



ภาคผนวก จ

เอกสารสอบเทียบเครื่องมือวิเคราะห์

PM10 HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

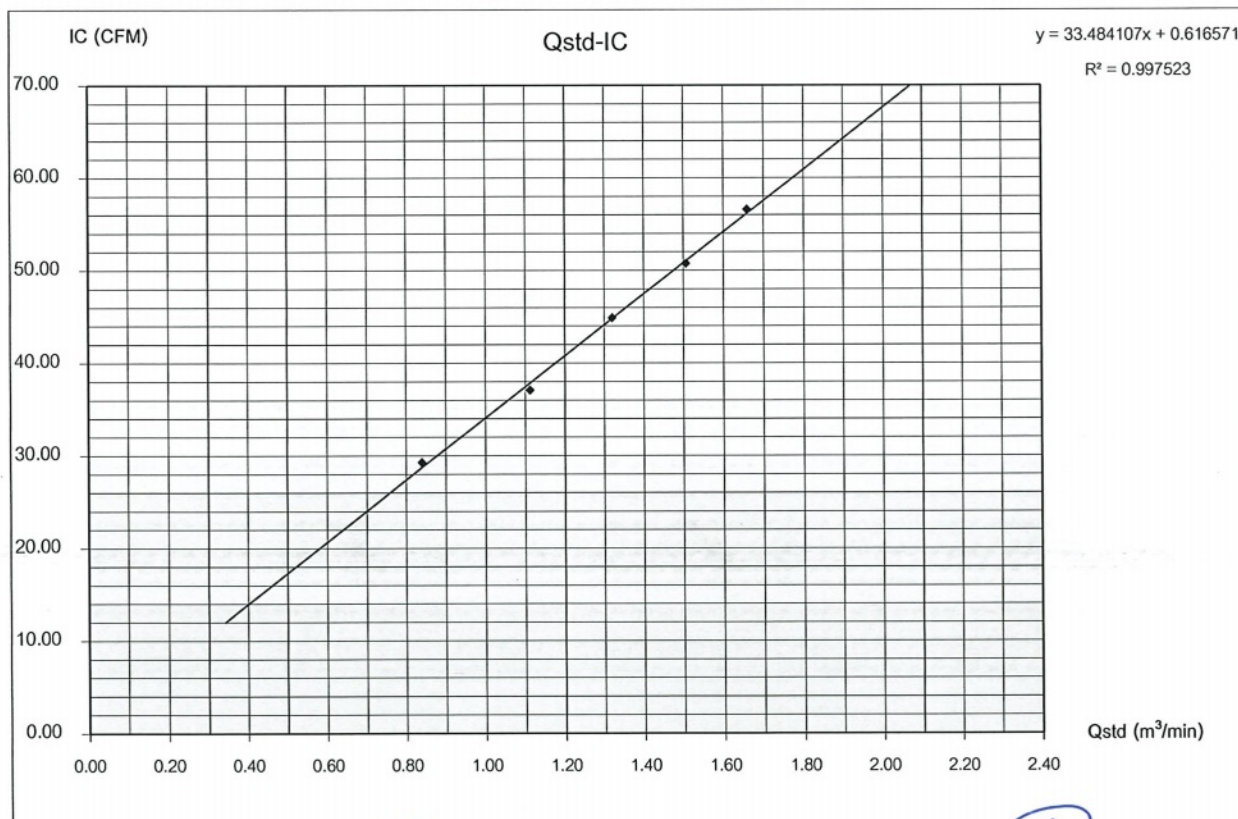
Sampler Location				Date	May 5, 2023
วัดใหม่ประจวบชน (2023-01330)				Start Time	12:40 PM
Sampler Number	PM-10 No.15	Transfer Standard Type	Orifice	Stop Time	12:50 PM
Instrument Model	HIVOL-BMBBE	Calibrator Model	TE-5025A	Calibrated By	Mr.Anan Kongnguenok
Motor Serial Number	B2012-02	Calibrator Serial Number	3883		
Recorder Serial Number	4649				

Plate No.	(Delta H)			(A)	(X)	(I)	(Y)	Temperature	Barometric Pressure	Start Meter	Stop Meter
	Pressure Drop Across Orifice (inH ₂ O)			$[\Delta H_2O(Pa/P_{std})(T_{std}/T_a)]^{1/2}$	$Q_{std} = (1/m)[(A-b)]$	ample Flow Rate Indication	$IC = I[(Pa/P_{std})(T_{std}/T_a)]^{1/2}$	(°K = °C+273)	(mmHg)		
	Positive	Negative	ΔH_2O		(m ³ /min)	(ft ³ /min)					
5	1.5	1.6	3.1	1.71830	0.84011	30.0	29.28	310.0	753.0		
7	2.7	2.8	5.5	2.28876	1.11182	38.0	37.09	310.0	753.0		
10	3.9	3.9	7.8	2.72562	1.31990	46.0	44.89	310.0	753.0		
13	5.1	5.1	10.2	3.11687	1.50625	52.0	50.75	310.0	753.0		
18	6.2	6.2	12.4	3.43660	1.65854	58.0	56.60	310.0	753.0		
Linear Regression Y ON X : Y= mX + b							Average	310.0	753.0		

1	Slope (m)	2.09951	Linear Equation		r^2	0.997523	Pstd(mmHg)	760.0
2	Intercept (b)	-0.04553	Set Point Flow Rate (X) (m ³ /min)	1.133	r	0.9987607	T _{MTP}	298.0
3	Correlation Coefficient (r)	0.99992	Final Set Flow Rate = (I)	0	(Pa/Pstd)*(Tstd/Ta)		0.952436333	
Result							C=(Pa/Pstd)*(Tstd/Ta)^0.5	0.975928447

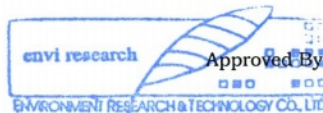
COMMENT

Andersen Instruments, Inc.



Checked By

(Mr. Prayun Detkla)
Technician



Approved By

(Mr. Panupon Podang)
Environmental Scientist

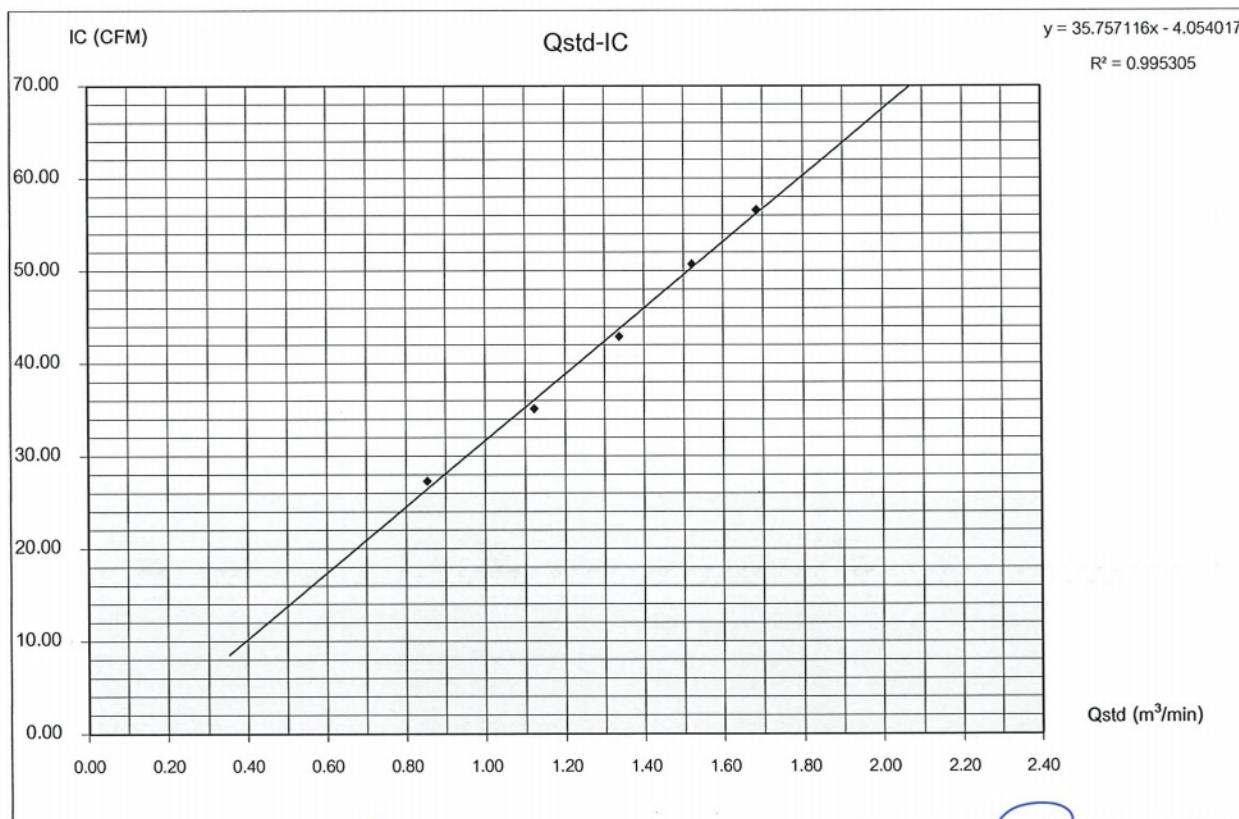
TSP HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

Sampler Location				Date	May 5, 2023
วัดใหม่ประจวบ (2022-01330)				Start Time	12:30 PM
Sampler Number	TSP No.A5	Transfer Standard Type	Orifice	Stop Time	12:40 PM
Instrument Model	HIVOL-BBCBE	Calibrator Model	TE-5025A	Calibrated By	Mr.Anan Kongnguenok
Motor Serial Number	1203-431	Calibrator Serial Number	3883		
Recorder Serial Number	4640				

Plate No.	(Delta H)			(A)	(X)	(I)	(Y)	Temperature	Barometric Pressure	Start Meter	Stop Meter
	Pressure Drop Across Orifice (inH ₂ O)			[ΔH ₂ O(Pa/P _{std})(T _{std} /Ta)] ^{1/2}	Qstd = (1/m)[(A-b)]	ample Flow Rate Indicato	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	1.6	1.6	3.2	1.74579	0.85321	28.0	27.33	310.0	753.0		
7	2.8	2.8	5.6	2.30947	1.12169	36.0	35.13	310.0	753.0		
10	4.0	4.0	8.0	2.76034	1.33644	44.0	42.94	310.0	753.0		
13	5.2	5.2	10.4	3.14727	1.52074	52.0	50.75	310.0	753.0		
18	6.4	6.4	12.8	3.49159	1.68473	58.0	56.60	310.0	753.0		
Linear Regression Y ON X : Y= mX + b							Average	310.0	753.0		
1	Slope (m)			2.09951	Linear Equation			r ²	0.995305	Pstd(mmHg)	760
2	Intercept (b)			-0.04553	Set Point Flow Rate (X) (m ³ /min)		1.133	r	0.9976497	T _{NTP}	298
3	Correlation Coefficient (r)			0.99992	Final Set Flow Rate = (I)		0	(Pa/Pstd)*(Tstd/Ta)		0.952436333	
Result								C=(Pa/Pstd)*(Tstd/Ta)^0.5		0.975928447	

COMMENT

Andersen Instruments, Inc.



Checked By

Prayan

(Mr. Prayun Detkla)
Technician



Approved By

Panpa

(Mr. Panupon Podang)
Environmental Scientist

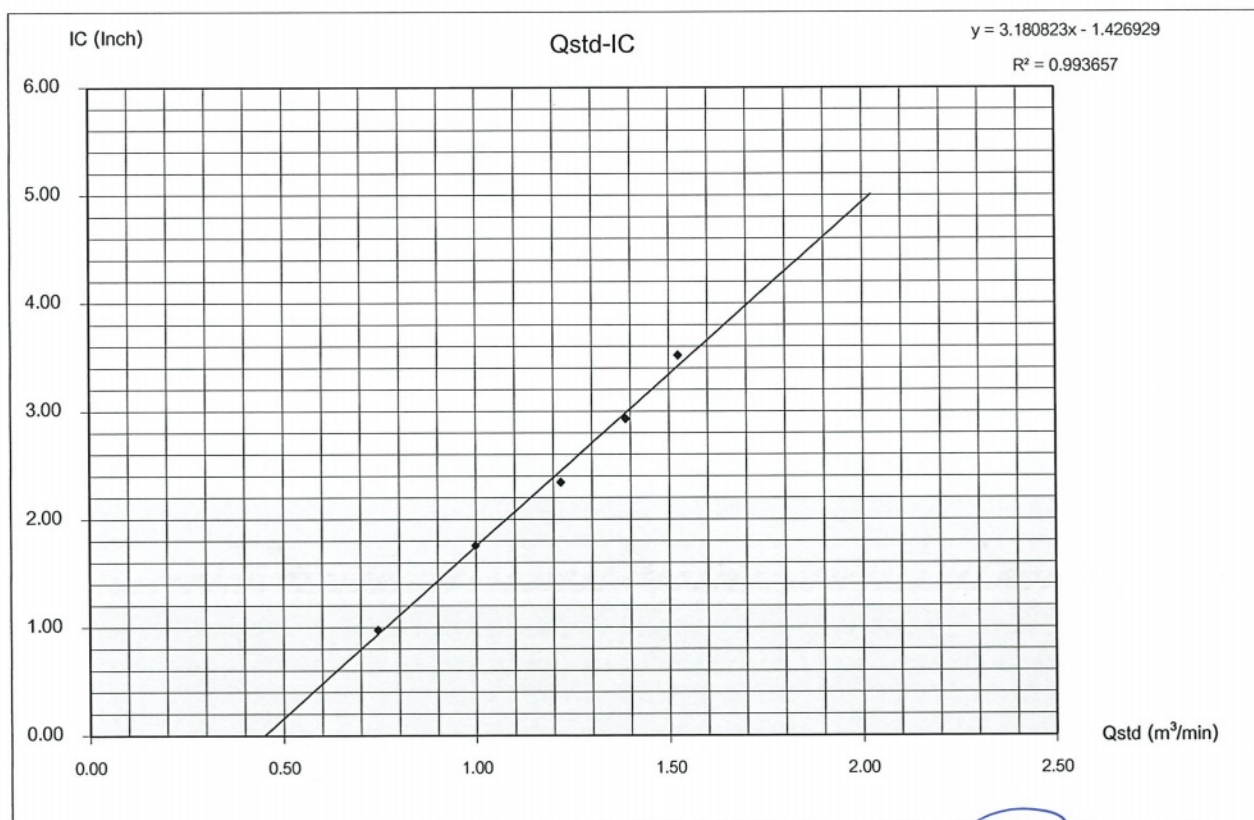
PM10 HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

Sampler Location				Date	May 5, 2023
บ้านโป่งกระพ้อ (2022-01330)				Start Time	12:10 PM
Sampler Number	PM-10 No.6	Transfer Standard Type	Orifice	Stop Time	12:20 PM
Instrument Model	HIVOL-BMBBE	Calibrator Model	TE-5025A	Calibrated By	Mr. Anan Kongnguenok
Motor Serial Number	No.6	Calibrator Serial Number	3883		
Recorder Serial Number					

Plate No.	(Delta H)			(A)	(X)	(I)	(Y)	Temperature	Barometric Pressure	Start Meter	Stop Meter
	Pressure Drop Across Orifice (inH ₂ O)			$[\Delta H_2O(Pa/P_{std})(T_{std}/Ta)]^{1/2}$	$Q_{std} = (1/m)[(A-b)]$	ample Flow Rate Indication	$IC = I[(Pa/P_{std})(T_{std}/Ta)]^{1/2}$				
	Positive	Negative	ΔH_2O		(m ³ /min)	(inch/min)		(°K = °C+273)	(mmHg)		
5	1.2	1.2	2.4	1.51435	0.74297	1.0	0.98	309.0	753.0		
7	2.2	2.2	4.4	2.05043	0.99831	1.8	1.76	309.0	753.0		
10	3.3	3.3	6.6	2.51126	1.21780	2.4	2.35	309.0	753.0		
13	4.3	4.3	8.6	2.86661	1.38706	3.0	2.93	309.0	753.0		
18	5.2	5.2	10.4	3.15236	1.52316	3.6	3.52	309.0	753.0		
Linear Regression Y ON X : Y= mX + b							Average	309.0	753.0		
1	Slope (m)			2.09951	Linear Equation			r^2	0.993657	Pstd(mmHg)	760
2	Intercept (b)			-0.04553	Set Point Flow Rate (X) (m ³ /min)		1.133	r	0.9968235	T _{NTP}	298
3	Correlation Coefficient (r)			0.99992	Final Set Flow Rate = (I)		0	(Pa/Pstd)*(Tstd/Ta)		0.955518651	
Result								C=(Pa/Pstd)*(Tstd/Ta)^0.5		0.977506343	

COMMENT

Andersen Instruments, Inc.



