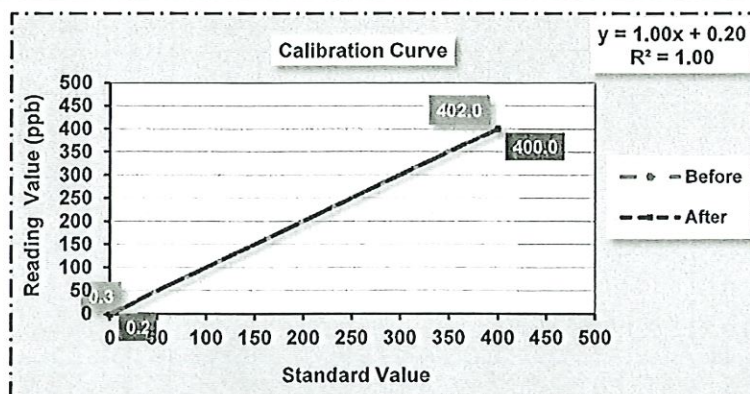
Equipment	Gas Analyzer (SO ₂)	Customer Name	โพธิ์เขียว คอนซัลแตนต์
Manufacture	Thermo	Location	Envi Research
Model	43C	Quotation	2023-00467
Serial No.	64390-343/2	Calibration Date	October 25, 2023
Analyzer Unit	ppb	Time	2:11 PM

Instruments for Calibration

Instruments	Manufacture	Model	Serial Number
Zero Air Supply	Thermo Env.	111	0700419829
Dynamic Dilution Calibrator	Tanabyte	300	0165
Standard Gas Components	CO = 4,516 ppm		
Cylinder No : EB0123013	NO = 55.3 ppm		
Expire Date : Oct 22, 2027	SO ₂ = 54.9 ppm		

Single Point Calibration

Standard Gas	Standard Gas Value	Analyzer Value (ppb)		Stability		% Abs Error
		Before	After	Before	After	
Zero	0	0.3	0.2	-	-	-
Span	400	402.0	400.0	-	-	0.5



STATUS TEST AND VALIDATION OF SO₂ ANALYZER MODEL 43C

Parameter	Display As	Unit	Observed Value		Nominal Range
			Before Adjust	After Adjust	
Range	RANGE	ppb	500	500	0 - 500 standard
Internal Temperature	INTERNAL	°C	32.3	32.3	8.0 °C to 47.0 °C
Chamber Temp	CHAMBER	°C	45.2	45.1	43.0 °C to 47.0 °C
Pressure	PRESSURE	mmHg	723.7	723.7	400.0 to 1,000
Sample Flow	SAMP FLOW	LPM	0.658	0.658	0.350 to 1.000
Lamp Intensity	INTENSITY	Hz	21,869	22,024	20,000 to 50,000
Lamp Voltage	LAMP VOLTAGE	V	874	874	750 to 1,200
SO ₂ Concentration	SO ₂ CONCENTRATION	ppb	1.6	1.5	0 to 10,000
Motherboard Status	MOTHERBOARD STATUS	-	OK	OK	OK
Interface Status	INTERFACE STATUS	-	OK	OK	OK

Calibrate By :

(MR.PANUPON PODANG)
October 25, 2023



Checked By :

(MS.SUTATIP IM-NOI)
October 25, 2023

Calibration Data of SO₂ Analyzer

Analyzer Performance Test

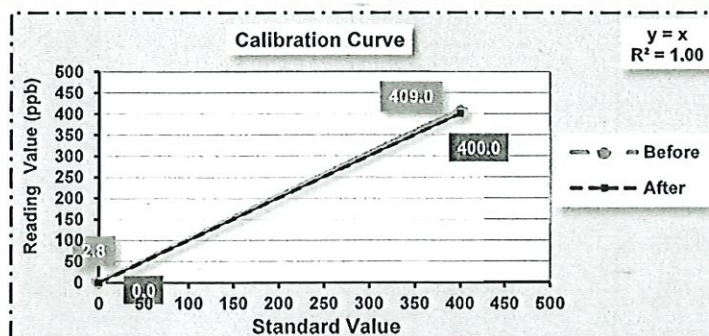
Equipment	Gas Analyzer (SO ₂)	Customer Name	โพธิ์เกียรติ์ คอนซัลแตนต์
Manufacture	Horiba	Location	Envi Research
Model	APSA-370	Quotation	2023-00467
Serial No.	A5VTX5AF	Calibration Date	October 31, 2023
Analyzer Unit	ppb	Time	2:34 PM

Instruments for Calibration

Instruments	Manufacture	Model	Serial Number
Zero Air Supply	Thermo Env.	111	0700419829
Dynamic Dilution Calibrator	Tanabyte	300	0165
Standard Gas Components	CO = 4,516 ppm		
Cylinder No : EB0123013	NO = 55.3 ppm		
Expire Date : Oct 22, 2027	SO ₂ = 54.9 ppm		

Single Point Calibration

Standard Gas	Standard Gas Value	Analyzer Value (ppb)		Stability		% Abs Error
		Before	After	Before	After	
Zero	0	2.8	0.0	-	-	-
Span	400	409.0	400.0	-	-	2.3



STATUS TEST AND VALIDATION OF SO₂ ANALYZER MODEL APSA-370

Parameter	Unit	Observed Value		Nominal Range
		Before Adjust	After Adjust	
Range	ppb	500	500	0 - 500 Standard
Signal (SO ₂)	mV	12.3	8.4	Voltage of the measured SO ₂ value
LAMP	mV	250.0	251.2	200 mV - 1200 mV
CELL	°C	32.9	32.9	Ambient temperature + 5 °C - 15 °C
PUMP	Kpa	44.8	44.8	65 kPa or less
AMBIENT	kPa	101.8	101.9	Current atmospheric pressure
DC 24V	V	24.0	24.0	24 V ±0.5 V
DC 5V	V	4.9	4.9	5 V ±0.5 V

Calibrate By :

(MR.PANUPON PODANG)

October 31, 2023

envi research
Checked By :
ENVIRONMENT RESEARCH & TECHNOLOGY CO., LTD.

(MS.SUTATIP IM-NOI)

October 31, 2023

Calibration Data of SO₂ Analyzer

Analyzer Performance Test

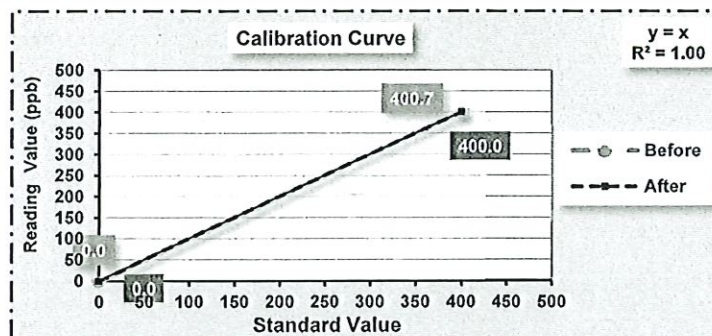
Equipment	Gas Analyzer (SO ₂)	Customer Name	โพธิ์เกียรติ์ คอนซัลแตนต์
Manufacture	Horiba	Location	Envi Research
Model	APSA-370	Quotation	2023-00467
Serial No.	ETSTKURU	Calibration Date	October 26, 2023
Analyzer Unit	ppb	Time	11:38 AM

Instruments for Calibration

Instruments	Manufacture	Model	Serial Number
Zero Air Supply	Thermo Env.	111	0700419829
Dynamic Dilution Calibrator	Tanabyte	300	0165
Standard Gas Components	CO = 4,516 ppm		
Cylinder No : EB0123013	NO = 55.3 ppm		
Expire Date : Oct 22, 2027	SO ₂ = 54.9 ppm		

Single Point Calibration

Standard Gas	Standard Gas Value	Analyzer Value (ppb)		Stability		% Abs Error
		Before	After	Before	After	
Zero	0	0.0	0.0	-	-	-
Span	400	400.7	400.0	-	-	0.2



STATUS TEST AND VALIDATION OF SO₂ ANALYZER MODEL APSA-370

Parameter	Unit	Observed Value		Nominal Range
		Before Adjust	After Adjust	
Range	ppb	500	500	0 - 500 Standard
Signal (SO ₂)	mV	4.9	5	Voltage of the measured SO ₂ value
LAMP	mV	234.3	234.5	200 mV - 1200 mV
CELL	°C	33.9	33.8	Ambient temperature + 5 °C - 15 °C
PUMP	Kpa	44.4	44.3	65 kPa or less
AMBIENT	kPa	101.0	100.9	Current atmospheric pressure
DC 24V	V	23.9	23.9	24 V ±0.5 V
DC 5V	V	5.0	5.0	5 V ±0.5 V

Calibrate By :

(MR.PANUPON PODANG)
October 26, 2023



Checked By :

(MS.SUTATIP IM-NOI)
October 26, 2023

Calibration Data of NOx Analyzer

Analyzer Performance Test

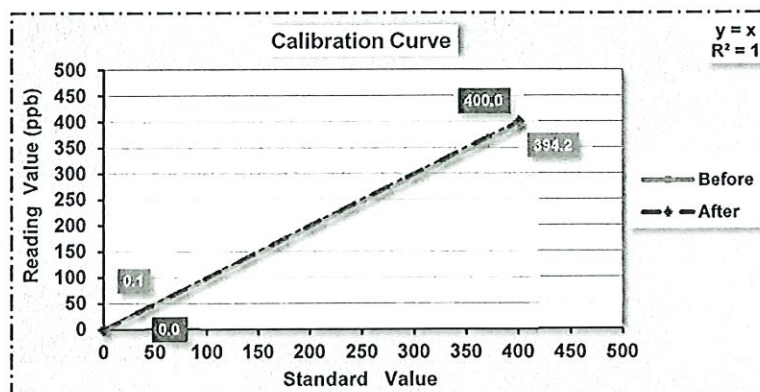
Equipment	Gas Analyzer (NOx)	Customer Name	โพธิ์เพียร คอนซัลแตนต์
Manufacture	HORIBA	Location	Envi Research
Model	APNA-370	Quotation	2023-00467
Serial No.	KPACV8NA	Calibration Date	October 31, 2023
Analyzer Unit	ppb	Time	2:48 PM

Instruments for Calibration

Instruments	Manufacture	Model	Serial Number
Zero Air Supply	Thermo Env.	111	0700419829
Dynamic Dilution Calibrator	Tanabyte	300	0165
Standard Gas Components	CO = 4,516 ppm		
Cylinder No : EB0123013	NO = 55.3 ppm		
Expire Date : Oct 22, 2027	SO ₂ = 54.9 ppm		

Single Point Calibration

Standard Gas	Standard Gas Value	Analyzer Value								% Abs Error
		NO _x (ppb)		NO (ppb)		NO ₂ (ppb)		Stability		
		Before	After	Before	After	Before	After	Before	After	
Zero	0	-0.5	0.0	0.1	0.0	-0.6	0.0	-	-	-
Span	400	396.3	400.0	394.2	400.0	2.1	0.0	-	-	1.5



STATUS TEST AND VALIDATION OF NOx ANALYZER MODEL APNA-370

Parameter	Unit	Observed Value		Nominal Range
		Before Adjust	After Adjust	
Range	ppb	500	500	0 - 500 Standard
Signal NO	mV	1.9	2.0	Voltage of the measured NO value
Signal NOx	mV	14.7	14.8	Voltage of the measured NOx value
Detector	°C	42.1	42.0	43 °C ± 5 °C
Ambient	kPa	101.2	101.0	Current atmospheric pressure
DC 24V	V	23.8	23.8	24V ±0.5
DC 5V	V	5.0	5.0	5V ±0.5
NO Slope	-	0.91997	0.92145	0.50000 - 2.0000
NOx Slope	-	0.92375	0.92856	0.50000 - 2.0000

Calibrate By :

(MR.PANUPON PODANG)
October 31, 2023

Checked By :

(MS.SUTATIP IM-NOI)
October 31, 2023

Calibration Data of NOx Analyzer

Analyzer Performance Test

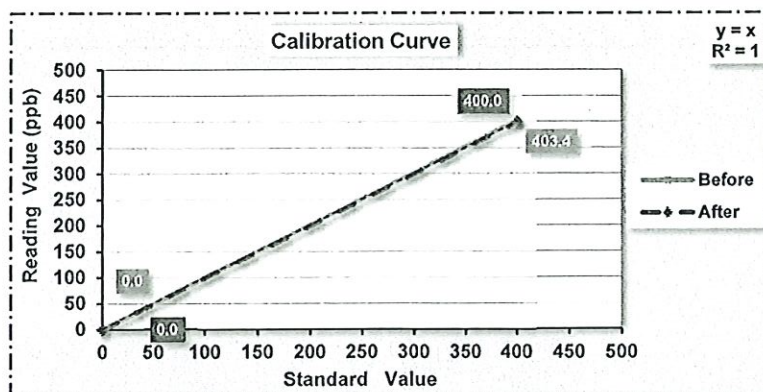
Equipment	Gas Analyzer (NOx)	Customer Name	โฟรท์เบียร์ คอนซัลแตนต์
Manufacture	HORIBA	Location	Envi Research
Model	APNA-370	Quotation	2023-00467
Serial No.	NGABK8F2	Calibration Date	October 30, 2023
Analyzer Unit	ppb	Time	1:08 PM

