

ภาคผนวก จ



เอกสารสอบเทียบเครื่องมือวิเคราะห์

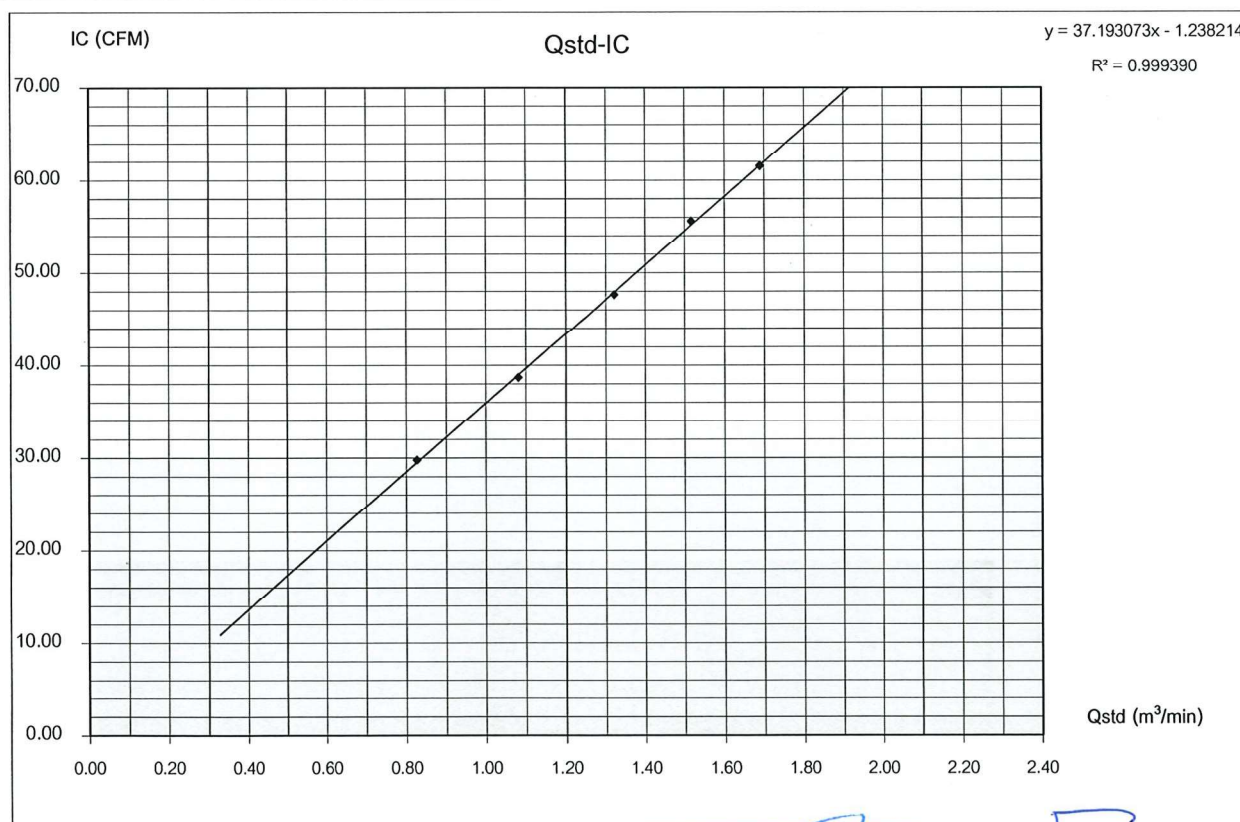
## TSP HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

Quotation	2023-00722			Date	October 4, 2023
Sampler Location	พต.คลองหนึ่ง			Start Time	11:30 AM
Sampler Number	TSP No.A27	Transfer Standard Type	Orifice	Stop Time	11:40 AM
Instrument Model	HIVOL-BBCBE	Calibrator Model	TE-5025A	Calibrated By	Mr.Anan Kongngoennok
Motor Serial Number	R2215	Calibrator Serial Number	2716		
Recorder Serial Number	2133				

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 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	1.4	1.5	2.9	1.68997	0.82696	30.0	29.77	301.0	756.0		
7	2.5	2.5	5.0	2.21903	1.08176	39.0	38.70	301.0	756.0		
10	3.7	3.8	7.5	2.71775	1.32193	48.0	47.63	301.0	756.0		
13	4.9	5.0	9.9	3.12246	1.51683	56.0	55.57	301.0	756.0		
18	6.1	6.2	12.3	3.48042	1.68922	62.0	61.53	301.0	756.0		
Linear Regression Y ON X : Y= mX + b							Average	301.0	756.0		
1	Slope ( m )			2.07647	Linear Equation			r <sup>2</sup>	0.999390	Pstd(mmHg)	760
2	Intercept ( b )			-0.02720	Set Point Flow Rate ( X ) (m <sup>3</sup> /min)		1.133	r	0.999695	T <sub>NTP</sub>	298
3	Correlation Coefficient ( r )			0.99954	Final Set Flow Rate = ( I )		0	(Pa/Pstd)*(Tstd/Ta)		0.984822521	
Result								C=(Pa/Pstd)*(Tstd/Ta)^0.5		0.992382246	

COMMENT

Andersen Instruments, Inc.



Checked By

*Marongrit Tibon*

( Mr. Prayun Detkla )

Technician

envi research  
ENVIRONMENT RESEARCH & TECHNOLOGY CO., LTD.

Approved By

*Mr. Panupon Podang*

( Mr. Panupon Podang )

Environmental Scientist

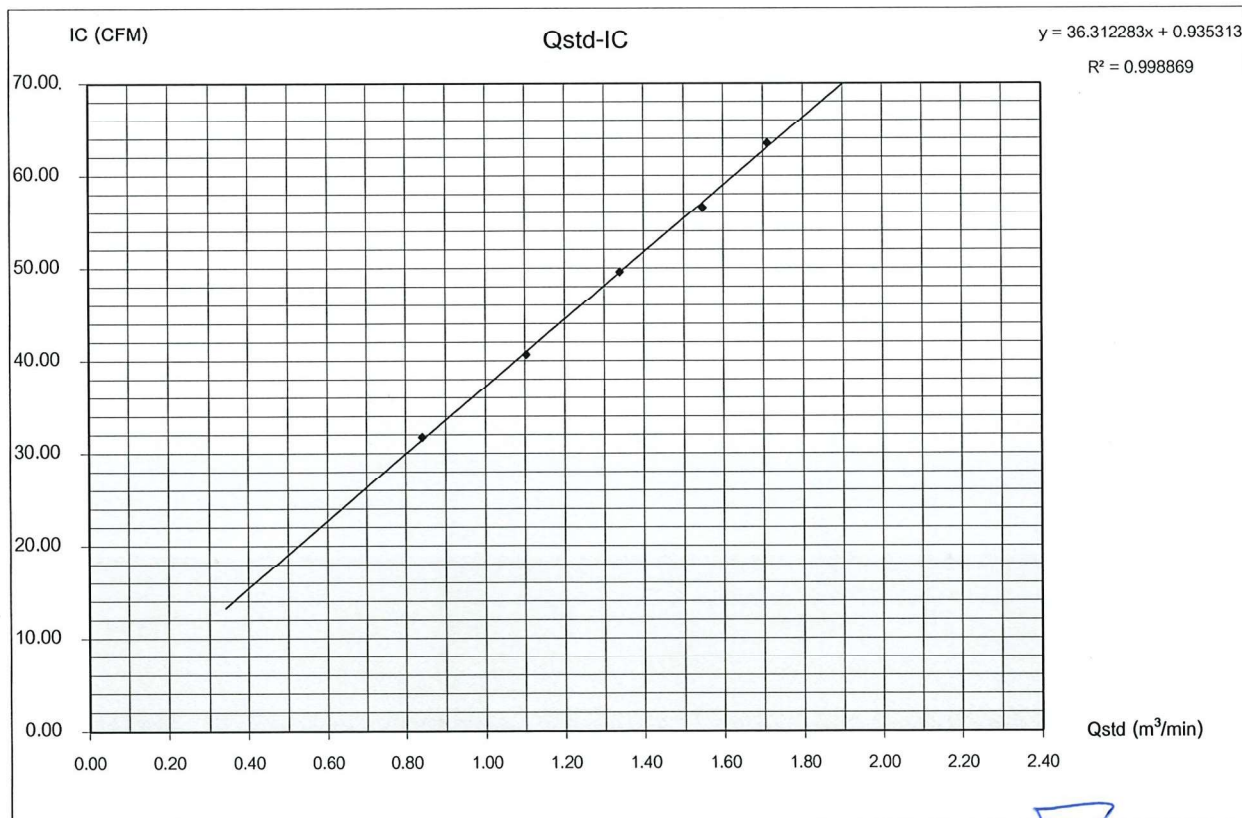
# PM10 HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

Quotation	2023-00722			Date	October 4, 2023
Sampler Location	รพศ.คลองตัน			Start Time	11:40 AM
Sampler Number	PM-10 No.25	Transfer Standard Type	Orifice	Stop Time	11:50 AM
Instrument Model	HIVOL-BMBBE	Calibrator Model	TE-5025A	Calibrated By	Mr.Anan Kongngoenmuk
Motor Serial Number	2150	Calibrator Serial Number	2716		
Recorder Serial Number	2409				

Plate	(Delta H)			( A )	( X )	( I )	( Y )	Temperature	Barometric	Start	Stop
No.	Pressure Drop Across Orifice (inH <sub>2</sub> O)			$[\Delta H_2O(Pa/P_{std})(T_{std}/Ta)]^{1/2}$	Qstd = ( l/m)[(A-b)]	ample Flow Rate Indicato	IC = I[(Pa/P <sub>std</sub> )(T <sub>std</sub> /Ta)] <sup>1/2</sup>	(^°K = ^°C+273)	Pressure	Meter	Meter
	Positive	Negative	ΔH <sub>2</sub> O								
5	1.5	1.5	3.0	1.71886	0.84088	32.0	31.76	301.0	756.0		
7	2.6	2.6	5.2	2.26298	1.10292	41.0	40.69	301.0	756.0		
10	3.8	3.9	7.7	2.75375	1.33927	50.0	49.62	301.0	756.0		
13	5.1	5.2	10.3	3.18491	1.54691	57.0	56.57	301.0	756.0		
18	6.3	6.3	12.6	3.52261	1.70954	64.0	63.51	301.0	756.0		
Linear Regression Y ON X : Y= mX + b							Average	301.0	756.0		
1	Slope ( m )			2.07647	Linear Equation			r <sup>2</sup>	0.998869	Pstd(mmHg)	760.0
2	Intercept ( b )			-0.02720	Set Point Flow Rate ( X ) (m <sup>3</sup> /min)		1.133	r	0.9994343	T <sub>NTP</sub>	298.15
3	Correlation Coefficient ( r )			0.99954	Final Set Flow Rate = ( I )		0	(Pa/Pstd)*(Tstd/Ta)			0.984822521
Result								C=(Pa/Pstd)*(Tstd/Ta)^0.5			0.992382246

## COMMENT

Andersen Instruments, Inc.