Checked By

Prayun

(Mr. Prayun Detkla)
Technician



Approved By

Panpan

(Mr. Panupon Podang)
Environmental Scientist

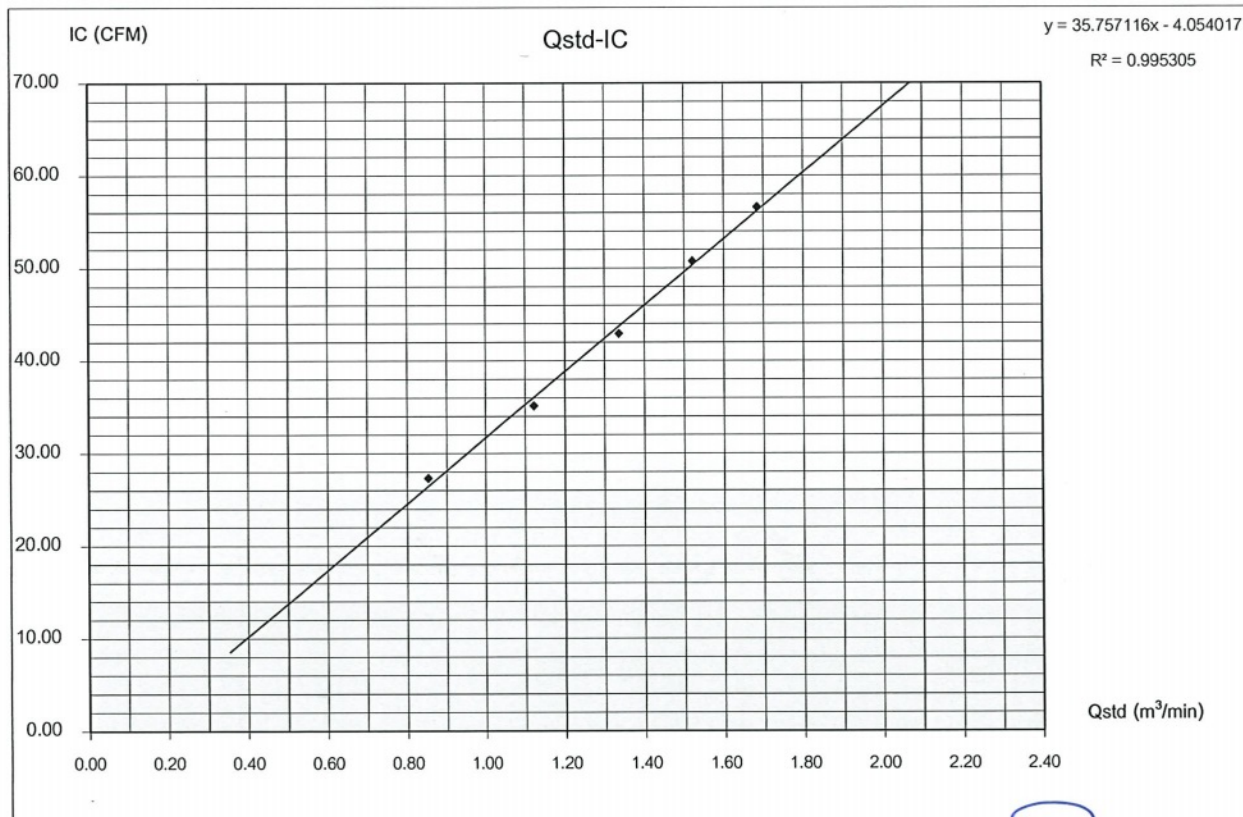
TSP HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

Sampler Location				Date	May 5, 2023
วัดใหม่ประทุม軒 (2022-01329)				Start Time	12:30 PM
Sampler Number	TSP No.A5	Transfer Standard Type	Orifice	Stop Time	12:40 PM
Instrument Model	HIVOL-BBCBE	Calibrator Model	TE-5025A	Calibrated By	Mr.Anan Kongnguenok
Motor Serial Number	1203-431	Calibrator Serial Number	3883		
Recorder Serial Number	4640				

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 Indication	$IC = I[(Pa/P_{std})(T_{std}/Ta)]^{1/2}$	(°K = °C+273)	(mmHg)		
	Positive	Negative	ΔH ₂ O		(m ³ /min)	(ft ³ /min)					
5	1.6	1.6	3.2	1.74579	0.85321	28.0	27.33	310.0	753.0		
7	2.8	2.8	5.6	2.30947	1.12169	36.0	35.13	310.0	753.0		
10	4.0	4.0	8.0	2.76034	1.33644	44.0	42.94	310.0	753.0		
13	5.2	5.2	10.4	3.14727	1.52074	52.0	50.75	310.0	753.0		
18	6.4	6.4	12.8	3.49159	1.68473	58.0	56.60	310.0	753.0		
Linear Regression Y ON X : Y= mX + b							Average	310.0	753.0		
1	Slope (m)			2.09951	Linear Equation			r ²	0.995305	Pstd(mmHg)	760
2	Intercept (b)			-0.04553	Set Point Flow Rate (X) (m ³ /min)		1.133	r	0.9976497	T _{HTP}	298
3	Correlation Coefficient (r)			0.99992	Final Set Flow Rate = (I)		0	(Pa/Pstd)*(Tstd/Ta)		0.952436333	
Result								C=(Pa/Pstd)*(Tstd/Ta)^0.5		0.975928447	

COMMENT

Andersen Instruments, Inc.



Checked By

(Mr. Prayun Detkla)
Technician



Approved By

(Mr. Panupon Podang)
Environmental Scientist

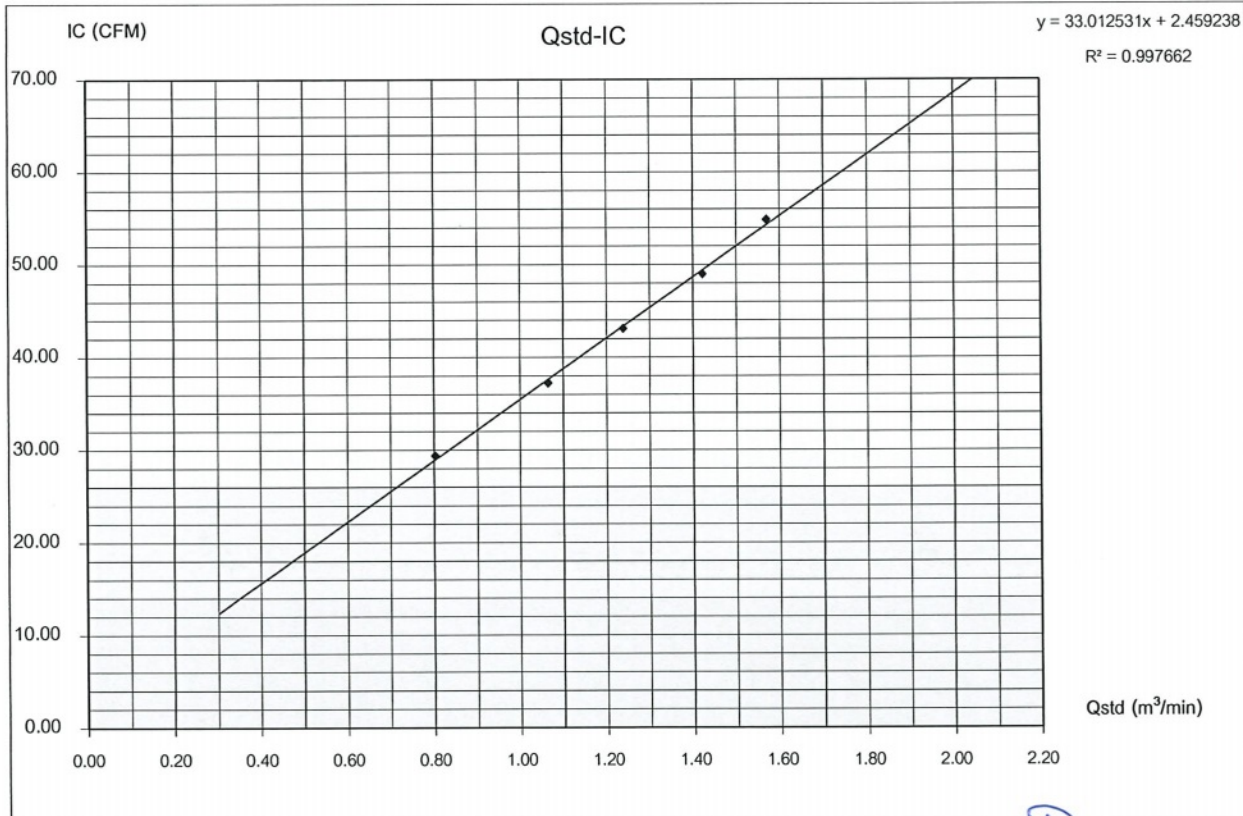
TSP HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

Sampler Location				Date	May 5, 2023
บ้านโคกอุดมดี (2022-01330)				Start Time	10:55 AM
Sampler Number	TSP No.A20	Transfer Standard Type	Orifice	Stop Time	11:05 AM
Instrument Model	HIVOL-BBCBE	Calibrator Model	TE-5025A	Calibrated By	Mr.Anan Kongnguenok
Motor Serial Number	2142	Calibrator Serial Number	3883		
Recorder Serial Number	2397				

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		(m ³ /min)	(ft ³ /min)					
5	1.4	1.4	2.8	1.63942	0.80255	30.0	29.39	308.0	754.0		
7	2.5	2.5	5.0	2.19077	1.06515	38.0	37.23	308.0	754.0		
10	3.4	3.4	6.8	2.55485	1.23857	44.0	43.11	308.0	754.0		
13	4.5	4.5	9.0	2.93923	1.42164	50.0	48.99	308.0	754.0		
18	5.5	5.5	11.0	3.24944	1.56940	56.0	54.87	308.0	754.0		
Linear Regression Y ON X : Y= mX + b							Average	308.0	754.0		
1	Slope (m)			2.09951	Linear Equation			r ²	0.997662	Pstd(mmHg)	760.0
2	Intercept (b)			-0.04553	Set Point Flow Rate (X) (m ³ /min)		1.133	r	0.9988303	T _{NTP}	298.0
3	Correlation Coefficient (r)			0.99992	Final Set Flow Rate = (I)		0	(Pa/Pstd)*(Tstd/Ta)			0.959894053
Result								C=(Pa/Pstd)*(Tstd/Ta)^0.5			0.97974183

COMMENT

Andersen Instruments, Inc.



Checked By

(Mr. Prayun Detkla)
Technician



Approved By

(Mr. Panupon Podang)
Environmental Scientist

PM10 HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

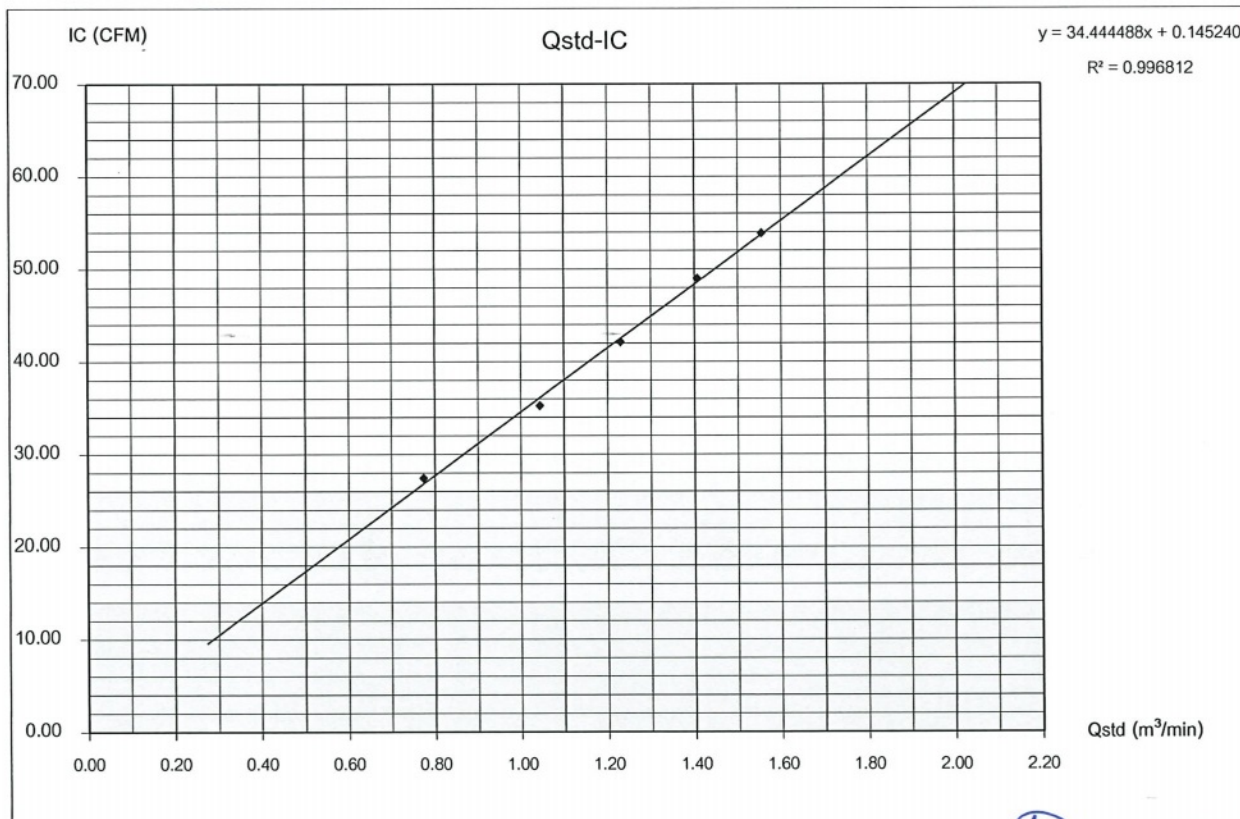
Sampler Location				Date	May 5, 2023
บ้านโคกอุดมดี (2022-01330)				Start Time	10:45 AM
Sampler Number	PM-10 No.26	Transfer Standard Type	Orifice	Stop Time	10:55 AM
Instrument Model	HIVOL-BMBBE	Calibrator Model	TE-5025A	Calibrated By	Mr.Anan Kongnguenok
Motor Serial Number	2211	Calibrator Serial Number	3883		
Recorder Serial Number	2610				

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 Indication	$IC = I[(Pa/P_{std})(T_{std}/Ta)]^{1/2}$	(°K = °C+273)	(mmHg)		
	Positive	Negative	ΔH_2O		(m ³ /min)	(ft ³ /min)					
5	1.3	1.3	2.6	1.57979	0.77414	28.0	27.43	308.0	754.0		
7	2.4	2.4	4.8	2.14651	1.04407	36.0	35.27	308.0	754.0		
10	3.3	3.4	6.7	2.53600	1.22959	43.0	42.13	308.0	754.0		
13	4.4	4.4	8.8	2.90638	1.40600	50.0	48.99	308.0	754.0		
18	5.4	5.4	10.8	3.21976	1.55526	55.0	53.89	308.0	754.0		
Linear Regression Y ON X : Y= mX + b								Average	308.0	754.0	

1	Slope (m)	2.09951	Linear Equation					r^2	0.996812	Pstd(mmHg)	760.0
2	Intercept (b)	-0.04553	Set Point Flow Rate (X) (m ³ /min)				1.133	r	0.9984047	T _{MTP}	298.0
3	Correlation Coefficient (r)	0.99992	Final Set Flow Rate = (I)				0	(Pa/Pstd)*(Tstd/Ta)		0.959894053	
Result								C=(Pa/Pstd)*(Tstd/Ta)^0.5		0.97974183	

COMMENT

Andersen Instruments, Inc.



Checked By

Prayun

(Mr. Prayun Detkla)
Technician



Approved By

Panupon

(Mr. Panupon Podang)
Environmental Scientist

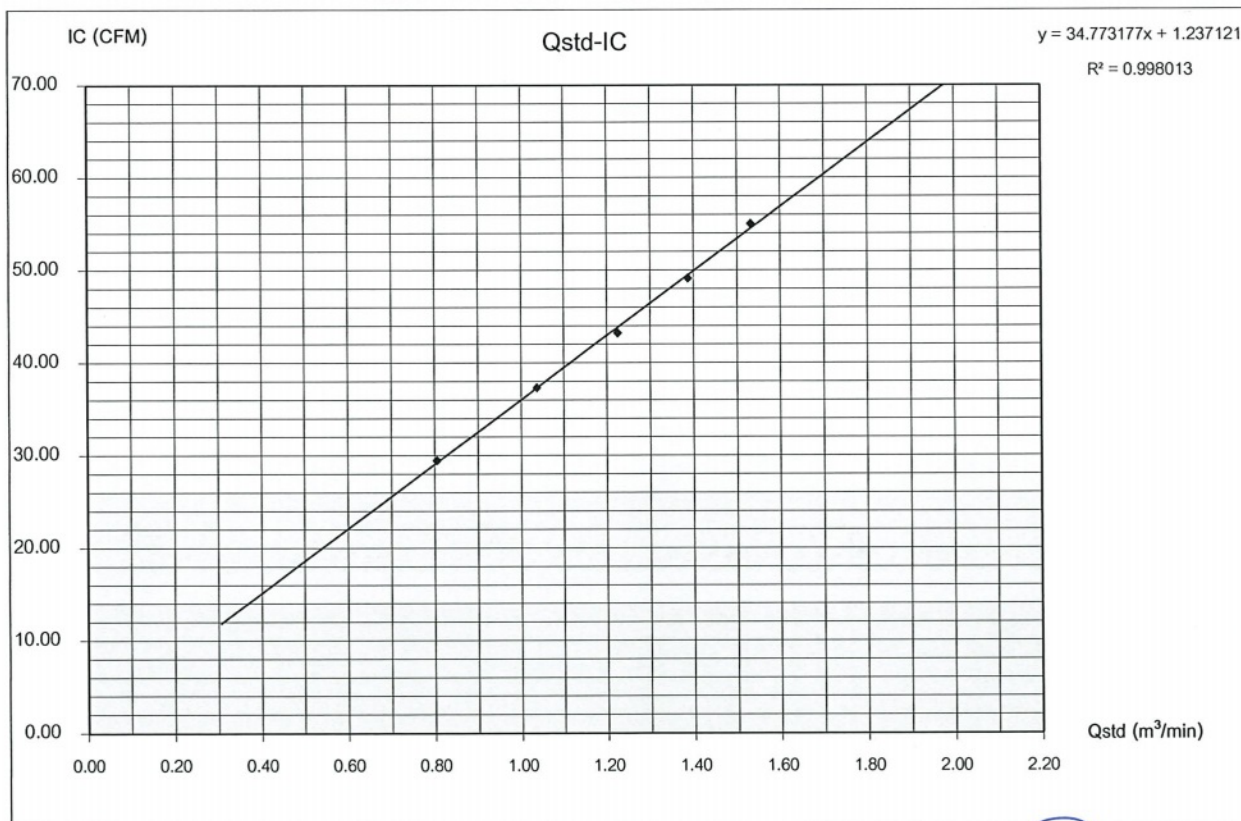
PM10 HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

Sampler Location				Date	May 5, 2023
บ้านคลองสมบูรณ์ (2022-01330)				Start Time	10:15 AM
Sampler Number	PM-10 No.5	Transfer Standard Type	Orifice	Stop Time	10:25 AM
Instrument Model	HIVOL-BMBBE	Calibrator Model	TE-5025A	Calibrated By	Mr.Anan Kongnguenok
Motor Serial Number	2015-5	Calibrator Serial Number	3883		
Recorder Serial Number	4654				

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)] (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	1.4	1.4	2.8	1.64477	0.80509	30.0	29.49	306.0	754.0		
7	2.4	2.3	4.7	2.13096	1.03667	38.0	37.35	306.0	754.0		
10	3.3	3.3	6.6	2.52521	1.22445	44.0	43.25	306.0	754.0		
13	4.3	4.2	8.5	2.86573	1.38664	50.0	49.15	306.0	754.0		
18	5.2	5.2	10.4	3.16988	1.53151	56.0	55.04	306.0	754.0		
Linear Regression Y ON X : Y= mX + b							Average	306.0	754.0		
1	Slope (m)			2.09951	Linear Equation			r ²	0.998013	Pstd(mmHg)	760.0
2	Intercept (b)			-0.04553	Set Point Flow Rate (X) (m ³ /min)		1.133	r	0.999006	T _{HTP}	298.0
3	Correlation Coefficient (r)			0.99992	Final Set Flow Rate = (I)		0	(Pa/Pstd)*(Tstd/Ta)		0.966167871	
Result								C=(Pa/Pstd)*(Tstd/Ta)^0.5		0.982938386	

COMMENT

Andersen Instruments, Inc.