Instruments for Calibration

Instruments	Manufacture	Model	Serial Number
Zero Air Supply	Thermo Env.	111	0700419829
Dynamic Dilution Calibrator	Tanabyte	300	0165
Standard Gas Components	CO = 4,516 ppm		
Cylinder No : EB0123013	NO = 55.3 ppm		
Expire Date : Oct 22, 2027	SO ₂ = 54.9 ppm		

Single Point Calibration

Standard Gas	Standard Gas Value	Analyzer Value								% Abs Error
		NO _x (ppb)		NO (ppb)		NO ₂ (ppb)		Stability		
		Before	After	Before	After	Before	After	Before	After	
Zero	0	-0.1	0.0	0.0	0.0	-0.1	0.0	-	-	-
Span	400	404.0	400.0	403.4	400.0	0.6	0.0	-	-	0.8



STATUS TEST AND VALIDATION OF NOx ANALYZER MODEL APNA-370

Parameter	Unit	Observed Value		Nominal Range
		Before Adjust	After Adjust	
Range	ppb	500	500	0 - 500 Standard
Signal NO	mV	1.4	1.6	Voltage of the measured NO value
Signal NOx	mV	9.7	9.5	Voltage of the measured NOx value
Detector	°C	40.6	40.7	43 °C ± 5 °C
Ambient	kPa	101.0	101.0	Current atmospheric pressure
DC 24V	V	23.6	23.6	24V ±0.5
DC 5V	V	5.0	5.0	5V ±0.5
NO Slope	-	1.44170	1.42510	0.50000 - 2.0000
NOx Slope	-	1.37980	1.37450	0.50000 - 2.0000

Calibrate By :

(MR.PANUPON PODANG)
October 30, 2023

Checked By :

(MS.SUTATIP IM-NOI)
October 30, 2023

Calibration Data of NOx Analyzer

Analyzer Performance Test

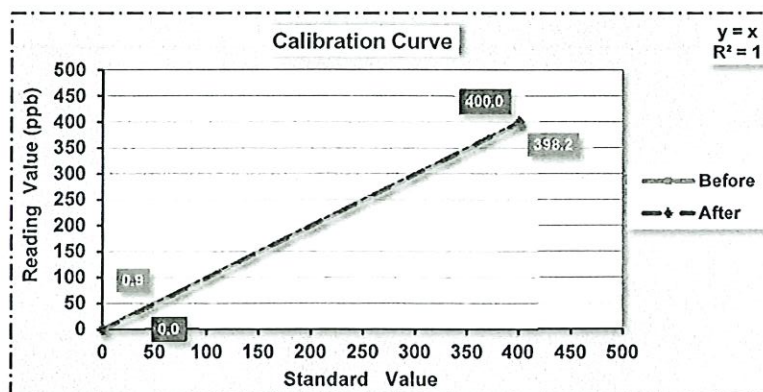
Equipment	Gas Analyzer (NOx)	Customer Name	โพธิ์ชัย คอนซัลแตนต์
Manufacture	HORIBA	Location	Envi Research
Model	APNA-370	Quotation	2023-00467
Serial No.	U9LS50WU	Calibration Date	14-21/11/2023
Analyzer Unit	ppb	Time	3:00 PM

Instruments for Calibration

Instruments	Manufacture	Model	Serial Number
Zero Air Supply	Thermo Env.	111	0700419829
Dynamic Dilution Calibrator	Tanabyte	300	0165
Standard Gas Components	CO = 4,516 ppm		
Cylinder No : EB0123013	NO = 55.3 ppm		
Expire Date : Oct 22, 2027	SO ₂ = 54.9 ppm		

Single Point Calibration

Standard Gas	Standard Gas Value	Analyzer Value								% Abs Error
		NO _x (ppb)		NO (ppb)		NO ₂ (ppb)		Stability		
		Before	After	Before	After	Before	After	Before	After	
Zero	0	-0.2	0.0	0.9	0.0	-1.1	0.0	-	-	-
Span	400	397.6	400.0	398.2	400.0	-0.6	0.0	-	-	0.5



STATUS TEST AND VALIDATION OF NOx ANALYZER MODEL APNA-370

Parameter	Unit	Observed Value		Nominal Range
		Before Adjust	After Adjust	
Range	ppb	500	500	0 - 500 Standard
Signal NO	mV	1.1	1.0	Voltage of the measured NO value
Signal NOx	mV	10.0	11.3	Voltage of the measured NOx value
Detector	°C	14.8	41.8	43 °C ± 5 °C
Ambient	kPa	101.1	101.0	Current atmospheric pressure
DC 24V	V	23.7	23.7	24V ±0.5
DC 5V	V	5.0	5.0	5V ±0.5
NO Slope	-	0.80920	0.81580	0.50000 - 2.0000
NOx Slope	-	0.79280	0.80190	0.50000 - 2.0000

Calibrate By :

(MR.PANUPON PODANG)
14-21/11/2023



Checked By :

(MS.SUTATIP IM-NOI)
14-21/11/2023

Calibration Data of NOx Analyzer

Analyzer Performance Test

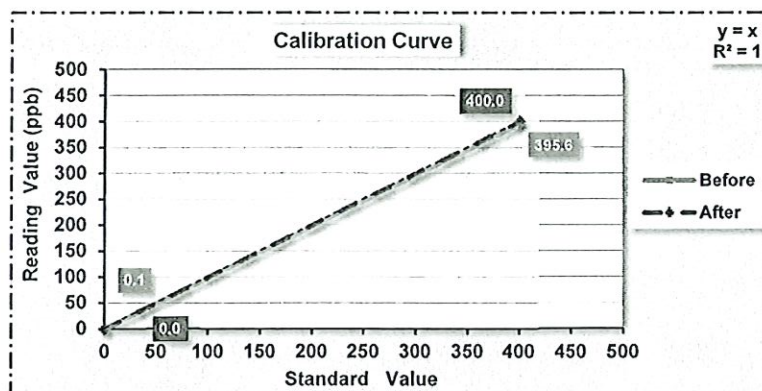
Equipment	Gas Analyzer (NOx)	Customer Name	โพธิ์เพชร คอนซัลแตนต์
Manufacture	HORIBA	Location	Envi Research
Model	APNA-370	Quotation	2023-00467
Serial No.	YCPL4HTM	Calibration Date	October 30, 2023
Analyzer Unit	ppb	Time	1:23 PM

Instruments for Calibration

Instruments	Manufacture	Model	Serial Number
Zero Air Supply	Thermo Env.	111	0700419829
Dynamic Dilution Calibrator	Tanabyte	300	0165
Standard Gas Components	CO = 4,516 ppm		
Cylinder No : EB0123013	NO = 55.3 ppm		
Expire Date : Oct 22, 2027	SO ₂ = 54.9 ppm		

Single Point Calibration

Standard Gas	Standard Gas Value	Analyzer Value								% Abs Error
		NO _x (ppb)		NO (ppb)		NO ₂ (ppb)		Stability		
		Before	After	Before	After	Before	After	Before	After	
Zero	0	-2.7	0.0	0.1	0.0	-2.8	0.0	-	-	-
Span	400	396.7	400.0	395.6	400.0	1.1	0.0	-	-	1.1



STATUS TEST AND VALIDATION OF NOx ANALYZER MODEL APNA-370

Parameter	Unit	Observed Value		Nominal Range
		Before Adjust	After Adjust	
Range	ppb	500	500	0 - 500 Standard
Signal NO	mV	0.8	0.9	Voltage of the measured NO value
Signal NOx	mV	8.1	8.9	Voltage of the measured NOx value
Detector	°C	39.7	9.8	43 °C ± 5 °C
Ambient	kPa	101.4	101.4	Current atmospheric pressure
DC 24V	V	23.5	23.5	24V ±0.5
DC 5V	V	5.0	5.0	5V ±0.5
NO Slope	-	1.03660	1.04580	0.50000 - 2.0000
NOx Slope	-	0.96960	1.00420	0.50000 - 2.0000

Calibrate By :

(MR.PANUPON PODANG)
October 30, 2023



Checked By :

(MS.SUTATIP IM-NOI)
October 30, 2023



THAI METEOROLOGICAL DEPARTMENT

4353 Sukhumvit, Bangna, Bangkok 10260 Tel. 081-454-2804,0-2399-0469

Calibration Certificate

Issued by : Calibration & Test Section : Meteorological Instruments Bureau

Date of Issue 12 April, 2023

Certification No. 157/23

Page : 1 of 2

Object : Wind speed and wind direction

Manufacturer : Davis Instruments Inc.

Type : Weather Wizard III Product No. 7425

Serial No. : WC61112A76 ID No. : No.15

Customer : Environment Research & Technology Company Limited.
25/113-114 Moo 6 Soi Chinaket 1, Ngamwongwan Road,
Toongsonghong, Laksi, Bangkok 10210.

Calibration Condition : Temperature 25.1 °C Barometric Pressure 1008.2 hPa

NATIONAL STANDARD WIND TUNNEL :

: Thermal Anemometer 642 S/N 91563

: HOOK GAGE NO 1425 Pitot Tube Theodor Friedrichs Type 0800.0000 serial 9023

N.I.S.T. Test Reference Number 731/241460 : Standard Velocity at 20 - 30 m/sec

: Ultrasonic Anemometer Model DA-650-3TV (sensor TR-90AH)

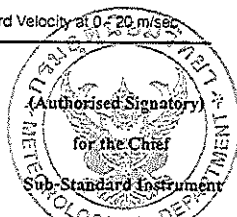
Serial Number 110730029 (sensor 120629586)

JAPAN QUALITY ASSURANCE ORGANIZATION

: Standard Velocity at 0 - 20 m/sec

Calibrated by : *Watcharapol*
Mr. Watcharapol Subwat
Mechanical Engineer

Signed : *Mr. Pisood Promsut*



THAI METEOROLOGICAL DEPARTMENT

4353 Sukhumvit, Bangna, Bangkok 10260 Tel. 081-454-2804,0-2399-0469

The Result of Calibration

Certification No. 157/23

12 April, 2023

Page : 2 of 2

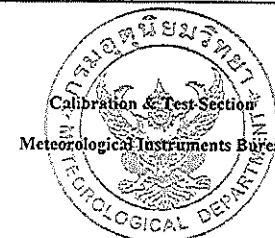
Standard Ultrasonic Anemometer m/sec	HOOK GAGE NO. 1425			TESTED ANEMOMETER	
	Pressure inches H2O	Vacuum inches H2O	Velocity m/sec	Velocity m/sec	Correction m/sec
1.00	-	-	-	0.9	0.10
3.02	-	-	-	2.7	0.32
5.00	-	-	-	4.9	0.10
7.04	-	-	-	6.7	0.34
9.02	-	-	-	8.9	0.12
11.01	-	-	-	10.7	0.31
13.01	-	-	-	12.5	0.51
15.01	-	-	-	14.7	0.31
17.02	-	-	-	16.5	0.52
20.02	-	-	-	19.8	0.22

Wind Aloft Plotting Board.	
US.DEPARTMENT OF COMMERCE WEATHER BUREAU	
WIND DIRECTION	TESTED WIND DIRECTION
0	0
90	90
180	180
270	270

Calibrated by :

Watcharapol

Mr. Watcharapol Subwat
Mechanical Engineer



Sound Level Meter Calibration Report

Support Equipment Type	:	Sound Level Calibrator
Manufacture	:	BSWA Technology
Model	:	CA114
Serial No.	:	590048
Range of Calibrator		
- Support Equipment Type	:	94.1
- Frequency	:	1,000 Hz.
Calibrated By	:	Mr.Nitad Sirichad
Calibration Date	:	November 14, 2023
Customer Name	:	บริษัท โฟร์เทียร์ คอนซัลแตนท์ จำกัด : โครงการนิคมอุตสาหกรรมป่องทอง 33 ของ บริษัท ป่องทอง อินดัสทรี เทคโนโลยี จำกัด

[illegible]

Checked By

Praym

Mr.Prayun Detkla

Technician



Approved By

Soln.

.....
Ms.Sutatip Im-noi

Environmental Scientist



THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-67/0003

MTC No. EEL. BP. 22/1066

CALIBRATION CERTIFICATE

Submitted by : Environment Research & Technology Co.,Ltd.

Address : 25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Road, Toongsonghong, Laksi, Bangkok 10210.

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 : BSWA TECH

Model : CA114

Serial No. : 590048

Ambient Environment

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

Relative Humidity : $(50 \pm 15) \%$

Ambient Pressure : $(101.325 \pm 1.500) \text{ kPa}$

- 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 Panasonic VP-7722A S/N 041477D122.
 7. Condenser Microphone B&K 4180 S/N 2889871.

