

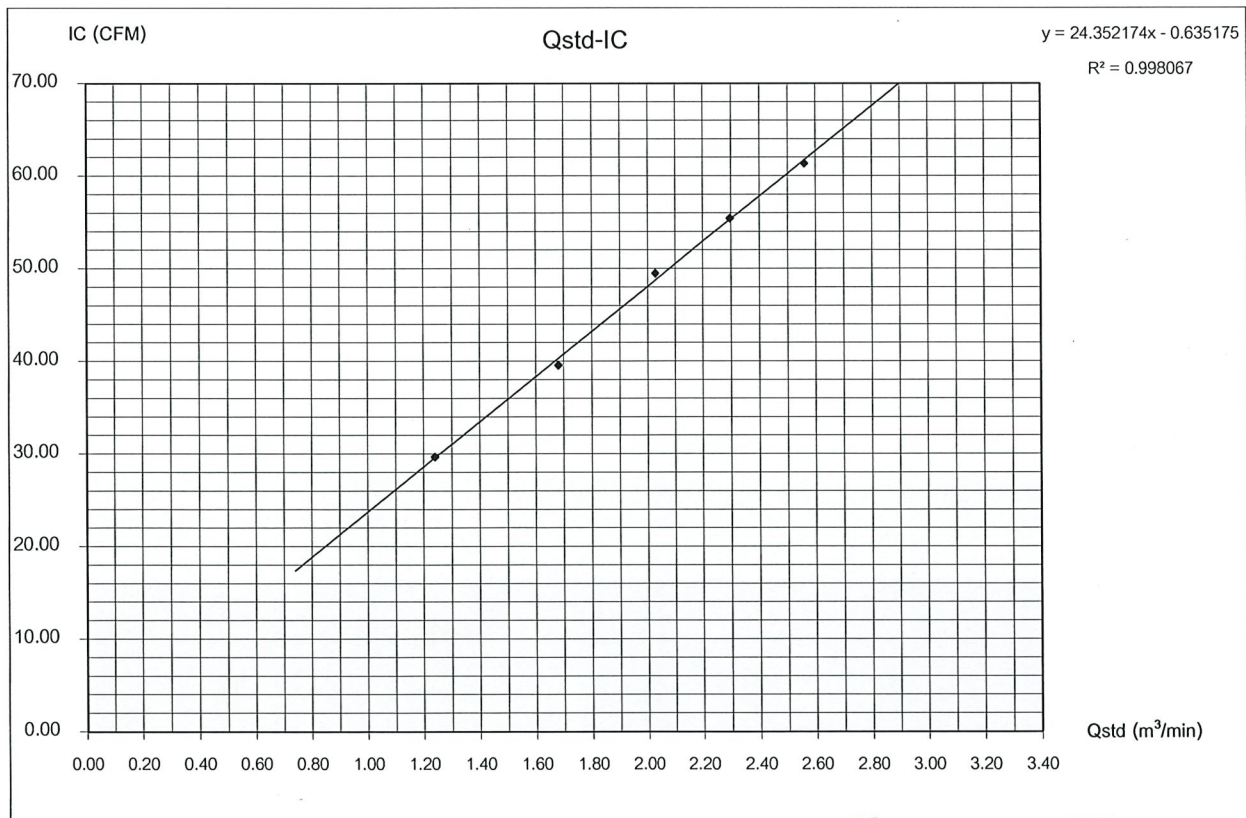
## PM10 HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

Sampler Location				Date	May 4, 2023
วัดเขาคันทรง (2022-01744)				Start Time	11:35 AM
Sampler Number	PM-10 No.28	Transfer Standard Type	Orifice	Stop Time	11:45 AM
Instrument Model	HIVOL-BMBBE	Calibrator Model	TE-5025A	Calibrated By	Mr.Somprasong Thetsakun
Motor Serial Number	2206	Calibrator Serial Number	2716		
Recorder Serial Number	2613				

Plate No.	(Delta H)			( A )	( X )	( I )	( Y )	Temperature	Barometric Pressure	Start Meter	Stop Meter
	Pressure Drop Across Orifice (inH <sub>2</sub> O)			$[\Delta H_2O(Pa/P_{std})(T_{std}/Ta)]^{1/2}$	$Qstd = (1/m)[(A-b)]$	Sample Flow Rate Indication	$IC = I[(Pa/P_{std})(T_{std}/Ta)]^{1/2}$				
	Positive	Negative	$\Delta H_2O$		( m <sup>3</sup> /min )	( ft <sup>3</sup> /min )		(°K = °C+273)	( mmHg )		
5	1.3	1.3	2.6	1.59593	1.24026	30.0	29.69	303.0	757.0		
7	2.4	2.4	4.8	2.16845	1.68046	40.0	39.59	303.0	757.0		
10	3.5	3.5	7.0	2.61865	2.02662	50.0	49.49	303.0	757.0		
13	4.5	4.5	9.0	2.96927	2.29620	56.0	55.43	303.0	757.0		
18	5.6	5.6	11.2	3.31236	2.56000	62.0	61.36	303.0	757.0		
Linear Regression Y ON X : Y= mX + b							Average	303.0	757.0		
1	Slope ( m )			1.30058	Linear Equation			r <sup>2</sup>	0.998067	Pstd(mmHg)	760.0
2	Intercept ( b )			-0.01713	Set Point Flow Rate ( X ) (m <sup>3</sup> /min)		1.133	r	0.999033	T <sub>NTP</sub>	298.0
3	Correlation Coefficient ( r )			0.99953	Final Set Flow Rate = ( I )		0	(Pa/Pstd)*(Tstd/Ta)			0.97961612
Result								C=(Pa/Pstd)*(Tstd/Ta)^0.5			0.989755586

COMMENT

Andersen Instruments, Inc.



Checked By

( Mr. Prayun Detkla )  
Technician

envi research  
ENVIRONMENT RESEARCH & TECHNOLOGY CO., LTD.

Approved By

( Mr. Panupon Podang )  
Environmental Scientist

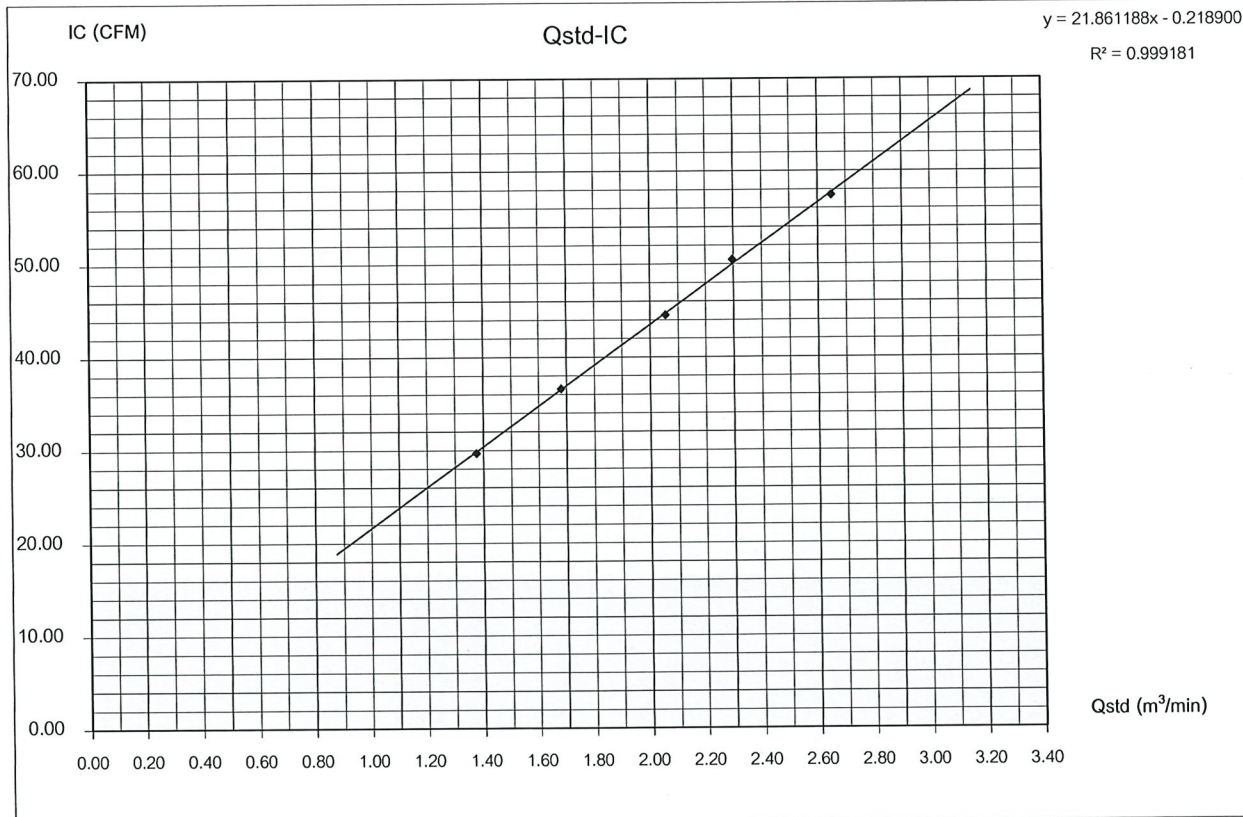
# TSP HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

Sampler Location		Date	
วัดเขาคันทรง(2022-01744)		May 4, 2023	
Sampler Number	TSP No.A28	Transfer Standard Type	Orifice
Instrument Model	HIVOL-BBCBE	Calibrator Model	TE-5025A
Motor Serial Number	2217	Calibrator Serial Number	2716
Recorder Serial Number	2134	Calibrated By	
		Mr.Somprasong Thetsakun	

Plate No.	(Delta H)			( A )	( X )	( I )	( Y )	Temperature	Barometric Pressure	Start Meter	Stop Meter
	Pressure Drop Across Orifice (inH <sub>2</sub> O)			[ΔH <sub>2</sub> O(Pa/P <sub>std</sub> )(T <sub>std</sub> /Ta)] <sup>1/2</sup>	Qstd = (1/m)[(A-b)] ( m <sup>3</sup> /min )	ample Flow Rate Indication ( ft <sup>3</sup> /min )	IC = I[(Pa/P <sub>std</sub> )(T <sub>std</sub> /Ta)] <sup>1/2</sup>	(°K = °C+273)	( mmHg )		
	Positive	Negative	ΔH <sub>2</sub> O								
5	1.6	1.6	3.2	1.77053	1.37451	30.0	29.69	303.0	757.0		
7	2.4	2.4	4.8	2.16845	1.68046	37.0	36.62	303.0	757.0		
10	3.6	3.6	7.2	2.65579	2.05518	45.0	44.54	303.0	757.0		
13	4.5	4.5	9.0	2.96927	2.29620	51.0	50.48	303.0	757.0		
18	6.0	6.0	12.0	3.42861	2.64939	58.0	57.41	303.0	757.0		
Linear Regression Y ON X : Y= mX + b							Average	303.0	757.0		
1	Slope ( m )			1.30058	Linear Equation			r <sup>2</sup>	0.999181	Pstd(mmHg)	760.0
2	Intercept ( b )			-0.01713	Set Point Flow Rate ( X ) ( m <sup>3</sup> /min )		1.133	r	0.9995904	T <sub>NTP</sub>	298.0
3	Correlation Coefficient ( r )			0.99953	Final Set Flow Rate = ( I )		0	(Pa/Pstd)*(Tstd/Ta)		0.97961612	
Result								C=(Pa/Pstd)*(Tstd/Ta)^0.5		0.98975586	

## COMMENT

Andersen Instruments, Inc.



Checked By

( Mr. Prayun Detkla )  
Technician

envi research  
ENVIRONMENT RESEARCH & TECHNOLOGY CO., LTD.

Approved By

( Mr. Panupon Podang )  
Environmental Scientist



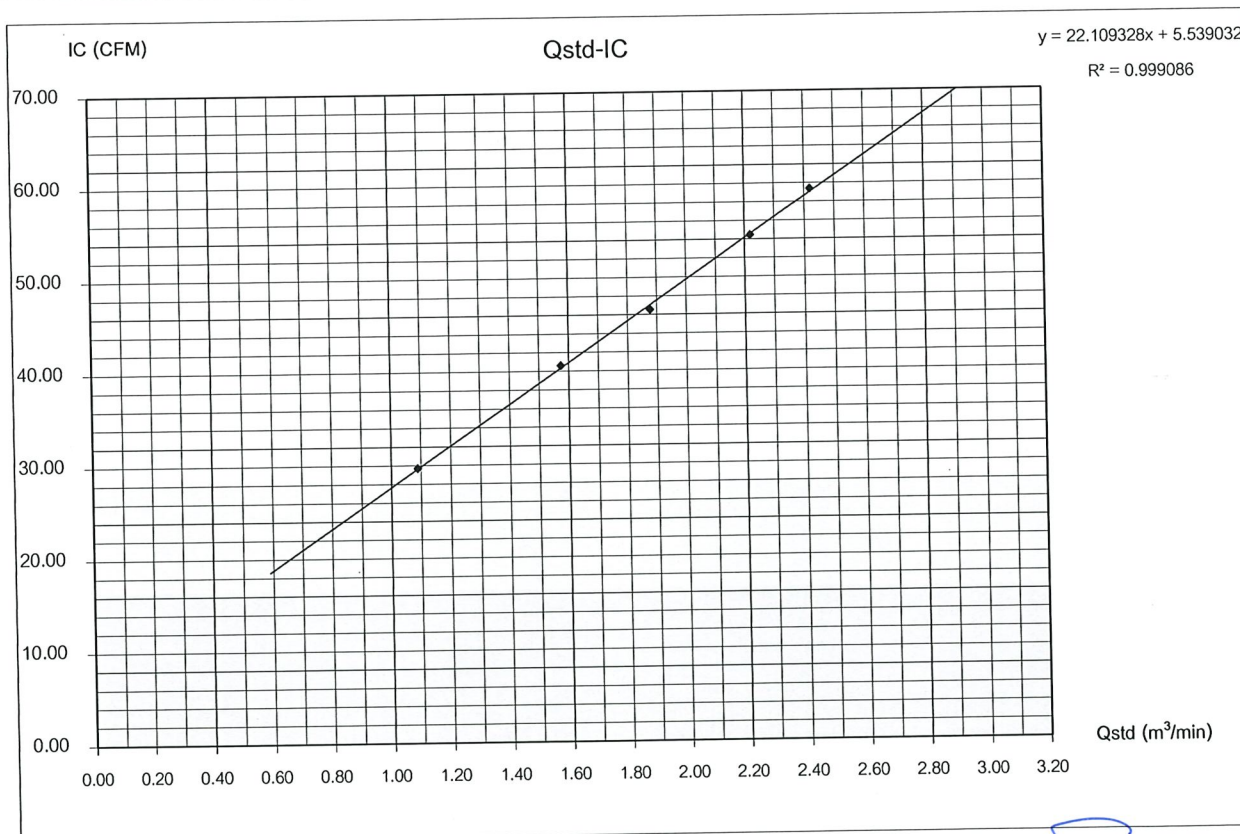
# PM10 HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