Checked By

Prayun
(Mr. Prayun Detkla)
Technician

envi research
ENVIRONMENT RESEARCH & TECHNOLOGY CO., LTD.

Approved By

Pan pan
(Mr. Panupon Podang)
Environmental Scientist

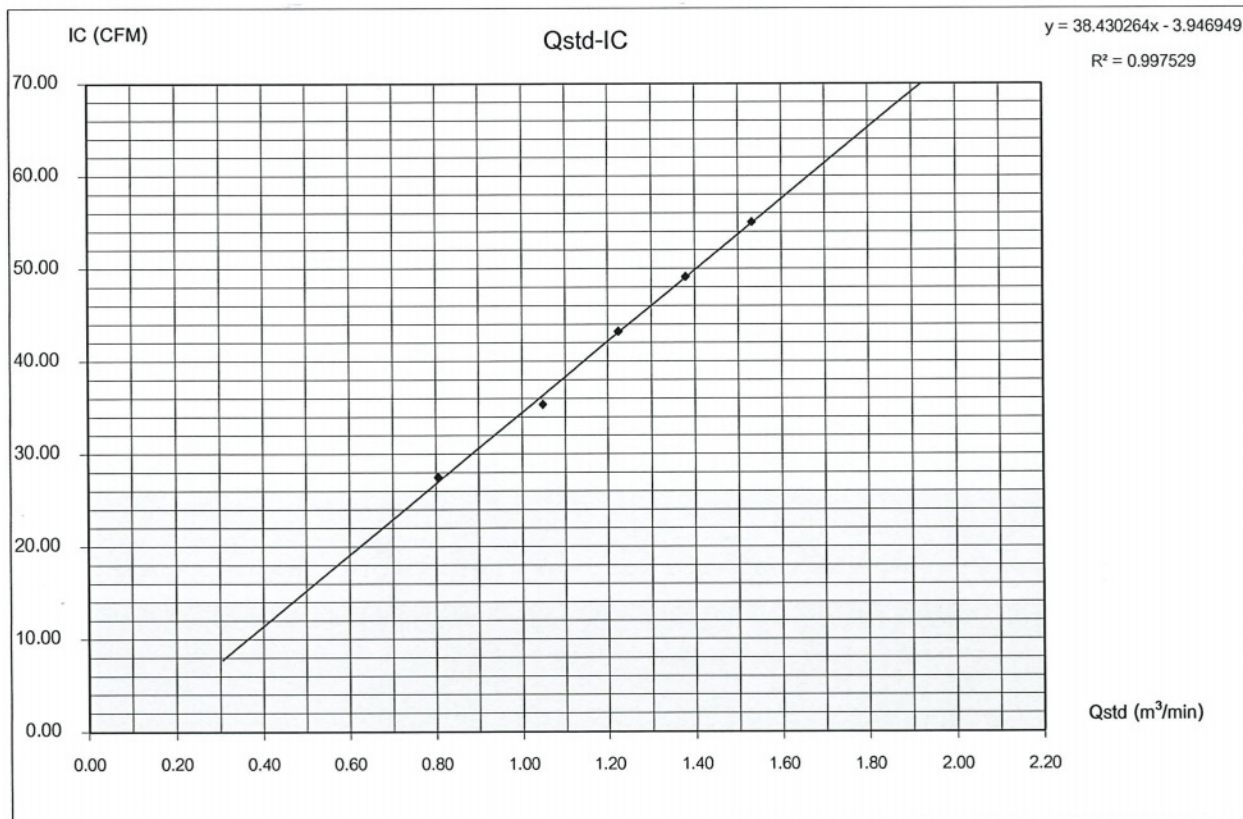
TSP HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

Sampler Location				Date	May 5, 2023
บ้านคลองสมบูรณ์ (2022-01330)				Start Time	10:05 AM
Sampler Number	TSP No.A8	Transfer Standard Type	Orifice	Stop Time	10:15 AM
Instrument Model	HIVOL-BBCBE	Calibrator Model	TE-5025A	Calibrated By	Mr.Anan Kongnguenok
Motor Serial Number	3680	Calibrator Serial Number	3883		
Recorder Serial Number	3767				

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)] (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	1.4	1.4	2.8	1.64477	0.80509	28.0	27.52	306.0	754.0		
7	2.4	2.4	4.8	2.15351	1.04741	36.0	35.39	306.0	754.0		
10	3.3	3.3	6.6	2.52521	1.22445	44.0	43.25	306.0	754.0		
13	4.2	4.2	8.4	2.84883	1.37859	50.0	49.15	306.0	754.0		
18	5.2	5.2	10.4	3.16988	1.53151	56.0	55.04	306.0	754.0		
Linear Regression Y ON X : Y= mX + b							Average	306.0	754.0		
1	Slope (m)			2.09951	Linear Equation			r ²	0.997529	Pstd(mmHg)	760.0
2	Intercept (b)			-0.04553	Set Point Flow Rate (X) (m ³ /min)		1.133	r	0.9987637	T _{NTP}	298.0
3	Correlation Coefficient (r)			0.99992	Final Set Flow Rate = (I)		0	(Pa/Pstd)*(Tstd/Ta)			0.966167871
Result								C=(Pa/Pstd)*(Tstd/Ta)^0.5			0.982938386

COMMENT

Andersen Instruments, Inc.



Checked By

Prayan
(Mr. Prayun Detkla)
Technician

envi research
ENVIRONMENT RESEARCH & TECHNOLOGY CO., LTD.

Approved By

Panpa
(Mr. Panupon Podang)
Environmental Scientist



Certificate of Calibration

Calibration Certification Information

Cal. Date: January 17, 2023 Rootsmeter S/N: 438320 Ta: 295 °K
 Operator: Jim Tisch Pa: 740.2 mm Hg
 Calibration Model #: TE-5025A Calibrator S/N: **3883**

Run	Vol. Init (m3)	Vol. Final (m3)	ΔVol. (m3)	ΔTime (min)	ΔP (mm Hg)	ΔH (in H2O)
1	1	2	1	1.4140	3.2	2.00
2	3	4	1	1.0110	6.4	4.00
3	5	6	1	0.9050	8.0	5.00
4	7	8	1	0.8620	8.8	5.50
5	9	10	1	0.7100	12.9	8.00

Data Tabulation

Vstd (m3)	Qstd (x-axis)	$\sqrt{\Delta H \left(\frac{Pa}{Pstd} \right) \left(\frac{Tstd}{Ta} \right)}$ (y-axis)	Va	Qa (x-axis)	$\sqrt{\Delta H \left(\frac{Ta}{Pa} \right)}$ (y-axis)
0.9795	0.6927	1.4027	0.9957	0.7042	0.8928
0.9753	0.9647	1.9837	0.9914	0.9806	1.2626
0.9732	1.0753	2.2179	0.9892	1.0930	1.4117
0.9721	1.1277	2.3261	0.9881	1.1463	1.4806
0.9666	1.3615	2.8054	0.9826	1.3839	1.7856
QSTD	m=	2.09951	QA	m=	1.31468
	b=	-0.04553		b=	-0.02898
	r=	0.99992		r=	0.99992

Calculations

Vstd=	$\Delta Vol((Pa-\Delta P)/Pstd)(Tstd/Ta)$	Va=	$\Delta Vol((Pa-\Delta P)/Pa)$
Qstd=	Vstd/ΔTime	Qa=	Va/ΔTime
For subsequent flow rate calculations:			
Qstd=	$1/m \left(\left(\sqrt{\Delta H \left(\frac{Pa}{Pstd} \right) \left(\frac{Tstd}{Ta} \right)} \right) - b \right)$	Qa=	$1/m \left(\left(\sqrt{\Delta H \left(\frac{Ta}{Pa} \right)} \right) - b \right)$

Standard Conditions

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

RECALIBRATION

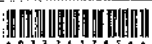
US EPA recommends annual recalibration per 1998
 40 Code of Federal Regulations Part 50 to 51,
 Appendix B to Part 50, Reference Method for the
 Determination of Suspended Particulate Matter in
 the Atmosphere, 9.2.17, page 30

Mettler-Toledo (Thailand) Ltd.
846/4 - 846/5 Lasalle Rd., Bangna Tai Sub-District
Bangna District, Bangkok 10260
+66 2723 0362
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: Laksa Contact: Ramita Taengthai
Zip / Postat: 10210
State / Province: Bangkok
Order Number:  0332417656

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
Rooms: 406

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

Procedure


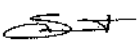
Calibration Guidelines: EURAMET cg-18 v. 4.0 (11/2015)
METTLER TOLEDO Work Instruction: CP/W002/20

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.

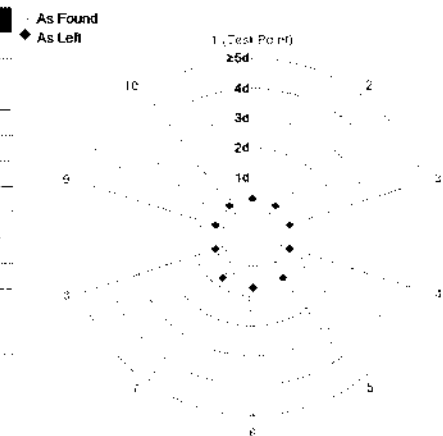
	Temperature		Humidity	
As Found	Start: 23.6 °C	End: 23.5 °C	Start: 34.6 %	End: 35.1 %
As Left	Start: 23.6 °C	End: 23.5 °C	Start: 35.0 %	End: 35.7 %

As Found Calibration Date: 17-Jan-2023 Calibration: 
As Left Calibration Date: 17-Jan-2023
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	99.9992 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

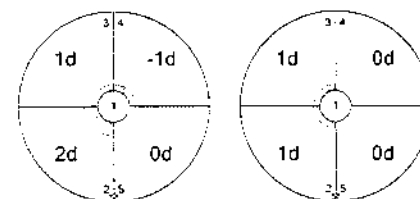


The "d" in the graph represents the readability of the range/interval in which the test was performed.

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



As Found

As Left

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

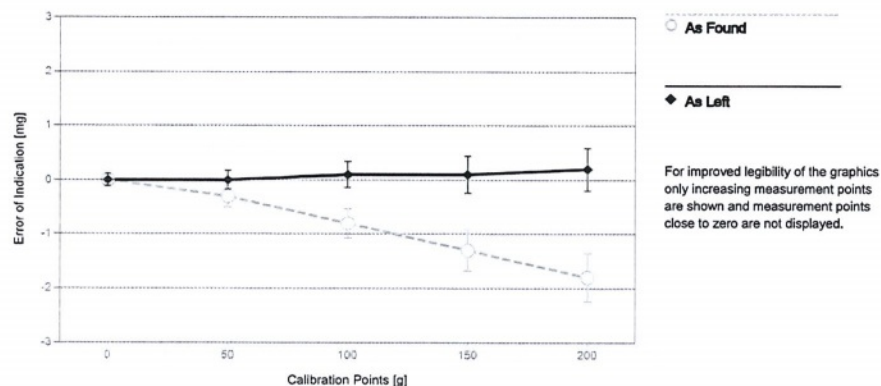
Error of Indication

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.: 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

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: $3 K$

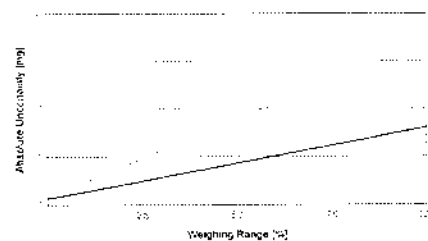
Linearization of Uncertainty Equation

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

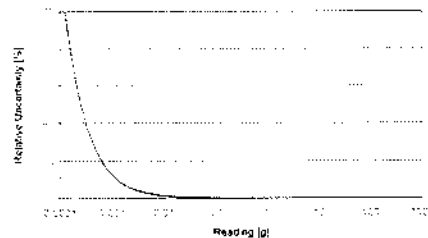
To optimize the stability of the linearization, besides of the zero load only increasing measurement points with a test load of 5% of the measurement range or larger are taken for the calculation of the linear equation.

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	0.0065%
22.0000 g	0.48 mg	0.0022%	0.28 mg	0.0013%
220.0000 g	3.4 mg	0.0015%	1.5 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

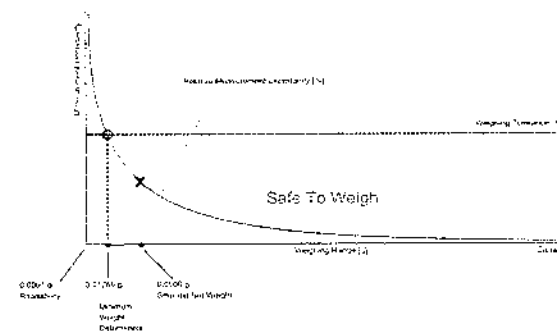
Process Requirements

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

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	-0.0003 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

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	0.0000 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

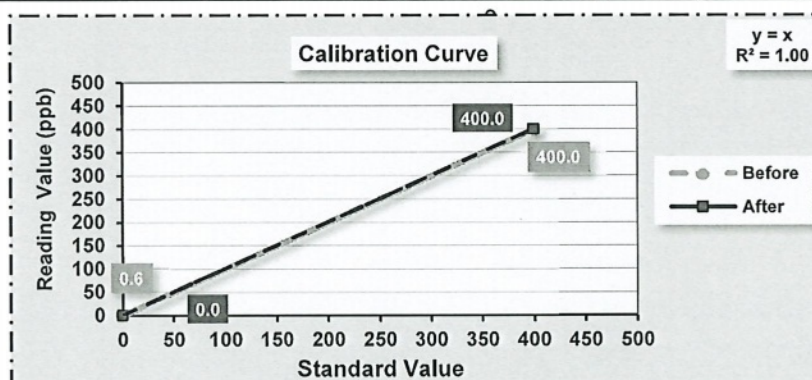
Equipment	Gas Analyzer (SO ₂)	Customer Name	โพธิ์เกียรติ์ คอนซัลแตนต์
Manufacture	Thermo	Location	Envi Research
Model	43i-BNSAA	Quotation	2022-01330
Serial No.	CM14430004	Calibration Date	May 2, 2023
Analyzer Unit	ppb	Time	1:20 PM

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	0.6	0.0	-	-	-
Span	400	400.0	400.0	-	-	0.0



STATUS TEST AND VALIDATION OF SO₂ ANALYZER MODEL 43i-BNSAA

Parameter	Display As	Unit	Observed Value		Nominal Range
			Before Adjust	After Adjust	
Range	RANGE	ppb	500	500	0 - 500 standard
Internal Temperature	INTERNAL	°C	36.7	36.0	8.0 °C to 45.0 °C
Chamber Temp	CHAMBER	°C	45.1	45.2	43.0 °C to 47.0 °C
Pressure	PRESSURE	mmHg	732	731.4	400.0 to 1,000
Sample Flow	SAMP FLOW	LPM	0.453	0.453	0.350 to 0.750
Lamp Intensity	LAMP INTENSITY	%	92	92	20 to 100
Lamp Voltage	LAMP VOLTAGE	V	1073	1073	500 to 1200
SO ₂ Concentration	SO ₂ CONCENTRATION	ppb	3.1	2.1	0 to 10,000
Motherboard Status	MOTHERBOARD STATUS	-	OK	OK	OK
Interface Status	INTERFACE STATUS	-	OK	OK	OK

Calibrate By :