Calibration Procedure: CP-102-04 based on IEC 60942-2003; The sound pressure level generated by sound calibrator under test shall be 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 : 3 Oct. 2023

Date of Calibration : 5 Oct. 2023

1/2/

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.BLMTC.002 Rev.4

Head Office
35 Mu 3 Tambon Khlong Ha, Amphoe Khlong Luang,
Changwat Pathumthani 12120, Thailand
Tel. (66) 0 2577 9000
Fax. (66) 0 2577 9009
E-mail : rumpai@tistr.or.th Website:www.tistr.or.th

Office/Laboratory
Soi 1C, Bangpoo Industrial Estate, Sukhumvit Road,
Amphoe Muang, Changwat Samutprakan 10280, Thailand
Tel. (66) 0 2323 1672-80 ext. 115, 116
Fax. (66) 0 2323 9165
E-mail : mtc@tistr.or.th

Office
196 Phahonyothin Road, Chatuchak, Bangkok 10900,
Thailand
Tel. (66) 0 2579 1121-30 ext. 5219, 5225, 5217
Fax. (66) 0 2579 8592
E-mail : sumalee@tistr.or.th



TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)
CORPORATE SERVICES 3: EQUIPMENT CALIBRATION AND TESTING SERVICES
53/4/4 PATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG BANGKOK 10250
TEL. 0-2717-3000-27 FAX. 0-2719-9484



Cert.No.: 22CH1754
Page.: 2 of 2

Certificate of Calibration

Cert.No.: 22CH1754
Page.: 1 of 2

Equipment : pH Meter
Manufacturer : Eutech
Model : pHTestr 30
Serial No. : 3066320
ID No. : -
Condition As-Received: Used Item
Received Date : 27 December 2022
Calibration Date : 27 December 2022
Reference : 2212-0734WN-10
Submitted by : Environment Research & Technology Company Limited.
25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Road,
Toongsonghong, Laksi, Bangkok 10210
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)

Calibrated by : Warakorn Lernagatrakul

Approved by :

Approved Signatory

() Malee Butkruea
() Saitip Meangmai
(✓) Ponpan Paipim

Issue Date : 28 December 2022

The Uncertainties are for a confidence probability of approximately 95%

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

Condition of this calibration result

1. 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

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

Calibration Results

Function : pH Measurement

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

Unit Under Calibration	Standard pH Buffer Solution	Actual pH Reading	Actual mV Reading (mV)	Uncertainty of pH Measurement (±)	Coverage factor k
pH Electrode	4.008	4.01	N/A	0.0071	2.00
S/N.: 3066320	6.987	7.01	N/A	0.011	2.00
	10.008	10.01	N/A	0.0092	2.00

Remark - pH meter does not have voltage mode.
- Can not connect the BNC because the plug does not match with the socket.
- N/A = Not Available

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

-o0o-



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



Cert.No.: 23CHO1
Page.: 1 of 2

Certificate of Calibration

Equipment : Conductivity Meter
Manufacturer : WTW
Model : inoLab Cond 730
Serial No. : 06140612
ID No. : ERTC-L-In-050
Condition As-Received: Used Item
Received Date : 04 January 2023
Calibration Date : 04 January 2023
Reference : 2301-0002ON-12
Submitted by : Environment Research & Technology Company Limited,
25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Road,
Toongsonghong, Lakki, Bangkok 10210
Calibration Place : ห้องปฏิบัติการวิเคราะห์ COD, TDS
Ambient Temperature : (25.2 - 25.2) °C (On-Site)
Relative Humidity : (55 - 56) % (On-Site)
Calibration Procedure: In-house method :
- CP-OCH3 : based on direct measurement by
using certified reference material (CRM)

Calibrated by : Uthen Kankawi

Approved by :

Malee Butkruea
Approved Signatory

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

Issue Date : 17 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.



Cert.No.: 23CHO1

Page.: 2 of 2

Condition of this result of calibration

1. Reference Standard Instrument :-

Instrument	Serial No.	ID No.	Certificate No.	Due date
1) Digital Thermometer	307901	70RC137	221236	10 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
147.0 µS/cm	CPA Chem	823327	20 June 2023
1413.0 µS/cm	CPA Chem	823328	20 June 2023
12.880 mS/cm	CPA Chem	823329	20 June 2023

- Control Conductivity calibration solution temperature by Water bath (25±0.2) °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.: 1011551

Standard Conductivity Solution	Before Adjustment UUC* Reading	After Adjustment UUC* Reading	Uncertainty of Measurement (±)	Coverage factor k
147.0 µS/cm	143.7 µS/cm	147.5 µS/cm	1.2 µS/cm	2.00
1413.0 µS/cm	1356 µS/cm	1414 µS/cm	11 µS/cm	2.00
12.880 mS/cm	12.44 mS/cm	12.86 mS/cm	0.099 mS/cm	2.00

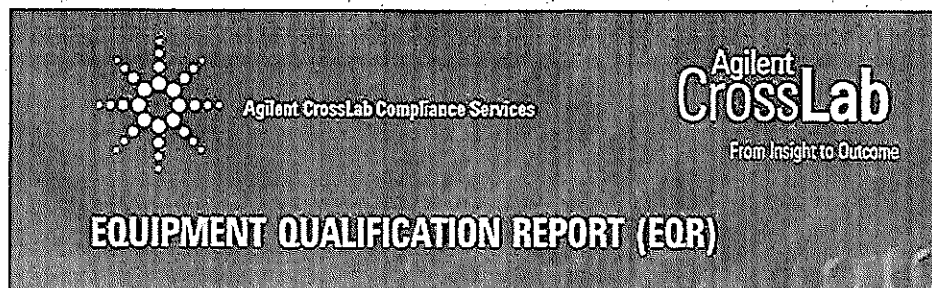
Remark

- UUC* = Unit Under Calibration

- Cell constant = 0.479 cm⁻¹

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

-000-



Agilent CrossLab Compliance

Qualification Type: ES-OQ

System ID: MY15330001

EQP Name: AgilentRecommended

EQP Revision: ES.02.50

EQP Publish Date: March 2020

Date: November 28, 2022 4:16:06 PM

Report Type: Report

Org. Name: Environment Research & Technology Co.,Ltd

Org. Location: 25/114 Moo 6 Soi Chinaket, Ngamwongwan Rd.,Bangkok 10210

Section	Page
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Protocol Details	6
Tests	7
Preparation : 5100 VDV	7
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Details

This section includes a status for each scheduled test and the overall qualification. For each test that is run, (1) the status is automatically determined based on pre-defined limits, and (2) the total number of times the test was run is displayed. For detailed results and specifications for a test, refer to the test results in this EQR.

Details

Test	Status	Runs
Preparation : 5100 VDV	Pass	1
Instrument Tests : 5100 VDV	Pass	1
Autosampler Operation : Autosampler 1 - SPS4	Pass	1

Overall Qualification Status

Pass

This section includes local contact and delivery details for this service.

General Details

Service Order No./Request:	6005573434
EQP Name:	AgilentRecommended
EQP Revision:	ES.02.50
Report Type:	Report

Organization Details

Name:	Environment Research & Technology Co.,Ltd
Location:	25/114 Moo 6 Soi Chinaket, Ngamwongwan Rd.,Bangkok 10210

Local Contact Details

Name:	Khun Raiwin Posit
Job Title:	Supervisor Scientist
Qualification Location:	ICPOES Room

Operator Details

Name:	Worawit Timakul
Job Title:	Field Service Engineer

Data Acquisition Details

Acquisition Software Name:	ICP Expert
Acquisition Software Revision:	7.1.0.6821

Customer Data System (CDS):	Es: ICP Expert
-----------------------------	----------------

This section describes the as found system configuration.

Details

Spectrometer 1

Manufacturer	Agilent Technologies
Name	5100 VDV
Model Number	G8011A
Sample Introduction	Double pass glass cyclonic spraychamber and seaspray nebulizer
Serial Number	MY15330001
Firmware Revision	2994

Chiller 1

Manufacturer	Agilent Technologies
Name	Chiller
Model Number	G8481A
Serial Number	1A1560387

Autosampler 1

Manufacturer	Agilent Technologies
Name	SPS4
Model Number	G8410A
Serial Number	AU15220240

Vapor Generator 1

Manufacturer	Agilent Technologies
Name	VGA77P
Model Number	G8475A
Serial Number	MY15330002

Date: November 28, 2022 4:16:06 PM
System ID: MY15330001

This section lists the revisions for all test units used in this report. For complete test-specific and high-level change details, refer to the Revision History document.

Test Revision	Test
ES.02.50	Autosampler Operation
ES.02.50	Instrument Tests
ES.02.50	Preparation

Date: November 28, 2022 4:16:06 PM
System ID: MY15330001

Purpose:

This test records a status for each preparation task for the Agilent ICP-OES.

Configuration Details

Model/Serial No.:

G8011A

MY15330001

Results

Criteria

Observed Result

Expected Result

Status

Does the plasma ignite successfully in the first three attempts?

Yes

Yes

Pass

Was the detector calibration performed and completed successfully?

Yes

Yes

Pass

Was the instrument calibration performed and completed successfully?

Yes

Yes

Pass

Image Details:

Date and Time:

Was the detector calibration performed and completed successfully?

November 28, 2022 4:07:22 PM

Host Name:

5CG0202NQ4

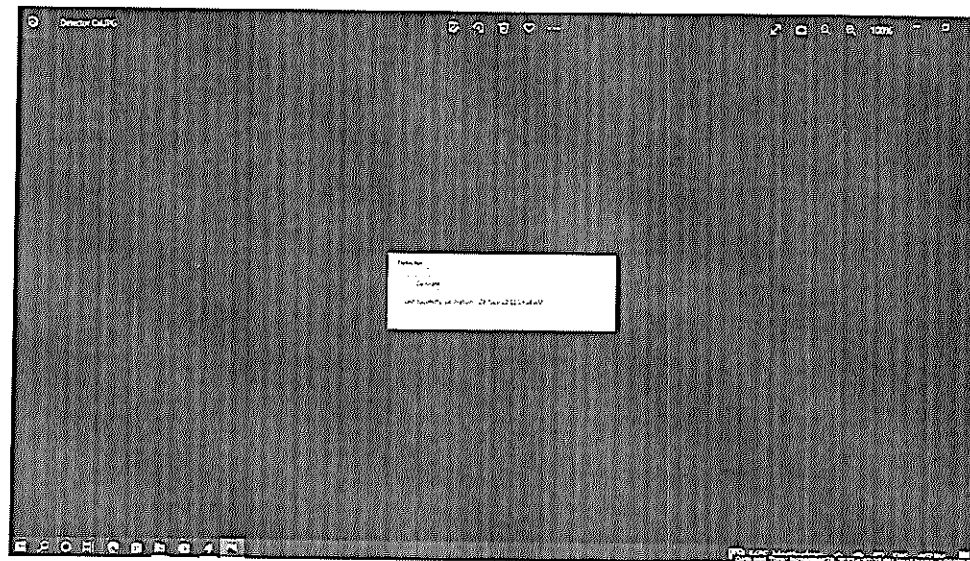


Image Details:

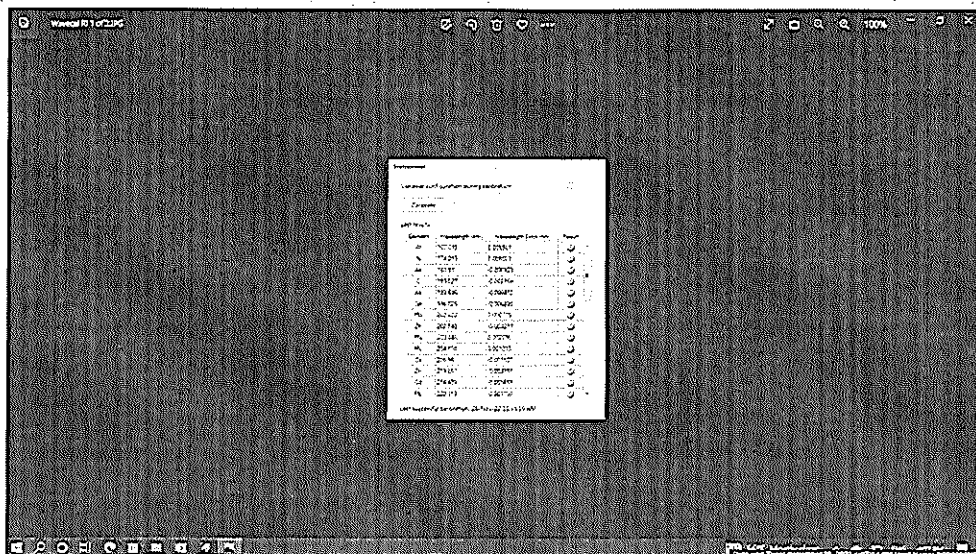
Was the instrument calibration performed and completed successfully?

Date and Time:

November 28, 2022 4:07:34 PM

Host Name:

5CG0202NQ4



Overall Test Status

Pass

Runs: 1

Purpose:

This test records a status for each of the automated tests within the Agilent ICP-OES CDS. For detailed test criteria, refer to the attached report.

Configuration Details

Model/Serial No.:

G8011A

MY15330001

Results

Observed Result

Expected Result

Status

Are the Functional Tests results within acceptance criteria?

Subsystem Communications

Yes

Yes

Pass

Air Flow

Yes

Yes

Pass

Water Flow

Yes

Yes

Pass

Gas Flows

Yes

Yes

Pass

RF Generator

Yes

Yes

Pass

Camera

Yes

Yes

Pass

Optics

Yes

Yes

Pass

Are the Instrument Performance Tests results within acceptance criteria?

Resolution

Yes

Yes

Pass

Sensitivity

Yes

Yes

Pass

Precision

Yes

Yes

Pass

Overall Test Status

Pass

Runs: 1

Purpose

This test verifies that the autosampler operates properly.

Configuration Details

Model/Serial No.:

G8410A

AU15220240

Results

Criteria

Observed Result

Expected Result

Status

Does the autosampler successfully move to the specified location(s)?