Sampler Location				Date	May 4, 2023
บ้านนาบเชิง (2022-01744)				Start Time	12:13 PM
Sampler Number	PM-10 No.27	Transfer Standard Type	Orifice	Stop Time	12:23 PM
Instrument Model	HIVOL-BMBBE	Calibrator Model	TE-5025A	Calibrated By	Mr. Auttapol Areejit
Motor Serial Number	2209	Calibrator Serial Number	2716		
Recorder Serial Number	2612				

Plate No.	(Delta H)			( A )	( X )	( I )	( Y )	Temperature	Barometric	Start	Stop
	Pressure Drop Across Orifice (inH <sub>2</sub> O)			$[\Delta H_2O(Pa/P_{std})(T_{std}/Ta)]^{1/2}$	Qstd = (1/m)[(A-b)] ( m <sup>3</sup> /min )	Sample Flow Rate Indication ( ft <sup>3</sup> /min )	$IC = I[(Pa/P_{std})(T_{std}/Ta)]^{1/2}$	(^°K = ^°C+273)	Pressure ( mmHg )	Meter	Meter
	Positive	Negative	ΔH <sub>2</sub> O								
5	1.0	1.0	2.0	1.39973	1.08940	30.0	29.69	303.0	757.0		
7	2.1	2.1	4.2	2.02840	1.57278	41.0	40.58	303.0	757.0		
10	3.0	3.0	6.0	2.42440	1.87726	47.0	46.52	303.0	757.0		
13	4.2	4.2	8.4	2.86858	2.21879	55.0	54.44	303.0	757.0		
18	5.0	5.0	10.0	3.12988	2.41970	60.0	59.39	303.0	757.0		
Linear Regression Y ON X : Y = mX + b							Average	303.0	757.0		
1	Slope ( m )			1.30058	Linear Equation			r <sup>2</sup>	0.999086	Pstd(mmHg)	760.0
2	Intercept ( b )			-0.01713	Set Point Flow Rate ( X ) ( m <sup>3</sup> /min )		1.133	r	0.9995429	T <sub>HTP</sub>	298.15
3	Correlation Coefficient ( r )			0.99953	Final Set Flow Rate = ( I )		0	(Pa/Pstd)*(Tstd/Ta)			0.97961612
Result								C=(Pa/Pstd)*(Tstd/Ta)^0.5			0.989755586

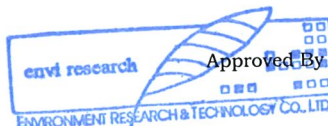
## COMMENT

Andersen Instruments, Inc.



Checked By

( Mr. Prayun Detkla )  
Technician



Approved By

( Mr. Panupon Podang )  
Environmental Scientist

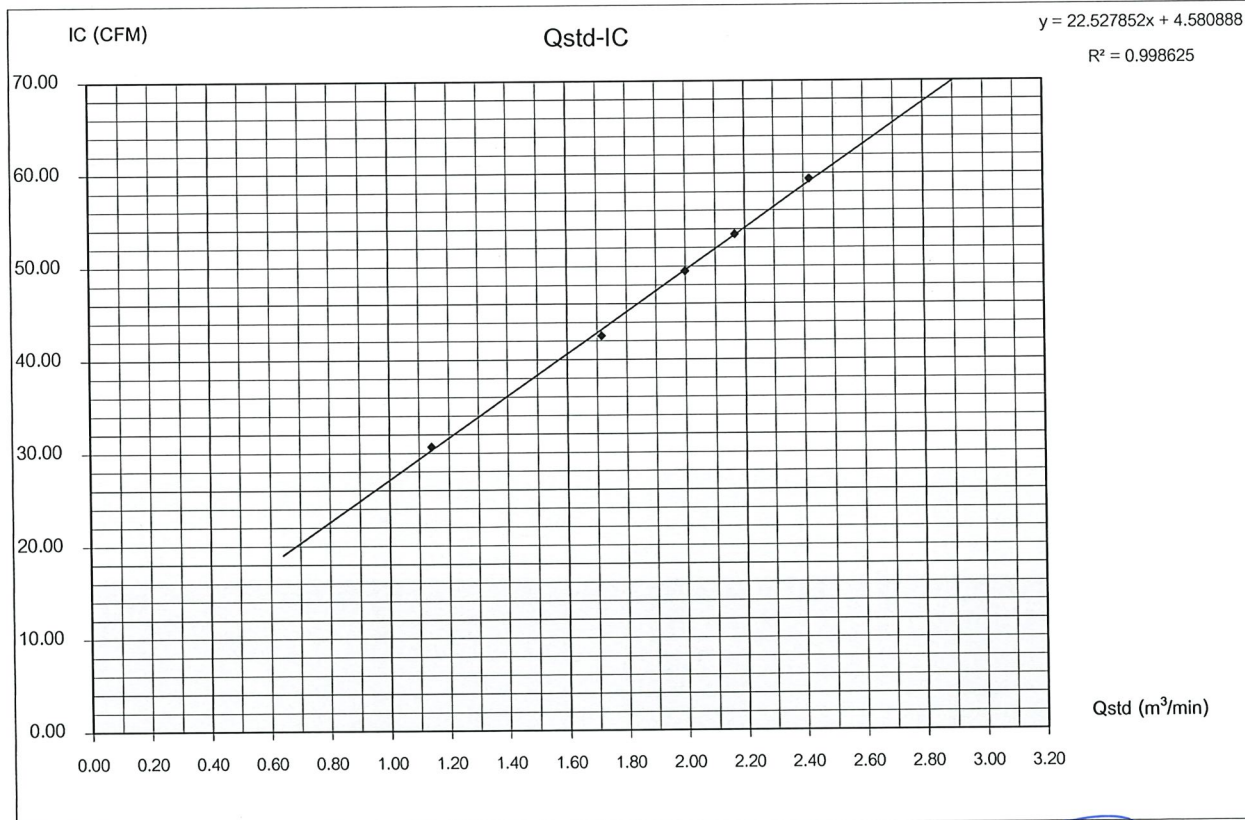
# TSP HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

Sampler Location		Date	
บ้านนาบเชิง(2022-01744)		May 4, 2023	
Sampler Number	TSP No.A21	Transfer Standard Type	Orifice
Instrument Model	HIVOL-BBCBE	Calibrator Model	TE-5025A
Motor Serial Number	2216	Calibrator Serial Number	2716
Recorder Serial Number	2398	Calibrated By	
		Mr. Auttapol Areejit	

Plate No.	(Delta H)			( A )	( X )	( I )	( Y )	Temperature	Barometric Pressure	Start Meter	Stop Meter
	Pressure Drop Across Orifice (inH <sub>2</sub> O)			$[\Delta H_2O(Pa/P_{std})(T_{std}/Ta)]^{1/2}$	Qstd = (1/m)[(A-b)] ( m <sup>3</sup> /min )	ample Flow Rate Indication ( ft <sup>3</sup> /min )	IC = I[(Pa/P <sub>std</sub> )(T <sub>std</sub> /Ta)] <sup>1/2</sup>	°K = °C+273)	( mmHg )		
	Positive	Negative	ΔH <sub>2</sub> O								
5	1.1	1.1	2.2	1.46804	1.14193	31.0	30.68	303.0	757.0		
7	2.5	2.5	5.0	2.21316	1.71484	43.0	42.56	303.0	757.0		
10	3.4	3.4	6.8	2.58097	1.99764	50.0	49.49	303.0	757.0		
13	4.0	4.0	8.0	2.79945	2.16563	54.0	53.45	303.0	757.0		
18	5.0	5.0	10.0	3.12988	2.41970	60.0	59.39	303.0	757.0		
Linear Regression Y ON X : Y= mX + b							Average	303.0	757.0		
1	Slope ( m )			1.30058	Linear Equation			r <sup>2</sup>	0.998625	Pstd(mmHg)	760.0
2	Intercept ( b )			-0.01713	Set Point Flow Rate ( X ) (m <sup>3</sup> /min)		1.133	r	0.9993123	T <sub>NTP</sub>	298.0
3	Correlation Coefficient ( r )			0.99953	Final Set Flow Rate = ( I )		0	(Pa/Pstd)*(Tstd/Ta)			0.97961612
Result								C=(Pa/Pstd)*(Tstd/Ta)^0.5			0.989755586

## COMMENT

Andersen Instruments, Inc.



Checked By

( Mr. Prayun Detkla )  
Technician



Approved By

( Mr. Panupon Podang )  
Environmental Scientist



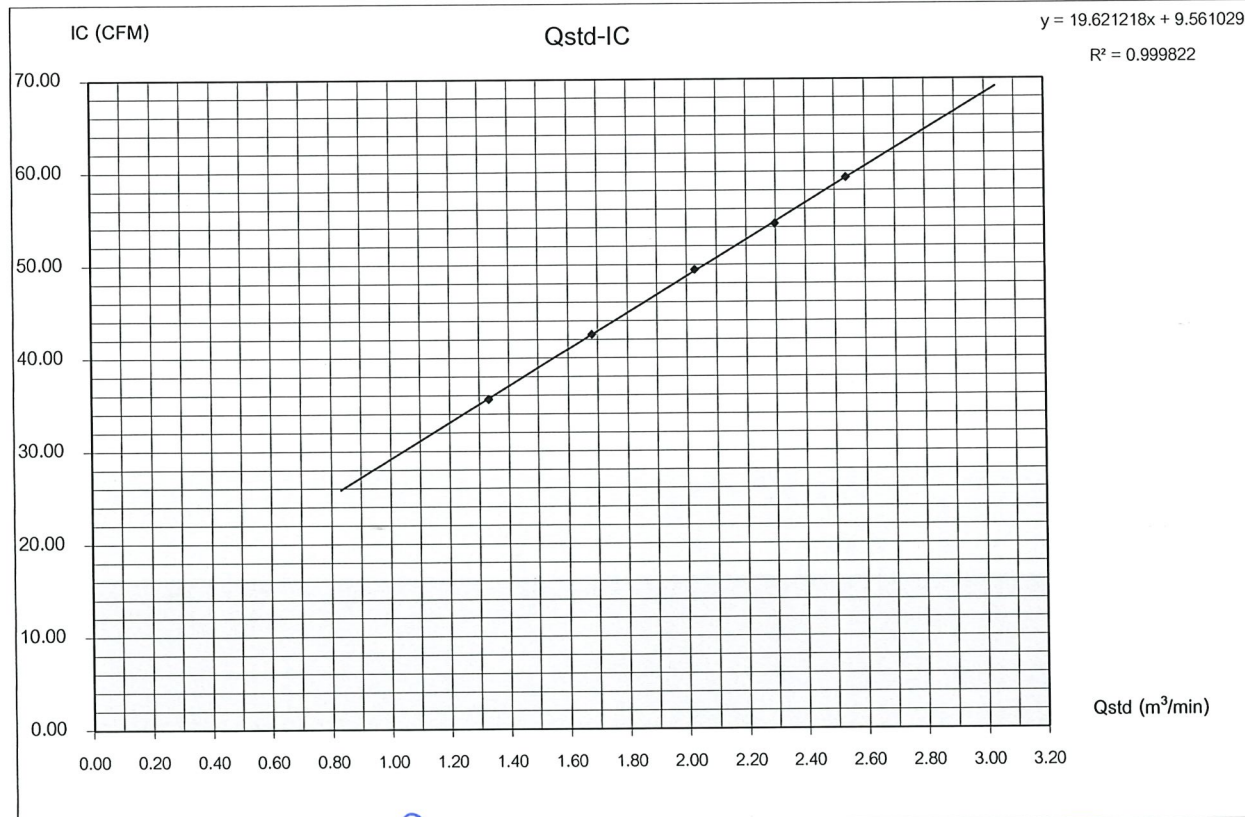
# TSP HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

Sampler Location		Date	
บ้านนาบดิน (2022-01744)		May 4, 2023	
Sampler Number	TSP No.A25	Transfer Standard Type	Orifice
Instrument Model	HIVOL-BBCBE	Calibrator Model	TE-5025A
Motor Serial Number	2152	Calibrator Serial Number	2716
Recorder Serial Number	2411	Calibrated By	
		Mr. Auttapol Areejit	

Plate No.	(Delta H)			( A )	( X )	( I )	( Y )	Temperature	Barometric Pressure	Start Meter	Stop Meter
	Pressure Drop Across Orifice (inH <sub>2</sub> O)			[ΔH <sub>2</sub> O(Pa/P <sub>std</sub> )(T <sub>std</sub> /Ta)] <sup>1/2</sup>	Qstd = (1/m)[(A-b)] ( m <sup>3</sup> /min )	ample Flow Rate Indicato ( ft <sup>3</sup> /min )	IC = I[(Pa/P <sub>std</sub> )(T <sub>std</sub> /Ta)] <sup>1/2</sup>	(°K = °C+273)	( mmHg )		
	Positive	Negative	ΔH <sub>2</sub> O								
5	1.5	1.5	3.0	1.71431	1.33128	36.0	35.63	303.0	757.0		
7	2.4	2.4	4.8	2.16845	1.68046	43.0	42.56	303.0	757.0		
10	3.5	3.5	7.0	2.61865	2.02662	50.0	49.49	303.0	757.0		
13	4.5	4.5	9.0	2.96927	2.29620	55.0	54.44	303.0	757.0		
18	5.5	5.5	11.0	3.28265	2.53716	60.0	59.39	303.0	757.0		
Linear Regression Y ON X : Y= mX + b							Average	303.0	757.0		
1	Slope ( m )			1.30058	Linear Equation			r <sup>2</sup>	0.999822	Pstd(mmHg)	760.0
2	Intercept ( b )			-0.01713	Set Point Flow Rate ( X ) ( m <sup>3</sup> /min )		1.133	r	0.999911	T <sub>NTP</sub>	298.0
3	Correlation Coefficient ( r )			0.99953	Final Set Flow Rate = ( I )		0	(Pa/Pstd)*(Tstd/Ta)			0.97961612
Result								C=(Pa/Pstd)*(Tstd/Ta)^0.5			0.98975586

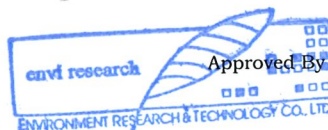
## COMMENT

Andersen Instruments, Inc.