(MR.PANUPON PODANG)
May 2, 2023

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

(MS.SUTATIP IM-NOI)
May 2, 2023

Calibration Data of SO₂ Analyzer

Analyzer Performance Test

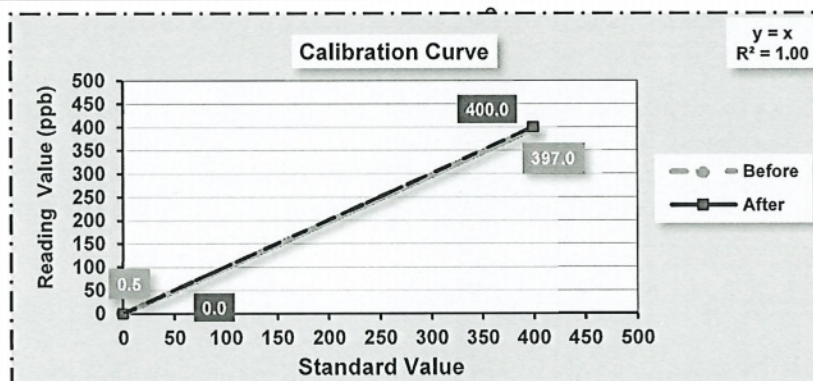
Equipment	Gas Analyzer (SO ₂)	Customer Name	โพธิ์เกียรติ์ คอนซัลแตนต์
Manufacture	Thermo	Location	Envi Research
Model	43i-BNSAA	Quotation	2022-01330
Serial No.	CM14430005	Calibration Date	May 3, 2023
Analyzer Unit	ppb	Time	10:18 AM

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	0.5	0.0	-	-	-
Span	400	397.0	400.0	-	-	0.8



STATUS TEST AND VALIDATION OF SO₂ ANALYZER MODEL 43i-BNSAA

Parameter	Display As	Unit	Observed Value		Nominal Range
			Before Adjust	After Adjust	
Range	RANGE	ppb	500	500	0 - 500 standard
Internal Temperature	INTERNAL	°C	34.1	34.5	8.0 °C to 45.0 °C
Chamber Temp	CHAMBER	°C	45.1	44.5	43.0 °C to 47.0 °C
Pressure	PRESSURE	mmHg	699.5	698.6	400.0 to 1,000
Sample Flow	SAMP FLOW	LPM	0.511	0.511	0.350 to 0.750
Lamp Intensity	LAMP INTENSITY	%	74	74	20 to 100
Lamp Voltage	LAMP VOLTAGE	V	983	988	500 to 1200
SO ₂ Concentration	SO ₂ CONCENTRATION	ppb	3.7	1.4	0 to 10,000
Motherboard Status	MOTHERBOARD STATUS	-	OK	OK	OK
Interface Status	INTERFACE STATUS	-	OK	OK	OK

Calibrate By :

Panpun
(MR.PANUPON PODANG)
May 3, 2023

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

Sutap
(MS.SUTATIP IM-NOI)
May 3, 2023

Calibration Data of NOx Analyzer

Analyzer Performance Test

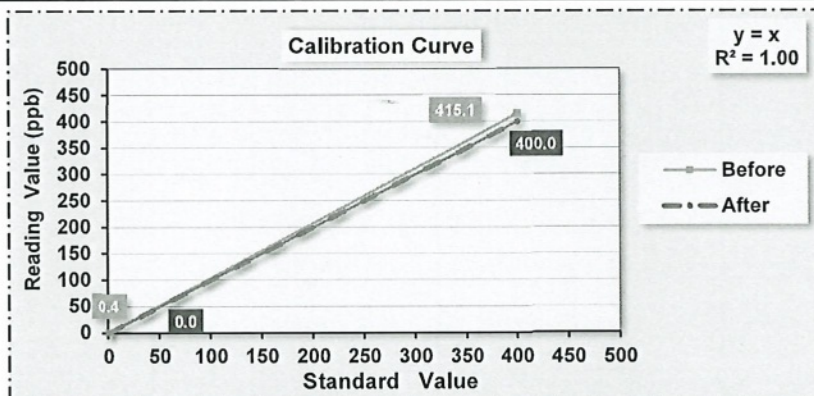
Equipment	Gas Analyzer (NOx)	Customer Name	โพธิ์เพียร คอนซัลแตนต์
Manufacture	HORIBA	Location	Envi Research
Model	APNA-360	Quotation	2022-01330
Serial No.	EYC70000	Calibration Date	April 5, 2023
Analyzer Unit	ppm	Time	1:34 PM

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								% Abs Error
		NO _x (ppb)		NO (ppb)		NO ₂ (ppb)		Stability		
		Before	After	Before	After	Before	After	Before	After	
Zero	0	0.3	0.0	0.4	0.0	-0.1	0.0	-	-	-
Span	400	415.0	400.0	415.1	400.0	-0.1	0.0	-	-	3.8



STATUS TEST AND VALIDATION OF NOx ANALYZER MODEL APNA-360

Parameter	Unit	Observed Value		Nominal Range
		Before Adjust	After Adjust	
Range	ppm	0.5	0.5	0.1 - 1.0 Standard
Signal NO	mV	4.0	2.4	Voltage of the measured NO value
Signal NOx	mV	9.8	4.4	Voltage of the measured NOx value
Detector	kPa	86.6	86.4	(Present Air Pressure/101.3 x100 - 20) ± 4
Sample Flow	LPM	0.7	0.7	1.1 ± 0.3
NO Slope	-	1.19410	1.09710	0.50000 - 2.0000
NOx Slope	-	1.09620	1.00888	0.50000 - 2.0000
Motherboard Status	-	OK	OK	OK
Alarm Detected	-	None	None	None

Calibrate By :

(MR.PANUPON PODANG)

April 5, 2023



Checked By :

(MS.SUTATIP IM-NOI)

April 5, 2023

Calibration Data of NOx Analyzer

Analyzer Performance Test

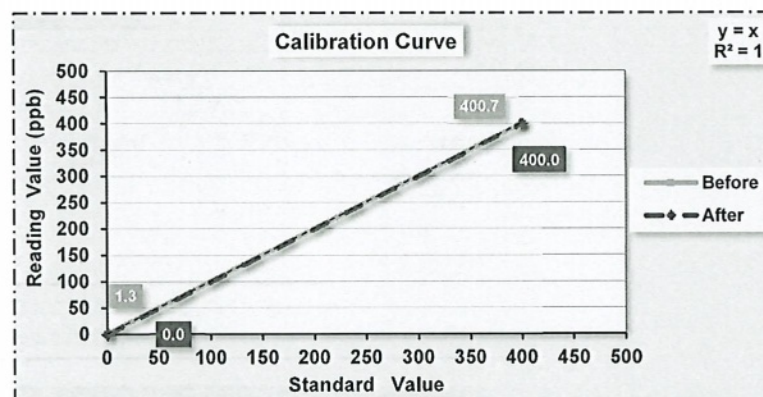
Equipment	Gas Analyzer (NOx)	Customer Name	โพธิ์เพียร คอนซัลแตนต์
Manufacture	HORIBA	Location	Envi Research
Model	APNA-370	Quotation	2022-01330
Serial No.	FC2E28YU	Calibration Date	May 3, 2023
Analyzer Unit	ppb	Time	1:44 PM

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	0.9	0.0	1.3	0.0	-0.4	0.0	-	-	-
Span	400	400.4	400.0	400.7	400.0	-0.3	0.0	-	-	0.2



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	2.0	Voltage of the measured NO value
Signal NOx	mV	7.4	7.9	Voltage of the measured NOx value
Detector	°C	41.8	41.9	43 °C ± 5 °C
Ambient	kPa	100.2	100.0	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	-	1.20190	1.19850	0.50000 - 2.00000
NOx Slope	-	1.16540	1.16820	0.50000 - 2.00000

Calibrate By :

(MR.PANUPON PODANG)
May 3, 2023

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

(MS.SUTATIP IM-NOI)
May 3, 2023

Calibration Data of NOx Analyzer

Analyzer Performance Test

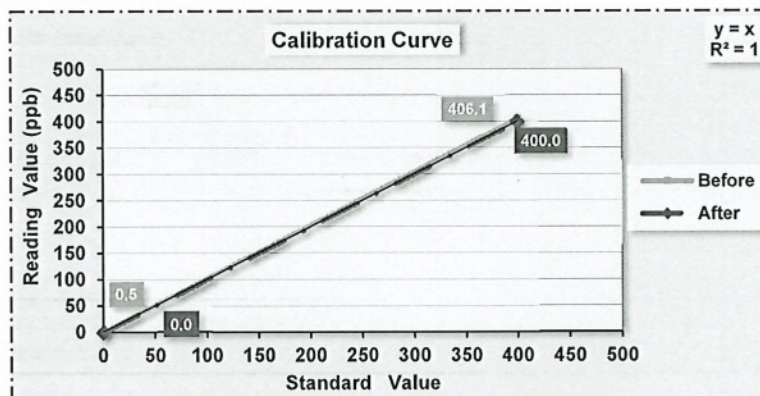
Equipment	Gas Analyzer (NOx)	Customer Name	โพธิ์เพชร คอนซัลแตนต์
Manufacture	HORIBA	Location	Envi Research
Model	APNA-370	Quotation	2022-01330
Serial No.	J6GUBA4N	Calibration Date	May 2, 2023
Analyzer Unit	ppb	Time	10:58 AM

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								% Abs Error
		NO _x (ppb)		NO (ppb)		NO ₂ (ppb)		Stability		
		Before	After	Before	After	Before	After	Before	After	
Zero	0	5.8	0.0	0.5	0.0	5.3	0.0	-	-	-
Span	400	400.9	400.0	406.1	400.0	-5.2	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	1.1	1.1	Voltage of the measured NO value
Signal NOx	mV	23.0	16.3	Voltage of the measured NOx value
Detector	°C	42.4	42.5	43 °C ± 5 °C
Ambient	kPa	101.6	101.6	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	-	0.96061	0.84006	0.50000 - 2.0000
NOx Slope	-	0.87643	0.88002	0.50000 - 2.0000

Calibrate By :

Panpon
(MR.PANUPON PODANG)
May 2, 2023

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

Sutap
(MS.SUTATIP IM-NOI)
May 2, 2023

Calibration Data of NOx Analyzer

Analyzer Performance Test

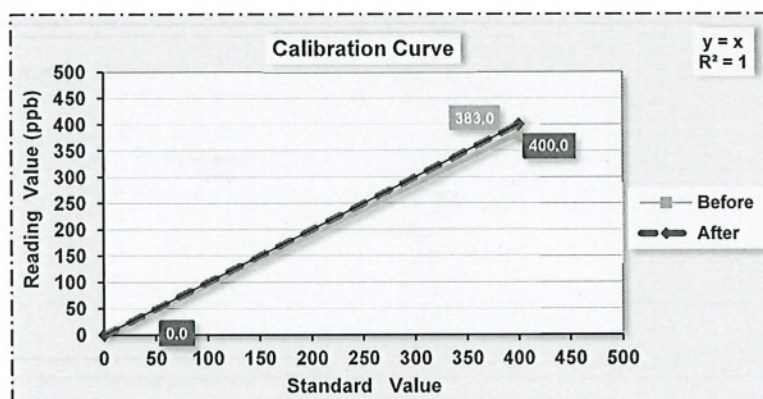
Equipment	Gas Analyzer (NOx)	Customer Name	โพธิ์เพชร คอนซัลแตนต์
Manufacture	HORIBA	Location	Envi Research
Model	APNA-370	Quotation	2022-01330
Serial No.	PA6VVAJ9	Calibration Date	May 2, 2023
Analyzer Unit	ppb	Time	11:13 AM

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								% Abs Error
		NO _x (ppb)		NO (ppb)		NO ₂ (ppb)		Stability		
		Before	After	Before	After	Before	After	Before	After	
Zero	0	-3.7	0.0	-0.6	0.0	-3.1	0.0	-	-	-
Span	400	381.5	400.0	383.0	400.0	-1.5	0.0	-	-	4.3



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	0.9	1.1	Voltage of the measured NO value
Signal NOx	mV	17.9	14.4	Voltage of the measured NOx value
Detector	°C	41.1	41.9	43 °C ± 5 °C
Ambient	kPa	100.4	100.3	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	-	1.00170	1.04480	0.50000 - 2.0000
NOx Slope	-	0.98810	1.09840	0.50000 - 2.0000

Calibrate By :

Panpon
(MR.PANUPON PODANG)
May 2, 2023

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

Sutap
(MS.SUTATIP IM-NOI)
May 2, 2023

Calibration Data of SO₂ Analyzer

Analyzer Performance Test

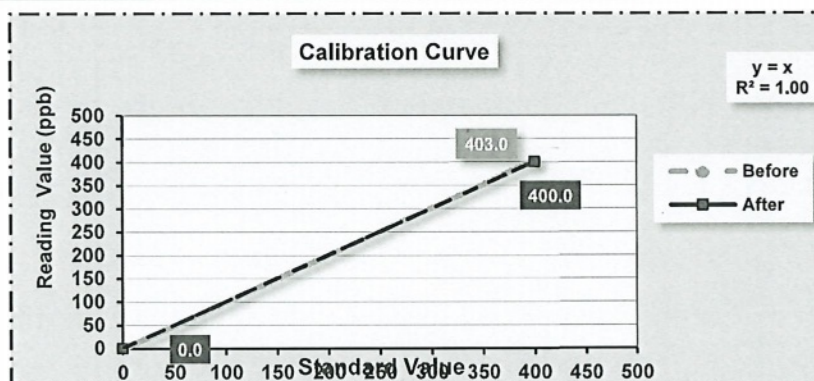
Equipment	Gas Analyzer (SO ₂)	Customer Name	โพธิ์เกียรติ์ คอนซัลแตนต์
Manufacture	Thermo	Location	Envi Research
Model	43i-BNSAA	Quotation	2022-01330
Serial No.	CM14430001	Calibration Date	May 3, 2023
Analyzer Unit	ppb	Time	10:17 AM

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	-0.2	0.0	-	-	-
Span	400	403.0	400.0	-	-	0.8



STATUS TEST AND VALIDATION OF SO₂ ANALYZER MODEL 43i-BNSAA

Parameter	Display As	Unit	Observed Value		Nominal Range
			Before Adjust	After Adjust	
Range	RANGE	ppb	500	500	0 - 500 standard
Internal Temperature	INTERNAL	°C	35.8	36.0	8.0 °C to 45.0 °C
Chamber Temp	CHAMBER	°C	44.8	45.2	43.0 °C to 47.0 °C
Pressure	PRESSURE	mmHg	734.8	733.6	400.0 to 1,000
Sample Flow	SAMP FLOW	LPM	0.552	0.551	0.350 to 0.750
Lamp Intensity	LAMP INTENSITY	%	87	88	20 to 100
Lamp Voltage	LAMP VOLTAGE	V	900	904	500 to 1200
SO ₂ Concentration	SO ₂ CONCENTRATION	ppb	2.4	1	0 to 10,000
Motherboard Status	MOTHERBOARD STATUS	-	OK	OK	OK
Interface Status	INTERFACE STATUS	-	OK	OK	OK

Calibrate By :

(MR.PANUPON PODANG)
May 3, 2023

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

(MS.SUTATIP IM-NOI)
May 3, 2023

Calibration Data of SO₂ Analyzer

Analyzer Performance Test

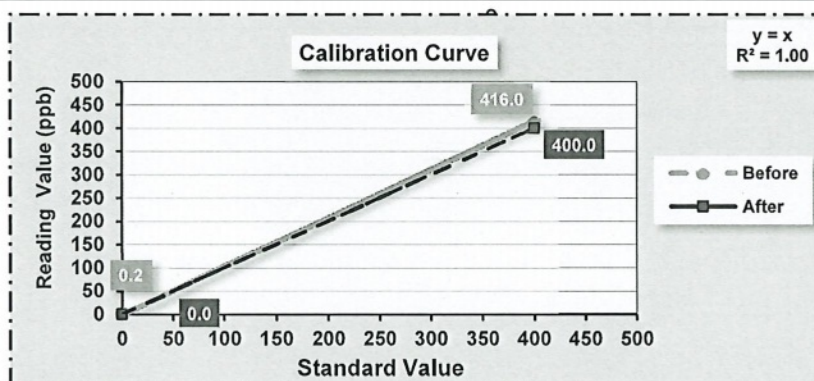
Equipment	Gas Analyzer (SO ₂)	Customer Name	โพธิ์เทียมร์ คอนซัลแตนต์
Manufacture	Thermo	Location	Envi Research
Model	43i-BNSAA	Quotation	2022-01330
Serial No.	CM14430003	Calibration Date	May 3, 2023
Analyzer Unit	ppb	Time	10:25 AM

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	0.2	0.0	-	-	-
Span	400	416.0	400.0	-	-	4.0



STATUS TEST AND VALIDATION OF SO₂ ANALYZER MODEL 43i-BNSAA

Parameter	Display As	Unit	Observed Value		Nominal Range
			Before Adjust	After Adjust	
Range	RANGE	ppb	500	500	0 - 500 standard
Internal Temperature	INTERNAL	°C	34.1	34.9	8.0 °C to 45.0 °C
Chamber Temp	CHAMBER	°C	45.2	45.2	43.0 °C to 47.0 °C
Pressure	PRESSURE	mmHg	704.6	708.5	400.0 to 1,000
Sample Flow	SAMP FLOW	LPM	0.5	0.479	0.350 to 0.750
Lamp Intensity	LAMP INTENSITY	%	95	95	20 to 100
Lamp Voltage	LAMP VOLTAGE	V	945	946	500 to 1200
SO ₂ Concentration	SO ₂ CONCENTRATION	ppb	2.5	1.9	0 to 10,000
Motherboard Status	MOTHERBOARD STATUS	-	OK	OK	OK
Interface Status	INTERFACE STATUS	-	OK	OK	OK

Calibrate By :

(MR.PANUPON PODANG)
May 3, 2023

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

(MS.SUTATIP IM-NOI)
May 3, 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 10 August, 2022

Certification No. 288/22

Page : 1 of 2

Object : Wind speed and wind direction

Manufacturer : Davis Instruments Inc.

Type : Weather Wizard III Product No. 7425

Serial No. : WC40801A97 ID No. : No.16

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

Calibration Condition : Temperature 25.1 °C Barometric Pressure 1005.2 hPa

NATIONAL STANDARD WIND TUNNEL :

: Micromanometer Theodor Friedrichs FC014 Serial No. 9310119

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

N.I.S.T. Test Reference Number 731/241450 : Standard Velocity at 20 - 30 m/sec

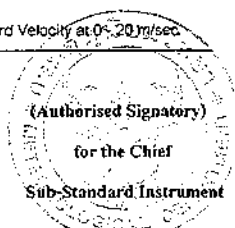
: Ultrasonic Anemometer Model DA-650-3TV (sensor TR-90AH)

Serial Number 110730029 (sensor 120629586)

JAPAN QUALITY ASSURANCE ORGANIZATION : Standard Velocity at 0 - 20 m/sec.