Checked By

Maromrit Tibja

( Mr. Prayun Detkla )

Technician

Approved By

envi research  
ENVIRONMENT RESEARCH & TECHNOLOGY CO., LTD.

( Mr. Panupon Podang )

Environmental Scientist



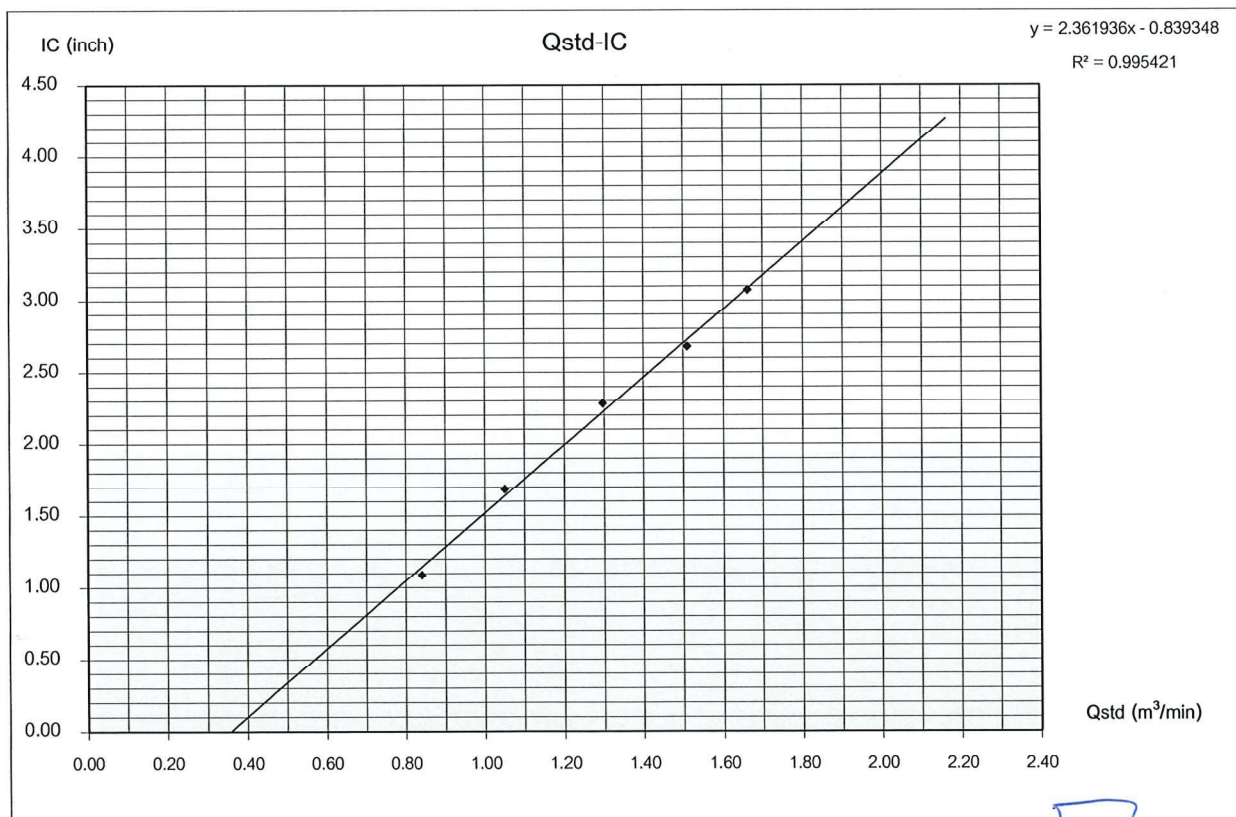
# TSP HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

Quotation	2023-00722	Date	October 4, 2023
Sampler Location	บ้านเลขที่ 60	Start Time	12:40 PM
Sampler Number	TSP No.C18	Transfer Standard Type	Orifice
Instrument Model	HIVOL-BBCBE	Calibrator Model	TE-5025A
Motor Serial Number	2012-06	Calibrator Serial Number	2716
Recorder Serial Number	-	Calibrated By	Mr.Anan Kongngoenok

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 )	Sample Flow Rate Indication ( inch )	$IC = I/[(Pa/P_{std})(T_{std}/Ta)]^{1/2}$	(^°K = ^°C+273)	( mmHg )		
	Positive	Negative	$\Delta H_2O$								
5	1.5	1.5	3.0	1.71886	0.84088	1.1	1.09	301.0	756.0		
7	2.3	2.4	4.7	2.15143	1.04920	1.7	1.69	301.0	756.0		
10	3.6	3.6	7.2	2.66284	1.29549	2.3	2.28	301.0	756.0		
13	4.9	4.9	9.8	3.10665	1.50922	2.7	2.68	301.0	756.0		
18	5.0	6.0	11.0	3.42336	1.66174	3.1	3.08	301.0	756.0		
Linear Regression Y ON X : Y= mX + b							Average	301.0	756.0		
1	Slope ( m )			2.07647	Linear Equation			r <sup>2</sup>	0.995421	Pstd(mmHg)	760.0
2	Intercept ( b )			-0.02720	Set Point Flow Rate ( X ) (m <sup>3</sup> /min)		1.133	r	0.9977079	T <sub>NTP</sub>	298.0
3	Correlation Coefficient ( r )			0.99954	Final Set Flow Rate = ( I )		0	(Pa/Pstd)*(Tstd/Ta)		0.984822521	
Result								C=(Pa/Pstd)*(Tstd/Ta)^0.5		0.992382246	

## COMMENT

Andersen Instruments, Inc.



Checked By

Mrongrit Tibsa

( Mr. Prayun Detkla )  
Technician

Approved By

( Mr. Panupon Podang )  
Environmental Scientist



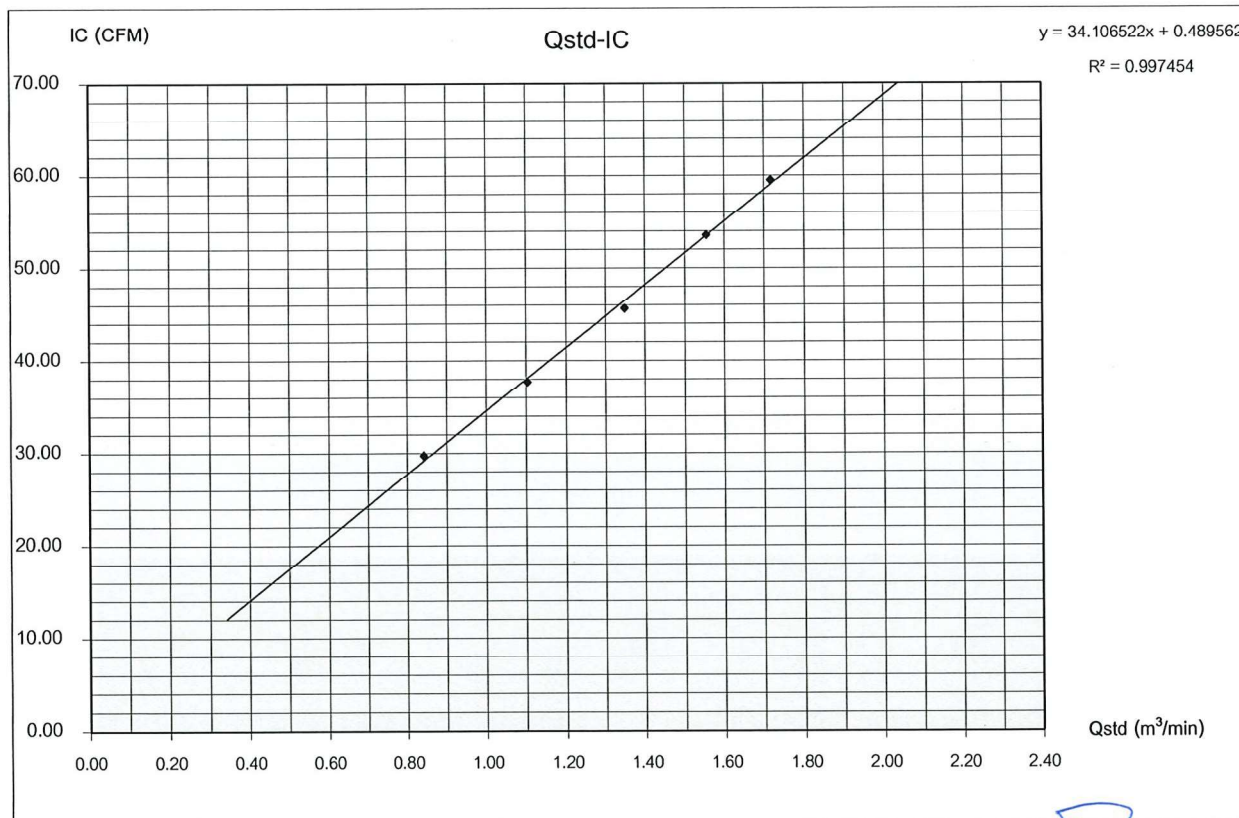
# PM10 HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

Quotation	2023-00722			Date	October 4, 2023
Sampler Location	บ้านเลขที่ 60			Start Time	12:50 PM
Sampler Number	PM-10 No.28	Transfer Standard Type	Orifice	Stop Time	1:00 PM
Instrument Model	HIVOL-BMBBE	Calibrator Model	TE-5025A	Calibrated By	Mr. Anan Kongngoenok
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)] ( 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	1.71886	0.84088	30.0	29.77	301.0	756.0		
7	2.6	2.6	5.2	2.26298	1.10292	38.0	37.71	301.0	756.0		
10	3.9	3.9	7.8	2.77157	1.34785	46.0	45.65	301.0	756.0		
13	5.2	5.2	10.4	3.20034	1.55434	54.0	53.59	301.0	756.0		
18	6.3	6.4	12.7	3.53656	1.71626	60.0	59.54	301.0	756.0		
Linear Regression Y ON X : Y= mX + b							Average	301.0	756.0		
1	Slope ( m )			2.07647	Linear Equation			r <sup>2</sup>	0.997454	Pstd(mmHg)	760
2	Intercept ( b )			-0.02720	Set Point Flow Rate ( X ) (m <sup>3</sup> /min)		1.133	r	0.9987262	T <sub>NTP</sub>	298
3	Correlation Coefficient ( r )			0.99954	Final Set Flow Rate = ( I )		0	(Pa/Pstd)*(Tstd/Ta)		0.984822521	
Result								C=-(Pa/Pstd)*(Tstd/Ta)^0.5		0.992382246	

## COMMENT

Andersen Instruments, Inc.