Checked By

( Mr. Prayun Detkla )  
Technician



Approved By

( Mr. Panupon Podang )  
Environmental Scientist

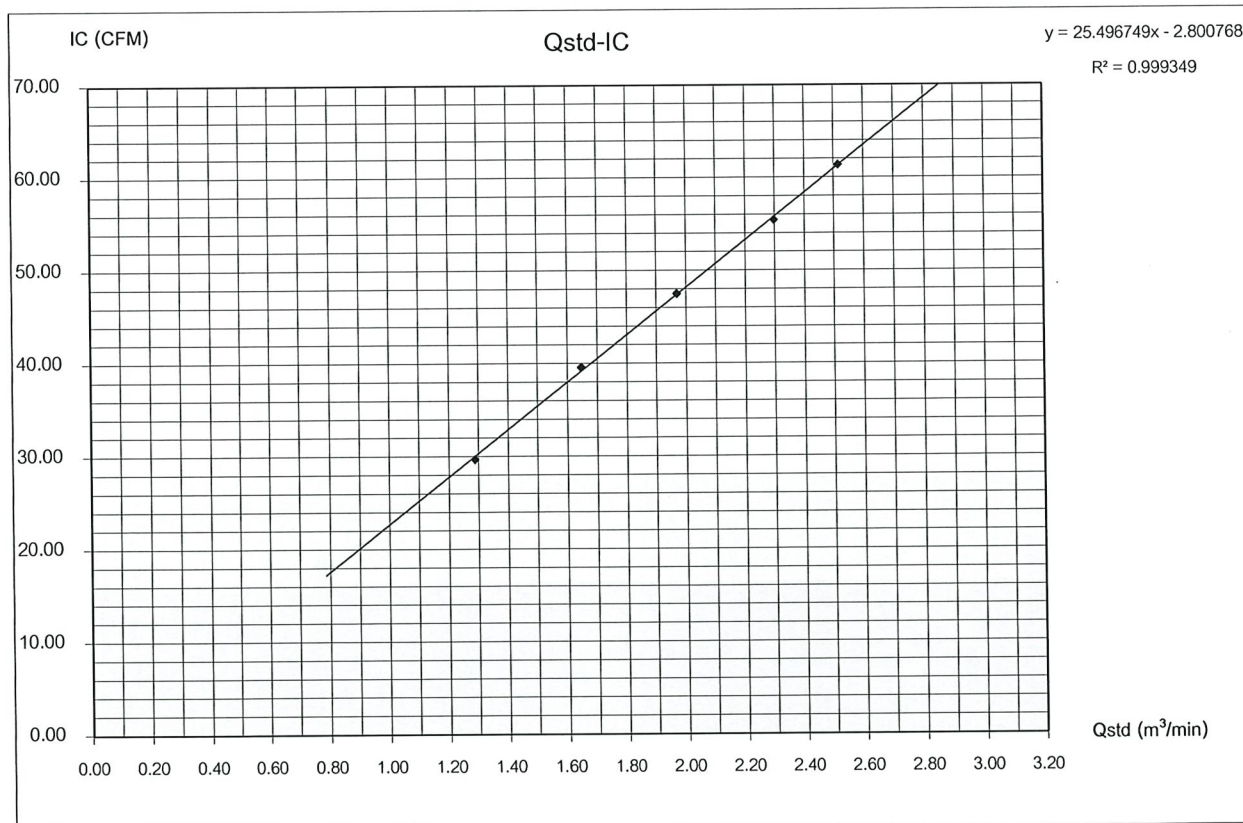
## PM10 HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

Sampler Location				Date	May 4, 2023
บ้านนาแสนสุข (2022-01744)				Start Time	12:40 PM
Sampler Number	PM-10 No.23	Transfer Standard Type	Orifice	Stop Time	12:50 PM
Instrument Model	HIVOL-BMBBE	Calibrator Model	TE-5025A	Calibrated By	Mr. Auttapol Areejit
Motor Serial Number	2135	Calibrator Serial Number	2716		
Recorder Serial Number	2391				

Plate No.	(Delta H)			( A )	( X )	( I )	( Y )	Temperature	Barometric Pressure	Start Meter	Stop Meter
	Pressure Drop Across Orifice (inH <sub>2</sub> O)			[ΔH <sub>2</sub> O(Pa/P <sub>std</sub> )(T <sub>std</sub> /Ta)] <sup>1/2</sup>	Qstd = (1/m)[(A-b)] ( m <sup>3</sup> /min )	ample Flow Rate Indicaio ( ft <sup>3</sup> /min )	IC = I[(Pa/P <sub>std</sub> )(T <sub>std</sub> /Ta)] <sup>1/2</sup>	(°K = °C+273)	( mmHg )		
	Positive	Negative	ΔH <sub>2</sub> O								
5	1.4	1.4	2.8	1.65618	1.28659	30.0	29.69	303.0	757.0		
7	2.3	2.3	4.6	2.12279	1.64536	40.0	39.59	303.0	757.0		
10	3.3	3.3	6.6	2.54273	1.96824	48.0	47.51	303.0	757.0		
13	4.5	4.5	9.0	2.96927	2.29620	56.0	55.43	303.0	757.0		
18	5.4	5.4	10.8	3.25267	2.51411	62.0	61.36	303.0	757.0		
Linear Regression Y ON X : Y= mX + b							Average	303.0	757.0		
1	Slope ( m )			1.30058	Linear Equation			r <sup>2</sup>	0.999349	Pstd(mmHg)	760.0
2	Intercept ( b )			-0.01713	Set Point Flow Rate ( X ) (m <sup>3</sup> /min)		1.133	r	0.9996744	T <sub>NTP</sub>	298.15
3	Correlation Coefficient ( r )			0.99953	Final Set Flow Rate = ( I )		0	(Pa/Pstd)*(Tstd/Ta)			0.97961612
Result								C=(Pa/Pstd)*(Tstd/Ta)^0.5			0.989755586

### COMMENT

Andersen Instruments, Inc.



Checked By

( Mr. Prayun Detkla )  
Technician



Approved By

( Mr. Panupon Podang )  
Environmental Scientist



## CERTIFICATE OF CALIBRATION

Certificate No. : CL-006-66

Page 1 of 2 Pages

**MEASUREMENT ITEM** : Top Load Orifice  
**MANUFACTURER** : TISCH  
**MODEL/TYPE** : TE-5025A  
**SERIAL NUMBER** : 2716  
**ID NUMBER** : -  
**CONDITION AS-RECEIVED** : Used Item  
**CUSTOMER** : Environment Research & Technology Co., Ltd.  
25/114 Moo 6 Soi Chinaket 1, Ngamwongwan Road,  
Toongsonghong, Laksi, Bangkok 10210

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

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

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

### ENVIRONMENTAL CONDITIONS:

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

### CALIBRATION CONDITION:

Preconditioning : 24 hours at ambient conditions.  
Measurement Condition : The average values during measurement are 24.4 °C and 62.0%RH.

### TABULATION OF RESULTS:

The table on next page give the measured values.

### MEASUREMENT RESULTS:

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

Table 1: The results of  $Q$  Standard calibration data

Plate	Flow rate $m^3/min$	Pressure [Pa] mmHg	Temperature [Ta] °C	Temperature [Tm] °C	$\Delta p_{meter}$ mmHg	$\Delta p_{Orifice}$ inH <sub>2</sub> O	$\gamma$	Standard Flow [ $Q_s$ ] $m^3/min$
1	0.701	754.759	24.59	24.15	53.063	1.773	1.328	0.649
2	0.999	754.747	24.68	24.23	56.842	3.507	1.867	0.920
3	1.125	754.738	24.15	23.97	40.867	4.758	2.177	1.060
4	1.166	754.757	24.46	24.26	29.829	5.265	2.289	1.115
5	1.416	754.783	24.27	24.08	30.001	7.812	2.789	1.354

Slope (m): 2.07647  
Intercept (b): -0.02720  
Correlation coefficient (r): 0.99954  
Uncertainty ( $k=2$ ): 0.015  $m^3/min$

Table 2: The results of  $Q$  actual calibration data

Plate	Flow rate $m^3/min$	Pressure [Pa] mmHg	Temperature [Ta] °C	Temperature [Tm] °C	$\Delta p_{meter}$ mmHg	$\Delta p_{Orifice}$ inH <sub>2</sub> O	$\gamma$	Standard Flow [ $Q_s$ ] $m^3/min$
1	0.701	754.759	24.59	24.15	53.063	1.773	0.836	0.652
2	0.999	754.747	24.68	24.23	56.842	3.507	1.176	0.925
3	1.125	754.738	24.15	23.97	40.867	4.758	1.369	1.064
4	1.166	754.757	24.46	24.26	29.829	5.265	1.441	1.121
5	1.416	754.783	24.27	24.08	30.001	7.812	1.754	1.360

Slope (m): 1.30058  
Intercept (b): -0.01713  
Correlation coefficient (r): 0.99953  
Uncertainty ( $k=2$ ): 0.015  $m^3/min$



\*\*\*End of Certificate of Calibration\*\*\*

Calibrated by:

☒ Mr. Sorawit Thachalad  
☐ Miss Jitraporn Lertsomphol




Approved signatory:   
Mr. Parinya Booncharoen  
Calibration Department Manager

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: 

### Weighing Device

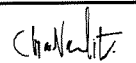
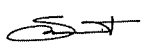
Manufacturer: Mettler Toledo Instrument Type: Weighing Instrument  
Model: AB204-S Asset Number: ERTC-LIN-0048  
Serial No.: 1123103723 Terminal Model: N/A  
Building: N/A Terminal Serial No.: N/A  
Floor: 4 Terminal Asset No.: N/A  
Room: 406

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

### Procedure

Calibration Guideline: EURAMET cg-18 v. 4.0 (11/2015)  
METTLER TOLEDO Work Instruction: CP/W002/20  
This calibration certificate contains measurements for As Found and As Left calibrations.  
The sensitivity/span of the weighing instrument was adjusted before As Found and As Left calibrations with a built-in weight.  
In accordance with EURAMET cg-18 (11/2015), the test loads were selected to reflect the specific use of the weighing device or to accommodate specific calibration conditions.

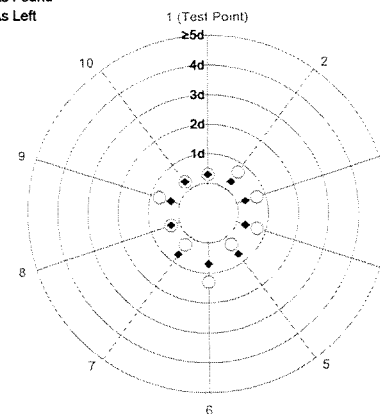
	Temperature		Humidity	
As Found	Start: 23.6 °C	End: 23.5 °C	Start: 34.6 %	End: 35.1 %
As Left	Start: 23.6 °C	End: 23.5 °C	Start: 35.0 %	End: 35.7 %

As Found Calibration Date: 17-Jan-2023  
As Left Calibration Date: 17-Jan-2023  
Issue Date: 19-Jan-2023  
Calibrator:   
Chawalit 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	99.9992 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		

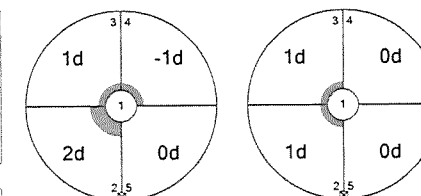


The "d" in the graph represents the readability of the range/interval in which the test was performed.

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.



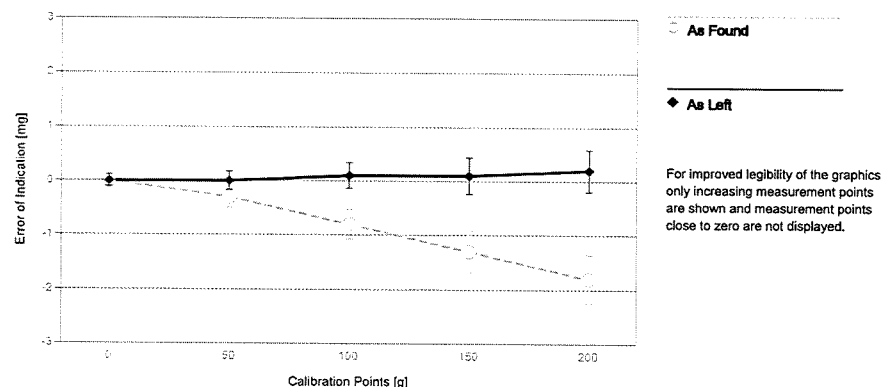
Error of Indication

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 · 10<sup>-6</sup> / K

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

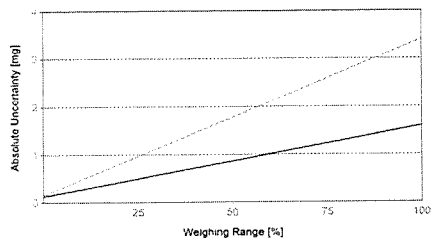
Linearization of Uncertainty Equation

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

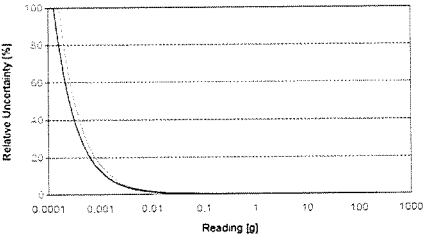
To optimize the stability of the linearization, besides of the zero load only increasing measurement points with a test load of 5% of the measurement range or larger are taken for the calculation of the linear equation.