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

Signed: *P. P.*
Mr. Pisob Promsut



THAI METEOROLOGICAL DEPARTMENT

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

The Result of Calibration

Certification No. 288/22

10 August, 2022

Page : 2 of 2

Standard Ultrasonic Anemometer	HOOK GAGE NO. 1425			TESTED ANEMOMETER	
	Pressure m/sec	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	-	-	-	8.5	0.52
11.01	-	-	-	10.7	0.31
13.01	-	-	-	13.0	0.01
15.01	-	-	-	14.8	0.21
17.02	-	-	-	17.0	0.02
20.02	-	-	-	19.7	0.32

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

Calibrated by :

Watchapol

Mr. Watchapol Subwat
Mechanical Engineer

Calibration & Test Section
Meteorological Instruments Bureau





THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-65/0605

MTC No. EEL. BP. 99/0665

CALIBRATION CERTIFICATE

Submitted by : Environment Research & Technology Co., Ltd.
Address : 25/114 Moo 6, Soi Chinakiet 1, Ngamwongwan Rd., 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 : Precision Acoustic Calibrator
 Manufacturer : Larson Davis
 Model : CAL200
 Serial No. : 5652

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 Bruel&Kjaer 4180 S/N 2633526.

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

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

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

Date of Receipt : 29 Jun. 2022

Date of Calibration : 5 Jul. 2022

1/3

Signature

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 : numpai@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



THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-65/0605

MTC No. EEL. BP. 99/0665

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

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

Acoustic Output in dB re 20 μPa , Corrected to Reference Conditions: 101.325 kPa, 23.0 $^\circ\text{C}$ and 50 %RH.

1. Sound Pressure Level

Standard Microphone Type	Measured Sound Pressure Level (dB)	Deviated value (dB)	Uncertainty (dB)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer4180	93.51	-0.49	± 0.10	$\pm 0.40 \text{ dB}$

2. Frequency

Standard Microphone Type	Measured Frequency (Hz)	Deviated value (Hz)	Uncertainty (Hz)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer4180	1000.0	0.0	± 1.5	$\pm 1.0 \%$

3. Total distortion

Standard Microphone Type	Measured Total distortion (%)	Uncertainty (%)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer4180	1.21	± 0.50	$\pm 3.0 \%$

Note : 1. No adjustment.

2. The calibrator pressure correction was not included.

3. The microphone volume correction was included at the level of 0.26 dB from manual.

Date of Calibration : 5 Jul. 2022

2/3

Signature

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 : numpai@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



THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-65/0605

MTC No. EEL. BP. 99/0665

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

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

1. Sound Pressure Level

Standard Microphone Type	Measured Sound Pressure Level (dB)	Deviated value (dB)	Uncertainty (dB)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer 4180	113.52	-0.48	± 0.10	± 0.40 dB

2. Frequency

Standard Microphone Type	Measured Frequency (Hz)	Deviated value (Hz)	Uncertainty (Hz)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer 4180	1000.0	0.0	± 1.5	± 1.0 %

3. Total Distortion

Standard Microphone Type	Measured Total Distortion (%)	Uncertainty (%)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer 4180	0.41	± 0.50	± 3.0 %

Note : 1. No adjustment.

2. The calibrator pressure correction was not included.

3. The microphone volume correction was included at the level of 0.26 dB from manual.

Calibrated by :

(Mr. Nuttapong Niljrusvanit)

(Mr. Tawikiat Iamsamran)

Approved by :

(Mr. Prawate Klauaypa)
Director

Electrical and Electronic Standards Laboratory

Industrial Metrology and Testing Service Centre

Date of Calibration : 5 Jul. 2022

Date of Issue : 6 Jul. 2022

Ref : 2011265062902932004

3 / 3

End of Certificate

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

Advertising the Report/Certificate and publicity of the results except in full are prohibited unless written permission is obtained from the governor of TISTR.

FM.BL.MTC.002 Rev.4

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

Graph showing Meter Gamma (Y) versus Flowrate Standardized & Corrected (m^3/min) for 100% humidity. The Y-axis ranges from 0.970 to 1.025. The X-axis ranges from 0.000 to 0.040. The data points for Gamma Y are plotted, showing a linear relationship. The Max Allow Y and Min Allow Y are indicated by horizontal dashed lines.

Flowrate Standardized & Corrected (m^3/min)	Meter Gamma (Y)
0.011	0.973
0.016	0.975
0.023	0.977
0.030	0.985
0.036	0.988

บริษัท อี. บี. ซี. จำกัด
E. B. C. COMPANY LIMITED

Console Model: XC-572-V

SITHIPARN Environmental Hygiene Products Division (EHD) <small>Web site: www.sithiparn.com • E-Mail: sithiparn@ethiopian.com</small>						METHOD 5 PRE-TEST CONSOLE CALIBRATION USING REFERENCE METER # WET TEST METER W-NKSA No. 540961 5-POINT METRIC UNIT		Preventive Maintenance & Check	
Meter Console Information									
Console Model Number		XC-572-V							
Console Serial Number		1602011							
DGM Model Number		SK2SEX							
DGM Serial Number		0006265							
Calibration Conditions									
Date	Time	21-Jul-22		9:00 AM					
Calibration Reference No.		3APE650010							
Barometric Pressure		756		mm Hg					
Calibration Meter Gamma		0.9980		unitless					
Factors/Conversions									
Std Temp		298		K					
Std Press		760		mm Hg					
K _f		0.392							
Run Time									
		Motoring Console				Calibration Meter			
Elapsed Time	DGM Orifice ΔH	Volume Initial	Volume Final	Outlet Temp Initial	Outlet Temp Final	Volume Initial	Volume Final	Outlet Temp Initial	Outlet Temp Final
(t _B)	(P _m)	(V _i)	(V _f)	(T _w)	(T _w)	(V _w)	(V _w)	(T _w)	(T _w)
min	mm H ₂ O	m ³	m ³	°C	°C	m ³	m ³	°C	°C
15.00	13.0	421.0715	421.2445	25	25	298.71711	298.88807	25	25
10.00	25.0	421.2899	421.4557	26	27	298.92765	299.08914	25	25
8.00	50.0	421.5005	421.6953	27	27	299.13177	299.32212	25	25
7.00	80.0	421.7161	421.9296	27	28	299.34277	299.55343	25	25
5.00	120.0	421.9538	422.1391	28	29	299.57750	299.76100	25	25
Results									
Standardized Data				Dry Gas Meter					
Dry Gas Meter		Calibration Meter		Calibration Factor		Flowrate		ΔH @	
(V _{drygas})	(Q _{v,drygas})	(V _{v,calib})	(Q _{v,calib})	Value	Variation	Std & Corr	0.0212 m ³ /min	Variation	
(m ³)	m ³ /min	m ³	m ³ /min	(Y)	(ΔY)	(Q _{v,calibcorr})	(ΔH _g)	(ΔΔH _g)	
						m ³ /min	mm H ₂ O		
0.172	0.011	0.168	0.011	0.973	-0.006	0.011	47.571	4.385	
0.184	0.016	0.160	0.016	0.975	-0.005	0.016	44.388	1.203	
0.193	0.024	0.189	0.024	0.977	-0.003	0.024	41.025	-2.161	
0.212	0.030	0.209	0.030	0.985	0.006	0.030	41.202	-1.983	
0.164	0.037	0.182	0.036	0.988	0.009	0.035	41.740	-1.445	
				0.980	Y Average		43.185	ΔH _g Average	
Note: For Calibration Factor Y, the ratio of the reading of the calibration meter to the dry gas meter, acceptable tolerance of individual values from the average is +0.02.									
Note: For ΔH _g , orifice pressure differential that equates to 0.75cfm (0.0212m ³ /min) at standard temperature and pressure, acceptable tolerance of individual values from the average is ±0.2inches (5.1mm) H ₂ O.									
Signature _____ (Surachal Chaisana) Senior Engineer				Date <u>21/7/2022</u>					

THERMOCOUPLES SYSTEM CALIBRATION

Sampling System Equipment Information	
Console Model Number	XC-572-V
Console Serial Number	1602011
DGM Model Number	SK25EX
DGM Serial Number	0006265
Meter Box Model Number	JENCO 765
Meter Box Serial Number	JC15496

Calibration Conditions			
Date	Time	21-Jul-22	11:00 AM
Calibration Reference No.	3APE650010		
Barometric Pressure	756	mm Hg	
Reference Thermometer	FLUKE 714		
Serial Number	9038005		

Results											
Console Thermocouple Simulator											
Channel and test point	Meter Box Channel Temperature Reading (°C)										
	-18.0	25.0	38.0	93.0	149.0	260.0	371.0	482.0	593.0	816.0	1038.0
Stack	-18	25	37	94	148	259	370	480	592	815	1037
Filter	-18	25	37	94	148						
Probe	-18	25	37	94	148						
Aux	-18	25	37	94	148						
Exit	-18	25	37								

Tolerance Range

Stack ± 1.50% Absolute
Probe ± 3.0 °C
Filter ± 3.0 °C

Aux ± 3.0 °C
Exit ± 2.0 °C

Signature Surachai Chaisana
(Surachai Chaisana)
Service Engineer

บริษัท สิทธีพร แอสโซซิเอต จำกัด
SITHIPHORN ASSOCIATES COMPANY LIMITED

บริษัท สิทธีพร แอสโซซิเอต จำกัด

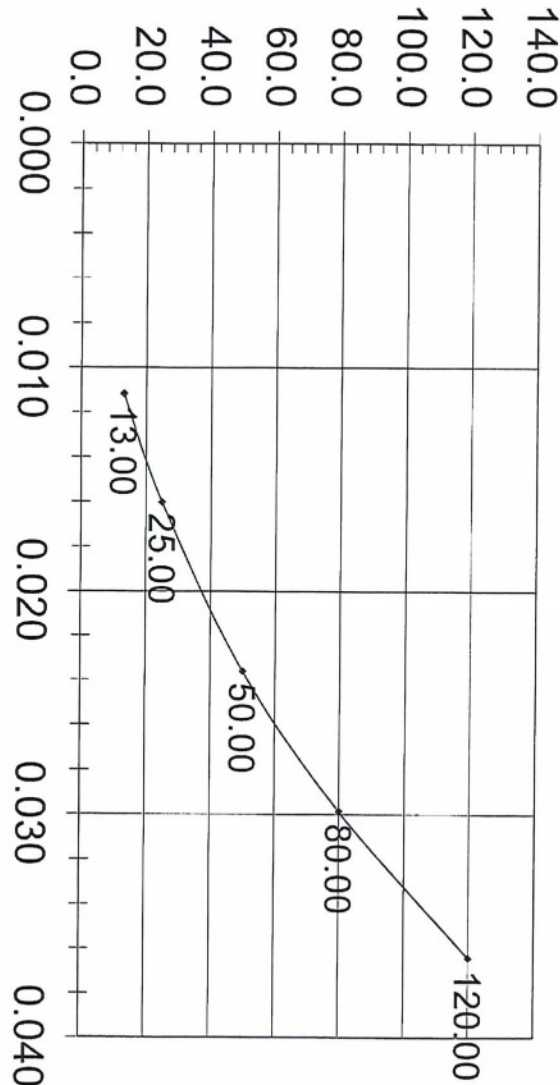
Sithiphorn Associates Co., Ltd.

451-451/1 ถนนสีรินธร แขวงบางนาพรุ เขตบางนา กรุงเทพมหานคร 10700 โทร. 0-2433-8331, 0-2435-8800, 0-2434-9191 แฟกซ์: 0-2433-1679, 0-2434-9510

451-451/1 Sirinthorn Road, Bangbunru, Bangplud, Bangkok 10700 Thailand Tel. (662) 433-8331, 435-8800, 434-9191 Fax: (662) 433-1679, 434-9510

EMAIL: center@sithiphorn.com www.sithiphorn.com

DGM Orifice ΔH (mm H2O)



Meter Pressure vs Flowrate

Calibration Date: 7-21-2022

Calibration Reference No: 3APE650010

Console Serial:

1602011


บริษัท สิทธีพร แอสโซซิเอต จำกัด
SITHIPHORN ASSOCIATES COMPANY LIMITED

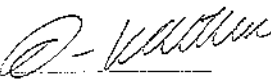
Console Model:

XC-572-V

Instrument description : Flue gas Analyzer
Instrument model : Testo 350 NEW
Instrument serial no. : 60534802
ID no. or control no. : -
Manufacturer : Testo SE & Co. KGaA
Probe description : -
Probe model : -
Probe serial : -
Customer name : Environment Research & Technology Co., Ltd.
Customer address : 25/114 Moo 6, Soi Chinnakhet 1, Ngamwongwan Rd., Toongsonghong, Laksi, Bangkok 10210 Thailand
Total pages of certificate : 2 Pages
Receiving no. : L-222474
Receiving date. : 18-Jul-22
Parameter of calibration : Gas Calibration(Oxygen 2.498,10.00,21.00 %vol, Carbon Monoxide 80.97,309.9,1003 ppm, Nitrogen Dioxide 80.62 ppm, Nitric Oxide 150.9 ppm, Sulphur Dioxide 100.9 ppm)
Condition of UUC. : Used
Ambient condition : All of the Measurement were carried out the stabilized laboratory
Temperature : 23 ± 5 °C
Humidity : 55 ± 15 %RH
Calibration place : 17/121 Soi Ngamwongwan 47 Yaek 48, Toongsonghong, Laksi, Bangkok 10210
Calibration procedure no. : WI-CL-28-C

The calibration certificate expanded uncertainty of measurement is stated as the standard uncertainty of measurement
Multiplied by coverage factor $k=2$, which for a normal distribution corresponds to a coverage probability of approximately 95%.
This certificate is applied only to item under test Environmental condition.
This Calibration Certificate may not be reproduced other than in full except with the permission of the issuing laboratory.
Calibration certificates without signature and seal not valid.
This calibration certificate documents are traceability to national standards, which realize measurement according to the International System of Units (SI).
Date of calibration : 20-Jul-22


Mr. Sedawut Nueathong
Calibration Technician


Mrs. Nongluck Wongsettee
Technical Manager

Standard References (Table 1)

Standard	Certificate No.	Vendor	Due date
Oxygen (O ₂) 2.498 % Vol	4219/21	Linde	30-Sep-25
Oxygen (O ₂) 10.00 % Vol	2453/19	Linde	18-Jul-23
Oxygen (O ₂) 21.00 % Vol	2426/19	Linde	16-Jul-23
Carbon monoxide (CO) 80.97 ppm	2842/21	Linde	24-Jun-23
Carbon monoxide (CO) 309.9 ppm	2803/21	Linde	22-Jun-23
Carbon monoxide (CO) 1003 ppm	2829/21	Linde	23-Apr-23
Nitrogen Dioxide (NO ₂) 80.62 ppm	3240/21	Linde	25-Jul-23
Nitric Oxide (NO) 150.9 ppm	2857/21	Linde	27-Jun-23
Sulphur Dioxide (SO ₂) 100.9 ppm	4942/20	Linde	20-Nov-22

Measured room conditions

Temperature : 22.5 °C Humidity : 57.5 %RH Pressure : 1016.6 mbar

Calibration conditions

Gas Temperature : 23 °C Flow rate : 1,200 ml/min Gas pressure : 1024.3 mbar

Calibration Results Before Adjustment (Table 2)

Parameter of Standard	Standard Values	Mean of UUC	Error	Uncertainty (±)
O ₂ (%Vol)	2.498	2.51	0.012	0.20
O ₂ (%Vol)	10.00	9.86	-0.14	0.40
O ₂ (%Vol)	21.00	21.09	0.09	0.80
CO (ppm)	80.97	79	-1.97	3.0
CO (ppm)	309.9	308	-1.9	6.0
CO (ppm)	1003	1004	1	12
*NO ₂ (ppm)	80.62	75.6	-5.02	8.0
*NO (ppm)	150.9	151	0.1	8.0
*SO ₂ (ppm)	100.9	96	-4.9	6.0

Calibration Results After Adjustment (Table 3)

Parameter of Standard	Standard Values	Mean of UUC	Error	Uncertainty (±)
O ₂ (%Vol)	2.498	2.51	0.012	0.20
O ₂ (%Vol)	10.00	9.86	-0.14	0.40
O ₂ (%Vol)	21.00	21.09	0.09	0.80
CO (ppm)	80.97	79	-1.97	3.0
CO (ppm)	309.9	308	-1.9	6.0
CO (ppm)	1003	1004	1	12
*NO ₂ (ppm)	80.62	81.6	0.98	8.0
*NO (ppm)	150.9	151	0.1	8.0
*SO ₂ (ppm)	100.9	96	-4.9	6.0

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

* Calibrations marked Not TISI Accredited "in this Certificate have been included for completeness."

End of Report



Certificate of Calibration

Page 1 of 2 Pages

Certificate Number : MB2-008-2023
Equipment : Electronic Balance
Manufacturer : Radwag
Model : WTB2000
Serial Number : 460684
ID Number : Stack 3
Max Capacity : 2000 (g)
Resolution : 0.01 (g)

The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor k , providing a level of confidence of approximately 95 %. The uncertainty evaluation has been carried out in accordance with UKAS M3003 requirements. This calibration certificate documents the traceability to national standards, which realize the units of measurement according to the International System of Units (SI). This Certificate may not be reproduced other than in full except with the prior written approval of Calibration Center, Intro TSC Co., Ltd.