Checked By

Varongit Tibog

( Mr. Prayun Detkla )

Technician

Approved By  
ENVIRONMENT RESEARCH & TECHNOLOGY CO., LTD.

( Mr. Panupon Podang )

Environmental Scientist



JIRANATEE ASSOCIATES CO., LTD.

Accredited calibration laboratory  
ISO/IEC 17025:2017  
NSC-TISI-TIS 17025  
CALIBRATION 0367

Jiranatee Associates Co., Ltd.  
63/14-15, 67/35-36  
Petchbassam 7/71, Rd. Warthapa, Bangkokkyl,  
Bangkok 10600 (Thailand)  
Tel: +6608860812  
Mobile: +66653999453  
E-mail: jnac-calibration@jiranatee.com  
Web site: www.jiranatee.com

Flow measurement laboratory  
Calibration services department

## CERTIFICATE OF CALIBRATION

Certificate No. : CL-006-66

### MEASUREMENT ITEM

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 Chinakiet 1, Ngamwongwan Road,  
Toongsongkhong, Lakse, Bangkok 10210

### RECEIVED DATE

MEASUREMENT DATE : 21 Mar 2023  
ISSUE DATE : 07 Apr 2023

### 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.

Calibrated by:

☒ Mr. Sorawit Thachalad  
☐ Miss Jitraporn Lertsomphol

Approved signatory:

Mr. Parinya Booncharoen  
Calibration Department Manager



*Parinya Booncharoen*

Page 1 of 2 Pages

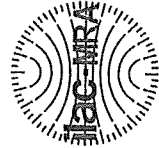
**Calibration procedure:**  
The Orifice gas flow device was calibrated against Standard Rotary Displacement Meter (Roots Meter) Model G65/INCM2-dp. The WP-CL-004 was used as a calibration guideline.

### 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'



NSC-TISI-TIS 17025  
CALIBRATION 0367



JIRANATEE ASSOCIATES CO., LTD.

Continuation of Certificate of Calibration Number CL-006-66

### 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 <sup>3</sup> /min]	Pressure [Pa] mmHg	Temperature [T <sub>a</sub> ] °C	Temperature [T <sub>m</sub> ] °C	Δp <sub>meter</sub> mmHg	Δp <sub>orifice</sub> inH <sub>2</sub> O	γ	Standard Flow [Q <sub>s</sub> ] m <sup>3</sup> /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<sup>3</sup>/min

Table 2: The results of Q actual calibration data

Plate	Flow rate [m <sup>3</sup> /min]	Pressure [Pa] mmHg	Temperature [T <sub>a</sub> ] °C	Temperature [T <sub>m</sub> ] °C	Δp <sub>meter</sub> mmHg	Δp <sub>orifice</sub> inH <sub>2</sub> O	γ	Standard Flow [Q <sub>s</sub> ] m <sup>3</sup> /min
1	0.701	754.759	24.59	24.15	53.063	1.773	0.856	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<sup>3</sup>/min



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

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



## Accuracy Calibration Certificate

### Customer

Company: Environment Research & Technology Co., Ltd.  
Address: 25/114 Moo 6, Soi Chinakiet 1, Ngamwongwan Rd., Toongsongkhong  
City: Lakki  
Zip / Postal: 10210  
State / Province: Bangkok  
Order Number: 0332617830

Contact: Ramita Taengthai

### Weighing Device

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

Range	Max Capacity	Repeatability (g)
1	220 g	0.0001 g

### Procedure

Calibration Guideline: EURAMET cg-18 v. 4.0 (11/2015)  
METTLER TOLEDO Work Instruction: CPW002/20  
This calibration certificate contains measurements for As Found and As Left calibrations.  
The sensitivity/span of the weighing instrument was adjusted before As Found and As Left calibrations.  
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.

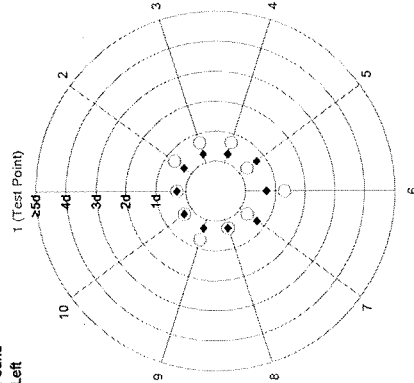
	As Found	As Left	Temperature	Humidity
Start: 23.6 °C	End: 23.5 °C	Start: 34.6 %	End: 35.1 %	
Start: 23.6 °C	End: 23.5 °C	Start: 35.0 %	End: 35.7 %	

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

## Measurement Results

### Repeatability

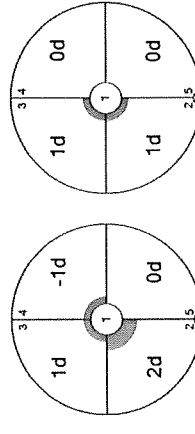
Test Load: 100 g	As Found	As Left
1	99.9992 g	100.0001 g
2	99.9991 g	100.0001 g
3	99.9991 g	100.0001 g
4	99.9991 g	100.0001 g
5	99.9992 g	100.0002 g
6	99.9993 g	100.0002 g
7	99.9992 g	100.0002 g
8	99.9992 g	100.0001 g
9	99.9991 g	100.0001 g
10	99.9992 g	100.0001 g
Standard Deviation	0.00007 g	0.00005 g



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

### Eccentricity

Test Load: 100 g	Position	As Found	As Left
1	1	99.9991 g	100.0001 g
2	2	99.9993 g	100.0002 g
3	3	99.9992 g	100.0002 g
4	4	99.9990 g	100.0001 g
5	5	99.9991 g	100.0001 g
Maximum Deviation		0.0002 g	0.0001 g



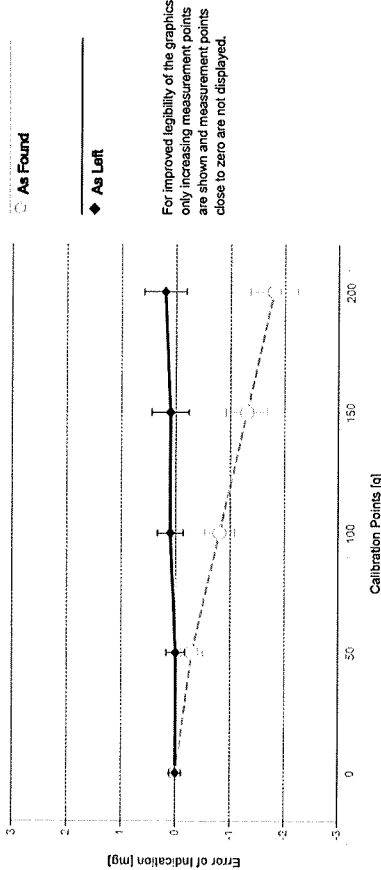
The "d" in the graph represents the readability of the range/interval in which the test was performed.



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  $k = 2$  which can be larger than 2 according to EURAMET cg-18. The value of the measurand lies within the assigned range of values with a probability of approximately 95%.

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

Test Equipment

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

Weight Set 1: OIML E2

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

Thermo Hygrometer

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

Remarks

Equipment condition: Good

Next calibration according to customer's procedure

Calibration data not decide by calibration laboratory

End of Accredited Section

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

Measurement Uncertainty of the Weighing Instrument in Use

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

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

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

Linearization of Uncertainty Equation

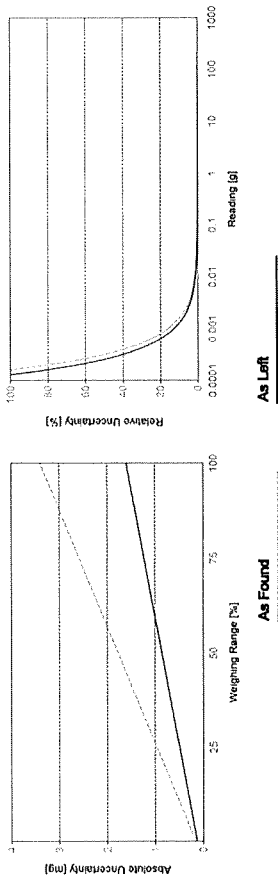
	Range		As Found	As Left
	d	Max		
1	0.0001 g	220 g	$U_1 = 0.16 \text{ mg} + 0.0147 \text{ mg/g} \cdot R$	$U_1 = 0.13 \text{ mg} + 0.00671 \text{ mg/g} \cdot R$

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

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

Net Indication	As Found	As Left
0.0220 g	0.16 mg	0.13 mg
0.2200 g	0.16 mg	0.13 mg
2.2000 g	0.19 mg	0.14 mg
22.0000 g	0.48 mg	0.28 mg
220.0000 g	3.4 mg	1.6 mg

ภาคผนวก จ หน้า 8/50



GWP®  
Certificate



As Found

As Left

The weighing device meets the given process requirements.