Yes

Yes

Pass

Overall Test Status

Pass

Runs: 1

This document is under change control. Revision history is maintained and printed on each document. Access to the master documents is limited to process owners. Documents receive periodic review and cannot be assigned an evergreen status. The qualification performed according to this document refers only to the hardware/software configuration in place at the time of the qualification. Agilent Technologies recommends that instrument configuration change management procedures be in place in order to maintain the validation process. Any changes to the analytical or computer hardware or software must be clearly specified. A change management system provides a means for determining the degree of requalification required according to the extent of the changes made. All details of the changes must be thoroughly recorded and documented, together with details of completed tests and their results. Note: Hardware/software configuration management is the customer's responsibility.

Training requirements note: The delivery engineer attaches an ACE technique-specific training certificate to the Equipment Qualification Report (EQR). Obtaining ACE technique-specific certification includes pre-requisite trainings for Data Integrity, General Compliance topics (GMP, GLP, ALCOA, etc.), Instrument hardware and software components, and the ACE technique itself. The one certificate encompasses all pre-requisite trainings as documented in the Agilent Learning Management System called Success Factors.

Location	Category	Document Name	Page
EQR	General	Certificate of Qualification for ACE	14
EQR	General	Operator's training certificate and qualifications	15
EQR	General	Operator's training certificate and qualifications	16
EQR	General	Certificate of System Qualification	17
EQR	General	Instrument's Test Report	18
EQR	General	Software verification	21
EQR	Material	Certificate of Analysis Wavelength calibration solution	22

Document Name: Certificate of Qualification for ACE



Agilent Compliance Engine Self Qualification

Date: April 17, 2022 11:11:13 PM

Drive Serial #: 90593EBA

Platform Revision:

ACE 3.11.27

Individual self-qualification reports for each specific technique installed are also available upon request. They provide additional details on the general report from the concise summary and are structured by the actual algorithms challenged during the process. There is not a one-to-one relationship between algorithms and OQ program tests because some algorithms are used by several tests and across multiple similar hardware components of the qualified systems.

Technique Type	Tests Completed	Result
Atomic Absorption	7	Conforms
Capillary Electrophoresis	10	Conforms
Dissolution	6	Conforms
Emission Spectroscopy	3	Conforms
Gas Chromatography - GCMS	17	Conforms
Gas Chromatography	29	Conforms
Gel Permeation Chromatography	9	Conforms
ICP-MS	6	Conforms
Infrared Spectroscopy	7	Conforms
Liquid Chromatography	17	Conforms
Liquid Chromatography - LCMS	8	Conforms
Microfluidics	18	Conforms
Sample Preparation - Gas Chromatography	9	Conforms
Sample Preparation - Liquid Chromatography	8	Conforms
Supercritical Fluid Chromatography	15	Conforms
Software	6	Conforms
UV-Vis Spectrophotometer	13	Conforms

Overall Qualification Status

Conforms

Serial

Document Name: Operator's training certificate and qualifications



Certificate of Completion

Learner Name: Worawit Timakul

Title Of Course: ANV-CE-ICPOES-2-008-A: Agilent 5100 ICP-OES Support Neophyte Training

Completion Date: August 25, 2016

Certified By Company: Learning at Agilent

All Service and Support training certificates have the following specific limitations.

A certificate for Service and Support training is only valid while employed by Agilent Technologies or while working as an Agilent-authorized service provider, through which the service employee has ongoing access to Agilent's: Safety Alerts, Service Notes, internal technical updates, update training, current documentation, technical support, current parts, and parts updates. Completion of training alone, without being employed by Agilent Technologies, does not qualify an individual to safely install, service or maintain Agilent products.

General

Document Name: Operator's training certificate and qualifications



Certificate of Completion

Learner Name: Worawit Timakul

Title Of Course: ANV-CE-ICPOES-2-007-C: CrossLab Compliance Hardware Specific Delivery for Agilent ICP-OES Systems

Completion Date: October 30, 2020

Certified By Company: Learning at Agilent

All Service and Support training certificates have the following specific limitations.

A certificate for Service and Support training is only valid while employed by Agilent Technologies or while working as an Agilent-authorized service provider, through which the service employee has ongoing access to Agilent's: Safety Alerts, Service Notes, internal technical updates, update training, current documentation, technical support, current parts, and parts updates. Completion of training alone, without being employed by Agilent Technologies, does not qualify an individual to safely install, service or maintain Agilent products.

General

Document Name: Certificate of System Qualification



Certificate of Completion

Learner Name: Worawit Timakul

Title Of Course: AN-CE-SS-II-030-A: ACE 3.X User Update Training

Completion Date: July 1, 2020

Certified By Company: Learning at Agilent

All Service and Support training certificates have the following specific limitations.

A certificate for Service and Support training is only valid while employed by Agilent Technologies or while working as an Agilent-authorized service provider, through which the service employee has ongoing access to Agilent's Safety Alerts, Service Notes, internal technical updates, update training, current documentation, technical support, current parts, and parts updates. Completion of training alone, without being employed by Agilent Technologies, does not qualify an individual to safely install, service or maintain Agilent products.

Date: November 28, 2022 4:16:06 PM
System ID: MY15330001

General

Document Name: Instrument's Test Report

Report Summary

Instrument Model: Agilent 5100 VDV ICP-OES
Instrument ID: G8011A
Instrument Serial Number: MY15330001
Software Version: 7.1.0.6821
Firmware Version: 2994
Tested By: Worawit T.
Test Completed On: 28-Nov-22 3:29:24 PM

Result Summary

Resolution Test: Pass
Sensitivity Test: Pass
Precision Test: Pass

Resolution Test: Pass

Element Wavelength	Specification	Width
N (174.213 nm)	≤ 9.40	7.40
As (188.980 nm)	≤ 8.20	6.48
C (193.027 nm)	≤ 11.50	8.05
Mo (202.032 nm)	≤ 8.20	6.88
Cr (206.158 nm)	≤ 13.40	10.29
Zn (213.857 nm)	≤ 8.70	7.43
Pb (220.353 nm)	≤ 9.50	8.06
Co (228.615 nm)	≤ 17.20	10.85
Ba (230.424 nm)	≤ 9.40	7.87
Mn (257.610 nm)	≤ 13.30	9.47
Mn (260.568 nm)	≤ 20.30	16.41
Cr (267.716 nm)	≤ 11.00	8.93
Cu (324.754 nm)	≤ 25.00	18.01
Cu (327.395 nm)	≤ 14.20	12.72
Sr (338.071 nm)	≤ 33.50	28.00
Ba (455.403 nm)	≤ 44.00	33.09
Sr (460.733 nm)	≤ 36.00	20.22
Ba (493.408 nm)	≤ 36.00	30.03
Ba (614.171 nm)	≤ 42.00	28.64
Ar (675.283 nm)	≤ 74.00	65.29
K (766.491 nm)	≤ 80.00	61.84

Date: November 28, 2022 4:16:06 PM
System ID: MY15330001

Document Name: Instrument's Test Report

Sensitivity Test				Pass		
Radial						
Element Wavelength	Specification	Method	Ratio	Standard	Blank	
As (188.980 nm)	≥ 49.0	SRBR	124.4	1263.4	89.1	
Se (196.026 nm)	≥ 41.0	SRBR	74.4	903.6	112.9	
Zn (213.857 nm)	≥ 1421.0	SRBR	4159.8	58879.6	199.0	
Pb (220.353 nm)	≥ 46.0	SRBR	191.9	3092.4	223.5	
Mn (257.610 nm)	≥ 3518.0	SRBR	12083.1	303064.1	626.5	
Al (396.152 nm)	≥ 3.4	SBR	8.0	41307.1	4600.0	
Ba (493.408 nm)	≥ 34.0	SBR	103.1	1275727.5	12253.3	
K (766.491 nm)	≥ 1.8	SBR	3.9	111109.8	22733.2	
Axial						
Element Wavelength	Specification	Method	Ratio	Standard	Blank	
As (188.980 nm)	≥ 208.0	SRBR	250.8	3667.4	192.0	
Se (196.026 nm)	≥ 159.0	SRBR	172.2	2902.2	239.1	
Zn (206.200 nm)	≥ 234.0	SRBR	1960.5	17846.2	168.8	
Zn (213.857 nm)	≥ 1743.0	SRBR	9129.7	200493.0	480.0	
Cd (214.439 nm)	≥ 4227.0	SRBR	8255.6	156439.2	357.4	
Pb (220.353 nm)	≥ 320.0	SRBR	698.7	16502.1	571.0	
Mn (257.610 nm)	≥ 10625.0	SRBR	39180.3	1593731.9	1651.2	
Cr (267.716 nm)	≥ 1048.0	SRBR	4892.3	176423.2	1297.2	
Cu (324.754 nm)	≥ 19.0	SBR	65.7	268073.8	4020.3	
Al (396.152 nm)	≥ 6.0	SBR	24.3	271032.8	10722.4	
Ba (493.408 nm)	≥ 60.0	SBR	275.4	8034589.3	29068.7	
K (766.491 nm)	≥ 24.0	SBR	81.9	3677804.4	44370.4	

Page 2 of 3

Document Name: Instrument's Test Report

Precision Test			Pass
Radial			
Element Wavelength	Specification	Measured Value % RSD	
As (188.980 nm)	≤ 2.60	0.99	
Se (196.026 nm)	≤ 2.60	1.01	
Zn (213.857 nm)	≤ 1.50	0.31	
Pb (220.353 nm)	≤ 2.60	0.41	
Mn (257.610 nm)	≤ 1.50	0.43	
Al (396.152 nm)	≤ 1.50	0.39	
Ba (493.408 nm)	≤ 1.50	0.65	
K (766.491 nm)	≤ 1.50	0.29	
Axial			
Element Wavelength	Specification	Measured Value % RSD	
As (188.980 nm)	≤ 1.50	0.87	
Se (196.026 nm)	≤ 1.50	0.76	
Zn (206.200 nm)	≤ 1.50	0.42	
Zn (213.857 nm)	≤ 1.50	0.51	
Cd (214.439 nm)	≤ 1.50	0.50	
Pb (220.353 nm)	≤ 1.50	0.49	
Mn (257.610 nm)	≤ 1.50	0.50	
Cr (267.716 nm)	≤ 1.50	0.43	
Cu (324.754 nm)	≤ 1.50	0.48	
Al (396.152 nm)	≤ 1.50	0.48	
Ba (493.408 nm)	≤ 1.50	0.71	
K (766.491 nm)	≤ 1.50	0.50	

Page 3 of 3

General

Document Name: Software verification

Software Verification Report

Date: Monday, November 28, 2022 Time: 3:44:56 PM (UTC +07:00:00) Host Name: S100VDV-RP
 Windows User Name: Admin Base Revision Number: 7.0.1 Product Name: ICP Expert
 Install Type: N/A Additional Packages: NA

Base Reference File Name: ICPReferenceFile.xml

Summary:

Overall Evaluation of Installation Check: PASS

File Report Summary

No missing files or invalid files found

No system file difference found

Files Registration Report Summary

Files Registration check not required for this product

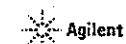
Registry Report Summary

Registry entries check not required for this product

Date: November 28, 2022 4:16:06 PM
 System ID: MY15330001

Certificates

Document Name: Certificate of Analysis Wavelength calibration solution



CERTIFICATE OF ANALYSIS

Agilent Product Name: Wavelength Calibration Solution for ICP-OES & MP-AES, 5 mg/L, 500mL

Agilent Part No: 66180330100

Lot No: 0012183521

Product Specifications

Analyte	Starting Material	CAS #	Certified Conc.	Analyte	Starting Material	CAS #	Certified Conc.
Al	Al(NO ₃) ₃	7784-27-2	5.000 ± 0.025 mg/L	Mn	Mn	7439-96-6	5.001 ± 0.025 mg/L
As	As	7440-38-2	5.001 ± 0.025 mg/L	Mo	(NH ₄) ₂ MoO ₄	13106-76-9	5.000 ± 0.025 mg/L
Ba	Ba(NO ₃) ₂	10222-31-8	5.000 ± 0.025 mg/L	Ni	Ni	7440-42-0	5.000 ± 0.025 mg/L
Cd	Cd	7440-43-9	5.000 ± 0.025 mg/L	Pb	Pb	7439-92-1	5.001 ± 0.025 mg/L
Co	Co	7440-42-4	5.000 ± 0.025 mg/L	Se	Se	7782-49-2	5.000 ± 0.025 mg/L
Cr	Cr(NO ₃) ₃	13568-38-4	5.000 ± 0.025 mg/L	Str	Str(NO ₃) ₂	10042-76-9	5.000 ± 0.025 mg/L
Cu	Cu	7440-50-8	5.000 ± 0.025 mg/L	Zn	Zn	7440-66-6	4.999 ± 0.025 mg/L
K	KNO ₃	7757-79-1	50.30 ± 0.25 mg/L				

Matrix: 5% HNO₃

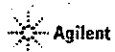
Intended Use: This solution is intended for use as a certified reference material or calibration standard for inductively coupled plasma optical emission spectroscopy (ICP-OES), inductively coupled plasma mass spectrometry (ICP-MS), atomic absorption spectroscopy (flame AAS or GFAAS), microwave plasma atomic emission spectroscopy (MP-AES), x-ray fluorescence spectroscopy (XRF), and other techniques for elemental analysis.