Customer Reference : F411 **Customer :** Environment Research & Technology Co., Ltd.
CSRS No.: 00670123 **25/114 Moo 6 Soi Chinaket 1, Ngamongwan Road,**
Date of Receipt : 12-Jan-23 **Toongsonghong, Laksi, Bangkok 10210**
Date of Calibration : 13-Jan-23 **Location :** Mass Calibration Laboratory

Condition of this result of calibration

1. Reference Standard instruments :

Instruments	Model	Serial No.	Certificate No.	Due Date
Standard Weight Set (1 g to 5000 g)	N/A	N/A	22M1144	20-Jun-23

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

- Technology Promotion Association (Thailand-Japan)

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

Method : Measurement In-house Method Calibration Procedure No. CP-CL-07 base on UKAS Publication Ref : Lab 14 : 2019

Environmental Conditions :

Temperature : (20 ± 2) °C

Humidity : (50 ± 15) %

Air Pressure : (1010 ± 10) mbar

Calibrated By : Mr. Pratchaya Sanguankongvilai

Date of Issued : 16-Jan-23

Approved Signatory :

Mr. Panuchit Samart

FM-CL-11-05

Certificate Number : MB2-008-2023

Page 2 of 2 Pages

Calibration Result (Weight) : Without Adjustment

1. Repeatability of Reading

Nominal Value (g)	Standard Deviation (g)	Maximum diff. Between successive (g)
2000	0.000	0.00

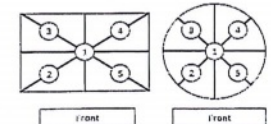
2. Error of indication from nominal value

Nominal Value (g)	Balance Reading (g)	Correction Value (g)	Uncertainty (±) (g)	factor k	Balance Reading Before Adjust (g)
Unload	0.00	0.00	0.0084	2.00	-
200	199.99	0.01	0.0085	2.00	-
400	399.98	0.02	0.0086	2.00	-
600	599.96	0.04	0.0088	2.00	-
800	799.96	0.04	0.0091	2.00	-
1000	999.96	0.04	0.0091	2.00	-
1200	1199.96	0.04	0.095	2.00	-
1400	1399.96	0.04	0.095	2.00	-
1600	1599.96	0.04	0.095	2.00	-
1800	1799.99	0.01	0.095	2.00	-
2000	2000.02	-0.02	0.095	2.00	-

3. Eccentric or off-center loading

Nominal Value (g)	Reference Position				
	Position 1 (g)	Position 2 (g)	Position 3 (g)	Position 4 (g)	Position 5 (g)
1000	999.96	999.98	999.94	999.98	1000.03

Eccentric Error = 0.07 (g)



End of report

Signature




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.: 22CH1753
Page.: 2 of 2

Cert.No.: 22CH1753
Page.: 1 of 2

Certificate of Calibration

Equipment : pH Meter
Manufacturer : Eutech
Model : pHTestr 30
Serial No. : 3015187
ID No. : NO.27
Condition As-Received: Used Item
Received Date : 27 December 2022
Calibration Date : 27 December 2022
Reference : 2212-0734WN-9
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 Lemgagtrakul
Approved by : 
Approved Signatory
() Malee Butkruea
() Sathip Meangmai
(X) Ponpan Paipim
Issue Date : 28 December 2022

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	4.02	N/A	0.0079	2.00
S/N.: 3015187	6.987	7.01	N/A	0.011	2.00
	10.008	10.02	N/A	0.011	2.05

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-

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.

Mettler-Toledo (Thailand) Ltd.
846/4 - 846/5 Lasalle Rd., Bangna Tal 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 / 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: 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.

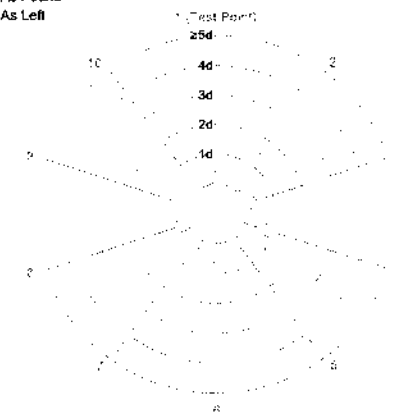
	Temperature		Humidity	
As Found	Start: 23.7 °C	End: 23.6 °C	Start: 46.5 %	End: 45.6 %

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

Measurement Results

Repeatability

Test Load: 100 g			As Found	As Left
	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		

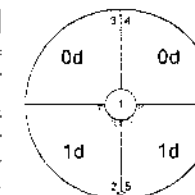


The "d" in the graph represents the readability of the range/interval in which the test was performed.

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

Eccentricity

Test Load: 100 g			As Found	As Left
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		



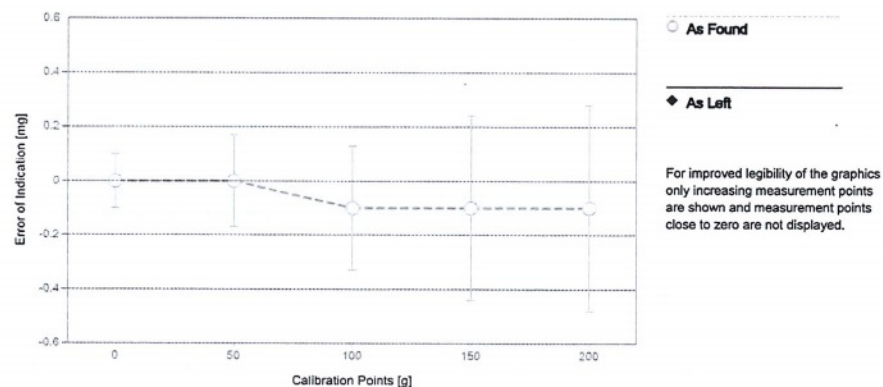
As Found

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: $1.5 \cdot 10^{-5} / K$

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

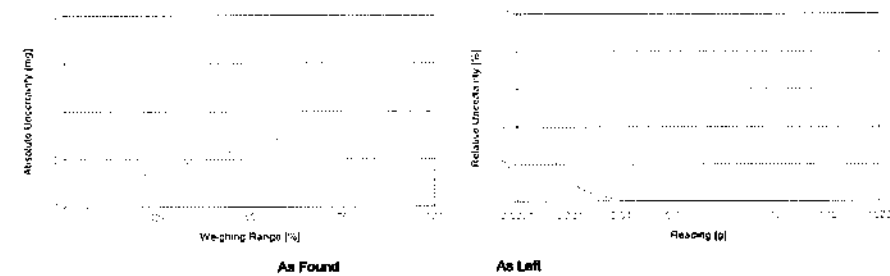
Linearization of Uncertainty Equation

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



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.

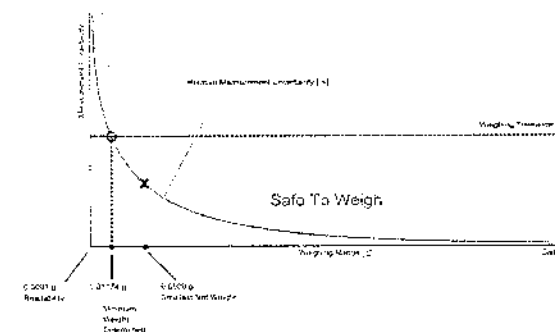
Process Requirements

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 $0.41 \cdot d$ 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	0.0001 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	0.0000 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

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	0.0000 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.



TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)
CORPORATE SERVICES 3: EQUIPMENT CALIBRATION AND TESTING SERVICES
534/4 PATTANAKARN ROAD SOI 14, SUANLUANG, SUANLUANG BANGKOK 10250
TEL. 0-2717-3000-27 FAX. 0-2719-9484



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

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

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, 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 Hahib

Approved by :
Approved Signatory

() Pornthippa Tameyakul
(☒) Malee Butkruea
() Suwit Imjai

Issue Date : 16 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.

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

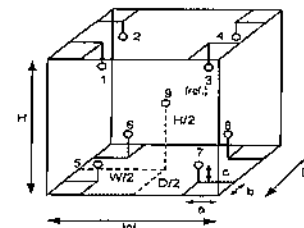
2. This certificate is valid only to the item calibrated on date and place of calibration.

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 %.

-o0o-

Malu.



TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)
CORPORATE SERVICES & EQUIPMENT CALIBRATION AND TESTING SERVICES
534/4 PATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG BANGKOK 10350
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 : Malee Butkruea
Approved Signatory

() Pomthippa Tameyakul
(/) Malee Butkruea
() Suwit Imjai

Issue Date : 16 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 & Equipment Calibration and Testing Services.



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

Cert. No.: 23TM31
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

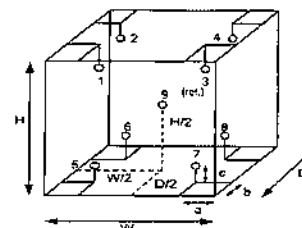
2. This certificate is valid only to the item calibrated on date and place of calibration.

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



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

Probe Installation Details : Dimension of Chamber :
a = 5.0 cm D = 0.40 m
b = 5.0 cm W = 0.60 m
c = 5.0 cm H = 0.48 m
Capacity = 0.12 m³

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

Malee



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 %.

-o0o-


Malu.

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 / Postal: 10210
State / Province: Bangkok
Order Number:  40332617856*

Weighing Device

Manufacturer: Mettler Toledo Instrument Type: Weighing Instrument
Model: MS204TS/00 Asset Number: ERTC-LIN-114
Serial No.: B547728937 Terminal Model: N/A
Building: N/A Terminal Serial No.: N/A
Floor: 5 Terminal Asset No.: N/A
Room: S04

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

Procedure


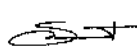
Calibration Guideline: EURAMET cg-18 v. 4.0 (11/2015)
METTLER TOLEDO Work Instructions: CPW002/20

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.

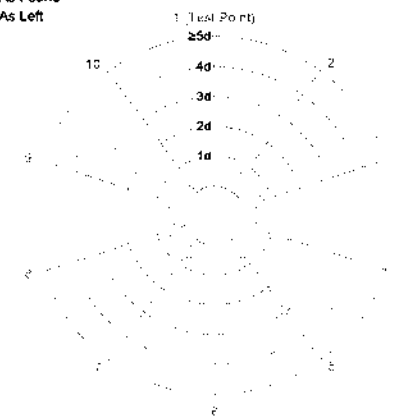
	Temperature		Humidity	
As Found	Start: 23.7 °C	End: 23.8 °C	Start: 45.6 %	End: 46.8 %

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

Measurement Results

Repeatability

Test Load: 100 g			As Found ◆ As Left
	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	

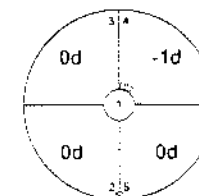


The "d" in the graph represents the readability of the range/interval in which the test was performed.

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



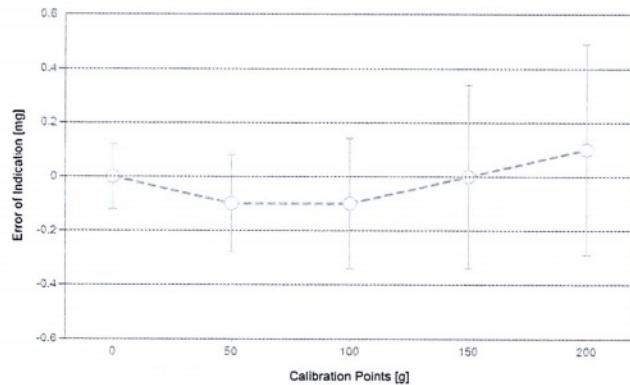
As Found

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



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

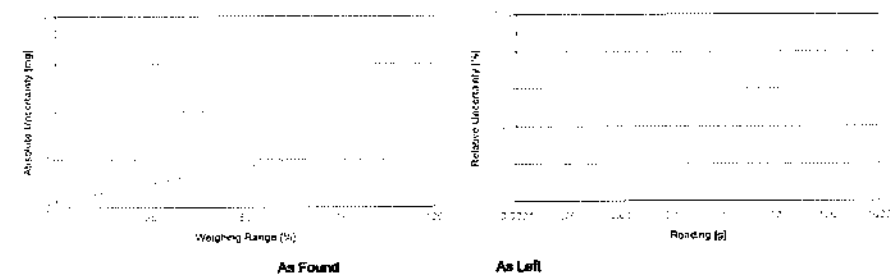
Linearization of Uncertainty Equation

	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.

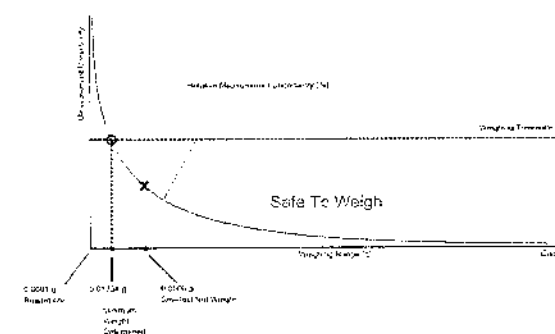
Process Requirements

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

⚠ = 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		✓		✗
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	0.0001 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

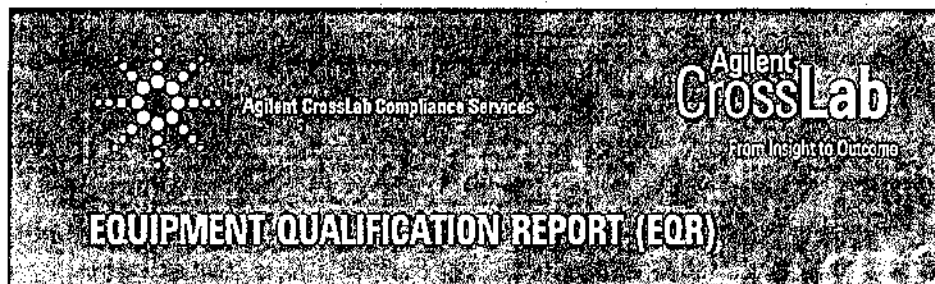
As Found

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.



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
Cover page	1
Table of Contents	2
Test Summary	3
Service Details	4
Instrument Details	5
Protocol Details	6
Tests	7
Preparation : 5100 VDV	7
Instrument Tests : 5100 VDV	10
Autosampler Operation : Autosampler 1 - SPS4	11
Declaration of Change Control	12
Attachments	13
Signature	25
Transaction Logs	26

Service Details

Purpose

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

Service Details

Purpose

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
-----------------------------	----------------

As Found Data

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

Revision History

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

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:

Was the detector calibration performed and completed successfully?

Date and Time:

November 28, 2022 4:07:22 PM

Host Name:

5CG0202NQ4

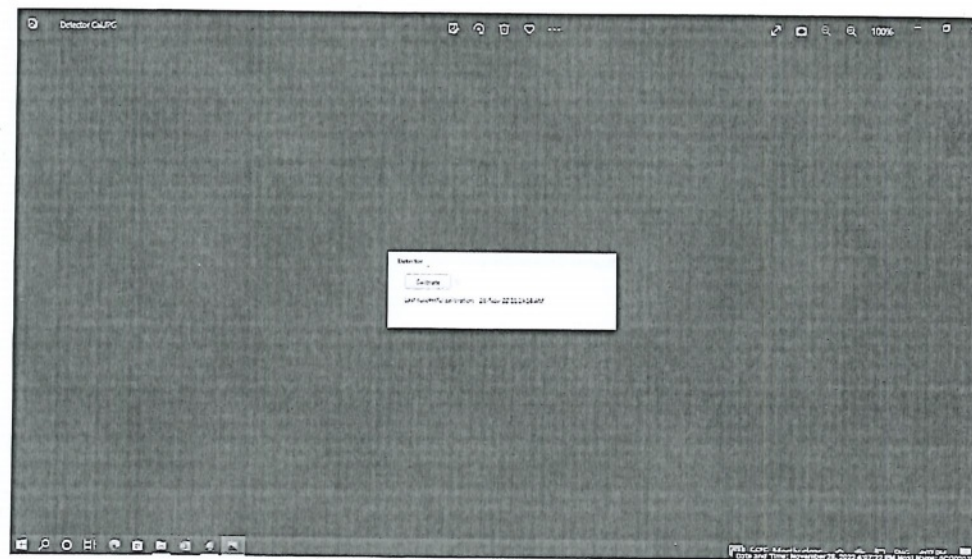


Image Details:

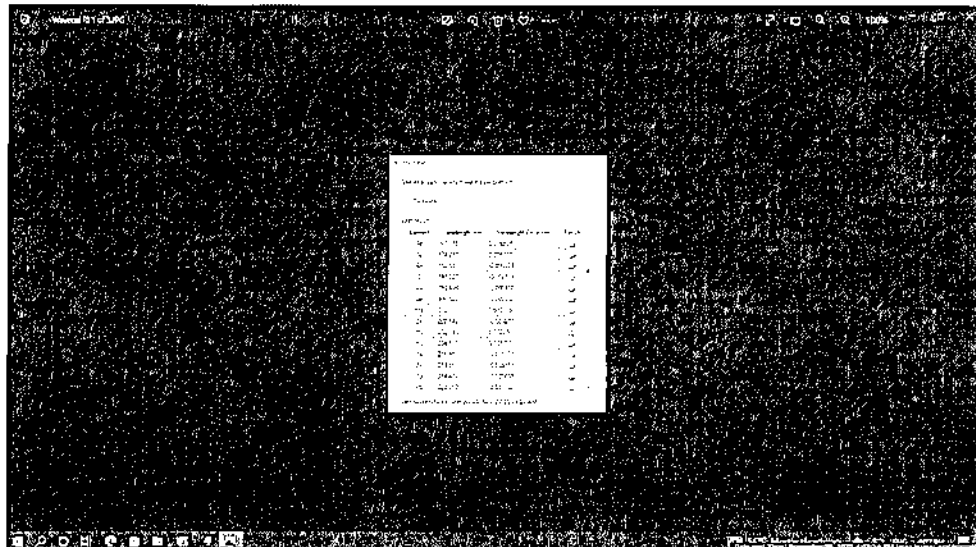
Was the instrument calibration performed and completed successfully?

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

Autosampler Operation

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


Declaration of Change Control

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 Technologies

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 - GC/MS	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 - LC/MS	6	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

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.