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

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



As Found



As Left

GWP®  
Certificate



As  
Found



The weighing device meets the given  
process requirements.

As  
Left



The weighing device meets the given  
process requirements.

Tests Performed: ☒ As Found ☒ As Left

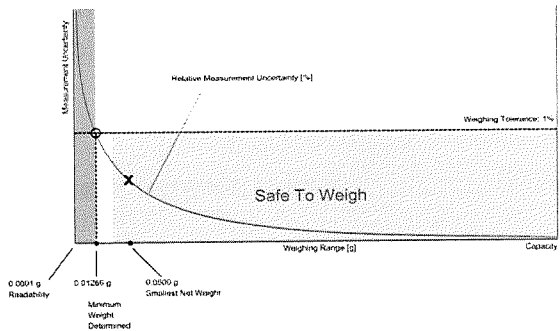
Process Requirements

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:

- If "N/A" is shown above, no appropriate value could be calculated.
- 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\*d rule is used for the assessment of this repeatability test and the calculation of the minimum weight.

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

### Eccentricity

Test Load: 100 g

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

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

Error of Indication

As Found

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

As Left

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

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

## Calibration Data of NOx Analyzer

### Analyzer Performance Test

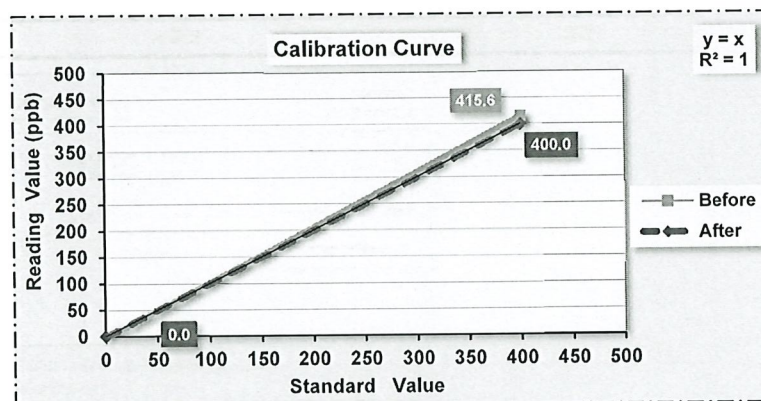
Equipment	Gas Analyzer ( NOx )	Customer Name	โพธิ์เพียร คอนซัลแตนต์
Manufacture	HORIBA	Location	Envi Research
Model	APNA-370	Quotation	2023-00617
Serial No.	4VWFEBUK	Calibration Date	May 3, 2023
Analyzer Unit	ppb	Time	11:14 AM

### 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 <sub>2</sub> = 54.9 ppm		

### Single Point Calibration

Standard Gas	Standard Gas Value	Analyzer Value								% Abs Error
		NO <sub>x</sub> ( ppb )		NO ( ppb )		NO <sub>2</sub> ( ppb )		Stability		
		Before	After	Before	After	Before	After	Before	After	
Zero	0	-2.5	0.0	-2.9	0.0	0.4	0.0	-	-	-
Span	400	423.2	400.0	415.6	400.0	7.6	0.0	-	-	3.9



### 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	0.6	1.4	Voltage of the measured NO value
Signal NOx	mV	15.5	15.4	Voltage of the measured NOx value
Detector	°C	41.0	41.2	43 °C ± 5 °C
Ambient	kPa	100.9	100.9	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	-	1.28830	0.78090	0.50000 - 2.0000
NOx Slope	-	1.28200	0.69670	0.50000 - 2.0000

Calibrate By :

(MR.PANUPON PODANG)

May 3, 2023



Checked By :

(MS.SUTATIP IM-NOI)

May 3, 2023



## Calibration Data of SO<sub>2</sub> Analyzer

### Analyzer Performance Test

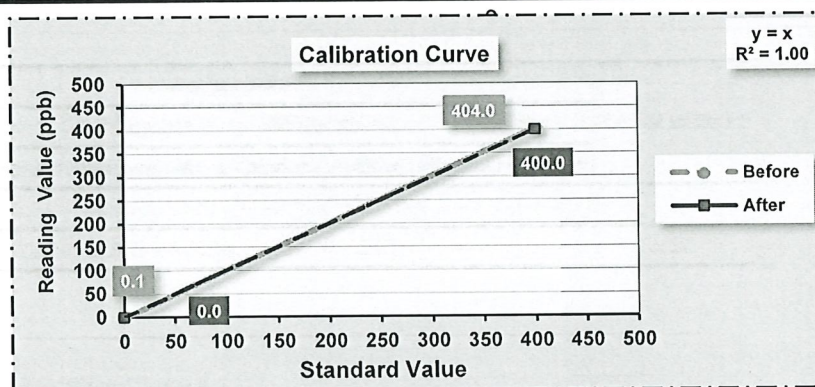
Equipment	Gas Analyzer ( SO <sub>2</sub> )	Customer Name	โพธิ์เกียรติ์ คอนซัลแตนต์
Manufacture	Thermo	Location	Envi Research
Model	43i-BNSAA	Quotation	2023-00617
Serial No.	CM14430002	Calibration Date	May 3, 2023
Analyzer Unit	ppb	Time	10:25 AM

### 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 <sub>2</sub> = 54.9 ppm		

### Single Point Calibration

Standard Gas	Standard Gas Value	Analyzer Value ( ppb )		Stability		% Abs Error
		Before	After	Before	After	
Zero	0	0.1	0.0	-	-	-
Span	400	404.0	400.0	-	-	1.0



### STATUS TEST AND VALIDATION OF SO<sub>2</sub> 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	35.9	36.0	8.0 °C to 45.0 °C
Chamber Temp	CHAMBER	°C	45.1	44.9	43.0 °C to 47.0 °C
Pressure	PRESSURE	mmHg	733.7	732.0	400.0 to 1,000
Sample Flow	SAMP FLOW	LPM	0.433	0.432	0.350 to 0.750
Lamp Intensity	LAMP INTENSITY	%	91	90	20 to 100
Lamp Voltage	LAMP VOLTAGE	V	1070	1073	500 to 1200
SO <sub>2</sub> Concentration	SO <sub>2</sub> CONCENTRATION	ppb	0.7	2.4	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 NOx Analyzer

### Analyzer Performance Test

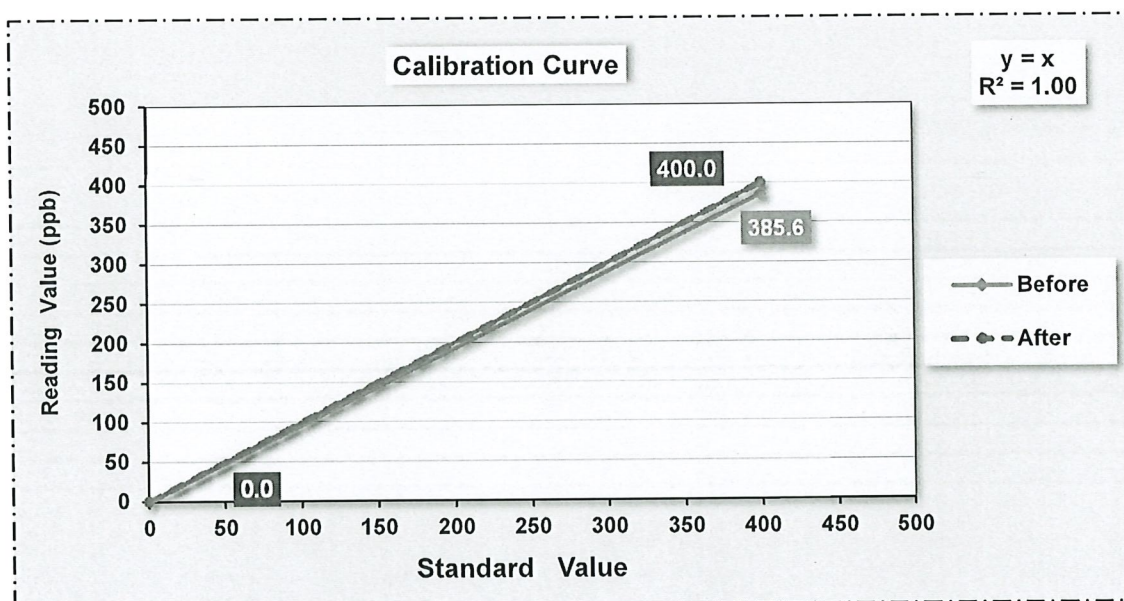
Equipment	Gas Analyzer ( NOx )	Customer Name	โพธิ์เทียมร์ คอนซัลแตนต์
Manufacture	API	Location	Envi Research
Model	200A	Quotation	2022-01744
Serial No.	1975	Calibration Date	May 3, 2023
Analyzer Unit	ppb	Time	11:33 AM

### 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 <sub>2</sub> = 54.9 ppm		

### Single Point Calibration

Standard Gas	Standard Gas Value	Analyzer Value								% Abs Error
		NO <sub>x</sub> ( ppb )		NO ( ppb )		NO <sub>2</sub> ( ppb )		Stability		
		Before	After	Before	After	Before	After	Before	After	
Zero	0	-0.2	0.0	-0.1	0.0	-0.1	0.0	-	-	-
Span	400	383.7	405.0	385.6	400.0	-1.9	5.0	-	-	3.6



## STATUS TEST AND VALIDATION OF NO<sub>x</sub> ANALYZER MODEL 200A

Parameter	Display As	Unit	Observed Value		Nominal Range
			Before Adjust	After Adjust	
Range	RANGE	ppb	500	500	0 - 500 standard
Stability	STABIL	ppb	0.4	0.2	< 2 with zero air
Sample Flow	SAMP FL	cc / min	483.0	480.0	500 +/- 50
Ozone Flow	OZONE FL	cc / min	74.0	7.5	80 +/- 10
PMT signal	PMT	mV	55.5	46.4	0 to 5,000
Auto - Zero	AZERO	mV	34.9	34.8	-20 to 150
High Voltage Power Supply	HVPS	V	790.0	790.0	450 to 900
Reaction Cell Temperature	RCELL TEMP	°C	49.8	49.8	50 +/- 1
Box Temperature	BOX TEMP	°C	35.4	32.8	Ambient temp.+3 / -7
PMT Temperature	PMT TEMP	°C	7.0	7.1	7 +/- 1
Converter Temperature	MOLY TEMP	°C	314.2	315.1	315 +/- 5
Reaction Cell Pressure	RCEL	In - Hg - A	9.8	9.6	2 to 10 ( Constant )
Sample Pressure	SAMP	In - Hg - A	30.9	31.2	Ambient - 1 ( Constant )
NO <sub>x</sub> Slope	NO <sub>x</sub> SLOPE	-	1.135	1.216	1.000 +/- 0.300
NO <sub>x</sub> Offset	NO <sub>x</sub> OFFSET	mV	-1.3	-1.3	0 +/- 20
NO Slope	NO SLOPE	-	1.061	1.102	1.000 +/- 0.300
NO Offset	NO OFFSET	mV	-1.5	-1.5	0 +/- 20

Calibrate By :



(MR.PANUPON PODANG)

May 3, 2023



Checked By :



(MS.SUTATIP IM-NOI)

May 3, 2023



## Calibration Data of SO<sub>2</sub> Analyzer

### Analyzer Performance Test

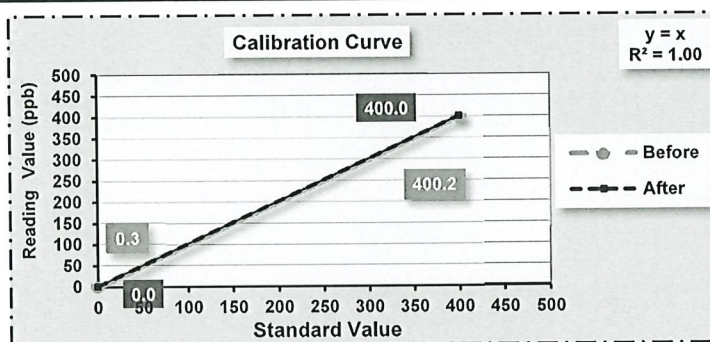
Equipment	Gas Analyzer ( SO <sub>2</sub> )	Customer Name	โพธิ์เกียรติ์ คอนซัลแตนต์
Manufacture	Horiba	Location	Envi Research
Model	APSA-370	Quotation	2023-00617
Serial No.	12E8X34P	Calibration Date	May 2, 2023
Analyzer Unit	ppb	Time	1:47 PM

### 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 <sub>2</sub> = 54.9 ppm		

### Single Point Calibration

Standard Gas	Standard Gas Value	Analyzer Value ( ppb )		Stability		% Abs Error
		Before	After	Before	After	
Zero	0	0.3	0.0	-	-	-
Span	400	400.2	400.0	-	-	0.0



### STATUS TEST AND VALIDATION OF SO<sub>2</sub> ANALYZER MODEL APSA-370

Parameter	Unit	Observed Value		Nominal Range
		Before Adjust	After Adjust	
Range	ppb	500	500	0 - 500 Standard
Signal (SO <sub>2</sub> )	mV	3.6	3.0	Voltage of the measured SO <sub>2</sub> value
LAMP	mV	272.4	272.4	200 mV - 1200 mV
CELL	°C	38.7	38.8	Ambient temperature + 5 °C - 15 °C
PUMP	Kpa	44.0	44.0	65 kPa or less
AMBIENT	kPa	100.7	100.7	Current atmospheric pressure
DC 24V	V	23.9	23.9	24 V ±0.5 V
DC 5V	V	5.0	5.0	5 V ±0.5 V

Calibrate By :

(MR.PANUPON PODANG)  
May 2, 2023

Checked By :

(MS.SUTATIP IM-NOI)  
May 2, 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 20 August, 2022

Certification No. 340/22

Page : 1 of 2

Object : Wind speed and wind direction

Manufacturer : Davis Instruments Inc.