Certification & Traceability: This CRM was manufactured under a quality management system that is registered to ISO 9001, ISO 17034 and ISO/IEC 17025. This CRM was prepared to the certified concentrations shown above by gravimetric methods using single-element concentrates that were certified using the "High Performance ICP-OES" protocol developed by NIST and are directly traceable to the NIST SRMs listed below. This solution was stabilized using high purity nitric acid (HNO₃) and diluted with filtered (0.22µm), 18 M-ohm deionized water. The balances used in the preparation of this CRM are calibrated regularly with traceability to NIST. All volumetric dilutions are performed in Class A calibrated glassware. The certified concentrations were determined based upon gravimetric procedures. Secondary verification of the certified concentrations was performed using ICP-OES that was calibrated and/or referenced against NIST SRMs: 3101a, 3103a, 3104a, 3108, 3112, 3112a, 3114, 3141a, 3102, 3134, 3136, 3128, 3148, 3153a, and 3168a. The uncertainty associated with each certified concentration represents the expanded uncertainty at the 95% confidence level using a coverage factor of k=2.

Instructions for Use: Agilent recommends that the solution be thoroughly mixed by repeated shaking or swirling of the bottle immediately prior to use. To achieve the highest accuracy the analyst should: (1) use only pre-cleaned containers and transferware, (2) avoid pipetting directly from the CRM's original container, (3) use a minimum sub-sample size of 500µL, (4) make dilutions using calibrated balances or certified volumetric class A flasks and pipettes, (5) dilute to volume using the same matrix as the original CRM, and (6) never pour used product back into the original container. The solution should be kept tightly capped and stored under normal laboratory conditions. Do not freeze, heat, or expose to direct sunlight. Minimize exposure to moisture or high humidity.

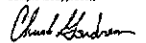
Date: November 28, 2022 4:16:06 PM
 System ID: MY15330001

Document Name: Certificate of Analysis Wavelength calibration solution



Period of Validity: Agilent ensures the accuracy of this solution until the expiration date shown below, provided the instructions for use are followed. During the period of validity, the purchaser will be notified if this product is recalled due to any significant changes in the stability of the solution.

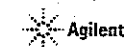
Sample lot approval:


Chuck Gaudreau, Certifying Officer

Date of release: 21 January 2022
Date of expiration: 21 July 2023

Page 2 of 3

Document Name: Certificate of Analysis Wavelength calibration solution



Hazard Information: Refer to the Safety Data Sheet (SDS), which can be obtained at www.agilent.com/chem/sds.

Homogeneity: This solution was determined to be homogeneous by procedures consistent with the requirements of ISO 17024 and ISO Guide 35. Replicate samples of the finished solution were analyzed to confirm its homogeneity, in accordance with OSP 6-13 Assessment of Homogeneity and Stability. To ensure homogeneity, users should not take a smaller sub-sample than specified in the instructions for use, as doing so will invalidate the certified values and uncertainties.

Further Information: Please contact Agilent for further information about this CRM.

Quality Certifications: This CRM was prepared under a quality management system that is:

- Registered to ISO 9001 – Quality Management Systems – Requirements (TUV NORD Cert. No. 44 100 16580231)
- Accredited to ISO 17034 – General Requirements for the Competence of Reference Material Producers (AZLA Cert. No. 2848.02)
 - ISO 17034 references additional requirements specified in ISO Guide 31 and ISO Guide 35.
- Accredited to ISO/IEC 17025 – General Requirements for the Competence of Testing and Calibration Laboratories (AZLA Cert. No. 2848.01)
- LSC Sunderland, 279 Abbey Road, Sunderland, NH 03102

Page 3 of 3

Electronic Signature

Page 25

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

Details

Full Name of Signer: Worawit Timakul
 Logged On User Name: worawit.timakul@agilent.com
 Signature Creation Date: November 28, 2022
 Reason for Signature: Executed protocol and published this original version of document

Regulatory Disclaimer

This document provides a protocol to verify and record instrument configuration and evidence of proper operation. It has been prepared from our interpretation of applicable regulations as well as industry best practices. The document is designed to provide an important component of a complete compliance package. Validation depends upon many factors and use of this protocol alone does not assure compliance. Agilent Technologies makes no promises or representations as to its sufficiency for any specific regulatory program.

Warranty

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Date: November 28, 2022 4:16:06 PM
 System ID: MY15330001

User Name: worawit.timakul
 Hostname: SC61020122

System ID: MY15330001
 Print Date: November 28, 2022 4:16:10 PM

OQ HW ICP \$100 Envl research Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
November 28, 2022 4:02:15 PM	Audit	SessionCreated	Session	None
November 28, 2022 4:02:15 PM	Start	Configuration	Session	None
November 28, 2022 4:02:15 PM	Audit	Entitlement	Licensing	User is FieldEngineer, and does not require an unlock code
November 28, 2022 4:06:30 PM	Audit	EqpLoaded	Session	EQP details for primary technique [Es] - File path: [ProtocolPacks/Es/Configurations/02.50/Es.02.50.eqp], EQP File Name: [Es.02.50.eqp], EQP Name: [AgilentRecommended]
November 28, 2022 4:06:32 PM	End	Configuration	Session	None
November 28, 2022 4:06:35 PM	Start	Qualification	Session	OQ
November 28, 2022 4:06:36 PM	Start	Execution	Preparation : \$100 VDV: Qualitative Test - No setpoints associated	None
November 28, 2022 4:07:38 PM	End	Execution	Preparation : \$100 VDV: Qualitative Test - No setpoints associated	Run Count : 1
November 28, 2022 4:07:39 PM	Start	Execution	Instrument Tests : \$100 VDV: Qualitative Test - No setpoints associated	None
November 28, 2022 4:08:52 PM	End	Execution	Instrument Tests : \$100 VDV: Qualitative Test - No setpoints associated	Run Count : 1

Date: November 28, 2022 4:16:06 PM
 System ID: MY15330001

User Name: worawit.timakul
 Hostname: SCG0201128

System ID: MY15330001
 Print Date: November 28, 2022 4:16:06 PM

OQ HW ICP 5100 Envi research Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
November 28, 2022 4:09:01 PM	Start	Execution	Autosampler Operation : Autosampler 1 - SPS4; Qualitative Test - No setpoints associated	None
November 28, 2022 4:09:05 PM	End	Execution	Autosampler Operation : Autosampler 1 - SPS4; Qualitative Test - No setpoints associated	Run Count : 1
November 28, 2022 4:09:09 PM	End	Qualification	Session	OQ
November 28, 2022 4:09:09 PM	Start	Reporting	Session	None
November 28, 2022 4:14:49 PM	Audit	Reporting	Session	Report Generated : Certificate
November 28, 2022 4:15:27 PM	Audit	Reporting	Session	Report Signed : Certificate PDF Name: OQ HW ICP 5100 Envi research_20221128_Certificat e_1.pdf User Name: worawit.timakul@agilent.com Full Name of Signer: Worawit Timakul Reason for signature: Executed protocol and published this original version of document
November 28, 2022 4:15:43 PM	Audit	Reporting	Session	Report Generated : Report



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Saimai, Bangkok 10220, Thailand
Tel. (662) 909-8820 (Auto 10 lines) www.imcinstrument.com



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Certificate of Calibration

Certificate No. : MT22-6773
Page : 1 of 2

Customer : Environment Research & Technology Co., Ltd.
Address : 25/114 Moo 6 Soi Chinaket 1, Ngamwongwan Road, Toongsonghong, Laksi, Bangkok 10210

Description : Incubator
Manufacturer : Sanyo
Model : MIR-254
Serial No. : 1103017
Identification No. : ERTC-L-IN-066
Calibration Place : Customer Laboratory

Order No. : 3555/22
Received date : Dec 06, 2022
Calibration date : Dec 12, 2022
Environment Condition :
Temperature : (25 \pm 10) °C
Humidity : (50 \pm 30) %RH

Calibration Method : Calibration were conducted using In-house calibration procedure CP-MT-006 According to comparison with LXI Data Acquisition Switch Unit with sensor. The calibration methods based on Euramet Calibration Guide No.20 - guidelines on the Calibration of Temperature and/or Humidity Controlled Enclosures.

Reference Standard Instruments :

Instrument	Model	Serial No.	Certificate No.	Due Date
LXI Data Acquisition Switch Unit with Sensor	34972A	MY57003222	MT22-5466	Oct 06, 2023

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

Traceability : This measurement are traceable to the International System of Unit (SI), through
National Institute of Metrology Thailand (NIMT)

The reported uncertainty of measurement was based on standard uncertainty multiplied by coverage factor $k = 2$,
providing a level of confidence of not less than 95%



Calibrated by : Mr.Jiraphan Sreebannasarn
Issue date : Dec 19, 2022

Approved by :
(Mr.Choophong Khumdet)

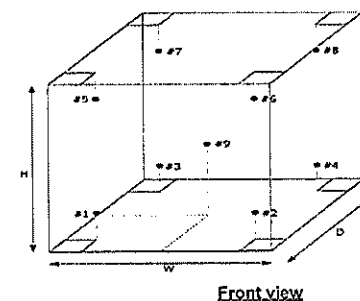
This calibration certificate shall not be reproduced other than in full except with the prior written approval of Inctech Metrological Center Co.,Ltd

Function : Temperature measurement
Calibration point : 20 °C

Certificate No. : MT22-6773
Page : 2 of 2
Result : Without adjustment
Resolution : 0.1 °C

Calibration point (°C)	Temperature of UUC* at each position (°C)									Uncertainty of measurement (+/- °C)
	Ch.1	Ch.2	Ch.3	Ch.4	Ch.5	Ch.6	Ch.7	Ch.8	Ch.9	
20	19.634	19.407	19.345	19.258	19.687	19.616	19.630	19.542	19.568	0.65

Setting temperature (°C)	Indicating Temperature (°C)	Measured stability (+/- °C)	Measured uniformity (°C)	Overall variation (°C)
20.0	20 to 20.2	0.51	0.87	1.5



#1 Lower Left Front
#2 Lower Right Front
#3 Lower Left Rear
#4 Lower Right Rear
#5 Upper Left Front
#6 Upper Right Front
#7 Upper Left Rear
#8 Upper Right Rear
#9 Geometric Center

UUC* = Unit under calibration

Uniformity = Maximum and Minimum difference of measured temperature at any probes and the measured temperature at the reference and same time.

Overall Variation = Difference of temperature value between the maximum and minimum any time.

Stability = One half of the maximum difference of measured temperatures at any one probe.



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Saimai, Bangkok 10220, Thailand
Tel. (662) 909-8820 (Auto 10 lines) www.imcinstrument.com



Inctech Metrological Center Co.Ltd.
39/1 Soi 82, Sukhapiban 5 Rd., O ngoen,
Saimai, Bangkok 10220, Thailand
Tel. (662) 909-8820 (Auto 10 lines) www.imcinstrument.com



Certificate No. : MT23-1348
Page : 2 of 3

Certificate of Calibration

Certificate No. : MT23-1348
Page : 1 of 3

Customer : Environment research & Technology Co.,Ltd.
Address : 25/114 Moo6 Soi Chinaket1, Ngamwongwan Road, Toongsonghong, Laksi, Bangkok 10210

Description : Heating Block (TC -K)
Manufacturer : Hanna
Model : HI8398000-02
Serial No. : G0059491
Identification No. : ERTC-L-In-112
Calibration Place : Customer Laboratory

Order No. : 0030/23
Received date : Jan 02, 2023
Calibration date : Jan 02, 2023
Environment Condition :
Temperature : (25 \pm 10) °C
Humidity : (50 \pm 30) %RH

Calibration Method : Calibration were conducted using In-house calibration procedure *CP-MT-009* According to comparison with LXI Data Acquisition Switch Unit.

Reference Standard Instruments :

Instrument	Model	Serial No.	Certificate No.	Due Date
LXI Data Acquisition Switch Unit with RTD Sensor	34972A	MY49020096	MT22-6392	Dec 06, 2023

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

Traceability : This measurement are traceable to the International System of Unit (SI), through
National Institute of Metrology Thailand (NIMT)

The reported uncertainty of measurement was based on standard uncertainty multiplied by coverage factor $k = 2$,
providing a level of confidence of not less than 95%

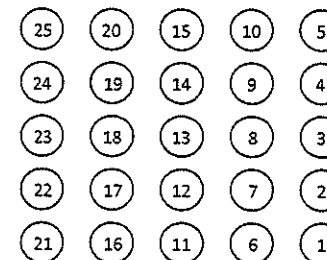


Calibrated by : Mr.Jiraphan Sreebannasarn
Issue date : Jan 06, 2023

Approved by : _____
(Mr.Panuwat Phuklan)

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Position



↑
Top view

Function : Temperature measurement (Cont.)
Calibration point : 150 °C
Immersion depth : 50 mm.

Result : Without adjustment

Position No.	UUC* setting (°C)	Standard reading (°C)	UUC* correction (°C)	Uncertainty of measurement (\pm °C)
1	150	153.601	3.601	0.12
2	150	153.612	3.612	0.12
3	150	153.921	3.921	0.12
4	150	150.662	0.662	0.12
5	150	153.559	3.559	0.12
6	150	153.631	3.631	0.12
7	150	154.258	4.258	0.12
8	150	154.463	4.463	0.12
9	150	154.486	4.486	0.12
10	150	154.461	4.461	0.12

UUC* = Unit under calibration



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Certificate No. : MT23-1348

Page : 3 of 3

Function : Temperature measurement

Result : Without adjustment

Calibration point : 150 °C

Immersion depth : 50 mm.