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 (174.219 nm)	≤ 9.40	7.40
As (189.960 nm)	≤ 8.20	6.40
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 (228.616 nm)	≤ 17.20	10.85
Ba (230.424 nm)	≤ 9.40	7.87
Mn (257.610 nm)	≤ 13.30	9.47
Mn (260.569 nm)	≤ 20.30	16.41
Cr (267.716 nm)	≤ 11.00	8.93
Co (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)	≤ 38.00	30.03
Ba (514.171 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)	≥ 46.0	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	1360.5	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	666.7	16502.1	571.0
Mn (257.610 nm)	≥ 10625.0	SRBR	39180.3	1593731.9	1651.2
Cr (267.716 nm)	≥ 1048.0	SRBR	4862.3	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

03/10/18

Document Name: Software verification

Software Verification Report			
Date:	Monday, November 28, 2022	Time:	3:44:56 PM (UTC +07:30:00)
Host Name:	S100VDV-HP		
Windows User Name:	Admin	Base Revision Number:	7.0.1
Product Name:	ICP Expert		
Install Type:	N/A	Additional Packages:	N/A
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 4:16:05 PM
System ID: MY15330001

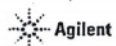
03/10/18

Document Name: Certificate of Analysis Wavelength calibration solution

Agilent							
CERTIFICATE OF ANALYSIS							
Agilent Product Name: Wavelength Calibration Solution for ICP-BES & MP-AES, 5 mg/L, 500mL							
Agilent Part No: 6316030100							
Lot No: 0012185521							
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	Mo	Mo	7439-98-5	5.001 ± 0.025 mg/L
As	As	7440-38-2	5.001 ± 0.025 mg/L	Nb	(NH ₄) ₂ NbO ₇	13109-76-8	5.000 ± 0.025 mg/L
Ba	Ba(NO ₃) ₂	50072-31-8	5.000 ± 0.025 mg/L	Ni	Ni	7440-42-0	5.000 ± 0.025 mg/L
Cd	Cd	7440-43-8	5.000 ± 0.025 mg/L	Pb	Pb	7439-92-1	5.001 ± 0.025 mg/L
Co	Co	7440-48-4	5.000 ± 0.025 mg/L	Se	Se	7782-49-2	5.000 ± 0.025 mg/L
Cr	Cr(NO ₃) ₃	13546-30-4	5.000 ± 0.025 mg/L	Sr	Sr(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	50.00 ± 0.25 mg/L				
Matrix: 5% HNO ₃							
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 (HNO ₃) 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, 3106, 3113, 3112a, 3114, 3141a, 3132, 3134, 3136, 3128, 3149, 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-decanted 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.							
Page 1 of 2							

Date: November 28, 2022 4:16:05 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.

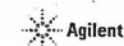
Date of release: 21 January 2022
Date of expiration: 31 July 2023

Sample lot approval:


Chuck Goudreau, Certifying Officer

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 17034 and ISO Guide 35. Replicate samples of the finished solution were analyzed to confirm its homogeneity, in accordance with QSP 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. Reg. No. 44 100 10560231)
- Accredited to ISO 17034 – General Requirements for the Competence of Reference Material Producers (AZLA Cert. No. 2848.02)
 - o 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)
- LCC Swedens, 211 Abby Road, Northwood, NH 03072

Page 3 of 3

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

Details

Full Name of Signer: 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

Agilent Technologies makes no warranty of any kind to this material, including but not limited to, the implied warranties or merchantability and fitness for a particular purpose. Agilent Technologies shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this material.

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

User Name: vcrack@agilent.com
 Hostname: SDC610001
 System ID: MY15330001
 Login Date: November 28, 2022 4:02:15 PM

QD HW ICP 5100 Envl research Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
November 28, 2022 4:02:15 PM	AuG	SessionCreated	Session	None
November 28, 2022 4:02:15 PM	Start	Configuration	Session	None
November 28, 2022 4:02:15 PM	AuG	Entitlement	Licensing	User is FieldEngineer and does not require an unlock code
November 28, 2022 4:06:30 PM	AuG	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 4:08:36 PM	Start	Execution	Preparation : 5100 VDV: Qualitative Test - No setpoints associated	None
November 28, 2022 4:07:36 PM	End	Execution	Preparation : 5100 VDV: Qualitative Test - No setpoints associated	Run Count : 1
November 28, 2022 4:07:39 PM	Start	Execution	Instrument Tests : 5100 VDV: Qualitative Test - No setpoints associated	None
November 28, 2022 4:08:52 PM	End	Execution	Instrument Tests : 5100 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: SC002011024

System ID: MY15330001
 Print Date: November 28, 2022 4:16:19 PM

OQ HW ICP 5100 Envi researc 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 researc_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



TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)
CORPORATE SERVICES 3 : EQUIPMENT CALIBRATION AND TESTING SERVICES

534/4 PATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG BANGKOK 10250

Tel. 0-2717-3000 FAX. 0-2719-9484



Cert.No.: 22TW286

Page.: 2 of 2

Cert.No.: 22TW286

Page.: 1 of 2

Certificate of Testing

Equipment : DO Meter
Manufacturer : YSI
Model : Pro20
Serial No. : 14L101229
ID No. : NO.4
Received Date : 27 December 2022
Test Date : 27 December 2022
Reference : 2212-0734WN-5
Submitted by : Environment Research & Technology Company Limited.
25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Road,
Toongsonghong, Laksi, Bangkok 10210
Laboratory Condition : Temperature (25 ± 5) °C
Humidity (50 ± 20) %
Test Procedure : In - house method : CP-CH9
by Comparison Technique with Azide Modification Method
Tested by : Walalak Sirithean

Approved by : Warakorn
Approved Signatory

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

Issue Date : 28 December 2022

Condition of this result of calibration

1. Reference Standard Instruments :

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

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

2. Standard Material :-

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

Result : Dissolved Oxygen Meter Adjustment With Air 100 %

Dissolved Oxygen Probe No.: 14L100144

Titration Method (Azide Modification Method) (mg/L)	DO Meter Reading (mg/L)	Standard Deviation (mg/L)
8.12	8.12	0.0084

This report was certified only for the instrument we tested. It is allowable to use for study the system efficiency. The environmental impact control and present to organization it may concerned intend to use for advertising and referral purpose is prohibited. This report may not be reproduced other in full, without written approval of the laboratory

-o0o-

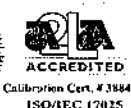
Warakorn



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



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 of Calibration

Certificate No. : MT22-6773

Page : 1 of 2

Customer : Environment Research & Technology Co., Ltd.
Address : 25/114 Moo 6 Soi Chinakiet 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 Sreebannasam
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

Certificate No. : MT22-6773

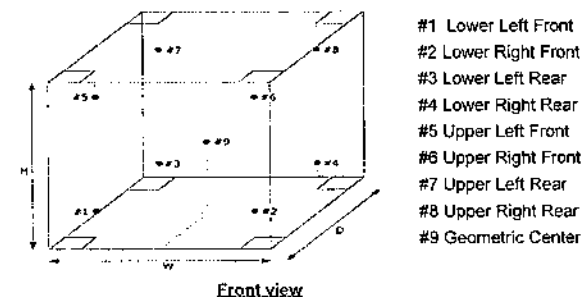
Page : 2 of 2

Function : Temperature measurement
Calibration point : 20 °C

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	18.687	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



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.



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.: 23TM3
Page : 1 of 3

Certificate of Calibration

Equipment : Incubator
Manufacturer : Memmert
Model : IF 160
Serial No. : D522.0070
ID No. : ERTC-L-In.-181
Submitted by : Environment Research & Technology Company Limited,
25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Road,
Toongsonghong, Laksi,
Bangkok 10210
Location : 408/2 ห้องปฏิบัติการนมอาหารเลี้ยงเชื้อ
Received Order : 4 January 2023
Calibration Date : 5 January 2023
Ambient Temperature : $(26 \pm 10) ^\circ\text{C}$
Relative Humidity : $(50 \pm 30) \%$
Calibrated by : Krisda Malee

Approved by : Malee
Approved Signatory

() Pornthippa Tameyakul
(✓) Malee Butkruea
() Suwit Imjai

Issue Date : 16 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.



Equipment : Incubator
Condition As-Received : Used Item
Reference : 2301-0002ON-5
Procedure Used :-

Cert. No.: 23TM3
Page : 2 of 3

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

The temperature scale used was based on ITS-90.

Condition of this result of calibration

1. Reference standard instrument:-

Instrument	Model	Serial No.	Cert. No.	Due Date
1) Data Acquisition	34970A	MY44073381	22LM78/1	12 May 2023

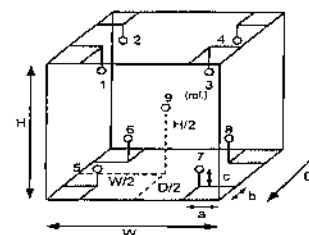
2. This certificate is valid only to the item calibrated on date and place of calibration.

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 :

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 =	0.73 m
		Capacity =	0.16 m ³

Environment during calibration		
	Beginning	Finished
Temp. (°C)	24	26
REL.Humid. (%)	50	51
AC Supply (Volt)	220	221

Position :	Ref. Std. ID No.:
1	1RTD-2/1
2	1RTD-2/2
3	22-01RTD-03
4	1RTD-2/4
5	1RTD-2/5
6	1RTD-2/6
7	1RTD-2/7
8	1RTD-2/8
9 (ref.)	1RTD-2/9



Equipment : Incubator
Condition As-Received : Used Item
Reference : 2301-0002ON-5
Result of Calibration :- (*) Without Adjustment
Function of UUC* : Temperature Source
Fresh air setting : Close

Cert. No.: 23TM3
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>
35.0	35.0	35.0	0.026	0.30	0.33	0.30	2

Calibration Point (°C)	Measured Temperature (°C)								
	Position								
	1	2	3	4	5	6	7	8	9 (ref.)
35.0	35.132	35.177	35.048	35.188	35.186	35.131	35.154	35.144	35.334

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 %.

-o0o-

mlu.



THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Mechanical Engineering Standards Laboratory Soi 1, Bangpoo Industrial Estate, Muang, Samutprakan 10280, Thailand.

Request No.23-66/0084

MTC.No.23-66/0084

Number of page(s) 2

CALIBRATION CERTIFICATE

Nomenclature : DRYCAL FLOWMETER

Manufacturer : BIOS International Corporation, U.S.A.

Serial No.: 120021

Model : Defender 510 M

Scale range : 50 ml/min to 5000 ml/min

Subdivision : (0.01, 0.1, 1) ml/min

Submitted by : ENVIRONMENT RESEARCH & TECHNOLOGY CO.,LTD.

25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Road,

Toongsonghong, Laksi, Bangkok 10210, Thailand.

Received date : 7 November 2022 Condition of measured item : Normal

Calibration date : 10 November 2022

Standard :

Standard	Certificate No.	Date due	Traceability
RTD Thermometer	PSL-T 643/65	1-Jun-24	TISTR
Molbox/Pressure Transducer/UpStream	MP-0013-21	25-Jan-23	NIMT
Primary Flow Calibrator S/N 117982	MW-0011-21	8-Apr-23	NIMT
Primary Flow Calibrator S/N 119521	MW-0012-21	31-Mar-23	NIMT

Calibrated by :

(Mr.Terasak Panna)

Approved by :

(Ms.Kirana Luanghirun)

Director

Mechanical Engineering Standards Laboratory

Ref. 2013265110704833001

Issued Date 10 November 2022

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

Advertising the Report/Certificate and publicity of the results except in full are prohibited unless written permission is obtained from the governor of TISTR.

FM.BL.MTC.002 Rev.4

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



THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Mechanical Engineering Standards Laboratory Soi 1, Bangpoo Industrial Estate, Muang, Samutprakan 10280, Thailand.

Request No.23-66/0084

2/2

MTC.No.23-66/0084

Calibration point : (50, 200, 2000) ml/min

Ambient condition : Temperature (23 ± 3) °C , Relative humidity (55 ± 15) %

Atmospheric pressure (1010±13) hPa

Calibration method : The flowmeter (UUC) was calibrated by comparison method with standard flowmeter according to CP-370.01.

The reported value is the value that converted to value at reference condition within pressure and temperature of the actual gas entering the UUC

Measurement data :

UUC Value (ml/min)	Standard Value (ml/min)	Temperature (°C)	Pressure (hPa)	Deviation (%)	Uncertainty (%)
59.07	58.252	23.189	1010.25	+1.40	1.08
202.23	197.32	23.203	1010.35	+2.49	1.06
2020.6	1970.4	23.211	1011.26	+2.55	0.87

The reported expanded uncertainties are based on standard uncertainties multiplied by a coverage factor $k=2$, which provides a level of confidence of approximately 95%.

The end of calibration certificate.

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

Advertising the Report/Certificate and publicity of the results except in full are prohibited unless written permission is obtained from the governor of TISTR.

FM.BL.MTC.002 Rev.4

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 : 121-30 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
53/44 PATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG BANGKOK 10250
TEL. 0-2717-3000-27 FAX. 0-2719-9484



Cert.No.: 23MM1
Page.: 1 of 3

Certificate of Calibration

Equipment : Electronic Balance
Manufacturer : AND
Model : BM-5
Serial No. : T1004302
ID No. : ERTC-L-In.-176
Submitted by : Environment Research & Technology Company Limited.
25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Road,
Toongsonghong, Lakso,
Bangkok 10210
Location : ห้องปฏิบัติการวิเคราะห์ (411)
Received order : 4 January 2023
Calibration Date : 4 January 2023
Ambient Temperature : 15 °C to 40 °C
Relative Humidity : 30 % to 90 %
Calibrated by : Krisda Malee
Approved by :
(/) Pornthippa Tameyakul
(/) Malee Butkruea
(/) Suwit Imjai
Issue Date : 16 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.



Equipment : Electronic Balance
Condition As-Received : Used Item
Reference : 2301-0002ON-10
Procedure used :-

Cert.No.: 23MM1
Page: 2 of 3

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

Condition of this result of calibration

1. Reference standard instruments:-

Instruments	Model	Serial No.	ID No.	Test report No.	Due date
1) Standard Weight Set (E2)	15884	-	70RC138	MM-0009-21	03 Feb 2023

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

3. This result of calibration was made on requested at the point specified by customer.

4. This certificate is not certified for any commercial transaction.

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

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

Range capacity : 0 g to 5.2 g Resolution 0.000001 g

Before Adjustment :

Applied Weight	Balance Reading	Correction	Measurement Uncertainty	Coverage Factor
(g)	(g)	(g)	(± mg)	(k)
2.5	2.500008	-0.000008	0.026	2.00
5	5.000007	-0.000007	0.027	2.00

After Adjustment :

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

Applied Weight	Standard Deviation of Reading (g)
(g)	
2.5	0.0000007
5	0.0000007

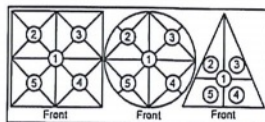


Equipment : Electronic Balance
 Condition As-Received : Used Item
 Reference : 2301-0002ON-10
 Result of calibration

Cert.No.: 23MM1
 Page: 3 of 3

2. Effect of off center loading

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



Maximum difference between
 off-center and central loading
 (g)
 0.000003

Position 1 (g)	Position 2 (g)	Position 3 (g)	Position 4 (g)	Position 5 (g)
+0.000002	+0.000005	+0.000004	+0.000002	+0.000003

3. Departure from nominal value

Applied Weight (g)	Balance Reading (g)	Correction (g)	Measurement Uncertainty (\pm mg)	Coverage Factor (k)
Unload	0.000000	0.000000	0.0060	2.11
0.014	0.014002	-0.000002	0.0060	2.00
0.015	0.015001	-0.000001	0.0060	2.00
0.5	0.499995	+0.000005	0.013	2.00
1	1.000001	-0.000001	0.016	2.00
1.5	1.500001	-0.000001	0.020	2.00
2	1.999996	+0.000004	0.020	2.00
2.5	2.500001	-0.000001	0.026	2.00
3	3.000004	-0.000004	0.026	2.00
4	3.999997	+0.000003	0.027	2.00
5	5.000002	-0.000002	0.027	2.00

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

-o0o-

Mahar



TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)
CORPORATE SERVICES 3: EQUIPMENT CALIBRATION AND TESTING SERVICES
534/4 PATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG, BANGKOK 10250
TEL. 0-2717-3000-24 FAX. 0-2719-9484



Cert. No.: 22PH435
Page.: 2 of 2

Certificate of Calibration

Certificate No. : 22PH435
Page : 1 of 2

Equipment : Lux Meter
Manufacturer: Exttech
Model : 407026
Serial No.: A.048465
ID No.: -

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 As-Received: Used Item
Received Date: 25 August 2022
Calibration Date: 29 August 2022

Reference: 2206-0898WN Submitted by: Environment Research & Technology Company Limited.
Ambient Temperature: (23 ± 2) °C
Relative Humidity: (50 ± 15) %
25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Road,
Toongsonghong, Laksi, Bangkok 10210

Procedure used: Calibration were conducted using in-house calibration procedure CP-PH01 by measuring against
luminous-intensity standard lamp (source-based method) According to the inverse square law measurement
method.