Type : Weather Wizard III Product No. 7425

Serial No. : WC60110A03 ID No. : No.11

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

Calibration Condition : Temperature 25.1 °C Barometric Pressure 1008.1 hPa

### NATIONAL STANDARD WIND TUNNEL :

: Thermal Anemometer 642 S/N 91563

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

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

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

Serial Number 110730029 (sensor 120629586)

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

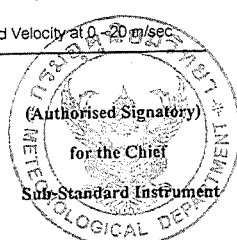
Calibrated by : *Handwritten signature*

Mr. Watcharapol Subwat

Mechanical Engineer

Signed :

Mr. Pisood Promsut



# THAI METEOROLOGICAL DEPARTMENT

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

## The Result of Calibration

Certification No. 340/22

20 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	-	-	-	0.4	0.60
3.02	-	-	-	2.2	0.82
5.00	-	-	-	4.5	0.50
7.04	-	-	-	6.3	0.74
9.02	-	-	-	8.5	0.52
11.01	-	-	-	10.3	0.71
13.01	-	-	-	12.5	0.51
15.01	-	-	-	14.8	0.21
17.02	-	-	-	16.5	0.52
20.02	-	-	-	19.8	0.22

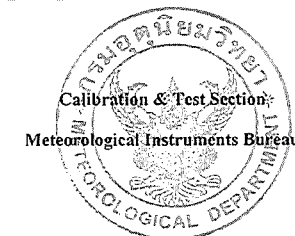
Wind Aloft Plotting Board.	
US.DEPARTMENT OF COMMERCE WEATHER BUREAU	
WIND DIRECTION	TESTED WIND DIRECTION
0	0
90	90
180	180
270	270

Calibrated by :

*Handwritten signature*

Mr. Watcharapol Subwat

Mechanical Engineer





# Sound Level Meter Calibration Report

**Support Equipment Type** : Sound Level Calibrator

**Manufacture** : BSWA

**Model** : CA111

**Serial No.** : 590337

### Range of Calibrator

**- Sound Pressure Level : 94.0 dB.**

- **Frequency** : 1,000 Hz.

**Calibrated By** : Mr.Akarawat Kochobog

**Calibration Date** : May 5, 2023

**Customer Name** : บริษัท โฟร์เทียร์ คอนสตรัคชั่น จำกัด : โครงการโรงงานผลิตทองแดงบริสุทธิ์และโลหะมีค่า  
บริษัท จิน จี แมททีเรียล เทคโนโลยี จำกัด

[illegible]

Checked By

Mr. Prayun Detkla  
Technician

Approved By

Ms.Sutatip Im-noi  
Environmental Scientist



# Calibration Chart

BSWA TECH

BSWA-IV-C021-03-0048A

Sound Calibrator model CA111  
Serial Number 590337  
Appearance OK  
Power Supply 1.5V LR6 (AA battery) x2  
Sound Pressure Level 94.02 / 114.0 dB  
Frequency 1000.6 / 1000.6 Hz  
THD (@1000Hz) 0.52 / 1.22 %

Copying and using select parts, or tampering with this document without the permission of BSWA is forbidden!

## BSWA Technology Ltd.

[www.bswa-tech.com](http://www.bswa-tech.com)

This equipment was calibrated at the following ambient conditions:

Temperature: 20 °C  
Humidity: 40 %RH  
Pressure: 1025 hPa

This equipment is qualified!

C. J.  
Calibrated

2023-3-7  
Date



## Certificate of Calibration - Supplemental

### Nomenclature

$P_b$  - Barometric Pressure  
DGM - Dry Gas Meter  
 $K_1$  - Constant based on standard temp and press  
 $t$  - Run time, in minutes  
 $P_{ref}$  -  $\Delta H$  (Meter Pressure, gauge)  
 $V_{ref}$  - Volume collected by test meter, corrected for STP  
 $Q_{ref}$  - Calculated flow rate of test meter  
 $K'$  - Critical orifice coefficient  
 $P_w$  - Measured pressure of reference meter  
 $T_w$  - Temperature measured in reference meter

### Equations

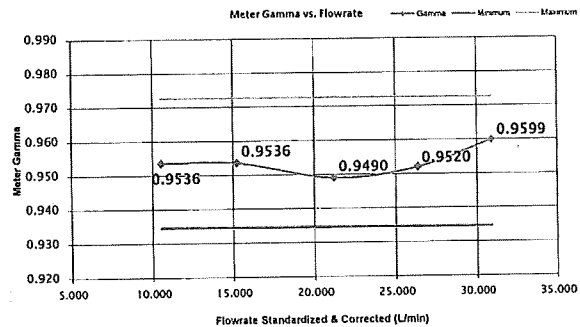
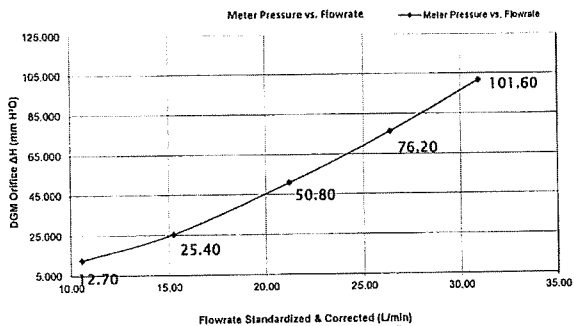
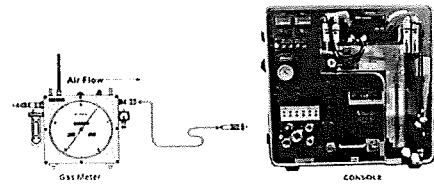
$$V_{ref}(std) = Y * K_1 * \frac{V_w * (P_{bar} + \frac{P_{ref}(std)}{13.6})}{T_w}$$

$$V_{ref}(std) = \frac{K_1 * V_w * (P_{bar} + \frac{\Delta H}{13.6})}{T_w}$$

$$K_1 = \frac{T_{std}}{P_{std}} \quad Y = \frac{V_{ref}(std)}{V_w} \quad Q_{ref}(std) = \frac{V_{ref}(std)}{t}$$

$$Metric \Delta H_g = \frac{P_{ref} + 0.0011606 * (P_{bar} + \frac{P_{ref}}{13.6})}{T_w} * (T_w + 273)^2$$

### Calibration Train



neediss  
Neediss Supply Instrument Co., Ltd.



## Certificate of Calibration

Method 5 Pre-Test Calibration - Liters (L)

### UUT Meter Console Information

Model #: XC-522  
Serial #: 1107043  
DGM Model #: GB/T6968-2011  
DGM Serial #: L15000332903

### Calibration Conditions

Bar. Pressure (mm Hg): 762.8  
Ambient Temperature (°C): 24.9  
Relative Humidity (%): 61  
Altitude (m): 1.83  
Bar. Pressure Corr. (mm Hg): 762.7

### Factors/Conversions

Std. Temp. (K): 293.15  
Std. Press. (mm Hg): 760  
 $K_1$  (K/mm Hg): 0.3857

### Reference Equipment

Calibration Meter Model: DGM-200H  
Cal. Due Date: 13-May-22  
Serial No.: 0000026  
Gamma: 1.0000

### UUT Meter (DGM)

Run Time (min:sec)	Orifice, $\Delta H$ (mm H <sub>2</sub> O)	Volume			Meter Temperature (°C)		Meter Pressure (mm H <sub>2</sub> O)	Volume (L)			Outlet Temperature (°C)	
		Initial (L)	Final (L)	Total (L)	Initial	Final		Initial	Final	Total	Initial	0.00
$\Theta$	$P_{ref}(g)$	$V_{ref}$	$V_{ref}$	$V_{ref}$	$t_{ref}$	$t_{ref}$	$P_w$	$V_{ref}$	$V_{ref}$	$V_{ref}$	$t_{ref}$	$t_{ref}$
870.00	12.70	426.4	588.4	162.0	24.0	24.0	0.3	0.00	155.07	155.07	25.0	25.0
630.00	25.40	588.4	757.6	169.2	24.0	24.0	0.5	0.00	162.09	162.09	25.0	25.0
450.00	50.80	757.6	926.5	168.9	24.0	25.0	0.6	0.00	161.10	161.10	25.0	25.0
390.00	76.20	926.5	1107.8	181.3	25.0	25.0	2.0	0.00	173.02	173.02	25.0	25.0
330.00	101.60	1107.8	1286.1	178.3	25.0	26.0	2.4	0.00	171.54	171.54	25.0	25.0

### Standardized Data

Reference Meter (L)		UUT Meter (L)		Correction Factor		$\Delta H$ @ (mm H <sub>2</sub> O)	
Std. Vol.	Std. Flow	Std. Vol.	Std. Flow	Value	Variance	0.0212 SCMM	Variance
$V_{ref}(std)$	$Q_{ref}(std)$	$V_{ref}(std)$	$V_{ref}(std)$	Y	$\Delta Y$	$\Delta H@$	$\Delta \Delta H@$
153.12	10.56	160.58	10.6	0.9536	-0.0001	51.0	1.328
160.12	15.25	167.92	15.2	0.9536	0.0000	49.0	-0.655
159.18	21.22	167.75	21.2	0.9490	-0.0047	50.7	1.000
171.55	26.39	180.20	26.4	0.9520	-0.0016	49.5	-0.142
170.25	30.95	177.35	31.0	0.9599	0.0063	48.1	-1.531
				0.9536 = Y Avg.		49.7	= $\Delta H@$ Avg. Metric

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  $\pm 0.02$ .

Note: For  $\Delta H_g$ , orifice pressure differential that equals to 0.0212m<sup>3</sup>/min at standard temperature and pressure, acceptable tolerance of individual values from the average is  $\pm 0.2$  inches (5.1mm) H<sub>2</sub>O.

Pass/Fail Judgment : **Pass**

Calibrate By: Dharmapalan P.

Approved By: [Signature]

Date: 10 May 22

The instruments listed and described on this certificate have been calibrated against standards traceable to the National Institute of Standards and Technology (NIST) and in reference to EPA Method 5, Section 10.3.1.

neediss  
Neediss Supply Instrument Co., Ltd.



## Certificate of Calibration

Method 5 Console Sensor Calibration - Metric Units

### Console Information

Model #: XC-522  
Serial #: 1107043  
Units: Metric

### Calibration Condition

Pbar (mm. Hg): 762.8  
Humidity (%): 61  
Tamb (°C): 24.9  
Elevation (m): 1.8  
Corr. Pbar (mm. Hg): 762.7

### Reference Devices

TC Calibrator Model: CC-VTR-SH  
Reference #: 091109269  
Barometer Model: 736930  
Reference #: EBARODIALSPE01  
Pressure Model: 718 30G  
Reference #: 9543013

### Temperature Display Calibration Data

Reference Point <sup>1</sup>	Reference Temp.	Test Display Calibrations					Reference Point Status <sup>2</sup>
		Probe	Stack	Filter	Exit	Aux	
#	°C	°C	°C	°C	°C	°C	Pass/Fail
1	-18	-17	-17	-17	-18	-18	PASS
2	38	37	36	36	36	37	PASS
3	93	93	92	92	92	92	PASS
4	149	149	149	149	149	148	PASS
5	260	259	259	259	259	259	PASS
6	371	371	371	370	370	370	PASS
7	482	481	481	481	481	481	PASS
8	593	593	593	593	593	593	PASS
9	816	816	816	817	816	816	PASS
10	1038	1037	1037	1037	1036	1037	PASS
PASS							

Overall Audit Status

NIST Reference Thermocouple ID: 12702001

	Ref Point	Theoretical Temp.	DGM Thermocouple Sensor Reading	$\Delta T_{\text{bias}}^4$
	#	°C	°C	°C
Ice Water	1	0.1	0	0.04%
Ambient <sup>2</sup>	2	24.9	25	0.02%
Maximum <sup>2</sup>				0.04%
Status				PASS

Internal temperature thermocouple is not audited to EPA standards, and should not be used as an official reference for ambient temperature.

Calibrate By: Patterson P.

Approved By: [Signature]

Date: 10 May 22

### Notes

<sup>1</sup> Suggested, minimum reference points are 10 (0, 100, 200, 300, 500, 700, 900, 1100, 1500, 1900 °F), can test for more.