Position No.	UUC* setting (°C)	Standard reading (°C)	UUC* correction (°C)	Uncertainty of measurement (+/- °C)
11	150	154.817	4.817	0.12
12	150	154.137	4.137	0.12
13	150	154.294	4.294	0.12
14	150	150.914	0.914	0.12
15	150	154.203	4.203	0.12
16	150	153.716	3.716	0.12
17	150	154.134	4.134	0.12
18	150	154.312	4.312	0.12
19	150	154.143	4.143	0.12
20	150	154.166	4.166	0.12
21	150	153.133	3.133	0.12
22	150	153.083	3.083	0.12
23	150	153.499	3.499	0.12
24	150	154.246	4.246	0.12
25	150	153.461	3.461	0.12

UUC* = Unit under calibration

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TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)
CORPORATE SERVICES 3: EQUIPMENT CALIBRATION AND TESTING SERVICES
134/4 PATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG BANGKOK 10250
TEL. 0-2717-3000-27 FAX. 0-2719-9484



Cert. No.: 23TM31
Page : 1 of 3

Certificate of Calibration

Equipment : Hot Air Oven
Manufacturer : Binder
Model : FED 115 E2
Serial No. : 11-22823
ID No. : ERTC-L-In.-076
Submitted by : Environment Research & Technology Company Limited,
25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Road,
Toongsonghong, Laksi,
Bangkok 10210
Location : Laboratory (ERTC)
Received Order : 4 January 2023
Calibration Date : 4 January 2023
Ambient Temperature : $(26 \pm 10) ^\circ\text{C}$
Relative Humidity : $(50 \pm 30) \%$
Calibrated by : Preecha Hlahib
Approved by :
() Pornthippa Tameyakul
() Malee Butkruea
() Suwit Imjai

Issue Date : 16 January 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.



Equipment : Hot Air Oven
Condition As-Received : Used Item
Reference : 2301-0002ON-2
Procedure Used :-

Calibration were conducted using calibration procedure CP-OT02 according to direct measurement method with Data Acquisition which connected with Resistance Temperature Detector (RTD) and Thermocouple Type T.

The temperature scale used was based on ITS-90.

Condition of this result of calibration

1. Reference standard instrument:-

Instrument	Model	Serial No.	Cert. No.	Due Date
1) Data Acquisition	34972A	MY57013823	22LM24	26 Feb 2023

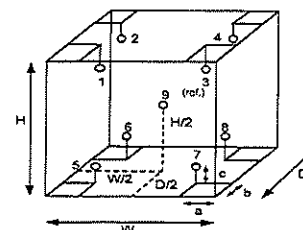
2. This certificate is valid only to the item calibrated on date and place of calibration.

3. This certification is traceable to the International System of Unit.

Result of Calibration :- (*) Without Adjustment

Function of UUC* : Temperature Source

Fresh air setting : Close



Probe Installation Details :		Dimension of Chamber :	
a =	5.0 cm	D =	0.40 m
b =	5.0 cm	W =	0.60 m
c =	5.0 cm	H =	0.48 m
		Capacity =	0.12 m ³

Environment during calibration		
	Beginning	Finished
Temp. (°C)	28	32
REL.Humid. (%)	60	55
AC Supply (Volt)	220	221

Ref. Std. ID No.: @ Calibration Point		
Position :	(104) °C	(180) °C
1	21-17RTD-01	22-17TC-01
2	21-17RTD-02	19-17TC-02
3	17RTD-03	19-17TC-03
4	17RTD-04	19-17TC-04
5	17RTD-05	19-17TC-05
6	17RTD-06	19-17TC-06
7	17RTD-07	19-17TC-07
8	17RTD-08	19-17TC-08
9 (ref.)	17RTD-09	19-17TC-09



Equipment : Hot Air Oven
Condition As-Received : Used Item
Reference : 2301-0002ON-2
Result of Calibration :- (*) Without Adjustment
Function of UUC* : Temperature Source
Fresh air setting : Close

Cert. No.: 23TM31
Page : 3 of 3

Calibration Point (°C)	UUC* Setting (°C)	UUC* Reading (°C)	Temperature stability (± °C)	Temperature uniformity (°C)	Overall Variation (°C)	Uncertainty (± °C)	Coverage Factor <i>k</i>
104	104	104	0.16	2.4	2.6	0.86	2
180	180	180	0.34	6.1	8.8	1.8	2

Calibration Point (°C)	Measured Temperature (°C)								
	Position								
	1	2	3	4	5	6	7	8	9 (ref.)
104	104.819	103.334	104.574	104.185	103.981	103.001	105.409	103.368	103.014
180	176.454	179.253	182.386	180.810	181.999	178.253	184.629	179.227	178.688

Average* : The average of 30 values in each position.

Temperature stability : One-half of the greatest maximum difference of measured temperature at any one sensor.

Temperature uniformity : The maximum difference of measured temperatures at any sensors and the measured temperature at the reference location which are observed at the same time or at as close an observation time as possible to determine the temperature pattern or homogeneity within the chamber under steady-state conditions.

Overall Variation : The Difference of the maximum and minimum measured temperatures throughout observation.

UUC* : Unit Under Calibration

Note : The reported uncertainty of measurement was included stability and excluded uniformity .

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

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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



Cert. No.: 23TM32
Page : 1 of 3

Certificate of Calibration

Equipment : Hot Air Oven
Manufacturer : Memmert
Model : UF 110
Serial No. : B414.0652
ID No. : ERTC-L-In.-098
Submitted by : Environment Research & Technology Company Limited.
25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Road,
Toongsonghong, Laksl,
Bangkok 10210
Location : Laboratory (ERTC)
Received Order : 4 January 2023
Calibration Date : 4 January 2023
Ambient Temperature : $(26 \pm 10) ^\circ\text{C}$
Relative Humidity : $(50 \pm 30) \%$
Calibrated by : Preecha Hlahib

Approved by : Mahu
Approved Signatory
() Pornthippa Tameyakul
() Maiee Butkruea
() Suwit Imjai

Issue Date : 16 January 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.



Equipment : Hot Air Oven
Condition As-Received : Used Item
Reference : 2301-0002ON-3
Procedure Used :-

Cert. No.: 23TM32
Page : 2 of 3

Calibration were conducted using calibration procedure CP-OT02 according to direct measurement method with Data Acquisition which connected with Resistance Temperature Detector (RTD) and Thermocouple Type T.

The temperature scale used was based on ITS-90.

Condition of this result of calibration

1. Reference standard instrument:-

Instrument	Model	Serial No.	Cert. No.	Due Date
1) Data Acquisition	34972A	MY57013823	22LM24	26 Feb 2023

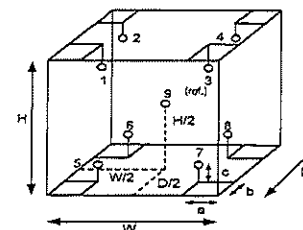
2. This certificate is valid only to the item calibrated on date and place of calibration.

3. This certification is traceable to the International System of Unit.

Result of Calibration :- (*) Without Adjustment

Function of UUC* : Temperature Source

Fresh air setting : Close



Probe Installation Details :	Dimension of Chamber :
a = 5.0 cm	D = 0.40 m
b = 5.0 cm	W = 0.56 m
c = 5.0 cm	H = 0.48 m
	Capacity = 0.11 m ³

Environment during calibration		
	Beginning	Finished
Temp. (°C)	28	32
REL.Humid. (%)	60	55
AC Supply (Volt)	220	221

Ref. Std. ID No.: @ Calibration Point		
Position :	(104) °C	(180) °C
1	21-17RTD-01	22-17TC-01
2	21-17RTD-02	19-17TC-02
3	17RTD-03	19-17TC-03
4	17RTD-04	19-17TC-04
5	17RTD-05	19-17TC-05
6	17RTD-06	19-17TC-06
7	17RTD-07	19-17TC-07
8	17RTD-08	19-17TC-08
9 (ref.)	17RTD-09	19-17TC-09



Equipment : Hot Air Oven
Condition As-Received : Used Item
Reference : 2301-0002ON-3
Result of Calibration :- (*) Without Adjustment
Function of UUC* : Temperature Source
Fresh air setting : Close

Cert. No.: 23TM32
Page : 3 of 3

Calibration Point (°C)	UUC* Setting (°C)	UUC* Reading (°C)	Temperature stability (± °C)	Temperature uniformity (°C)	Overall Variation (°C)	Uncertainty (± °C)	Coverage Factor <i>k</i>
104.0	104.0	104.0	0.10	0.95	1.6	0.42	2
180.0	180.0	180.0	0.29	1.8	3.3	1.1	2

Calibration Point (°C)	Measured Temperature (°C)								
	Position								
	1	2	3	4	5	6	7	8	9 (ref.)
104.0	104.630	103.574	103.239	103.951	104.422	104.052	103.192	104.041	104.089
180.0	179.591	179.816	178.321	179.612	181.116	179.997	178.605	179.735	179.508

Average* : The average of 30 values in each position.

Temperature stability : One-half of the greatest maximum difference of measured temperature at any one sensor.

Temperature uniformity : The maximum difference of measured temperatures at any sensors and the measured temperature at the reference location which are observed at the same time or at as close an observation time as possible to determine the temperature pattern or homogeneity within the chamber under steady-state conditions.

Overall Variation : The Difference of the maximum and minimum measured temperatures throughout observation.

UUC* : Unit Under Calibration

Note : The reported uncertainty of measurement was included stability and excluded uniformity .

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

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Mala.

Mettler-Toledo (Thailand) Ltd.
846/4 - 846/5 Lasalle Rd., Bangna Tai Sub-District
Bangna District, Bangkok 10260
+66 2723 0382
MT-TH.ServiceSupport@mt.com



Accuracy Calibration Certificate

Customer

Company: Environment Research & Technology Co., Ltd.
Address: 25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Rd., Toongsonghong
City: Laksi Contact: Ramita Taengihai
Zip / Postal: 10210
State / Province: Bangkok
Order Number:



Weighing Device

Manufacturer: Mettler Toledo Instrument Type: Weighing Instrument
Model: MS204S/01 Asset Number: ERTC-L-IN-088
Serial No.: B334691537 Terminal Model: N/A
Building: N/A Terminal Serial No.: N/A
Floor: 5 Terminal Asset No.: N/A
Room: 504

Range	Max. Capacity	Readability (d)
1	220 g	0.0001 g

Procedure

Calibration Guideline: EURAMET cg-18 v. 4.0 (11/2015)
METTLER TOLEDO Work Instruction: CP/W002/20
This calibration certificate contains measurements for As Found calibration. No As Left calibration was performed because the device was not modified after As Found calibration. Therefore, results for As Left correspond to As Found.
The sensitivity/span of the weighing instrument was adjusted before calibration with a built-in weight.
In accordance with EURAMET cg-18 (11/2015), the test loads were selected to reflect the specific use of the weighing device or to accommodate specific calibration conditions.

	Temperature	Humidity
As Found	Start: 23.7 °C End: 23.6 °C	Start: 46.5 % End: 45.6 %

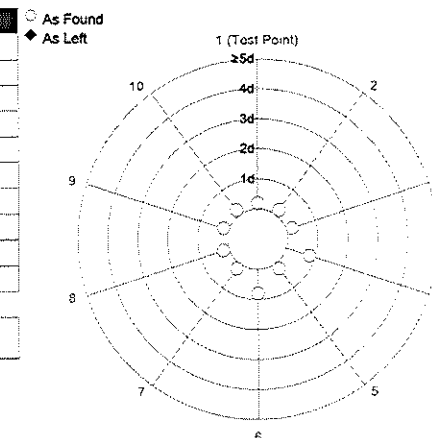
As Found Calibration Date: 17-Jan-2023
As Left Calibration Date: N/A
Issue Date: 19-Jan-2023
Calibrator: Chawalit Martsuloke
Approved Signatory: [Signature]
Technical Manager / Head of Calibration Center

Measurement Results

Repeatability

Test Load: 100 g

	As Found	As Left
1	99.9999 g	N/A
2	99.9999 g	N/A
3	99.9999 g	N/A
4	99.9998 g	N/A
5	99.9999 g	N/A
6	99.9998 g	N/A
7	99.9999 g	N/A
8	99.9999 g	N/A
9	99.9999 g	N/A
10	99.9999 g	N/A
Standard Deviation	0.00004 g	N/A

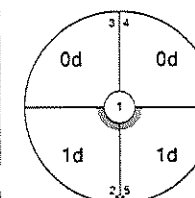


The "d" in the graph represents the readability of the range/interval in which the test was performed.
The results of this graph are based upon the absolute values of the differences from the mean value.