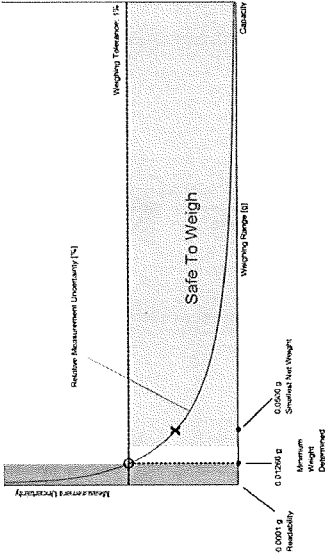
The weighing device meets the given process requirements.

Tests Performed: ☒ As Found ☒ As Left

Process Requirements

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

Safe Weighing Range



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

Minimum Weight

As Found Minimum Weight Table

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

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

As Left Minimum Weight Table

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

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

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

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

Notes on minimum weight values in above table:

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

Measurement Results

Results Summary

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

- ✓ = Passed  
✗ = Failed  
! = Safety Factor not met

Repeatability

Test Load: 100 g

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

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

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



Error of Indication

As Found

Reference Value		Control limits for various weighing tolerances							
		0.1%	0.2%	0.5%	1%	2%	5%		
0.0000 g	0.0000 g	N/A	N/A	N/A	N/A	N/A	N/A	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	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	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	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	5.0000 g	
Result		✓	✓	✓	✓	✓	✓	✓	✓

As Left

Reference Value		Control limits for various weighing tolerances							
		0.1%	0.2%	0.5%	1%	2%	5%		
0.0000 g	0.0000 g	N/A	N/A	N/A	N/A	N/A	N/A	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	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	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	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	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 Certificate



Issued by : Calibration &amp; Test Section : Meteorological Instruments Bureau

Date of Issue : 11 August, 2023

Certification No. 284/23

Page : 1 of 2

Object : Wind speed and wind direction

Manufacturer : Davis Instruments Inc.

Type : Weather Wizard III Product No. 7425

Serial No. : WC20516A58 ID No. : No.13

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 1008.5 hPa

NATIONAL STANDARD WIND TUNNEL :

: Thermal Anemometer 642 S/N 91563

: HOOK GAGE NO 1425 Pilot 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)

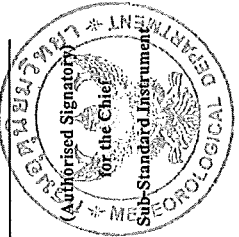
Serial Number 110730029 (sensor 120629586)

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

Calibrated by : Netrapol Signed:

Mr. Wacharapol Subwat  
Mechanical Engineer

Mr. Pisod Promsut



## The Result of Calibration

Certification No. 284/23

11 August, 2023

Page : 2 of 2

Standard Ultrasonic Anemometer m/sec	HOOK GAGE NO. 1425			TESTED ANEMOMETER	
	Pressure inches H <sub>2</sub> O	Vacuum inches H <sub>2</sub> O	Velocity m/sec	Velocity m/sec	Correction m/sec
1.00	-	-	-	0.4	0.60
3.02	-	-	-	2.7	0.32
5.00	-	-	-	4.5	0.50
7.04	-	-	-	6.7	0.34
9.02	-	-	-	8.5	0.52
11.01	-	-	-	10.7	0.31
13.01	-	-	-	12.5	0.51
15.01	-	-	-	14.7	0.31
17.02	-	-	-	16.5	0.52
20.02	-	-	-	19.7	0.32

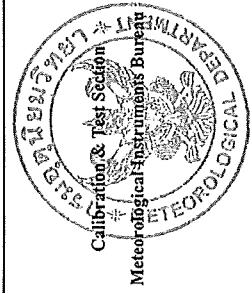
Wind Aloft Plotting Board.

U.S. DEPARTMENT OF COMMERCE WEATHER BUREAU

WIND DIRECTION	TESTED WIND DIRECTION
0	0
90	90
180	180
270	270

Calibrated by :

Netrapol

Mr. Wacharapol Subwat  
Mechanical Engineer

## Calibration Certificate



Issued by : Calibration &amp; Test Section : Meteorological Instruments Bureau

Date of Issue 11 August, 2023 Certification No. 282/23

Page : 1 of 2

Object : Wind speed and wind direction

Manufacturer : Davis Instruments Inc.

Type : Weather Wizard III Product No. 7425

Serial No. : WE60321A26A ID No. : No.5

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 1007.9 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 0.2 m/sec

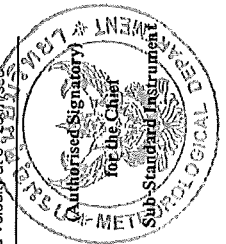
Calibrated by : *Watarapol* Signed :

Mr. Watcharapol Subwat

Mechanical Engineer

Mr. Pisood Promsut

Mechanical Engineer



## The Result of Calibration

Certification No. 282/23

11 August, 2023

Page : 2 of 2

Standard Ultrasonic Anemometer m/sec	HOOK GAGE NO. 1425			TESTED ANEMOMETER	
	Pressure Inches H <sub>2</sub> O	Vacuum Inches H <sub>2</sub> O	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	-	-	-	14.3	0.71
17.02	-	-	-	16.5	0.52
20.02	-	-	-	19.3	0.72

## Wind Aloft Plotting Board.

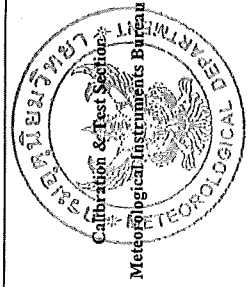
US.DEPARTMENT OF COMMERCE WEATHER BUREAU	
WIND DIRECTION	TESTED WIND DIRECTION
0	0
90	90
180	180
270	270

Calibrated by :

*Watarapol*

Mr. Watcharapol Subwat

Mechanical Engineer









## Calibration Chart

BSWA-IV-C021-03-0048A

Sound Calibrator model

CA11

Serial Number

590338

Appearance

OK

Power Supply

1.5V LR6 (AA battery) x2

Sound Pressure Level

14.06 / 114.04 dB

Frequency

1000.5 Hz

TND (@1000Hz)

0.55 / 1.51 %

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-28

Calibrated

2023-3-7

Date



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

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

TEL. 0-2717-3000-29 FAX. 0-2719-9484

Cert.No.: 23CH705  
Page.: 1 of 2

## Certificate of Calibration

Equipment : pH Meter  
Manufacturer : Waterproof  
Model : pHtest30  
Serial No. : 3066362  
ID No. : -  
Condition As-Received: Used Item  
Received Date : 02 June 2023  
Calibration Date : 06 June 2023  
Reference : 2306-0067DN-4

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 reference material (RM)

Calibrated by : Warakorn Lengagtrakul

Approved by :   
Approved Signatory

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

Issue Date : 8 June 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 Calibration and Testing Equipment Services.

A 0011220



Cert.No.: 23CH705  
Page.: 2 of 2

### Condition of this calibration result

1. Certified Reference Materials : Standard buffer solution (Traceable to NIST, U.S.A.)

Buffer Solution	Manufacturer	Lot No.	Exp. date
pH 4.01	Thermo Scientific	491/10	10 Dec 2024
pH 7.00	Thermo Scientific	152/02	14 Apr 2025
pH 10.01	Thermo Scientific	162/06	22 Apr 2025

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	4.01	4.01	N/A	0.013	2.00
S/N.: 3066362	7.00	7.00	N/A	0.013	2.00
	10.01	10.01	N/A	0.017	2.00

Remark : - pH meter does not have voltage mode.

- Can not connect the BNC because the plug does not match with the socket.

- N/A = Not Available

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

-o0o-



a 1165238





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

53/4/4 PATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG BANGKOK 10250  
TEL. 0-2717-3000 FAX. 0-2719-9484



Cert.No.: 22TW286  
Page.: 2 of 2

Cert.No.: 22TW286  
Page.: 1 of 2

## Certificate of Testing

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

Approved by : Warakorn  
Approved Signatory

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

Issue Date : 28 December 2022

B 0303343

### Condition of this result of calibration

#### 1. Reference Standard Instruments :

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

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

#### 2. Standard Material :-

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

Result : Dissolved Oxygen Meter Adjustment With Air 100 %

Dissolved Oxygen Probe No.: 14L100144

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

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

-o0o-

Warakorn

a 1142236



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



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



## Certificate of Calibration

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

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

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

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

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

### Reference Standard Instruments :

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

This result of calibration was found accurate as shown on date and place of calibration only.  
**Traceability** : This measurement are traceable to the International System of Unit (SI), through National Institute of Metrology Thailand ( NIMT )

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



**Calibrated by :** Mr.Jiraphan Sreebannasarn  
**Issue date :** Dec 19, 2022  
**Approved by :** ( Mr.Choopong Khumdet )

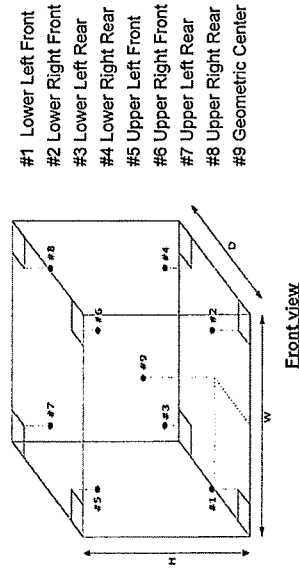
This calibration certificate shall not be reproduced other than in full except with the prior written approval of Incotech Metrological Center Co.,Ltd

**Function** : Temperature measurement  
**Calibration point** : 20 °C

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

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

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



UUC\* = Unit under calibration  
Uniformity = Maximum and Minimum difference of measured temperature at any probes and the measured temperature at the reference and same time.  
Overall Variation = Difference of temperature value between the maximum and minimum any time.  
Stability = One half of the maximum difference of measured temperatures at any one probe.



TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)  
CORPORATE SERVICES 3: EQUIPMENT CALIBRATION AND TESTING SERVICES  
53/44 PATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG BANGKOK 10250  
TEL. 0-2717-3000-27 FAX. 0-2719-9484



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

## Certificate of Calibration

Equipment : Hot Air Oven  
Manufacturer : Binder  
Model : FED 115 E2  
Serial No. : 11-22823  
ID No. : ERTC-Ln-076  
Submitted by : Environment Research & Technology Company Limited,  
25/114 Moo 6, Soi Chinakhet 1, Ngamwongwan Road,  
Toongsonghong, Laksi,  
Bangkok 10210  
Location : Laboratory (ERTC)

Received Order : 4 January 2023  
Calibration Date : 4 January 2023  
Ambient Temperature : ( 26 ± 10 ) °C  
Relative Humidity : ( 50 ± 30 ) %

Calibrated by : Preecha Hlahib

Approved by :   
Approved Signatory

( ) Pormthippa Tameyakul  
( ) Malee Butkruea  
( ) Suwit Injai

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

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

The temperature scale used was based on ITS-90.

Condition of this result of calibration

1. Reference standard instrument:-

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

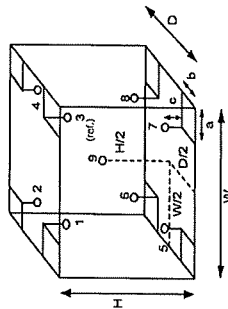
2. This certificate is valid only to the item calibrated on date and place of calibration.  
3. This certification is traceable to the International System of Unit.

Result of Calibration :- ( \* ) Without Adjustment

Function of UUC\* : Temperature Source

Fresh air setting : Close

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



Probe Installation Details :

a = 5.0 cm D = 0.40 m  
b = 5.0 cm W = 0.60 m  
c = 5.0 cm H = 0.48 m  
Capacity = 0.12 m³

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



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

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

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

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

Average\* : The average of 30 values in each position.  
Temperature stability : One-half of the greatest maximum difference of measured temperature at any one sensor.  
Temperature uniformity : The maximum difference of measured temperatures at any sensors and the measured temperature at the reference location which are observed at the same time or at as close an observation time as possible to determine the temperature pattern or homogeneity within the chamber under steady-state conditions.  
Overall Variation : The Difference of the maximum and minimum measured temperatures throughout observation.  
UUC\* : Unit Under Calibration  
Note : The reported uncertainty of measurement was included stability and excluded uniformity .

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

-000-

Wah.



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.: 23TM32  
Page : 1 of 3

## Certificate of Calibration

Equipment : Hot Air Oven  
Manufacturer : Memmert  
Model : UF 110  
Serial No. : B414.0652  
ID No. : ERTC-L-In.-098

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

Location : Laboratory (ERTC)

Received Order : 4 January 2023  
Calibration Date : 4 January 2023  
Ambient Temperature :  $(26 \pm 10) ^\circ\text{C}$   
Relative Humidity :  $(50 \pm 30) \%$

Calibrated by : Preecha Hlahib

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.

A 0049319



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

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

### Procedure Used :-

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

The temperature scale used was based on ITS-90.

### Condition of this result of calibration

#### 1. Reference standard instrument:-

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

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

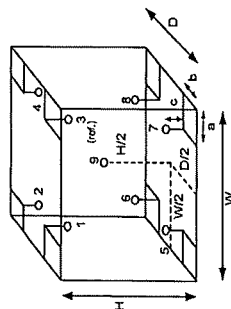
3. This certification is traceable to the International System of Unit.

Result of Calibration :- ( \* ) Without Adjustment

Function of UUC\* : Temperature Source

Fresh air setting : Close

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



### Probe Installation Details :

Probe	Dimension of Chamber :
a = 5.0 cm	D = 0.40 m
b = 5.0 cm	W = 0.56 m
c = 5.0 cm	H = 0.48 m
	Capacity = 0.11 m³

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

Walu

a 1142804





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

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

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

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

Average\* : The average of 30 values in each position.  
Temperature stability : One-half of the greatest maximum difference of measured temperature at any one sensor.  
Temperature uniformity : The maximum difference of measured temperatures at any sensors and the measured temperature at the reference location which are observed at the same time or at as close an observation time as possible to determine the temperature pattern or homogeneity within the chamber under steady-state conditions.  
Overall Variation : The Difference of the maximum and minimum measured temperatures throughout observation.  
UUC\* : Unit Under Calibration  
Note : The reported uncertainty of measurement was included stability and excluded uniformity .

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

-000-

Malu.

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



## Accuracy Calibration Certificate

### Customer

Company: Environment Research & Technology Co., Ltd.  
Address: 25/114 Moo 6, Soi Chinakiet 1, Ngamwongwan Rd., Toongsongkhong  
City: Laksl  
Zip / Postal: 10210  
State / Province: Bangkok  
Order Number: 0332617656

Contact: Ramita Taengthai



### Weighing Device

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

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

### Procedure

#### Calibration Guidelines:

##### METTLER TOLEDO Work Instruction:

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

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

As Found Calibration Date: 17-Jan-2023

As Left Calibration Date: N/A

Issue Date: 19-Jan-2023

Calibrator: Chawalit

Chawalit Martsujoke

#### Approved Signatory:

Signature

Technical Manager / Head of Calibration Center

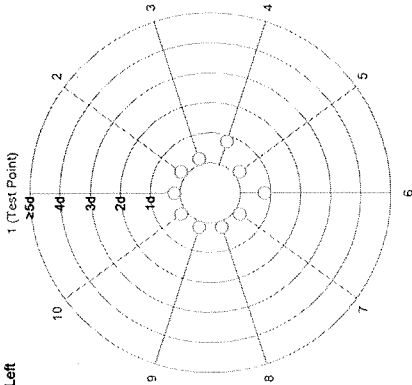
## Measurement Results

### Repeatability

Test Load: 100 g

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

○ As Found  
◆ As Left

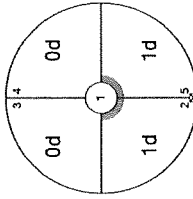


The "g" in the graph represents the readability of the range/interval in which the test was performed.  
The results of this graph are based upon the absolute values of the differences from the mean value.

### Eccentricity

Test Load: 100 g

Position	As Found	As Left
1	99.9999 g	N/A
2	100.0000 g	N/A
3	99.9999 g	N/A
4	99.9999 g	N/A
5	100.0000 g	N/A
Maximum Deviation	0.0001 g	N/A

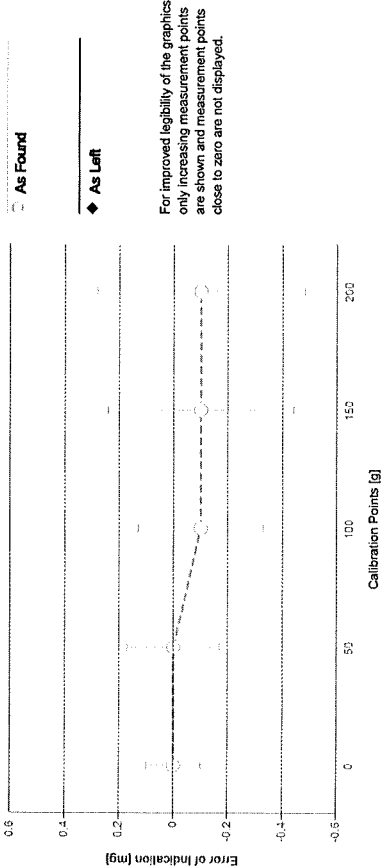


As Found

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

Error of Indication

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



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

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

Test Equipment

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

Weight Set 1: OIML E2

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

Thermo Hygrometer

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

Remarks

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

End of Accredited Section

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

Measurement Uncertainty of the Weighing Instrument in Use

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

Temperature coefficient for the evaluation of the measurement uncertainty in use:  $1.5 \cdot 10^{-6} / K$

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

Linearization of Uncertainty Equation

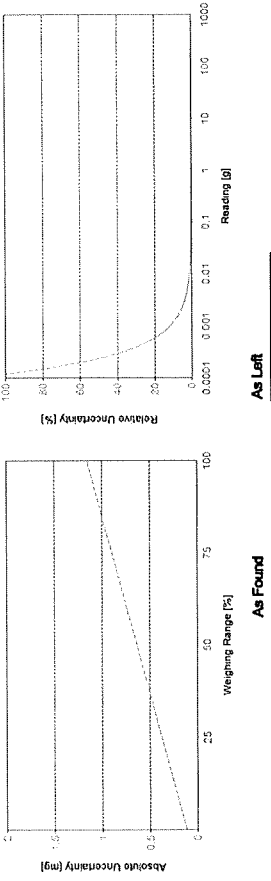
Range	As Found		As Left
	d	Max	
1	0.0001 g	220 g	N/A

$U_1 = 0.12 \text{ mg} + 0.00474 \text{ mg/g} \cdot R$

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	0.12 mg	0.55%	N/A	N/A
0.2200 g	0.12 mg	0.055%	N/A	N/A
2.2000 g	0.13 mg	0.0059%	N/A	N/A
22.0000 g	0.22 mg	0.0010%	N/A	N/A
220.0000 g	1.2 mg	0.00063%	N/A	N/A



GWP®  
Certificate



As Found



As Left



The weighing device meets the given process requirements.

The weighing device meets the given process requirements.

Tests Performed:

☒ As Found

☐ As Left

☒ No adjustments/modifications made. As Left results correspond to As Found.