<sup>2</sup> For valid test results, the maximum difference between temperature and reference readings should be less than  $\pm 5.4$  °F ( $\pm 3$  °C), for all thermocouples except for the stack thermocouple which should be less than  $\pm 1.5\%$  absolute temperature from the reference reading and the exit thermocouple which should be less than  $\pm 2$  °F ( $\pm 1$  °C) from the reference reading (EPA Method 2, Section 6.3 and EPA Method 5, Sections 6.1.1, 7.6.1.1.4)

<sup>3</sup> Do not change this cell value, it is instead based on input from Cell H8 at the top of this sheet under "Calibration Conditions"

<sup>4</sup> Absolute temperature difference and other formulas are calculated based on unit input from cell C6 at the top of this sheet under "Meter Console Information"

<sup>5</sup> For valid test results, the maximum difference between console and reference barometric pressure readings should be less than  $\pm 0.1$  in. Hg ( $\pm 2.5$  mm Hg). (EPA Method 5, Section 6.1.2)

<sup>6</sup> For valid test results, the maximum difference between console and reference vacuum readings should be less than  $\pm 0.5$  in. Hg ( $\pm 12.5$  mm Hg)

<sup>7</sup> For valid test results, the maximum difference between console and reference vacuum readings should be less than  $\pm 0.05$  in. Hg ( $\pm 1.25$  mm Hg), or 5% of full scale



## Console Sensor Calibration Data Sheet

### Console Information

Model #: XC-522  
Serial #: 1107043  
Units: Metric  
Type: English

### Calibration Conditions

Pbar (mm. Hg): 762.8  
Humidity (%): 61.0  
Tamb (°C): 24.9  
Corr. Pbar (mm. Hg): 762.7

### Reference Devices

TC Simulator Model: CC-VTR-SH  
Reference #: 091109269  
Barometer Model: 736930  
Reference #: EBARODIALSPE01  
Digital Pressure Calibrator Model: 718 30G  
Reference #: 9543013

### Pressure Gauge / Manometer Calibration Data

Console Vacuum Calibration			
Reference Point	Reference Vacuum	Console Vacuum	Reference Point Status <sup>2</sup>
#	in. Hg	in. Hg	Pass/Fail
1	-5.0	-5.0	PASS
2	-15.0	-15.0	PASS
3	-25.0	-25.0	PASS

Reference Point <sup>1</sup>	$\Delta H$ Manometer Calibration			Reference Point Status <sup>2</sup>
	Reference Pressure	Positive (+) Pilot	Negative (-) Pilot	
#	mm H2O	mm H2O	mm H2O	Pass/Fail
1	-203.20	0.0	-203.2	PASS
2	-152.40	0.0	-152.4	PASS
3	-101.60	0.0	-101.6	PASS
4	-76.20	0.0	-76.2	PASS
5	-50.80	0.0	-50.8	PASS
6	0.00	0.0	0.0	PASS
7	50.80	50.8	0.0	PASS
8	76.20	76.2	0.0	PASS
9	101.60	101.6	0.0	PASS
10	152.40	152.4	0.0	PASS
11	203.20	203.2	0.0	PASS
$\Delta H$ Overall Audit Status				PASS

Reference Point <sup>1</sup>	$\Delta P$ Manometer Calibration			Reference Point Status <sup>2</sup>
	Reference Pressure	Positive (+) Pilot	Negative (-) Pilot	
#	mm H2O	mm H2O	mm H2O	Pass/Fail
1	-203.20	0.0	-203.2	PASS
2	-152.40	0.0	-152.4	PASS
3	-101.60	0.0	-101.6	PASS
4	-76.20	0.0	-76.2	PASS
5	-50.80	0.0	-50.8	PASS
6	0.00	0.0	0.0	PASS
7	50.80	50.8	0.0	PASS
8	76.20	76.2	0.0	PASS
9	101.60	101.0	0.0	PASS
10	152.40	152.4	0.0	PASS
11	203.20	203.2	0.0	PASS
$\Delta P$ Overall Audit Status				PASS

Calibrate By: Patterson P.

Approved By: [Signature]

Date: 10 May 22

### Notes

<sup>1</sup> Suggested, minimum reference points are 10 (0, 100, 200, 300, 500, 700, 900, 1100, 1500, 1900 °F), can test for more.

<sup>2</sup> For valid test results, the maximum difference between temperature and reference readings should be less than  $\pm 5.4$  °F ( $\pm 3$  °C), for all thermocouples except for the stack thermocouple which should be less than  $\pm 1.5\%$  absolute temperature from the reference reading and the exit thermocouple which should be less than  $\pm 2$  °F ( $\pm 1$  °C) from the reference reading (EPA Method 2, Section 6.3 and EPA Method 5, Sections 6.1.1, 7.6.1.1.4)

<sup>3</sup> Do not change this cell value, it is instead based on input from Cell H8 at the top of this sheet under "Calibration Conditions"

<sup>4</sup> Absolute temperature difference and other formulas are calculated based on unit input from cell C6 at the top of this sheet under "Meter Console Information"

<sup>5</sup> For valid test results, the maximum difference between console and reference barometric pressure readings should be less than  $\pm 0.1$  in. Hg ( $\pm 2.5$  mm Hg). (EPA Method 5, Section 6.1.2)

<sup>6</sup> For valid test results, the maximum difference between console and reference vacuum readings should be less than  $\pm 0.5$  in. Hg ( $\pm 12.5$  mm Hg)

<sup>7</sup> For valid test results, the maximum difference between console and reference vacuum readings should be less than  $\pm 0.05$  in. Hg ( $\pm 1.25$  mm Hg), or 5% of full scale  
I certify that the above Thermocouple Sensors were calibrated in accordance with EPA Methods 2 and 5, CFR 48 Part 69





# neediss Console Sensor Audit QA Sheet

## Meter Console Information (UUT)

Model #: XC-522  
Serial #: 1107043  
Units: Metric

## Calibration Conditions

Pbar (mm. Hg): 762.8  
Humidity (%): 61%  
Amb. Temp. (°C): 24.9  
Altitude (m): 1.8  
Corrected Pbar (mm. Hg): 762.7

## Reference Devices

TC Simulator Model: CC-VTR-SH  
Reference #: 91109269  
Barometer Model: 369307  
Reference #: EBARODIALSPE01  
Digital Pressure Calibrator Model: 718 30G  
Reference #: 9543013

## Audit Data

Reference Point	Reference Temp.	Thermocouple Probe Audit						Reference Point Status <sup>1</sup>
		Probe	Stack	Filter	Meter	Exit	Aux	
	°C	°C	°C	°C	°C	°C	°C	Pass/Fail
Boiling	100.0	100	99	99	99	99	99	PASS
Room	24.9	25	25	25	25	25	25	PASS
Ice Water	0.2	0	0	0	0	0	0	PASS

## Console Vacuum Audit

Reference Point	Reference Vacuum	Console Vacuum	Reference Point Status <sup>2</sup>
#	in. Hg	in. Hg	Pass/Fail
1	17.0	17.0	PASS

Calibrate By: Patterson P.

Approved By: [Signature]

Date: 10 May 22

## Notes

<sup>1</sup>For valid test results, the maximum difference between test and reference readings should be less than 5.4 °F (3 °C), for all thermocouples except for the stack thermocouple which should be less than 1.5% absolute temperature from the reference reading and the exit thermocouple which should be less than 2°F (1 °C) from the reference reading (EPA Method 3, Section 8.3 and EPA Method 5, Sections 6.1.1.7-6.1.1.8).

<sup>2</sup>For valid test results, the maximum difference between console and reference barometric pressure readings should be less than 0.1 in. Hg (2.5 mm Hg), (EPA Method 5, Section 6.1.2)

<sup>3</sup>For valid test results, the maximum difference between console and reference vacuum readings should be less than 0.5 in. Hg (12.5 mm Hg)

I certify that the above Thermocouple, Barometric, and Vacuum Sensors were calibrated and audited in accordance with US EPA Methods, CFR 40 Part 60.

**Instrument description** : Flue gas Analyzer  
**Instrument model** : Testo 350 New  
**Instrument serial no.** : 62227997  
**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-230076  
**Receiving date.** : 9-Jan-23  
**Parameter of calibration** : Gas Calibration(Oxygen 2.498,10.04,21.02 %vol, Carbon Monoxide 80.14,309.9,1003 ppm, Nitric Oxide 150.9 ppm, Nitrogen Dioxide 80.96 ppm, Sulphur Dioxide 100.8 ppm)  
**Condition of UUC.** : Used  
**Ambient condition** : All of the Measurment were caried out the stabilized labotary  
 Temperature : 23 ±5 °C  
 Humidity : 55 ± 15 %RH  
**Calibration place** : 17/121 Soi Ngamwongwan 47 Yaek 48, Toongsonghong, Laksi, Bangkok 10210  
**Calibration procedure no.:** WI-CL-28-C

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

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

This Calibration Certificate may not be reporduced 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 tracebility to national standards, which realize measurement according to the  
 International System of Units (SI).

**Date of calibration** : 10-Jan-23

*[Signature]*

Mr. Sedtawut Nueathong  
 Calibration Technician

*[Signature]*

Mrs. Nongluck Wongsettee  
 Technical Manager

Standard References (Table 1)

Standard	Certificate No.	Vendor	Due date
Oxygen ( O <sub>2</sub> ) 2.498 % Vol	4219/21	Linde	30-Sep-25
Oxygen ( O <sub>2</sub> ) 10.04 % Vol	CG-0153-21	Nimt	18-Nov-26
Oxygen ( O <sub>2</sub> ) 21.02 % Vol	CG-0041-22	Nimt	10-Feb-27
Carbon monoxide ( CO ) 80.14 ppm	CG-0040-22	Nimt	14-Feb-27
Carbon monoxide ( CO ) 309.9 ppm	2803/21	Linde	22-Jun-23
Carbon monoxide ( CO ) 1003 ppm	2583/22	Linde	09-Aug-24
Nitrogen Dioxide ( NO <sub>2</sub> ) 80.96 ppm	3240/21	Linde	26-Jun-24
Nitric Oxide ( NO ) 150.9 ppm	2857/21	Linde	27-Jun-23
Sulphur Dioxide ( SO <sub>2</sub> ) 100.8 ppm	3507/22	Linde	09-Nov-24

Measured room conditions

Temperature : 22.4 °C Humidity : 56.8 %RH Pressure : 1015.4 mbar

Calibration conditions

Gas Temperature : 23 °C Flow rate : 1,200 ml/min Gas pressure : 1020.6 mbar

Calibration Results (before adjustment) (Table 2)

Parameter of Standard	Standard Values	Mean of UUC	Error	Uncertainty (±)
O <sub>2</sub> (%Vol)	2.498	2.44	-0.058	0.20
O <sub>2</sub> (%Vol)	10.04	9.91	-0.13	0.40
O <sub>2</sub> (%Vol)	21.02	21.11	0.09	0.80
CO (ppm)	80.14	78	-2.14	3.0
CO (ppm)	309.9	302	-7.9	6.0
CO (ppm)	1003	979	-24	12
*NO (ppm)	150.9	152	1.1	8.0
*NO <sub>2</sub> (ppm)	80.96	71.1	-9.86	8.0
*SO <sub>2</sub> (ppm)	100.8	102	1.2	6.0

Calibration Results (after adjustment) (Table 3)

Parameter of Standard	Standard Values	Mean of UUC	Error	Uncertainty (±)
O <sub>2</sub> (%Vol)	2.498	2.44	-0.058	0.20
O <sub>2</sub> (%Vol)	10.04	9.91	-0.13	0.40
O <sub>2</sub> (%Vol)	21.02	21.11	0.09	0.80
CO (ppm)	80.14	81	0.86	3.0
CO (ppm)	309.9	311	1.1	6.0
CO (ppm)	1003	1001	-2	12
*NO (ppm)	150.9	152	1.1	8.0
*NO <sub>2</sub> (ppm)	80.96	81.2	0.24	8.0
*SO <sub>2</sub> (ppm)	100.8	102	1.2	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



**INTRO TSC Company Limited**  
**Calibration Center Measuring and Testing Instrument**  
 46/155 Nualchan Rd., Nualchan, Bungkum, Bangkok 10230, Thailand  
 Tel : +66-2363-4417-21 Fax : +66-2363-4427 E-mail : info@intro.co.th



## Certificate of Calibration

Page 1 of 2 Pages

Certificate Number : MB2-006-2023  
 Equipment : Electronic Balance  
 Manufacturer : Radwag  
 Model : WTB2000  
 Serial Number : 460680  
 ID Number : Stack 1  
 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, Lakki, 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-Dec-22

Approved Signatory :

*Pu*

Mr. Panuchit Samart

FM-CL-11-05



**INTRO TSC Company Limited**  
**Calibration Center Measuring and Testing Instrument**  
 46/155 Nualchan Rd., Nualchan, Bungkum, Bangkok 10230, Thailand  
 Tel : +66-2363-4417-21 Fax : +66-2363-4427 E-mail : info@intro.co.th

Certificate Number : MB2-006-2023

Page 2 of 2 Pages

Calibration Result ( Weight ) : Without Adjustment

### 1. Repeatability of Reading

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

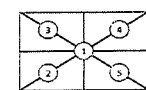
### 2. Error of indication from nominal value

Nominal Value	Balance Reading	Correction Value	Uncertainty ( ± )	factor $k$	Balance Reading Before Adjust
( g )	( g )	( g )	( g )		( g )
Unload	0.00	0.00	0.0082	2.00	-
200	199.98	0.02	0.0082	2.00	-
400	399.95	0.05	0.0083	2.00	-
600	599.96	0.04	0.0086	2.00	-
800	799.96	0.04	0.0088	2.00	-
1000	999.98	0.02	0.0089	2.00	-
1200	1199.98	0.02	0.0095	2.00	-
1400	1399.98	0.02	0.0095	2.00	-
1600	1599.99	0.01	0.0095	2.00	-
1800	1799.99	0.01	0.0095	2.00	-
2000	2000.01	-0.01	0.0095	2.00	-

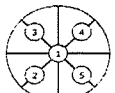
### 3. Eccentric or off-center loading

Nominal Value	Reference Position				
	Position 1	Position 2	Position 3	Position 4	Position 5
( g )	( g )	( g )	( g )	( g )	( g )
1000	999.98	999.96	999.98	1000.01	999.99

Eccentric Error = 0.03 ( g )



Front



Front

End of report

*Pu*






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.: 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 Lernagatrakul  
Approved by :   
( ) Malee Butkruea  
( ) Saitthip Meangmai  
(x) Ponpan Paipim  
Issue Date : 28 December 2022

The Uncertainties are for a confidence probability of approximately 95%

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



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

### 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

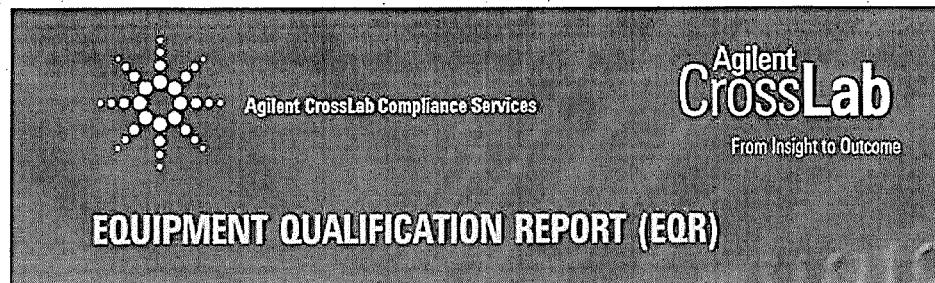
Performing three buffers standard curve by using buffer nominal pH (4,7,10)