Eccentricity

Test Load: 100 g

Position	As Found	As Left
1	99.9999 g	N/A
2	100.0000 g	N/A
3	99.9999 g	N/A
4	99.9999 g	N/A
5	100.0000 g	N/A



Maximum Deviation	0.0001 g	N/A
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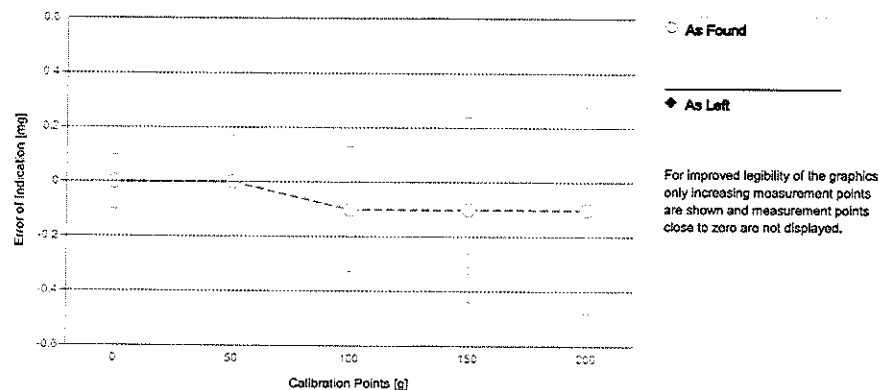
As Found

The "d" in the graph represents the readability of the range/interval in which the test was performed.

Error of Indication

As Found

	Reference Value	Indication	Error of Indication	Expanded Uncertainty	k
1	0.0000 g	0.0000 g	0.0000 g	0.10 mg	2
2	0.0500 g	0.0500 g	0.0000 g	0.12 mg	2
3	0.1000 g	0.1000 g	0.0000 g	0.12 mg	2
4	0.5000 g	0.5000 g	0.0000 g	0.12 mg	2
5	1.0000 g	1.0000 g	0.0000 g	0.12 mg	2
6	5.0000 g	5.0000 g	0.0000 g	0.13 mg	2
7	10.0000 g	10.0001 g	0.0001 g	0.13 mg	2
8	50.0000 g	50.0000 g	0.0000 g	0.17 mg	2
9	100.0000 g	99.9999 g	-0.0001 g	0.23 mg	2
10	150.0000 g	149.9999 g	-0.0001 g	0.34 mg	2
11	200.0000 g	199.9999 g	-0.0001 g	0.38 mg	2



The uncertainty stated is the expanded uncertainty at calibration obtained by multiplying the standard combined uncertainty by the coverage factor k – which can be larger than 2 according to EURAMET cg-18. The value of the measurand lies within the assigned range of values with a probability of approximately 95%.

The user is responsible for maintaining environmental conditions and the settings of the weighing instrument when it was calibrated.

Test Equipment

All weights used for metrological testing are traceable to national or international standards. The weights were calibrated and certified by an accredited calibration laboratory.

Weight Set 1: OIML E2

Weight Set No.:	WS57	Date of Issue:	06-Jan-2022
Certificate Number:	177037	Calibration Due Date:	03-Jul-2023

Thermo Hygrometer

Equipment No.:	IN255	Date of Issue:	20-Jul-2022
Certificate Number:	22H1503	Calibration Due Date:	04-Jul-2023

Remarks

- FACT adjustment functionality activated
- Equipment condition: Good
- Next calibration according to customer's procedure
- Calibration data not decide by calibration laboratory

End of Accredited Section

The information below and any attachments to this calibration certificate are not part of the accredited calibration.

Measurement Uncertainty of the Weighing Instrument in Use

Stated is the expanded uncertainty with $k=2$ in use. The formula shall be used for the estimation of the uncertainty under consideration of the errors of indication. The value R represents the net load indication in the unit of measure of the device.

Temperature coefficient for the evaluation of the measurement uncertainty in use: $1,5 \cdot 10^{-6} / K$

Temperature range on site for the evaluation of the measurement uncertainty in use: 3 K

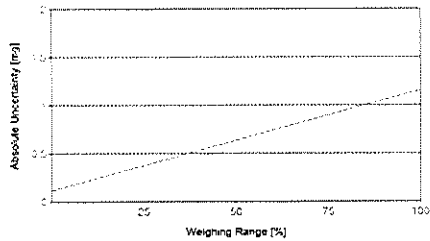
Linearization of Uncertainty Equation

Range	d		Max	As Found	As Left
	d	Max			
1	0.0001 g	220 g		$U_1 = 0.12 \text{ mg} + 0.00474 \text{ mg/g} \cdot R$	N/A

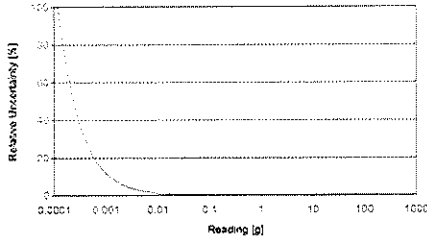
To optimize the stability of the linearization, besides of the zero load only increasing measurement points with a test load of 5% of the measurement range or larger are taken for the calculation of the linear equation.

Absolute and Relative Measurement Uncertainty In Use for Various Net Indications (Examples)

Net Indication	As Found		As Left	
0.0220 g	0.12 mg	0.55%	N/A	N/A
0.2200 g	0.12 mg	0.055%	N/A	N/A
2.2000 g	0.13 mg	0.0059%	N/A	N/A
22.0000 g	0.22 mg	0.0010%	N/A	N/A
220.0000 g	1.2 mg	0.00053%	N/A	N/A



As Found



As Left

GWP®
Certificate



As
Found



As
Left



The weighing device meets the given process requirements.

The weighing device meets the given process requirements.

Tests Performed: ☒ As Found ☐ As Left ☒ No adjustments/modifications made. As Left results correspond to As Found.

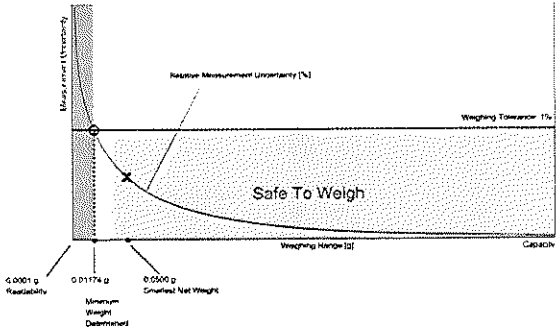
Process Requirements

Weighing Tolerance: 1%

Smallest Net Weight: 0.0500 g

Safety Factor: 2

Safe Weighing Range



While the values in this graph reflect the actual calibration results, the measurement uncertainty curves are simply a visual representation. This graph reflects As Left testing, unless only As Found was performed.

Minimum Weight

As Found Minimum Weight Table

Minimum weights for different weighing tolerances and safety factors					
Tolerance	Safety Factor				
	1	2	3	5	10
0.1%	0.11794 g	0.23700 g	0.35721 g	0.60113 g	1.23215 g
0.2%	0.05883 g	0.11794 g	0.17733 g	0.29696 g	0.60113 g
0.5%	0.02350 g	0.04704 g	0.07063 g	0.11794 g	0.23700 g
1%	0.01174 g	0.02350 g	0.03526 g	0.05883 g	0.11794 g
2%	0.00587 g	0.01174 g	0.01762 g	0.02938 g	0.05883 g
5%	0.00235 g	0.00470 g	0.00704 g	0.01174 g	0.02350 g



Pass: The determined minimum weight meets the requirement for the smallest net weight.

As Left Minimum Weight Table

Minimum weights for different weighing tolerances and safety factors					
Tolerance	Safety Factor				
	1	2	3	5	10
0.1%	0.11794 g	0.23700 g	0.35721 g	0.60113 g	1.23215 g
0.2%	0.05883 g	0.11794 g	0.17733 g	0.29696 g	0.60113 g
0.5%	0.02350 g	0.04704 g	0.07063 g	0.11794 g	0.23700 g
1%	0.01174 g	0.02350 g	0.03526 g	0.05883 g	0.11794 g
2%	0.00587 g	0.01174 g	0.01762 g	0.02938 g	0.05883 g
5%	0.00235 g	0.00470 g	0.00704 g	0.01174 g	0.02350 g



Pass: The determined minimum weight meets the requirement for the smallest net weight.

At these net minimum weight values, the measurement uncertainty of the weighing device is equal to or less than 1/1 (no safety factor), 1/2, 1/3, 1/5, or 1/10 of the required tolerance. The values are calculated with $k = 2$ and based on the linear formula of the measurement uncertainty of the weighing device in use.

The safety factor for As Found is always 1. This implies no safety factor. As Found testing looks at the behavior of the instrument from the past until test occurred. For the past, it is necessary to know that the tolerance was met, but not the safety factor. The safety factor is a proactive measure to apply for future measurements.

Notes on minimum weight values in above table:

1. If "N/A" is shown above, no appropriate value could be calculated.
2. METTLER TOLEDO is not responsible for the definition of the process requirements.

Measurement Results

Results Summary

	Repeatability	Eccentricity	Error of Indication
As Found	✓	✓	✓
As Left	✓	✓	✓

✓ = Passed

✗ = Failed

! = Safety Factor not met

Repeatability

Test Load: 100 g

Tolerance	Control Limit	As Found		As Left	
		Std. Deviation	Result	Std. Deviation	Result
0.1%	N/A	0.00004 g*	N/A	0.00004 g*	N/A
0.2%	0.00005 g		✓		!
0.5%	0.00013 g		✓		✓
1%	0.00025 g		✓		✓
2%	0.00050 g		✓		✓
5%	0.00125 g		✓		✓

*The calculated standard deviation value is below the rounding error of the balance. The 0.41*d rule is used for the assessment of this repeatability test and the calculation of the minimum weight.

The weighing tolerance is met if the standard deviation is less than or equal to the corresponding control limit.

Eccentricity

Test Load: 100 g

Tolerance	Control Limit	As Found		As Left	
		Deviation	Result	Deviation	Result
0.1%	0.0500 g	0.0001 g	✓	0.0001 g	✓
0.2%	0.1000 g		✓		✓
0.5%	0.2500 g		✓		✓
1%	0.5000 g		✓		✓
2%	1.0000 g		✓		✓
5%	2.5000 g		✓		✓

The weighing tolerance is met if the deviation is less than or equal to the corresponding control limit.

Error of Indication

As Found

		Control limits for various weighing tolerances					
Reference Value	Error	0.1%	0.2%	0.5%	1%	2%	5%
0.0000 g	0.0000 g	N/A	N/A	N/A	N/A	N/A	N/A
50.0000 g	0.0000 g	0.0250 g	0.0500 g	0.1250 g	0.2500 g	0.5000 g	1.2500 g
100.0000 g	-0.0001 g	0.0500 g	0.1000 g	0.2500 g	0.5000 g	1.0000 g	2.5000 g
150.0000 g	-0.0001 g	0.0750 g	0.1500 g	0.3750 g	0.7500 g	1.5000 g	3.7500 g
200.0000 g	-0.0001 g	0.1000 g	0.2000 g	0.5000 g	1.0000 g	2.0000 g	5.0000 g
Result		✓	✓	✓	✓	✓	✓

As Left

		Control limits for various weighing tolerances					
Reference Value	Error	0.1%	0.2%	0.5%	1%	2%	5%
0.0000 g	0.0000 g	N/A	N/A	N/A	N/A	N/A	N/A
50.0000 g	0.0000 g	0.0250 g	0.0500 g	0.1250 g	0.2500 g	0.5000 g	1.2500 g
100.0000 g	-0.0001 g	0.0500 g	0.1000 g	0.2500 g	0.5000 g	1.0000 g	2.5000 g
150.0000 g	-0.0001 g	0.0750 g	0.1500 g	0.3750 g	0.7500 g	1.5000 g	3.7500 g
200.0000 g	-0.0001 g	0.1000 g	0.2000 g	0.5000 g	1.0000 g	2.0000 g	5.0000 g
Result		✓	✓	✓	✓	✓	✓

The weighing tolerance is met if the error (of indication) for each test point is less than or equal to the corresponding control limit for that particular weighing tolerance. Results at or close to the zero point cannot be assessed.

Mettler-Toledo (Thailand) Ltd.

846/4 - 846/5 Lasalle Rd., Bangna Tai Sub-District

Bangna District, Bangkok 10260


+66 2723 0382

MT-TH.ServiceSupport@mt.com



Accuracy Calibration Certificate

Customer

Company: Environment Research & Technology Co., Ltd.
Address: 25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Rd., Toongsonghong
City: Laksi Contact: Ramita Taengthai
Zip / Postalt: 10210
State / Province: Bangkok
Order Number: 

Weighing Device

Manufacturer: Mettler Toledo Instrument Type: Weighing Instrument
Model: MS204TS/00 Asset Number: ERTC-L-IN-114
Serial No.: B547728937 Terminal Model: N/A
Building: N/A Terminal Serial No.: N/A
Floor: 5 Terminal Asset No.: N/A
Room: 504

Range	Max. Capacity	Readability (d)
1	220 g	0.0001 g

Procedure

Calibration Guideline: EURAMET cg-18 v. 4.0 (11/2015)

METTLER TOLEDO Work Instruction: CPW002/20

This calibration certificate contains measurements for As Found calibration. No As Left calibration was performed because the device was not modified after As Found calibration. Therefore, results for As Left correspond to As Found.

The sensitivity/span of the weighing instrument was adjusted before calibration with a built-in weight.

In accordance with EURAMET cg-18 (11/2015), the test loads were selected to reflect the specific use of the weighing device or to accommodate specific calibration conditions.