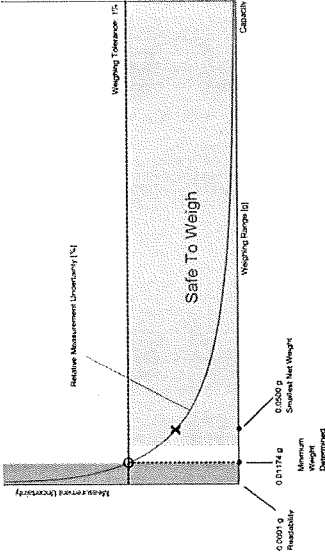
Process Requirements

Weighing Tolerance: 1%

Smallest Net Weight: 0.0500 g

Safety Factor: 2

Safe Weighing Range



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

Minimum Weight

As Found Minimum Weight Table

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

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

As Left Minimum Weight Table

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

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

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

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

Notes on minimum weight values in above table:

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

Measurement Results

Results Summary

Repeatability			
As Found	As Left	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			N/A		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			✓		✓
0.2%		0.1000 g			✓		✓
0.5%		0.2500 g			✓		✓
1%		0.5000 g			✓		✓
2%		1.0000 g			✓		✓
5%		2.5000 g			✓		✓

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



Error of Indication

As Found

Reference Value		Control limits for various weighing tolerances						
		Error	0.1%	0.2%	0.5%	1%	2%	5%
0.0000 g	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	0.0250 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	0.1000 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	0.1500 g	0.3750 g	0.7500 g	1.5000 g	3.7500 g
200.0000 g	-0.0001 g	0.1000 g	0.2000 g	0.2000 g	0.5000 g	1.0000 g	2.0000 g	5.0000 g
Result		✓	✓	✓	✓	✓	✓	✓

As Left

Reference Value		Control limits for various weighing tolerances						
		Error	0.1%	0.2%	0.5%	1%	2%	5%
0.0000 g	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	0.0250 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	0.1000 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	0.1500 g	0.3750 g	0.7500 g	1.5000 g	3.7500 g
200.0000 g	-0.0001 g	0.1000 g	0.2000 g	0.2000 g	0.5000 g	1.0000 g	2.0000 g	5.0000 g
Result		✓	✓	✓	✓	✓	✓	✓

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



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



NSC-TS1-TS17025  
CALIBRATION 0008

Cert. No.: 23TM3  
Page : 1 of 3

## Certificate of Calibration

Equipment: Incubator  
Manufacturer: Memmert  
Model: IF 160  
Serial No.: D522.0070  
ID No.: ERTC-L-In-181

Submitted by: Environment Research & Technology Company Limited,  
25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Road,  
Toongsonghong, Laksi,  
Bangkok 10210

Location: 408/2 ห้องปฏิบัติการปศุสัตว์อาหารเลี้ยงเชื้อ

Received Order: 4 January 2023  
Calibration Date: 5 January 2023  
Ambient Temperature:  $(26 \pm 10) ^\circ\text{C}$   
Relative Humidity:  $(50 \pm 30) \%$

Calibrated by: Krisda Malee

Approved by:   
Approved Signatory

( ) Ponthippa Tameyakul  
(x) 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.

A 0049321



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

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

### Procedure Used :-

Calibration were conducted using calibration procedure CP-OT02 according to direct measurement method with Data Acquisition which connected with Resistance Temperature Detector (RTD ).  
The temperature scale used was based on ITS-90.

### Condition of this result of calibration

1. Reference standard instrument:-

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

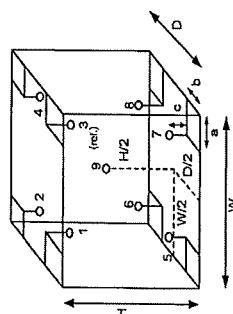
2. This certificate is valid only to the item calibrated on date and place of calibration.  
3. This certification is traceable to the International System of Unit

Result of Calibration :- ( \* ) Without Adjustment

Function of UUC\* : Temperature Source

Fresh air setting : Close

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



### Probe Installation Details :

a = 5.0 cm  
b = 5.0 cm  
c = 5.0 cm  
D = 0.40 m  
W = 0.56 m  
H = 0.73 m  
Capacity = 0.16 m<sup>3</sup>

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



Calibration Point (°C)	UUC* Setting (°C)	UUC* Reading (°C)	Temperature stability (± °C)	Temperature uniformity (°C)	Overall Variation (°C)	Uncertainty (±°C)	Coverage Factor <i>k</i>
35.0	35.0	35.0	0.026	0.30	0.33	0.30	2
Measured Temperature (°C)							
Calibration Point (°C)	Position						
	1	2	3	4	5	6	7
35.0	35.132	35.177	35.048	35.188	35.186	35.131	35.154
							9 (ref.)
							35,334

**Average\***: The average of 30 values in each position.  
**Temperature stability**: One-half of the greatest maximum difference of measured temperature at any one sensor.  
**Temperature uniformity**: The maximum difference of measured temperatures at any sensors and the measured temperature at the reference location which are observed at the same time or at as close an observation time as possible to determine the temperature pattern or homogeneity within the chamber under steady-state conditions.  
**Overall Variation**: The Difference of the maximum and minimum measured temperatures throughout observation.  
**IUC\***: Unit Under Calibration  
**note**: The reported uncertainty of measurement was included stability and excluded uniformity.

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

-000-

male.



TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)  
CORPORATE SERVICES 3: EQUIPMENT CALIBRATION AND TESTING SERVICES  
53/44 PATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG BANGKOK 10250  
TEL. 0-2717-3000-27 FAX. 0-2719-5484



Cert. No.: 23TM1  
Page : 1 of 3

## Certificate of Calibration

Equipment: Incubator  
Manufacturer: Ehret  
Model: BK 4106  
Serial No.: 22162  
ID No.: ERTC-L-In-022

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

Location: ห้องปฏิบัติการมาตรฐานสิ่งแวดล้อม (408/2)

Received Order: 4 January 2023  
Calibration Date: 4 January 2023  
Ambient Temperature:  $(26 \pm 10) ^\circ\text{C}$   
Relative Humidity:  $(50 \pm 30) \%$

Calibrated by: Krisda Malee

Approved by:   
Approved Signatory

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

Issue Date: 17 January 2023

The Uncertainties are for a confidence probability of approximately 95 %

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

A 0045995



Equipment: Incubator  
Condition As-Received: Used Item  
Reference: 2301-0002ON-6

Cert. No.: 23TM1  
Page : 2 of 3

### Procedure Used :-

Calibration were conducted using calibration procedure CP-OT02 according to direct measurement method with Data Acquisition which connected with Resistance Temperature Detector (RTD ).  
The temperature scale used was based on ITS-90.

### Condition of this result of calibration

1. Reference standard instrument:-

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

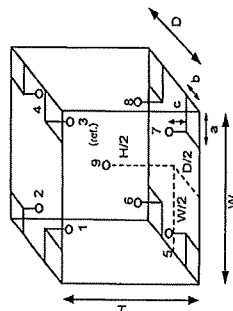
2. This certificate is valid only to the item calibrated on date and place of calibration.  
3. This certification is traceable to the International System of Unit.

Result of Calibration :- ( \* ) Without Adjustment

Function of UUC\* : Temperature Source

Fresh air setting : Close

Environment during calibration		
	Beginning	Finished
Temp. ( °C )	26	27
REL.Humid. ( % )	49	47
AC Supply ( Volt )	221	220



### Probe Installation Details :

a = 5.0 cm      D = 0.50 m  
b = 5.0 cm      W = 0.60 m  
c = 5.0 cm      H = 0.50 m  
Capacity = 0.15 m<sup>3</sup>

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

Walu.

a 1142797



Equipment : Incubator  
Condition As-Received : Used Item  
Reference : 2301-00020N-6  
Result of Calibration :- ( \* ) Without Adjustment  
Function of UUC\* : Temperature Source  
Fresh air setting : Close

Cert. No.: 23TM1  
Page : 3 of 3

Calibration Point (°C)	UUC* Setting (°C)	UUC* Reading (°C)	Temperature stability (± °C)	Temperature uniformity (°C)	Overall Variation (°C)	Uncertainty (±°C)	Coverage Factor k
44.5	44.5	44.5	0.34	1.3	1.9	0.80	2
Measured Temperature (°C)							
Position							
1	2	3	4	5	6	7	8
44.5	44.527	45.501	45.139	45.606	43.898	44.165	44.411
							44.551
							45.204

Average\* : The average of 30 values in each position.  
Temperature stability : One-half of the greatest maximum difference of measured temperature at any one sensor.  
Temperature uniformity : The maximum difference of measured temperatures at any sensors and the measured temperature at the reference location which are observed at the same time or at as close an observation time as possible to determine the temperature pattern or homogeneity within the chamber under steady-state conditions.  
Overall Variation : The Difference of the maximum and minimum measured temperatures throughout observation.  
UUC\* : Unit Under Calibration  
Note : The reported uncertainty of measurement was included stability and excluded uniformity .

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

-000-

Malu.





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



Cert.No.: 23CHO3  
Page: 1 of 3

## Certificate of Calibration

Equipment: UV-VIS Spectrophotometer  
Manufacturer: PerkinElmer  
Model: Lambda 365+  
Serial No.: 365PK22072603  
ID No.: ERTC-L-In.-180  
Condition As-Received: Used Item  
Received Date: 04 January 2023  
Calibration Date: 04 January 2023  
Reference: 2301-0002ON-14  
Submitted by: Environment Research & Technology Company Limited.  
25/114 Moo 6, Soi Chinaket 1, Ngamwongwan Road,  
Toongsonghong, Laksi, Bangkok 10210

Calibration Place: ห้องปฏิบัติการวิเคราะห์ Spectrophotometer  
Ambient Temperature: ( 24.8 - 25.2 ) °C ( On-Site )  
Relative Humidity: ( 56 - 61 ) % ( On-Site )  
Calibration Procedure: In - house method :  
CP-OCH4 based on ASTM E 275-01

Calibrated by: Uthen Kankawi

Approved by:   
Approved Signatory

( ✓ ) Malee Butkrua  
( ) Saithip Meangmai  
( ) Warakorn Lemgagtrakul

Issue Date: 17 January 2023

The Uncertainties are for a confidence probability of approximately 95 %

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

A 0045992

a 1142780



Cert. No. : 23CHO3  
Page : 2 of 3

### Condition of calibration result

#### 1. Reference Standard Material :

Material	Serial No.	Certificate No.	Due date
1. Absorbance Standard set	32588	103225	08 July 2024
2. Absorbance Standard set	32592	104226	04 Aug 2024
3. Absorbance Standard set	39130	106269	10 Oct 2024
4. Wavelength Standard set	29829	94776	02 Sep 2023
5. Wavelength Standard set	29829	94777	02 Sep 2023
6. Stray Light Standard set	32629	9112960	03 Aug 2024

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

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

- National Physical Laboratory (NPL), The United Kingdom of Great Britain and Northern Ireland
- National Institute of Standards and Technology (NIST), The United States of America

4. Spectral Bandwidth : 1 nm

Scan Speed : 30 nm/min

### Calibration Results : without adjustment

#### Wavelength Accuracy

Certified Values of Reference Material ( nm )	UUC Reading ( nm )	Uncertainty of Measurement ( ± nm )	Coverage Factor k
360.89	360.96	0.12	2.00
459.99	459.98	0.12	2.00
536.52	536.38	0.12	2.00
638.00	637.88	0.12	2.00
879.41	879.43	0.12	2.00

Malee.