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-



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

## Details

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

## Overall Qualification Status

Pass

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

## General Details

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

## Organization Details

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

## Local Contact Details

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

## Operator Details

Name:	Worawit Timakul
Job Title:	Field Service Engineer

## Data Acquisition Details

Acquisition Software Name:	ICP Expert
Acquisition Software Revision:	7.1.0.6821

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

## System Details

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

## Test Details

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

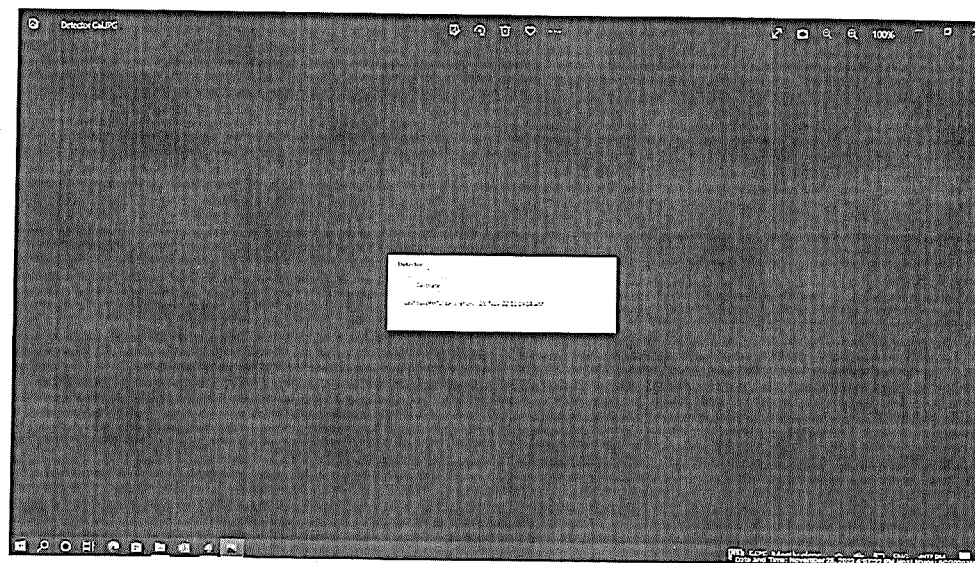


Image Details:

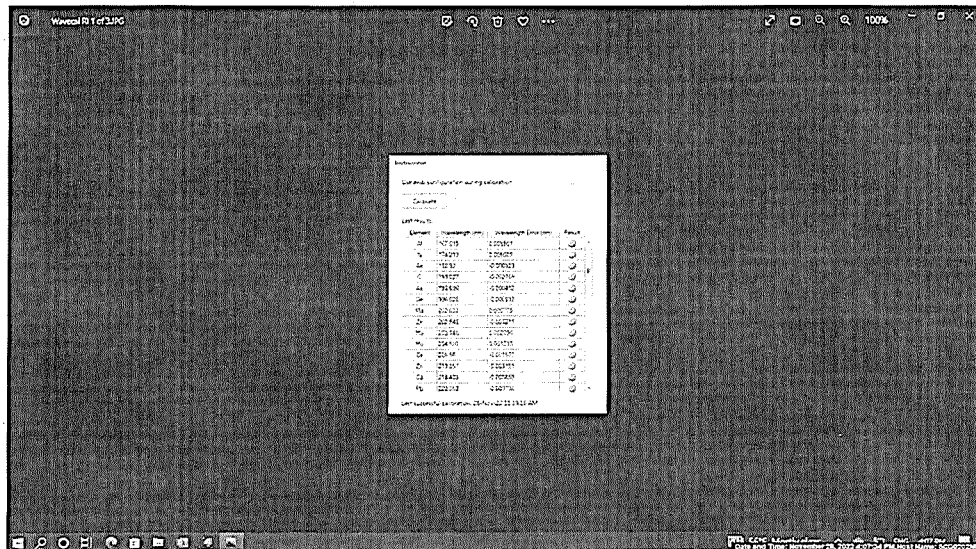
Was the instrument calibration performed and completed successfully?

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

## 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

## Section 1 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 Compliance Engine Self Qualification

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

Drive Serial #: 90593EBA

Platform Revision: ACE 3.11.27

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

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

### Overall Qualification Status

Conforms



General

Document Name: Operator's training certificate and qualifications



## Certificate of Completion

Learner Name: Worawit Timakul

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

Completion Date: August 25, 2016

Certified By Company: Learning at Agilent

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

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

General

Document Name: Operator's training certificate and qualifications



## Certificate of Completion

Learner Name: Worawit Timakul

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

Completion Date: October 30, 2020

Certified By Company: Learning at Agilent

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

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

General

Document Name: Certificate of System Qualification



## Certificate of Completion

Learner Name: Worawit Timakul

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

Completion Date: July 1, 2020

Certified By Company: Learning at Agilent

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

A certificate for Service and Support training is only valid while employed by Agilent Technologies or while working as an Agilent-authorized service provider, through which the service employee has ongoing access to Agilent's Safety Alerts, Service Notes, internal technical updates, update training, current documentation, technical support, cartoon 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: Instrument's Test Report

## Report Summary

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

## Result Summary

Resolution Test Pass  
Sensitivity Test Pass  
Precision Test Pass

## Resolution Test Pass

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

Document Name: Instrument's Test Report

## Sensitivity Test

Pass

## Radial

Element Wavelength	Specification	Method	Ratio	Standard	Blank
As (188.980 nm)	≥ 45.0	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

General

Document Name: Software verification

## Software Verification Report

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

Base Reference File Name : ICPReferenceFile.xml

## Summary :

Overall Evaluation of Installation Check : PASS

## File Report Summary

No missing files or invalid files found

No system file difference found

## Files Registration Report Summary

Files Registration check not required for this product

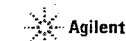
## Registry Report Summary

Registry entries check not required for this product

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

Materials

Document Name: Certificate of Analysis Wavelength calibration solution



## CERTIFICATE OF ANALYSIS

Agilent Product Name: Wavelength Calibration Solution for ICP-OES & MP-AES, 5 mg/L, 500mL  
Agilent Part No: 6610030100  
Lot No: 0012183521

## Product Specifications

Analyte	Starting Material	CAS #	Certified Conc.	Analyte	Starting Material	CAS #	Certified Conc.
Al	Al(NO <sub>3</sub> ) <sub>3</sub>	7784-27-2	5.000 ± 0.025 mg/L	Mn	Mn	7439-96-5	5.001 ± 0.025 mg/L
As	As	7440-38-2	5.001 ± 0.025 mg/L	Mo	(NH <sub>4</sub> ) <sub>2</sub> MoO <sub>4</sub>	13106-76-8	5.000 ± 0.025 mg/L
Ba	Ba(NO <sub>3</sub> ) <sub>2</sub>	10022-31-6	5.000 ± 0.025 mg/L	Ni	Ni	7440-02-0	5.000 ± 0.025 mg/L
Cd	Cd	7440-43-9	5.000 ± 0.025 mg/L	Pb	Pb	7439-92-1	5.001 ± 0.025 mg/L
Co	Co	7440-48-4	5.000 ± 0.025 mg/L	Se	Se	7782-49-2	5.000 ± 0.025 mg/L
Cr	Cr(NO <sub>3</sub> ) <sub>3</sub>	13548-38-4	5.000 ± 0.025 mg/L	Sr	Sr(NO <sub>3</sub> ) <sub>2</sub>	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 <sub>3</sub>	7757-79-1	50.00 ± 0.25 mg/L				

Matrix: 5% HNO<sub>3</sub>

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<sub>3</sub>) and diluted with filtered (0.22µm), 18 M-ohm deionized water. The balances used in the preparation of this CRM are calibrated regularly with traceability to NIST. All volumetric dilutions are performed in Class A calibrated glassware. The certified concentrations were determined based upon gravimetric procedures. Secondary verification of the certified concentrations was performed using ICP-OES that was calibrated and/or referenced against NIST SRMs: 3101a, 3103a, 3104a, 3108, 3113, 3112a, 3114, 3141a, 3132, 3134, 3136, 3128, 3148, 3153a, and 3168a. The uncertainty associated with each certified concentration represents the expanded uncertainty at the 95% confidence level using a coverage factor of k=2.

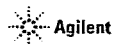
Instructions for Use: Agilent recommends that the solution be thoroughly mixed by repeated shaking or swirling of the bottle immediately prior to use. To achieve the highest accuracy the analyst should: (1) use only pre-cleaned containers and transferware, (2) avoid pipetting directly from the CRM's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

Page 1 of 3

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



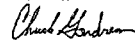
Document Name: Certificate of Analysis Wavelength calibration solution



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

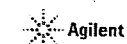
Date of release: 21 January 2022  
Date of expiration: 31 July 2023

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](http://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 8-13 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 16580231)
- Accredited to ISO 17034 – General Requirements for the Competence of Reference Material Producers (AZLA Cert. No. 2848.02)
  - ISO 17034 references additional requirements specified in ISO Guide 31 and ISO Guide 35.
- Accredited to ISO/IEC 17025 – General Requirements for the Competence of Testing and Calibration Laboratories (AZLA Cert. No. 2848.01)
- LGC Services, 271 Abing Road, Northbrook, IL 60062

Page 3 of 3

## Electronic Signature

Signature

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### 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.

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User Name: worawit.timakul  
 Hostname: SC602001-02

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

### OQ HW ICP 5100 Envi research Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
November 28, 2022 4:02:15 PM	Audit	SessionCreated	Session	None
November 28, 2022 4:02:15 PM	Start	Configuration	Session	None
November 28, 2022 4:02:15 PM	Audit	Entitlement	Licensing	User is FieldEngineer, and does not require an unlock code
November 28, 2022 4:06:30 PM	Audit	EqpLoaded	Session	EQP details for primary technique [Es] - File path: [ProtocolPacks/Es/Configurations/02.50/Es.02.50.eqp], EQP File Name: [Es.02.50.eqp], EQP Name: [AgilentRecommended]
November 28, 2022 4:06:32 PM	End	Configuration	Session	None
November 28, 2022 4:06:35 PM	Start	Qualification	Session	OQ
November 28, 2022 4:06:36 PM	Start	Execution	Preparation : 5100 VDV: Qualitative Test - No setpoints associated	None
November 28, 2022 4:07:38 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

User Name: worawit.timakul  
 Username: 5CG0231420

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



# PinAAcle 900Z Preventive Maintenance Report

Company Name: ENVIRONMENT RESEARCH

Instrument Location: 25/114 M.6, THANON NGAMWONGWAN  
THUNG SONG HONG, LAKSI, BANGKOK, 10210

Instrument Serial No.: PZAS19031401

Date: 28-Jun-2022

## PinAAcle 900Z Preventive Maintenance (PM)

Company Name:	ENVIRONMENT RESEARCH		
Address (Instrument Location):	25/114 M.6, THANON NGAMWONGWAN, THUNG SONG HONG, LAKSI, BANGKOK		
Serial Number:	PZAS19031401	PM Number:	1/2
Customer Name (if applicable):	K. RAIWIN	Telephone Number:	099-182-9241
Customer Support Engineer Name:	K. DUANG	Service Order Number:	WO-01710018
Date PM Performed: (DD-MMM-YYYY)	28-Jun-2022	Next PM Due Date: (DD-MMM-YYYY)	28-Dec-2022
Standard Labor Hours to Complete PM :		5 hours	

Part Number	Release	Publication Date	
09370144 Rev.9	A	January 2018	

### Scope

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

The customer should save their method before the PM begins.

### General Instructions:

The customer must provide the engineer operational data to demonstrate recent instrument performance prior to starting the PM.

Always check with the customer before making any changes that may affect the customer's analysis or calibration, including a current back-up of system software and/or data files.

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

Update the PM sticker and instrument logbook as required.

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## Component List

Component / Specific Model	Serial #	Configuration Notes

## Parts Lists

Parts Included with the PM		
Part Number (if applicable)	Description	Quantity
B0501696	Fan Filters	N/A
B3002013	THGA Contact Cylinders	N/A
B3141064	Glycerol for THGA Cooling	N/A

Additional Reagents and Standards Required for PM				
Part Number (if applicable)	Description	Quality	Batch/Lot #	Expired Date (MM/YY)
N9300244	GFAAS Mixed Standard	AR	56-021CRY1	30-Jun-2022

Additional Reagents and Standards Required for PM (Customer Support Solution)				
Part Number (if applicable)	Description	Quantity	Batch/Lot #	Expiration Date (MM/YY)
N/A	DI Water	250 ml.	AR	AR
N/A	0.5% HNO <sub>3</sub>	250 ml.	AR	AR

## Additional Tools Required for PM

Part Number (if applicable)	Description	Quantity	Serial #
B3100652 Or N9307029	Electronic Flow Meter	1	NA
B0505495	Test Jig	1	NA
03030997	System 2 EDL Driver	1	03030997
N3050605	As System 2 EDL	1	16148
N3050121	Cu Lumina HCL	1	092216-010130
N3050109	Ba Lumina HCL	1	102416-040160
N3050139	K Lumina HCL	1	110716-010060
N3050152	Ni Lumina HCL	1	100516-030190
N3050119	Cr Lumina HCL	1	091911-020150

## Procedure Checklist

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

### 1. General:

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

### 2. PC Instrument Software:

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

### 3. Mechanical:

- ☒ Inspect and clean all fans and filters. Replace filters if necessary
- ☒ Inspect all gas and water lines for leaks and/or wear. Replace if needed. Thoroughly inspect all quick connects. Replace the Y connector, P/N 09921079, if needed.
- ☒ Clean exterior of the instrument.
- ☒ Check the drain system for signs of wear. Replace worn or damaged parts.
- ☒ Inspect the pole pieces and clean where the pole pieces contact the furnace. Replace the pole piece p-rings as needed, P/N's B0501018 & B0501250. Grease the O-rings as needed with Apiezon L grease, P/N 09905148
- ☒ Inspect the four insulation pads on the front contact housing of the THGA in furnace. If the pads are missing replace the THGA furnace or replace the insulator pads on the furnace.
- ☒ Inspect the graphite tube and clean the contact cylinders. Replace if necessary.
- ☒ Check internal and external gas flows with the Electronic Gas Flow Meter and the Gas Flow Test Probe as described in the Service Manual. Correct if necessary.
- ☒ Check furnace open/close function.
- ☒ Verify the operation of the GFTV Camera for proper operation and viewing alignment in the furnace camera Tube View window. Align if needed.
- ☒ Check the operation of the Halogen Light ASSY for the GFTV Camera. Replace if needed.
- ☒ Check the water level/quality in the recirculation (if applicable). Add distilled water if necessary.
- ☒ Check the cooling system fluid flow rate with the FCS In-Line Flow Meter for proper levels if needed. Refer to SDB# COSY008.STN
- ☒ Perform Cooling System maintenance if needed per SDB# COSY005.STN.
- ☒ Check auto sampler operation.
- ☒ Perform an auto sampler check valve test as described in the Service Manual.
- ☒ Lubricate the spindles of the auto sampler pumps and all moving parts of the tray mechanics as described in the Service Manual.
- ☒ Inspect the auto sampler sampling capillary as described in the Service Manual. Replace if necessary.
- ☒ Inspect the four insulation pads on the front contact housing of the THGA in furnace. If the pads are missing replace the THGA furnace or replace the insulator pads on the furnace.
- ☒ Inspect the graphite tube and clean the contact cylinders. Replace if necessary.
- ☒ Check internal and external gas flows with the Electronic Gas Flow Meter and the Gas Flow Test Probe as described in the Service Manual. Correct if necessary.
- ☒ Check furnace open/close function

### 4. Electrical:

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

### 5. Optics:

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

### 6. Gasses:

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

### 7. After PM Performance tests [THGA]:

#### 7.1 Furnace Gas Flows

Description: Ensures the flow rates are within specification.