Condition of this result of calibration

1. Reference standards instruments :

Instrument	Model	Serial No.	Certificate No.	Due Date
1) Photometry & Encoder	LMguide 9.6 m	120RC003	61-140006-1	30 Apr 2023
2) High-accuracy Irradiance Standard	OL-FEL-U	F-1471	TP-1037-21	18 Oct 2022

2. This result of calibration was made on requested at the point specified by customer.

3. Test Equipment : Programmable Voltage/Current Source (Model : OL83A, S/N : 09220284).

4. Test Equipment : Illuminance Meter (Model : 51002, S/N : 080129).

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

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

-National Institute of Metrology Thailand (NIMT)

Calibrated by : Nival Nitas
Issue Date : 31 August 2022

Approved Signatory :
[] Phalinee Prabpaipal
[] Chatchawan Khunpiluek
[x] Nuntawat Khamchai

Result of calibration:- (*) Without adjustment () After adjustment
Function : Illuminance Measurement Range : 2000 lx

Standard Value	UUC* Reading	Error	Uncertainty
(lx)	(lx)	(lx)	(± lx)
0	0	0	0.60
15	14	-1	0.62
100	101	1	1.6
500	505	5	7.3
1000	1012	12	15
1500	Over Range	-	-
1900	Over Range	-	-

Function : Illuminance Measurement Range : 2000 lx

Standard Value	UUC* Reading	Error	Uncertainty
(lx)	(lx)	(lx)	(± lx)
2000	2620	620	30
3000	3840	840	45
4000	5060	1060	59
5000	6380	1380	74

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

Light source factor setting mode : L

UUC* = Unit Under Calibration.

-o0o-



Request No. 22-66 / 0047

MTC No. PSL-H 0022 / 66

Certificate of Calibration

Customer : Environment Research & Technology Company Limited
25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Rd., Laksi, Bangkok

Item : Thermo-Hygrometer (Thermal Environment Monitor)

Model /Type : QUESTemp[®]32

Serial Number : TPG030012

Manufacturer : 3M, QUEST Technologies

Date of Request : 25 October 2022

Date of Calibration : 1 November 2022

The certifies the above equipment was calibrated in accordance with the recognised International Standard ISO/IEC 17025:2017 and the operation according to procedure no. WI.CP.18.

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

Calibrated by :

Paranit T.

(Ms. Panit Thummasri)

Approved by :

Kamchai Singhapiwat

(Mr. Kamchai Singhapiwat)

Director

Photometry and Temperature Standards Laboratory

Ref. No : 2012265102504612001

Issued Date : 10 November 2022

Page 1 of 4

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 : suma.ee@tistr.or.th



Request No. 22-66 / 0047

MTC No. PSL-H 0022 / 66

Description of Unit Under Calibration :

Customer : Environment Research & Technology Company Limited

Address : 25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Rd., Laksi, Bangkok

Item : Thermo-Hygrometer (Thermal Environment Monitor)

Serial Number : TPG030012

Calibration Required : Temperature at (30, 35, 40) °C

Ambient Condition : Ambient temperature (23 ± 3) °C
Relative humidity (55 ± 20) %

Laboratory Address : Photometry and Temperature Standards Laboratory
Soi 1, Bangpoo Industrial Estate, Sukhumvit Rd., Samutprakan

Reference Standard :

Digital Thermometer with Sensor, Model : F250H, S/N : 9345 008 2331, Sensor RTD Probe No. RTD-01 and RTD-02 which was calibrated by Industrial Metrology and Testing Service Centre, Certificate No. PSL-T 0786/65.

The temperature scale in use of this laboratory is the International Temperature Scale of 1990.

Calibration Procedure :

The certifies the above equipment was calibrated according to procedure no. WI.CP.18.

Support Equipment :

Temperature & Humidity Controlled Chamber, Model : 9141-5110, S/N : 1205101

Adjustments : NONE

Page 2 of 4

PT.

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 : suma.ee@tistr.or.th

Request No. 22-66 / 0047

MTC No. PSL-H 0022 / 66

Results of Calibration :- () Without Adjustment (/) After Adjustment

Table : Temperature Measurement @ Wet Bulb

Average Measured Temperature (°C)	Average Displayed of UUC (°C)	Correction Measured of UUC (°C)	Expanded Uncertainty of Measurement (± °C)
29.9	29.3	0.6	0.50
35.0	34.3	0.7	0.50
40.0	39.3	0.7	0.50

Table : Temperature Measurement @ Dry Bulb

Average Measured Temperature (°C)	Average Displayed of UUC (°C)	Correction Measured of UUC (°C)	Expanded Uncertainty of Measurement (± °C)
29.9	29.4	0.5	0.50
35.0	34.4	0.6	0.50
40.0	39.4	0.6	0.50

Request No. 22-64 / 0005

MTC No. PSL-H 005 / 64

Results of Calibration :-

Table : Temperature Measurement @ Globe Bulb

Average Measured Temperature (°C)	Average Displayed of UUC (°C)	Correction Measured of UUC (°C)	Expanded Uncertainty of Measurement (± °C)
29.9	29.5	0.4	0.50
35.0	34.4	0.6	0.50
40.0	39.3	0.7	0.50

- Note :
1. This calibration was done without removing reservoir cover, white plates and blackened copper sphere of the instrument.
 2. The calibration data for instrument in this report is reported within the condition existing at the time of measurement only.

...end of certificate...



Request No. 22-65 / 0547

MTC No. PSL-H 0260 / 65

Certificate of Calibration

Customer : Environment Research & Technology Company Limited
25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Rd., Laksi, Bangkok

Equipment : Thermo-Hygrometer (Area Heat Stress Monitor)

Model /Type : hs-32

Serial Number : MCB110008

Maker : METROSONICS

Date of Request : 23 May 2022

Date of Calibration : 7 June 2022

This certificate is traceable to International System of Units (SI Units) through Photometry and Temperature Standards Laboratory, Industrial Metrology and Testing Service Centre, Thailand Institute of Scientific and Technology Research (TISTR), NSC-ONSC accredited Calibration No. 0015.

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

Calibrated by :

(Ms. Panit Thummasri)

Approved by :

(Mr. Kamichai Singhapiwat)

Director

Photometry and Temperature Standards Laboratory

Ref. No : 2012265052302254001

Issued Date : 23 June 2022

Page 1 of 4

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 9592
E-mail : sumatee@tistr.or.th



Request No. 22-65 / 0547

MTC No. PSL-H 0260 / 65

Description of Unit Under Calibration :

Customer : Environment Research & Technology Company Limited

Address : 25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Rd., Laksi, Bangkok

Equipment : Thermo-Hygrometer (Area Heat Stress Monitor)

Serial Number : MCB110008

Calibration Required : Temperature at (30, 35, 40) °C

Ambient Condition : Ambient temperature (23 ± 3) °C
Relative humidity (55 ± 20) %

Laboratory Address : Photometry and Temperature Standards Laboratory
Soi 1, Bangpoo Industrial Estate, Sukhumvit Rd., Samutprakan

Reference Standard :

Digital Thermometer with Sensor, Model : F250H, S/N : 9345 008 2331, Sensor RTD Probe No. RTD-01 and RTD-02 which was calibrated by Industrial Metrology and Testing Service Centre, Certificate No. PSL-T 1081/64.

The temperature scale in use of this laboratory is the International Temperature Scale of 1990.

Calibration Procedure :

The certifies the above equipment was calibrated according to procedure no. WLCP.18.

Support Equipment :

Temperature & Humidity Controlled Chamber, Model : 9145-5116-00AA, S/N : 1403041

Adjustments : NONE

Page 2 of 4

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.

P.T.

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 9592
E-mail : sumatee@tistr.or.th

Request No. 22-65 / 0547

MTC No. PSL-H 0260 / 65

Results of Calibration :-

Table : Temperature Measurement @ Wet Bulb

Average Measured Temperature (°C)	Average Displayed of UUC (°C)	Correction Measured of UUC (°C)	Expanded Uncertainty of Measurement (± °C)
29.9	30.3	-0.4	0.50
35.1	35.4	-0.3	0.50
40.0	40.1	-0.1	0.50

Table : Temperature Measurement @ Dry Bulb

Average Measured Temperature (°C)	Average Displayed of UUC (°C)	Correction Measured of UUC (°C)	Expanded Uncertainty of Measurement (± °C)
29.9	30.4	-0.5	0.50
35.1	35.5	-0.4	0.50
40.0	40.3	-0.3	0.50

Request No. 22-65 / 0547

MTC No. PSL-H 0260 / 65

Results of Calibration :-

Table : Temperature Measurement @ Globe Bulb

Average Measured Temperature (°C)	Average Displayed of UUC (°C)	Correction Measured of UUC (°C)	Expanded Uncertainty of Measurement (± °C)
29.9	30.4	-0.5	0.50
35.1	35.4	-0.3	0.50
40.0	40.1	-0.1	0.50

Note :

1. This calibration was done without removing reservoir cover, white plates and blackened copper sphere of the instrument.
2. The calibration data for instrument in this report is reported within the condition existing at the time of measurement only.

...end of certificate...



Request No. 22-65 / 0547

MTC No. PSL-H 0261 / 65

Certificate of Calibration

Customer : Environment Research & Technology Company Limited
25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Rd., Laksi, Bangkok

Equipment : Thermo-Hygrometer (Area Heat Stress Monitor)

Model /Type : hs-32

Serial Number : MCG080057

Maker : METROSONICS

Date of Request : 23 May 2022

Date of Calibration : 7 June 2022

This certificate is traceable to International System of Units (SI Units) through Photometry and Temperature Standards Laboratory, Industrial Metrology and Testing Service Centre, Thailand Institute of Scientific and Technology Research (TISTR), NSC-ONSC accredited Calibration No. 0015.

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

Calibrated by :

(Ms. Panit Thummasri)

Approved by :

(Mr. Kamchai Singhapiwat)

Director

Photometry and Temperature Standards Laboratory

Ref. No : 2012265052302254002

Issued Date : 23 June 2022

Page 1 of 4

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



Request No. 22-65 / 0547

MTC No. PSL-H 0261 / 65

Description of Unit Under Calibration :

Customer : Environment Research & Technology Company Limited

Address : 25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Rd., Laksi, Bangkok

Equipment : Thermo-Hygrometer (Area Heat Stress Monitor)

Serial Number : MCG080057

Calibration Required : Temperature at (30, 35, 40) °C

Ambient Condition : Ambient temperature (23 ± 3) °C
Relative humidity (55 ± 20) %

Laboratory Address : Photometry and Temperature Standards Laboratory
Soi 1, Bangpoo Industrial Estate, Sukhumvit Rd., Samutprakan

Reference Standard :

Digital Thermometer with Sensor, Model : F250H, S/N : 9345 008 2331, Sensor RTD Probe No. RTD-01 and RTD-02 which was calibrated by Industrial Metrology and Testing Service Centre, Certificate No. PSL-T 1081/64.

The temperature scale in use of this laboratory is the International Temperature Scale of 1990.

Calibration Procedure :

The certifies the above equipment was calibrated according to procedure no. WI.CP.18.

Support Equipment :

Temperature & Humidity Controlled Chamber, Model : 9145-5116-00AA, S/N : 1403041

Adjustments : NONE

Page 2 of 4

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.

DT

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

Request No. 22-65 / 0547

MTC No. PSL-H 0261 / 65

Results of Calibration :-

Table : Temperature Measurement @ Wet Bulb

Average Measured Temperature (°C)	Average Displayed of UUC (°C)	Correction Measured of UUC (°C)	Expanded Uncertainty of Measurement (± °C)
29.9	30.2	-0.3	0.50
35.1	35.3	-0.2	0.50
40.0	39.9	0.1	0.50

Table : Temperature Measurement @ Dry Bulb

Average Measured Temperature (°C)	Average Displayed of UUC (°C)	Correction Measured of UUC (°C)	Expanded Uncertainty of Measurement (± °C)
29.9	30.2	-0.3	0.50
35.1	35.3	-0.2	0.50
40.0	40.2	-0.2	0.50

Request No. 22-65 / 0547

MTC No. PSL-H 0261 / 65

Results of Calibration :-

Table : Temperature Measurement @ Globe Bulb

Average Measured Temperature (°C)	Average Displayed of UUC (°C)	Correction Measured of UUC (°C)	Expanded Uncertainty of Measurement (± °C)
29.9	30.1	-0.2	0.50
35.1	35.2	-0.1	0.54
40.0	39.7	0.3	0.50

- Note :
1. This calibration was done without removing reservoir cover, white plates and blackened copper sphere of the instrument.
 2. The calibration data for instrument in this report is reported within the condition existing at the time of measurement only.

...end of certificate...



Request No. 22-66 / 0084

MTC No. PSL-H 0038 / 66

Certificate of Calibration

Customer : Environment Research & Technology Company Limited
25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Rd., Laksi, Bangkok

Item : Thermo-Hygrometer (Thermal Environment Monitor)

Model /Type : QUESTemp[®]32

Serial Number : TPI030030

Manufacturer : QUEST Technologies

Date of Request : 7 November 2022

Date of Calibration : 29 November 2022

The certifies the above equipment was calibrated in accordance with the recognised International Standard ISO/IEC 17025:2017 and the operation according to procedure no. WI.CP.18.

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

Calibrated by :

(Ms. Panit Thummasri)

Approved by :

(Mr. Kamchai Singhapiwat)

Director

Photometry and Temperature Standards Laboratory

Ref. No : 2012265110704831001

Issued Date : 8 December 2022

Page 1 of 4

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 : rumpag@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

Request No. 22-66 / 0084

MTC No. PSL-H 0038 / 66

Description of Unit Under Calibration :

Customer : Environment Research & Technology Company Limited

Address : 25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Rd., Laksi, Bangkok

Item : Thermo-Hygrometer (Thermal Environment Monitor)

Serial Number : TPI030030

Calibration Required : Temperature at (30, 35, 40) °C

Ambient Condition : Ambient temperature (23 ± 3) °C
Relative humidity (55 ± 20) %

Laboratory Address : Photometry and Temperature Standards Laboratory
Soi 1, Bangpoo Industrial Estate, Sukhumvit Rd., Samutprakan

Reference Standard :

Digital Thermometer with Sensor, Model : F250H, S/N : 9345 008 2331, Sensor RTD Probe No. RTD-01 and RTD-02 which was calibrated by Industrial Metrology and Testing Service Centre, Certificate No. PSL-T 0786/65.

The temperature scale in use of this laboratory is the International Temperature Scale of 1990.

Calibration Procedure :

The certifies the above equipment was calibrated according to procedure no. WI.CP.18.

Support Equipment :

Temperature & Humidity Controlled Chamber, Model : 9141-5110, S/N : 1205101

Adjustments : NONE

Page 2 of 4

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 : rumpag@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

Request No. 22-66 / 0084

MTC No. PSL-H 0038 / 66

Results of Calibration :- (☒) Without Adjustment (☐) After Adjustment

Table : Temperature Measurement @ Wet Bulb

Average Measured Temperature (°C)	Average Displayed of UUC (°C)	Correction Measured of UUC (°C)	Expanded Uncertainty of Measurement (± °C)
30.0	30.0	0.0	0.50
35.0	35.0	0.0	0.50
40.0	39.9	0.1	0.50

Table : Temperature Measurement @ Dry Bulb

Average Measured Temperature (°C)	Average Displayed of UUC (°C)	Correction Measured of UUC (°C)	Expanded Uncertainty of Measurement (± °C)
30.0	29.9	0.1	0.50
35.0	35.0	0.0	0.50
40.0	39.9	0.1	0.50

Request No. 22-66 / 0084

MTC No. PSL-H 0038 / 66

Results of Calibration :-

Table : Temperature Measurement @ Globe Bulb

Average Measured Temperature (°C)	Average Displayed of UUC (°C)	Correction Measured of UUC (°C)	Expanded Uncertainty of Measurement (± °C)
30.0	30.0	0.0	0.50
35.0	34.9	0.1	0.50
40.0	39.9	0.1	0.50

- Note :
1. This calibration was done without removing reservoir cover, white plates and blackened copper sphere of the instrument.
 2. The calibration data for instrument in this report is reported within the condition existing at the time of measurement only.

...end of certificate...



THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-65/0605

MTC No. EEL. BP. 100/0665

CALIBRATION CERTIFICATE

Submitted by : Environment Research & Technology Co., Ltd.
 Address : 25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Rd., 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 :

Ambient Environment

Description : Calibrator
 Manufacturer : Quest Electronics
 Model : QC-10
 Serial No. : QE2080089

Temperature : (23 ± 3) °C
 Relative Humidity : (50 ± 15) %
 Ambient Pressure : (101.325 ± 1.500) kPa

Standards used : 1. Digital Function Synthesizer NF Electronic DF-193A S/N 122037.

2. Measuring Amplifier Bruel&Kjaer 2636 S/N 1537484.

3. Programmable Attenuator Tamagawa TPA-303A S/N OF 2214.

4. Digital Multimeter Agilent 34401A S/N MY44005560.

5. Pressure Transmitter Vaisala PTB202AD S/N 10650001.

6. Audio Analyzer Panasonic VP-7722A S/N 041477D122.

7. Condenser Microphone Bruel&Kjaer 4180 S/N 2633526.

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

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

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

Date of Receipt : 29 Jun. 2022

Date of Calibration : 4 Jul. 2022

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.

FMBL/MTC.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



THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-65/0605

MTC No. EEL. BP. 100/0665

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

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

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

1. Sound Pressure Level

Standard Microphone Type	Measured Sound Pressure Level (dB)	Deviated value (dB)	Uncertainty (dB)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer 4180	114.03	0.03	± 0.10	± 0.40 dB

2. Frequency

Standard Microphone Type	Measured Frequency (Hz)	Deviated value (Hz)	Uncertainty (Hz)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer 4180	999.6	-0.4	± 1.5	± 1.0%

3. Total Distortion

Standard Microphone Type	Measured Total Distortion (%)	Uncertainty (%)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer 4180	0.97	± 0.50	± 3.0%

Note : 1. No adjustment.

2. The calibrator pressure correction was not included.

3. The microphone volume correction was not included.

Calibrated by :

N. Nutapong Nilrusvanit
 (Mr. Nutapong Nilrusvanit)

Tawikiat Jamsamran
 (Mr. Tawikiat Jamsamran)

Date of Calibration : 4 Jul. 2022

Date of Issue : 6 Jul. 2022

Approved by :

Prasert Klauyap
 (Mr. Prasert Klauyap)
 Director

Electrical and Electronic Standards Laboratory

Industrial Metrology and Testing Service Centre

Ref : 2011265062902932005

2 / 2

End of Certificate

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.

FMBL/MTC.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