Cert. No. : 23CHO3

Page : 3 of 3

**Calibration Results : without adjustment**

**Photometric Accuracy**

Wavelength (nm)	Certified Values of Reference Material ( Abs )	UUC Reading ( Abs )	Uncertainty of Measurement ( ±Abs )	Coverage Factor k
350.0	Zero	0.0000	0.0046	2.00
	0.4253	0.4239	0.0051	2.00
546.1	Zero	0.0000	0.0050	2.00
	0.6389	0.6383	0.0056	2.00
	Zero	0.0000	0.0028	2.00
	0.5281	0.5269	0.0028	2.00
635.0	0.6962	0.6945	0.0028	2.00
	0.9984	0.9962	0.0028	2.00
	Zero	0.0000	0.0028	2.00
	0.5699	0.5676	0.0028	2.00
635.0	0.7606	0.7581	0.0028	2.00
	1.0927	1.0894	0.0028	2.00

**Stray Light**

* Straylight at 280.05 nm ± 0.11 nm	Reading at 280.05 nm ± 0.11 nm
Abs	2.0810
%T	0.8214

**Remark**

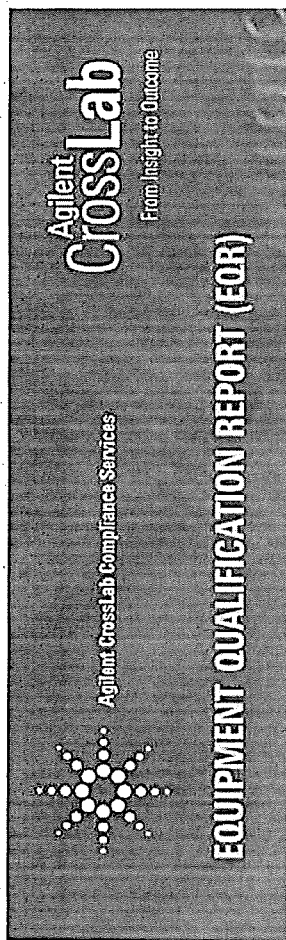
- Each individual filter is measured against the empty filter holder (blank) used to zero the spectrophotometer
- The Potassium Dichromate filled cells are measured against a Perchloric acid blank.
- Cut-off wavelength of stray light reference material (Potassium Iodide) at wavelength 280.05 nm ± 0.11 nm
- Result = Pass, If Absorbance > 2.00 Abs and Transmission < 1.0 %T at Wavelength 280.05 nm ± 0.11 nm
- \* : Not NSC-ONSC Accredited

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

-000-

๗๖๖๖.

a 1142779



Agilent CrossLab Compliance

Qualification Type: ES-OQ  
System ID: MY15330001  
EQP Name: AgilentRecommended  
EQP Revision: ES.02.50  
EQP Publish Date: March 2020

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

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

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

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

Page 34/50

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

## Overall Qualification Status

Pass

ภาคผนวก จ หน้า 34/50

Page 47

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

General Details	
Service Order No./Request	6005573434
EQP Name:	AgilentRecommended
EQP Revision:	ES.02.50
Report Type:	Report
Organization Details	
Name:	Environment Research & Technology Co.,Ltd
Location:	25/114 Moo 6 Soi Chinaket, Ngamwongwan Rd., Bangkok 10210
Local Contact Details	
Name:	Khun Raiwin Posit
Job Title:	Supervisor Scientist
Qualification Location:	ICPOES Room
Operator Details	
Name:	Worawit Timakul
Job Title:	Field Service Engineer
Data Acquisition Details	
Acquisition Software Name:	ICP Expert
Acquisition Software Revision:	7.1.0.6821
Customer Data System (CDS):	Es: ICP Expert

This section 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

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

## Purpose

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

## Configuration Details

Model/Serial No.:

G8011A

MY15330001

## Results

## Criteria

Does the plasma ignite successfully in the first three attempts?

Was the detector calibration performed and completed successfully?

Was the instrument calibration performed and completed successfully?

Observed Result

Yes

Yes

Yes

Expected Result

Yes

Yes

Yes

Status

Pass

Pass

Pass

## Image Details:

Was the detector calibration performed and completed successfully?

Date and Time: November 28, 2022 4:07:22 PM

Host Name: 5CG0202NQ4

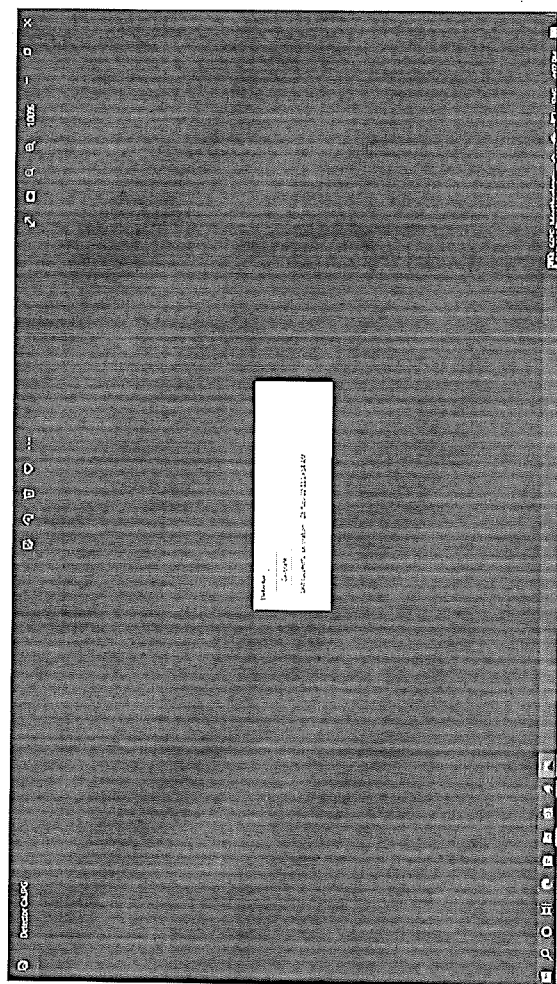


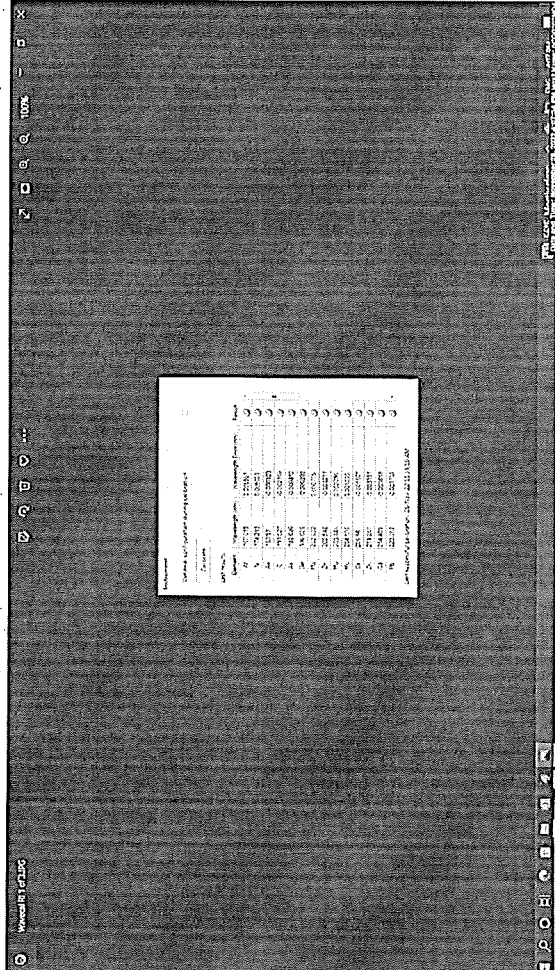


Image Details:

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

Air Flow

Water Flow

Gas Flows

RF Generator

Camera

Optics

Are the Instrument Performance Tests results within acceptance criteria?

Resolution

Sensitivity

Precision

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

## Purpose:

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

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

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

Document Name:

Certificate of Qualification for ACE



## Agilent Technologies

## Agilent Compliance Engine Self Qualification

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

Drive Serial #: 90593EEA

Platform Revision:

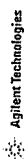
ACE 3.11.27

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	16	Conforms
Sample Preparation - Gas Chromatography	9	Conforms
Sample Preparation - Liquid Chromatography	8	Conforms
Supercritical Fluid Chromatography	15	Conforms
Software	6	Conforms
UV-Vis Spectrophotometer	13	Conforms
Overall Qualification Status		Conforms

Document Name:

Operator's training certificate and qualifications



## Certificate of Completion

Learner Name:	Worawit Timakul
Title Of Course:	ANY-CE-ICPOES-2-008-A: Agilent 5100 ICPOES 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, and parts updates. Completion of training alone, without being employed by Agilent Technologies, does not qualify an individual to safely install, service or maintain Agilent products.

Document Name:

Operator's training certificate and qualifications



## Certificate of Completion

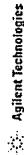
Learner Name:	Worawit Timakul
Title Of Course:	ANY-CE-ICPOES-2-007-C: CrossLab Compliance Hardware Specific Delivery for Agilent ICP-OES Systems
Completion Date:	October 30, 2020
Certified By Company:	Learning at Agilent

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, and parts updates. Completion of training alone, without being employed by Agilent Technologies, does not qualify an individual to safely install, service or maintain Agilent products.