Parameter	Specification	Test Results	Pass/Fail
Internal Flow Rate	250 mL/min ± 25 mL/min	255	Passed
External Flow Rate	100 mL/min ± 10 mL/min	104	Passed

#### 7.2 Chromium Baseline Noise

Description: Signal to noise check.

Parameter	Specification	Results	Pass/Fail
Baseline Noise	≤ 0.005 Abs.	0.0007	Passed
Standard Deviation	≤ 0.005	0.0002	Passed

#### 7.3 Chromium Characteristic Mass and Precision

Description: Calculate the characteristic mass using the characteristic mass tool and precision from the integrated absorbance values.

Parameter	Specification	Results	Pass/Fail
Cr m <sub>0</sub> Results	≤ 7.0 pg/0.0044 A-s	6.3	Passed
Precision	≤ 2.0 %	1.49	Passed

#### 7.4 Copper Characteristic Mass and Zeeman Ratio

Description: Calculate the characteristic mass using the characteristic mass tool and check the Zeeman Ratio.

Parameter	Specification	Results	Pass/Fail
Cu m <sub>0</sub> Result	≤ 16.5 pg/0.0044 A-s	14.2	Passed
Zeeman Ratio	0.52 ± 0.04	0.52	Passed

#### 8. Review:

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

#### Additional Comments

Additional Comments Regarding the PM	
Zeeman Ratio	$= \frac{\text{Atomic Signal (Peak area)}}{\text{Atomic Signal (Peak area)} + \text{Background Signal (Peak area)}}$ $= \frac{0.1529}{0.1529 + 0.1361}$ $= 0.52$

#### Review


The preventive maintenance checks and if applicable performance tests for PinAAcle 900Z have been completed.	
This PinAAcle 900Z Passes <input checked="" type="checkbox"/> Fails <input type="checkbox"/> the preventive maintenance.	
Review of Preventive Maintenance:	
Authorized PerkinElmer Representative: Duang Hiransuk	Date: 28-Jun-2022 (DD-MMM-YYYY)
Authorized Customer Representative: ๖๕๐๙๕๖	Date: 28-Jun-2022 (DD-MMM-YYYY)

## Personal Pump Calibration Report


**Equipment Type** : Personal Pump  
**Equipment Range** : 0.005 – 5.0 L/min  
**Calibration Range** : 0.01 – 3.0 L/min  
**Calibration Type** : DryCal Bubble Type  
**Volume for Calibration** : 0.2 L/min, 1.0 L/min, 1.7 L/min, 2.0 L/min  
**Calibrated By** : Ms.Budsakorn Somrak  
**Calibration Date** : May 6, 2023  
**Customer Name** : บริษัท ไฟร์เทียร์ คอนซัลแตนต์ จำกัด : โครงการโรงงานผลิตทองแดงบริสุทธิ์และโลหะมีค่า  
 บริษัท จูน จี แมททีเรียล เทคโนโลยี จำกัด

Item	Personal Pump Serial Number	High Flow/ Low Flow	First Time	Second Time	Third Time	Average	Uncertainty
1	ERTC39 : 3-44613	0.2 L/min	0.20797	0.20813	0.20781	0.20797	±0.0002
2	ERTC41 : 3-44617	0.2 L/min	0.20796	0.20779	0.20726	0.20767	±0.0004
3	ERTC42 : 3-44618	0.2 L/min	0.20357	0.20342	0.20317	0.20338	±0.0002
4	ERTC44 : 3-44621	0.2 L/min	0.2050	0.20436	0.20535	0.20493	±0.0005
5	ERTC46 : 3-44623	0.2 L/min	0.20968	0.20969	0.20950	0.20962	±0.0001
6	ERTC47 : 3-44432	0.2 L/min	0.20166	0.20137	0.20193	0.20165	±0.0003
7	ERTC78 : 17655	1.7 L/min	1.8781	1.7756	1.7755	1.7764	±0.0592
8	ERTC86 : 20080503027	1.7 L/min	1.7959	1.7944	1.7952	1.7951	±0.0008
9	ERTC99 : 20150603047	2.0 L/min	2.0706	2.0738	2.0703	2.0715	±0.0019
10	ERTC109 : 20070601022	1.7 L/min	1.7316	1.7135	1.7353	1.7268	±0.0117
11	ERTC115 : 12121	1.0 L/min	1.0744	1.0729	1.0716	1.0729	±0.0014
12	ERTC NO.150 : 20060201004	0.2 L/min	0.20406	0.20394	0.20407	0.20402	±0.0001
13	ERTC NO.151 : 012888	0.2 L/min	0.20338	0.20411	0.20578	0.20447	±0.0012
14	ERTC NO.152 : 20190605008	2.0 L/min	2.0345	2.0203	2.0427	2.0325	±0.0113
15	ERTC NO.157 : 20190605036	1.7 L/min	1.7530	1.7307	1.7426	1.7421	±0.0112
16	ERTC NO.158 : 20190605038	2.0 L/min	2.0591	2.0595	2.0632	2.0606	±0.0023
17	ERTC NO.161 : 20190605043	1.7 L/min	1.7712	1.7637	1.7589	1.7646	±0.0062
18	ERTC NO.169 : 20070301007	1.7 L/min	1.7121	1.7243	1.7267	1.7210	±0.0078
19	ERTC NO.174 : 20210701115	2.0 L/min	2.0612	2.0579	2.0636	2.0609	±0.0029
20	ERTC NO.177 : 20210803018	2.0 L/min	2.0321	2.0342	2.0133	2.0265	±0.0115

Checked By

  
 Mr. Prayun Detkla  
 Technician

Approved By

  
 Ms. Sutatip Im-noi  
 Environmental Scientist







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 : Terasak Panna

(Mr.Terasak Panna)

Approved by : Ms. Kirana Luanghirun

(Ms.Kirana Luanghirun)

Director

Mechanical Engineering Standards Laboratory

Ref. 2013265110704833001

Issued Date 10 November 2022

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Changwat Pathumthani 12120, Thailand  
Tel. (66) 0 2577 9000  
Fax. (66) 0 2577 9009  
E-mail : rumpa@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



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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	Standard Value	Temperature	Pressure	Deviation	Uncertainty
(ml/min)	(ml/min)	(°C)	(hPa)	(%)	(%)
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.

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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 : rumpa@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  
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


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534/4 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, Laksi,  
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 :   
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 : 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

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

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

Range capacity : 0 g to 5.2 g Resolution 0.000001 g

Before Adjustment :

Applied Weight ( g )	Balance Reading ( g )	Correction ( g )	Measurement Uncertainty ( ± mg )	Coverage Factor ( 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 ( g )	Standard Deviation of Reading ( g )
2.5	0.000007
5	0.000007



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

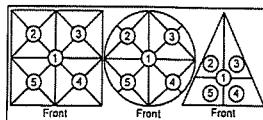
Cert.No.: 23MM1

Page: 3 of 3

**Result of calibration**

**2. Effect of off center loading**

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



Maximum difference between  
 off-center and central loading

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

-o-o-

*Mali*

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<sup>®</sup>32

**Serial Number :** TPG030012

**Manufacturer :** 3M, QUEST Technologies

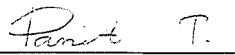
**Date of Request :** 25 October 2022

**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 :

  
(Ms. Panit Thummasri)

Approved by :

  
(Mr. Kamchai Singhapiwat)

Director

Photometry and Temperature Standards Laboratory

Ref. No : 2012265102504612001

Issued Date : 10 November 2022

Page 1 of 4

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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,  
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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 / 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

P.T.

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Fax. (66) 0 2579 8592  
E-mail : sumalee@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. 22-66 / 0047

MTC No. PSL-H 0025 / 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<sup>®</sup>34

**Serial Number :** TEH070023

**Manufacturer :** QUEST Technologies

**Date of Request :** 25 October 2022

**Date of Calibration :** 3 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 :

*Donit T.*

(Ms. Panit Thummasri)

Approved by :

*K. Kamchai Singhapiwat*

(Mr. Kamchai Singhapiwat)

Director

Photometry and Temperature Standards Laboratory

Ref. No : 2012265102504612004

Issued Date : 10 November 2022

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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,  
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Tel. (66) 0 2323 1672-80 ext. 115, 116  
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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 / 0047

MTC No. PSL-H 0025 / 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 :** TEH070023

**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

P.T.

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Thailand  
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Fax. (66) 0 2579 8592  
E-mail : sumalee@tistr.or.th

Request No. 22-66 / 0047

MTC No. PSL-H 0025 / 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	29.9	0.1	0.50
35.0	35.0	0.0	0.50
40.0	39.8	0.2	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

Page 3 of 4

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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)
30.0	30.1	-0.1	0.50
35.0	35.0	0.0	0.50
40.0	39.8	0.2	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...

Page 4 of 4

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TEL. 0-2717-3000-24 FAX. 0-2719-9484



Cert. No.: 22PH282

Page.: 2 of 2

## Certificate of Calibration

Certificate No. : 22PH282

Page : 1 of 2

Equipment : Lux Meter

Manufacturer: Exttech

Model : 407026

Serial No.: 048466

ID No.: -

Condition As-Received: Used Item

Received Date: 27 May 2022

Calibration Date: 02 June 2022

Reference: 2205-0924WN

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 & Encorder	LMguide 9,6 m	120RC003	61-140006-1	30 Apr 2023
2) High-accuracy Irradiance Standard	OL FEL-U	F-1470	TP-1036-21	21 Aug 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 : Nivat Nitas

Issue Date : 08 June 2022

Approved Signatory :

[ ✓ ] Phalinee Prabpaipal

[ ] 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	99	-1	1.5
500	499	-1	6.8
1000	1002	2	14
1500	1495	-5	21
1900	1885	-15	26

Function : Illuminance Measurement

Range : 20000 lx

Standard Value	UUC* Reading	Error	Uncertainty
( lx )	( lx )	( lx )	( ± lx )
2000	1970	-30	28
3000	2870	-130	42
4000	3760	-240	55
5000	4680	-320	69

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.

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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-65/0732

MTC No. EEL. BP. 96/0865

## CALIBRATION CERTIFICATE

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

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

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

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

### Instrument Calibrated :

### Ambient Environment

Description : Acoustic Calibrator

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

Manufacturer : Quest Technologies

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

Model : QC-10

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

Serial No. : Q19010208

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

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

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

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

5. Pressure Transmitter Vaisala PTB202AD S/N T0650001.

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

7. Condenser Microphone B&K 4180 S/N 2633526.

Calibration Procedure: CP-102-04 based on IEC 60942-2003; The sound pressure level generated by sound calibrator under test shall be measured by standard microphone using an insert voltage technique.

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

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

Date of Receipt : 29 Aug. 2022

Date of Calibration : 6 Sep. 2022

1/2

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35 Mu 3 Tambon Khlong Ha, Amphoe Khlong Luang,  
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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-65/0732

MTC No. EEL. BP. 96/0865

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 20 $\mu\text{Pa}$  at 1000 Hz

Acoustic Output in dB re 20 $\mu\text{Pa}$ , 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&Kjaer 4180	114.18	0.18	$\pm 0.10$	$\pm 0.40 \text{ dB}$

### 2. Frequency

Standard Microphone Type	Measured Frequency (Hz)	Deviated value (Hz)	Uncertainty (Hz)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer 4180	997.3	-2.7	$\pm 1.5$	$\pm 1.0\%$

### 3. Total Distortion

Standard Microphone Type	Measured Total Distortion (%)	Uncertainty (%)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer 4180	0.60	$\pm 0.50$	$\pm 3.0\%$

Note : 1. No adjustment.

2. The calibrator pressure correction was not included.

3. The microphone volume correction was not included.

Calibrated by :

(Mr. Weerachai Deechaiyae)

Approved by :

(Mr. Prawate Kluaypa)

Director

Electrical and Electronic Standards Laboratory

Industrial Metrology and Testing Service Centre

Date of Calibration : 6 Sep. 2022

Date of Issue : 7 Sep. 2022

Ref : 2011265082903844002

End of Certificate

2 / 2

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35 Mu 3 Tambon Khlong Ha, Amphoe Khlong Luang,  
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