	Temperature		Humidity	
As Found	Start: 23.7 °C	End: 23.8 °C	Start: 45.6 %	End: 46.8 %

As Found Calibration Date: 17-Jan-2023

Calibrator:

As Left Calibration Date: N/A

Issue Date: 19-Jan-2023

Chawalit Martsuloke

Approved Signatory:

Technical Manager / Head of Calibration Center

Measurement Results

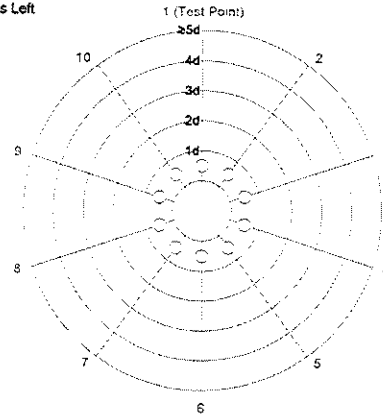
Repeatability

Test Load: 100 g

	As Found	As Left
1	99.9999 g	N/A
2	99.9999 g	N/A
3	99.9999 g	N/A
4	100.0000 g	N/A
5	100.0000 g	N/A
6	99.9999 g	N/A
7	99.9999 g	N/A
8	100.0000 g	N/A
9	100.0000 g	N/A
10	100.0000 g	N/A

Standard Deviation	0.00005 g	N/A
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○ As Found
◆ As Left



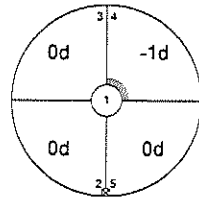
The "d" in the graph represents the readability of the range/interval in which the test was performed.
The results of this graph are based upon the absolute values of the differences from the mean value.

Eccentricity

Test Load: 100 g

Position	As Found	As Left
1	99.9999 g	N/A
2	99.9999 g	N/A
3	99.9999 g	N/A
4	99.9998 g	N/A
5	99.9999 g	N/A

Maximum Deviation	0.0001 g	N/A
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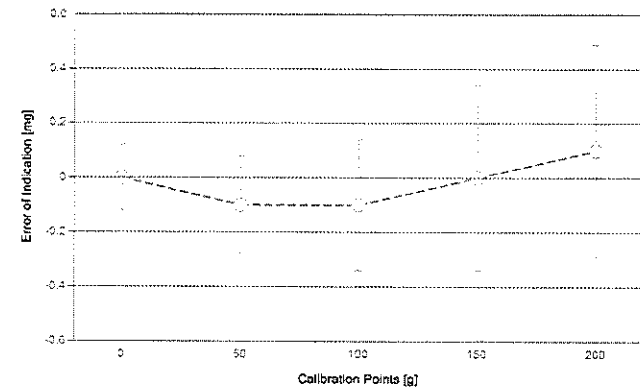
As Found

The "d" in the graph represents the readability of the range/interval in which the test was performed.

Error of Indication

As Found

	Reference Value	Indication	Error of Indication	Expanded Uncertainty	k
1	0.0000 g	0.0000 g	0.0000 g	0.12 mg	2
2	0.0500 g	0.0500 g	0.0000 g	0.13 mg	2
3	0.1000 g	0.1000 g	0.0000 g	0.13 mg	2
4	0.5000 g	0.5000 g	0.0000 g	0.14 mg	2
5	1.0000 g	1.0000 g	0.0000 g	0.14 mg	2
6	5.0000 g	5.0001 g	0.0001 g	0.14 mg	2
7	10.0000 g	10.0001 g	0.0001 g	0.15 mg	2
8	50.0000 g	49.9999 g	-0.0001 g	0.18 mg	2
9	100.0000 g	99.9999 g	-0.0001 g	0.24 mg	2
10	150.0000 g	150.0000 g	0.0000 g	0.34 mg	2
11	200.0000 g	200.0001 g	0.0001 g	0.39 mg	2



○ As Found

◆ As Left

For improved legibility of the graphics only increasing measurement points are shown and measurement points close to zero are not displayed.

The uncertainty stated is the expanded uncertainty at calibration obtained by multiplying the standard combined uncertainty by the coverage factor k – which can be larger than 2 according to EURAMET cg-18. The value of the measurand lies within the assigned range of values with a probability of approximately 95%.

The user is responsible for maintaining environmental conditions and the settings of the weighing instrument when it was calibrated.

Test Equipment

All weights used for metrological testing are traceable to national or international standards. The weights were calibrated and certified by an accredited calibration laboratory.

Weight Set 1: OIML E2

Weight Set No.:	WS57	Date of Issue:	06-Jan-2022
Certificate Number:	177037	Calibration Due Date:	03-Jul-2023

Thermo Hygrometer

Equipment No.:	IN255	Date of Issue:	20-Jul-2022
Certificate Number:	22H1503	Calibration Due Date:	04-Jul-2023

Remarks

FACT adjustment functionality activated
Equipment condition: Good
Next calibration according to customer's procedure
Calibration data not decide by calibration laboratory

End of Accredited Section

The information below and any attachments to this calibration certificate are not part of the accredited calibration.

Measurement Uncertainty of the Weighing Instrument in Use

Stated is the expanded uncertainty with $k=2$ in use. The formula shall be used for the estimation of the uncertainty under consideration of the errors of indication. The value R represents the net load indication in the unit of measure of the device.

Temperature coefficient for the evaluation of the measurement uncertainty in use: $3.0 \cdot 10^{-6} / K$

Temperature range on site for the evaluation of the measurement uncertainty in use: $3 K$

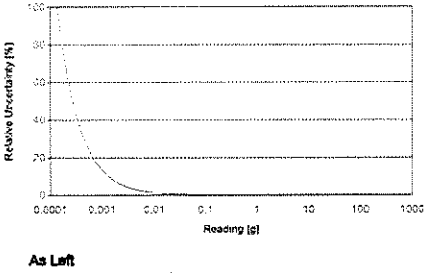
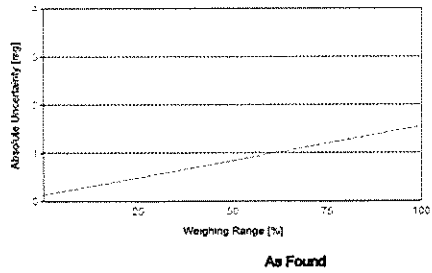
Linearization of Uncertainty Equation

Range			As Found	As Left
	d	Max		
1	0.0001 g	220 g	$U_1 = 0.13 \text{ mg} + 0.00647 \text{ mg/g} \cdot R$	N/A

To optimize the stability of the linearization, besides of the zero load only increasing measurement points with a test load of 5% of the measurement range or larger are taken for the calculation of the linear equation.

Absolute and Relative Measurement Uncertainty in Use for Various Net Indications (Examples)

Net Indication	As Found		As Left	
0.0220 g	0.13 mg	0.59%	N/A	N/A
0.2200 g	0.13 mg	0.060%	N/A	N/A
2.2000 g	0.14 mg	0.0066%	N/A	N/A
22.0000 g	0.27 mg	0.0012%	N/A	N/A
220.0000 g	1.6 mg	0.00071%	N/A	N/A



GWP® Certificate



As
Found



As
Left



The weighing device meets the given
process requirements.

The weighing device meets the given
process requirements.

Tests Performed: ☒ As Found ☐ As Left ☐ No adjustments/modifications made. As Left results correspond to As Found.

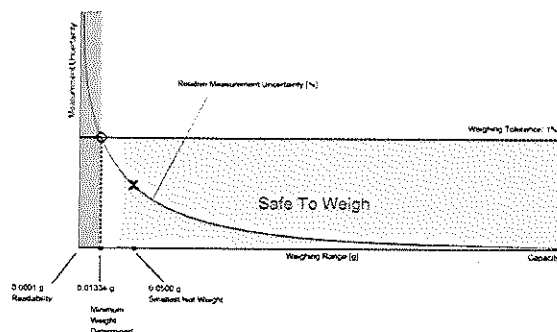
Process Requirements

Weighing Tolerance: 1%

Smallest Net Weight: 0.0500 g

Safety Factor: 2

Safe Weighing Range



While the values in this graph reflect the actual calibration results, the measurement uncertainty curves are simply a visual representation. This graph reflects As Left testing, unless only As Found was performed.

Minimum Weight

As Found Minimum Weight Table

Minimum weights for different weighing tolerances and safety factors					
Tolerance	Safety Factor				
	1	2	3	5	10
0.1%	0.13420 g	0.27016 g	0.40792 g	0.68895 g	1.42555 g
0.2%	0.06688 g	0.13420 g	0.20196 g	0.33881 g	0.68895 g
0.5%	0.02670 g	0.05347 g	0.08031 g	0.13420 g	0.27016 g
1%	0.01334 g	0.02670 g	0.04008 g	0.06688 g	0.13420 g
2%	0.00667 g	0.01334 g	0.02002 g	0.03339 g	0.06688 g
5%	0.00267 g	0.00533 g	0.00800 g	0.01334 g	0.02670 g

☒ Pass: The determined minimum weight meets the requirement for the smallest net weight.

As Left Minimum Weight Table

Minimum weights for different weighing tolerances and safety factors					
Tolerance	Safety Factor				
	1	2	3	5	10
0.1%	0.13420 g	0.27016 g	0.40792 g	0.68895 g	1.42555 g
0.2%	0.06688 g	0.13420 g	0.20196 g	0.33881 g	0.68895 g
0.5%	0.02670 g	0.05347 g	0.08031 g	0.13420 g	0.27016 g
1%	0.01334 g	0.02670 g	0.04008 g	0.06688 g	0.13420 g
2%	0.00667 g	0.01334 g	0.02002 g	0.03339 g	0.06688 g
5%	0.00267 g	0.00533 g	0.00800 g	0.01334 g	0.02670 g

☒ Pass: The determined minimum weight meets the requirement for the smallest net weight.

At these net minimum weight values, the measurement uncertainty of the weighing device is equal to or less than 1/1 (no safety factor), 1/2, 1/3, 1/5, or 1/10 of the required tolerance. The values are calculated with $k = 2$ and based on the linear formula of the measurement uncertainty of the weighing device in use.

The safety factor for As Found is always 1. This implies no safety factor. As Found testing looks at the behavior of the instrument from the past until test occurred. For the past, it is necessary to know that the tolerance was met, but not the safety factor. The safety factor is a proactive measure to apply for future measurements.

Notes on minimum weight values in above table:

1. If "N/A" is shown above, no appropriate value could be calculated.
2. METTLER TOLEDO is not responsible for the definition of the process requirements.

Measurement Results

Results Summary

	Repeatability	Eccentricity	Error of Indication
As Found	✓	✓	✓
As Left	✓	✓	✓

✓ = Passed

✗ = Failed

Δ = Safety Factor not met

Repeatability

Test Load: 100 g

Tolerance	Control Limit	As Found		As Left	
		Std. Deviation	Result	Std. Deviation	Result
0.1%	N/A	0.00005 g*	N/A	0.00005 g*	N/A
0.2%	0.00005 g		✓		Δ
0.5%	0.00013 g		✓		✓
1%	0.00025 g		✓		✓
2%	0.00050 g		✓		✓
5%	0.00125 g		✓		✓

*The calculated standard deviation value is below the rounding error of the balance. The 0.41*d rule is used for the assessment of this repeatability test and the calculation of the minimum weight.

The weighing tolerance is met if the standard deviation is less than or equal to the corresponding control limit.

Eccentricity

Test Load: 100 g

Tolerance	Control Limit	As Found		As Left	
		Deviation	Result	Deviation	Result
0.1%	0.0500 g	0.0001 g	✓	0.0001 g	✓
0.2%	0.1000 g		✓		✓
0.5%	0.2500 g		✓		✓
1%	0.5000 g		✓		✓
2%	1.0000 g		✓		✓
5%	2.5000 g		✓		✓

The weighing tolerance is met if the deviation is less than or equal to the corresponding control limit.

Error of Indication

As Found

Reference Value	Error	Control limits for various weighing tolerances					
		0.1%	0.2%	0.5%	1%	2%	5%
0.0000 g	0.0000 g	N/A	N/A	N/A	N/A	N/A	N/A
50.0000 g	-0.0001 g	0.0250 g	0.0500 g	0.1250 g	0.2500 g	0.5000 g	1.2500 g
100.0000 g	-0.0001 g	0.0500 g	0.1000 g	0.2500 g	0.5000 g	1.0000 g	2.5000 g
150.0000 g	0.0000 g	0.0750 g	0.1500 g	0.3750 g	0.7500 g	1.5000 g	3.7500 g
200.0000 g	0.0001 g	0.1000 g	0.2000 g	0.5000 g	1.0000 g	2.0000 g	5.0000 g
Result		✓	✓	✓	✓	✓	✓

As Left

Reference Value	Error	Control limits for various weighing tolerances					
		0.1%	0.2%	0.5%	1%	2%	5%
0.0000 g	0.0000 g	N/A	N/A	N/A	N/A	N/A	N/A
50.0000 g	-0.0001 g	0.0250 g	0.0500 g	0.1250 g	0.2500 g	0.5000 g	1.2500 g
100.0000 g	-0.0001 g	0.0500 g	0.1000 g	0.2500 g	0.5000 g	1.0000 g	2.5000 g
150.0000 g	0.0000 g	0.0750 g	0.1500 g	0.3750 g	0.7500 g	1.5000 g	3.7500 g
200.0000 g	0.0001 g	0.1000 g	0.2000 g	0.5000 g	1.0000 g	2.0000 g	5.0000 g
Result		✓	✓	✓	✓	✓	✓

The weighing tolerance is met if the error (of indication) for each test point is less than or equal to the corresponding control limit for that particular weighing tolerance. Results at or close to the zero point cannot be assessed.