Document Name:

Certificate of System Qualification



# Certificate of Completion

Learner Name:

Worawit Timakul

Title Of Course:

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

Completion Date:

July 1, 2020

Certified By Company:

Learning at Agilent

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

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

Document Name:

Instrument's Test Report

Report Summary		Agilent 5100 VDV ICP-OES
Instrument Model	G8011A	
Instrument ID	MY15330001	
Instrument Serial Number	7.1.0.6821	
Software Version	2394	
Firmware Version	Worawit T.	
Tested By	28-Nov-22 3:29:24 PM	
Test Completed On		
Result Summary		
Resolution Test		
Sensitivity Test		
Precision Test		
Resolution Test		
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)	≤ 8.40	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 (483.408 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

Document Name: Instrument's Test Report

Sensitivity Test					Pass	
Radial						
Element Wavelength	Specification	Method	Ratio	Standard	Blank	
As (188.980 nm)	≥ 46.0	SRBR	124.4	1253.4	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	12093.1	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	250.9	3667.4	192.0	
Se (196.026 nm)	≥ 159.0	SRBR	172.2	2902.2	239.1	
Zn (213.857 nm)	≥ 1743.0	SRBR	1360.5	17846.2	168.8	
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)	≥ 10525.0	SRBR	39180.3	1593731.9	1651.2	
Cr (267.716 nm)	≥ 1046.0	SRBR	4862.3	176423.2	1297.2	
Cu (324.754 nm)	≥ 19.0	SBR	65.7	288073.8	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

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)	≤ 2.80	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	0.28				
Axial						
Element Wavelength	Specification	Measured Value % RSD				
As (188.980 nm)	≤ 1.50	0.87				
Se (196.026 nm)	≤ 1.50	0.76				
Zn (213.857 nm)	≤ 1.50	0.42				
Cd (214.439 nm)	≤ 1.50	0.51				
Pb (220.353 nm)	≤ 1.50	0.50				
Mn (257.610 nm)	≤ 1.50	0.49				
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

Document Name:

Software verification

### Software Verification Report

Date:	Monday, November 28, 2022	Time:	3:44:56 PM (UTC 4:07:00PM)	Host Name:	5100V-DV-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 : ICPPrdremdfile.xml

#### Summary :

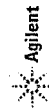
Overall Evaluation of Installation Check :PASS  
File Report Summary  
No missing file or invalid file found  
No system file difference found

#### File Registration Report Summary

Files Registration check not required for this product  
Registry Report Summary  
Registry entries check not required for this product

Document Name:

Certificate of Analysis Wavelength calibration solution



### CERTIFICATE OF ANALYSIS

Agilent Product Name: Wavelength Calibration Solution for ICP-QES & MP-AES, 6 mg/L, 500mL  
Agilent Part No: 691003100  
Lot No: 001718521

#### 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	Al	Mn	7439-96-6	5.001 ± 0.025 mg/L
As	As	7440-38-2	5.001 ± 0.025 mg/L	As	Rh <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	13105-76-8	5.000 ± 0.025 mg/L
Ba	Ba(NO <sub>3</sub> ) <sub>2</sub>	10025-31-6	5.000 ± 0.025 mg/L	Bi	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	Si(NO <sub>3</sub> ) <sub>4</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>	7757-19-1	50.00 ± 0.25 mg/L				

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

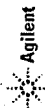
Intended Use: This solution is intended for use as a certified reference material for calibration standard for inductively coupled plasma optical emission spectroscopy (ICP-OES), inductively coupled plasma mass spectrometry (ICP-MS), atomic absorption spectroscopy (flame AAS or GFAAS), microwave plasma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

Certification & Traceability: The CRM was manufactured under a quality management system that is registered to ISO 9001:2015 and ISO/IEC 17025. This CRM was prepared to the certified concentrations shown above by gravimetric methods using single-element concentrate that were certified using the "High Purity" (ICP-QES) protocol developed by NIST and directly traceable to the NIST SRM 910a. The solution was stabilized using high purity nitric acid (HNO<sub>3</sub>) and filtered (0.22µm) 0.2 µm membrane filter. 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 by gravimetric methods. Secondary verification of the certified concentrations was performed using ICP-QES that was calibrated and for reference against NIST SRM 910a, 3103a, 3104a, 3108, 3113, 3114, 3115, 3123, 3124, 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-decanted containers and transferware, (2) avoid pipetting directly from the CRM's original container, (3) use a minimum sub-sample size of 500µL, (4) make dilutions using calibrated balances or certified volumetric class A flasks and pipettes, (5) dilute to volume using the same matrix as the original CRM, and (6) never pour used product back into the original container. The solution should be kept tightly capped and stored under normal laboratory conditions. Do not freeze, heat, or expose to direct sunlight. Minimize exposure to moisture or high humidity.

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, this purchaser will be notified if this product is recalled due to any significant changes in the stability of this solution.

Date of release: 21 January 2022  
Date of expiration: 31 July 2025

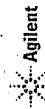
Sample test approval:

  
Christa Lindner, Certifying Officer

Page 2 of 3

Document Name:

Certificate of Analysis Wavelength calibration solution



Revised Information: Refer to the Safety Data Sheet (SDS), which can be obtained at [www.agilent.com/chem/sds](https://www.agilent.com/chem/sds).  
Homogeneity: This solution was determined to be homogeneous by procedures compliant with the requirements of ISO 17033 and ISO Guide 35. Replicate samples of the finished solution were analyzed to confirm its homogeneity. In accordance with USP <613> 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 17033 - General Requirements for the Competence of Reference Material Producers (A2LA Cert. No. 2848.02)
- Accredited to ISO 17025 - General Requirements for the Competence of Calibration Laboratories (A2LA Cert. No. 2848.01)
- ISO 15189 reference additional requirements specified in ISO Guide 31 and ISO Guide 35.
- ISO 15189 reference additional requirements for the Competence of Testing and Calibration Laboratories (A2LA Cert. No. 2848.01)
- ISO 15189 reference additional requirements for the Competence of Calibration Laboratories (A2LA Cert. No. 2848.01)

Page 3 of 2



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

Details

Full Name of Signer: Worawit Timakul  
Logged On User Name: worawit.timakul@agilent.com  
Signature Creation Date: November 28, 2022

Reason for Signature: Executed protocol and published this original version of document

Regulatory Disclaimer

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

Warranty

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

OQ HW ICP \$100 Envl resasrc 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	ExpLoaded	Session	EQP details for primary technique [Eq - File path: onat02.50(Es.02.50.eqp), [ProtocolPacks/Es/Configurat onat02.50(Es.02.50.eqp), EQP File Name: [Es.02.50.eqp], EQP Name: [AgilentRecommended]
November 28, 2022 4:06:32 PM	End	Configuration	Session	None
November 28, 2022 4:06:35 PM	Start	Qualification	Session	OQ
November 28, 2022 4:06:36 PM	Start	Execution	Preparation : \$100 VDV; Qualitative Test - No setpoints associated	None
November 28, 2022 4:07:38 PM	End	Execution	Preparation : \$100 VDV; Qualitative Test - No setpoints associated	Run Count : 1
November 28, 2022 4:07:39 PM	Start	Execution	Instrument Tests : \$100 VDV; Qualitative Test - No setpoints associated	None
November 28, 2022 4:08:52 PM	End	Execution	Instrument Tests : \$100 VDV; Qualitative Test - No setpoints associated	Run Count : 1

User Name: worawit.timakul  
Headlines: SCG0221128  
System ID: 15330001  
Print Date: November 28, 2022 4:15:43 PM

## OQ HW ICP 5100 Envi research Transaction log :

Time	Transaction State	Activity Performed	Type of Transaction	Optional Information
November 28, 2022 4:09:01 PM	Start	Execution	Autosampler Operation : Autosampler 1 - SPS4; Qualitative Test - No seipoints associated	None
November 28, 2022 4:09:05 PM	End	Execution	Autosampler Operation : Autosampler 1 - SPS4; Qualitative Test - No seipoints 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 resenc_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

Page 2 / 2



# PinAAcle 900Z Preventive Maintenance Report

Company Name: ENVIRONMENT RESEARCH


Instrument Location: 25/114 M.6, THANON NGAMWONGWAN  
THUNGSONGHONG, LAKSI, BANGKOK, 10210

Instrument Serial No.: PZAS19031401

Date: 30-Jun-2023

## PinAAcle 900Z Preventive Maintenance (PM)

Company Name:	ENVIRONMENT RESEARCH			
Address (Instrument Location):	25/114 M.6, THANON NGAMWONGWAN, THUNGSONGHONG, 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-02273780	
Date PM Performed: (DD-MMM-YYY)	30-Jun-2023	Next PM Due Date: (DD-MMM-YYY)	30-Dec-2023	
Standard Labor Hours to Complete PM:			5 hours	

Part Number	Release	Publication Date	 PerkinElmer®
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.

### Copyright Information

This document contains proprietary information that is protected by copyright. All rights are reserved.

No part of this publication may be reproduced in any form whatsoever or translated into any language without the prior, written permission of PerkinElmer, Inc. Copyright © 2013 PerkinElmer, Inc.

### Trademarks

Registered names, trademarks, etc. used in this document, even when not specifically marked as such, are protected by law. PerkinElmer is a registered trademark of PerkinElmer, Inc. All other trademarks and registered trademarks not owned by PerkinElmer, Inc. or its subsidiaries that are depicted herein are the property of their respective owners. Except as specifically set forth in its terms and conditions of sale, PerkinElmer makes no warranty of any kind with regard to this document, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose.

PerkinElmer shall not be liable for incidental or consequential damages in connection with the furnishing or use of this document.

Component List

Component / Specific Model	Serial #	Configuration Notes

Parts Lists

Parts Included with the PM		
Part Number (if applicable)	Description	Quantity
B0501696	Fan Filters	2
B3002013	THGA Contact Cylinders	1
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-2023

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 $\pm$ 25 mL/min	255	Passed
External Flow Rate	100 mL/min $\pm$ 10 mL/min	105	Passed

#### 7.2 Chromium Baseline Noise

Description: Signal to noise check.

Parameter	Specification	Results	Pass/Fail
Baseline Noise	$\leq$ 0.005 Abs.	0.0011	Passed
Standard Deviation	$\leq$ 0.005	0.0003	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	$\leq$ 7.0 pg/0.0044 A-s	6.6	Passed
Precision	$\leq$ 2.0 %	1.47	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	15.4	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	
$\text{Zeeman Ratio} = \frac{\text{Atomic Signal (Peak area)}}{\text{Atomic Signal (Peak area)} + \text{Background Signal (Peak area)}}$	
	$= \frac{0.1456}{0.1456 + 0.1293}$
	$= 0.52$

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:	Date: 30-Jun-2023 (DD-MM-YYYY)
Authorized Customer Representative:	Date: 30-Jun-2023 (DD-MM-YYYY)